##### CST8233 W16 Assignment #3

##### Population Dynamics with Harvesting

**Due Date:** 23.59 17 April 2016

**Earnings:** 9% of your final grade **Purpose:** Solving ODE. **Language:** C or C++

#### Mathematically, one can model animal population dynamics with harvesting via a differential equation of the form:

dP/dt = rP(1-P/K) – hP

where P(t) is the population that changes with time t (in years).

The symbols have the meanings:

* dP/dt is the instantaneous population growth rate (as an increase per year)
* r is the natural reproductive increase rate (as a fractional increase per year)
* K is the population carrying capacity (maximum population the environment can support)
* h is the harvesting rate – rate at which the population is culled (as a fractional loss per year)

#### The equation is an ODE that we can solve numerically to explore how a population changes with different parameters. The example output you will be shown uses data of the Kentucky Deer population, but the same equation applies to fish stocks and many other species. You will solve the equation numerically using Euler’s method to run a real-time simulation that the user can interact with. The output at the end shows snapshots at different times in the running application. It uses a second to represent a year.

#### Algorithm

The user is first asked to enter the parameters of the simulation. Then the simulation runs until the user decides to quit, with continuous (optional) user input.

The algorithm takes time from the system clock and uses 1 second to represent a year. Therefore in each iteration, the time that has elapsed, in seconds, is the step in years that enters the Euler correction.

Set up a Win32 console application in Visual Studio 2013 with the name *ass3*. Write the code to implement the application using Euler’s method as described above.

**In Addition…** explore how increasing the harvesting rate affects the equilibrium population for the Kentucky Deer parameters. Find out what is the smallest harvesting rate that leads to Deer extinction, i.e. when the equilibrium population just drops to zero. Include a table, in a text file (extinction.txt) in your zip, of 10 harvesting rates that head to extinction and their associated equilibrium populations of Deer.

**What to Submit :** Use the Drop on Blackboard to submit this assignment as a zip file (not RAR) containing the source code file and the text file (ass3.cpp and extinction.txt).

**The name of the zipped folder must contain your name as a prefix so that I can identify it, for example using my name the file would be tylera8233\_ass3.zip.** It is also vital that you include the file header as specified in the Submission Standard in your source files so the files can be identified as yours. Use comment lines in the files to include the headers.

Before you submit the code, check that that it builds and executes in Visual Studio 2012 as you expect - if it doesn’t build for me, for whatever reason, you get a deduction of at least 60%. ***Due to Final Exams it cannot be late***. Do not send me file(s) as an email attachment – it will get 0.

***EXAMPLE OUTPUT SNAPSHOTS***

1. ***Entering data***

Population Simulation

1. run the simulation

2. Quit

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ENTER SIMULATION PARAMETERS

Initial population (typically 900000)? 900000

Maximum population the environment can support (typically 1000000)? 1000000

Initial harvesting rate (fraction per year - 0 for no harvesting)? .01

Natural fractional growth population rate (typically 0.2 per year)? 0.2

1. ***Running the simulation***

starting simulation

Simulation run time minute = 0; second = 3; millisec = 156

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Year of simulation = 3

Rate of population change = 5180.209961

Population = 921904

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Press w/e to increase/decrease harvesting rate.

Current harvesting rate: 0.010000

Press p/o to increase/decrease Max population supported.

Current Max population: 1000000

Press k/l to increase/decrease growth rate.

Current growth rate: 0.200000

Press q to quit.

1. ***After “47 years”***

Simulation run time: minute = 0; second = 47; millisec = 0

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Year of simulation = 47

Rate of population change = 1.950195

Population = 949989

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Press w/e to increase/decrease harvesting rate.

Current harvesting rate: 0.010000

Press p/o to increase/decrease Max population supported.

Current Max population: 1000000

Press k/l to increase/decrease growth rate.

Current growth rate: 0.200000

Press q to quit.

1. ***At “50 years” change the harvesting rate to 0.07 and run to 70 years***

w was pressed - increase harvesting

Simulation run time: minute = 1; second = 10; millisec = 407

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Year of simulation = 70

Rate of population change = -2453.187500

Population = 668313

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Press w/e to increase/decrease harvesting rate.

Current harvesting rate: 0.070000

Press p/o to increase/decrease Max population supported.

Current Max population: 1000000

Press k/l to increase/decrease growth rate.

Current growth rate: 0.200000

Press q to quit.