Qt Quick Best Practices Part I

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Agenda

- Building Blocks of QML
- Qt Properties
- Declarative Code
- Anchors

Building Blocks of QML

QObject

- Heart and Soul of Qt Object
  - Signals and Slots are implemented here
  - QObjects can have “child objects”
    - Parents have some control over children
      - Deleting them, laying them out, etc
  - Also Qt Properties!

Introspection

- QObjects can report at runtime
  - Class name, Super class
  - Lists of signals and list their arguments
  - Lists of functions and list their arguments
  - Invoke methods by name
    - QMetaObject::invokeMethod(objPtr, “function”…)

Meta Object Compiler

- Introspection info is generated by moc
  - Reads header files. Writes source code
    - moc -o moc_class.cpp class.h
  - MetaObject is static
    - One instance per QObject subclass

QQuickItem

- Most Qt Objects inherit QObject
  - QQuickItem is no exception
    - Gets many of it’s features directly from QObject
  - We will be leveraging these capabilities throughout class

Deferred Deletion

- Qt is an event driven GUI toolkit
  - Deleting object can be tricky in an event based system
    - Deleting objects from within an event
    - Deleting the sender object from a signal and slot connection
  - QObject has a deleteLater() method

deleteLater()

- Posts an event to the event loop
  - On the next lap of the loop
    - The object is deleted and all events cleared
  - destroy() in QML is QObject::deleteLater()

QVariant

- Qt’s “Anything” class
  - Think: Typed void*
  - Supports most Qt data types out of the box
    - Easy to add support for your own types
    - Automatically supports all pointer types

QVariant and QML

- QVariant maps to var in JavaScript
  - Used to pass data back and forth to C++
  - If you register your types correctly you can attain runtime type safety

QVariant Containers

- QVariantList maps to Array in JavaScript
- QList<QVariantMap> can be used with JSON syntax JavaScript
  - Better off using QJson classes
    - If you are using JSON data
    - Easier to convert back to JSON

Qt Properties

Qt Properties

- Combination of Get/Set/Notify
  - Allows introspection system to use these functions as one concept
  - Properties have been in Qt for a very long time
    - Qt Designer is based on properties
    - QML is also based on properties

Declaration of a Qt Property

```
#include <QObject>

class Car : public QObject
{
  Q_OBJECT
  Q_PROPERTY(int value READ value WRITE setValue NOTIFY valueChanged)

public:
  int getValue() const;
  void setValue(int newValue);

signals:
  void valueChanged(int value);
};
```

Qt Property with Enum

```
#include <QObject>

class Car : public QObject
{
  Q_OBJECT
  Q_ENUMS(KeyState)
  Q_PROPERTY(KeyState keyState READ keyState NOTIFY keyStateChanged)
public:
  enum KeyState {
    KeyOff,
    KeyOn,
    KeyStart
  };
  [...]
};
```

Getting and Setting Qt Properties

```
void someFunction(Qobject* obj)
{
  // Getting
  QVariant propValue = obj->property(“value”);
  qDebug() << propValue.typeName() << propValue.toInt();

  //Setting
  QVariant newValue = QVariant::fromValue(Car::KeyOn);
  obj->setProperty(“keyState”, newValue);
}
```

Dynamic Propeties

- Properties are Key-Value Pairs
    - QObject can create properties on demand
        - Less type safe, but perfectly useful for QML

```
obj->setProperty(“newPropName”, 1);
obj->setProperty(“another”, “Value”);

int propInt = obj->property(“newPropName”).toInt();
QString propString = obj->property(“another”).toString();
```

Declarative Code

Basic QML Syntax

- QML is declarative language
  - With hooks for procedural JavaScript
    - Use as little JavaScript as possible
- QML files a read at runtime
  - The declarative parts create C++ instances
  - JavaScript is JIT interpreted

QtQuick Hello World

```
import QtQuick 2.2

Rectangle{
  id: toplevel
  color: “blue”

  Text {
    text: “Hello World”
  }

  MouseArea {
    anchors.fill: parent
    onClicked: Qt.quit()
  }
}
```

Qt Quick Items

- Rectangle, Text and MouseArea
  - Are implemented in C++
  - Instances of QQuickRectangle, QQuickText, Etc
  - Loading QML is slower than compiled code
    - At runtime performance is great

QML Bindings

- “:” is the binding operator
  - Right of the binding operator is JavaScript

  -
    ```
    Text {
        text: “Hello World ” + Math.rand()
     }
    ```
  - If the expression is simple
    - The full JavaScript interpreter may be skipped
      - More on this later in the webinar series

Bindings are Declarative

- When any property used in a binding changes the expression is recalculated

```
Gauge {
    value: Math.min(gaugeMax, Math.max(gaugeMin, oilPressure.value))
}
```

  - Value is updated whenever properties change
    - gaugeMax, gaugeMin or oilPressure.value

JavaScript is Procedural

- Avoid this!

```
Gauge {

    Component.onCompleted: {
      setGaugeValue(oilPressure.value)
      oilPressure.valueChanged.connect(setGaugeValue)
    }

    onGaugeMinChanged: setGaugeValue(value)
    onGaugeMaxChanged: setGaugeValue(value)

    function setGaugeValue(oilValue) {
      value = Math.min(gaugeMax, Math.max(gaugeMin, oilValue))
    }
}
```

Broken Bindings

- Assignment operator breaks bindings
  - Binding works for awhile. Then doesn't.
  - Solution: Use States
    - More in later in the webinar series

```
Gauge {
    id: gauge
    visible: Dashboard.isOilPressureVisible
}

Button {
  onClicked: { // Tries to temporarily hide gauge
      if(gauge.visible)
         gauge.visible = false
          else
         gauge.visible = Dashboard.isOilPressureVisible
      }
}
```

Anchors

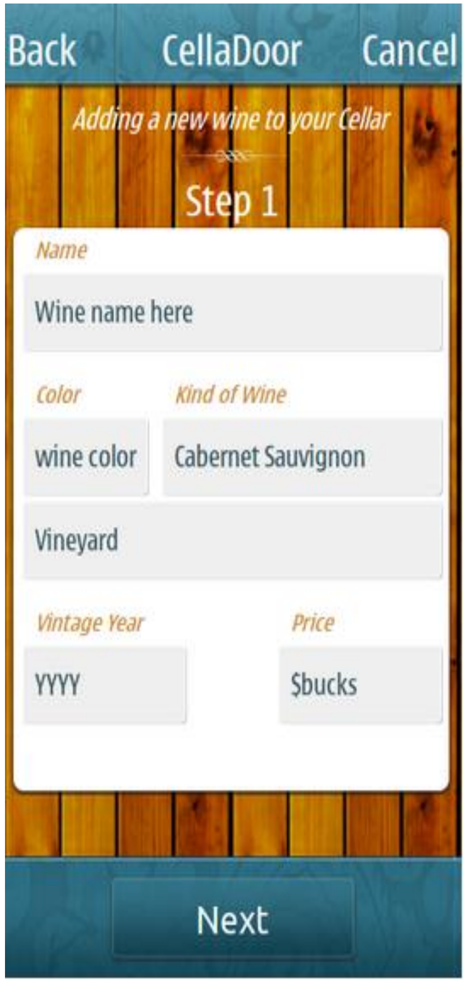
Dead Reckoning Layout

```
Item {
  width: 800; height: 400;

  Rectangle {
    id:rectA
    color: 'red`
    height: 50 ; width: 70
    x: 0; y: 0
  }

  Rectangle {
    id:rectB
    color: 'blue`
    height: rectA.height * 2; width: rectA.width * 2
    x: 0; y: 100
  }
}
```

Why is dead reckoning bad?

- The good:
  - It resizes correctly
  - It uses bindings so it’s “declarative”
- The bad:
  - There are a lot of binding re-calculations
    - Each recalculation is run in JavaScript
  - Cascading bindings cause intermediate states

Binding Recalculation



- This example has ~40 items
- If each item needs 2 bindings
  - 80 Recalculations on resize
    - Not including intermediate states

Intermediate States

Example 2.2. src/anchors/tst_bindings_1.qml

```
Item {
  property int c: a + b
  property int a
  property int b: a

  onAChanged: console.log("a == " + a)
  onBChanged: console.log("b == " + b)
  onCChanged: console.log("c == " + c)
  Component.onCompleted: a = 1
}
```

Output:

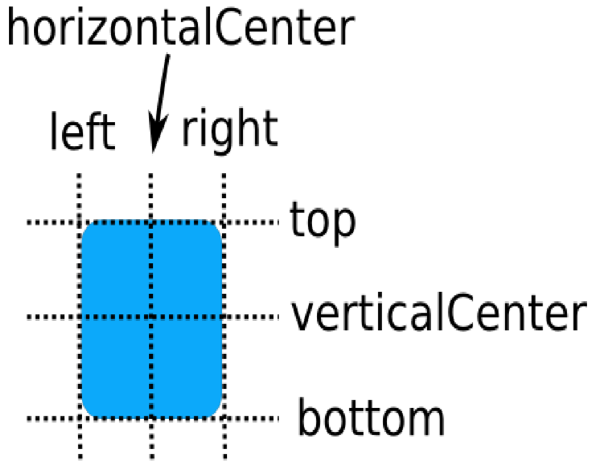
```
  a == 1
  c == 1
  b == 1
  c == 2
```

Anchors Are Better!

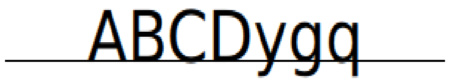
- Anchors are stored and calculated in C++
  - Remember all Items are actually C++ instances
  - Anchors let you attach an item to other items
    - Parent item
    - Any sibling item
  - Anyone remember the Motif Form Widget?
    - Eerily similar. What’s old is new again!

Anchor Lines

- There are 6 anchors lines all Items have



- Text item has a 7th anchor called baseline
  - Bottom of text without descenders

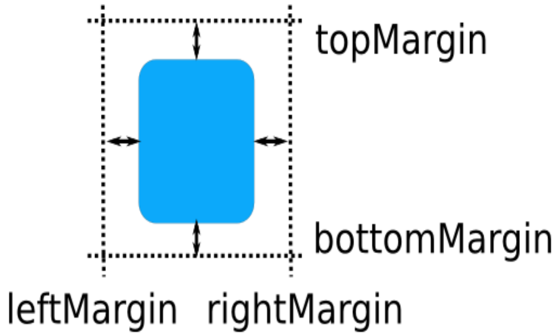


Setting Anchors

```
Rectangle {
  width: 800; height:600

  Rectangle {
    id: rect1
    width: 400
    anchors.top: parent.top
    anchors.bottom: parent.bottom
  }

  Rectangle {
    id: rect2
    anchors {
       top: parent.top; bottom: parent.bottom
       left: rect1.right; right: parent.right
    }
  }
}
```

Anchor Margins

- Each item has 6 adjustable margins



  - Not shown are [horizontal|vertical]CenterOffset
  - Text has a baselineOffset margin
  - anchors.margins sets all outer margins at once

Complex Anchors

- Set multiple anchors at once
  - anchors.fill: anotherItem
    - Sets left, right, top and bottom
    - Can use all outer margins
  - anchors.centerIn: anotherItem
    - Sets horizontalCenter and verticalCenter
    - Can use horizontal and vertical offsets

Thank You!