Graphical User Interface Programming (Part 2)

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Objectives

- We will cover:
  - “High-level” GUI programming using the ***PyQt5*** GUI library

Agenda

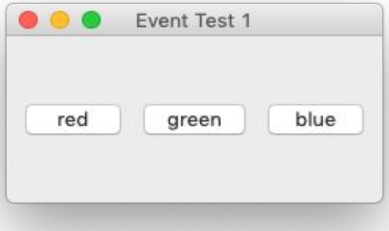
- **PyQt5 event handling**
- PyQt5 signal & slot reference
- PyQt5 dialogs
- A larger PyQt5 example
- GUI principles

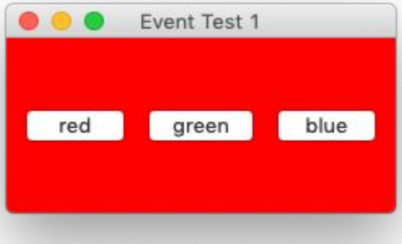
PyQt5 Event Handling

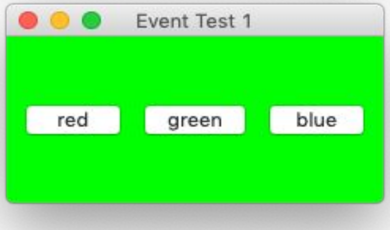
- PyQt5 event handling mechanism:
  - ***Signals*** & ***slots***

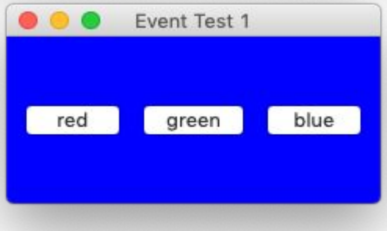
PyQt5 Event Handling

- See **eventtest1.py**









PyQt5 Event Handling

- See **eventtest2.py**
  - Same behavior as eventtest1.py

Question (lecture06part2)

- Consider **eventtestbad.py**. It doesn't work. Why?
  - Browse to https://cos333attend.cs.princeton.edu to answer

Agenda

- PyQt5 event handling
- **PyQt5 signal & slot reference**
- PyQt5 dialogs
- A larger PyQt5 example
- GUI principles

PyQt5 Signal & Slot Reference

Legend:

```
Class
    signal => slot(type param, …)
```

Example:

```
QPushButton
   clicked => f(bool checked)
```

When a `QPushButton` object receives a `clicked` signal, it can call a slot with 0 or 1 parameters

If there is a parameter, its type is `bool`, and a descriptive name for it is `checked`

PyQt5 Signal & Slot Reference

```
Class
     signal => slot(type param, …)
```

```
QPushButton
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    clicked => f(bool checked)
       Called when the user clicks and releases.
    pressed => f()
    released => f()
    toggled => f(bool checked)
```

PyQt5 Signal & Slot Reference

```
Class
     signal => slot(type param, …)
```

```
QLabel
     destroyed => f(QObject obj)
     customContextMenuRequested => f(QPoint pos)
     windowIconChanged => f(QIcon icon)
     windowIconTextChanged => f(QIcon iconText)
     windowTitleChanged => f(str title)
     linkActivated => f(str link)
     linkHovered => f(str link)
```

PyQt5 Signal & Slot Reference

```
Class
    signal => slot(type param, …)
```

```
QLineEdit
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    cursorPositionChanged => f(int oldPos, int newPos)
    editingFinished => ()
    inputRejected => f()
    returnPressed => f()
       Called when the user presses the Enter key.
    selectionChanged => f()
    textChanged => f(str newText)
       Called when the user enters a character.
    textEdited => f(str newText)
```

PyQt5 Signal & Slot Reference

```
Class
     signal => slot(type param, …)
```

```
QTextEdit
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    copyAvailable => f(bool yes)
    currentCharFormatChanged => f(QTextCharFormat fmt)
    cursorPositionChanged => f()
    redoAvailable=> f(bool available)
    selectionChanged => f()
    textChanged => f()
       Called when the user enters a character.
    undoAvailable => f(bool available)
```

PyQt5 Signal & Slot Reference

```
Class
    signal => slot(type param, …)
```

```
QSlider
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    actionTriggered => f(int action)
    rangeChanged => f(int min, int max)
    sliderMoved => f(int value)
    sliderPressed => f()
    sliderReleased => f()
    valueChanged => f(int value)
       Called when the user moves the QSlider handle.
```

PyQt5 Signal & Slot Reference

```
Class
     signal => slot(type param, …)
```

```
QCheckBox
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    clicked => f(bool checked)
       Called when the user clicks and releases.
    pressed => f()
    released => f()
    toggled => f(bool checked)
    stateChanged => f(int state)
```

PyQt5 Signal & Slot Reference

```
Class
     signal => slot(type param, …)
```

```
QRadioButton
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    clicked => f(bool checked)
       Called when the user clicks and releases.
    pressed => f()
    released => f()
    toggled => f(bool checked)
```

PyQt5 Signal & Slot Reference

```
Class
     signal => slot(type param, …)
```

```
QListWidget
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    currentItemChanged =>
        f(QListWidgetItem cur, QListWidgetItem previous)
    currentRowChanged => f(int currentRow)
    currentTextChanged => f(str currentText)
    itemActivated => f(QListWidgetItem item)
       Called when the user, having selected an item,
       double-clicks on that item or presses the Enter key
       (or Ctrl-o on some Macs).
    itemChanged => f(QListWidgetItem  item)
    itemClicked => f(QListWidgetItem  item)
    itemDoubleClicked => f(QListWidgetItem  item)
    itemEntered => f(QListWidgetItem  item)
    itemPressed => f(QListWidgetItem  item)
    itemSelectionChanged => f()
```

PyQt5 Signal & Slot Reference

```
Class
    signal => slot(type param, …)
```

```
QMenuBar
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    hovered => f(QAction action)
    triggered => f(QAction action)
```

PyQt5 Signal & Slot Reference

```
Class
    signal => slot(type param, …)
```

```
QMenu
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    aboutToHide => f()
    aboutToShow => f()
    hovered => f(QAction action)
    triggered => f(QAction action)
       Called when the user clicks and releases.
```

PyQt5 Signal & Slot Reference

```
Class
    signal => slot(type param, …)
```

```
QFrame
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
```

PyQt5 Signal & Slot Reference

```
Class
     signal => slot(type param, …)
```

```
QMainWindow
    destroyed => f(QObject obj)
    customContextMenuRequested => f(QPoint pos)
    windowIconChanged => f(QIcon icon)
    windowIconTextChanged => f(QIcon iconText)
    windowTitleChanged => f(str title)
    iconSizeChanged => f(QSize iconSize)
    tabifiedDockWidgetActivated =>
        f(QDockWidget dockWidget)
    toolButtonStyleChanged =>
        f(QToolButtonStyle toolButtonStyle)
```

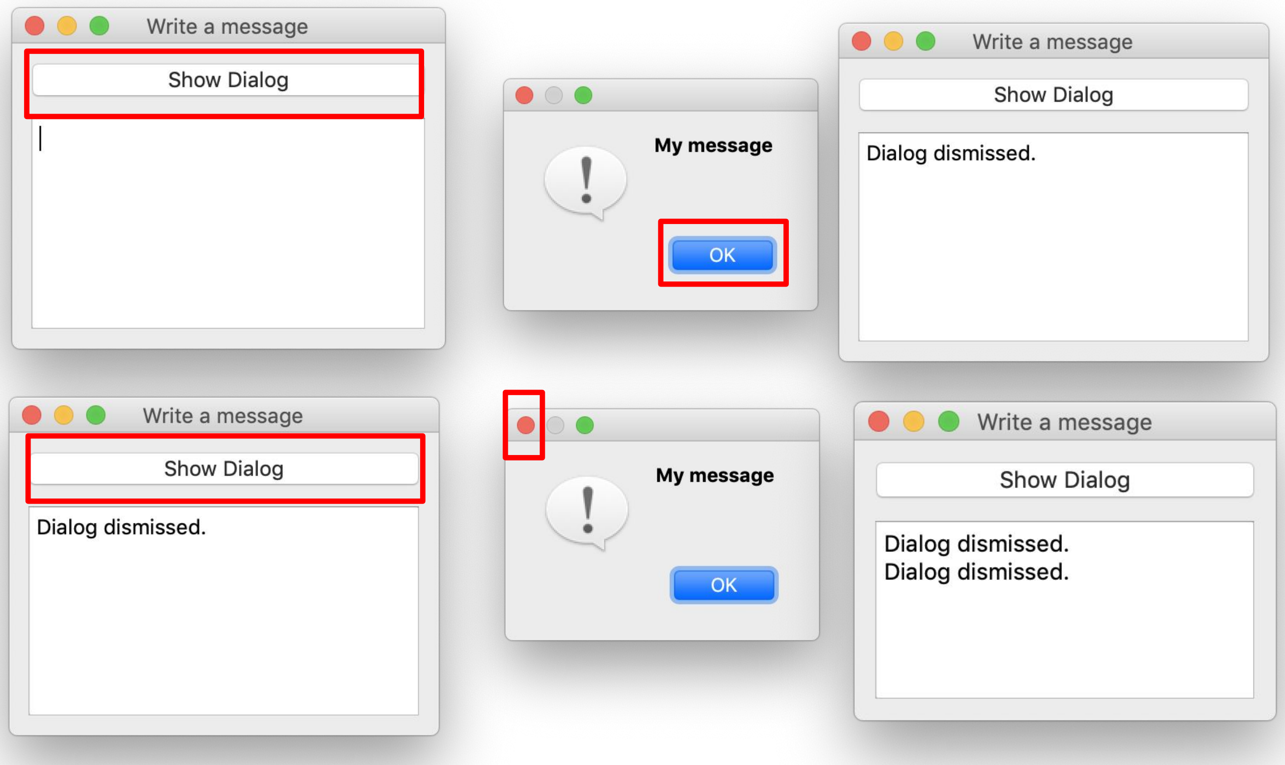
Agenda

- PyQt5 event handling
- PyQt5 signal & slot reference
- **PyQt5 dialogs**
- A larger PyQt5 example
- GUI principles

PyQt5 Dialogs

- See **<u>dialogwritemessage.py</u>**

Title missing on Mac only!



My message

Dialog dismissed.

Dialog dismissed.

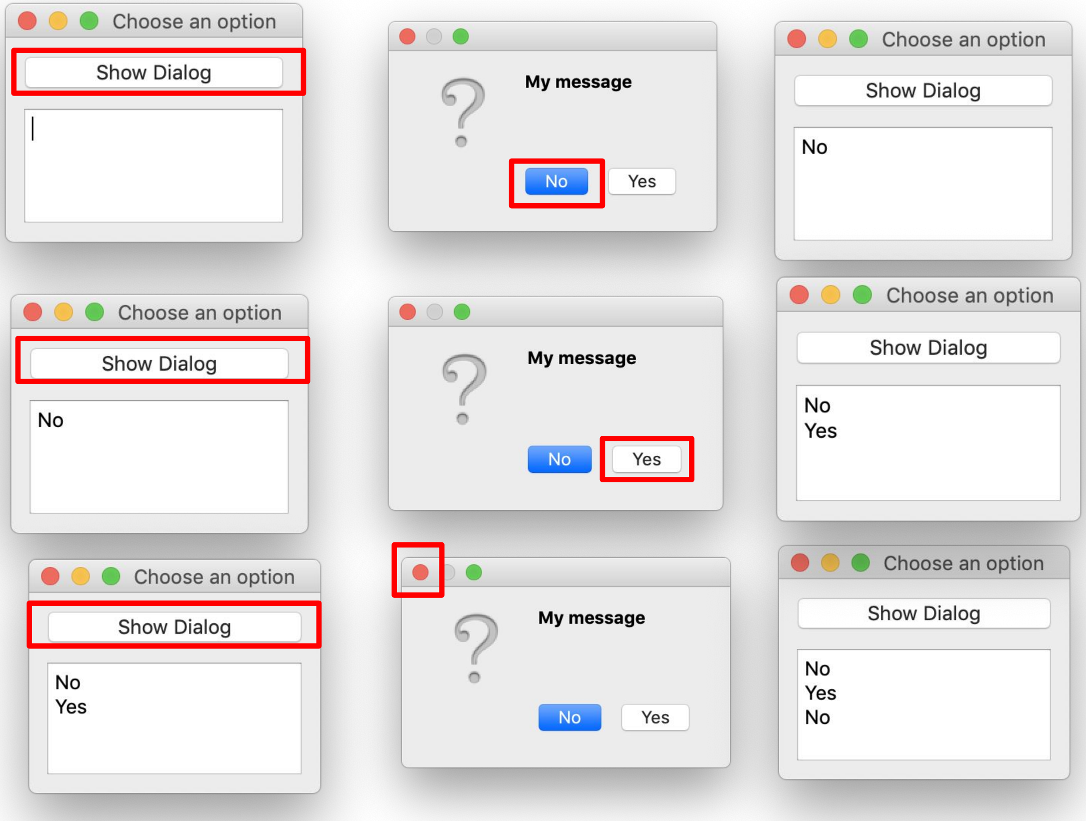
My message

Dialog dismissed.
Dialog dismissed.

PyQt5 Dialogs

- See **dialogchooseoption.py**

Title missing on Mac only!

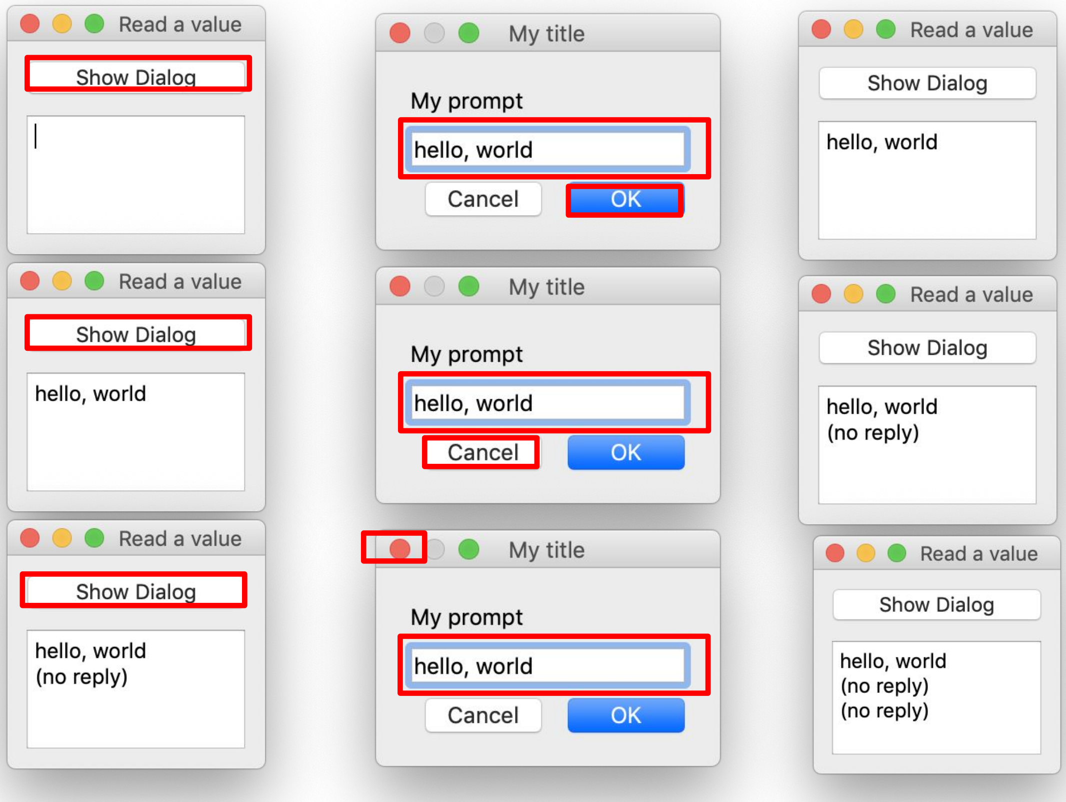


Can’t distinguish
“No” vs.
no response

PyQt5 Dialogs

- See **dialogreadvalue.py**

Title not missing!!!



hello, world

hello, world
(no reply)

hello, world

hello, world

hello, world

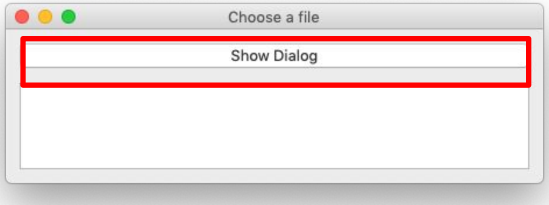
hello, world

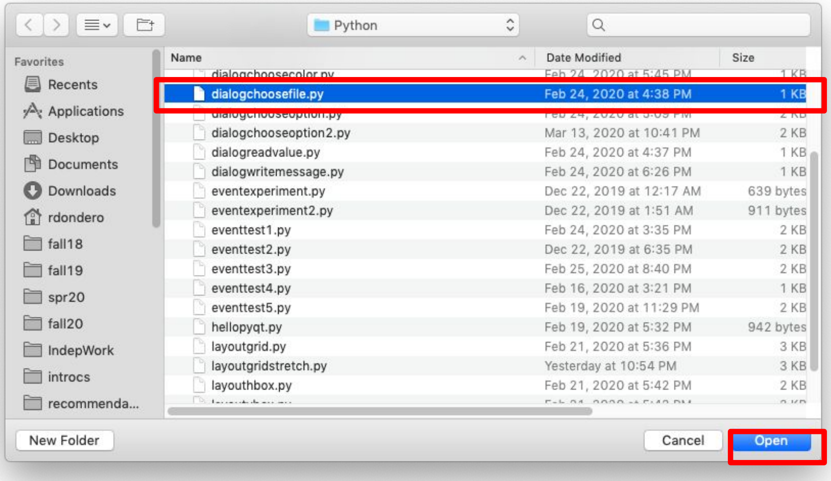
hello, world
(no reply)

hello, world
(no reply)
(no reply)

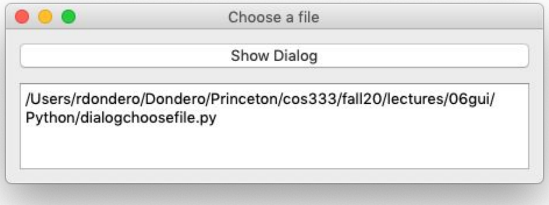
PyQt5 Dialogs

- See **dialogchoosefile.py**





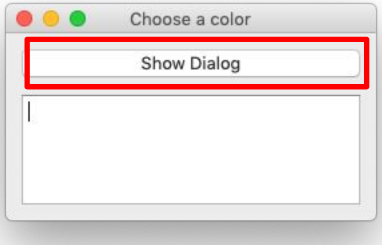
Name	Date Modified	Size
dialogchoosecolor.py	Feb 24, 2020 at 5:45 PM	1 KB
dialogchoosefile.py	Feb 24, 2020 at 4:38 PM	1 KB
dialogchooseoption.py	Feb 24, 2020 at 5:09 PM	2 KB
dialogchooseoption2.py	Mar 13, 2020 at 10:41 PM	2 KB
dialogreadvalue.py	Feb 24, 2020 at 4:37 PM	1 KB
dialogwritemessage.py	Feb 24, 2020 at 6:26 PM	1 KB
eventexperiment.py	Dec 22, 2019 at 12:17 AM	639 bytes
eventexperiment2.py	Dec 22, 2019 at 1:51 AM	911 bytes
eventtest1.py	Feb 24, 2020 at 3:35 PM	2 KB
eventtest2.py	Dec 22, 2019 at 6:35 PM	2 KB
eventtest3.py	Feb 25, 2020 at 8:40 PM	2 KB
eventtest4.py	Feb 16, 2020 at 3:21 PM	1 KB
eventtest5.py	Feb 19, 2020 at 11:29 PM	2 KB
hellopyqt.py	Feb 19, 2020 at 5:32 PM	942 bytes
layoutgrid.py	Feb 21, 2020 at 5:36 PM	3 KB
layoutgridstretch.py	Yesterday at 10:54 PM	3 KB
layouthbox.py	Feb 21, 2020 at 5:42 PM	2 KB

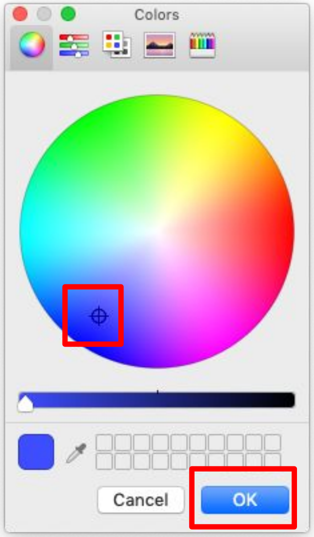


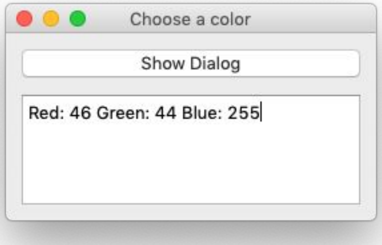
```
/Users/rdondero/Dondero/Princeton/cos333/fall20/lectures/06gui/
Python/dialogchoosefile.py
```

PyQt5 Dialogs

- See **dialogchoosecolor.py**







```
Red: 46 Green: 44 Blue: 255
```

PyQt5 Dialogs

PyQt5 dialog classes:

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

PyQt5 Dialogs

PyQt5 dialog classes:

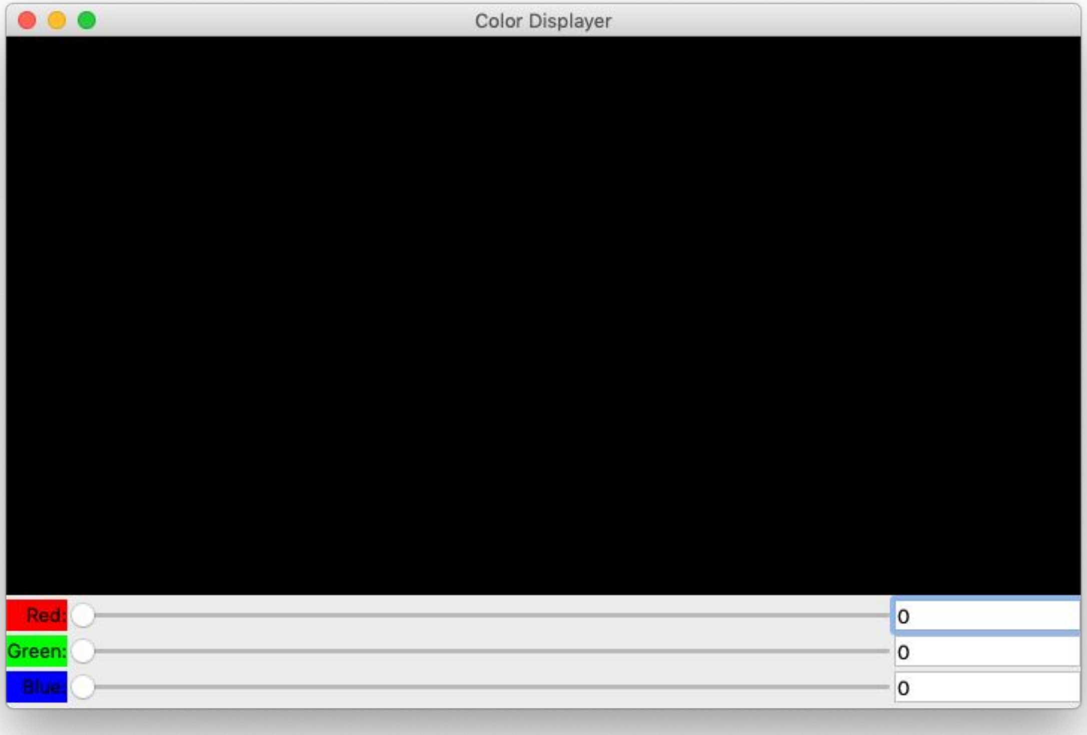
```
QWidget
    QDialog
        QFileDialog
            getOpenFileName()
            getExistingDirectory()
            getExistingDirectoryUrl()
            getOpenFileNames()
            getOpenFileUrl()
            getOpenFileUrls()
            getSaveFileName()
            getSaveFileUrl()
            saveFileContent()
        QColorDialog
            customColor()
            customCount()
            getColor()
            setCustomColor()
            setStandardColor()
            standardColor()
```

Agenda

- PyQt5 event handling
- PyQt5 signal & slot reference
- PyQt5 dialogs
- **A larger PyQt5 example**
- GUI principles

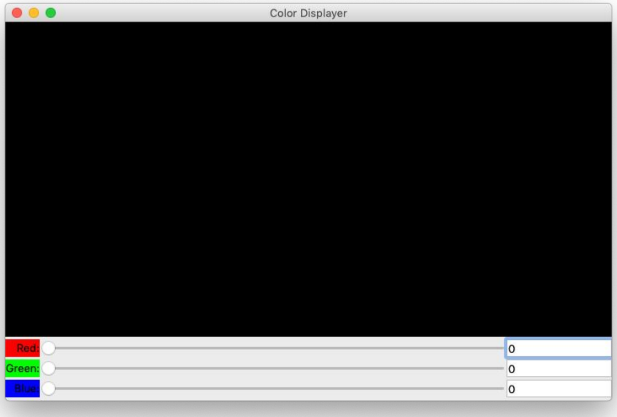
Larger Example: Behavior

- See **colordisplayer.py**

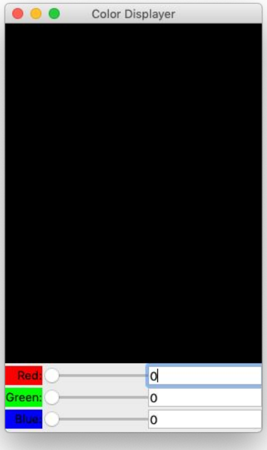


Larger Example: Behavior

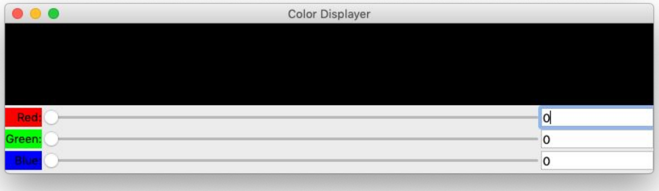
- See **colordisplayer.py** (cont.)



Red: 0
Green: 0
Blue: 0



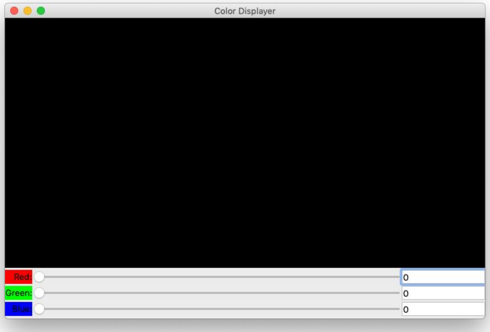
Red: 0
Green: 0
Blue: 0



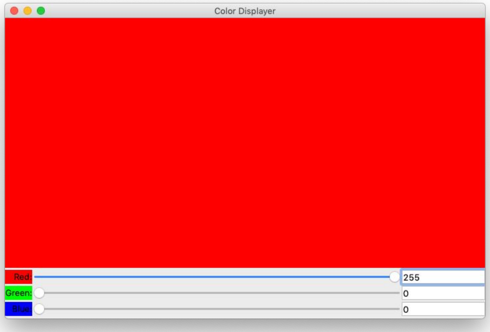
Red: 0
Green: 0
Blue: 0

Larger Example: Behavior

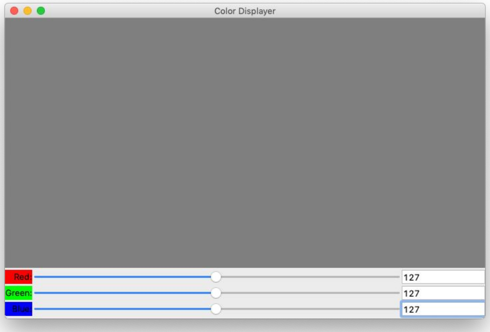
- See **colordisplayer.py** (cont.)



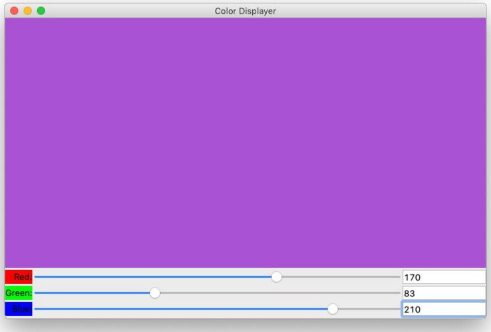
Red: 0
Green: 0
Blue: 0



Red: 255
Green: 0
Blue: 0



Red: 127
Green: 127
Blue: 127

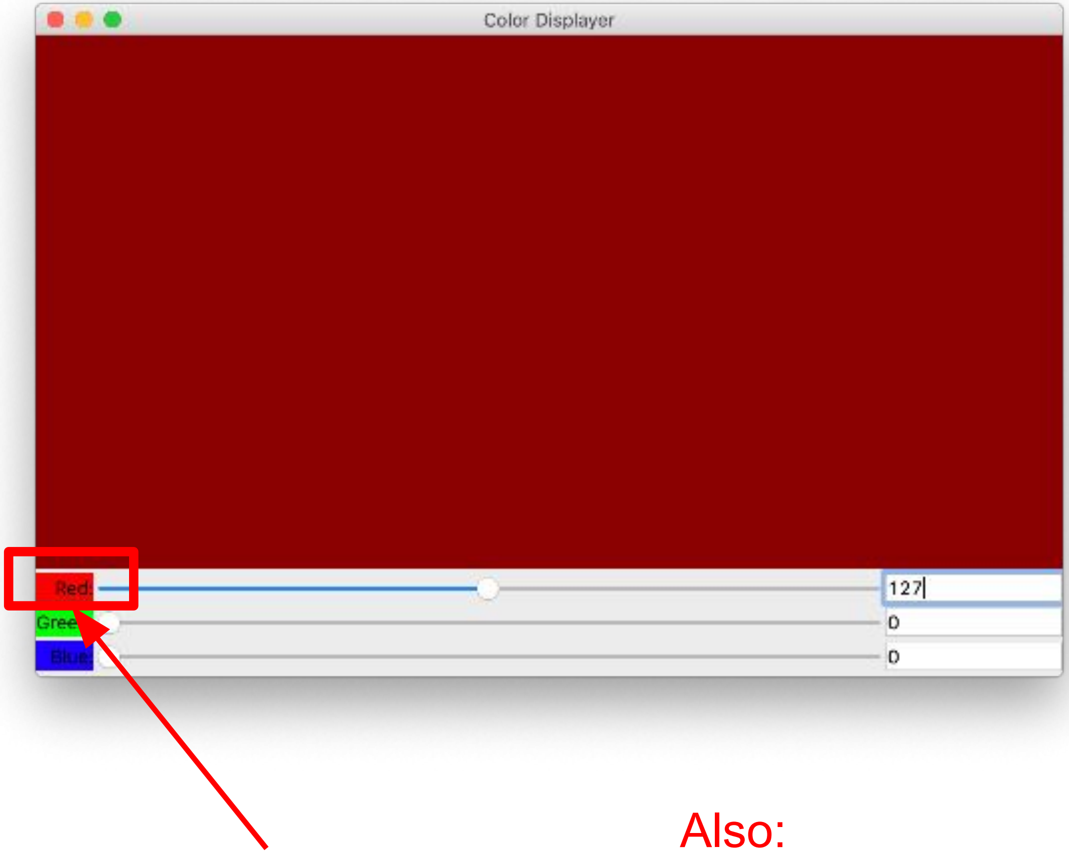


Red: 170
Green: 83
Blue: 210

Larger Example: Points Illustrated

- See **colordisplayer.py** (cont.)
  - Points illustrated:
    - Nothing new!
    - Multiple interacting widgets
    - More complex layout
      - Nested frames
  - Read on for the details…

Larger Example: Widgets



Red: 127

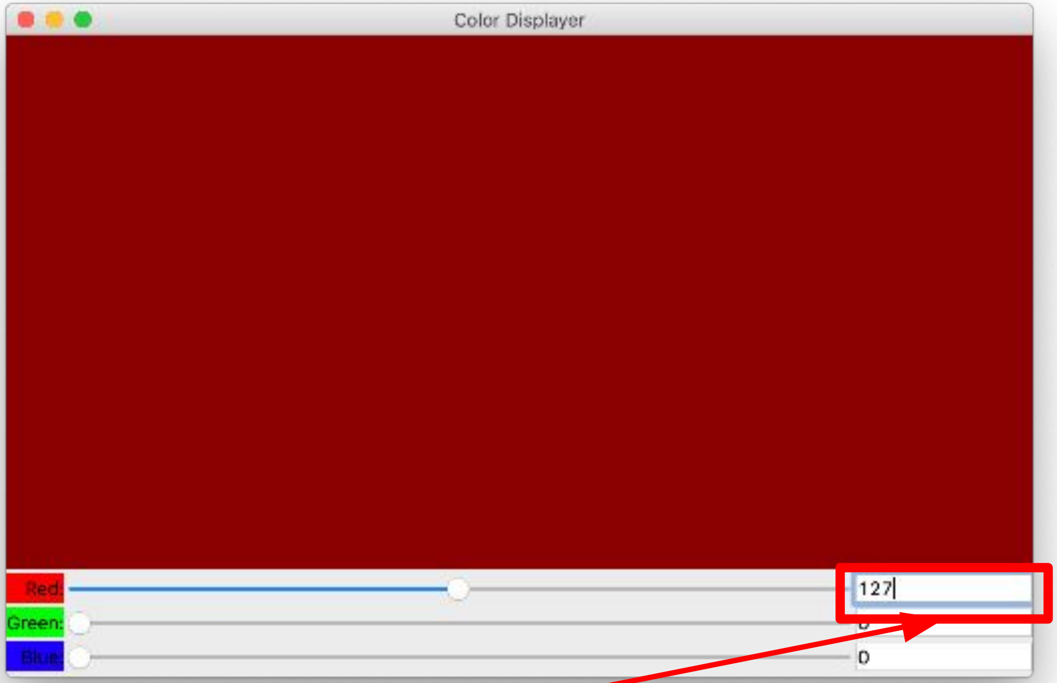
Gree 0

Blue: 0

labels[0] (class QLabel)

Also:
labels[1] (class QLabel)
labels[2] (class QLabel)

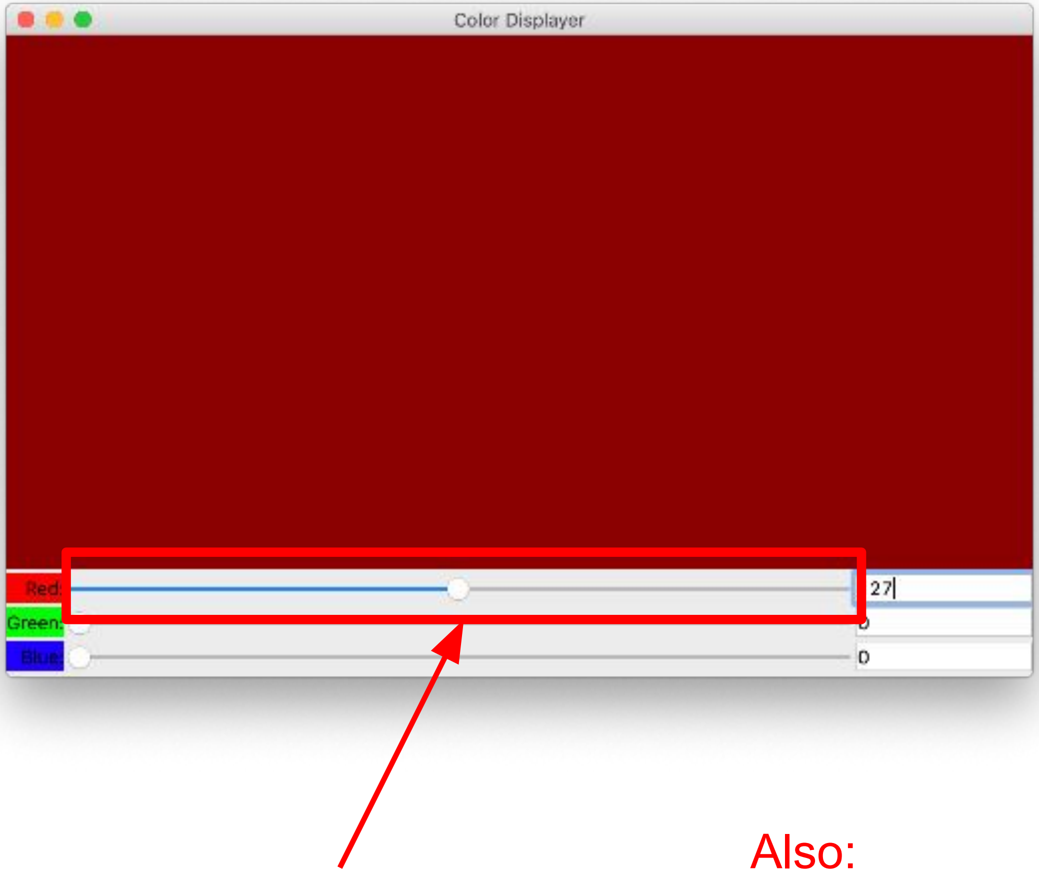
Larger Example: Widgets



lineedits[0] (class QLineEdit)

Also:
 lineedits[1] (class QLineEdit)
 lineedits[2] (class QLineEdit)

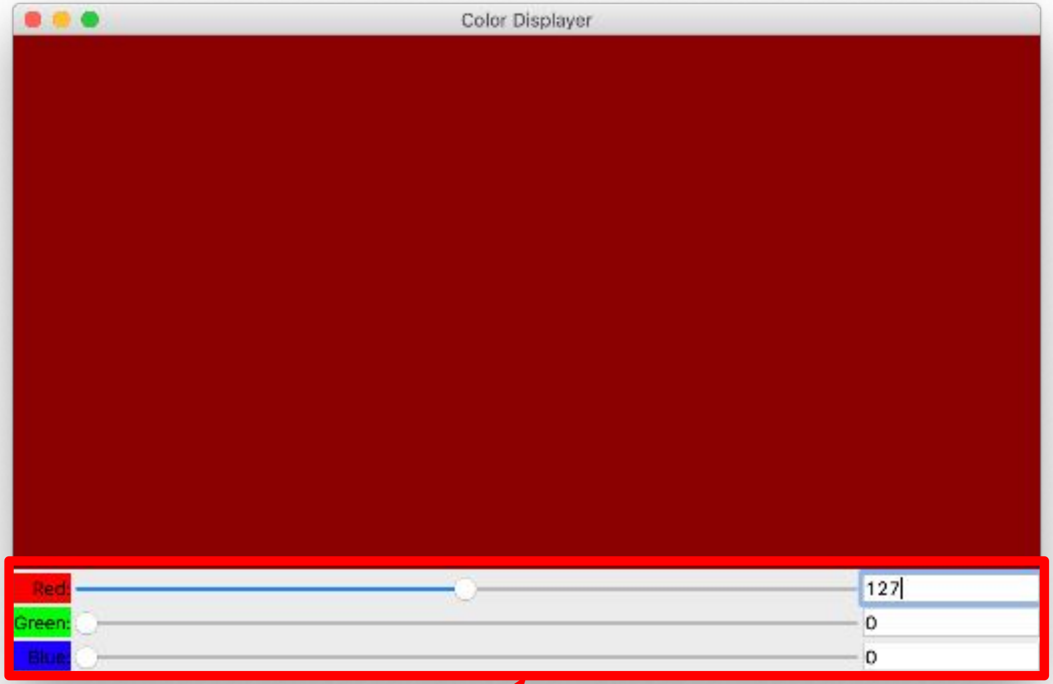
Larger Example: Widgets



sliders[0] (class QSlider)

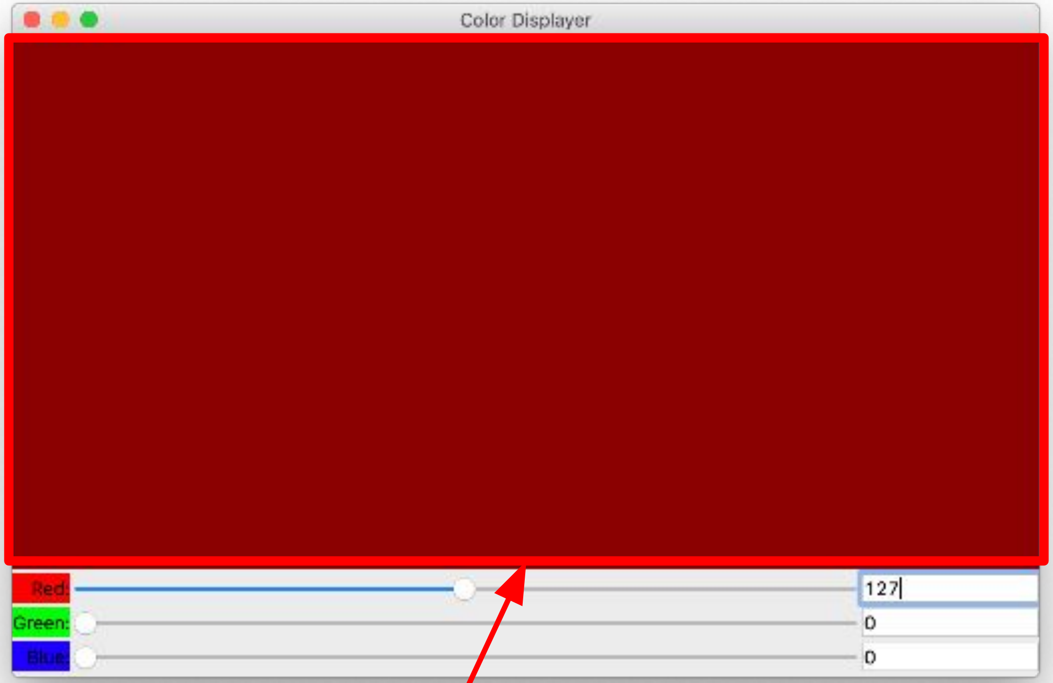
Also:
  sliders[1] (class QSlider)
  sliders[2] (class QSlider)

Larger Example: Widgets



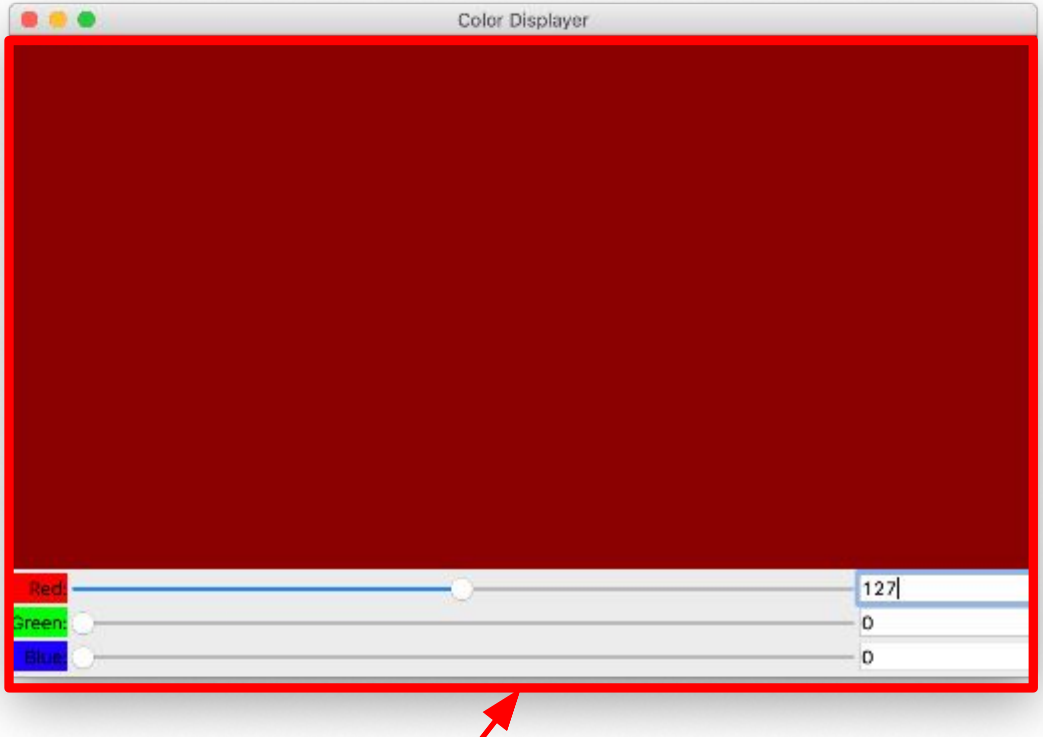
control_frame (class QFrame)

Larger Example: Widgets



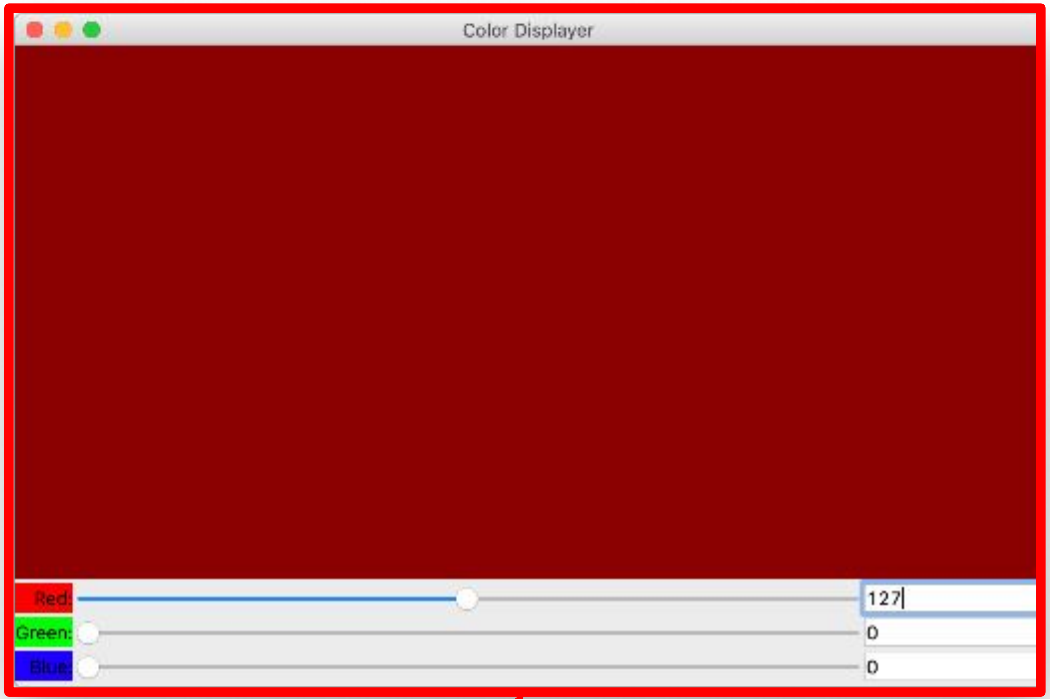
color_frame (class QFrame)

Larger Example: Widgets



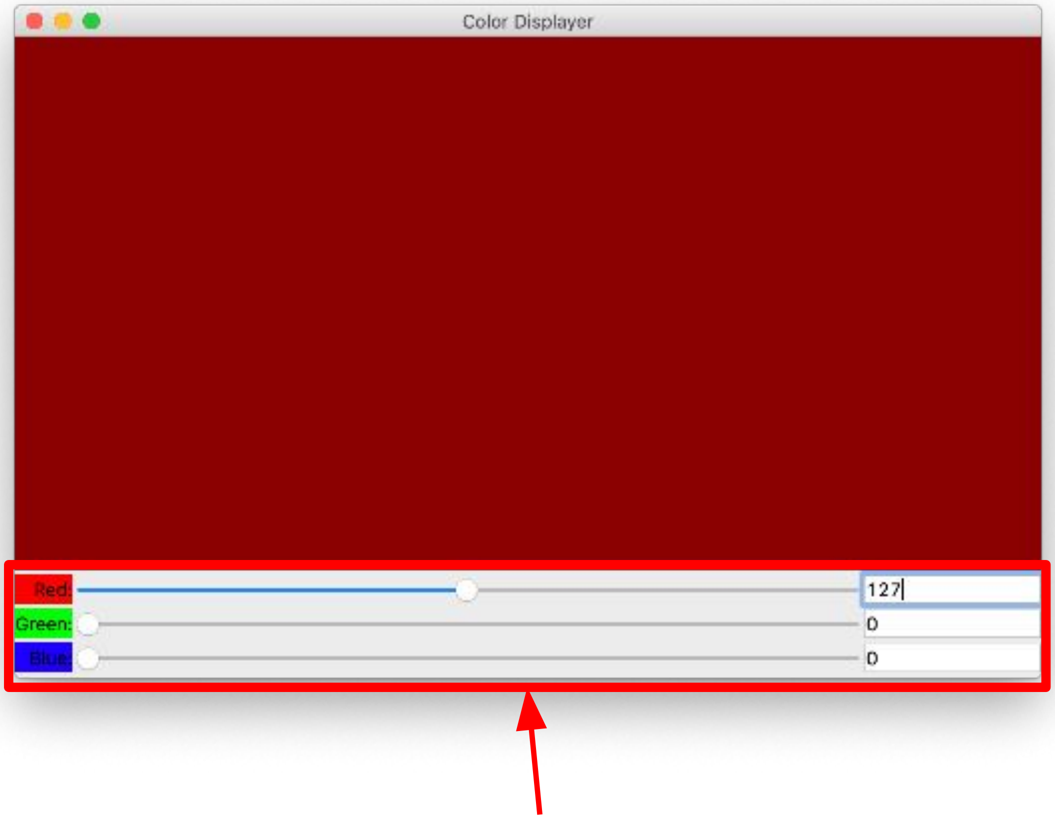
central_frame (class QFrame)

Larger Example: Widgets



window (class QMainWindow)

Larger Example: Layout



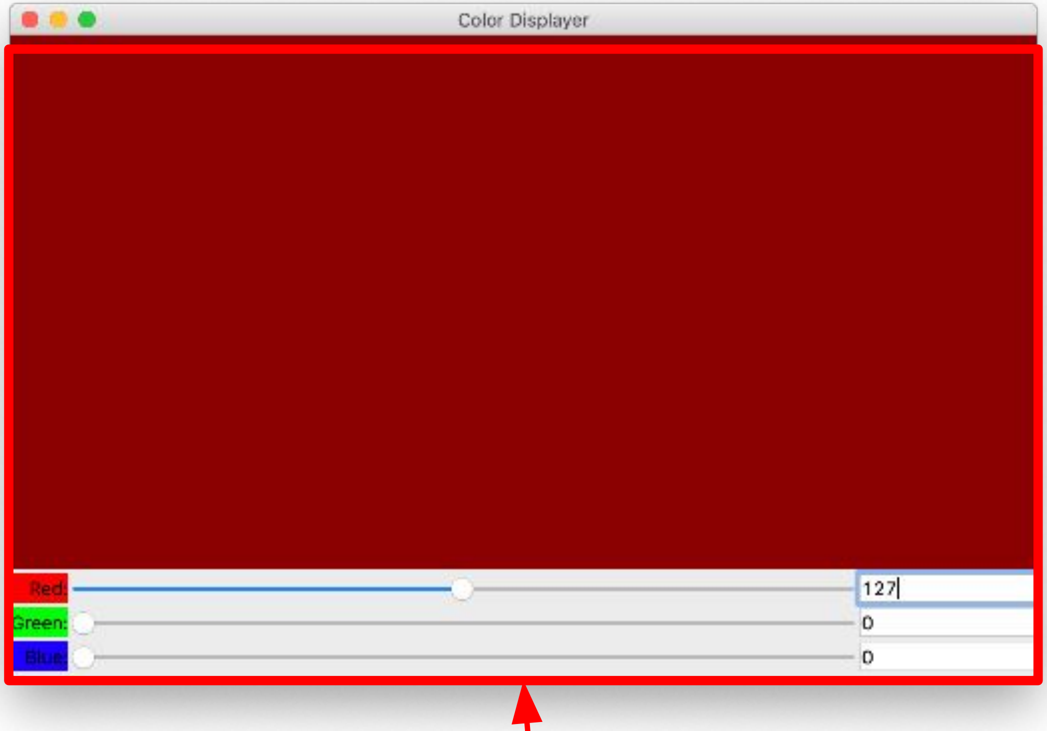
Red: 127

Green: 0

Blue: 0

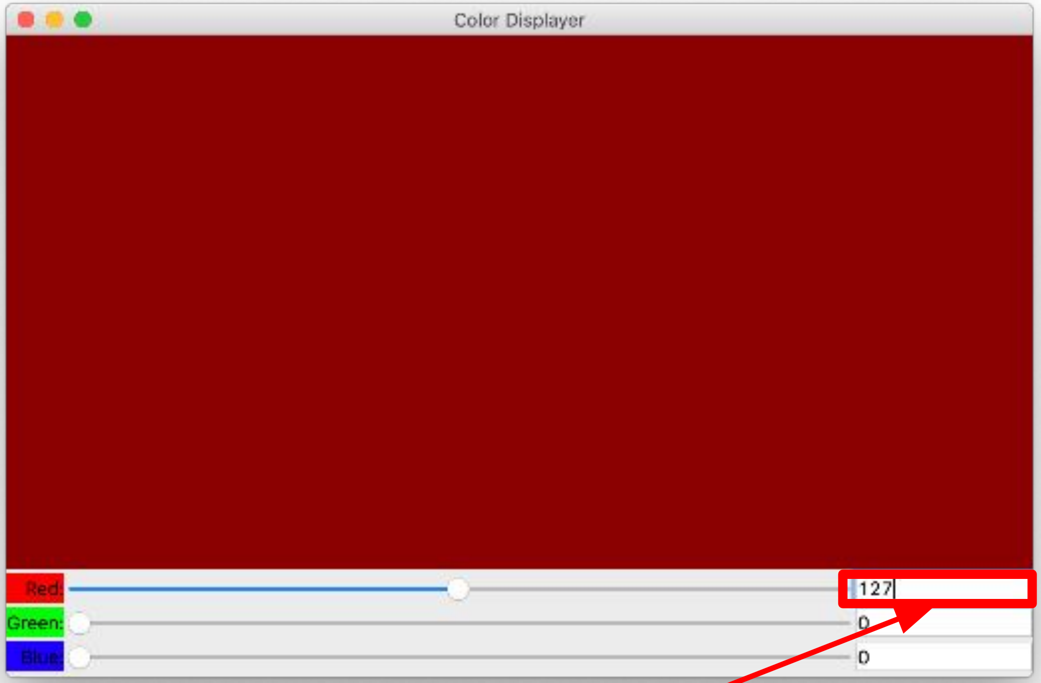
control_frame: Grid: 3 rows, 3 columns
Contains labels, sliders, lineedits

Larger Example: Layout



central_frame: Grid: 2 rows, 1 column
Contains color_frame, control_frame

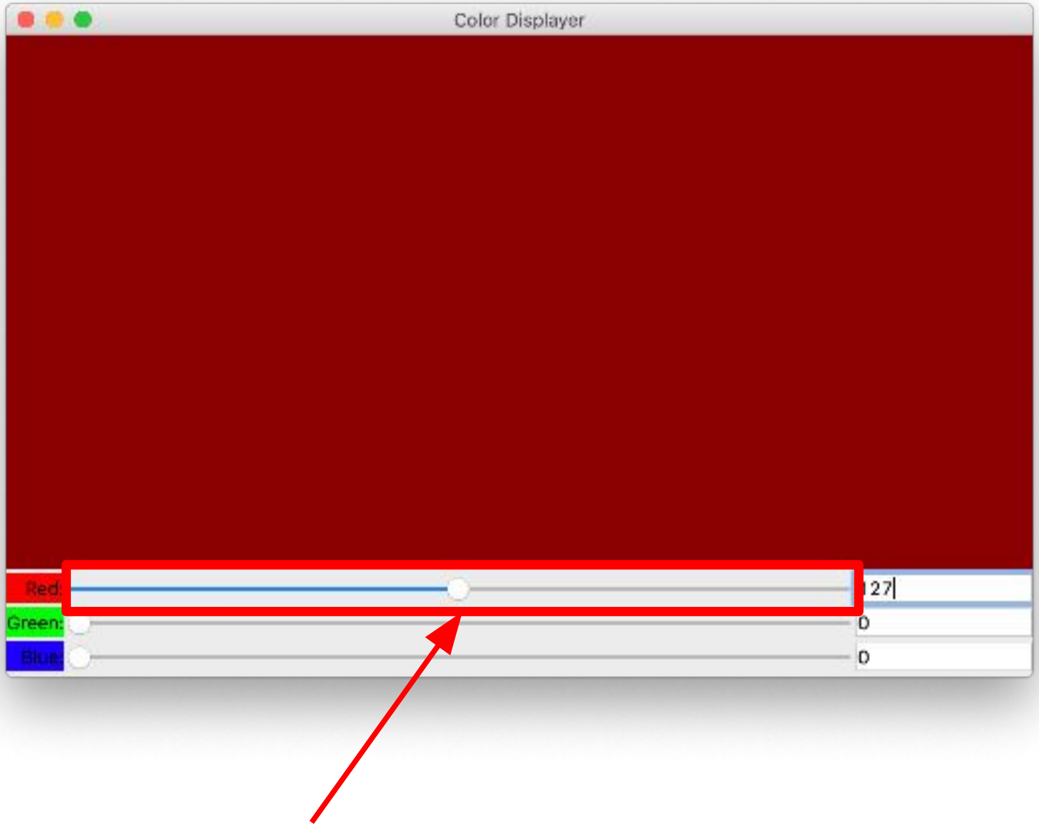
Larger Example: Event Handling



lineedits[0]
Signal: returnPressed
Inform sliders[0] and color_frame of change

Similar for lineedits[1], lineedits[2]

Larger Example: Event Handling



Red: 127

Green: 0

Blue: 0

sliders[0]
  Signal: valueChanged
  Inform lineedits[0] and colorFrame of change

Similar for
sliders[1],
sliders[2]

Agenda

- PyQt5 event handling
- PyQt5 signal & slot reference
- PyQt5 dialogs
- A larger PyQt5 example
- **GUI principles**

GUI Principles

- All GUI libraries provide:
  - Widgets
  - Containers
  - Layout managers
  - Event handling mechanism(s)
  - Dialogs

GUI Principles

- All GUI libraries provide:
  - An ***event loop***

GUI Principles

- All GUI libraries provide:
  - ***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

- PyQt5 reference guide
  - https://doc.bccnsoft.com/docs/PyQt5/
- PySide2 reference guide
  - https://doc.qt.io/qtforpython/#documentation

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

Summary

- We have covered:
  - PyQt5 event handling
    - PyQt signals & slots
  - PyQt5 dialogs
  - A larger PyQt5 example
  - GUI principles

Summary

- We have covered:
  - “High-level” GUI programming using the ***PyQt5*** GUI library
- We have not covered:
  - Low-level drawing (see PyQt5 `QPainter` class)
- See also:
  - **Appendix 1**: Python Lambda Expressions
  - **Appendix 2**: Some Bad GUIs

Appendix 1:
Python Lambda Expressions

Lambda Expressions

- ***Lambda expression***
  - From Alonzo Church
  - 1930s
  - A nameless function

Lambda Expressions

- In Python:
  - The keyword `lambda`
  - (optionally) Parameters separated by commas
  - A colon
  - A single expression that uses the parameters

Lambda Expressions

Without using a lambda expression:

```
def mult(x, y):
   return x * y
…
prod = mult(5, 6)
print(prod)  # prints 30
```

Using a lambda expression:

```
mult = lambda x, y: x * y
…
prod = mult(5, 6)
print(prod)  # prints 30
```

Using a lambda expression:

```
print( (lambda x, y: x * y)(5, 6) )  # prints 30
```

Lambda Expressions

Without lambda expression:

```
def compareLengths(word1, word2):
   return len(word1)-len(word2)
…
words.sort(compareLengths)
…
```

With lambda expression:

```
…
words.sort(
   lambda word1,word2: len(word1)-len(word2) )
…
```

Lambda Expressions

- Recall eventtest2.py

```
…
def red_button_slot(): …
def green_button_slot(): …
def blue_button_slot(): …
…
red_button.clicked.connect(red_button_slot)
green_button.clicked.connect(green_button_slot)
blue_button.clicked.connect(blue_button_slot)
…
```

Works

Lambda Expressions

- Recall eventtestbad.py

```
…
def button_slot(color): …
…
red_button.clicked.connect(
   button_slot(PyQt5.QtCore.Qt.red))
green_button.clicked.connect(
   button_slot(PyQt5.QtCore.Qt.green))
blue_button.clicked.connect(
   button_slot(PyQt5.QtCore.Qt.blue))
…
```

Fails

Lambda Expressions

- See **eventtestlambda.py**
  - Same behavior as eventtest2.py

```
…
def set_window_color(color): …
…
red_button.clicked.connect(
   lambda: set_window_color(PyQt5.QtCore.Qt.red))
green_button.clicked.connect(
   lambda: set_window_color(PyQt5.QtCore.Qt.green))
blue_button.clicked.connect(
   lambda: set_window_color(PyQt5.QtCore.Qt.blue))
…
```

Works!

Appendix 2:
Bad GUIs

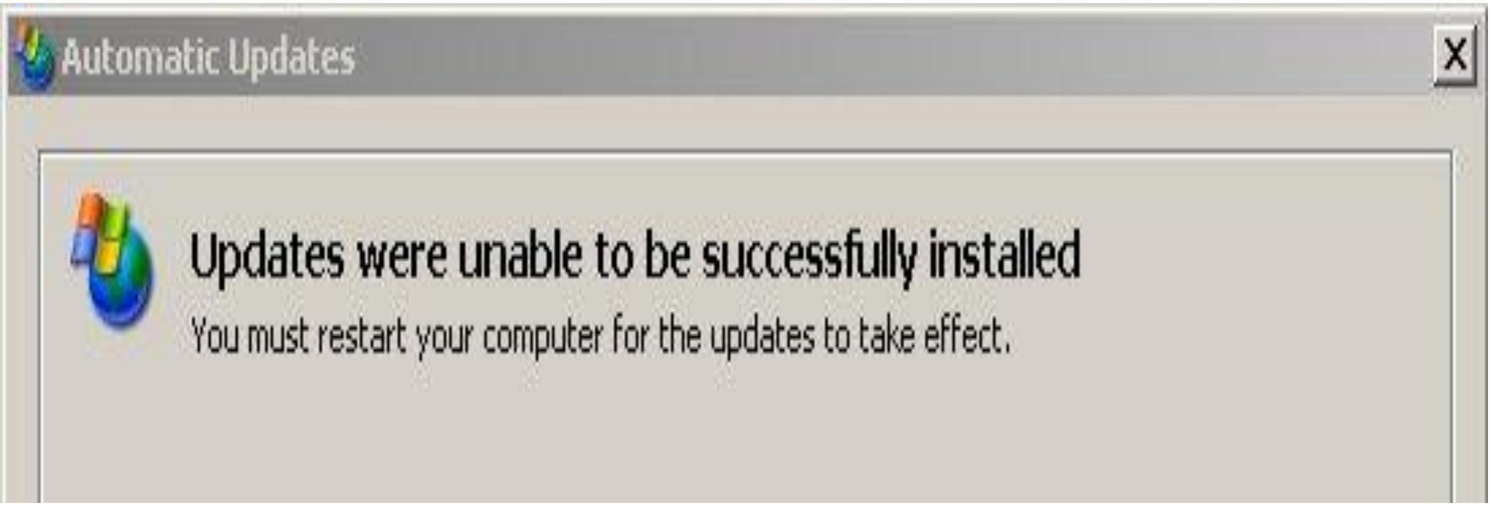
Bad GUIs

- For your amusement…
- Some bad GUIs
  - Mostly some bad dialog boxes

Bad GUIs

- Collected by Prof. Kernighan:

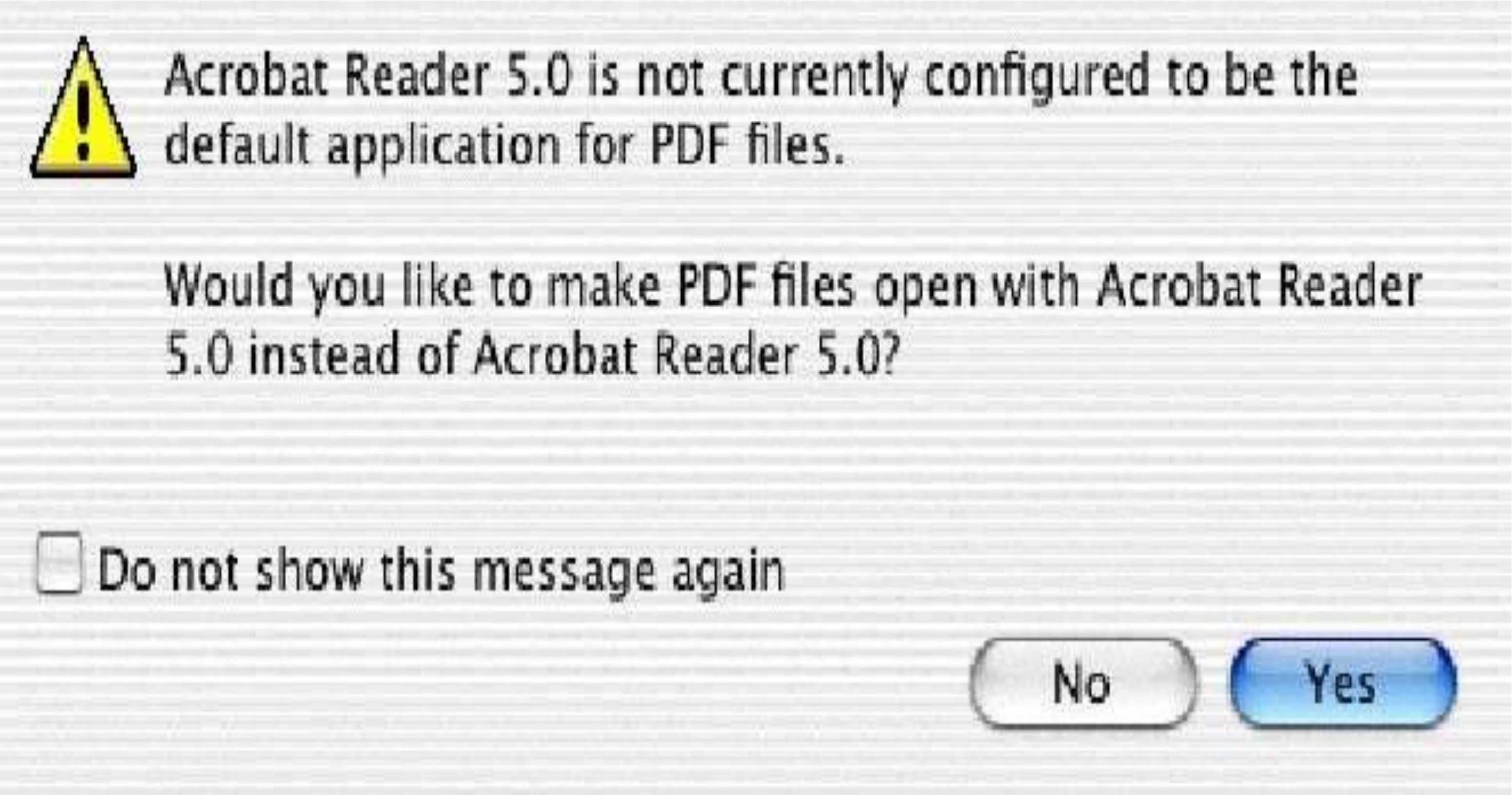
Bad GUIs



Updates were unable to be successfully installed

You must restart your computer for the updates to take effect.

Bad GUIs

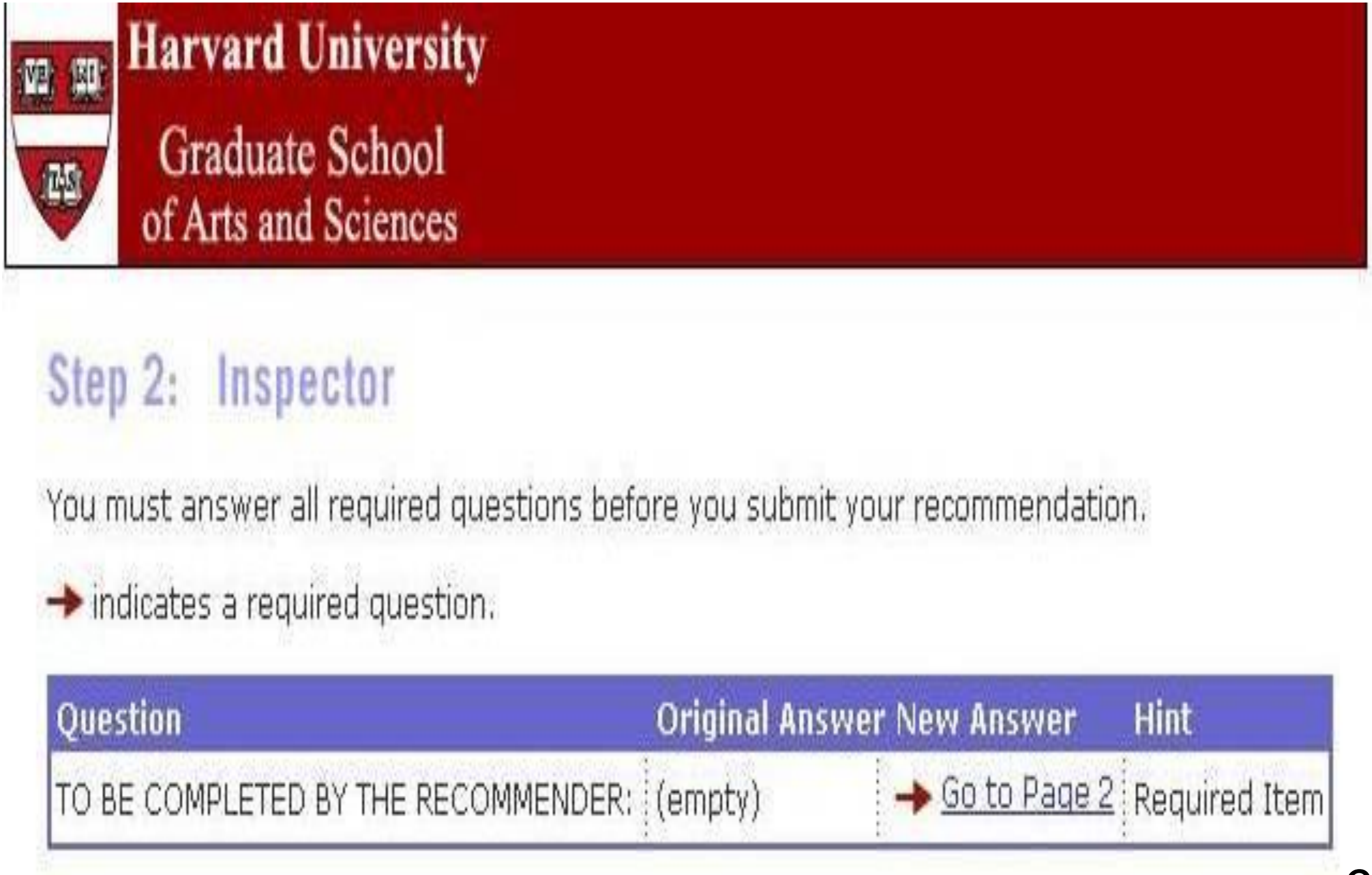


Acrobat Reader 5.0 is not currently configured to be the default application for PDF files.

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

Bad GUIs



Harvard University
Graduate School
of Arts and Sciences

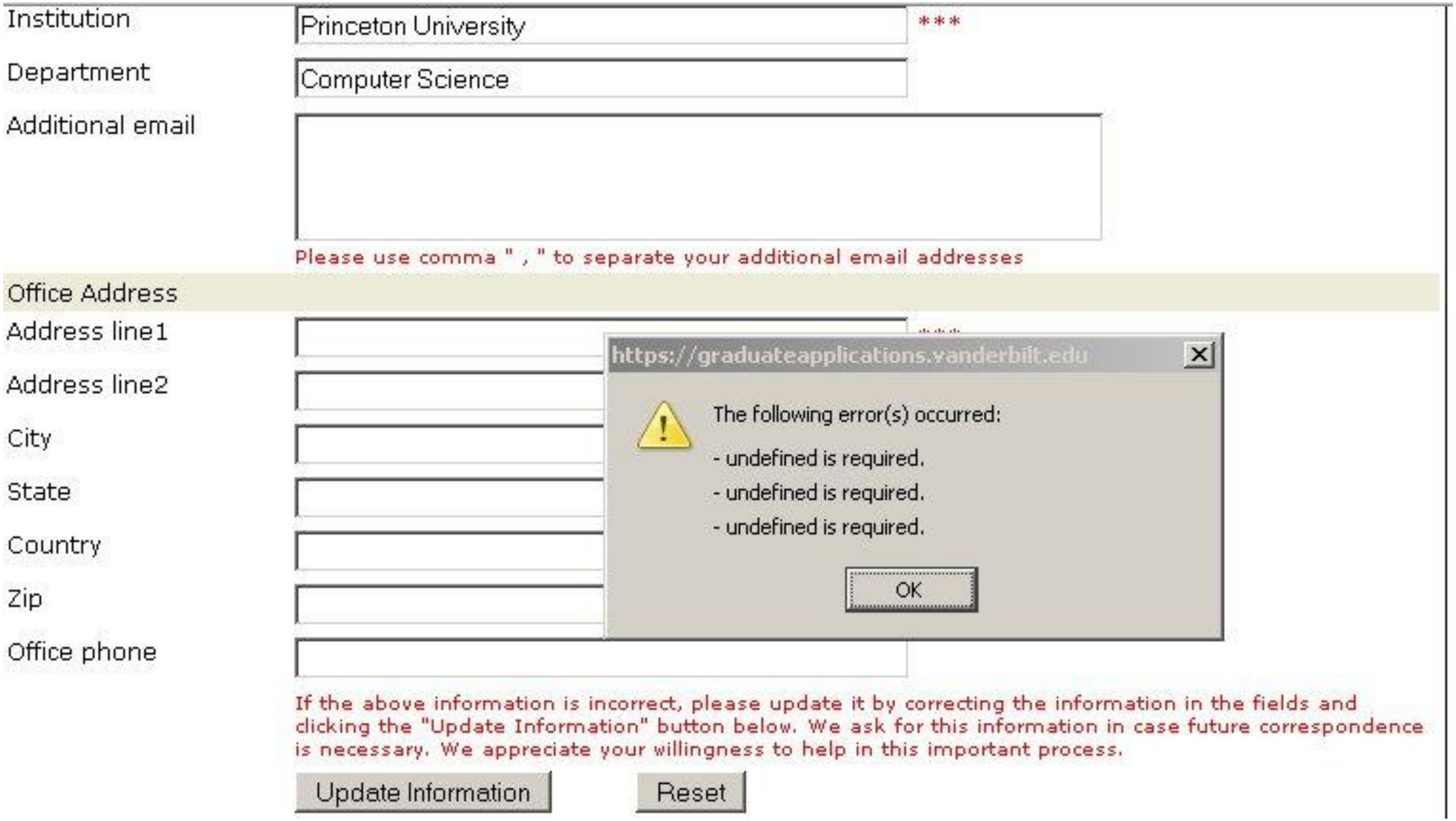
Step 2: Inspector

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

→ indicates a required question.

Question	Original Answer	New Answer	Hint
TO BE COMPLETED BY THE RECOMMENDER:	(empty)	→ Go to Page 2	Required Item

Bad GUIs



Institution	Princeton University	***
Department	Computer Science	
Additional email		

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

Office Address

Address line1		***
Address line2		
City		
State		
Country		
Zip		
Office phone		

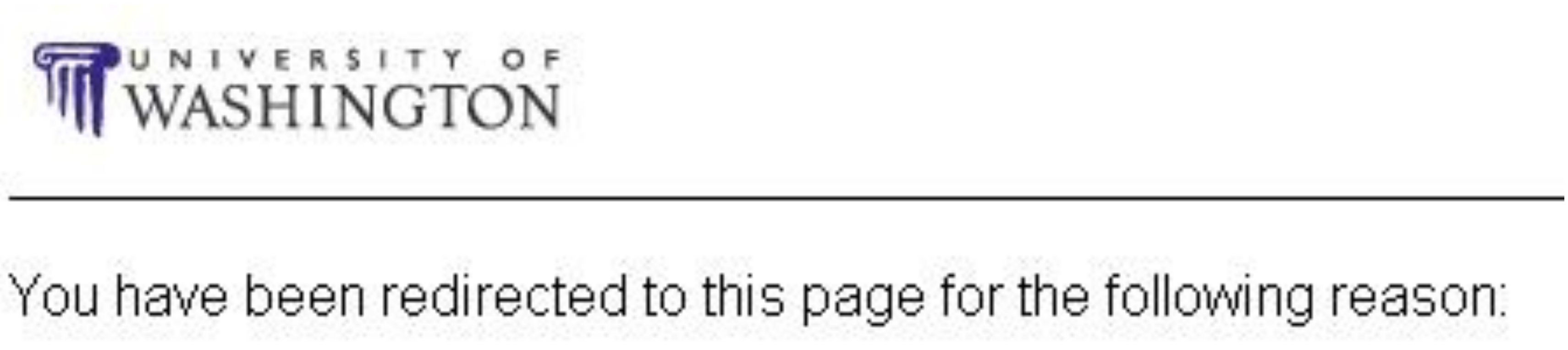
https://graduateapplications.vanderbilt.edu

The following error(s) occurred:

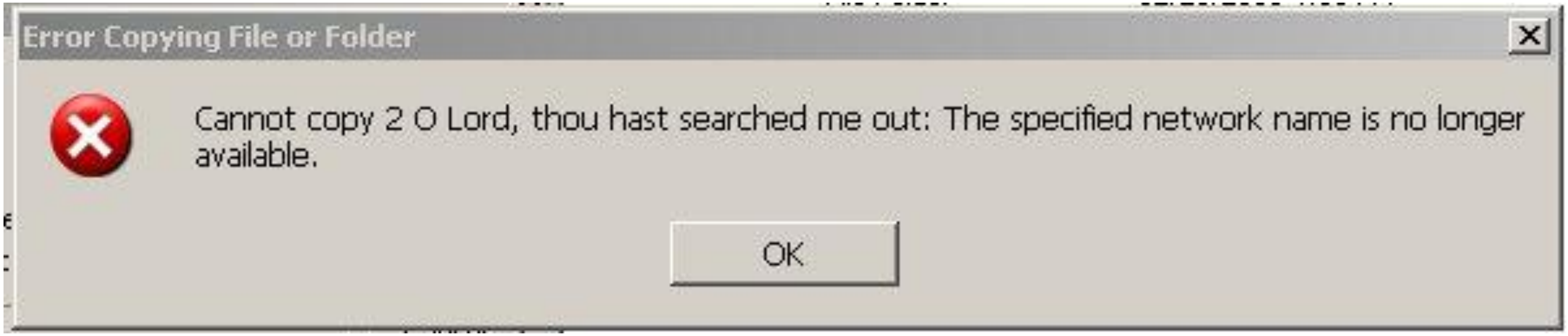
- undefined is required.
- undefined is required.
- undefined is required.

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.

Bad GUIs

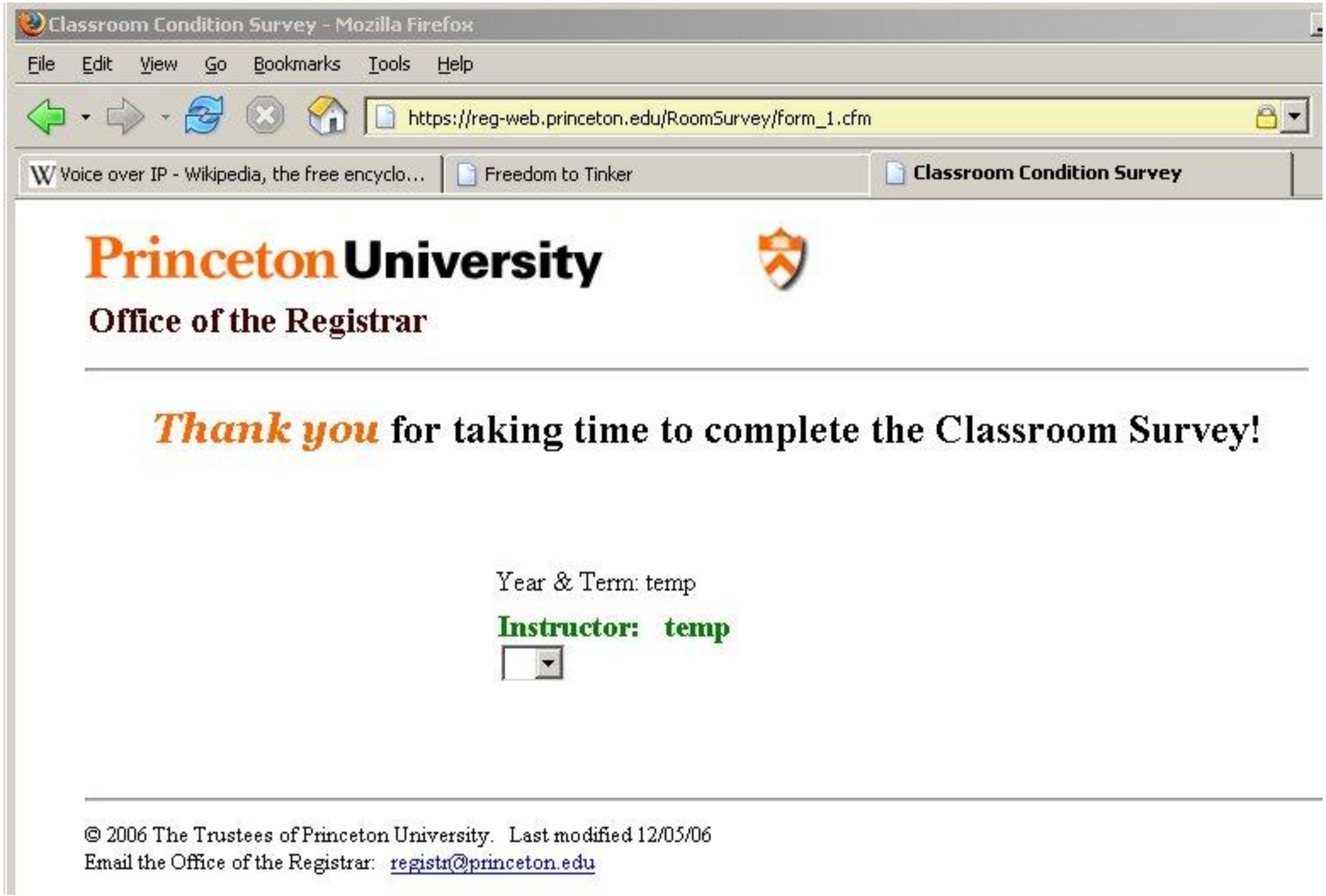


You have been redirected to this page for the following reason:



Cannot copy 2 O Lord, thou hast searched me out: The specified network name is no longer available.

Bad GUIs



Classroom Condition Survey - Mozilla Firefox
File Edit View Go Bookmarks Tools Help
https://reg-web.princeton.edu/RoomSurvey/form_1.cfm
Voice over IP - Wikipedia, the free encyclo...
Freedom to Tinker
Classroom Condition Survey

Princeton University

Office of the Registrar

Thank you for taking time to complete the Classroom Survey!

Year & Term: temp

Instructor: temp

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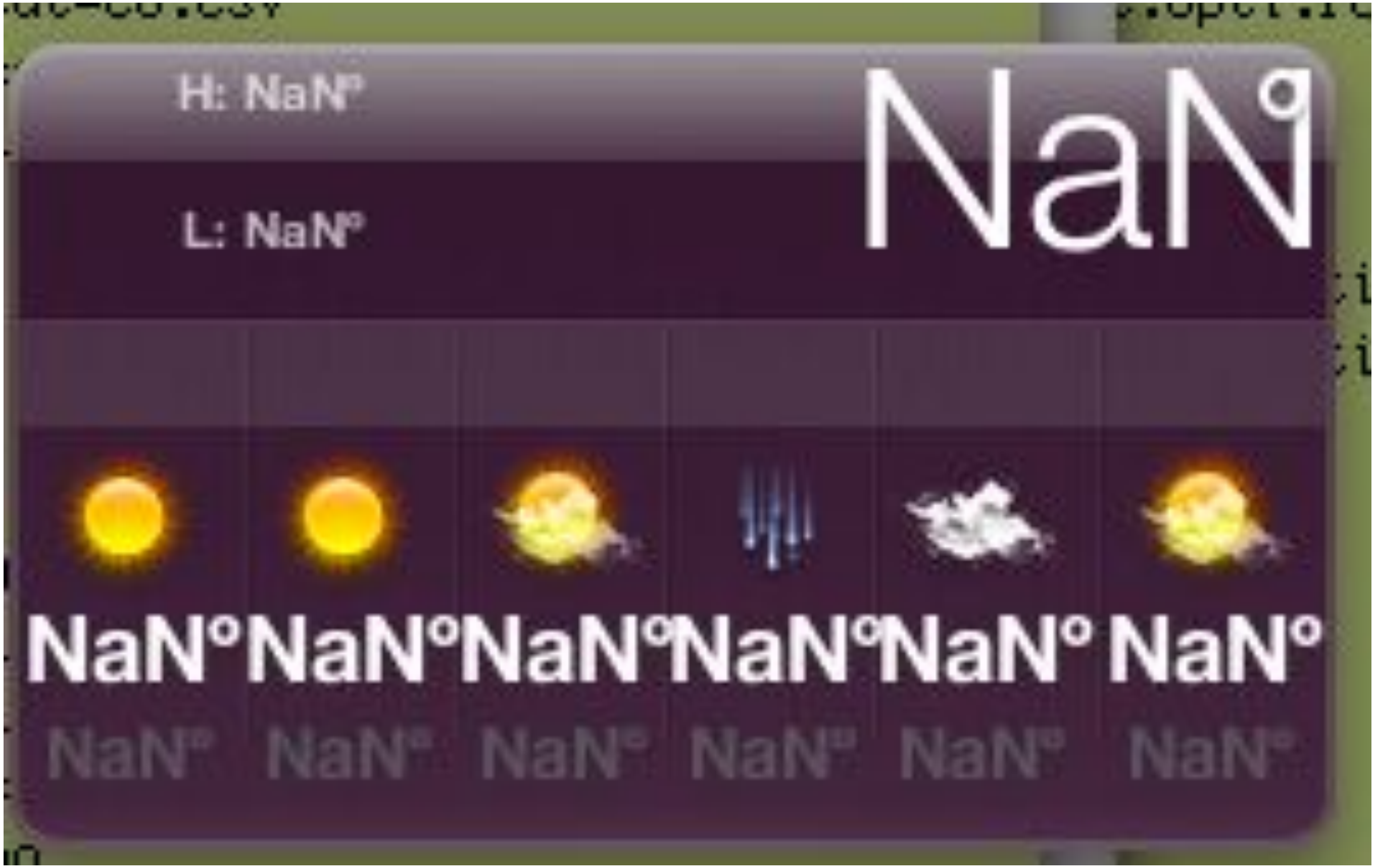
Email the Office of the Registrar: registr@princeton.edu

Bad GUIs



H: NaN°

L: NaN°

NaN°

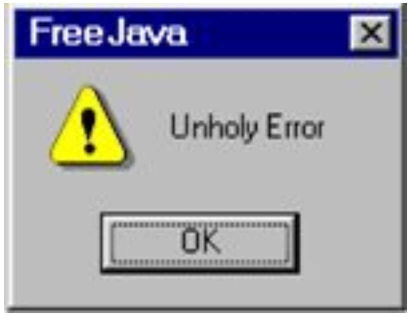
NaN° NaN° NaN° NaN° NaN° NaN°

NaN° NaN° NaN° NaN° NaN° NaN°

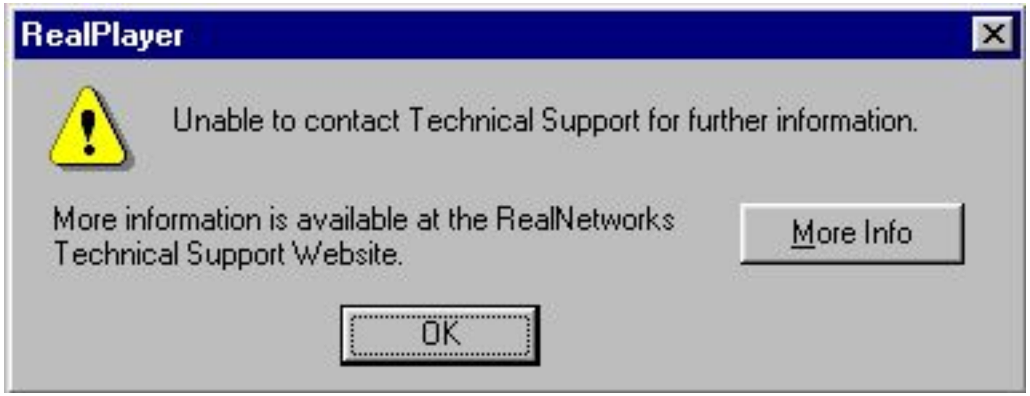
Bad GUIs

- From the **Interface Hall of Shame** at http://hallofshame.gp.co.at/index.php?mode=original

Bad GUIs

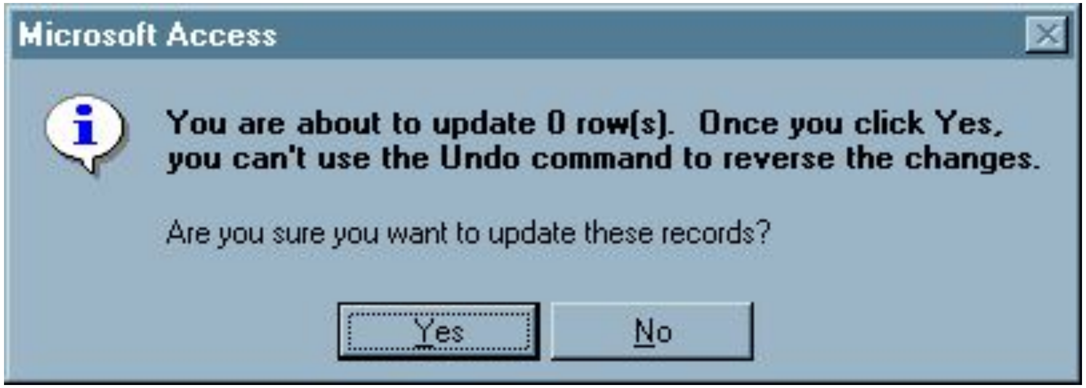


Unholy Error



Unable to contact Technical Support for further information.

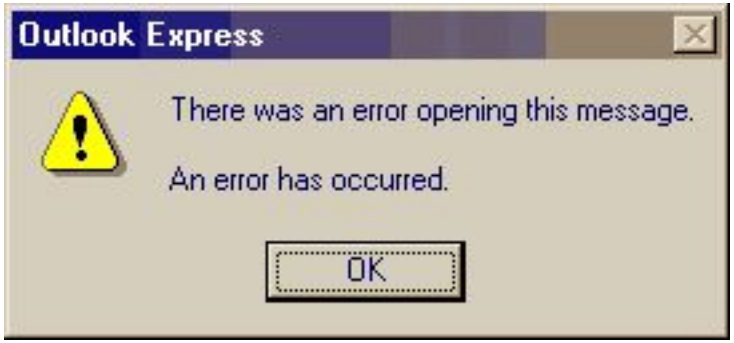
More information is available at the RealNetworks Technical Support Website.



You are about to update 0 row(s). Once you click Yes, you can't use the Undo command to reverse the changes.

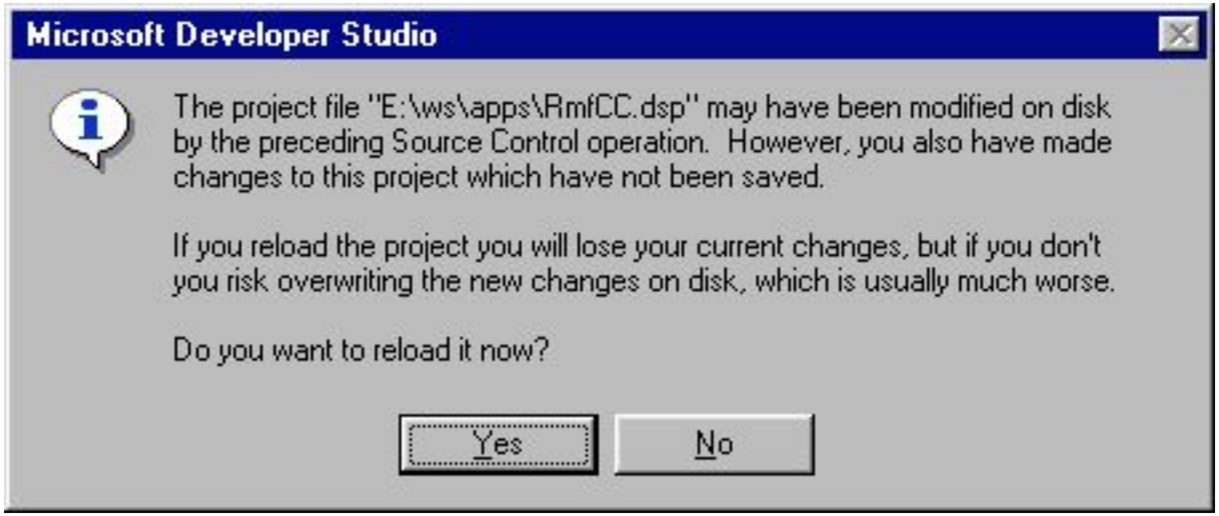
Are you sure you want to update these records?

Bad GUIs



There was an error opening this message.

An error has occurred.

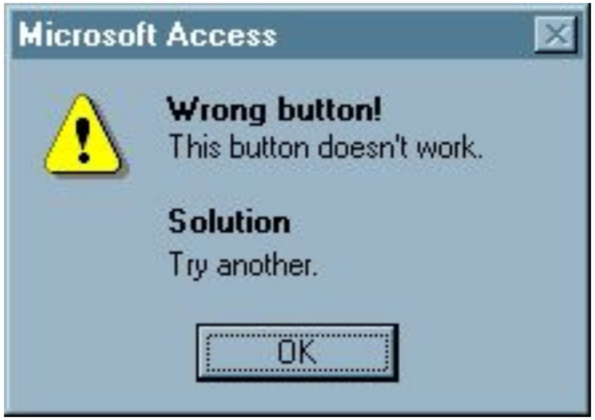


The project file "E:\ws\apps\RmfCC.dsp" may have been modified on disk by the preceding Source Control operation. However, you also have made changes to this project which have not been saved.

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.

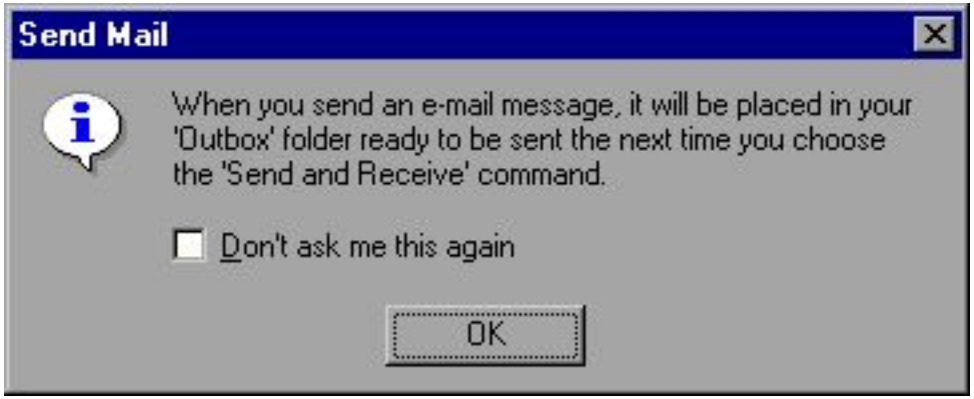
Do you want to reload it now?

Bad GUIs



Wrong button!
This button doesn't work.

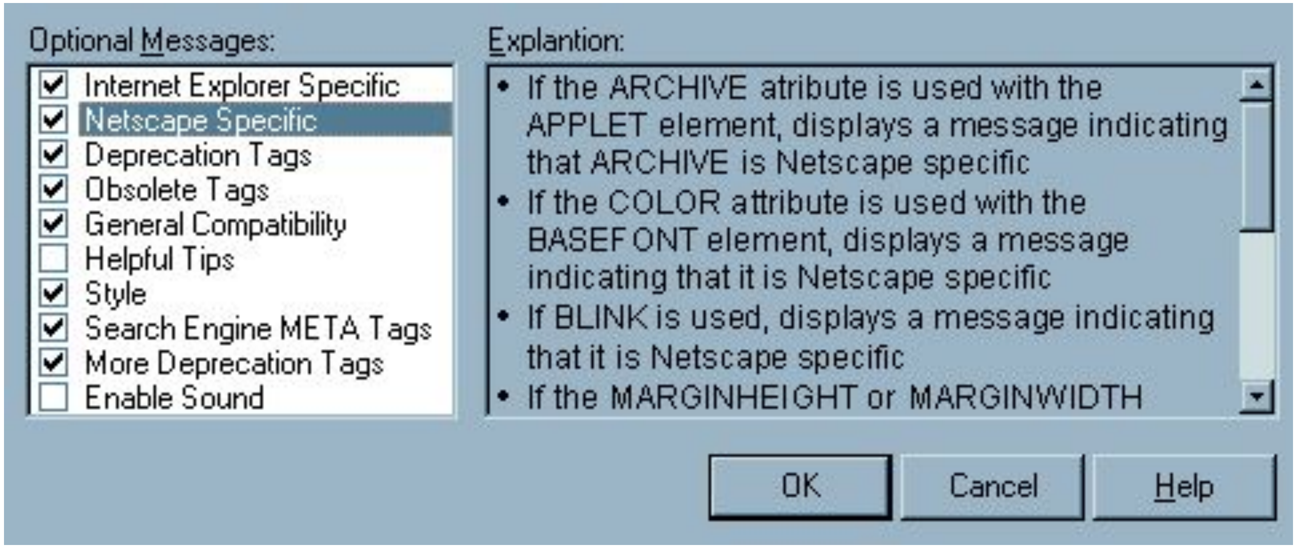
Solution
Try another.



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

Bad GUIs

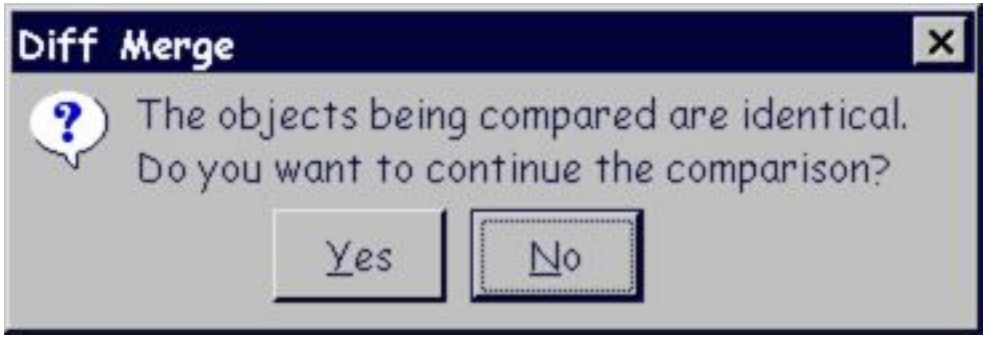


Optional Messages:

- ☑ Internet Explorer Specific
- ☑ Netscape Specific
- ☑ Deprecation Tags
- ☑ Obsolete Tags
- ☑ General Compatibility
- □ Helpful Tips
- ☑ Style
- ☑ Search Engine META Tags
- ☑ More Deprecation Tags
- □ Enable Sound

Explantion:

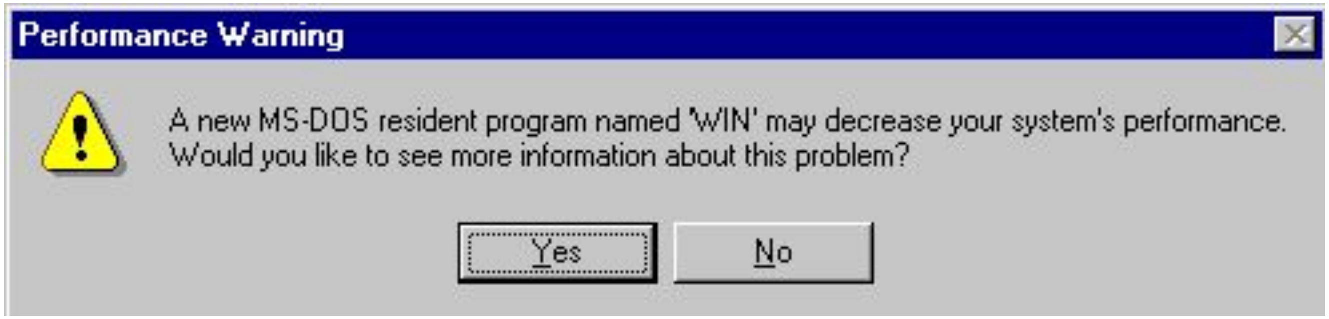
- If the ARCHIVE atribute is used with the APPLET element, displays a message indicating that ARCHIVE is Netscape specific
- If the COLOR attribute is used with the BASEFONT element, displays a message indicating that it is Netscape specific
- If BLINK is used, displays a message indicating that it is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



Diff Merge

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

Bad GUIs



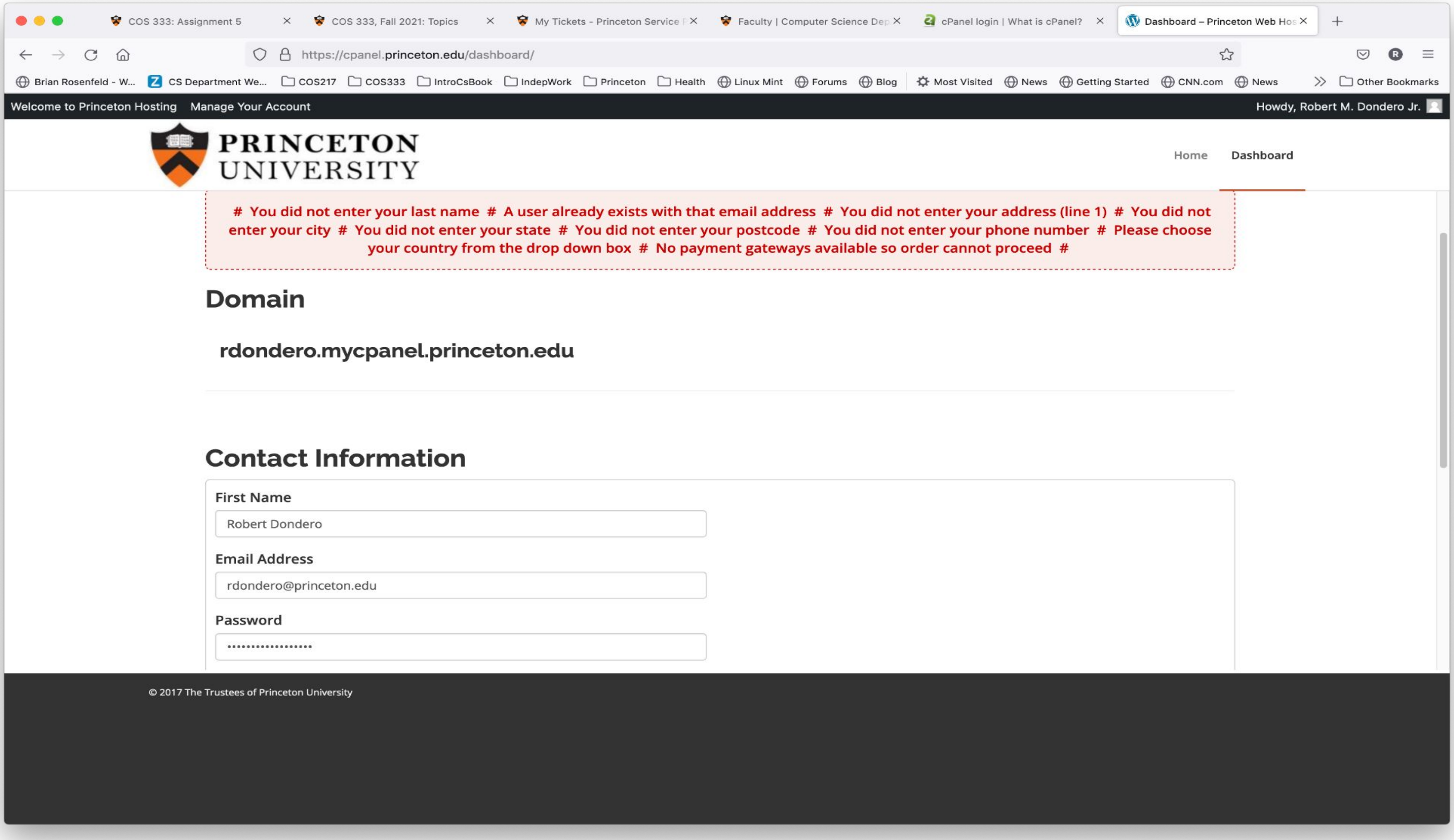
Performance Warning

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

Bad GUIs

- A recent one:

Bad GUIs



COS 333: Assignment 5
COS 333, Fall 2021: Topics
My Tickets - Princeton Service
Faculty | Computer Science Dep
cPanel login | What is cPanel?
Dashboard – Princeton Web Hos
https://cpanel.princeton.edu/dashboard/
Brian Rosenfeld - W...
CS Department We...
COS217
COS333
IntroCsBook
IndepWork
Princeton
Health
Linux Mint
Forums
Blog
Most Visited
News
Getting Started
CNN.com
News
Other Bookmarks
Welcome to Princeton Hosting
Manage Your Account
Howdy, Robert M. Dondero Jr.
PRINCETON UNIVERSITY
Home
Dashboard

You did not enter your last name # A user already exists with that email address # You did not enter your address (line 1) # You did not enter your city # You did not enter your state # You did not enter your postcode # You did not enter your phone number # Please choose your country from the drop down box # No payment gateways available so order cannot proceed

Domain

rdondero.mycpanel.princeton.edu

Contact Information

First Name

Robert Dondero

Email Address

rdondero@princeton.edu

Password

••••••••••••••••••

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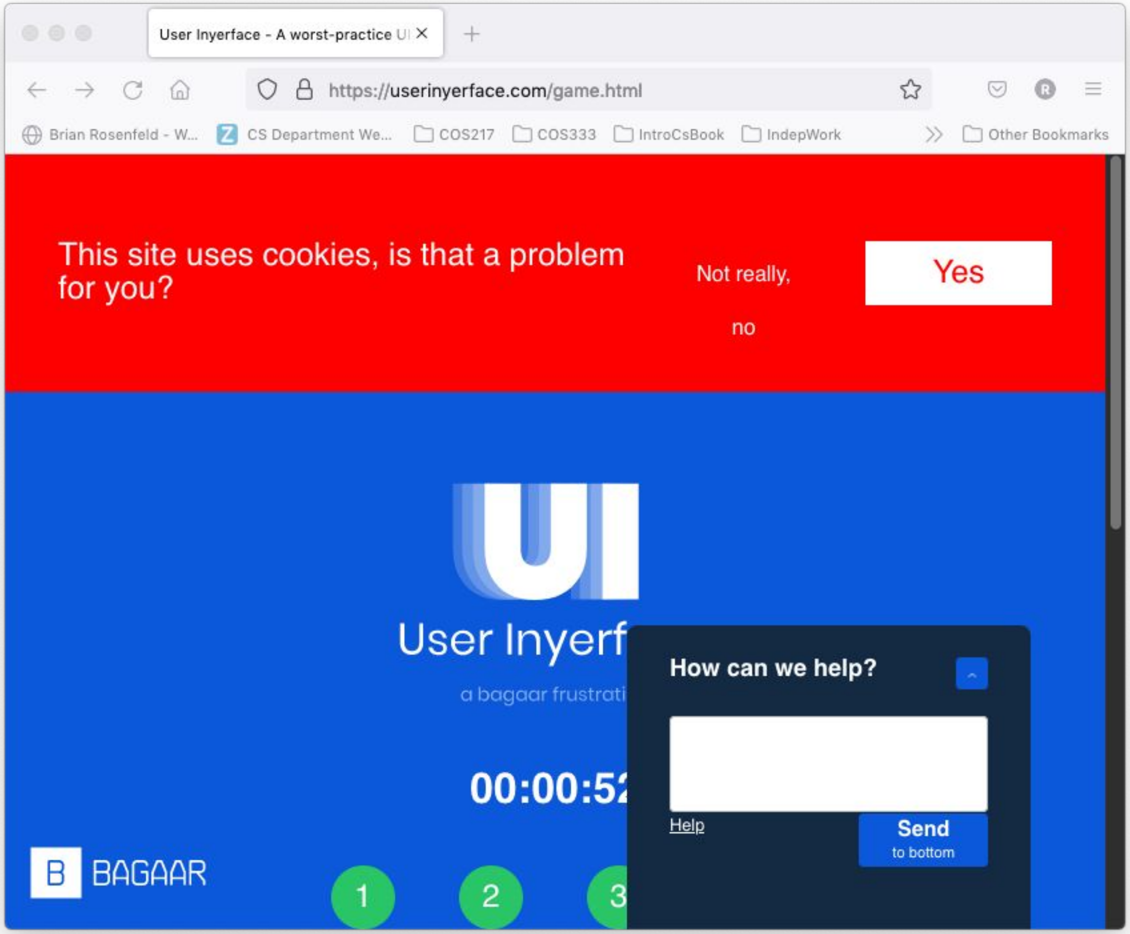
Bad GUIs

- User Inyerface
  - https://userinyerface.com/game.html
  - Brought to my attention by COS 333 alumnus Joseph Kim…
  - Intention: The worst user interface imaginable…

Bad GUIs



User Inyerface - A worst-practice UI

https://userinyerface.com/game.html

Brian Rosenfeld - W... CS Department We... COS217 COS333 IntroCsBook IndepWork Other Bookmarks

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Not really, no

Yes

User Inyerf

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00:00:52

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Help

Send to bottom