Section with Barbara

Week 2

All

About That

Bayes!

FREQUENTIST

What is our belief from our observations?

BAYESIAN

How should we change our belief from the evidence?

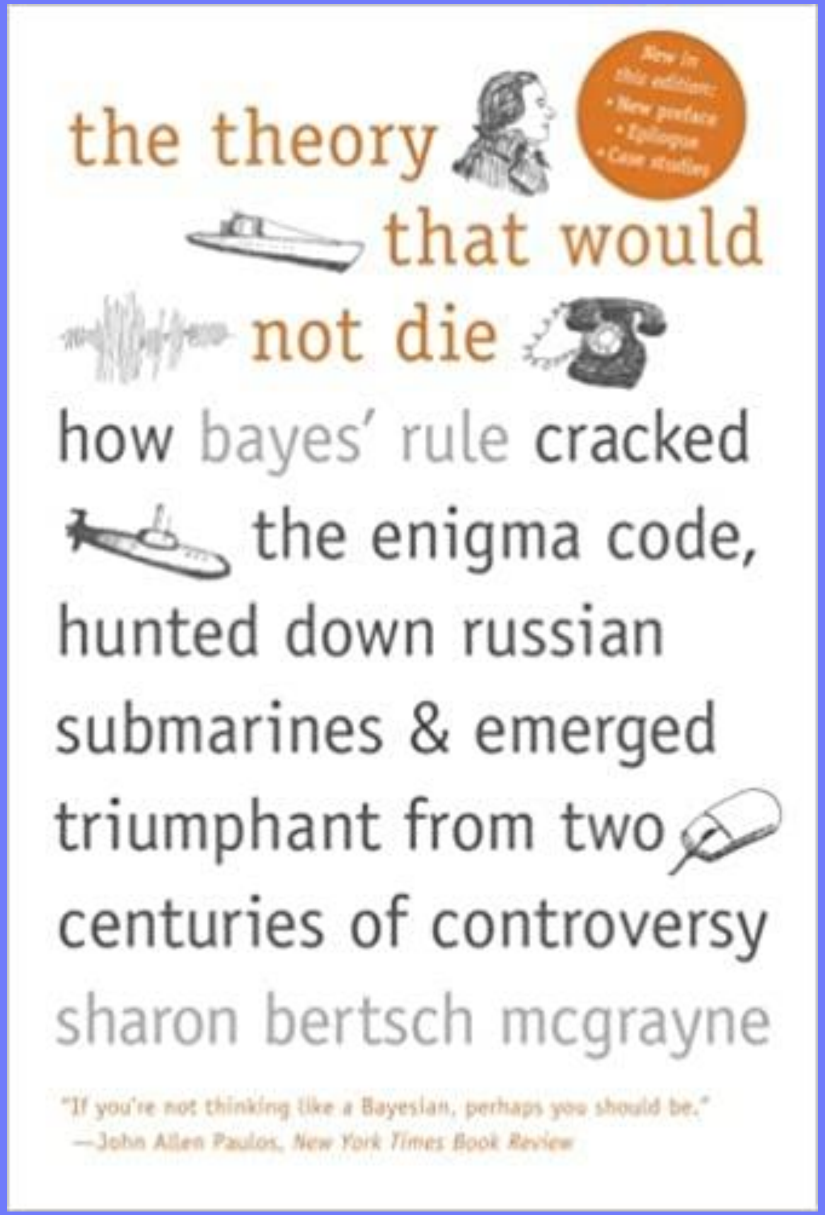
"

The frame of the world must be the effect of the wisdom and power of an intelligent cause

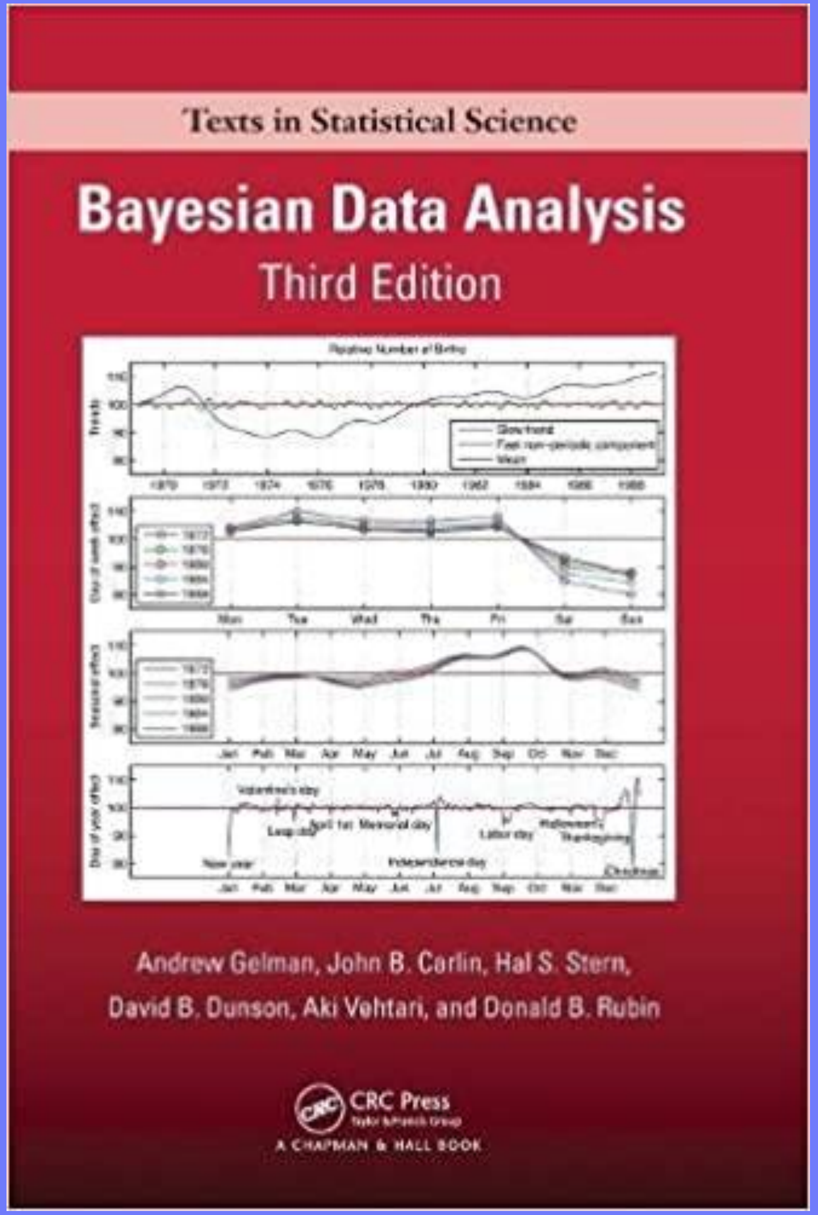
An Essay towards solving a Problem in the Doctrine of Chances. Richard Price (1763)

"

Fun Book on Bayes

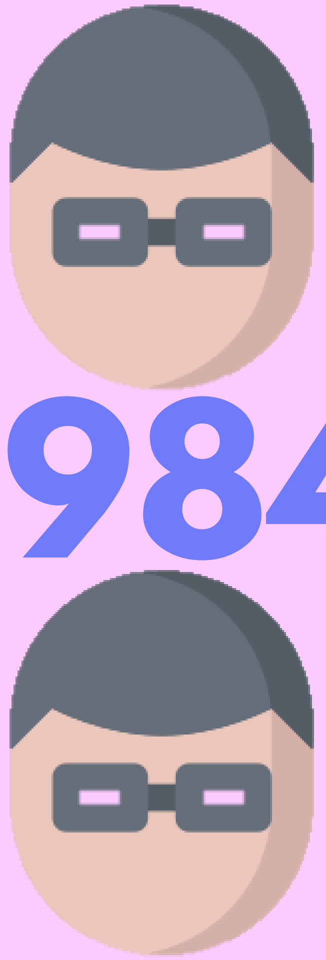


"The" Textbook on Bayes



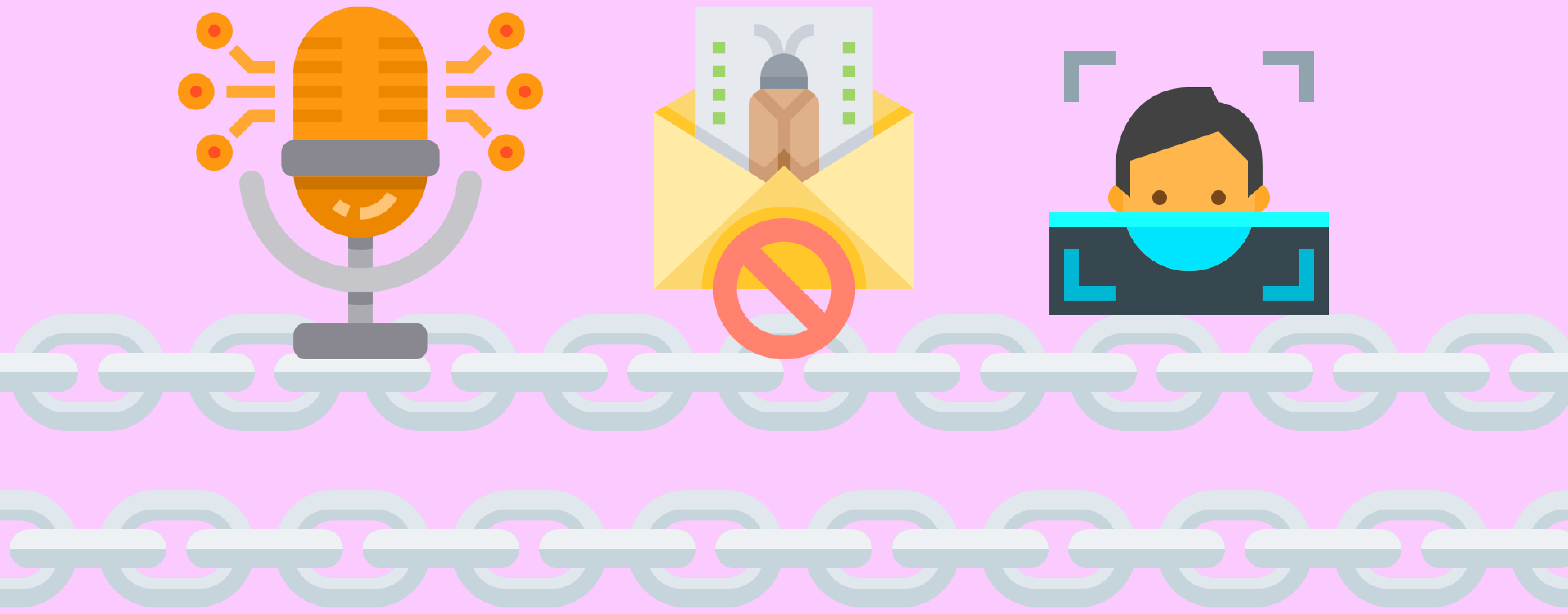
BAYES BEGINNINGS

18th century



1984

BAYES NOW



AI Stories: Recommender Systems

HALO

Knowledge: Gaming Stats
Uncertainty: TrueSkill Ranking
Search: Player Matchmaking

projects

BAYES THEOREM

THE PROBABILITY OF "B" BEING TRUE GIVEN THAT "A" IS TRUE

THE PROBABILITY OF "A" BEING TRUE

$$P(A|B) = \frac{P(B|A)\ P(A)}{P(B)}$$

THE PROBABILITY OF "A" BEING TRUE GIVEN THAT "B" IS TRUE

THE PROBABILITY OF "B" BEING TRUE

Bayes' Theorem Examples: A Visual Introduction For Beginners

PROBABILITY CHAIN RULE

conditional
probability

$$P(B \text{ and } A) = P(A \mid B) * P(B)$$

joint probability

marginal
probability

CHAIN RULE TO BAYES

$$P(B \text{ and } A) = P\ (A \text{ and } B)$$

$$P(A \mid B) * P(B) = P(B \mid A) * P(A)$$

$$P(A \mid B) = \frac{P(B \mid A) * P(A)}{P(B)}$$

“SCIENTIFIC” BAYES

$$P(A|B) = \frac{P(B|A) * \mathrm{P}(A)}{\mathrm{P}(\mathrm{B}|A) * P(A) + P(B|A') * P(A')}$$

$$P(H_i|data) = \frac{P(data|H_i) * \mathrm{P}(H_i)}{\sum_{i=1}^{n} P(data|H_i) * P(H_i)}$$

BAYESIAN INFERENCE

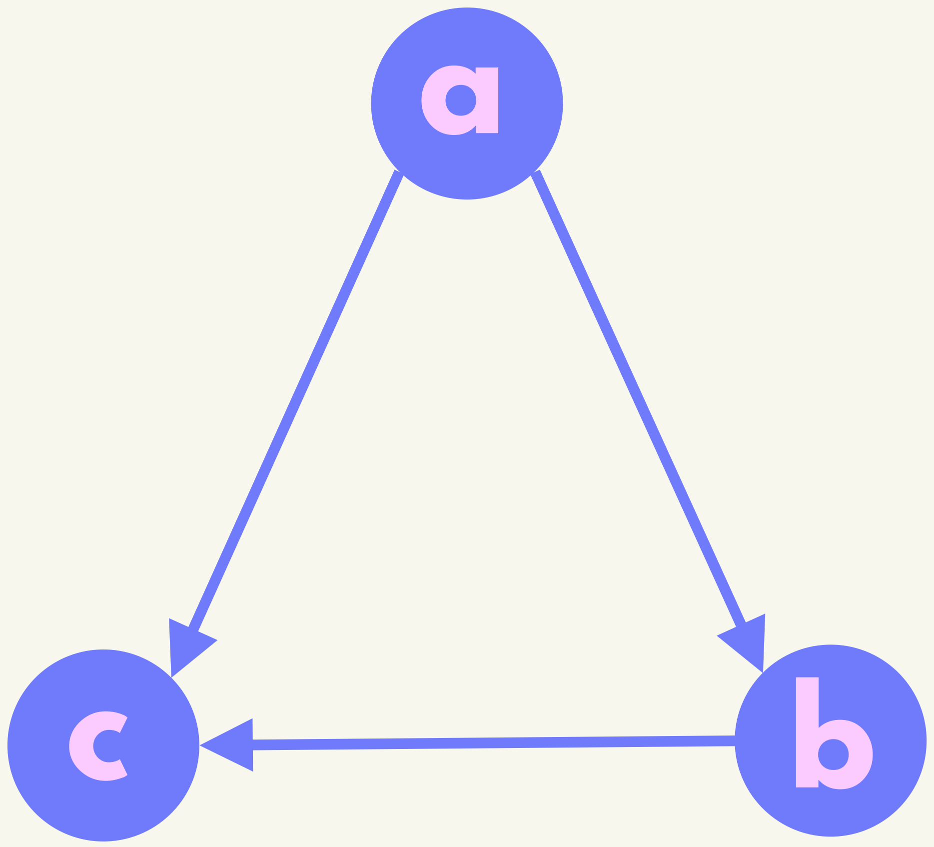
$$\mathrm{P(A)} = \text{a prior}, \qquad \mathrm{P(B)} = \text{normalization}$$

$$\mathrm{P(B \mid A)} = \text{a likelihood}$$

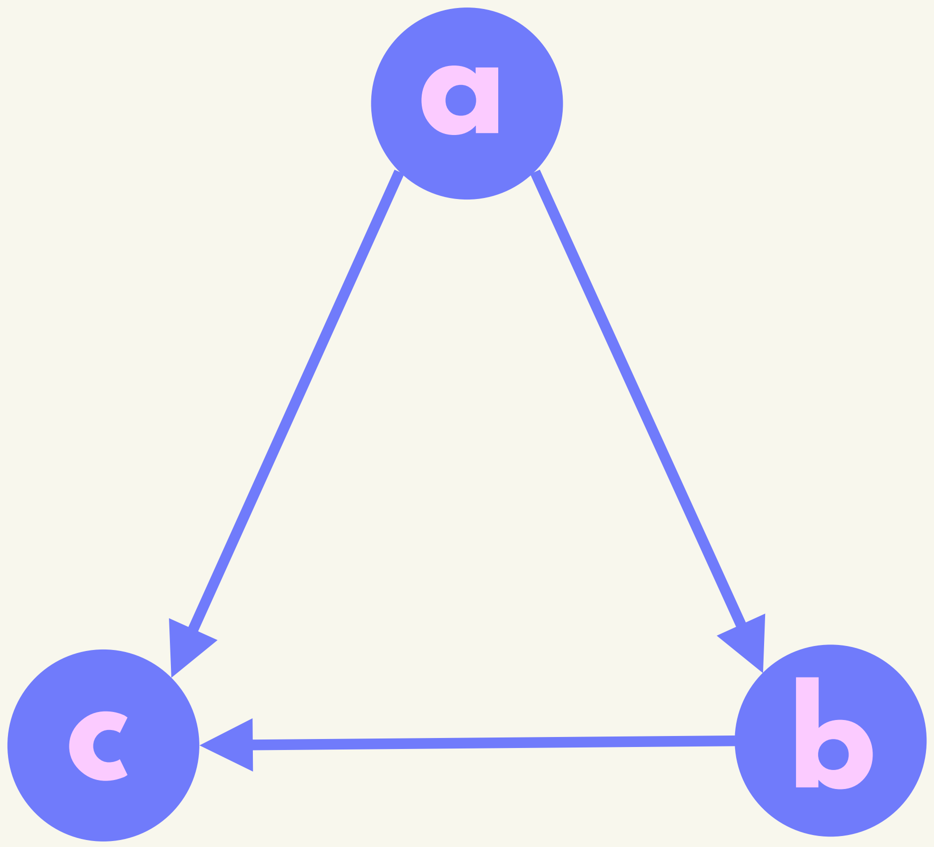
$$P(A \mid B) = \text{a posterior}$$

$$\text{posterior} = \frac{\text{likelihood} * \text{prior}}{\text{normalization}}$$

BAYESIAN NETWORK

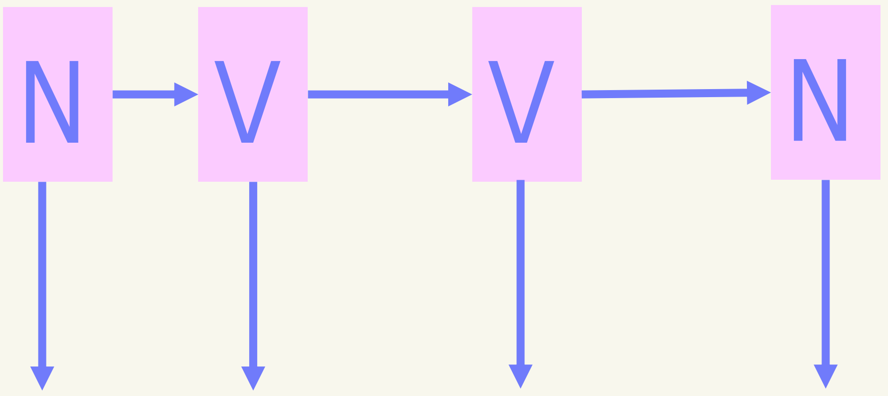


MARKOV CHAIN



$$p(a, b, c) = p(a) \cdot p(b \mid a) \cdot p(c \mid a, b)$$

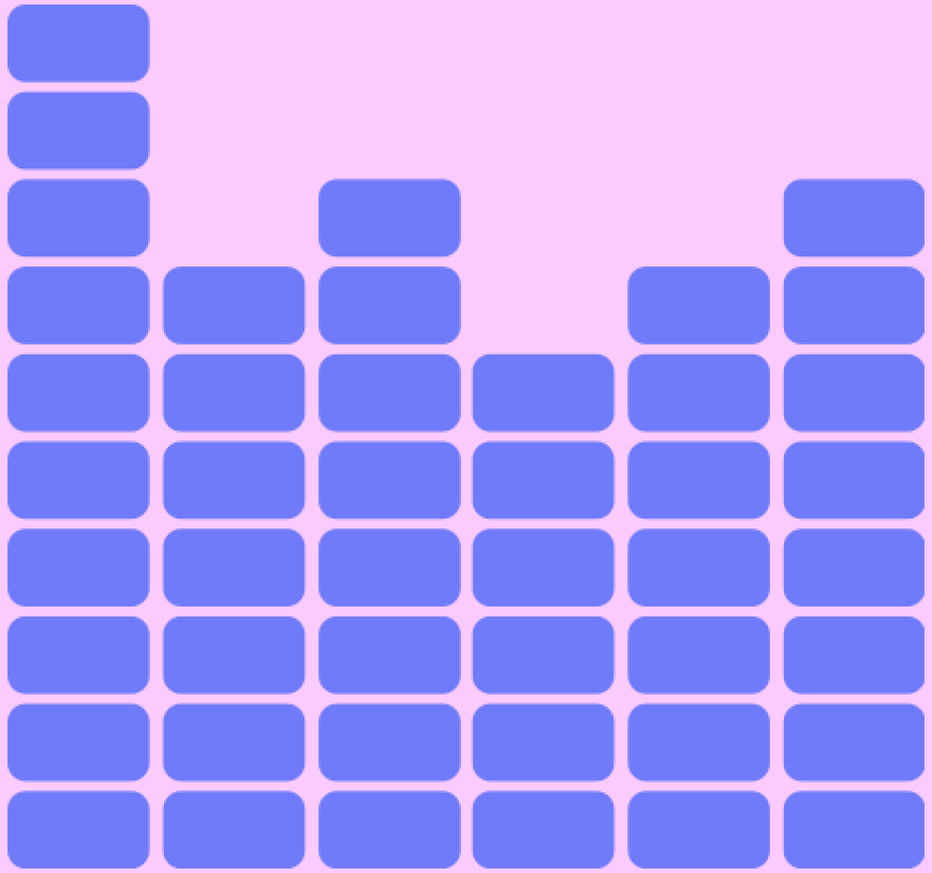
HIDDEN MARKOV MODELS



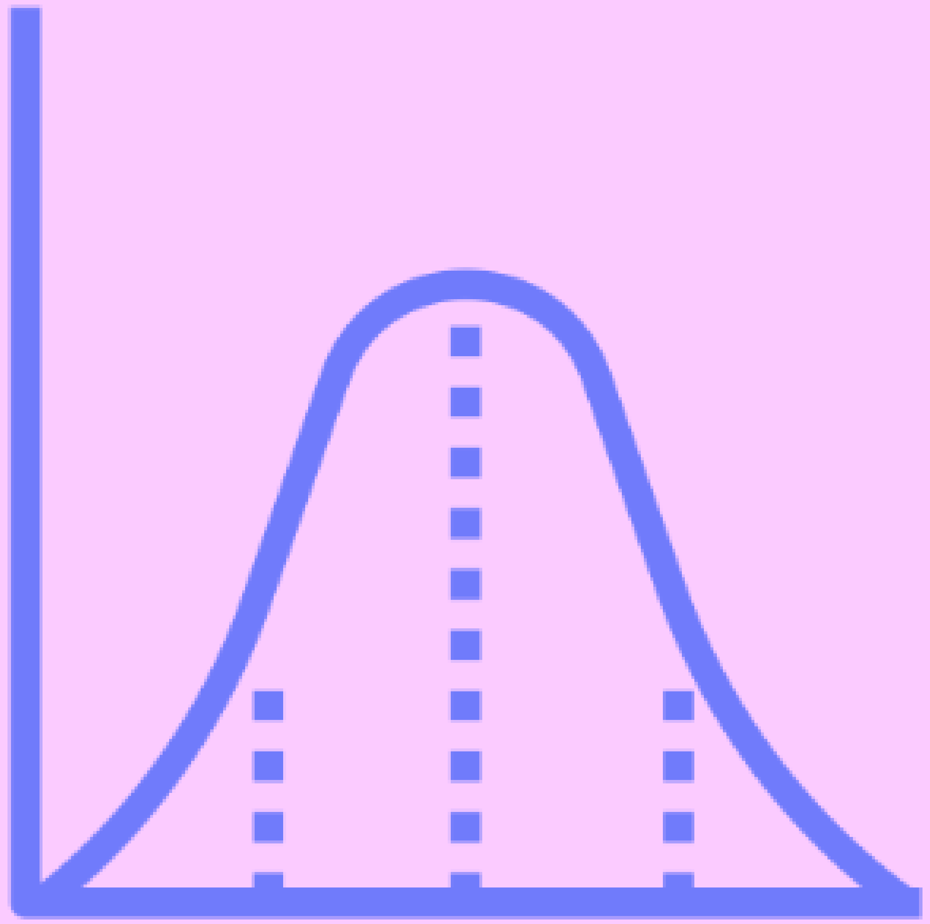
I will text Will

What is the prior? What is the posterior?

PROBABILITY DISTRIBUTIONS

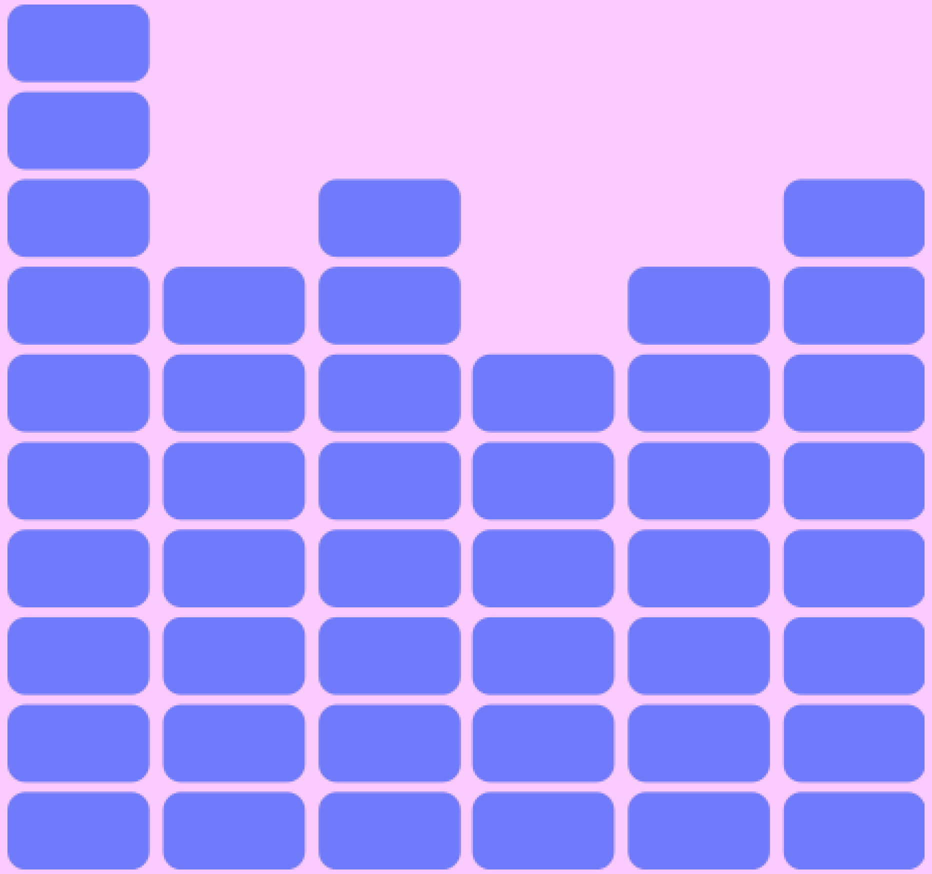


discrete



continuous

DISCRETE DISTRIBUTIONS



$$\begin{cases} P(A = a) \geq 0 \\ \sum P(A = a) = 1 \end{cases}$$

JOINT LIKELIHOODS

Genes

Trait

	0	1	2
Yes			
No			

CONDITIONAL LIKELIHOODS

Parent

Child

	0	1	2
Has Gene			

CONDITIONAL LIKELIHOODS

P(Child Genes = 0 | Mom Genes, Dad Genes)

P(Child Genes = 1 | Mom Genes, Dad Genes)

P(Child Genes = 2 | Mom Genes, Dad Genes)

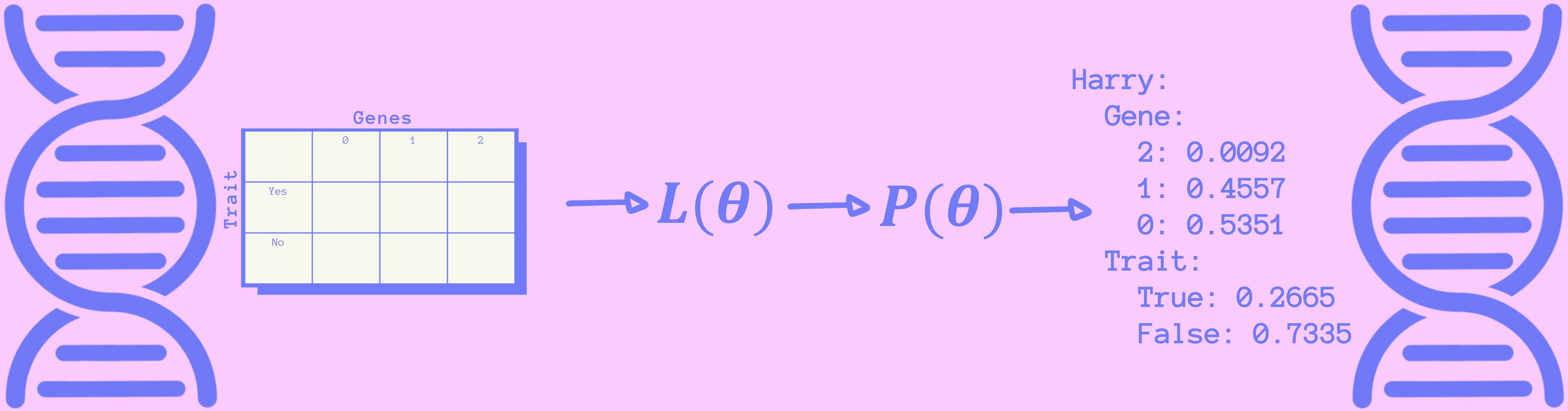
MARGINAL PROBABILITY

Genes

Trait	0	1	2
Yes			
No			

```
Harry:
  Gene:
    2: 0.0092
    1: 0.4557
    0: 0.5351
  Trait:
    True: 0.2665
    False: 0.7335
```

LIKELIHOOD TO PROBABILITY



pagerank

```
def transition_model(corpus, page, damping_factor):
    """
    Return a probability distribution over which page to visit next,
    given a current page.
    With probability `damping_factor`, choose a link at random
    linked to by `page`. With probability `1 - damping_factor`,
    choose a link at random chosen from all pages in the corpus.
    """
```

What is the probability of visiting a page from a link? What is the probability of visiting a page randomly?

pagerank

```
def sample_pagerank(corpus, damping_factor, n):
    """
    Return PageRank values for each page by sampling `n` pages
    according to transition model, starting with a page at random.
    Return a dictionary where keys are page names, and values are
    their estimated PageRank value (a value between 0 and 1). All
    PageRank values should sum to 1.
    """
```

Check out random.choice from numpy - it will be helpful here.

pagerank

```
def iterate_pagerank(corpus, damping_factor):
    """
    Return PageRank values for each page by iteratively updating
    PageRank values until convergence.
    Return a dictionary where keys are page names, and values are
    their estimated PageRank value (a value between 0 and 1). All
    PageRank values should sum to 1.
    """
```

Make sure you understand generally how the Pagerank equation works in the project specs

Are you still confused about Bayes?

Let's do an exercise!