DATA 8

Spring 2022

Lecture 37

Updating Probabilities

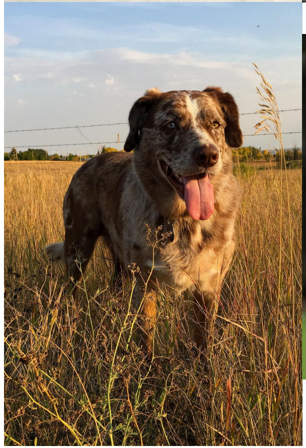
Announcements

- Homework 11 now **due tonight**
- Project 3 Checkpoint **due tomorrow**
  - Entire project due next Friday (04/29)
- Homework 12 due Thursday (04/28)
  - Turn in on Wednesday for a bonus point

Before Classifying

Dog or Wolf?





Start with a Representative Sample

- Both the training and test sets must accurately represent the population on which you use your classifier

- **Overfitting** happens when a classifier does very well on the training set, but can't do as well on the test set

Standardize if Necessary

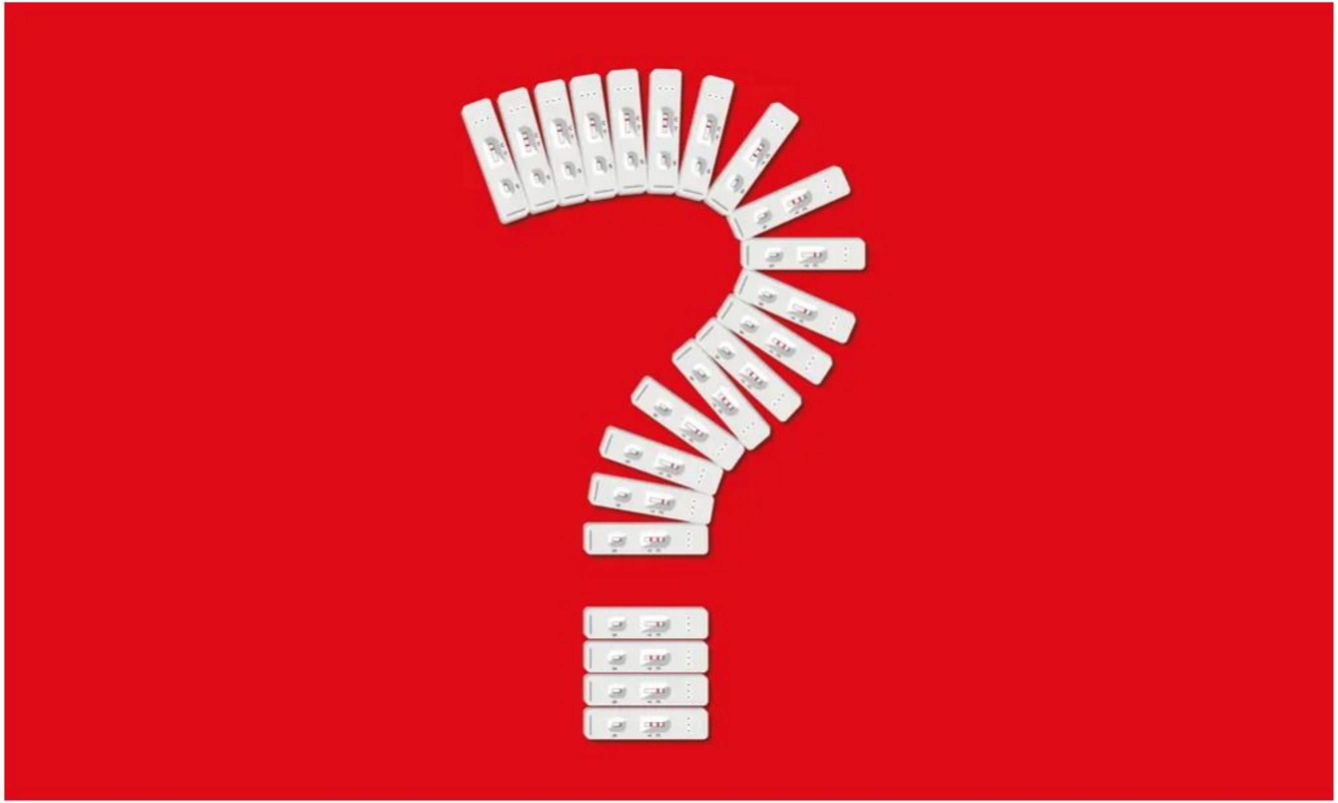
Chronic Kidney Disease data set

Glucose	Hemoglobin	White Blood Cell Count	Class
117	11.2	6700	1
70	9.5	12100	1
380	10.8	4500	1
157	5.6	11000	1

- If the attributes are on very different numerical scales, distance can be affected
- In such a situation, it is a good idea to convert all the variables to standard units

Updating Probabilities

The obscure maths theorem that governs the reliability of Covid testing



Source: Guardian

Updating Probabilities

Interpretation by Physicians of Clinical Laboratory Results (1978)

> "We asked 20 house officers, 20 fourth-year medical students and 20 attending physicians, selected in 67 consecutive hallway encounters at four Harvard Medical School teaching hospitals, the following question:
>
> "If a test to detect a disease whose prevalence is 1/1000 has a false positive rate of 5%, what is the chance that a person found to have a positive result actually has the disease, assuming that you know nothing about the person's symptoms or signs?"

Updating Probabilities

Interpretation by Physicians of Clinical Laboratory Results (1978)

"Eleven of 60 participants, or **18%, gave the correct answer**. These participants included four of 20 fourth-year students, three of 20 residents in internal medicine and four of 20 attending physicians. The most common answer, given by 27, was that the chance that a person found to have a positive result actually has the disease was 95%.

Conditional Probability

Scenario 1

- Scenario:
  - Class consists of second years (60%) and third years (40%)
  - 50% of the second years have declared their major
  - 80% of the third years have declared their major
- **I pick one student at random.**
- Which is more likely: Second year or Third year?
  - Second year, because they are 60% of the class

Scenario 2

- Slightly different scenario:
  - Class consists of second years (60%) and third years (40%)
  - 50% of the second years have declared their major
  - 80% of the third years have declared their major
- **I pick one student at random...**
  That student has declared a major!

(Demo)

- Which is more likely: Second Year or Third Year?

Bayes' Rule

Purpose of Bayes' Rule

- Update your prediction based on new information

- In a multi-stage experiment,
  find the chance of an event at an earlier stage,
  given the result of a later stage

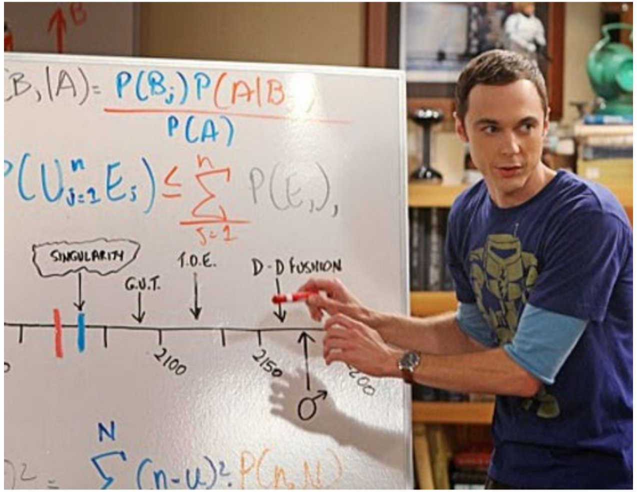
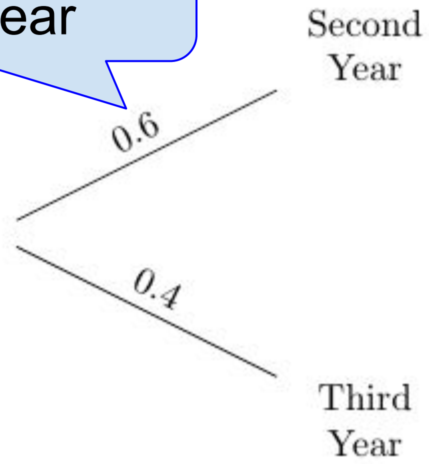


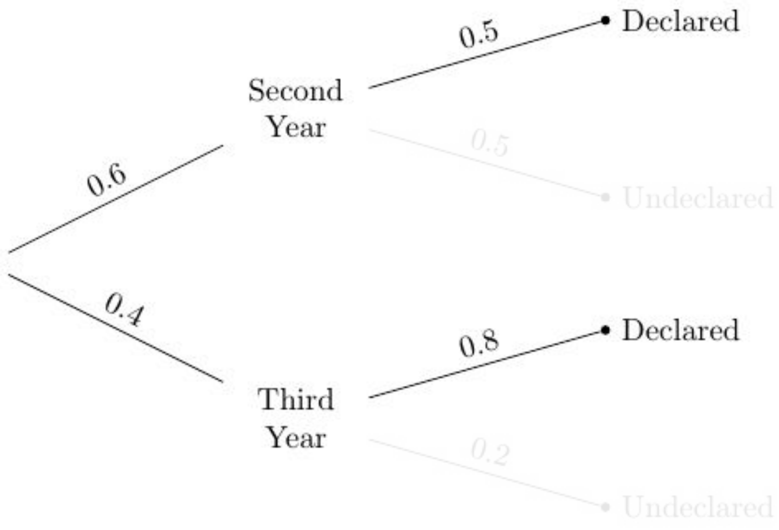
Diagram and Terminology

Prior probability of being a 2nd year

Likelihood of declared, given 2nd year



Data & Calculation



Pick a student at random.

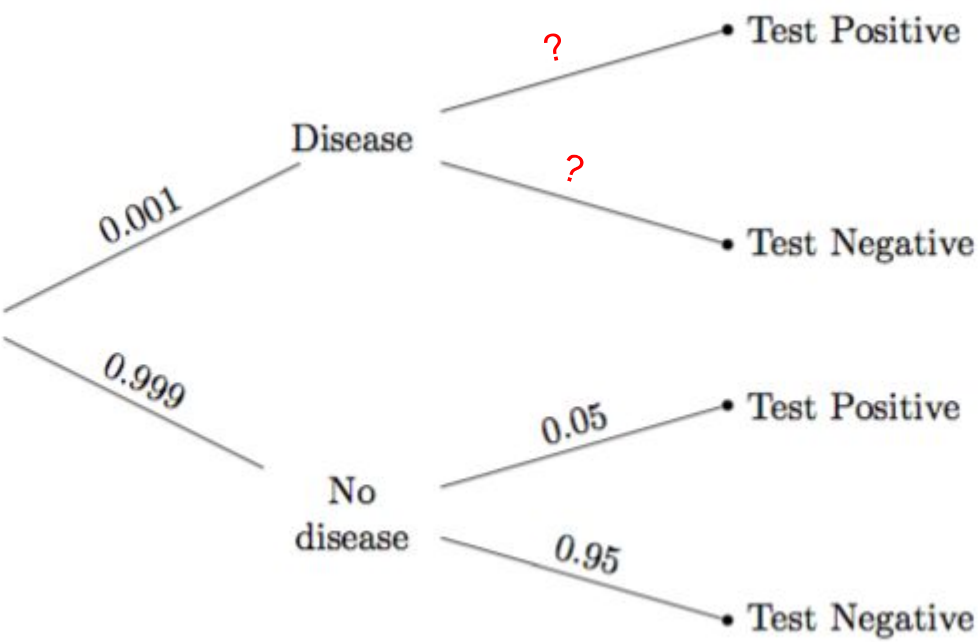
Posterior probability:

P(Second Year | Declared)

$$= \frac{0.6 \times 0.5}{(0.6 \times 0.5) + (0.4 \times 0.8)}$$

= 0.4839…

Example: Doctors & Clinical Tests

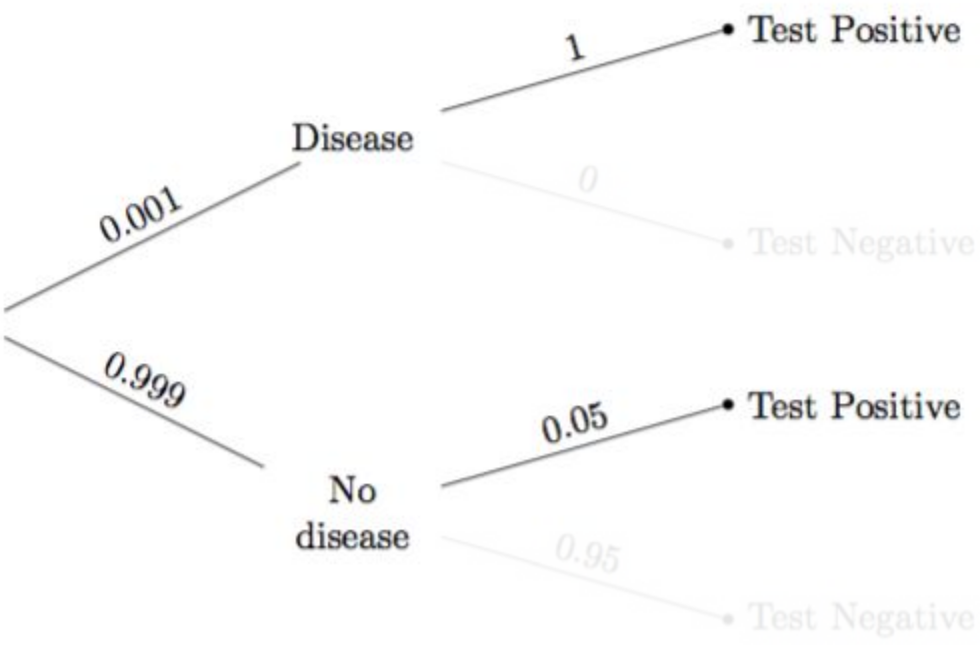


Problem did not give the *true positive* rate.

That's the chance the test says "positive" if the person has the disease.

It was assumed to be 100%.

Data and Calculation



$$P(\text{Disease} \mid \text{Test} +) = \frac{0.001 * 1}{(0.001 * 1) + (0.999 * 0.05)}$$

$= 0.0196270\ldots$

(Demo)

Subjective Probabilities

Subjective Probabilities

A probability of an outcome is…

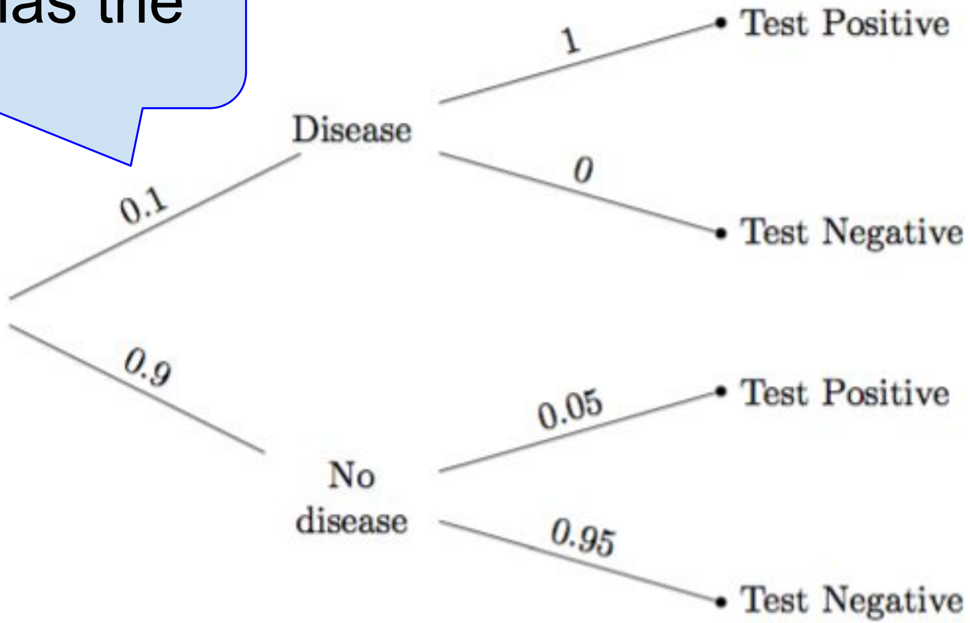
- The frequency with which it will occur in repeated trials, *or*
- The subjective degree of belief that it will (or has) occurred

Why use subjective priors?

- In order to quantify a belief that is relevant to a decision
- If the subject of your prediction was not selected randomly from the population

A Subjective Opinion

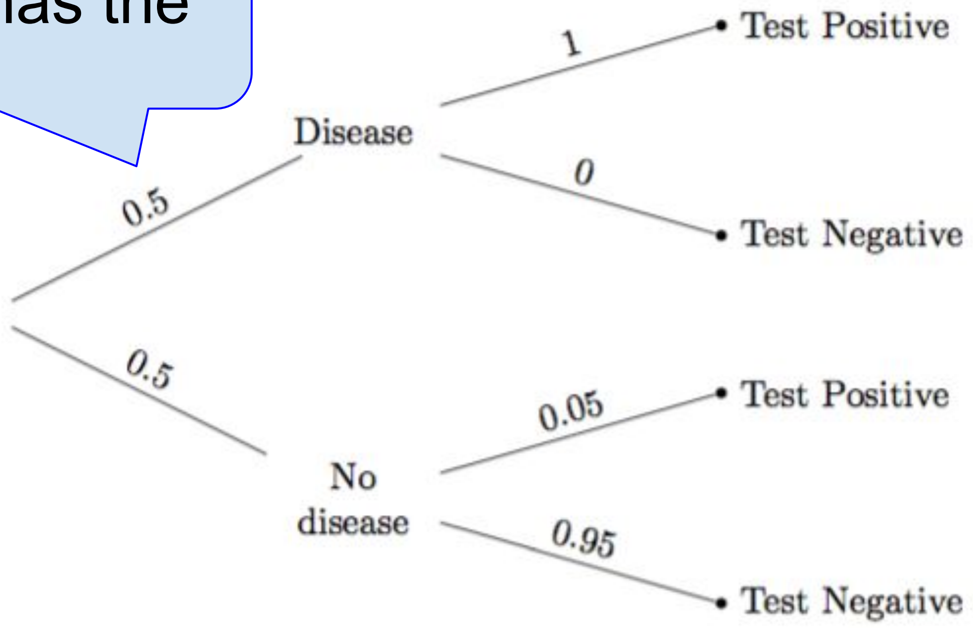
prior probability that the person has the disease



(Demo)

A Different Subjective Opinion

prior probability that the person has the disease



(Demo)