GUI

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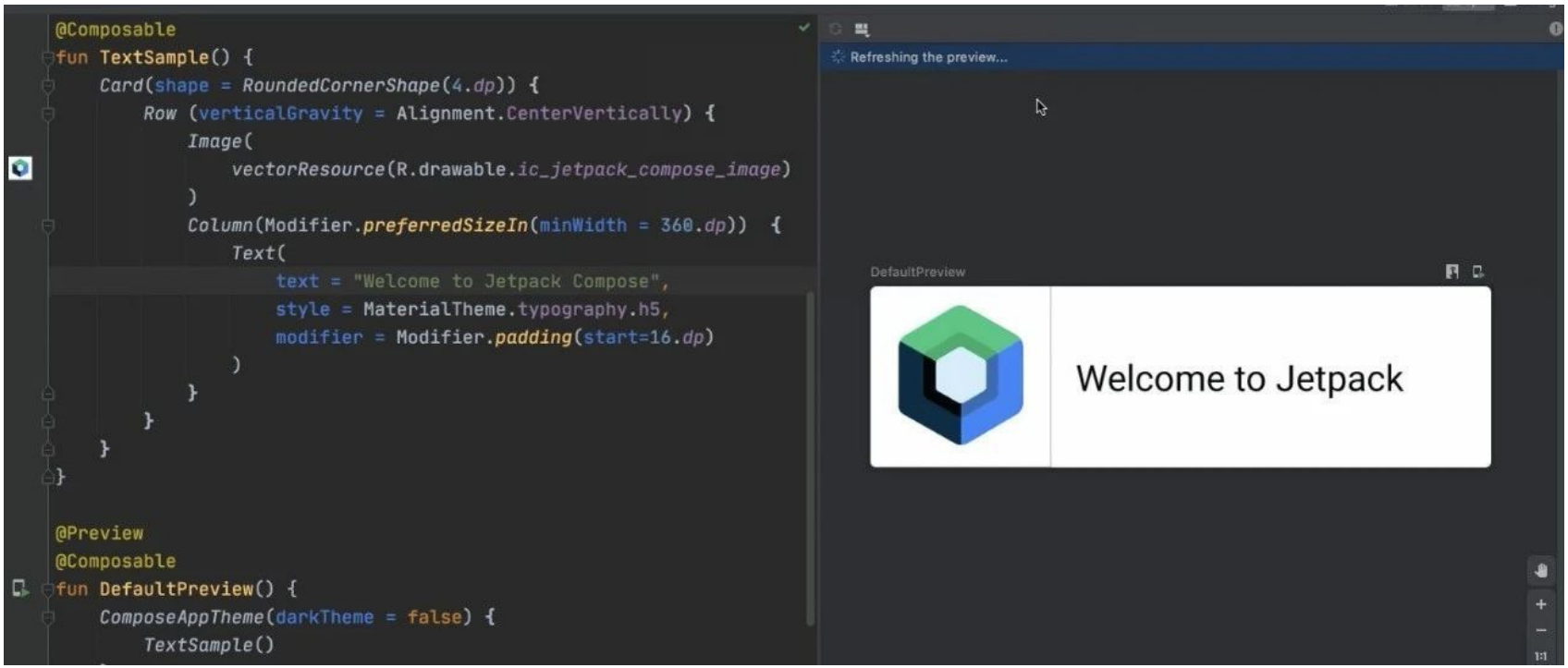
GUI: Introduction

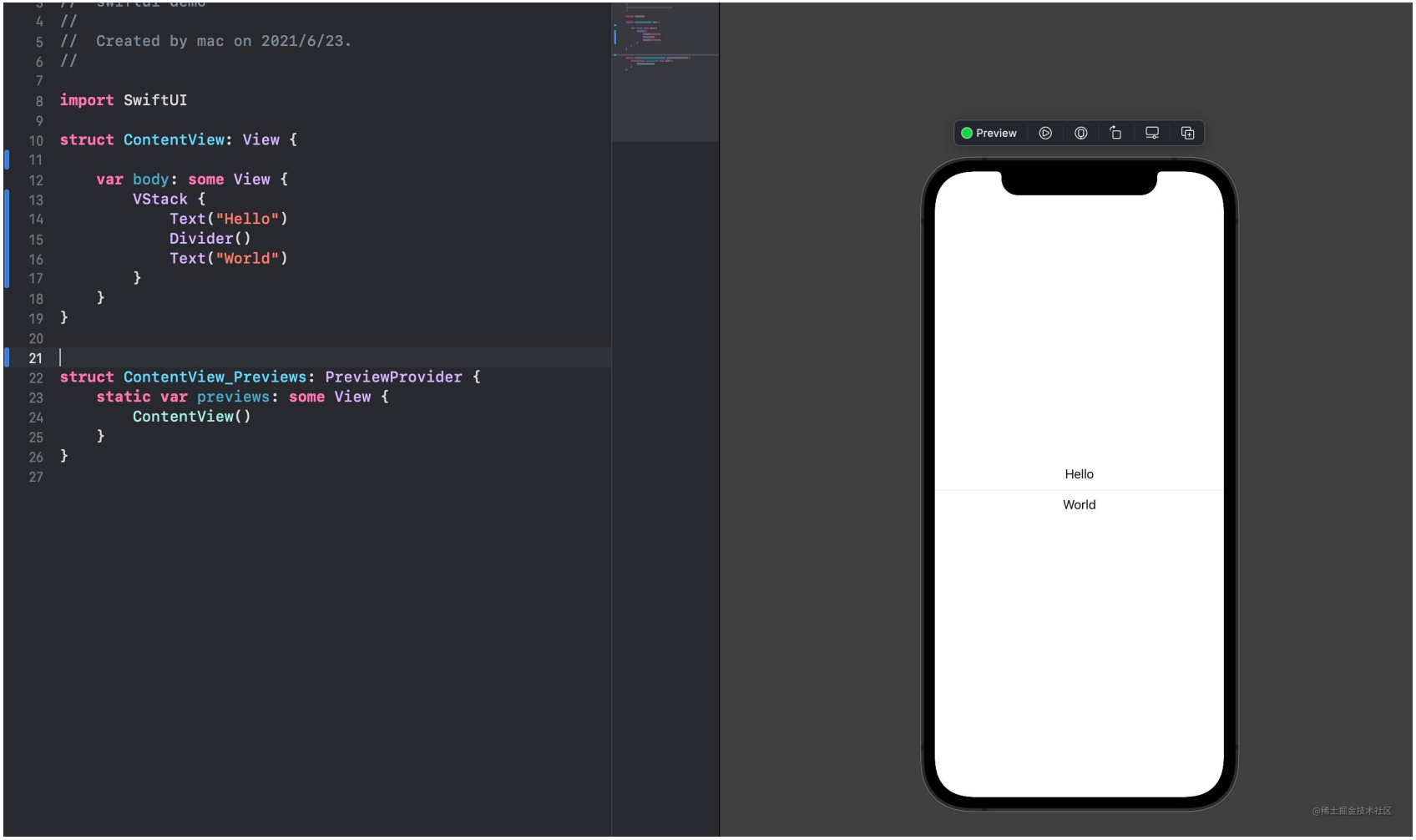
1. Old approach: XML for Layout, code for rest
2. New approach: Everything is code

Example: Jackpack compose



Definition of the layout with KOTLIN class instances.

Example: SwiftUI



Again, definition of the layout with SWIFT class instances.

QT

- **Qt** is a cross-platform windows development environment for Linux, Windows and Mac written in C++.
- Elements in Qt are *Widgets* which can contain anything form plots, buttons, text fields or the layout themselves. They are classes.
- QT works with callbacks using a QT-specific signal/slot concept.

Layout

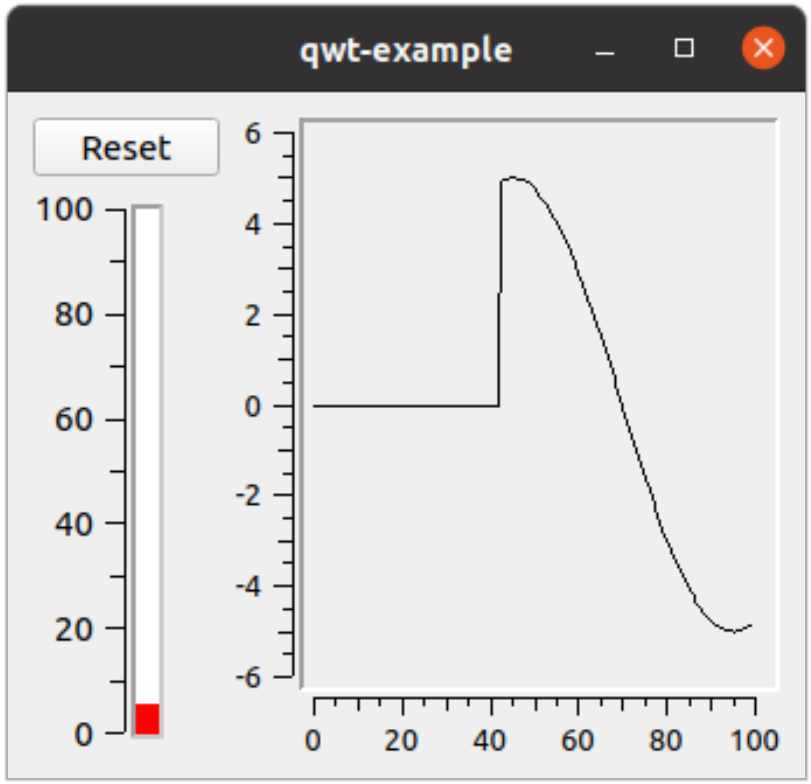


Figure: QT example layout

Widgets are usually organised into nested vertical and horizontal layouts for the result). A lot of other options available.

Layout II

```
// create 3 widgets
button = new QPushButton;
thermo = new QwtThermo;
plot = new QwtPlot;

// vertical layout
vLayout = new QVBoxLayout;
vLayout->addWidget(button);
vLayout->addWidget(thermo);

// horizontal layout
hLayout = new QHBoxLayout;
hLayout->addLayout(vLayout);
hLayout->addWidget(plot);

// main layout
setLayout(hLayout);
```

Events from widgets

A method of a class needs to be combined with the instance pointer. The Qt method "connect" does exactly that:

```
connect(button, &QPushButton::clicked,
        this, &Window::reset);
```

The QPushButton instance `button` has a method called `clicked()` which is called whenever the user clicks on the button. This is then forwarded to the method `reset()` in the application Widget.

Plotting realtime data arriving via a callback

A callback `addSample()` is called in real-time whenever a sample has arrived:

```
void Window::addSample( float v ) {
    // add the new input to the plot
    std::move( yData, yData + plotDataSize - 1, yData+1 );
    curve->setSamples(xData, yData, plotDataSize);
    yData[0] = v;
    plot->replot(); // triggers replot but not now
}
```

which stores the sample `v` in the shift buffer `yData`.

Plotting realtime data arriving via a callback

Then the screen refresh (which is slow) is done at a lower and unreliable rate:

```
void Window::timerEvent( QTimerEvent * )
{
    update(); // triggers the update of all Widgets
}
```

the `paintEvent()` callback

`update()` triggers a paint event and then Qt calls the callback `paintEvent()` "as soon as possible" (which is to say, not in real-time) to repaint the canvas of the widget:

```
void ScopeWindow::paintEvent(QPaintEvent *) {
        QPainter paint( this );

        paint.drawLine( ... )
}
```

In Qt timing is not guaranteed

Note that neither the timer callback nor the `update()` function provide reliable realtime timing. So Qt timers cannot be used to sample data but should only be used for screen refresh and other non-time-critical tasks.

. . . but what about QML???

GUI in QML (javascript-ish) $\Leftrightarrow$ C++ application

The problem is that QML needs to call C++ but we have two very different languages.

. . . but what about QML? Part 2

QML:

```
BackEnd {
    id: backend
}

TextField {
    text: backend.userName
    placeholderText: qsTr("User name")
    anchors.centerIn: parent

    onEditingFinished: backend.userName = text
}
```

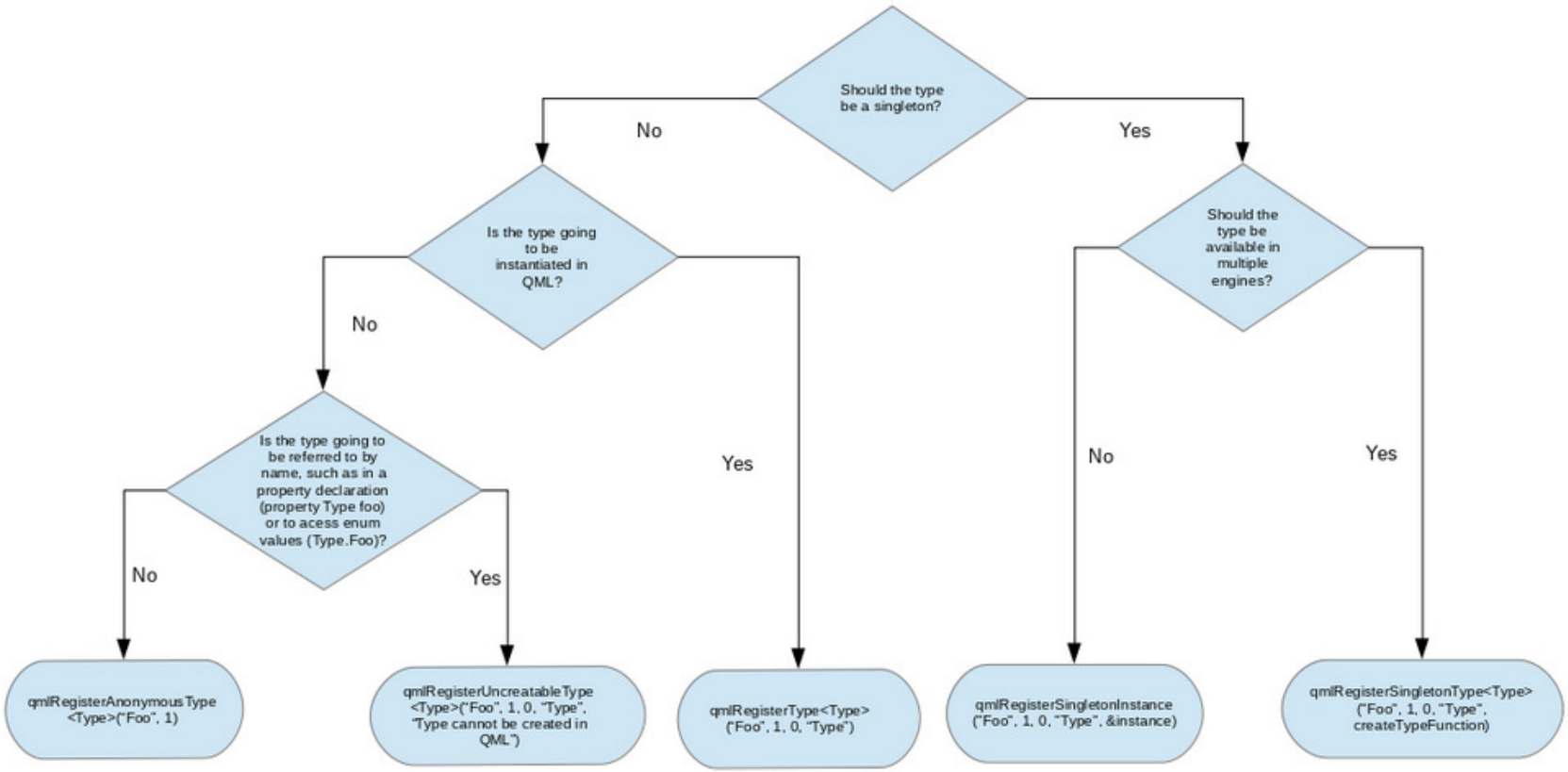
C++

```
class BackEnd : public QObject
{
    Q_OBJECT
    Q_PROPERTY(QString userName READ userName WRITE setUserName NOTIFY userNameChanged)
    QML_ELEMENT

public:
    explicit BackEnd(QObject *parent = nullptr);

    QString userName();
    void setUserName(const QString &userName);
```

. . . but what about QML? Part 3

Choosing the Correct Integration Method Between C++ and QML

To quickly determine which integration method is appropriate for your situation, the following flowchart can be used:



. . . so in a nutshell: don't do QML.

GUI summary

Stick to C++ for *both* frontend (GUI) and backend.

Generally, the trend goes towards GUI- and backend in the *same language*.