DATA 8

Spring 2018

Lecture 36

Classifiers

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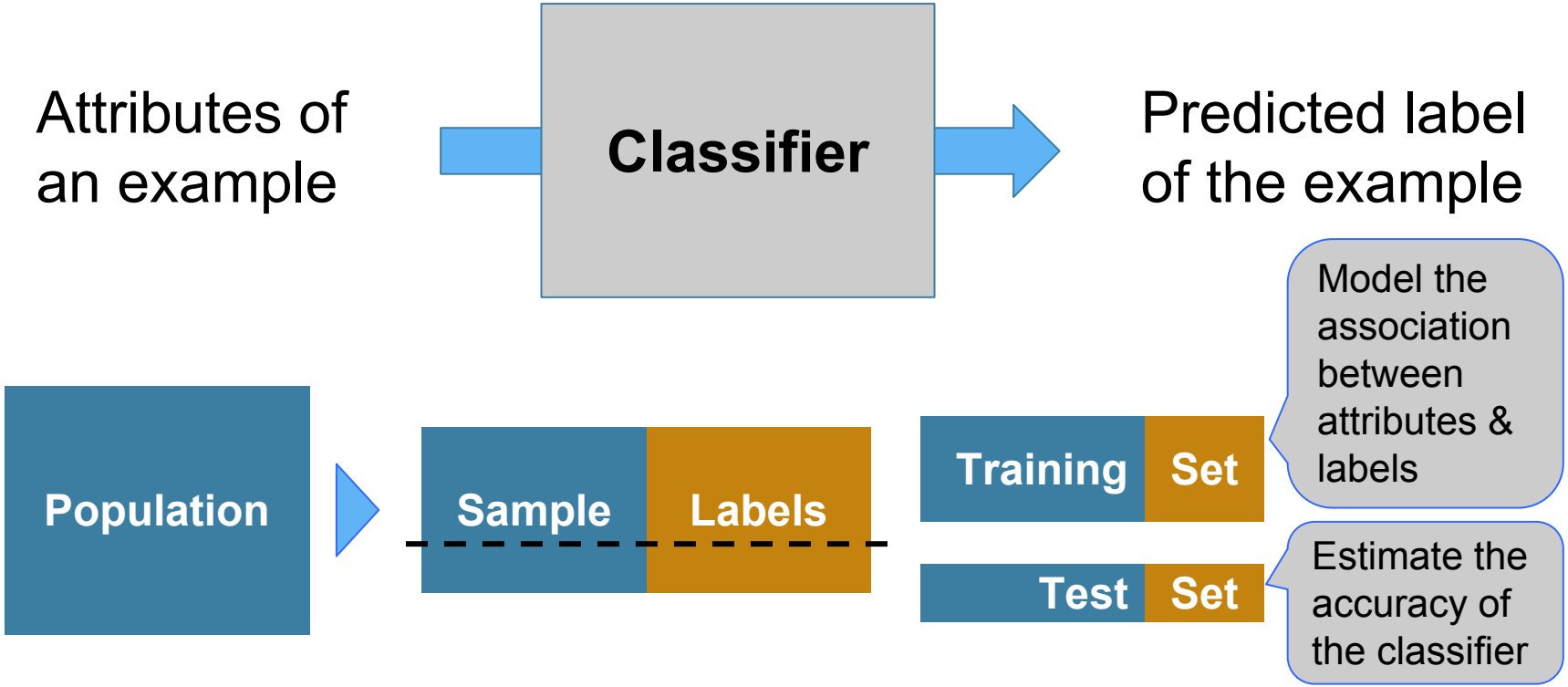
Announcements

Classifiers

Training a Classifier



Nearest Neighbors

Finding the *k* Nearest Neighbors

To find the *k* nearest neighbors of an example:

- Find the distance between the example and each example in the training set
- Augment the training data table with a column containing all the distances
- Sort the augmented table in increasing order of the distances
- Take the top *k* rows of the sorted table

The Classifier

To classify a point:

- Find its *k* nearest neighbors
- Take a majority vote of the *k* nearest neighbors to see which of the two classes appears more often
- Assign the point the class that wins the majority vote

(Demo)

Evaluation

Accuracy of a Classifier

- The accuracy of a classifier on a labeled data set is the proportion of examples that are labeled correctly
- Need to compare classifier predictions to true labels
- If the labeled data set is sampled at random from a population, then we can infer accuracy on that population

(Demo)

Decisions

Decisions Under Uncertainty

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?"

Decisions Under Uncertainty

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

Round One

- 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

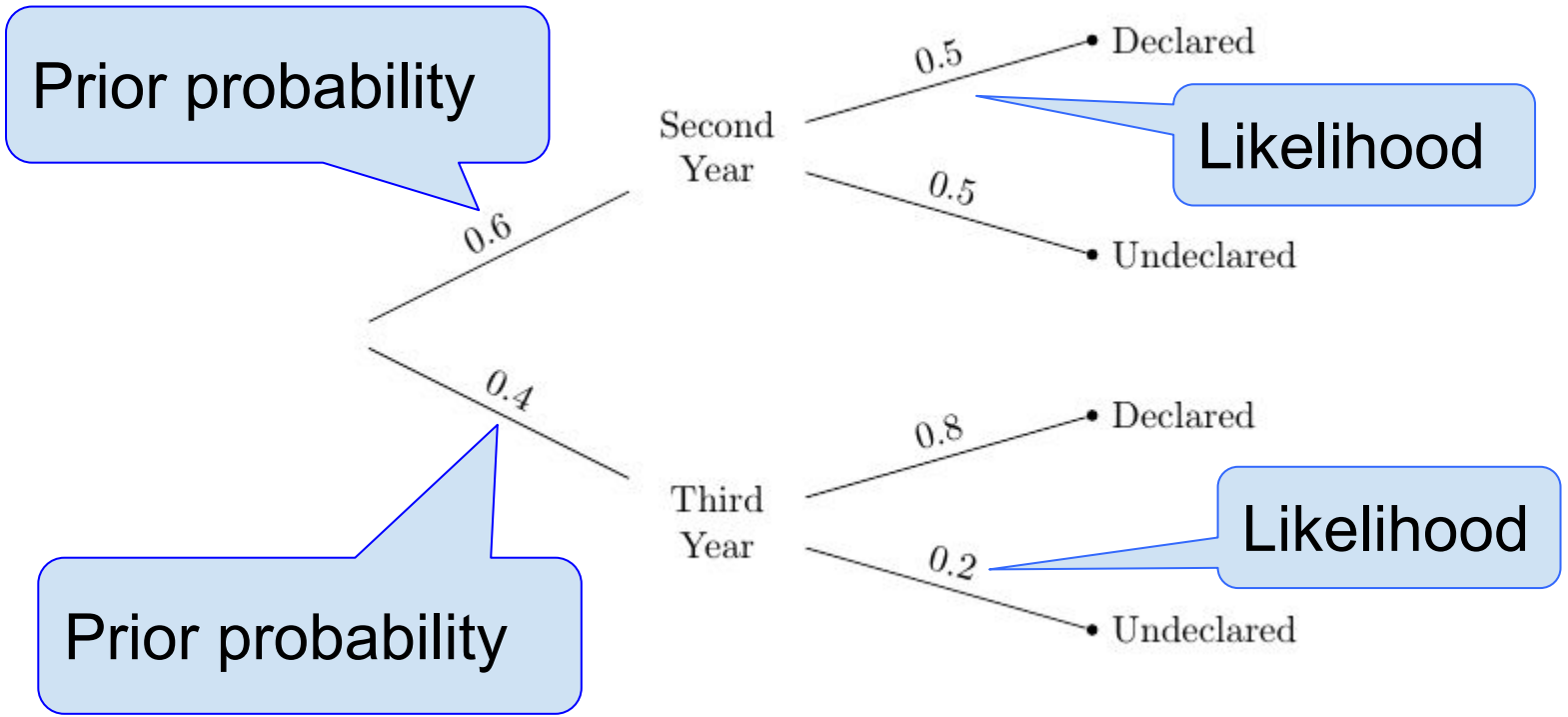
Round Two

- 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!
- Second Year or Third Year?

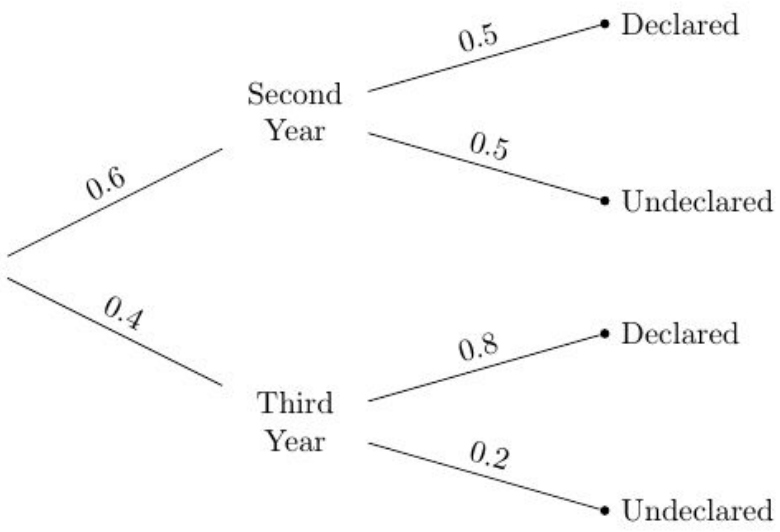
(Demo)

Bayes' Rule

Diagram and Terminology



Bayes' Rule



Pick a student at random.

Posterior probability:

P(Third Year | Declared)

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

= 0.5161…

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

Decisions Under Uncertainty

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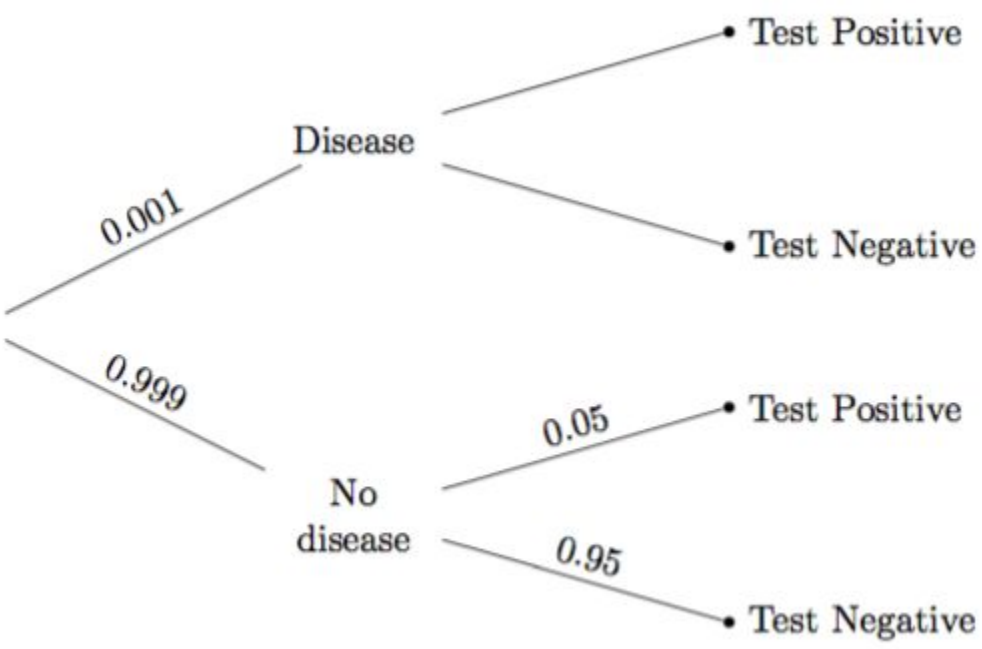
Example: Doctors & Clinical Tests

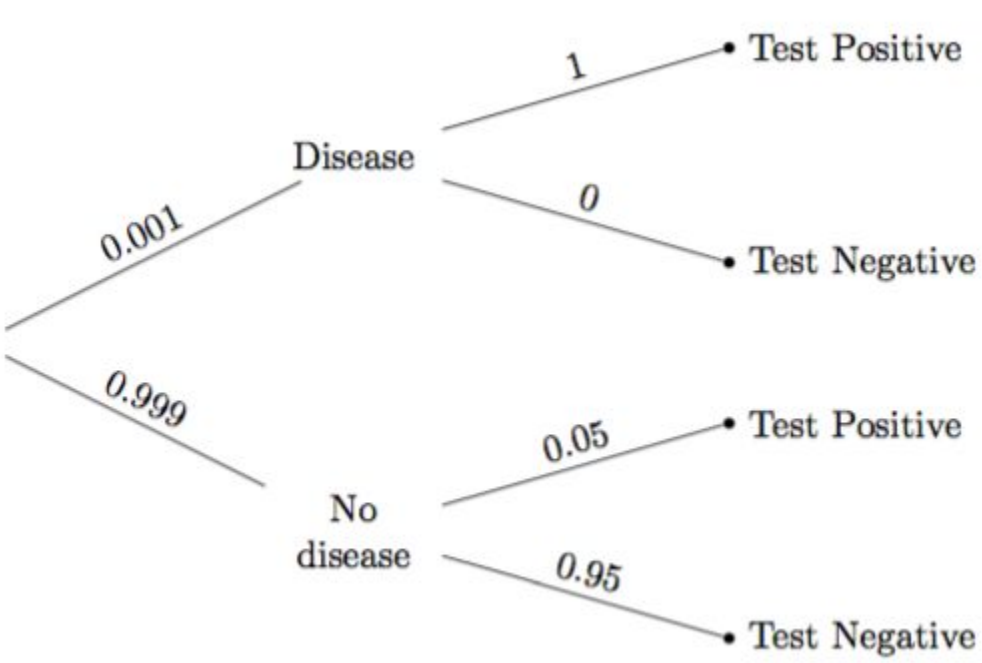


Problem did not give the *true positive* rate.

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

It was assumed to be 100%.

Data and Calculation



P(Disease given Test +)

=

$$\frac{0.001 * 1}{(0.001 * 1) + (0.999 * 0.05)}$$

= 0.0196270…

(Demo)

Decisions

Subjective Probabilities

A probability of an outcome is…

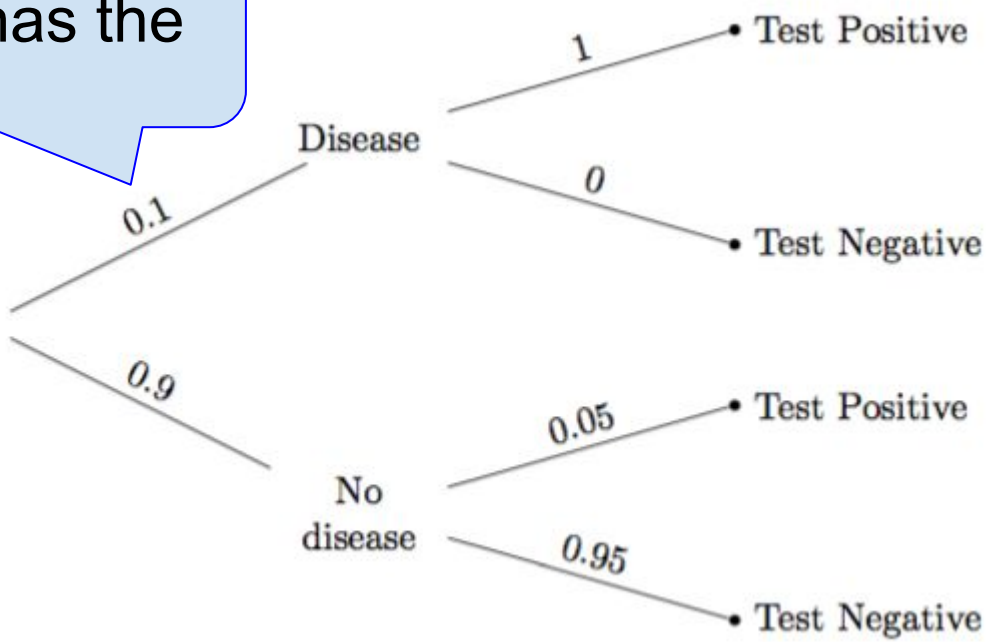
- The frequency with which it will occur in repeated trials, *or*
- The subjective degree of belief that it will (or has) occurred

Why use subjective priors?

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

A Subjective Opinion

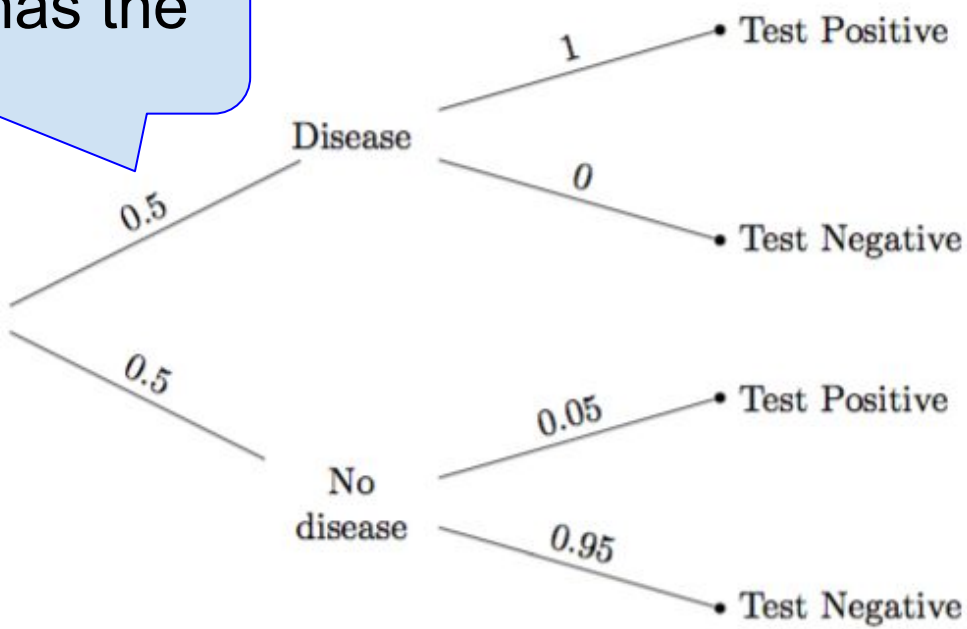
prior probability that the person has the disease



(Demo)

A Different Subjective Opinion

prior probability that the person has the disease



(Demo)