JOHNS HOPKINS BLOOMBERG SCHOOL of PUBLIC HEALTH

Statistics for laboratory scientists

Homework problems for lecture 6

1. Consider two events, A and B.

   a. Suppose that A and B are *mutually exclusive*. Calculate, in terms of Pr(A) and Pr(B),

      i. Pr(A or B)

      ii. Pr(A and B)

   b. Suppose that A and B are *independent*. Calculate, in terms of Pr (A) and Pr(B),

      i. Pr(A and B)

      ii. Pr(A or B)

   c. Suppose that A and B are *both* mutually exclusive and independent. What can we say about Pr(A or B), Pr(A and B), Pr (A) and Pr(B).

2. Consider a rare recessive trait. Let p be the frequency of the disease allele, d. (Let + denote the normal allele. Assume Hardy-Weinberg equilibrium and random mating, so that the frequencies of the three genotypes, ++, +d, and dd are $(1-p)^2$, $2p(1-p)$, and p^2, respectively.

   Consider picking a woman at random from the population. Let U = {She is unaffected}, C = {She is a carrier}, A = {her brother is affected and her parents are both unaffected}, B = {her first child is affected}, D = {at least one of her five children is affected}. Note: let's assume that "carrier" means having either genotype +d or dd.

   Assume that $p = 1\%$, and calculate the following.

   a. Pr(C | U)

   b. Pr(C | U and A)

   c. Pr(B | U and A)

d. Pr(D | U and A)

3. Consider two urns. Urn A contains 5 green balls and 5 blue balls. Urn B contains 2 green balls and 8 blue balls. I roll a six-sided, fair die. If I get a 3 or a 4, I draw two balls *without replacement* from urn A; otherwise, I draw two balls without replacement from urn B.

   Let A = {draws are made from urn A}, B = {draws are made from urn B}, G_1 = {first ball is green} and G_2 = {second ball is green}.

   Calculate the following.

   a. Pr(G_1)

   b. Pr(G_2 | A and G_1)

   c. Pr(G_2 | A)

   d. Pr(G_2 | B and G_1)

   e. Pr(G_2 | G_1)

   f. Pr(exactly one green ball)

   g. Pr(A | at least one green ball)

4. Suppose that a mare is corralled with two stallions: a champion and a dud. The mare gets pregnant and produces a colt.

   a. What is Pr(the champion is the colt's father)?

   b. Suppose that the champion is known to carry a rare marker on its Y chromosome, present in only 2% of male horses. Suppose that the colt is found to also carry this Y marker. What is Pr(the champion is the colt's father | this information)?

   c. Suppose that, in addition to the conditions in (b), the mare had been "exposed" to another 998 stallions. What is Pr(the champion is the colt's father | this information)?

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