VISUALIZATION WITH PYTHON

Matplotlib

- 2D plotting library for python
- Can be used in scripts and in interactive shell
- Publication quality in various hardcopy formats
- “Easy things easy, hard things possible”
- Some 3D functionality

Matplotlib interfaces

- Simple command style functions similar to Matlab

plot.py

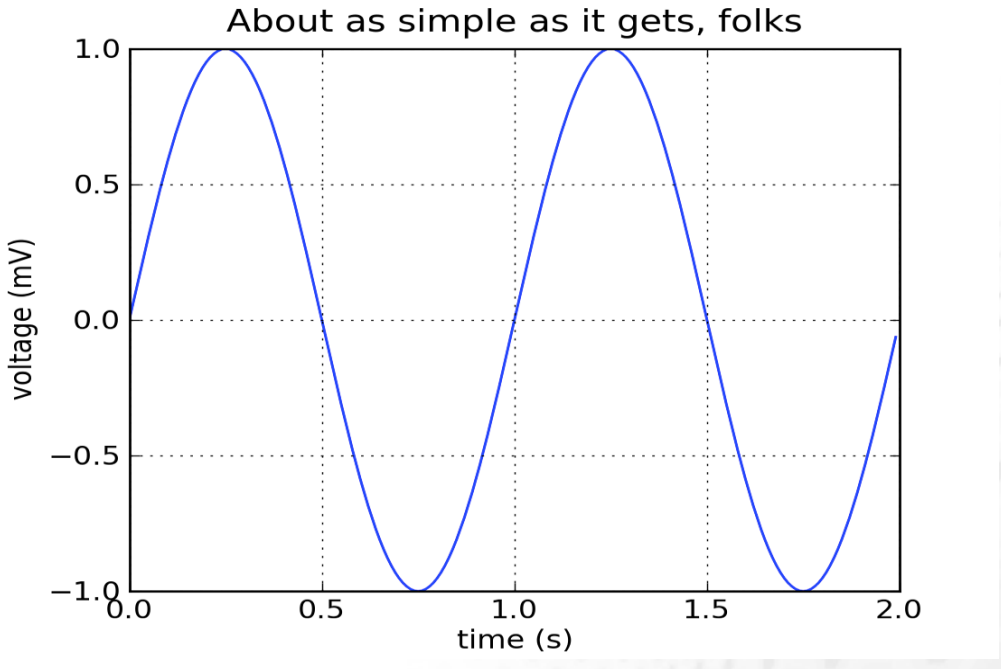
```
from matplotlib import pylab as pl
...
pl.plot(x, y)
```

- Powerful object oriented API for full control of plotting

Basic concepts

- Figure: the main container of a plot
- Axes: the “plotting” area, a figure can contain multiple Axes
- graphical objects: lines, rectangles, text
- Command style functions are used for creating and manipulating figures, axes, lines, ...
- The command style interface is stateful:
  - track is kept about current figure and plotting area

Simple plot

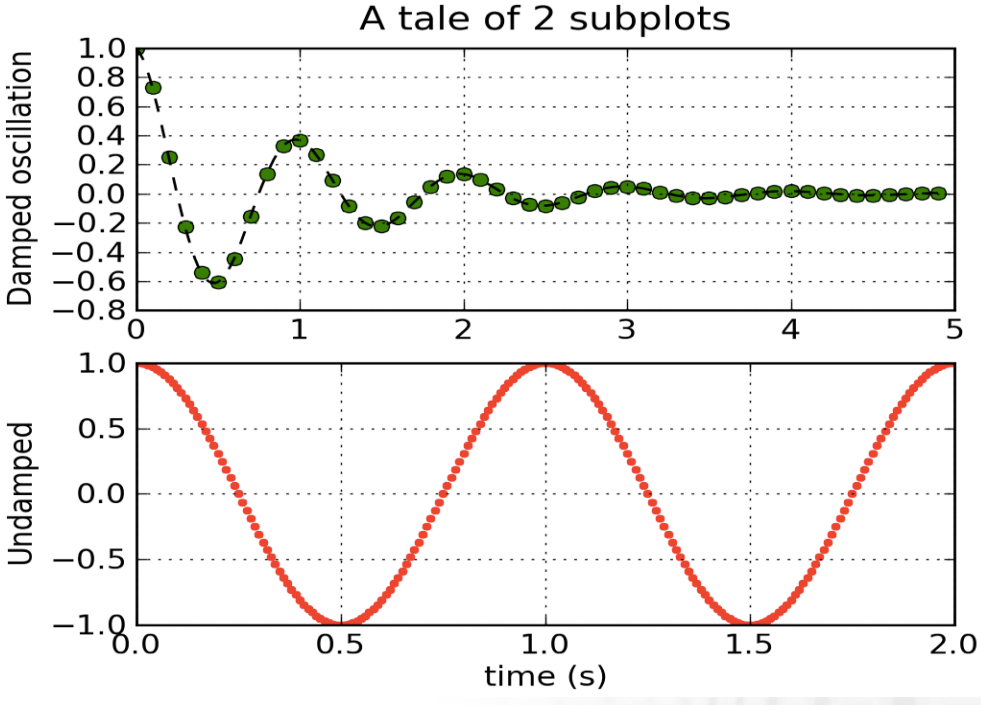


- plot : create a simple plot. Figure and axes are created if needed

Interactive vs. batch mode

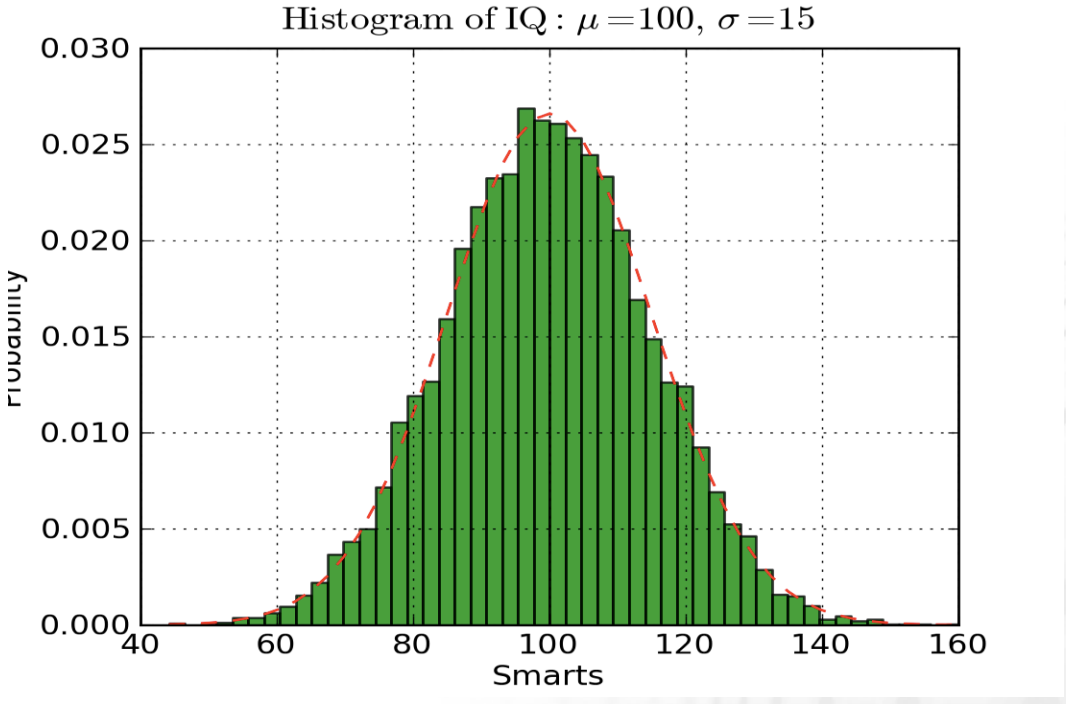
- In many installations batch mode is default
  - Figures do not show up without show() function
  - Batch mode is useful e.g. for writing out files during simulation and for heavy rendering
- Mode can be controlled as:
  - ion() : turn on interactive mode
  - ioff() : turn on interactive mode

Multiple subplots



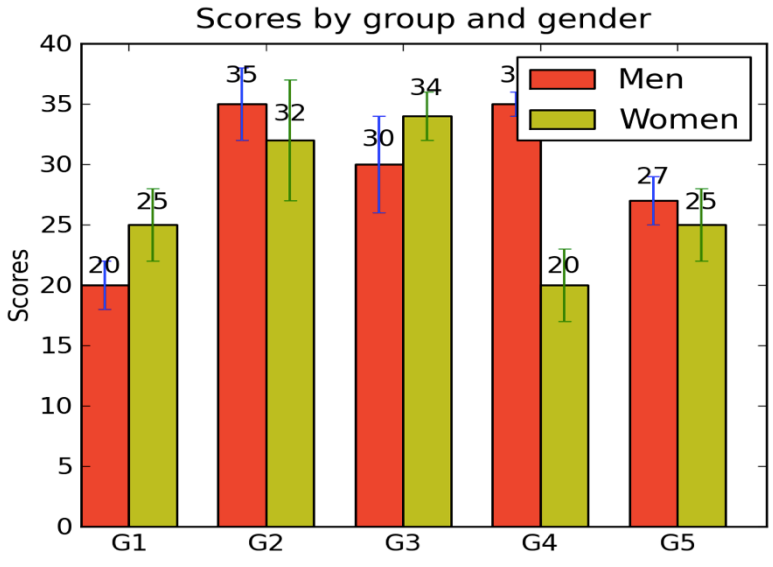
- subplot : create multiple axes in the figure and switch between subplots

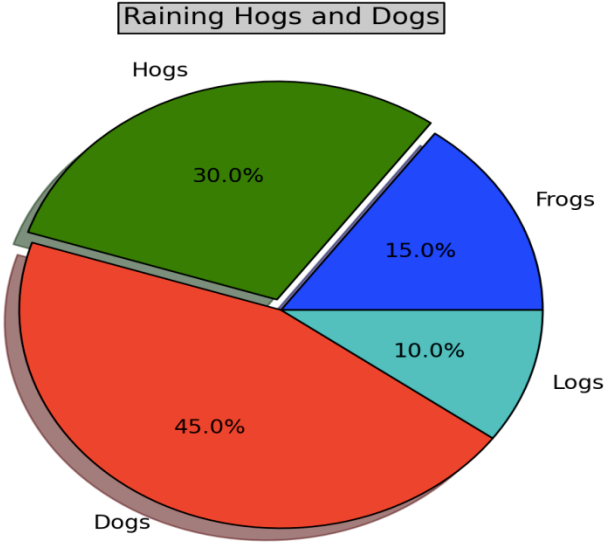
Histograms



- hist : create histogram
- Latex can be used with matplotlib

Bar and pie charts





- bar : bar charts
- pie : pie charts

Summary of basic functions

- Simple plot: plot
- Interactive vs. batch mode: ion / ioff
- Hardcopies: savefig
- Multiple plots: subplot
- Histograms: hist
- Bar charts: bar
- Pie charts: pie
- Switch plotting on top of existing figure: hold
- Contour plots: contour, contourf

Summary

- Matplotlib provides a simple command style interface for creating publication quality figures
- Interactive plotting and different output formats (.png, .pdf, .eps)
- Simple plots, multiplot figures, decorations
- Possible to use Latex in text

Mayavi

- General purpose, cross-platform tool for 3-D scientific data visualization
- Visualization of scalar, vector and tensor data in 2 and 3 dimensions
- Easy scriptability using Python
- Convenient functionality for rapid scientific plotting via mlab

Simple example

- Surface described by three 2D arrays

```
>>> from mayavi import mlab
>>> from numpy import pi, sin, cos, mgrid
>>>
>>> delta = pi/250.0
>>> phi, theta = mgrid[0:pi:delta, 0:2*pi:delta]
>>>
>>> r = sin(4*phi)**3 + cos(2*phi)**3 + sin(6*theta)**2 + cos(6*theta)**4
>>> x = r*sin(phi)*cos(theta)
>>> y = r*cos(phi)
>>> z = r*sin(phi)*sin(theta)
>>>
>>> mlab.mesh(x,y,z)
>>> mlab.show()
```

Simple example 2

- Iso-surfaces for a 3D volume

```
>>> from mayavi import mlab
>>> import numpy
>>>
>>> x, y, z = numpy.ogrid[-5:5:64j, -5:5:64j, -5:5:64j]
>>> scalars = 0.5*x*x + y*y + 2.0*z*z
>>>
>>> mlab.contour3d(scalars, contours=4, transparent=True)
```

Additional basic functions

- imshow : view a 2D array as an image
- surf : view a 2D array as a carpet plot
- quiver3d : plot arrows to represent vectors at data points
- savefig : write out a hardcopy

Summary

- Mayavi is easy-to-use tool for 3D visualization
- Surfaces, iso-surfaces, vector fields
- Hardcopies in various formats
- Vast set of more advanced features

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Python in High-Performance Computing

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