5.13: Bayes Demo

Learning Objectives

- Calculate probabilities based on a tree diagram
- Calculate probabilities based on Bayes' theorem

Instructions

This demonstration lets you examine the effects of base rate, true positive rate, and false positive rate on the probability that a person diagnosed with disease X actually has the disease. The base rate is the proportion of people who have the disease. The true positive rate is the probability that a person with the disease will test positive. The false positive rate is the probability that someone who does not have the disease will test positive. The demonstration is based on $10,000$ people being tested. A tree diagram showing the results and calculations based on Bayes' theorem are shown. They should always agree.

You can change the initial values and then press the "Calculate" button.

Illustrated Instructions

The Bayes' Theorem demonstration starts by displaying the results for the default base rate, true positive rate and the false positive rate as shown in the screenshot below. You can change any of these three numbers and click the "Calculate" button to get the results based on the changes you make.

Demonstration of Bayes' Law

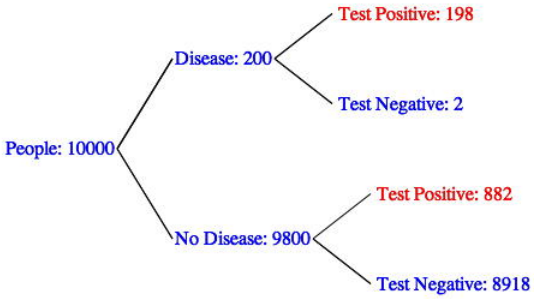
You can change the proportions and see the results (hit return or go to another field after changing the value).

The base rate, the proportion of people have Disease X is: 0.02
The true positive rate is: 0.99
The false positive rate is: 0.09

Question: If a person is tests positive, what is the probability the person has the disease?

Calculate

Expected frequencies for 10,000 people.



198 + 882 = 1080 test positive.
198/1080 = 0.1833 of those testing positive have the disease.

Therefore, the probability that one has the disease given that they test positive P(D|T) is: 0.1833.

The same answer can be computed with Bayes's Theorem:

$$P(D|T) = \frac{P(T|D)P(D)}{P(T|D)P(D) + P(T|D')P(D')}$$

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P(D|T)  = Probability of having the disease if you tested positive.
P(T|D)  = Probability of testing positive if you have the disease.
P(T|D') = Probability of testing postive if you do not have the disease.
P(D)    = Probability of the disease.
P(D')   = Probability of not having the disease.
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For this example:

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P(T|D)  = 0.99
P(T|D') = 0.09
P(D)    = 0.02
P(D')   = 0.98
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Figure 5.13.1: Bayes' Theorem Demonstration