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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. $\Pr(A \text{ or } B)$
 - ii. $\Pr(A \text{ and } B)$
 - b. Suppose that A and B are *independent*. Calculate, in terms of $\Pr(A)$ and $\Pr(B)$,
 - i. $\Pr(A \text{ and } B)$
 - ii. $\Pr(A \text{ or } B)$
 - c. Suppose that A and B are *both* mutually exclusive and independent. What can we say about $\Pr(A \text{ or } B)$, $\Pr(A \text{ and } B)$, $\Pr(A)$ 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 $U = \{\text{She is unaffected}\}$, $C = \{\text{She is a carrier}\}$, $A = \{\text{her brother is affected and her parents are both unaffected}\}$, $B = \{\text{her first child is affected}\}$, $D = \{\text{at least one of her five children is affected}\}$. Note: let's assume that "carrier" means having either genotype $+d$ or dd .

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

- a. $\Pr(C \mid U)$
- b. $\Pr(C \mid U \text{ and } A)$
- c. $\Pr(B \mid U \text{ and } A)$

- d. $\Pr(D \mid U \text{ and } A)$
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 $A = \{\text{draws are made from urn A}\}$, $B = \{\text{draws are made from urn B}\}$, $G_1 = \{\text{first ball is green}\}$ and $G_2 = \{\text{second ball is green}\}$.

Calculate the following.

- a. $\Pr(G_1)$
- b. $\Pr(G_2 \mid A \text{ and } G_1)$
- c. $\Pr(G_2 \mid A)$
- d. $\Pr(G_2 \mid B \text{ and } G_1)$
- e. $\Pr(G_2 \mid G_1)$
- f. $\Pr(\text{exactly one green ball})$
- g. $\Pr(A \mid \text{at least one green ball})$
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 $\Pr(\text{the champion is the colt's father})$?
- 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 $\Pr(\text{the champion is the colt's father} \mid \text{this information})$?
- c. Suppose that, in addition to the conditions in (b), the mare had been "exposed" to another 998 stallions. What is $\Pr(\text{the champion is the colt's father} \mid \text{this information})$?

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