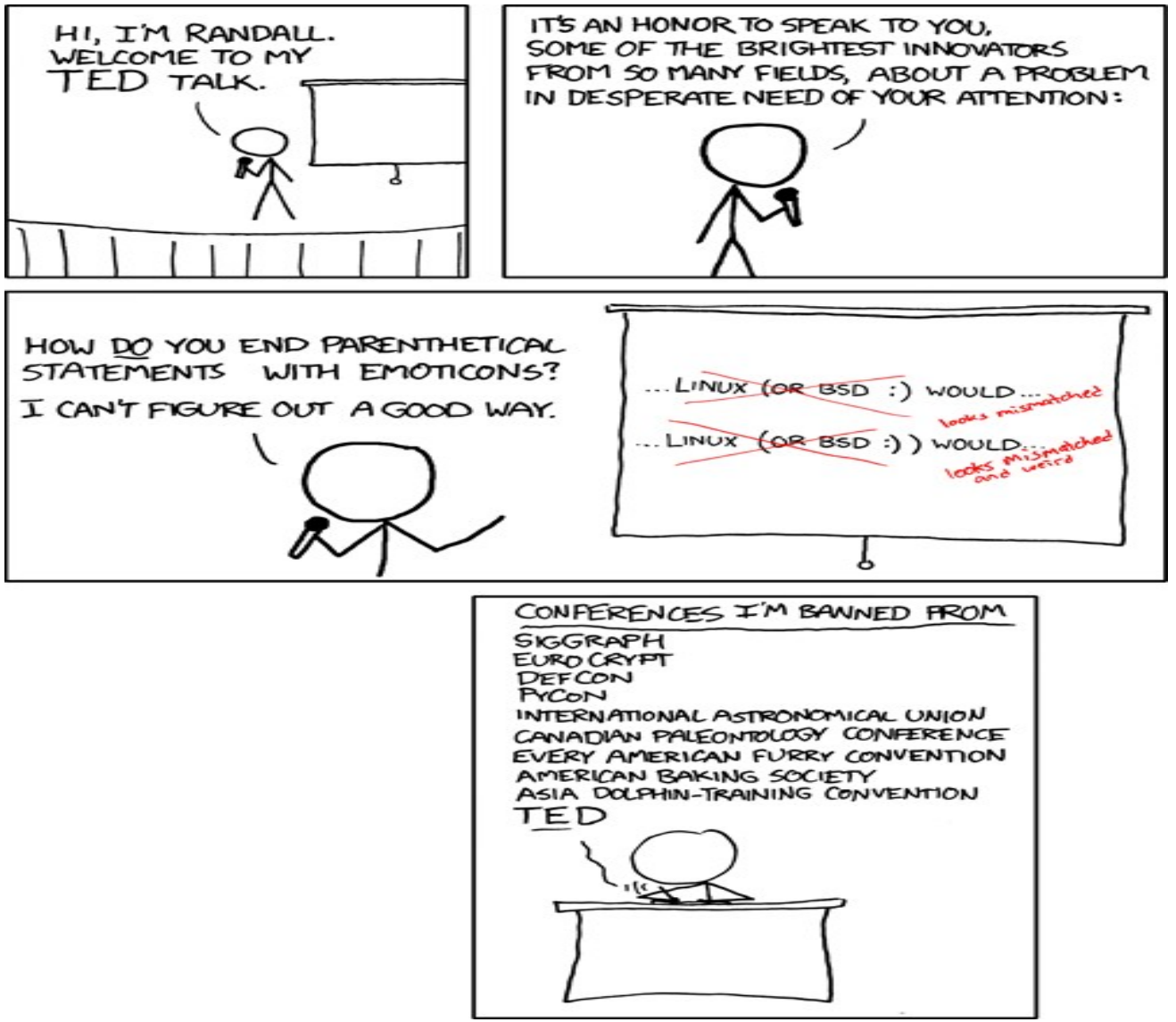
CS3101.3 Python: Lecture 5



source: http://xkcd.com/541/

HW2, HW3 stats, Grading

- Class did well on average
- 9 on HW2, 9+ on HW3
- I was generous – (research has been busy – the extra points are courtesy of the delay)
- If you're in that range you're doing great, 9 curves to about an A-
- If you have not turned in HW3 (and have not spoken with me already) – do so immediately
- Project proposals: see me tonight re: CCLS

CVN

Agenda – using libraries in the real world

- Extra credit and project exercises
- Working with compressed files – zip creation, appending, extracting
- Recursively exploring a directory structure
- Serializing data with cPickle (a couple elegant examples)
- An introduction to the Python DBAPI – connecting to MySQL and PostgreSQL databases
- PyWin32 – leveraging (hacking) the windows common object model to access Word and Excel functionality
- An introduction to Tkinter

In class extra credit exercise: Treasure Hunt

- Use the necessary libraries to write a routine which searches for a pattern within plain text files recursively reachable from the starting directory
- Look within compressed archives
- The input to your script should be the starting directory followed by the search string
- python treasureHunt.py /home/josh treasure

In class exercise: adding functionality to your project

- At your discretion, begin adding either
  - A simple GUI framework to your project
  - Serialization capability
  - Database connectivity
- Suggestions to get you started
  - GUIs: Start / Stop buttons, an about box, a file chooser rather than command line arguments
  - Serialization, the ability to save and resume program state, send data across networks
  - Databases: reading / storing data, logging program results

Working with Compressed Files

- Python can work directly with data in zip, gzip, bz2, tars, etc
- Most libraries offer decompression on the fly (i.e., unnecessary to extract the entire archive to modify files)
- Third party libraries are available to handle pretty much any format

Reading a zip archive, simple right?

```
import zipfile

def read():
    #use r, not rb
    z = zipfile.ZipFile('test.zip', 'r')
    for filename in z.namelist():
    #slurp the uncompressed bytes
    #into a string
        contents = z.read(filename)
        print 'File:', filename
        print contents

if __name__ == '__main__':
     read()
```

```
File: helloworld.txt

hello world


File: hey_dad.txt

hey dad!


File: hi_ma.txt

hi ma!
```

Creating an archive, simple again

see: http://en.wikipedia.org/wiki/DEFLATE

```
import zipfile
#create using Deflate as the
#default compresssion is deflate
z = zipfile.ZipFile("test.zip", "w")
path_1 = 'helloworld.txt'
path_2 = 'hey_dad.txt'
z.write(path_1)
z.write(path_2)
print z.namelist()
z.close()
```

```
helloworld.txt
hey_dad.txt
```

```
#append
z = zipfile.ZipFile("test.zip", "a")
path_3 = 'hi_mom.txt'
z.write(path_3)
print z.namelist()
z.close()
```

```
helloworld.txt
hey_dad.txt
hi_mom.txt
```

Recursively exploring a directory structure using os.walk()

- os.walk generates a tuple for each directory rooted at the starting path
- (dirpath, dirnames, filenames)
- dirpath: a string holding the path of the current directory
- dirnames: a list containing the names of subdirectories
- filenames: a list of the names of the non-directory files in dirpath
- See: http://docs.python.org/library/os.html

Recursively explore a directory

```
import os
from os.path import join, getsize

for current, dirs, files in os.walk('/Users/josh/'):
    print 'current dir', current
    print 'contains subdirectories', dirs
    print 'contains files', files
    print 'consumes',
    #reconstruct the path
    print sum(getsize(join(current, name)) for name in files),
    print "bytes in", len(files), "non-directory files"

#current dir /Users/josh/
#contains subdirectories [...]
#contains files [...]
#consumes 44127 bytes in 9 non-directory files
#current dir /Users/josh/courses
# ...
```

Regular expression reminder

```
import re
exp = re.compile('donut')
f = '/Users/josh/Desktop/test.txt'
lines = open(f).readlines()
text = ''.join(lines)
match = exp.search(text)
if match: print match.group()
```

Serializing Data using cPickle

- Serialization: turning data into a string of bytes which can be saved to disk, inserted into a database, sent across a network, etc
- Useful for:
  - interprocess python communication
  - saving and restoring program state
  - storing data (caveat – **never do this if you need to play well with other development environments!**)
- Options:
  - cPickle = python extension coded in C, fast – usually available, use this
  - pickle = pure python, same thing, slower, 100% compatible, always available
  - No size limitations on serializable objects

Serializing Data using cPickle
(w.r.t naming: software engineers are not poets)

- Basic operations: dump and load
- Dump: store arbitrary data structure
  - Supports text and binary forms (where might you need text data?)
- Load
  - Compatibility is guaranteed from one Python release to the next
  - Machine and implementation independent
- In between dumps and loads you can
  - Store data to a file, compress, send over a network, etc

Simple example

```
import cPickle

donuts = {'homer':12, 'lisa':0, \
'marge':1, 'bart':6}

#serialize to text

text = cPickle.dumps(donuts)

#binary string, faster, more compact

bytes = cPickle.dumps(donuts, 2)

print bytes

#bring it back

restored_donuts = cPickle.loads(text)

restored_donuts_2 = cPickle.loads(bytes)

print restored_donuts_2
```

```
€}q(UhomerqKUlisaqKU
margeqKUbartqKu.

{'homer': 12, 'lisa': 0,
'marge': 1, 'bart': 6}
```

Store, compress, and load objects using a generator

```
import cPickle, gzip
def store(f_name, *objs):
    out = gzip.open(f_name, 'wb')
    for object in objs:
        cPickle.dump(object, out, 2)
    out.close()
```

```
def retriever(f_name):
    in_file = gzip.open(f_name, 'rb')
    while True:
        try:
            yield cPickle.load(in_file)
        except EOFError:
            ...
    in_file.close()
```

Pickling class instances and mixed types

```
foo = 'hello pickle world'
Bar = [7,5,1,9]
x = range(5)

store('test.dat', foo,bar, x)
x = retriever('test.dat')

while True:
    try:
        print x.next()
    except StopIteration:
        Break
```

```
hello pickle world
[7, 5, 1, 9]
[0, 1, 2, 3, 4]
```

```
class Donut():
    def __init__(self):
        self.tasty = True
        self.homer = 'hungry'
        self.cost = {'jelly':5, \
            'orange':1}

d = Donut()
store('test.dat', d)
x = retriever('test.dat')
y = x.next()
print y
print y.tasty
```

```
<__main__.Donut instance at
0x78cd8>
True
```

The Python Database API (DBAPI)

- Python specifies a common interface for database access, but the standard library does not include a RDBMS (relation db management sys) module - why?
- Designed to encourage similarity between database implementations – pick a module, same patterns apply
  - Defines common connection objects, cursor objects, types, etc

Implementations

- There are many free third-party modules (including XML db support).
- Pretty much these all work the same way programatically
- Differences are mostly in SQL variations
- PostgreSQL:http://www.initd.org/
- PostgreSQL: http://pybrary.net/pg8000/
- MySQL http://sourceforge.net/projects/mysql-python
- MSSQL: http://pymssql.sourceforge.net/

DBAPI Pattern

- Download and install the DBAPI implementation
- Import the module and call the connect function (when you're finished, remember to close it)
- Specify the server address, port, database, and authentication
- Get a cursor, use it to execute SQL (cursors are emulated for DBs which do not support them)
- Fetch results as a sequence of tuples, one tuple per row in the result, where tuple indexes correspond to columns
- Cursors pretty much work the way you expect in other languages, just with less code.
- Standard methods on cursors: fetchone(), fetchmany(), fetchall()

Accessing a MySQL Database, getting column names

```
import MySQLdb
#create a connection object
con = \
MySQLdb.connect('127.0.0.1', \
      port=3306, user='tomato', \
      passwd='squish', db='test')

#get a cursor
cursor = con.cursor()

#some quick sql
sql = 'SELECT * FROM Simpsons

#execute and fetch
cursor.execute(sql)

results = cursor.fetchall()
print results
#close the connection
con.close()
```

```
id, name, favorite_food

0, homer, donuts

1, marge, pasta

..

[(0, 'homer', 'donuts'), (1,
'marge', 'pasta')]

print results[0][1]
homer

columns = [i[0] for i in \
      cur.description]

print columns
Id, name, favorite_food
```

A more elegant way to access columns

```
def fields(cursor):
    """ Given a DB API 2.0 cursor object that has been executed, \
        returns a dictionary that maps \
        each field name to a column index, 0 and up"""
    results = {}
    for column, description in enumerate(cursor.description):
        results[description[0]] = column
    return results
```

Source: The Python CookBook – O'Reilly

Insert some data into a PostgreSQL database

```
from pg8000 import DBAPI
conn = DBAPI.connect(host='localhost', user="tomato",
password="squish")
cursor = conn.cursor()
cursor.execute(\
    'CREATE TEMPORARY TABLE book (id SERIAL, title TEXT)')
cursor.execute("INSERT INTO book (title) VALUES (%s), (%s) \
     RETURNING id, title",("Ender's Game", "Speaker for the
Dead"))
for row in cursor:
    id, title = row
    print "id = %s, title = %s" % (id, title)
#id = 1, title = Ender's Game
#id = 2, title = Speaker for the Dead
conn.commit()
cursor.close()
conn.close()
```

Living in a Windows World

- Proprietary formats abound (.xlxs, .docx, etc)
- Often times you need to access data stored in them, or create them on the fly
- Couple of ways to do that
  - Leverage the Win32 API and the common object model (trivial, but annoying)
  - Leverage libraries with specific format knowledge (case by case)
- Note on corporate environments
  - make yourself look good.

PyWin32 winapi and COM

- COM: older protocol enabling interprocess communication and dynamic object creation
  - Umbrella term: encompasses OLE (object linking and embedding)
- Language neutral, the idea is to allow use of objects with minimal knowledge of their internal structure
- Well supported in windows
- References:
- http://www.microsoft.com/com/default.mspx
- http://sourceforge.net/projects/pywin32/

Leverage Win32 API to set file attributes

```
import win32com, win32api, os

filename = 'foo.txt'
f = open(filename, 'w')
f.close()
win32api.SetFileAttributes(filename,\
     win32com.FILE_ATTRIBUTE_HIDDEN)
#FILE_ATTRIBUTE_READONLY
#FILE_ATTRIBUTE_NORMAL
```

Converting word documents to plaintext via COM (icky, but great when you need it)

```
import os, sys, win32com.client
word = win32com.client.Dispatch("Word.Application")
try:
    for current_dir, sub_dirs, files in os.walk(sys.argv[1]):
        for filename in files:
            if not (filename.endswith.endswith('doc')): continue
            doc = os.path.abspath(os.path.join(path, filename))
            print 'converting %s' % doc
            word.Documents.Open(doc)
            new_name = doc[:-3] + 'txt'
            word.ActiveDocument.SaveAs(new_name, \
              FileFormat=win32com.client.constants.wdFormatText)
            word.ActiveDocument.Close()
finally:
    word.Quit()
```

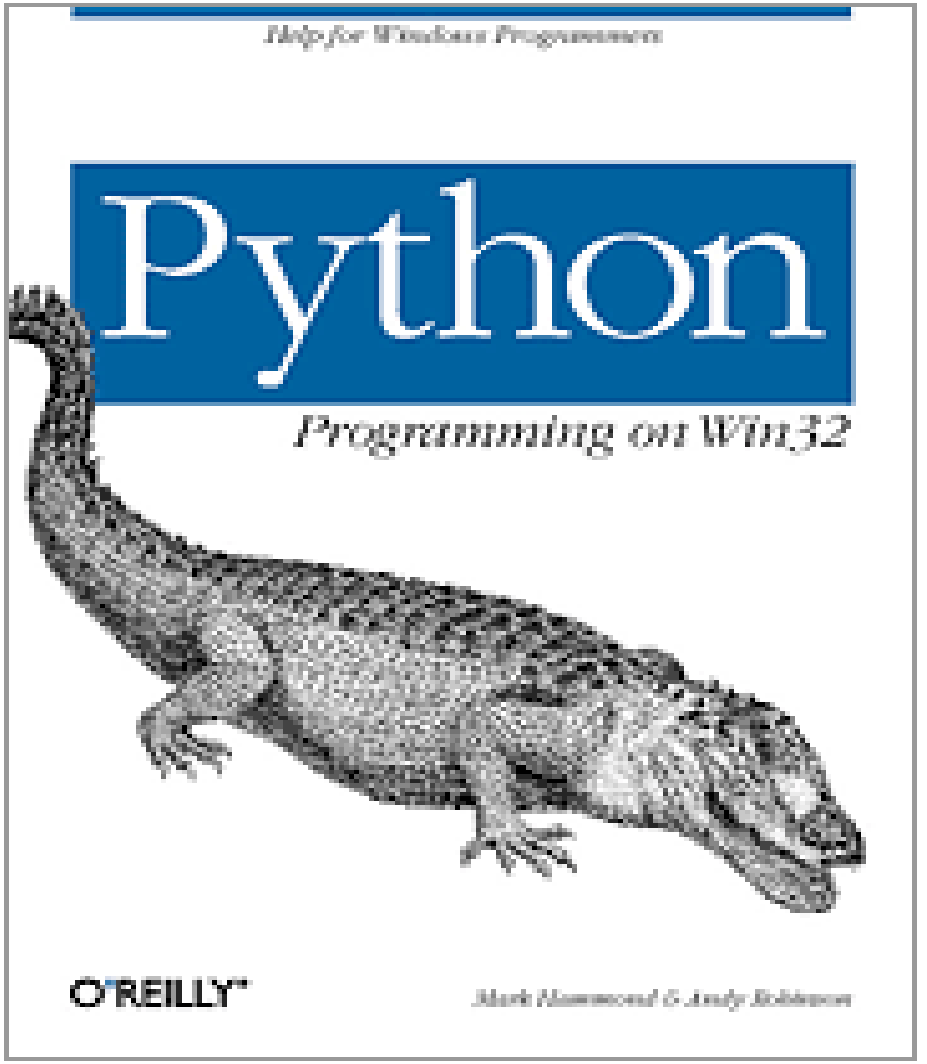
Programatically control Excel via COM

```
# reference an Excel instance
import win32com.client
app = \
win32com.client.Dispatch("Excel.
Application")
# set visible if you like
app.Visible=1
# create a workbook
book = app.Workbooks.Add()
# get a reference to the first
sheet
sheet = book.Sheets(1)
# extract the value from a cell
val = xlSheet.Cells(1,1).Value
# insert a formula
sheet.Cells(1,2).Value = "5"
sheet.Cells(1,3).Value = "=a2*2"

...
```

- Corporate environments LOVE this
- Nice if the output of your script appears in a prettily formated excel sheet, yes?
- Icky – but trivial to code with the right documentation

Python Programming On Win32

- Detailed resources available
- You can integrate code pretty deeply
- Customers will love you
- FYI: you can work w/ Open Office standards (xml based) without any special libraries



Tkinter GUIs

- GUIs are programmed via toolkits, which supply prebuilt controls (aka widgets)
- Widgets range from simple buttons to complex graphs
- There are many toolkits available for Python
- Many are cross platform – ignore anything that's not
- Most popular toolkit is probably wxpython
- Tkinter is included by default

Tkinter

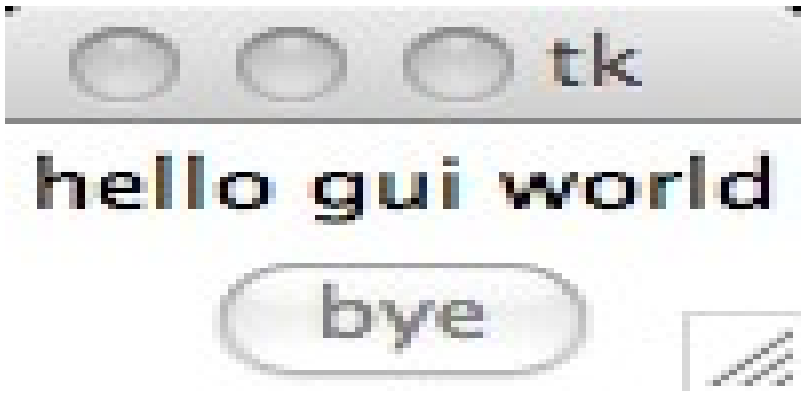
- Object oriented Python wrapper for TK
- Tk – basic cross platform toolkit originally written for Tcl, wrappers available for Ruby and Perl as well.
- Works on Windows / Mac / Linux
- FYI: when debugging gui applications, run them as a standalone from the command line – interference issues running one tk gui w/in another
- We're interested in simple, functional guis

Tkinter Fundamentals

- Basic pattern
- Import Tkinter
- Create, configure, and position the widget
- Enter the Tk mainloop at which point your code becomes event driven
- Terminology
  - layout manager – responsible for geometric on screen layout
  - Pack() - hands control of the widget to the layout man.

GUIs 101

```
import sys, Tkinter
Tkinter.Label( \
    text='hello gui world').pack()
Tkinter.Button(text='bye', \
       command=sys.exit).pack()
Tkinter.mainloop()
```



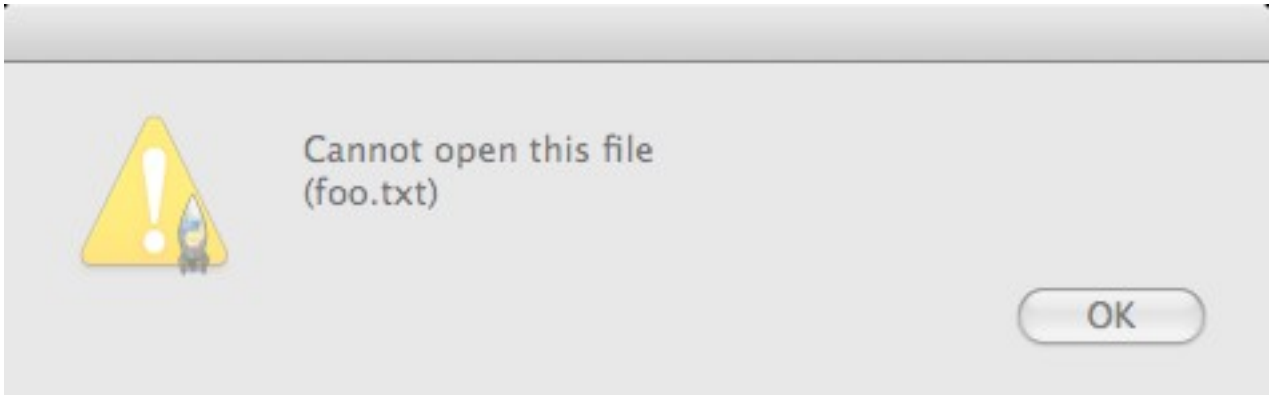
- The calls to label and button instantiate the widgets
- We do not specify parent windows, so these are placed on the applications top level
- Notice the command field, this may be any callable object

Widget	Description
Button	A simple button, used to execute a command or other operation.
Canvas	Structured graphics. This widget can be used to draw graphs and plots, create graphics editors, and to implement custom widgets.
Checkbutton	Represents a variable that can have two distinct values. Clicking the button toggles between the values.
Entry	A text entry field.
Frame	A container widget. The frame can have a border and a background, and is used to group other widgets when creating an application or dialog layout.
Label	Displays a text or an image.
Listbox	Displays a list of alternatives. The listbox can be configured to get radiobutton or checklist behavior.
Menu	A menu pane. Used to implement pulldown and popup menus.
Menubutton	A menubutton. Used to implement pulldown menus.
Message	Display a text. Similar to the label widget, but can automatically wrap text to a given width or aspect ratio.
Radiobutton	Represents one value of a variable that can have one of many values. Clicking the button sets the variable to that value, and clears all other radiobuttons associated with the same variable.
Scale	Allows you to set a numerical value by dragging a "slider".
Scrollbar	Standard scrollbars for use with canvas, entry, listbox, and text widgets.
Text	Formatted text display. Allows you to display and edit text with various styles and attributes. Also supports embedded images and windows.
Toplevel	A container widget displayed as a separate, top-level window.

Warnings

(what's wrong about this pattern?)

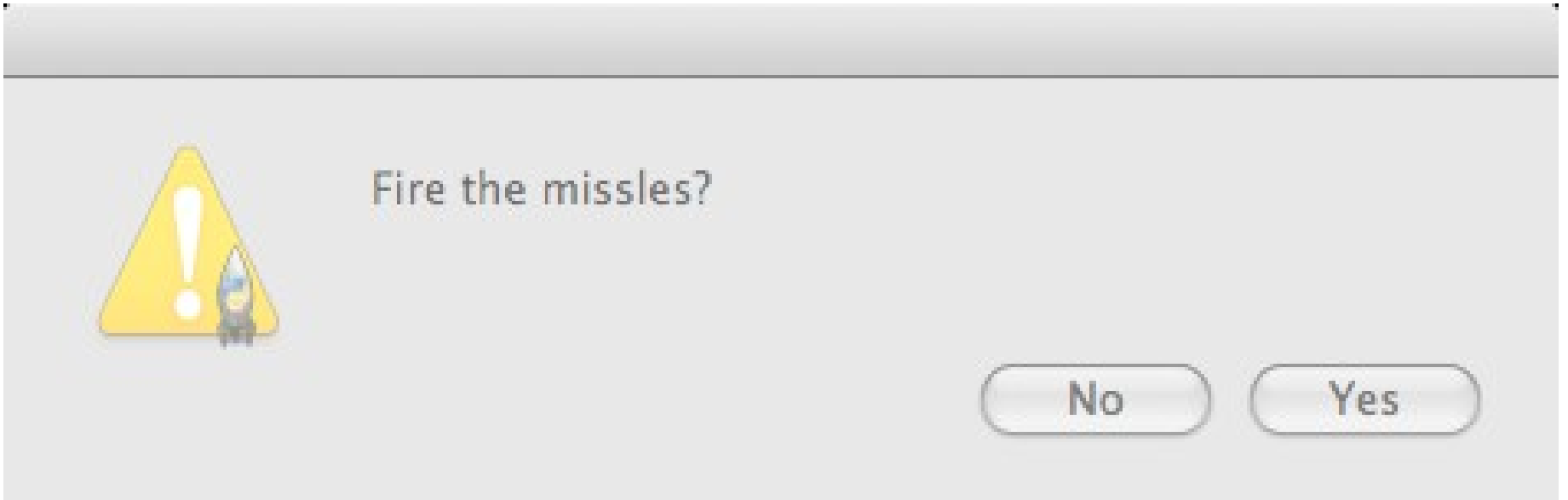
```
import tkMessageBox
name = 'foo.txt'
try:
    fp = open(name)
except:
    tkMessageBox.showwarning("Open file",\
        "Cannot open this file\n(%s)" % name)
```



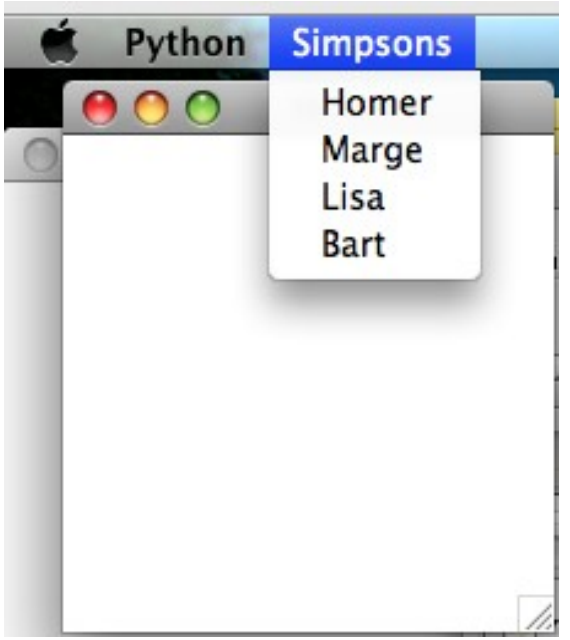
Questions

```
import tkMessageBox
print tkMessageBox.askquestion(\
    message='Fire the missles?')
```

```
'yes'
```



Menus




```
import Tkinter

root = Tkinter.Tk()

menubar = Tkinter.Menu()

def handle_click(menu, entry): print menu, entry

filemenu = Tkinter.Menu()

for x in 'Homer', 'Marge', 'Lisa', 'Bart':

    filemenu.add_command(label = x, command=lambda
x=x:handle_click('Simpsons', x))

menubar.add_cascade(label='Simpsons', menu=filemenu)

root.config(menu=menubar)

Tkinter.mainloop()
```

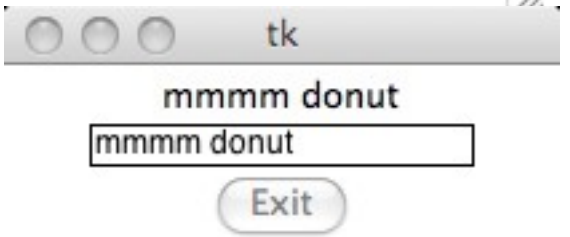
Simpsons Marge

Tkinter Variable Objects

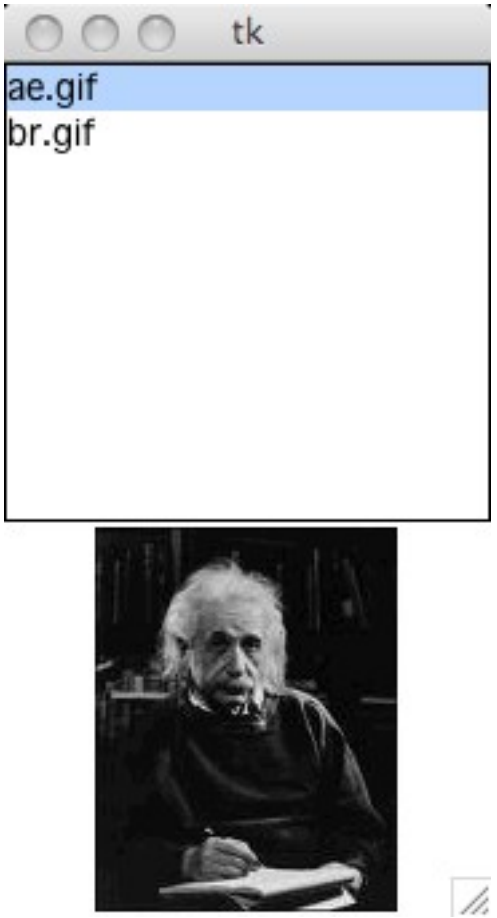
- The Tkinter module supplies classes whose members are variables
  - DoubleVar, IntVar, StringVar
- You can pass a StringVar as the textvariable parameter for a widget
- When you do this, that widget will display changes to the variable

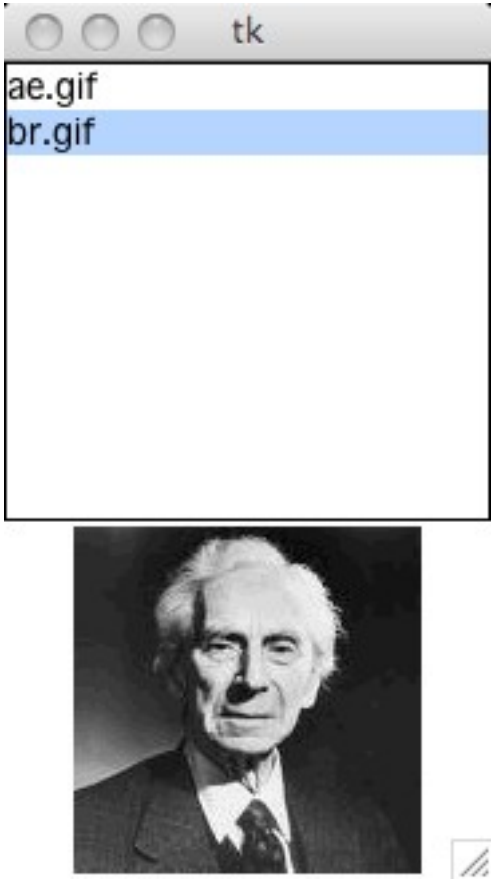
Tkinter Variable Objects

```
import Tkinter
root = Tkinter.Tk()
tv = Tkinter.StringVar()
Tkinter.Label(textvariable=tv).pack()
Tkinter.Entry(textvariable=tv).pack()
tv.set('Hello tk variable world')
Tkinter.Button(text='Exit', command=root.quit).pack()
Tkinter.mainloop()
```



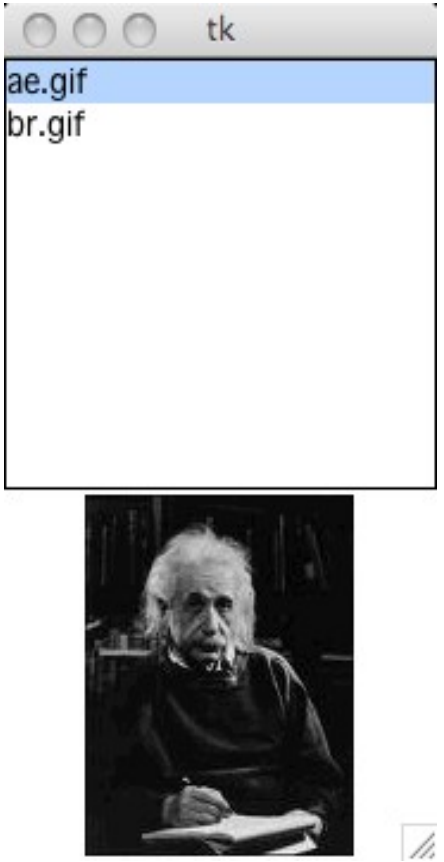
Tkinter Lists, Images, and Clicks





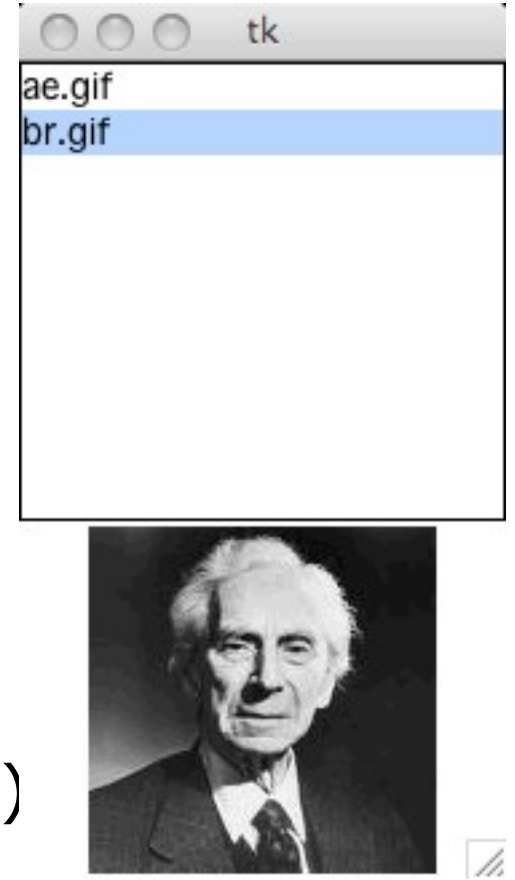
Tkinter Lists, Images, and Clicks

```
import os,  Tkinter

root = Tkinter.Tk()
L = Tkinter.Listbox(selectmode=Tkinter.SINGLE)
imgdict = {}
path= '/Users/josh/Desktop'
for name in os.listdir(path):
    if not name[-3:] == 'gif': continue
    imgpath = os.path.join(path, name)
    img = Tkinter.PhotoImage(file=imgpath)
    imgdict[name] = img
    L.insert(Tkinter.END, name)

L.pack()

...
```



Tkinter Lists, Images, and Clicks

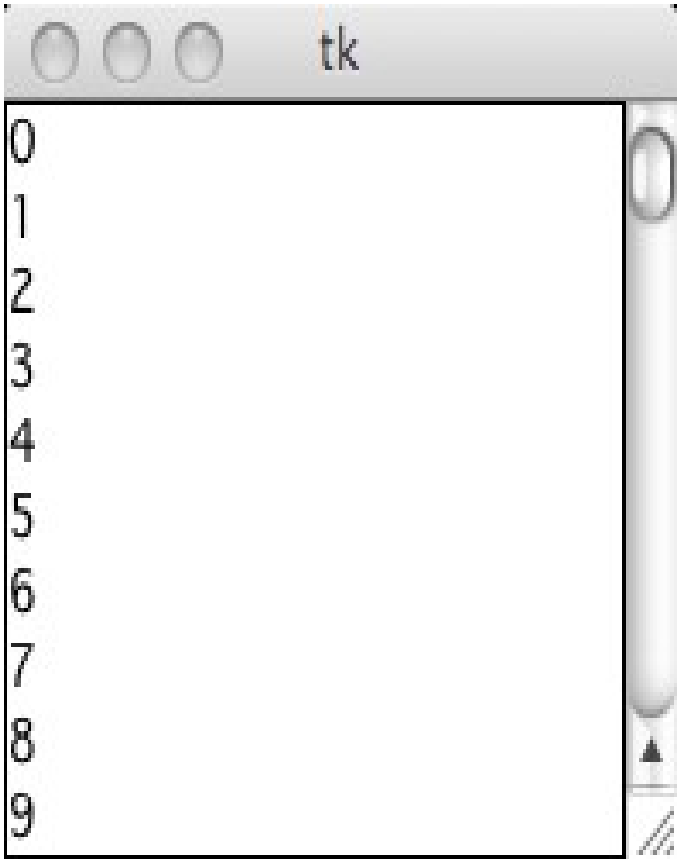
```
...

label = Tkinter.Label()
label.pack()


def list_entry_clicked(*ignore):
    name = L.get(L.curselection()[0])
    label.config(image=imgdict[name])


L.bind('<ButtonRelease-1>',list_entry_clicked)

root.mainloop()
```



Tkinter Lists and Scroll bars

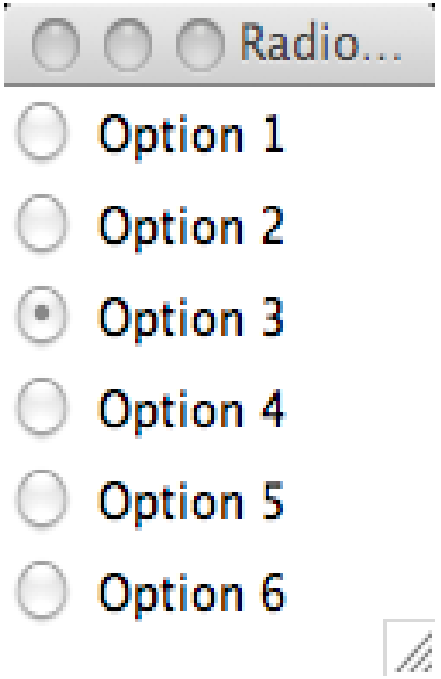
Listbox can display textual items, selection capability
L.delete(0, END) #clear the box
L.insert(End, foo) #insert a string to the back

```
import Tkinter
S = Tkinter.Scrollbar()
L = Tkinter.Listbox()
S.pack(side=Tkinter.RIGHT, fill=Tkinter.Y)
L.pack()
S.config(command=L.yview)
L.config(yscrollcommand=S.set)
for i in range(100):
    L.insert(Tkinter.END, str(i))
Tkinter.mainloop()
```



Tkinter Radio Buttons

```
from Tkinter import *
root = Tk()
root.title('Radiobutton')
opts =[('Option 1', 1), ('Option 2', 2), ('Option 3', 3),
       ('Option 4', 4), ('Option 5', 5), ('Option 6', 6)]
var = IntVar()
def which():
    print var.get(), 'selected'
for text, value in opts:
    Radiobutton(root, text=text, value=value,\
      variable=var, command=which).pack()
var.set(3)
root.mainloop()
```



4 Selected
5 Selected

Frames

```
from Tkinter import *
class LittleWrapper:
    def __init__(self, parent):
        frame = Frame(parent)
        frame.pack()
        self.button = \
                Button(frame, text="Bye", command=frame.quit)
        self.button.pack(side=LEFT)
        self.hi_there = \
                Button(frame, text="Hello", command=self.say_hi)
        self.hi_there.pack(side=LEFT)

    def say_hi(self):
        print "hi there, everyone!"

root = Tk()
app = LittleWrapper(root)
root.mainloop()
```

Frames

```
class LittleWrapper:
    def __init__(self, master):
        frame = Frame(master)
        frame.pack()
```

- The constructor (the __init__ method) is called with a parent widget (the master), to which it adds a number of child widgets.
- The constructor starts by creating a Frame widget. A frame is a simple container, and is in this case only used to hold the other two widgets.

Tkinter References

- http://docs.python.org/library/tkinter.html
- http://www.pythonware.com/library/tkinter/introduction/
- http://wiki.python.org/moin/TkInter