

WORKING WITH QTQUICK AND PYTHON ON A REAL-LIFE ROBOTICS PROJECT

- **From C++ to Python**
- **Project Structure & Workflow**
- **Quality Assurance & Issues**
- **Conclusion**

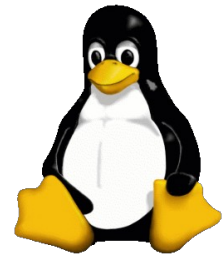
A teal speech bubble with a tail pointing towards the bottom-left corner, containing the text 'FROM C++ TO PYTHON' in yellow.

FROM C++ TO PYTHON

A LONG LONG TIME AGO...



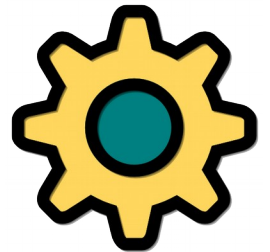
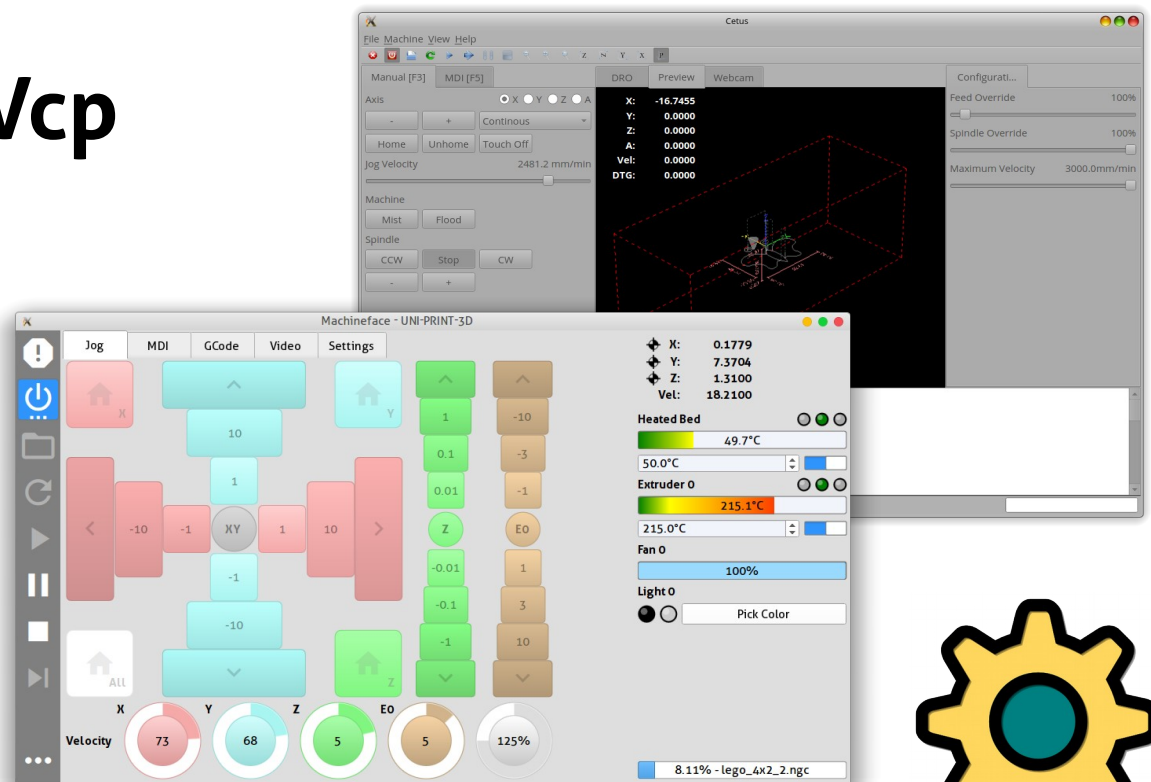
- > 10 years
- Delphi → C++ and Qt



OPEN SOURCE



- Machinekit
- New UI → QtQuickVcp
- Cross-platform



OBJECTIONS

- **Not scale-able**
- **Slow**
- **Not safe**
- **Prototyping only**
- **No mobile OS**



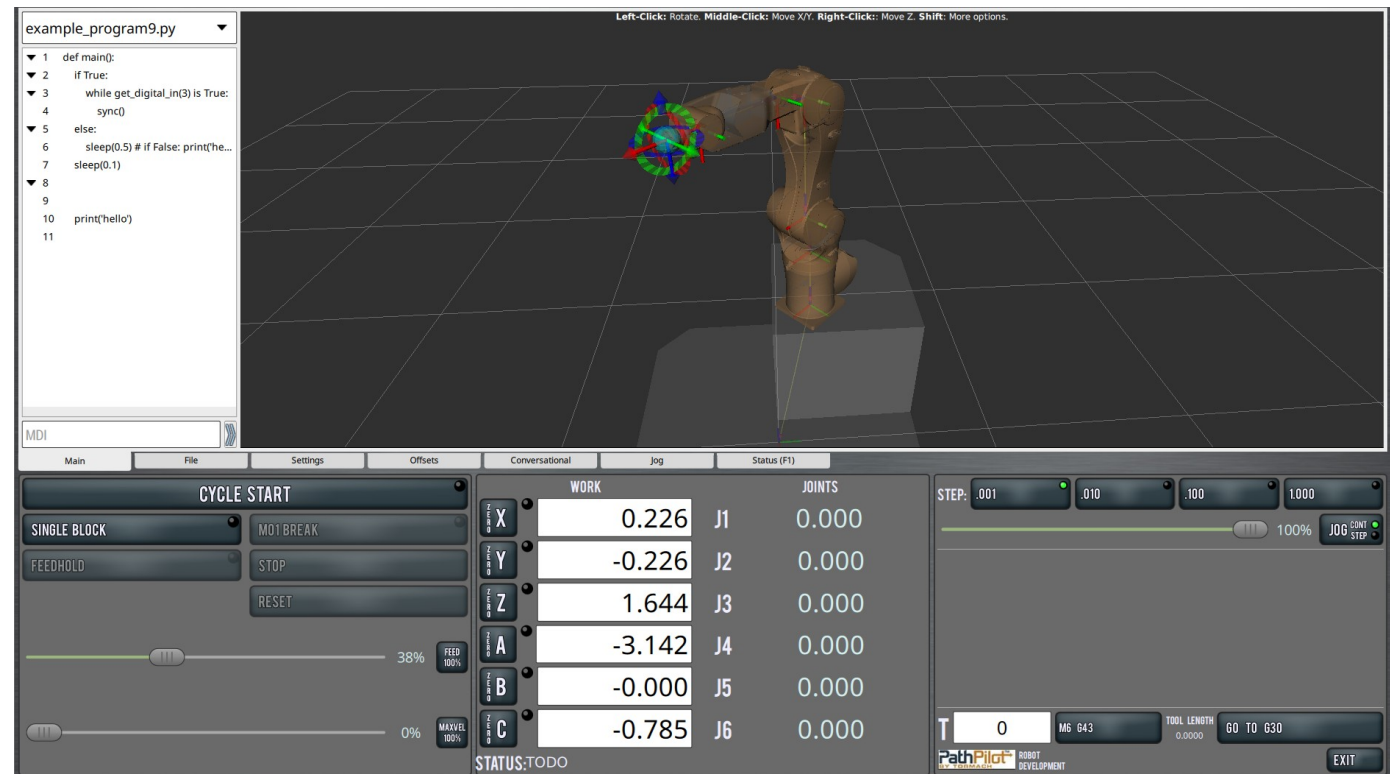
- Affordable CNC
- PathPilot
- User Friendly



ROBOT PROJECT



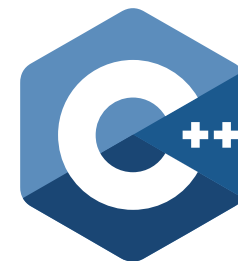
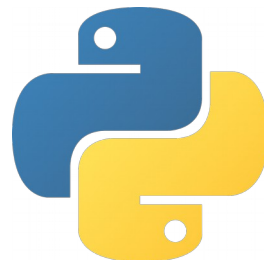
- Python widely used
- Gtk2 → ?
- ROS, rospy
- Rviz



REASONS



	Qt/Python	Qt/C++
LOC	1x	2-3x
Development Speed	3-5x	1x
Popularity	3.	5.
Cross-platform	Desktop +, Mobile -	All++
QA	Duck-typing, interpreted, ..	Static-typing, compiled, memory, ...
Testing	Duck-typing, no recompile, TDD	Static-typing, templates, compiled
Performance	Slow	Very fast
Features/Bugs	Qt/C++ and wrapper, few users	Qt/C++, many users



PYQT OR QT FOR PYTHON?



	PyQt	Qt for Python
License	GPLv3 or Riverbank Commercial	LGPLv3 or Qt Commercial License
API Completeness	~	~
Tools and Add-ons	pyqtdeploy, QScintilla, Sip	...
Community	PyQt, longer history	Qt project, relatively new
Support	500\$ commercial	Qt commercial support
Binding Generator	sip	shiboken

PYQT OR QT FOR PYTHON?



- **Wrapper**
- **python_qt_binding**
- **QtPy**
- **...**

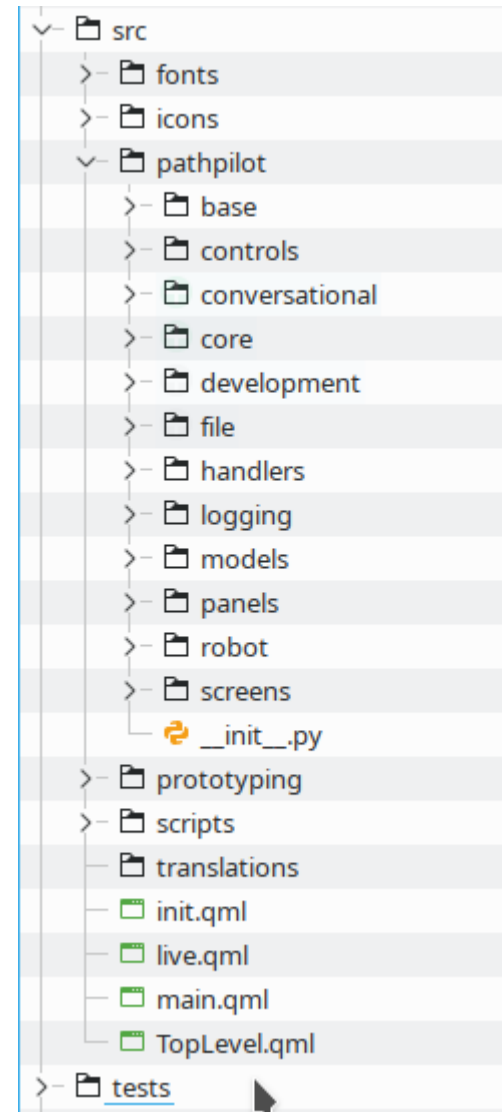
A teal speech bubble with a tail pointing towards the bottom-left corner, containing the title text.

PROJECT STRUCTURE & WORKFLOW

PROJECT STRUCTURE



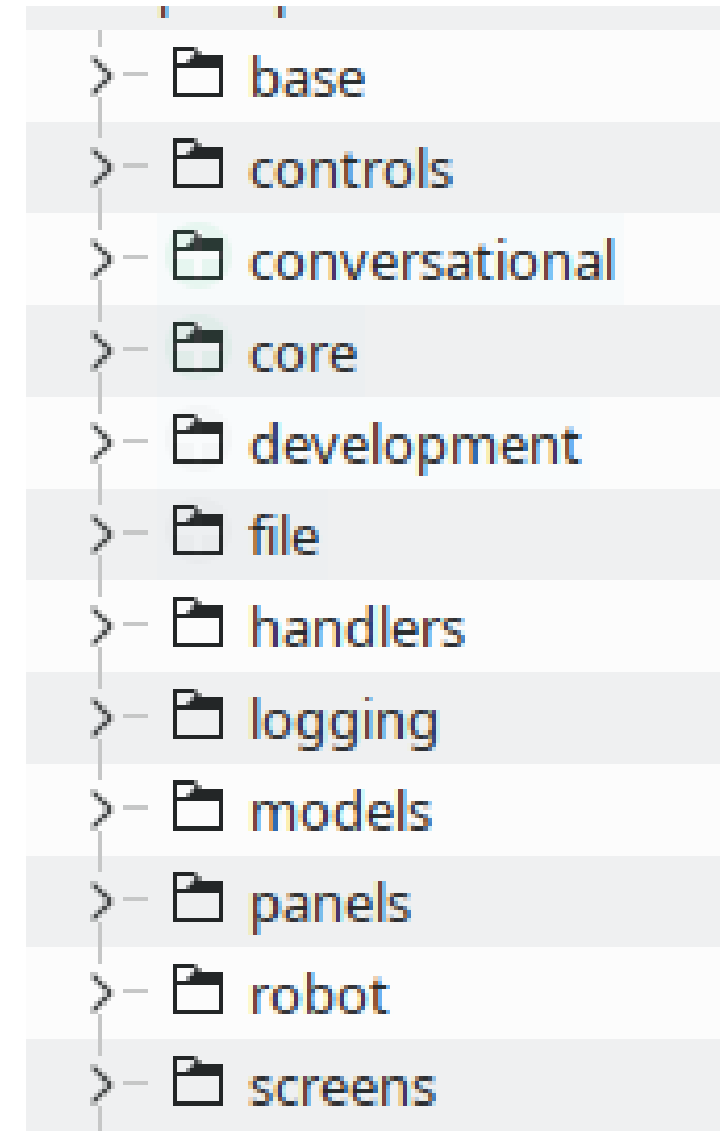
- **init/main.qml → production**
- **live.qml → live coding**
- **main.py → scripts**



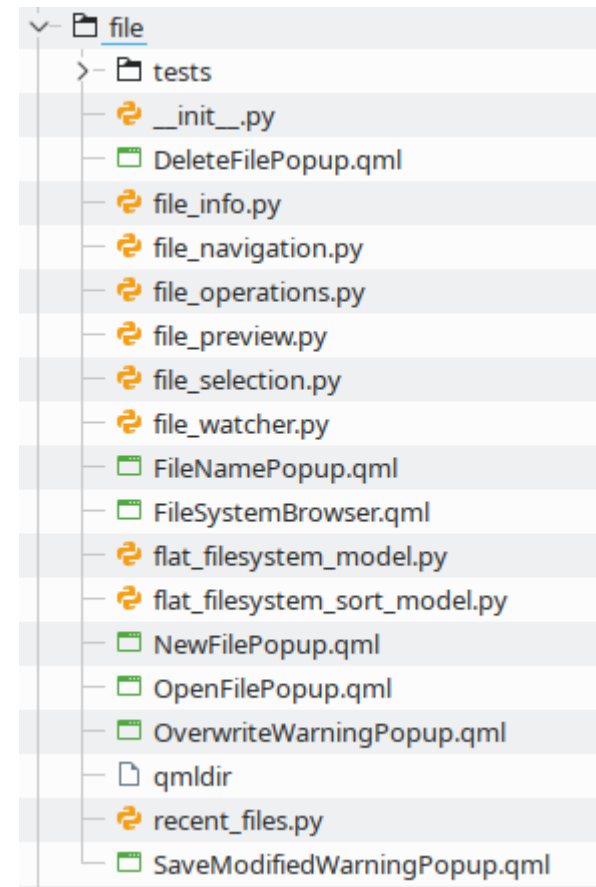
PROJECT STRUCTURE



- **init/main.qml → production**
- **live.qml → live coding**
- **main.py → scripts**



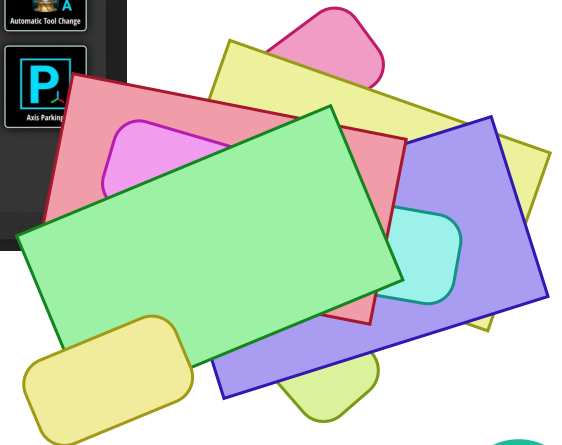
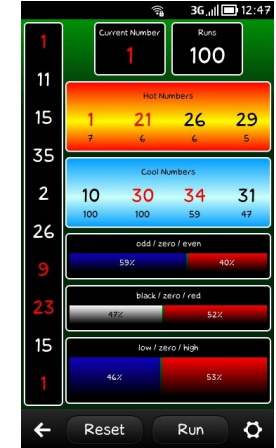
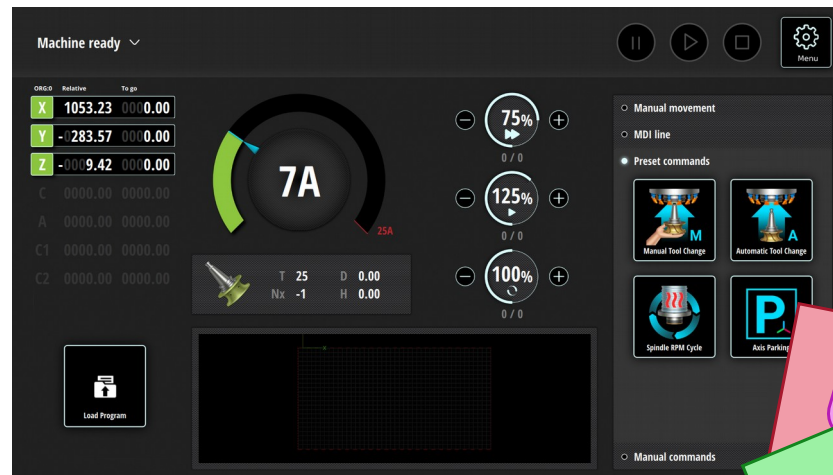
- QML and Python
- QML modules
- C++ → external
- Binding



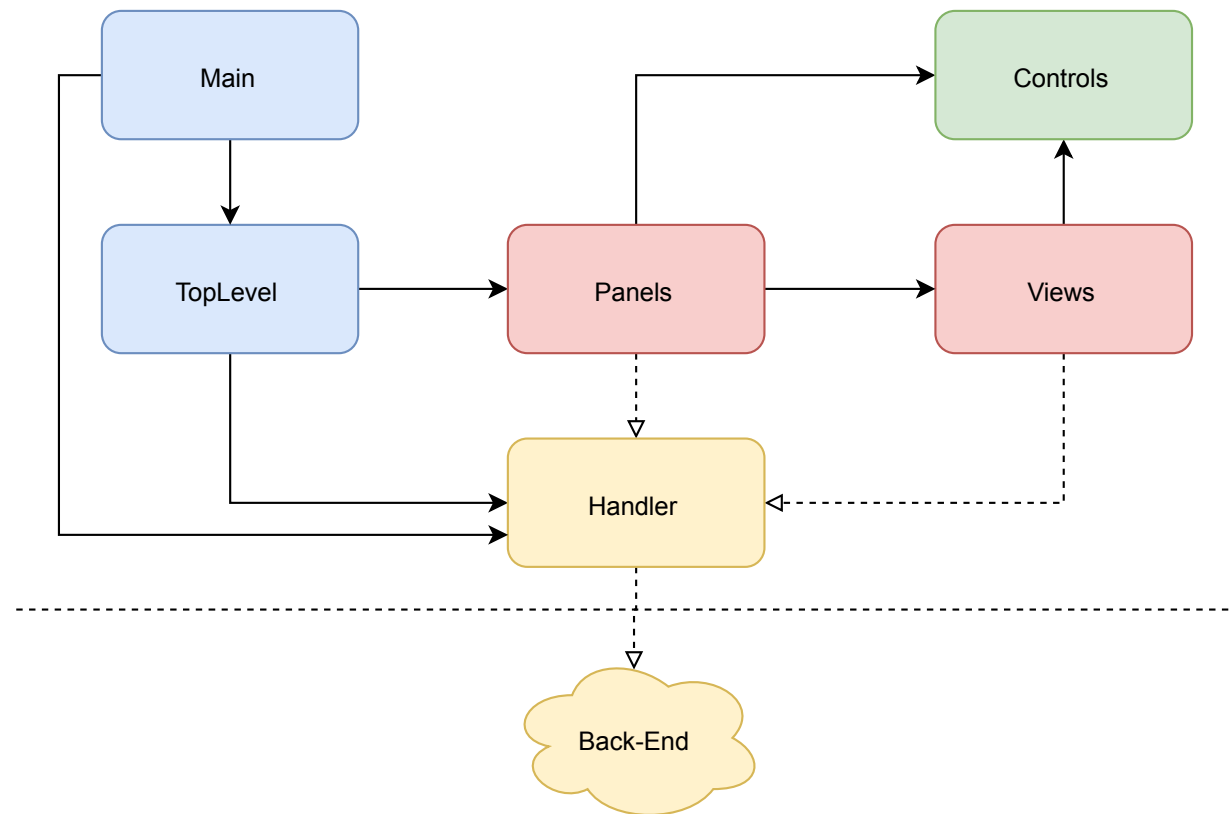
SCALING UP QML



- Small app → straightforward
- Complex HMI → ???
- QtCon 2016
- Neptune 3



- **Scaling up**
- **~Neptune 3**



HANDLERS



BACK

HOME

LOAD PROGRAM

Name	Size	Modified
subdir	0 items	31 Jul 2018
1.py	49.0 B	14 Mar 2019
1_1.py	113.0 B	19 Dec 2018
2.py	205.0 B	13 Mar 2019
2_1.py	205.0 B	15 Mar 2019
bar.py	111.0 B	24 Sep 2018
barus.py	65.0 B	14 Mar 2019
broken.py	2.0 B	1 Jun 2018
continue_forever.py	45.0 B	8 Feb 2019
cycle_start.py	83.0 B	23 Jan 2019
demo.py	172.0 B	3 Jan 2019
demo2.py	563.0 B	24 Oct 2018
demo3.py	541.0 B	24 Oct 2018
digital_io.py	199.0 B	14 Mar 2019
double_if.py	94.0 B	20 Sep 2018

COPY FROM USB

COPY TO USB

NEW FOLDER

RENAME

DELETE

BACK

USB

EJECT

Name	Size	Modified
------	------	----------

NEW FOLDER

RENAME

DELETE

PROGRAM FILE PREVIEW

```
waypoint_2 = j[-0.322, 0.086, 0.277, -0.7
waypoint_1 = j[0.264, 1.524, -3.052, -0.2
def main():
    movej(waypoint_1)
    sleep(0.5)
    movel(waypoint_2)
    sleep(0.5)
```

CONV. EDIT

EDIT PROG.

Main

File

Settings

Offsets

Conversational

Jog

Status (F1)

CYCLE START

SINGLE BLOCK

FEEDHOLD

STOP

RESET

POWER ON

10%

FEED 100%

0%

MAXVEL 100%

WORK

X	0.482	J1	0.652
Y	0.087	J2	0.226
Z	1.635	J3	-0.231
A	-0.001	J4	1.533
B	0.001	J5	0.133
C	0.000	J6	-4.676

STATUS: TODO

JOINTS

X	0.652
Y	0.226
Z	-0.231
A	1.533
B	0.133
C	-4.676

STEP: .001 .010 .100 1.000

27%

JOG CONT STEP

T 0

M6 G43

TOOL LENGTH 0.0000

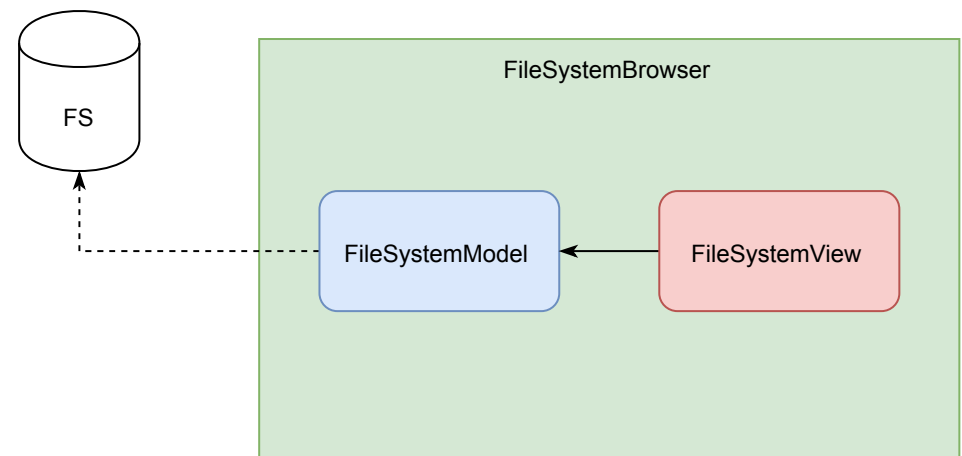
GO TO G30

EXIT

PathPilot

ROBOT DEVELOPMENT

- **Good for single use**
- **Dialogs**
- **Popups**
- **...**



HANDLERS



Left-Click: Rotate. Middle-Click: Move X/Y. Right-Click/Mouse Wheel: Zoom. Shift: More options.

WAYPOINT NAME: waypoint 3

POSE JOINTS

X: 0.482
Y: 0.087
Z: 1.635
A: -0.001
B: 0.001
C: 0.000

J1 J2 J3 J4 J5 J6

MOVE TOOL: A+ B+ C+ A- B- C- Y+ Z+ X- X+ Y- Z-

WARNING

MOVE TO MARKER
MARKER OPS
ADD WAYPOINT
CANCEL

Main File Settings Offsets Conversational Jog Status (F1)

CYCLE START

SINGLE BLOCK STOP
FEEDHOLD RESET
POWER ON

FEED 10%
MAXVEL 0%

WORK JOINTS

WORK	JOINTS
X: 0.482	J1: 0.652
Y: 0.087	J2: 0.226
Z: 1.635	J3: -0.231
A: -0.001	J4: 1.533
B: 0.001	J5: 0.133
C: 0.000	J6: -4.676

STATUS: TODO

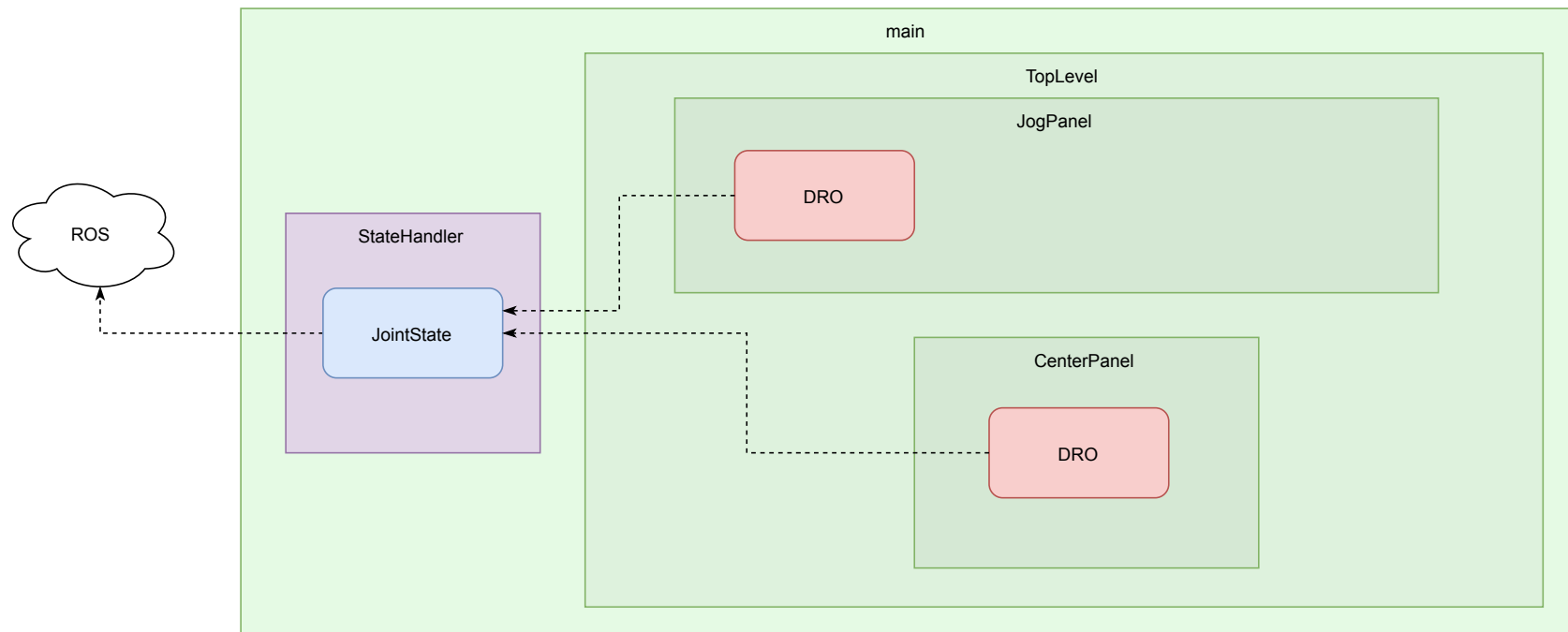
STEP: .001 .010 .100 1.000 27% JOG CONT STEP

T 0 M6 G43 TOOL LENGTH 0.0000 GO TO G30

ROBOT DEVELOPMENT

EXIT

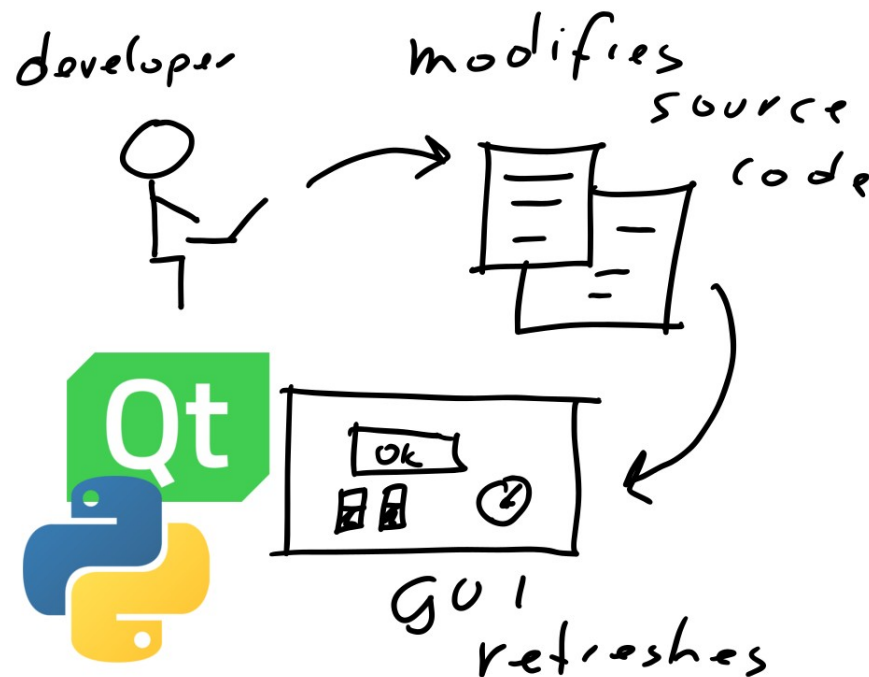
- Access via reference
- Consistent state



WORKING WITH QTQUICK & PYTHON



- Live coding
- Short feedback loops



WORKING WITH QTQUICK & PYTHON



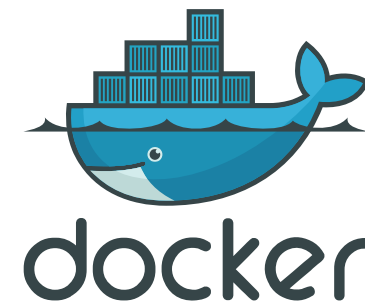
- **Code editor**
 - QtCreator → PyCharm → CLion
- **QML support**
- **Python tests**



A large teal speech bubble with a tail pointing towards the bottom left, containing the text 'QUALITY ASSURANCE & ISSUES' in yellow.

QUALITY ASSURANCE & ISSUES

- Black
- qmlfmt
- Flake8
- Pre-commit
- Docker



- TDD
- Pytest
- pytest-qt



```
# -*- coding: utf-8 -*-
import os

import pytest
from ros_pytest_qt import QtQuickTestWindow
from python_qt_binding.QtGui import QColor

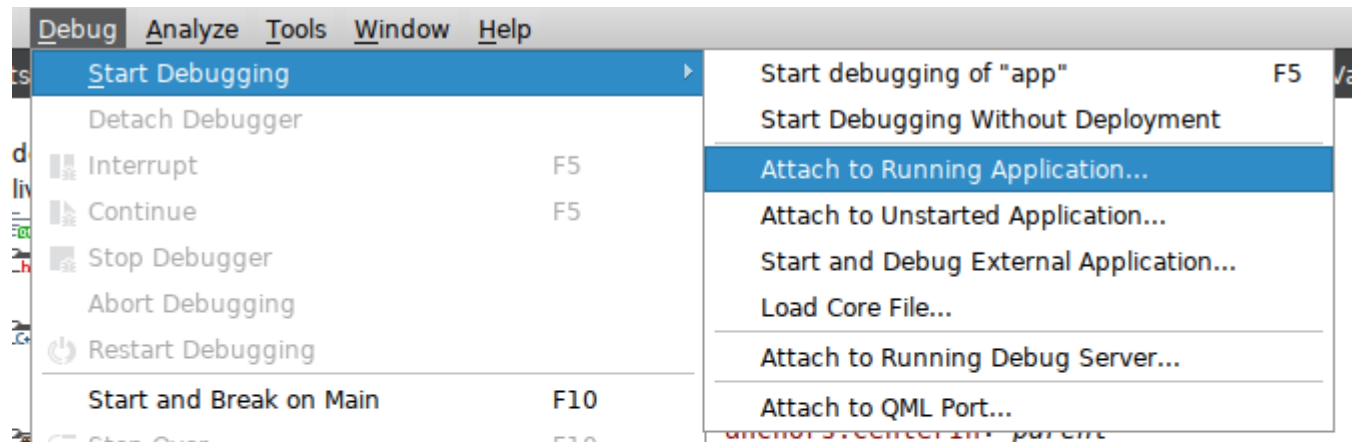
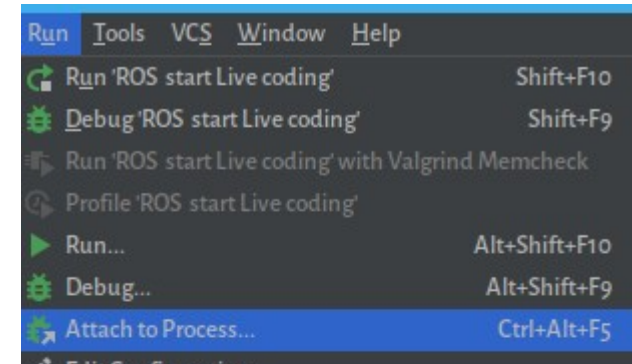
MODULE_PATH = os.path.realpath(os.path.dirname(__file__))

@pytest.fixture
def led_window():
    window = QtQuickTestWindow(visible=False, path=MODULE_PATH)
    window.load_data('Led {}')
    return window

def test_led_has_on_color_when_value_is_true(led_window, qtbot):
    led = led_window.item(class_='Led')
    led.onColor = 'red'
    led.offColor = 'blue'
    led.value = True

    assert led.color == QColor('red')
```

- Qt Creator or CLion
- Attach to Running Application
- Logging



- Ctrl-C

```
import sys

from PyQt5.QtGui import QApplication
from PyQt5.QtQml import QQmlApplicationEngine

if __name__ == '__main__':
    app = QApplication(sys.argv)

    engine = QQmlApplicationEngine()
    engine.load('./main.qml')

    sys.exit(app.exec_())
```



- Ctrl-C

```
import sys

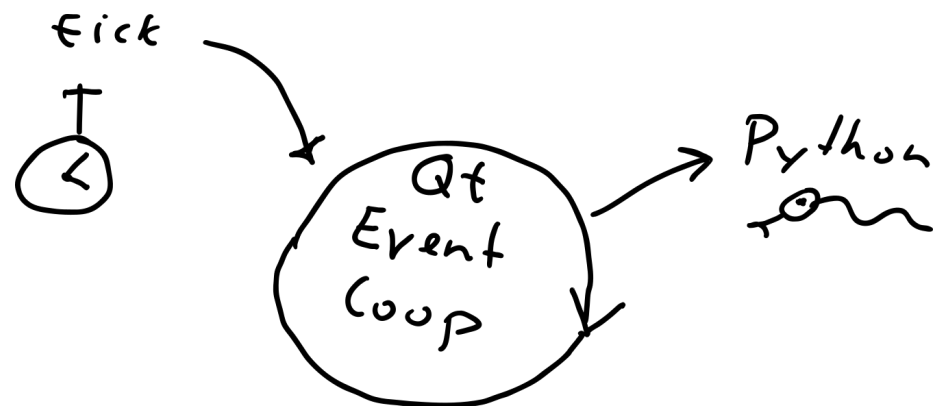
from PyQt5.QtCore import QTimer
from PyQt5.QtGui import QApplication
from PyQt5.QtQml import QQmlApplicationEngine

if __name__ == '__main__':
    app = QApplication(sys.argv)

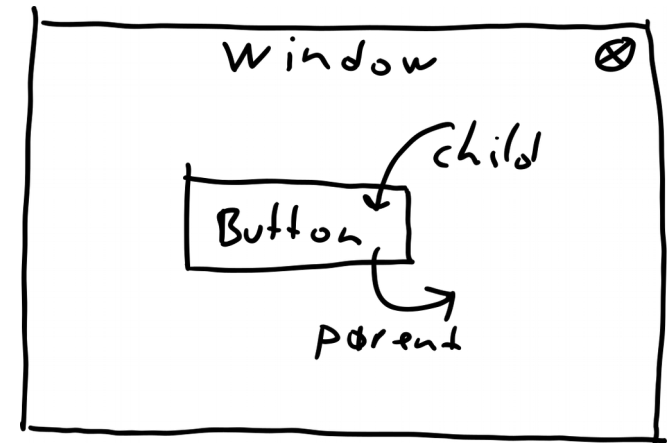
    engine = QQmlApplicationEngine()
    engine.load('./main.qml')

    timer = QTimer()
    timer.timeout.connect(lambda: None)
    timer.start(100)

    sys.exit(app.exec_())
```

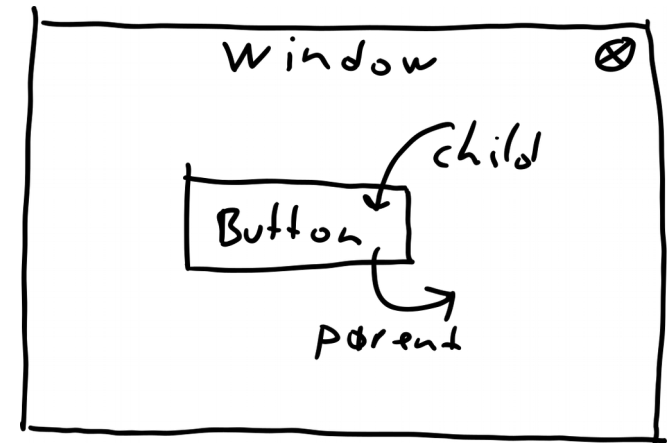


- Python object
- QML component
- Global reference



```
class InteractiveMarker(QObject):  
    def __init__(self, parent=None):  
        super(InteractiveMarker, self).__init__(parent)  
  
        self.data = None  
        self._fb_sub = rospy.Subscriber(  
            FEEDBACK_TOPIC, InteractiveMarkerFeedback, self._feedback_received  
        )  
  
    def _feedback_received(self, msg):  
        self.data = msg.data
```

- Python object
- QML component
- Global reference



```
class InteractiveMarker(QObject):  
  
    def __init__(self, parent=None):  
        super(InteractiveMarker, self).__init__(parent)  
  
        self.data = None  
        self._fb_sub = rospy.Subscriber(  
            FEEDBACK_TOPIC, InteractiveMarkerFeedback, self._feedback_received  
        )  
        self.destroyed.connect(lambda: self._fb_sub.unregister())  
  
    def _feedback_received(self, msg):  
        self.data = msg.data
```

- **QJSValue**

```
@Property(QVariant, notify=targetPoseChanged)
def targetPose(self):
    return self._target_pose
```

- **List**

```
@targetPose.setter
def targetPose(self, value):
    value = value.toVariant() if isinstance(value, QJSValue) else value
    if value == self._target_pose:
        return
    self._target_pose = value
    self.targetPoseChanged.emit(value)
```

```
move.targetPose = [0, 0, 0, 0, 0, 0]
```

```
InteractiveMove {
    targetPose: [0, 0, 0, 0, 0, 0]
}
```


- **QML type limit: 60**
- **PySide2: qmlRegisterSingletonType**
- **PyQt: QValidator and QQuickItem**
- **Boilerplate code**
- **CamelCase vs snake_case**

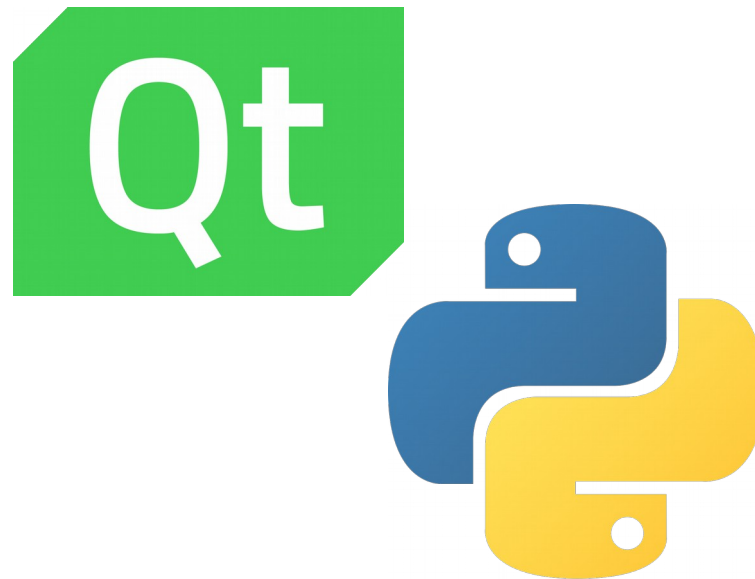
A large teal speech bubble with a tail pointing towards the bottom-left corner, centered on a dark gray background.

CONCLUSION

CONCLUSION



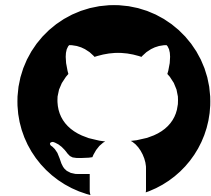
- **Try Qt for Python**
- **Use C++ where necessary**



MORE INFORMATION



- <https://machinekoder.com>
- <https://github.com/machinekoder>



QUESTIONS ?