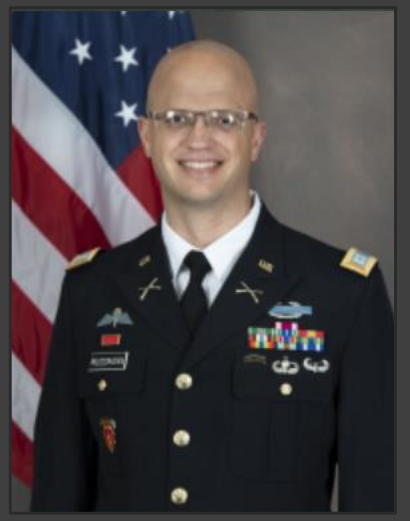
Problem B:

PUNISHING INFANTS



By

Team 1109

Sponsored by MAJ. Thomas Mussmann *(United States Military Academy - West Point, New York, USA)*

Landry Lee

United States Military Academy

(West Point, New York, USA)

Ethan Wiltz

United States Military Academy

(West Point, New York, USA)

Masen Turner

United States Military Academy

(West Point, New York, USA)

Roadmap

1. Choosing a prompt
2. Making sense of the problem
3. Contextualize your problem
4. Creating the Project
5. Solving
6. Interpreting
7. Preparing the Presentation

How To Choose Your Prompt

Are you interested in the prompt?

↓

Do I have experience in this area?

↓

Can I envision this working out?

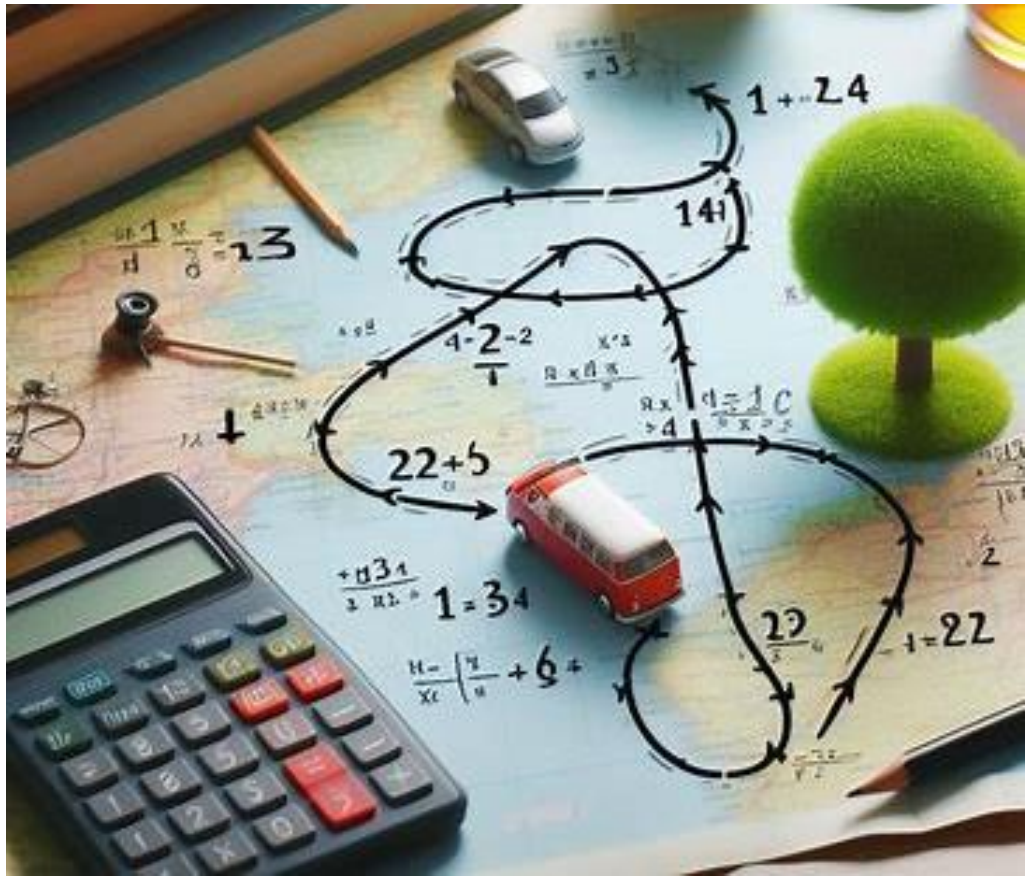
Choosing Our Prompt

Prompt A: Kangaroo Care - Develop a model of the interactions between an infant kangaroo and its mother or human baby and its mother under Kangaroo Mother Care (KMC) treatment.

Prompt B: Punishing Infants - Develop a model that includes different populations with different propensities to act out against those who interact aggressively towards others.

Prompt C: Dog Cannot Catch - Use your analysis of the situation to decide if Fritz is just clumsy or if his owner is being mean to the dog on the Internet.

Understanding The Task



- Read the question *Thoroughly*
- Look for keywords/questions in the prompt to figure out *what* you are modeling
- Look into the research provided by the question
- Do more research
- Brainstorm what graph may look like

Understanding the Task

What am I modeling?

- *'Develop a…'*
- *'Use your analysis…*
- *'Analyze if..'*
- *'Explore…'*

- Look at all the questions that the prompt asks you to answer…

Common Research Tips or Resources

- Read the **Bibliography** and see any other sources used by the source provided
- Use credited, peer-reviewed sources

- Break up the prompt into keywords:
- Ex: 'Model with different populations'
- 'Populations model' ; 'Changing populations' ;
- ***Jstor, Google Scholar, Science Direct Journal, Local Libraries***

MATHEMATICAL SCIENCES

Transform Equations

- Take a preexisting model that relates to your model
- Start with a simple model and increase complexity one step at a time
- You do not have to reinvent the wheel

Competing Species Model

$$x'(t) = x(t)(n_1 - n_2x(t) - n_3y(t))$$
$$y'(t) = y(t)(n_4 - n_5y(t) - n_6x(t))$$

Making Your Innovation

- Manage expectations – you only three weeks
- Add complexity to fit data or ideas from research
- Add complexity and then test in a modeling software

Competing Species Model

$$x'(t) = x(t)(n_1 - n_2x(t) - n_3y(t))$$
$$y'(t) = y(t)(n_4 - n_5y(t) - n_6x(t))$$

Competing Species Model Adjusted to One Population

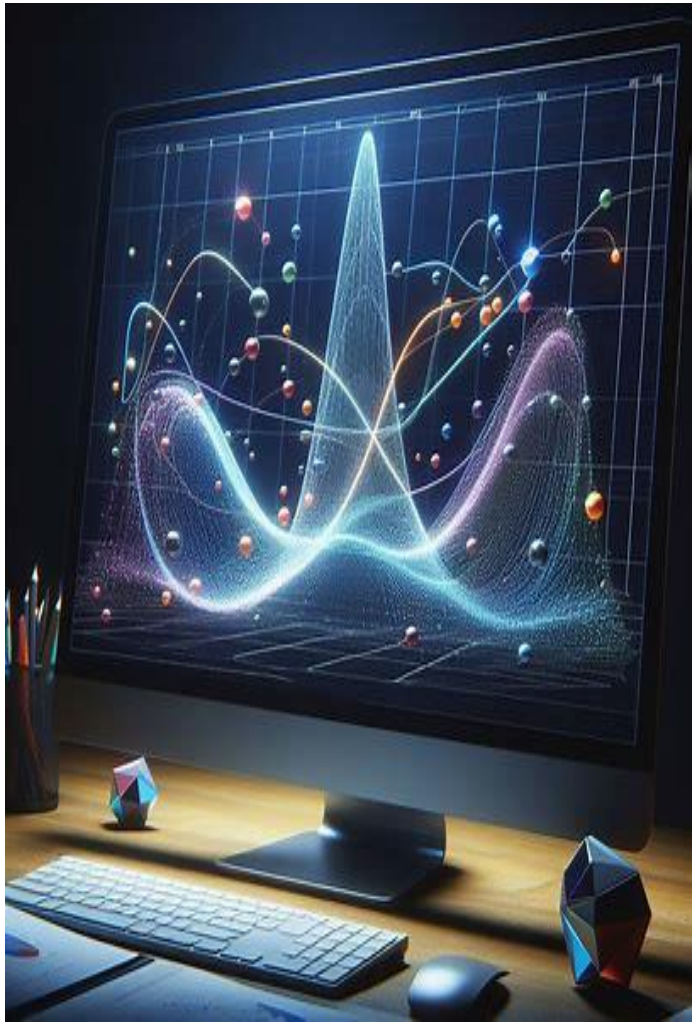
$$x'(t) = k_1x(t)(1 - \frac{x(t) + y(t)}{m_1}) - k_2y(t)$$
$$y'(t) = k_3y(t)(1 - \frac{x(t) + y(t)}{m_1}) - k_4x(t)$$

Competing Species Model Adjusted to One Population and Limits

$$x'(t) = \left[k_1x(t)\left(1 - \frac{x(t) + y(t)}{m_1}\right) - k_2y(t)\right](x(t) - l_1)$$
$$y'(t) = \left[k_3y(t)\left(1 - \frac{x(t) + y(t)}{m_1}\right) - k_4x(t)\right](y(t) - l_2)$$
$$z'(t) = -x'(t) - y'(t)$$

MATHEMATICAL SCIENCES

Solve/Iterate



- Find a software to model
  - Mathematica*
  - MATLAB
  - Manim
- During the innovation process continue checking your model
- Does your model do what you expected?

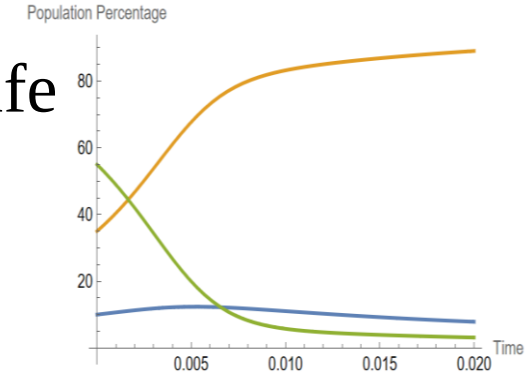
Interpret

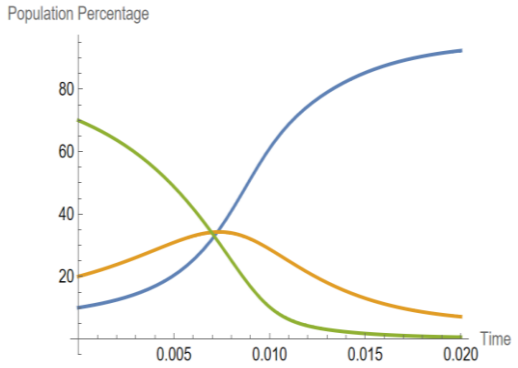
- Put the equation into context of the problem
- Explain
  - Variables
  - Parameters
  - Assumptions
  - Limitations to the model
- What can this tell us about the problem?

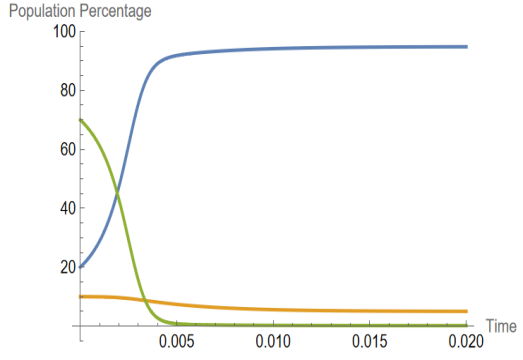
Interpret

- Real Life

$k_1 = .3$
$k_2 = 1$
$k_3 = .1$
$k_4 = 3$

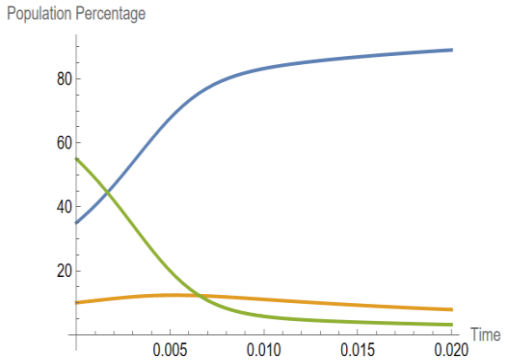


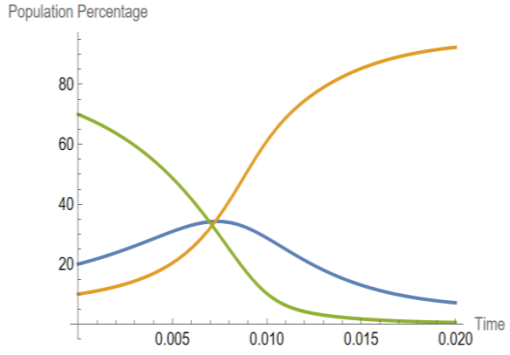


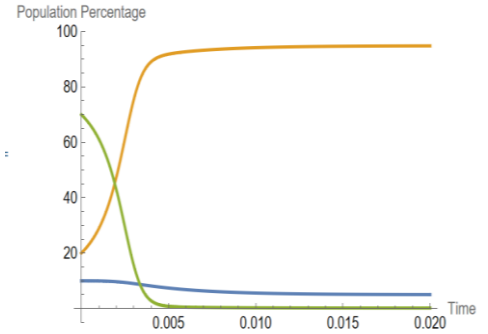


- Online

$k_1 = .1$
$k_2 = 3$
$k_3 = .3$
$k_4 = 1$







x(t)– Population Percentage of Punishers
y(t)– Population Percentage Antisocial Behavior
z(t)– Population of Neither

$l_1 = 5, l_2 = 5$
(At least 5 $x(t)$ and $y(t)$ at all times)

MATHEMATICAL SCIENCES

Present

- 5 - 10 minute video
- Create Presentation
- Explain the full prompt
- Explain Variables
- Explain Equation
- Show and explain Graphs
- Interpret your solution
- Draw conclusions
- Use mathematical language

Questions?