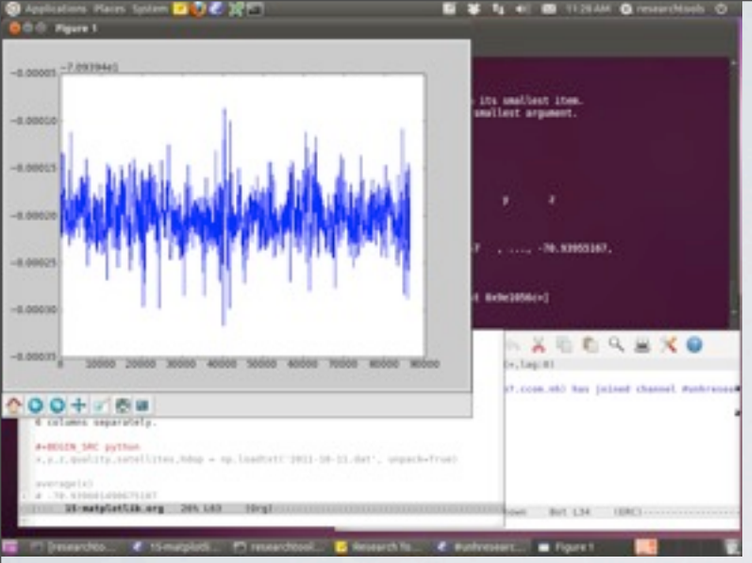
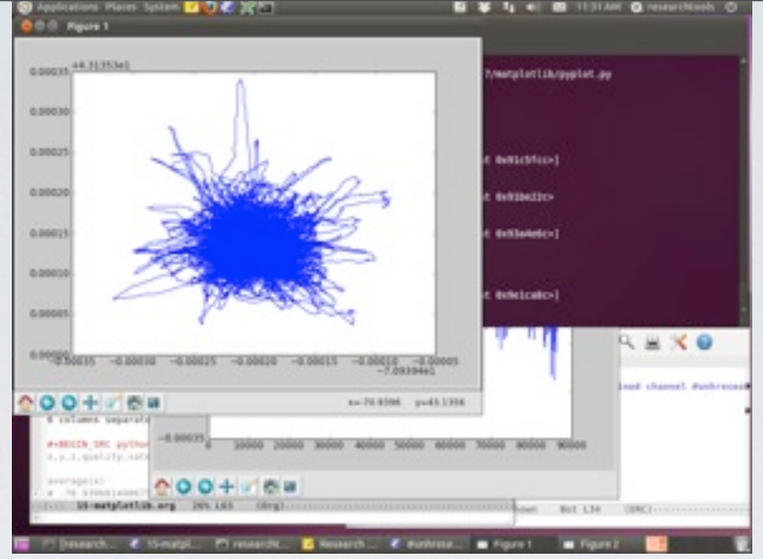
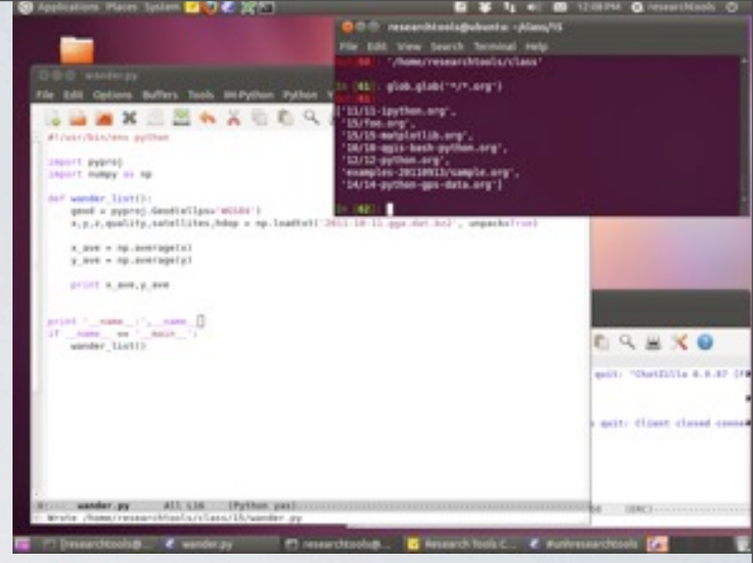




RESEARCH TOOLS 2011
LECTURE 15

2011-Oct-20

Kurt Schwehr
http://schwehr.org

UNH CCOM/JHC

Python: Matplotlib part 1

http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci895-researchtools/

Applications Places System 11:02 AM researchtools

emacs23@ubuntu

File Edit Options Buffers Tools Operate Mark Regexp Immediate Subdir Help

```
/home/researchtools/class/15:
total used in directory 8 available 10826732
drwxr-xr-x  2 researchtools researchtools 4096 2011-10-20 10:09 .
drwxr-xr-x 12 researchtools researchtools 4096 2011-10-20 10:09 ..
```

Research Tools Class 15

Search Link Text Notebook

Research Tools Class 15

Python: plotting data with Matplotlib and spatial distances with proj

Kurt Schwehr
2011-Oct-20
http://schwehr.org

```
-U:%%-  15                    All L5     (Dired by name)----------------------------
```

[researchtools@ubun... emacs23@ubuntu researchtools@ubunt... Research Tools Class 15

Index of /~schwehr/rt - Mozilla Firefox

File Edit View History Bookmarks Tools Help

Index of /~schwehr/rt

vislab-ccom.unh.edu/~schwehr/rt/

Google

Most Visited Getting Started Latest Headlines

Lectures:

No.	Date	Title/Notes	Audio	Present	Video	Blog
15	2011-10-20	Python: Matplotlib [org]				
14	2011-10-18	Python: parsing GPS da		pdf key		
Rd 1	2011-10-13	NOAA - Making Wave	b3	txt		
Vid 13	2011-10-15	Python part 6 - parsing		pdf key	YouTube H264	
13	2011-10-13	Python: if, while, functi	b3	pdf key		comment
Vid 12	2011-10-13	Python part 5 - while loops		pdf key	YouTube m4v	
Vid 11	2011-10-12	Python part 4 - if, modules, command line args [org]		pdf key	YouTube H264	
	2011-10-11	No class - UNH Monday Schedule				
Vid 10	2011-10-10	Emacs part 5 - modes [org]			YouTube H264	
Vid 9	2011-10-09	Python part 3: parts [org]			YouTube H264	
Vid 8	2011-10-09	Python part 2: ways to run python code [org]			YouTube H264	
12	2011-10-06	Python: files, for loops [org]	mp3 m4a ogg	pdf key ppt		comment
11	2011-10-04	ipython and python data types [org]	mp3 m4a ogg	pdf key ppt		comment
Vid 7	2011-10-02	Python part 1: intro to python/ipython [org]			YouTube H264	

Open Link in New Tab
Open Link in New Window
Bookmark This Link
Save Link As...
Send Link...
Copy Link Location

[researchtools@... emacs23@ubuntu researchtools@... Research Tools C... Index of /~schwe...

Applications Places System 11:04 AM researchtools

emacs23@ubuntu

File Edit Options Buffers Tools Operate

```
/home/researchtools/class/15:
total used in directory 8 available 10
drwxr-xr-x  2 researchtools researchto
drwxr-xr-x 12 researchtools researchto
```

-U:%%- 15 All L5 (Dired by name)----------

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
researchtools@ubuntu:~/class/15$ wget
wget: missing URL
Usage: wget [OPTION]... [URL]...

Try `wget --help' for more options.
researchtools@ubuntu:~/class/15$ wget http://vislab-ccom.unh.edu/~schwehr/Classe
s/2011/esci895-researchtools/src/15-matplotlib.org
--2011-10-20 11:04:11--  http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci89
5-researchtools/src/15-matplotlib.org
Resolving vislab-ccom.unh.edu... 192.168.3.3
Connecting to vislab-ccom.unh.edu|192.168.3.3|:80... connected.
HTTP request sent, awaiting response... 200 OK
Length: 7250 (7.1K) [text/plain]
Saving to: `15-matplotlib.org'

100%[======================================>] 7,250       --.-K/s   in 0s

2011-10-20 11:04:11 (14.6 MB/s) - `15-matplotlib.org' saved [7250/7250]

researchtools@ubuntu:~/class/15$
researchtools@ubuntu:~/class/15$
```

[researchtools@ubun... emacs23@ubuntu researchtools@ubunt... Research Tools Class 15

Applications Places System 11:06 AM researchtools

emacs23@ubuntu

File Edit Options Buffers Tools ERC Help

```
kurt_vm on irc.debian.org:6667 (+,lag:0)
*** - irc.debian.org message of the day
*** - ************************************************
*** - *              H    E    L    L   O             *
*** - *    Welcome on our new IRC server, running on:  *
*** - *    Debian GNU/Linux (www.debian.org)           *
*** - ************************************************
*** End of MOTD command
ERC> /join
```

-U:**- Unknown Bot L25 (ERC)----------

```
#+STARTUP: showall

#+TITLE:     Class 15: matplotlib - graphing
#+AUTHOR:    Kurt Schwehr
#+EMAIL:     schwehr@ccom.unh.edu
#+DATE:      <2011-10-20 Thu>
#+DESCRIPTION: Marine Research Data Manipulation and Practices
#+KEYWORDS: ipython matplotlib
#+LANGUAGE:  en
#+OPTIONS:   H:3 num:nil toc:t \n:nil @:t ::t |:t ^:t -:t f:t *:t <:t
#+OPTIONS:   TeX:t LaTeX:nil skip:t d:nil todo:t pri:nil tags:not-in-toc
#+INFOJS_OPT: view:nil toc:nil ltoc:t mouse:underline buttons:0 path:http://orgm→
#+LINK_HOME: http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci895-researchto→

* Introduction

This class is about starting to plot data!  Matplotlib is a *super*
```

--:--- 15-matplotlib.org Top L1 (Org)----------

```
p://vislab-ccom.unh.edu/~schwehr/Classe
otlib.org
om.unh.edu/~schwehr/Classes/2011/esci89

3.3
.3.3|:80... connected.
00 OK



==>] 7,250       --.-K/s   in 0s

plotlib.org' saved [7250/7250]
```

[researchtools@ubun... emacs23@ubuntu researchtools@ubunt... Research Tools Class 15

Friday, October 21, 11

/join #unhresearchtools

Applications Places System 11:07 AM researchtools

emacs23@ubuntu

File Edit Options Buffers Tools ERC Help

```
kurt_vm on #unhresearchtools (+,lag:0)
<nhassan> hi everyone
<kurt_vm> morning all
*** cenglert (~chatzill@lab8.ccom.nh) has quit: "ChatZilla 0.9.87 [Firefox
    6.0/20110811165603]"
*** Gmasetti (~chatzill@192.168.8.241) has joined channel #unhresearchtools
                                                                    [11:07]
<kurt_vm> please grab the org file and get the bz2 data file in the notes
<kurt_vm> do NOT bunzip the file!!
<matt_w> hi
*** bwelton (~chatzill@lab6.ccom.nh) has joined channel #unhresearchtools
*** cenglert (~chatzill@lab8.ccom.nh) has joined channel #unhresearchtools
<bwelton> hello
ERC>
-U:**-  #unhresearchtools@Unknown    Bot L21    (ERC)----------------------------
#+STARTUP: showall

#+TITLE:     Class 15: matplotlib - graphing
#+AUTHOR:    Kurt Schwehr
#+EMAIL:     schwehr@ccom.unh.edu
#+DATE:      <2011-10-20 Thu>
#+DESCRIPTION: Marine Research Data Manipulation and Practices
#+KEYWORDS: ipython matplotlib
#+LANGUAGE:  en
#+OPTIONS:   H:3 num:nil toc:t \n:nil @:t ::t |:t ^:t -:t f:t *:t <:t
#+OPTIONS:   TeX:t LaTeX:nil skip:t d:nil todo:t pri:nil tags:not-in-toc
#+INFOJS_OPT: view:nil toc:nil ltoc:t mouse:underline buttons:0 path:http://orgm→
#+LINK_HOME: http://vislab-ccom.unh.edu/~schwehr/Classes/2011/esci895-researchto→

* Introduction

This class is about starting to plot data!  Matplotlib is a *super*
--:---  15-matplotlib.org   Top L1     (Org)----------------------------------
```

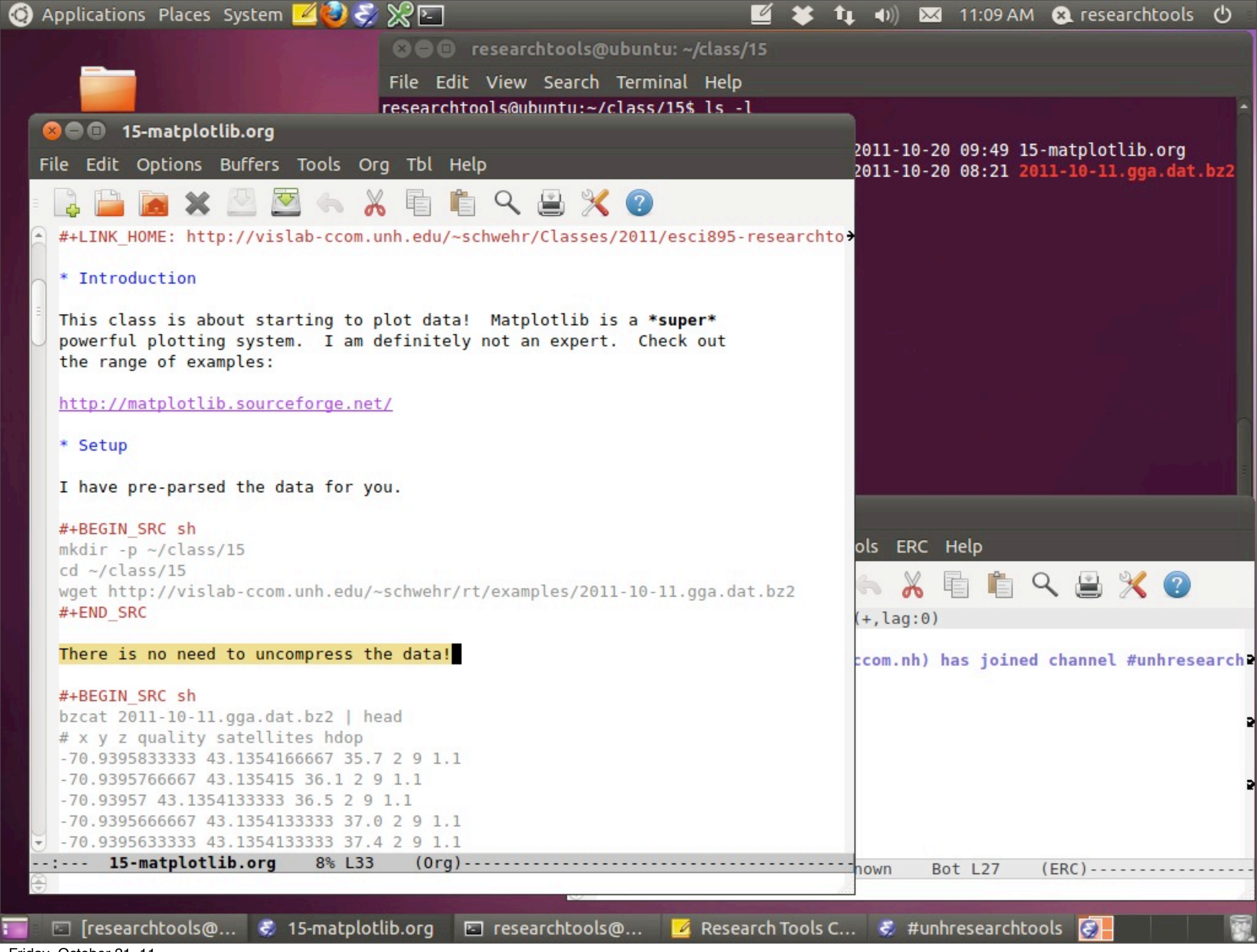
```
p://vislab-ccom.unh.edu/~schwehr/Classe
otlib.org
om.unh.edu/~schwehr/Classes/2011/esci89

3.3
.3.3|:80... connected.
00 OK


==>] 7,250       --.-K/s   in 0s

plotlib.org' saved [7250/7250]
```

[researchtools@ubun... emacs23@ubuntu researchtools@ubunt... Research Tools Class 15



Do NOT uncompress the 2011-10-11.gga.dat.bz2

Applications Places System 11:14 AM researchtools

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
researchtools@ubuntu:~/class/15$ ls -l
total 232
-rw-r--r-- 1 researchtools researchtools   7250 2011-10-20 09:49 15-matplotlib.org
-rw-r--r-- 1 researchtools researchtools 226512 2011-10-20 08:21 2011-10-11.gga.dat.bz2
researchtools@ubuntu:~/class/15$ bzcat 2011-10-11.gga.dat.bz2 | head
# x y z quality satellites hdop
-70.9395833333 43.1354166667 35.7 2 9 1.1
-70.9395766667 43.135415 36.1 2 9 1.1
-70.93957 43.1354133333 36.5 2 9 1.1
-70.9395666667 43.1354133333 37.0 2 9 1.1
-70.9395633333 43.1354133333 37.4 2 9 1.1
-70.9395633333 43.1354133333 37.8 2 9 1.1
-70.9395616667 43.1354133333 38.3 2 9 1.1
-70.9395616667 43.135415 38.7 2 9 1.1
-70.93956 43.1354133333 39.1 2 9 1.1
researchtools@ubuntu:~/class/15$
```

15-matplotlib.org

File Edit Options Buffers Tools Or

```
#+LINK_HOME: http://vislab-ccom.u

* Introduction

This class is about starting to p
powerful plotting system.  I am c
the range of examples:

http://matplotlib.sourceforge.net

* Setup

I have pre-parsed the data for yo

#+BEGIN_SRC sh
mkdir -p ~/class/15
cd ~/class/15
wget http://vislab-ccom.unh.edu/~schwehr/rt/examples/2011-10-11.gga.dat.bz2
#+END_SRC

There is no need to uncompress the data!

#+BEGIN_SRC sh
bzcat 2011-10-11.gga.dat.bz2 | head
# x y z quality satellites hdop
-70.9395833333 43.1354166667 35.7 2 9 1.1
-70.9395766667 43.135415 36.1 2 9 1.1
-70.93957 43.1354133333 36.5 2 9 1.1
-70.9395666667 43.1354133333 37.0 2 9 1.1
-70.9395633333 43.1354133333 37.4 2 9 1.1
```

--:--- **15-matplotlib.org** 8% L33 (Org)----------

(+,lag:0)

92.168.17.11) has joined channel #unhres

nown Bot L31 (ERC)----------

[researchtools@... 15-matplotlib.org researchtools@... Research Tools C... #unhresearchtools

Friday, October 21, 11

x is longitude
y is latitude
x y z is a right handed coordinate frame

Applications Places System 11:15 AM researchtools

15-matplotlib.org

File Edit Options Buffers Tools Or

```
#+LINK_HOME: http://vislab-ccom.u

* Introduction

This class is about starting to p
powerful plotting system.  I am c
the range of examples:

http://matplotlib.sourceforge.net

* Setup

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#+BEGIN_SRC sh
mkdir -p ~/class/15
cd ~/class/15
wget http://vislab-ccom.unh.edu/~schwehr/rt/examples/2011-10-11.gga.dat.bz2
#+END_SRC

There is no need to uncompress the data!

#+BEGIN_SRC sh
bzcat 2011-10-11.gga.dat.bz2 | head
# x y z quality satellites hdop
-70.9395833333 43.1354166667 35.7 2 9 1.1
-70.9395766667 43.135415 36.1 2 9 1.1
-70.93957 43.1354133333 36.5 2 9 1.1
-70.9395666667 43.1354133333 37.0 2 9 1.1
-70.9395633333 43.1354133333 37.4 2 9 1.1
```

--:--- **15-matplotlib.org** 8% L33 (Org)----------

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
researchtools@ubuntu:~/class/15$ ls -l
total 232
-rw-r--r-- 1 researchtools researchtools   7250 2011-10-20 09:49 15-matplotlib.org
-rw-r--r-- 1 researchtools researchtools 226512 2011-10-20 08:21 2011-10-11.gga.dat.bz2
researchtools@ubuntu:~/class/15$ bzcat 2011-10-11.gga.dat.bz2 | head
# x y z quality satellites hdop
-70.9395833333 43.1354166667 35.7 2 9 1.1
-70.9395766667 43.135415 36.1 2 9 1.1
-70.93957 43.1354133333 36.5 2 9 1.1
-70.9395666667 43.1354133333 37.0 2 9 1.1
-70.9395633333 43.1354133333 37.4 2 9 1.1
-70.9395633333 43.1354133333 37.8 2 9 1.1
-70.9395616667 43.1354133333 38.3 2 9 1.1
-70.9395616667 43.135415 38.7 2 9 1.1
-70.93956 43.1354133333 39.1 2 9 1.1
researchtools@ubuntu:~/class/15$ bzcat 2011-10-11.gga.dat.bz2 | wc -l
86331
researchtools@ubuntu:~/class/15$ ipython --
```

(+,lag:0)

92.168.17.11) has joined channel #unhres

nown Bot L31 (ERC)----------

[researchtools@... 15-matplotlib.org researchtools@... Research Tools C... #unhresearchtools

Friday, October 21, 11

make sure to start ipython with “--pylab” or you will be missing a lot of the functions we will be using today.

Applications Places System 11:15 AM researchtools

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
-70.9395666667 43.1354133333 37.0 2 9 1.1
-70.9395633333 43.1354133333 37.4 2 9 1.1
-70.9395633333 43.1354133333 37.8 2 9 1.1
-70.9395616667 43.1354133333 38.3 2 9 1.1
-70.9395616667 43.135415 38.7 2 9 1.1
-70.93956 43.1354133333 39.1 2 9 1.1
researchtools@ubuntu:~/class/15$ bzcat 2011-10-11.gga.dat.bz2 | wc -l
86331
researchtools@ubuntu:~/class/15$ ipython --pylab
Python 2.7.1+ (r271:86832, Apr 11 2011, 18:05:24)
Type "copyright", "credits" or "license" for more information.

IPython 0.10.1 -- An enhanced Interactive Python.
?         -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object'. ?object also works, ?? prints more.

  Welcome to pylab, a matplotlib-based Python environment.
  For more information, type 'help(pylab)'.

In [1]:
```

15-matplotlib.org

File Edit Options Buffers Tools Or

```
#+LINK_HOME: http://vislab-ccom.u

* Introduction

This class is about starting to p
powerful plotting system.  I am c
the range of examples:

http://matplotlib.sourceforge.net

* Setup

I have pre-parsed the data for yo

#+BEGIN_SRC sh
mkdir -p ~/class/15
cd ~/class/15
wget http://vislab-ccom.unh.edu/~schwehr/rt/examples/2011-10-11.gga.dat.bz2
#+END_SRC

There is no need to uncompress the data!

#+BEGIN_SRC sh
bzcat 2011-10-11.gga.dat.bz2 | head
# x y z quality satellites hdop
-70.9395833333 43.1354166667 35.7 2 9 1.1
-70.9395766667 43.135415 36.1 2 9 1.1
-70.93957 43.1354133333 36.5 2 9 1.1
-70.9395666667 43.1354133333 37.0 2 9 1.1
-70.9395633333 43.1354133333 37.4 2 9 1.1
```

--:--- **15-matplotlib.org** 8% L33 (Org)----------

(+,lag:0)

b7.ccom.nh) has joined channel #unhresea

nown Bot L34 (ERC)----------

[researchtools@... 15-matplotlib.org researchtools@... Research Tools C... #unhresearchtools

Friday, October 21, 11

Applications Places System 11:15 AM researchtools

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
-70.9395666667 43.1354133333 37.0 2 9 1.1
-70.9395633333 43.1354133333 37.4 2 9 1.1
-70.9395633333 43.1354133333 37.8 2 9 1.1
-70.9395616667 43.1354133333 38.3 2 9 1.1
-70.9395616667 43.135415 38.7 2 9 1.1
-70.93956 43.1354133333 39.1 2 9 1.1
researchtools@ubuntu:~/class/15$ bzcat 2011-10-11.gga.dat.bz2 | wc -l
86331
researchtools@ubuntu:~/class/15$ ipython --pylab
Python 2.7.1+ (r271:86832, Apr 11 2011, 18:05:24)
Type "copyright", "credits" or "license" for more information.

IPython 0.10.1 -- An enhanced Interactive Python.
?         -> Introduction and overview of IPython's features.
%quickref -> Quick reference.
help      -> Python's own help system.
object?   -> Details about 'object'. ?object also works, ?? prints more.

  Welcome to pylab, a matplotlib-based Python environment.
  For more information, type 'help(pylab)'.

In [1]: loadtxt?
```

15-matplotlib.org

File Edit Options Buffers Tools Or

```
-70.9395633333 43.1354133333 37.8
-70.9395616667 43.1354133333 38.3
-70.9395616667 43.135415 38.7 2 9
-70.93956 43.1354133333 39.1 2 9 1.1
#+END_SRC

* Loading the data

Start ipython with pylab loaded

#+BEGIN_SRC sh
ipython --pylab
#+END_SRC

We can load the data using numpy's
handle gzip and bzip2 compressed

#+BEGIN_SRC python
loadtxt?
# q to quit out of the pager

data = loadtxt('2011-10-11.gga.dat.bz2')

data

# The results
array([[-70.93958333,  43.13541667,  35.7       ,   2.        ,
          9.        ,   1.1       ],
       [-70.93957667,  43.135415  ,  36.1       ,   2.        ,
          9.        ,   1.1       ],
--:---  15-matplotlib.org   19% L61    (Org)----------
```

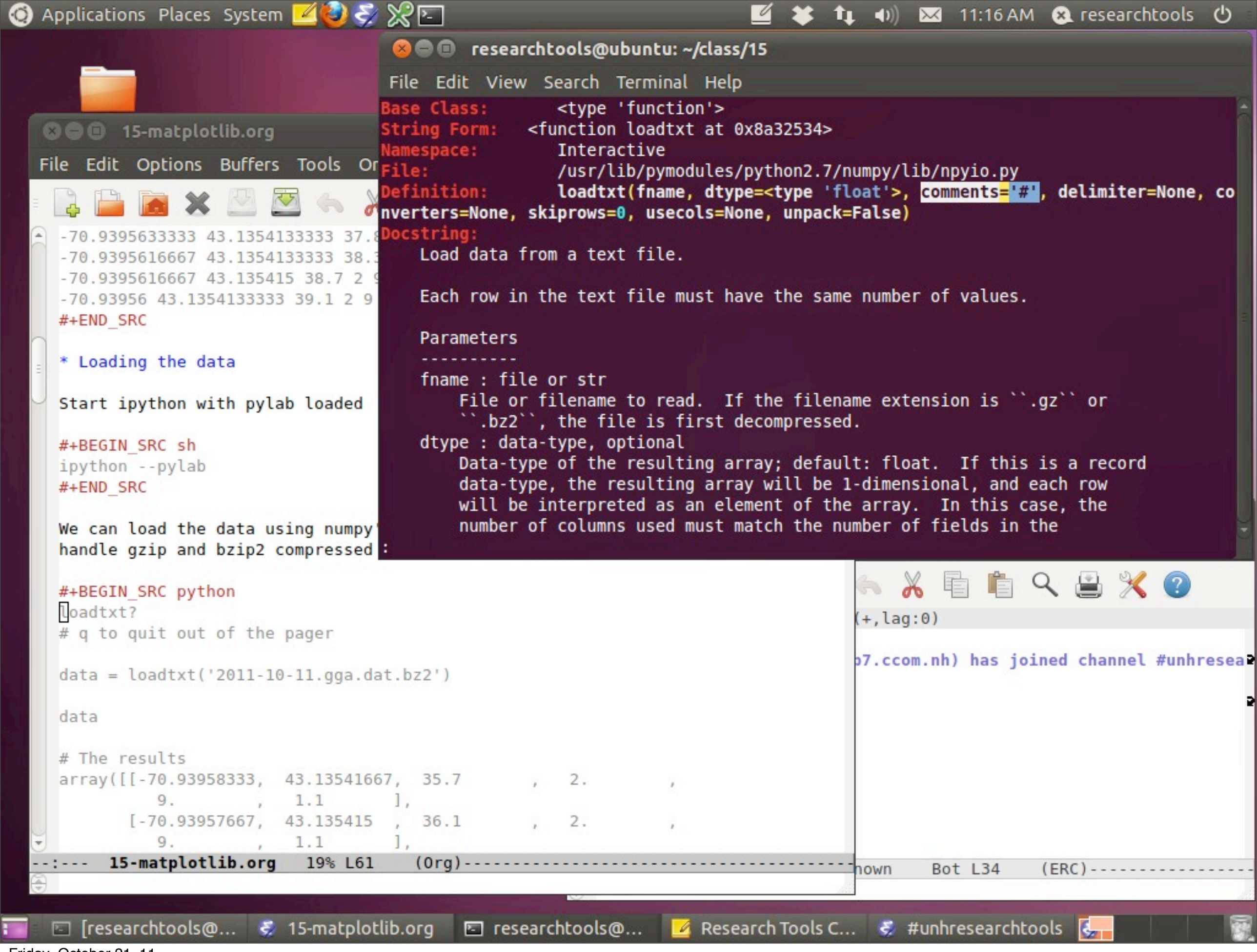
```
(+,lag:0)

b7.ccom.nh) has joined channel #unhresea
nown    Bot L34    (ERC)----------
```

[researchtools@... 15-matplotlib.org researchtools@... Research Tools C... #unhresearchtools

Friday, October 21, 11

Asking for help with loadtxt



Look at the “File:” path and you will see that loadtext is a part of “numpy”

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
Definition:      loadtxt(fname, dtype=<type 'float'>, comments='#', delimiter=None, co
nverters=None, skiprows=0, usecols=None, unpack=False)
Docstring:
    Load data from a text file.

    Each row in the text file must have the same number of values.

    Parameters
    ----------
    fname : file or str
        File or filename to read.  If the filename extension is ``.gz`` or
        ``.bz2``, the file is first decompressed.
    dtype : data-type, optional
        Data-type of the resulting array; default: float.  If this is a record
        data-type, the resulting array will be 1-dimensional, and each row
        will be interpreted as an element of the array.  In this case, the
        number of columns used must match the number of fields in the
        data-type.
    comments : str, optional
        The character used to indicate the start of a comment; default: '#'.
    delimiter : str, optional
:
```

15-matplotlib.org

File Edit Options Buffers Tools Or

```
-70.9395633333 43.1354133333 37.8
-70.9395616667 43.1354133333 38.3
-70.9395616667 43.135415 38.7 2 9
-70.93956 43.1354133333 39.1 2 9
#+END_SRC

* Loading the data

Start ipython with pylab loaded

#+BEGIN_SRC sh
ipython --pylab
#+END_SRC

We can load the data using numpy'
handle gzip and bzip2 compressed

#+BEGIN_SRC python
loadtxt?
# q to quit out of the pager

data = loadtxt('2011-10-11.gga.dat.bz2')

data

# The results
array([[-70.93958333,  43.13541667,  35.7       ,   2.        ,
          9.        ,   1.1       ],
       [-70.93957667,  43.135415  ,  36.1       ,   2.        ,
          9.        ,   1.1       ],
--:---  15-matplotlib.org   19% L61    (Org)----------------------------------------
```

```
(+,lag:0)

b7.ccom.nh) has joined channel #unhresea
nown    Bot L34    (ERC)----------------
```

[researchtools@... 15-matplotlib.org researchtools@... Research Tools C... #unhresearchtools

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
        The string used to separate values.  By default, this is any
        whitespace.
    converters : dict, optional
        A dictionary mapping column number to a function that will convert
        that column to a float.  E.g., if column 0 is a date string:
        ``converters = {0: datestr2num}``.  Converters can also be used to
        provide a default value for missing data:
        ``converters = {3: lambda s: float(s or 0)}``.  Default: None.
    skiprows : int, optional
        Skip the first `skiprows` lines; default: 0.
    usecols : sequence, optional
        Which columns to read, with 0 being the first.  For example,
        ``usecols = (1,4,5)`` will extract the 2nd, 5th and 6th columns.
        The default, None, results in all columns being read.
    unpack : bool, optional
        If True, the returned array is transposed, so that arguments may be
        unpacked using ``x, y, z = loadtxt(...)``.  The default is False.

    Returns
    -------
    out : ndarray
:
```

15-matplotlib.org

File Edit Options Buffers Tools Or

```
-70.9395633333 43.1354133333 37.8
-70.9395616667 43.1354133333 38.3
-70.9395616667 43.135415 38.7 2 9
-70.93956 43.1354133333 39.1 2 9
#+END_SRC

* Loading the data

Start ipython with pylab loaded

#+BEGIN_SRC sh
ipython --pylab
#+END_SRC

We can load the data using numpy
handle gzip and bzip2 compressed

#+BEGIN_SRC python
loadtxt?
# q to quit out of the pager

data = loadtxt('2011-10-11.gga.dat.bz2')

data

# The results
array([[-70.93958333,  43.13541667,  35.7       ,   2.        ,
          9.        ,   1.1       ],
       [-70.93957667,  43.135415  ,  36.1       ,   2.        ,
          9.        ,   1.1       ],
--:---  15-matplotlib.org   19% L61    (Org)----------------------------------------
```

```
(+,lag:0)

b7.ccom.nh) has joined channel #unhresea
nown    Bot L34    (ERC)----------------
```

[researchtools@... 15-matplotlib.org researchtools@... Research Tools C... #unhresearchtools

Friday, October 21, 11

Applications Places System 11:20 AM researchtools

researchtools@ubuntu: ~/class/15

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```
In [2]: data = loadtxt('2011-10-11.gga.dat.bz2')

In [3]: type(data)
Out[3]: <type 'numpy.ndarray'>

In [4]: data
Out[4]:
array([[-70.93958333,  43.13541667,  35.7       ,   2.        ,
          9.        ,   1.1       ],
       [-70.93957667,  43.135415  ,  36.1       ,   2.        ,
          9.        ,   1.1       ],
       [-70.93957   ,  43.13541333,  36.5       ,   2.        ,
          9.        ,   1.1       ],
       ...,
       [-70.93955167,  43.13545667,  43.        ,   2.        ,
          8.        ,   1.2       ],
       [-70.93955167,  43.13545667,  43.3       ,   2.        ,
          8.        ,   1.2       ],
       [-70.93955167,  43.13545833,  43.5       ,   2.        ,
          8.        ,   1.2       ]])

In [5]:
```

15-matplotlib.org

File Edit Options Buffers Tools Or

```
-70.9395633333 43.1354133333 37.8
-70.9395616667 43.1354133333 38.3
-70.9395616667 43.135415 38.7 2 9
-70.93956 43.1354133333 39.1 2 9
#+END_SRC

* Loading the data

Start ipython with pylab loaded

#+BEGIN_SRC sh
ipython --pylab
#+END_SRC

We can load the data using numpy'
handle gzip and bzip2 compressed

#+BEGIN_SRC python
loadtxt?
# q to quit out of the pager

data = loadtxt('2011-10-11.gga.dat.bz2')

data

# The results
array([[-70.93958333,  43.13541667,  35.7       ,   2.        ,
          9.        ,   1.1       ],
       [-70.93957667,  43.135415  ,  36.1       ,   2.        ,
          9.        ,   1.1       ],
--:---  15-matplotlib.org   19% L64    (Org)----------
```

(+,lag:0)

```
b7.ccom.nh) has joined channel #unhresea
```

nown Bot L34 (ERC)----------

[researchtools@... 15-matplotlib.org researchtools@... Research Tools C... #unhresearchtools

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Applications Places System 11:25 AM researchtools

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```
In [5]: data[0]
Out[5]:
array([-70.93958333,  43.13541667,  35.7       ,   2.        ,
         9.        ,   1.1       ])

In [6]: len (data[0])
Out[6]: 6

In [7]: x,y,z,quality,satellites,hdop = loadtxt('2011-10-11.gga.dat.bz2', unpack=True)

In [8]: x
Out[8]:
array([-70.93958333, -70.93957667, -70.93957   , ..., -70.93955167,
       -70.93955167, -70.93955167])

In [9]: y
Out[9]:
array([ 43.13541667,  43.135415  ,  43.13541333, ...,  43.13545667,
        43.13545667,  43.13545833])

In [10]:
```

15-matplotlib.org

File Edit Options Buffers Tools Or

```
data = loadtxt('2011-10-11.gga.da

data

# The results
array([[-70.93958333,  43.135416
         9.        ,   1.1
       [-70.93957667,  43.135415
         9.        ,   1.1
       [-70.93957   ,  43.135413
         9.        ,   1.1
       ...,
       [-70.93955167,  43.135456
         8.        ,   1.2
       [-70.93955167,  43.135456
         8.        ,   1.2       ],
       [-70.93955167,  43.13545833,  43.5       ,   2.        ,
         8.        ,   1.2       ]])
#+END_SRC

That's not really what we want.  We would like an array for each variable.
There is a "unpack" option for loadtxt that will let us assign each of the
6 columns separately.

#+BEGIN_SRC python
x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.dat', unpack=True)

average(x)
# -70.939601490675187
```

--:--- **15-matplotlib.org** 26% L63 (Org)----------

(+,lag:0)

b7.ccom.nh) has joined channel #unhresea

nown Bot L34 (ERC)----------

[researchtools@... | 15-matplotlib.org | researchtools@... | Research Tools C... | #unhresearchtools

Applications Places System 11:26 AM researchtools

researchtools@ubuntu: ~/class/15

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```
In [7]: x,y,z,quality,satellites,hdop = loadtxt('2011-10-11.gga.dat.bz2', unpack=True)

In [8]: x
Out[8]:
array([-70.93958333, -70.93957667, -70.93957   , ..., -70.93955167,
       -70.93955167, -70.93955167])

In [9]: y
Out[9]:
array([ 43.13541667,  43.135415  ,  43.13541333, ...,  43.13545667,
        43.13545667,  43.13545833])

In [10]: average(x)
Out[10]: -70.939601490675187

In [11]: average(y)
Out[11]: 43.135434976022353

In [12]: min(x)
Out[12]: -70.939716666699994

In [13]: min
```

15-matplotlib.org

File Edit Options Buffers Tools Or

```
data = loadtxt('2011-10-11.gga.da

data

# The results
array([[-70.93958333,  43.135416
          9.        ,   1.1
       [-70.93957667,  43.135415
          9.        ,   1.1
       [-70.93957   ,  43.135413
          9.        ,   1.1
       ...,
       [-70.93955167,  43.135456
          8.        ,   1.2
       [-70.93955167,  43.135456
          8.        ,   1.2       ],
       [-70.93955167,  43.13545833,  43.5       ,   2.        ,
          8.        ,   1.2       ]])
#+END_SRC

That's not really what we want.  We would like an array for each variable.
There is a "unpack" option for loadtxt that will let us assign each of the
6 columns separately.

#+BEGIN_SRC python
x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.dat', unpack=True)

average(x)
# -70.939601490675187
```

--:--- **15-matplotlib.org** 26% L63 (Org)----------

(+,lag:0)

b7.ccom.nh) has joined channel #unhresea

nown Bot L34 (ERC)----------

[researchtools@... | 15-matplotlib.org | researchtools@... | Research Tools C... | #unhresearchtools

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```
Out[10]: -70.939601490675187

In [11]: average(y)
Out[11]: 43.135434976022353

In [12]: min(x)
Out[12]: -70.939716666699994

In [13]: min?
Type:           builtin_function_or_method
Base Class:     <type 'builtin_function_or_method'>
String Form:    <built-in function min>
Namespace:      Python builtin
Docstring:
    min(iterable[, key=func]) -> value
    min(a, b, c, ...[, key=func]) -> value

    With a single iterable argument, return its smallest item.
    With two or more arguments, return the smallest argument.


In [14]:
```

15-matplotlib.org

File Edit Options Buffers Tools Or

```
data = loadtxt('2011-10-11.gga.da

data

# The results
array([[-70.93958333,  43.1354166
          9.        ,   1.1
       [-70.93957667,  43.135415
          9.        ,   1.1
       [-70.93957   ,  43.1354133
          9.        ,   1.1
       ...,
       [-70.93955167,  43.1354566
          8.        ,   1.2
       [-70.93955167,  43.1354566
          8.        ,   1.2       ],
       [-70.93955167,  43.13545833,  43.5       ,   2.        ,
          8.        ,   1.2       ]])
#+END_SRC

That's not really what we want.  We would like an array for each variable.
There is a "unpack" option for loadtxt that will let us assign each of the
6 columns separately.

#+BEGIN_SRC python
x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.dat', unpack=True)

average(x)
# -70.939601490675187
```

--:--- **15-matplotlib.org** 26% L63 (Org)----------

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b7.ccom.nh) has joined channel #unhresea

nown Bot L34 (ERC)----------

[researchtools@... 15-matplotlib.org researchtools@... Research Tools C... #unhresearchtools

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Applications Places System 11:27 AM researchtools

15-matplotlib.org

File Edit Options Buffers Tools Or

```
data = loadtxt('2011-10-11.gga.da

data

# The results
array([[-70.93958333,  43.1354166
          9.        ,   1.1
       [-70.93957667,  43.135415
          9.        ,   1.1
       [-70.93957   ,  43.1354133
          9.        ,   1.1
       ...,
       [-70.93955167,  43.1354566
          8.        ,   1.2
       [-70.93955167,  43.1354566
          8.        ,   1.2       ],
       [-70.93955167,  43.13545833,  43.5       ,   2.        ,
          8.        ,   1.2       ]])
#+END_SRC

That's not really what we want.  We would like an array for each variable.
There is a "unpack" option for loadtxt that will let us assign each of the
6 columns separately.

#+BEGIN_SRC python
x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.dat', unpack=True)

average(x)
# -70.939601490675187
```

--:--- **15-matplotlib.org** 26% L63 (Org)----------

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```
String Form:    <built-in function min>
Namespace:      Python builtin
Docstring:
    min(iterable[, key=func]) -> value
    min(a, b, c, ...[, key=func]) -> value

    With a single iterable argument, return its smallest item.
    With two or more arguments, return the smallest argument.


In [14]: who
Out[14]: <function who at 0x899764c>

In [15]: %who
data    hdop    quality satellites      x       y       z

In [16]: x
Out[16]:
array([-70.93958333, -70.93957667, -70.93957   , ..., -70.93955167,
       -70.93955167, -70.93955167])

In [17]: plot(x)
```

(+,lag:0)

b7.ccom.nh) has joined channel #unhresea

nown Bot L34 (ERC)----------

[researchtools@... 15-matplotlib.org researchtools@... Research Tools C... #unhresearchtools

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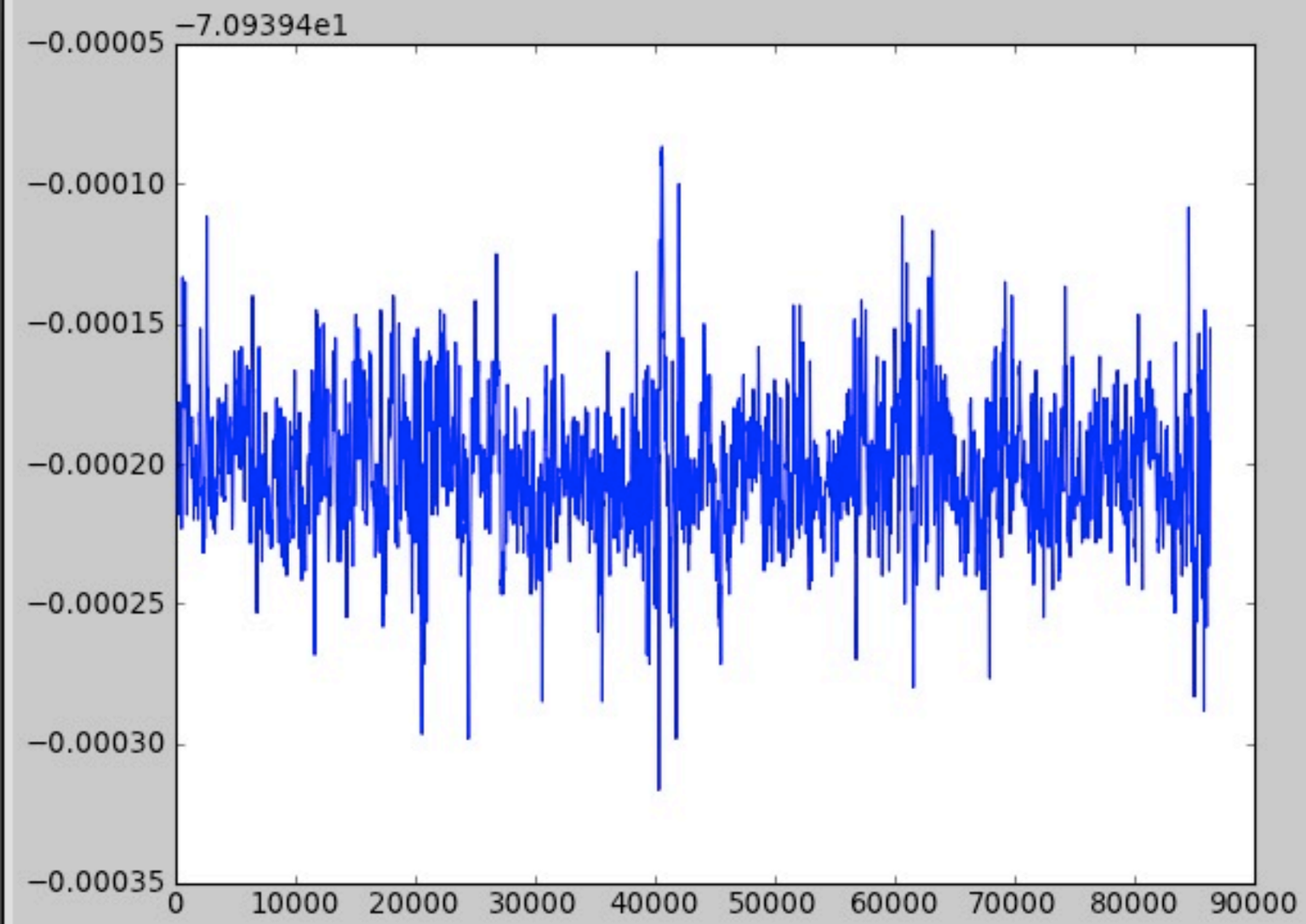
Applications Places System 11:28 AM researchtools

Figure 1



its smallest item.
smallest argument.

y z

7 , ..., -70.93955167,

t 0x9e1056c>]

(+,lag:0)

b7.ccom.nh) has joined channel #unhresea

6 columns separately.

```
#+BEGIN_SRC python
x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.dat', unpack=True)

average(x)
# -70.939601490675187
```

--:--- **15-matplotlib.org** 26% L63 (Org)----------

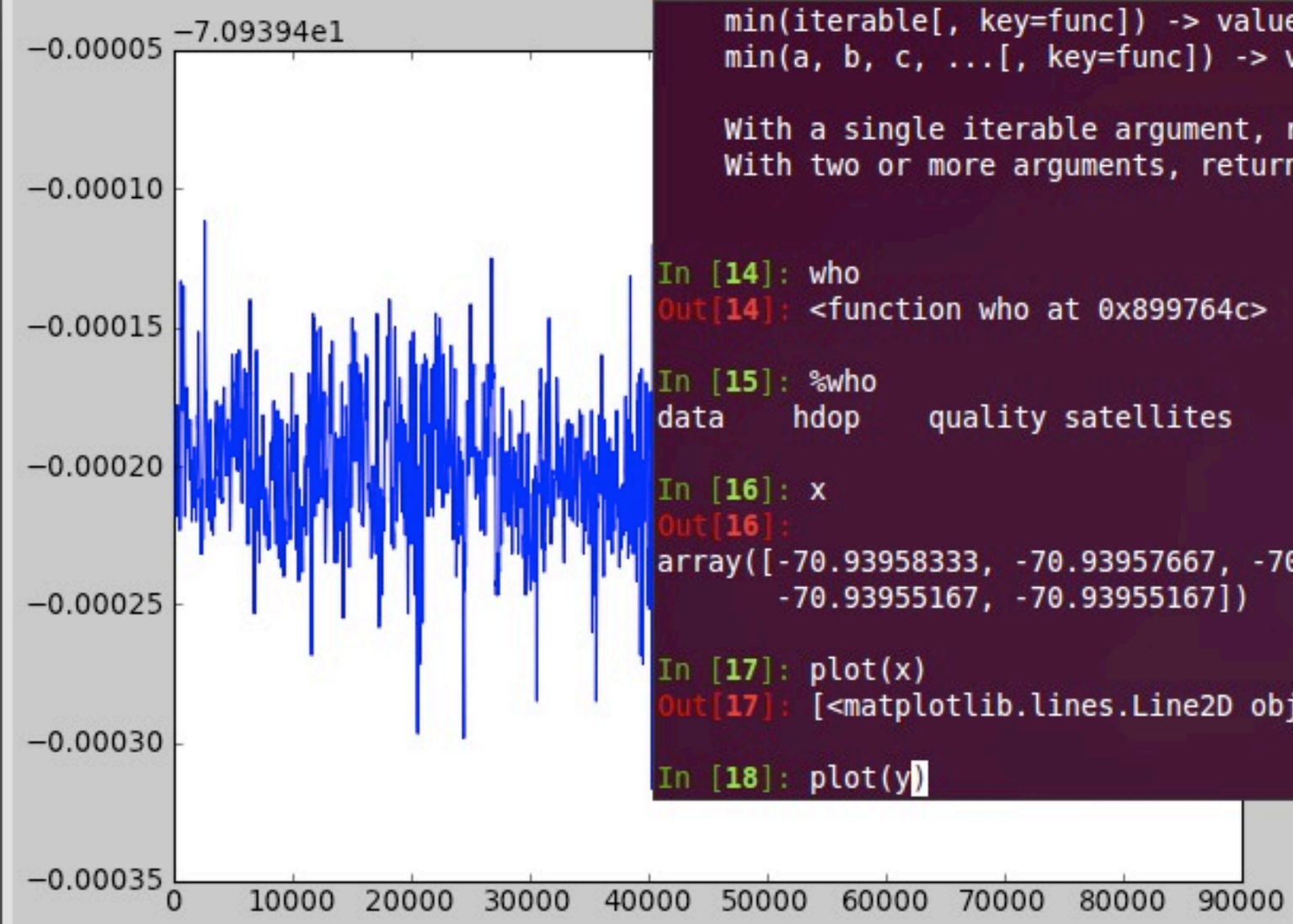
nown Bot L34 (ERC)----------

[researchto... 15-matplotli... researchtool... Research To... #unhresearc... Figure 1

Friday, October 21, 11

Applications Places System 11:28 AM researchtools

Figure 1



researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
    min(iterable[, key=func]) -> value
    min(a, b, c, ...[, key=func]) -> value

    With a single iterable argument, return its smallest item.
    With two or more arguments, return the smallest argument.


In [14]: who
Out[14]: <function who at 0x899764c>

In [15]: %who
data    hdop    quality satellites      x       y       z

In [16]: x
Out[16]:
array([-70.93958333, -70.93957667, -70.93957   , ..., -70.93955167,
       -70.93955167, -70.93955167])

In [17]: plot(x)
Out[17]: [<matplotlib.lines.Line2D object at 0x9e1056c>]

In [18]: plot(y)
```

```
6 columns separately.

#+BEGIN_SRC python
x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.dat', unpack=True)

average(x)
# -70.939601490675187
--:---  15-matplotlib.org   26% L63    (Org)----------------------------------------
```

```
(+,lag:0)

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nown    Bot L34    (ERC)----------------
```
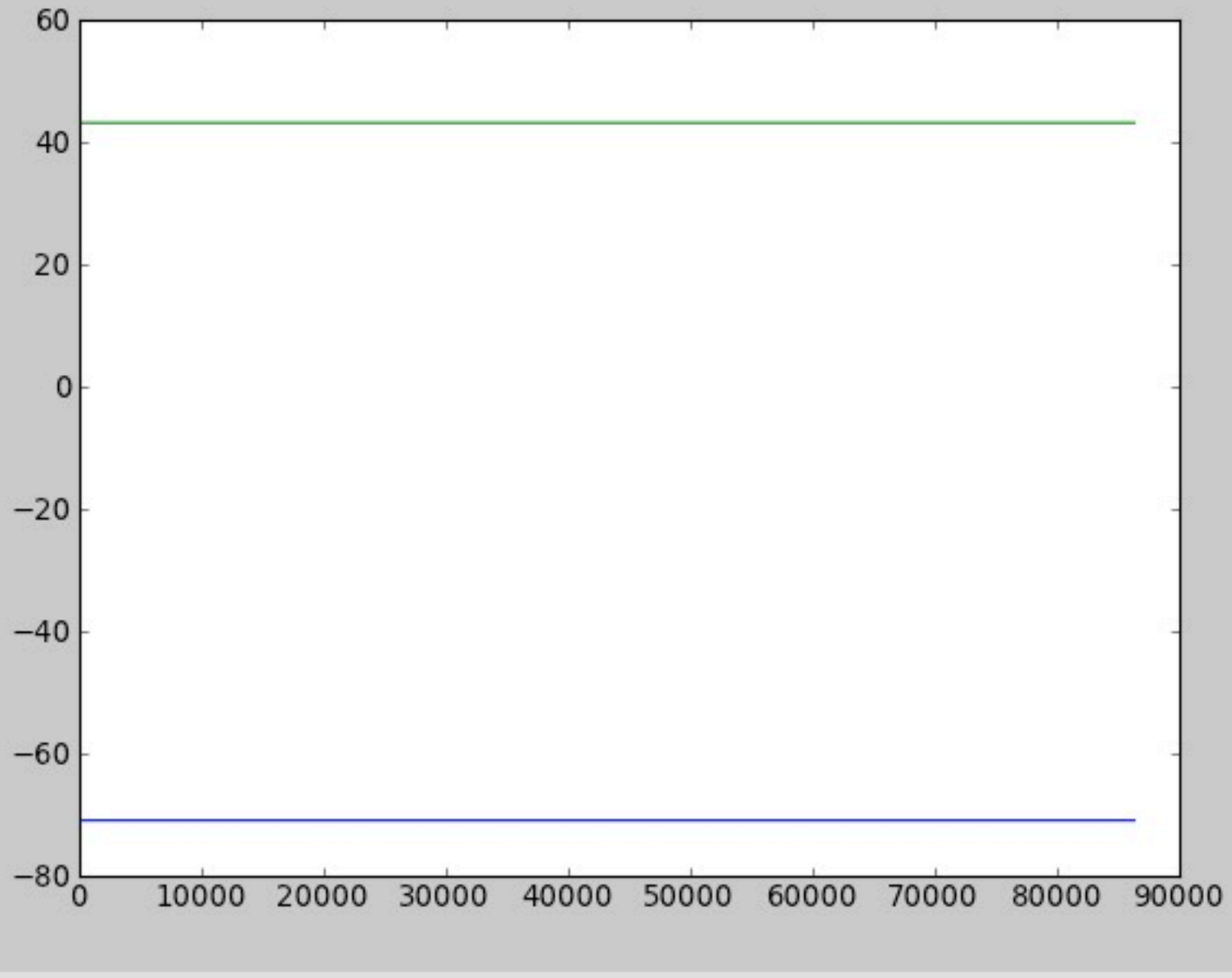

[researchto... 15-matplotli... researchtool... Research To... #unhresearc... Figure 1

Friday, October 21, 11

Applications Places System 11:28 AM researchtools

Figure 1



its smallest item.
smallest argument.

y z

7 , ..., -70.93955167,

t 0x9e1056c>]

t 0x919adac>]

(+,lag:0)

b7.ccom.nh) has joined channel #unhresea

6 columns separately.

```
#+BEGIN_SRC python
x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.dat', unpack=True)

average(x)
# -70.939601490675187
```

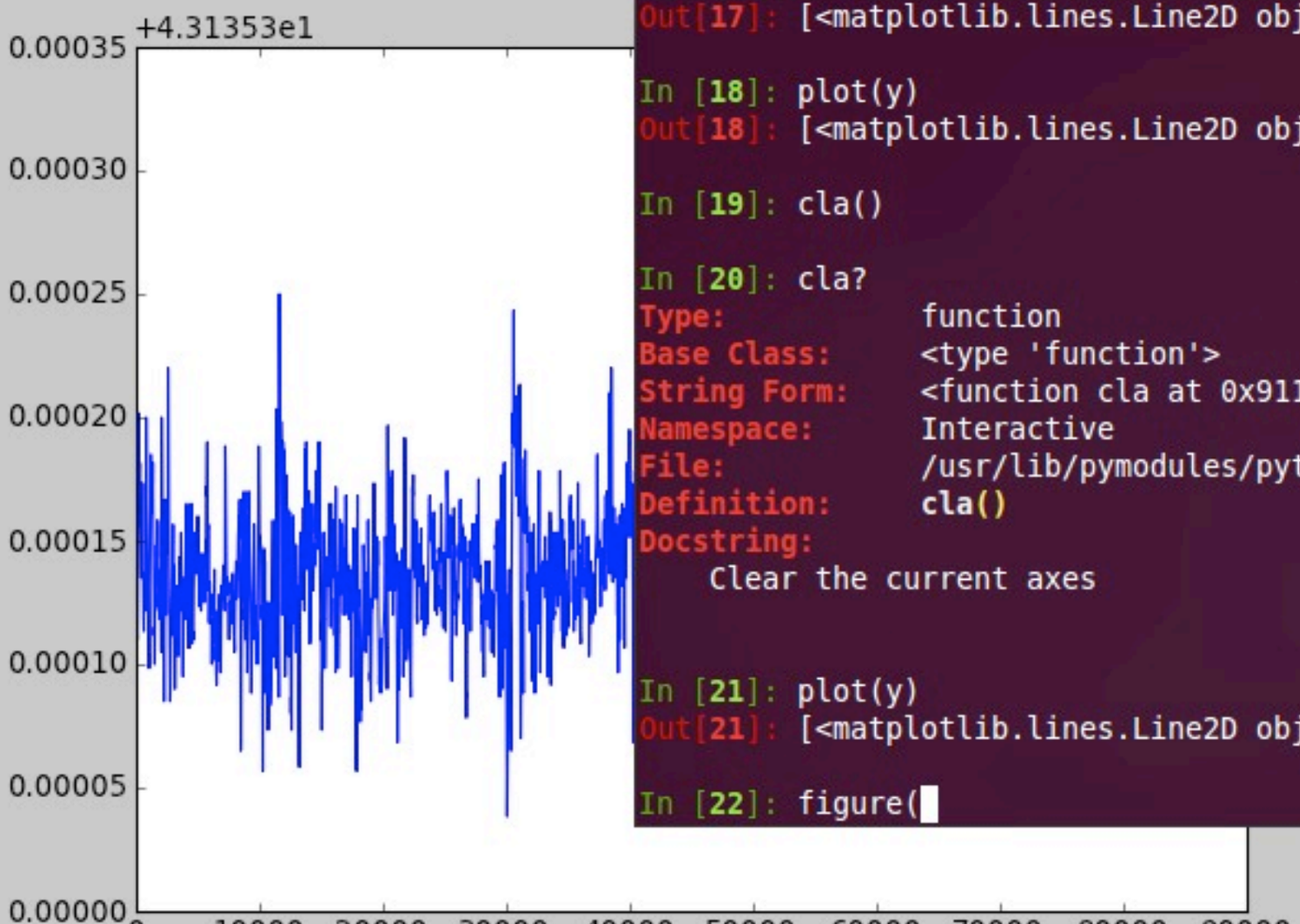
--:--- **15-matplotlib.org** 26% L63 (Org)----------

nown Bot L34 (ERC)----------

[researchto... 15-matplotli... researchtool... Research To... #unhresearc... Figure 1

Applications Places System 11:30 AM researchtools

Figure 1



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```
Out[17]: [<matplotlib.lines.Line2D object at 0x9e1056c>]

In [18]: plot(y)
Out[18]: [<matplotlib.lines.Line2D object at 0x919adac>]

In [19]: cla()

In [20]: cla?
Type:           function
Base Class:     <type 'function'>
String Form:    <function cla at 0x9118bc4>
Namespace:      Interactive
File:           /usr/lib/pymodules/python2.7/matplotlib/pyplot.py
Definition:     cla()
Docstring:
    Clear the current axes


In [21]: plot(y)
Out[21]: [<matplotlib.lines.Line2D object at 0x91c5fcc>]

In [22]: figure(
```

```
6 columns separately.

#+BEGIN_SRC python
x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.dat', unpack=True)

average(x)
# -70.939601490675187
--:---  15-matplotlib.org   26% L63    (Org)----------
```

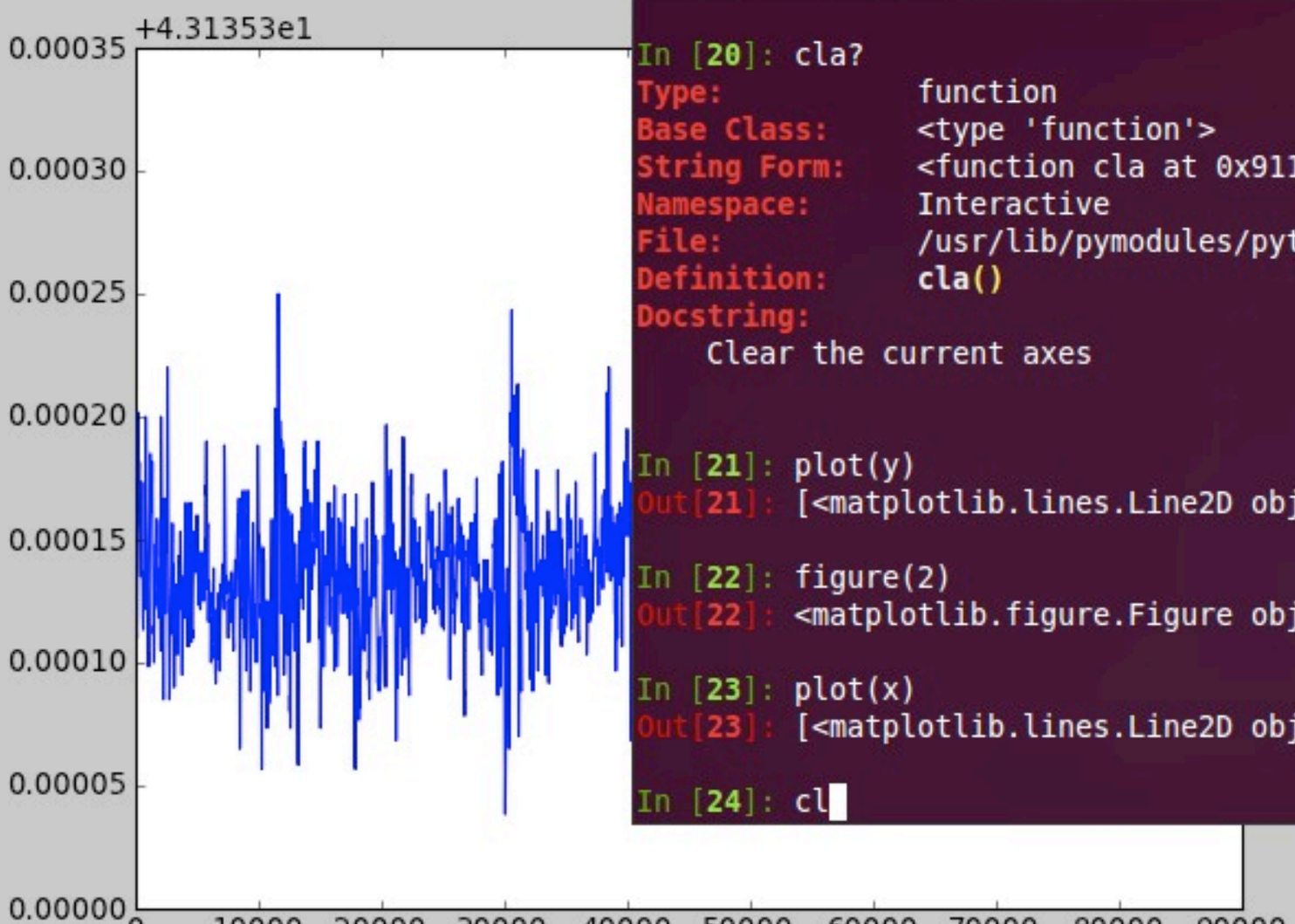
```
(+,lag:0)

b7.ccom.nh) has joined channel #unhresea
nown    Bot L34    (ERC)----------
```

[researchto... 15-matplotli... researchtool... Research To... #unhresearc... Figure 1

Applications Places System 11:30 AM researchtools

Figure 1



researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

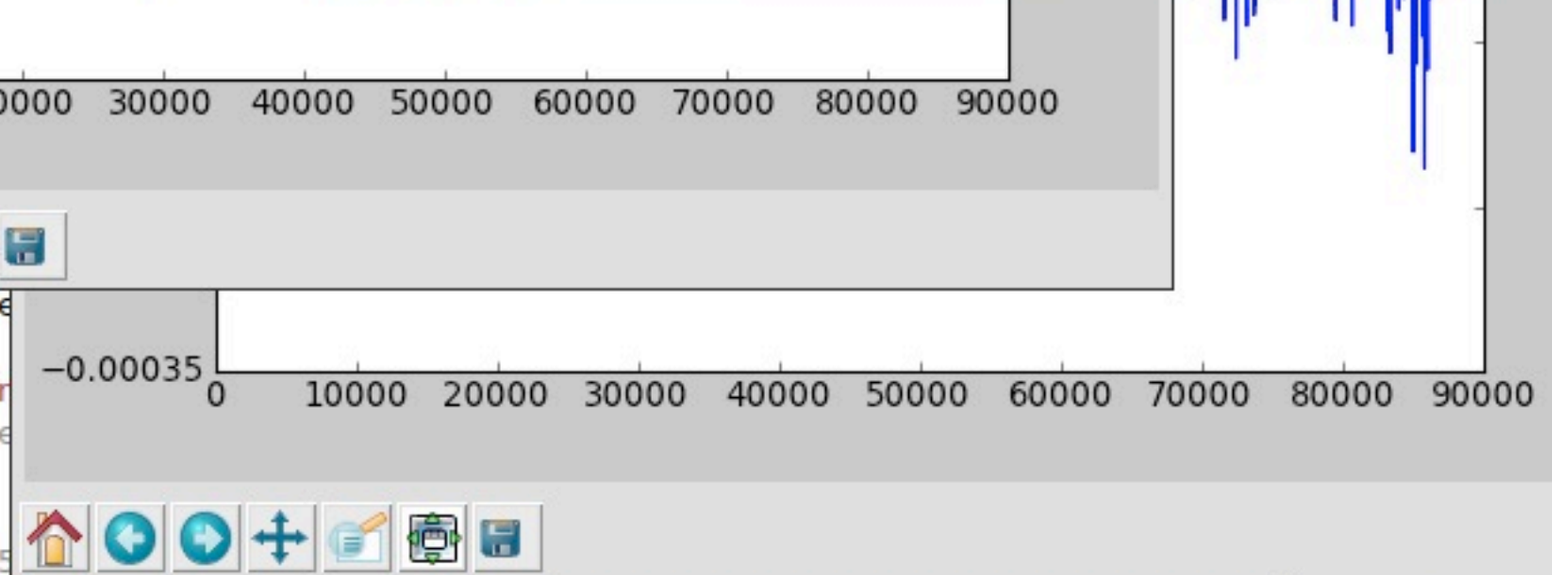
```
In [20]: cla?
Type:           function
Base Class:     <type 'function'>
String Form:    <function cla at 0x9118bc4>
Namespace:      Interactive
File:           /usr/lib/pymodules/python2.7/matplotlib/pyplot.py
Definition:     cla()
Docstring:
    Clear the current axes


In [21]: plot(y)
Out[21]: [<matplotlib.lines.Line2D object at 0x91c5fcc>]

In [22]: figure(2)
Out[22]: <matplotlib.figure.Figure object at 0x91be22c>

In [23]: plot(x)
Out[23]: [<matplotlib.lines.Line2D object at 0x93a4e6c>]

In [24]: cl
```



6 columns separate

#+BEGIN_SRC python

x,y,z,quality,sate

average(x)

-70.939601490675

ined channel #unhresea

--:--- 15-matplotlib.org 26% L63 (Org)----------

nown Bot L34 (ERC)----------

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

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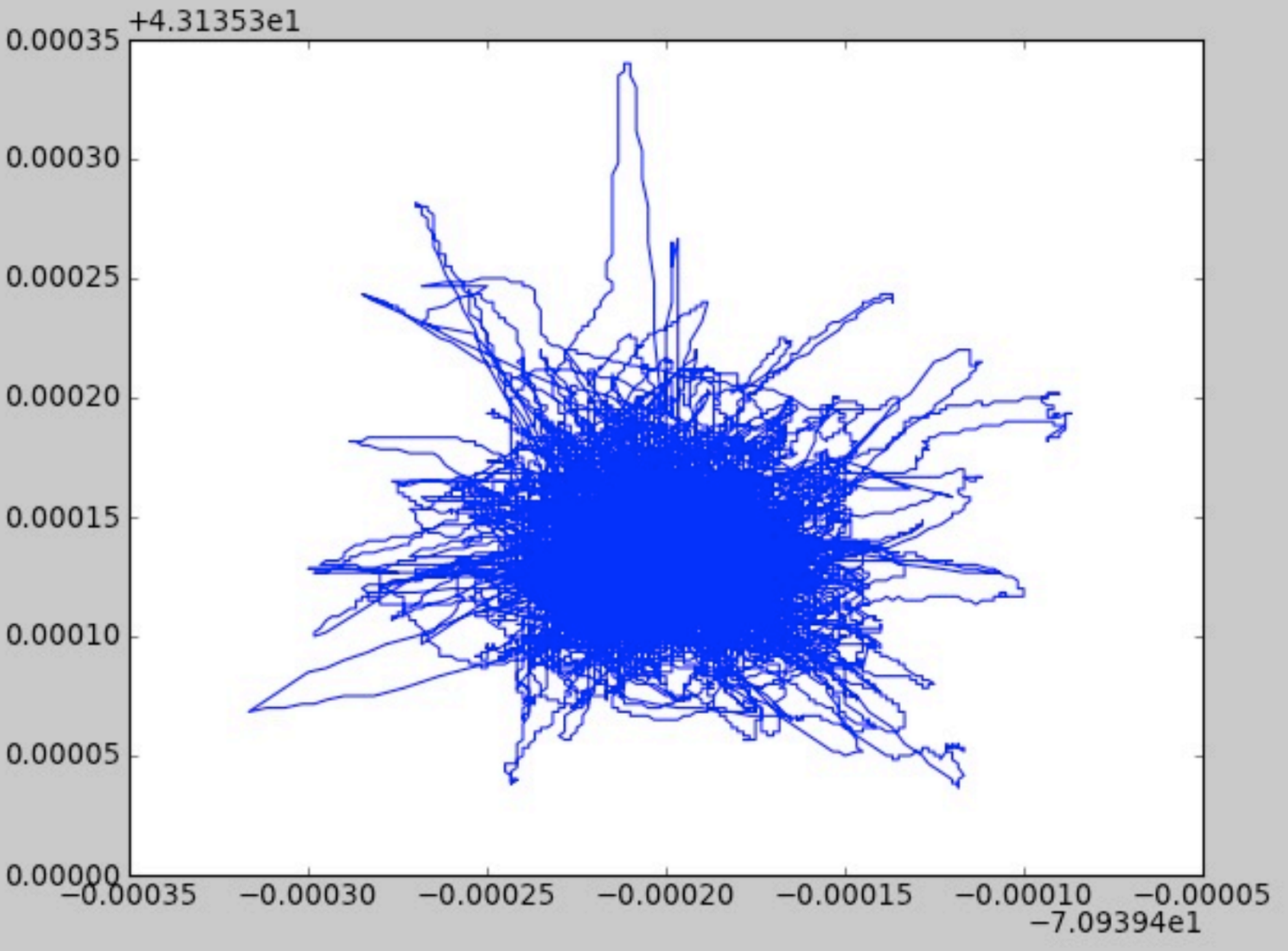
Applications Places System 11:31 AM researchtools

Figure 1



x=-70.9396 y=43.1356

7/matplotlib/pyplot.py

t 0x91c5fcc>]

t 0x91be22c>

t 0x93a4e6c>]

t 0x9e1ca8c>]

ined channel #unhresea

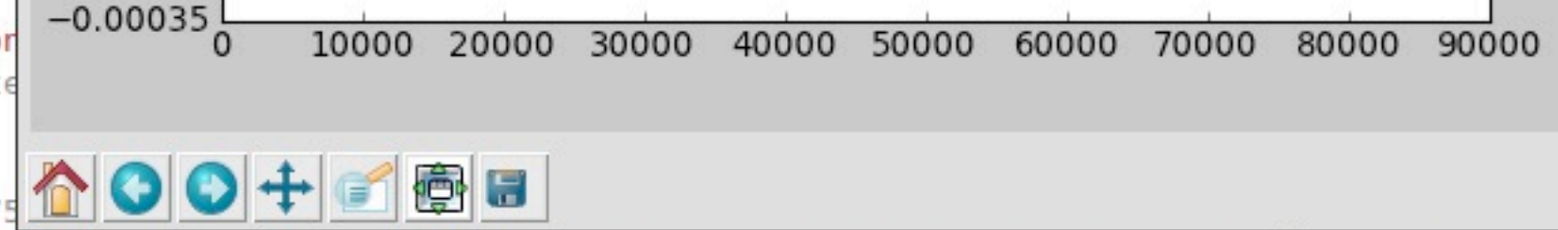
6 columns separate

#+BEGIN_SRC python

x,y,z,quality,sate

average(x)

-70.939601490675



--:--- 15-matplotlib.org 26% L63 (Org)----------

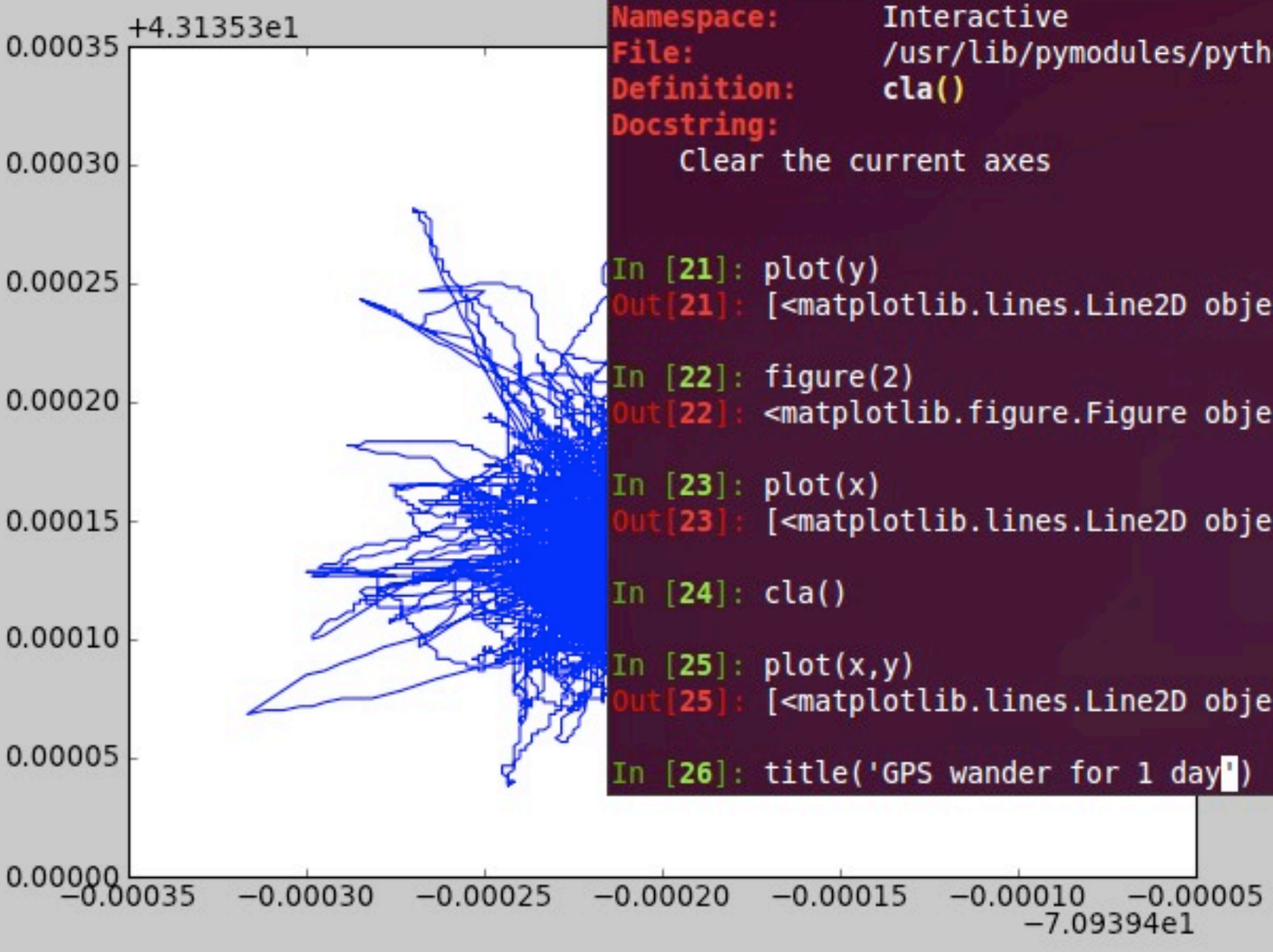
nown Bot L34 (ERC)----------

[research... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

Friday, October 21, 11

Applications Places System 11:32 AM researchtools

Figure 1



researchtools@ubuntu: ~/class/15

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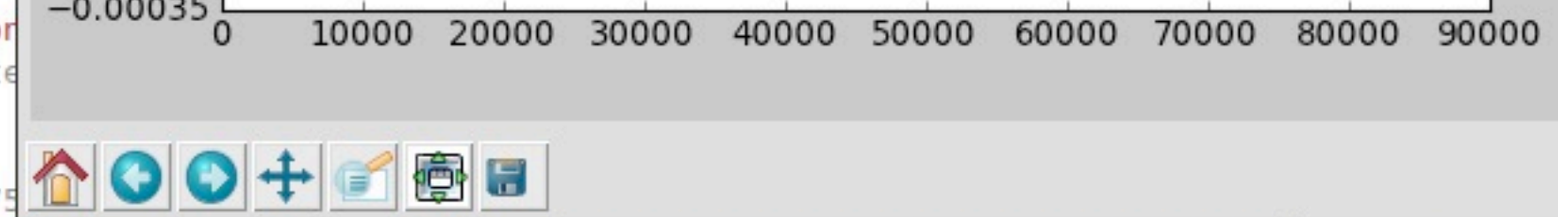
```
Namespace:      Interactive
File:           /usr/lib/pymodules/python2.7/matplotlib/pyplot.py
Definition:     cla()
Docstring:
    Clear the current axes


In [21]: plot(y)
Out[21]: [<matplotlib.lines.Line2D object at 0x91c5fcc>]

In [22]: figure(2)
Out[22]: <matplotlib.figure.Figure object at 0x91be22c>

In [23]: plot(x)
Out[23]: [<matplotlib.lines.Line2D object at 0x93a4e6c>]

In [24]: cla()

In [25]: plot(x,y)
Out[25]: [<matplotlib.lines.Line2D object at 0x9e1ca8c>]

In [26]: title('GPS wander for 1 day')
```



ined channel #unhresea

6 columns separate

#+BEGIN_SRC python

x,y,z,quality,sate

average(x)

-70.939601490675

--:--- 15-matplotlib.org 26% L63 (Org)----------

nown Bot L34 (ERC)----------

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

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Applications Places System 11:33 AM researchtools

Figure 1

researchtools@ubuntu: ~/class/15

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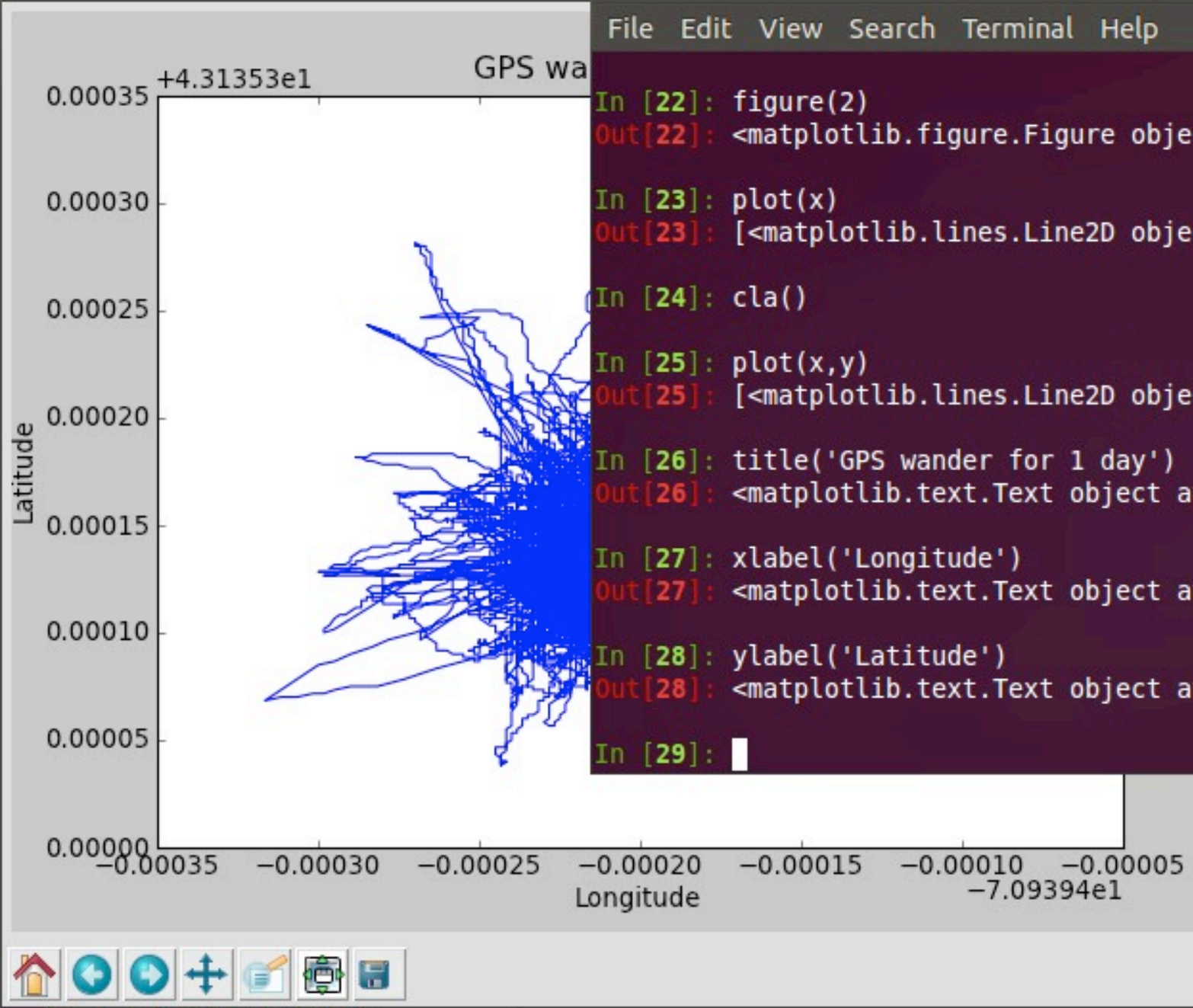
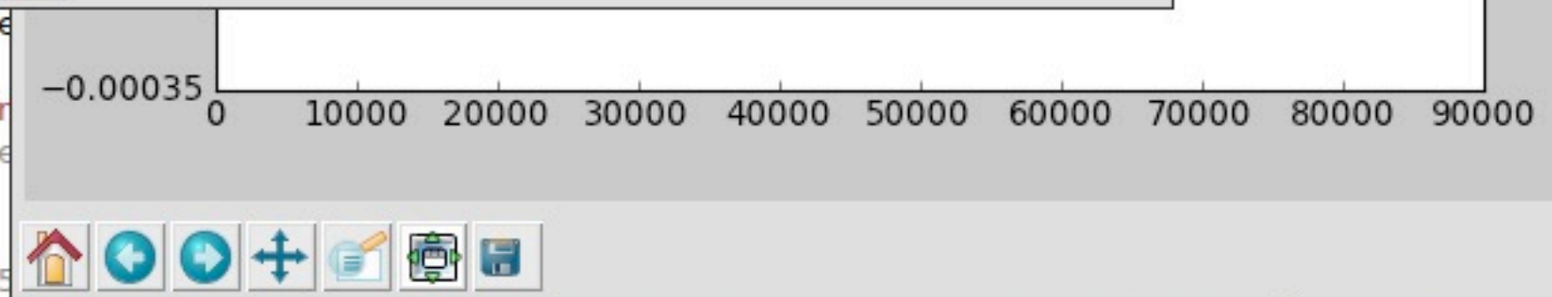
```
In [22]: figure(2)
Out[22]: <matplotlib.figure.Figure object at 0x91be22c>

In [23]: plot(x)
Out[23]: [<matplotlib.lines.Line2D object at 0x93a4e6c>]

In [24]: cla()

In [25]: plot(x,y)
Out[25]: [<matplotlib.lines.Line2D object at 0x9e1ca8c>]

In [26]: title('GPS wander for 1 day')
Out[26]: <matplotlib.text.Text object at 0x91be1ec>

In [27]: xlabel('Longitude')
Out[27]: <matplotlib.text.Text object at 0x9e0320c>

In [28]: ylabel('Latitude')
Out[28]: <matplotlib.text.Text object at 0x9e03eec>

In [29]:
```





6 columns separate

#+BEGIN_SRC python

x,y,z,quality,sate

average(x)

-70.939601490675

--:--- 15-matplotlib.org 26% L63 (Org)----------

nown Bot L34 (ERC)----------

ined channel #unhresea

[research... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

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Thumbnail gallery — Matplotli…

matplotlib.sourceforge.net/gallery.html

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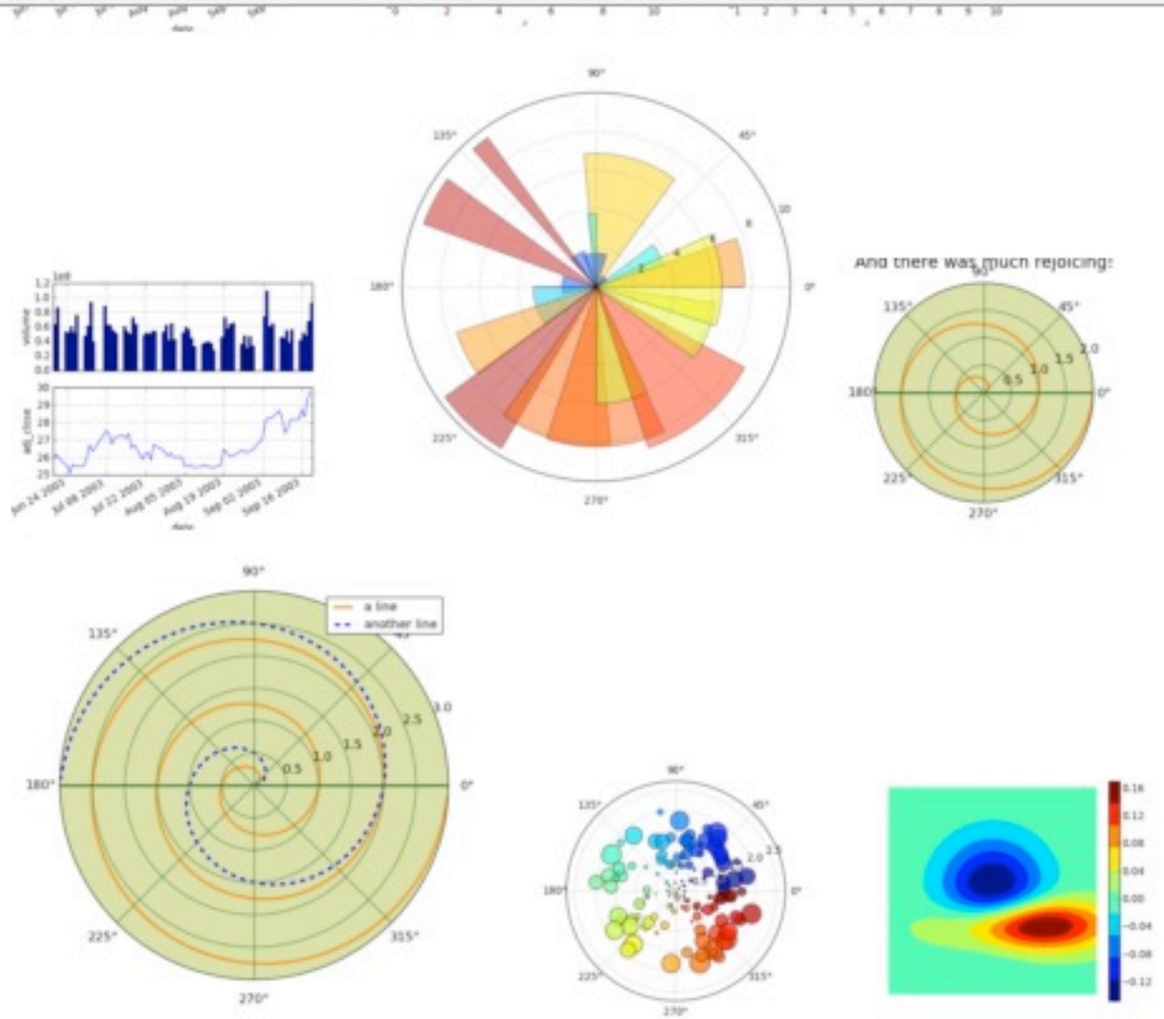
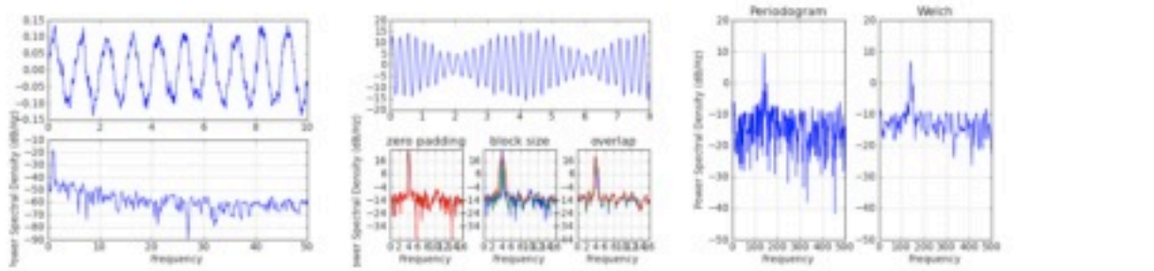




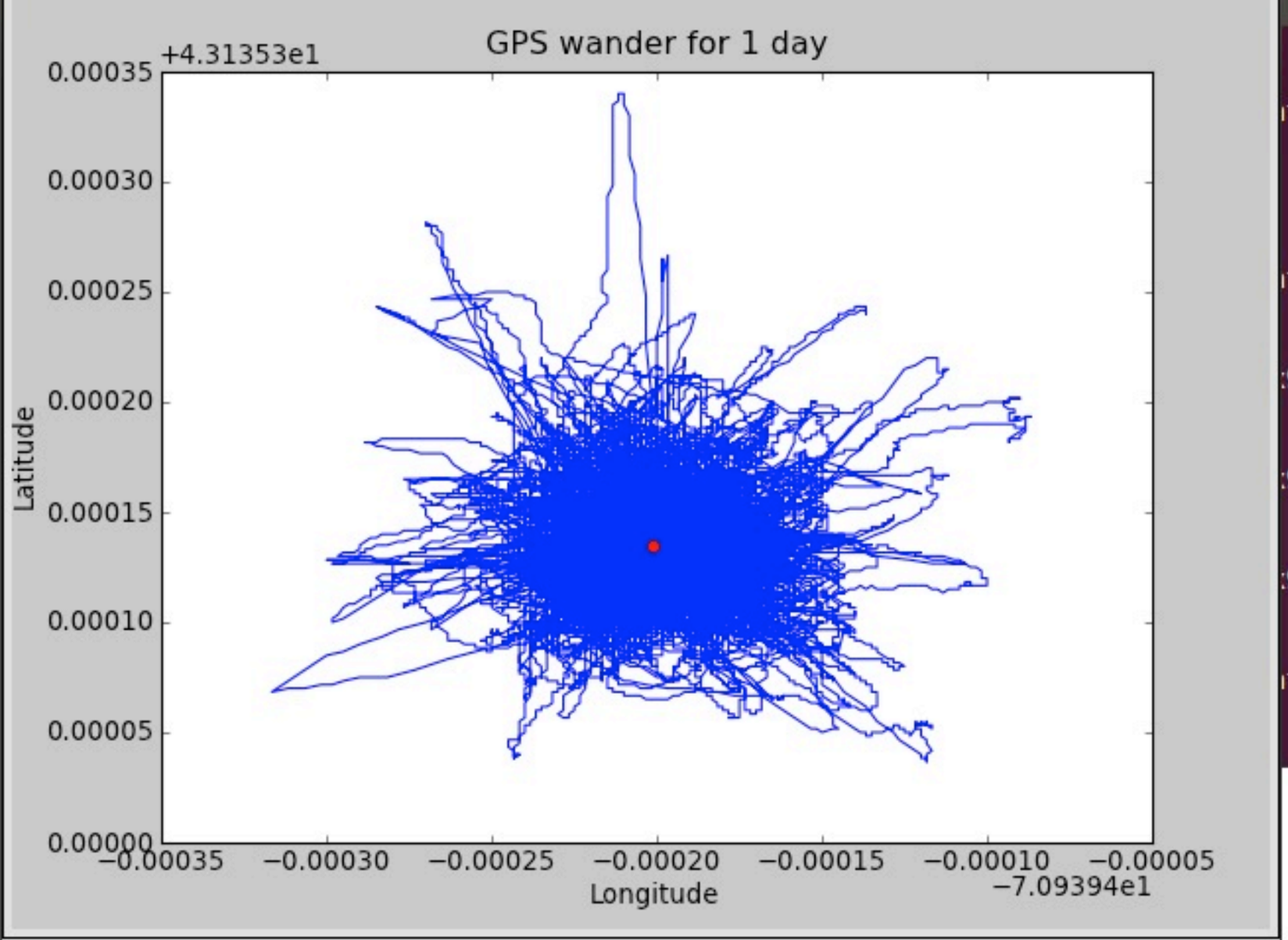
http://matplotlib.sourceforg…ylab_examples/psd_demo2.html

[resear… 15-mat… researc… Resear… #unhre… Figure 1 Figure 2 Thumb…

Friday, October 21, 11

Applications Places System 11:36 AM researchtools

Figure 1



x=-70.9396 y=43.1354

```
#+END_SRC

Try something nicer - the lines with the average of x and y marked:

#+BEGIN_SRC python
cla()
plot(x,y)
```

--:--- **15-matplotlib.org** 46% L146 (Org)----------

```
t 0x93a4e6c>]

t 0x9e1ca8c>]

:91be1ec>

:9e0320c>

:9e03eec>

t 0x9e1bd8c>]
```

80000 90000

```
ined channel #unhresea
```

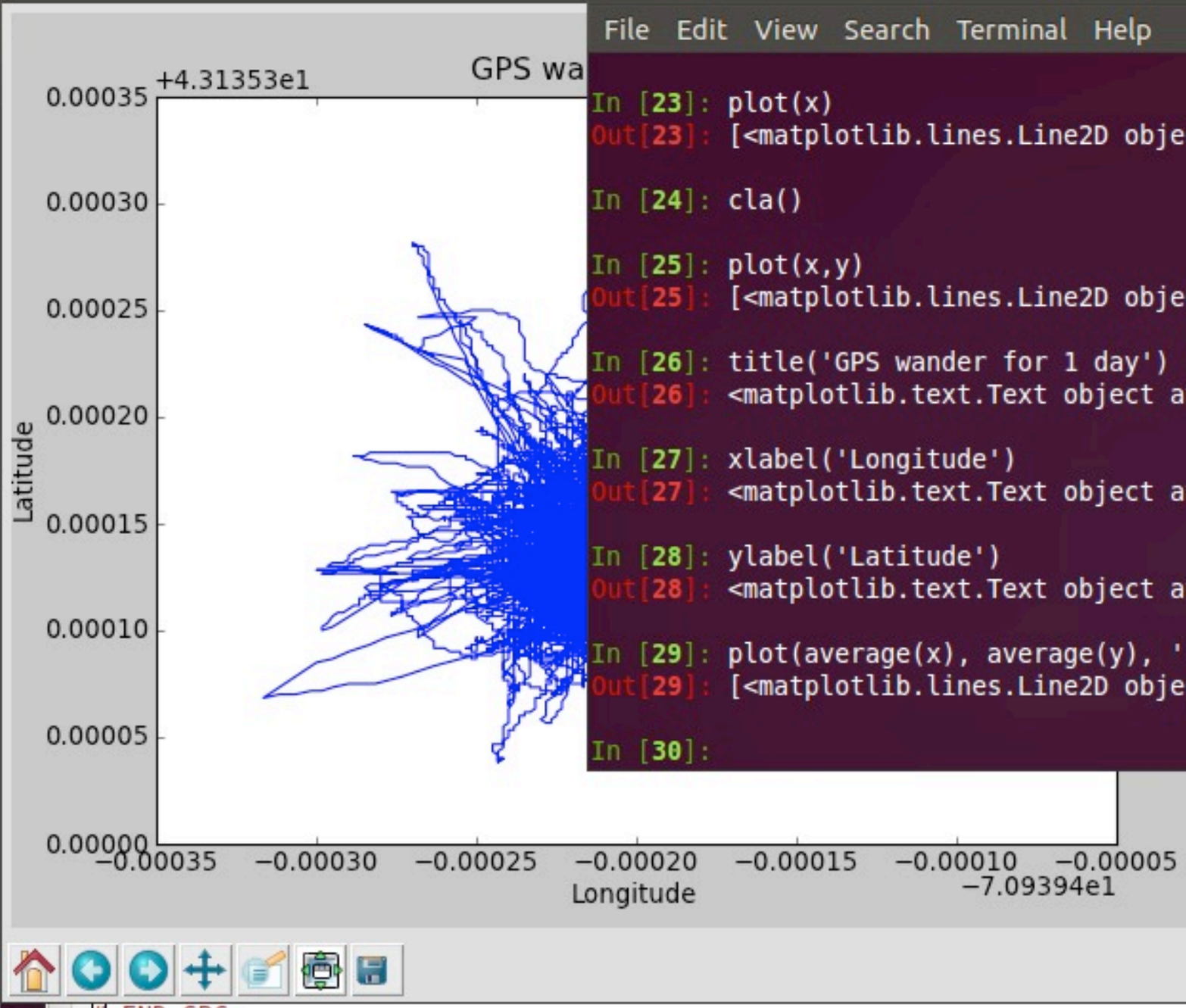
nown Bot L34 (ERC)----------

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

Friday, October 21, 11

Applications Places System 11:36 AM researchtools

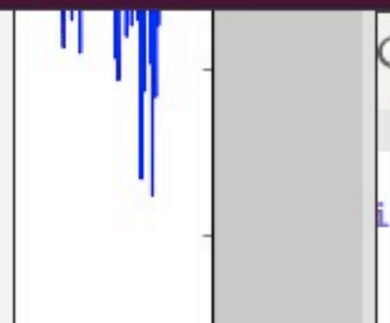
Figure 1



researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
In [23]: plot(x)
Out[23]: [<matplotlib.lines.Line2D object at 0x93a4e6c>]

In [24]: cla()

In [25]: plot(x,y)
Out[25]: [<matplotlib.lines.Line2D object at 0x9e1ca8c>]

In [26]: title('GPS wander for 1 day')
Out[26]: <matplotlib.text.Text object at 0x91be1ec>

In [27]: xlabel('Longitude')
Out[27]: <matplotlib.text.Text object at 0x9e0320c>

In [28]: ylabel('Latitude')
Out[28]: <matplotlib.text.Text object at 0x9e03eec>

In [29]: plot(average(x), average(y), 'ro')
Out[29]: [<matplotlib.lines.Line2D object at 0x9e1bd8c>]

In [30]:
```



ined channel #unhresea

```
#+END_SRC

Try something nicer - the lines with the average of x and y marked:

#+BEGIN_SRC python
cla()
plot(x,y)
```

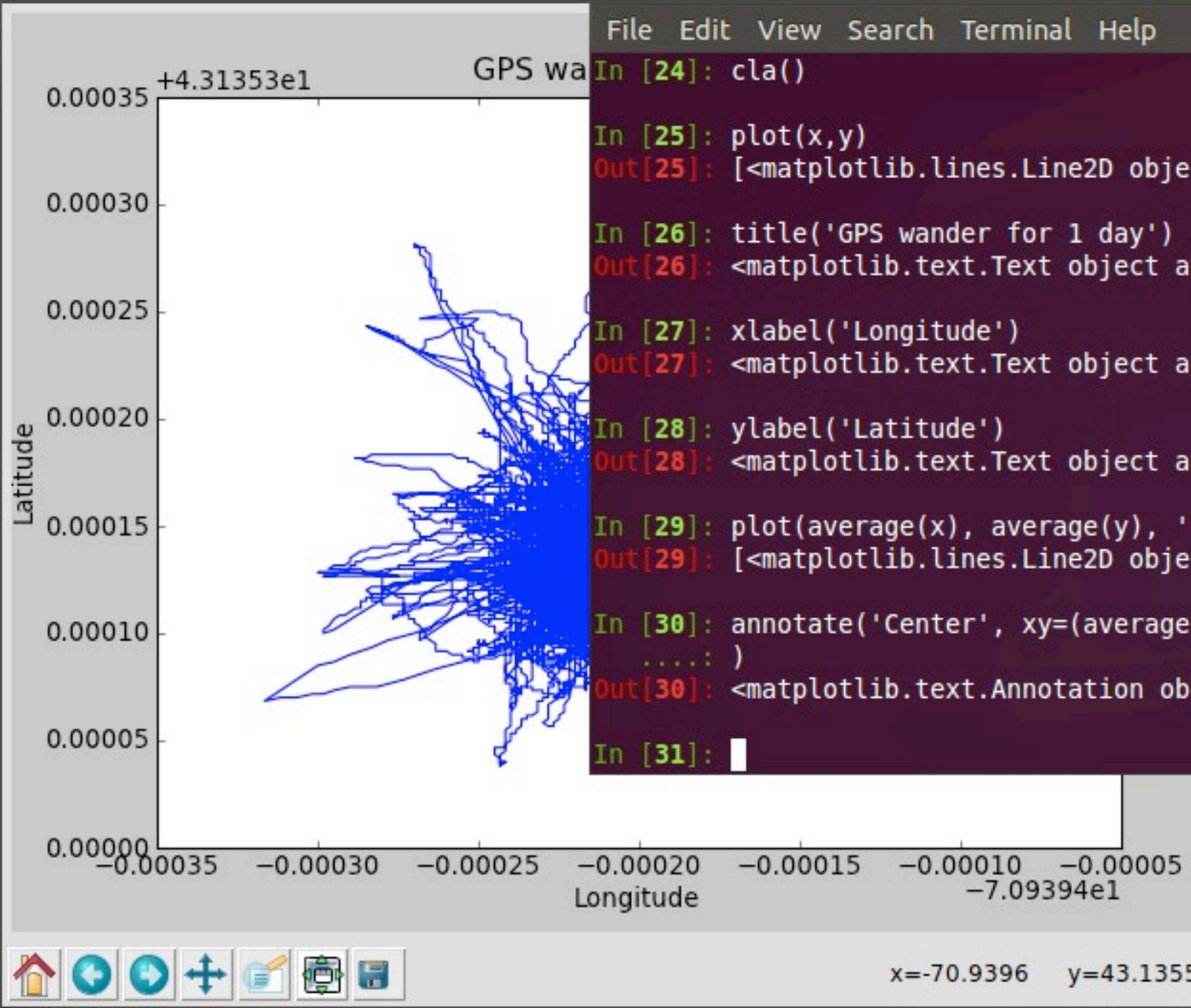
--:--- **15-matplotlib.org** 46% L146 (Org)----------

nown Bot L34 (ERC)----------

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

Applications Places System 11:37 AM researchtools

Figure 1



researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
In [24]: cla()

In [25]: plot(x,y)
Out[25]: [<matplotlib.lines.Line2D object at 0x9e1ca8c>]

In [26]: title('GPS wander for 1 day')
Out[26]: <matplotlib.text.Text object at 0x91be1ec>

In [27]: xlabel('Longitude')
Out[27]: <matplotlib.text.Text object at 0x9e0320c>

In [28]: ylabel('Latitude')
Out[28]: <matplotlib.text.Text object at 0x9e03eec>

In [29]: plot(average(x), average(y), 'ro')
Out[29]: [<matplotlib.lines.Line2D object at 0x9e1bd8c>]

In [30]: annotate('Center', xy=(average(x), average(y))
    ....: )
Out[30]: <matplotlib.text.Annotation object at 0x9e1606c>

In [31]:
```

80000 90000

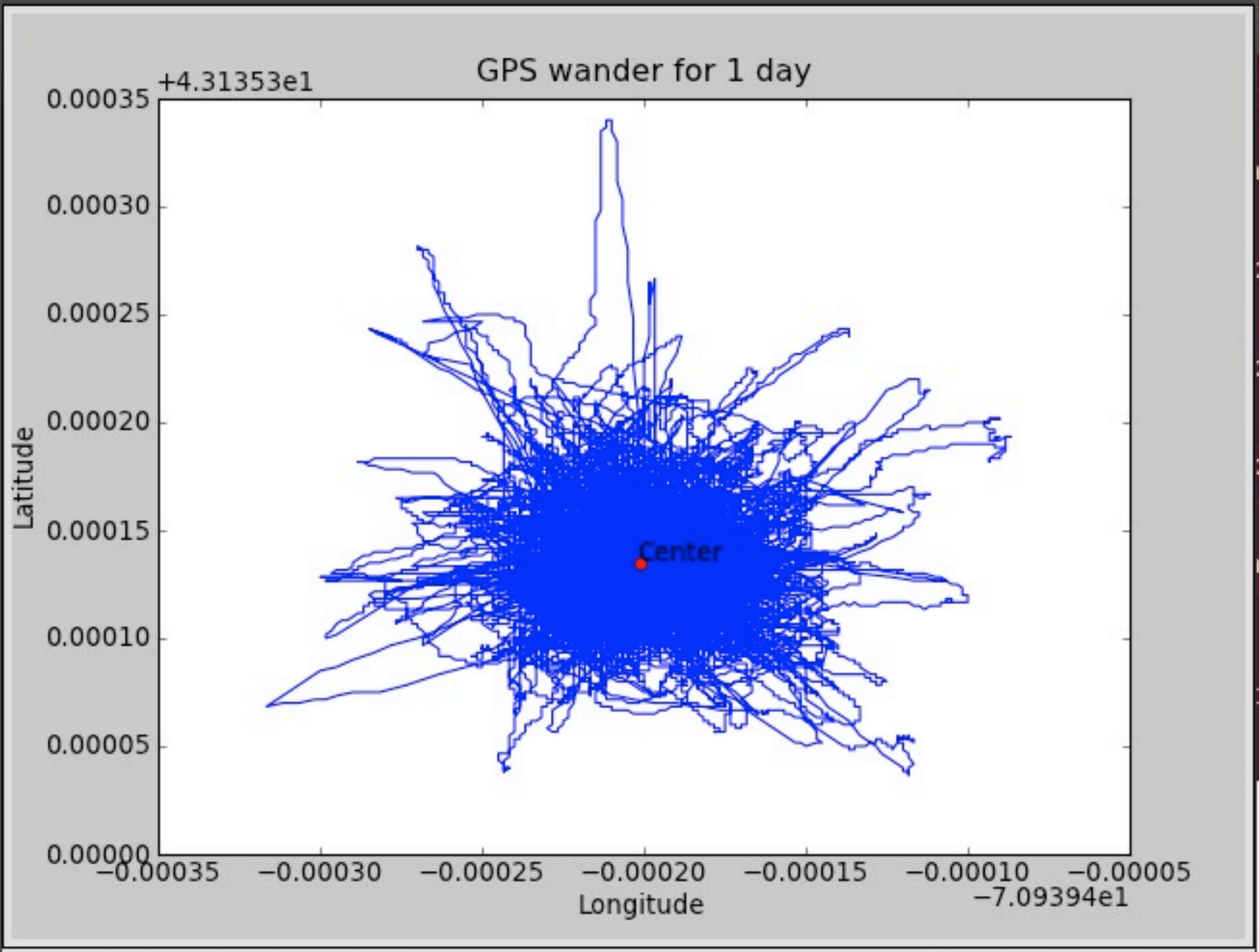
ined channel #unhresea

```
#+END_SRC

Try something nicer - the lines with the average of x and y marked:

#+BEGIN_SRC python
cla()
plot(x,y)
--:---  15-matplotlib.org   46% L146   (Org)----------
nown    Bot L34    (ERC)----------
```

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

Applications Places System 11:37 AM researchtools

Figure 1



x=-70.9396 y=43.1355

```
t 0x9e1ca8c>]

:91be1ec>

:9e0320c>

:9e03eec>

t 0x9e1bd8c>]

 average(y))

: at 0x9e1606c>
```

80000 90000

ined channel #unhresea

```
#+END_SRC

Try something nicer - the lines with the average of x and y marked:

#+BEGIN_SRC python
cla()
plot(x,y)
```

--:--- **15-matplotlib.org** 46% L146 (Org)----------

nown Bot L34 (ERC)----------

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

Friday, October 21, 11

Applications Places System 11:38 AM researchtools

Figure 1

GPS wander for 1 day

+4.31353e1

Latitude

researchtools@ubuntu: ~/class/15

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```
In [26]: title('GPS wander for 1 day')
Out[26]: <matplotlib.text.Text object at 0x91be1ec>

In [27]: xlabel('Longitude')
Out[27]: <matplotlib.text.Text object at 0x9e0320c>

In [28]: ylabel('Latitude')
Out[28]: <matplotlib.text.Text object at 0x9e03eec>

In [29]: plot(average(x), average(y), 'ro')
Out[29]: [<matplotlib.lines.Line2D object at 0x9e1bd8c>]

In [30]: annotate('Center', xy=(average(x), average(y))
    ....: )
Out[30]: <matplotlib.text.Annotation object at 0x9e1606c>

In [31]: show()

In [32]: figure(2)
Out[32]: <matplotlib.figure.Figure object at 0x91be22c>

In [33]:
```

Figure 2

−7.09394e1

#+END_SRC

Try something nice

#+BEGIN_SRC python

cla()

plot(x,y)

--:--- 15-matplotlib.org 46% L146 (Org)----------

ined channel #unhresea

nown Bot L34 (ERC)----------

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

Applications Places System 11:41 AM researchtools

Figure 1

GPS wander for 1 day

+4.31353e1

Latitude

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
In [28]: ylabel('Latitude')
Out[28]: <matplotlib.text.Text object at 0x9e03eec>

In [29]: plot(average(x), average(y), 'ro')
Out[29]: [<matplotlib.lines.Line2D object at 0x9e1bd8c>]

In [30]: annotate('Center', xy=(average(x), average(y))
    ....: )
Out[30]: <matplotlib.text.Annotation object at 0x9e1606c>

In [31]: show()

In [32]: figure(2)
Out[32]: <matplotlib.figure.Figure object at 0x91be22c>

In [33]: import pyproj

In [34]: geod = py
pylab         pylab_setup   pyproj

In [34]: pyproj.Geod?
```

Figure 2

−7.09394e1

```
#+END_SRC

Try something nice

#+BEGIN_SRC python
cla()
plot(x,y)
```

--:--- **15-matplotlib.org** 46% L146 (Org)----------

ined channel #unhresea

nown Bot L34 (ERC)----------

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

Applications Places System 11:42 AM researchtools

Figure 1

GPS wander for 1 day

+4.31353e1

Latitude

Figure 2

−7.09394e1

x=67131.5 y=-70.9396

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
In [34]: geod = py
pylab        pylab_setup  pyproj

In [34]: pyproj.Geod?
Type:            type
Base Class:      <type 'type'>
String Form:     <class 'pyproj.Geod'>
Namespace:       Interactive
File:            /usr/lib/pymodules/python2.7/pyproj/__init__.py
Docstring:
    performs forward and inverse geodetic, or Great Circle,
    computations.  The forward computation (using the 'fwd' method)
    involves determining latitude, longitude and back azimuth of a
    terminus point given the latitude and longitude of an initial
    point, plus azimuth and distance. The inverse computation (using
    the 'inv' method) involves determining the forward and back
    azimuths and distance given the latitudes and longitudes of an
    initial and terminus point.


In [35]: geod = pyproj.Geod
```

```
#+END_SRC

Try something nice

#+BEGIN_SRC python
cla()
plot(x,y)
```

--:--- 15-matplotlib.org 46% L146 (Org)----------

ined channel #unhresea

nown Bot L34 (ERC)----------

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

Applications Places System 11:45 AM researchtools

Figure 1

GPS wander for 1 day

+4.31353e1

Latitude

Figure 2

−7.09394e1

x=51230.8 y=-70.9396

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
   the 'inv' method) involves determining the forward and back
   azimuths and distance given the latitudes and longitudes of an
   initial and terminus point.


In [35]: geod = pyproj.Geod(ellps='WGS84')

In [36]: geod.
geod.__class__          geod.__new__            geod._fwd
geod.__delattr__        geod.__reduce__         geod._inv
geod.__dict__           geod.__reduce_ex__      geod._npts
geod.__doc__            geod.__repr__           geod.fwd
geod.__format__         geod.__setattr__        geod.geodstring
geod.__getattribute__   geod.__sizeof__         geod.inv
geod.__hash__           geod.__str__            geod.npts
geod.__init__           geod.__subclasshook__   geod.proj_version
geod.__module__         geod.__weakref__

In [36]: geod.inv(x[0],y[0], x[-1], y[-1])
Out[36]: (29.09995959658065, -150.90001875216535, 5.298079823618996)

In [37]: geod.inv
```

```
#+END_SRC

Try something nice

#+BEGIN_SRC python
cla()
plot(x,y)
```

```
--:---  15-matplotlib.org   46% L146   (Org)----------
```

```
ined channel #unhresea

k it up"

nown   Bot L35   (ERC)----------
```

[researc... 15-matpl... researcht... Research ... #unhrese... Figure 1 Figure 2

Applications Places System 11:49 AM researchtools

wander.py

File Edit Options Buffers Tools IM-Python Python Y

```
#!/usr/bin/env python

import pyproj


def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
```

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
4 : data
5 : data[0]
6 : len (data[0])
7 : x,y,z,quality,satellites,hdop = loadtxt('2011-10-11.gga.dat.bz2',
unpack=True)
8 : x
9 : y
10: average(x)
11: average(y)
12: min(x)
13: #?min
14: who
15: _ip.magic("who ")
16: x
17: plot(x)
18: plot(y)
19: cla()
20: #?cla
21: plot(y)
22: figure(2)
23: plot(x)
24: cla()
25: plot(x,y)
26: title('GPS wander for 1 day')
27: xlabel('Longitude')
28: ylabel('Latitude')
29: plot(average(x), average(y), 'ro')
30:
```

way of saying "suck it up"

-U:**- wander.py All L8 (Python yas)----------

nown Bot L35 (ERC)----------

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Applications Places System 11:52 AM researchtools

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

Help on function average in module numpy.lib.function_base:

=False)
pecified axis.

. If `a` is not an array,

`None`, averaging is done

the values in `a`. Each va

ding to its associated wei

(in which case its length

) or of the same shape as

`a` are assumed to have a

"suck it up"

35 (ERC)----------

wander.py

File Edit Options Buffers Tools IM-Python Python YASnippet Help

```
#!/usr/bin/env python

import pyproj # as some_really_annoying_name
import numpy as np

def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
    x,y,z,quality,satellites,hdop = loadtxt('2011-10-11.gga.dat.bz2', unpack=True)

    x_ave = average(x)
    y_ave = average(y)
```

-U:**- wander.py All L3 (Python yas)----------

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Applications Places System 11:53 AM researchtools

wander.py

File Edit Options Buffers Tools IM-Python Python Y

```
#!/usr/bin/env python

import pyproj
import numpy as np

def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
    x,y,z,quality,satellites,hdop = loadtxt('2011-

    x_ave = np.average(x)
    y_ave = np.average(y)
```

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
22: figure(2)
23: plot(x)
24: cla()
25: plot(x,y)
26: title('GPS wander for 1 day')
27: xlabel('Longitude')
28: ylabel('Latitude')
29: plot(average(x), average(y), 'ro')
30:
annotate('Center', xy=(average(x), average(y))
)
31: show()
32: figure(2)
33: import pyproj
34: #?pyproj.Geod
35: geod = pyproj.Geod(ellps='WGS84')
36: geod.inv(x[0],y[0], x[-1], y[-1])
37: #?geod.inv
38: _ip.magic("history ")

In [39]:

In [40]: help (average)


In [41]: import numpy as np

In [42]: np.
```

"suck it up"

-U:--- wander.py All L11 (Python yas)----------35 (ERC)----------

Wrote /home/researchtools/class/15/wander.py

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Friday, October 21, 11

Applications Places System 11:53 AM researchtools

wander.py

File Edit Options Buffers Tools IM-Python Python Y

```
#!/usr/bin/env python

import pyproj
import numpy as np

def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
    x,y,z,quality,satellites,hdop = loadtxt('2011-

    x_ave = np.average(x)
    y_ave = np.average(y)
```

-U:--- wander.py All L11 (Python yas)----------

Wrote /home/researchtools/class/15/wander.py

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
np.greater                np.unicode
np.greater_equal          np.unicode0
np.hamming                np.unicode_
np.hanning                np.union1d
np.histogram              np.unique
np.histogram2d            np.unique1d
np.histogramdd            np.unpackbits
np.hsplit                 np.unravel_index
np.hstack                 np.unsignedinteger
np.hypot                  np.unwrap
np.i0                     np.ushort
np.identity               np.vander
np.iinfo                  np.var
np.imag                   np.vdot
np.in1d                   np.vectorize
np.index_exp              np.version
np.indices                np.void
np.inexact                np.void0
np.inf                    np.vsplit
np.info                   np.vstack
np.infty                  np.where
np.inner                  np.who
np.insert                 np.zeros
np.int                    np.zeros_like

In [42]: np.average?

In [43]:
```

"suck it up"

35 (ERC)----------

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Applications Places System 11:55 AM researchtools

wander.py

File Edit Options Buffers Tools IM-Python Python Y

```
#!/usr/bin/env python

import pyproj
import numpy as np

def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
    x,y,z,quality,satellites,hdop = loadtxt('2011-

    x_ave = np.average(x)
    y_ave = np.average(y)

    print x_ave,y_ave
```

-U:--- wander.py All L14 (Python yas)----------

Wrote /home/researchtools/class/15/wander.py

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
np.insert                   np.zeros
np.int                      np.zeros_like

In [42]: np.average?

In [43]: ls
15-matplotlib.org  2011-10-11.gga.dat.bz2  wander.py  wander.py~

In [44]: run wander

In [45]: import wander

In [46]: wander.
wander.__builtins__       wander.__reduce__
wander.__class__          wander.__reduce_ex__
wander.__delattr__        wander.__repr__
wander.__dict__           wander.__setattr__
wander.__doc__            wander.__sizeof__
wander.__file__           wander.__str__
wander.__format__         wander.__subclasshook__
wander.__getattribute__   wander.np
wander.__hash__           wander.py
wander.__init__           wander.pyc
wander.__name__           wander.pyproj
wander.__new__            wander.py~
wander.__package__        wander.wander_list

In [46]: wander.wander_list()
```

"suck it up"

35 (ERC)----------

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Applications Places System 11:56 AM researchtools

wander.py

File Edit Options Buffers Tools IM-Python Python Y

```
#!/usr/bin/env python

import pyproj
import numpy as np

def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
    x,y,z,quality,satellites,hdop = np.loadtxt('20

    x_ave = np.average(x)
    y_ave = np.average(y)

    print x_ave,y_ave
```

researchtools@ubuntu: ~/class/15

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```
NameError                                 Traceback (most recent call
last)

/home/researchtools/class/15/wander.py in <module>()
----> 1
      2
      3
      4
      5

/home/researchtools/class/15/wander.py in wander_list()
      6 def wander_list():
      7     geod = pyproj.Geod(ellps='WGS84')
----> 8     x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.gga
.dat.bz2', unpack=True)
      9
     10     x_ave = np.average(x)

NameError: global name 'loadtxt' is not defined

In [49]: reload wander
-------> reload(wander)
Out[49]: <module 'wander' from 'wander.py'>

In [50]: wander.wander_list()
-70.9396014907 43.135434976

In [51]:
```

"suck it up"

-U:--- wander.py All L8 (Python yas)----------35 (ERC)----------

Wrote /home/researchtools/class/15/wander.py

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Applications Places System 12:06 PM researchtools

wander.py

File Edit Options Buffers Tools IM-Python Python Y

```
#!/usr/bin/env python

import pyproj
import numpy as np

def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
    x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.gga.dat.bz2', unpack=True)

    x_ave = np.average(x)
    y_ave = np.average(y)

    print x_ave,y_ave


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

-U:--- wander.py All L18 (Python yas)----------

Wrote /home/researchtools/class/15/wander.py

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
NameError: global name 'loadtxt' is not defined

In [49]: reload wander
-------> reload(wander)
Out[49]: <module 'wander' from 'wander.py'>

In [50]: wander.wander_list()
-70.9396014907 43.135434976

In [51]: run wander.py
-70.9396014907 43.135434976

In [52]: reload wander
```

```
has quit: "ChatZilla 0.9.87

as quit: "ChatZilla 0.9.87

quit: "ChatZilla 0.9.87 [Fi
```

47 (ERC)----------

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Applications Places System 12:06 PM researchtools

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
-------> reload(wander)
Out[52]: <module 'wander' from 'wander.py'>

In [53]: run wander.py
__name__: __main__
-70.9396014907 43.135434976

In [54]: reload wander
-------> reload(wander)
__name__: wander
Out[54]: <module 'wander' from 'wander.py'>

In [55]:
```

wander.py

File Edit Options Buffers Tools IM-Python Python Y

```
#!/usr/bin/env python

import pyproj
import numpy as np

def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
    x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.gga.dat.bz2', unpack=True)

    x_ave = np.average(x)
    y_ave = np.average(y)

    print x_ave,y_ave


print '__name__:',__name__
if __name__ == '__main__':
    wander_list()
```

```
-U:---  wander.py      All L16    (Python yas)----------------------------------------------------
Wrote /home/researchtools/class/15/wander.py
```

s quit: "ChatZilla 0.9.87 [

49 (ERC)----------

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Applications Places System 12:08 PM researchtools

wander.py

File Edit Options Buffers Tools IM-Python Python Y

```
#!/usr/bin/env python

import pyproj
import numpy as np

def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
    x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.gga.dat.bz2', unpack=True)

    x_ave = np.average(x)
    y_ave = np.average(y)

    print x_ave,y_ave


print '__name__:',__name__
if __name__ == '__main__':
    wander_list()
```

-U:--- wander.py All L16 (Python yas)----------

Wrote /home/researchtools/class/15/wander.py

researchtools@ubuntu: ~/class/15

File Edit View Search Terminal Help

```
2011-10-11.gga.dat.bz2  wander.py~

In [56]: !touch foo.org

In [57]: import glob

In [58]: glob.gl
glob.glob   glob.glob0  glob.glob1

In [58]: glob.glob('*.org')
Out[58]: ['foo.org', '15-matplotlib.org']

In [59]:
```

as quit: "ChatZilla 0.9.87

as quit: "ChatZilla 0.9.87

quit: "ChatZilla 0.9.87 [F

59 (ERC)----------

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Friday, October 21, 11

There was a question outside of class about “glob” for finding files. I will try to do a video that talks more about working with files and directories.

Applications Places System 12:08 PM researchtools

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File Edit View Search Terminal Help

```
Out[60]: '/home/researchtools/class'

In [61]: glob.glob('*/*.org')
Out[61]:
['11/11-ipython.org',
 '15/foo.org',
 '15/15-matplotlib.org',
 '10/10-qgis-bash-python.org',
 '12/12-python.org',
 'examples-20110913/sample.org',
 '14/14-python-gps-data.org']

In [62]:
```

wander.py

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```
#!/usr/bin/env python

import pyproj
import numpy as np

def wander_list():
    geod = pyproj.Geod(ellps='WGS84')
    x,y,z,quality,satellites,hdop = np.loadtxt('2011-10-11.gga.dat.bz2', unpack=True)

    x_ave = np.average(x)
    y_ave = np.average(y)

    print x_ave,y_ave


print '__name__:',__name__
if __name__ == '__main__':
    wander_list()
```

-U:--- wander.py All L16 (Python yas)----------

Wrote /home/researchtools/class/15/wander.py

```
quit: "ChatZilla 0.9.87 [F

s quit: Client closed conne

60 (ERC)----------
```

[researchtools@... wander.py researchtools@... Research Tools C... #unhresearchtools

Friday, October 21, 11