Logistic Map

1 Setting Up The Equation

The dynamical equation is as follows: $x_{n+1} = rx_n(1 - x_n)$

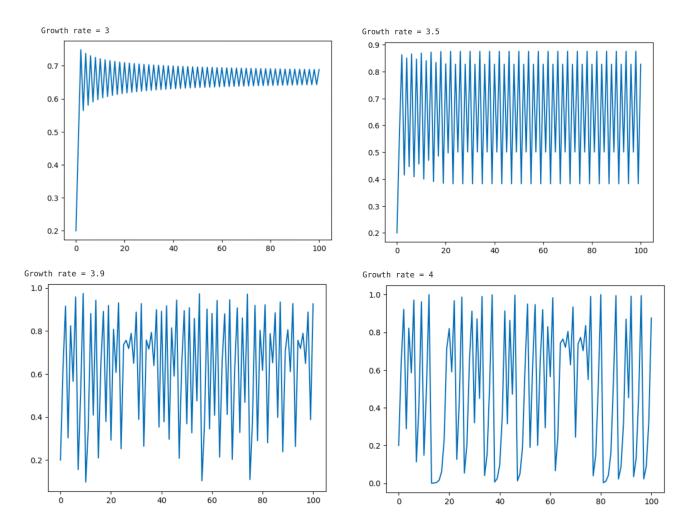
where r can be considered akin to a growth rate, x_{n+1} is the population next year, and x_n is the current population.

2 Python Script

```
1 import matplotlib.pyplot as plt
                                                                                1 import matplotlib.pyplot as plt
 3 def logistic_map(r, x0, n):
                                                                                3 def logistic_map(r, x0, n):
                                                                                      x = [x0]
for i in range(n):
       x = [x0]
        for i in range(n):
                                                                                          x.append(r * x[-1] * (1 - x[-1]))
          x.append(r * x[-1] * (1 - x[-1]))
                                                                               9 # Example usage
 9 # Example usage
                                                                               10 r = float(input("Growth rate = "))
10 r = int(input("Growth rate = "))
                                                                               11 \times 0 = 0.2
11 \times 0 = 0.2
12 n = 100
                                                                               12 n = 100
                                                                               14 \times = logistic_map(r, \times 0, n)
14 \times = logistic_map(r, x0, n)
                                                                               15 plt.plot(x)
15 plt.plot(x)
16 plt.show()
                                                                               16 plt.show()
                                                                              Growth rate = 2.5
Growth rate = 1
                                                                                0.60
 0.200
                                                                                0.55
                                                                                0.50
 0.150
                                                                                0.45
 0.125
                                                                                0.40
                                                                                0.35
 0.075
                                                                                0.30
 0.050
                                                                                0.25
 0.025
                                                                                0.20
 0.000
                                                                                                  20
                                                                                                                          60
                                                                                                                                                 100
                     20
                                                                    100
```

When,

- r = 1. Population Outcome is 1.
- \bullet r = 2.5, two output occurs but stables into one again.
- r = 3, two output occurs and stabilizes.
- r = 3.5, four output stabilizes.



As r value increases, the number of outcomes increases. When r approaches 4, the number of outcomes becomes chaotic.