Topics in Computational Science Report
Logistic Map and Sensitivity on Initial Condition

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1. Plot the solution of the following map:

$$\begin{cases} x_{n+1} = ax_n(1 - x_n), & n = 1 \cdots 100 \\ x_0 = 0.35 \end{cases} \tag{1}$$

   (a) a = 0.5
   (b) a = 1.5
   (c) a = 3.3
   (d) a = 4.0

Below is the graph of the solution from (1), plotted using Python Code attached on the next page.

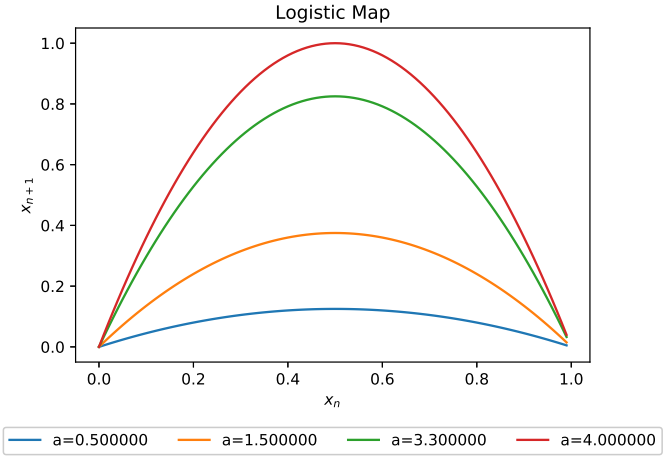

Figure 1: Logistic Map of various a

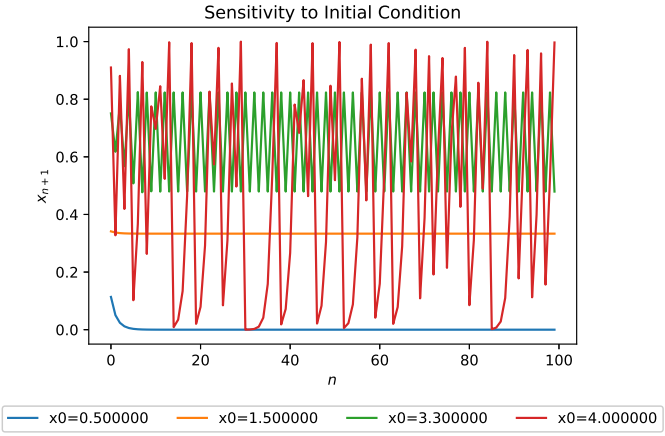

Figure 2: Sensitivity to Initial Condition Plot

1 Python Code

```
import matplotlib.pyplot as plt
import numpy as np

a = [0.5,1.5,3.3,4.0]
x0 = 0.35
n = 100

#recursive function
def f(x,a):
    return a*x*(1-x)

#sensitivity to initial function
def sensitivity_map(a,x0,n):
    datax = np.zeros(n)
    datay = np.zeros_like(datax)
    for a in a:
        x = x0
        for i in range(n):
            xold = x
            x = f(x,a)
            datax[i] = i
            datay[i] = x
        plt.plot(datax,datay,label="x0=%f"%(a,))
    leg = plt.legend(loc='lower␣center', ncol=4, shadow=False, fancybox=True, bbox_to_anchor=(0.5,-0.3))
    leg.get_frame().set_alpha(0.5)
    plt.xlabel("$n$")
    plt.ylabel("$x_{n+1}$")
    plt.title("Sensitivity␣to␣Initial␣Condition")
    plt.savefig("sensitivity.eps", format="eps", bbox_extra_artists=(leg,), bbox_inches='tight')
    plt.show()

#logistic map function
def logistic_map(a,x0,n):
    datax = np.zeros(n)
    datay = np.zeros_like(datax)
    for a in a:
        for i in range(n):
            x = i/n
            xold = x
            x = f(x,a)
            datax[i] = xold
            datay[i] = x
        plt.plot(datax,datay,label="a=%f"%(a,))
    leg = plt.legend(loc='lower␣center', ncol=4, shadow=False, fancybox=True, bbox_to_anchor=(0.5,-0.3))
    leg.get_frame().set_alpha(0.5)
    plt.xlabel("$x_{n}$")
    plt.ylabel("$x_{n+1}$")
    plt.title("Logistic␣Map")
    plt.savefig("logisticmap.eps", format="eps", bbox_extra_artists=(leg,), bbox_inches='tight')
    plt.show()

#main
sensitivity_map(a,x0,n)
logistic_map(a,x0,n)
```