Lab 6

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In class this week you began to look the topic of probability and certain rules of probability. In today's lab we will go through these probability properties and give you some different ways to look at probability calculations such as tree diagrams.

Properties of Probability

$$\text{Addition Rule: } P(A \cup B) = P(A) + P(B) - P(A \cap B)$$

$$\text{Complement Rule: } P(A^C) = 1 - P(A)$$

$$\text{Multiplication Rule: } P(A \cap B) = P(A)P(B|A)$$

$$\text{Law of Total Probability: } P(A) = P(A \cap B) + P(A \cap B^c)$$

$$\text{Bayes' Rule: } P(A|B) = \frac{P(A)P(B|A)}{P(A)P(B|A)+P(A^c)P(B|A^c)}$$

Independence VS Mutually Exclusive

These two terms are very easily confused, but need to be kept separate as they mean two different things. Two outcomes are said to be independent if the probability of the first outcome does not change the probability of the second outcome.

$$\text{Independent: } P(A|B) = P(A)$$

This independence works both was as the outcome of A will not effect the outcome of B also. Mutually excluse on the other hand is the idea that the two outcomes cannot occur simultaneously. That is the interesection of the two events is always equal to zero. In terms of a venn diagram the two cirlces will never overlap.

$$\text{Mutually Exclusvie: } P(A \cap B) = 0$$

Tree Diagrams to Help With Problems

When doing probability examples sometimes it may come in handy to use tree diagrams. you start with a probability of one at the top and fraction off probabilities as you go down. In some of the problems below we will work out how to do them using a tree diagram.

Practice Probability Examples

1. As a class you are going to guess a card that the TA is thinking of using conditional questions. After every question we as a class will find the probability of guessing the card correctly.

2. On the Iowa Football Team there are exactly 99 players on the team. Of them 32 are freshman, 12 are sophmores, 34 are juniors, and 21 are seniors.

A. If a football player is selected at random what is the probability that he is not a senior?

B. If you select a random football player and it is given that he is not a senior what is the probability of him being a sophmore?

C. What is the probability that I pull two juniors out randomly with replacement? without replacement?

3. Lets suppose we have two urns and in urn 1 there are three times as many blue balls as red ones and in urn 2 there are three times as many red balls as there are blue ones. Now we choose one of these bags at random with equal probability and select three balls out of it with replacement. From this pull we obtained 2 red balls and 1 blue balls. What is the probability that we were using the bag that was mainly blue? What is the probability that we used the bag that was mainly red?

Screening Test Examples

1. Scenario (from Gigerenzer 2007): The prevalence of breast cancer in women is 1%. A mammography has sensitivity of 90% (90% of women with breast cancer will test positive) and a false positive rate of 9%. Of the four choices below, what you would tell a patient with a positive mammogram?

What is the probability a person has the disease given that they tested positive (use bayes' rule).

Remember:

$$\text{Prevalence:} P(cancer) = .01$$

$$\text{Sensitivity: } P(+|cancer) = .9$$

$$\text{False Positive rate: } P(+|nocancer) = .09$$

$$\text{Specificity: } P(-|nocancer) = 1 - FPR = .91$$

A tree diagram would look like:

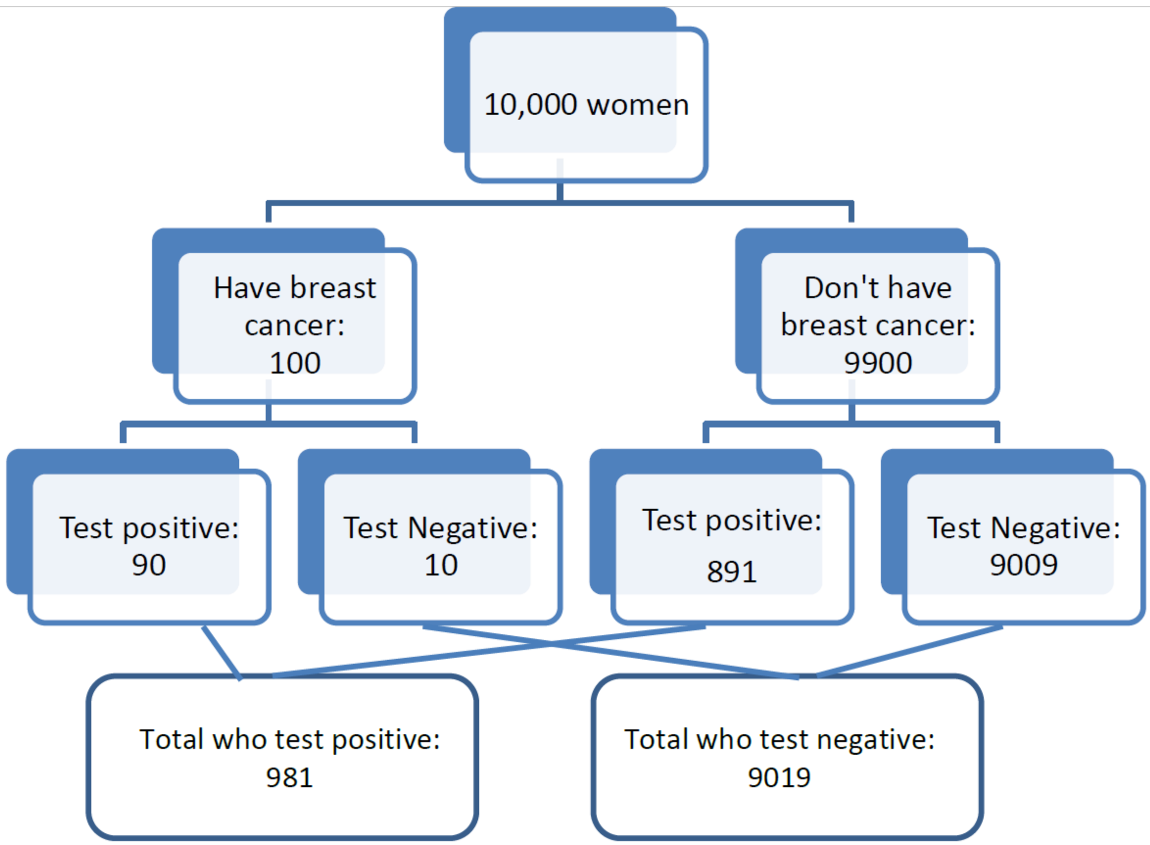
10,000 women
Have breast cancer: 100
Don't have breast cancer: 9900
Test positive: 90
Test Negative: 10
Test positive: 891
Test Negative: 9009
Total who test positive: 981
Total who test negative: 9019

Figure 1: