

Introductory Scientific Computing with Python

Introduction, IPython and Plotting

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SciPy India, 2015
December, 2015

Acknowledgement

FOSSEE group (fossee.in)
based at
IIT Bombay
and funded by
The National Mission on Education
through ICT,
Ministry of HRD, India

Outline

- 1 Checklist
- 2 Starting up IPython
- 3 Breaking out of loops
- 4 Plotting
 - Drawing plots
 - Decoration
 - More decoration
- 5 Multiple plots
- 6 Scripts – Saving & Running

Checklist

- 1 IPython
- 2 Editor
- 3 Data files:
 - `pendulum.txt`
 - `sslc.txt`
- 4 Images
 - `bird.png`

About the Tutorial

Intended Audience

- Engg., Mathematics and Science researchers with a reasonable programming background.

Goal: Successful participants will be able to

- Start using Python as plotting, computational tool.
- Use the basic libraries and tools for scientific computing with Python.

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Starting up ...

Terminal

```
$ ipython -pylab
```

```
# OR
```

```
$ jupyter console -pylab
```

Running IPython

```
In []: print("Hello, World!")  
Hello, World!
```

Exiting on the terminal

```
In []: ^D(Ctrl-D)  
Do you really want to exit([y]/n)? y
```

Or hit **Return** or **Ctrl-D** again

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Breaking out of Loops

Breaking out of loops

```
In []: while True:  
    ...:     print("Hello, World!")  
    ...:
```

Hello, World!

Hello, World! ^C (Ctrl-C)

KeyboardInterrupt

10 m

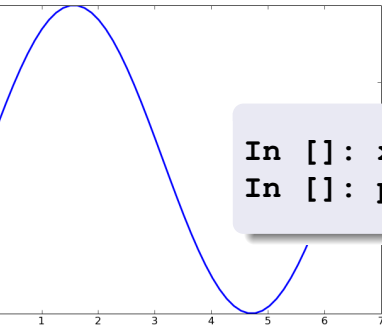
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First Plot



```
In []: x = linspace(0, 2*pi, 50)  
In []: plot(x, sin(x))
```

Walkthrough

```
x = linspace(start, stop, num)
```

returns **num** evenly spaced points, in the interval **[start, stop]**.

```
x[0] = start
```

```
x[num - 1] = end
```

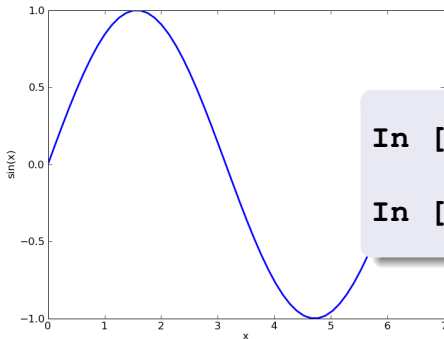
```
plot(x, y)
```

plots **x** and **y** using default line style and color

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Adding Labels



```
In []: xlabel('x')
```

```
In []: ylabel('sin(x)')
```


Another example

```
In []: clf()
```

Clears the plot area.

```
In []: y = linspace(0, 2*pi, 50)
```

```
In []: plot(y, sin(2*y))
```

```
In []: xlabel('y')
```

```
In []: ylabel('sin(2y)')
```

IPython tips ...

- Use **TAB** to complete command

History

- Accesses history (also from past sessions)
- Up and down arrows (**Ctrl-p**/**Ctrl-n**)
- Search: **Ctrl-r** and start typing
- **Ctrl-a**: go to start of line
- **Ctrl-e**: go to end of line
- **Ctrl-k**: kill to end of line

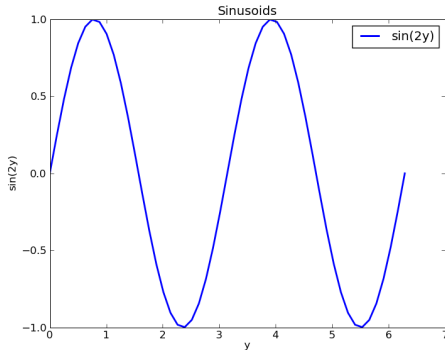
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Title and Legends

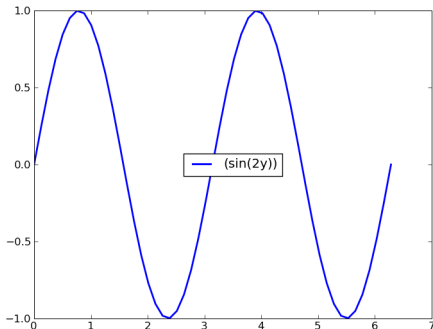
```
In []: title('Sinusoids')
```

```
In []: legend(['sin(2y)'])
```



Legend Placement

```
In []: legend(['sin(2y)'], loc = 'center')
```



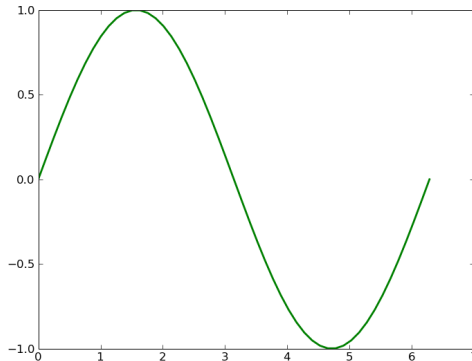
'best'
'right'
'center'

Showing it better

```
In []: plot(y, cos(y), 'r')
```

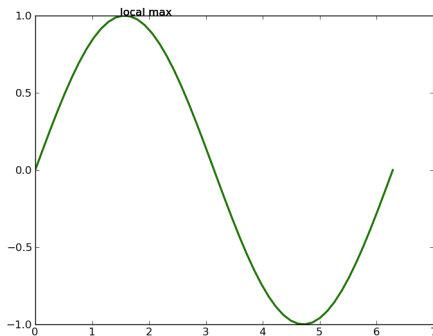
```
In []: clf()
```

```
In []: plot(y, sin(y), 'g', linewidth=2)
```



Annotating

```
In []: annotate('local max', xy=(1.5, 1))
```



Saving & Closing

```
In []: savefig('sin.png')
```

```
In []: close()
```

Supported formats to store images:

- png
- eps - Easy to embed in LaTeX files
- pdf
- raw
- rgba
- svg

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Overlaid Plots

```
In []: clf()  
In []: plot(y, sin(y))  
In []: plot(y, cos(y))  
In []: xlabel('y')  
In []: ylabel('f(y)')  
In []: legend(['sin(y)', 'cos(y)'])
```

By default plots would be overlaid!

Plotting separate figures

```
In []: clf()
In []: figure(1)
In []: plot(y, sin(y))
In []: figure(2)
In []: plot(y, cos(y))
In []: savefig('cosine.png')
In []: figure(1)
In []: title('sin(y)')
In []: savefig('sine.png')
In []: close()
In []: close()
```

Axes lengths

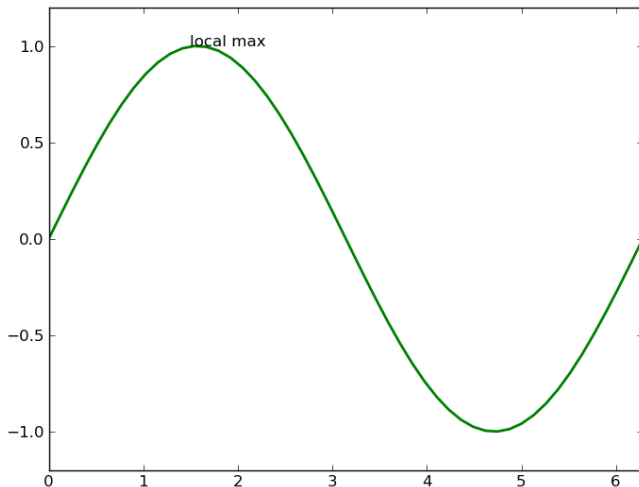
Getting axes lengths

```
In []: xmin, xmax = xlim()  
In []: ymin, ymax = ylim()  
In []: print xmin, xmax
```

Set the axes limits

```
In []: xlim(xmin, 2*pi )  
In []: ylim(ymin-0.2, ymax+0.2)
```

Axes lengths



IPython tips ...

- Try:

```
In []: plot?
```

to get more information on **plot**

- Try:

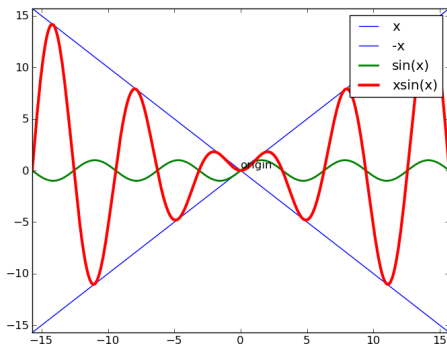
```
In []: plot??
```

to see the source code for **plot**

- Note: exit pager with “q” or “ESC”

Review Problem

- 1 Plot x , $-x$, $\sin(x)$, $x\sin(x)$ in range -5π to 5π
- 2 Add a legend
- 3 Annotate the origin
- 4 Set axes limits to the range of x



Review Problem ...

Plotting ...

```
In []: x = linspace(-5*pi, 5*pi, 500)
In []: plot(x, x, 'b')
In []: plot(x, -x, 'b')
In []: plot(x, sin(x), 'g', linewidth=2)
In []: plot(x, x*sin(x), 'r',
            linewidth=3)

:
```


Review Problem ...

Legend & Annotation...

```
In []: legend(['x', '-x', 'sin(x)',  
              'xsin(x)'])
```

```
In []: annotate('origin', xy = (0, 0))
```

Setting Axes limits...

```
In []: xlim(-5*pi, 5*pi)
```

```
In []: ylim(-5*pi, 5*pi)
```

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Command History

Use the `%hist` **magic** command of IPython

```
In []: %hist
```

This displays all the commands typed in so far aka Command History.

Careful about errors!

`%hist` will contain the errors as well.

Magic Commands?

Magic commands are commands provided by IPython to make our life easier.

Command History

Use the `%hist` **magic** command of IPython

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In []: %hist
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Magic Commands?

Magic commands are commands provided by IPython to make our life easier.

Saving commands into script

Use the **%save** magic command of IPython

```
%save script_name line_numbers
```

Line numbers can be specified individually separated by spaces or as a range separated by a dash.

```
%save four_plot.py 16 18-27
```

This saves from the history the commands entered on line numbers **16, 18, 19, 20, ... 27**

Python Scripts...

Now, `four_plot.py` is called a Python Script.

- run the script in IPython using
`%run four_plot.py`

`NameError: name 'linspace' is not defined`

To avoid this, run using `%run -i four_plot.py`

You may need to do `show()` to see a plot window

Python Scripts...

Now, four_plot.py is called a Python Script.

- run the script in IPython using

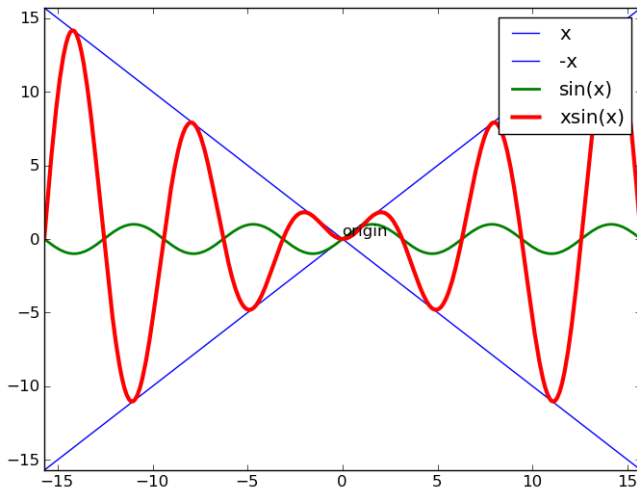
```
%run four_plot.py
```

NameError: name 'linspace' is not defined

To avoid this, run using **%run -i four_plot.py**

You may need to do **show()** to see a plot window

Result graph



What did we learn?

- Starting up IPython
- Creating simple plots
- Adding labels and legends
- Annotating plots
- Changing the looks: size, linewidth
- Accessing history, documentation
- `%hist` - History of commands
- `%save` - Saving commands
- Running a script using `%run -i`