**Homework 2**

1. Do out the “Bayes’ Rule” calculations needed to reproduce the conclusion of the article “Propensity to Abuse-Propensity to Murder?” from *Chance* magazine (available as a word file in the homework package). Use the following events:
   1. M: Murdered woman was killed by current or former partner,
   2. E: Murdered woman was killed by someone else,

## A: Murdered woman has a known history of abuse by current or former partner,

* 1. N: Murdered woman has no history of abuse by current or former partner.

The goal is to compute P(M|A). Do this under the assumption that P(M) = 0.29, P(A|M) = 0.5, and P(A|E) = 0.05, as suggested in the article. The article states that under the above assumptions, the “posterior odds ratio” is 4:1, which is the same thing as saying that P(M|A) = 0.8, or 80%. *Ignore the “odds form of Bayes’ rule” given in the article. Hint, consider a population of 1,000,000 men whose wives were murdered.*

1. As a marketing manager for a fast food company, you are developing menu item for the Asian market called Fugu McNuggets. Based off historical data on past ventures, new products introduced in the marketplace result in a “high” sales category 10% of the time and a “low” sales category 90% of the time. You are considering a test marketing campaign to better gauge the sales of this new product. It is estimated that a test market has the following accuracies: for high sales products, consumer test reaction is positive 70% of the time and inconclusive 25% of the time; for low sales products, the consumer test reaction is negative 55% of the time and inconclusive 30% of the time. Given a positive test market outcome, what is the probability of high sales and the probability of low sales? Given a negative test market outcome, what is the probability of high sales and the probability of low sales? Given an inconclusive test market outcome, what is the probability of high sales and the probability of low sales? Hint: assume a population of 100,000 new products.

For the next two problems, assume that the probabilities of having either male or female children are equal---a 50-50 proposition. Further, assume that births are equally likely on any day of the week.

1. Suppose you meet a man and learn that he has exactly two children. Suppose further, that you learn that the older child is a boy. What is the probability that both children are boys? Hint: count out the possibilities and see which can be eliminated.
2. Suppose you meet a woman and learn that she has exactly two children. Suppose further, that you learn that at least one of the two children is a boy. What is the probability that both children are boys?
3. Sickle cell anemia is an inherited blood disorder characterized primarily by chronic anemia and periodic episodes of pain. The underlying problem involves hemoglobin, a component of red blood cells. Hemoglobin molecules in each red blood cell carry oxygen from the lungs to body organs and tissues and bring carbon dioxide back to the lungs.   
     
   In sickle cell anemia, the hemoglobin is defective. After hemoglobin molecules give up their oxygen, some may cluster together and form long, rod-like structures. These structures cause red blood cells to become stiff and assume a sickle shape.   
     
   Unlike normal red cells, which are usually smooth and donut-shaped, sickled red cells cannot squeeze through small blood vessels. Instead, they stack up and cause blockages that deprive organs and tissues of oxygen-carrying blood. This process produces periodic episodes of pain and ultimately can damage tissues and vital organs and lead to other serious medical problems. Normal red blood cells live about 120 days in the bloodstream, but sickled red cells die after about 10 to 20 days. Because they cannot be replaced fast enough, the blood is chronically short of red blood cells, a condition called anemia.Sickle cell anemia is an autosomal recessive genetic disorder caused by a defect in the HBB gene, which codes for hemoglobin. The presence of two defective genes (SS) is needed for sickle cell anemia. A person who carries one sickle hemoglobin gene (S) and one normal gene (A) does not develop the disease but is said to carry the sickle cell trait. We shall say that a person codes AA for sickle cell if he or she inherits the A gene from both parents. If the person inherits an S gene from the male parent and an A gene from the female parent, we shall say they code SA. If they inherit an A gene from the male parent and an S gene from the female parent, we shall say they code AS, while if they inherit an S gene from both parents, we shall say they code SS. In practice it is frequently impossible to tell which parent the genes were inherited from, so SA and AS may be indistinguishable, and it is common to “lump” them together as coding SA regardless of which parent donated which gene.
   1. If a husband and wife both carry the sickle cell trait, what is the probability that a child born of their union
      1. will develop sickle cell disease,
      2. will carry the sickle cell trait but not develop the disease, and
      3. will be completely free of sickle cell genes?
   2. Suppose that the proportion of males as well as females in a certain population that have the sickle cell trait is 1 out of 12. Suppose further that marriages between men and women occur randomly without respect to sickle cell trait. What proportion of children born in this population will develop sickle cell disease? To keep things simple, assume that people who develop sickle cell disease do not marry and hence produce no offspring. What other (reasonable) assumptions do you need?
4. A particular hypothetical human disease occurs with a probability of 0.1 in males and with a probability of 0.4 in females.

* 1. Assuming that the frequency of males is 0.5 and females 0.5 in a very large population, what is the probability that an individual selected at random from this population will have the disease?
  2. Under the same assumptions, what is the probability that an individual will be male and have the disease? Be female and not have the disease?