QtQuick for Complex Applications
Concepts & Best Practices

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About Me

Me = Andreas <CoLa> Cord-Landwehr

- KDE developer since \(\approx 4\) years
- doing stuff with QtQuick for \(\approx 2\) years
- PhD student, doing “strange things” with networks and algorithmic game theory

...and this fall/after my PhD, one can hire me :)

This Talk...

1. will tell you/remind you what QtQuick is and why it is useful
2. gives walk-through important topics & techniques when working with QtQuick
3. has no live-coding, but an example:
   https://github.com/cordlandwehr/example-fosdem-2015
4. is focused on people with \(\approx\) basic QtQuick knowledge
5. will cover:
   - the interplay of C++ code and QtQuick
   - the basic design patterns needed for using QtQuick
   - best practices for hybrid C++/QtQuick applications
6. is available on the FOSDEM website
Introduction
About Me
And About the Talk

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**Introduction**

QtQuick ≠ QML

**Basic Notions**

1. **QML** = name of a declarative language that also allows imperative JavaScript expressions
2. **QtQuick** = toolkit for QML, allowing to develop graphical interfaces


**Simple Code Example of QML Code**

```qml
import QtQuick 2.1
import QtQuick.Controls 1.3
import QtQuick.Layouts 1.0

ApplicationWindow {
    ToolBar {
        RowLayout {
            anchors.fill: parent
            spacing: 2
            ToolButton { iconName: "edit-copy" }
            ToolButton { iconName: "edit-paste" }
            Slider { Layout.fillWidth: true }
        }
    }
}```
QtWidgets: rock stable and sufficient for many use cases

- discrete forms/pages, each containing static controls (known as widgets)
- presenting new forms to user = new window/dialog that replaces current one
- created in C++ (resp. language bindings) or by compiling XML files (UI-files)
- common sets of widgets (along with theme) gives good graphical consistency between apps with same toolkit

QtQuick: declarative and powerful

- create interfaces by describing them (= declarative language)
- make changes easier to understand for humans (= animations instead of discrete changes)
- do interface once for different form factors: touch, desktop
- QtQuick enforces clear separation of UI and data
**Introduction**

**QtWidgets or QtQuick?**

**Two Different Concepts**

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**QtQuick: declarative and powerful**
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- QtQuick enforces clear separation of UI and data
This Talk’s Definition: Complex application ≈ something complex enough to spend time setting up a build system.

Typical non-complex applications
- plasmoids/desktop applets
- mobile applications

Benefits of hybrid C++/QML applications
1. compared to QtWidget based UIs, allows much more flexibility
2. results in code that can be unit tested
3. much better performance (no need for tools like qtquickcompiler to speed-up JS)
4. your (modern) compiler helps discovering tons of issues
Introduction
This Talk’s Example
Yeah, this example is actually non-complex...

Example: A Visual Box Placement Editor
- (blue) whiteboard where we can place (yellow) boxes
- list-view that displays all box-coordinates

Topics for the rest of this talk:
1. How to expose data to the QML engine?
2. How to write data back to the model?
3. How to combine QtQuick with QtWidgets?
4. Some Best-Practices for complex UIs?
Exposing the Data
Models and Views in QtQuick

Implementation of the Proxy Pattern

- **Model** contains the data and its structure
- **View** a container that displays the data
- **Delegate** dictates how the data should appear in the view

In Our Example

- Data = Boxes + BoxManager (C++)
- Model = BoxModel (C++ with QML interfaces)
- View = ListView (QML)
- Delegate = Rectangles and Labels (QML)

Further Reading:
Exposing the Data
Models and Views in Qt Quick
How it is done in code: a Box (boring) (1/4)

class Box : public QObject
{
  Q_OBJECT
  Q_PROPERTY(QPointF position READ position WRITE setPosition NOTIFY positionChanged)

public:
  explicit Box(QObject *parent = Q_NULLPTR);
  ~Box();
  QPointF position() const;
  void setPosition(const QPointF &position);

Q_SIGNALS:
  void positionChanged();

private:
  Q_DISABLE_COPY(Box)
  QPointF m_position;
};
class BoxManager : public QObject
{
   Q_OBJECT

public:
   explicit BoxManager(QObject *parent = Q_NULLPTR);
   ~BoxManager();
   Box * createBox();
   void removeBox(Box *box);
   QList<Box*> boxes() const;

Q_SIGNALS:
   void boxAdded();
   void boxAboutToBeAdded(Box*, int);
   void boxRemoved();
   void boxAboutToBeRemoved(int);

private:
   Q_DISABLE_COPY(BoxManager);
   QList<Box*> m_boxes;
};
Exposing the Data
Models and Views in QtQuick
How it is done in code: the BoxModel (important!) (3/4)

```cpp
class BoxModel : public QAbstractListModel
{
    Q_OBJECT
public:
    enum boxRoles {
        PositionRole = Qt::UserRole + 1,
        DataRole
    };
    [ ... ]
virtual int rowCount(const QModelIndex &parent = QModelIndex()) const Q_DECL_OVERRIDE;
virtual QVariant data(const QModelIndex &index, int role = Qt::DisplayRole) const Q_DECL_OVERRIDE;
virtual QHash<int, QByteArray> roleNames() const Q_DECL_OVERRIDE;
    [ ... ]
private Q_SLOTS:
    void boxAboutToBeAdded(Box *box, int index);
    void onBoxAdded();
    void onBoxAboutToBeRemoved(int index);
    void emitBoxChanged(int row);
    [ ... ]
```

Caution: important (yet boring) code was removed!
[...]
Repeater {
  model: BoxModel {
    boxManager: globalBoxManager
  }
  Rectangle {
    width: 20; height: 20
    color: "yellow"
    border.width: 2
    property Box box: model.dataRole
    x: box.position.x
    y: box.position.y
  }
}

Remaining Questions

1. how can we tell the engine about the globalBoxManager?
2. how can we tell the box manager when a new box shall be created?
Exposing the Data
Models and Views in QtQuick
How it is done in code: the UI code for the whiteboard (4/4)

[...] Repeater {
    model: BoxModel {
        boxManager: globalBoxManager
    }
    Rectangle {
        width: 20; height: 20
        color: "yellow"
        border.width: 2
        property Box box: model.dataRole
        x: box.position.x
        y: box.position.y
    }
}
Exposing the Data

Structure of a Hybrid C++/QML App

QtQuick Engine Lifting

```cpp
qmlRegisterType<BoxManager>("org.kde.fosdemexample", 1, 0, "BoxManager");
qmlRegisterType<BoxModel>("org.kde.fosdemexample", 1, 0, "BoxModel");
qmlRegisterType<Box>("org.kde.fosdemexample", 1, 0, "Box");
```

```cpp
m_widget = new QQuickWidget;
m_boxManager = new BoxManager;

// register box manager globally in QML Context
// set this before loading the scene
m_widget->rootContext()->setContextProperty("globalBoxManager", m_boxManager);

m_widget->setSource(QUrl::fromLocalFile("path/to/my/qml/Scene.qml"));

// listen to context signals
connect(m_widget->rootObject(), SIGNAL(createBox(qreal, qreal)),
        this, SLOT(createBox(qreal, qreal)));
```

**Hence:** root context must provide signal `createBox(x,y)`
Exposing the Data
Live Demo of Example Application
Keep your Fingers Crossed

...hopefully :)}
Best Practices

Working with Complex Objects

Data Access → Bypassing the Proxy Pattern

There are two ways for accessing your (Q)Objects:

1. add an access role to your model for every property
2. provide “raw” access role and equip object with Q_PROPERTIES (← my choice)

Announce roles:

```cpp
QHash<int, QByteArray> BoxModel::roleNames() const {
    QHash<int, QByteArray> roles;
    roles[DataRole] = "dataRole";
    return roles;
}
```

Provide access:

```cpp
QVariant BoxModel::data(const QModelIndex &index, int role) const {
    if (!index.isValid() || index.row() >= m_boxManager->boxes().count())
        return QVariant();
    Box * const box = m_boxManager->boxes().at(index.row());
    switch (role) {
    case DataRole:
        return QVariant::fromValue<QObject*>(box);
    [...]
    }
Since Qt 5.3: QtQuickWidgets

- provides a widget for displaying a QtQuick user interface → you can add QtQuick in a QWidget based UI
- convenience wrapper for QQuickWindow which will automatically load and display a QML scene

Note:
- QQuickWidget disables the threaded render loop on all platforms
- Qt 5.4 fixes a lot of issues

Final Words
Wrapping-Up the Talk
Keep QML files maintainable

QtQuick allows a lot
- fancy interfaces
- better UI design experience
- clear separation of logic and UI

...but requires discipline
1. Keep logic in C++ and unit test it
2. Keep file sizes moderate (rule of thumb: < 500 LOC)
3. Keep a common coding and naming style
   → “private” variable naming space, root ids...
4. for complex interactions: think about using state machines
   → without them, the editor functionality would not be maintainable in Rocs
Thank you for your attention!

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