Create your own Custom Widgets

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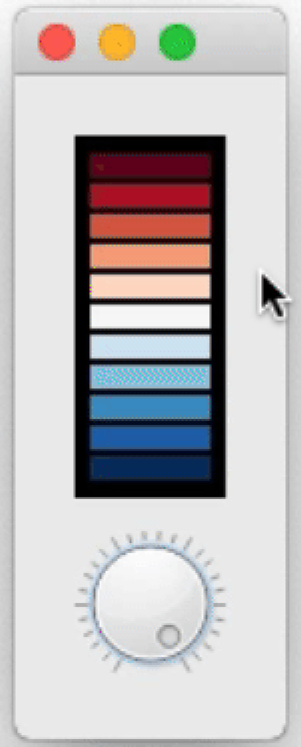
Martin Fitzpatrick Custom Widgets

Read time 13:29

In the previous tutorial we introduced `QPainter` and looked at some basic bitmap drawing operations which you can used to draw dots, lines, rectangles and circles on a `QPainter` *surface* such as a `QPixmap` .

This process of *drawing on a surface* with `QPainter` is in fact the basis by which all widgets in Qt are drawn.Now you know how to use `QPainter` you know how to draw your own custom widgets!

In this article we'll take what we've learnt so far and use it to construct a completely new *custom* GUI widget. For a working example we'll be building the following widget — a customisable PowerBar meter with a dial control.



This widget is actually a mix of a *compound widget* and *custom widget* in that we are using the built-in Qt `QDial` component for the dial, while drawing the power bar ourselves. We then assemble these two parts together into a parent widget which can be dropped into place seamlessly in any application, without needing to know how it's put together. The resulting widget provides the common `QAbstractSlider` interface with some additions for configuring the bar display.

After following this example you will be able to make your very own custom GUI widgets — whether they are compounds of built-ins or completely novel self-drawn wonders.

Getting started

As we've previously seen compound widgets are simply widgets with a layout applied, which itself contains >1 other widget. The resulting "widget" can then be used as any other, with the internals hidden/exposed as you like.

The outline for our *PowerBar* widget is given below — we'll build our custom widget up gradually from this outline stub.

- PyQt5
- PySide2

python

```python
from PyQt5 import QtCore, QtGui, QtWidgets
from PyQt5.QtCore import Qt


class _Bar(QtWidgets.QWidget):
    pass

class PowerBar(QtWidgets.QWidget):
    """
    Custom Qt Widget to show a power bar and dial.
    Demonstrating compound and custom-drawn widget.
    """

    def __init__(self, steps=5, *args, **kwargs):
        super(PowerBar, self).__init__(*args, **kwargs)

        layout = QtWidgets.QVBoxLayout()
        self._bar = _Bar()
        layout.addWidget(self._bar)

        self._dial = QtWidgets.QDial()
        layout.addWidget(self._dial)

        self.setLayout(layout)
```

This simply defines our custom power bar is defined in the `_Bar` object — here just unaltered subclass of `QWidget` . The `PowerBar` widget (which is the complete widget) combines this, using a `QVBoxLayout` with the built in `QDial` to display them together.

Save this to a file named `power_bar.py`

We also need a little demo application to display the widget.

- PyQt5
- PySide2

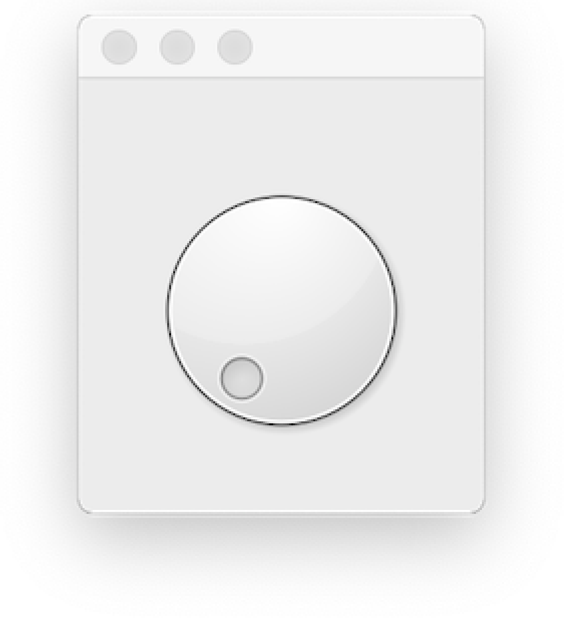
python

```
from PyQt5 import QtCore, QtGui, QtWidgets
from power_bar import PowerBar


app = QtWidgets.QApplication([])
volume = PowerBar()
volume.show()
app.exec_()
```

We don't need to create a `QMainWindow` since any widget without a parent is a window in it's own right. Our custom `PowerBar` widget will appear as any normal window.

This is all you need, just save it in the same folder as the previous file, under something like `demo.py`. You can run this file at any time to see your widget in action. Run it now and you should see something like this:

If you stretch the window down you'll see the dial has more space above it than below — this is being taken up by our (currently invisible) `_Bar` widget.



Our widget, a QDial with an invisible empty widget above it (trust me).

paintEvent

The `paintEvent` handler is the core of all widget drawing in PyQt.

Every complete and partial re-draw of a widget is triggered through a `paintEvent` which the widget handles to draw itself. A `paintEvent` can be triggered by —

- repaint() or update() was called
- the widget was obscured and has now been uncovered
- the widget has been resized

— but it can also occur for many other reasons. What is important is that when a `paintEvent` is triggered your widget is able to redraw it.

If a widget is simple enough (like ours is) you can often get away with simply redrawing the entire thing any time *anything* happens. But for more complicated widgets this can get very inefficient. For these cases the `paintEvent` includes the specific region that needs to be updated. We'll make use of this in later, more complicated examples.

For now we'll do something very simple, and just fill the entire widget with a single colour. This will allow us to see the area we're working with to start drawing the bar.

```
    def paintEvent(self, e):
        painter = QtGui.QPainter(self)
        brush = QtGui.QBrush()
        brush.setColor(QtGui.QColor('black'))
        brush.setStyle(Qt.SolidPattern)
        rect = QtCore.QRect(0, 0, painter.device().width(), painter.device().height())
        painter.fillRect(rect, brush)
```

Using the draw instructions we introduced in the previous part you can completely customise the style, look and feel of your custom widget.

Positioning

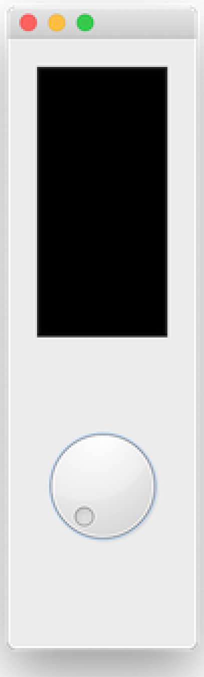
Now we can see the `_Bar` widget we can tweak its positioning and size. If you drag around the shape of the window you'll see the two widgets changing shape to fit the space available. This is what we want, but the `QDial` is also expanding vertically more than it should, and leaving empty space we could use for the bar.

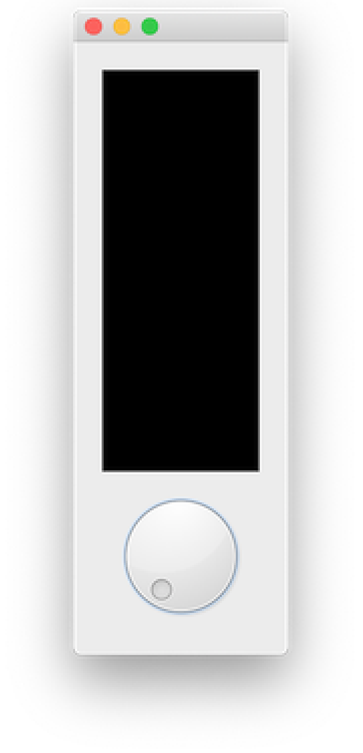
We can use `setSizePolicy` on our `_Bar` widget to make sure it expands as far as possible. By using the `QSizePolicy.MinimumExpanding` the provided `sizeHint` will be used as a minimum, and the widget will expand as much as possible.

```
class _Bar(QtWidgets.QWidget):

    def __init__(self, *args, **kwargs):
        super().__init__(*args, **kwargs)

        self.setSizePolicy(
            QtWidgets.QSizePolicy.MinimumExpanding,
            QtWidgets.QSizePolicy.MinimumExpanding
        )

    def sizeHint(self):
        return QtCore.QSize(40,120)
```

It's still not *perfect* as the `QDial` widget resizes itself a bit awkwardly, but our bar is now expanding to fill all the available space.

With the positioning sorted we can now move on to define our paint methods to draw our PowerBar meter in the top part (currently black) of the widget.


Filling the custom widget part with black.


Widget with QSizePolicy.MinimumExpanding set.

Updating the display

We now have our canvas completely filled in black, next we'll use `QPainter` draw commands to actually draw something on the widget.

Before we start on the bar, we've got a bit of testing to do to make sure we can update the display with the values of our dial. Update the `paintEvent` with the following code.

```
    def paintEvent(self, e):
        painter = QtGui.QPainter(self)

        brush = QtGui.QBrush()
        brush.setColor(QtGui.QColor('black'))
        brush.setStyle(Qt.SolidPattern)
        rect = QtCore.QRect(0, 0, painter.device().width(), painter.device().height())
        painter.fillRect(rect, brush)

        # Get current state.
        dial = self.parent()._dial
        vmin, vmax = dial.minimum(), dial.maximum()
        value = dial.value()

        pen = painter.pen()
        pen.setColor(QtGui.QColor('red'))
        painter.setPen(pen)

        font = painter.font()
        font.setFamily('Times')
        font.setPointSize(18)
        painter.setFont(font)

        painter.drawText(25, 25, "{}-->{}<--{}".format(vmin, value, vmax))
        painter.end()
```

This draws the black background as before, then uses `.parent()` to access our parent `PowerBar` widget and through that the `QDial` via `_dial`. From there we get the current value, as well as the allowed range minimum and maximum values. Finally we draw those using the painter, just like we did in the previous part.

T> We're leaving handling of the current value, min and max values to the `QDial` here, but we could also store that value ourselves and use signals to/from the dial to keep things in sync.

Run this, wiggle the dial around and .....nothing happens. Although we've defined the `paintEvent` handler we're not triggering a repaint when the dial changes.

T> You can force a refresh by resizing the window, as soon as you do this you should see the text appear. Neat, but terrible UX — "just resize your app to see your settings!"

To fix this we need to hook up our `_Bar` widget to repaint itself in response to changing values on the dial. We can do this using the `QDial.valueChanged` signal, hooking it up to a custom slot method which calls `.refresh()` — triggering a full-repaint.

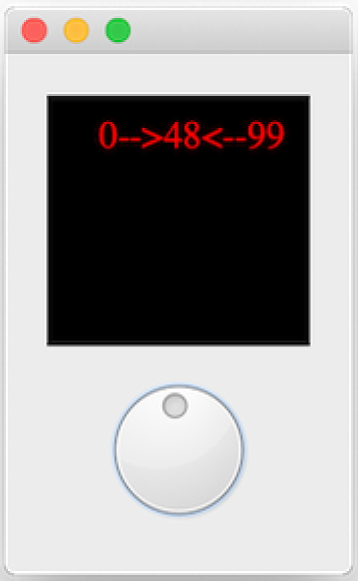
Add the following method to the `_Bar` widget.

```
    def _trigger_refresh(self):
        self.update()
```

...and add the following to the `__init__` block for the parent `PowerBar` widget.

```
self._dial.valueChanged.connect(self._bar._trigger_refresh)
```

If you re-run the code now, you will see the display updating automatically as you turn the dial (click and drag with your mouse). The current value is displayed as text.

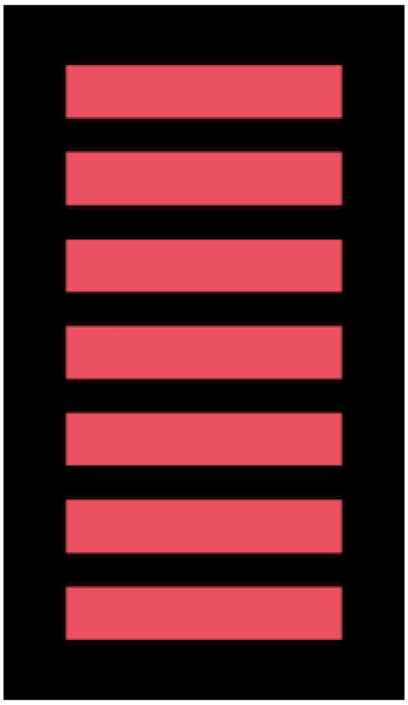

0-->48<--99

Displaying the current QDial value in text.

Drawing the bar

Now we have the display updating and displaying the current value of the dial, we can move onto drawing the actual bar display. This is a little complicated, with a bit of maths to calculate bar positions, but we'll step through it to make it clear what's going on.

The sketch below shows what we are aiming for — a series of *N* boxes, inset from the edges of the widget, with spaces between them.



What we're aiming for with this widget.

Calculating what to draw

The number of boxes to draw is determined by the current value — and how far along it is between the minimum and maximum value configured for the `QDial`. We already have that information in the example above.

```
dial = self.parent()._dial
vmin, vmax = dial.minimum(), dial.maximum()
value = dial.value()
```

If `value` is half way between `vmin` and `vmax` then we want to draw half of the boxes (if we have 4 boxes total, draw 2). If `value` is at `vmax` we want to draw them all.

To do this we first convert our `value` into a number between 0 and 1, where `0 = vmin` and `1 = vmax`. We first subtract `vmin` from `value` to adjust the range of possible values to start from zero — i.e. from `vmin...vmax` to `0…(vmax-vmin)`. Dividing this value by `vmax-vmin` (the new maximum) then gives us a number between 0 and 1.

The trick then is to multiply this value (called `pc` below) by the number of steps and that gives us a number between 0 and 5 — the number of boxes to draw.

```
pc = (value - vmin) / (vmax - vmin)
n_steps_to_draw = int(pc * 5)
```

We're wrapping the result in `int` to convert it to a whole number (rounding down) to remove any partial boxes.

Update the `drawText` method in your paint event to write out this number instead.

```
pc = (value - vmin) / (vmax - vmin)
n_steps_to_draw = int(pc * 5)
painter.drawText(25, 25, "{}".format(n_steps_to_draw))
```

As you turn the dial you will now see a number between 0 and 5.

Drawing boxes

Next we want to convert this number 0...5 to a number of bars drawn on the canvas. Start by removing the `drawText` and font and pen settings, as we no longer need those.

To draw accurately we need to know the size of our canvas — i.e the size of the widget. We will also add a bit of padding around the edges to give space around the edges of the blocks against the black background.

All measurements in the `QPainter` are in pixels.

```
        padding = 5

        # Define our canvas.
        d_height = painter.device().height() - (padding * 2)
        d_width = painter.device().width() - (padding * 2)
```

We take the height and width and subtract `2 * padding` from each — it's 2x because we're padding both the left and right (and top and bottom) edges. This gives us our resulting *active canvas* area in `d_height` and `d_width` .

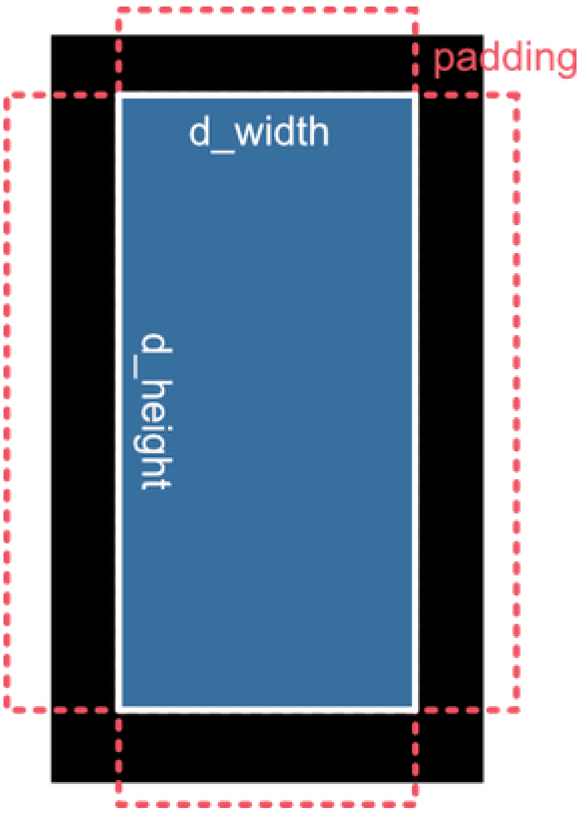
We need to break up our `d_height` into 5 equal parts, one for each block — we can calculate that height simply by `d_height / 5` . Additionally, since we want spaces between the blocks we need to calculate how much of this step size is taken up by space (top and bottom, so halved) and how much is actual block.

```
step_size = d_height / 5
bar_height = step_size * 0.6
bar_spacer = step_size * 0.4 / 2
```

These values are all we need to draw our blocks on our canvas. To do this we count up to the number of steps-1 starting from 0 using `range` and then draw a `fillRect` over a region for each block.

```
brush.setColor(QtGui.QColor('red'))

for n in range(5):
    rect = QtCore.QRect(
        padding,
        padding + d_height - ((n+1) * step_size) + bar_spacer,
        d_width,
        bar_height
    )
painter.fillRect(rect, brush)
```

The fill is set to a red brush to begin with but we will customise this later.



The widget canvas, padding and inner draw area.

The box to draw with `fillRect` is defined as a `QRect` object to which we pass, in turn, the left x, top y, width and height.

The *width* is the full canvas width minus the padding, which we previously calculated and stored in `d_width` . The *left x* is similarly just the `padding` value (5px) from the left hand side of the widget.

The *height* of the bar `bar_height` we calculated as 0.6 times the `step_size` .

This leaves parameter 2 `d_height - ((1 + n) * step_size) + bar_spacer` which gives the *top y* position of the rectangle to draw. This is the only calculation that changes as we draw the blocks.

A key fact to remember here is that *y* coordinates in `QPainter` start at the top and increase down the canvas. This means that plotting at `d_height` will be plotting at the very bottom of the canvas. When we draw a rectangle from a point it is drawn to the *right* and *down* from the starting position.

To draw a block at the very bottom we must start drawing at `d_height-step_size` i.e. one block up to leave space to draw downwards.

In our bar meter we're drawing blocks, in turn, starting at the bottom and working upwards. So our very first block must be placed at `d_height-step_size` and the second at `d_height-(step_size*2)` . Our loop iterates from 0 upwards, so we can achieve this with the following formula —

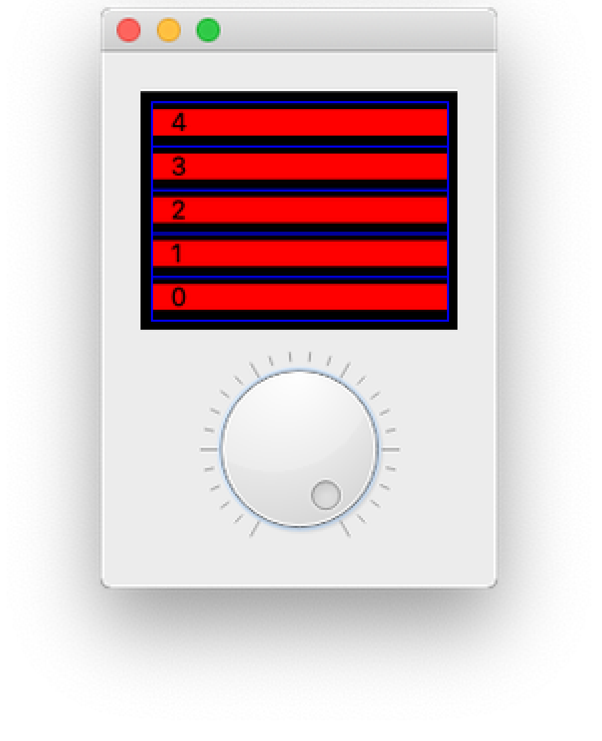
```
d_height - ((1 + n) * step_size
```

The final adjustment is to account for our blocks only taking up part of each `step_size` (currently 0.6). We add a little padding to move the block away from the edge of the box and into the middle, and finally add the padding for the bottom edge. That gives us the final formula —

```
padding + d_height - ((n+1) * step_size) + bar_spacer,
```

This produces the following layout.

In the picture below the current value of `n` has been printed over the box, and a blue box has been drawn around the complete `step_size` so you can see the padding and spacers in effect.



Spacing between bars in the layout, and block draw order.

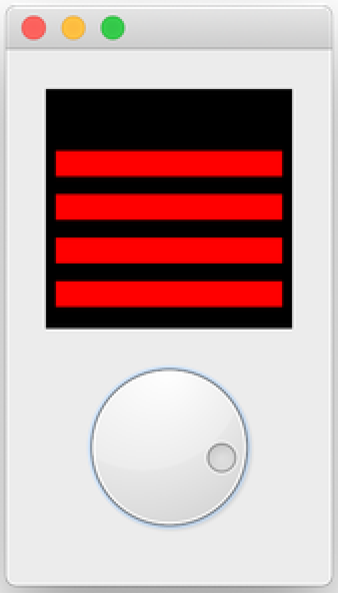
Putting this all together gives the following code, which when run will produce a working power-bar widget with blocks in red. You can drag the wheel back and forth and the bars will move up and down in response.

- PyQt5
- PySide2

python

```
from PyQt5 import QtCore, QtGui, QtWidgets
from PyQt5.QtCore import Qt

class _Bar(QtWidgets.QWidget):

    def __init__(self, *args, **kwargs):
        super().__init__(*args, **kwargs)

        self.setSizePolicy(
            QtWidgets.QSizePolicy.MinimumExpanding,
            QtWidgets.QSizePolicy.MinimumExpanding
        )

    def sizeHint(self):
        return QtCore.QSize(40,120)

    def paintEvent(self, e):
        painter = QtGui.QPainter(self)

        brush = QtGui.QBrush()
        brush.setColor(QtGui.QColor('black'))
        brush.setStyle(Qt.SolidPattern)
        rect = QtCore.QRect(0, 0, painter.device().width(), painter.device().height())
        painter.fillRect(rect, brush)

        # Get current state.
        dial = self.parent()._dial
        vmin, vmax = dial.minimum(), dial.maximum()
        value = dial.value()

        padding = 5

        # Define our canvas.
        d_height = painter.device().height() - (padding * 2)
        d_width = painter.device().width() - (padding * 2)

        # Draw the bars.
        step_size = d_height / 5
        bar_height = step_size * 0.6
        bar_spacer = step_size * 0.4 / 2

        pc = (value - vmin) / (vmax - vmin)
        n_steps_to_draw = int(pc * 5)
        brush.setColor(QtGui.QColor('red'))
        for n in range(n_steps_to_draw):
            rect = QtCore.QRect(
                padding,
                padding + d_height - ((n+1) * step_size) + bar_spacer,
                d_width,
                bar_height
            )
            painter.fillRect(rect, brush)

        painter.end()

    def _trigger_refresh(self):
        self.update()


class PowerBar(QtWidgets.QWidget):
    """
    Custom Qt Widget to show a power bar and dial.
    Demonstrating compound and custom-drawn widget.
    """

    def __init__(self, steps=5, *args, **kwargs):
        super(PowerBar, self).__init__(*args, **kwargs)

        layout = QtWidgets.QVBoxLayout()
        self._bar = _Bar()
        layout.addWidget(self._bar)

        self._dial = QtWidgets.QDial()
        self._dial.valueChanged.connect(
           self._bar._trigger_refresh
        )

        layout.addWidget(self._dial)
        self.setLayout(layout)
```

That already does the job, but we can go further to provide more customisation, add some UX improvements and improve the API for working with our widget.


A working 1-colour power bar.

Customising the Bar

We now have a working power bar, controllable with a dial. But it's nice when creating widgets to provide options to configure the behaviour and style of your widget to make it more flexible. In this part we'll add methods to set customisable numbers of segments, colours, padding and spacing.

The elements we're going to provide customisation of are as follows —

Option	Description
number of bars	How many bars are displayed on the widget
colours	Individual colours for each of the bars
background colour	The colour of the draw canvas (default black)

Option	Description
padding	Space around the widget edge, between bars and edge of canvas.
bar height / bar percent	Proportion (0...1) of the bar which is solid (the rest will be spacing between adjacent bars)

We can store each of these as attributes on the `_bar` object, and use them from the `paintEvent` method to change its behaviour.

The `_Bar.__init__` is updated to accept an initial argument for either the number of bars (as an integer) or the colours of the bars (as a list of `QColor`, hex values or names). If a number is provided, all bars will be coloured red. If the a list of colours is provided the number of bars will be determined from the length of the colour list. Default values for `self._bar_solid_percent`, `self._background_color`, `self._padding` are also set.

- PyQt5
- PySide2

python

```
class _Bar(QtWidgets.QWidget):
    clickedValue = QtCore.pyqtSignal(int)

    def __init__(self, steps, *args, **kwargs):
        super().__init__(*args, **kwargs)

        self.setSizePolicy(
            QtWidgets.QSizePolicy.MinimumExpanding,
            QtWidgets.QSizePolicy.MinimumExpanding
        )

        if isinstance(steps, list):
            # list of colours.
            self.n_steps = len(steps)
            self.steps = steps

        elif isinstance(steps, int):
            # int number of bars, defaults to red.
            self.n_steps = steps
            self.steps = ['red'] * steps

        else:
            raise TypeError('steps must be a list or int')

        self._bar_solid_percent = 0.8
        self._background_color = QtGui.QColor('black')
        self._padding = 4.0  # n-pixel gap around edge.
```

Likewise we update the `PowerBar.__init__` to accept the steps parameter, and pass it through.

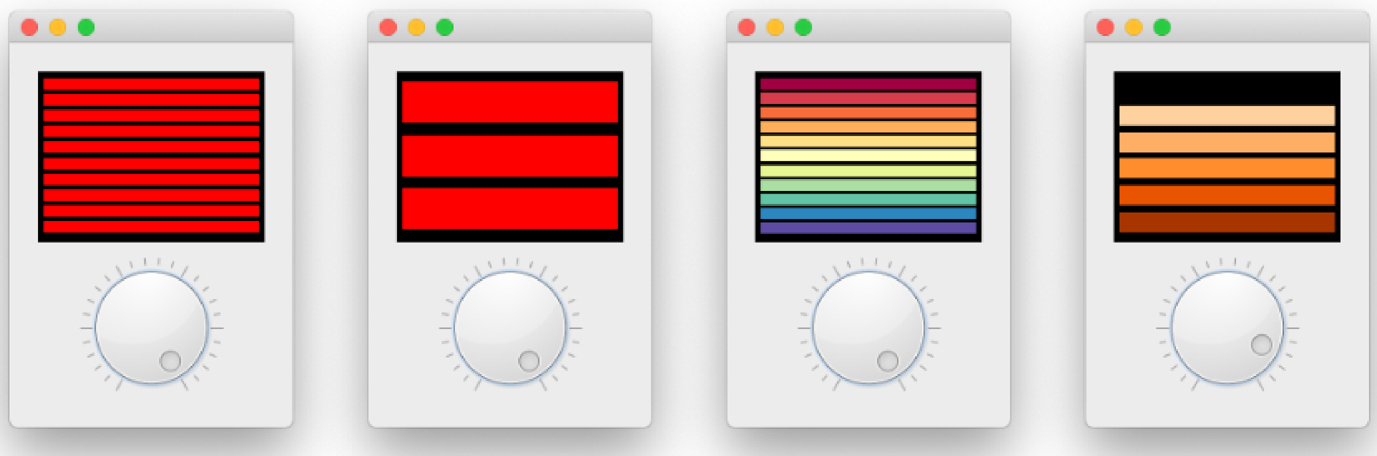
```
class PowerBar(QtWidgets.QWidget):
    def __init__(self, steps=5, *args, **kwargs):
        super().__init__(*args, **kwargs)

        layout = QtWidgets.QVBoxLayout()
        self._bar = _Bar(steps)

        #...continued as before.
```

We now have the parameters in place to update the `paintEvent` method. The modified code is shown below.

```
    def paintEvent(self, e):
        painter = QtGui.QPainter(self)

        brush = QtGui.QBrush()
        brush.setColor(self._background_color)
        brush.setStyle(Qt.SolidPattern)
        rect = QtCore.QRect(0, 0, painter.device().width(), painter.device().height())
        painter.fillRect(rect, brush)

        # Get current state.
        parent = self.parent()
        vmin, vmax = parent.minimum(), parent.maximum()
        value = parent.value()

        # Define our canvas.
        d_height = painter.device().height() - (self._padding * 2)
        d_width = painter.device().width() - (self._padding * 2)

        # Draw the bars.
        step_size = d_height / self.n_steps
        bar_height = step_size * self._bar_solid_percent
        bar_spacer = step_size * (1 - self._bar_solid_percent) / 2

        # Calculate the y-stop position, from the value in range.
        pc = (value - vmin) / (vmax - vmin)
        n_steps_to_draw = int(pc * self.n_steps)

        for n in range(n_steps_to_draw):
            brush.setColor(QtGui.QColor(self.steps[n]))
            rect = QtCore.QRect(
                self._padding,
                self._padding + d_height - ((1 + n) * step_size) + bar_spacer,
                d_width,
                bar_height
            )
            painter.fillRect(rect, brush)

        painter.end()
```

You can now experiment with passing in different values for the init to `PowerBar`, e.g. increasing the number of bars, or providing a colour list. Some examples are shown below — a good source of hex palettes is the Bokeh source.

```
PowerBar(10)
PowerBar(3)
PowerBar(["#5e4fa2", "#3288bd", "#66c2a5", "#abdda4", "#e6f598", "#ffffbf", "#fee08b", "#fdae61", "#f46d43",
"#d53e4f", "#9e0142"])
PowerBar(["#a63603", "#e6550d", "#fd8d3c", "#fdae6b", "#fdd0a2", "#feedde"])
```



Examples of customised bars.

You could fiddle with the padding settings through the variables e.g. `self._bar_solid_percent` but it'd be nicer to provide proper methods to set these.

We're following the Qt standard of camelCase method names for these external methods for consistency with the others inherited from `QDial`.

```
    def setColor(self, color):
        self._bar.steps = [color] * self._bar.n_steps
        self._bar.update()

    def setColors(self, colors):
        self._bar.n_steps = len(colors)
        self._bar.steps = colors
        self._bar.update()

    def setBarPadding(self, i):
        self._bar._padding = int(i)
        self._bar.update()

    def setBarSolidPercent(self, f):
        self._bar._bar_solid_percent = float(f)
        self._bar.update()

    def setBackgroundColor(self, color):
        self._bar._background_color = QtGui.QColor(color)
        self._bar.update()
```

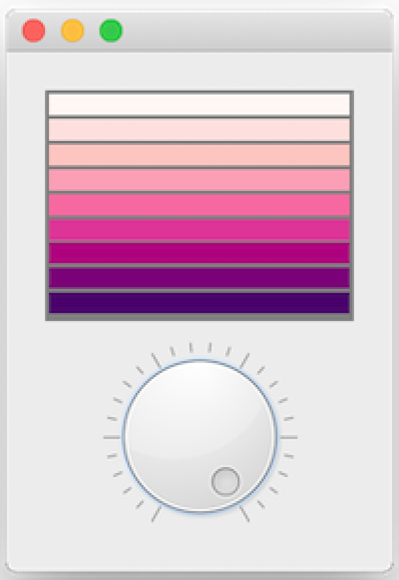
In each case we set the private variable on the `_bar` object and then call `_bar.update()` to trigger a redraw of the widget. The method support changing the colour to a single colour, or updating a list of them — setting a list of colours can also be used to change the number of bars.

There is no method to set the bar count, since expanding a list of colours would be faffy. But feel free to try adding this yourself!

Here's an example using 25px padding, a fully solid bar and a grey background.

```
bar = PowerBar(["#49006a", "#7a0177", "#ae017e", "#dd3497", "#f768a1", "#fa9fb5", "#fcc5c0", "#fde0dd", "#fff7f3"])
bar.setBarPadding(2)
bar.setBarSolidPercent(0.9)
bar.setBackgroundColor('gray')
```

With these settings you get the following result.



Bar padding 2, solid percent 0.9 and grey background.

Adding the QAbstractSlider Interface

We've added methods to configure the behaviour of the power bar. But we currently provide no way to configure the standard `QDial` methods — for example, setting the min, max or step size — from our widget. We could work through and add wrapper methods for all of these, but it would get very tedious very quickly.

```
# Example of a single wrapper, we'd need 30+ of these.
def setNotchesVisible(self, b):
    return self._dial.setNotchesVisible(b)
```

Instead we can add a little handler onto our outer widget to automatically look for methods (or attributes) on the `QDial` instance, if they don't exist on our class directly. This way we can implement our own methods, yet still get all the `QAbstractSlider` goodness for free.

The wrapper is shown below, implemented as a custom `__getattr__` method.

```
def __getattr__(self, name):
    if name in self.__dict__:
        return self[name]

    try:
        return getattr(self._dial, name)
    except AttributeError:
        raise AttributeError(
          "'{}' object has no attribute '{}'".format(self.__class__.__name__, name)
        )
```

When accessing a property (or method) — e.g. when when call `PowerBar.setNotchesVisible(true)` Python internally uses `__getattr__` to get the property from the current object. This handler does this through the object dictionary `self.__dict__` . We've overridden this method to provide our custom handling logic.

Now, when we call `PowerBar.setNotchesVisible(true)` , this handler first looks on our current object (a `PowerBar` instance) to see if `.setNotchesVisible` exists and if it does uses it. If *not* it then calls `getattr()` on `self._dial` instead returning what it finds there. This gives us access to all the methods of `QDial` from our custom `PowerBar` widget.

If `QDial` doesn't have the attribute either, and raises an `AttributeError` we catch it and raise it again from our custom widget, where it belongs.

This works for any properties or methods, including signals. So the standard `QDial` signals such as `.valueChanged` are available too.

Updating from the Meter display

Currently you can update the current value of the PowerBar meter by twiddling with the dial. But it would be nicer UX if you could also update the value by clicking a position on the power bar, or by dragging you mouse up and down. To do this we can update our `_Bar` widget to handle mouse events.

- PyQt5
- PySide2

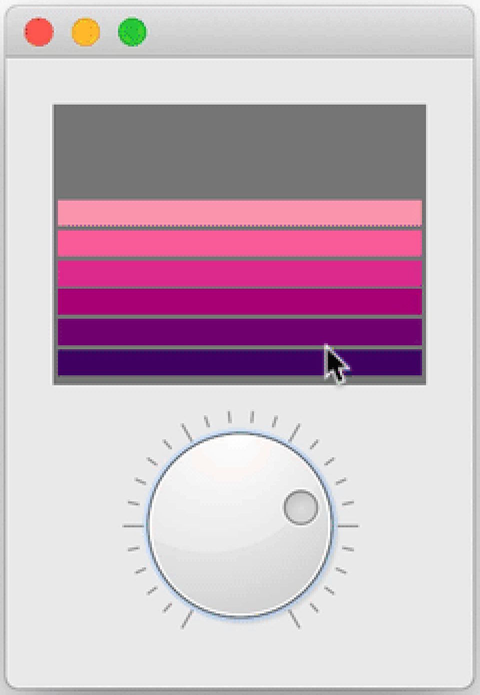
python

```python
class _Bar(QtWidgets.QWidget):

    clickedValue = QtCore.pyqtSignal(int)

    # ... existing code ...

    def _calculate_clicked_value(self, e):
        parent = self.parent()
        vmin, vmax = parent.minimum(), parent.maximum()
        d_height = self.size().height() + (self._padding * 2)
        step_size = d_height / self.n_steps
        click_y = e.y() - self._padding - step_size / 2

        pc = (d_height - click_y) / d_height
        value = vmin + pc * (vmax - vmin)
        self.clickedValue.emit(value)

    def mouseMoveEvent(self, e):
        self._calculate_clicked_value(e)

    def mousePressEvent(self, e):
        self._calculate_clicked_value(e)
```

In the `__init__` block for the `PowerBar` widget we can connect to the `_Bar.clickedValue` signal and send the values to `self._dial.setValue` to set the current value on the dial.

```python
# Take feedback from click events on the meter.
self._bar.clickedValue.connect(self._dial.setValue)
```

If you run the widget now, you'll be able to click around in the bar area and the value will update, and the dial rotate in sync.



The final code

Below is the complete final code for our PowerBar meter widget, called `PowerBar`. You can save this over the previous file (e.g. named `power_bar.py`) and then use it in any of your own projects, or customise it further to your own requirements.

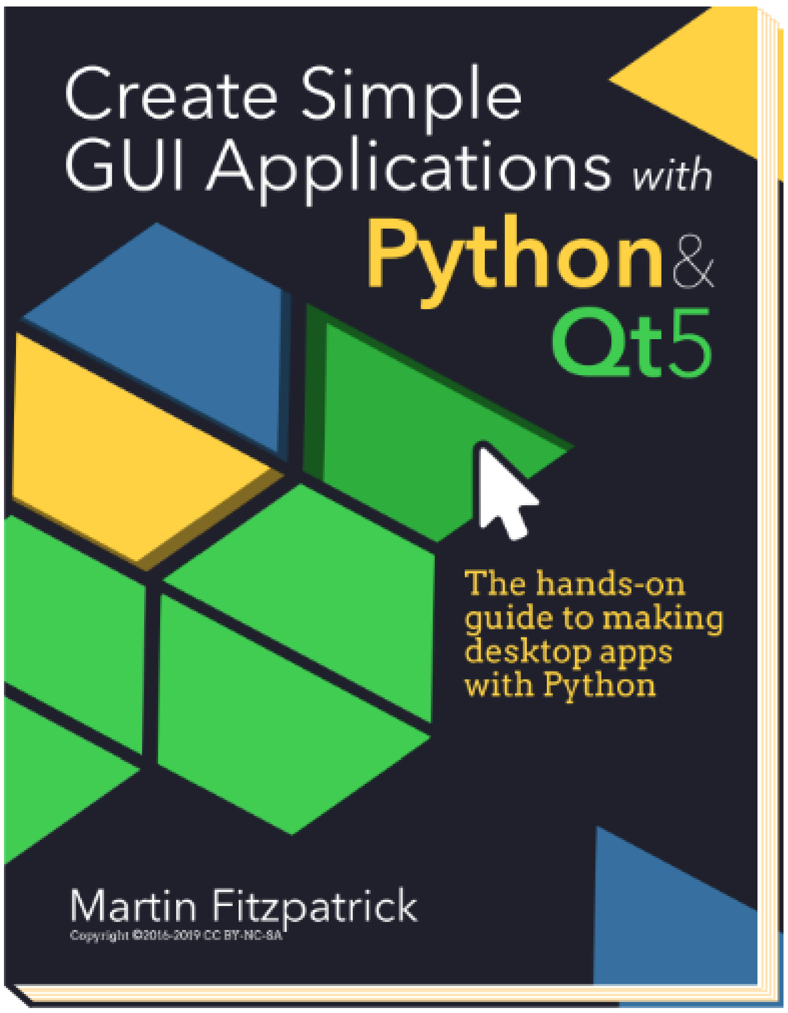
- PyQt5
- PySide2

python

```
from PyQt5 import QtCore, QtGui, QtWidgets
from PyQt5.QtCore import Qt


class _Bar(QtWidgets.QWidget):

    clickedValue = QtCore.pyqtSignal(int)

    def __init__(self, steps, *args, **kwargs):
        super().__init__(*args, **kwargs)

        self.setSizePolicy(
            QtWidgets.QSizePolicy.MinimumExpanding,
            QtWidgets.QSizePolicy.MinimumExpanding
        )

        if isinstance(steps, list):
            # list of colours.
            self.n_steps = len(steps)
            self.steps = steps

        elif isinstance(steps, int):
            # int number of bars, defaults to red.
            self.n_steps = steps
            self.steps = ['red'] * steps

        else:
            raise TypeError('steps must be a list or int')

        self._bar_solid_percent = 0.8
        self._background_color = QtGui.QColor('black')
        self._padding = 4.0  # n-pixel gap around edge.

    def paintEvent(self, e):
        painter = QtGui.QPainter(self)

        brush = QtGui.QBrush()
        brush.setColor(self._background_color)
        brush.setStyle(Qt.SolidPattern)
        rect = QtCore.QRect(0, 0, painter.device().width(), painter.device().height())
        painter.fillRect(rect, brush)

        # Get current state.
        parent = self.parent()
        vmin, vmax = parent.minimum(), parent.maximum()
        value = parent.value()

        # Define our canvas.
        d_height = painter.device().height() - (self._padding * 2)
        d_width = painter.device().width() - (self._padding * 2)

        # Draw the bars.
        step_size = d_height / self.n_steps
        bar_height = step_size * self._bar_solid_percent
        bar_spacer = step_size * (1 - self._bar_solid_percent) / 2

        # Calculate the y-stop position, from the value in range.
        pc = (value - vmin) / (vmax - vmin)
        n_steps_to_draw = int(pc * self.n_steps)

        for n in range(n_steps_to_draw):
            brush.setColor(QtGui.QColor(self.steps[n]))
            rect = QtCore.QRect(
                self._padding,
                self._padding + d_height - ((1 + n) * step_size) + bar_spacer,
                d_width,
                bar_height
            )
            painter.fillRect(rect, brush)

        painter.end()

    def sizeHint(self):
        return QtCore.QSize(40, 120)

    def _trigger_refresh(self):
        self.update()

    def _calculate_clicked_value(self, e):
        parent = self.parent()
        vmin, vmax = parent.minimum(), parent.maximum()
        d_height = self.size().height() + (self._padding * 2)
        step_size = d_height / self.n_steps
        click_y = e.y() - self._padding - step_size / 2

        pc = (d_height - click_y) / d_height
        value = vmin + pc * (vmax - vmin)
        self.clickedValue.emit(value)

    def mouseMoveEvent(self, e):
        self._calculate_clicked_value(e)

    def mousePressEvent(self, e):
        self._calculate_clicked_value(e)


class PowerBar(QtWidgets.QWidget):
    """
    Custom Qt Widget to show a power bar and dial.
    Demonstrating compound and custom-drawn widget.

    Left-clicking the button shows the color-chooser, while
    right-clicking resets the color to None (no-color).
    """

    colorChanged = QtCore.pyqtSignal()

    def __init__(self, steps=5, *args, **kwargs):
        super().__init__(*args, **kwargs)

        layout = QtWidgets.QVBoxLayout()
        self._bar = _Bar(steps)
        layout.addWidget(self._bar)

        # Create the QDial widget and set up defaults.
        # - we provide accessors on this class to override.
        self._dial = QtWidgets.QDial()
        self._dial.setNotchesVisible(True)
        self._dial.setWrapping(False)
        self._dial.valueChanged.connect(self._bar._trigger_refresh)

        # Take feedback from click events on the meter.
        self._bar.clickedValue.connect(self._dial.setValue)

        layout.addWidget(self._dial)
        self.setLayout(layout)

    def __getattr__(self, name):
        if name in self.__dict__:
            return self[name]

        return getattr(self._dial, name)
    def setColor(self, color):
        self._bar.steps = [color] * self._bar.n_steps
        self._bar.update()

    def setColors(self, colors):
        self._bar.n_steps = len(colors)
        self._bar.steps = colors
        self._bar.update()

    def setBarPadding(self, i):
        self._bar._padding = int(i)
        self._bar.update()

    def setBarSolidPercent(self, f):
        self._bar._bar_solid_percent = float(f)
        self._bar.update()

    def setBackgroundColor(self, color):
        self._bar._background_color = QtGui.QColor(color)
        self._bar.update()
```

You should be able to use many of these ideas in creating your own custom widgets.

Want to see some more examples of custom widgets? Check out our Widget library which has free PyQt5/PySide2 compatible widgets for you to drop into your own GUI projects.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