A brief introduction to the course

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Who is Dr. Smith?

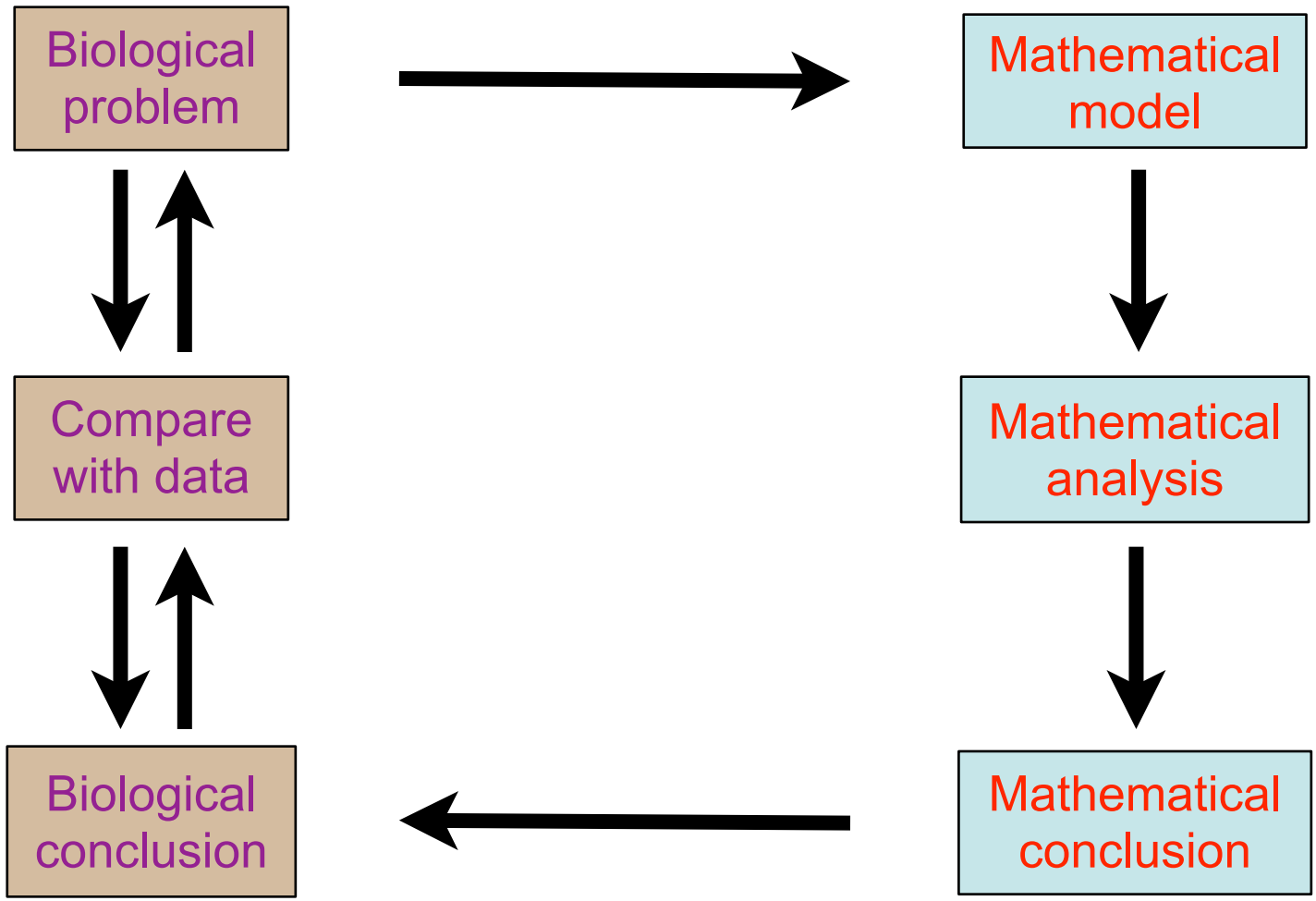
- Most profs never tell you how to address them
- Please call me Dr. Smith?
  - my pronouns are she/her
- The question mark is part of my name
- So if you use my surname, don't forget the question mark
- You won't lose marks for this transgression...

  ...but I may frown quite heavily.

What do I do when I'm not teaching?

- I'm a tenured professor
- This means I conduct research into cutting-edge topics using mathematics
- In my case, I research infectious diseases
- These include
  - COVID-19
  - HIV
  - human papillomavirus
  - various tropical diseases
  - zombies.

Using math to solve real problems



Summary

- From simple assumptions, we can make models that might be simple, or might be complicated
- Mathematical modelling is like map-making
- We need to decide which factors are important and which we can safely ignore

"All models are wrong... but some are useful"
- George Box.

COVID-19

- Can the vaccine make things worse?

  (Answer: Yes, if we abandon masks and distancing before everyone is vaccinated)
- Can we use past pandemics to predict how this one will go?
- (Yes, but only for one wave at a time).

HIV

- How many doses of your HIV drugs could you safely miss without causing drug resistance?

  (It depends on the individual regimen, but short breaks can be tolerated)
- Can we spend our way out of the AIDS epidemic?

  (Yes, but we have to act quickly).

Human papillomavirus

- There's a vaccine being given to children for free in schools, but adults have to pay for it
- Should we supplement the childhood vaccination program with an adult one?

  (Answer: Yes, even moderate increases in adult vaccination can lead to eradication of certain HPV strains).

Tropical diseases

- How often should we spray insecticide to control mosquitos in sub-Saharan Africa?

  (Answer: Every few months, but the frequency is going to have to increase as global warming makes mosquitos breed faster)
- What's the best way to eradicate Guinea Worm disease, a parasite you get from the water?

  (Education about not reinfecting the water is best, but chlorination and distributing cloth filters to the remaining four countries can result in total eradication within the next few years).

Zombies

- Can we survive a zombie outbreak?

  (Answer: Yes, but only if we strike first and strike quickly...

  ...otherwise we're all going to die).

Survey

Who's good at math?

Who's not?

Who's hard-working?

Who's not?

Hardworking

- You can be a lazy genius
- If you're not a genius, hard work will do just as well

  (often better)
- The choice is up to you
- No one's going to make you study or do extra practice questions...
- …just don't be lazy and not a genius.

Assessment

- Assignments 20%
  - these can be done in groups
  - we'll work through Chapters 3–14 in the textbook, due weekly
- Midterm (40%)
  - March 26
- Project presentation (15%)
  - group project, individual presentations
- Final project (25%)
  - due by the end of semester.

Professors aren't teachers

- Instead, we're here to facilitate your learning
- Think of lectures as a resource...

  ...but it's one resource among many
- Other resources include:
  - Friends
  - Office hours
  - Textbook
  - Internet
- You learn when you assemble all these resources in the context of problem-solving.

What's this course about?

- A. How to create mathematical models from real-world phenomena
- We need to learn:
  - the steps involved in turning the biology into models
  - how to theoretically analyse the model
  - how to numerically analyse the model (using Matlab)
  - what can go wrong.

Course outline (theory)

- Fitting curves to data
- Matlab overview
- Fitting linear and cubic splines
- Simple epidemic models
- The basic reproduction number
- More advanced models
- Partial differential equations
- Discrete-time dynamical systems
- Bifurcations
- More advanced models.

Course outline (applications)

- Spatial diffusion of measles
- AIDS and end-stage renal disease
- Malaria with a delay
- Guinea-worm disease
- Zombies.

Language

- Math is like a language
- You can’t learn a language by sitting in class and listening to someone speak it
- You need to practice, practice, practice
- Do a mixture of questions with answers and those without (worked solutions don’t count)
- Your time is best spent trying to nut out a problem
- And, if you’re sufficiently proficient at math...

  ...you’ll be grateful when the zombies arrive.