PRACTICAL EXERCISES
THURSDAY 25/4-2024

Skud ud👍

CLASS 10

ANALYTICAL OLS, LIN-REG WITH BAYESIAN INFERENCE

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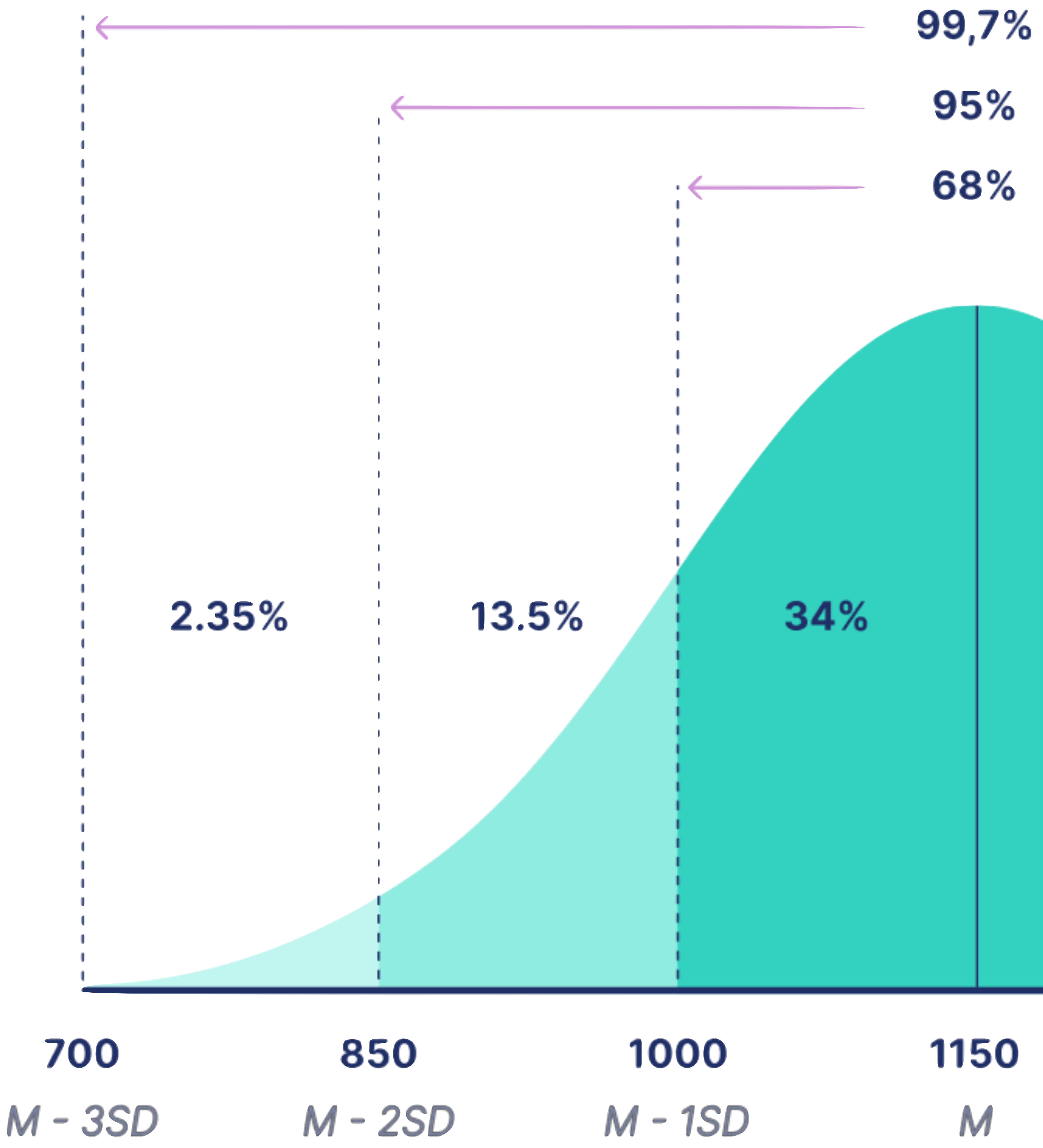
COURSE | METHODS 2: THE GENERAL LINEAR MODEL

AGENDA

- **Anything to recap?**
- **Linear models and Bayesian inference**
  - **lm() vs. stan_glm()**
- **Exercises 📝 + portfolio work**
- **More recap if time**



https://www.scribbr.com/statistics/normal-distribution/
https://da.wikipedia.org/wiki/B%C3%B8rsen

LINEAR MODEL ON MATRIX FORM

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} 1 & x_1 \\ 1 & x_2 \\ \vdots & \vdots \\ 1 & x_n \end{bmatrix} \begin{bmatrix} \beta_0 \\ \beta_1 \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_n \end{bmatrix}$$

$$Y = X\beta + \varepsilon$$

Try to compute the vector and matrix multiplications and additions as we have learned in previous weeks if this is hard to grasp ;)

🎉WHAT IS BAYESIAN INFERENCE?🎉

Something with PRIORS??? What are priors

We use Bayes'
theorem to
update prob of a
hypo,
as more evidence
becomes
available

🎉WHAT IS BAYESIAN INFERENCE?🎉

Different from classical stats in that:

Classical stats: Probabilities are associated with the data 📈

Bayesian stats: Probabilities are associated with the hypotheses ❓

Something with PRIORS??? What are **priors**

Prior distribution: What do you know about the parameters before we see the data?

We use Bayes' theorem to update prob of a hypo,
as more evidence becomes available

🎉WHAT IS BAYESIAN INFERENCE?🎉

Different from classical stats in that:

Classical stats: Probabilities are associated with the data 📈

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EXAMPLE OF BAYESIAN INFERENCE :
EXPLAINING WHAT PRIORS/POSTERIORS ARE USING HEIGHTS

If it’s hard to grasp (this is difficult stuff) 👉😬👈

InfoTrust

Who We Are What We Do Industries

Analytics, Data Science

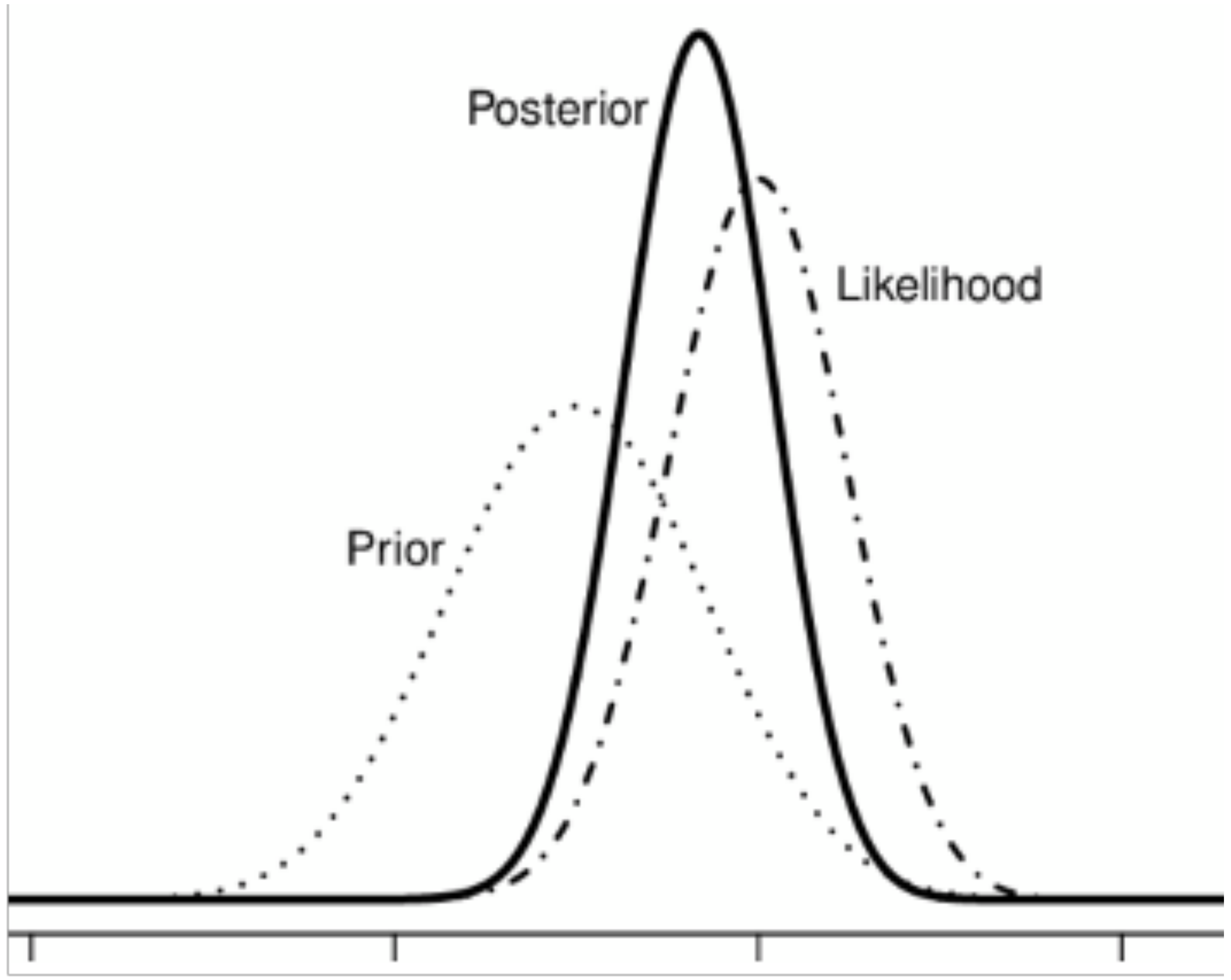
Bayesian vs. Frequentist Methodologies Explained in Five Minutes

https://infotrust.com/articles/bayesian-vs-frequentist-methodologies-explained-in-five-minutes/

BAYESIAN INFERENCE

BAYES THEOREM

$$\overbrace{p(theta|Data)}^{\text{Posterior}} = \frac{\overbrace{p(Data|theta)}^{\text{Likelihood}}\,\overbrace{p(theta)}^{\text{Prior}}}{\underbrace{p(Data)}_{\text{Normalization}}}$$



Remember theta is the general term for model parameters, which in the case of the linear model are the betas

BAYESIAN INFERENCE

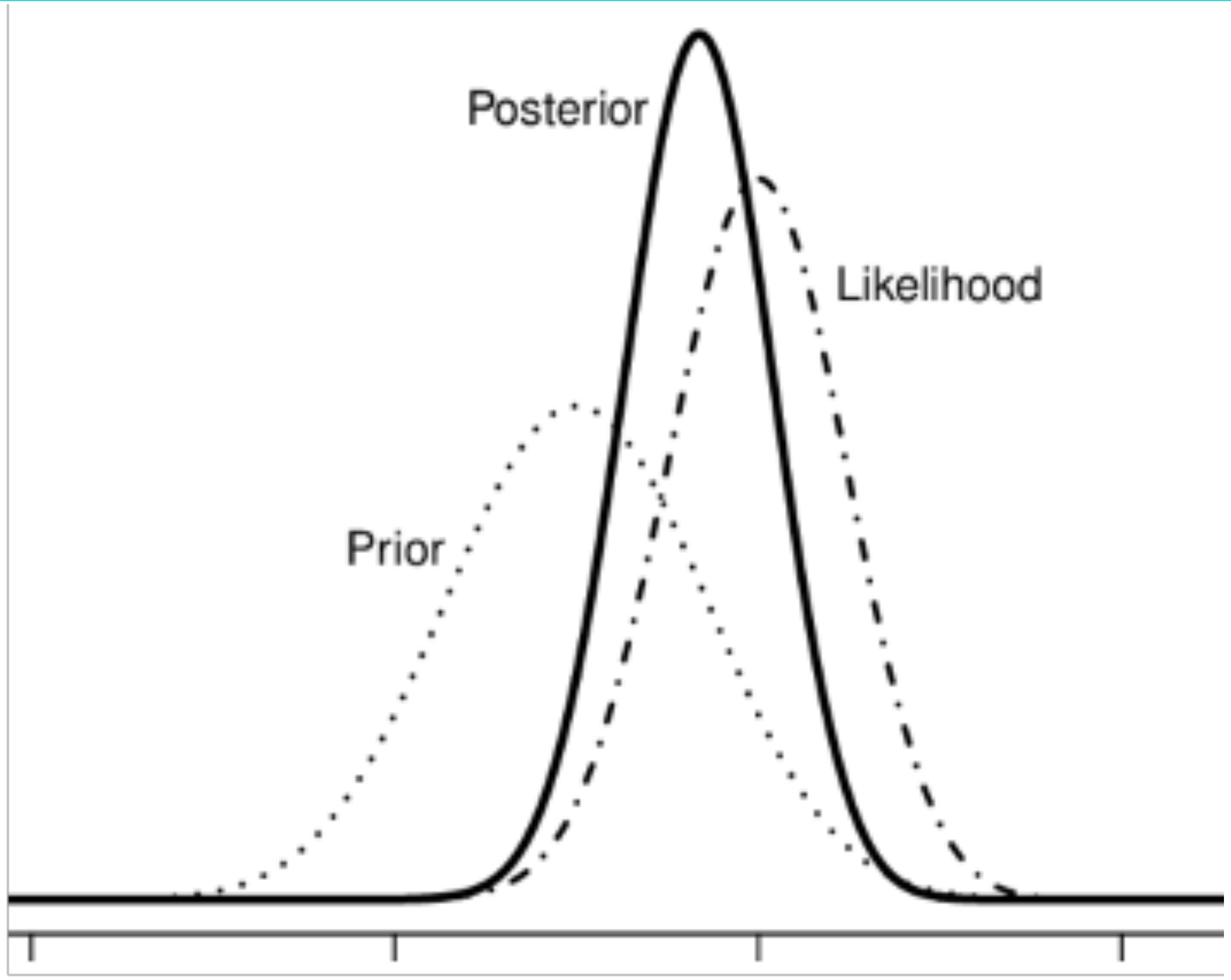
Bayes' theorem ...
1) updates our beliefs about parameters (the **priors**)
2) with new info from the data (the **likelihood**)
3) to give us a revised belief (the **posterior**)

BAYES THEOREM

Posterior | Likelihood | Prior

$$p(theta|Data) = \frac{p(Data|theta)\,p(theta)}{p(Data)}$$

Normalization



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BAYESIAN INFERENCE

Bayes' theorem ...
1) updates our beliefs about parameters (the **priors**)
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3) to give us a revised belief (the **posterior**)

stan_glm() does this 3 step programme ^^^^

in contrast, lm() just fits lin-reg models using **what**?

(hint: 📽️)

BAYES THEOREM

Likelihood

Posterior

Prior

$$p(theta|Data) = \frac{p(Data|theta)\,p(theta)}{p(Data)}$$

Normalization

Remember theta is the general term for model parameters,

Why might **this (bayesian inf)** be better then?

- Incorporating prior knowledge allows building on previous work
- Probabilistic interpretation
- Many other reasons...

https://www.reddit.com/r/mathmemes/comments/esxajs/the_virgin_frequentist_vs_the_chad_bayesian/

LM() VS STAN_GLM()

LM

Uses classical least squares and returns estimates and standard errors.

STAN_GLM

Performs bayesian inference and returns estimates, standard errors and posterior distributions.

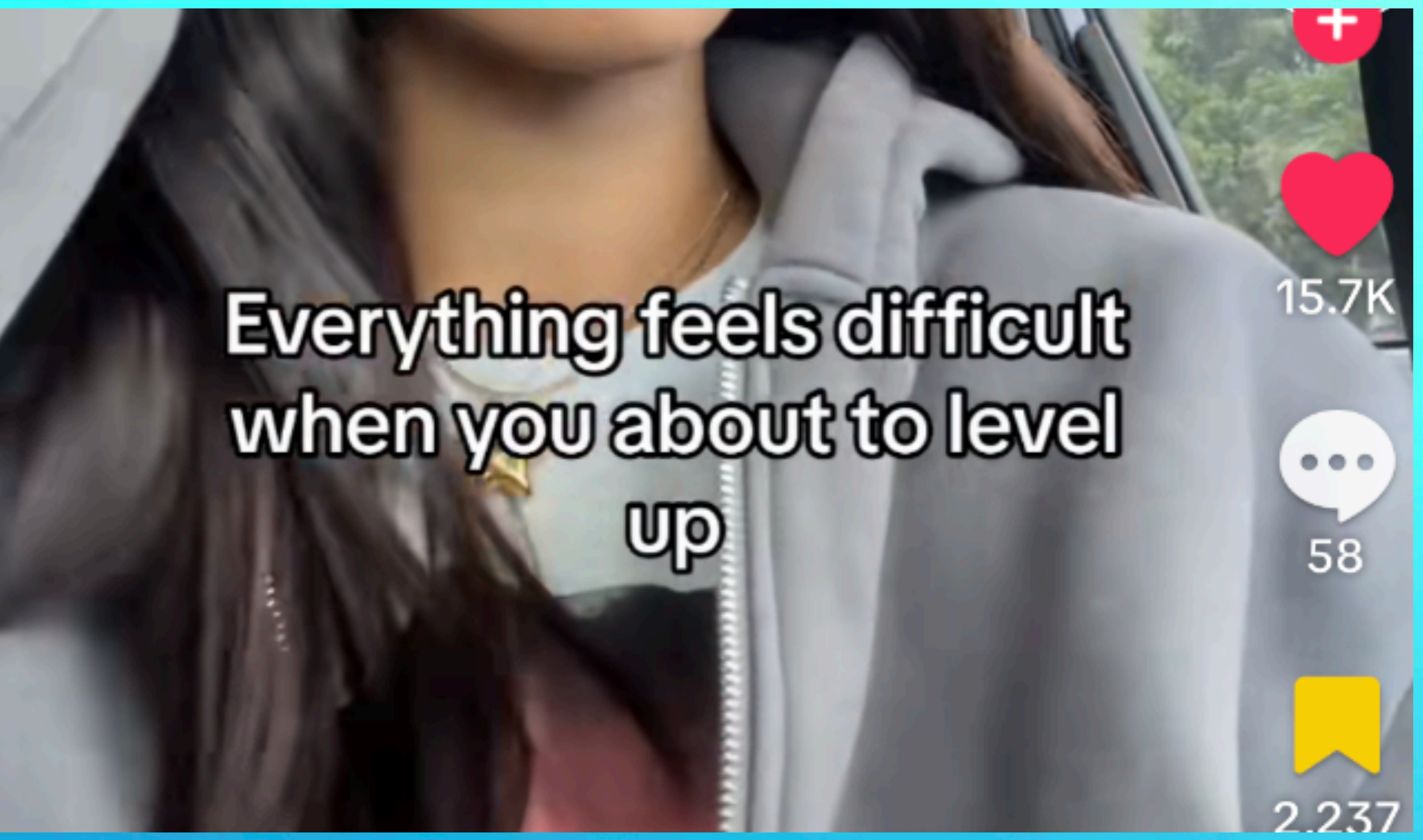
Useful for visualizing uncertainty

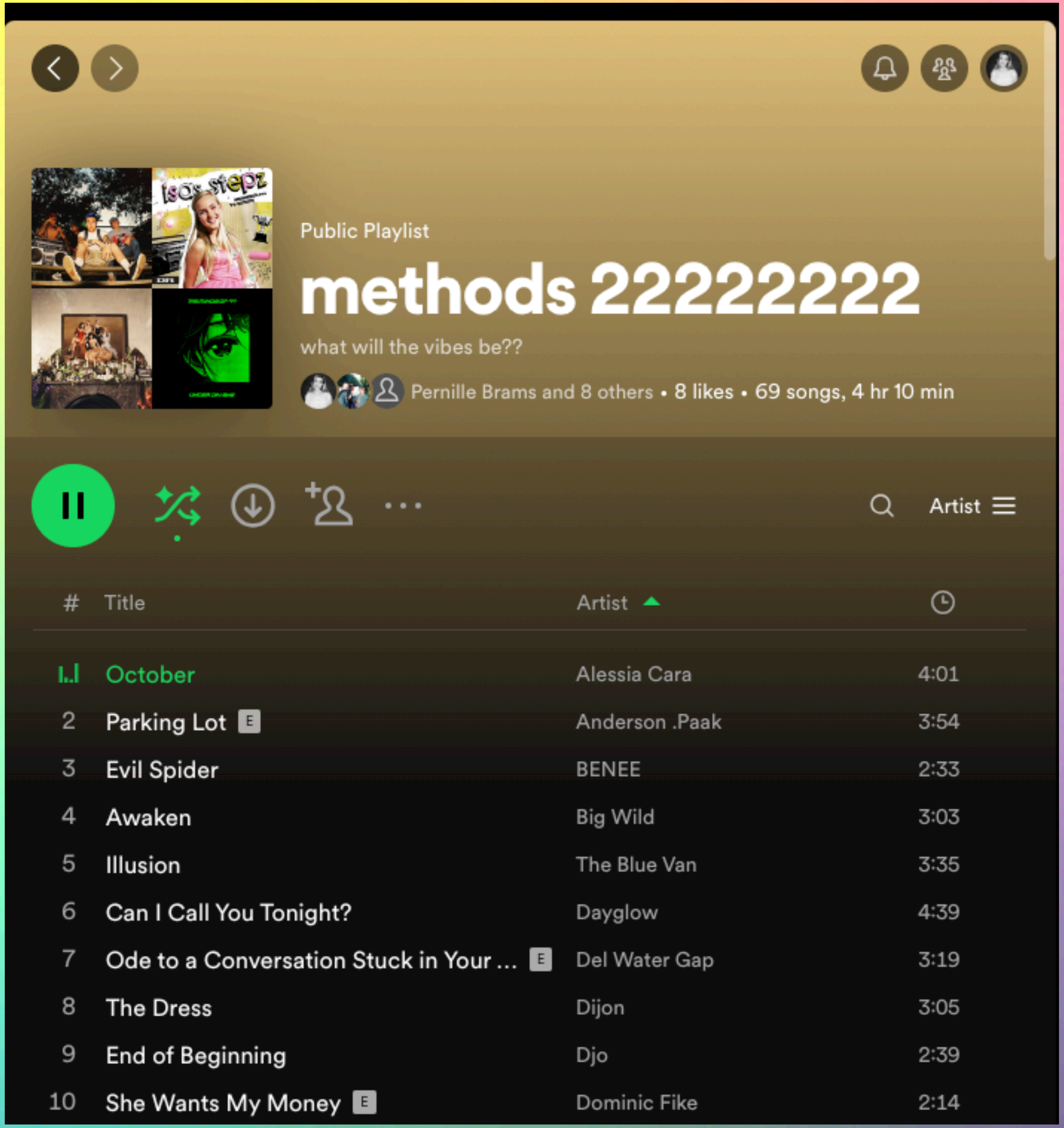
Prior information can be incorporated

- For simple problems with no prior the LM and STAN_GLM will yield the same results

EXERCISES

See .Rmd markdown for this class (10) on Git, and if extra time: portfolio work





Collab: https://open.spotify.com/playlist/5UUiKD15vyFwymQ4qLur9V?si=82f6d92034de4285&pt=87474f98050a67a4599d7dfb9fa852d0