Toga Documentation

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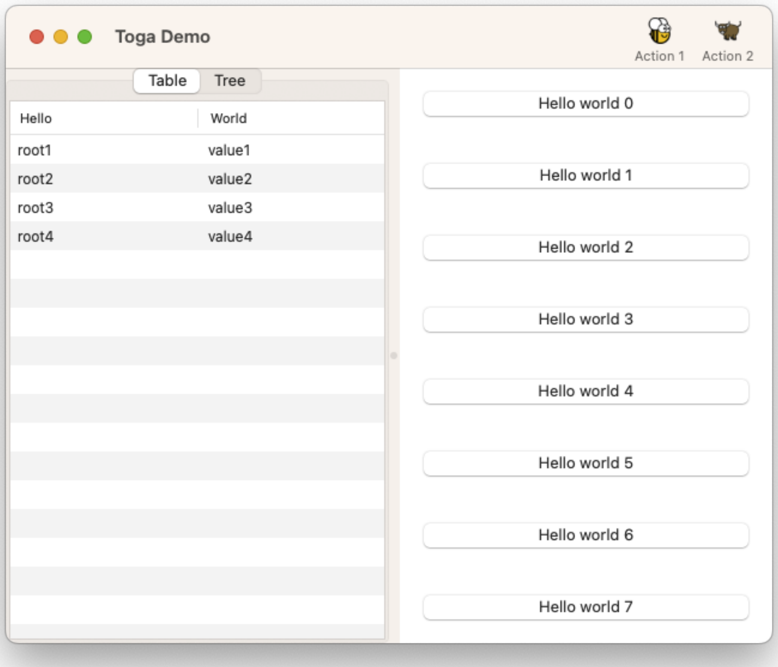
Toga is a Python native, OS native, cross platform GUI toolkit. Toga consists of a library of base components with a shared interface to simplify platform-agnostic GUI development.

Toga is available on macOS, Windows, Linux (GTK), Android, iOS, and for single-page web apps.

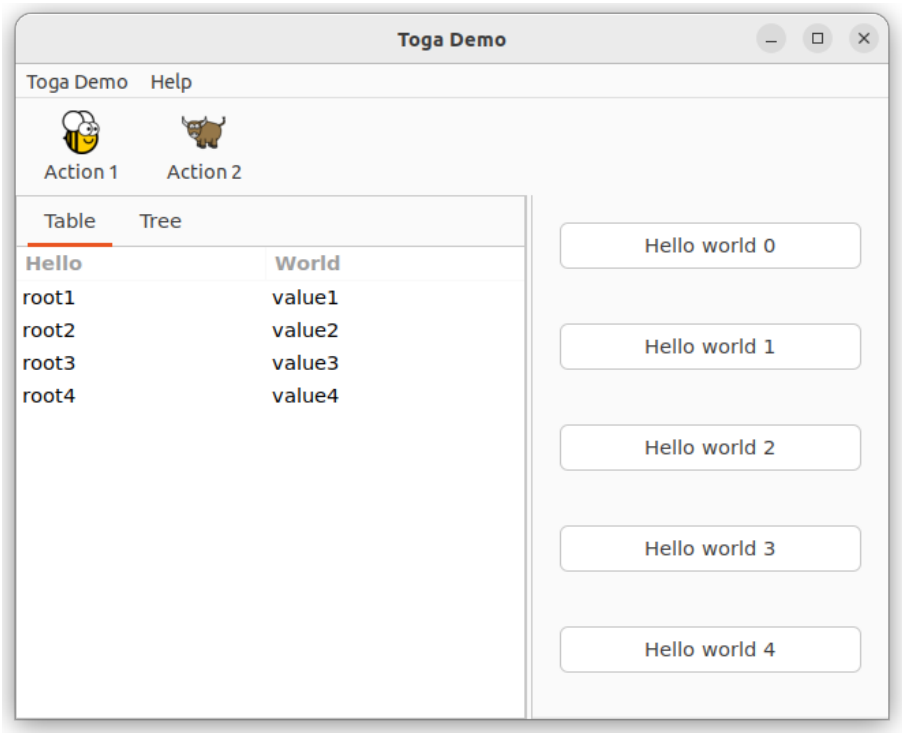
macOS

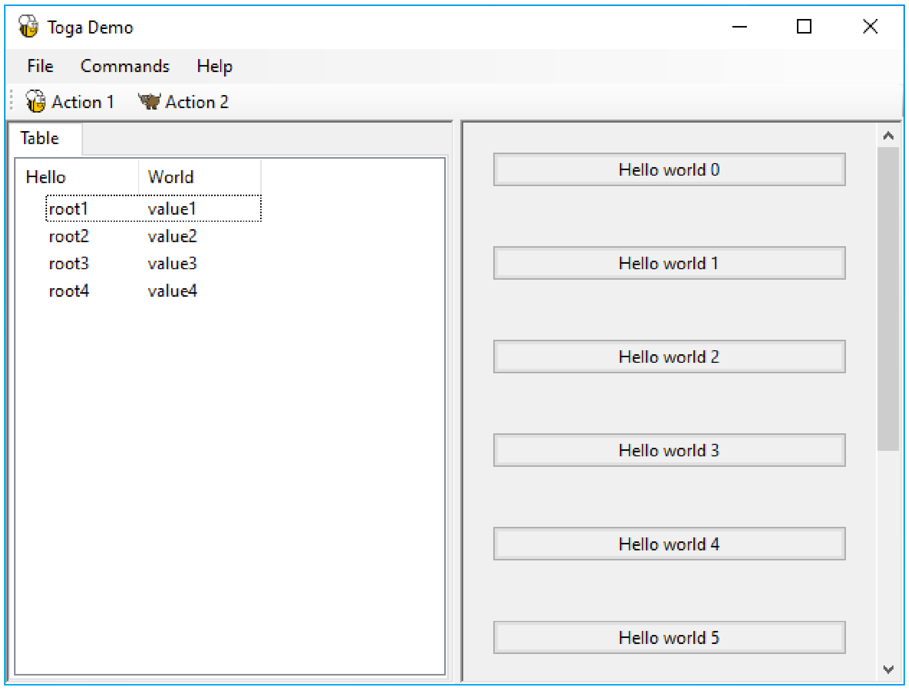


Hello	World
root1	value1
root2	value2
root3	value3
root4	value4

Linux

Windows


Toga Demo
Toga Demo
Help
Action 1
Action 2
Table
Tree
Hello
World
root1
value1
root2
value2
root3
value3
root4
value4
Hello world 0
Hello world 1
Hello world 2
Hello world 3
Hello world 4


Toga Demo
File
Commands
Help
Action 1
Action 2
Table
Hello
World
root1
value1
root2
value2
root3
value3
root4
value4
Hello world 0
Hello world 1
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Hello world 3
Hello world 4
Hello world 5

CHAPTER

ONE

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Get started with a hands-on introduction to Toga for beginners.

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CHAPTER

TWO

COMMUNITY

Toga is part of the BeeWare suite. You can talk to the community through:

- @beeware@fosstodon.org on Mastodon
- Discord
- The Toga Github Discussions forum

We foster a welcoming and respectful community as described in our BeeWare Community Code of Conduct.

2.1 Tutorials

Note: Is this the tutorial you're looking for?

If this is your first time using BeeWare, we suggestion you start with the BeeWare tutorial. This tutorial only covers BeeWare's GUI toolkit, Toga, and doesn't cover any of the details of getting your code running on specific hardware platforms. Once you've completed the BeeWare tutorial, this tutorial will introduce more details about Toga's capabilities as a GUI toolkit.

2.1.1 Your first Toga app

In this example, we're going to build a desktop app with a single button, that prints to the console when you press the button.

Set up your development environment

If you haven't got Python 3 installed, you can do so via the official installer, or using your operating system's package manager.

The recommended way of setting up your development environment for Toga is to install a virtual environment, install the required dependencies and start coding. To set up a virtual environment, open a fresh terminal session, and run:

macOS

```
$ mkdir toga-tutorial
$ cd toga-tutorial
$ python3 -m venv venv
$ source venv/bin/activate
```

Linux

```
$ mkdir toga-tutorial
$ cd toga-tutorial
$ python3 -m venv venv
$ source venv/bin/activate
```

Windows

```
C:\...>mkdir toga-tutorial
C:\...>cd toga-tutorial
C:\...>py -m venv venv
C:\...>venv\Scripts\activate
```

Your prompt should now have a `(venv)` prefix in front of it.

Next, install Toga into your virtual environment:

macOS

```
(venv) $ python -m pip install toga
```

Linux

Before you install Toga, you'll need to install some system packages.

These instructions are different on almost every version of Linux and Unix; here are some of the common alternatives:

Ubuntu 18.04+ / Debian 10+

```
(venv) $ sudo apt update
(venv) $ sudo apt install pkg-config python3-dev libgirepository1.0-dev libcairo2-dev␣
↪gir1.2-webkit2-4.0 libcanberra-gtk3-module
```

Fedora

```
(venv) $ sudo dnf install pkg-config python3-devel gobject-introspection-devel cairo-
↪gobject-devel webkit2gtk3 libcanberra-gtk3
```

Arch / Manjaro

```
(venv) $ sudo pacman -Syu git pkgconf gobject-introspection cairo webkit2gtk libcanberra
```

FreeBSD

```
(venv) $ sudo pkg update
(venv) $ sudo pkg install gobject-introspection cairo webkit2-gtk3 libcanberra-gtk3
```

If you're not using one of these, you'll need to work out how to install the developer libraries for `python3`, `cairo`, and `gobject-introspection` (and please let us know so we can improve this documentation!)

These instructions are different on almost every version of Linux and Unix; here are some of the common alternatives:

Ubuntu 18.04+ / Debian 10+

```
(venv) $ sudo apt update
(venv) $ sudo apt install pkg-config python3-dev libgirepository1.0-dev libcairo2-dev␣
↪gir1.2-webkit2-4.0 libcanberra-gtk3-module
```

Fedora

```
(venv) $ sudo dnf install pkg-config python3-devel gobject-introspection-devel cairo-
↪gobject-devel webkit2gtk3 libcanberra-gtk3
```

Arch / Manjaro

```
(venv) $ sudo pacman -Syu git pkgconf gobject-introspection cairo webkit2gtk libcanberra
```

FreeBSD

```
(venv) $ sudo pkg update
(venv) $ sudo pkg install gobject-introspection cairo webkit2-gtk3 libcanberra-gtk3
```

If you're not using one of these, you'll need to work out how to install the developer libraries for `python3`, `cairo`, and `gobject-introspection` (and please let us know so we can improve this documentation!)

Then, install Toga:

```
(venv) $ python -m pip install toga
```

If you get an error when installing Toga, please ensure that you have fully installed all the platform prerequisites.

Windows

Confirm that your system meets the *Windows prerequisites*; then run:

```
(venv) C:\...>python -m pip install toga
```

After a successful installation of Toga you are ready to get coding.

Write the app

Create a new file called `helloworld.py` and add the following code for the "Hello world" app:

```python
import toga


def button_handler(widget):
    print("hello")


def build(app):
    box = toga.Box()

    button = toga.Button("Hello world", on_press=button_handler)
    button.style.padding = 50
    button.style.flex = 1
    box.add(button)

    return box


def main():
    return toga.App("First App", "org.beeware.helloworld", startup=build)
```

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```


if __name__ == "__main__":
    main().main_loop()
```

Let's walk through this one line at a time.

The code starts with imports. First, we import toga:

```
import toga
```

Then we set up a handler, which is a wrapper around behavior that we want to activate when the button is pressed. A handler is just a function. The function takes the widget that was activated as the first argument; depending on the type of event that is being handled, other arguments may also be provided. In the case of a simple button press, however, there are no extra arguments:

```
def button_handler(widget):
    print("hello")
```

When the app gets instantiated (in `main()`, discussed below), Toga will create a window with a menu. We need to provide a method that tells Toga what content to display in the window. The method can be named anything, it just needs to accept an app instance:

```
def build(app):
```

We want to put a button in the window. However, unless we want the button to fill the entire app window, we can't just put the button into the app window. Instead, we need create a box, and put the button in the box.

A box is an object that can be used to hold multiple widgets, and to define padding around widgets. So, we define a box:

```
box = toga.Box()
```

We can then define a button. When we create the button, we can set the button text, and we also set the behavior that we want to invoke when the button is pressed, referencing the handler that we defined earlier:

```
button = toga.Button('Hello world', on_press=button_handler)
```

Now we have to define how the button will appear in the window. By default, Toga uses a style algorithm called `Pack`, which is a bit like "CSS-lite". We can set style properties of the button:

```
button.style.padding = 50
```

What we've done here is say that the button will have a padding of 50 pixels on all sides. If we wanted to define padding of 20 pixels on top of the button, we could have defined `padding_top = 20`, or we could have specified the `padding = (20, 50, 50, 50)`.

Now we will make the button take up all the available width:

```
button.style.flex = 1
```

The `flex` attribute specifies how an element is sized with respect to other elements along its direction. The default direction is row (horizontal) and since the button is the only element here, it will take up the whole width. Check out style docs for more information on how to use the `flex` attribute.

The next step is to add the button to the box:

```
box.add(button)
```

The button has a default height, defined by the way that the underlying platform draws buttons. As a result, this means we'll see a single button in the app window that stretches to the width of the screen, but has a 50 pixel space surrounding it.

Now we've set up the box, we return the outer box that holds all the UI content. This box will be the content of the app's main window:

```
return box
```

Lastly, we instantiate the app itself. The app is a high level container representing the executable. The app has a name and a unique identifier. The identifier is used when registering any app-specific system resources. By convention, the identifier is a "reversed domain name". The app also accepts our method defining the main window contents. We wrap this creation process into a method called `main()`, which returns a new instance of our application:

```
def main():
    return toga.App('First App', 'org.beeware.helloworld', startup=build)
```

The entry point for the project then needs to instantiate this entry point and start the main app loop. The call to `main_loop()` is a blocking call; it won't return until you quit the main app:

```
if __name__ == '__main__':
    main().main_loop()
```

And that's it! Save this script as `helloworld.py`, and you're ready to go.

Running the app

The app acts as a Python module, which means you need to run it in a different manner than running a regular Python script: You need to specify the `-m` flag and *not* include the `.py` extension for the script name.

Here is the command to run for your platform from your working directory:

macOS

```
(venv) $ python -m helloworld
```

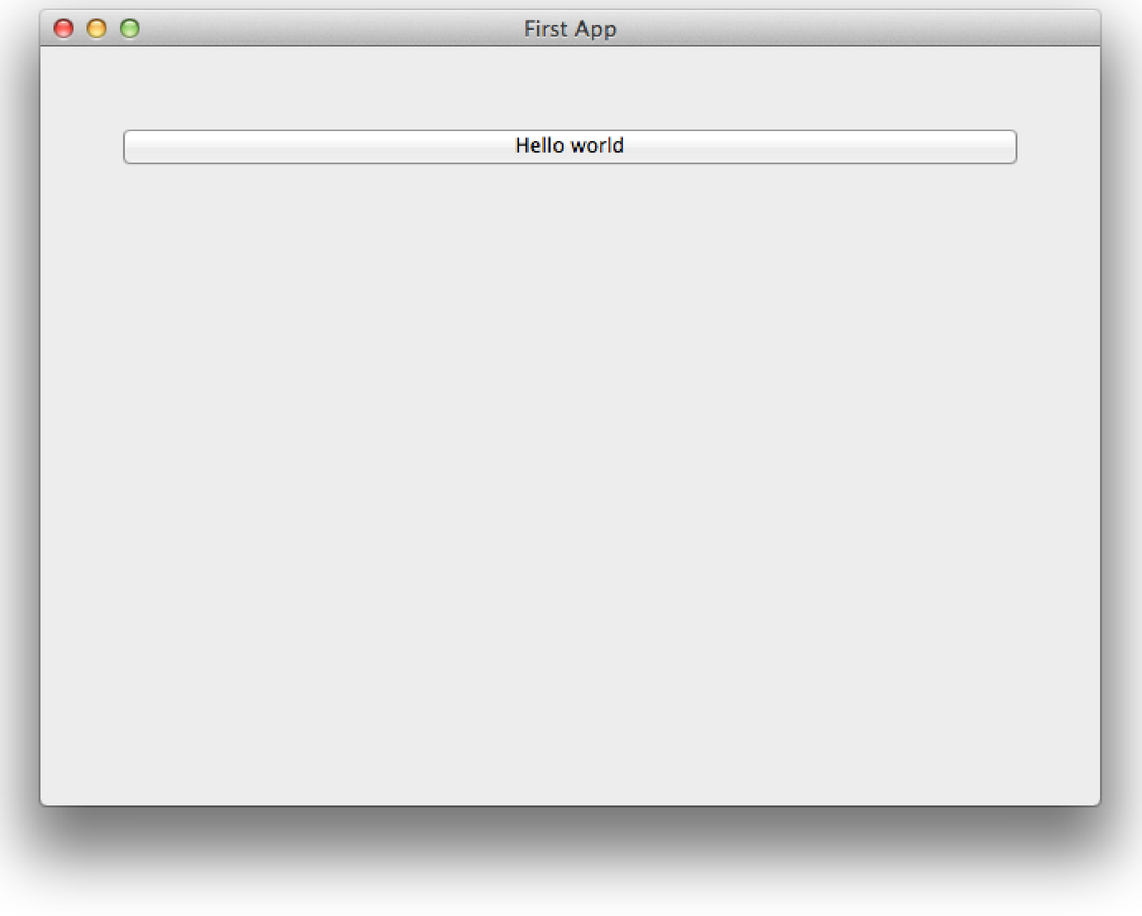
Linux

```
(venv) $ python -m helloworld
```

Windows

```
(venv) C:\...>python -m helloworld
```

This should pop up a window with a button:



If you click on the button, you should see messages appear in the console. Even though we didn't define anything about menus, the app will have default menu entries to quit the app, and an About page. The keyboard bindings to quit the app, plus the "close" button on the window will also work as expected. The app will have a default Toga icon (a picture of Tiberius the yak).

Troubleshooting issues

Occasionally you might run into issues running Toga on your computer.

Before you run the app, you'll need to install toga. Although you *can* install toga by just running:

```
$ python -m pip install toga
```

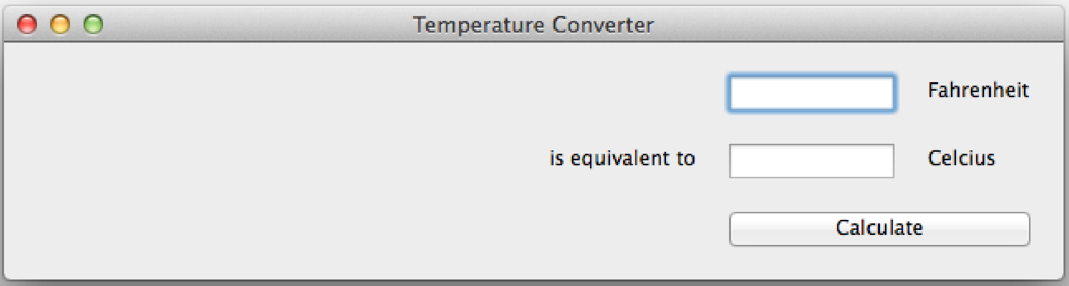
We strongly suggest that you **don't** do this. We'd suggest creating a virtual environment first, and installing toga in that virtual environment as directed at the top of this guide.

Once you've got Toga installed, you can run your script:

```
(venv) $ python -m helloworld
```

2.1.2 A slightly less toy example

Most applications require a little more than a button on a page. Lets build a slightly more complex example - a Fahrenheit to Celsius converter:



Here's the source code:

```
import toga
from toga.style.pack import COLUMN, LEFT, RIGHT, ROW, Pack


def build(app):
    c_box = toga.Box()
    f_box = toga.Box()
    box = toga.Box()

    c_input = toga.TextInput(readonly=True)
    f_input = toga.TextInput()

    c_label = toga.Label("Celsius", style=Pack(text_align=LEFT))
    f_label = toga.Label("Fahrenheit", style=Pack(text_align=LEFT))
    join_label = toga.Label("is equivalent to", style=Pack(text_align=RIGHT))

    def calculate(widget):
        try:
            c_input.value = (float(f_input.value) - 32.0) * 5.0 / 9.0
        except ValueError:
            c_input.value = "???"

    button = toga.Button("Calculate", on_press=calculate)

    f_box.add(f_input)
    f_box.add(f_label)

    c_box.add(join_label)
    c_box.add(c_input)
    c_box.add(c_label)

    box.add(f_box)
```

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```
    box.add(c_box)
    box.add(button)

    box.style.update(direction=COLUMN, padding=10)
    f_box.style.update(direction=ROW, padding=5)
    c_box.style.update(direction=ROW, padding=5)

    c_input.style.update(flex=1)
    f_input.style.update(flex=1, padding_left=210)
    c_label.style.update(width=100, padding_left=10)
    f_label.style.update(width=100, padding_left=10)
    join_label.style.update(width=200, padding_right=10)

    button.style.update(padding=15)

    return box


def main():
    return toga.App("Temperature Converter", "org.beeware.f_to_c", startup=build)


if __name__ == "__main__":
    main().main_loop()
```

This example shows off some more features of Toga's Pack style engine. In this example app, we've set up an outer box that stacks vertically; inside that box, we've put 2 horizontal boxes and a button.

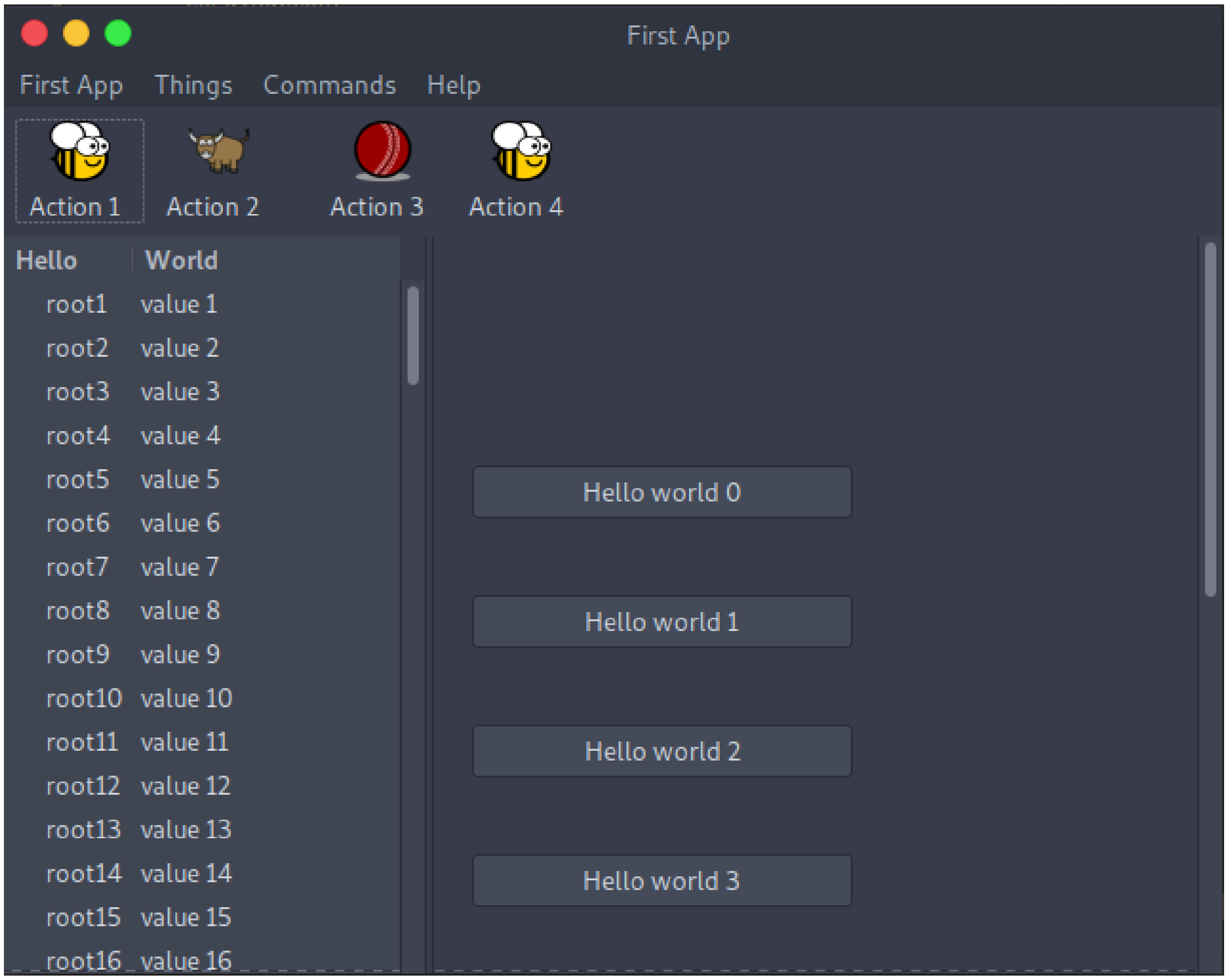
Since there's no width styling on the horizontal boxes, they'll try to fit the widgets they contain into the available space. The `TextInput` widgets have a style of `flex=1`, but the `Label` widgets have a fixed width; as a result, the `TextInput` widgets will be stretched to fit the available horizontal space. The margin and padding terms then ensure that the widgets will be aligned vertically and horizontally.

2.1.3 You put the box inside another box…

If you've done any GUI programming before, you will know that one of the biggest problems that any widget toolkit solves is how to put widgets on the screen in the right place. Different widget toolkits use different approaches - constraints, packing models, and grid-based models are all common. Toga's Pack style engine borrows heavily from an approach that is new for widget toolkits, but well proven in computing: Cascading Style Sheets (CSS).

If you've done any design for the web, you will have come across CSS before as the mechanism that you use to lay out HTML on a web page. Although this is the reason CSS was developed, CSS itself is a general set of rules for laying out any "boxes" that are structured in a tree-like hierarchy. GUI widgets are an example of one such structure.

To see how this works in practice, lets look at a more complex example, involving layouts, scrollers, and containers inside other containers:



Hello	World
root1	value 1
root2	value 2
root3	value 3
root4	value 4
root5	value 5
root6	value 6
root7	value 7
root8	value 8
root9	value 9
root10	value 10
root11	value 11
root12	value 12
root13	value 13
root14	value 14
root15	value 15
root16	value 16

Here's the source code:

```python
import toga
from toga.style.pack import COLUMN, Pack


def button_handler(widget):
    print("button handler")
    for i in range(0, 10):
        print("hello", i)
        yield 1
    print("done", i)


def action0(widget):
    print("action 0")


def action1(widget):
    print("action 1")
```

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```python
def action2(widget):
    print("action 2")


def action3(widget):
    print("action 3")


def action5(widget):
    print("action 5")


def action6(widget):
    print("action 6")


class Tutorial2App(toga.App):
    def startup(self):
        brutus_icon = "icons/brutus"
        cricket_icon = "icons/cricket-72.png"

        data = [("root%s" % i, "value %s" % i) for i in range(1, 100)]

        left_container = toga.Table(headings=["Hello", "World"], data=data)

        right_content = toga.Box(style=Pack(direction=COLUMN, padding_top=50))

        for b in range(0, 10):
            right_content.add(
                toga.Button(
                    "Hello world %s" % b,
                    on_press=button_handler,
                    style=Pack(width=200, padding=20),
                )
            )

        right_container = toga.ScrollContainer(horizontal=False)

        right_container.content = right_content

        split = toga.SplitContainer()

        # The content of the split container can be specified as a simple list:
        #    split.content = [left_container, right_container]
        # but you can also specify "weight" with each content item, which will
        # set an initial size of the columns to make a "heavy" column wider than
        # a narrower one. In this example, the right container will be twice
        # as wide as the left one.
        split.content = [(left_container, 1), (right_container, 2)]

        # Create a "Things" menu group to contain some of the commands.
```

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```
        # No explicit ordering is provided on the group, so it will appear
        # after application-level menus, but *before* the Command group.
        # Items in the Things group are not explicitly ordered either, so they
        # will default to alphabetical ordering within the group.
        things = toga.Group("Things")
        cmd0 = toga.Command(
            action0,
            text="Action 0",
            tooltip="Perform action 0",
            icon=brutus_icon,
            group=things,
        )
        cmd1 = toga.Command(
            action1,
            text="Action 1",
            tooltip="Perform action 1",
            icon=brutus_icon,
            group=things,
        )
        cmd2 = toga.Command(
            action2,
            text="Action 2",
            tooltip="Perform action 2",
            icon=toga.Icon.TOGA_ICON,
            group=things,
        )

        # Commands without an explicit group end up in the "Commands" group.
        # The items have an explicit ordering that overrides the default
        # alphabetical ordering
        cmd3 = toga.Command(
            action3,
            text="Action 3",
            tooltip="Perform action 3",
            shortcut=toga.Key.MOD_1 + "k",
            icon=cricket_icon,
            order=3,
        )

        # Define a submenu inside the Commands group.
        # The submenu group has an order that places it in the parent menu.
        # The items have an explicit ordering that overrides the default
        # alphabetical ordering.
        sub_menu = toga.Group("Sub Menu", parent=toga.Group.COMMANDS, order=2)
        cmd5 = toga.Command(
            action5,
            text="Action 5",
            tooltip="Perform action 5",
            order=2,
            group=sub_menu,
        )
        cmd6 = toga.Command(
```

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```
            action6,
            text="Action 6",
            tooltip="Perform action 6",
            order=1,
            group=sub_menu,
        )

        def action4(widget):
            print("CALLING Action 4")
            cmd3.enabled = not cmd3.enabled

        cmd4 = toga.Command(
            action4,
            text="Action 4",
            tooltip="Perform action 4",
            icon=brutus_icon,
            order=1,
        )

        # The order in which commands are added to the app or the toolbar won't
        # alter anything. Ordering is defined by the command definitions.
        self.commands.add(cmd1, cmd0, cmd6, cmd4, cmd5, cmd3)

        self.main_window = toga.MainWindow()
        # Command 2 has not been *explicitly* added to the app. Adding it to
        # a toolbar implicitly adds it to the app.
        self.main_window.toolbar.add(cmd1, cmd3, cmd2, cmd4)
        self.main_window.content = split

        self.main_window.show()


def main():
    return Tutorial2App("Tutorial 2", "org.beeware.helloworld")


if __name__ == "__main__":
    main().main_loop()
```

In order to render the icons, you will need to move the icons folder into the same directory as your app file.

Here are the `Icons`

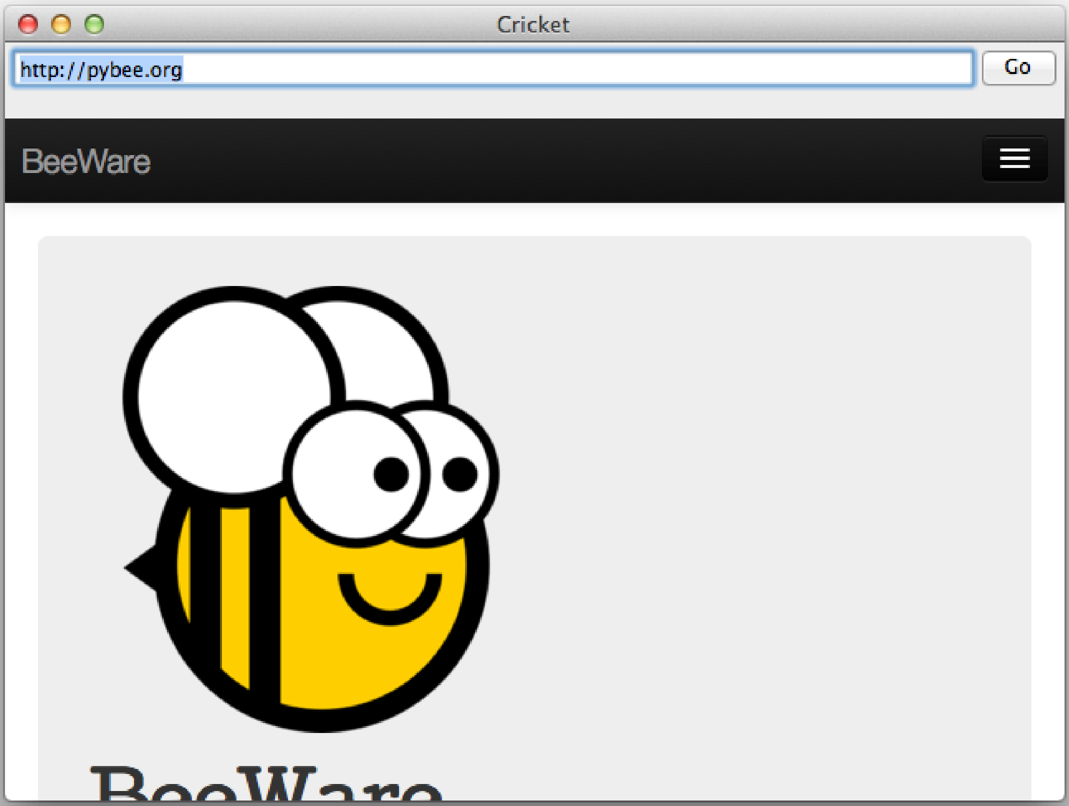
In this example, we see a couple of new Toga widgets - `Table`, `SplitContainer`, and `ScrollContainer`. You can also see that CSS styles can be added in the widget constructor. Lastly, you can see that windows can have toolbars.

You'll also see that we're not creating a `toga.App` directly. Instead, we're declaring a subclass of *toga.App*, and instantiating that class. This also changes the startup sequence of the app - instead of a function called `build()`, the app invokes a method on the app class named `startup()`. This method behaves slightly differently to our `build()` method - whereas previously the `build()` method returned the content that we wanted to put into our main window, the `startup()` method is responsible for creating and showing the main window of the app.

2.1.4 Let's build a browser!

Although it's possible to build complex GUI layouts, you can get a lot of functionality with very little code, utilizing the rich components that are native on modern platforms.

So - let's build a tool that lets our pet yak graze the web - a primitive web browser, in less than 40 lines of code!



Here's the source code:

```
import toga
from toga.style.pack import CENTER, COLUMN, ROW, Pack


class Graze(toga.App):
    def startup(self):
        self.main_window = toga.MainWindow()

        self.webview = toga.WebView(
            on_webview_load=self.on_webview_loaded, style=Pack(flex=1)
        )
        self.url_input = toga.TextInput(
            value="https://beeware.org/", style=Pack(flex=1)
        )
```

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```
        box = toga.Box(
            children=[
                toga.Box(
                    children=[
                        self.url_input,
                        toga.Button(
                            "Go",
                            on_press=self.load_page,
                            style=Pack(width=50, padding_left=5),
                        ),
                    ],
                    style=Pack(
                        direction=ROW,
                        alignment=CENTER,
                        padding=5,
                    ),
                ),
                self.webview,
            ],
            style=Pack(direction=COLUMN),
        )

        self.main_window.content = box
        self.webview.url = self.url_input.value

        # Show the main window
        self.main_window.show()

    def load_page(self, widget):
        self.webview.url = self.url_input.value

    def on_webview_loaded(self, widget):
        self.url_input.value = self.webview.url


def main():
    return Graze("Graze", "org.beeware.graze")


if __name__ == "__main__":
    main().main_loop()
```

In this example, you can see an application being developed as a class, rather than as a build method. You can also see boxes defined in a declarative manner - if you don’t need to retain a reference to a particular widget, you can define a widget inline, and pass it as an argument to a box, and it will become a child of that box.

2.1.5 Let's draw on a canvas!

One of the main capabilities needed to create many types of GUI applications is the ability to draw and manipulate lines, shapes, text, and other graphics. To do this in Toga, we use the Canvas Widget.

Utilizing the Canvas is as easy as determining the drawing operations you want to perform and then creating a new Canvas. All drawing objects that are created with one of the drawing operations are returned so that they can be modified or removed.

1. We first define the drawing operations we want to perform in a new function:

```
def draw_eyes(self):
    with self.canvas.fill(color=WHITE) as eye_whites:
        eye_whites.arc(58, 92, 15)
        eye_whites.arc(88, 92, 15, math.pi, 3 * math.pi)
```

Notice that we also created and used a new fill context called eye_whites. The "with" keyword that is used for the fill operation causes everything draw using the context to be filled with a color. In this example we filled two circular eyes with the color white.

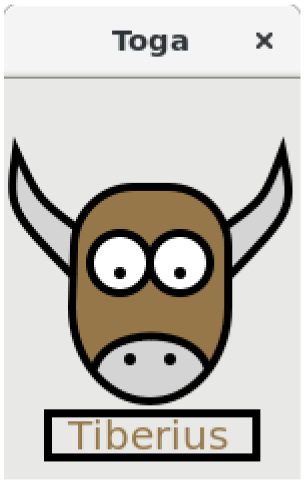
2. Next we create a new Canvas:

```
self.canvas = toga.Canvas(style=Pack(flex=1))
```

That's all there is to! In this example we also add our canvas to the MainWindow through use of the Box Widget:

```
box = toga.Box(children=[self.canvas])
self.main_window.content = box
```

You'll also notice in the full example below that the drawing operations utilize contexts in addition to fill including context, closed_path, and stroke. This reduces the repetition of commands as well as groups drawing operations so that they can be modified together.



Here's the source code

```
import math

import toga
from toga.colors import WHITE, rgb
from toga.constants import Baseline
```

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```python
from toga.fonts import SANS_SERIF
from toga.style import Pack


class StartApp(toga.App):
    def startup(self):
        self.main_window = toga.MainWindow(size=(150, 250))

        # Create empty canvas
        self.canvas = toga.Canvas(
            style=Pack(flex=1),
            on_resize=self.on_resize,
            on_press=self.on_press,
        )
        box = toga.Box(children=[self.canvas])

        # Add the content on the main window
        self.main_window.content = box

        # Draw tiberius on the canvas
        self.draw_tiberius()

        # Show the main window
        self.main_window.show()

    def fill_head(self):
        with self.canvas.Fill(color=rgb(149, 119, 73)) as head_filler:
            head_filler.move_to(112, 103)
            head_filler.line_to(112, 113)
            head_filler.ellipse(73, 114, 39, 47, 0, 0, math.pi)
            head_filler.line_to(35, 84)
            head_filler.arc(65, 84, 30, math.pi, 3 * math.pi / 2)
            head_filler.arc(82, 84, 30, 3 * math.pi / 2, 2 * math.pi)

    def stroke_head(self):
        with self.canvas.Stroke(line_width=4.0) as head_stroker:
            with head_stroker.ClosedPath(112, 103) as closed_head:
                closed_head.line_to(112, 113)
                closed_head.ellipse(73, 114, 39, 47, 0, 0, math.pi)
                closed_head.line_to(35, 84)
                closed_head.arc(65, 84, 30, math.pi, 3 * math.pi / 2)
                closed_head.arc(82, 84, 30, 3 * math.pi / 2, 2 * math.pi)

    def draw_eyes(self):
        with self.canvas.Fill(color=WHITE) as eye_whites:
            eye_whites.arc(58, 92, 15)
            eye_whites.arc(88, 92, 15, math.pi, 3 * math.pi)

        # Draw eyes separately to avoid miter join
        with self.canvas.Stroke(line_width=4.0) as eye_outline:
            eye_outline.arc(58, 92, 15)
        with self.canvas.Stroke(line_width=4.0) as eye_outline:
```

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```
            eye_outline.arc(88, 92, 15, math.pi, 3 * math.pi)

        with self.canvas.Fill() as eye_pupils:
            eye_pupils.arc(58, 97, 3)
            eye_pupils.arc(88, 97, 3)

    def draw_horns(self):
        with self.canvas.Context() as r_horn:
            with r_horn.Fill(color=rgb(212, 212, 212)) as r_horn_filler:
                r_horn_filler.move_to(112, 99)
                r_horn_filler.quadratic_curve_to(145, 65, 139, 36)
                r_horn_filler.quadratic_curve_to(130, 60, 109, 75)
            with r_horn.Stroke(line_width=4.0) as r_horn_stroker:
                r_horn_stroker.move_to(112, 99)
                r_horn_stroker.quadratic_curve_to(145, 65, 139, 36)
                r_horn_stroker.quadratic_curve_to(130, 60, 109, 75)

        with self.canvas.Context() as l_horn:
            with l_horn.Fill(color=rgb(212, 212, 212)) as l_horn_filler:
                l_horn_filler.move_to(35, 99)
                l_horn_filler.quadratic_curve_to(2, 65, 6, 36)
                l_horn_filler.quadratic_curve_to(17, 60, 37, 75)
            with l_horn.Stroke(line_width=4.0) as l_horn_stroker:
                l_horn_stroker.move_to(35, 99)
                l_horn_stroker.quadratic_curve_to(2, 65, 6, 36)
                l_horn_stroker.quadratic_curve_to(17, 60, 37, 75)

    def draw_nostrils(self):
        with self.canvas.Fill(color=rgb(212, 212, 212)) as nose_filler:
            nose_filler.move_to(45, 145)
            nose_filler.bezier_curve_to(51, 123, 96, 123, 102, 145)
            nose_filler.ellipse(73, 114, 39, 47, 0, math.pi / 4, 3 * math.pi / 4)
        with self.canvas.Fill() as nostril_filler:
            nostril_filler.arc(63, 140, 3)
            nostril_filler.arc(83, 140, 3)
        with self.canvas.Stroke(line_width=4.0) as nose_stroker:
            nose_stroker.move_to(45, 145)
            nose_stroker.bezier_curve_to(51, 123, 96, 123, 102, 145)

    def draw_text(self):
        font = toga.Font(family=SANS_SERIF, size=20)
        self.text_width, text_height = self.canvas.measure_text("Tiberius", font)

        x = (150 - self.text_width) // 2
        y = 175

        with self.canvas.Stroke(color="REBECCAPURPLE", line_width=4.0) as rect_stroker:
            self.text_border = rect_stroker.rect(
                x - 5,
                y - 5,
                self.text_width + 10,
                text_height + 10,
```

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```
            )
        with self.canvas.Fill(color=rgb(149, 119, 73)) as text_filler:
            self.text = text_filler.write_text("Tiberius", x, y, font, Baseline.TOP)

    def draw_tiberius(self):
        self.fill_head()
        self.draw_eyes()
        self.draw_horns()
        self.draw_nostrils()
        self.stroke_head()
        self.draw_text()

    def on_resize(self, widget, width, height, **kwargs):
        # On resize, center the text horizontally on the canvas. on_resize will be
        # called when the canvas is initially created, when the drawing objects won't
        # exist yet. Only attempt to reposition the text if there's context objects on
        # the canvas.
        if widget.context:
            left_pad = (width - self.text_width) // 2
            self.text.x = left_pad
            self.text_border.x = left_pad - 5
            widget.redraw()

    def on_press(self, widget, x, y, **kwargs):
        self.main_window.info_dialog("Hey!", f"You poked the yak at ({x}, {y})")


def main():
    return StartApp("Tutorial 4", "org.beeware.helloworld")


if __name__ == "__main__":
    main().main_loop()
```

In this example, we see a new Toga widget - `Canvas`.

2.1.6 Tutorial 0 - your first Toga app

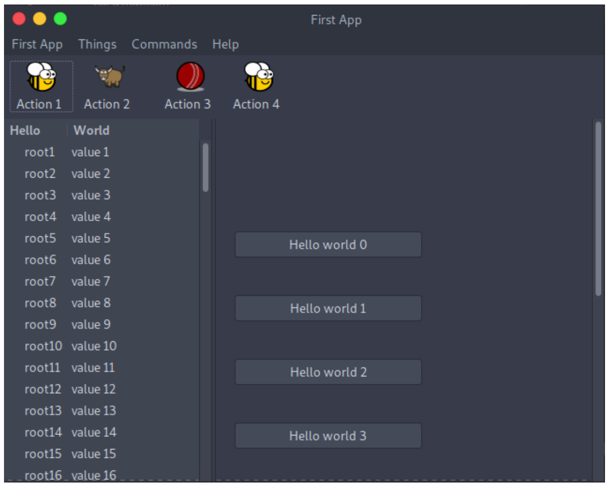
In *Your first Toga app*, you will discover how to create a basic app and have a simple `Button` widget to click.

2.1.7 Tutorial 1 - a slightly less toy example

In *A slightly less toy example*, you will discover how to capture basic user input using the `TextInput` widget and control layout.

2.1.8 Tutorial 2 - you put the box inside another box…

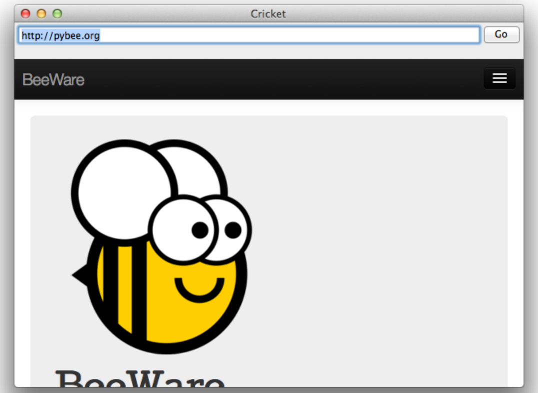
In *You put the box inside another box…*, you will discover how to use the `SplitContainer` widget to display some components, a toolbar and a table.



Hello	World
root1	value 1
root2	value 2
root3	value 3
root4	value 4
root5	value 5
root6	value 6
root7	value 7
root8	value 8
root9	value 9
root10	value 10
root11	value 11
root12	value 12
root13	value 13
root14	value 14
root15	value 15
root16	value 16

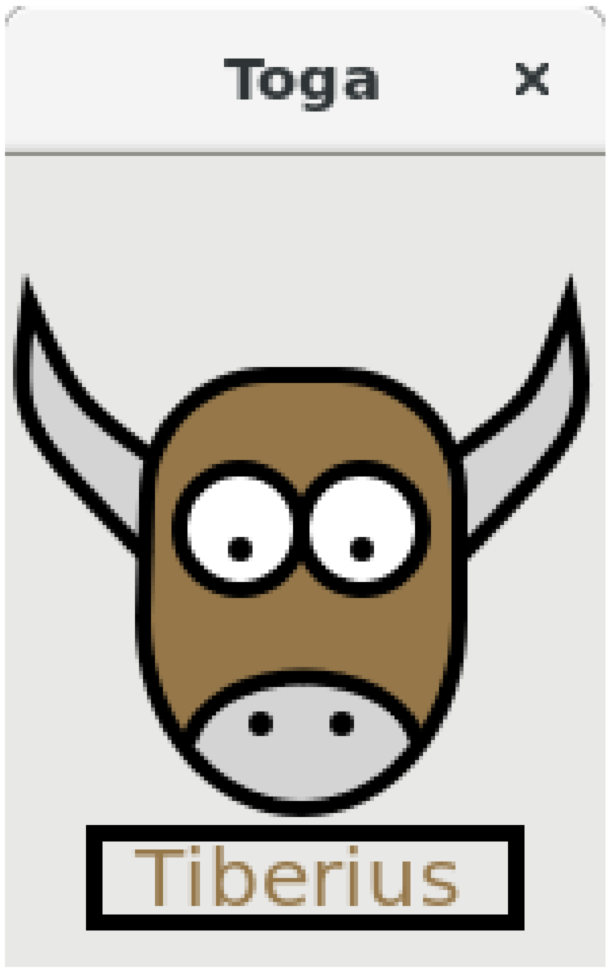
2.1.9 Tutorial 3 - let's build a browser!

In *Let's build a browser!*, you will discover how to use the `WebView` widget to display a simple browser.



2.1.10 Tutorial 4 - let's draw on a canvas!

In *Let's draw on a canvas!*, you will discover how to use the `Canvas` widget to draw lines and shapes on a canvas.


Toga
Tiberius

2.2 How-to Guides

How-to guides are recipes that take the user through steps in key subjects. They are more advanced than tutorials and assume a lot more about what the user already knows than tutorials do, and unlike documents in the tutorial they can stand alone.

2.2.1 How to get started

Quickstart

Create a new virtual environment. In your virtual environment, install Toga, and then run it:

```
$ python -m pip install toga-demo
$ toga-demo
```

This will pop up a GUI window showing the full range of widgets available to an application using Toga.

Have fun, and see the *Reference* to learn more about what's going on.

2.2.2 How to contribute code to Toga

If you experience problems with Toga, log them on GitHub. If you want to contribute code, please fork the code and submit a pull request.

Set up your development environment

First, ensure that you have Python 3 and pip installed. To do this, run:

macOS

```
$ python3 --version
$ pip3 --version
```

Linux

```
$ python3 --version
$ pip3 --version
```

Windows

```
C:\...>python3 --version
C:\...>pip3 --version
```

The recommended way of setting up your development environment for Toga is to install a virtual environment, install the required dependencies and start coding. To set up a virtual environment, run:

macOS

```
$ python3 -m venv venv
$ source venv/bin/activate
```

Linux

```
$ python3 -m venv venv
$ source venv/bin/activate
```

Windows

```
C:\...>python3 -m venv venv
C:\...>venv\Scripts\activate
```

Your prompt should now have a `(venv)` prefix in front of it.

Next, install any additional dependencies for your operating system:

macOS

No additional dependencies

Linux

Ubuntu 18.04+, Debian 10+

```
(venv) $ sudo apt update
(venv) $ sudo apt install pkg-config python3-dev libgirepository1.0-dev libcairo2-dev␣
↪gir1.2-webkit2-4.0 libcanberra-gtk3-module
```

Fedora

```
(venv) $ sudo dnf install pkg-config python3-devel gobject-introspection-devel cairo-
↪gobject-devel webkit2gtk3 libcanberra-gtk3
```

Arch / Manjaro

```
(venv) $ sudo pacman -Syu git pkgconf gobject-introspection cairo webkit2gtk libcanberra
```

FreeBSD

```
(venv) $ sudo pkg update
(venv) $ sudo pkg install gobject-introspection cairo webkit2-gtk3
```

Windows

No additional dependencies

Next, go to the Toga page on GitHub, fork the repository into your own account, and then clone a copy of that repository onto your computer by clicking on “Clone or Download”. If you have the GitHub desktop application installed on your computer, you can select “Open in Desktop”; otherwise, copy the URL provided, and use it to clone using the command line:

macOS

Fork the Toga repository, and then:

```
(venv) $ git clone https://github.com/<your username>/toga.git
```

(substituting your GitHub username)

Linux

Fork the Toga repository, and then:

```
(venv) $ git clone https://github.com/<your username>/toga.git
```

(substituting your GitHub username)

Windows

Fork the Toga repository, and then:

```
(venv) C:\...>git clone https://github.com/<your username>/toga.git
```

(substituting your GitHub username)

Now that you have the source code, you can install Toga into your development environment. The Toga source repository contains multiple packages. Since we're installing from source, we can't rely on pip to resolve the dependencies to source packages, so we have to manually install each package:

macOS

```
(venv) $ cd toga
(venv) $ pip install -e "./core[dev]" -e ./dummy -e ./cocoa
```

Linux

```
(venv) $ cd toga
(venv) $ pip install -e ./core[dev] -e ./dummy -e ./gtk
```

Windows

```
(venv) C:\...>cd toga
(venv) C:\...>pip install -e ./core[dev] -e ./dummy -e ./winforms
```

Toga uses a tool called Pre-Commit to identify simple issues and standardize code formatting. It does this by installing a git hook that automatically runs a series of code linters prior to finalizing any git commit. To enable pre-commit, run:

macOS

```
(venv) $ pre-commit install
pre-commit installed at .git/hooks/pre-commit
```

Linux

```
(venv) $ pre-commit install
pre-commit installed at .git/hooks/pre-commit
```

Windows

```
(venv) C:\...>pre-commit install
pre-commit installed at .git/hooks/pre-commit
```

When you commit any change, pre-commit will run automatically. If there are any issues found with the commit, this will cause your commit to fail. Where possible, pre-commit will make the changes needed to correct the problems it has found:

macOS

```
(venv) $ git add some/interesting_file.py
(venv) $ git commit -m "Minor change"
black....................................................................Failed
- hook id: black
- files were modified by this hook

reformatted some/interesting_file.py

All done!
1 file reformatted.

flake8...................................................................Passed
check toml............................................(no files to check)Skipped
check yaml............................................(no files to check)Skipped
check for case conflicts.................................................Passed
check docstring is first.................................................Passed
fix end of files.........................................................Passed
trim trailing whitespace.................................................Passed
isort....................................................................Passed
pyupgrade................................................................Passed
docformatter.............................................................Passed
```

Linux

```
(venv) $ git add some/interesting_file.py
(venv) $ git commit -m "Minor change"
black....................................................................Failed
- hook id: black
- files were modified by this hook

reformatted some/interesting_file.py

All done!
1 file reformatted.

flake8...................................................................Passed
check toml............................................(no files to check)Skipped
check yaml............................................(no files to check)Skipped
check for case conflicts.................................................Passed
check docstring is first.................................................Passed
fix end of files.........................................................Passed
trim trailing whitespace.................................................Passed
isort....................................................................Passed
pyupgrade................................................................Passed
docformatter.............................................................Passed
```

Windows

```
(venv) C:\...>git add some/interesting_file.py
(venv) C:\...>git commit -m "Minor change"
black....................................................................Failed
- hook id: black
- files were modified by this hook
```

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```
reformatted some\interesting_file.py

All done!
1 file reformatted.

flake8...................................................................Passed
check toml...........................................(no files to check)Skipped
check yaml...........................................(no files to check)Skipped
check for case conflicts.................................................Passed
check docstring is first.................................................Passed
fix end of files.........................................................Passed
trim trailing whitespace.................................................Passed
isort....................................................................Passed
pyupgrade................................................................Passed
docformatter.............................................................Passed
```

You can then re-add any files that were modified as a result of the pre-commit checks, and re-commit the change.

macOS

```
(venv) $ git add some/interesting_file.py
(venv) $ git commit -m "Minor change"
black....................................................................Passed
flake8...................................................................Passed
check toml...........................................(no files to check)Skipped
check yaml...........................................(no files to check)Skipped
check for case conflicts.................................................Passed
check docstring is first.................................................Passed
fix end of files.........................................................Passed
trim trailing whitespace.................................................Passed
isort....................................................................Passed
pyupgrade................................................................Passed
docformatter.............................................................Passed
[bugfix e3e0f73] Minor change
1 file changed, 4 insertions(+), 2 deletions(-)
```

Linux

```
(venv) $ git add some/interesting_file.py
(venv) $ git commit -m "Minor change"
black....................................................................Passed
flake8...................................................................Passed
check toml...........................................(no files to check)Skipped
check yaml...........................................(no files to check)Skipped
check for case conflicts.................................................Passed
check docstring is first.................................................Passed
fix end of files.........................................................Passed
trim trailing whitespace.................................................Passed
isort....................................................................Passed
pyupgrade................................................................Passed
docformatter.............................................................Passed
[bugfix e3e0f73] Minor change
```

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```
1 file changed, 4 insertions(+), 2 deletions(-)
```

Windows

```
(venv) C:\...>git add some\interesting_file.py
(venv) C:\...>git commit -m "Minor change"
black...................................................................Passed
flake8..................................................................Passed
check toml.............................................(no files to check)Skipped
check yaml.............................................(no files to check)Skipped
check for case conflicts................................................Passed
check docstring is first................................................Passed
fix end of files........................................................Passed
trim trailing whitespace................................................Passed
isort...................................................................Passed
pyupgrade...............................................................Passed
docformatter............................................................Passed
```

Now you are ready to start hacking on Toga!

What should I do?

Depending on your level of expertise, or areas of interest, there are a number of ways you can contribute to Toga's code.

Fix a bug in an existing widget

Toga's issue tracker logs the known issues with existing widgets. Any of these issues are candidates to be worked on. This list can be filtered by platform, so you can focus on issues that affect the platforms you're able to test on. There's also a filter for good first issues . These have been identified as problems that have a known cause, and we believe the fix *should* be relatively simple (although we might be wrong in our analysis).

We don't have any formal process of "claiming" or "assigning" issues; if you're interested in a ticket, leave a comment that says you're working on it. If there's an existing comment that says someone is working on the issue, and that comment is recent, then leave a comment asking if they're still working on the issue. If you don't get a response in a day or two, you can assume the issue is available. If the most recent comment is more than a few weeks old, it's probably safe to assume that the issue is still available to be worked on.

If an issue is particularly old (more than 6 months), it's entirely possible that the issue has been resolved, so the first step is to verify that you can reproduce the problem. Use the information provided in the bug report to try and reproduce the problem. If you can't reproduce the problem, report what you have found as a comment on the ticket, and pick another ticket.

If a bug report has no comments from anyone other than the original reporter, the issue needs to be triaged. Triaging a bug involves taking the information provided by the reporter, and trying to reproduce it. Again, if you can't reproduce the problem, report what you have found as a comment on the ticket, and pick another ticket.

If you can reproduce the problem - try to fix it! Work out what combination of core and backend-specific code is implementing the feature, and see if you can work out what isn't working correctly. You may need to refer to platform specific documentation (e.g., the Cocoa AppKit, iOS UIKit, GTK, Winforms, Android, Shoelace or Textual API documentation) to work out why a widget isn't behaving as expected.

If you're able to fix the problem, you'll need to add tests for *the core API* and/or *the testbed backend* for that widget, depending on whether the fix was in the core API or to the backend (or both).

Even if you can't fix the problem, reporting anything you discover as a comment on the ticket is worthwhile. If you can find the source of the problem, but not the fix, that knowledge will often be enough for someone who knows more about a platform to solve the problem. Even a good reproduction case (a sample app that does nothing but reproduce the problem) can be a huge help.

Contribute improvements to documentation

We've got a *separate contribution guide* for documentation contributions. This covers how to set up your development environment to build Toga's documentation, and separate ideas for what to work on.

Implement a platform native widget

If the core library already specifies an interface for a widget, but the widget isn't implemented on your platform of choice, implement that interface. The *supported widgets by platform* table can show you the widgets that are missing on various platforms. You can also look for log messages in a running app (or the direct `factory.not_implemented()` function calls that produce those log messages). At present, the Web and Textual backends have the most missing widgets. If you have web skills, or would like to learn more about PyScript and Shoelace, the web backend could be a good place to contribute; if you'd like to learn more about terminal applications and the or Textual API, contributing to the Textual backend could be a good place for you to contribute.

Alternatively, if there's a widget that doesn't exist, propose an interface design, and implement it for at least one platform. You may find this presentation by BeeWare emeritus team member Dan Yeaw helpful. This talk gives an architectural overview of Toga, as well as providing a guide to the process of adding new widgets.

If you implement a new widget, don't forget you'll need to write tests for the new core API. If you're extending an existing widget, you may need to *add a probe for the backend*.

Add a new feature to an existing widget

Can you think of a feature than an existing widget should have? Propose a new API for that widget, and provide a sample implementation. If you don't have any ideas of your own, the Toga issue tracker has some existing feature suggestions that you could try to implement.

Again, you'll need to add unit tests and/or backend probes for any new features you add.

Implement an entirely new platform backend

Toga currently has support for 7 backends - but there's room for more! In particular, we'd be interested in seeing a Qt-based backend to support KDE-based Linux desktops.

The first steps of any new platform backend are always the same:

1. Implement enough of the Toga Application and Window classes to allow you to create an empty application window, integrated with the Python `asyncio` event loop.
2. Work out how to use native platform APIs to position a widget at a specific position on the window. Most widget frameworks will have some sort of native layout scheme; we need to replace that scheme with Toga's layout algorithm. If you can work out how to place a button with a fixed size at a specific position on the screen, that's usually sufficient.
3. Get Tutorial 0 working. This is the simple case of a single box that contains a single button. To get this tutorial working, you'll need to implement the factory class for your new backend so that Toga can instantiate widgets on your new backend, and connect the Toga style applicator methods on the base widget that sets the position of widgets on the screen.

Once you have those core features in place, you can start implementing widgets and other Toga features (like fonts, images, and so on).

Improve the testing API for application writers

The dummy backend exists to validate that Toga's internal API works as expected. However, we would like it to be a useful resource for *application* authors as well. Testing GUI applications is a difficult task; a Dummy backend would potentially allow an end user to write an application, and validate behavior by testing the properties of the Dummy. Think of it as a GUI mock - but one that is baked into Toga as a framework. See if you can write a GUI app of your own, and write a test suite that uses the Dummy backend to validate the behavior of that app.

Running the core test suite

Toga uses tox to manage the testing process. To run the core test suite:

macOS

```
(venv) $ tox -e py
```

Linux

```
(venv) $ tox -e py
```

Windows

```
(venv) C:\...>tox -e py
```

You should get some output indicating that tests have been run. You may see `SKIPPED` tests, but shouldn't ever get any `FAIL` or `ERROR` test results. We run our full test suite before merging every patch. If that process discovers any problems, we don't merge the patch. If you do find a test error or failure, either there's something odd in your test environment, or you've found an edge case that we haven't seen before - either way, let us know!

At the end of the test output there should be a report of the coverage data that was gathered:

```
Name    Stmts   Miss Branch BrPart   Cover   Missing
----------------------------------------------------
TOTAL     4345      0   1040      0  100.0%
```

This tells us that the test suite has executed every possible branching path in the `toga-core` library. This isn't a 100% guarantee that there are no bugs, but it does mean that we're exercising every line of code in the core API.

If you make changes to the core API, it's possible you'll introduce a gap in this coverage. When this happens, the coverage report will tell you which lines aren't being executed. For example, lets say we made a change to `toga/window.py`, adding some new logic. The coverage report might look something like:

```
Name                    Stmts   Miss Branch BrPart  Cover   Missing
-----------------------------------------------------------------
src/toga/window.py        186      2     22      2  98.1%   211, 238-240
-----------------------------------------------------------------
TOTAL                    4345      2   1040      2  99.9%
```

This tells us that line 211, and lines 238-240 are not being executed by the test suite. You'll need to add new tests (or modify an existing test) to restore this coverage.

When you're developing your new test, it may be helpful to run *just* that one test. To do this, you can pass in the name of a specific test file (or a specific test, using pytest specifiers):

macOS

```
(venv) $ tox -e py -- tests/path_to_test_file/test_some_test.py
```

Linux

```
(venv) $ tox -e py -- tests/path_to_test_file/test_some_test.py
```

Windows

```
(venv) C:\...>tox -e py -- tests/path_to_test_file/test_some_test.py
```

These test paths are relative to the `core` directory. You'll still get a coverage report when running a part of the test suite - but the coverage results will only report the lines of code that were executed by the specific tests you ran.

Running the testbed

The core API tests exercise `toga-core` - but what about the backends? To verify the behavior of the backends, Toga has a testbed app. This app uses the core API to exercise all the behaviors that the backend APIs need to perform - but uses an actual platform backend to implement that behavior.

To run the testbed app, install Briefcase, and run the app in developer test mode:

macOS

```
(venv) $ python -m pip install briefcase
(venv) $ cd testbed
(venv) $ briefcase dev --test
```

Linux

```
(venv) $ python -m pip install briefcase
(venv) $ cd testbed
(venv) $ briefcase dev --test
```

Windows

```
(venv) C:\...>python -m pip install briefcase
(venv) C:\...>cd testbed
(venv) C:\...>briefcase dev --test
```

This will display a Toga app window, which will flash as it performs all the GUI tests. You'll then see a coverage report for the code that has been executed.

If you want to run a subset of the entire test suite, Briefcase honors pytest specifiers) in the same way as the main test suite.

The testbed app provides one additional feature that the core tests don't have – slow mode. Slow mode runs the same tests, but deliberately pauses for 1 second between each GUI action so that you can observe what is going on.

So - to run *only* the button tests in slow mode, you could run:

macOS

```
(venv) $ briefcase dev --test -- tests/widgets/test_button.py --slow
```

Linux

```
(venv) $ briefcase dev --test -- tests/widgets/test_button.py --slow
```

Windows

```
(venv) C:\...>briefcase dev --test -- tests/widgets/test_button.py --slow
```

This test will take a lot longer to run, but you'll see the widget (Button, in this case) go through various color, format, and size changes as the test runs. You won't get a coverage report if you run a subset of the tests, or if you enable slow mode.

Developer mode is useful for testing desktop platforms (Cocoa, Winforms and GTK); but if you want to test a mobile backend, you'll need to use `briefcase run`.

macOS

To run the Android test suite:

```
(venv) $ briefcase run android --test
```

To run the iOS test suite:

```
(venv) $ briefcase run iOS --test
```

Linux

To run the Android test suite:

```
(venv) $ briefcase run android --test
```

iOS tests can't be executed on Linux.

Windows

To run the Android test suite:

```
(venv) C:\...>briefcase run android --test
```

iOS tests can't be executed on Windows.

You can also use slow mode or pytest specifiers with `briefcase run`, using the same `--` syntax as you used in developer mode.

How the testbed works

The testbed works by providing a generic collection of behavioral tests on a live app, and then providing an API to instrument the live app to verify that those behaviors have been implemented. That API is then implemented by each backend.

The implementation of the generic behavioral tests is contained in the tests folder of the testbed app. These tests use the public API of a widget to exercise all the corner cases of each implementation. Some of the tests are generic (for example, setting the background color of a widget) and are shared between widgets, but each widget has its own set of specific tests. These tests are all declared `async` because they need to interact with the event loop of a running application.

Each test will make a series of calls on a widget's public API. The public API is used to verify the behavior that an end user would experience when programming a Toga app. The test will *also* make calls on the *probe* for the widget.

The widget probe provides a generic interface for interacting with the internals of widget, verifying that the implementation is in the correct state as a result of invoking a public API. The probes for each platform are implemented in the `tests_backend` folder of each backend. For example, the Cocoa tests backend and probe implementations can be found here.

The probe for each widget provides a way to manipulate and inspect the internals of a widget in a way that may not be possible from a public API. For example, the Toga public API doesn't provide a way to determine the physical size of a widget, or interrogate the font being used to render a widget; the probe implementation does. This allows a testbed test case to verify that a widget has been laid out correctly inside the Toga window, is drawn using the right font, and has any other other appropriate physical properties or internal state.

The probe also provides a programmatic interface for interacting *with* a widget. For example, in order to test a button, you need to be able to press that button; the probe API provides an API to simulate that press. This allows the testbed to verify that the correct callbacks will be invoked when a button is pressed. These interactions are performed by generating events in the GUI framework being tested.

The widget probe also provides a `redraw()` method. GUI libraries don't always immediately apply changes visually, as graphical changes will often be batched so that they can be applied in a single redraw. To ensure that any visual changes have been applied before a test asserts the properties of the app, a test case can call `await probe.redraw()`. This guarantees that any outstanding redraw events have been processed. These `redraw()` requests are also used to implement slow mode - each redraw is turned into a 1 second sleep.

If a widget doesn't have a probe for a given widget, the testbed should call `pytest.skip()` for that platform when constructing the widget fixture (there is a `skip_on_platforms()` helper method in the testbed method to do this). If a widget hasn't implemented a specific probe method that the testbed required, it should call `pytest.skip()` so that the backend knows to skip the test.

If a widget on a given backend doesn't support a given feature, it should use `pytest.xfail()` (expected failure) for the probe method testing that feature. For example, Cocoa doesn't support setting the text color of buttons; as a result, the Cocoa implementation of the `color` property of the Button probe performs an `xfail` describing that limitation.

Submitting a pull request

Before you submit a pull request, there's a few bits of housekeeping to do.

Submit from a feature branch, not your `main` branch

Before you start working on your change, make sure you've created a branch. By default, when you clone your repository fork, you'll be checked out on your `main` branch. This is a direct copy of Toga's `main` branch.

While you *can* submit a pull request from your `main` branch, it's preferable if you *don't* do this. If you submit a pull request that is *almost* right, the core team member who reviews your pull request may be able to make the necessary changes, rather than giving feedback asking for a minor change. However, if you submit your pull request from your `main` branch, reviewers are prevented from making modifications.

Instead, you should make your changes on a *feature branch*. A feature branch has a simple name to identify the change that you've made. For example, if you've found a bug in Toga's layout algorithm, you might create a feature branch `fix-layout-bug`. If your bug relates to a specific issue that has been reported, it's also common to reference that issue number in the branch name (e.g., `fix-1234`).

To create a feature branch, run:

macOS

```
(venv) $ git checkout -b fix-layout-bug
```

Linux

```
(venv) $ git checkout -b fix-layout-bug
```

Windows

```
(venv) C:\...>git checkout -b fix-layout-bug
```

Commit your changes to this branch, then push to GitHub and create a pull request.

Add change information for release notes

Before you submit this change as a pull request, you need to add a *change note*. Toga uses towncrier to automate building release notes. To support this, every pull request needs to have a corresponding file in the `changes/` directory that provides a short description of the change implemented by the pull request.

This description should be a high level summary of the change from the perspective of the user, not a deep technical description or implementation detail. It is distinct from a commit message - a commit message describes what has been done so that future developers can follow the reasoning for a change; the change note is a "user facing" description. For example, if you fix a bug caused by date handling, the commit message might read:

> Modified date validation to accept US-style MM-DD-YYYY format.

The corresponding change note would read something like:

> Date widgets can now accept US-style MM-DD-YYYY format.

See News Fragments for more details on the types of news fragments you can add. You can also see existing examples of news fragments in the `changes/` folder. Name the file using the number of the issue that your pull request is addressing. When there isn't an existing issue, you can create the pull request in two passes: First submit it without a change note - this will fail, but will also assign a pull request number. You can then push an update to the pull request, adding the change note with the assigned number.

It's not just about coverage!

Although we're always trying to improve test coverage, the task isn't *just* about increasing the numerical coverage value. Part of the task is to audit the code as you go. You could write a comprehensive set of tests for a concrete life jacket… but a concrete life jacket would still be useless for the purpose it was intended!

As you develop tests and improve coverage, you should be checking that the core module is internally **consistent** as well. If you notice any method names that aren't internally consistent (e.g., something called `on_select` in one module, but called `on_selected` in another), or where the data isn't being handled consistently (one widget updates then refreshes, but another widget refreshes then updates), flag it and bring it to our attention by raising a ticket. Or, if you're confident that you know what needs to be done, create a pull request that fixes the problem you've found.

One example of the type of consistency we're looking for is described in this ticket.

Waiting for feedback

Once you've written your code, test, and change note, you can submit your changes as a pull request. One of the core team will review your work, and give feedback. If any changes are requested, you can make those changes, and update your pull request; eventually, the pull request will be accepted and merged. Congratulations, you're a contributor to Toga!

What next?

Rinse and repeat! If you've improved coverage by one line, go back and do it again for *another* coverage line! If you've implemented a new widget, implement *another* widget!

Most importantly - have fun!

2.2.3 Contributing to Toga's documentation

You might have the best software in the world - but if nobody knows how to use it, what's the point? Documentation can always be improved - and we need need your help!

Toga's documentation is written using Sphinx and reStructuredText. We aim to follow the Diataxis framework for structuring documentation.

Building Toga's documentation

To build Toga's documentation, start by *setting up a development environment*.

You'll also need to install the Enchant spell checking library.

macOS

Enchant can be installed using Homebrew:

```
(venv) $ brew install enchant
```

If you're on an M1 machine, you'll also need to manually set the location of the Enchant library:

```
(venv) $ export PYENCHANT_LIBRARY_PATH=/opt/homebrew/lib/libenchant-2.2.dylib
```

Linux

Enchant can be installed as a system package:

Ubuntu 20.04+ / Debian 10+

```
$ sudo apt update
$ sudo apt install enchant-2
```

Fedora

```
$ sudo dnf install enchant
```

Arch, Manjaro

```
$ sudo pacman -Syu enchant
```

Windows

Enchant is installed automatically when you set up your development environment.

Build documentation locally

Once your development environment is set up, run:

macOS

```
(venv) $ tox -e docs
```

Linux

```
(venv) $ tox -e docs
```

Windows

```
(venv) C:\...>tox -e docs
```

The output of the file should be in the `docs/_build/html` folder. If there are any markup problems, they'll raise an error.

Documentation linting

The build process will identify reStructuredText problems, but Toga performs some additional "lint" checks. To run the lint checks:

macOS

```
(venv) $ tox -e docs-lint
```

Linux

```
(venv) $ tox -e docs-lint
```

Windows

```
(venv) C:\...>tox -e docs-lint
```

This will validate the documentation does not contain:

- dead hyperlinks
- misspelled words

If a valid spelling of a word is identified as misspelled, then add the word to the list in `docs/spelling_wordlist`. This will add the word to the spellchecker's dictionary. When adding to this list, remember:

- We prefer US spelling, with some liberties for programming-specific colloquialism (e.g., "apps") and verbing of nouns (e.g., "scrollable")
- Any reference to a product name should use the product's preferred capitalization. (e.g., "macOS", "GTK", "pytest", "Pygame", "PyScript").
- If a term is being used "as code", then it should be quoted as a literal rather than being added to the dictionary.

Rebuilding all documentation

To force a rebuild for all of the documentation:

macOS

```
(venv) $ tox -e docs-all
```

Linux

```
(venv) $ tox -e docs-all
```

Windows

```
(venv) C:\...>tox -e docs-all
```

The documentation should be fully rebuilt in the `docs/_build/html` folder. If there are any markup problems, they'll raise an error.

What to work on?

If you're looking for specific areas to improve, there are tickets tagged "documentation" in Toga's issue tracker.

However, you don't need to be constrained by these tickets. If you can identify a gap in Toga's documentation, or an improvement that can be made, start writing! Anything that improves the experience of the end user is a welcome change.

Submitting a pull request

Before you submit a pull request, there's a few bits of housekeeping to do. See the section on submitting a pull request in the *code contribution guide* for details on our submission process.

2.2.4 Internal How-to guides

These guides are for the maintainers of the Toga project, documenting internal project procedures.

How to cut a Toga release

The release infrastructure for Toga is semi-automated, using GitHub Actions to formally publish releases.

This guide assumes that you have an `upstream` remote configured on your local clone of the Toga repository, pointing at the official repository. If all you have is a checkout of a personal fork of the Toga repository, you can configure that checkout by running:

```
$ git remote add upstream https://github.com/beeware/toga.git
```

The procedure for cutting a new release is as follows:

1. Check the contents of the upstream repository's main branch:

   ```
   $ git fetch upstream
   $ git checkout --detach upstream/main
   ```

Check that the HEAD of release now matches upstream/main.

2. Ensure that the release notes are up to date. Run:

```
$ tox -e towncrier -- --draft
```

to review the release notes that will be included, and then:

```
$ tox -e towncrier
```

to generate the updated release notes. After doing any edits that may be required, run:

```
$ tox -r -e docs-lint,docs
```

to confirm that there are no spelling errors or formatting problems with the new release notes, and the docs build using the current documentation tool versions.

3. Tag the release, and push the branch and tag upstream:

```
$ git tag v1.2.3
$ git push upstream HEAD:main
$ git push upstream v1.2.3
```

4. Pushing the tag will start a workflow to create a draft release on GitHub. You can follow the progress of the workflow on GitHub; once the workflow completes, there should be a new draft release, and entries on the TestPyPI server for toga-core, toga-cocoa, etc.

   Confirm that this action successfully completes. If it fails, there's a couple of possible causes:

   a. The final upload to TestPyPI failed. TestPyPI doesn't have the same service monitoring as PyPI-proper, so it sometimes has problems. However, it's not critical to the release process.

   b. Something else fails in the build process. If the problem can be fixed without a code change to the Toga repository (e.g., a transient problem with build machines not being available), you can re-run the action that failed through the GitHub Actions GUI. If the fix requires a code change, delete the old tag, make the code change, and re-tag the release.

5. Download the "packages" artifact from the GitHub workflow, and use its wheels to build some apps and perform any pre-release testing that may be appropriate.

6. Log into ReadTheDocs, visit the Versions tab, and activate the new version. Ensure that the build completes; if there's a problem, you may need to correct the build configuration, roll back and re-tag the release.

7. Edit the GitHub release to add release notes. You can use the text generated by Towncrier, but you'll need to update the format to Markdown, rather than ReST. If necessary, check the pre-release checkbox.

8. Double check everything, then click Publish. This will trigger a publication workflow on GitHub.

9. Wait for the packages to appear on PyPI (toga-core, toga-cocoa, etc.).

Congratulations, you've just published a release!

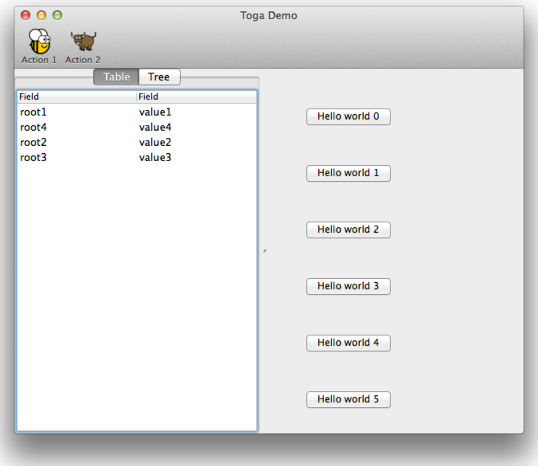
Once the release has successfully appeared on PyPI or TestPyPI, it cannot be changed. If you spot a problem after that point, you'll need to restart with a new version number.

2.3 Reference

2.3.1 Supported platforms

Desktop

macOS



Field	Field
root1	value1
root4	value4
root2	value2
root3	value3

The Toga backend for macOS is toga-cocoa.

Prerequisites

`toga-cocoa` requires macOS 10.10 (Yosemite) or newer.

Installation

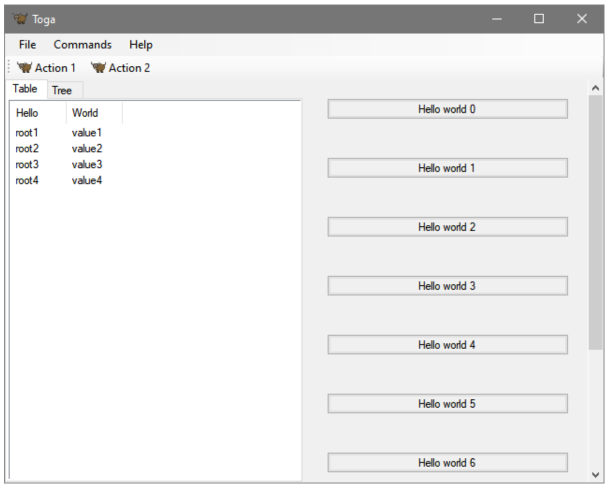
`toga-cocoa` is installed automatically on macOS machines (machines that report `sys.platform == 'darwin'`), or can be manually installed by running invoking:

```
$ python -m pip install toga-cocoa
```

Implementation details

`toga-cocoa` uses the macOS AppKit Objective-C APIs to build apps. It uses Rubicon Objective-C to provide a bridge to the native AppKit libraries from Python.

Windows



The Toga backend for Windows is toga-winforms.

Prerequisites

`toga-winforms` requires Windows 10 or newer.

If you are using Windows 10 and want to use a WebView to display web content, you will also need to install the Edge WebView2 Evergreen Runtime. Windows 11 has this runtime installed by default.

Installation

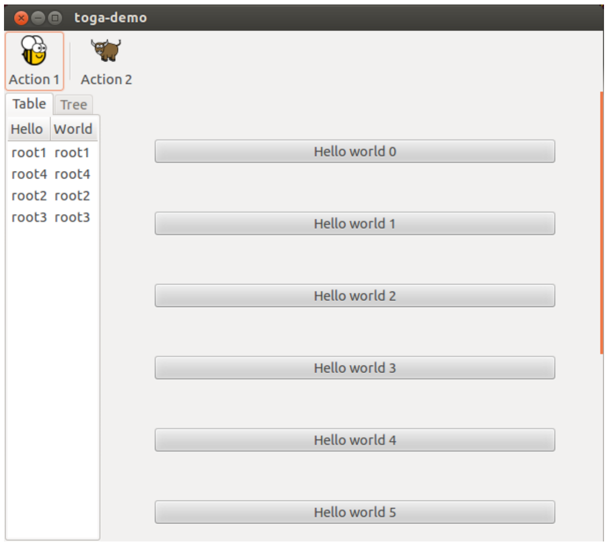
`toga-winforms` is installed automatically on Windows machines (machines that report `sys.platform == 'win32'`), or can be manually installed by running:

```
$ python -m pip install toga-winforms
```

Implementation details

`toga-winforms` uses Python.net.

Linux/Unix



The Toga backend for Linux (and other Unix-like operating systems) is toga-gtk.

Qt support

Toga does not currently have a Qt backend for KDE-based desktops. However, we would like to add one; see this ticket for details. If you would like to contribute, please get in touch on that ticket, on Mastodon or on Discord.

GTK on Windows and macOS

Although GTK *can* be installed on Windows and macOS, and the `toga-gtk` backend *may* work on those platforms, this is not officially supported by Toga. We recommend using `toga-winforms` on Windows, and `toga-cocoa` on macOS.

Prerequisites

`toga-gtk` requires GTK 3.22 or newer. This requirement can be met with with all versions of Ubuntu since 18.04, and all versions of Fedora since Fedora 26.

Toga receives the most testing with GTK 3.24. This is the version that has shipped with all versions of Ubuntu since Ubuntu 20.04, and all versions of Fedora since Fedora 29.

The system packages that provide GTK must be installed manually:

These instructions are different on almost every version of Linux and Unix; here are some of the common alternatives:

Ubuntu 18.04+ / Debian 10+

```
(venv) $ sudo apt update
(venv) $ sudo apt install pkg-config python3-dev libgirepository1.0-dev libcairo2-dev␣
↪gir1.2-webkit2-4.0 libcanberra-gtk3-module
```

Fedora

```
(venv) $ sudo dnf install pkg-config python3-devel gobject-introspection-devel cairo-
↪gobject-devel webkit2gtk3 libcanberra-gtk3
```

Arch / Manjaro

```
(venv) $ sudo pacman -Syu git pkgconf gobject-introspection cairo webkit2gtk libcanberra
```

FreeBSD

```
(venv) $ sudo pkg update
(venv) $ sudo pkg install gobject-introspection cairo webkit2-gtk3 libcanberra-gtk3
```

If you're not using one of these, you'll need to work out how to install the developer libraries for `python3`, `cairo`, and `gobject-introspection` (and please let us know so we can improve this documentation!)

Toga does not currently support GTK 4.

Installation

`toga-gtk` is installed automatically on any Linux machine (machines that report `sys.platform == 'linux'`), or any FreeBSD machine (machines that report `sys.platform == 'freebsd*'`). It can be manually installed by running:

```
$ python -m pip install toga-gtk
```

Implementation details

`toga-gtk` uses the native GObject Python bindings.

Mobile

Android

The Toga backend for Android is toga-android.

Prerequisites

`toga-android` requires Android SDK 24 (Android 7 / Nougat) or newer.

Installation

`toga-android` must be manually installed into an Android project; The recommended approach for deploying `toga-android` is to use Briefcase to package your app.

Implementation details

`toga-android` uses the Android Java APIs to build apps. It uses Chaquopy to provide a bridge to the native Android Java libraries and implement Java interfaces from Python.

iOS

The Toga backend for iOS is toga-iOS.

Prerequisites

`toga-iOS` requires iOS 12 or newer.

Installation

`toga-iOS` must be manually installed into an iOS project; The recommended approach for deploying `toga-iOS` is to use Briefcase to package your app.

Implementation details

`toga-iOS` uses the iOS UIKit Objective-C APIs to build apps. It uses Rubicon Objective-C to provide a bridge to the native UIKit libraries from Python.

Other

Web

Toga is able to deploy apps as a single-page web app using the toga-web backend.

Note: The Web backend is currently proof-of-concept only. Most widgets have not been implemented.

Prerequisites

`toga-web` will run in any modern browser. It requires PyScript 2023.05.01 or newer, and Shoelace v2.3.

Installation

The recommended approach for deploying `toga-web` is to use Briefcase to package your app.

`toga-web` can be installed manually by adding `toga-web` to your `pyscript.toml` configuration file.

Implementation details

toga-web uses PyScript to run Python code in the browser.

Terminal

The Toga backend for terminal applications is toga-textual.

Prerequisites

toga-textual should run on any terminal or command shell provided by macOS, Windows or Linux.

Installation

toga-textual must be manually installed by running:

```
$ python -m pip install toga-textual
```

If toga-textual is the only Toga backend that is installed, it will be picked up automatically on any desktop operating system. If you have another backend installed (usually, this will be the default GUI for your operating system), you will need to set the TOGA_BACKEND environment variable to toga-textual to force the selection of the backend.

Implementation details

toga-textual uses the Textual UI toolkit.

macOS Terminal.app limitations

There are some known issues with the default macOS Terminal.app. In some layouts, box outlines render badly; this can *sometimes* be resolved by altering the line spacing of the font used in the terminal. The default Terminal.app also has a limited color palette. The maintainers of Textual recommend using an alternative terminal application to avoid these problems.

Testing

Toga provides a toga-dummy backend that can be used for testing purposes. This backend implements the full interface required by a platform backend, but does not display any widgets visually. It provides an API that can be used to verify widget operation.

Prerequisites

The dummy backend has no prerequisites.

Installation

The dummy backend must be installed manually:

```
$ python -m pip install toga-dummy
```

To force Toga to use the dummy backend, it must either be the only backend that is installed in the current Python environment, or you must define the `TOGA_BACKEND` environment variable:

macOS

```
(venv) $ export TOGA_BACKEND=toga_dummy
```

Linux

```
(venv) $ export TOGA_BACKEND=toga_dummy
```

Windows

```
(venv) $ set TOGA_BACKEND=toga_dummy
```

Future Plans

Eventually, the Toga project would like to provide support for:

- WinUI (for Modern Windows look and feel)
- Qt (for KDE-based Unix desktops)
- tvOS (for AppleTV devices)
- watchOS (for Apple Watch devices)

If you are interested in these platforms and would like to contribute, please get in touch on Mastodon or Discord.

Unofficial support

At present, there are no known unofficial platform backends.

2.3.2 Toga APIs by platform

Key

	Partly supported: functionality or testing is incomplete
	Fully supported

Core Components

Component	macOS	GTK	Windows	iOS	Android	Web	Terminal
App							
DocumentApp							
Window							
MainWindow							

General Widgets

Component	macOS	GTK	Windows	iOS	Android	Web	Terminal
ActivityIndicator							
Button							
Canvas							
DateInput							
DetailedList							
Divider							
ImageView							
Label							
MultilineTextInput							
NumberInput							
PasswordInput							
ProgressBar							
Selection							
Slider							
Switch							
Table							
TextInput							
TimeInput							
Tree							
WebView							
Widget							

Layout Widgets

Component	macOS	GTK	Windows	iOS	Android	Web	Terminal
Box							
ScrollContainer							
SplitContainer							
OptionContainer							

Resources

Component	macOS	GTK	Windows	iOS	Android	Web	Terminal
`Paths`							
`Font`							
`Command`							
`Icon`							
`Image`							

2.3.3 API Reference

Core application components

Component	Description
App	The top-level representation of an application.
DocumentApp	An application that manages documents.
Window	An operating system-managed container of widgets.
MainWindow	The main window of the application.

General widgets

Component	Description
ActivityIndicator	A small animated indicator showing activity on a task of indeterminate length, usually rendered as a "spinner" animation.
Button	A button that can be pressed or clicked.
Canvas	A drawing area for 2D vector graphics.
DateInput	A widget to select a calendar date
DetailedList	An ordered list of content where each item has an icon, a main heading, and a line of supplementary text.
Divider	A separator used to visually distinguish two sections of content in a layout.
ImageView	Image Viewer
Label	A text label for annotating forms or interfaces.
MultilineTextInput	A scrollable panel that allows for the display and editing of multiple lines of text.
NumberInput	A text input that is limited to numeric input.
PasswordInput	A widget to allow the entry of a password. Any value typed by the user will be obscured, allowing the user to see the number of characters they have typed, but not the actual characters.
ProgressBar	A horizontal bar to visualize task progress. The task being monitored can be of known or indeterminate length.
Selection	A widget to select an single option from a list of alternatives.
Slider	A widget for selecting a value within a range. The range is shown as a horizontal line, and the selected value is shown as a draggable marker.
Switch	A clickable button with two stable states: True (on, checked); and False (off, unchecked). The button has a text label.
Table	A widget for displaying columns of tabular data.
TextInput	A widget for the display and editing of a single line of text.
TimeInput	A widget to select a clock time
Tree	A widget for displaying a hierarchical tree of tabular data.
WebView	An embedded web browser.
Widget	The abstract base class of all widgets. This class should not be be instantiated directly.

Layout widgets

Usage	Description
Box	A generic container for other widgets. Used to construct layouts.
ScrollContainer	A container that can display a layout larger that the area of the container, with overflow controlled by scroll bars.
SplitContainer	A container that divides an area into two panels with a movable border.
OptionContainer	A container that can display multiple labeled tabs of content.

Resources

Component	Description
App Paths	A mechanism for obtaining platform-appropriate file system locations for an application.
Command	A representation of app functionality that the user can invoke from menus or toolbars.
Font	Fonts
Icon	An icon for buttons, menus, etc
Image	An image
ListSource	A data source describing an ordered list of data.
Source	A base class for data source implementations.
TreeSource	A data source describing an ordered hierarchical tree of data.
Validators	A mechanism for validating that input meets a given set of criteria.
ValueSource	A data source describing a single value.

Other

Component	Description
Constants	Symbolic constants used by various APIs.

App

The top-level representation of an application.

Table 5: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal

Usage

The App class is the top level representation of all application activity. It is a singleton object - any given process can only have a single App. That application may manage multiple windows, but it is guaranteed to have at least one window (called the `main_window`); when the App's `main_window` is closed, the application will exit.

The application is started by calling `main_loop()`. This will invoke the `startup()` method of the app.

```python
import toga

app = toga.App("Simplest App", "com.example.simplest")
app.main_loop()
```

You can populate an app's main window by passing a callable as the `startup` argument to the `toga.App` constructor. This `startup` method must return the content that will be added to the main window of the app.

```python
import toga

def create_content(app):
```

(continues on next page)

(continued from previous page)

```
    return toga.Box(children=[toga.Label("Hello!")])

app = toga.App("Simple App", "com.example.simple", startup=create_content)
app.main_loop()
```

This approach to app construction is most useful with simple apps. For most complex apps, you should subclass *toga.App*, and provide an implementation of *startup()*. This implementation *must* create and assign a main_window for the app.

```
import toga

class MyApp(toga.App):
    def startup(self):
        self.main_window = toga.MainWindow()
        self.main_window.content = toga.Box(children=[toga.Label("Hello!")])
        self.main_window.show()

if __name__ == '__main__':
    app = MyApp("Realistic App", "org.beeware.realistic")
    app.main_loop()
```

Every app must have a formal name (a human readable name), and an app ID (a machine-readable identifier - usually a reversed domain name). In the examples above, these are provided as constructor arguments. However, you can also provide these details, along with many of the other constructor arguments, as packaging metadata in a format compatible with `importlib.metadata`. If you deploy your app with Briefcase, this will be done automatically.

Reference

class toga.**App**(*formal_name=None*, *app_id=None*, *app_name=None*, ***, *icon=None*, *author=None*, *version=None*, *home_page=None*, *description=None*, *startup=None*, *on_exit=None*, *id=None*, *windows=None*)

Create a new App instance.

Once the app has been created, you should invoke the *main_loop()* method, which will start the event loop of your App.

Parameters

- **formal_name** (`Optional[str]`) – The human-readable name of the app. If not provided, the metadata key `Formal-Name` must be present.
- **app_id** (`Optional[str]`) – The unique application identifier. This will usually be a reversed domain name, e.g. `org.beeware.myapp`. If not provided, the metadata key `App-ID` must be present.
- **app_name** (`Optional[str]`) – The name of the distribution used to load metadata with `importlib.metadata`. If not provided, the following will be tried in order:
  1. If the `__main__` module is contained in a package, that package's name will be used.
  2. If the `app_id` argument was provided, its last segment will be used. For example, an `app_id` of `com.example.my-app` would yield a distribution name of `my-app`.
  3. As a last resort, the name `toga`.

- **icon** (UnionType[*Icon*, str, None]) – The *Icon* for the app. If not provided, Toga will attempt to load an icon from `resources/app_name`, where `app_name` is defined above. If no resource matching this name can be found, a warning will be printed, and the app will fall back to a default icon.
- **author** (Optional[str]) – The person or organization to be credited as the author of the app. If not provided, the metadata key `Author` will be used.
- **version** (Optional[str]) – The version number of the app. If not provided, the metadata key `Version` will be used.
- **home_page** (Optional[str]) – The URL of a web page for the app. Used in auto-generated help menu items. If not provided, the metadata key `Home-page` will be used.
- **description** (Optional[str]) – A brief (one line) description of the app. If not provided, the metadata key `Summary` will be used.
- **startup** (Optional[*AppStartupMethod*]) – A callable to run before starting the app.
- **on_exit** (Optional[*OnExitHandler*]) – The initial *on_exit* handler.
- **id** – **DEPRECATED** - This argument will be ignored. If you need a machine-friendly identifier, use `app_id`.
- **windows** – **DEPRECATED** – Windows are now automatically added to the current app. Passing this argument will cause an exception.

`about()`

Display the About dialog for the app.

Default implementation shows a platform-appropriate about dialog using app metadata. Override if you want to display a custom About dialog.

Return type
None

`add_background_task(`*handler*`)`

Schedule a task to run in the background.

Schedules a coroutine or a generator to run in the background. Control will be returned to the event loop during await or yield statements, respectively. Use this to run background tasks without blocking the GUI. If a regular callable is passed, it will be called as is and will block the GUI until the call returns.

Parameters
handler (*BackgroundTask*) – A coroutine, generator or callable.

Return type
None

`property app_id: str`

The unique application identifier (read-only). This will usually be a reversed domain name, e.g. `org.beeware.myapp`.

`property app_name: str`

The name of the distribution used to load metadata with `importlib.metadata` (read-only).

`property author: str | None`

The person or organization to be credited as the author of the app (read-only).

`beep()`

Play the default system notification sound.

Return type
`None`

property commands: MutableSet[*Command*]

The commands available in the app.

property current_window: *Window* | None

Return the currently active window.

property description: str | None

A brief (one line) description of the app (read-only).

exit()

Exit the application gracefully.

This *does not* invoke the `on_exit` handler; the app will be immediately and unconditionally closed.

Return type
`None`

exit_full_screen()

Exit full screen mode.

Return type
`None`

property formal_name: str

The human-readable name of the app (read-only).

hide_cursor()

Hide cursor from view.

Return type
`None`

property home_page: str | None

The URL of a web page for the app (read-only). Used in auto-generated help menu items.

property icon: *Icon*

The Icon for the app.

When setting the icon, you can provide either an *`Icon`* instance, or a path that will be passed to the `Icon` constructor.

property id: str

DEPRECATED – Use *`app_id`*.

property is_full_screen: bool

Is the app currently in full screen mode?

property loop: AbstractEventLoop

The event loop of the app's main thread (read-only).

main_loop()

Start the application.

On desktop platforms, this method will block until the application has exited. On mobile and web platforms, it returns immediately.

Return type
`None`

property main_window: *MainWindow*

The main window for the app.

property name: str

DEPRECATED – Use *formal_name*.

property on_exit: *OnExitHandler*

The handler to invoke if the user attempts to exit the app.

property paths: *Paths*

Paths for platform-appropriate locations on the user's file system.

Some platforms do not allow access to any file system location other than these paths. Even when arbitrary file access is allowed, there are preferred locations for each type of content.

set_full_screen(**windows*)

Make one or more windows full screen.

Full screen is not the same as "maximized"; full screen mode is when all window borders and other window decorations are no longer visible.

Parameters

windows (*Window*) – The list of windows to go full screen, in order of allocation to screens. If the number of windows exceeds the number of available displays, those windows will not be visible. If no windows are specified, the app will exit full screen mode.

Return type

None

show_cursor()

Make the cursor visible.

Return type

None

startup()

Create and show the main window for the application.

Subclasses can override this method to define customized startup behavior; however, any override *must* ensure the *main_window* has been assigned before it returns.

Return type

None

property version: str | None

The version number of the app (read-only).

visit_homepage()

Open the application's *home_page* in the default browser.

If the *home_page* is `None`, this is a no-op.

Return type

None

property widgets: Mapping[str, *Widget*]

The widgets managed by the app, over all windows.

Can be used to look up widgets by ID over the entire app (e.g., `app.widgets["my_id"]`).

property windows: `Collection[`*`Window`*`]`

The windows managed by the app. Windows are automatically added to the app when they are created, and removed when they are closed.

protocol `toga.app.`**`AppStartupMethod`**

`typing.Protocol`.

Classes that implement this protocol must have the following methods / attributes:

`__call__`(*app*, ***kwargs*)

The startup method of the app.

Called during app startup to set the initial main window content.

Parameters

- **app** (*App*) – The app instance that is starting.
- **kwargs** (`Any`) – Ensures compatibility with additional arguments introduced in future versions.

Return type
Widget

Returns
The widget to use as the main window content.

protocol `toga.app.`**`BackgroundTask`**

`typing.Protocol`.

Classes that implement this protocol must have the following methods / attributes:

`__call__`(*app*, ***kwargs*)

Code that should be executed as a background task.

Parameters

- **app** (*App*) – The app that is handling the background task.
- **kwargs** (`Any`) – Ensures compatibility with additional arguments introduced in future versions.

Return type
`None`

protocol `toga.app.`**`OnExitHandler`**

`typing.Protocol`.

Classes that implement this protocol must have the following methods / attributes:

`__call__`(*app*, ***kwargs*)

A handler to invoke when the app is about to exit.

The return value of this callback controls whether the app is allowed to exit. This can be used to prevent the app exiting with unsaved changes, etc.

Parameters

- **app** (*App*) – The app instance that is exiting.
- **kwargs** (`Any`) – Ensures compatibility with additional arguments introduced in future versions.

Return type
bool

Returns
True if the app is allowed to exit; False if the app is not allowed to exit.

DocumentApp

The top-level representation of an application that manages documents.

Table 6: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web

Usage

A DocumentApp is a specialized subclass of App that is used to manage documents. A DocumentApp does *not* have a main window; each document that the app manages has it's own main window. Each document may also define additional windows, if necessary.

The types of documents that the DocumentApp can manage must be declared as part of the instantiation of the DocumentApp. This requires that you define a subclass of *toga.Document* that describes how your document can be read and displayed. In this example, the code declares an "Example Document" document type, whose files have an extension of mydoc:

```
import toga

class ExampleDocument(toga.Document):
    def __init__(self, path, app):
        super().__init__(document_type="Example Document", path=path, app=app)

    def create(self):
        # Create the representation for the document's main window
        self.main_window = toga.DocumentMainWindow(self)
        self.main_window.content = toga.MultilineTextInput()

    def read(self):
        # Put your logic to read the document here. For example:
        with self.path.open() as f:
            self.content = f.read()

        self.main_window.content.value = self.content

app = toga.DocumentApp("Document App", "com.example.document", {"mydoc": MyDocument})
app.main_loop()
```

The exact behavior of a DocumentApp is slightly different on each platform, reflecting platform differences.

macOS

On macOS, there is only ever a single instance of a DocumentApp running at any given time. That instance can manage multiple documents. If you use the Finder to open a second document of a type managed by the DocumentApp, it will be opened in the existing DocumentApp instance. Closing all documents will not cause the app to exit; the app will keep executing until explicitly exited.

If the DocumentApp is started without an explicit file reference, a file dialog will be displayed prompting the user to select a file to open. If this dialog can be dismissed, the app will continue running. Selecting "Open" from the file menu will also display this dialog; if a file is selected, a new document window will be opened.

Linux/Windows

On Linux and Windows, each DocumentApp instance manages a single document. If your app is running, and you use the file manager to open a second document, a second instance of the app will be started. If you close a document's main window, the app instance associated with that document will exit, but any other app instances will keep running.

If the DocumentApp is started without an explicit file reference, a file dialog will be displayed prompting the user to select a file to open. If this dialog is dismissed, the app will continue running, but will show an empty document. Selecting "Open" from the file menu will also display this dialog; if a file is selected, the current document will be replaced.

Reference

`class toga.DocumentApp(`*formal_name=None*, *app_id=None*, *app_name=None*, ***, *icon=None*, *author=None*, *version=None*, *home_page=None*, *description=None*, *startup=None*, *document_types=None*, *on_exit=None*, *id=None*`)`

Bases: *App*

Create a document-based application.

A document-based application is the same as a normal application, with the exception that there is no main window. Instead, each document managed by the app will create and manage it's own window (or windows).

Parameters

document_types (`dict[str, type[Document]]`) – Initial `document_types` mapping.

property document_types: dict[str, type[*toga.documents.Document*]]

The document types this app can manage.

A dictionary of file extensions, without leading dots, mapping to the `toga.Document` subclass that will be created when a document with that extension is opened. The subclass must take exactly 2 arguments in its constructor: `path` and `app`.

property documents: list[*toga.documents.Document*]

The list of documents associated with this app.

startup()

No-op; a DocumentApp has no windows until a document is opened.

Subclasses can override this method to define customized startup behavior.

Return type

`None`

`class toga.Document(path, document_type, app=None)`

Bases: `ABC`

Create a new Document.

Parameters

- **`path`** (`str` | `Path`) – The path where the document is stored.
- **`document_type`** (`str`) – A human-readable description of the document type.
- **`app`** (*`App`*) – The application the document is associated with.

`property app: App`

The app that this document is associated with (read-only).

`can_close()`

Is the main document window allowed to close?

The default implementation always returns `True`; subclasses can override this to prevent a window closing with unsaved changes, etc.

This default implementation is a function; however, subclasses can define it as an asynchronous co-routine if necessary to allow for dialog confirmations.

Return type
`bool`

`abstract create()`

Create the window (or windows) for the document.

This method must, at a minimum, assign the *`main_window`* property. It may also create additional windows or UI elements if desired.

Return type
`None`

`property document_type: Path`

A human-readable description of the document type (read-only).

`property filename: Path`

DEPRECATED - Use *`path`*.

`async handle_close(window, **kwargs)`

An `on-close` handler for the main window of this document that implements platform-specific document close behavior.

It interrogates the *`can_close()`* method to determine if the document is allowed to close.

`property main_window: Window`

The main window for the document.

`property path: Path`

The path where the document is stored (read-only).

`abstract read()`

Load a representation of the document into memory and populate the document window.

Return type
`None`

show()

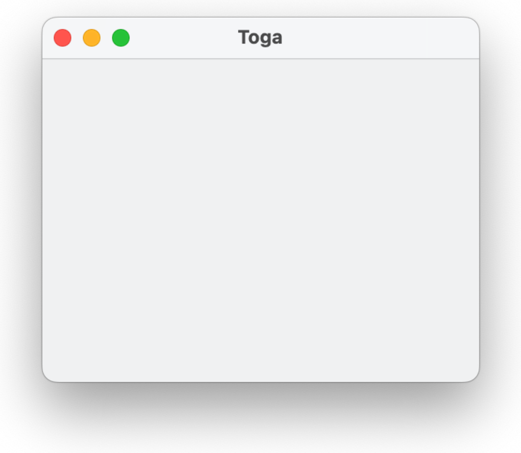
Show the *main_window* for this document.

Return type
None

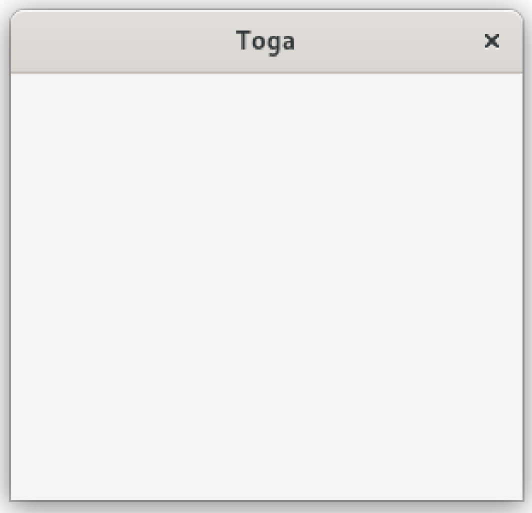
Window

An operating system-managed container of widgets.

macOS

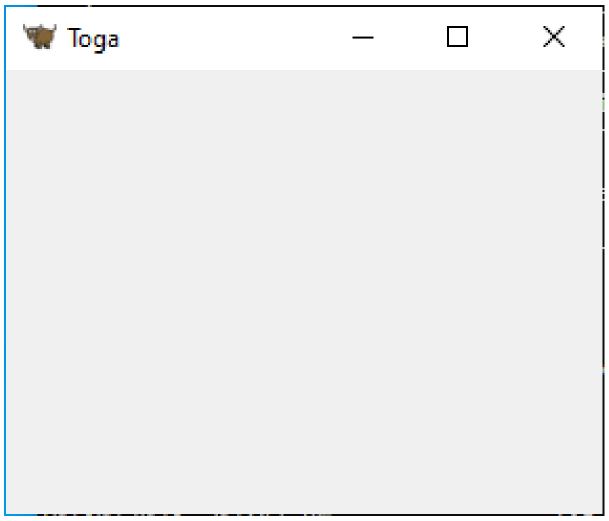


Linux



Windows

Android ×



Not supported

iOS ×

Not supported

Usage

A window is the top-level container that the operating system uses to display widgets. A window may also have other decorations, such as a title bar or toolbar.

When first created, a window is not visible. To display it, call the `show()` method.

The window has content, which will usually be a container widget of some kind. The content of the window can be changed by re-assigning its *content* attribute to a different widget.

```
import toga

window = toga.Window()
window.content = toga.Box(children=[...])
window.show()

# Change the window's content to something new
window.content = toga.Box(children=[...])
```

The operating system may provide controls that allow the user to resize, reposition, minimize, maximize or close the window. However, the availability of these controls is entirely operating system dependent.

If the user attempts to close the window, Toga will call the `on_close` handler. This handler must return a `bool` confirming whether the close is permitted. This can be used to implement protections against closing a window with unsaved changes.

Once a window has been closed (either by user action, or programmatically with `close()`), it *cannot* be reused. The behavior of any method on a `Window` instance after it has been closed is undefined.

Notes

- A mobile application can only have a single window (the `MainWindow`), and that window cannot be moved, resized, hidden, or made full screen. Toga will raise an exception if you attempt to create a secondary window on a mobile platform. If you try to modify the size, position, or visibility of the main window, the request will be ignored.

Reference

class toga.Window(*id=None*, *title=None*, *position=(100, 100)*, *size=(640, 480)*, *resizable=True*, *closable=True*, *minimizable=True*, *on_close=None*, *resizeable=None*, *closeable=None*)

Create a new Window.

Parameters

- **id** (`Optional[str]`) – A unique identifier for the window. If not provided, one will be automatically generated.
- **title** (`Optional[str]`) – Title for the window. Defaults to "Toga".
- **position** (`tuple[int, int]`) – Position of the window, as a tuple of `(x, y)` coordinates, in *CSS pixels*.
- **size** (`tuple[int, int]`) – Size of the window, as a tuple of `(width, height)`, in *CSS pixels*.
- **resizable** (`bool`) – Can the window be resized by the user?
- **closable** (`bool`) – Can the window be closed by the user?
- **minimizable** (`bool`) – Can the window be minimized by the user?
- **on_close** (`Optional[OnCloseHandler]`) – The initial `on_close` handler.
- **resizeable** – **DEPRECATED** - Use `resizable`.
- **closeable** – **DEPRECATED** - Use `closable`.

property app: *App*

The *App* that this window belongs to (read-only).

New windows are automatically associated with the currently active app.

as_image()

Render the current contents of the window as an image.

Return type

Image

Returns

A `toga.Image` containing the window content.

property closable: `bool`

Can the window be closed by the user?

close()

Close the window.

This *does not* invoke the `on_close` handler; the window will be immediately and unconditionally closed.

Once a window has been closed, it *cannot* be reused. The behavior of any method or property on a `Window` instance after it has been closed is undefined, except for `closed` which can be used to check if the window was closed.

Return type
`None`

property closeable: bool

DEPRECATED Use `closable`

property closed: bool

Whether the window was closed.

confirm_dialog(*title*, *message*, *on_result=None*)

Ask the user to confirm if they wish to proceed with an action.

Presents as a dialog with "Cancel" and "OK" buttons (or whatever labels are appropriate on the current platform).

Parameters

- **title** (`str`) – The title of the dialog window.
- **message** (`str`) – A message describing the action to be confirmed.
- **on_result** (`Optional[DialogResultHandler[bool]]`) – A callback that will be invoked when the user selects an option on the dialog.

Return type
`Dialog`

Returns
An awaitable Dialog object. The Dialog object returns `True` when the "OK" button is pressed, `False` when the "Cancel" button is pressed.

property content: Widget | None

Content of the window. On setting, the content is added to the same app as the window.

error_dialog(*title*, *message*, *on_result=None*)

Ask the user to acknowledge an error state.

Presents as an error dialog with a "OK" button to close the dialog.

Parameters

- **title** (`str`) – The title of the dialog window.
- **message** (`str`) – The error message to display.
- **on_result** (`Optional[DialogResultHandler[None]]`) – A callback that will be invoked when the user selects an option on the dialog.

Return type
`Dialog`

Returns
An awaitable Dialog object. The Dialog object returns `None` when the user presses the "OK" button.

property full_screen: bool

Is the window in full screen mode?

Full screen mode is *not* the same as "maximized". A full screen window has no title bar, toolbar or window controls; some or all of these items may be visible on a maximized window. A good example of "full screen" mode is a slideshow app in presentation mode - the only visible content is the slide.

hide()

Hide the window. If the window is already hidden, this method has no effect.

Return type
`None`

property id: str

A unique identifier for the window.

info_dialog(*title*, *message*, *on_result=None*)

Ask the user to acknowledge some information.

Presents as a dialog with a single "OK" button to close the dialog.

Parameters

- **title** (`str`) – The title of the dialog window.
- **message** (`str`) – The message to display.
- **on_result** (`Optional[DialogResultHandler[None]]`) – A callback that will be invoked when the user selects an option on the dialog.

Return type
`Dialog`

Returns
An awaitable Dialog object. The Dialog object returns `None` when the user presses the 'OK' button.

property minimizable: bool

Can the window be minimized by the user?

property on_close: *OnCloseHandler*

The handler to invoke if the user attempts to close the window.

open_file_dialog(*title*, *initial_directory=None*, *file_types=None*, *multiple_select=False*, *on_result=None*, *multiselect=None*)

Prompt the user to select a file (or files) to open.

This dialog is not currently supported on Android or iOS.

Parameters

- **title** (`str`) – The title of the dialog window
- **initial_directory** (`UnionType[Path, str, None]`) – The initial folder in which to open the dialog. If `None`, use the default location provided by the operating system (which will often be the last used location)
- **file_types** (`Optional[list[str]]`) – The allowed filename extensions, without leading dots. If not provided, all files will be shown.
- **multiple_select** (`bool`) – If True, the user will be able to select multiple files; if False, the selection will be restricted to a single file.
- **on_result** (`Optional[DialogResultHandler[UnionType[list[Path], Path, None]]]`) – A callback that will be invoked when the user selects an option on the dialog.

- `multiselect` – **DEPRECATED** Use `multiple_select`.

Return type
`Dialog`

Returns
An awaitable Dialog object. The Dialog object returns a list of `Path` objects if `multiple_select` is `True`, or a single `Path` otherwise. Returns `None` if the open operation is cancelled by the user.

property position: tuple[int, int]

Position of the window, as a tuple of `(x, y)` coordinates, in *CSS pixels*.

question_dialog(*title*, *message*, *on_result=None*)

Ask the user a yes/no question.

Presents as a dialog with “Yes” and “No” buttons.

Parameters

- **title** (`str`) – The title of the dialog window.
- **message** (`str`) – The question to be answered.
- **on_result** (`Optional`[*DialogResultHandler*[`bool`]]) – A callback that will be invoked when the user selects an option on the dialog.

Return type
`Dialog`

Returns
An awaitable Dialog object. The Dialog object returns `True` when the “Yes” button is pressed, `False` when the “No” button is pressed.

property resizable: bool

Can the window be resized by the user?

property resizeable: bool

DEPRECATED Use *resizable*

save_file_dialog(*title*, *suggested_filename*, *file_types=None*, *on_result=None*)

Prompt the user for a location to save a file.

This dialog is not currently supported on Android or iOS.

Parameters

- **title** (`str`) – The title of the dialog window
- **suggested_filename** (`Path` | `str`) – A default filename
- **file_types** (`Optional`[`list`[`str`]]) – The allowed filename extensions, without leading dots. If not provided, any extension will be allowed.
- **on_result** (`Optional`[*DialogResultHandler*[`Optional`[`Path`]]]) – A callback that will be invoked when the user selects an option on the dialog.

Return type
`Dialog`

Returns
An awaitable Dialog object. The Dialog object returns a path object for the selected file location, or `None` if the user cancelled the save operation.

`select_folder_dialog`(*title*, *initial_directory=None*, *multiple_select=False*, *on_result=None*, *multiselect=None*)

Prompt the user to select a directory (or directories).

This dialog is not currently supported on Android or iOS.

Parameters

- **`title`** (`str`) – The title of the dialog window
- **`initial_directory`** (`UnionType`[`Path`, `str`, `None`]) – The initial folder in which to open the dialog. If `None`, use the default location provided by the operating system (which will often be "last used location")
- **`multiple_select`** (`bool`) – If True, the user will be able to select multiple directories; if False, the selection will be restricted to a single directory. This option is not supported on WinForms.
- **`on_result`** (`Optional`[*`DialogResultHandler`*[`UnionType`[`list`[`Path`], `Path`, `None`]]]) – A callback that will be invoked when the user selects an option on the dialog.
- **`multiselect`** – **DEPRECATED** Use `multiple_select`.

Return type
`Dialog`

Returns
An awaitable Dialog object. The Dialog object returns a list of `Path` objects if `multiple_select` is `True`, or a single `Path` otherwise. Returns `None` if the open operation is cancelled by the user.

`show`()

Show the window. If the window is already visible, this method has no effect.

Return type
`None`

property size: `tuple[int, int]`

Size of the window, as a tuple of `(width, height)`, in *CSS pixels*.

`stack_trace_dialog`(*title*, *message*, *content*, *retry=False*, *on_result=None*)

Open a dialog to display a large block of text, such as a stack trace.

Parameters

- **`title`** (`str`) – The title of the dialog window.
- **`message`** (`str`) – Contextual information about the source of the stack trace.
- **`content`** (`str`) – The stack trace, pre-formatted as a multi-line string.
- **`retry`** (`bool`) – If true, the user will be given options to "Retry" or "Quit"; if false, a single option to acknowledge the error will be displayed.
- **`on_result`** (`Optional`[*`DialogResultHandler`*[`Optional`[`bool`]]]) – A callback that will be invoked when the user selects an option on the dialog.

Return type
`Dialog`

Returns
An awaitable Dialog object. If `retry` is true, the Dialog object returns `True` when the user selects "Retry", and `False` when they select "Quit". If `retry` is false, the Dialog object returns `None`.

property title: `str`

Title of the window. If no title is provided, the title will default to "Toga".

property toolbar: `MutableSet[Command]`

Toolbar for the window.

property visible: `bool`

Is the window visible?

property widgets: `Mapping[str, Widget]`

The widgets contained in the window.

Can be used to look up widgets by ID (e.g., `window.widgets["my_id"]`).

protocol `toga.window.`**`OnCloseHandler`**

`typing.Protocol`.

Classes that implement this protocol must have the following methods / attributes:

`__call__`(*window*, ***kwargs*)

A handler to invoke when a window is about to close.

The return value of this callback controls whether the window is allowed to close. This can be used to prevent a window closing with unsaved changes, etc.

Parameters

- **window** (*Window*) – The window instance that is closing.
- **kwargs** (Any) – Ensures compatibility with additional arguments introduced in future versions.

Return type

`bool`

Returns

`True` if the window is allowed to close; `False` if the window is not allowed to close.

protocol `toga.window.`**`DialogResultHandler`**

`typing.Protocol`.

Classes that implement this protocol must have the following methods / attributes:

`__call__`(*window*, *result*, ***kwargs*)

A handler to invoke when a dialog is closed.

Parameters

- **window** (*Window*) – The window that opened the dialog.
- **result** (TypeVar(T)) – The result returned by the dialog.
- **kwargs** (Any) – Ensures compatibility with additional arguments introduced in future versions.

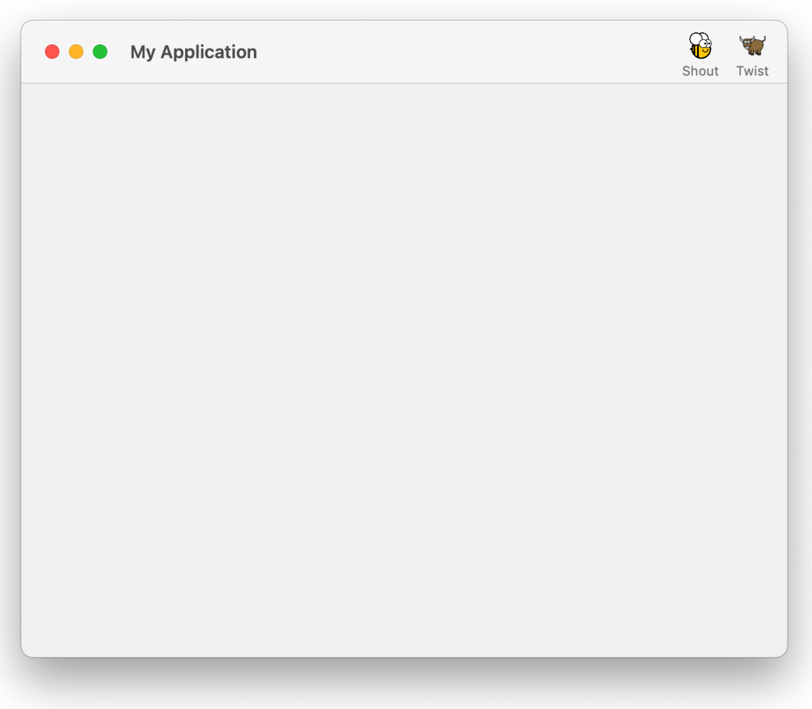
Return type

`None`

MainWindow

The main window of the application.

macOS



Linux

Windows

Android

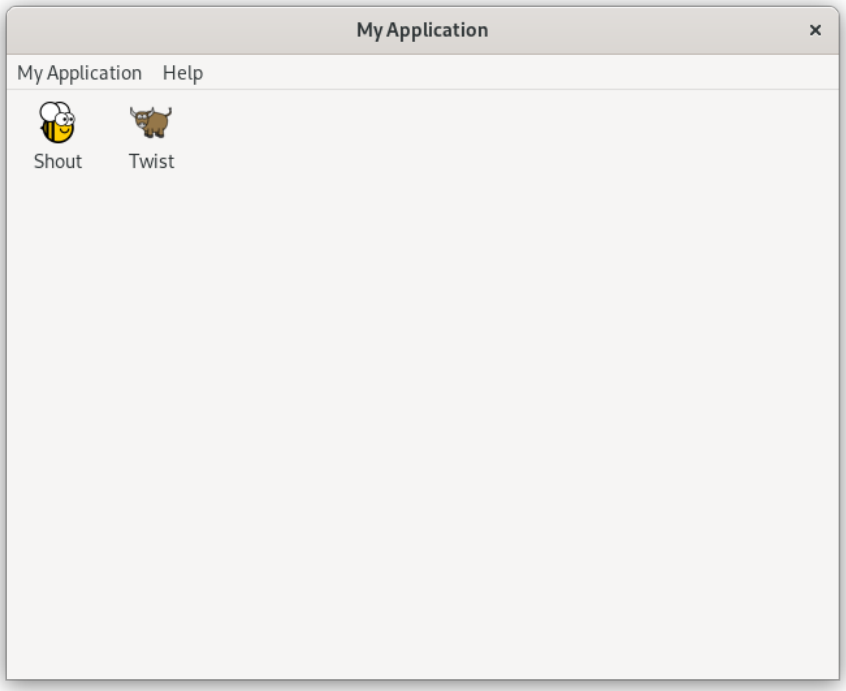
iOS

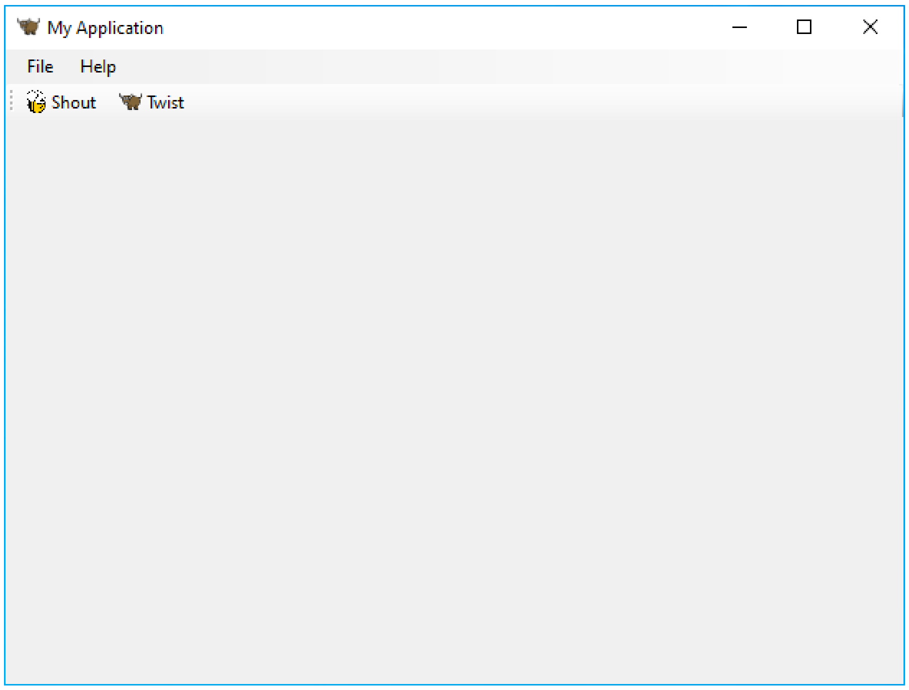
Usage

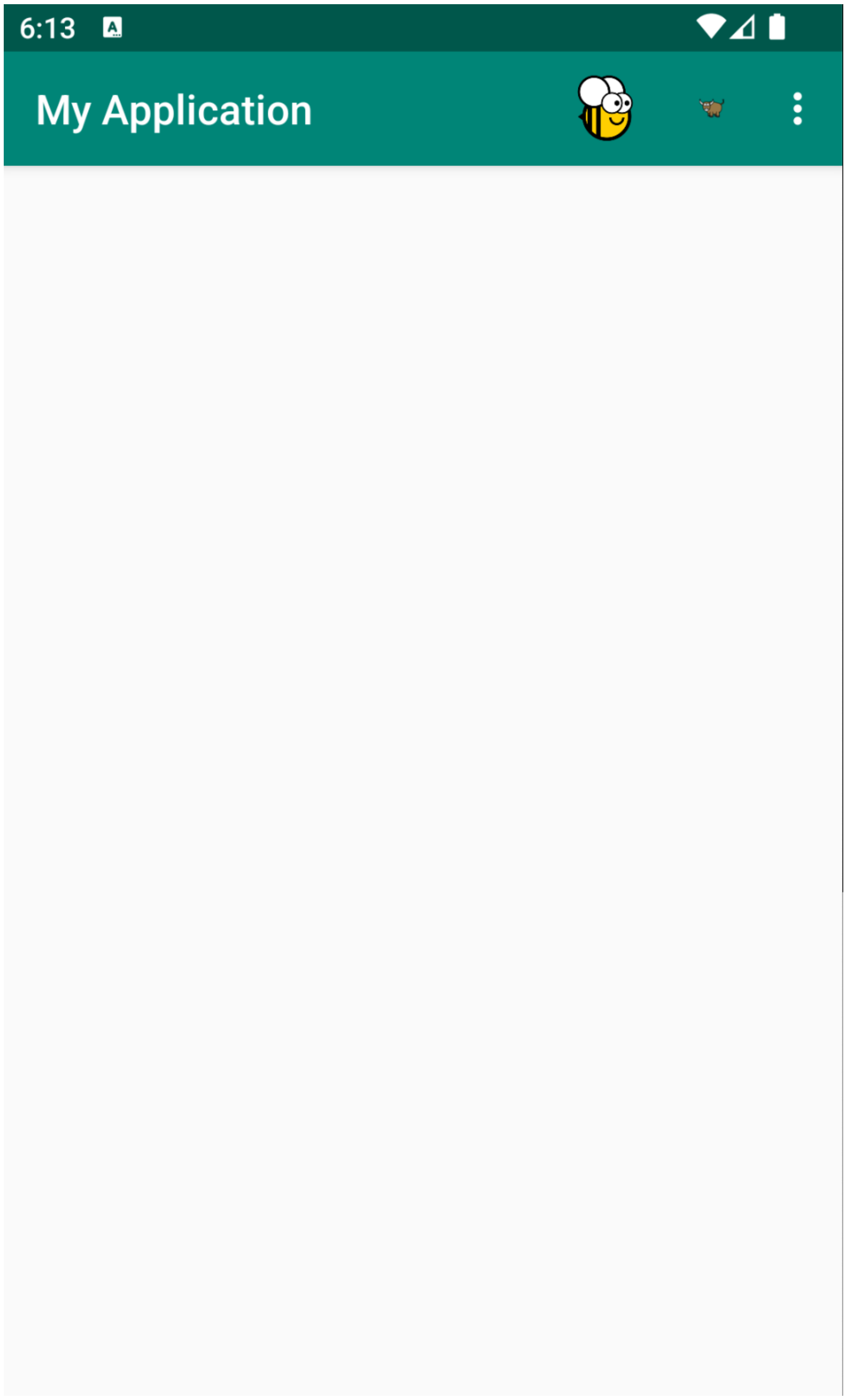
The main window of an application is a normal *toga.Window*, with one exception - when the main window is closed, the application exits.

```
import toga

main_window = toga.MainWindow(title='My Application')

self.toga.App.main_window = main_window
main_window.show()
```

As the main window is closely bound to the App, a main window *cannot* define an `on_close` handler. Instead, if you want to prevent the main window from exiting, you should use an `on_exit` handler on the *toga.App* that the main window is associated with.


My Application
My Application
Help
Shout
Twist


My Application
File
Help
Shout
Twist


6:13
My Application

8:42
My Application

Reference

class toga.**MainWindow**(*id=None*, *title=None*, *position=(100, 100)*, *size=(640, 480)*, *resizable=True*, *minimizable=True*, *resizeable=None*, *closeable=None*)

Bases: *Window*

Create a new main window.

Parameters

- **id** (Optional[str]) – A unique identifier for the window. If not provided, one will be automatically generated.
- **title** (Optional[str]) – Title for the window. Defaults to the formal name of the app.
- **position** (tuple[int, int]) – Position of the window, as a tuple of `(x, y)` coordinates, in *CSS pixels*.
- **size** (tuple[int, int]) – Size of the window, as a tuple of `(width, height)`, in *CSS pixels*.
- **resizable** (bool) – Can the window be resized by the user?
- **minimizable** (bool) – Can the window be minimized by the user?
- **resizeable** – **DEPRECATED** - Use `resizable`.
- **closeable** – **DEPRECATED** - Use `closable`.

property on_close: None

The handler to invoke before the window is closed in response to a user action.

Always returns `None`. Main windows should use *toga.App.on_exit()*, rather than `on_close`.

Raises

ValueError – if an attempt is made to set the `on_close` handler.

Containers

Box

A generic container for other widgets. Used to construct layouts.

Table 7: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal

Usage

An empty Box can be constructed without any children, with children added to the box after construction:

```python
import toga

box = toga.Box()

label1 = toga.Label('Hello')
label2 = toga.Label('World')

box.add(label1)
box.add(label2)
```

Alternatively, children can be specified at the time the box is constructed:

```python
import toga

label1 = toga.Label('Hello')
label2 = toga.Label('World')

box = toga.Box(children=[label1, label2])
```

In most apps, a layout is constructed by building a tree of boxes inside boxes, with concrete widgets (such as *`Label`* or *`Button`*) forming the leaf nodes of the tree. Style directives can be applied to enforce padding around the outside of the box, direction of child stacking inside the box, and background color of the box.

Reference

`class toga.`**`Box`**(*id=None*, *style=None*, *children=None*)

Bases: *`Widget`*

Create a new Box container widget.

Parameters

- **`id`** (`Optional[str]`) – The ID for the widget.
- **`style`** – A style object. If no style is provided, a default style will be applied to the widget.
- **`children`** (`Optional[list[`*`Widget`*`]]`) – An optional list of children for to add to the Box.

`property enabled:` `bool`

Is the widget currently enabled? i.e., can the user interact with the widget?

Box widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

`focus``()`

No-op; Box cannot accept input focus.

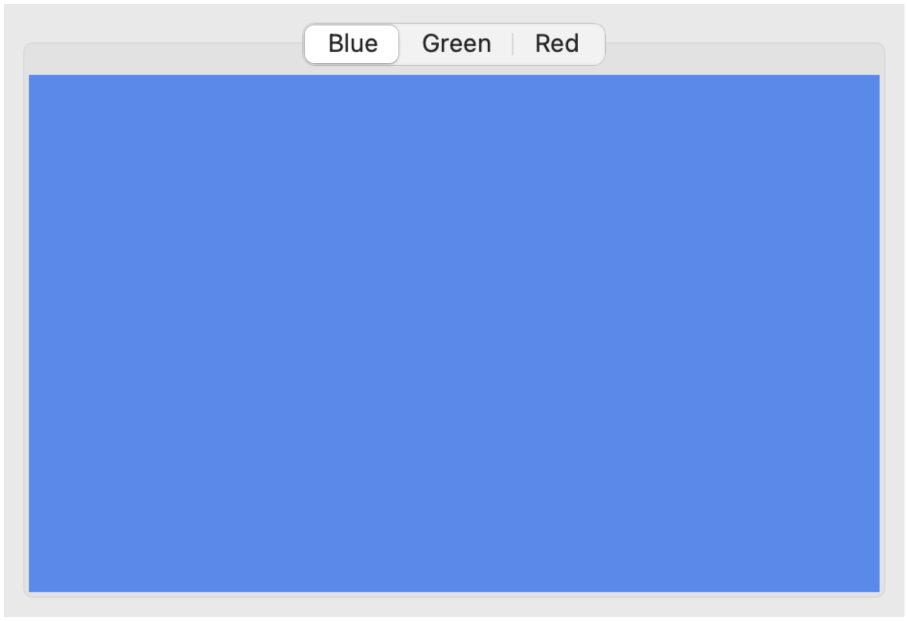
Return type

`None`

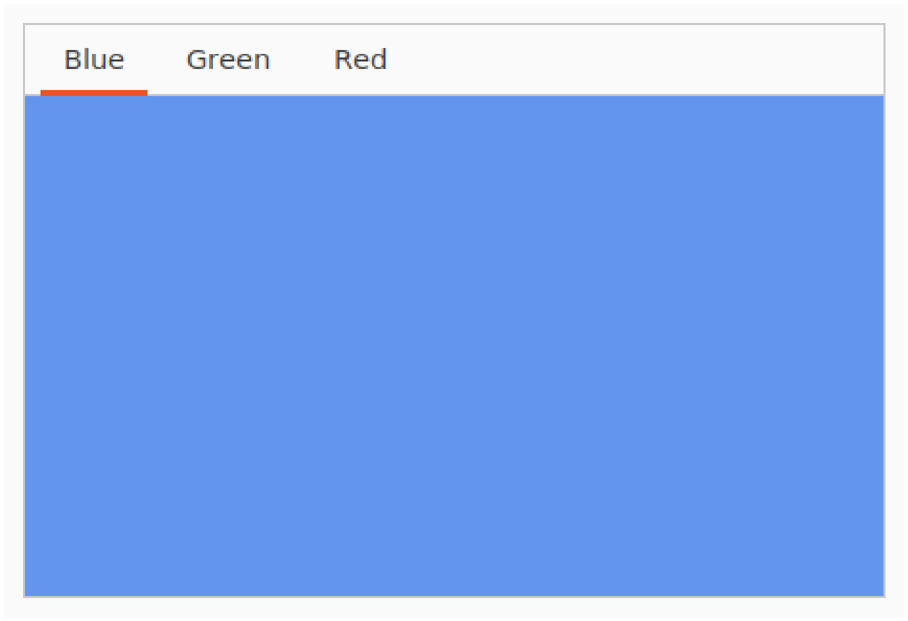
OptionContainer

A container that can display multiple labeled tabs of content.

macOS



Linux

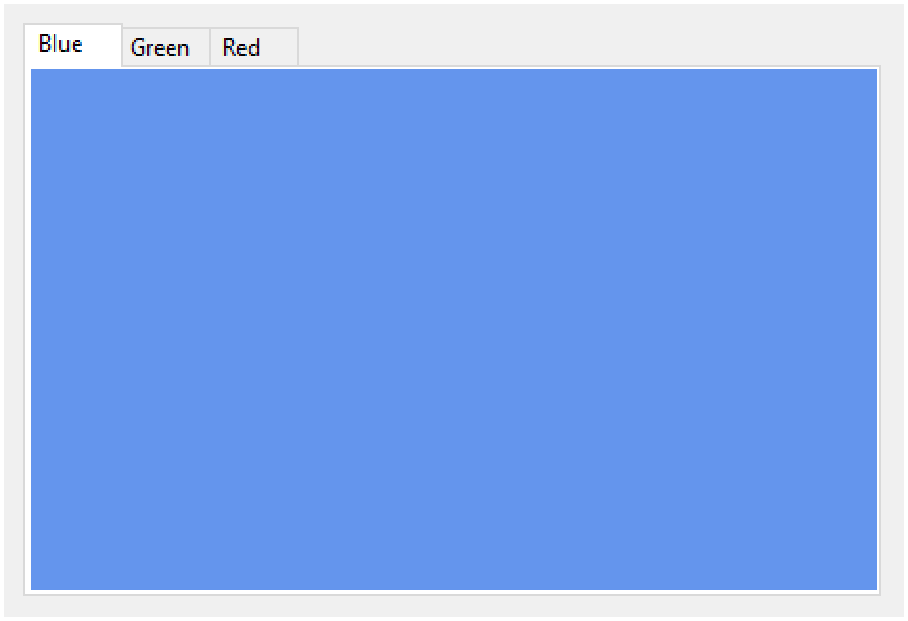


Windows

Android ×

Not supported

iOS ×



Not supported

Web ×

Not supported

Textual ×

Not supported

Usage

```python
import toga

pizza = toga.Box()
pasta = toga.Box()

container = toga.OptionContainer(
    content=[("Pizza", pizza), ("Pasta", pasta)]
)

# Add another tab of content
salad = toga.Box()
container.content.append("Salad", salad)
```

When retrieving or deleting items, or when specifying the currently selected item, you can specify an item using:

- The index of the item in the list of content:

  ```python
  # Insert a new second tab
  container.content.insert(1, "Soup", toga.Box())
  # Make the third tab the currently active tab
  container.current_tab = 2
  ```

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```python
# Delete the second tab
del container.content[1]
```

- The string label of the tab:

```python
# Insert a tab at the index currently occupied by a tab labeled "Pasta"
container.content.insert("Pasta", "Soup", toga.Box())
# Make the tab labeled "Pasta" the currently active tab
container.current_tab = "Pasta"
# Delete tab labeled "Pasta"
del container.content["Pasta"]
```

- A reference to an `OptionItem`:

```python
# Get a reference to the "Pasta" tab
pasta_tab = container.content["Pasta"]
# Insert content at the index currently occupied by the pasta tab
container.content.insert(pasta_tab, "Soup", toga.Box())
# Make the pasta tab the currently active tab
container.current_tab = pasta_tab
# Delete the pasta tab
del container.content[pasta_tab]
```

Reference

class `toga.OptionContainer`(*id=None*, *style=None*, *content=None*, *on_select=None*)

Bases: `Widget`

Create a new OptionContainer.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **content** (*list[tuple[str, Widget]] | None*) – The initial content to display in the OptionContainer. A list of 2-tuples, each of which is the title for the option, and the content widget to display for that title.
- **on_select** (*callable | None*) – Initial `on_select` handler.

property content: `OptionList`

The tabs of content currently managed by the OptionContainer.

property current_tab: `OptionItem` **|** `None`

The currently selected tab of content, or `None` if there are no tabs.

This property can also be set with an `int` index, or a `str` label.

property enabled: `bool`

Is the widget currently enabled? i.e., can the user interact with the widget?

OptionContainer widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

`focus()`

No-op; OptionContainer cannot accept input focus

property on_select: callable

The callback to invoke when a new tab of content is selected.

class `toga.widgets.optioncontainer.OptionList`(*interface*)

`__delitem__`(*index*)

Same as `remove`.

`__getitem__`(*index*)

Obtain a specific tab of content.

Return type
`OptionItem`

append(*text*, *widget*, *enabled=True*)

Add a new tab of content to the OptionContainer.

Parameters

- **text** (`str`) – The text label for the new tab
- **widget** (`Widget`) – The content widget to use for the new tab.

index(*value*)

Find the index of the tab that matches the given value.

Parameters
value (`str` | `int` | `OptionItem`) – The value to look for. An integer is returned as-is; if an `OptionItem` is provided, that item's index is returned; any other value will be converted into a string, and the first tab with a label matching that string will be returned.

Raises
`ValueError` – If no tab matching the value can be found.

insert(*index*, *text*, *widget*, *enabled=True*)

Insert a new tab of content to the OptionContainer at the specified index.

Parameters

- **index** (`int` | `str` | `OptionItem`) – The index where the new tab should be inserted.
- **text** (`str`) – The text label for the new tab.
- **widget** (`Widget`) – The content widget to use for the new tab.
- **enabled** (`bool`) – Should the new tab be enabled?

remove(*index*)

Remove the specified tab of content.

The currently selected item cannot be deleted.

class `toga.widgets.optioncontainer.OptionItem`(*interface*, *widget*, *index*)

A tab of content in an OptionContainer.

property content: `Widget`

The content widget displayed in this tab of the OptionContainer.

property enabled: bool

Is the panel of content available for selection?

property index: int

The index of the tab in the OptionContainer.

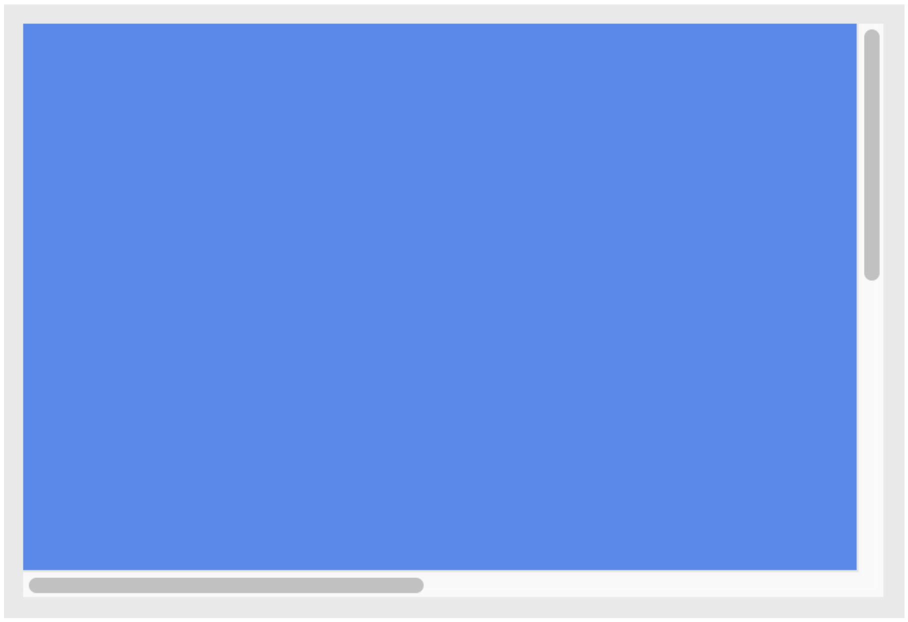
property text: str

The label for the tab of content.

ScrollContainer

A container that can display a layout larger than the area of the container, with overflow controlled by scroll bars.

macOS



Linux

Windows

Android

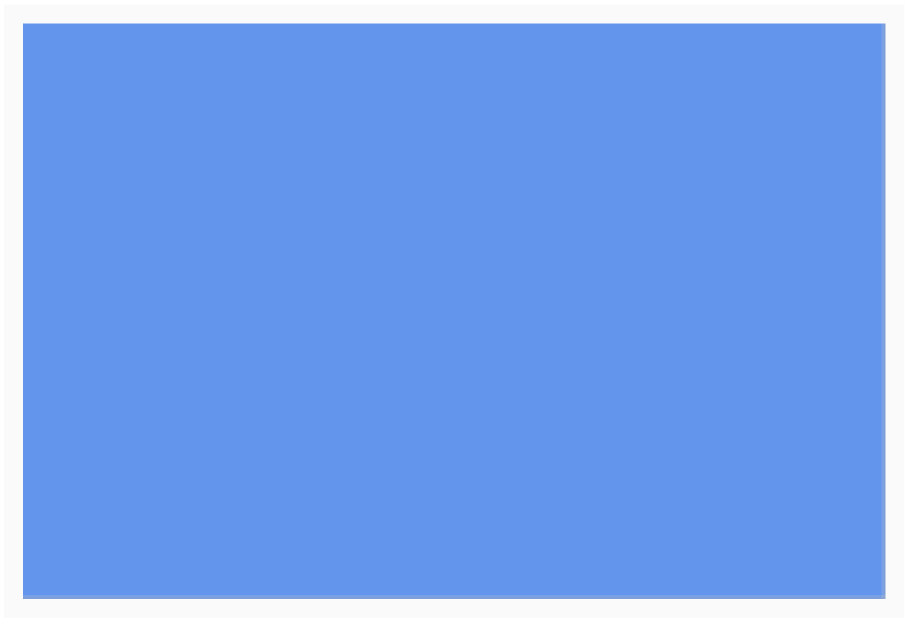
iOS

Web ×

Not supported

Textual ×

Not supported



Usage

```python
import toga

content = toga.Box(children=[...])

container = toga.ScrollContainer(content=content)
```

Reference

class toga.**ScrollContainer**(*id=None*, *style=None*, *horizontal=True*, *vertical=True*, *on_scroll=None*, *content=None*)

Bases: *Widget*

Create a new Scroll Container.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **horizontal** (*bool*) – Should horizontal scrolling be permitted?
- **vertical** (*bool*) – Should horizontal scrolling be permitted?
- **on_scroll** (*callable | None*) – Initial *on_scroll* handler.
- **content** (Widget | *None*) – The content to display in the scroll window.

property content: *Widget*

The root content widget displayed inside the scroll container.

property enabled: bool

Is the widget currently enabled? i.e., can the user interact with the widget?

ScrollContainer widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

focus()

No-op; ScrollContainer cannot accept input focus

property horizontal: bool

Is horizontal scrolling enabled?

property horizontal_position: int

The current horizontal scroll position.

If the value provided is negative, or greater than the maximum horizontal position, the value will be clipped to the valid range.

Returns
The current horizontal scroll position.

Raises
ValueError – If an attempt is made to change the horizontal position when horizontal scrolling is disabled.

property max_horizontal_position: int

The maximum horizontal scroll position (read-only).

property max_vertical_position: int

The maximum vertical scroll position (read-only).

property on_scroll: callable

Handler to invoke when the user moves a scroll bar.

property position: tuple[int, int]

The current scroll position, in the form (horizontal, vertical).

If the value provided for either axis is negative, or greater than the maximum position in that axis, the value will be clipped to the valid range.

If scrolling is disabled in either axis, the value provided for that axis will be ignored.

property vertical: bool

Is vertical scrolling enabled?

property vertical_position: int

The current vertical scroll position.

If the value provided is negative, or greater than the maximum vertical position, the value will be clipped to the valid range.

Returns
The current vertical scroll position.

Raises
`ValueError` – If an attempt is made to change the vertical position when vertical scrolling is disabled.

SplitContainer

A container that divides an area into two panels with a movable border.

macOS

Linux

Windows

Android ×

Not supported

iOS ×

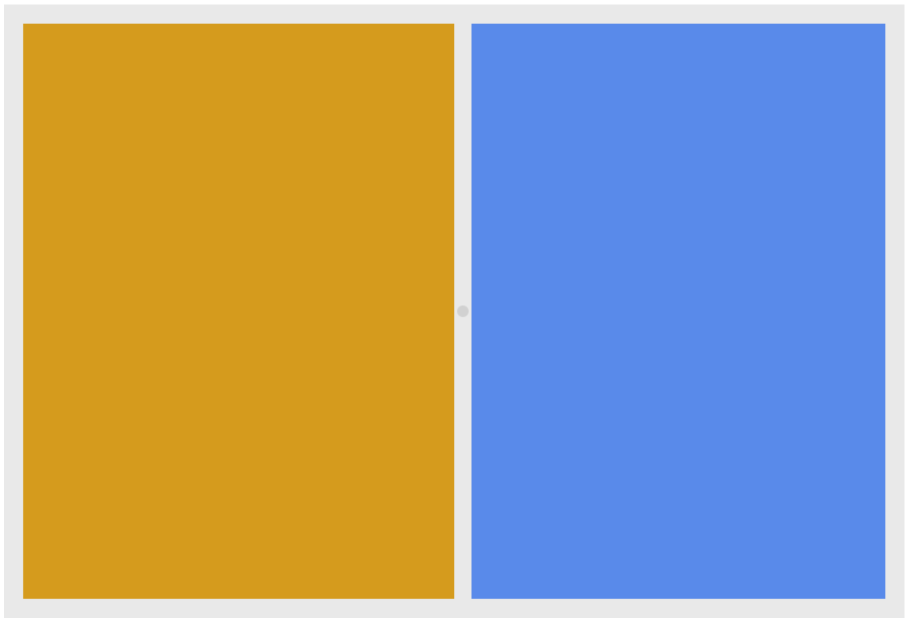
Not supported

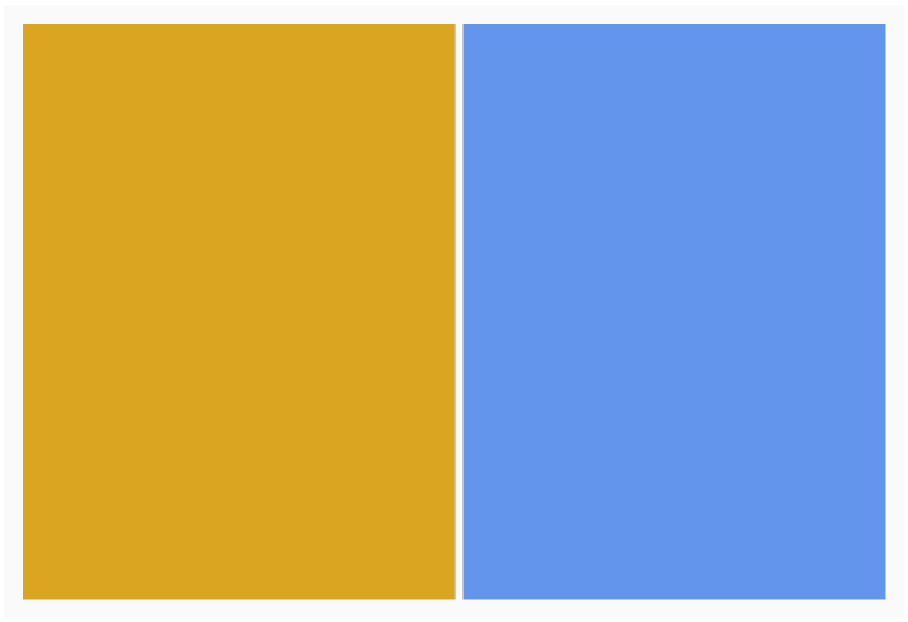
Web ×

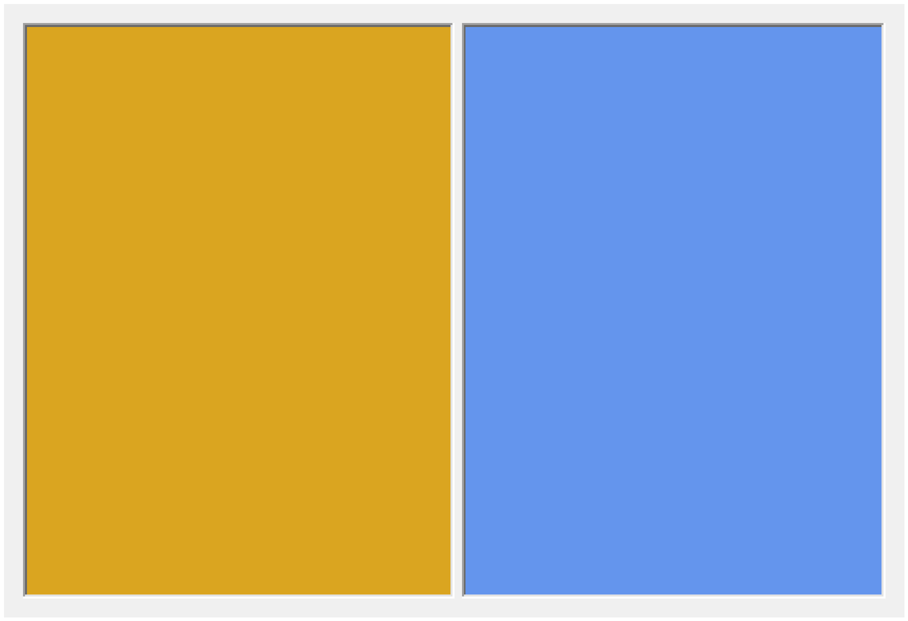
Not supported

Textual ×

Not supported







Usage

```python
import toga

left_container = toga.Box()
right_container = toga.ScrollContainer()

split = toga.SplitContainer(content=[left_container, right_container])
```

Content can be specified when creating the widget, or after creation by assigning the `content` attribute. The direction of the split can also be configured, either at time of creation, or by setting the `direction` attribute:

```python
import toga
from toga.constants import Direction

split = toga.SplitContainer(direction=Direction.HORIZONTAL)

left_container = toga.Box()
right_container = toga.ScrollContainer()

split.content = [left_container, right_container]
```

By default, the space of the SplitContainer will be evenly divided between the two panels. To specify an uneven split, you can provide a flex value when specifying content. In the following example, there will be a 60/40 split between the left and right panels.

```python
import toga

split = toga.SplitContainer()
left_container = toga.Box()
right_container = toga.ScrollContainer()
```

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```
split.content = [(left_container, 3), (right_container, 2)]
```

This only specifies the initial split; the split can be modified by the user once it is displayed.

Reference

class toga.SplitContainer(*id=None*, *style=None*, *direction=Direction.VERTICAL*, *content=(None, None)*)

Bases: *Widget*

Create a new SplitContainer.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **direction** (*Direction*) – The direction in which the divider will be drawn. Either *HORIZONTAL* or *VERTICAL*; defaults to *VERTICAL*
- **content** (tuple[UnionType[*Widget*, None, tuple], UnionType[*Widget*, None, tuple]]) – Initial *content* of the container. Defaults to both panels being empty.

property content: tuple[*toga.widgets.base.Widget* | None | tuple, *toga.widgets.base.Widget* | None | tuple]

The widgets displayed in the SplitContainer.

This property accepts a sequence of exactly 2 elements, each of which can be either:

- A *Widget* to display in the panel.
- None, to make the panel empty.
- A tuple consisting of a Widget (or None) and the initial flex value to apply to that panel in the split, which must be greater than 0.

If a flex value isn't specified, a value of 1 is assumed.

When reading this property, only the widgets are returned, not the flex values.

property direction: *Direction*

The direction of the split

property enabled: bool

Is the widget currently enabled? i.e., can the user interact with the widget?

SplitContainer widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

focus()

No-op; SplitContainer cannot accept input focus

Resources

App Paths

A mechanism for obtaining platform-appropriate file system locations for an application.

Table 8: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal

Usage

When Python code executes from the command line, the working directory is a known location - the location where the application was started. However, when executing GUI apps, the working directory varies between platforms. As a result, when specifying file paths, relative paths cannot be used, as there is no location to which they can be considered relative.

Complicating matters further, operating systems have conventions (and in some cases, hard restrictions) over where certain file types should be stored. For example, macOS provides the `~/Library/Application Support` folder; Linux encourages use of the `~/.config` folder (amongst others), and Windows provides the `AppData/Local` folder in the user's home directory. Application sandbox and security policies will prevent sometimes prevent reading or writing files in any location other than these pre-approved locations.

To assist with finding an appropriate location to store application files, every Toga application instance has a *`paths`* attribute that returns an instance of *`Paths`*. This object provides known file system locations that are appropriate for storing files of given types, such as configuration files, log files, cache files, or user data.

Each location provided by the *`Paths`* object is a `pathlib.Path` that can be used to construct a full file path. If required, additional sub-folders can be created under these locations.

You should not assume that any of these paths already exist. The location is guaranteed to follow operating system conventions, but the application is responsible for ensuring the folder exists prior to writing files in these locations.

Reference

class `toga.paths.`**`Paths`**

property app: `Path`

The path of the folder that contains the definition of the app class.

This path should be considered read-only. You should not attempt to write files into this path.

property cache: `Path`

The platform-appropriate location for storing cache files associated with this app.

It should be assumed that the operating system will purge the contents of this directory without warning if it needs to recover disk space.

property config: `Path`

The platform-appropriate location for storing user configuration files associated with this app.

property data: `Path`

The platform-appropriate location for storing user data associated with this app.

property logs: Path

The platform-appropriate location for storing log files associated with this app.

property toga: Path

The path that contains the core Toga resources.

This path should be considered read-only. You should not attempt to write files into this path.

Font

A font for displaying text.

Table 9: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal

Usage

For most widget styling, you do not need to create instances of the `Font` class. Fonts are applied to widgets using style properties:

```
import toga
from toga.style.pack import pack, SERIF, BOLD

# Create a bold label in the system's serif font at default system size.
my_label = toga.Label("Hello World", style=Pack(font_family=SERIF, font_weight=BOLD))
```

Toga provides a number of *built-in system fonts*. Font sizes are specified in *CSS points*; the default size depends on the platform and the widget.

If you want to use a custom font, the font file must be provided as part of your app's resources, and registered before first use:

```
import toga

# Register the user font with name "Roboto"
toga.Font.register("Roboto", "resources/Roboto-Regular.ttf")

# Create a label with the new font.
my_label = toga.Label("Hello World", style=Pack(font_family="Roboto"))
```

When registering a font, if an invalid value is provided for the style, variant or weight, `NORMAL` will be used.

When a font includes multiple weights, styles or variants, each one must be registered separately, even if they're stored in the same file:

```
import toga
from toga.style.pack import BOLD

# Register a regular and bold font, contained in separate font files
Font.register("Roboto", "resources/Roboto-Regular.ttf")
```

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```
Font.register("Roboto", "resources/Roboto-Bold.ttf", weight=BOLD)

# Register a single font file that contains both a regular and bold weight
Font.register("Bahnschrift", "resources/Bahnschrift.ttf")
Font.register("Bahnschrift", "resources/Bahnschrift.ttf", weight=BOLD)
```

A small number of Toga APIs (e.g., `Context.write_text`) *do* require the use of `Font` instance. In these cases, you can instantiate a Font using similar properties to the ones used for widget styling:

```
import toga
from toga.style.pack import BOLD

# Obtain a 14 point Serif bold font instance
my_font = toga.Font(SERIF, 14, weight=BOLD)

# Use the font to write on a canvas.
canvas = toga.Canvas()
canvas.context.write_text("Hello", font=my_font)
```

Notes

- iOS and macOS do not support the use of variant font files (that is, fonts that contain the details of multiple weights/variants in a single file). Variant font files can be registered; however, only the "normal" variant will be used.
- Android and Windows do not support the oblique font style. If an oblique font is specified, Toga will attempt to use an italic style of the same font.
- Android and Windows do not support the small caps font variant. If a Small Caps font is specified, Toga will use the normal variant of the same font.

Reference

class `toga.`**`Font`**(*family*, *size*, ***, *weight=NORMAL*, *style=NORMAL*, *variant=NORMAL*)

Constructs a reference to a font.

This class should be used when an API requires an explicit font reference (e.g. `Context.write_text`). In all other cases, fonts in Toga are controlled using the style properties linked below.

Parameters

- **family** (`str`) – The *font family*.
- **size** (`int` | `str`) – The *font size*.
- **weight** (`str`) – The *font weight*.
- **style** (`str`) – The *font style*.
- **variant** (`str`) – The *font variant*.

static register(*family*, *path*, ***, *weight=NORMAL*, *style=NORMAL*, *variant=NORMAL*)

Registers a file-based font.

Note: This is not currently supported on macOS or iOS.

Parameters

- **family** – The *font family*.
- **path** – The path to the font file. This can be an absolute path, or a path relative to the module that defines your *App* class.
- **weight** – The *font weight*.
- **style** – The *font style*.
- **variant** – The *font variant*.

Command

A representation of app functionality that the user can invoke from menus or toolbars.

Table 10: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal

Usage

Aside from event handlers on widgets, most GUI toolkits also provide other ways for the user to give instructions to an app. In Toga, these UI patterns are supported by the `Command` class.

A command encapsulates a piece of functionality that the user can invoke - no matter how they invoke it. It doesn't matter if they select a menu item, press a button on a toolbar, or use a key combination - the functionality is wrapped up in a Command.

Commands are added to an app using the properties `toga.App.commands` and `toga.Window.toolbar`. Toga then takes control of ensuring that the command is exposed to the user in a way that they can access. On desktop platforms, this may result in a command being added to a menu.

Commands can be organized into a `Group` of similar commands. Groups are hierarchical, so a group can contain a sub-group, which can contain a sub-group, and so on. Inside a group, commands can be organized into sections.

For example:

```
import toga

def callback(sender, **kwargs):
    print("Command activated")

stuff_group = Group('Stuff', order=40)

cmd1 = toga.Command(
    callback,
    label='Example command',
    tooltip='Tells you when it has been activated',
    shortcut='k',
    icon='icons/pretty.png',
    group=stuff_group,
    section=0
```

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```
)
cmd2 = toga.Command(
    ...
)
...

app.commands.add(cmd1, cmd4, cmd3)
app.main_window.toolbar.add(cmd2, cmd3)
```

This code defines a command `cmd1` that will be placed in the first section of the "Stuff" group. It can be activated by pressing CTRL-k (or CMD-K on a Mac).

The definitions for `cmd2`, `cmd3`, and `cmd4` have been omitted, but would follow a similar pattern.

It doesn't matter what order you add commands to the app - the group, section and order will be used to display the commands in the right order.

If a command is added to a toolbar, it will automatically be added to the app as well. It isn't possible to have functionality exposed on a toolbar that isn't also exposed by the app. So, `cmd2` will be added to the app, even though it wasn't explicitly added to the app commands.

Reference

`class toga.Command(`*action*, *text*, ***, *shortcut=None*, *tooltip=None*, *icon=None*, *group=Group.COMMANDS*, *section=0*, *order=0*, *enabled=True*`)`

Create a new Command.

Commands may not use all the arguments - for example, on some platforms, menus will contain icons; on other platforms they won't.

Parameters

- **action** (`Optional[`*ActionHandler*`]`) – A handler to invoke when the command is activated. If this is `None`, the command will be disabled.
- **text** (`str`) – A label for the command.
- **shortcut** (`Optional[str]`) – A key combination that can be used to invoke the command.
- **tooltip** (`Optional[str]`) – A short description of what the command will do.
- **icon** (`UnionType[str, `*Icon*`, None]`) – The icon, or icon resource, that can be used to decorate the command if the platform requires.
- **group** (*Group*) – The group to which this command belongs.
- **section** (`int`) – The section where the command should appear within its group.
- **order** (`int`) – The position where the command should appear within its section. If multiple items have the same group, section and order, they will be sorted alphabetically by their text.
- **enabled** (`bool`) – Is the Command currently enabled?

`property enabled: bool`

Is the command currently enabled?

property icon: *Icon* | None

The Icon for the command.

When setting the icon, you can provide either an *Icon* instance, or a path that will be passed to the `Icon` constructor.

class toga.Group(*text*, **, *parent=None*, *section=0*, *order=0*)

An collection of commands to display together.

Parameters

- **text** (`str`) – A label for the group.
- **parent** (`Optional`[*Group*]) – The parent of this group; use `None` to make a root group.
- **section** (`int`) – The section where the group should appear within its parent. A section cannot be specified unless a parent is also specified.
- **order** (`int`) – The position where the group should appear within its section. If multiple items have the same group, section and order, they will be sorted alphabetically by their text.

APP = <Group text='*' order=0>

Application-level commands

COMMANDS = <Group text='Commands' order=30>

Default group for user-provided commands

EDIT = <Group text='Edit' order=10>

Editing commands

FILE = <Group text='File' order=1>

File commands

HELP = <Group text='Help' order=100>

Help commands

VIEW = <Group text='View' order=20>

Content appearance commands

WINDOW = <Group text='Window' order=90>

Window management commands

is_child_of(*parent*)

Is this group a child of the provided group, directly or indirectly?

Parameters
parent (`Optional`[*Group*]) – The potential parent to check

Return type
`bool`

Returns
True if this group is a child of the provided parent.

is_parent_of(*child*)

Is this group a parent of the provided group, directly or indirectly?

Parameters
child (`Optional`[*Group*]) – The potential child to check

Return type
`bool`

Returns
True if this group is a parent of the provided child.

property parent: *Group* | None

The parent of this group; returns `None` if the group is a root group.

property root: *Group*

The root group for this group.

This will be `self` if the group *is* a root group.

protocol toga.command.ActionHandler

`typing.Protocol`.

Classes that implement this protocol must have the following methods / attributes:

`__call__`(*command*, ***kwargs*)

A handler that will be invoked when a Command is invoked.

Parameters

- **command** (*Command*) – The command that triggered the action.
- **kwargs** – Ensures compatibility with additional arguments introduced in future versions.

Return type
`bool`

Icon

A small, square image, used to provide easily identifiable visual context to a widget.

Table 11: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal

Usage

The filename specified for an icon should be specified *without* an extension; the platform will determine an appropriate extension, and may also modify the name of the icon to include a size qualifier.

The following formats are supported (in order of preference):

- **Android** - PNG
- **iOS** - ICNS, PNG, BMP, ICO
- **macOS** - ICNS, PNG, PDF
- **GTK** - PNG, ICO, ICNS. 32px and 72px variants of each icon can be provided;
- **Windows** - ICO, PNG, BMP

The first matching icon of the most specific size will be used. For example, on Windows, specifying an icon of `myicon` will cause Toga to look for `myicon.ico`, then `myicon.png`, then `myicon.bmp`. On GTK, Toga will look for `myicon-72.png` and `myicon-32.png`, then `myicon.png`, then `myicon-72.ico` and `myicon-32.ico`, and so on.

An icon is **guaranteed** to have an implementation. If you specify a path and no matching icon can be found, Toga will output a warning to the console, and load a default "Tiberius the yak" icon.

Reference

`class toga.Icon(path, *, system=False)`

Create a new icon.

Parameters

path (str | Path) – Base filename for the icon. The path can be an absolute file system path, or a path relative to the module that defines your Toga application class.

This base filename should *not* contain an extension. If an extension is specified, it will be ignored.

DEFAULT_ICON

TOGA_ICON

Image

Table 12: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal

An image is graphical content of arbitrary size.

Usage

```
from pathlib import Path
import toga

# Load an image in the same folder as the file that declares the App class
my_image = toga.Image("brutus.png")

# Load an image at an absolute path
my_image = toga.Image(Path.home() / "path" / "to" / "brutus.png")

# Create an image from raw data
with (Path.home() / "path" / "to" / "brutus.png").open("rb") as f:
    my_image = toga.Image(data=f.read())
```

Notes

- PNG and JPEG formats are guaranteed to be supported. Other formats are available on some platforms:
  - macOS: GIF, BMP, TIFF
  - GTK: BMP
  - Windows: GIF, BMP, TIFF

Reference

`class toga.Image(path=None, *, data=None)`

Create a new image.

An image must be provided either a `path` or `data`, but not both.

Parameters

- **path** (UnionType[str, None, Path]) – Path to the image to load. This can be specified as a string, or as a `pathlib.Path` object. The path can be an absolute file system path, or a path relative to the module that defines your Toga application class.
- **data** (Optional[bytes]) – A bytes object with the contents of an image in a supported format.

Raises

- `FileNotFoundError` – If a path is provided, but that path does not exist.
- `ValueError` – If the path or data cannot be loaded as an image.

`property data: bytes`

The raw data for the image, in PNG format.

Returns
The raw image data in PNG format.

`property height: int`

The height of the image, in pixels.

`save(path)`

Save image to given path.

The file format of the saved image will be determined by the extension of the filename provided (e.g `path/to/mypicture.png` will save a PNG file).

Parameters
path (str | Path) – Path where to save the image.

`property size: int, int`

The size of the image, as a tuple

`property width: int`

The width of the image, in pixels.

Source

A base class for data source implementations.

Usage

Data sources are abstractions that allow you to define the data being managed by your application independent of the GUI representation of that data. For details on the use of data sources, see the *background guide*.

Source isn't useful on its own; it is a base class for data source implementations. It is used by ListSource, TreeSource and ValueSource, but it can also be used by custom data source implementations. It provides an implementation of the notification API that data sources must provide.

Reference

class `toga.sources.`**`Listener`**(**args*, ***kwargs*)

Bases: `Protocol`

The protocol that must be implemented by objects that will act as a listener on a data source.

`change`(*item*)

A change has occurred in an item.

Parameters
`item` – The data object that has changed.

`clear`()

All items have been removed from the data source.

Parameters

- **`index`** – The 0-index position in the data.
- **`item`** – The data object that was added.

`insert`(*index*, *item*)

An item has been added to the data source.

Parameters

- **`index`** (`int`) – The 0-index position in the data.
- **`item`** – The data object that was added.

`remove`(*index*, *item*)

An item has been removed from the data source.

Parameters

- **`index`** (`int`) – The 0-index position in the data.
- **`item`** – The data object that was added.

class `toga.sources.`**`Source`**

A base class for data sources, providing an implementation of data notifications.

`add_listener`(*listener*)

Add a new listener to this data source.

If the listener is already registered on this data source, the request to add is ignored.

Parameters
`listener` (*`Listener`*) – The listener to add

property listeners: list[*toga.sources.base.Listener*]

The listeners of this data source.

Returns

A list of objects that are listening to this data source.

notify(*notification*, ***kwargs*)

Notify all listeners an event has occurred.

Parameters

- **notification** (str) – The notification to emit.
- **kwargs** – The data associated with the notification.

remove_listener(*listener*)

Remove a listener from this data source.

Parameters

listener (*Listener*) – The listener to remove.

ListSource

A data source describing an ordered list of data.

Usage

Data sources are abstractions that allow you to define the data being managed by your application independent of the GUI representation of that data. For details on the use of data sources, see the *background guide*.

ListSource is an implementation of an ordered list of data. When a ListSource is created, it is given a list of `accessors` - these are the attributes that all items managed by the ListSource will have. The API provided by ListSource is `list`-like; the operations you'd expect on a normal Python list, such as `insert`, `remove`, `index`, and indexing with `[]`, are also possible on a ListSource:

```python
from toga.sources import ListSource

source = ListSource(
    accessors=["name", "weight"],
    data=[
        {"name": "Platypus", "weight": 2.4},
        {"name": "Numbat", "weight": 0.597},
        {"name": "Thylacine", "weight": 30.0},
    ]
)

# Get the first item in the source
item = source[0]
print(f"Animal's name is {item.name}")

# Find an item with a name of "Thylacine"
item = source.find({"name": "Thylacine"})

# Remove that item from the data
source.remove(item)
```

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```
# Insert a new item at the start of the data
source.insert(0, {"name": "Bettong", "weight": 1.2})
```

The ListSource manages a list of *Row* objects. Each Row has all the attributes described by the source's `accessors`. A Row object will be constructed for each item that is added to the ListSource, and each item can be:

- A dictionary, with the accessors mapping to the keys in the dictionary.
- Any other iterable object (except for a string), with the accessors being mapped onto the items in the iterable in order of definition.
- Any other object, which will be mapped onto the *first* accessor.

Although Toga provides ListSource, you are not required to create one directly. A ListSource will be transparently constructed if you provide an iterable object to a GUI widget that displays list-like data (i.e., *toga.Table*, *toga.Selection*, or *toga.DetailedList*).

Custom List Sources

For more complex applications, you can replace ListSource with a *custom data source* class. Such a class must:

- Inherit from *Source*
- Provide the same methods as *ListSource*
- Return items whose attributes match the accessors expected by the widget
- Generate a `change` notification when any of those attributes change
- Generate `insert`, `remove` and `clear` notifications when items are added or removed

Reference

class `toga.sources.`**`Row`**(***data*)

Create a new Row object.

The keyword arguments specified in the constructor will be converted into attributes on the new Row object.

When any public attributes of the Row are modified (i.e., any attribute whose name doesn't start with `_`), the source to which the row belongs will be notified.

`__setattr__`(*attr*, *value*)

Set an attribute on the Row object, notifying the source of the change.

Parameters

- **attr** (`str`) – The attribute to change.
- **value** – The new attribute value.

class `toga.sources.`**`ListSource`**(*accessors*, *data=None*)

Bases: *Source*

A data source to store an ordered list of multiple data values.

Parameters

- **accessors** (list[str]) – A list of attribute names for accessing the value in each column of the row.
- **data** (Optional[Iterable]) – The initial list of items in the source. Items are converted as shown *above*.

`__delitem__`(*index*)

Deletes the item at position `index` of the list.

`__getitem__`(*index*)

Returns the item at position `index` of the list.

Return type
Row

`__len__`()

Returns the number of items in the list.

Return type
`int`

`__setitem__`(*index*, *value*)

Set the value of a specific item in the data source.

Parameters

- **index** (`int`) – The item to change
- **value** (`Any`) – The data for the updated item. This data will be converted into a Row object.

`append`(*data*)

Insert a row at the end of the data source.

Parameters
data – The data to append to the ListSource. This data will be converted into a Row object.

Returns
The newly constructed Row object.

`clear`()

Clear all data from the data source.

`find`(*data*, *start=None*)

Find the first item in the data that matches all the provided attributes.

This is a value based search, rather than an instance search. If two Row instances have the same values, the first instance that matches will be returned. To search for a second instance, provide the first found instance as the `start` argument. To search for a specific Row instance, use the *`index()`*.

Parameters

- **data** (*Any*) – The data to search for. Only the values specified in data will be used as matching criteria; if the row contains additional data attributes, they won't be considered as part of the match.
- **start** (*None | None*) – The instance from which to start the search. Defaults to `None`, indicating that the first match should be returned.

Returns
The matching Row object

Raises
`ValueError` – If no match is found.

index(*row*)

The index of a specific row in the data source.

This search uses Row instances, and searches for an *instance* match. If two Row instances have the same values, only the Row that is the same Python instance will match. To search for values based on equality, use *find()*.

Parameters
row (*Row*) – The row to find in the data source.

Return type
int

Returns
The index of the row in the data source.

Raises
ValueError – If the row cannot be found in the data source.

insert(*index*, *data*)

Insert a row into the data source at a specific index.

Parameters

- **index** (int) – The index at which to insert the item.
- **data** (Any) – The data to insert into the ListSource. This data will be converted into a Row object.

Returns
The newly constructed Row object.

remove(*row*)

Remove a row from the data source.

Parameters
row (*Row*) – The row to remove from the data source.

TreeSource

A data source describing an ordered hierarchical tree of values.

Usage

Data sources are abstractions that allow you to define the data being managed by your application independent of the GUI representation of that data. For details on the use of data sources, see the *background guide*.

TreeSource is an implementation of an ordered hierarchical tree of values. When a TreeSource is created, it is given a list of `accessors` - these are the attributes that all items managed by the TreeSource will have. The API provided by TreeSource is `list`-like; the operations you'd expect on a normal Python list, such as `insert`, `remove`, `index`, and indexing with `[]`, are also possible on a TreeSource. These methods are available on the TreeSource itself to manipulate root nodes, and also on each node within the tree.

```python
from toga.sources import TreeSource

source = TreeSource(
    accessors=["name", "height"],
```

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```
    data={
        "Animals": [
            ({"name": "Numbat", "height": 0.15}, None),
            ({"name": "Thylacine", "height": 0.6}, None),
        ],
        "Plants": [
            ({"name": "Woollybush", "height": 2.4}, None),
            ({"name": "Boronia", "height": 0.9}, None),
        ],
    }
)

# Get the Animal group in the source.
# The Animal group won't have a "height" attribute.
group = source[0]
print(f"Group's name is {group.name}")

# Get the second item in the animal group
animal = group[1]
print(f"Animals's name is {animal.name}; it is {animal.height}m tall.")

# Find an animal with a name of "Thylacine"
row = source.find(parent=source[0], {"name": "Thylacine"})

# Remove that row from the data. Even though "Thylacine" isn't a root node,
# remove will find it and remove it from the list of animals.
source.remove(row)

# Insert a new item at the start of the list of animals.
group.insert(0, {"name": "Bettong", "height": 0.35})

# Insert a new root item in the middle of the list of root nodes
source.insert(1, {"name": "Minerals"})
```

The TreeSource manages a tree of `Node` objects. Each Node has all the attributes described by the source's `accessors`. A Node object will be constructed for each item that is added to the TreeSource.

Each Node object in the TreeSource can have children; those children can in turn have their own children. A child that *cannot* have children is called a *leaf Node*. Whether a child *can* have children is independent of whether it *does* have children - it is possible for a Node to have no children and *not* be a leaf node. This is analogous to files and directories on a file system: a file is a leaf Node, as it cannot have children; a directory *can* contain files and other directories in it, but it can also be empty. An empty directory would *not* be a leaf Node.

When creating a single Node for a TreeSource (e.g., when inserting a new item), the data for the Node can be specified as:

- A dictionary, with the accessors mapping to the keys in the dictionary
- Any iterable object (except for a string), with the accessors being mapped onto the items in the iterable in order of definition.
- Any other object, which will be mapped onto the *first* accessor.

When constructing an entire TreeSource, the data can be specified as:

- A dictionary. The keys of the dictionary will be converted into Nodes, and used as parents; the values of the dictionary will become the children of their corresponding parent.

- Any other iterable object (except a string). Each value in the iterable will be treated as a 2-item tuple, with the first item being data for the parent Node, and the second item being the child data.
- Any other object will be converted into a single node with no children.

When specifying children, a value of `None` for the children will result in the creation of a leaf node. Any other value will be processed recursively - so, a child specifier can itself be a dictionary, an iterable of 2-tuples, or data for a single child, and so on.

Although Toga provides TreeSource, you are not required to create one directly. A TreeSource will be transparently constructed for you if you provide one of the items listed above (e.g. `list`, `dict`, etc) to a GUI widget that displays tree-like data (i.e., *`toga.Tree`*).

Custom TreeSources

For more complex applications, you can replace TreeSource with a *custom data source* class. Such a class must:

- Inherit from *`Source`*
- Provide the same methods as *`TreeSource`*
- Return items whose attributes match the accessors expected by the widget
- Generate a `change` notification when any of those attributes change
- Generate `insert`, `remove` and `clear` notifications when nodes are added or removed

Reference

`class toga.sources.`**`Node`**`(**data)`

Bases: *`Row`*

Create a new Node object.

The keyword arguments specified in the constructor will be converted into attributes on the new object.

When initially constructed, the Node will be a leaf node (i.e., no children, and marked unable to have children).

When any public attributes of the node are modified (i.e., any attribute whose name doesn't start with `_`), the source to which the node belongs will be notified.

`__delitem__``(index)`

`__getitem__``(index)`

Return type
`Node`

`__len__``()`

Return type
`int`

`__setitem__``(index, data)`

Set the value of a specific child in the Node.

Parameters

- **`index`** (`int`) – The index of the child to change

- **data** (Any) – The data for the updated child. This data will be converted into a Node object.

append(*data*, *children=None*)

Append a node to the end of the list of children of this node.

Parameters

- **data** (Any) – The data to append as a child of this node. This data will be converted into a Node object.
- **children** (Any) – The data for the children of the new child node.

Returns
The new added child Node object.

can_have_children()

Can the node have children?

A value of `True` does not necessarily mean the node *has* any children, only that the node is *allowed* to have children. The value of `len()` for the node indicates the number of actual children.

Return type
`bool`

find(*data*, *start=None*)

Find the first item in the child nodes of this node that matches all the provided attributes.

This is a value based search, rather than an instance search. If two Node instances have the same values, the first instance that matches will be returned. To search for a second instance, provide the first found instance as the `start` argument. To search for a specific Node instance, use the *`index()`*.

Parameters

- **data** (Any) – The data to search for. Only the values specified in data will be used as matching criteria; if the node contains additional data attributes, they won't be considered as part of the match.
- **start** (*Node*) – The instance from which to start the search. Defaults to `None`, indicating that the first match should be returned.

Returns
The matching Node object.

Raises

- **ValueError** – If no match is found.
- **ValueError** – If the node is a leaf node.

index(*child*)

The index of a specific node in children of this node.

This search uses Node instances, and searches for an *instance* match. If two Node instances have the same values, only the Node that is the same Python instance will match. To search for values based on equality, use *`find()`*.

Parameters
child (*Node*) – The node to find in the children of this node.

Returns
The index of the node in the children of this node.

Raises
ValueError – If the node cannot be found in children of this node.

`insert`(*index*, *data*, *children=None*)

Insert a node as a child of this node a specific index.

Parameters

- **`index`** (`int`) – The index at which to insert the new child.
- **`data`** (`Any`) – The data to insert into the Node as a child. This data will be converted into a Node object.
- **`children`** (`Any`) – The data for the children of the new child node.

Returns

The new added child Node object.

`remove`(*child*)

Remove a child node from this node.

Parameters

`child` (*`Node`*) – The child node to remove from this node.

`class toga.sources.`**`TreeSource`**(*accessors*, *data=None*)

Bases: *`Source`*

`__delitem__`(*index*)

`__getitem__`(*index*)

Return type

`Node`

`__len__`()

Return type

`int`

`__setitem__`(*index*, *data*)

Set the value of a specific root item in the data source.

Parameters

- **`index`** (`int`) – The root item to change
- **`data`** (`Any`) – The data for the updated item. This data will be converted into a Node object.

`append`(*data*, *children=None*)

Append a root node at the end of the list of children of this source.

If the node is a leaf node, it will be converted into a non-leaf node.

Parameters

- **`data`** (`Any`) – The data to append onto the list of children of the given parent. This data will be converted into a Node object.
- **`children`** (`Any`) – The data for the children to insert into the TreeSource.

Returns

The newly constructed Node object.

Raises

`ValueError` – If the provided parent is not part of this TreeSource.

`clear()`

Clear all data from the data source.

`find(data, start=None)`

Find the first item in the child nodes of the given node that matches all the provided attributes.

This is a value based search, rather than an instance search. If two Node instances have the same values, the first instance that matches will be returned. To search for a second instance, provide the first found instance as the `start` argument. To search for a specific Node instance, use the `index()`.

Parameters

- **`data`** (`Any`) – The data to search for. Only the values specified in data will be used as matching criteria; if the node contains additional data attributes, they won't be considered as part of the match.
- **`start`** (*`Node`*) – The instance from which to start the search. Defaults to `None`, indicating that the first match should be returned.

Returns

The matching Node object.

Raises

- **`ValueError`** – If no match is found.
- **`ValueError`** – If the provided parent is not part of this TreeSource.

`index(node)`

The index of a specific root node in the data source.

This search uses Node instances, and searches for an *instance* match. If two Node instances have the same values, only the Node that is the same Python instance will match. To search for values based on equality, use `find()`.

Parameters

`node` (*`Node`*) – The node to find in the data source.

Return type

`int`

Returns

The index of the node in the child list it is a part of.

Raises

`ValueError` – If the node cannot be found in the data source.

`insert(index, data, children=None)`

Insert a root node into the data source at a specific index.

If the node is a leaf node, it will be converted into a non-leaf node.

Parameters

- **`index`** (`int`) – The index into the list of children at which to insert the item.
- **`data`** (`Any`) – The data to insert into the TreeSource. This data will be converted into a Node object.
- **`children`** (`Any`) – The data for the children to insert into the TreeSource.

Returns

The newly constructed Node object.

Raises
`ValueError` – If the provided parent is not part of this TreeSource.

`remove`(*node*)

Remove a node from the data source.

This will also remove the node if it is a descendant of a root node.

Parameters
node (*Node*) – The node to remove from the data source.

ValueSource

A data source describing a single value.

Usage

Data sources are abstractions that allow you to define the data being managed by your application independent of the GUI representation of that data. For details on the use of data sources, see the *background guide*.

ValueSource is an wrapper around a single atomic value.

```
from toga.sources import ValueSource

source = ValueSource(42)

# Get the value managed by the source
print(f"Meaning of life, the universe, and everything is {source.value}")
```

Custom ValueSources

A custom ValueSource has 3 requirements:

- It must have an `accessor` attribute that describes the name of the attribute that stores the data for the source.
- It must have an attribute matching the name of the accessor that can be used to set and retrieve and the value.
- When any change is made to the value, a `change` notification will be emitted.

Reference

class toga.sources.**ValueSource**(*value=None*, *accessor='value'*)

Bases: *Source*

Validators

A mechanism for validating that input meets a given set of criteria.

Usage

A validator is a callable that accepts a string as input, and returns `None` on success, or a string on failure. If a string is returned, that string will be used as an error message. For example, the following example will validate that the user's input starts with the text "Hello":

```
def must_say_hello(value):
    if value.lower().startswith("hello"):
        return None
    return "Why didn't you say hello?"
```

Toga provides built-in validators for a range of common validation types, as well as some base classes that can be used as a starting point for custom validators.

A list of validators can then be provided to any widget that performs validation, such as the *`TextInput`* widget. In the following example, a `TextInput` will validate that the user has entered text that starts with "hello", and has provided at least 10 characters of input:

```
import toga
from toga.validators import MinLength

widget = toga.TextInput(validators=[
    must_say_hello,
    MinLength(10)
])
```

Whenever the input changes, all validators will be evaluated in the order they have been specified. The first validator to fail will put the widget into an "error" state, and the error message returned by that validator will be displayed to the user.

Reference

`class toga.validators.`**`BooleanValidator`**(*error_message*, *allow_empty=True*)

An abstract base class for defining a simple validator.

Subclasses should implement the `is_valid()` method

Parameters

- **`error_message`** (`str`) – The error to display to the user when the input isn't valid.
- **`allow_empty`** (`bool`) – Optional; Is no input considered valid? Defaults to `True`

`abstract` **`is_valid`**(*input_string*)

Is the input string valid?

Parameters
`input_string` (`str`) – The string to validate.

Return type
`bool`

Returns
`True` if the input is valid.

class `toga.validators.`**`Contains`**(*substring*, *count=None*, *error_message=None*, *allow_empty=True*)

Bases: *`CountValidator`*

A validator confirming that the string contains one or more copies of a substring.

Parameters

- **`substring`** (`str`) – The substring that must exist in the input.
- **`count`** (`Optional[int]`) – Optional; The exact number of matches that are expected.
- **`error_message`** (`Optional[str]`) – Optional; the error message to display when the input doesn't contain the substring (or the requested count of substrings).
- **`allow_empty`** (`bool`) – Optional; Is no input considered valid? Defaults to `True`

`count`(*input_string*)

Count the instances of content of interest in the input string.

Parameters
`input_string` (`str`) – The string to inspect for content of interest.

Return type
`int`

Returns
The number of instances of content that the validator is looking for.

class `toga.validators.`**`ContainsDigit`**(*count=None*, *error_message=None*, *allow_empty=True*)

Bases: *`CountValidator`*

A validator confirming that the string contains digits.

Parameters

- **`count`** (`Optional[int]`) – Optional; if provided, the exact count of digits that must exist. If not provided, the existence of any digit will make the string valid.
- **`error_message`** (`Optional[str]`) – Optional; the error message to display when the input doesn't contain digits (or the requested count of digits).
- **`allow_empty`** (`bool`) – Optional; Is no input considered valid? Defaults to `True`

`count`(*input_string*)

Count the instances of content of interest in the input string.

Parameters
`input_string` (`str`) – The string to inspect for content of interest.

Return type
`int`

Returns
The number of instances of content that the validator is looking for.

class `toga.validators.`**`ContainsLowercase`**(*count=None*, *error_message=None*, *allow_empty=True*)

Bases: *`CountValidator`*

A validator confirming that the string contains lower case letters.

Parameters

- **count** (Optional[int]) – Optional; if provided, the exact count of lower case letters that must exist. If not provided, the existence of any lower case letter will make the string valid.
- **error_message** (Optional[str]) – Optional; the error message to display when the input doesn't contain lower case letters (or the requested count of lower case letters).
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to `True`

`count`(*input_string*)

Count the instances of content of interest in the input string.

Parameters
input_string (str) – The string to inspect for content of interest.

Return type
int

Returns
The number of instances of content that the validator is looking for.

`class toga.validators.`**`ContainsSpecial`**(*count=None*, *error_message=None*, *allow_empty=True*)

Bases: *CountValidator*

A validator confirming that the string contains "special" (i.e., non-alphanumeric) characters.

Parameters

- **count** (Optional[int]) – Optional; if provided, the exact count of special characters that must exist. If not provided, the existence of any special character will make the string valid.
- **error_message** (Optional[str]) – Optional; the error message to display when the input doesn't contain special characters (or the requested count of special characters).
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to `True`

`count`(*input_string*)

Count the instances of content of interest in the input string.

Parameters
input_string (str) – The string to inspect for content of interest.

Return type
int

Returns
The number of instances of content that the validator is looking for.

`class toga.validators.`**`ContainsUppercase`**(*count=None*, *error_message=None*, *allow_empty=True*)

Bases: *CountValidator*

A validator confirming that the string contains upper case letters.

Parameters

- **count** (Optional[int]) – Optional; if provided, the exact count of upper case letters that must exist. If not provided, the existence of any upper case letter will make the string valid.
- **error_message** (Optional[str]) – Optional; the error message to display when the input doesn't contain upper case letters (or the requested count of upper case letters).
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to `True`

`count`(*input_string*)

Count the instances of content of interest in the input string.

Parameters
`input_string` (`str`) – The string to inspect for content of interest.

Return type
`int`

Returns
The number of instances of content that the validator is looking for.

`class toga.validators.CountValidator`(*count*, *expected_existence_message*, *expected_non_existence_message*, *expected_count_message*, *allow_empty=True*)

Bases: `object`

An abstract base class for validators that are based on counting instances of some content in the overall content.

Subclasses should implement the `count()` method to identify the content of interest.

Parameters

- `count` (`Optional[int]`) – Optional; The expected count.
- `expected_existence_message` (`str`) – The error message to show if matches are expected, but were not found.
- `expected_non_existence_message` (`str`) – The error message to show if matches were not expected, but were found.
- `expected_count_message` (`str`) – The error message to show if matches were expected, but a different number were found.
- `allow_empty` (`bool`) – Optional; Is no input considered valid? Defaults to `True`

`abstract count`(*input_string*)

Count the instances of content of interest in the input string.

Parameters
`input_string` (`str`) – The string to inspect for content of interest.

Return type
`int`

Returns
The number of instances of content that the validator is looking for.

`class toga.validators.Email`(*error_message=None*, *allow_empty=True*)

Bases: *`MatchRegex`*

A validator confirming that the string is an email address.

Note: It’s impossible to do *true* RFC-compliant email validation with a regex. This validator does a “best effort” validation. It will inevitably allow some email addresses that aren’t *technically* valid. However, it shouldn’t *exclude* any valid email addresses.

Parameters

- `error_message` (`Optional[str]`) – Optional; the error message to display when the input isn’t a number.

- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to True

EMAIL_REGEX = "^[a-zA-Z0-9.!#$%&'*+/=?^_`{|}~-]+@[a-zA-Z0-9-]+(?:\\.[a-zA-Z0-9-]+)*$"

class toga.validators.**EndsWith**(*substring*, *error_message=None*, *allow_empty=True*)

Bases: *BooleanValidator*

A validator confirming that the string ends with a given substring.

Parameters

- **substring** (str) – The substring that the input must end with.
- **error_message** (Optional[str]) – Optional; the error message to display when the string doesn't end with the given substring.
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to True

is_valid(*input_string*)

Is the input string valid?

Parameters
input_string (str) – The string to validate.

Return type
bool

Returns
True if the input is valid.

class toga.validators.**Integer**(*error_message=None*, *allow_empty=True*)

Bases: *BooleanValidator*

A validator confirming that the string is an integer.

Parameters

- **error_message** (Optional[str]) – Optional; the error message to display when the input isn't an integer.
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to True

is_valid(*input_string*)

Is the input string valid?

Parameters
input_string (str) – The string to validate.

Return type
bool

Returns
True if the input is valid.

class toga.validators.**LengthBetween**(*min_length*, *max_length*, *error_message=None*, *allow_empty=True*)

Bases: *BooleanValidator*

A validator confirming that the length of input falls in a given range.

Parameters

- **min_length** (Optional[int]) – The minimum length of the string (inclusive).

- **max_length** (Optional[int]) – The maximum length of the string (inclusive).
- **error_message** (Optional[str]) – Optional; the error message to display when the length isn't in the given range.
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to `True`

is_valid(*input_string*)

Is the input string valid?

Parameters
input_string (str) – The string to validate.

Return type
bool

Returns
`True` if the input is valid.

class toga.validators.**MatchRegex**(*regex_string*, *error_message=None*, *allow_empty=True*)

Bases: *BooleanValidator*

A validator confirming that the string matches a given regular expression.

Parameters

- **regex_string** – A regular expression that the input must match.
- **error_message** (Optional[str]) – Optional; the error message to display when the input doesn't match the provided regular expression.
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to `True`

is_valid(*input_string*)

Is the input string valid?

Parameters
input_string (str) – The string to validate.

Return type
bool

Returns
`True` if the input is valid.

class toga.validators.**MaxLength**(*length*, *error_message=None*)

Bases: *LengthBetween*

A validator confirming that the length of input does not exceed a maximum size.

Parameters

- **length** (int) – The maximum length of the string (inclusive).
- **error_message** (Optional[str]) – Optional; the error message to display when the string is too long.

class toga.validators.**MinLength**(*length*, *error_message=None*, *allow_empty=True*)

Bases: *LengthBetween*

A validator confirming that the length of input exceeds a minimum size.

Parameters

- **length** (int) – The minimum length of the string (inclusive).

- **error_message** (Optional[str]) – Optional; the error message to display when the string isn't long enough.
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to `True`

`class toga.validators.`**`NotContains`**`(`*substring*, *error_message=None*`)`

Bases: *`Contains`*

A validator confirming that the string does not contain a substring.

Parameters

- **substring** (str) – A substring that must not exist in the input.
- **error_message** (Optional[str]) – Optional; the error message to display when the input contains the provided substring.

`class toga.validators.`**`Number`**`(`*error_message=None*, *allow_empty=True*`)`

Bases: *`BooleanValidator`*

A validator confirming that the string is a number.

Parameters

- **error_message** (Optional[str]) – Optional; the error message to display when the input isn't a number.
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to `True`

`is_valid``(`*input_string*`)`

Is the input string valid?

Parameters
input_string (str) – The string to validate.

Return type
bool

Returns
`True` if the input is valid.

`class toga.validators.`**`StartsWith`**`(`*substring*, *error_message=None*, *allow_empty=True*`)`

Bases: *`BooleanValidator`*

A validator confirming that the input starts with a given substring.

Parameters

- **substring** (str) – The substring that the input must start with.
- **error_message** (Optional[str]) – Optional; the error message to display when the string doesn't start with the given substring.
- **allow_empty** (bool) – Optional; Is no input considered valid? Defaults to `True`

`is_valid``(`*input_string*`)`

Is the input string valid?

Parameters
input_string (str) – The string to validate.

Return type
bool

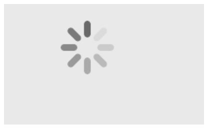
Returns
`True` if the input is valid.

Widgets

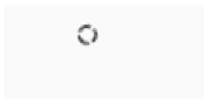
ActivityIndicator

A small animated indicator showing activity on a task of indeterminate length, usually rendered as a "spinner" animation.

macOS



Linux



Windows ×

Not supported

Android ×

Not supported

iOS ×

Not supported

Web

Screenshot not available

Textual ×

Not supported

Usage

```python
import toga

indicator = toga.ActivityIndicator()

# Start the animation
indicator.start()

# Stop the animation
indicator.stop()
```

Notes

- The ActivityIndicator will always take up a fixed amount of physical space in a layout. However, the widget will not be visible when it is in a "stopped" state.

Reference

`class toga.ActivityIndicator`(*id=None*, *style=None*, *running=False*)

Bases: `Widget`

Create a new ActivityIndicator widget.

Parameters

- **`id`** – The ID for the widget.
- **`style`** – A style object. If no style is provided, a default style will be applied to the widget.
- **`running`** (`bool`) – Describes whether the indicator is running at the time it is created.

`property enabled: Literal[True]`

Is the widget currently enabled? i.e., can the user interact with the widget?

ActivityIndicator widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

`focus()`

No-op; ActivityIndicator cannot accept input focus

Return type
`None`

`property is_running: bool`

Determine if the activity indicator is currently running.

Use `start()` and `stop()` to change the running state.

True if this activity indicator is running; False otherwise.

`start()`

Start the activity indicator.

If the activity indicator is already started, this is a no-op.

Return type
`None`

`stop()`

Stop the activity indicator.

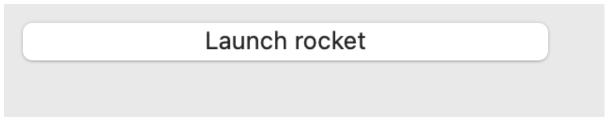
If the activity indicator is already stopped, this is a no-op.

Return type
`None`

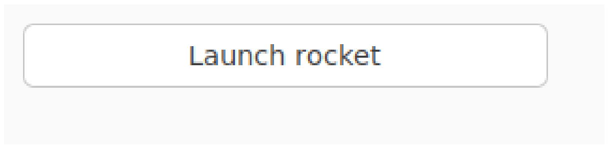
Button

A button that can be pressed or clicked.

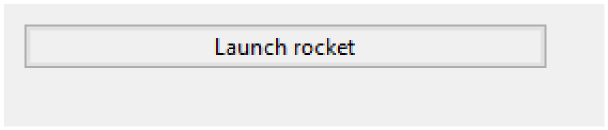
macOS



Linux



Windows



Android

iOS

Web

Screenshot not available

Textual

Screenshot not available

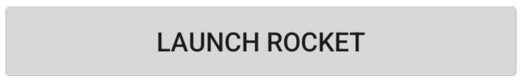
Usage

A button has a text label. A handler can be associated with button press events.

```python
import toga

def my_callback(button):
    # handle event
    pass

button = toga.Button("Click me", on_press=my_callback)
```



Notes

- A background color of `TRANSPARENT` will be treated as a reset of the button to the default system color.
- On macOS, the button text color cannot be set directly; any `color` style directive will be ignored. The text color is automatically selected by the platform to contrast with the background color of the button.

Reference

class `toga.`**`Button`**(*text*, *id=None*, *style=None*, *on_press=None*, *enabled=True*)

Bases: *`Widget`*

Create a new button widget.

Parameters

- **`text`** (`Optional`[`str`]) – The text to display on the button.
- **`id`** (`Optional`[`str`]) – The ID for the widget.
- **`style`** – A style object. If no style is provided, a default style will be applied to the widget.
- **`on_press`** (`Optional`[*`OnPressHandler`*]) – A handler that will be invoked when the button is pressed.
- **`enabled`** (`bool`) – Is the button enabled (i.e., can it be pressed?). Optional; by default, buttons are created in an enabled state.

`property on_press:` *`OnPressHandler`*

The handler to invoke when the button is pressed.

`property text:` `str`

The text displayed on the button.

`None`, and the Unicode codepoint U+200B (ZERO WIDTH SPACE), will be interpreted and returned as an empty string. Any other object will be converted to a string using `str()`.

Only one line of text can be displayed. Any content after the first newline will be ignored.

`protocol` `toga.widgets.button.`**`OnPressHandler`**

`typing.Protocol`.

Classes that implement this protocol must have the following methods / attributes:

`__call__`(*widget*, ***kwargs*)

A handler that will be invoked when a button is pressed.

Note: `**kwargs` ensures compatibility with additional arguments introduced in future versions.

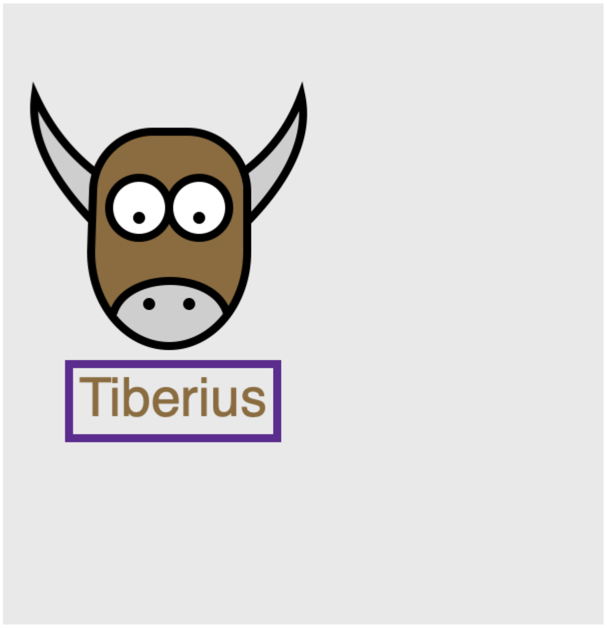
Parameters
`widget` (*`Button`*) – The button that was pressed.

Return type
`None`

Canvas

A drawing area for 2D vector graphics.

macOS



Linux

Windows

Android

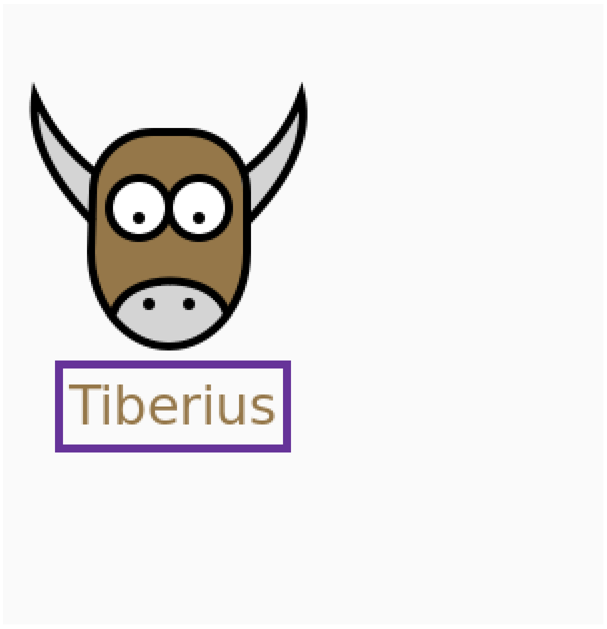
iOS

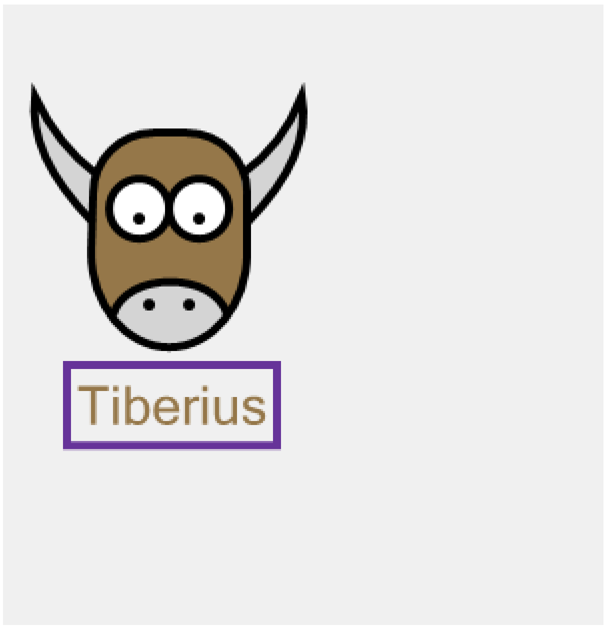
Web ×

Not supported

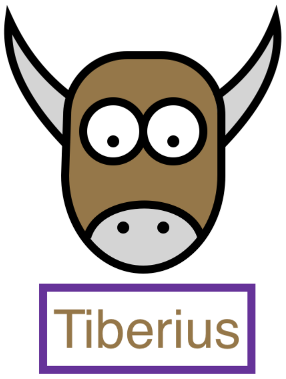
Textual ×

Not supported


Tiberius


Tiberius

Tiberius


Tiberius

Usage

Canvas is a 2D vector graphics drawing area, whose API broadly follows the HTML5 Canvas API. The Canvas provides a drawing Context; drawing instructions are then added to that context by calling methods on the context. All positions and sizes are measured in *CSS pixels*.

For example, the following code will draw an orange horizontal line:

```
import toga
canvas = toga.Canvas()
context = canvas.context

context.begin_path()
context.move_to(20, 20)
context.line_to(160, 20)
context.stroke(color="orange")
```

Toga adds an additional layer of convenience to the base HTML5 API by providing context managers for operations that have a natural open/close life cycle. For example, the previous example could be replaced with:

```
import toga
canvas = toga.Canvas()

with canvas.context.Stroke(20, 20, color="orange") as stroke:
    stroke.line_to(160, 20)
```

Any argument provided to a drawing operation or context object becomes a property of that object. Those properties can be modified after creation, after which you should invoke *`Canvas.redraw`* to request a redraw of the canvas.

Drawing operations can also be added to or removed from a context using the `list` operations `append`, `insert`, `remove` and `clear`. In this case, *`Canvas.redraw`* will be called automatically.

For example, if you were drawing a bar chart where the height of the bars changed over time, you don't need to completely reset the canvas and redraw all the objects; you can use the same objects, only modifying the height of existing bars, or adding and removing bars as required.

In this example, we create 2 filled drawing objects, then manipulate those objects, requesting a redraw after each set of changes.

```
import toga

canvas = toga.Canvas()
with canvas.context.Fill(color="red") as fill:
    circle = fill.arc(x=50, y=50, radius=15)
    rect = fill.rect(x=50, y=50, width=15, height=15)

# We can then change the properties of the drawing objects.
# Make the circle smaller, and move it closer to the origin.
circle.x = 25
circle.y = 25
circle.radius = 5
canvas.redraw()

# Change the fill color to blue
fill.color = "blue"
```

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```
canvas.redraw()

# Remove the rectangle from the canvas
fill.remove(rect)
```

For detailed tutorials on the use of Canvas drawing instructions, see the MDN documentation for the HTML5 Canvas API. Other than the change in naming conventions for methods - the HTML5 API uses `lowerCamelCase`, whereas the Toga API uses `snake_case` - both APIs are very similar.

Notes

- The Canvas API allows the use of handlers to respond to mouse/pointer events. These event handlers differentiate between "primary" and "alternate" modes of activation. When a mouse is in use, alternate activation will usually be interpreted as a "right click"; however, platforms may not implement an alternate activation mode. To ensure cross-platform compatibility, applications should not use the alternate press handlers as the sole mechanism for accessing critical functionality.

Reference

`class toga.Canvas`(*id=None*, *style=None*, *on_resize=None*, *on_press=None*, *on_activate=None*, *on_release=None*, *on_drag=None*, *on_alt_press=None*, *on_alt_release=None*, *on_alt_drag=None*)

Bases: *`Widget`*

Create a new Canvas widget.

Inherits from *`toga.Widget`*.

Parameters

- **`id`** – The ID for the widget.
- **`style`** – A style object. If no style is provided, a default style will be applied to the widget.
- **`on_resize`** (*`OnResizeHandler`*) – Initial *`on_resize`* handler.
- **`on_press`** (*`OnTouchHandler`*) – Initial *`on_press`* handler.
- **`on_activate`** (*`OnTouchHandler`*) – Initial *`on_activate`* handler.
- **`on_release`** (*`OnTouchHandler`*) – Initial *`on_release`* handler.
- **`on_drag`** (*`OnTouchHandler`*) – Initial *`on_drag`* handler.
- **`on_alt_press`** (*`OnTouchHandler`*) – Initial *`on_alt_press`* handler.
- **`on_alt_release`** (*`OnTouchHandler`*) – Initial *`on_alt_release`* handler.
- **`on_alt_drag`** (*`OnTouchHandler`*) – Initial *`on_alt_drag`* handler.

`ClosedPath`(*x=None*, *y=None*)

Construct and yield a new *`ClosedPathContext`* context in the root context of this canvas.

Parameters

- **x** (`Optional[float]`) – The x coordinate of the path's starting point.
- **y** (`Optional[float]`) – The y coordinate of the path's starting point.

Yields
The new *ClosedPathContext* context object.

`Context()`
Construct and yield a new sub-*Context* within the root context of this Canvas.

Yields
The new *Context* object.

`Fill`(*x=None*, *y=None*, *color=BLACK*, *fill_rule=FillRule.NONZERO*)
Construct and yield a new *FillContext* in the root context of this canvas.

A drawing operator that fills the path constructed in the context according to the current fill rule.

If both an x and y coordinate is provided, the drawing context will begin with a `move_to` operation in that context.

Parameters

- **x** (`Optional[float]`) – The x coordinate of the path's starting point.
- **y** (`Optional[float]`) – The y coordinate of the path's starting point.
- **fill_rule** (*FillRule*) – *nonzero* is the non-zero winding rule; *evenodd* is the even-odd winding rule.
- **color** (`UnionType[Color, str, None]`) – The fill color.

Yields
The new *FillContext* context object.

`Stroke`(*x=None*, *y=None*, *color=BLACK*, *line_width=2.0*, *line_dash=None*)
Construct and yield a new *StrokeContext* in the root context of this canvas.

If both an x and y coordinate is provided, the drawing context will begin with a `move_to` operation in that context.

Parameters

- **x** (`Optional[float]`) – The x coordinate of the path's starting point.
- **y** (`Optional[float]`) – The y coordinate of the path's starting point.
- **color** (`UnionType[Color, str, None]`) – The color for the stroke.
- **line_width** (`float`) – The width of the stroke.
- **line_dash** (`Optional[list[float]]`) – The dash pattern to follow when drawing the line. Default is a solid line.

Yields
The new *StrokeContext* context object.

`as_image()`
Render the canvas as an Image.

Return type
Image

Returns
A *toga.Image* containing the canvas content.

`property context:` *Context*
The root context for the canvas.

property enabled: bool

Is the widget currently enabled? i.e., can the user interact with the widget? ScrollContainer widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

focus()

No-op; ScrollContainer cannot accept input focus

measure_text(*text*, *font=None*, *tight=None*)

Measure the size at which `write_text()` would render some text.

Parameters

- **text** (str) – The text to measure. Newlines will cause line breaks, but long lines will not be wrapped.
- **font** (Optional[*Font*]) – The font in which to draw the text. The default is the system font.
- **tight** – **DEPRECATED**: this argument has no effect.

Return type

tuple[float, float]

Returns

A tuple of `(width, height)`.

property on_activate: *OnTouchHandler*

The handler invoked when the canvas is pressed in a way indicating the pressed object should be activated. When a mouse is in use, this will usually be a double click with the primary (usually the left) mouse button.

This event is not supported on Android or iOS.

property on_alt_drag: *OnTouchHandler*

The handler to invoke when the location of an alternate press changes.

This event is not supported on Android or iOS.

property on_alt_press: *OnTouchHandler*

The handler to invoke when the canvas is pressed in an alternate manner. This will usually correspond to a secondary (usually the right) mouse button press.

This event is not supported on Android or iOS.

property on_alt_release: *OnTouchHandler*

The handler to invoke when an alternate press is released.

This event is not supported on Android or iOS.

property on_drag: *OnTouchHandler*

The handler invoked when the location of a press changes.

property on_press: *OnTouchHandler*

The handler invoked when the canvas is pressed. When a mouse is being used, this press will be with the primary (usually the left) mouse button.

property on_release: *OnTouchHandler*

The handler invoked when a press on the canvas ends.

property on_resize: *OnResizeHandler*

The handler to invoke when the canvas is resized.

redraw()

Redraw the Canvas.

The Canvas will be automatically redrawn after adding or removing a drawing object, or when the Canvas resizes. However, when you modify the properties of a drawing object, you must call `redraw` manually.

class toga.widgets.canvas.**Context**(*canvas*, ***kwargs*)

Bases: `DrawingObject`

A drawing context for a canvas.

You should not create a `Context` directly; instead, you should use the `Context()` method on an existing context, or use `Canvas.context` to access the root context of the canvas.

ClosedPath(*x=None*, *y=None*)

Construct and yield a new `ClosedPath` sub-context that will draw a closed path, starting from an origin.

This is a context manager; it creates a new path and moves to the start coordinate; when the context exits, the path is closed. For fine-grained control of a path, you can use `begin_path()` and `close_path()`.

Parameters

- **x** (`Optional[float]`) – The x coordinate of the path's starting point.
- **y** (`Optional[float]`) – The y coordinate of the path's starting point.

Yields

The `ClosedPathContext` context object.

Context()

Construct and yield a new sub-`Context` within this context.

Yields

The new `Context` object.

Fill(*x=None*, *y=None*, *color='black'*, *fill_rule=FillRule.NONZERO*)

Construct and yield a new `Fill` sub-context within this context.

This is a context manager; it creates a new path, and moves to the start coordinate; when the context exits, the path is closed with a fill. For fine-grained control of a path, you can use `begin_path`, `move_to`, `close_path` and `fill`.

If both an x and y coordinate is provided, the drawing context will begin with a `move_to` operation in that context.

Parameters

- **x** (`Optional[float]`) – The x coordinate of the path's starting point.
- **y** (`Optional[float]`) – The y coordinate of the path's starting point.
- **fill_rule** (`FillRule`) – *nonzero* is the non-zero winding rule; *evenodd* is the even-odd winding rule.
- **color** (`str`) – The fill color.

Yields

The new `FillContext` context object.

Stroke(*x=None*, *y=None*, *color='black'*, *line_width=2.0*, *line_dash=None*)

Construct and yield a new `Stroke` sub-context within this context.

This is a context manager; it creates a new path, and moves to the start coordinate; when the context exits, the path is closed with a stroke. For fine-grained control of a path, you can use *begin_path*, *move_to*, *close_path* and *stroke*.

If both an x and y coordinate is provided, the drawing context will begin with a `move_to` operation in that context.

Parameters

- **x** (Optional[float]) – The x coordinate of the path's starting point.
- **y** (Optional[float]) – The y coordinate of the path's starting point.
- **color** (str) – The color for the stroke.
- **line_width** (float) – The width of the stroke.
- **line_dash** (Optional[list[float]]) – The dash pattern to follow when drawing the line. Default is a solid line.

Yields

The new *StrokeContext* context object.

__getitem__(*index*)

Returns the drawing object at the given index.

Return type

DrawingObject

__len__()

Returns the number of drawing objects that are in this context.

Return type

int

append(*obj*)

Append a drawing object to the context.

Parameters

obj (*DrawingObject*) – The drawing object to add to the context.

arc(*x*, *y*, *radius*, *startangle=0.0*, *endangle=2 * pi*, *anticlockwise=False*)

Draw a circular arc in the canvas context.

A full circle will be drawn by default; an arc can be drawn by specifying a start and end angle.

Parameters

- **x** (float) – The X coordinate of the circle's center.
- **y** (float) – The Y coordinate of the circle's center.
- **startangle** (float) – The start angle in radians, measured clockwise from the positive X axis.
- **endangle** (float) – The end angle in radians, measured clockwise from the positive X axis.
- **anticlockwise** (bool) – If true, the arc is swept anticlockwise. The default is clockwise.

Returns

The `Arc` *DrawingObject* for the operation.

`begin_path()`

Start a new path in the canvas context.

Returns
The `BeginPath` *`DrawingObject`* for the operation.

`bezier_curve_to`(*cp1x*, *cp1y*, *cp2x*, *cp2y*, *x*, *y*)

Draw a Bézier curve in the canvas context.

A Bézier curve requires three points. The first two are control points; the third is the end point for the curve. The starting point is the last point in the current path, which can be changed using move_to() before creating the Bézier curve.

Parameters

- **cp1y** (`float`) – The y coordinate for the first control point of the Bézier curve.
- **cp1x** (`float`) – The x coordinate for the first control point of the Bézier curve.
- **cp2x** (`float`) – The x coordinate for the second control point of the Bézier curve.
- **cp2y** (`float`) – The y coordinate for the second control point of the Bézier curve.
- **x** (`float`) – The x coordinate for the end point.
- **y** (`float`) – The y coordinate for the end point.

Returns
The `BezierCurveTo` *`DrawingObject`* for the operation.

`property canvas:` *`Canvas`*

The canvas that is associated with this drawing context.

`clear()`

Remove all drawing objects from the context.

`close_path()`

Close the current path in the canvas context.

This closes the current path as a simple drawing operation. It should be paired with a *`begin_path()`* operation; or, to complete a complete closed path, use the *`ClosedPath()`* context manager.

Returns
The `ClosePath` *`DrawingObject`* for the operation.

`closed_path`(*x*, *y*)

DEPRECATED - use *`ClosedPath()`*

`context()`

DEPRECATED - use *`Context()`*

`ellipse`(*x*, *y*, *radiusx*, *radiusy*, *rotation=0.0*, *startangle=0.0*, *endangle=2 * pi*, *anticlockwise=False*)

Draw an elliptical arc in the canvas context.

A full ellipse will be drawn by default; an arc can be drawn by specifying a start and end angle.

Parameters

- **x** (`float`) – The X coordinate of the ellipse's center.
- **y** (`float`) – The Y coordinate of the ellipse's center.
- **radiusx** (`float`) – The ellipse's horizontal axis radius.
- **radiusy** (`float`) – The ellipse's vertical axis radius.

- **rotation** (float) – The ellipse's rotation in radians, measured clockwise around its center.
- **startangle** (float) – The start angle in radians, measured clockwise from the positive X axis.
- **endangle** (float) – The end angle in radians, measured clockwise from the positive X axis.
- **anticlockwise** (bool) – If true, the arc is swept anticlockwise. The default is clockwise.

Returns
The `Ellipse` *DrawingObject* for the operation.

fill(*color=BLACK*, *fill_rule=FillRule.NONZERO*, *preserve=None*)

Fill the current path.

The fill can use either the Non-Zero or Even-Odd winding rule for filling paths.

Parameters

- **fill_rule** (*FillRule*) – *nonzero* is the non-zero winding rule; *evenodd* is the even-odd winding rule.
- **color** (str) – The fill color.
- **preserve** – **DEPRECATED**: this argument has no effect.

Returns
The `Fill` *DrawingObject* for the operation.

insert(*index*, *obj*)

Insert a drawing object into the context at a specific index.

Parameters

- **index** (int) – The index at which the drawing object should be inserted.
- **obj** (*DrawingObject*) – The drawing object to add to the context.

line_to(*x*, *y*)

Draw a line segment ending at a point in the canvas context.

Parameters

- **x** (float) – The x coordinate for the end point of the line segment.
- **y** (float) – The y coordinate for the end point of the line segment.

Returns
The `LineTo` *DrawingObject* for the operation.

move_to(*x*, *y*)

Moves the current point of the canvas context without drawing.

Parameters

- **x** (float) – The x coordinate of the new current point.
- **y** (float) – The y coordinate of the new current point.

Returns
The `MoveTo` *DrawingObject* for the operation.

new_path()

DEPRECATED - Use *begin_path()*.

quadratic_curve_to(*cpx*, *cpy*, *x*, *y*)

Draw a quadratic curve in the canvas context.

A quadratic curve requires two points. The first point is a control point; the second is the end point. The starting point of the curve is the last point in the current path, which can be changed using `moveTo()` before creating the quadratic curve.

Parameters

- **cpx** (`float`) – The x axis of the coordinate for the control point of the quadratic curve.
- **cpy** (`float`) – The y axis of the coordinate for the control point of the quadratic curve.
- **x** (`float`) – The x axis of the coordinate for the end point.
- **y** (`float`) – The y axis of the coordinate for the end point.

Returns

The `QuadraticCurveTo` *DrawingObject* for the operation.

rect(*x*, *y*, *width*, *height*)

Draw a rectangle in the canvas context.

Parameters

- **x** (`float`) – The horizontal coordinate of the left of the rectangle.
- **y** (`float`) – The vertical coordinate of the top of the rectangle.
- **width** (`float`) – The width of the rectangle.
- **height** (`float`) – The height of the rectangle.

Returns

The `Rect` *DrawingObject* for the operation.

redraw()

Calls *Canvas.redraw* on the parent Canvas.

remove(*obj*)

Remove a drawing object from the context.

Parameters

obj (*DrawingObject*) – The drawing object to remove.

reset_transform()

Reset all transformations in the canvas context.

Returns

A `ResetTransform` *DrawingObject*.

rotate(*radians*)

Add a rotation to the canvas context.

Parameters

radians (`float`) – The angle to rotate clockwise in radians.

Returns

The `Rotate` *DrawingObject* for the transformation.

scale(*sx*, *sy*)

Add a scaling transformation to the canvas context.

Parameters

- **sx** (float) – Scale factor for the X dimension. A negative value flips the image horizontally.
- **sy** (float) – Scale factor for the Y dimension. A negative value flips the image vertically.

Returns
The Scale *DrawingObject* for the transformation.

stroke(*color=BLACK*, *line_width=2.0*, *line_dash=None*)

Draw the current path as a stroke.

Parameters

- **color** (str) – The color for the stroke.
- **line_width** (float) – The width of the stroke.
- **line_dash** (Optional[list[float]]) – The dash pattern to follow when drawing the line, expressed as alternating lengths of dashes and spaces. The default is a solid line.

Returns
The Stroke *DrawingObject* for the operation.

translate(*tx*, *ty*)

Add a translation to the canvas context.

Parameters

- **tx** (float) – Translation for the X dimension.
- **ty** (float) – Translation for the Y dimension.

Returns
The Translate *DrawingObject* for the transformation.

write_text(*text*, *x=0.0*, *y=0.0*, *font=None*, *baseline=Baseline.ALPHABETIC*)

Write text at a given position in the canvas context.

Drawing text is effectively a series of path operations, so the text will have the color and fill properties of the canvas context.

Parameters

- **text** (str) – The text to draw. Newlines will cause line breaks, but long lines will not be wrapped.
- **x** (float) – The X coordinate of the text's left edge.
- **y** (float) – The Y coordinate: its meaning depends on `baseline`.
- **font** (Optional[*Font*]) – The font in which to draw the text. The default is the system font.
- **baseline** (*Baseline*) – Alignment of text relative to the Y coordinate.

Returns
The WriteText *DrawingObject* for the operation.

class `toga.widgets.canvas.`**`DrawingObject`**

Bases: `ABC`

A drawing operation in a *`Context`*.

Every context drawing method creates a `DrawingObject`, adds it to the context, and returns it. Each argument passed to the method becomes a property of the `DrawingObject`, which can be modified as shown in the *Usage* section.

`DrawingObjects` can also be created manually, then added to a context using the *`append()`* or *`insert()`* methods. Their constructors take the same arguments as the corresponding *`Context`* method, and their classes have the same names, but capitalized:

- *`toga.widgets.canvas.Arc`*
- *`toga.widgets.canvas.BeginPath`*
- *`toga.widgets.canvas.BezierCurveTo`*
- *`toga.widgets.canvas.ClosePath`*
- *`toga.widgets.canvas.Ellipse`*
- *`toga.widgets.canvas.Fill`*
- *`toga.widgets.canvas.LineTo`*
- *`toga.widgets.canvas.MoveTo`*
- *`toga.widgets.canvas.QuadraticCurveTo`*
- *`toga.widgets.canvas.Rect`*
- *`toga.widgets.canvas.ResetTransform`*
- *`toga.widgets.canvas.Rotate`*
- *`toga.widgets.canvas.Scale`*
- *`toga.widgets.canvas.Stroke`*
- *`toga.widgets.canvas.Translate`*
- *`toga.widgets.canvas.WriteText`*

class `toga.widgets.canvas.`**`ClosedPathContext`**(*canvas*, *x=None*, *y=None*)

Bases: *`Context`*

A drawing context that will build a closed path, starting from an origin.

This is a context manager; it creates a new path and moves to the start coordinate; when the context exits, the path is closed. For fine-grained control of a path, you can use *`begin_path`*, *`move_to`* and *`close_path`*.

If both an x and y coordinate is provided, the drawing context will begin with a `move_to` operation in that context.

You should not create a *`ClosedPathContext`* context directly; instead, you should use the *`ClosedPath()`* method on an existing context.

class `toga.widgets.canvas.`**`FillContext`**(*canvas*, *x=None*, *y=None*, *color=BLACK*, *fill_rule=FillRule.NONZERO*)

Bases: *`ClosedPathContext`*

A drawing context that will apply a fill to any paths all objects in the context.

The fill can use either the Non-Zero or Even-Odd winding rule for filling paths.

This is a context manager; it creates a new path, and moves to the start coordinate; when the context exits, the path is closed with a fill. For fine-grained control of a path, you can use `begin_path`, `move_to`, `close_path` and `fill`.

If both an x and y coordinate is provided, the drawing context will begin with a `move_to` operation in that context.

You should not create a `FillContext` context directly; instead, you should use the `Fill()` method on an existing context.

property color: Color

The fill color.

class `toga.widgets.canvas.`**`StrokeContext`**(*canvas*, *x=None*, *y=None*, *color=BLACK*, *line_width=2.0*, *line_dash=None*)

Bases: `ClosedPathContext`

Construct a drawing context that will draw a stroke on all paths defined within the context.

This is a context manager; it creates a new path, and moves to the start coordinate; when the context exits, the path is drawn with the stroke. For fine-grained control of a path, you can use `begin_path`, `move_to`, `close_path` and `stroke`.

If both an x and y coordinate is provided, the drawing context will begin with a `move_to` operation in that context.

You should not create a `StrokeContext` context directly; instead, you should use the `Stroke()` method on an existing context.

property color: Color

The color of the stroke.

protocol `toga.widgets.canvas.`**`OnTouchHandler`**

`typing.Protocol`.

Classes that implement this protocol must have the following methods / attributes:

`__call__`(*widget*, *x*, *y*, ***kwargs*)

A handler that will be invoked when a `Canvas` is touched with a finger or mouse.

Parameters

- **widget** (`Canvas`) – The canvas that was touched.
- **x** (`int`) – X coordinate, relative to the left edge of the canvas.
- **y** (`int`) – Y coordinate, relative to the top edge of the canvas.
- **kwargs** – Ensures compatibility with arguments added in future versions.

protocol `toga.widgets.canvas.`**`OnResizeHandler`**

`typing.Protocol`.

Classes that implement this protocol must have the following methods / attributes:

`__call__`(*widget*, *width*, *height*, ***kwargs*)

A handler that will be invoked when a `Canvas` is resized.

Parameters

- **widget** (`Canvas`) – The canvas that was resized.
- **width** (`int`) – The new width.
- **height** (`int`) – The new height.
- **kwargs** – Ensures compatibility with arguments added in future versions.

DateInput

A widget to select a calendar date.

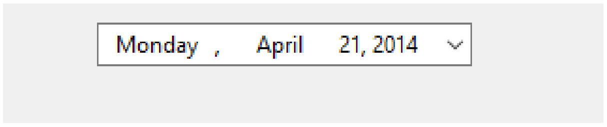
macOS ×

Not supported

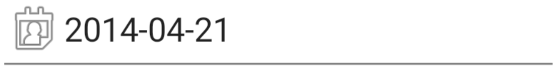
Linux ×

Not supported

Windows



Android



iOS ×

Not supported

Web ×

Not supported

Textual ×

Not supported

Usage

```
import toga

current_date = toga.DateInput()
```

Notes

- This widget supports years from 1800 to 8999 inclusive.
- Properties that return `datetime.date` objects can also accept:
  - `datetime.datetime`: The date portion will be extracted.
  - `str`: Will be parsed as an ISO8601 format date string (e.g., "2023-12-25").

Reference

class toga.**DateInput**(*id=None*, *style=None*, *value=None*, *min=None*, *max=None*, *on_change=None*)

Bases: *Widget*

Create a new DateInput widget.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **value** (*datetime.date | None*) – The initial date to display. If not specified, the current date will be used.
- **min** (*datetime.date | None*) – The earliest date (inclusive) that can be selected.
- **max** (*datetime.date | None*) – The latest date (inclusive) that can be selected.
- **on_change** (*callable | None*) – A handler that will be invoked when the value changes.

property max: date

The maximum allowable date (inclusive). A value of None will be converted into the highest supported date of 8999-12-31.

When setting this property, the current *value* and *min* will be clipped against the new maximum value.

Raises
ValueError – If set to a date outside of the supported range.

property min: date

The minimum allowable date (inclusive). A value of None will be converted into the lowest supported date of 1800-01-01.

When setting this property, the current *value* and *max* will be clipped against the new minimum value.

Raises
ValueError – If set to a date outside of the supported range.

property on_change: callable

The handler to invoke when the date value changes.

property value: date

The currently selected date. A value of None will be converted into today's date.

If this property is set to a value outside of the min/max range, it will be clipped.

DetailedList

macOS

Linux

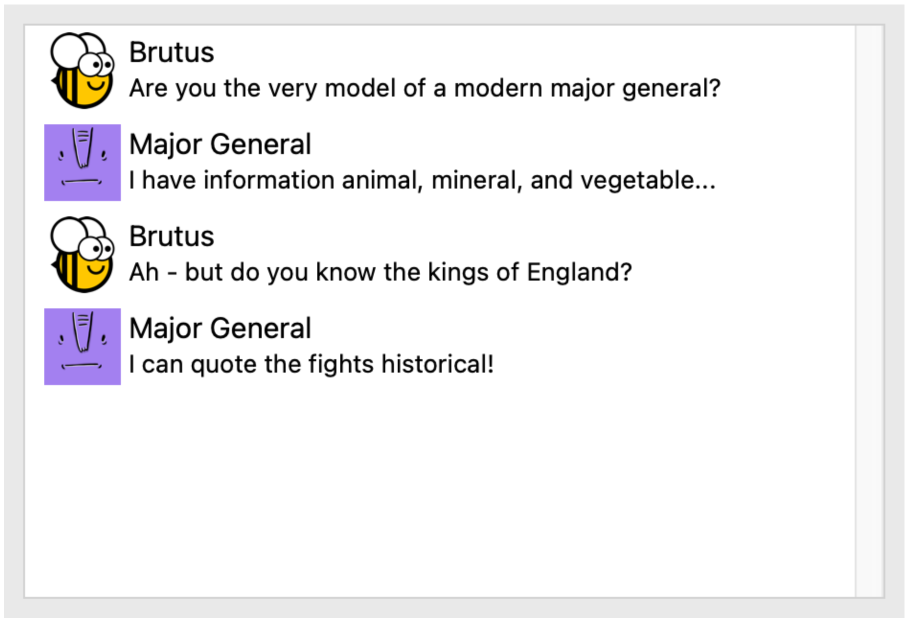
Windows

Android

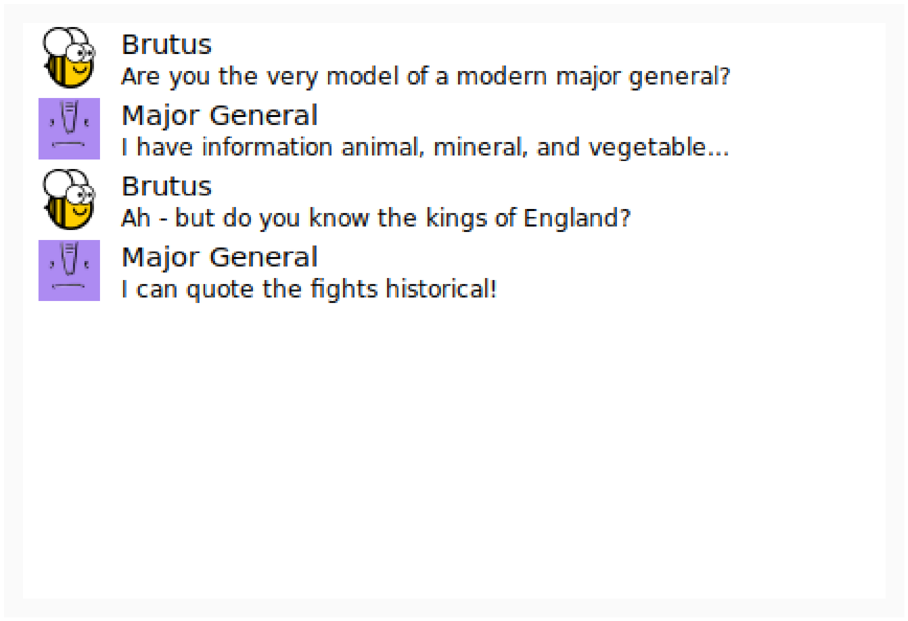
iOS

Web ×

Not supported



Brutus
Are you the very model of a modern major general?
Major General
I have information animal, mineral, and vegetable...
Brutus
Ah - but do you know the kings of England?
Major General
I can quote the fights historical!



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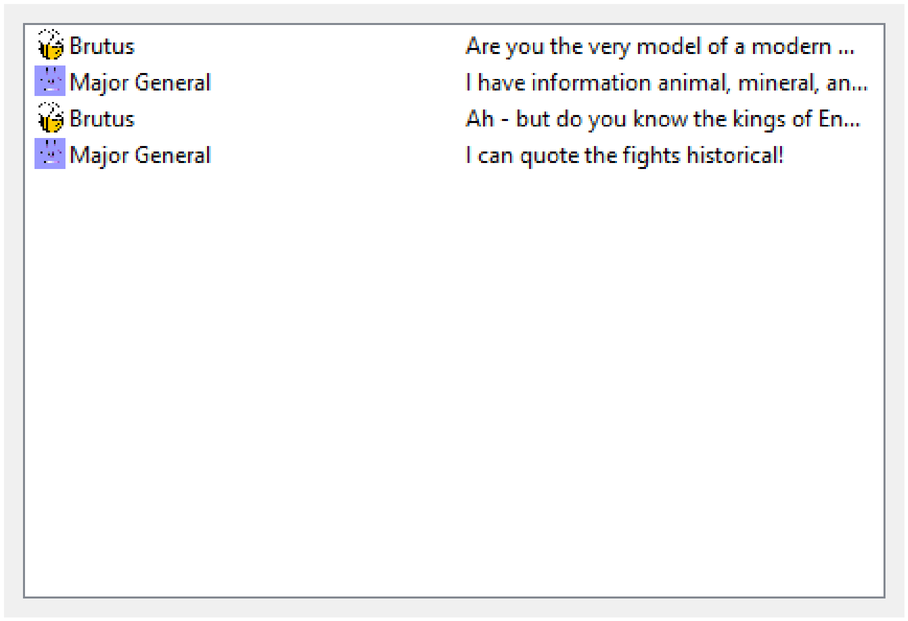
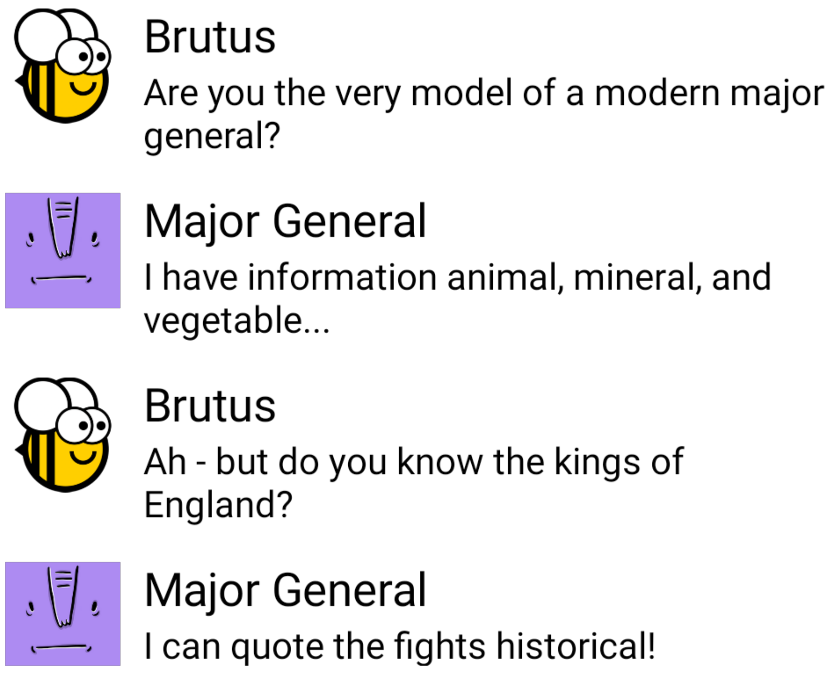


Brutus Are you the very model of a modern ...
Major General I have information animal, mineral, an...
Brutus Ah - but do you know the kings of En...
Major General I can quote the fights historical!

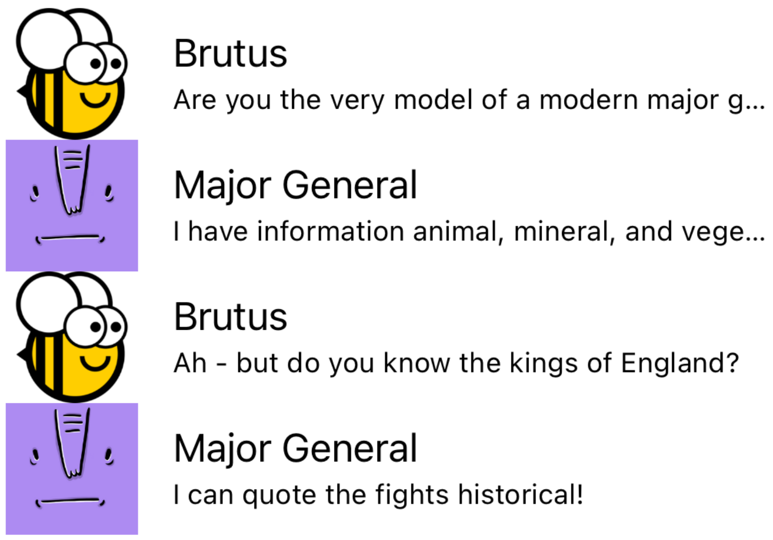


Brutus
Are you the very model of a modern major general?

Major General
I have information animal, mineral, and vegetable...

Brutus
Ah - but do you know the kings of England?

Major General
I can quote the fights historical!


Brutus
Are you the very model of a modern major g...
Major General
I have information animal, mineral, and vege...
Brutus
Ah - but do you know the kings of England?
Major General
I can quote the fights historical!

Textual ×

Not supported

Usage

The simplest way to create a DetailedList is to pass a list of dictionaries, with each dictionary containing three keys: `icon`, `title`, and `subtitle`:

```python
import toga

table = toga.DetailedList(
    data=[
        {
           "icon": toga.Icon("icons/arthur"),
           "title": "Arthur Dent",
           "subtitle": "Where's the tea?"
        },
        {
           "icon": toga.Icon("icons/ford"),
           "title": "Ford Prefect",
           "subtitle": "Do you know where my towel is?"
        },
        {
           "icon": toga.Icon("icons/tricia"),
           "title": "Tricia McMillan",
           "subtitle": "What planet are you from?"
        },
```

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(continued from previous page)

```
    ]
)
```

If you want to customize the keys used in the dictionary, you can do this by providing an `accessors` argument to the DetailedList when it is constructed. `accessors` is a tuple containing the attributes that will be used to provide the icon, title, and subtitle, respectively:

```python
import toga

table = toga.DetailedList(
    accessors=("picture", "name", "quote"),
    data=[
        {
           "picture": toga.Icon("icons/arthur"),
           "name": "Arthur Dent",
           "quote": "Where's the tea?"
        },
        {
           "picture": toga.Icon("icons/ford"),
           "name": "Ford Prefect",
           "quote": "Do you know where my towel is?"
        },
        {
           "picture": toga.Icon("icons/tricia"),
           "name": "Tricia McMillan",
           "quote": "What planet are you from?"
        },
    ]
)
```

If the value provided by the title or subtitle accessor is `None`, or the accessor isn't defined, the `missing_value` will be displayed. Any other value will be converted into a string.

The icon accessor should return an *`Icon`*. If it returns `None`, or the accessor isn't defined, then no icon will be displayed, but space for the icon will remain in the layout.

Items in a DetailedList can respond to a primary and secondary action. On platforms that use swipe interactions, the primary action will be associated with "swipe left", and the secondary action will be associated with "swipe right". Other platforms may implement the primary and secondary actions using a different UI interaction (e.g., a right-click context menu). The primary and secondary actions will only be enabled in the DetailedList UI if a handler has been provided.

By default, the primary and secondary action will be labeled as "Delete" and "Action", respectively. These names can be overridden by providing a `primary_action` and `secondary_action` argument when constructing the DetailedList. Although the primary action is labeled "Delete" by default, the DetailedList will not perform any data deletion as part of the UI interaction. It is the responsibility of the application to implement any data deletion behavior as part of the `on_primary_action` handler.

The DetailedList as a whole can also respond to a refresh UI action. This is usually implemented as a "pull down" action, such as you might see on a social media timeline. This action will only be enabled in the UI if an `on_refresh` handler has been provided.

Notes

- The iOS Human Interface Guidelines differentiate between "Normal" and "Destructive" actions on a row. Toga will interpret any action with a name of "Delete" or "Remove" as destructive, and will render the action appropriately.
- The WinForms implementation currently uses a column layout similar to *Table*, and does not support the primary, secondary or refresh actions.

Reference

class toga.**DetailedList**(*id=None*, *style=None*, *data=None*, *accessors=('title', 'subtitle', 'icon')*, *missing_value=''*, *primary_action='Delete'*, *on_primary_action=None*, *secondary_action='Action'*, *on_secondary_action=None*, *on_refresh=None*, *on_select=None*, *on_delete=None*)

Bases: *Widget*

Create a new DetailedList widget.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **data** (Any) – Initial *data* to be displayed in the list.
- **accessors** (tuple[str, str, str]) – The accessors to use to retrieve the data for each item, in the form (title, subtitle, icon).
- **missing_value** (str) – The text that will be shown when a row doesn't provide a value for its title or subtitle.
- **on_select** (callable) – Initial *on_select* handler.
- **primary_action** (Optional[str]) – The name for the primary action.
- **on_primary_action** (callable) – Initial *on_primary_action* handler.
- **secondary_action** (Optional[str]) – The name for the secondary action.
- **on_secondary_action** (callable) – Initial *on_secondary_action* handler.
- **on_refresh** (callable) – Initial *on_refresh* handler.
- **on_delete** (callable) – **DEPRECATED**; use `on_primary_action`.

property accessors: list[str]

The accessors used to populate the list (read-only)

property data: ***ListSource***

The data to display in the table.

When setting this property:

- A *Source* will be used as-is. It must either be a *ListSource*, or a custom class that provides the same methods.
- A value of None is turned into an empty ListSource.
- Otherwise, the value must be an iterable, which is copied into a new ListSource. Items are converted as shown *here*.

property enabled: bool

Is the widget currently enabled? i.e., can the user interact with the widget? DetailedList widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

focus()

No-op; DetailedList cannot accept input focus

property missing_value: str

The text that will be shown when a row doesn't provide a value for its title or subtitle.

property on_delete

DEPRECATED; Use *on_primary_action*

property on_primary_action: callable

The handler to invoke when the user performs the primary action on a row of the DetailedList.

The primary action is "swipe left" on platforms that use swipe interactions; other platforms may manifest this action in other ways (e.g, a context menu).

If no `on_primary_action` handler is provided, the primary action will be disabled in the UI.

property on_refresh: callable

The callback function to invoke when the user performs a refresh action (usually "pull down") on the DetailedList.

If no `on_refresh` handler is provided, the refresh UI action will be disabled.

property on_secondary_action: callable

The handler to invoke when the user performs the secondary action on a row of the DetailedList.

The secondary action is "swipe right" on platforms that use swipe interactions; other platforms may manifest this action in other ways (e.g, a context menu).

If no `on_secondary_action` handler is provided, the secondary action will be disabled in the UI.

property on_select: callable

The callback function that is invoked when a row of the DetailedList is selected.

scroll_to_bottom()

Scroll the view so that the bottom of the list (last row) is visible.

scroll_to_row(*row*)

Scroll the view so that the specified row index is visible.

Parameters

row (`int`) – The index of the row to make visible. Negative values refer to the nth last row (-1 is the last row, -2 second last, and so on).

scroll_to_top()

Scroll the view so that the top of the list (first row) is visible.

property selection: *Row* | None

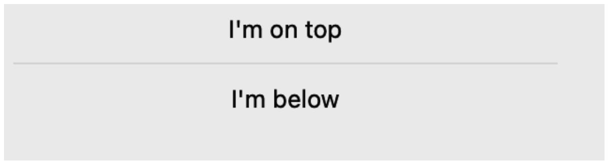
The current selection of the table.

Returns the selected Row object, or `None` if no row is currently selected.

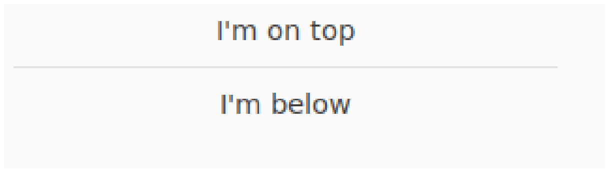
Divider

A separator used to visually distinguish two sections of content in a layout.

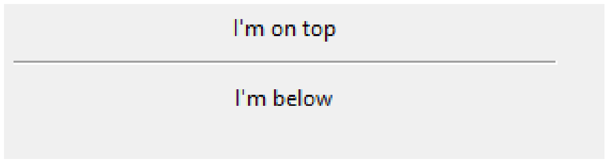
macOS



Linux



Windows



Android

iOS ×

Not supported

Web

Screenshot not available

Textual ×

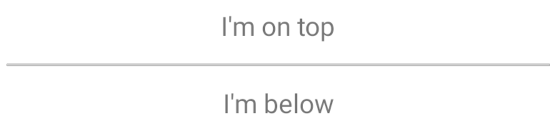
Not supported

Usage

To separate two labels stacked vertically with a horizontal line:

```python
import toga
from toga.style.pack import Pack, COLUMN

box = toga.Box(
    children=[
        toga.Label("First section"),
        toga.Divider(),
        toga.Label("Second section"),
    ],
    style=Pack(direction=COLUMN, flex=1, padding=10)
)
```



The direction (horizontal or vertical) can be given as an argument. If not specified, it will default to horizontal.

Reference

class toga.**Divider**(*id=None*, *style=None*, *direction=HORIZONTAL*)

Bases: *Widget*

Create a new divider line.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **direction** (*Direction*) – The direction in which the divider will be drawn. Either *HORIZONTAL* or *VERTICAL*; defaults to *HORIZONTAL*

HORIZONTAL = 0

VERTICAL = 1

property direction: *Direction*

The direction in which the visual separator will be drawn.

property enabled: bool

Is the widget currently enabled? i.e., can the user interact with the widget?

Divider widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

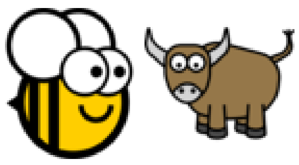
focus()

No-op; Divider cannot accept input focus

ImageView

A widget that displays an image.

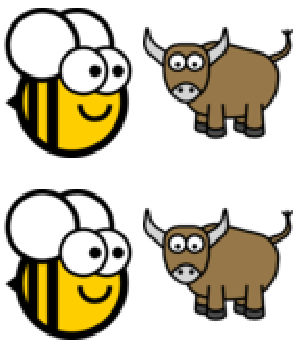
macOS



Linux

Windows

Android



iOS

Web ×

Not supported

Textual ×

Not supported

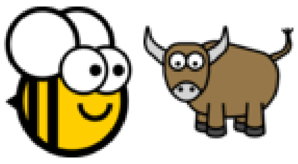
Usage

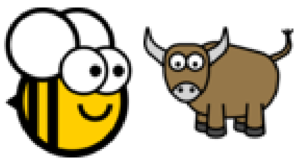
```python
import toga

my_image = toga.Image(self.paths.app / "brutus.png")
view = toga.ImageView(my_image)
```

Notes

- The default size of the view is the size of the image, or 0x0 if `image` is `None`.
- If an explicit width *or* height is specified, the size of the image will be fixed in that axis, and the size in the other axis will be determined by the image's aspect ratio.
- If an explicit width *and* height is specified, the image will be scaled to fill the described size without preserving the aspect ratio.
- If an ImageView is given a style of `flex=1`, and doesn't have an explicit size set along its container's main axis, it will be allowed to expand and contract along that axis.
  - If the cross axis size is unspecified, it will be determined by the image's aspect ratio, with a minimum size in the main axis matching the size of the image in the main axis.
  - If the cross axis has an explicit size, the image will be scaled to fill the available space so that the entire image can be seen, while preserving its aspect ratio. Any extra space will be distributed equally between both sides.





Reference

`class toga.ImageView`(*image=None*, *id=None*, *style=None*)

Bases: `Widget`

Create a new image view.

Parameters

- **`image`** (`UnionType[Image, Path, str, None]`) – The image to display.
- **`id`** – The ID for the widget.
- **`style`** – A style object. If no style is provided, a default style will be applied to the widget.

`property enabled: bool`

Is the widget currently enabled? i.e., can the user interact with the widget?

ImageView widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

`focus()`

No-op; ImageView cannot accept input focus

`property image: Image | None`

The image to display.

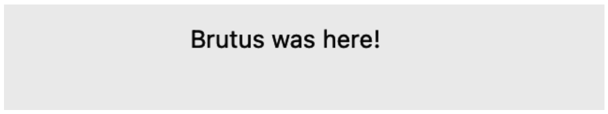
When setting an image, you can provide:

- An `Image` instance; or
- Any value that would be a valid path specifier when creating a new `Image` instance; or
- `None` to clear the image view.

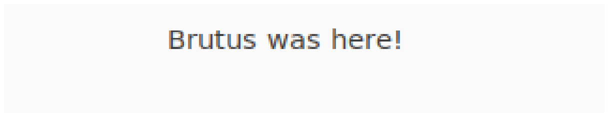
Label

A text label for annotating forms or interfaces.

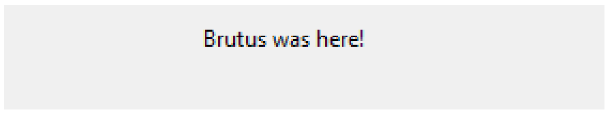
macOS


Brutus was here!

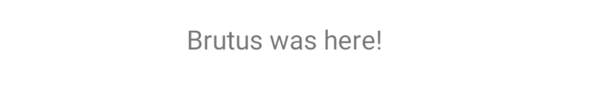
Linux


Brutus was here!

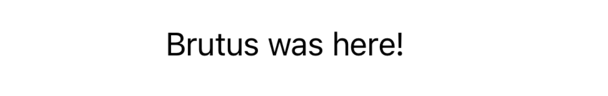
Windows


Brutus was here!

Android


Brutus was here!

iOS


Brutus was here!

Web

Screenshot not available

Textual

Screenshot not available

Usage

```
import toga

label = toga.Label("Hello world")
```

Notes

- Winforms does not support an alignment value of JUSTIFIED. If this alignment value is used, the label will default to left alignment.

Reference

class toga.**Label**(*text*, *id=None*, *style=None*)

Bases: *Widget*

Create a new text label.

Parameters

- **text** (str) – Text of the label.
- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.

focus()

No-op; Label cannot accept input focus

property text: str

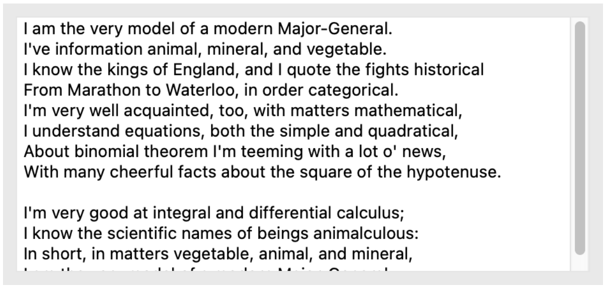
The text displayed by the label.

`None`, and the Unicode codepoint U+200B (ZERO WIDTH SPACE), will be interpreted and returned as an empty string. Any other object will be converted to a string using `str()`.

MultilineTextInput

A scrollable panel that allows for the display and editing of multiple lines of text.

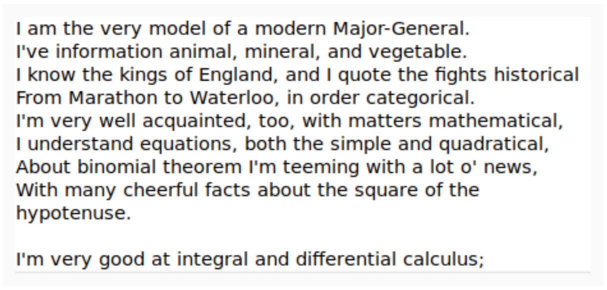
macOS



```
I am the very model of a modern Major-General.
I've information animal, mineral, and vegetable.
I know the kings of England, and I quote the fights historical
From Marathon to Waterloo, in order categorical.
I'm very well acquainted, too, with matters mathematical,
I understand equations, both the simple and quadratical,
About binomial theorem I'm teeming with a lot o' news,
With many cheerful facts about the square of the hypotenuse.

I'm very good at integral and differential calculus;
I know the scientific names of beings animalculous:
In short, in matters vegetable, animal, and mineral,
```

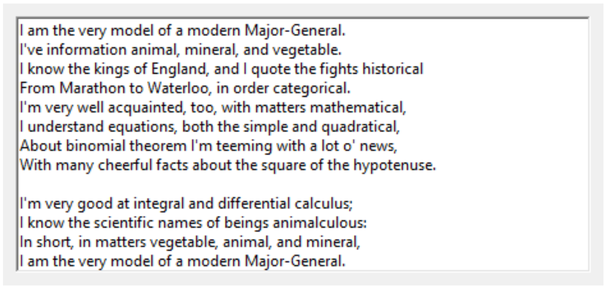
Linux



```
I am the very model of a modern Major-General.
I've information animal, mineral, and vegetable.
I know the kings of England, and I quote the fights historical
From Marathon to Waterloo, in order categorical.
I'm very well acquainted, too, with matters mathematical,
I understand equations, both the simple and quadratical,
About binomial theorem I'm teeming with a lot o' news,
With many cheerful facts about the square of the
hypotenuse.

I'm very good at integral and differential calculus;
```

Windows



```
I am the very model of a modern Major-General.
I've information animal, mineral, and vegetable.
I know the kings of England, and I quote the fights historical
From Marathon to Waterloo, in order categorical.
I'm very well acquainted, too, with matters mathematical,
I understand equations, both the simple and quadratical,
About binomial theorem I'm teeming with a lot o' news,
With many cheerful facts about the square of the hypotenuse.

I'm very good at integral and differential calculus;
I know the scientific names of beings animalculous:
In short, in matters vegetable, animal, and mineral,
I am the very model of a modern Major-General.
```

Android

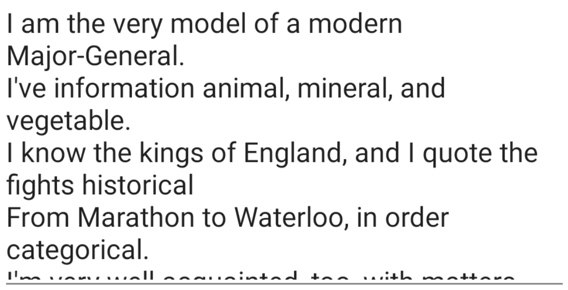
iOS

Web ×

Not supported

Textual ×

Not supported


I am the very model of a modern
Major-General.
I've information animal, mineral, and
vegetable.
I know the kings of England, and I quote the
fights historical
From Marathon to Waterloo, in order
categorical.

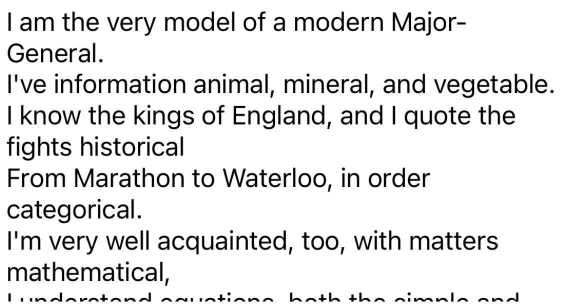

I am the very model of a modern Major-
General.
I've information animal, mineral, and vegetable.
I know the kings of England, and I quote the
fights historical
From Marathon to Waterloo, in order
categorical.
I'm very well acquainted, too, with matters
mathematical,

Table 13: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal

Usage

```python
import toga

textbox = toga.MultilineTextInput()
textbox.value = "Some text.\nIt can be multiple lines of text."
```

The input can be provided a placeholder value - this is a value that will be displayed to the user as a prompt for appropriate content for the widget. This placeholder will only be displayed if the widget has no content; as soon as a value is provided (either by the user, or programmatically), the placeholder content will be hidden.

Notes

- Winforms does not support the use of partially or fully transparent colors for the MultilineTextInput background. If a color with an alpha value is provided (including `TRANSPARENT`), the alpha channel will be ignored. A `TRANSPARENT` background will be rendered as white.

Reference

class toga.**MultilineTextInput**(*id=None*, *style=None*, *value=None*, *readonly=False*, *placeholder=None*, *on_change=None*)

Bases: *Widget*

Create a new multi-line text input widget.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **value** (*str | None*) – The initial content to display in the widget.
- **readonly** (*bool*) – Can the value of the widget be modified by the user?
- **placeholder** (*str | None*) – The content to display as a placeholder when there is no user content to display.
- **on_change** (*callable | None*) – A handler that will be invoked when the the value of the widget changes.

property on_change: callable

The handler to invoke when the value of the widget changes.

property placeholder: str

The placeholder text for the widget.

A value of `None` will be interpreted and returned as an empty string. Any other object will be converted to a string using `str()`.

property readonly: bool

Can the value of the widget be modified by the user?

This only controls manual changes by the user (i.e., typing at the keyboard). Programmatic changes are permitted while the widget has `readonly` enabled.

scroll_to_bottom()

Scroll the view to make the bottom of the text field visible.

scroll_to_top()

Scroll the view to make the top of the text field visible.

property value: str

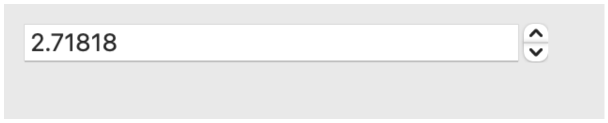
The text to display in the widget.

A value of `None` will be interpreted and returned as an empty string. Any other object will be converted to a string using `str()`.

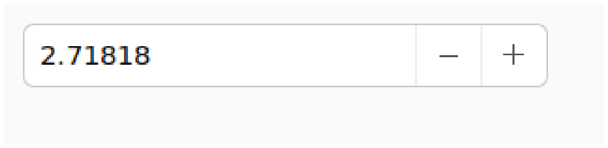
NumberInput

A text input that is limited to numeric input.

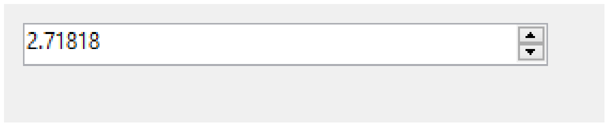
macOS



Linux



Windows



Android

iOS

Web ×

Not supported

Textual ×

Not supported

Usage

```
import toga

widget = toga.NumberInput(min_value=1, max_value=10, step=0.001)
widget.value = 2.718
```

NumberInput's properties can accept integers, floats, and strings containing numbers, but they always return `decimal.Decimal` objects to ensure precision is retained.

2.71818

2.71818

Reference

class toga.**NumberInput**(*id=None*, *style=None*, *step=1*, *min=None*, *max=None*, *value=None*, *readonly=False*, *on_change=None*, *min_value=None*, *max_value=None*)

Bases: *Widget*

Create a new number input widget.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **step** (*Decimal*) – The amount that any increment/decrement operations will apply to the widget's current value.
- **min** (*Decimal | None*) – If provided, *value* will be guaranteed to be greater than or equal to this minimum.
- **max** (*Decimal | None*) – If provided, *value* will be guaranteed to be less than or equal to this maximum.
- **value** (*Decimal | None*) – The initial value for the widget.
- **readonly** (*bool*) – Can the value of the widget be modified by the user?
- **on_change** (*callable | None*) – A handler that will be invoked when the the value of the widget changes.
- **min_value** (*Decimal | None*) – **DEPRECATED**; alias of min.
- **max_value** (*Decimal | None*) – **DEPRECATED**; alias of max.

property max: Decimal | None

The maximum bound for the widget's value.

Returns None if there is no maximum bound.

When setting this property, the current *value* and *min* will be clipped against the new maximum value.

property max_value: Decimal | None

DEPRECATED; alias of *max*.

property min: Decimal | None

The minimum bound for the widget's value.

Returns None if there is no minimum bound.

When setting this property, the current *value* and *max* will be clipped against the new minimum value.

property min_value: Decimal | None

DEPRECATED; alias of *min*.

property on_change: callable

The handler to invoke when the value of the widget changes.

property readonly: bool

Can the value of the widget be modified by the user?

This only controls manual changes by the user (i.e., typing at the keyboard). Programmatic changes are permitted while the widget has `readonly` enabled.

property step: Decimal

The amount that any increment/decrement operations will apply to the widget's current value. (Not all backends provide increment and decrement buttons.)

property value: Decimal | None

Current value of the widget, rounded to the same number of decimal places as *step*, or `None` if no value has been set.

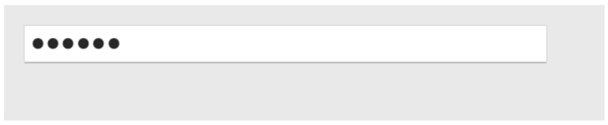
If this property is set to a value outside of the min/max range, it will be clipped.

While the widget is being edited by the user, it is possible for the UI to contain a value which is outside of the min/max range, or has too many decimal places. In this case, this property will return a value that has been clipped and rounded, and the visible text will be updated to match as soon as the widget loses focus.

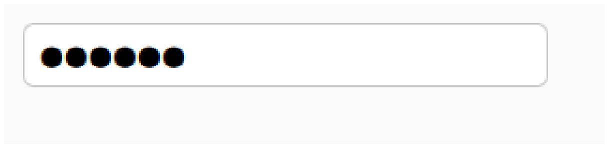
PasswordInput

A widget to allow the entry of a password. Any value typed by the user will be obscured, allowing the user to see the number of characters they have typed, but not the actual characters.

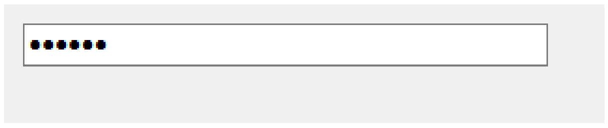
macOS



Linux



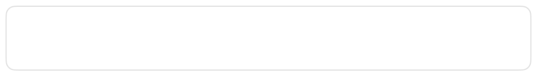
Windows



Android

iOS

Web ×



Not supported

Textual ×

Not supported

Usage

The `PasswordInput` is functionally identical to a *`TextInput`*, except for how the text is displayed. All features supported by *`TextInput`* are also supported by PasswordInput.

```
import toga

password = toga.PasswordInput()
```

Notes

- Winforms does not support the use of partially or fully transparent colors for the PasswordInput background. If a color with an alpha value is provided (including `TRANSPARENT`), the alpha channel will be ignored. A `TRANSPARENT` background will be rendered as white.
- On Winforms, if a PasswordInput is given an explicit height, the rendered widget will not expand to fill that space. The widget will have the fixed height determined by the font used on the widget. In general, you should avoid setting a `height` style property on PasswordInput widgets.

Reference

`class toga.`**`PasswordInput`**`(`*id=None*, *style=None*, *value=None*, *readonly=False*, *placeholder=None*, *on_change=None*, *on_confirm=None*, *on_gain_focus=None*, *on_lose_focus=None*, *validators=None*`)`

Bases: *`TextInput`*

Create a new password input widget.

Parameters

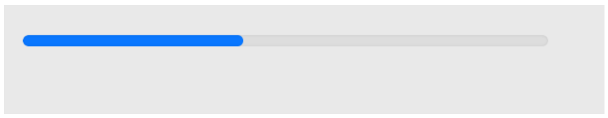
- **`id`** – The ID for the widget.
- **`style`** – A style object. If no style is provided, a default style will be applied to the widget.
- **`value`** (*`str | None`*) – The initial content to display in the widget.
- **`readonly`** (*`bool`*) – Can the value of the widget be modified by the user?

- **placeholder** (*str | None*) – The content to display as a placeholder when there is no user content to display.
- **on_change** (*callable | None*) – A handler that will be invoked when the the value of the widget changes.
- **on_confirm** (*callable | None*) – A handler that will be invoked when the user accepts the value of the input (usually by pressing Return on the keyboard).
- **on_gain_focus** (*callable | None*) – A handler that will be invoked when the widget gains input focus.
- **on_lose_focus** (*callable | None*) – A handler that will be invoked when the widget loses input focus.
- **validators** (*list[callable] | None*) – A list of validators to run on the value of the input.

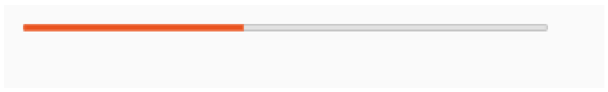
ProgressBar

A horizontal bar to visualize task progress. The task being monitored can be of known or indeterminate length.

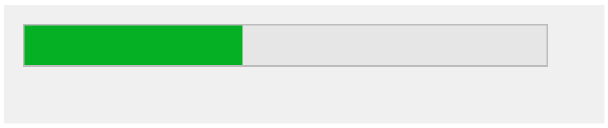
macOS



Linux



Windows



Android

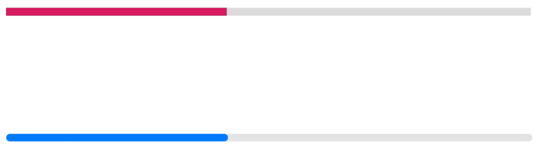
iOS

Web

Screenshot not available

Textual ×

Not supported



Usage

If a progress bar has a `max` value, it is a *determinate* progress bar. The value of the progress bar can be altered over time, indicating progress on a task. The visual indicator of the progress bar will be filled indicating the proportion of `value` relative to `max`. `max` can be any positive numerical value.

```
import toga

progress = toga.ProgressBar(max=100, value=1)

# Start progress animation
progress.start()

# Update progress to 10%
progress.value = 10

# Stop progress animation
progress.stop()
```

If a progress bar does *not* have a `max` value (i.e., `max == None`), it is an *indeterminate* progress bar. Any change to the value of an indeterminate progress bar will be ignored. When started, an indeterminate progress bar animates as a throbbing or "ping pong" animation.

```
import toga

progress = toga.ProgressBar(max=None)

# Start progress animation
progress.start()

# Stop progress animation
progress.stop()
```

Notes

- The visual appearance of progress bars varies from platform to platform. Toga will try to provide a visual distinction between running and not-running determinate progress bars, but this cannot be guaranteed.

Reference

`class toga.ProgressBar(`*id=None*, *style=None*, *max=1.0*, *value=0.0*, *running=False*`)`

Bases: `Widget`

Create a new Progress Bar widget.

Parameters

- **`id`** – The ID for the widget.
- **`style`** – A style object. If no style is provided, a default style will be applied to the widget.
- **`max`** (`float`) – The value that represents completion of the task. Must be > 0.0; defaults to 1.0. A value of `None` indicates that the task length is indeterminate.
- **`value`** (`float`) – The current progress against the maximum value. Must be between 0.0 and `max`; any value outside this range will be clipped. Defaults to 0.0.
- **`running`** (`bool`) – Describes whether the indicator is running at the time it is created. Default is False.

`property enabled: bool`

Is the widget currently enabled? i.e., can the user interact with the widget?

ProgressBar widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

`property is_determinate: bool`

Describe whether the progress bar has a known or indeterminate maximum.

True if the progress bar has determinate length; False otherwise.

`property is_running: bool`

Describe if the activity indicator is currently running.

Use `start()` and `stop()` to change the running state.

True if this activity indicator is running; False otherwise.

`property max: float | None`

The value indicating completion of the task being monitored.

Must be a number > 0, or `None` for a task of indeterminate length.

start()

Start the progress bar.

If the progress bar is already started, this is a no-op.

stop()

Stop the progress bar.

If the progress bar is already stopped, this is a no-op.

property value: float

The current value of the progress indicator.

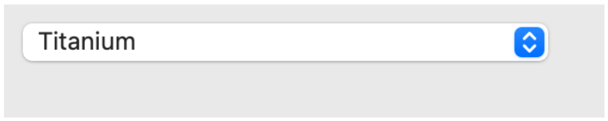
If the progress bar is determinate, the value must be between 0 and `max`. Any value outside this range will be clipped.

If the progress bar is indeterminate, changes in value will be ignored, and the current value will be returned as `None`.

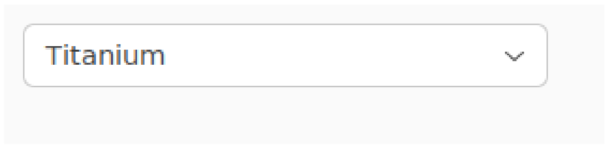
Selection

A widget to select a single option from a list of alternatives.

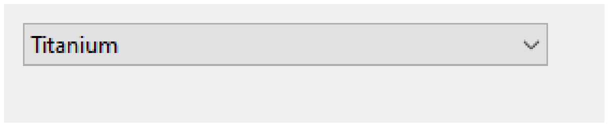
macOS



Linux



Windows



Android

iOS

Web

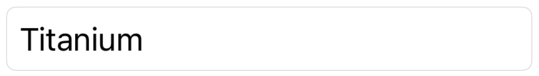
Not supported

Textual

Not supported

Table 14: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal



Usage

The Selection uses a *ListSource* to manage the list of options. If `items` is not specified as a ListSource, it will be converted into a ListSource at runtime.

The simplest instantiation of a Selection is to use a list of strings. If a list of non-string objects are provided, they will be converted into a string for display purposes, but the original data type will be retained when returning the current value.

```python
import toga

selection = toga.Selection(items=["Alice", "Bob", "Charlie"])

# Change the selection to "Charlie"
selection.value = "Charlie"

# Which item is currently selected? This will print "Charlie"
print(f"Currently selected: {selection.value}")
```

A Selection can also be used to display a list of dictionaries, with the `accessor` detailing which attribute of the dictionary will be used for display purposes. When the current value of the widget is retrieved, a Row object will be returned; this Row object will have all the original data as attributes on the Row. In the following example, the GUI will only display the names in the list of items, but the age will be available as an attribute on the selected item.

```python
import toga

selection = toga.Selection(
    items=[
        {"name": "Alice", "age": 37},
        {"name": "Bob", "age": 42},
        {"name": "Charlie", "age": 24},
    ],
    accessor="name",
)

# Select Bob explicitly
selection.value = selection.items[1]

# What is the age of the currently selected person? This will print 42
print(f"Age of currently selected person: {selection.value.age}")

# Select Charlie by searching
selection.value = selection.items.find(name="Charlie")
```

Notes

- On macOS and Android, you cannot change the font of a Selection.
- On macOS, GTK and Android, you cannot change the text color, background color, or alignment of labels in a Selection.
- On GTK, a Selection widget with flexible sizing will expand its width (to the extent possible possible) to accommodate any changes in content (for example, to accommodate a long label). However, if the content subsequently *decreases* in width, the Selection widget *will not* shrink. It will retain the size necessary to accommodate the longest label it has historically contained.
- On iOS, the size of the Selection widget does not adapt to the size of the currently displayed content, or the potential list of options.

Reference

`class toga.Selection`(*id=None*, *style=None*, *items=None*, *accessor=None*, *value=None*, *on_change=None*, *enabled=True*, *on_select=None*)

Bases: *`Widget`*

Create a new Selection widget.

Parameters

- **`id`** – The ID for the widget.
- **`style`** – A style object. If no style is provided, a default style will be applied to the widget.
- **`items`** (*`list`* | `ListSource` | *`None`*) – Initial *`items`* to display for selection.
- **`accessor`** (*`str`* | *`None`*) – The accessor to use to extract display values from the list of items. See *`items`* and *`value`* for details on how `accessor` alters the interpretation of data in the Selection.
- **`value`** (*`None`*) – Initial value for the selection. If unspecified, the first item in `items` will be selected.
- **`on_change`** (*`callable`* | *`None`*) – Initial *`on_change`* handler.
- **`enabled`** – Whether the user can interact with the widget.

`property items:` *`ListSource`*

The items to display in the selection.

When setting this property:

- A *`Source`* will be used as-is. It must either be a *`ListSource`*, or a custom class that provides the same methods.
- A value of None is turned into an empty ListSource.
- Otherwise, the value must be an iterable, which is copied into a new ListSource using the widget's accessor, or "value" if no accessor was specified. Items are converted as shown *here*.

`property on_change: callable`

Handler to invoke when the value of the selection is changed, either by the user or programmatically.

`property on_select: callable`

Use on_change

Type
DEPRECATED

property value

The currently selected item.

Returns None if there are no items in the selection.

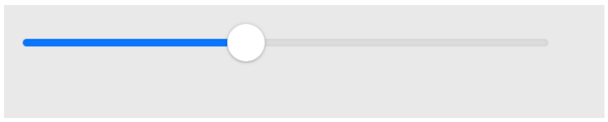
If an `accessor` was specified when the Selection was constructed, the value returned will be Row objects from the ListSource; to change the selection, a Row object from the ListSource must be provided.

If no `accessor` was specified when the Selection was constructed, the value returned will be the value stored as the `value` attribute on the Row object. When setting the value, the widget will search for the first Row object whose `value` attribute matches the provided value. In practice, this means that you can treat the selection as containing a list of literal values, rather than a ListSource containing Row objects.

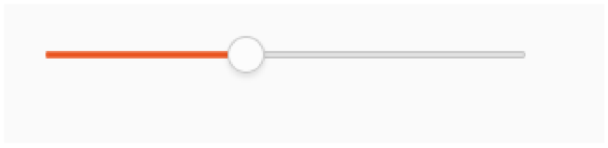
Slider

A widget for selecting a value within a range. The range is shown as a horizontal line, and the selected value is shown as a draggable marker.

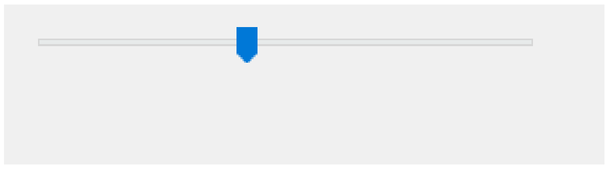
macOS



Linux



Windows



Android

iOS

Web ×

Not supported

Textual ×

Not supported

Usage

A slider can either be continuous (allowing any value within the range), or discrete (allowing a fixed number of equally-spaced values). For example:

```
import toga

def my_callback(slider):
    print(slider.value)

# Continuous slider, with an event handler.
toga.Slider(range=(-5, 10), value=7, on_change=my_callback)

# Discrete slider, accepting the values [0, 1.5, 3, 4.5, 6, 7.5].
toga.Slider(range=(0, 7.5), tick_count=6)
```

Reference

class toga.**Slider**(*id=None*, *style=None*, *value=None*, *min=None*, *max=None*, *tick_count=None*, *on_change=None*, *on_press=None*, *on_release=None*, *enabled=True*, *range=None*)

Bases: `Widget`

Create a new Slider widget.

Parameters

- **id** (*str | None*) – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **value** (*float | None*) – Initial `value` of the slider. Defaults to the mid-point of the range.
- **min** (*float*) – Initial minimum value of the slider. Defaults to 0.
- **max** (*float*) – Initial maximum value of the slider. Defaults to 1.
- **tick_count** (*int | None*) – Initial `tick_count` for the slider. If `None`, the slider will be continuous.
- **on_change** (*callable | None*) – Initial `on_change` handler.
- **on_press** (*callable | None*) – Initial `on_press` handler.
- **on_release** (*callable | None*) – Initial `on_release` handler.
- **enabled** (*bool*) – Whether the user can interact with the widget.

- **range** (*tuple[float, float] | None*) – **DEPRECATED**; use `min` and `max` instead. Initial *range* of the slider. Defaults to `(0, 1)`.

property max: float

Maximum allowed value.

When setting this property, the current *value* and *min* will be clipped against the new maximum value.

property min: float

Minimum allowed value.

When setting this property, the current *value* and *max* will be clipped against the new minimum value.

property on_change: callable

Handler to invoke when the value of the slider is changed, either by the user or programmatically.

Setting the widget to its existing value will not call the handler.

property on_press: callable

Handler to invoke when the user presses the slider before changing it.

property on_release: callable

Handler to invoke when the user releases the slider after changing it.

property range: tuple[float, float]

DEPRECATED; use *min* and *max* instead.

Range of allowed values, in the form (min, max).

If the provided min is greater than the max, both values will assume the value of the max.

If the current value is less than the provided `min`, the current value will be clipped to the minimum value. If the current value is greater than the provided `max`, the current value will be clipped to the maximum value.

property tick_count: int | None

Number of tick marks to display on the slider.

- If this is `None`, the slider will be continuous.
- If this is an `int`, the slider will be discrete, and will have the given number of possible values, equally spaced within the *range*.

Setting this property to an `int` will round the current value to the nearest tick.

Raises
`ValueError` – If set to a count which is not at least 2 (for the min and max).

Note: On iOS, tick marks are not currently displayed, but discrete mode will otherwise work correctly.

property tick_step: float | None

Step between adjacent ticks.

- If the slider is continuous, this property returns `None`
- If the slider is discrete, it returns the difference in value between adjacent ticks.

This property is read-only, and depends on the values of *tick_count* and *range*.

property tick_value: int | None

Value of the slider, measured in ticks.

- If the slider is continuous, this property returns `None`.

- If the slider is discrete, it returns an integer between 1 (representing *min*) and *tick_count* (representing *max*).

  Raises
  `ValueError` – If set to anything inconsistent with the rules above.

property value: `float`
Current value.

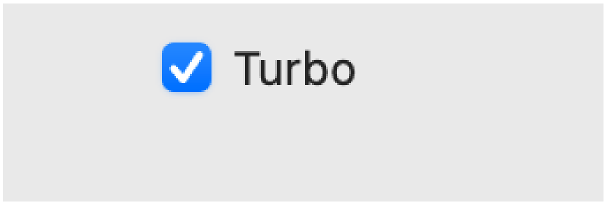
If the slider is discrete, setting the value will round it to the nearest tick.

Raises
`ValueError` – If set to a value which is outside of the *range*.

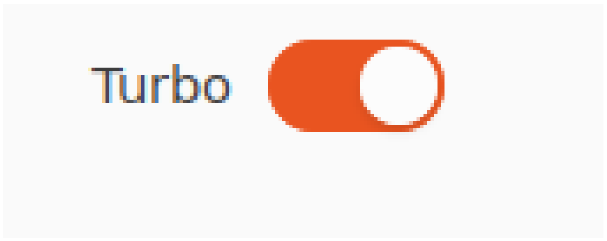
Switch

A clickable button with two stable states: True (on, checked); and False (off, unchecked). The button has a text label.

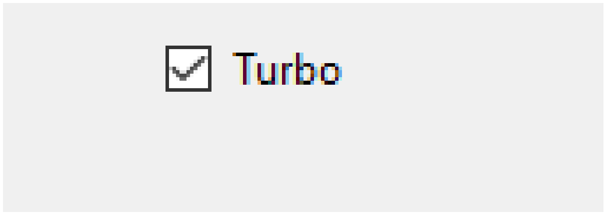
macOS



Linux



Windows



Android

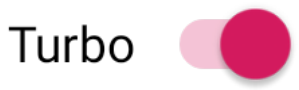
iOS

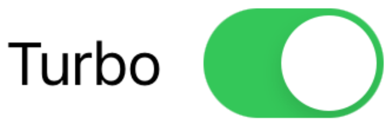
Web

Screenshot not available

Textual ×

Not supported





Usage

```python
import toga

switch = toga.Switch()

# What is the current state of the switch?
print(f"The switch is {switch.value}")
```

Notes

- The button and the label are considered a single widget for layout purposes.
- The visual appearance of a Switch is not guaranteed. On some platforms, it will render as a checkbox. On others, it will render as a physical "switch" whose position (and color) indicates if the switch is active. When rendered as a checkbox, the label will appear to the right of the checkbox. When rendered as a switch, the label will be left-aligned, and the switch will be right-aligned.
- You should avoid setting a `height` style property on Switch widgets. The rendered height of the Switch widget will be whatever the platform style guide considers appropriate; explicitly setting a `height` for the widget can lead to widgets that have a distorted appearance.
- On macOS, the text color of the label cannot be set directly; any `color` style directive will be ignored.

Reference

`class toga.Switch`(*text*, *id=None*, *style=None*, *on_change=None*, *value=False*, *enabled=True*)

Bases: `Widget`

Create a new Switch widget.

Parameters

- **`text`** – The text to display beside the switch.
- **`id`** – The ID for the widget.

- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **value** (*bool*) – The initial value for the switch.
- **on_change** (*callable | None*) – A handler that will be invoked when the switch changes value.
- **enabled** (*bool*) – Is the switch enabled (i.e., can it be pressed?). Optional; by default, switches are created in an enabled state.

property on_change: callable

The handler to invoke when the value of the switch changes.

property text: str

The text label for the Switch.

`None`, and the Unicode codepoint U+200B (ZERO WIDTH SPACE), will be interpreted and returned as an empty string. Any other object will be converted to a string using `str()`.

Only one line of text can be displayed. Any content after the first newline will be ignored.

toggle()

Reverse the current value of the switch.

property value: bool

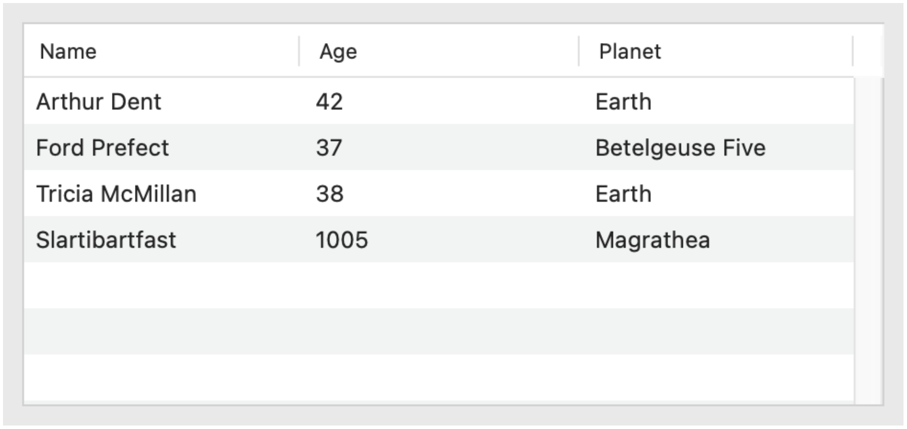
The current state of the switch, as a Boolean.

Any non-Boolean value will be converted to a Boolean.

Table

A widget for displaying columns of tabular data. Scroll bars will be provided if necessary.

macOS



Name	Age	Planet
Arthur Dent	42	Earth
Ford Prefect	37	Betelgeuse Five
Tricia McMillan	38	Earth
Slartibartfast	1005	Magrathea

Linux

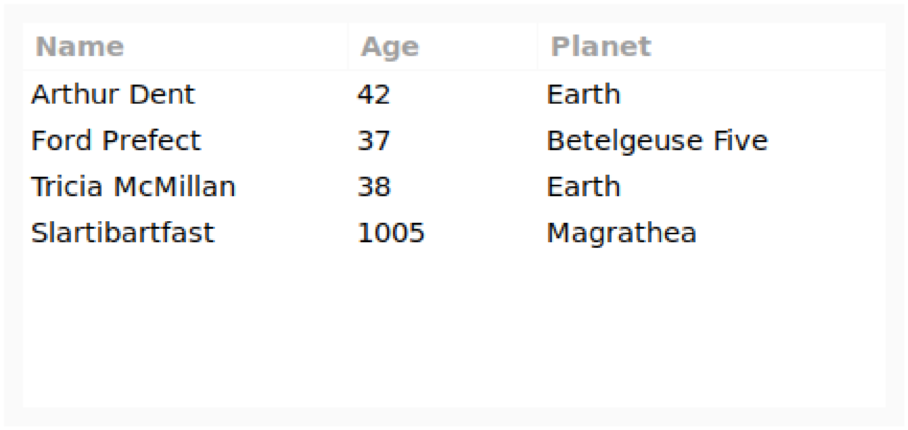
Windows

Android

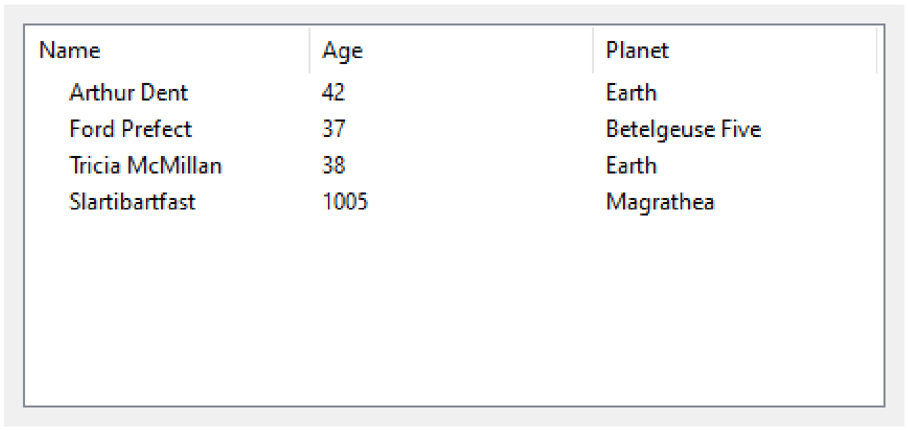
iOS ×

Not supported

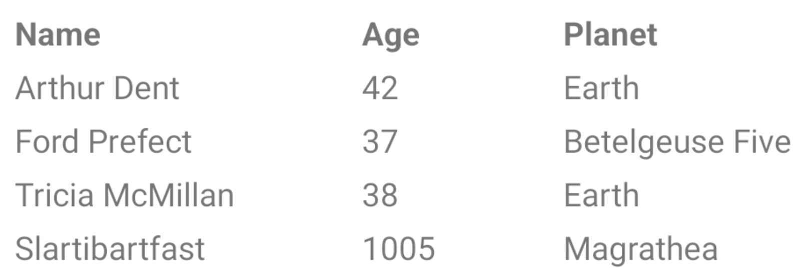
Web ×



Name	Age	Planet
Arthur Dent	42	Earth
Ford Prefect	37	Betelgeuse Five
Tricia McMillan	38	Earth
Slartibartfast	1005	Magrathea



Name	Age	Planet
Arthur Dent	42	Earth
Ford Prefect	37	Betelgeuse Five
Tricia McMillan	38	Earth
Slartibartfast	1005	Magrathea



Name	Age	Planet
Arthur Dent	42	Earth
Ford Prefect	37	Betelgeuse Five
Tricia McMillan	38	Earth
Slartibartfast	1005	Magrathea

Not supported

Textual ×

Not supported

Usage

The simplest way to create a Table is to pass a list of tuples containing the items to display, and a list of column headings. The values in the tuples will then be mapped sequentially to the columns.

In this example, we will display a table of 2 columns, with 3 initial rows of data:

```python
import toga

table = toga.Table(
    headings=["Name", "Age"],
    data=[
        ("Arthur Dent", 42),
        ("Ford Prefect", 37),
        ("Tricia McMillan", 38),
    ]
)

# Get the details of the first item in the data:
print(f"{table.data[0].name} is age {table.data[0].age}")

# Append new data to the table
table.data.append(("Zaphod Beeblebrox", 47))
```

You can also specify data for a Table using a list of dictionaries. This allows you to store data in the data source that won't be displayed in the table. It also allows you to control the display order of columns independent of the storage of that data.

```python
import toga

table = toga.Table(
    headings=["Name", "Age"],
    data=[
        {"name": "Arthur Dent", "age": 42, "planet": "Earth"},
        {"name", "Ford Prefect", "age": 37, "planet": "Betelgeuse Five"},
        {"name": "Tricia McMillan", "age": 38, "planet": "Earth"},
    ]
)

# Get the details of the first item in the data:
row = table.data[0]
print(f"{row.name}, who is age {row.age}, is from {row.planet}")
```

The attribute names used on each row (called "accessors") are created automatically from the headings, by:

1. Converting the heading to lower case
2. Removing any character that can't be used in a Python identifier
3. Replacing all whitespace with _

4. Prepending _ if the first character is a digit

If you want to use different attributes, you can override them by providing an accessors argument. In this example, the table will use "Name" as the visible header, but internally, the attribute "character" will be used:

```
import toga

table = toga.Table(
    headings=["Name", "Age"],
    accessors={"Name", 'character'},
    data=[
        {"character": "Arthur Dent", "age": 42, "planet": "Earth"},
        {"character", "Ford Prefect", "age": 37, "planet": "Betelgeuse Five"},
        {"name": "Tricia McMillan", "age": 38, "planet": "Earth"},
    ]
)

# Get the details of the first item in the data:
row = table.data[0]
print(f"{row.character}, who is age {row.age}, is from {row.planet}")
```

The value provided by an accessor is interpreted as follows:

- If the value is a *Widget*, that widget will be displayed in the cell. Note that this is currently a beta API: see the Notes section.
- If the value is a tuple, it must have two elements: an icon, and a second element which will be interpreted as one of the options below.
- If the value is None, then missing_value will be displayed.
- Any other value will be converted into a string. If an icon has not already been provided in a tuple, it can also be provided using the value's icon attribute.

Icon values must either be an *Icon*, which will be displayed on the left of the cell, or None to display no icon.

Notes

- Widgets in cells is a beta API which may change in future, and is currently only supported on macOS.
- macOS does not support changing the font used to render table content.
- On Winforms, icons are only supported in the first column. On Android, icons are not supported at all.
- The Android implementation is not scalable beyond about 1,000 cells.

Reference

class toga.Table(*headings=None*, *id=None*, *style=None*, *data=None*, *accessors=None*, *multiple_select=False*, *on_select=None*, *on_activate=None*, *missing_value=''*, *on_double_click=None*)

Bases: *Widget*

Create a new Table widget.

Parameters

- **headings** (*list[str] | None*) – The column headings for the table. Headings can only contain one line; any text after a newline will be ignored.

  A value of `None` will produce a table without headings. However, if you do this, you *must* give a list of accessors.

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **data** (*Any*) – Initial *data* to be displayed in the table.
- **accessors** (*list[str] | None*) – Defines the attributes of the data source that will be used to populate each column. Must be either:
  - `None` to derive accessors from the headings, as described above; or
  - A list of the same size as `headings`, specifying the accessors for each heading. A value of `None` will fall back to the default generated accessor; or
  - A dictionary mapping headings to accessors. Any missing headings will fall back to the default generated accessor.
- **multiple_select** (*bool*) – Does the table allow multiple selection?
- **on_select** (*callable | None*) – Initial *on_select* handler.
- **on_activate** (*callable | None*) – Initial *on_activate* handler.
- **missing_value** (*str*) – The string that will be used to populate a cell when the value provided by its accessor is `None`, or the accessor isn't defined.
- **on_double_click** – **DEPRECATED**; use *on_activate*.

property accessors: list[str]

The accessors used to populate the table (read-only)

add_column(*heading*, *accessor=None*)

DEPRECATED: use *append_column()*

append_column(*heading*, *accessor=None*)

Append a column to the end of the table.

Parameters

- **heading** (`str`) – The heading for the new column.
- **accessor** (`Optional[str]`) – The accessor to use on the data source when populating the table. If not specified, an accessor will be derived from the heading.

property data: *ListSource*

The data to display in the table.

When setting this property:

- A *Source* will be used as-is. It must either be a *ListSource*, or a custom class that provides the same methods.
- A value of None is turned into an empty ListSource.
- Otherwise, the value must be an iterable, which is copied into a new ListSource. Items are converted as shown *here*.

property enabled: bool

Is the widget currently enabled? i.e., can the user interact with the widget? Table widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

focus()

No-op; Table cannot accept input focus

property headings: list[str] | None

The column headings for the table, or None if there are no headings (read-only)

insert_column(*index*, *heading*, *accessor=None*)

Insert an additional column into the table.

Parameters

- **index** (int | str) – The index at which to insert the column, or the accessor of the column before which the column should be inserted.
- **heading** (Optional[str]) – The heading for the new column. If the table doesn't have headings, the value will be ignored.
- **accessor** (Optional[str]) – The accessor to use on the data source when populating the table. If not specified, an accessor will be derived from the heading. An accessor *must* be specified if the table doesn't have headings.

property missing_value: str

The value that will be used when a data row doesn't provide an value for an attribute.

property multiple_select: bool

Does the table allow multiple rows to be selected?

property on_activate: callable

The callback function that is invoked when a row of the table is activated, usually with a double click or similar action.

property on_double_click

Use `on_activate`

Type
DEPRECATED

property on_select: callable

The callback function that is invoked when a row of the table is selected.

remove_column(*column*)

Remove a table column.

Parameters
column (int | str) – The index of the column to remove, or the accessor of the column to remove.

scroll_to_bottom()

Scroll the view so that the bottom of the list (last row) is visible.

scroll_to_row(*row*)

Scroll the view so that the specified row index is visible.

Parameters
row (int) – The index of the row to make visible. Negative values refer to the nth last row (-1 is the last row, -2 second last, and so on).

scroll_to_top()

Scroll the view so that the top of the list (first row) is visible.

property selection: `list[toga.sources.list_source.Row] | Row | None`

The current selection of the table.

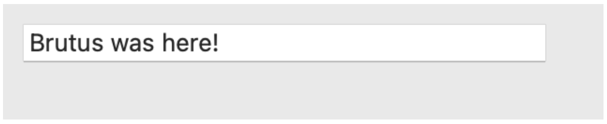
If multiple selection is enabled, returns a list of Row objects from the data source matching the current selection. An empty list is returned if no rows are selected.

If multiple selection is *not* enabled, returns the selected Row object, or `None` if no row is currently selected.

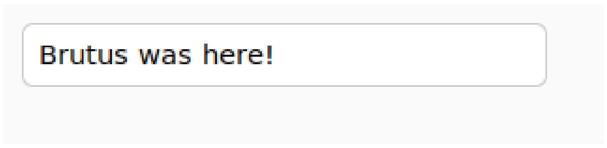
TextInput

A widget for the display and editing of a single line of text.

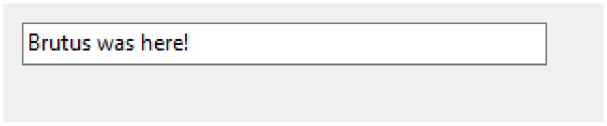
macOS



Linux



Windows



Android

iOS

Web

Screenshot not available

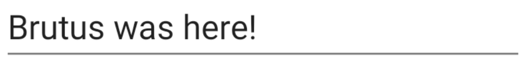
Textual

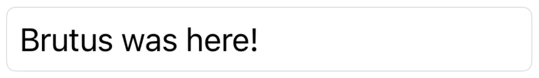
Screenshot not available

Usage

```
import toga

text_input = toga.TextInput()
text_input.value = "Jane Developer"
```





The input can be provided a placeholder value - this is a value that will be displayed to the user as a prompt for appropriate content for the widget. This placeholder will only be displayed if the widget has no content; as soon as a value is provided (either by the user, or programmatically), the placeholder content will be hidden.

The input can also be provided a list of *validators*. A validator is a function that will be invoked whenever the content of the input changes. The function should return `None` if the current value of the input is valid; if the current value is invalid, it should return an error message.

Notes

- Although an error message is provided when validation fails, Toga does not guarantee that this error message will be displayed to the user.
- Winforms does not support the use of partially or fully transparent colors for the TextInput background. If a color with an alpha value is provided (including `TRANSPARENT`), the alpha channel will be ignored. A `TRANSPARENT` background will be rendered as white.
- On Winforms, if a TextInput is given an explicit height, the rendered widget will not expand to fill that space. The widget will have the fixed height determined by the font used on the widget. In general, you should avoid setting a `height` style property on TextInput widgets.

Reference

`class toga.TextInput`(*id=None*, *style=None*, *value=None*, *readonly=False*, *placeholder=None*, *on_change=None*, *on_confirm=None*, *on_gain_focus=None*, *on_lose_focus=None*, *validators=None*)

Bases: `Widget`

Create a new single-line text input widget.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **value** (*str | None*) – The initial content to display in the widget.
- **readonly** (*bool*) – Can the value of the widget be modified by the user?
- **placeholder** (*str | None*) – The content to display as a placeholder when there is no user content to display.
- **on_change** (*callable | None*) – A handler that will be invoked when the the value of the widget changes.

- **on_confirm** (*callable | None*) – A handler that will be invoked when the user accepts the value of the input (usually by pressing Return on the keyboard).
- **on_gain_focus** (*callable | None*) – A handler that will be invoked when the widget gains input focus.
- **on_lose_focus** (*callable | None*) – A handler that will be invoked when the widget loses input focus.
- **validators** (*list[callable] | None*) – A list of validators to run on the value of the input.

property is_valid: bool

Does the value of the widget currently pass all validators without error?

property on_change: callable

The handler to invoke when the value of the widget changes.

property on_confirm: callable

The handler to invoke when the user accepts the value of the widget, usually by pressing return/enter on the keyboard.

property on_gain_focus: callable

The handler to invoke when the widget gains input focus.

property on_lose_focus: callable

The handler to invoke when the widget loses input focus.

property placeholder: str

The placeholder text for the widget.

A value of `None` will be interpreted and returned as an empty string. Any other object will be converted to a string using `str()`.

property readonly: bool

Can the value of the widget be modified by the user?

This only controls manual changes by the user (i.e., typing at the keyboard). Programmatic changes are permitted while the widget has `readonly` enabled.

property validators: list[callable]

The list of validators being used to check input on the widget.

Changing the list of validators will cause validation to be performed.

property value: str

The text to display in the widget.

A value of `None` will be interpreted and returned as an empty string. Any other object will be converted to a string using `str()`.

Any newline (`\n`) characters in the string will be replaced with a space.

Validation will be performed as a result of changing widget value.

TimeInput

A widget to select a clock time.

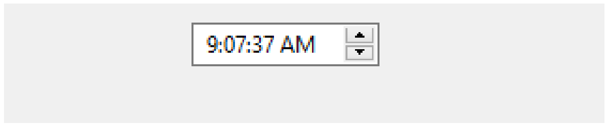
macOS ×

Not supported

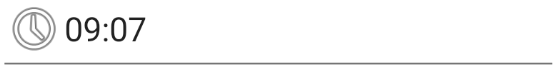
Linux ×

Not supported

Windows



Android



iOS ×

Not supported

Web ×

Not supported

Textual ×

Not supported

Usage

```python
import toga

current_time = toga.TimeInput()
```

Notes

- This widget supports hours, minutes and seconds. Microseconds will always be returned as zero.
  - On Android, seconds will also be returned as zero.
- Properties that return `datetime.time` objects can also accept:
  - `datetime.datetime`: The time portion will be extracted.
  - `str`: Will be parsed as an ISO8601 format time string (e.g., "06:12").

Reference

class `toga.TimeInput`(*id=None*, *style=None*, *value=None*, *min=None*, *max=None*, *on_change=None*)

Bases: `Widget`

Create a new TimeInput widget.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **value** (*datetime.time | None*) – The initial time to display. If not specified, the current time will be used.
- **min** (*datetime.time | None*) – The earliest time (inclusive) that can be selected.
- **max** (*datetime.time | None*) – The latest time (inclusive) that can be selected.
- **on_change** (*callable | None*) – A handler that will be invoked when the value changes.

property max: `time`

The maximum allowable time (inclusive). A value of `None` will be converted into 23:59:59.

When setting this property, the current `value` and `min` will be clipped against the new maximum value.

property min: `time`

The minimum allowable time (inclusive). A value of `None` will be converted into 00:00:00.

When setting this property, the current `value` and `max` will be clipped against the new minimum value.

property on_change: `callable`

The handler to invoke when the time value changes.

property value: `time`

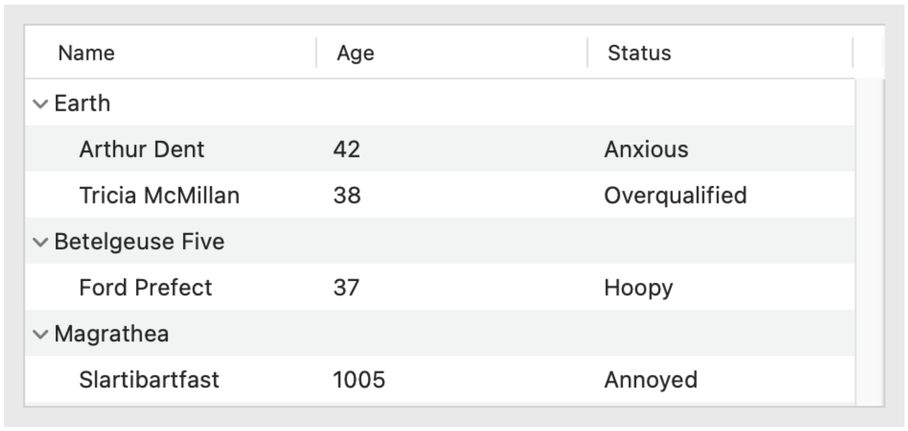
The currently selected time. A value of `None` will be converted into the current time.

If this property is set to a value outside of the min/max range, it will be clipped.

Tree

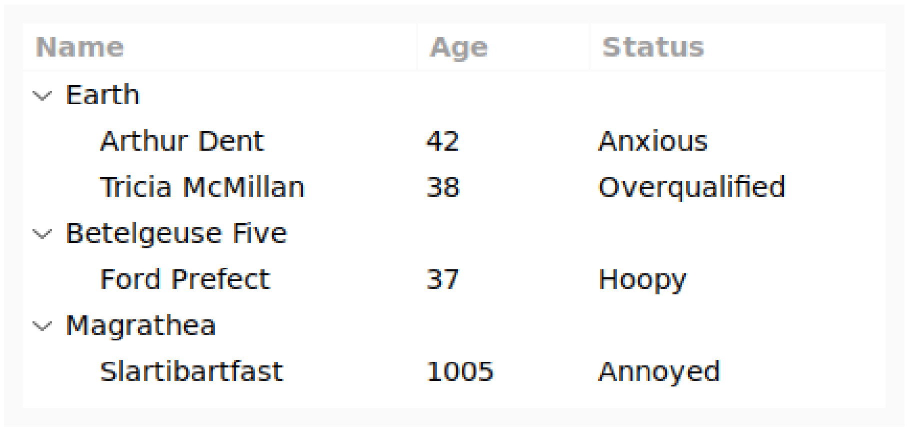
A widget for displaying a hierarchical tree of tabular data. Scroll bars will be provided if necessary.

macOS



Name	Age	Status
Earth		
Arthur Dent	42	Anxious
Tricia McMillan	38	Overqualified
Betelgeuse Five		
Ford Prefect	37	Hoopy
Magrathea		
Slartibartfast	1005	Annoyed

Linux



Name	Age	Status
Earth		
Arthur Dent	42	Anxious
Tricia McMillan	38	Overqualified
Betelgeuse Five		
Ford Prefect	37	Hoopy
Magrathea		
Slartibartfast	1005	Annoyed

Windows ×

Not supported

Android ×

Not supported

iOS ×

Not supported

Web ×

Not supported

Textual ×

Not supported

Usage

The simplest way to create a Tree is to pass a dictionary and a list of column headings. Each key in the dictionary can be either a tuple, whose contents will be mapped sequentially to the columns of a node, or a single object, which will be mapped to the first column. And each value in the dictionary can be either another dictionary containing the children of that node, or None if there are no children.

In this example, we will display a tree with 2 columns. The tree will have 2 root nodes; the first root node will have 1 child node; the second root node will have 2 children. The root nodes will only populate the "name" column; the other column will be blank:

```
import toga

tree = toga.Tree(
    headings=["Name", "Age"],
    data={
        "Earth": {
            ("Arthur Dent", 42): None,
        },
        "Betelgeuse Five": {
            ("Ford Prefect", 37): None,
```

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```
            ("Zaphod Beeblebrox", 47): None,
        },
    }
)

# Get the details of the first child of the second root node:
print(f"{tree.data[1][0].name} is age {tree.data[1][0].age}")

# Append new data to the first root node in the tree
tree.data[0].append(("Tricia McMillan", 38))
```

You can also specify data for a Tree using a list of 2-tuples, with dictionaries providing data values. This allows you to store data in the data source that won't be displayed in the tree. It also allows you to control the display order of columns independent of the storage of that data.

```
import toga

tree = toga.Tree(
    headings=["Name", "Age"],
    data=[
        (
            {"name": "Earth"},
            [({"name": "Arthur Dent", "age": 42, "status": "Anxious"}, None)]
        ),
        (
            {"name": "Betelgeuse Five"},
            [
                ({"name": "Ford Prefect", "age": 37, "status": "Hoopy"}, None),
                ({"name": "Zaphod Beeblebrox", "age": 47, "status": "Oblivious"}, None),
            ]
        ),
    ]
)

# Get the details of the first child of the second root node:
node = tree.data[1][0]
print(f"{node.name}, who is age {node.age}, is {node.status}")
```

The attribute names used on each row (called "accessors") are created automatically from the headings, by:

1. Converting the heading to lower case
2. Removing any character that can't be used in a Python identifier
3. Replacing all whitespace with _
4. Prepending _ if the first character is a digit

If you want to use different attributes, you can override them by providing an `accessors` argument. In this example, the tree will use "Name" as the visible header, but internally, the attribute "character" will be used:

```
import toga

tree = toga.Tree(
    headings=["Name", "Age"],
```

(continues on next page)

(continued from previous page)

```
    accessors={"Name", 'character'},
    data=[
        (
            {"character": "Earth"},
            [({"character": "Arthur Dent", "age": 42, "status": "Anxious"}, None)]
        ),
        (
            {"character": "Betelgeuse Five"},
            [
                ({"character": "Ford Prefect", "age": 37, "status": "Hoopy"}, None),
                ({"character": "Zaphod Beeblebrox", "age": 47, "status": "Oblivious"},␣
↪None),
            ]
        ),
    ]
)

# Get the details of the first child of the second root node:
node = tree.data[1][0]
print(f"{node.character}, who is age {node.age}, is {node.status}")
```

The value provided by an accessor is interpreted as follows:

- If the value is a *Widget*, that widget will be displayed in the cell. Note that this is currently a beta API: see the Notes section.
- If the value is a `tuple`, it must have two elements: an icon, and a second element which will be interpreted as one of the options below.
- If the value is `None`, then `missing_value` will be displayed.
- Any other value will be converted into a string. If an icon has not already been provided in a tuple, it can also be provided using the value's `icon` attribute.

Icon values must either be an *Icon*, which will be displayed on the left of the cell, or `None` to display no icon.

Notes

- Widgets in cells is a beta API which may change in future, and is currently only supported on macOS.
- On macOS, you cannot change the font used in a Tree.

Reference

`class toga.Tree`(*headings=None*, *id=None*, *style=None*, *data=None*, *accessors=None*, *multiple_select=False*, *on_select=None*, *on_activate=None*, *missing_value=''*, *on_double_click=None*)

Bases: *Widget*

Create a new Tree widget.

Parameters

- **headings** (*list[str] | None*) – The column headings for the tree. Headings can only contain one line; any text after a newline will be ignored.

A value of None will produce a table without headings. However, if you do this, you *must* give a list of accessors.

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **data** (*Any*) – Initial *data* to be displayed in the tree.
- **accessors** (*list[str] | None*) – Defines the attributes of the data source that will be used to populate each column. Must be either:
  - None to derive accessors from the headings, as described above; or
  - A list of the same size as headings, specifying the accessors for each heading. A value of None will fall back to the default generated accessor; or
  - A dictionary mapping headings to accessors. Any missing headings will fall back to the default generated accessor.
- **multiple_select** (*bool*) – Does the tree allow multiple selection?
- **on_select** (*callable | None*) – Initial *on_select* handler.
- **on_activate** (*callable | None*) – Initial *on_activate* handler.
- **missing_value** (*str*) – The string that will be used to populate a cell when the value provided by its accessor is None, or the accessor isn't defined.
- **on_double_click** – **DEPRECATED**; use *on_activate*.

property accessors: list[str]

The accessors used to populate the tree (read-only)

append_column(*heading*, *accessor=None*)

Append a column to the end of the tree.

Parameters

- **heading** (str) – The heading for the new column.
- **accessor** (Optional[str]) – The accessor to use on the data source when populating the tree. If not specified, an accessor will be derived from the heading.

collapse(*node=None*)

Collapse the specified node of the tree.

If no node is provided, all nodes of the tree will be collapsed.

If the provided node is a leaf node, or the node is already collapsed, this is a no-op.

Parameters

node (Optional[*Node*]) – The node to collapse

property data: *TreeSource*

The data to display in the tree.

When setting this property:

- A *Source* will be used as-is. It must either be a *TreeSource*, or a custom class that provides the same methods.
- A value of None is turned into an empty TreeSource.
- Otherwise, the value must be an dictionary or an iterable, which is copied into a new TreeSource as shown *here*.

property enabled: bool

Is the widget currently enabled? i.e., can the user interact with the widget? Tree widgets cannot be disabled; this property will always return True; any attempt to modify it will be ignored.

expand(*node=None*)

Expand the specified node of the tree.

If no node is provided, all nodes of the tree will be expanded.

If the provided node is a leaf node, or the node is already expanded, this is a no-op.

If a node is specified, the children of that node will also be expanded.

Parameters
node (`Optional`[*`Node`*]) – The node to expand

focus()

No-op; Tree cannot accept input focus

property headings: list[str]

The column headings for the tree (read-only)

insert_column(*index*, *heading*, *accessor=None*)

Insert an additional column into the tree.

Parameters

- **index** (`int` | `str`) – The index at which to insert the column, or the accessor of the column before which the column should be inserted.
- **heading** (`Optional`[`str`]) – The heading for the new column. If the tree doesn't have headings, the value will be ignored.
- **accessor** (`Optional`[`str`]) – The accessor to use on the data source when populating the tree. If not specified, an accessor will be derived from the heading. An accessor *must* be specified if the tree doesn't have headings.

property missing_value: str

The value that will be used when a data row doesn't provide an value for an attribute.

property multiple_select: bool

Does the tree allow multiple rows to be selected?

property on_activate: callable

The callback function that is invoked when a row of the tree is activated, usually with a double click or similar action.

property on_double_click

Use `on_activate`

Type
DEPRECATED

property on_select: callable

The callback function that is invoked when a row of the tree is selected.

remove_column(*column*)

Remove a tree column.

Parameters
column (`int` | `str`) – The index of the column to remove, or the accessor of the column to remove.

property selection: `list[toga.sources.tree_source.Node] | Node | None`

The current selection of the tree.

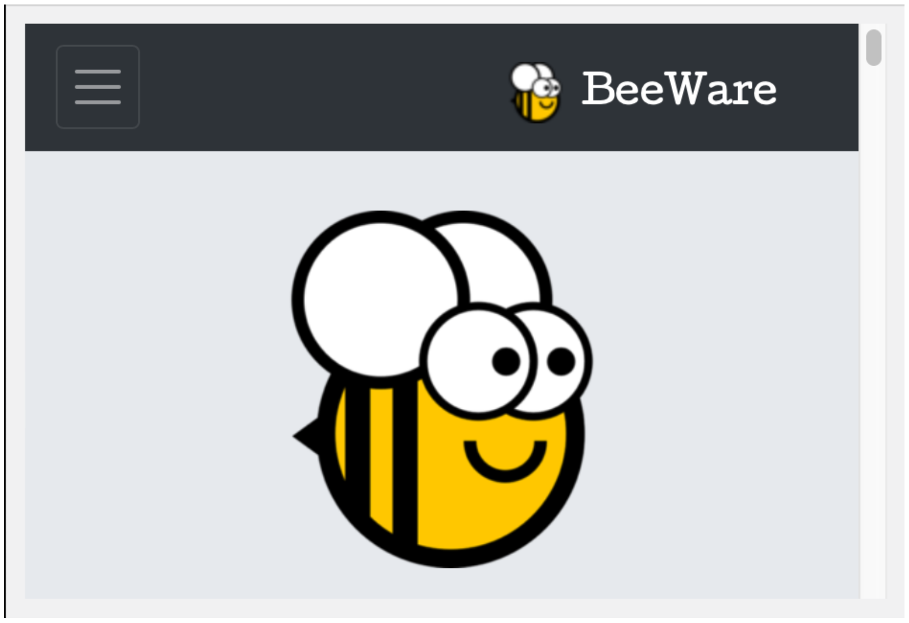
If multiple selection is enabled, returns a list of Node objects from the data source matching the current selection. An empty list is returned if no nodes are selected.

If multiple selection is *not* enabled, returns the selected Node object, or `None` if no node is currently selected.

WebView

An embedded web browser.

macOS



Linux

Windows

Android

iOS

Web ×

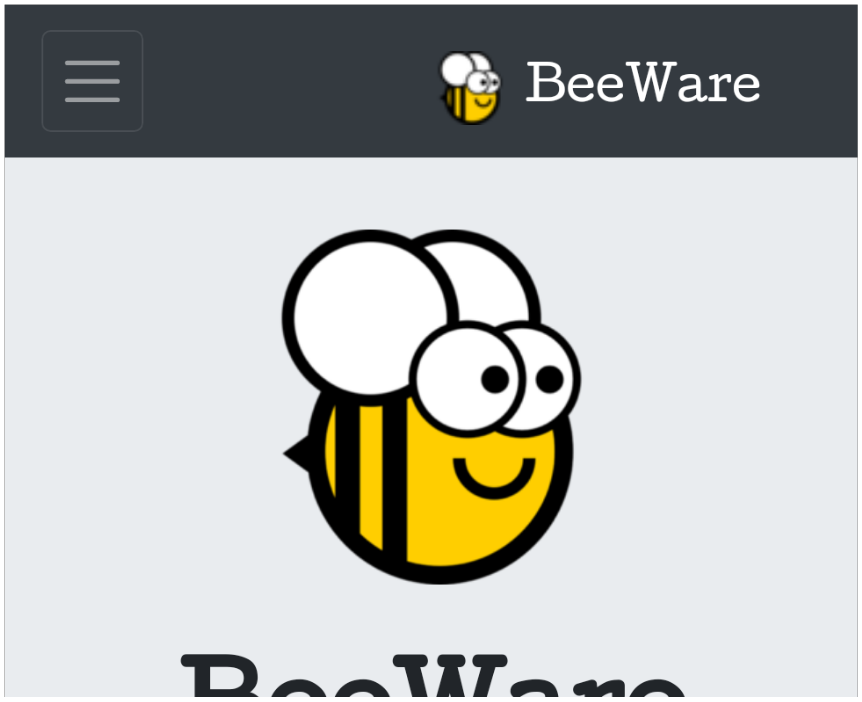
Not supported

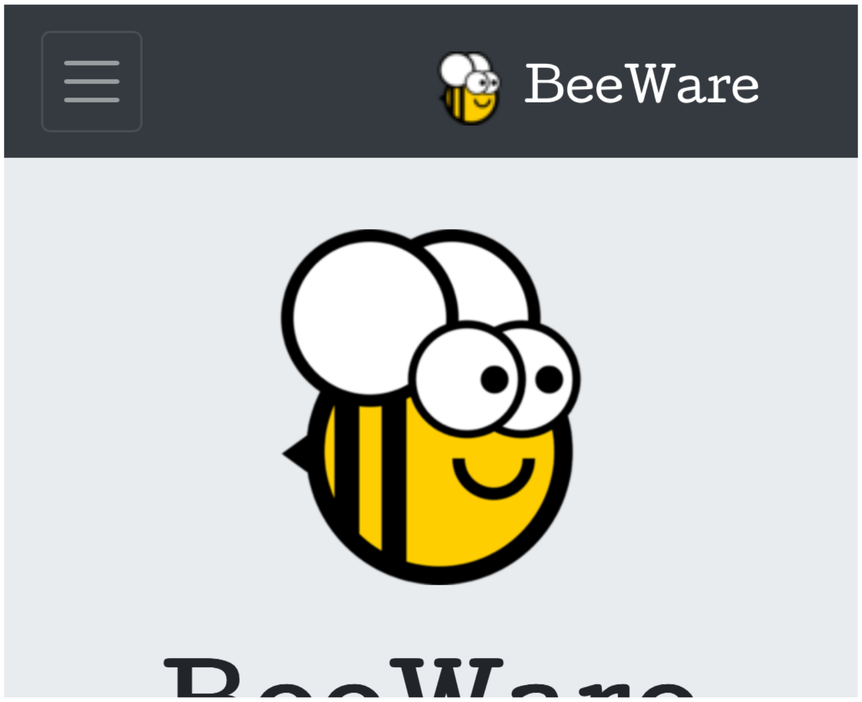
Textual ×

Not supported

BeeWare

BeeWare


BeeWare


BeeWare

Usage

```
import toga

webview = toga.WebView()

# Request a URL be loaded in the webview.
webview.url = "https://beeware.org"

# Load a URL, and wait (non-blocking) for the page to complete loading
await webview.load_url("https://beeware.org")

# Load static HTML content into the wevbview.
webview.set_content("https://example.com", "<html>...</html>")
```

Notes

- Due to app security restrictions, WebView can only display `http://` and `https://` URLs, not `file://` URLs. To serve local file content, run a web server on `localhost` using a background thread.
- Using WebView on Windows 10 requires that your users have installed the Edge WebView2 Evergreen Runtime. This is installed by default on Windows 11.
- Using WebView on Linux requires that the user has installed the system packages for WebKit2, plus the GObject Introspection bindings for WebKit2.
- On macOS 13.3 (Ventura) and later, the content inspector for your app can be opened by running Safari, enabling the developer tools, and selecting your app's window from the "Develop" menu.

  On macOS versions prior to Ventura, the content inspector is not enabled by default, and is only available when your code is packaged as a full macOS app (e.g., with Briefcase). To enable debugging, run:

  ```
  $ defaults write com.example.appname WebKitDeveloperExtras -bool true
  ```

  Substituting `com.example.appname` with the bundle ID for your packaged app.

Reference

class `toga.WebView`(*id=None*, *style=None*, *url=None*, *user_agent=None*, *on_webview_load=None*)

Bases: *Widget*

Create a new WebView widget.

Parameters

- **id** – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.
- **url** (*str | None*) – The full URL to load in the WebView. If not provided, an empty page will be displayed.
- **user_agent** (*str | None*) – The user agent to use for web requests. If not provided, the default user agent for the platform will be used.

- `on_webview_load` (*callable | None*) – A handler that will be invoked when the web view finishes loading.

`evaluate_javascript`(*javascript*, *on_result=None*)

Evaluate a JavaScript expression.

There is no guarantee that the JavaScript has finished evaluating when this method returns. The object returned by this method can be awaited to obtain the value of the expression, or you can provide an `on_result` callback.

Note: On Android and Windows, *no exception handling is performed*. If a JavaScript error occurs, a return value of None will be reported, but no exception will be provided.

Parameters

- `javascript` – The JavaScript expression to evaluate.
- `on_result` – A callback that will be invoked when the JavaScript completes. It should take one positional argument, which is the value of the expression.

  If evaluation fails, the positional argument will be `None`, and a keyword argument `exception` will be passed with an exception object.

Return type

`JavaScriptResult`

`async load_url`(*url*)

Load a URL, and wait until the next *`on_webview_load`* event.

Note: On Android, this method will return immediately.

Parameters

`url` (`str`) – The URL to load.

`property on_webview_load: callable`

The handler to invoke when the web view finishes loading.

Rendering web content is a complex, multi-threaded process. Although a page may have completed *loading*, there's no guarantee that the page has been fully *rendered*, or that the widget representation has been fully updated. The number of load events generated by a URL transition or content change can be unpredictable. An `on_webview_load` event should be interpreted as an indication that some change has occurred, not that a *specific* change has occurred, or that a specific change has been fully propagated into the rendered content.

Note: This is not currently supported on Android.

`set_content`(*root_url*, *content*)

Set the HTML content of the WebView.

Note: On Android and Windows, the `root_url` argument is ignored. Calling this method will set the `url` property to `None`.

Parameters

- `root_url` (`str`) – A URL which will be returned by the `url` property, and used to resolve any relative URLs in the content.
- `content` (`str`) – The HTML content for the WebView

`property url: str | None`

The current URL, or `None` if no URL is currently displayed.

After setting this property, it is not guaranteed that reading the property will immediately return the new value. To be notified once the URL has finished loading, use `load_url` or `on_webview_load`.

property user_agent: str

The user agent to use for web requests.

Note: On Windows, this property will return an empty string until the widget has finished initializing.

Widget

The abstract base class of all widgets. This class should not be be instantiated directly.

Table 15: Availability (Key)

macOS	GTK	Windows	iOS	Android	Web	Terminal

Reference

class toga.Widget(*id=None*, *style=None*)

Create a base Toga widget.

This is an abstract base class; it cannot be instantiated.

Parameters

- **id** (`Optional[str]`) – The ID for the widget.
- **style** – A style object. If no style is provided, a default style will be applied to the widget.

add(**children*)

Add the provided widgets as children of this widget.

If a child widget already has a parent, it will be re-parented as a child of this widget. If the child widget is already a child of this widget, there is no change.

Parameters
children (`Widget`) – The widgets to add as children of this widget.

Raises
`ValueError` – If this widget cannot have children.

Return type
`None`

property app: App | None

The App to which this widget belongs.

When setting the app for a widget, all children of this widget will be recursively assigned to the same app.

Raises
`ValueError` – If this widget is already associated with another app.

property can_have_children

Determine if the node can have children.

This does not resolve whether there actually *are* any children; it only confirms whether children are theoretically allowed.

property children

The children of this node. This *always* returns a list, even if the node is a leaf and cannot have children.

Returns
A list of the children for this widget.

clear()

Remove all child widgets of this node.

Refreshes the widget after removal if any children were removed.

Raises
`ValueError` – If this widget cannot have children.

Return type
`None`

property enabled: bool

Is the widget currently enabled? i.e., can the user interact with the widget?

focus()

Give this widget the input focus.

This method is a no-op if the widget can't accept focus. The ability of a widget to accept focus is platform-dependent. In general, on desktop platforms you can focus any widget that can accept user input, while on mobile platforms focus is limited to widgets that accept text input (i.e., widgets that cause the virtual keyboard to appear).

Return type
`None`

property id: str

The DOM identifier for the widget.

This id can be used to target CSS directives.

insert(*index*, *child*)

Insert a widget as a child of this widget.

If a child widget already has a parent, it will be re-parented as a child of this widget. If the child widget is already a child of this widget, there is no change.

Parameters

- **index** (`int`) – The position in the list of children where the new widget should be added.
- **child** (*`Widget`*) – The child to insert as a child of this node.

Raises
`ValueError` – If this widget cannot have children.

Return type
`None`

property parent

The parent of this node.

Returns
The parent of this node. Returns None if this node is the root node.

refresh()

Refresh the layout and appearance of the tree this node is contained in.

Return type
None

remove(**children*)

Remove the provided widgets as children of this node.

Any nominated child widget that is not a child of this widget will not have any change in parentage.

Refreshes the widget after removal if any children were removed.

Parameters
children (*Widget*) – The child nodes to remove.

Raises
ValueError – If this widget cannot have children.

Return type
None

property root

The root of the tree containing this node.

Returns
The root node. Returns self if this node *is* the root node.

property tab_index: int | None

The position of the widget in the focus chain for the window.

Note: This is a beta feature. The `tab_index` API may change in future.

property window: ***Window*** **| None**

The window to which this widget belongs.

When setting the window for a widget, all children of this widget will be recursively assigned to the same window.

Constants

class toga.constants.**Direction**(*value*, *names=None*, ***, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

Bases: Enum

The direction a given property should act

HORIZONTAL = 0

VERTICAL = 1

class toga.constants.**Baseline**(*value*, *names=None*, ***, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

Bases: Enum

The meaning of a Y coordinate when drawing text.

ALPHABETIC = 1
Alphabetic baseline of the first line

TOP = 2
Top of text

MIDDLE = 3
Middle of text

BOTTOM = 4
Bottom of text

class toga.constants.**FillRule**(*value*, *names=None*, ***, *module=None*, *qualname=None*, *type=None*, *start=1*, *boundary=None*)

Bases: `Enum`

The rule to use when filling paths.

EVENODD = 0

NONZERO = 1

2.3.4 Style

The Pack Style Engine

Toga's default style engine, **Pack**, is a layout algorithm based around the idea of packing boxes inside boxes. Each box specifies a direction for its children, and each child specifies how it will consume the available space - either as a specific width, or as a proportion of the available width. Other properties exist to control color, text alignment and so on.

It is similar in some ways to the CSS Flexbox algorithm; but dramatically simplified, as there is no allowance for overflowing boxes.

Note: The string values defined here are the string literals that the Pack algorithm accepts. These values are also pre-defined as Python constants in the `toga.style.pack` module with the same name; however, following Python style, the constants use upper case. For example, the Python constant `toga.style.pack.COLUMN` evaluates as the string literal `"column"`.

Pack style properties

`display`

Values: `pack` | `none`

Initial value: `pack`

Used to define the how to display the element. A value of `pack` will apply the pack layout algorithm to this node and its descendants. A value of `none` removes the element from the layout entirely. Space will be allocated for the element as if it were there, but the element itself will not be visible.

`visibility`

Values: `hidden` | `visible`

Initial value: `visible`

Used to define whether the element should be drawn. A value of `visible` means the element will be displayed. A value of `hidden` removes the element from view, but allocates space for the element as if it were still in the layout.

Any children of a hidden element are implicitly removed from view.

If a previously hidden element is made visible, any children of the element with a visibility of `hidden` will remain hidden. Any descendants of the hidden child will also remain hidden, regardless of their visibility.

`direction`

Values: `row` | `column`

Initial value: `row`

The packing direction for children of the box. A value of `column` indicates children will be stacked vertically, from top to bottom. A value of `row` indicates children will be packed horizontally; left-to-right if `text_direction` is `ltr`, or right-to-left if `text_direction` is `rtl`.

`alignment`

Values: `top` | `bottom` | `left` | `right` | `center`

Initial value: `top` if direction is `row`; `left` if direction is `column`

The alignment of children relative to the outside of the packed box.

If the box is a `column` box, only the values `left`, `right` and `center` are honored.

If the box is a `row` box, only the values `top`, `bottom` and `center` are honored.

If a value is provided, but the value isn't honored, the alignment reverts to the default for the direction.

`width`

Values: `<integer>` | `none`

Initial value: `none`

Specify a fixed width for the box, in *CSS pixels*.

The final width for the box may be larger, if the children of the box cannot fit inside the specified space.

`height`

Values: `<integer>` | `none`

Initial value: `none`

Specify a fixed height for the box, in *CSS pixels*.

The final height for the box may be larger, if the children of the box cannot fit inside the specified space.

`flex`

Values: `<number>`

Initial value: 0

A weighting that is used to compare this box with its siblings when allocating remaining space in a box.

Once fixed space allocations have been performed, this box will assume `flex / (sum of all flex for all siblings)` of all remaining available space in the direction of the parent's layout.

`padding_top`

`padding_right`

`padding_bottom`

`padding_left`

Values: `<integer>`

Initial value: `0`

The amount of space to allocate between the edge of the box, and the edge of the content in the box, in *CSS pixels*.

`padding`

Values: `<integer>` or `<tuple>` of length 1-4

A shorthand for setting the top, right, bottom and left padding with a single declaration.

If 1 integer is provided, that value will be used as the padding for all sides.

If 2 integers are provided, the first value will be used as the padding for the top and bottom; the second will be used as the value for the left and right.

If 3 integers are provided, the first value will be used as the top padding, the second for the left and right padding, and the third for the bottom padding.

If 4 integers are provided, they will be used as the top, right, bottom and left padding, respectively.

`color`

Values: `<color>`

Initial value: System default

Set the foreground color for the object being rendered.

Some objects may not use the value.

`background_color`

Values: `<color>` | `transparent`

Initial value: The platform default background color

Set the background color for the object being rendered.

Some objects may not use the value.

`text_align`

Values: `left` | `right` | `center` | `justify`

Initial value: `left` if `text_direction` is `ltr`; `right` if `text_direction` is `rtl`

Defines the alignment of text in the object being rendered.

`text_direction`

Values: `rtl` | `ltr`

Initial value: `rtl`

Defines the natural direction of horizontal content.

`font_family`

Values: `system` | `serif` | `sans-serif` | `cursive` | `fantasy` | `monospace` | `<string>`

Initial value: `system`

The font family to be used.

A value of `system` indicates that whatever is a system-appropriate font should be used.

A value of `serif`, `sans-serif`, `cursive`, `fantasy`, or `monospace` will use a system-defined font that matches the description (e.g. "Times New Roman" for `serif`, "Courier New" for `monospace`).

Any other value will be checked against the family names previously registered with *`Font.register`*. If the name cannot be resolved, the system font will be used.

`font_style`

Values: `normal` | `italic` | `oblique`

Initial value: `normal`

The style of the font to be used.

Note: Windows and Android do not support the oblique font style. A request for an `oblique` font will be interpreted as `italic`.

`font_variant`

Values: `normal` | `small_caps`

Initial value: `normal`

The variant of the font to be used.

Note: Windows and Android do not support the small caps variant. A request for a `small_caps` font will be interpreted as `normal`.

`font_weight`

Values: `normal` | `bold`

Initial value: `normal`

The weight of the font to be used.

`font_size`

Values: `<integer>`

Initial value: System default

The size of the font to be used, in *CSS points*.

The relationship between Pack and CSS

Pack aims to be a functional subset of CSS. Any Pack layout can be converted into an equivalent CSS layout. After applying this conversion, the CSS layout should be considered a "reference implementation". Any disagreement between the rendering of a converted Pack layout in a browser, and the layout produced by the Toga implementation of Pack should be considered to be either a bug in Toga, or a bug in the mapping.

The mapping that can be used to establish the reference implementation is:

- The reference HTML layout document is rendered in no-quirks mode, with a default CSS stylesheet:

```
<!DOCTYPE html>
<html>
   <head>
      <meta charset="UTF-8" />
      <title>Pack layout testbed</title>
      <style>
```

(continues on next page)

(continued from previous page)

```
            html, body {
                height: 100%;
            }
            body {
                overflow: hidden;
                display: flex;
                margin: 0;
                white-space: pre;
            }
            div {
                display: flex;
                white-space: pre;
            }
        </style>
    </head>
    <body></body>
</html>
```

- The root element of the Pack layout can be mapped to the `<body>` element of the HTML reference document. The rendering area of the browser window becomes the view area that Pack will fill.
- Images map to `<img>` elements. The `<img>` element has an additional style of `object-fit:  contain` unless *both* `height` and `width` are defined.
- All other elements in the DOM tree are mapped to `<div>` elements.
- The following Pack declarations can be mapped to equivalent CSS declarations:

Pack property	CSS property
alignment: top	align-items: start if direction == row; otherwise ignored.
alignment: bottom	align-items: end if direction == row; otherwise ignored.
alignment: left	align-items: start if direction == column; otherwise ignored.
alignment: right	align-items: end if direction == column; otherwise ignored.
alignment: center	align-items: center
direction: <str>	flex-direction: <str>
display: pack	display: flex
flex: <int>	If direction = row and width is set, or direction = column and height is set, ignore. Otherwise, flex: <int> 0 auto.
font_size: <int>	font-size: <int>pt
height: <value>	height: <value>px if value is an integer; height: auto if value is none.
padding_top: <int>	margin-top: <int>px
padding_bottom <int>	margin-bottom: <int>px
padding_left: <int>	margin-left: <int>px
padding_right: <int>	margin-right: <int>px
text_direction <str>	direction: <str>
width: <value>	width: <value>px if value is an integer; width: auto if value is none.

- All other Pack declarations should be used as-is as CSS declarations, with underscores being converted to dashes (e.g., background_color becomes background-color).

2.4 Background

2.4.1 About the project

Why Toga?

Toga isn't the world's first widget toolkit - there are dozens of other options. So why build a new one?

Native widgets - not themes

Toga uses native system widgets, not themes. When you see a Toga app running, it doesn't just *look* like a native app - it *is* a native app. Applying an operating system-inspired theme over the top of a generic widget set is an easy way for a developer to achieve a cross-platform goal, but it leaves the end user with the mess.

It's easy to spot apps that have been built using themed widget sets - they're the ones that don't behave quite like any other app. Widgets don't look *quite* right, or there's a menu bar on a window in a macOS app. Themes can get quite close - but there are always tell-tale signs.

On top of that, native widgets are always faster than a themed generic widget. After all, you're using native system capability that has been tuned and optimized, not a drawing engine that's been layered on top of a generic widget.

Abstract the broad concepts

It's not enough to just look like a native app, though - you need to *feel* like a native app as well.

A "Quit" option under a "File" menu makes sense if you're writing a Windows app - but it's completely out of place if you're on macOS - the Quit option should be under the application menu.

And besides - why did the developer have to code the location of a Quit option anyway? Every app in the world has to have a quit option, so why doesn't the widget toolkit provide a quit option pre-installed, out of the box?

Although Toga uses 100% native system widgets, that doesn't mean Toga is just a wrapper around system widgets. Wherever possible, Toga attempts to abstract the broader concepts underpinning the construction of GUI apps, and build an API for *that*. So - every Toga app has the basic set of menu options you'd expect of every app - Quit, About, and so on - all in the places you'd expect to see them in a native app.

When it comes to widgets, sometimes the abstraction is simple - after all, a button is a button, no matter what platform you're on. But other widgets may not be exposed so literally. What the Toga API aims to expose is a set of mechanisms for achieving UI goals, not a literal widget set.

Python native

Most widget toolkits start their life as a C or C++ layer, which is then wrapped by other languages. As a result, you end up with APIs that taste like C or C++.

Toga has been designed from the ground up to be a Python native widget toolkit. This means the API is able to exploit language level features like generators and context managers in a way that a wrapper around a C library wouldn't be able to (at least, not easily).

This also means supporting Python 3, and 3 only because that's where the future of Python is at.

pip install and nothing more

Toga aims to be no more than a *pip install* away from use. It doesn't require the compilation of C extensions. There's no need to install a binary support library. There's no need to change system paths and environment variables. Just install it, import it, and start writing (or running) code.

Embrace mobile

10 years ago, being a cross-platform widget toolkit meant being available for Windows, macOS and Linux. These days, mobile computing is much more important. But despite this, there aren't many good options for Python programming on mobile platforms, and cross-platform mobile coding is still elusive. Toga aims to correct this.

Why "Toga"? Why the Yak?

So... why the name Toga?

We all know the aphorism that "When in Rome, do as the Romans do."

So - what does a well dressed Roman wear? A toga, of course! And what does a well dressed Python app wear? Toga!

So... why the yak mascot?

It's a reflection of the long running joke about yak shaving in computer programming. The story originally comes from MIT, and is related to a Ren and Stimpy episode; over the years, the story has evolved, and now goes something like this:

> You want to borrow your neighbor's hose so you can wash your car. But you remember that last week, you broke their rake, so you need to go to the hardware store to buy a new one. But that means driving to the hardware store, so you have to look for your keys. You eventually find your keys inside a tear in a cushion - but you can't leave the cushion torn, because the dog will destroy the cushion if they find a little tear. The cushion needs a little more stuffing before it can be repaired, but it's a special cushion filled with exotic Tibetan yak hair.
>
> The next thing you know, you're standing on a hillside in Tibet shaving a yak. And all you wanted to do was wash your car.

An easy to use widget toolkit is the yak standing in the way of progress of a number of BeeWare projects, and the original creator of Toga has been tinkering with various widget toolkits for over 20 years, so the metaphor seemed appropriate.

Success Stories

Want to see examples of Toga in use? Here's some:

- Travel Tips is an app in the iOS App Store that uses Toga to describe it's user interface.
- Eddington is a data fitting tool based on *Toga* and *Briefcase*
- taRpnCalcTG is a Toga based calculator for Android, Windows and MacOS which is extensible with Python scripts.
- pyPlayground is a Toga based app for Android and Windows which can be modified to try Toga without additional tool chain.
- taAppLister is a Toga based Android app for listing and exporting all installed apps.
- RemoteCommand is a Toga based app for synchronizing the clipboard between Windows and MacOS.

Release History

0.4.0 (2023-11-03)

Features

- The Toga API has been fully audited. All APIs now have 100% test coverage, complete API documentation (including type annotations), and are internally consistent. (#1903, #1938, #1944, #1946, #1949, #1951, #1955, #1956, #1964, #1969, #1984, #1996, #2011, #2017, #2025, #2029, #2044, #2058, #2075)
- Headings are no longer mandatory for Tree widgets. If headings are not provided, the widget will not display its header bar. (#1767)
- Support for custom font loading was added to the GTK, Cocoa and iOS backends. (#1837)
- The testbed app has better diagnostic output when running in test mode. (#1847)
- A Textual backend was added to support terminal applications. (#1867)
- Support for determining the currently active window was added to Winforms. (#1872)
- Programmatically scrolling to top and bottom in MultilineTextInput is now possible on iOS. (#1876)
- A handler has been added for users confirming the contents of a TextInput by pressing Enter/Return. (#1880)
- An API for giving a window focus was added. (#1887)
- Widgets now have a `.clear()` method to remove all child widgets. (#1893)
- Winforms now supports hiding and re-showing the app cursor. (#1894)
- ProgressBar and Switch widgets were added to the Web backend. (#1901)
- Missing value handling was added to the Tree widget. (#1913)
- App paths now include a `config` path for storing configuration files. (#1964)
- A more informative error message is returned when a platform backend doesn't support a widget. (#1992)
- The example apps were updated to support being run with `briefcase run` on all platforms. (#1995)
- Headings are no longer mandatory Table widgets. (#2011)
- Columns can now be added and removed from a Tree. (#2017)
- The default system notification sound can be played via `App.beep()`. (#2018)
- DetailedList can now respond to "primary" and "secondary" user actions. These may be implemented as left and right swipe respectively, or using any other platform-appropriate mechanism. (#2025)
- A DetailedList can now provide a value to use when a row doesn't provide the required data. (#2025)
- The accessors used to populate a DetailedList can now be customized. (#2025)
- Transformations can now be applied to *any* canvas context, not just the root context. (#2029)
- Canvas now provides more `list`-like methods for manipulating drawing objects in a context. (#2029)
- On Windows, the default font now follows the system theme. On most devices, this means it has changed from Microsoft Sans Serif 8pt to Segoe UI 9pt. (#2029)
- Font sizes are now consistently interpreted as CSS points. On Android, iOS and macOS, this means any numeric font sizes will appear 33% larger than before. The default font size on these platforms is unchanged. (#2029)
- MultilineTextInputs no longer show spelling suggestions when in read-only mode. (#2136)
- Applications now verify that a main window has been created as part of the `startup()` method. (#2047)

- An implementation of ActivityIndicator was added to the Web backend. (#2050)
- An implementation of Divider was added to the Web backend. (#2051)
- The ability to capture the contents of a window as an image has been added. (#2063)
- A PasswordInput widget was added to the Web backend. (#2089)
- The WebKit inspector is automatically enabled on all macOS WebViews, provided you're using macOS 13.3 (Ventura) or iOS 16.4, or later. (#2109)
- Text input widgets on macOS now support undo and redo. (#2151)
- The Divider widget was implemented on Android. (#2181)

Bugfixes

- The WinForms event loop was decoupled from the main form, allowing background tasks to run without a main window being present. (#750)
- Widgets are now removed from windows when the window is closed, preventing a memory leak on window closure. (#1215)
- Android and iOS apps no longer crash if you invoke `App.hide_cursor()` or `App.show_cursor()`. (#1235)
- A Selection widget with no items now consistently returns a selected value of `None` on all platforms. (#1723)
- macOS widget methods that return strings are now guaranteed to return strings, rather than native Objective C string objects. (#1779)
- WebViews on Windows no longer have a black background when they are resized. (#1855)
- The interpretation of `MultilineTextInput.readonly` was corrected iOS (#1866)
- A window without an `on_close` handler can now be closed using the window frame close button. (#1872)
- Android apps running on devices older than API level 29 (Android 10) no longer crash. (#1878)
- Missing value handling on Tables was fixed on Android and Linux. (#1879)
- The GTK backend is now able to correctly identify the currently active window. (#1892)
- Error handling associated with the creation of Intents on Android has been improved. (#1909)
- The DetailedList widget on GTK now provides an accurate size hint during layout. (#1920)
- Apps on Linux no longer segfault if an X Windows display cannot be identified. (#1921)
- The `on_result` handler is now used by Cocoa file dialogs. (#1947)
- Pack layout now honors an explicit width/height setting of 0. (#1958)
- The minimum window size is now correctly recomputed and enforced if window content changes. (#2020)
- The title of windows can now be modified on Winforms. (#2094)
- An error on Winforms when a window has no content has been resolved. (#2095)
- iOS container views are now set to automatically resize with their parent view (#2161)

Backward Incompatible Changes

- The `weight`, `style` and `variant` arguments for `Font` and `Font.register` are now keyword-only. (#1903)
- The `clear()` method for resetting the value of a MultilineTextInput, TextInput and PasswordInput has been removed. This method was an ambiguous override of the `clear()` method on Widget that removed all child nodes. To remove all content from a text input widget, use `widget.value = ""`. (#1938)
- The ability to perform multiple substring matches in a `Contains` validator has been removed. (#1944)
- The `TextInput.validate` method has been removed. Validation now happens automatically whenever the `value` or `validators` properties are changed. (#1944)
- The argument names used to construct validators have changed. Error message arguments now all end with `_message`; `compare_count` has been renamed `count`; and `min_value` and `max_value` have been renamed `min_length` and `max_length`, respectively. (#1944)
- The `get_dom()` method on WebView has been removed. This method wasn't implemented on most platforms, and wasn't working on any of the platforms where it *was* implemented, as modern web view implementations don't provide a synchronous API for accessing web content in this way. (#1949)
- The `evaluate_javascript()` method on WebView has been modified to work in both synchronous and asynchronous contexts. In a synchronous context you can invoke the method and use a functional `on_result` callback to be notified when evaluation is complete. In an asynchronous context, you can await the result. (#1949)
- The `on_key_down` handler has been removed from WebView. If you need to catch user input, either use a handler in the embedded JavaScript, or create a `Command` with a key shortcut. (#1949)
- The `invoke_javascript()` method has been removed. All usage of `invoke_javascript()` can be replaced with `evaluate_javascript()`. (#1949)
- The usage of local `file://` URLs has been explicitly prohibited. `file://` URLs have not been reliable for some time; their usage is now explicitly prohibited. (#1949)
- `DatePicker` has been renamed `DateInput`. (#1951)
- `TimePicker` has been renamed `TimeInput`. (#1951)
- The `on_select` handler on the Selection widget has been renamed `on_change` for consistency with other widgets. (#1955)
- The `_notify()` method on data sources has been renamed `notify()`, reflecting its status as a public API. (#1955)
- The `prepend()` method was removed from the `ListSource` and `TreeSource` APIs. Calls to `prepend(...)` can be replaced with `insert(0, ...)`. (#1955)
- The `insert()` and `append()` APIs on `ListSource` and `TreeSource` have been modified to provide an interface that is closer to that `list` API. These methods previously accepted a variable list of positional and keyword arguments; these arguments should be combined into a single tuple or dictionary. This matches the API provided by `__setitem__()`. (#1955)
- Images and ImageViews no longer support loading images from URLs. If you need to display an image from a URL, use a background task to obtain the image data asynchronously, then create the Image and/or set the ImageView `image` property on the completion of the asynchronous load. (#1956)
- A row box contained inside a row box will now expand to the full height of its parent, rather than collapsing to the maximum height of the inner box's child content. (#1958)
- A column box contained inside a column box will now expand to the full width of its parent, rather than collapsing to the maximum width of the inner box's child content. (#1958)

- On Android, the user data folder is now a `data` sub-directory of the location returned by `context.getFilesDir()`, rather than the bare `context.getFilesDir()` location. (#1964)
- GTK now returns `~/.local/state/appname/log` as the log file location, rather than `~/.cache/appname/log`. (#1964)
- The location returned by `toga.App.paths.app` is now the folder that contains the Python source file that defines the app class used by the app. If you are using a `toga.App` instance directly, this may alter the path that is returned. (#1964)
- On Winforms, if an application doesn't define an author, an author of `Unknown` is now used in application data paths, rather than `Toga`. (#1964)
- Winforms now returns `%USERPROFILE%/AppData/Local/<Author Name>/<App Name>/Data` as the user data file location, rather than `%USERPROFILE%/AppData/Local/<Author Name>/<App Name>`. (#1964)
- Support for SplitContainers with more than 2 panels of content has been removed. (#1984)
- Support for 3-tuple form of specifying SplitContainer items, used to prevent panels from resizing, has been removed. (#1984)
- The ability to increment and decrement the current OptionContainer tab was removed. Instead of *container.current_tab += 1*, use *container.current_tab = container.current_tab.index + 1* (#1996)
- `OptionContainer.add()`, `OptionContainer.remove()` and `OptionContainer.insert()` have been removed, due to being ambiguous with base widget methods of the same name. Use the `OptionContainer.content.append()`, `OptionContainer.content.remove()` and `OptionContainer.content.insert()` APIs instead. (#1996)
- The `on_select` handler for OptionContainer no longer receives the `option` argument providing the selected tab. Use `current_tab` to obtain the currently selected tab. (#1996)
- `TimePicker.min_time` and `TimePicker.max_time` has been renamed `TimeInput.min` and `TimeInput.max`, respectively. (#1999)
- `DatePicker.min_date` and `DatePicker.max_date` has been renamed `DateInput.min` and `DateInput.max`, respectively. (#1999)
- `NumberInput.min_value` and `NumberInput.max_value` have been renamed `NumberInput.min` and `NumberInput.max`, respectively. (#1999)
- `Slider.range` has been replaced by `Slider.min` and `Slider.max`. (#1999)
- Tables now use an empty string for the default missing value, rather than warning about missing values. (#2011)
- `Table.add_column()` has been deprecated in favor of `Table.append_column()` and `Table.insert_column()` (#2011)
- `Table.on_double_click` has been renamed `Table.on_activate`. (#2011, #2017)
- Trees now use an empty string for the default missing value, rather than warning about missing values. (#2017)
- The `parent` argument has been removed from the `insert` and `append` calls on `TreeSource`. This improves consistency between the API for `TreeSource` and the API for `list`. To insert or append a row in to a descendant of a TreeSource root, use `insert` and `append` on the parent node itself - i.e., `source.insert(parent, index, ...)` becomes `parent.insert(index, ...)`, and `source.insert(None, index, ...)` becomes `source.insert(index, ...)`. (#2017)
- When constructing a DetailedList from a list of tuples, or a list of lists, the required order of values has changed from (icon, title, subtitle) to (title, subtitle, icon). (#2025)
- The `on_select` handler for DetailedList no longer receives the selected row as an argument. (#2025)

- The handling of row deletion in DetailedList widgets has been significantly altered. The `on_delete` event handler has been renamed `on_primary_action`, and is now *only* a notification that a "swipe left" event (or platform equivalent) has been confirmed. This was previously inconsistent across platforms. Some platforms would update the data source to remove the row; some treated `on_delete` as a notification event and expected the application to handle the deletion. It is now the application's responsibility to perform the data deletion. (#2025)
- Support for Python 3.7 was removed. (#2027)
- `fill()` and `stroke()` now return simple drawing operations, rather than context managers. If you attempt to use `fill()` or `stroke()` on a context as a context manager, an exception will be raised; using these methods on Canvas will raise a warning, but return the appropriate context manager. (#2029)
- The `clicks` argument to `Canvas.on_press` has been removed. Instead, to detect "double clicks", you should use `Canvas.on_activate`. The `clicks` argument has also been removed from `Canvas.on_release`, `Canvas.on_drag`, `Canvas.on_alt_press`, `Canvas.on_alt_release`, and `Canvas.on_alt_drag`. (#2029)
- The `new_path` operation has been renamed `begin_path` for consistency with the HTML5 Canvas API. (#2029)
- Methods that generate new contexts have been renamed: `context()`, `closed_path()`, `fill()` and `stroke()` have become `Context()`, `ClosedPath()`, `Fill()` and `Stroke()` respectively. This has been done to make it easier to differentiate between primitive drawing operations and context-generating operations. (#2029)
- A Canvas is no longer implicitly a context object. The `Canvas.context` property now returns the root context of the canvas. If you were previously using `Canvas.context()` to generate an empty context, it should be replaced with `Canvas.Context()`. Any operations to `remove()` drawing objects from the canvas or `clear()` the canvas of drawing objects should be made on `Canvas.context`. Invoking these methods on `Canvas` will now call the base `Widget` implementations, which will throw an exception because `Canvas` widgets cannot have children. (#2029)
- The `preserve` option on `Fill()` operations has been deprecated. It was required for an internal optimization and can be safely removed without impact. (#2029)
- Drawing operations (e.g., `arc`, `line_to`, etc) can no longer be invoked directly on a Canvas. Instead, they should be invoked on the root context of the canvas, retrieved with via the *canvas* property. Context creating operations (`Fill`, `Stroke` and `ClosedPath`) are not affected. (#2029)
- The `tight` argument to `Canvas.measure_text()` has been deprecated. It was a GTK implementation detail, and can be safely removed without impact. (#2029)
- The `multiselect` argument to Open File and Select Folder dialogs has been renamed `multiple_select`, for consistency with other widgets that have multiple selection capability. (#2058)
- `Window.resizeable` and `Window.closeable` have been renamed `Window.resizable` and `Window.closable`, to adhere to US spelling conventions. (#2058)
- Windows no longer need to be explicitly added to the app's window list. When a window is created, it will be automatically added to the windows for the currently running app. (#2058)
- The optional arguments of `Command` and `Group` are now keyword-only. (#2075)
- In `App`, the properties `id` and `name` have been deprecated in favor of `app_id` and `formal_name` respectively, and the property `module_name` has been removed. (#2075)
- `GROUP_BREAK`, `SECTION_BREAK` and `CommandSet` were removed from the `toga` namespace. End users generally shouldn't need to use these classes. If your code *does* need them for some reason, you can access them from the `toga.command` namespace. (#2075)
- The `windows` constructor argument of `toga.App` has been removed. Windows are now automatically added to the current app. (#2075)

- The `filename` argument and property of `toga.Document` has been renamed `path`, and is now guaranteed to be a `pathlib.Path` object. (#2075)
- Documents must now provide a `create()` method to instantiate a `main_window` instance. (#2075)
- `App.exit()` now unconditionally exits the app, rather than confirming that the `on_exit` handler will permit the exit. (#2075)

Documentation

- Documentation for application paths was added. (#1849)
- The contribution guide was expanded to include more suggestions for potential projects, and to explain how the backend tests work. (#1868)
- All code blocks were updated to add a button to copy the relevant contents on to the user's clipboard. (#1897)
- Class references were updated to reflect their preferred import location, rather than location where they are defined in code. (#2001)
- The Linux system dependencies were updated to reflect current requirements for developing and using Toga. (#2021)

Misc

- #1865, #1875, #1881, #1882, #1886, #1889, #1895, #1900, #1902, #1906, #1916, #1917, #1918, #1926, #1933, #1948, #1950, #1952, #1954, #1963, #1972, #1977, #1980, #1988, #1989, #1998, #2008, #2014, #2019, #2022, #2028, #2034, #2035, #2039, #2052, #2053, #2055, #2056, #2057, #2059, #2067, #2068, #2069, #2085, #2090, #2092, #2093, #2101, #2102, #2113, #2114, #2115, #2116, #2118, #2119, #2123, #2124, #2127, #2128, #2131, #2132, #2146, #2147, #2148, #2149, #2150, #2163, #2165, #2166, #2171, #2177, #2180, #2184, #2186

0.3.1 (2023-04-12)

Features

- The Button widget now has 100% test coverage, and complete API documentation. (#1761)
- The mapping between Pack layout and HTML/CSS has been formalized. (#1778)
- The Label widget now has 100% test coverage, and complete API documentation. (#1799)
- TextInput now supports focus handlers and changing alignment on GTK. (#1817)
- The ActivityIndicator widget now has 100% test coverage, and complete API documentation. (#1819)
- The Box widget now has 100% test coverage, and complete API documentation. (#1820)
- NumberInput now supports changing alignment on GTK. (#1821)
- The Divider widget now has 100% test coverage, and complete API documentation. (#1823)
- The ProgressBar widget now has 100% test coverage, and complete API documentation. (#1825)
- The Switch widget now has 100% test coverage, and complete API documentation. (#1832)
- Event handlers have been internally modified to simplify their definition and use on backends. (#1833)
- The base Toga Widget now has 100% test coverage, and complete API documentation. (#1834)
- Support for FreeBSD was added. (#1836)

- The Web backend now uses Shoelace to provide web components. (#1838)
- Winforms apps can now go full screen. (#1863)

Bugfixes

- Issues with reducing the size of windows on GTK have been resolved. (#1205)
- iOS now supports newlines in Labels. (#1501)
- The Slider widget now has 100% test coverage, and complete API documentation. (#1708)
- The GTK backend no longer raises a warning about the use of a deprecated `set_wmclass` API. (#1718)
- MultilineTextInput now correctly adapts to Dark Mode on macOS. (#1783)
- The handling of GTK layouts has been modified to reduce the frequency and increase the accuracy of layout results. (#1794)
- The text alignment of MultilineTextInput on Android has been fixed to be TOP aligned. (#1808)
- GTK widgets that involve animation (such as Switch or ProgressBar) are now redrawn correctly. (#1826)

Improved Documentation

- API support tables now distinguish partial vs full support on each platform. (#1762)
- Some missing settings and constant values were added to the documentation of Pack. (#1786)
- Added documentation for `toga.App.widgets`. (#1852)

Misc

- #1750, #1764, #1765, #1766, #1770, #1771, #1777, #1797, #1802, #1813, #1818, #1822, #1829, #1830, #1835, #1839, #1854, #1861

0.3.0 (2023-01-30)

Features

- Widgets now use a three-layered (Interface/Implementation/Native) structure.
- A GUI testing framework was added.
- A simplified "Pack" layout algorithm was added.
- Added a web backend.

Bugfixes

- Too many to count!

0.2.15

- Added more widgets and cross-platform support, especially for GTK+ and Winforms

0.2.14

- Removed use of `namedtuple`

0.2.13

- Various fixes in preparation for PyCon AU demo

0.2.12

- Migrated to CSS-based layout, rather than Cassowary/constraint layout.
- Added Windows backend
- Added Django backend
- Added Android backend

0.2.0 - 0.2.11

Internal development releases.

0.1.2

- Further improvements to multiple-repository packaging strategy.
- Ensure Ctrl-C is honored by apps.
- **Cocoa:** Added runtime warnings when minimum OS X version is not met.

0.1.1

- Refactored code into multiple repositories, so that users of one backend don't have to carry the overhead of other installed platforms
- Corrected a range of bugs, mostly related to problems under Python 3.

0.1.0

Initial public release. Includes:

- A Cocoa (OS X) backend
- A GTK+ backend
- A proof-of-concept Win32 backend
- A proof-of-concept iOS backend

Road Map

Toga is a new project - we have lots of things that we'd like to do. If you'd like to contribute, you can provide a patch for one of these features.

Widgets

The core of Toga is its widget set. Modern GUI apps have lots of native controls that need to be represented. The following widgets have no representation at present, and need to be added.

There's also the task of porting widgets available on one platform to another platform.

Input

Inputs are mechanisms for displaying and editing input provided by the user.

- `ComboBox` - A free entry text field that provides options (e.g., text with past choices)
  - Cocoa: `NSComboBox`
  - GTK: `Gtk.ComboBox.new_with_model_and_entry`
  - iOS: ?
  - Winforms: `ComboBox`
  - Android: `Spinner`
- `DateTimeInput` - A widget for selecting a date and a time.
  - Cocoa: `NSDatePicker`
  - GTK: *Gtk.Calendar* + ?
  - iOS: `UIDatePicker`
  - Winforms: `DateTimePicker`
  - Android: ?
- `ColorInput` - A widget for selecting a color
  - Cocoa: `NSColorWell`
  - GTK: `Gtk.ColorButton` or `Gtk.ColorSelection`
  - iOS: ?
  - Winforms: ?

  - Android: ?
- `SearchInput` - A variant of `TextField` that is decorated as a search box.
  - Cocoa: `NSSearchField`
  - GTK: `Gtk.Entry`
  - iOS: `UISearchBar`?
  - Winforms: ?
  - Android: ?

Views

Views are mechanisms for displaying rich content, usually in a read-only manner.

- `VideoView` - Display a video
  - Cocoa: `AVPlayerView`
  - GTK: Custom integration with `GStreamer`
  - iOS: `MPMoviePlayerController`
  - Winforms: ?
  - Android: ?
- `PDFView` - Display a PDF document
  - Cocoa: `PDFView`
  - GTK: ?
  - iOS: Integration with QuickLook?
  - Winforms: ?
  - Android: ?
- `MapView` - Display a map
  - Cocoa: `MKMapView`
  - GTK: Probably a `Webkit.WebView` pointing at Google Maps/OpenStreetMap
  - iOS: `MKMapView`
  - Winforms: ?
  - Android: ?

Container widgets

Containers are widgets that can contain other widgets.

- `ButtonContainer` - A layout for a group of radio/checkbox options
  - Cocoa: `NSMatrix`, or `NSView` with pre-set constraints.
  - GTK: `Gtk.ListBox`
  - iOS: ?

  - Winforms: ?
  - Android: ?
- `FormContainer` - A layout for a "key/value" or "label/widget" form
  - Cocoa: `NSForm`, or `NSView` with pre-set constraints.
  - GTK:
  - iOS:
  - Winforms: ?
  - Android: ?
- `NavigationContainer` - A container view that holds a navigable tree of sub-views

  Essentially a view that has a "back" button to return to the previous view in a hierarchy. Example of use: Top level navigation in the macOS System Preferences panel.

  - Cocoa: No native control
  - GTK: No native control; `Gtk.HeaderBar` in 3.10+
  - iOS: `UINavigationBar` + `NavigationController`
  - Winforms: ?
  - Android: ?

Miscellaneous

One of the aims of Toga is to provide a rich, feature-driven approach to app development. This requires the development of APIs to support rich features.

- Preferences - Support for saving app preferences, and visualizing them in a platform native way.
- Notification when updates are available
- Easy Licensing/registration of apps - Monetization is not a bad thing, and shouldn't be mutually exclusive with open source.

Platforms

Toga currently has good support for Cocoa on macOS, GTK on Linux, Winforms on Windows, iOS and Android. Proof-of-concept support exists for single page web apps. Support for a more modern Windows API would be desirable.

2.4.2 Topic guides

Widget layout

One of the major tasks of a GUI framework is to determine where each widget will be displayed within the application window. This determination must be made when a window is initially displayed, and every time the window changes size (or, on mobile devices, changes orientation).

Layout in Toga is performed using style engine. Toga provides a *built-in style engine called Pack*; however, other style engines can be used. Every widget keeps a style object, and it is this style object that is used to perform layout operations.

Each widget can also report an "intrinsic" size - this is the size of the widget, as reported by the underlying GUI library. The intrinsic size is a width and height; each dimension can be fixed, or specified as a minimum. For example, a button may have a fixed intrinsic height, but a minimum intrinsic width (indicating that there is a minimum size the button can be, but it can stretch to assume any larger size). This intrinsic size is computed when the widget is first displayed; if fundamental properties of the widget ever change (e.g., changing the text or font size on a button), the widget needs to be rehinted, which re-calculates the intrinsic size, and invalidates any layout.

Widgets are constructed in a tree structure. The widget at the root of the tree is called the *container* widget. Every widget keeps a reference to the container at the root of its widget tree.

When a window needs to perform a layout, the layout engine asks the style object for the container to lay out its contents within the space that the container has available. This will calculate a size and position for all the widgets in the tree.

Every window has a container representing the total viewable area of the window. However, some widgets (those with "Container" in their name) establish sub-containers. When a refresh is requested on a container, any sub-containers will also be refreshed.

Length units

Toga uses CSS units in its public API. Their physical size depends on the device type:

- A CSS pixel is about 1/96 of an inch (0.26 mm) on a desktop screen, and about 1/160 of an inch (0.16 mm) on a phone screen.
- A CSS point is 1.33 CSS pixels.

Toga only uses points to measure font sizes. All other lengths are expressed as pixels.

For a full explanation of CSS units, see this article.

Implementation notes

- On macOS and iOS, one CSS pixel equals one "point", which is 1, 2 or 3 linear physical pixels, depending on the device.
- On Windows, one CSS pixel equals one physical pixel at 100% scale, and is adjusted as necessary at higher scale factors.
- On Android, one CSS pixel equals one dp.

Data Sources

Most widgets in a user interface will need to interact with data - either displaying it, or providing a way to manipulate it.

Well designed GUI applications will maintain a strong separation between the storage and manipulation of data, and how that data is displayed. This separation allows developers to radically change how data is visualized without changing the underlying interface for interacting with this data.

Toga encourages this separation through the use of data sources. Instead of directly telling a widget to display a particular value (or collection of values), you should define a **data source**, and then attach a widget to that source. The data source is responsible for tracking the data that is in the source; the widget responds to those changes in the data, providing an appropriate visualization.

Built-in data sources

There are three built-in data source types in Toga:

- *Value Sources*: For managing a single value. A ValueSource has a single attribute, (by default, `value`), which is what will be rendered for display purposes.
- *List Sources*: For managing a list of items, each of which has one or more values. List data sources support the data manipulation methods you'd expect of a `list`, and return `Row` objects. The attributes of each `Row` object are the values that should be displayed.
- *Tree Sources*: For managing a hierarchy of items, each of which has one or more values. Tree data sources also behave like a `list`, except that each item returned is a `Node`. The attributes of the `Node` are the values that should be displayed; a `Node` also has children, accessible using the `list` interface on the `Node`.

Although Toga provides these built-in data sources, in general, *you shouldn't use them directly*. Toga's data sources are wrappers around Python's primitive collection types - `list`, `dict`, and so on. While this is useful for quick demonstrations, or to visualize simple data, more complex applications should define their own *custom data sources*.

Listeners

Data sources communicate using a `Listener` interface. When any significant event occurs to the data source, all listeners will be notified. This includes:

- Adding a new item
- Removing an existing item
- Changing an attribute of an existing item
- Clearing an entire data source

If any attribute of a `ValueSource`, `Row` or `Node` is modified, the source will generate a change event.

When you create a widget like Selection or Table, and provide a data source for that widget, the widget is automatically added as a listener on that source.

Although widgets are the obvious listeners for a data source, *any* object can register as a listener. For example, a second data source might register as a listener to an initial source to implement a filtered source. When an item is added to the first data source, the second data source will be notified, and can choose whether to include the new item in it's own data representation.

Custom data sources

A custom data source enables you to provide a data manipulation API that makes sense for your application. For example, if you were writing an application to display files on a file system, you shouldn't just build a dictionary of files, and use that to construct a `TreeSource`. Instead, you should write your own `FileSystemSource` that reflects the files on the file system. Your file system data source doesn't need to expose `insert()` or `remove()` methods - because the end user doesn't need an interface to "insert" files into your file system. However, you might have a `create_empty_file()` method that creates a new file in the file system and adds a representation to the data tree.

Custom data sources are also required to emit notifications whenever notable events occur. This allows the widgets rendering the data source to respond to changes in data. If a data source doesn't emit notifications, widgets may not reflect changes in data. Toga provides a *Source* base class for custom data source implementations. This base class implements the notification API.

2.4.3 Toga's internals

Architecture

Although Toga presents a single interface to the end user, there are three internal layers that make up every widget. They are:

- The **Interface** layer
- The **Implementation** layer
- The **Native** layer

Interface

The interface layer is the public, documented interface for each widget. Following *Toga's design philosophy*, these widgets reflect high-level design concepts, rather than specific common widgets. It forms the public API for creating apps, windows, widgets, and so on.

The interface layer is responsible for validation of any API inputs, and storage of any persistent values retained by a widget. That storage may be supplemented or replaced by storage on the underlying native widget (or widgets), depending on the capabilities of that widget.

The interface layer is also responsible for storing style and layout-related attributes of the widget.

The interface layer is defined in the `toga-core` module.

Implementation

The implementation layer is the platform-specific representation of each widget. Each platform that Toga supports has its own implementation layer, named after the widget toolkit that the implementation layer is wrapping – `toga-cocoa` for macOS (Cocoa being the name of the underlying macOS widget toolkit); `toga-gtk` for Linux (using the GTK+ toolkit); and so on. The implementation provides a private, internal API that the interface layer can use to create the widgets described by the interface layer.

The API exposed by the implementation layer is different to that exposed by the interface layer and is *not* intended for end-user consumption. It is a utility API, servicing the requirements of the interface layer.

Every widget in the implementation layer corresponds to exactly one widget in the interface layer. However, the reverse will not always be true. Some widgets defined by the interface layer are not available on all platforms.

An interface widget obtains its implementation when it is constructed, using the platform factory. Each platform provides a factory implementation. When a Toga application starts, it guesses its platform based on the value of `sys.platform`, and uses that factory to create implementation-layer widgets.

If you have an interface layer widget, the implementation widget can be obtained using the `_impl` attribute of that widget.

Native

The lowest layer of Toga is the native layer. The native layer represents the widgets required by the widget toolkit of your system. These are accessed using whatever bridging library or Python-native API is available on the implementation platform. This layer is usually provided by system-level APIs, not by Toga itself.

Most implementation widgets will have a single native widget. However, when a platform doesn't expose a single widget that meets the requirements of the Toga interface specification, the implementation layer will use multiple native widgets to provide the required functionality.

In this case, the implementation must provide a single "container" widget that represents the overall geometry of the combined native widgets. This widget is called the "primary" native widget. When there's only one native widget, the native widget is the primary native widget.

If you have an implementation widget, the interface widget can be obtained using the `interface` attribute, and the primary native widget using the `native` attribute.

If you have a native widget, the interface widget can be obtained using the `interface` attribute, and the implementation widget using the `impl` attribute.

An example

Here's how Toga's three-layer API works on the Button widget.

- `toga.Button` is defined in `core/src/toga/widgets/button.py`. This defines the public interface for the Button widget, describing (amongst other things) that there is an `on_click` event handler on a Button. It expects that there will be *an* implementation, but doesn't care which implementation is provided.
- `toga-gtk.widgets.Button` is defined in `gtk/src/toga-gtk/widgets/button.py`. This defines the Button at the implementation layer. It describes how to create a button on GTK, and how to connect the GTK `clicked` signal to the `on_click` Toga handler.
- `Gtk.Button` is the native GTK-Python widget API that implements buttons on GTK.

This three layered approach allows us to change the implementation of `Button` without changing the public API that end-users rely upon. For example, we could switch out `toga-gtk.widgets.Button` with `toga-cocoa.widgets.Button` to provide a macOS implementation of the Button without altering the API that end-users use to construct buttons.

The layered approach is especially useful with more complex widgets. Every platform provides a Button widget, but other widgets are more complex. For example, macOS doesn't provide a native DetailedList view, so it must be constructed out of a scroll view, a table view, and a collection of other pieces. The three layered architecture hides this complexity - the API exposed to developers is a single (interface layer) widget; the complexity of the implementation only matters to the maintainers of Toga.

Lastly, the layered approach provides a testing benefit. In addition to the Cocoa, GTK, and other platform implementations, there is a "dummy" implementation. This implementation satisfies all the API requirements of a Toga implementation layer, but without actually performing any graphical operations. This dummy API can be used to test code using the Toga interface layer.

PYTHON MODULE INDEX

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