

Lab Assignment – 1

Linear Transformations

The following code generates the cat's picture.

```
import numpy as np

import matplotlib.pyplot as plt

topx=np.array([1, .98, .8, .83, .8, .77, .5, .25, 0, -.25, -.5, -.8, -.8, -.98, -1])

topy=np.array([0, .15, .7, 1.15, 1.03, 1.15, .85, .95, 1, .95, .85, 1.2, .7, .15, 0])

botx=-np.cos(np.pi*np.arange(1,10)/10)

boty=-np.sin(np.pi*np.arange(1,10)/10)

wiskx=np.array([.2, 1.3, .2, 1.4, .2, 1.4, .2, 1.3, .2, .17, .13, .08, .03, 0])

wisky=np.array([ 0, .3, 0, .1, 0, -.1, 0, -.3, 0, .1, -.1, .1, -.1, 0])-.2

xeye=np.array([0, .2, .3, .4, .43, .45, .43, .4, .37, .35, .37, .4, .5, .6, .5, .4, .3, .2, 0])

yeye=np.array([.5, .5, .43, .4, .42, .5, .58, .6, .58, .5, .42, .4, .43, .5, .57, .6, .57, .5,
.5])-.2

x=np.concatenate((topx,botx,wiskx,xeye,-xeye,-wiskx[::-1]))

y=np.concatenate((topy,boty,wisky,yeye, yeye,wisky[::-1]))

cat = np.array([x,y]).T

plt.plot(cat[:,0], cat[:,1],'b')

plt.xlim(-2, 2)

plt.ylim(-2, 2)

plt.show
```

Do the following for each transformation below:

- a) create the matrix associated to the given transformation
- b) show the effect of applying this matrix to the picture.

The transformations are:

1. Reflection through the x-axis
2. Reflection through the y-axis
3. Reflection through the axis $y=x$
4. Reflection through the axis $y=-x$
5. Reflection through the origin
6. Horizontal Contraction by a factor $1/3$
7. Vertical Contraction by a factor $1/5$
8. Horizontal Expansions by a factor 3
9. Vertical Expansions by a factor of 4
10. Horizontal Shears by a factor of -1.5 then +1.5
11. Vertical Shears by a factor of -1.5 then +1.5
12. Projection onto the x-axis
13. Projection onto the y-axis
14. Rotation by an angle of $\pi/3$ counterclockwise
15. Rotation by an angle of $\pi/3$ clockwise