

ME 333: Introduction to Mechatronics

Assignment 1: Your first C program

Electronic submission due **before** 12:30 p.m. on January 18th, 2011

In this assignment you will implement the logistic map in MPLAB's IDE environment. The logistic map is a discrete recursive map that is often used to represent population growth or decay over a period of time. The formula for the map is:

$$x[n] = x_0, \text{ for } n = 0$$

$$x[n] = r * x[n-1] * (1 - x[n-1]), \text{ for } n > 0$$

where n is the n^{th} year, $r > 0$ is the growth rate (which combines death and birth rates), and $0 < x_0 < 1$ is the normalized initial population at $n = 0$. If at the end of n years $x[n] = 0$, then the population has died off and if $x[n] = 1$, it has reached its maximum population size.

Many interesting behaviors can be seen by varying the growth rate parameter, r , of the logistic map. In our program we are only interested in values of r such that $0 < r < 4$. The Wikipedia entry on the logistic map (http://en.wikipedia.org/wiki/Logistic_map) documents the behavior as r is varied and is a good resource for verifying your results.

The program you will write will process up to a maximum number of inputs from the user. If the user has successfully entered the maximum number of inputs, then your program will print the results of the logistic map for each input the user entered. In order to get you started, we've provided you with code in a file called `logistic_map.c`. The file defines the following functions:

```
void calculatePopulation(Params *lgmapp)
    int getUserInput(Params *lgmapp)
    void sendOutput(Params *lgmap_array)
    float *allocatePopulationArray(int years)
void freePopulationArrays(Params *lgmap_array, int n)
```

Your job is to finish writing the missing lines of code, so that the program compiles and runs correctly. In order to receive full credit, you must not modify or erase any existing content or add any new functions. To get the code to work, you are to do the following:

- 1) Create an MPLAB project called "LogisticMap". The project should contain `logistic_map.c`, `pic32_additions.h`, and `pic32_additions.c`. These files are provided in the assignment zip file.

The rest of the instructions pertain to `logistic_map.c`.

- 2) In `logistic_map.c`, at the top of the file, write a brief introduction summarizing the program and add your full name and date to the history section.
- 3) Add the relevant `#include` files under the PREPROCESSOR COMMANDS section

4) Define the following constants right below the #includes:

MAX_X0, the maximum value for the initial condition, x0.
MAX_RATE, the maximum growth rate for r.
MAX_YEARS, the maximum number of years to compute.
MAX_INPUTS, the maximum number of inputs to accept.

You should set the constants to reasonable values.

5) Define a struct, under STRUCTS AND STRUCT VARIABLE TYPES, with fields *x0* and *rate* as floats, *population* as a pointer to an array of floats, and *years* as type int. In addition, define a type after your struct called Params. Note that your struct defines a pointer as one of its fields, which is a major different from the struct in invest.c.

6) Initialize the array of strings, *myinputs*, to the following values (see the comments above *getUserInput()* for the expected string format):

x0	r	n
0.8	1.789	10
0.8	3.35	10.78

7) Add any function prototypes.

8) Add any missing logic in the functions defined in *logistic_map.c*. There are 9 comments that start with "WRITE CODE HERE", where you must fill in the blanks.

After you've completed these steps, you should be able to run your program and see the results in your Outputs window. The following sample output was produced with the above two inputs.

Enter the growth rate, initial population, and number of years:

Valid inputs? 1

Enter the growth rate, initial population, and number of years:

Valid inputs? 1

RESULTS:

Input 1: Year 0: 0.80000
Input 1: Year 1: 0.28624
Input 1: Year 2: 0.36550
Input 1: Year 3: 0.41489
Input 1: Year 4: 0.43429
Input 1: Year 5: 0.43953
Input 1: Year 6: 0.44071

Input 1: Year 7: 0.44096
Input 1: Year 8: 0.44101
Input 1: Year 9: 0.44103
Input 1: Year 10: 0.44103

Input 2: Year 0: 0.80000
Input 2: Year 1: 0.53600
Input 2: Year 2: 0.83316
Input 2: Year 3: 0.46567
Input 2: Year 4: 0.83355
Input 2: Year 5: 0.46479
Input 2: Year 6: 0.83335
Input 2: Year 7: 0.46525
Input 2: Year 8: 0.83345
Input 2: Year 9: 0.46501
Input 2: Year 10: 0.83340

What to submit:

You should submit `logistic_map.c` and `LogisticMap.mcp` (the MPLAB project file) in a zip file through Blackboard **before** class on the date the assignment is due. The name of the zip file you submit will be `lastname_a1.zip`. For example, the TA would submit his homework as `Rosa_a1.zip`

In addition to submitting your assignment via Blackboard, you will also demonstrate your program to the teaching staff at the beginning of class on the date the assignment is due. For demonstration in class use the inputs specified in step 5 of this homework assignment.

For full credit you must follow these instructions exactly.