Math and Zombies

\[
\sqrt{\text{Brains}^3 + x + 1} \\
i = 0 \\
\sum \text{Brains} \\
i = \infty \\
\text{BRAINS DELICIOUS}
\]
MY PATHWAY TO SCIENCE

SCIENCE OLYMPIAD

Oregon State University
COLLEGE OF AGRICULTURAL SCIENCES
Eco-Informatics Summer Institute
TODAY

Math Biology @ the U

Phoebe
Why zombies?

• I study: mathematical biology

• Mathematical model = a set of “rules” we think are true

• Zombie infections = good example!
Zombie Infection

Someone in this room = first zombie

Questions:
1. Will humans survive?
2. How quickly will zombies take over?
GAME RULES

• 1 person = zombie

• each turn: only zombie infects 2 people

• What happens?

"model"

game #1
**GAME RULES**

- 1 person = zombie
- *each turn*: only zombie infects 2 people

• What happens?

**Results**

- linear growth
- How can we make more realistic?

“model”

game #1
GAME RULES

• 1 person = zombie

• each turn: all zombies infects 2 people

• What happens?
GAME RULES

• 1 person = zombie

• each turn: all zombies infects 2 people

• What happens?

Results

• exponential growth (very fast!)

• More realistic? Realistic enough?
GAME RULES

• 1 person = secret 1st zombie

• each turn:
  • interact with 3 friends
  • each rolls a die: add up your two die
  • 2-4 = safe
  • 5-12 = dangerous (infected if with a zombie)
  • record this on your sheet!

• end of game: we’ll track zombie outbreak
GAME RESULTS

- More zombies = faster infection
- Eventually run out of humans!

![Logistic Growth Diagram](image)
Zombie Game

• Previous game: humans not able to fight back!
• How to model this? Math modeling helps!
• Need rules
INFECTION MODEL

25% of time

75% of time
Mathematicians like numbers

Mathematicians like Greek letters!

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INFECTION MODEL

\[(100 - \alpha)\% \quad \text{??\% of time} \quad \alpha \% \text{ of time}\]
Zombie Removal Model

85%

15%
ZOMBIE REMOVAL MODEL

\[ + \quad (100 - \beta)\% \]

\[ \beta\% \]
ZOMBIE REMOVAL MODEL

- Mathematicians like to count stuff!

- \( S = \#\) of survivors

- \( Z = \#\) of zombies

- \( R = \#\) of removed zombies
ZOMBIE REMOVAL

- How can $S$ (number of survivors) change?
  1 way:

- How can $Z$ (number of zombies) change?
  2 ways:
ZOMBIE REMOVAL

• How can $R$ (# removed zombies) change?

1 way:

$S = \# \text{ of survivors}$

$Z = \# \text{ of zombies}$

$R = \# \text{ of removed zombies}$
“derivative” = calculus language for how a thing can change

\[ \dot{S} = -\alpha SZ \]
\[ \dot{Z} = +\alpha SZ - \beta SZ \]
\[ \dot{R} = +\beta SZ \]
What does the model predict?

Will humans survive?

If not, for how long?
LESSONS LEARNED

• 2 ways to survive: reduce $\beta$ or increase $\alpha$

• Simplified a lot from “real life” but still learned stuff

• **Zombie-ism a disease!**

• Really how epidemiologists study diseases (zika, ebola, malaria)
Mathematical Biology

• Mathematical modeling of biology

- Cancer
- Neuroscience
- Ecology