04-examples

January 27, 2017

1 Examples

In [1]:
```
# setup

import math
import random
import matplotlib.pyplot as plt

# make plots render in the notebook, instead of in an external window,
# which tends to be annoying
%matplotlib inline
```

In [2]:
```
# want to swap the case of s[n]
# this won't work - can't modify a string

def swapone(s, n):
    c = s[n]
    # get the char, swap it
    c = c.swapcase()
    # and put back in the string
    s[n] = c
    return s

swapone('abcd', 2)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)

<ipython-input-2-fffc28ea2da6> in <module>()
 10     return s
 11
---> 12 swapone('abcd', 2)


<ipython-input-2-fffc28ea2da6> in swapone(s, n)
```

```
      7     c = c.swapcase()
      8     # and put back in the string
----> 9     s[n] = c
     10     return s
     11

TypeError: 'str' object does not support item assignment
```

In [3]:
```
# take 2

def swapone2(s, n):
    # take the string apart
    left = s[:n]
    right = s[n+1:]
    swap = s[n].swapcase()
    # and put it back together
    return left + swap + right

swapone2('abcd', 2)
```

Out[3]:
```
'abCd'
```

In [4]:
```
list('asdf')
```

Out[4]:
```
['a', 's', 'd', 'f']
```

In [5]:
```
# take 3

def swapone3(s, n):
    # convert to a list!!
    sl = list(s)
    # list can be updated
    sl[n] = sl[n].swapcase()
    # convert back to string
    print(sl)
    return ''.join(sl)

swapone3('abcd', 2)
```

```
['a', 'b', 'C', 'd']
```

Out[5]:
```
'abCd'
```

2 Structure sharing

In [6]:
```
# lists are zero origin
```

```
In [6]: x = [[1,2],[3,4],[5,6]]
        x

Out[6]: [[1, 2], [3, 4], [5, 6]]

In [7]: # 2nd element of outer list, then 1st element of [3,4]

        x[1][0]

Out[7]: 3

In [8]: x[1][0] = 55
        x

Out[8]: [[1, 2], [55, 4], [5, 6]]

In [9]: y = 5*[[1,2]]
        y

Out[9]: [[1, 2], [1, 2], [1, 2], [1, 2], [1, 2]]

In [10]: # why so many 55's?
         # because 5*[[1,2]] made a len 5 list, then
         # filled it with references to the same [1,2] list.
         # only one [1,2] was constructed, not 5

         y[1][0] = 55
         y

Out[10]: [[55, 2], [55, 2], [55, 2], [55, 2], [55, 2]]

In [11]: y[0] is y[1] is y[2]

Out[11]: True

In [12]: # this will make 5 separate [1,2] lists

         z = [[1,2] for j in range(5)]
         z

Out[12]: [[1, 2], [1, 2], [1, 2], [1, 2], [1, 2]]

In [13]: z[0] is z[1]

Out[13]: False

In [14]: # the other four [1,5] lists are not affected

         z[1][0] = 55
         z
```

```
Out[14]: [[1, 2], [55, 2], [1, 2], [1, 2], [1, 2]]
```

```
In [15]: # this was a typo i made
         # what is it doing?

         z = [[1,2] for j in range(5)]
         z[[1][0]] = 55
         z
```

```
Out[15]: [[1, 2], 55, [1, 2], [1, 2], [1, 2]]
```

3 define rcount

- recursively count elements in a nested list
- a common pattern for recursing thru a nested list is to split the list into the first element, and the rest of the list, then recurse on each piece
- if you are not familar with recursion, I will cover it in the next class

```
In [16]: def rcount(x):
             if isinstance(x, list):
                 # x is a list, get the length
                 xlen = len(x)
                 if xlen == 1:
                     return(rcount(x[0]))
                 else:
                     # use an array access and a slice
                     # to subdivide list
                     return rcount(x[0]) + rcount(x[1:])

             # x is not a list, so just counts as 1
             return(1)
```

```
In [17]: rcount([1,2,[3,4,[5,6,7],8],9])
```

```
Out[17]: 9
```

4 Histogram of Guassian samples

```
In [18]: # mean = 0, stddev = 1

         [random.gauss(0,1) for j in range(10)]
```

```
Out[18]: [0.05885332833576429,
          0.425418401574395,
          -1.2547376259741498,
          -0.2829826592391403,
          0.17238006654796997,
          -0.7702283883562511,
```

```
 1.2836252758740865,
 -1.0926753067897654,
 -1.0099278524605617,
 0.7331069484063992]
```

In [19]:
```
# get 100,100 samples, and filter out data greater than 2 SD

gd = [d for d in [random.gauss(0,1) for j in range(100000)] if abs(d)<2]
len(gd)
```

Out[19]:
```
95516
```

In [20]:
```
# int seems like an easy way to compute bin numbers
# truncates the fraction

[int(3.4), int(-3.2)]
```

Out[20]:
```
[3, -3]
```

In [21]:
```
# list of bins each data point fell into


bins = [int((d /.2)) for d in gd]
bins[:20]
```

Out[21]:
```
[6, 7, 2, 2, -3, -4, 6, -3, 1, -6, 6, 4, -4, -8, -2, -1, 2, 5, 1, -6]
```

In [22]:
```
# sort the bin numbers.
# range from -10 to 9

bins.sort()
[bins[0],bins[-1], len(bins)]
```

Out[22]:
```
[-9, 9, 95516]
```

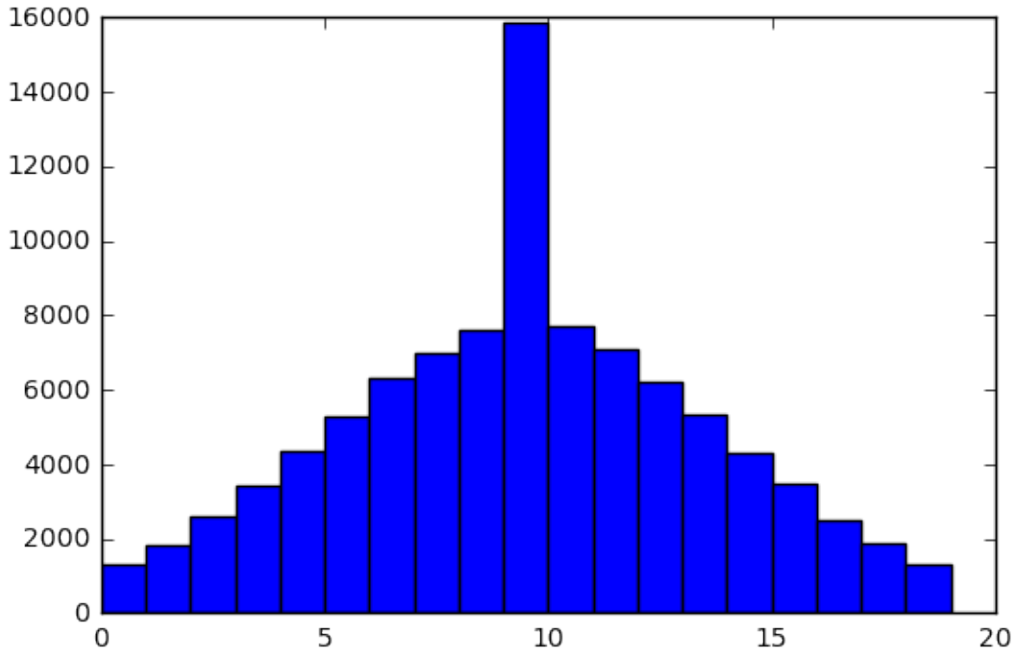
In [23]:
```
# offset bins so smallest bin number = 0

bins2 = [b - bins[0] for b in bins]
[bins2[0], bins2[-1]]
```

Out[23]:
```
[0, 18]
```

In [24]:
```
# make a list of zeros that we can increment
# to record the number of points in each bucket

cnts = [0] * (bins2[-1]+1)
cnts
```

Out[24]:
```
[0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0]
```

```
In [25]: for b in bins2:
             cnts[b] += 1
         cnts

Out[25]: [1288,
          1834,
          2592,
          3443,
          4375,
          5299,
          6341,
          6987,
          7596,
          15869,
          7708,
          7109,
          6197,
          5353,
          4325,
          3471,
          2522,
          1882,
          1325]

In [26]: # hmmm...

         plt.bar(range(len(cnts)), cnts, 1)

Out[26]: <Container object of 19 artists>
```



In [27]:
```
# let's try to figure out why 'int' doesn't work by plotting

# to plot a function, we need to generate a list of x values...
# but, range doesn't work with floats!

range(0,1,.1)
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)

<ipython-input-27-e09210850ac3> in <module>()
  4 # but, range doesn't work with floats!
  5
----> 6 range(0,1,.1)


TypeError: 'float' object cannot be interpreted as an integer
```

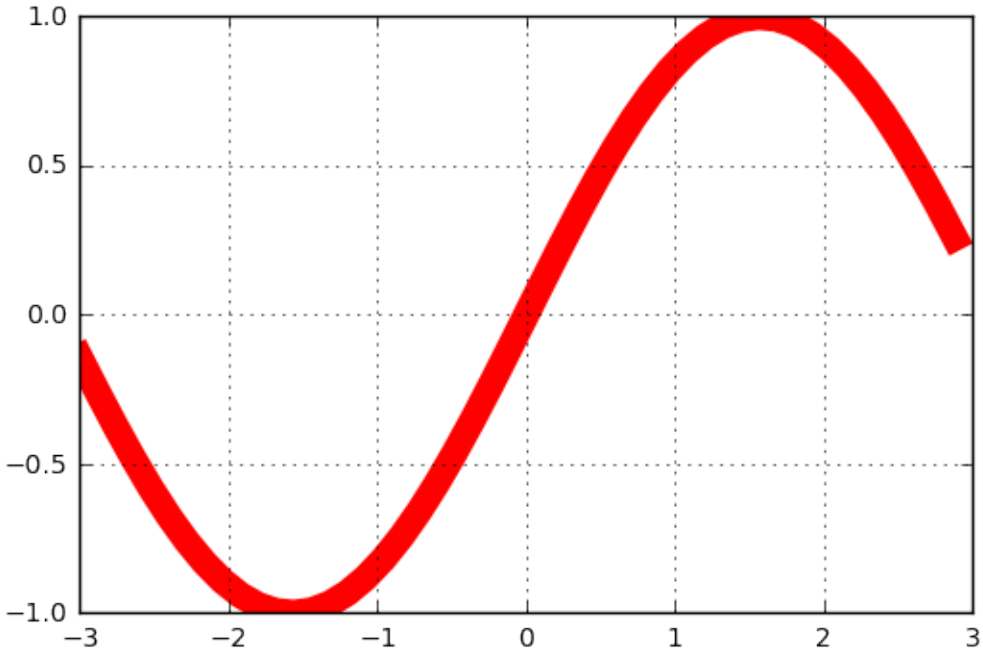
In [28]:
```
# make a float version of range

def frange(start, end, n):
    inc = (end - start)/float(n)
    return [start+j*inc for j in range(n)]

frange(0,1,10)
```

Out[28]:
```
[0.0,
 0.1,
 0.2,
 0.30000000000000004,
 0.4,
 0.5,
 0.6000000000000001,
 0.7000000000000001,
 0.8,
 0.9]
```

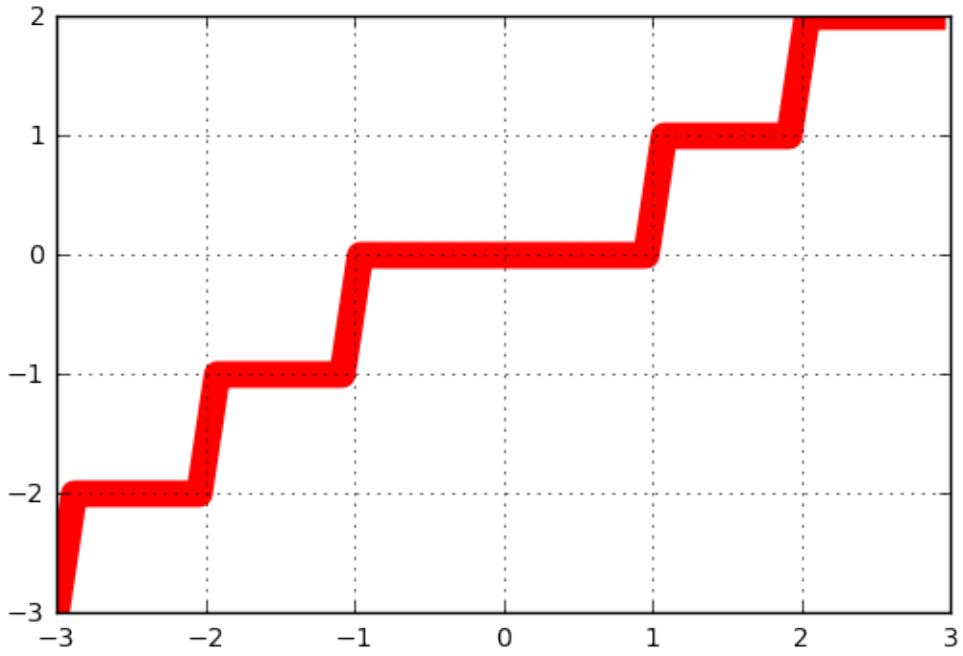
In [29]:
```
def plotf(func):
    # arg is function to plot
    # make a set of x vals
    x = frange(-3,3,50)
    # eval the func on the x vals
    y = [func(xv) for xv in x]
```

```
    plt.plot(x, y, 'r', linewidth=10)
    plt.grid(True)
```

In [30]:
```
# test

plotf(math.sin)
```

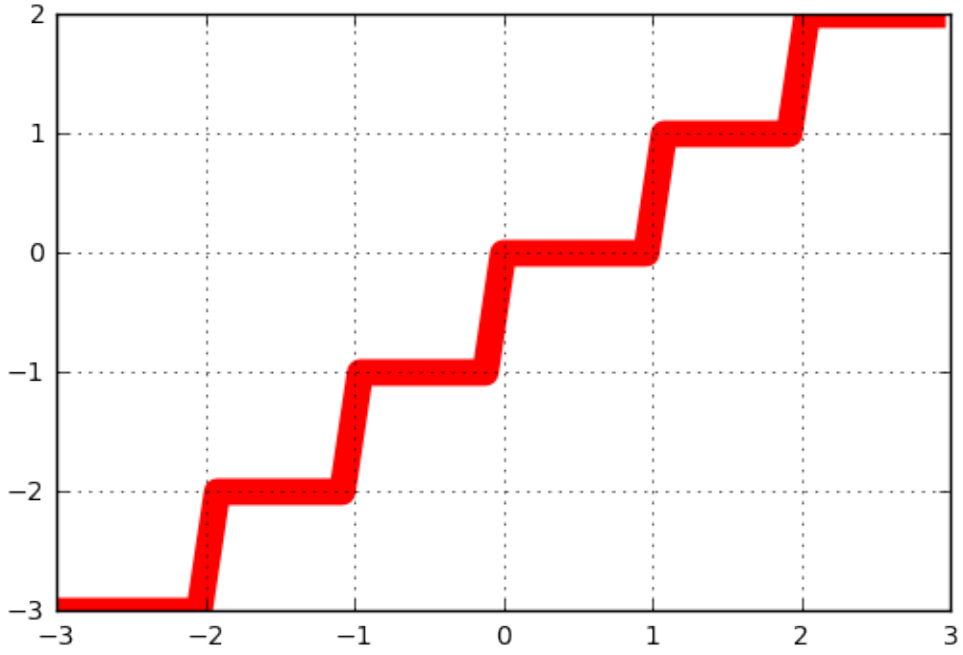


In [31]:
```
# now we see the problem - int is making the middle
# bucket twice as wide as the other buckets

plotf(int)
```



In [32]: *# math.floor does the right thing*

```
plotf(math.floor)
```



5 Fix

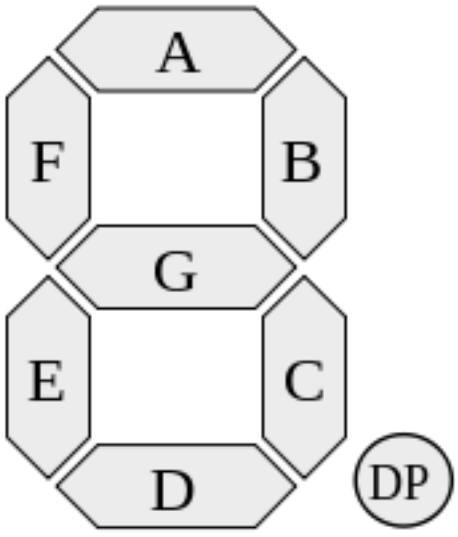
in code above, change
bins = [int((d /.2)) for d in gd]
to
bins = [math.floor((d /.2)) for d in gd]
and run again

6 7 segment display

- cheap displays
  - clock radios
  - elevators
- wiki article

```
In [33]: from IPython.display import Image

         Image('https://upload.wikimedia.org/wikipedia/commons/thumb/0/02/7_segment
```

Out[33]:

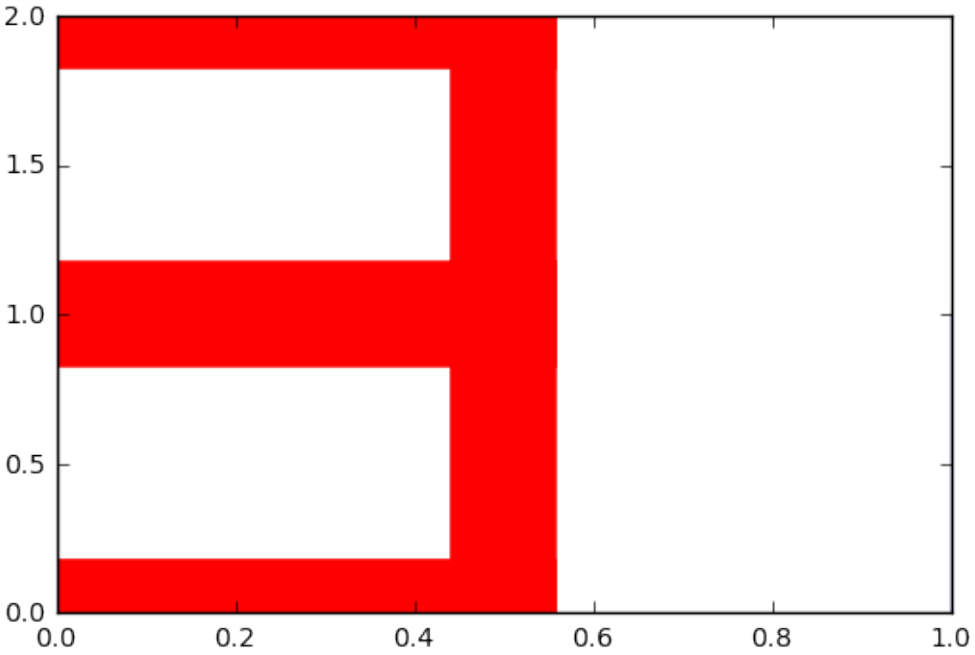


In [34]:
```
# a '1' means turn on the corresponding segment
# each tuple is (a,b,c,d,e,f,g)

segs = {' ':(0,0,0,0,0,0,0),
    '0':(1,1,1,1,1,1,0),
    '1':(0,1,1,0,0,0,0),
    '2':(1,1,0,1,1,0,1),
    '3':(1,1,1,1,0,0,1),
    '4':(0,1,1,0,0,1,1),
    '5':(1,0,1,1,0,1,1),
    '6':(1,0,1,1,1,1,1),
    '7':(1,1,1,0,0,0,0),
    '8':(1,1,1,1,1,1,1),
    '9':(1,1,1,1,0,1,1)}
```

In [35]:
```
# each segment is 1 long
# origin is at lower left

def seven(digit):
    # n or 'n' as arg
    a,b,c,d,e,f,g = segs[str(digit)]
    if a:
    # define line with two points
        pts = [[0,2], [1,2]]
        draw(pts)
    if b:
        pts = [[1,1], [1,2]]
        draw(pts)
    if c:
        pts = [[1,0], [1,1]]
        draw(pts)
    if d:
        pts = [[0,0], [1,0]]
        draw(pts)
    if e:
        pts = [[0,0],[0,1]]
        draw(pts)
    if f:
        pts = [[0,1],[0,2]]
        draw(pts)
    if g:
        pts = [[0,1],[1,1]]
        draw(pts)

    # trick to fix aspect ratio
    plt.plot([1,1], [0,1])

def draw(pts):
```

```
        pt1,pt2 = pts
        x = [pt1[0]*.5, pt2[0]*.5]
        y = [pt1[1], pt2[1]]
        plt.plot(x, y, linewidth=40, color='r')
```

In [36]:
```
seven(3)
```



In [37]:
```
# i don't like the above representation, find it hard to read
# so, i will convert to something i find more user friendly
# now i can easily see which segments to turn on

import string

alpha = {}

for key in segs.keys():
    val = segs[key]
    seglist = [a for a,n in zip(string.ascii_lowercase, val) if n]
    alpha[key] = seglist

alpha
```

Out[37]:
```
{' ': [],
 '0': ['a', 'b', 'c', 'd', 'e', 'f'],
 '1': ['b', 'c'],
 '2': ['a', 'b', 'd', 'e', 'g'],
```

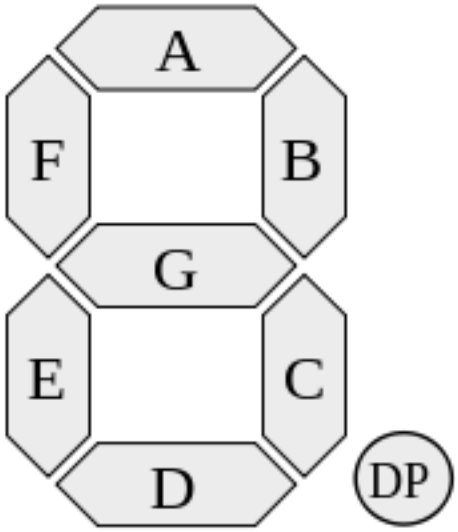
```
 '3': ['a', 'b', 'c', 'd', 'g'],
 '4': ['b', 'c', 'f', 'g'],
 '5': ['a', 'c', 'd', 'f', 'g'],
 '6': ['a', 'c', 'd', 'e', 'f', 'g'],
 '7': ['a', 'b', 'c'],
 '8': ['a', 'b', 'c', 'd', 'e', 'f', 'g'],
 '9': ['a', 'b', 'c', 'd', 'f', 'g']}
```

In [38]:
```
segs
```

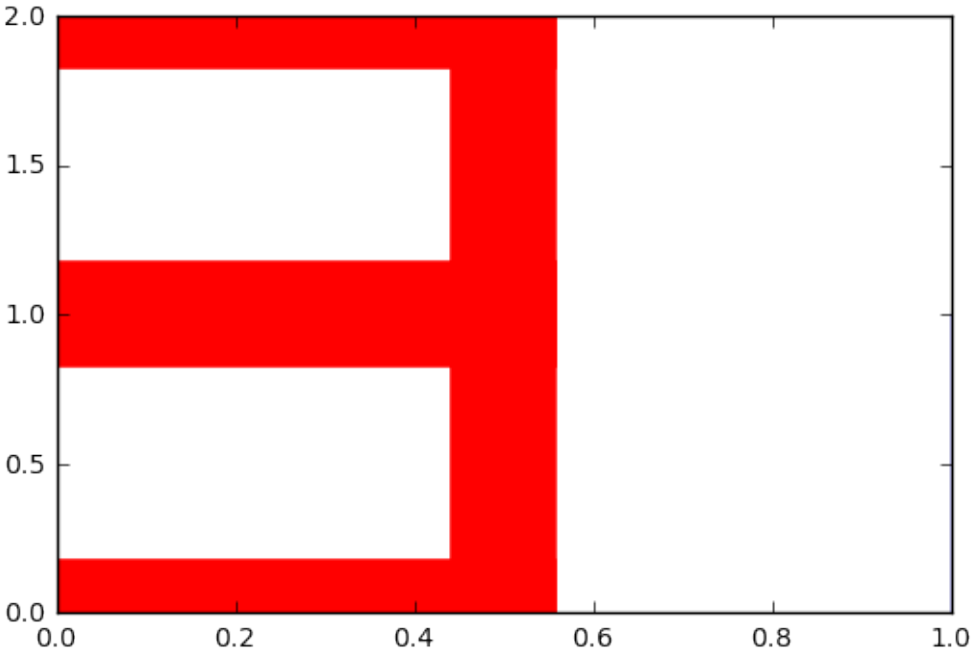
Out[38]:
```
{' ': (0, 0, 0, 0, 0, 0, 0),
 '0': (1, 1, 1, 1, 1, 1, 0),
 '1': (0, 1, 1, 0, 0, 0, 0),
 '2': (1, 1, 0, 1, 1, 0, 1),
 '3': (1, 1, 1, 1, 0, 0, 1),
 '4': (0, 1, 1, 0, 0, 1, 1),
 '5': (1, 0, 1, 1, 0, 1, 1),
 '6': (1, 0, 1, 1, 1, 1, 1),
 '7': (1, 1, 1, 0, 0, 0, 0),
 '8': (1, 1, 1, 1, 1, 1, 1),
 '9': (1, 1, 1, 1, 0, 1, 1)}
```

In [39]:
```
from IPython.display import Image

Image('https://upload.wikimedia.org/wikipedia/commons/thumb/0/02/7_segment
```

Out[39]:

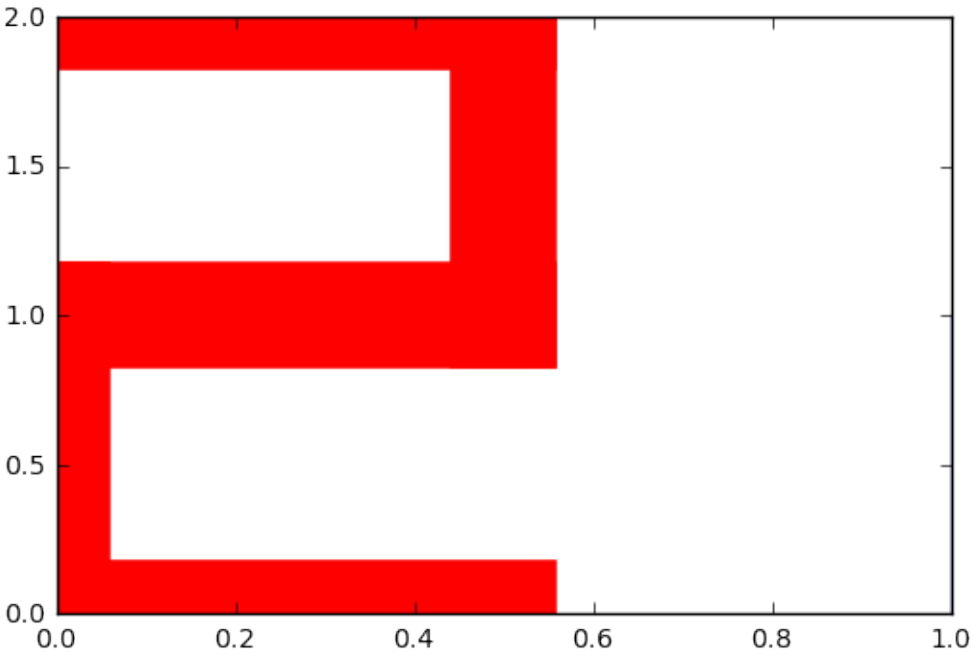


```
In [40]: # each segment is 1 long
         # origin is at lower left
         # a bad thing about the first version
         # and this one is alot of data is
         # encoded into the function.

         def seven2(digit):
             digit = str(digit)
             for seg in alpha[digit]:
                 # optimize if's?
                 if seg == 'a':
                     # define line with two points
                     pts = [[0,2], [1,2]]
                 if seg == 'b':
                     pts = [[1,1], [1,2]]
                 if seg == 'c':
                     pts = [[1,0], [1,1]]
                 if seg == 'd':
                     pts = [[0,0], [1,0]]
                 if seg == 'e':
                     pts = [[0,0],[0,1]]
                 if seg == 'f':
                     pts = [[0,1],[0,2]]
                 if seg == 'g':
                     pts = [[0,1],[1,1]]
                 pt1,pt2 = pts
                 x = [pt1[0]*.5, pt2[0]*.5]
                 y = [pt1[1], pt2[1]]
                 plt.plot(x, y, linewidth=40, color='r')
             # trick to fix aspect ratio
             plt.plot([1,1], [0,1])

In [41]: seven2(3)
```

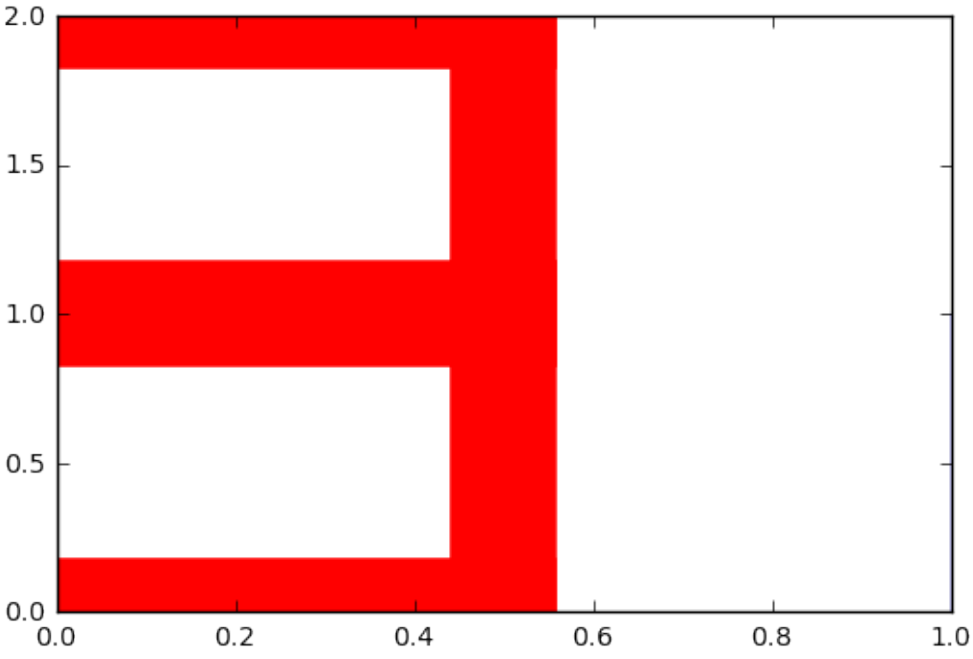


In [54]:
```
# much better to put data in a data structure

# each segment is 1 long
# origin is at lower left

ptsd = dict()
ptsd['a'] = [[0,2], [1,2]]
ptsd['b'] = [[1,1], [1,2]]
ptsd['c'] = [[1,0], [1,1]]
ptsd['d'] = [[0,0], [1,0]]
ptsd['e'] = [[0,0],[0,1]]
ptsd['f'] = [[0,1],[0,2]]
ptsd['g'] = [[0,1],[1,1]]

# now a simple function, with almost no data in it

def seven3(digit):
    digit = str(digit)
    for seg in alpha[digit]:
        pts = ptsd[seg]
        pt1,pt2 = pts
        x = [pt1[0]*.5, pt2[0]*.5]
        y = [pt1[1], pt2[1]]
        plt.plot(x, y, linewidth=40, color='r')
    # trick to fix aspect ratio
    plt.plot([1,1], [0,1])
```

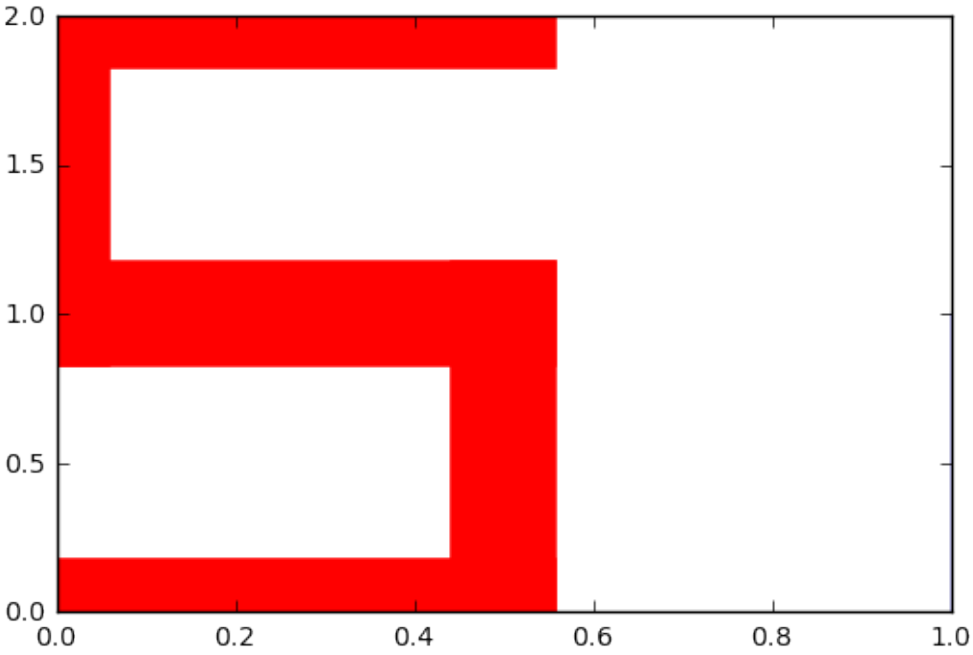
```
In [55]: seven3(2)
```




```
In [56]: seven3(3)
```



In [57]: seven3(5)



7 Change of a dollar

```
In [58]: # saving state in globals - ok for small/informal programs,
         # but later we will see how to make a class
         # note coins is a tuple, since the value of each
         # coin type never changes

         coins = (25, 10, 5, 1)
         coinInventory = [2, 3, 10, 7]

         def change(price):
             owe = 100 - price
             ans = [0]*len(coins)
             for j in range(len(coins)):
                 cval = coins[j]
                 cinv = coinInventory[j]
                 cnt = owe // cval
                 cnt = min(cnt, cinv)
                 ans[j] = cnt
                 coinInventory[j] -= cnt
                 owe -= cnt * cval
                 if owe == 0:
                     break
```

```
            # return amount still owed, if any
            # coins returned
            # coins left in inventory
            return [owe,ans,coinInventory]
```

```
In [60]: # // is integer division

         5//2
```

```
Out[60]: 2
```

```
In [61]: change(74)
```

```
Out[61]: [0, [1, 0, 0, 1], [1, 3, 10, 6]]
```

```
In [62]: change(74)
```

```
Out[62]: [0, [1, 0, 0, 1], [0, 3, 10, 5]]
```

```
In [63]: change(74)
```

```
Out[63]: [0, [0, 2, 1, 1], [0, 1, 9, 4]]
```

```
In [64]: change(74)
```

```
Out[64]: [0, [0, 1, 3, 1], [0, 0, 6, 3]]
```

```
In [65]: change(74)
```

```
Out[65]: [0, [0, 0, 5, 1], [0, 0, 1, 2]]
```

```
In [66]: # ran out of coins

         change(74)
```

```
Out[66]: [19, [0, 0, 1, 2], [0, 0, 0, 0]]
```