Objectives

• You will learn about:
  – Graphical user interface (GUI) programming
  – Specifically...
  – For Java: The *AWT/Swing* GUI library
  – For Python: The *PyQt5* GUI library
Agenda

• Dialogs
• Some larger examples
Dialogs

- **Dialog**
  - A pop-up window
  - Used to display information, or error message, or warning message
  - Used to collect some input
  - Common
    - AWT/Swing and PyQt5 provide high-level components
Swing Dialogs

• See `DialogWriteMessage.java`
  - JOptionPane

• See `DialogChooseOption.java`
  - JOptionPane

• See `DialogChooseOption2.java`
  - JOptionPane

• See `DialogReadValue.java`
  - JOptionPane
Swing Dialogs

• See `DialogChooseFile.java`
  – JFileChooser

• See `DialogChooseColor.java`
  – JColorChooser
Swing Dialogs

Swing dialog classes:

```
java.lang.Object
  java.awt.Component
    java.awt.Container
      javax.swing.JComponent
        javax.swing.JOptionPane
          showConfirmDialog()
          showInputDialog()
          showMessageDialog()
          showOptionDialog()
        javax.swing.JFileChooser
          showOpenDialog()
          showSaveDialog()
        javax.swing.JColorChooser
          showDialog()
```
PyQt5 Dialogs

- See `dialogwritemessage.py`  
  - `QMessageBox`
- See `dialogchooseoption.py`  
  - `QMessageBox`
- See `dialogreadvalue.py`  
  - `QInputDialog`
- See `dialogchoosefile.py`  
  - `QFileDialog`
- See `dialogchoosescolor.py`  
  - `QColorDialog`
PyQt5 Dialogs

PyQt5 dialog classes:

```
QWidget
  QDialog
    QMessageBox
      information()
      critical()
      warning()
      question()
    QInputDialog
      getText()
      getDouble()
      getInt()
      getItem()
      getMultiLineText()
```
PyQt5 Dialogs

PyQt5 dialog classes:

QWidget
   QDialog
      QFileDialog
         getOpenFileName()
         getExistingDirectory()
         getExistingDirectoryUrl()
         getOpenFileNames()
         getOpenFileUrl()
         getOpenFileUrls()
         getSaveFileName()
         getSaveFileUrl()
         saveFileContent()

QColorDialog
   customColor()
   customCount()
   getColor()
   setCustomColor()
   setStandardColor()
   standardColor()
Agenda

• Dialogs

• Some larger examples
AWT/Swing Example

• See **ColorDisplay.java**
  – Slightly larger and more realistic
  – Multiple interacting components
AWT/Swing Example: Components

redLabel (class JLabel)

Also:
greenLabel (class JLabel)
blueLabel (class JLabel)
AWT/Swing Example: Components

Also:
greenTextField (class JTextField)  
blueTextField (class JTextField)  
redTextField (class JTextField)
AWT/Swing Example: Components

redSlider (class JSlider)

Also:
greenSlider (class JSlider)
blueSlider (class JSlider)
AWT/Swing Example: Components

labelPanel (class JPanel)
AWT/Swing Example: Components

textFieldPanel (class JPanel)
AWT/Swing Example: Components

sliderPanel (class JPanel)
AWT/Swing Example: Components

```
controlPanel (class JPanel)
```
AWT/Swing Example: Components

colorPanel (class JPanel)
AWT/Swing Example: Components

frame (class JFrame)
AWT/Swing Example: Layout

labelPanel: GridLayout: 3 rows, 1 column
Contains redLabel, greenLabel, blueLabel
AWT/Swing Example: Layout

textFieldPanel: GridLayout: 3 rows, 1 column
Contains redTextField, greenTextField, blueTextField
AWT/Swing Example: Layout

sliderPanel: GridLayout: 3 rows, 1 column
Contains redSlider, greenSlider, blueSlider
AWT/Swing Example: Layout

controlPanel: BorderLayout
    Contains labelPanel (West), sliderPanel (Center), textFieldPanel (East)
AWT/Swing Example: Layout

frame: BorderLayout
Contains colorPanel (Center), controlPanel (South)
AWT/Swing Example: Events

Similar for greenTextField, blueTextField

redTextField
ActionListener
Inform redSlider and colorPanel of change
AWT/Swing Example: Events

Similar for redSlider, greenSlider, and blueSlider:

- ChangeListener
- Inform redTextField and colorPanel of change
PyQt5 Example

• See colordisplayer.py
  – Slightly larger and more realistic
  – Multiple interacting widgets
PyQt5 Example: Widgets

redLabel (class QLabel)

Also:
- greenLabel (class QLabel)
- blueLabel (class QLabel)
PyQt5 Example: Widgets

Also:
- greenLineEdit (class QLineEdit)
- blueLineEdit (class QLineEdit)
- redLineEdit (class QLineEdit)
PyQt5 Example: Widgets

redSlider (class QSlider)

Also:
  greenSlider (class QSlider)
  blueSlider (class QSlider)
PyQt5 Example: Widgets

controlFrame (class QFrame)
PyQt5 Example: Widgets

colorFrame (class QFrame)
 PyQt5 Example: Widgets

centralFrame (class QFrame)
PyQt5 Example: Widgets

window (class QMainWindow)
PyQt5 Example: Layout

controlFrame: Grid: 3 rows, 3 columns
Row 0 stretch = 0, row 1 stretch = 0, row 2 stretch = 0
Col 0 stretch = 0, col 1 stretch = 1, col 2 stretch = 0
Contains redLabel, greenLabel, blueLabel, redSlider, greenSlider, blueSlider, redLineEdit, greenLineEdit, blueLineEdit
PyQt5 Example: Layout

centralFrame: Grid: 2 rows, 1 column
Row 0 stretch = 1, row 1 stretch = 0
Col 0 stretch = 1
Contains colorFrame, controlFrame
PyQt5 Example: Events

Similar for greenLineEdit, blueLineEdit

redLineEdit
Signal: returnPressed
PyQt5 Example: Events

Similar for greenSlider, blueSlider

redSlider
Signal: valueChanged
GUI Principle: Composition

• All GUI libraries provide:
  – Components/widgets
  – Containers
  – Layout managers
  – Event handling mechanism(s)
  – Dialogs
GUI Principle: Event Loops

- All GUI libraries provide…
- Event loops
  - Client tells GUI library to run event loop
  - Event loop:
    - Detects GUI activity
      - Keystrokes, pointing device clicks, pointing device movement, …
    - Identifies relevant components/widgets
    - Calls functions (sends messages to objects) registered on those components/widgets
    - Repeats
GUI Principle: Inversion of Control

• All GUI libraries provide...

• **Inversion of control**
  – C `qsort()` function
    • Client defines callback function `compare()`
    • Client calls `qsort()`, providing `compare()`
      – As a function pointer
    • `qsort()` calls `compare()`
      – Repeatedly, as necessary
GUI Principle: Inversion of Control

- Inversion of control (cont.)
  - PyQt5
    - Client defines callback function
    - Client registers callback function with PyQt5
      - Client binds callback function to specific widget
    - PyQt5 calls callback function
      - Event occurs on specific widget => PyQt5 calls callback function registered on that widget
GUI Principle: Inversion of Control

• Inversion of control (cont.)
  – AWT/Swing
    • Client defines Listener object
    • Client registers Listener object with Swing
      – Client adds Listener object to specific component
    • Swing calls method in Listener object
      – Event occurs on specific component => Swing calls method within registered Listener object
GUI Principle: Inversion of Control

• Normally
  – Your code calls library code to request services
  – Your code is in control

• Inversion of control
  – Library code calls your code to request services
  – Library code is in control
Getting More Info: AWT/Swing

- Javadocs
  - https://docs.oracle.com/javase/8/docs/api/java/awt/package-summary.html
  - https://docs.oracle.com/javase/8/docs/api/javax/swing/package-summary.html
- Horstmann book
- Dondero A Subset of Java Swing and AWT document
- Additional resources referenced in Topics web page
Getting More Info: PyQt5

- PyQt5 reference Guide
  - https://doc.bccnsoft.com/docs/PyQt5/

- Qt for Python (PySide2)
  - https://doc.qt.io/qtforpython/#documentation

```python
$ python
>>> from PyQt5.QtWidgets import *
>>> help(QApplication)
>>> help(QMainWindow)
>>> help(QBoxLayout)
>>> help(QFrame)
>>> help(QPushButton)
...```
Summary

• We have covered:
  – Graphical user interface (GUI) programming
  – Specifically...
  – For Java: The **AWT/Swing** GUI library
  – For Python: The **PyQt5** GUI library
Summary

• For each:
  – Dialogs
  – Some larger examples
Summary

• Not covered...

• Low-level drawing
  – For Java: the AWT Graphics class (the Java 2D library)
  – For Python: the PyQt5 QPainter class
Appendix 1:
Graphical User Interfaces in C
GUls in C

• For C/Unix/Linux....

• The X-Window GUI library
  – X-Window server runs on local computer
  – X-Window client runs on server computer

• See
  http://www.paulgriffiths.net/program/c/srns/helloxsorc.html
  – Use -lX11 option to build
  – Explicit coding of event loop
GUls in C

• Higher level GUI modules exist
• For example...
• GTK+
  – See http://www.gtk.org/
Appendix 2: Bad GUls
Bad GUIs

• Some collected by Prof. Kernighan...
Bad GUls

Updates were unable to be successfully installed
You must restart your computer for the updates to take effect.
Bad GUIs

Acrobat Reader 5.0 is not currently configured to be the default application for PDF files.

Would you like to make PDF files open with Acrobat Reader 5.0 instead of Acrobat Reader 5.0?

☐ Do not show this message again

[Buttons: No, Yes]
Step 2: Inspector

You must answer all required questions before you submit your recommendation.

→ indicates a required question.

<table>
<thead>
<tr>
<th>Question</th>
<th>Original Answer</th>
<th>New Answer</th>
<th>Hint</th>
</tr>
</thead>
<tbody>
<tr>
<td>TO BE COMPLETED BY THE RECOMMENDER:</td>
<td>(empty)</td>
<td>➔ Go to Page 2</td>
<td>Required Item</td>
</tr>
</tbody>
</table>
## Bad GUIs

<table>
<thead>
<tr>
<th>Institution</th>
<th>Princeton University</th>
</tr>
</thead>
<tbody>
<tr>
<td>Department</td>
<td>Computer Science</td>
</tr>
<tr>
<td>Additional email</td>
<td></td>
</tr>
</tbody>
</table>

*Please use comma " , " to separate your additional email addresses*

### Office Address

<table>
<thead>
<tr>
<th>Address line1</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Address line2</td>
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</tr>
<tr>
<td>City</td>
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<tr>
<td>State</td>
<td></td>
</tr>
<tr>
<td>Country</td>
<td></td>
</tr>
<tr>
<td>Zip</td>
<td></td>
</tr>
<tr>
<td>Office phone</td>
<td></td>
</tr>
</tbody>
</table>

If the above information is incorrect, please update it by correcting the information in the fields and clicking the "Update Information" button below. We ask for this information in case future correspondence is necessary. We appreciate your willingness to help in this important process.

[Update Information] [Reset]
Bad GUIs

You have been redirected to this page for the following reason:

[Error message: Cannot copy 2 O Lord, thou hast searched me out: The specified network name is no longer available.]
Bad GUIs

Thank you for taking time to complete the Classroom Survey!

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Email the Office of the Registrar: registn@princeton.edu
Bad GUIs
Bad GUIs

• The *Interface Hall of Shame*
  – http://halloffshame.gp.co.at/index.php?mode=original

• Some from that website…
Bad GUIs
Bad GUls

Outlook Express

There was an error opening this message.
An error has occurred.

Microsoft Developer Studio

The project file "E:\ws\apps\RmfCC.dsp" may have been modified on disk by the preceding Source Control operation. However, you also have made changes to this project which have not been saved.

If you reload the project you will lose your current changes, but if you don’t you risk overwriting the new changes on disk, which is usually much worse.

Do you want to reload it now?

Yes  No
Bad GUIs

![Microsoft Access dialog box warning](image1)

Wrong button!
This button doesn't work.

Solution
Try another.

![Send Mail dialog box message](image2)

When you send an e-mail message, it will be placed in your 'Outbox' folder ready to be sent the next time you choose the 'Send and Receive' command.

Don't ask me this again

OK
Bad GUIs

Optional Messages:
- Internet Explorer Specific
- Netscape Specific
- Deprecation Tags
- Obsolete Tags
- General Compatibility
- Helpful Tips
- Style
- Search Engine META Tags
- More Deprecation Tags
- Enable Sound

Explanation:
- If the ARCHIVE attribute is used with the APPLET element, displays a message indicating that ARCHIVE is Netscape specific.
- If the COLOR attribute is used with the BASEFONT element, displays a message indicating that it is Netscape specific.
- If BLINK is used, displays a message indicating that it is Netscape specific.
- If the MARGINHEIGHT or MARGINWIDTH

Diff Merge
The objects being compared are identical. Do you want to continue the comparison?

Yes  No
Bad GUls

Performance Warning

A new MS-DOS resident program named 'WIN' may decrease your system's performance. Would you like to see more information about this problem?

Yes  No