Topics for this week

Introduction to graphing and visualization software

- VPython
- MatPlotLib

VPython

- A Python graphics module for modeling and simulation
- VPython = Python + IDLE + visual
- Supports the simulation of physical systems
  - Chabay and Sherwood, the authors of "Matter and Interaction" are co-developers of VPython
- http://www.vpython.org/VPython_Intro.pdf - overview for new Python users
- http://www.vpython.org/webdoc/visual/index.html
- from visual import *

MatPlotLib

- Matplotlib is a library for making 2D plots (of arrays)
- Origins in MATLAB
- Its philosophy: *Everyone should be able to create simple plots with just a few commands*
- http://matplotlib.sourceforge.net/users/pyplot_tutorial.html#pyplot-tutorial
- http://matplotlib.sourceforge.net/users/index.html

3 Monday, February 9, 2009

Clicker question

```
def f(list,k):
    list[0] = "change"
    list[1] = k
    k = k+10
    return

def main():
    L1 = ['a', 'b', 'c', 'd']
    k = 10

    f(L1,0)

    print L1
    print k

main()
```

What is printed?

A. ['change', 0, 'c', 'd']
   10
B. [a', 'b', 'c', 'd', 'f']
   10
C. ['change', 0, 'c', 'd']
   20
D. [a', 'b', 'c', 'd']
   20

4 Monday, February 9, 2009

Clicker question

```
def what(n):
    p=1
    for i in range(2,n+1):
        p = p*i
    return p
```

What is computed?

A. n! for n≥1
B. n! for n≥2
C. n*p
D. (n+1)! for n≥2
E. (n+1)! for n≥1

Clicker Question (participation only)

What plotting software have you used before?

A. **None**
B. **MS Excel**
C. **MatLab/Mathematica/Maple**
D. **VPython**
E. **Other**

About Part 1 of Project 1

- scale_volume(data, factor) - Scale the volume of a sound wave
- normalize(data) - Normalize (maximize volume of) a sound wave
- silence(dur) - Generate a silence
- *sin_sample(freq, amp, dur) - Generate a sine wave*

- half_speed(data) - generates a new array containing the same sound, but at half of the original speed
- combine_mean(wavs) - Combine a given list of sound waves into one of the same length using means
- combine_interleave(wavs) - Combine a given list of sound waves into one by interleaving samples

- echo(data, delay, level) - Add an echo effect to a sound

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moonpeople.py (access from project description)

```
from snd_io import read_wav_file, play
from primitives import *
from numpy import *

def main():
    data = read_wav_file('preamble.wav')
    slow = half_speed(data)

    dur = len(data)/float(SAMPLE_FREQUENCY)
    sine_data1 = sin_sample(440, .05, dur)
    sine_data2 = sin_sample(550, .05, dur)
    sine_data = combine_interleave([sine_data1, sine_data2])

    data = append(data, silence(dur))

    normalize(slow)
    data = combine_mean([sine_data, data, slow])
    data = echo(data, .3, .25)

    normalize(data)
    scale_volume(data, 1.2)

    play(data)

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

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Visual Reference

Previous: VPython Documentation **Up:** VPython Documentation **Next:** The cylinder Object

The Visual Module of VPython

VPython is the Python programming language plus a 3D graphics module called "Visual" developed by David Scherer. This document describes all of the Visual capabilities. To invoke the Visual module, place the following statement at the start of the file:

```
from visual import *
```

Introduction: for those new to Python and Visual

Basic Display Objects

cylinder **Start with cylinder:** much of what is said here applies to other objects as well.
arrow
cone
pyramid
sphere
ring
box
ellipsoid
curve
helix
convex

label
frame: combining several objects into one
faces: low-level object for special purposes
Additional Attributes: visible, frame, display, class, members
Convenient Defaults
Rotating an Object
Specifying Colors
Deleting an Object
Limiting the Animation Rate
Floating Division: 3/4 is 0, but 3./4. is 0.75 in Python

Vector Computations

- vector, including mag, mag2, norm, cross, dot, rotate, diff_angle

Plotting Graphs of Functions or Data

- Graph Plotting: gcurve, gdots, etc.

http://www.vpython.org/webdoc/visual/index.html

Visual Reference

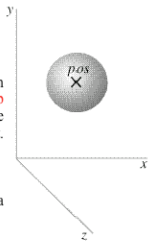
Previous: The pyramid Object **Up:** Contents **Next:** The ring Object

The sphere Object

Here is an example of how to make a sphere:

```
ball = sphere(pos=(1,2,1), radius=0.5)
```

This produces a sphere centered at location (1,2,1) with radius = 0.5, with the current foreground color.



The sphere object has the following attributes and default values, like those for cylinders except that there is no length attribute: pos (0,0,0), x (0), y(0), z(0), axis (1,0,0), color (1,1,1) which is color.white, red (1), green (1), blue (1), and up (0,1,0). As with cylinders, up has a subtle effect on the 3D appearance of a sphere. The axis attribute only affects the orientation of the sphere and has a subtle effect on appearance; the magnitude of the axis attribute is irrelevant. Additional sphere attributes:

radius Radius of the sphere, default = 1

Note that the pos attribute for cylinder, arrow, cone, and pyramid corresponds to one end of the object, whereas for a sphere it corresponds to the center of the object.

Originally there was a label attribute for the sphere object, but this has been superceded by the label object.

Visual Reference

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VPython Visual Objects

- VObjects exist for program duration
- VObjects are displayed on the display window
  - One default window
  - For multiple windows, give windows names
- VObjects have attributes
  - pos, color, length/height/width/radius, etc
- Changing attributes changes display

See example programs posted

```
# program vp2.py
from visual import *

ball = sphere(pos=(-5,0,0), radius=0.5, color=color.red)
wallR = box(pos=(6,0,0), size=(0.2,4,4), color=color.green)

dt = 0.05
ball.velocity = vector(0.2,0,0)

while (1==1):
    rate(150)
    ball.pos = ball.pos + ball.velocity*dt
    if ball.x > wallR.x:
        ball.velocity.x = -ball.velocity.x
```

vp0.py, vp1.py, vp2.py, Bounce.py, bounce 2.py, vpythonPoints.py

Other VPython Objects

- These are not displayed
- A vector object supports the usual:
  - mag, mag2 (mag squared), norm (normalized), cross, dot, rotate, etc

How we will use VPython

- Visualize/animate how data changes during the computation
  - Need to decide how data is visualized
- Visualize how quantities computed change during the computation
- Summarize results produced in a visual way
  - Use VPython for 3-D
- Examples
  - Animate points in square for Pi computation (PS2)
  - Visualize a closest pair computation (PS3)

Creating points in the VPython window

```
def highlight_points(points):
    # all points are initially green
    # set point[0] to red and then visit all other points,
    # coloring the points blue

    # create the points in the VPython window
    # vpoints[i] corresponds to points[i]
    color=(0,1,0)  # green
    vpoints = []
    for i in range(len(points)):
        vpoints.append(sphere(pos=points[i],radius=.4,color=color))

    vpoints[0].color = (1,0,0) # red

    for i in range(1,len(points)):
        vpoints[i].color = (0,0,1)
        rate(10)
```

vpythonPoints.py

VPython Graphs

- VPython has a powerful graph plotting subsystem
- from visual.graph import *
- Lines (gcurve), marks (gdots), bars (gvbars, ghbars), bins (ghistogram)