Instructions.

In this lab report we explore exponential and logistic population models by modeling the population growth of various states in the United States. Each group of two or three students will be assigned a different state and use data from the census to generate their models. This worksheet will lead to a typed report reflecting your findings, which will be due on Friday, January 30.

We have discussed several techniques for studying differential equations this quarter: analytic techniques providing explicit formulas for the solution; numerical techniques such as Euler’s method giving graphs of approximate solutions; geometric/qualitative techniques with predictions of long term behavior. You should use as many of these techniques as are appropriate to understand the models.


Your Report should answer the following questions:

1. Using an exponential growth model, determine as accurate a prediction as possible for the population of your state in the year 2020. How much does your prediction differ from the prediction that comes from linear extrapolation using the populations in 2000 and 2010? To what extent do solutions of your model agree with the historical data?

2. Produce a logistic growth model for the population of your state. What is the carrying capacity for your model? Using Euler’s method, predict the population in the years 2020 and 2050. Using analytic techniques, obtain a formula for the population function $P(t)$ that satisfies your model. To what extent do solutions of your model agree with historical data?

3. Comment on how much confidence you have in your predictions of the future populations. Discuss which model, exponential or logistic growth, is better for your data and why (and if neither is good, suggest alternatives).

Format of your Report:

Your report should have the following sections:

I. Introduction: Include a chart with data you used, an explanation of the problem, and what you intend to do in the following sections.

II. Exponential Growth Model: Include your differential equation, as well as information and justification about how you derived your equation. Include any diagrams, slope fields, phase lines, Euler’s method, etc. that aided you in locating your equation. Don’t forget to address all the issues listed above.
III. *Logistic Growth Model:* Include your differential equation, as well as information and justification about how you derived your equation. Include any diagrams, slope fields, phase lines, Euler’s method, etc. that aided you in locating your equation. Don’t forget to address all the issues listed above.

IV. *Conclusions:* This is the section for your comments and observations about your predictions. You should compare and contrast your results from the two models. Answer which you believe is a better model and why. Don’t forget to suggest alternatives if neither of the models is a good fit.

An appropriate length for this report is approximately 1 page per section typed, however there is no minimum number of pages (assuming all requirements are met).

Grading:
(10 points) Introduction
(30 points) Exponential Growth Model
(30 points) Logistic Growth Model
(20 points) Conclusion
(10 points) Student feedback

Students will be graded according to the attached evaluation form, and students will have the opportunity to review their peers for a portion of the report grade. *Any major concerns about group participation should be discussed with me in private or communicated to me via email.*

Appropriate spelling, grammar, and proper use of the English language is expected. Your work should be cohesive and easily read. Points will be deducted from each section that fails to be clearly written. **Having good ideas is meaningless if you are not able to effectively communicate them to others.**

These reports must be typed, printed, and physically turned in on **Friday, January 30, 2015.** No late or electronic submissions will be accepted.

Tools that may be useful:

- Mathematica (freely available to DU students)
- DETools (freely available from the publisher. See links on website)
- Wolframalpha (free website)
- [http://www.math.ubc.ca/~israel/applet/dfplotter/dfplotter.html](http://www.math.ubc.ca/~israel/applet/dfplotter/dfplotter.html)
Lab Report 1 Evaluation

Introduction:

2 points Chart with data.

3 points Explanation of the problem in your own words.

5 points Quick overview of what will be done in the following sections.

Exponential Growth Model:

10 points The differential equation used is stated with a clear explanation of its derivation.

5 points Diagrams, slope fields, etc. make sense for the problem and are appropriately used and cited.

5 points Results from the exponential growth model are compared to the historical data.

5 points The exponential prediction for 2020 is explained and compared to the prediction from linear extrapolation.

5 points A clear understanding of the exponential growth model is provided.

Logistic Growth Model:

10 points The differential equation is stated with a clear explanation of its derivation and a justification for its carrying capacity.

5 points Diagrams, slope fields, etc. make sense for the problem and are appropriately used and cited.

5 points Results from the logistic growth model are compared to the historical data.

5 points The logistic prediction for 2020 and 2050 are explained and compared to the predictions from Euler’s method.

5 points A clear understanding of the exponential growth model is provided, including comparisons to the historical data.

Conclusion:

5 points Discuss any comments or observations about your results from the previous sections.

5 points Compare and contrast the results from the two above models.

10 points Discuss which model is better for the data and/or suggest alternative models. Justify your responses.

Deductions and Feedback:

– points Deductions will be made for lack of cohesion, lack of clarity, poor grammar, and/or incorrect spellings

10 points Student Feedback
Student Project Feedback

Name AND State:

On a scale from 0 - 10 (on my own subjective scale with 0 low and 10 high), I feel that I would rate
myself at a ________ for my contribution to this group lab report. I feel that I did ________% of
the overall group work.

I worked on the following portions of the project:

On the same scale from 0 - 10, I feel that I would rate __________________ at a
________ for his/her contribution to this group lab report. I feel that he/she did ________% of
the overall group work.

He/she worked on the following portions of the project:

On the same scale from 0 - 10, I feel that I would rate __________________ at a
________ for his/her contribution to this group lab report. I feel that he/she did ________% of
the overall group work.

He/she worked on the following portions of the project: