Section Workshop 1- Project 1

Names of project team members:

Assign Roles for Project Teams

Roles will be assigned based on your birthdays. Whoever has the earliest birthday in the year is assigned to role 1, next birthday is role 2 and so on. If there are only 3 members in your group, combine roles 3 and 4.

1. Discussion coordinator - ensures all are heard
2. Notes coordinator - ensures documentation in a shareable form
3. Reporter - ready to speak for the group in with your Section Workshop leader and/or other groups
4. Submission coordinator - makes sure everyone understands what is left to do (if anything!) before the submission deadline, makes plans to get together, makes plans for uploading assignments to Gradescope (this person does not necessarily need to upload but is responsible for the group coming to a consensus on a plan).

Team project

Learning Goals

- In this project you will learn how to determine if a data set can be modeled by an exponential function or power function and how to choose the constants c and k that determine these functions' characteristics.
- You will apply the techniques introduced in this project to a real-world problem. The content of this project is related to sections 1.4.3 and 1.4.4 of the textbook related to log-log plots and semi-log plots.

Project work

You will work together through this content in a Desmos Activity called “Math 106 - Project 1” by going to student.desmos.com and typing in the code: TSZSMQ. Submit to Gradescope the answers to questions 1 and 2 below.

Growing populations

To identify the countries with the fastest growing populations, 24/7 Tempo2 reviewed the 2018 World Population Data Sheet3 produced by the Population Reference Bureau (PRB). This analysis ranks Guinea as one of the fastest growing countries in the world with a projected population growth over 2018-2030 to be 37%. Among the factors contributing to Guinea’s burgeoning population growth are

a high birth rate – 39 births per 1,000 people compared with 18.7 for the world average

an extended life expectancy - the life expectancy at birth for a person born in Guinea increased by approximately 28.5 years between 1960 and 2017.

In the Desmos activity, it will prompt you to refer to the population data for Guinea shown in the table. You can access this population data in a spreadsheet (make a copy!) in OneDrive. Using Excel, Google Sheets, or Desmos, show that the semi-log plot is (approximately) linear. Construct an exponential function to fit the data.

Question 1 In one-page, clearly explain the context of the data set you examined and the steps that you took to build your model. Include a plot of the data and your model function.

Galileo Galilei

When he was trying to determine the laws of motion, Galileo Galilei (1564-1642) at first tested the hypothesis that the velocity of a free-falling object would be proportional to the distance fallen by the object. Use the following data to determine if Galileo's first conjecture could be true. If it cannot be true, then determine what the correct relationship between distance and velocity is. (You should find an expression that gives the velocity as a function of the distance fallen, and you should test your function by graphing it over a plot of the data points listed in Table 1.)

DISTANCE (M)	VELOCITY (M/S)
4.9	9.8
19.6	19.6
44.1	29.4
78.4	39.2
122.5	49
176.4	58.8
240.1	68.6
313.6	78.4

TABLE 1. VELOCITY VS. DISTANCE

Plot the data and your function on a graph (we suggest using Demos or Excel and taking a screenshot to include in your submission to this question).

Question 2 In one-page, clearly explain the context of the data set you examined and the steps that you took to build your model. Include a plot of the data and your model function.

Individual Project for Final Portfolio

Work out the following problem using the techniques introduced in the team project. You do not need to submit separate answers to this part of the assignment.

While at a clinic in Carroll County, Maryland, a patient was given a dose of Xylopain, after which they lost consciousness. They were rushed to Carroll Hospital, where the level of the drug was checked hourly. The readings are recorded in Table 2.

TIME ELSAPSED SINCE DOSE (H)	CONCENTRATION OF XYLOPAIN (MG/ML)
4.9	9.8
19.6	19.6
44.1	29.4
78.4	39.2

122.5	49
176.4	58.8
240.1	68.6
313.6	78.4

TABLE 2. CONCENTRATION VS. TIME

Find a function, C(t), that approximates the level of Xylopain in the patient's blood t hours after the drug was given to the patient. To test your function, C(t), show a graph of C(t) superimposed on a plot of the data points (we suggest using Demos to make this comparison).

The patient, who recovered from the incident, has since discovered that the maximum allowable concentration of Xylopain is 10 milligrams (about the weight of a grain of table salt) per milliliter. They believe that the clinic exceeded this maximum recommended dosage, and they plan to sue the clinic for negligence. Making use of the function you found in part (a), write a brief outline of the argument that the patient's attorney might make in court.

For your individual project for your Final Portfolio, you will **prepare a technical argument that a legal team would prepare on behalf of the patient explaining the incident, how data was collected, what analysis was done, why the patient is bringing the lawsuit and what conclusions the legal team is drawing from the analysis.** This letter should include the relevant mathematics that was used in the analysis. The letter should be written in the voice of the legal team and the audience for the letter is a judge. Make sure that everything in your letter is properly labeled and the notation you use is consistent.

Further Reading

Want to see these methods in action? Check out this paper on piecewise quadratic growth during the 2019 novel coronavirus epidemic by Axel Brandenburg published in September 2020. The paper includes graphs that show semi-log plots of data. While parts of this paper still contain mathematics beyond the scope of this course, in a couple of weeks you will have the tools to read and connect most of sections 1 and 2 to content we have been covering in class.

Prepared by Emily Braley, Department of Mathematics, Johns Hopkins University

This project was inspired by a lab activity in the Math 111L-112L Course pack from Duke University [3].

[1] Braley, E. (2021, August 1). *Math 106 - Project 1*. Desmos. https://student.desmos.com/

[2] Brandenburg A. (2020). Piecewise quadratic growth during the 2019 novel coronavirus epidemic. *Infectious Disease Modelling*, *5*, 681–690. https://doi.org/10.1016/j.idm.2020.08.014

[3] *Department of Mathematics*. (n.d.). Duke: Trinity College of Arts and Sciences. https://math.duke.edu/

[4] Kolb, E. (2019, July 10). Countries with the top 20 fastest-growing populations. USA Today. https://www.usatoday.com/story/money/2019/07/10/world-population-day-fastest-growing-countries-guinea-chad-mali/39584997/