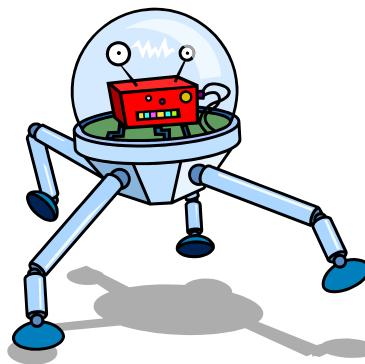
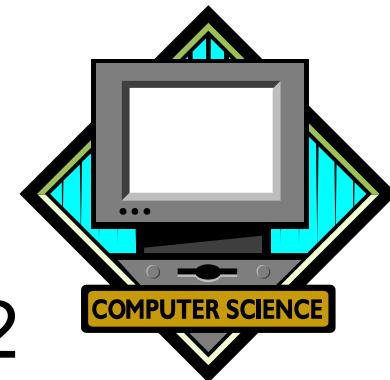


Caltech/LEAD Summer 2012 Computer Science



Lecture 13: July 20, 2012

Tkinter Widgets



Tkinter Widgets

- So far have spent a lot of time with the **Tkinter Canvas** widget
 - Very good for drawing simple graphics, as long as they're lines, circles, ovals, rectangles, etc.
- Tkinter also provides many other kinds of widgets for building more complex GUIs
 - Buttons, labels, text fields, menus, lists, etc.
 - Simple mechanisms for grouping and laying out widgets



Message Boxes

- Tkinter provides several prebuilt features
- Display a simple informational message:

```
import tkMessageBox  
  
tkMessageBox.showinfo('Hi from Tkinter!',  
                     'Hello world!\n\nThis is a message box.')
```

- Output:



Message Boxes (2)

- **tkMessageBox** module provides other functions as well
- Display warnings or errors:

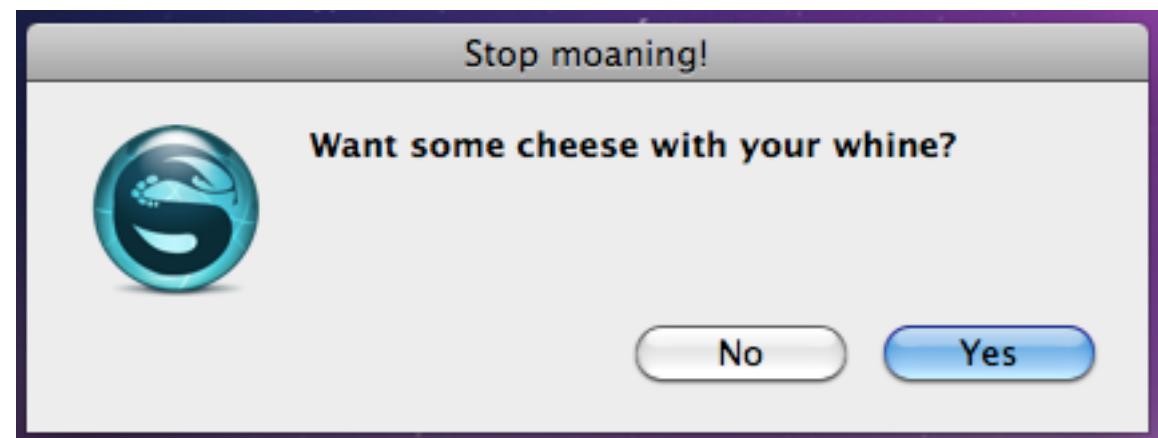
```
tkMessageBox.showwarning('HAL Warning',  
                         "I'm sorry Dave. I'm afraid I can't do that.")  
                         # also showerror() function
```

- Output:



Message Boxes (3)

- Can also perform simple interactions:
`tkMessageBox.askyesno('Stop moaning!',
'Want some cheese with your whine?')`
- Output:



- Returns **True** if “Yes” is clicked, or **False** if “No” is clicked

Message Boxes (4)

- Other functions with different options:
 - `askokcancel` – “Ok” and “Cancel”
 - `askretrycancel` – “Retry” and “Cancel”
 - All return `True` if “Yes” is clicked, or `False` if “No” is clicked
- Also:
 - `askquestion` – “Yes” and “No” options
 - Returns string '`yes`' if “Yes” is clicked, or '`no`' if “No” is clicked
- Message boxes also have keyword options
 - Choose what icon to use, default button, etc.



Buttons

- Buttons are a simple example of a widget
 - Very widely used user-interface component!
- Example:

```
from Tkinter import *
root = Tk()
btn = Button(root, text='Click Me!')
btn.pack()
root.mainloop()
```

- A very simple application:



Buttons (2)

- Buttons have a **command** option
 - Set this to a function to invoke when the button is clicked
- Example:

```
def clicked():  
    tkMessageBox.showinfo('AWESOME',  
                         'Way to go. You rule.')
```

...

```
btn = Button(root, text='Click Me!',  
             command=clicked)
```

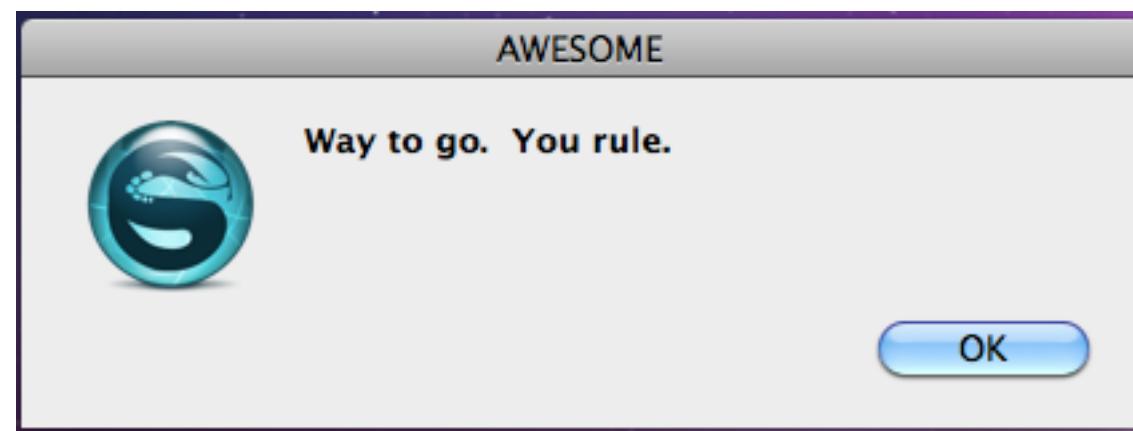


Buttons (3)

- When app is run:



- When you click the button:



Buttons (4)

- Can also set widget options using []

```
def clicked():
    tkMessageBox.showinfo('AWESOME',
        'Way to go. You rule.')
    btn['text'] = 'Thank you!'

...
btn = Button(root, text='Click Me!')
btn['command'] = clicked
```



Images

- Tkinter supports “bitmap images” and “photo images”
 - Bitmap image: black-and-white image, in **.xbm** format
 - Photo image: color image, in **.gif**, **.pgm** or **.ppm** formats
- Example:

```
img = PhotoImage(file='Alien.gif')
```

 - Argument is path to the image file
 - Must specify **file=** or will fail with an error!



Images (2)

- Can use images in several different places
- Can display in a **Canvas**

```
id = c.create_image(x, y, image=...)
```

- Can use in buttons, check-boxes, etc.

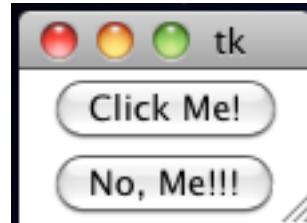
```
img = PhotoImage(file='Alien.gif')
```

```
b = Button(root, image=img)
```

- Displays:



Multiple Widgets

- Frequently want multiple widgets...
`btn1 = Button(root, text='Click Me!')`
`btn1.pack()`
`btn2 = Button(root, text='No, Me!')`
`btn2.pack()`
- Shows:

- The **pack()** method places a widget within its container

Multiple Widgets (2)

- The **pack()** method invokes the Pack layout manager
 - A special component that determines how widgets should be positioned
 - Pretty simple layout manager
- Also a Grid layout manager, which allows more specific placement of components
 - Components are placed on a 2D grid (surprise!)
 - Invoked via the **grid()** call
- Also a Place layout manager
- If you don't invoke a layout operation on a widget, it won't show up in your GUI!



Multiple Widgets (3)

- As with widget constructors, `grid()` method takes keyword arguments:
 - `row` = row to place widget in (zero-indexed)
 - `column` = column to place widget in
 - `rowspan` = how many rows the widget spans
 - `columnspan` = how many columns the widget spans
 - Other options to specify how extra space should be distributed to widgets



Multiple Widgets (4)

- Lay out our buttons horizontally instead:
`from Tkinter import *`

```
root = Tk()
```

```
btn1 = Button(root, text='Click Me!')
btn1.grid(row=0, column=0)
btn2 = Button(root, text='No, Me!')
btn2.grid(row=0, column=1)
```

```
root.mainloop()
```

- Shows:

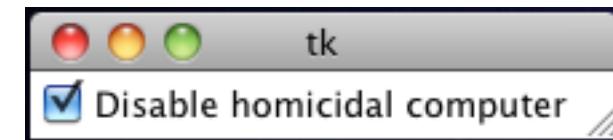
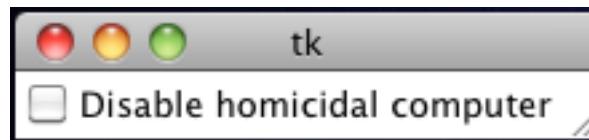


Check-Buttons

- Can create **Checkbutton** widgets:

```
from Tkinter import *
root = Tk()
cbox = Checkbutton(root,
                    text='Disable homicidal computer')
cbox.grid()
root.mainloop()
```

- Shows:



Check-Buttons (2)

- We have our user interface... but how to read out the value of the check-button?
- **Checkbutton** also has **command** value
 - Is called every time check-box state changes
 - Doesn't receive any arguments, so can't tell exactly what happened
- Tkinter uses *control variables* to associate UI widgets with the values they hold



Control Variables

- Update our code:

```
cbox_val = IntVar() # The control variable

def cbox_clicked():
    if cbox_val.get() == 1:
        tkMessageBox.showinfo('HAL9000',
                             'evil module disabled')
    else:
        tkMessageBox.showwarning('HAL9000',
                               'evil module enabled')

cbox = Checkbutton(root,
                   text='Disable homicidal computer',
                   variable=cbox_val, command=cbox_clicked)
```



Control Variables (2)

- Three kinds of control variables:
 - **IntVar** – initial value is 0
 - **DoubleVar** – initial value is 0.0
 - **StringVar** – initial value is empty string
 - Specify an initial value with **value** argument:
 - `s = StringVar(value='hello')`
- All control variables have two methods:
 - **get()** returns current value of the variable
 - **set(val)** sets the value of the variable



Control Variables (3)

- Control variables encourage a *separation of concerns* within graphical applications
 - Divide code into non-overlapping functional units
- A common approach:
 - Create a *model* class that encapsulates all state for the GUI application
 - Create a *view* class that sets up and manages the actual graphical widgets
 - A *controller* class handles events from the view (e.g. button-press commands), and manipulates the model's state accordingly
 - Called the Model-View-Controller design pattern



Text Fields

- Can use the **Entry** widget to input a single line of text
 - Has a **textvariable** option for specifying the control variable
 - Control variable must be of type **StringVar**
 - **StringVar** has **get()** and **set()** methods
- Other useful options:
 - **width** = width of text-field in characters
 - **show** = character to show when text is entered
 - e.g. set to '*' for password fields
 - **justify** = left/right justify or center text



Text Fields (2)

- Use the `Label` widget to show read-only text in a user interface
 - Specify label's contents with the `text` value
 - (Also has a `textvariable` option if you don't want to use `text` value)
- Other useful options:
 - `width` = width of text-field in characters
 - `justify` = left/right justify or center text
 - `wraplength` = specify number of characters to appear in each line of the label



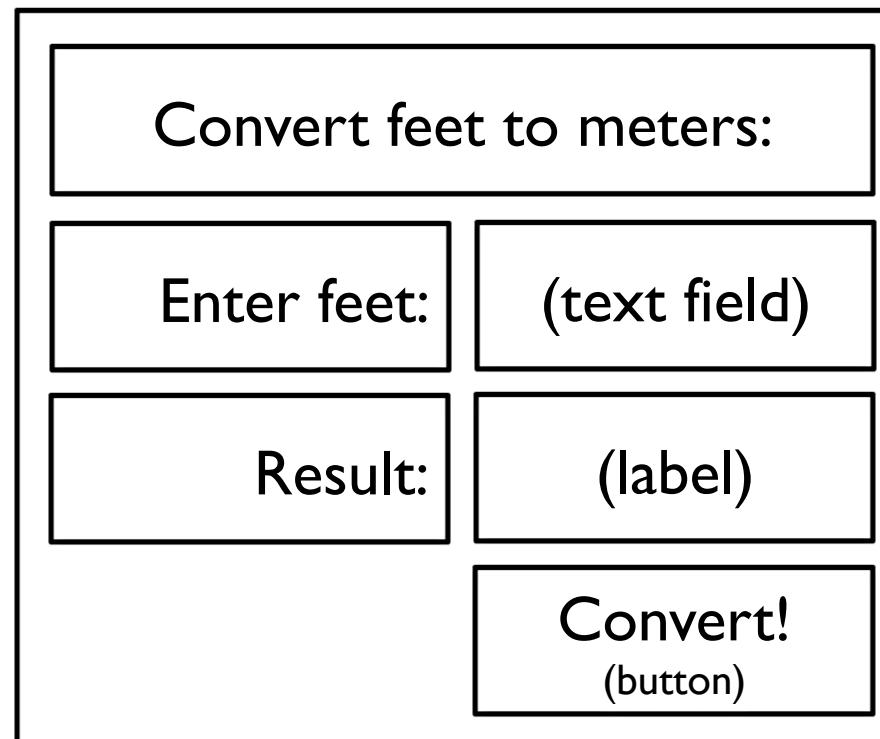
Example: Units Converter

- Program to convert feet to meters
 - User enters a distance in feet
 - Program computes distance in meters
- Very helpful to create a UI mock-up:
 - Design the user interface before you build it
 - (Just like you should do with programs...)
- Generally, programmers design very bad UIs
 - Tend to be overcomplicated and difficult to use
- Some people focus *entirely* on UI design
 - User-experience, human-computer interaction



Units Converter UI-Mockup

- A simple user-interface mockup:



- (I'm not a UI designer...)

Units Converter Usage

- Usage:
 - User enters a distance in feet, then presses a button to actually convert the value
- State:
 - Will need a control variable for **Entry** field that receives the number of feet
 - Note: It must be a **StringVar**...
 - We'll also use a control variable to display the number of meters
 - Use a **StringVar** here too



Units Converter Implementation

- App isn't very complicated, so we'll just use global variables
- Code:

```
from Tkinter import *
import tkMessageBox
```

```
root = Tk()
```

```
# Our state variables for the app
cvt_from = StringVar()
cvt_to = StringVar()
...
```



Units Converter UI Setup

- Next, set up the user interface
 - (This code tends to be tedious to write...)

```
lbl = Label(root,
            text='Convert from feet to meters:')
lbl.grid(row=0, column=0, columnspan=2)

from_lbl = Label(root, text='Enter feet:')
from_lbl.grid(row=1, column=0)

from_entry = Entry(root,
                   textvariable=cvt_from)
from_entry.grid(row=1, column=1)

...
```



Units Converter UI Setup (2)

- Continued:

```
to_lbl = Label(root, text='Result: ')
to_lbl.grid(row=2, column=0)

result_lbl = Label(root,
                    textvariable=cvt_to)
result_lbl.grid(row=2, column=1)

# TODO: Need to write do_convert...
convert_btn = Button(root,
                      text='Convert!', command=do_convert)
convert_btn.grid(row=3, column=1)

root.mainloop()
```



Doing the Conversion

- Finally, implement `do_convert` function
- Put it after the command variables, and before the UI setup:

```
def do_convert():
    feet_val = float(cvt_from.get())
    meters_val = feet_val * 0.3048
    cvt_to.set('%s meters' % meters_val)
```

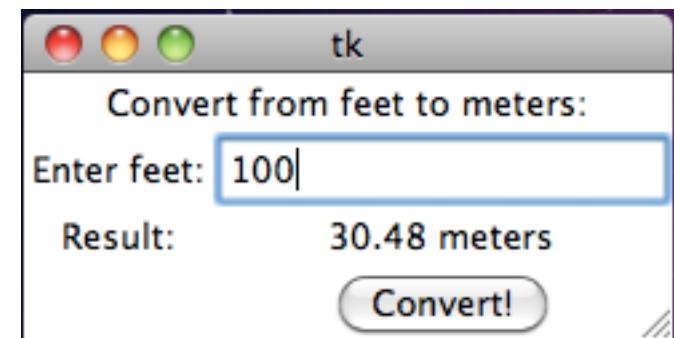
- Big assumption?
 - Users will always enter valid numbers!
 - Will deal with this in a bit.



Running the Application

- Application works great!
- That is, as long as you enter a number
 - In console, see an error message:

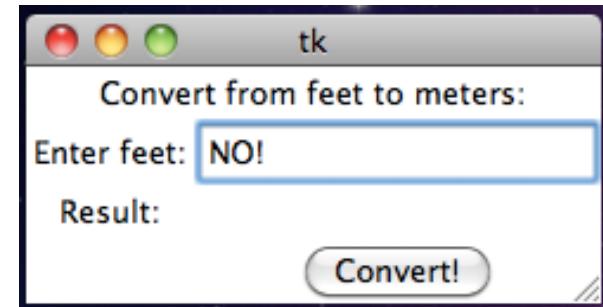
ValueError: could not convert string to float: NO!



Handling Bad Inputs

- Applications should always expect bad input from users
 - (Also, design the user interface to minimize opportunities for bad input...)
- Problem occurs in `do_convert`:

```
def do_convert():  
    feet_val = float(cvt_from.get())  
    meters_val = feet_val * 0.3048  
    cvt_to.set('%s meters' % meters_val)
```



Handling Bad Inputs (2)

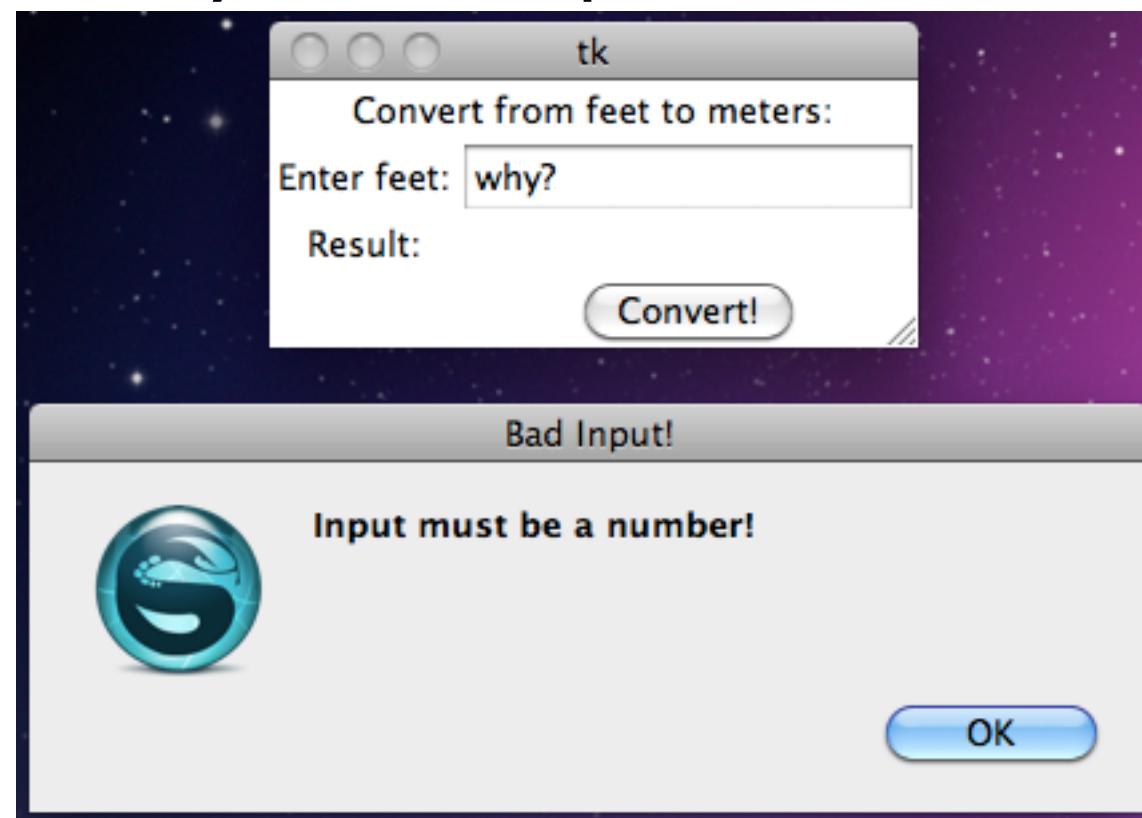
- When `float()` can't convert a value, it raises a `ValueError` exception
- Won't cover details of exceptions at all...
- ...but, they are easy enough to handle:

```
def do_convert():  
    cvt_to.set('')  
  
    try:  
        feet_val = float(cvt_from.get())  
        meters_val = feet_val * 0.3048  
        cvt_to.set('%s meters' % meters_val)  
    except ValueError:  
        tkMessageBox.showerror(...)
```



Handling Bad Inputs (3)

- Now, user interface responds more gracefully to bad input:



Combo-Boxes

- A common user-interface interaction:
 - Allow the user to choose one of a fixed set of options
 - Often provided by a *drop-down combo-box*
- Unit-conversion example: let user choose one of a number of conversions
 - feet → meters, meters → feet, miles → km
 - furlongs → feet, light-years → beard-seconds
 - Fahrenheit → Celsius, kilograms → slugs

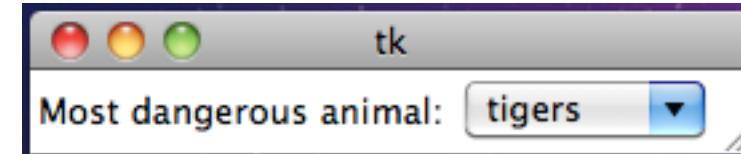
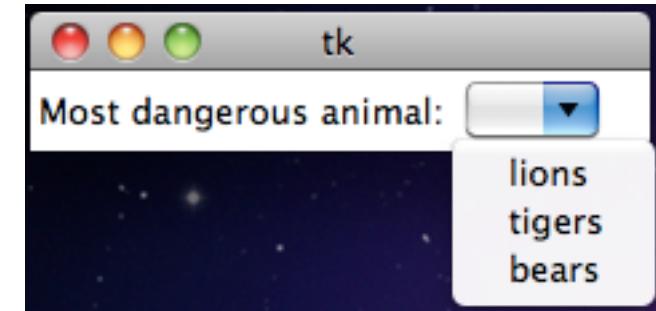
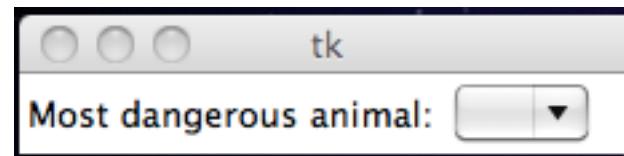


Combo-Boxes (2)

- Tkinter has an **OptionMenu** widget

```
choice_var = StringVar()  
opt_menu = OptionMenu(root, choice_var,  
                      'lions', 'tigers', 'bears')
```

- Displays as:



Combo-Boxes (3)

- Can separate out the option-list if needed

```
choice_var = StringVar()  
choices = ['lions', 'tigers', 'bears']  
opt_menu = OptionMenu(root, choice_var,  
                      *choices)
```

- Effectively inserts contents of **choices** as remaining args to **OptionMenu** constructor
 - Must be the last argument
- Can use this to set the option-menu's current state:

```
choice_var = choices[0]
```



Combo-Boxes (4)

- **OptionMenu** widgets aren't very smart
- Don't have a **command** option to handle when the user changes its value
 - Basically can only query the **OptionMenu**'s command variable for its current state
- Also, can't have separate “display values” and “choice values”
 - Can only display the actual values specified to the **OptionMenu**'s constructor



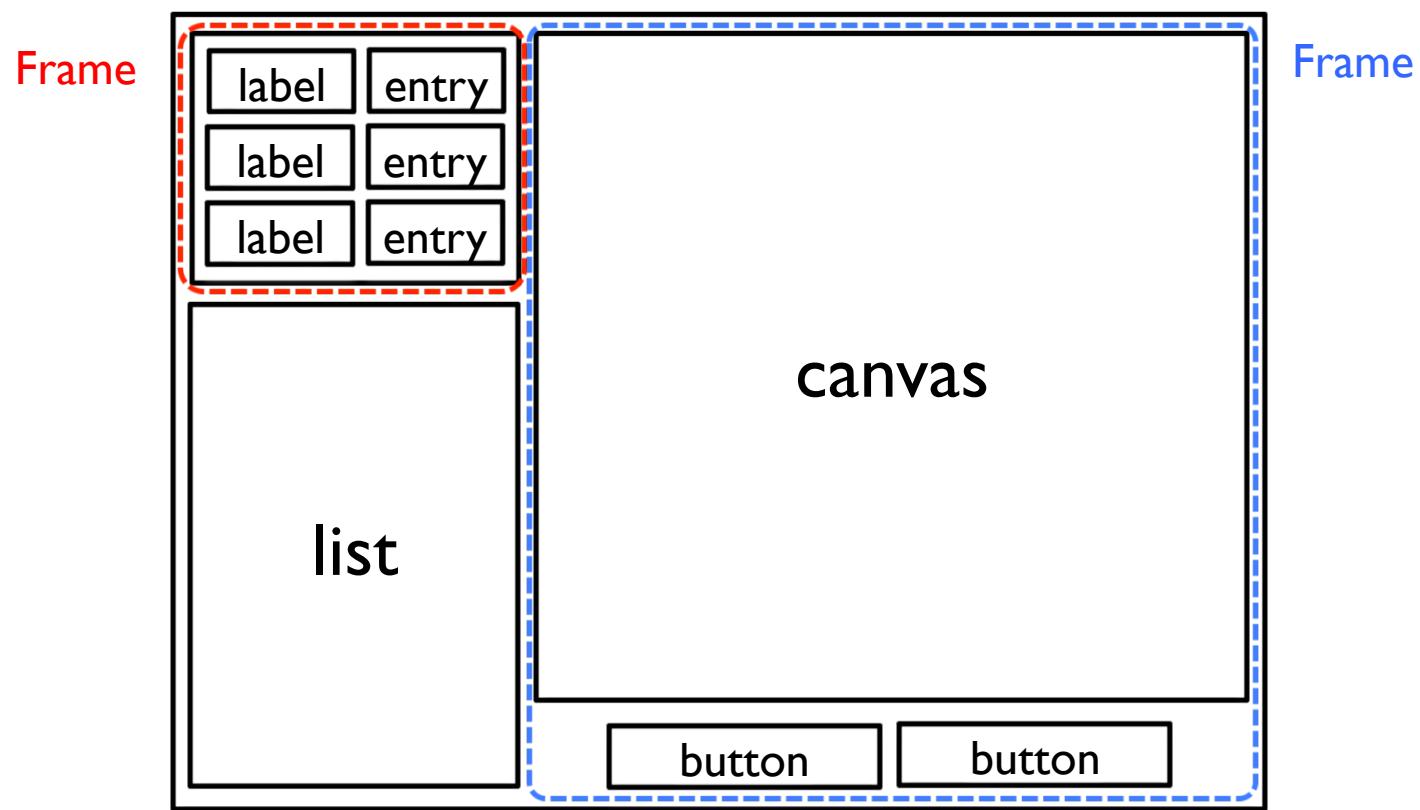
Groups of Widgets

- Sometimes want more sophisticated user-interface layouts
- The **Frame** widget simply holds other widgets
 - Doesn't have any visual appearance
 - Just groups widgets, and controls their layout
- Also a **LabelFrame** widget
 - Draws a labeled border around the widgets it contains



Groups of Widgets (2)

- Example: want a layout like this:



Enabling/Disabling Widgets

- Most widgets (buttons, lists, etc.) have a state value to enable/disable the widget
 - “Disabled” means the widget is still displayed, but the user can’t actually interact with it
 - Usually shown as grayed-out
- Example:

```
checkbox = Checkbutton(  
    text='Disable homicidal computer')
```

```
checkbox['state'] = DISABLED
```

- To reenable, set to the constant **NORMAL**



File Chooser

- Last component for today: the file chooser
- Frequently want to open a file for reading, or save data to an output file
- Like many frameworks, Tkinter provides a built-in file-chooser component
 - `import tkFileDialog`
- Two functions:
 - `tkFileDialog.askopenfilename(...)`
 - `tkFileDialog.asksavefilename(...)`



File Chooser (2)

- Main difference between `askopenfilename()` and `asksavefilename()`:
 - “Open file” requires that the file already exists
 - “Save file” allows you to “create a new file” (i.e. select a file that doesn’t exist)
- Can specify options to these functions:
 - `title` = title of file-chooser window
 - `defaultextension` = default extension to use when user doesn’t specify one



Example: Open an Image File

- Want to select an image file for opening

```
import tkFileDialog
```

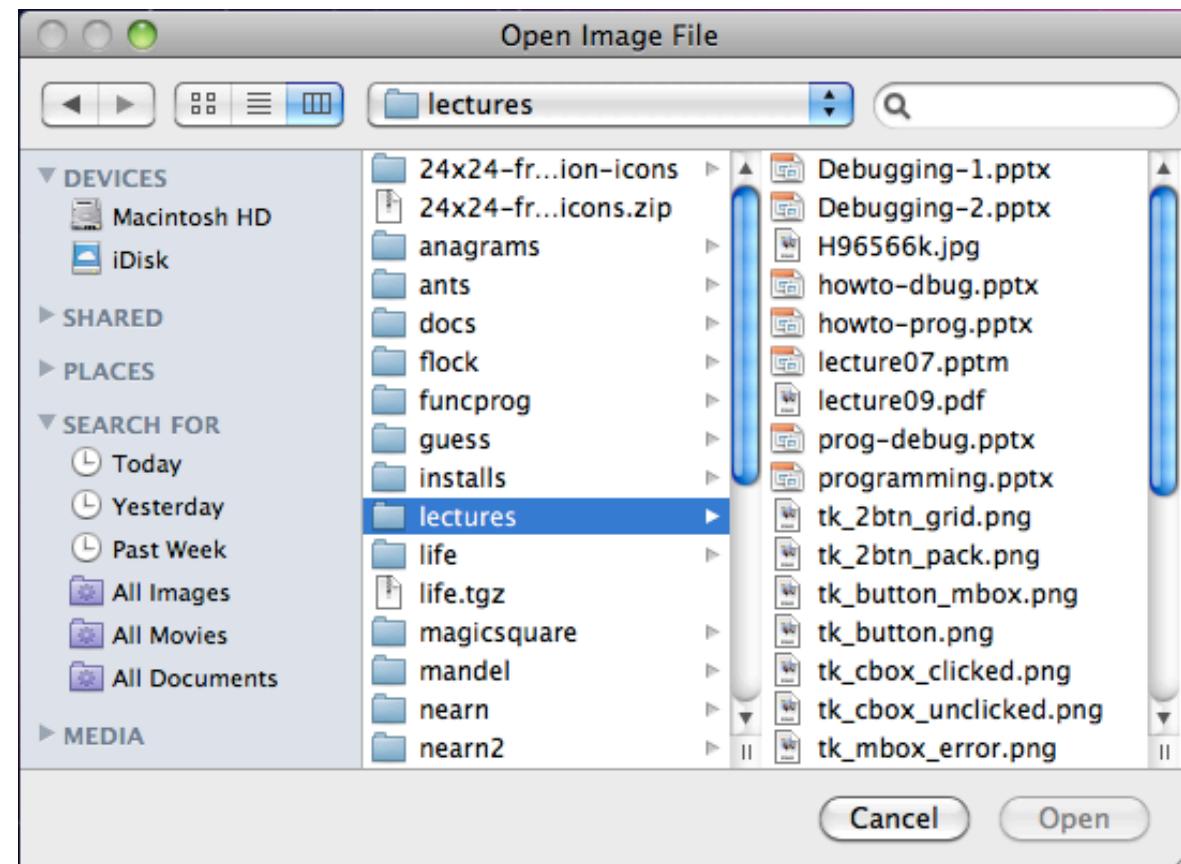
```
path = tkFileDialog.askopenfilename(  
        title='Open Image File')  
print 'Selected path: %s' % path
```

- If user selects a file, **path** will be the full path to the file
- If user selects “Cancel” button, **path** will be set to the empty string



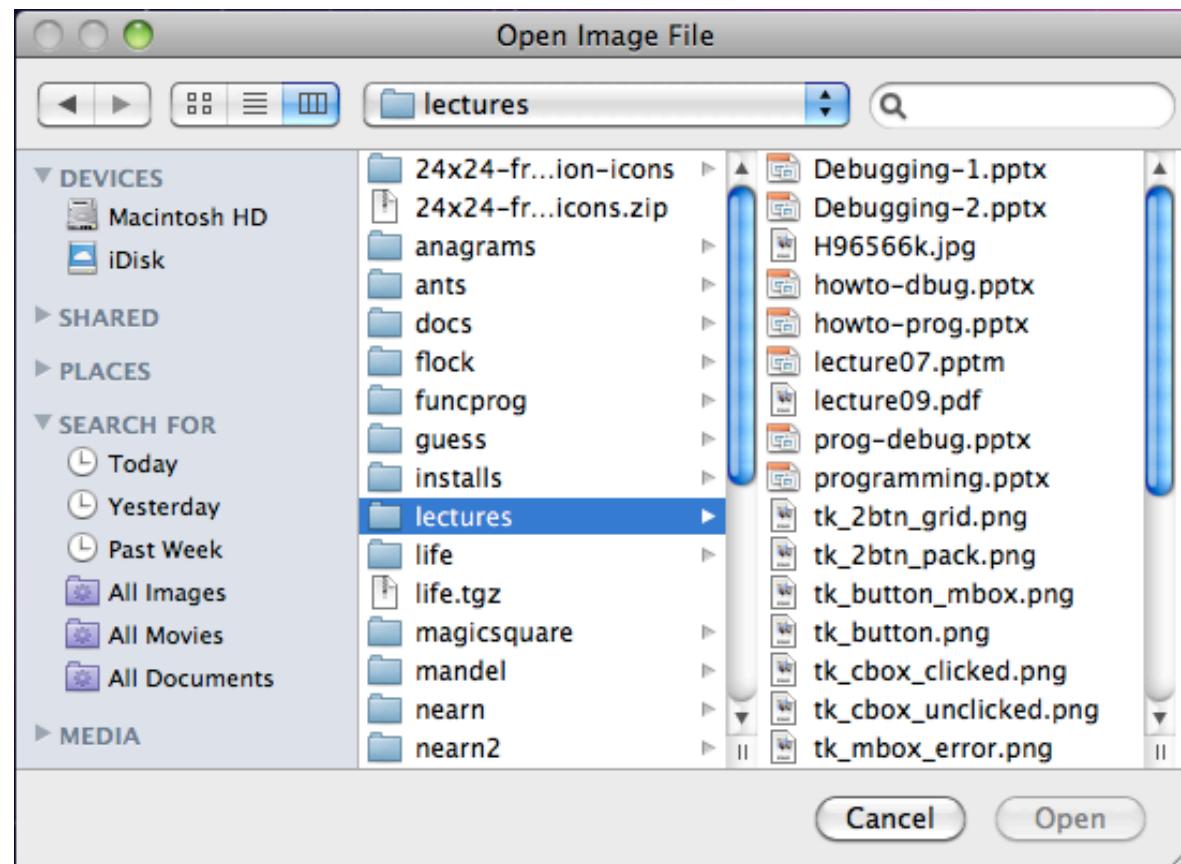
Example: Open an Image File

- Displays:



Opening an Image File (2)

- Problem: shows a lot of non-image files



Opening an Image File (3)

- Can also specify types of files the dialog should show:

```
types = [ ('JPEG files', '*.jpg'),  
          ('PNG files', '*.png'),  
          ('GIF files', '*.gif') ]
```

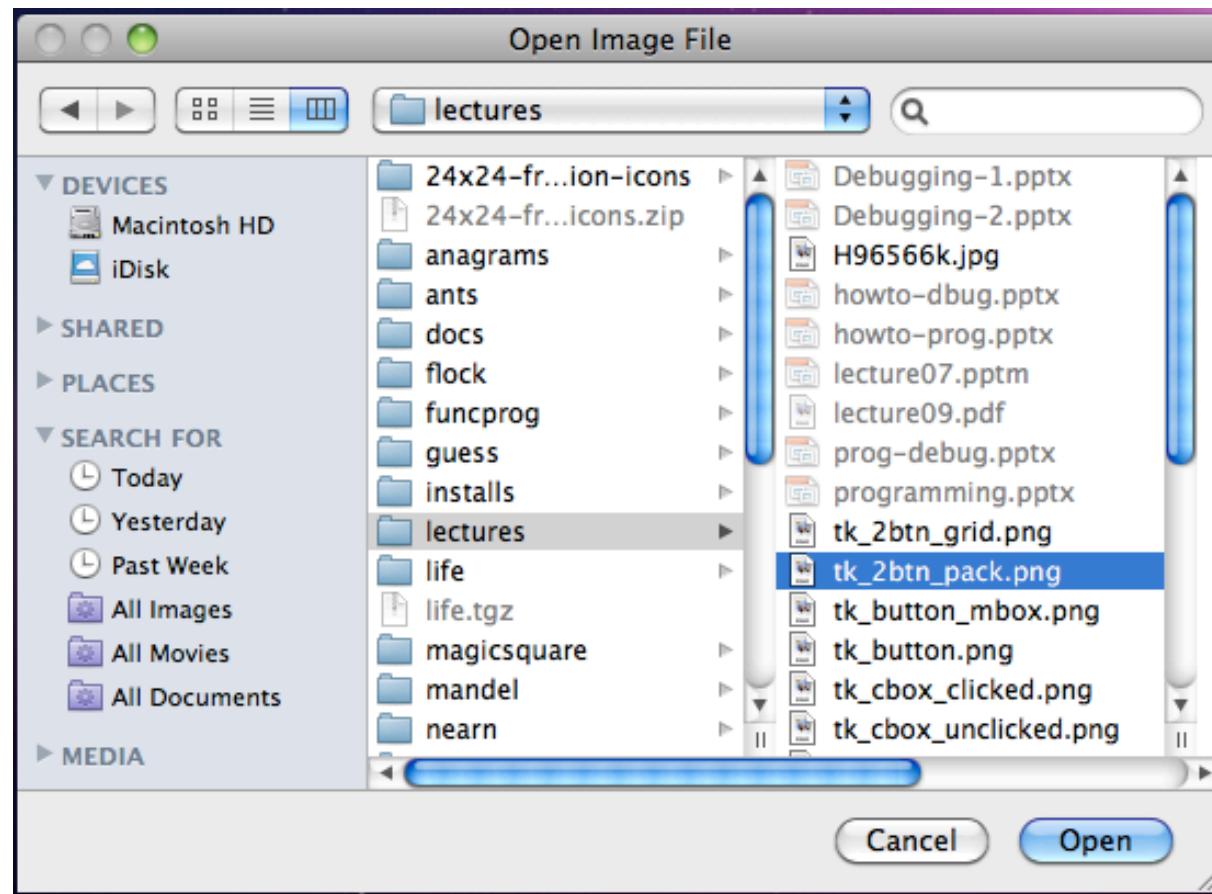
- Each element of the list is a tuple specifying a label and a pattern

```
path = tkFileDialog.askopenfilename(  
    title='Open Image File',  
    filetypes=types)
```



Opening an Image File (4)

- Now, non-matching file types are disabled:



Other Tkinter Widgets!

- Tkinter provides many other kinds of widgets
 - Lists, menus, multi-line text areas, radio buttons, images, sliders, paned windows, etc.
- Simply too much to cover in one class
- Feel free to consult the Tkinter docs:
 - <http://infohost.nmt.edu/tcc/help/pubs/.tkinter/>
- Write little programs to experiment with various widgets to learn more

