1 Class 1

1.1 Structure of today

- Few minutes for urgent course content questions ...
- Review what is Bayesian (briefly) and the workflow I will teach for it
- Focus on simulating data from a linear regression
- END: course content, grading etc..

Okay! You all should have received my email about the course, which means
you're here because ...

- Excited to learn Bayesian inference and modeling!
- Excited to work together in pairs or teams during class (even if you're auditing)
- Know enough R to code actively in class
- Have a laptop and note-taking devices

If you're **not sure** about any of these, stay here and come talk with me after.

1.2 Before I dive in ... reminder: don't panic

No one gets everything in a stats class the first time, but you need to keep listening and not zone out.

(Also, should I mention that this is the FIRST year I am teaching this class so bear with me?)

1.3 What is Bayesian? Pros and cons

It's a way of getting estimates from a model based on the likelihood from data and your prior beliefs.
It's a way of fitting and inferring from models that is extremely flexible and relies on prior knowledge. (That's basically all you need to know for today.)

Ask the students to list out pros and cons. Make sure they hit the below.

Pros

- Very flexible!
- Optimally handles uncertainty
- Intuitive
- No assumptions! No iid, nothing to memorize!

Cons

- No assumptions, you must check your own model and know what you're doing ...

– Computationally heavy

1.3.1 Types of Bayesians

There are **many** types of Bayesians:

– Andy Royle Bayesians with specific beliefs about how you fit mark-recapture models

– People obsessed with DAGs

– Facultative Bayesians

– Andrew Gelman Bayesians (BDA)

I will teach you my style of Bayesian ... which is pretty close to a Gelman Bayesian with other ideas (Betancourt etc.) thrown in.

This does not matter! Except when you go out into the world and meet the other Bayesians.

1.4 What is Bayesian? A workflow

1. Come up with your model
2. Simulate data from your model to check it
3. Prior predictive checks
4. Run your model on empirical data
5. Retrodictive checks (aka PPCs)

This class will focus on most of this workflow!
Except step 1 and we won't dwell on step 2 (prior checks).

2 Simulate from a linear model: Part 1

We're going to use something that works with linear regression for our model, so continuous x and continuous y

Get class to come up with an example and DRAW it out on a graph

Options: Plant growth in response to soil nutrient concentration, biometric scaling etc.

Ask students equation for a line.

Write out various notations and differentiate **parameters** from **data** (ideally, skip the error here)

Okay, I want to simulate data from this equation, what do I do?

In this section be sure to ...

- Slope versus intercept
- Come up with parameter numbers to write on board
- Mention `rnorm`
- Get the ERROR onto the equation if you have not already
- mention n
- What is an effect size?

Students should pair up and work on doing this with the following rules ...

- You must BOTH end up with the code you come up with.
- You alert me when you're done or have a question ... [If they are done, they should check their work using lm, then try to simulate a LOGISTIC regression.]

Note to self: Give the class a 10 minute break by 3pm!

3 Simulate from a linear model: Part 2

Come together and review how they did. Live code with them the course example using lm to check work.

Discuss: How might this be valuable?

And be sure to discuss why this is critical in Bayesian approaches (NO assumptions; you must CHECK and UNDERSTAND your model.

4 Simulate from a linear model: Add interactions

Review this if time allows ....

- Intercept only model
- Adding an interaction to a model ...

5 Review of course

- 3 weeks, 6 classes, we'll get to hierarchical modeling
- Grading is participation and homework
- There are TWO homework (end of each of the first 2 weeks). Please do them! Even if you are auditing.
- No project, you must use a provided dataset
- Course managed on GitHub; you can submit homework on GitHub or Canvas.

– GitHub has wiki with resources ... Review (if time allows)

– We will use rstanarm, which is a version of Stan – make sure you have it running before the next class.

– Remind me to give you a BREAK in the middle of class

– Questions?

6 Class 2

6.1 Cover interactions! If you have not already ...

6.2 What is Bayesian: Posterior

Go over it. Give my Star Wars example.

Discuss in pairs: Another example!

Other examples: Complete separation....

6.3 What is Bayesian: Prior

Types of priors (informative, non-informative, weakly informative)

Why we will not do prior checks ...
Because they are annoying in rstanarm, brms etc. They are easier in raw Stan code.

EXAMPLE: Show code where likelihood overwhelms prior.

6.4 Simulate another example ... and fit it in rstanarm

6.5 Review the homework assignment!

- How to submit
- What to do if you get stuck ..
- A note on using ChatGPT