

```
/usr/bin/env python
```

```
3 from scipy import *
4 from pylab import *
```

Bifurcation diagram of a mapping

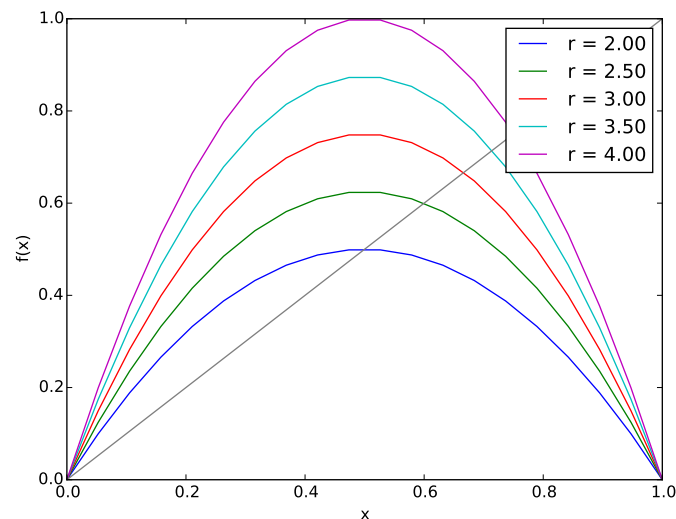
We are interested in the long term behavior of a sequence created by a the iteration of map.

The logistic map

```
13 f = lambda x,r : r * x * ( 1 -x )
```

The logistic map is parametrised by "r"

```
15 x = linspace( 0, 1, 20 )
16 rlist = linspace( 2, 4, 5 )
17 hold(True)
18 for r in rlist: plot(x, f(x,r), label = 'r = %.2f' % r)
19 legend()
20 xlabel('x')
21 ylabel('f(x)')
22 plot(x,x,color=(0.5,0.5,0.5), label = ' ')
23 show()
```



Behavior of the sequence

The sequence is created by iteration of the map over an initial value:

```
27 X = [0.1, ]
28 for i in range(0,9): X += [ f(X[-1],2) ]
29 print array(X)
```

```
[ 0.1      0.18      0.2952      0.41611392  0.48592625  0.49960386
 0.49999969  0.5      0.5      0.5      ]
```

The sequence converges to a stable fixed point if it has one, but can also oscillated between different unstable fixed points, or have no stable long term behavior, exhibiting chaos.

```
33 X = [ 0.1 * ones_like(rlist), ]
34 for i in range(0,30): X += [ f(X[-1], rlist) ]
35 X = vstack(X)
36 figure()
37 for i, r in enumerate(rlist):
38     subplot( rlist.size, 1, i+1)
```

```

39     plot( X[ :, i], label = 'r = %.2f' % r)
40     ylim ( 0, 1)
41     yticks ( '')
42     xticks ( '')
43     legend( loc = 10 )

```

Error:

Traceback (most recent call last):

```

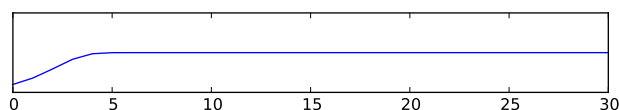
File "/Library/Python/2.7/site-packages/pyreport-0.3.4rc0-py2.7.egg/pyreport/main.py", line 1, in
exec block_text in self.namespace
File "<string>", line 7, in <module>
File "/Library/Python/2.7/site-packages/matplotlib/pyplot.py", line 1633, in yticks
labels = ax.get_yticklabels()
File "/Library/Python/2.7/site-packages/matplotlib/axes/_base.py", line 2896, in get_yticklabels
which=which))
File "/Library/Python/2.7/site-packages/matplotlib/axis.py", line 1214, in get_ticklabel
return self.get_majorticklabels()
File "/Library/Python/2.7/site-packages/matplotlib/axis.py", line 1168, in get_majorticklabels
ticks = self.get_major_ticks()
File "/Library/Python/2.7/site-packages/matplotlib/axis.py", line 1297, in get_major_ticks
numticks = len(self.get_major_locator()())
TypeError: len() of unsized object

```

```

44 show ()

```

**Error:**

Traceback (most recent call last):

```

File "/Library/Python/2.7/site-packages/pyreport-0.3.4rc0-py2.7.egg/pyreport/main.py", line 1, in
exec block_text in self.namespace
File "<string>", line 3, in <module>
File "/Library/Python/2.7/site-packages/pyreport-0.3.4rc0-py2.7.egg/pyreport/main.py", line 1, in
pylab.savefig(figure_name)
File "/Library/Python/2.7/site-packages/matplotlib/pyplot.py", line 577, in savefig
res = fig.savefig(*args, **kwargs)
File "/Library/Python/2.7/site-packages/matplotlib/figure.py", line 1470, in savefig
self.canvas.print_figure(*args, **kwargs)
File "/Library/Python/2.7/site-packages/matplotlib/backend_bases.py", line 2194, in print_figure
**kwargs)
File "/Library/Python/2.7/site-packages/matplotlib/backends/backend_pdf.py", line 2469, in
self.figure.draw(renderer)
File "/Library/Python/2.7/site-packages/matplotlib/artist.py", line 59, in draw_wrapper

```

```

draw(artist, renderer, *args, **kwargs)
File "/Library/Python/2.7/site-packages/matplotlib/figure.py", line 1079, in draw
    func(*args)
File "/Library/Python/2.7/site-packages/matplotlib/artist.py", line 59, in draw_wrapper
    draw(artist, renderer, *args, **kwargs)
File "/Library/Python/2.7/site-packages/matplotlib/axes/_base.py", line 2092, in draw
    a.draw(renderer)
File "/Library/Python/2.7/site-packages/matplotlib/artist.py", line 59, in draw_wrapper
    draw(artist, renderer, *args, **kwargs)
File "/Library/Python/2.7/site-packages/matplotlib/axis.py", line 1114, in draw
    ticks_to_draw = self._update_ticks(renderer)
File "/Library/Python/2.7/site-packages/matplotlib/axis.py", line 957, in _update_ticks
    tick_tups = [t for t in self.iter_ticks()]
File "/Library/Python/2.7/site-packages/matplotlib/axis.py", line 902, in iter_ticks
    majorTicks = self.get_major_ticks(len(majorLocs))
TypeError: len() of unsized object

```

Bifurcation diagram

To study the long term behavior of the sequence we can plot the values it visits after many iterations, as a function of the parameter

```

49 rlist = linspace( 2, 4, 800)
50 X = [ 0.5 * ones_like(rlist), ]
51 for i in arange(0,10000): X += [ f(X[-1], rlist) , ]
52 X = hsplit( vstack(X[-2000:]), rlist.size)
53 from scipy import stats
54 H = map( lambda Z : stats.histogram( Z, defaultlimits=(0,1), numbins=300 )[0],X)
55 H = map( lambda Z : 1-Z/Z.max(), H )
56 H = vstack(H)
57 figure()
58 imshow( rot90(H), aspect = 'auto' , extent = [2, 4, 0, 1])
59 bone()
60 xlabel('r')
61 ylabel(r'$X_{n \rightarrow \infty}$')
62 show()

```

