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Statistics for laboratory scientists

Homework problems for lecture 8

Some of these problems are taken from Sokal & Rohlf, *Biometry*.

You may want to use the computer to do the calculations.

1. In humans, the sex ratio of newborn infants is about 100 females : 105 males. If we were to take 10,000 random samples of 6 newborn infants each from the total population of such infants for one year, what would be the expected frequency (number) of groups of 6 males, 5 males, 4 males, and so on?
2. The Army Medical Corps is concerned about the intestinal disease X. From previous experience they know that soldiers suffering from the disease invariably harbor pathogenic organisms in their feces and that for all practical purposes every disease stool specimen contains these organisms. The organisms are never abundant, however, and thus only 20% of all slides prepared by the standard procedure contain some of them. (We assume that if an organism is present on a slide, it will be seen.) How many slides per stool specimen should the laboratory technicians prepare and examine to ensure that if a specimen is positive, it will be erroneously diagnosed negative in less than 1% of the cases (on the average)? On the basis of your answer, would you recommend that the Corps attempt to improve their diagnostic methods?
3. A cross is made in a genetic experiment in *Drosophila* in which it is expected that one-fourth of the progeny will have white eyes and one-half will have the trait called singed bristles. Assume that the two gene loci segregate independently.
 - a. What proportion of the progeny should exhibit both traits simultaneously?
 - b. If 4 flies are sampled at random, what is the probability that they will all have white eyes?
 - c. What is the probability that none of the 4 flies will have either white eyes or singed bristles?

- d. If 2 flies are sampled, what is the probability that at least one of the flies will have white eyes or singed bristles or both traits.
4. Which is more likely, getting exactly 50 heads in 100 tosses of a fair coin, or getting exactly 3 heads in 10 tosses of a fair coin? (**Use the computer.**)
5. Let X denote the number of double-sixes in 36 rolls of a pair of fair, six-sided dice.
 - a. What is the distribution of X ?
 - b. What is $\Pr(X = 2)$?
 - c. What is the expected value of X ?
 - d. What is the SD of X ?
 - e. What is $\Pr(X > 2)$?
6. Suppose that $1/100,000$ bacterial cells contain a mutation providing resistance to substance A. Suppose I create a bunch of plates with 200,000 cells per plate. Let X = number of cells on a plate that are resistant to substance A.

Then X should follow a Poisson($\lambda=2$) distribution.

- a. What is $E(X)$ (the mean number of cells in a plate that are resistant to A)?
 - b. What is $SD(X)$?
 - c. Calculate $\Pr(X = 0)$.
 - d. Calculate $\Pr(X = 5)$.
 - e. Calculate $\Pr(X > 2)$.
7. Suppose Y is a random variable with $E(Y) = 30$ and $SD(Y) = 5$.
 - a. Let $Z = (Y - 30)/5$. Calculate $E(Z)$ and $SD(Z)$.
 - b. Let $X = -Y$. Calculate $E(X)$ and $SD(X)$.

- c. Let $R = 5 + Y/3$. Calculate $E(R)$ and $SD(R)$.
8. Suppose U has a uniform(5, 10) distribution. Calculate the following.
- $E(U)$
 - $\Pr(U = 6)$
 - $\Pr(U > 6)$
 - $\Pr(7 < U < 9)$

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