



Figure 1: The phase portrait

```

1 import matplotlib.pyplot as plt
2 import numpy as np
3
4 # initialize lists containing values
5 x = []
6 y = []
7
8
9 def Refuge(X, r=1,c=1,b=1,m=1,s=1):
10     # here X[0] = x and x[1] = y
11     return np.array([ r*X[0] - c*(X[0]-s)*X[1] , b*(X[0]-s)*X[1] -m*X[1] ])
12
13 #plot
14 fig2 = plt.figure(figsize=(8,6))
15 ax4 = fig2.add_subplot(1,1,1)
16
17 ax4.set_title("Quiverplot")
18 ax4.legend(loc='best')
19
20 # quiverplot
21 # define a grid and compute direction at each point
22 x = np.linspace(0, 5, 20)
23 y = np.linspace(0, 5, 20)
24
25 X1 , Y1 = np.meshgrid(x, y)           # create a grid
26 DX1, DY1 = Refuge([X1, Y1])           # compute growth rate on the
    grid
27 M = (np.hypot(DX1, DY1))               # norm growth rate
28 M[ M == 0] = 1.                        # avoid zero division errors
29 DX1 /= M                                # normalize each arrows
30 DY1 /= M
31
32 ax4.quiver(X1, Y1, DX1, DY1, M, pivot='mid')
33 ax4.grid()

```