Killer Cane Toad

Due Time: 23:59, Sun 25 March2018 **Earnings:** 9% of your final grade

NOTE: Plan to finish a few days early to avoid last minute hardware/software issues for which there is no allowance.

The code in this assignment must be your own work. It must not be code taken from another student or written for you by someone else, even if you give a reference to the person you got it from (attribution); if it is not entirely your own work it will be treated as plagiarism and given a fail mark, or less.



Cane toads were introduced to Australia from Hawaii in June 1935 by the Bureau of Sugar Experiment Stations in an attempt to control the native grey-backed cane beetle. In a good example of the law of unintended consequences, the toad didn't kill the beetles because it couldn't jump high enough to catch them. But it did kill everything else since it has poisonous secretions, is poisonous to eat and has no natural predators

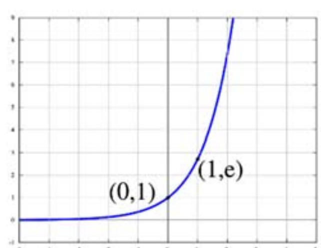
The spread of the Cane Toad population in Australia has been dramatic. Here are data. The data is also on BB in a text file.

Year T	Area Occupied A (millions of square km)
1939	0.0328
1944	0.0558
1949	0.0736
1954	0.138
1959	0.202
1964	0.257
1969	0.301
1974	0.584

Purpose In this assignment you will investigate two possible functions that describe the rapid rise of area with time. Once you have the formulas they can be used to perform extrapolations and interpolations.

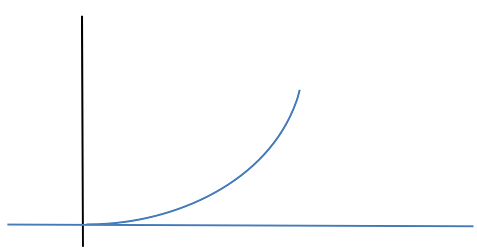
1. Exponential: $A = ce^{bt}$ where c and b are constants to be determined from the fit and t = (T-1939).

The exponential is a rapidly increasing function that looks like the graph on the right-hand side. Our function has the property that A = c when t = 0 (or T = 1939). So from the data you can see we expect c to be close to 32,800. The function will only be used for t>0.
This rapidly changing function will do a better fit at the high end of the data but will not be as good in the middle.



2. Power Law: $A = ct^b$ where c and b are constants to be determined from the fit and this time t = T-1935.

The graph of this function looks something like this.
In this case we are using our knowledge that there were no toads before 1935, since A will then be zero when t = 0 (or T = 1935). The function will only be used for t>0.
This slower changing function will do a better fit over the middle range of the data but will not be as good at the end where A is rising rapidly



In order to find the constants b and c in each case we need to linearize the functions so the straight-line formulas can be used.

case 1: $A = ce^{bt}$
It can be linearized by taking the natural logs of both sides:
$\ln(A) = \ln(c) + \ln(e^{bt}) = \ln(c) + bt$
then writing $\ln(A) = y$, $\ln(c) = C$ and $x = t$ we have
$y = C + bx$
which is the equation of a straight line with slope b and intercept C to which the least-squares linear regression formulas apply.
C must be converted back by $c = e^C$ to be used in the original formula.

case 2: $A = ct^b$
It can be linearized by taking the natural logs of both sides:
$\ln(A) = \ln(c) + \ln(t^b) = \ln(c) + b\ln(t)$
then writing $\ln(A) = y$, $\ln(c) = C$ and $x = \ln(t)$ we have
$y = C + bx$
which is the equation of a straight line with slope b and intercept C to which the least-squares linear regression formulas apply. C must be converted back by $c = e^C$ to be used in the original formula.

So we can use the equations for linear regression as discussed in lectures, but the initial data must be first converted as described above. You must do that in your code. The data is in the file toad.txt on Balckboard. Write code to read the file (or other similar toad file with an unspecified number of rows) and then perform the linear regression followed by interpolation/extrapolation as shown in the example output at the end.

See the Marking Sheet for how you can lose marks but note the following:

- [-30%] when the application terminates it releases all dynamically allocated memory so it does not have a resource leak,
- [-60%] before you submit the code, check that it builds and executes in Visual Studio 2015 as you expect,
- [-60%] it must not crash in normal operation,
- [-100%] make sure you have submitted the correct file – if I cannot build it because the file is wrong or missing from the zip, even if it's an honest mistake, you get 0 – no compromises

<u>What to Submit :</u> Use Blackboard to submit this assignment as a zip file (not RAR not 7-Zip not 9 Zip) containing the source code file(s) ass2.cpp (definitely not the entire project!). 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 tyleraAss2CST8233.zip. It is also vital that you include the Cover Information (as specified in the Submission Standard) as a file header in your source file so the file can be identified as yours. Use comment lines in the file to include the header.

Example Output:

```
*******************************************************
 Least-Sqares fit of Exponential and Power Law
1. Read Data from File
2. Quit
*******************************************************
Select an option: 1
please enter the name of the file to open:toad.txt


FILE OPENED FOR READING
There are 8 records.

1939 0.0328
1944 0.0558
1949 0.0736
1954 0.138
1959 0.202
1964 0.257
1969 0.301
1974 0.584
File read into memory

*******************************************************
1. Exponential fit to data
2. Power Law fit to data
3. Quit
*******************************************************
Select an option: 1

EXPONENTIAL
 A = 0.03645*exp(0.07789*(Y-1939))

*******************************************************
Exponential Interpolation/Extrapolation
1. Interpolation/Extrapolation of Toad area
2. Quit Interpolation/Extrapolation
*******************************************************
Select an option: 1
Exponential Interpolation/Extrapolation of Toad area
Please enter the year(e.g. 2018) : 1939
Toad area at 1939 = 0.03645 million square kilometres

*******************************************************
```

```
Exponential Interpolation/Extrapolation
1. Interpolation/Extrapolation of Toad area
2. Quit Interpolation/Extrapolation
*******************************************************
Select an option: 1
Exponential Interpolation/Extrapolation of Toad area
Please enter the year(e.g. 2018) : 1974
Toad area at 1974 = 0.5568 million square kilometres

*******************************************************
Exponential Interpolation/Extrapolation
1. Interpolation/Extrapolation of Toad area
2. Quit Interpolation/Extrapolation
*******************************************************
Select an option: 1
Exponential Interpolation/Extrapolation of Toad area
Please enter the year(e.g. 2018) : 2018
Toad area at 2018 = 17.15 million square kilometres

*******************************************************
Exponential Interpolation/Extrapolation
1. Interpolation/Extrapolation of Toad area
2. Quit Interpolation/Extrapolation
*******************************************************
Select an option: 2

*******************************************************
1. Exponential fit to data
2. Power Law fit to data
3. Quit
*******************************************************
Select an option: 2

POWER LAW A = 0.004485*(Y-1935)^1.208

*******************************************************
Power Law Interpolation/Extrapolation
1. Interpolation/Extrapolation of Toad Area
2. Quit Interpolation/Extrapolation
*******************************************************
Select an option: 1
Power Law Interpolation/Extrapolation of Toad Area
Please enter the year(e.g. 2018) : 1939
Toad Area at 1939 = 0.02394 million square kilometres

*******************************************************
Power Law Interpolation/Extrapolation
1. Interpolation/Extrapolation of Toad Area
2. Quit Interpolation/Extrapolation
*******************************************************
Select an option: 1
Power Law Interpolation/Extrapolation of Toad Area
Please enter the year(e.g. 2018) : 1974
Toad Area at 1974 = 0.3748 million square kilometres

*******************************************************
Power Law Interpolation/Extrapolation
1. Interpolation/Extrapolation of Toad Area
2. Quit Interpolation/Extrapolation
*******************************************************
Select an option: 1
Power Law Interpolation/Extrapolation of Toad Area
Please enter the year(e.g. 2018) : 2018
Toad Area at 2018 = 0.9334 million square kilometres

*******************************************************
Power Law Interpolation/Extrapolation
1. Interpolation/Extrapolation of Toad Area
2. Quit Interpolation/Extrapolation
*******************************************************
Select an option:
```