Project 2: Population Dynamics

Overview

You will be creating and analyzing a population dynamics model, using Chapters 5–8 of the ModSimPy book as your starting point. The book analyzes various models based on explicit assumptions that have a basis in the real world. Your project will also relate to population dynamics and be based in real world assumptions. Here are some possible themes to consider:

Option A: Human or Animal Population Models

The first option is to ask and answer an interesting question about a human population or an animal population on Earth by extending the model developed in class. You will collect data online relevant to the questions you want to answer.

Option B: Stochastic Population Models

For this option, you can try to simulate a human or animal population's growth over time using random processes, similar to how we used randomness in the Bike Share model. Instead of a deterministic growth rate, consider a model in which the growth rate for each time period is drawn at random from a probability distribution (which might in turn be estimated from empirical data). One question that a stochastic population model might address is the likelihood of a population dying out. You will find that there is a wealth of information (including time-series data) available for many different species in many areas of the world.

Option C: Predator–Prey Dynamics

As a third option for the project, you might choose to investigate the interactions between multiple species. Can you determine the populations of two competing species by using a deterministic or probabilistic model? Just as in the other two options, you will be required to use real world data and realistic assumptions to model their interaction.

Groups

You will work in a group of at least two and at most three people. It is important that you choose a group of people with whom you can **work** well. You will have to meet outside class with your groupmates throughout the next few weeks. Together you will come up with a project topic (vetted by Prof. Chris), determine the mathematical model you wish to study, collect relevant data, program a simulation in Python, and present your results to the class.

Timeline

- **Initial Planning due Wednesday, October 16:**

  Decide who you want to work with on your project and decide which of the project options you are most interested in pursuing. Start collecting data for your populations of interest. Bring these ideas to the brainstorming session in class this day.

- **Project Statement, Methodology, and Imported Data by Monday, October 21:**

Hone the primary question you and your group wish to investigate and have it ready for class this day. Think about the growth function(s) assumptions underlying your simulation. Make progress on importing the data you want to analyze into a Python notebook.

- **Primary simulation complete by Wednesday, October 23:**

  By this date, you must have translated your population dynamics model into Python and run the simulation. You should have decided upon a secondary question and that you will answer by determining a metric and sweeping a value.

- **Parameter sweep complete by Friday, November 1:**

  By this date, you should have completed the parameter sweep that answers your secondary question.

- **Draft Quad Chart due on Wednesday, November 6:**

  By this date, you are expected to be have completed the final draft of your project. On this day, we will spend time doing peer review, sharing your project with the other group at your table and discussing ways to improve it.

- **Final Quad Chart Due and Project Presentation on Monday, November 11:**

  On this day, your group will present your project to the entire class and turn in your quad chart for grading. Please also turn in your brainstorming worksheet, your first cut model worksheet, and send your python notebook by email. (One of each per group.) Your (individual) group dynamics essay is due the evening of your presentation.

Specifications

The final deliverables of this project will be a (group) quad chart, a (group) five-minute presentation, and an (individual) group dynamics paragraph.

The quad chart must:

- **Have a descriptive and meaningful title.**
- **Adhere to the correct format.**
  - Use four 8.5" × 11" sheets of paper.
  - Each sheet should be in landscape format with at least 0.5" margin around.
  - The fonts should be no smaller than 24pt.
  - Each sheet must be headed either "Objective", "Methodology", "Results", or "Conclusions".
- **Include an Objective Section.**

  Here you introduce the primary and secondary problem statements, highlighting the population being modeled, who cares about the problem, and setting the stage for the type of answer you are looking for.

- **Include an Methodology Section.**

  Here you include the main assumptions you made, why you made those assumptions, the way you decided to model the growth function, where you got your data, and the types of simulation you used, relating it back to the objective.

- **Include an Results Section.**

  Here you include chart(s) that show your most important results, with labeled axes, and a description of what the viewer is supposed to be getting out of your figure. You also need to explain how you validated or verified your results (variable sweeping perhaps?) Interpret your results as an answer to your question.

- **Include an Conclusions Section.**

  What does the model you created say? What are the limitations of your model? Are the assumptions realistic? Be honest and critical of your work. It is OK if you say your model didn't work. Show that you know it doesn't work and explain why.

- **Be formatted in a clear and organized manner.**

  Spend time organizing your text and images. Your quad chart should not be only text. Work to make your final layout visually appealing.

The presentation must:

- **Include an introduction.**

  Introduce yourselves, your topic, and explain who is the audience of your presentation.

- **Discuss each of the sections in the quad chart.**

  Spend time making sure that the class learns about your objective, methodology, results, and conclusions.

- **Use your quad chart as a visual aide.**

  Use it as such. Do not read from your chart.

- **Involve each of the groupmates.**

  Make sure each person speaks for at least two minutes (for a group with two members) or at least one minute (for a group with three members).

- **Be organized and rehearsed.**

You need to make sure that you have practiced what you are going to say a couple of times.

- **Respect the time limit.**

    Five minutes is a very short amount of time! This means you really need to have practiced multiple times so that you use your time efficiently.

For the group dynamics paragraph:

Write a paragraph that includes your impression of the contributions of the group members. Do you feel like each group member participated equally? Did each member contribute to the project throughout the process, including forming the project topic, developing the project methodology, planning and running the python simulations and results, analyzing the model, compiling the quad sheet, and preparing for the presentation?

Grading

This project represents 30% of your semester grade. You will be graded on each of the following standards. You are expected to arrive on time and make comments on your classmates' presentations and projects. If you are late or absent, this will negatively affect your own grade.

- Timeliness:
    - Did you make steady progress on your project from start to finish, respecting project deadlines?
    - Did you take the brainstorming worksheet seriously?
    - Did you contribute seriously to the peer review?
    - Did you turn in your final project by the deadline?
- Quad Chart Style:
    - Did you follow the Quad Chart format requirements?
    - It your quad chart well organized?
    - Does it capture the attention of the audience?
    - Is it visually appealing?
- Objective:
    - Have you given a precise population dynamics question that you are trying to answer?
    - Have you given a precise secondary question that you are trying to answer?
    - Have you been explicit about whether your project is explanatory or predictive?
    - Is it obvious who your target audience is?
- Methodology:
    - Have you based your model on clear, well thought-out assumptions? (Both about the variables you included and didn't include, and the structure of the population growth.)
    - Did you explicitly state these assumptions?
    - Do you give and discuss the population change function behind your model?
    - Did you discuss where your data came from and why you chose it?
- Results:

- o Are the plots that you chose to include relevant to your Primary and Secondary problem statements?
  - o Are the plots labeled correctly?
  - o Do you include an explanation for the observer about how they should interpret your plots?
  - o Have you interpreted your results in terms of the real world scenario and given answers to your problem statements?
- Conclusions:
  - o Is your simulation modeling the real-world situation well? (Remember: Be critical and truthful.)
  - o Do you discuss the validity of your assumptions?
  - o Have you analyzed how good your model is? (Remember the criteria: Accurate, Descriptively realistic, Precise, General, Fruitful.)
  - o How might you or someone else improve upon your model in the future?
- Python Notebook:
  - o Did you use python techniques that we learned in class?
  - o Were you able to import real-world data into python?
  - o Did you create a python simulation to model population growth?
  - o Were you able to use python to create **labeled** plots of your model?
  - o Did you sweep a parameter?
  - o Is your python notebook organized neatly? Have you broken down your notebook into sections?
  - o Have you used text cells or comments to explain to the reader what you are doing in your code?
- Presentation Style:
  - o Did you include an introduction?
  - o Did you discuss each of the sections?
  - o Have you ensured that your presentation does not end abruptly?
  - o Did you use the quad chart as a visual aide, and not read from it?
  - o Did you involve each of the groupmates?
  - o **Is it obvious that you were organized and had practiced for the presentation?**
  - o Do you keep the audience's attention?
  - o Did you respect the time constraints?
  - o Did you arrive on time for everyone else's presentation?

You will be assigned a score for each standard from the following scale.

4 **Outstanding:** Goes above and beyond expectations
3 **Excellent:** Meets all requirements at a high level.
2 **Good:** Meets all requirements at an competent level.
1 **Poor:** Makes an effort to meet requirements but does not succeed.
0 **Unacceptable:** No work, a weak start, or does not meet minimum acceptable standards.
Your final project grade will be based on the number of scores at each level as follows.
If you do not participate equally in the groupwork, your grade will be reduced accordingly.
A+ (100+) Earn a score of 4 on at least four standards and no score lower than 3.

A   (95)   Earn a score of 3 or more on at least six of eight standards and no score lower than 2.

B	(85)	Earn a score of 2 or more on at least six of eight standards and no score lower than 1.
C	(75)	Earn a score of 2 or more on four of eight standards and at most one score lower than 1.
D	(65)	Earn a score of 1 or more on at least seven of eight standards.
F	(0-50)	Earn a score of 0 on at least two standards.