Introduction to Biostatistics (BIOS:4120)
Breheny

Assignment 5
Due: Tuesday, March 3

1. This question involves dealing cards from a well-shuffled, standard deck.
   (a) The following line of reasoning is incorrect: "Because of the addition rule, the probability that the top card is the jack of clubs and the bottom card is the jack of hearts is 2/52." Point out the flaw in this argument.
   (b) The following line of reasoning is also incorrect: "Because of the addition rule, the probability that the top card is the jack of clubs or the bottom card is the jack of hearts is 2/52." Point out the flaw in this argument.
   (c) Both (a) and (b) contained incorrect arguments, but the flaws are not of equal importance. One approach obtains an answer that is much closer to the true answer than the other. Which one is closer?

2. (a) A penny is tossed 3 times. Let A denote the event that the 3rd flip is heads. Let B denote the event that the first two flips were heads. Does $P(A) = P(A|B)$?
   (b) Three cards are dealt from a deck. Let A denote the event that the 3rd card is a heart. Let B denote the event that the first two cards were hearts. Does $P(A) = P(A|B)$?
   (c) In parts (a) and (b) above, are events A and B independent?

3. About 51% of the population of the U.S. is female. Also, about 12% of the population is over age 65.
   (a) If sex and age are independent, what percent of the population is female and over age 65?
   (b) Still assuming independence, what percent of the population is either female or over age 65?
   (c) In parts (a) and (b), sex and age were assumed to be independent. Is this a reasonable assumption? If not, how might this affect your answers?

4. According to data collected by the Department of Highway Safety and Motor Vehicles in Florida on people involved in traffic accidents in 1998, 0.37% suffered a fatal accident, 28.4% did not wear a seat belt, and 0.28% did not wear a seat belt and suffered a fatal accident.
   (a) What is the probability that an accident involved a person not wearing a seat belt, given that it was a fatal accident?
   (b) What is the probability that an accident involved a fatal injury, given that the person was not wearing a seat belt?
   (c) What is the probability that an accident involved a fatal injury, given that the person was wearing a seat belt? How does this compare to (b)?

5. (a) Suppose that a man and a woman, neither of whom are affected by the disease, have a son with cystic fibrosis. What is the probability that their second child will be unaffected by the disease?
   (b) Suppose that the man and woman from part (a) have an unaffected daughter. What is the probability that she carries a harmful copy of the cystic fibrosis gene, given that she is unaffected?

(c) Suppose that the daughter from part (b) marries a man with cystic fibrosis. If the couple has a child together, what is the probability that their child will be unaffected?

(d) (Extra credit) Suppose that the couple from part (c) have an unaffected child. What is the probability that their second child will be unaffected, given that their first child was unaffected?

6. In 1988, the CDC conducted a large study investigating the accuracy of HIV testing with the following results:

		Patient's HIV status	
		Positive	Negative
Test	+	6545	47
	−	21	3004

(a) What is the observed sensitivity of HIV testing?

(b) What is the observed specificity of HIV testing?

(c) Suppose that population A consists of rural married men, while population B consists of single urban men. You decide to randomly screen individuals from each population. Will the probability that an individual has the disease, given that they test positive, be the same for each population? If they are different, which one will be larger?

(d) Suppose that the prevalence of the disease in population A is 0.005%, and the prevalence in population B is 3%. For each population, find the probability that an individual who tests positive truly has the disease.

7. (a) There are 8 people in a club. One person makes a list of all the possible committees containing 2 members. Another person makes a list of all the possible committees containing 5 members. Who will have the bigger list?

(b) A coin is flipped 10 times. Six of the flips are heads. How many different patterns could have led to this result?