Designing Interactive Systems II

Computer Science Graduate Programme SS 2010

Prof. Dr. Jan Borchers
RWTH Aachen University

http://hci.rwth-aachen.de

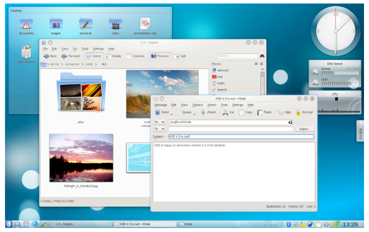
Review

- Web 2.0 in keywords
- GWT
- Cappuccino
- HTML5

http://qt.nokia.com/

Introduction

- Cross platform GUI Toolkit
  - Available for X11, Windows, Mac
  - Toolkit used by the KDE project
  - Managed by a company that provides official support
- Dual license
  - after pressure from open source community

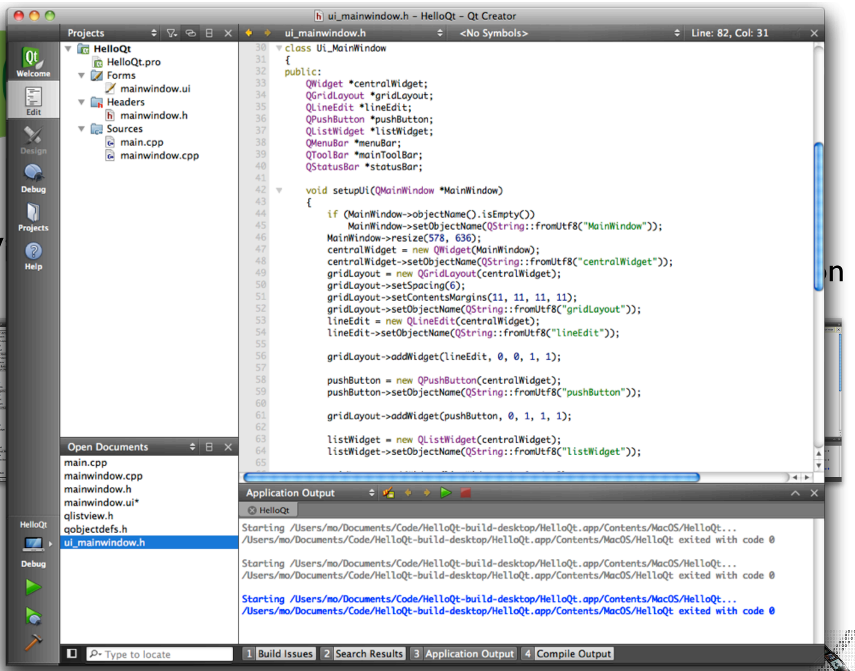


History

- Started out in 1994 by Trolltech (Norwegian)
- Adopted by Matthias Ettrich for KDE (1996)
- Trolltech introduced Qtopia (2001)
  - Application plattform for Linux based mobile devices
- Nokia bought Trolltech (2008)
  - Pushed Qtopia to be a new platform for Symbian, Windows CE / Mobile and Maemo

Features

- Extended C++
  - MOC files are meta-compiled into C++
- Custom widget behavior accomplished through signals and slots
- Plug-ins for mimicking look of other toolkits (Windows, Mac, Motif, etc...)
- UIDS creates XML files, which are meta-compiled into C++



```
class Ui_MainWindow
{
public:
    QWidget *centralWidget;
    QGridLayout *gridLayout;
    QLineEdit *lineEdit;
    QPushButton *pushButton;
    QListWidget *listWidget;
    QMenuBar *menuBar;
    QToolBar *mainToolBar;
    QStatusBar *statusBar;

    void setupUi(QMainWindow *MainWindow)
    {
        if (MainWindow->objectName().isEmpty())
            MainWindow->setObjectName(QString::fromUtf8("MainWindow"));
        MainWindow->resize(578, 636);
        centralWidget = new QWidget(MainWindow);
        centralWidget->setObjectName(QString::fromUtf8("centralWidget"));
        gridLayout = new QGridLayout(centralWidget);
        gridLayout->setSpacing(6);
        gridLayout->setContentsMargins(11, 11, 11, 11);
        gridLayout->setObjectName(QString::fromUtf8("gridLayout"));
        lineEdit = new QLineEdit(centralWidget);
        lineEdit->setObjectName(QString::fromUtf8("lineEdit"));

        gridLayout->addWidget(lineEdit, 0, 0, 1, 1);

        pushButton = new QPushButton(centralWidget);
        pushButton->setObjectName(QString::fromUtf8("pushButton"));

        gridLayout->addWidget(pushButton, 0, 1, 1, 1);

        listWidget = new QListWidget(centralWidget);
        listWidget->setObjectName(QString::fromUtf8("listWidget"));
```

```
Starting /Users/mo/Documents/Code/HelloQt-build-desktop/HelloQt.app/Contents/MacOS/HelloQt...
/Users/mo/Documents/Code/HelloQt-build-desktop/HelloQt.app/Contents/MacOS/HelloQt exited with code 0

Starting /Users/mo/Documents/Code/HelloQt-build-desktop/HelloQt.app/Contents/MacOS/HelloQt...
/Users/mo/Documents/Code/HelloQt-build-desktop/HelloQt.app/Contents/MacOS/HelloQt exited with code 0

Starting /Users/mo/Documents/Code/HelloQt-build-desktop/HelloQt.app/Contents/MacOS/HelloQt...
/Users/mo/Documents/Code/HelloQt-build-desktop/HelloQt.app/Contents/MacOS/HelloQt exited with code 0
```

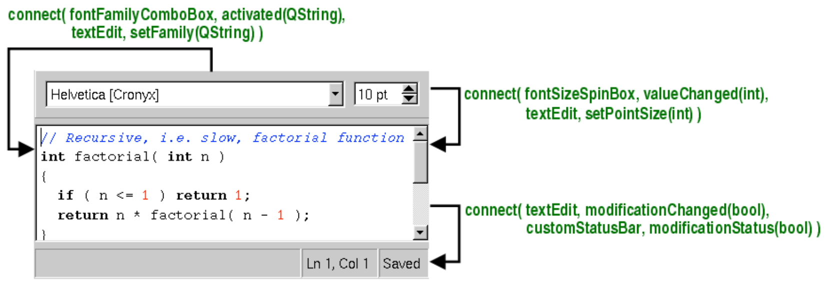
Signals & Slots Motivation

- Disadvantages of Callbacks
  - Callbacks are strongly coupled to processing function
  - Callbacks are not type safe when using (void *)
    - Example: Button_CB(Fl_Widget *, void *)

Signals & Slots

- Signals are emitted by objects when they change their state in a way that may be interesting to the outside world.
- Slots can be used for receiving signals, but they are also normal member functions.
- Advantages
  - loosely coupled, anonymous communication
  - type safe
- Similarities to bindings in Cocoa

Signals & Slots Example


connect(fontFamilyComboBox, activated(QString),
textEdit, setFamily(QString))

connect(fontSizeSpinBox, valueChanged(int),
textEdit, setPointSize(int))

connect(textEdit, modificationChanged(bool),
customStatusBar, modificationStatus(bool))

```
// Recursive, i.e. slow, factorial function
int factorial( int n )
{
  if ( n <= 1 ) return 1;
  return n * factorial( n - 1 );
}
```

Signals & Slots

```
class Hello : public QWidget
{
    Q_OBJECT
public:
    Hello( const char *text, QWidget );
signals:
    void clicked();
};
```

```
class Q_EXPORT QApplication : public QObject
{
    Q_OBJECT
public:
    QApplication( int &argc, char **argv );
public slots:
    void quit();
};
```

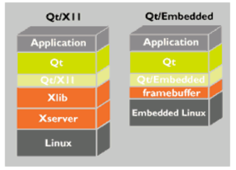
```
int main( int argc, char **argv )
{
    QApplication a(argc,argv);
    Hello h(“hello world”);
    QObject::connect( &h, SIGNAL(clicked()), &a, SLOT(quit()) );
}
```

Demo

Advanced Features

- Supports Phonon multimedia framework
- Adheres to MVC paradigm since v4.0 (InterView)
- OpenGL accelerated 2D rendering and transformations (even on active widgets)
- Extremely sophisticated parallel processing (multi-threading and IPC) capabilities (e.g., QFuture)
- Qt is one of the most well-documented UITKs (check out http://doc.trolltech.com)

Qt Embedded / Qtopia Core



- Qt for Linux based mobile devices
  - Replaced X by Linux framebuffer
- Has the same API as Qt Desktop
  - Learn one API, target multiple platforms (Windows, X11, Mac OS X, embedded Linux)

Evaluation

- Availability: high
  - free for GPL use on X11, Mac, and Windows
  - $3000/license for commercial use
- Productivity: high with Qt Creator
- Performance: signals & slots mechanism adds some extra overhead, but not a lot
- Graphics Model: rasterop and vector (since v4.0)

Evaluation

- Adaptability: mimic various other toolkit, define your own 'stylesheets'
- Extensibility: pretty high - free to modify source code
- Resource Sharing: yes

Java History

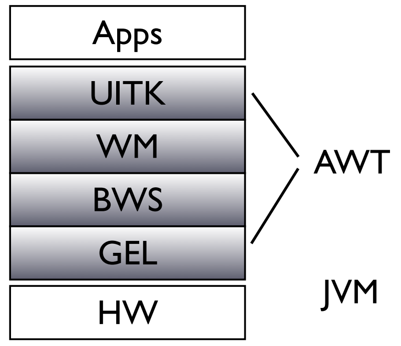
- Java 1.0 (1995): 6-week version of AWT
- Java 1.1: Listeners event model, localization
- Java 2, v.1.2: JFC (Swing, Java2D, Accessibility, Drag&Drop), audio playback
- Java 2, v.1.3: audio in, MIDI, Timer (for UI, animations, etc.)
- Java 2, v.1.4 (2002): full-screen mode, scrollwheels, Preferences API
- Java 2, v. 5.0 (a.k.a. J2SE 1.5) (2005): Java 2D, improved internationalization, Java Sound
- Java SE 6 (2006): Scripting host, dynamic compilation, JDB4

Java AWT

What is AWT?

- Abstract Window Toolkit
- OO UI toolkit for the Java platform
- Maps to native widgets of the host platform
- First version of AWT was developed in only 6 weeks!

AWT Architecture



- Java is not a complete OS
- No own window manager
- Applications use AWT for graphics
- AWT works on top of the Java Virtual Machine (JVM)

AWT overview

- Component as top level object
- Containers can contain multiple widgets
- Layout Managers handle the positioning
- Events are being handled with Listeners
- One window per widget (heavyweight)

Applets vs Applications

- Java offers two kinds of UI programs:
  - Applets
    - run inside a web browser (or AppletViewer)
    - embedded in HTML source
    - restricted access to underlying OS
  - Applications
    - run as standalone, (almost) full OS access
    - subclasses of Frame

Hello AWT

```
import java.awt.*;

public class Hello extends Frame {
  public static void main(String argv[])
  {
    new Hello();
  }
  Hello() {
    Label hello = new Label("Hello World");
    add(hello, "Center");
    setSize(200, 200);
    setVisible(true);
  }
}
```

The Component Class

- Parent class for all things to see and interact with onscreen (except for menus: MenuComponent)
- Over 150 methods
  - from getWidth() to addMouseMotionListener()

Events in Java 1.0

- Component class has an action() method
- Public boolean action (Event E, Object o);
- All events belonging to that Component go to action()
- Problem: huge action() methods with lots of if statements

```
import java.awt.*;

public class OldEvents extends Frame {
  public static void main(String argv[]) {
    new OldEvents();
  }
  OldEvents() {
    Button button = new Button("Click me");
    add(button, "Center");
    setSize(200, 200);
    setVisible(true);
  }
  public boolean action (Event e, Object o) {
     String caption = (String)o;
     if (e.target instanceof Button)
       if (caption == "Click me")
         System.out.println("Button clicked");
     return true;
  }
}
```

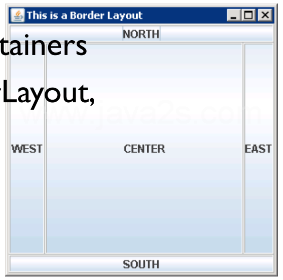
Events in Java 1.1

- Listeners: Developer can choose where events are supposed to go
- Widgets can have multiple listeners
- Listeners can be connected to multiple widgets
- Event listener interfaces for various kinds of events
- Adapter classes as ready-made listener implementations

```
import java.awt.*;
import java.awt.event.*;

public class NewEvents extends Frame implements ActionListener {
  public static void main(String argv[]) {
    new NewEvents();
  }

  NewEvents() {
    Button button = new Button("Click me");
    add(button, "Center");
    button.addActionListener(this);
    setSize(200, 200);
    setVisible(true);
  }

  public void actionPerformed(ActionEvent event) {
     System.out.println("Button pressed");
  }
}
```

Layout managers

- Widgets are dynamically positioned
- Container widgets have child widgets
- Layout managers are attached to containers
- Various types: GridBagLayout, BorderLayout, FlowLayout, ...
- No (pixel-) absolute positioning



Pros

- Advantages of AWT
  - Speed: use of native peers can speed up component performance
  - Applet Portability: most web browsers support AWT classes by default
  - Look and Feel: AWT components more closely reflect the look and feel of the OS they run on

Cons

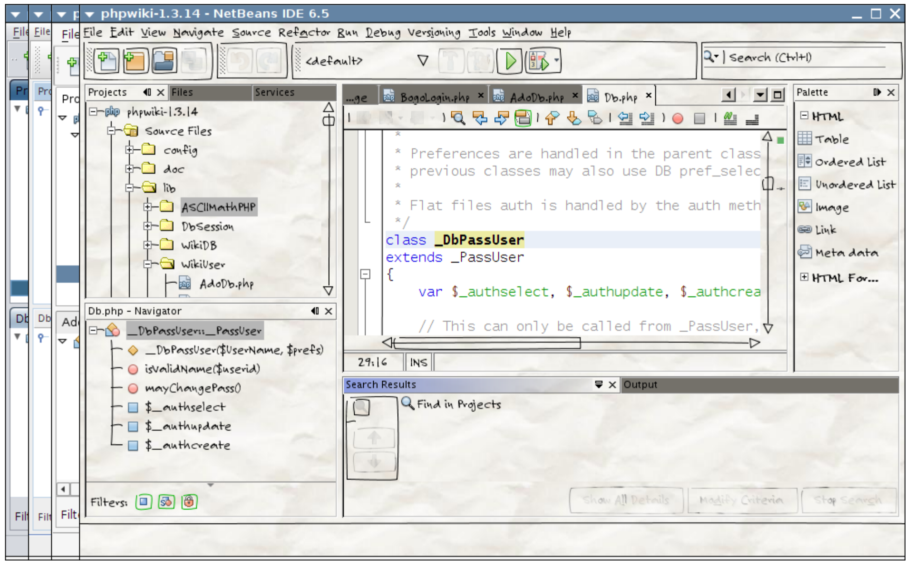
- Disadvantages of AWT:
  - high overhead (one window per widget)
  - only few widgets (common denominator)
  - hard to port (platform specific limitations)
  - not very extensible

Java Swing

it's spelled JFC

JFC/Swing?

- Derived from Netscape's IFC
- Swing is a "lightweight" UI toolkit for Java
- Four times as many widgets as AWT (trees, ...)
- Pluggable look and feel
- Runs on Java 1.1.5+, included with Java 1.2+
- JFC (Java Foundation Classes) include Swing, drag and drop, clipboard support, etc



```
 *
 * Preferences are handled in the parent class
 * previous classes may also use DB pref_selec
 *
 * Flat files auth is handled by the auth meth
 */
class _DbPassUser
extends _PassUser
{
    var $_authselect, $_authupdate, $_authcrea

    // This can only be called from _PassUser,
```

Java pluggable look-and-feel DEMO

The Swing solution

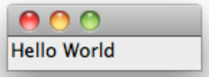
- Swing is implemented in "100% pure" Java
- Using AWT only for root-level widgets
- Providing AWT-like API
- Offers advanced widgets on all platforms
- Pluggable look and feel - can mimic host platform or be a custom theme
- Supports MVC

MVC in Swing

- View and controller combined into delegate
- Interfaces for Model and View (e.g. ButtonModel, ButtonUI)
- Delegates implement ComponentUI
- Allows customization of UIs

Hello, Swing

```
import javax.swing.*;

public class Hello extends JFrame {
  public static void main(String argv[])
  {
    new Hello();
  }
  Hello() {
    JLabel hello =
    new JLabel("Hello World");
    getContentPane().add(hello, "Center");
    setSize(200, 200);
    setVisible(true);
  }
}
```


Hello World

Other toolkits for Java

- SWT (http://www.eclipse.org/)
  - Written in Java, but using native widgets through JNI
- subArctic (http://www.cc.gatech.edu/gvu/ui/sub_arctic/)
  - animation, snapping, dragging, etc
- Piccolo (http://www.cs.umd.edu/hcil/piccolo/):
  - Toolkit for zoomable UIs
- bindings for Cocoa (discontinued), WinForms, wxWidgets, gtk, etc

Java: Evaluation

- Availability: high (binary portability)
- Productivity: medium with AWT, high with Swing
- Parallelism: external yes, internal depends on OS
- Performance: medium (bytecode interpretation), memory and performance tradeoffs between AWT and Swing

Java: Evaluation

- Graphics model: RasterOp, Vector based
  - Java2D offers vectors, uses GPU for acceleration
- Style: native with AWT, pluggable-simulated with Swing
- Extensibility: high
  - It's open source...

Java: Evaluation

- Adaptability: fairly high (Swing)
  - custom look and feels, can be switched at runtime
  - ResourceBundles can store resources (like text and icons for different languages)
    - but no human-readable format for all languages (properties files limited to ISO-8859-1)
  - Resource sharing: depends on core OS
  - Distribution: depends on core OS

Java: Evaluation

- API structure: OO
- API comfort: high with Swing
- Independence: high, Swing has support for MVC
- Communication: Clipboard and drag and drop with Swing (improved with J2SE6)