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Eco 602 – Week 5 Reading Questions

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Suppose it is a beautiful fall day and you are sitting underneath three oak trees: Bur oak (Quercus. macrocarpa), Northern Red Oak (Q. rubra), and white oak (Q. alba). They've just started to drop their acorns.

Without looking, you reach down and pick up <u>two acorns at the same time</u>.

Q1. What is the size of the sample space?

The sample space is defined as the set of all possible events that could occur in a scenario. (AKA the set of all possible outcomes of a stochastic process). This sample space is made up of **6 different possible outcomes** when drawing two acorns at the same time given the above scenario. This is assuming that the order of outcomes does not matter, which it shouldn't as two acorns are being picked up simultaneously. The six different possible outcomes include 1. Bur and Bur oak 2. Red and Red oak 3. White and White oak 4. Bur and Red oak 5. Red and White oak 6. Bur and White oak.

Q2. Given the scenario description, how many ways are to there to collect two acorns of the *same species*?

In this scenario, there are **3 different ways** to collect two acorns of the same species (at the same time). These three outcomes include collecting 1. Bur and Bur oak 2. Red and Red oak and 3. White and White oak. This is because there are three different species. If there were more species of acorn present, then there would be additional ways to collect two acorns of the same species.

Q3. Given the scenario description, how many ways can you collect two acorns of *different species*?

Given the six possible outcomes of picking two acorns at the same time due to three species being present, there are **3 possible ways** to select two acorns of different species at the same time. These ways include collecting 1. Bur and Red oak 2. Red and White oak and 3. Bur and White oak. Order here again doesn't matter since we are selecting two acorns simultaneously.

Suppose it is a beautiful fall day and you are sitting underneath three oak trees: Bur oak (Quercus. macrocarpa), Northern Red Oak (Q. rubra), and white oak (Q. alba). They've dropped most of their acorns. It was a productive year so there seem to be thousands of acorns from each species!

- There are approximately the same number of acorns from each species on the ground, and they seem to be evenly spread around.

You collect an acorn, place it in your left pocket, walk a short distance and collect a second acorn placing it in your right pocket.

Q4. What is the probability that the acorn in your *left pocket* is *Q. alba (White Oak)*?

Since there are three possible outcomes of oak species (Bur, Red, and White) the probability of the first acorn picked up and put in your left pocket being of Q.alba/White Oak is 1/3 or 0.33 (33%).

Q5.

a) What is the probability that the acorn in your *right pocket* is *Q. macrocarpa (Bur oak)*?

Here we are referring to the second event of picking up a second acorn and putting it in our right pocket. Since the scenario states there are thousands of acorns on the ground and all of which are evenly distributed amongst the three different oak species, the probability of the second acorn you pick up and put in your right pocket being of Q.macrocarpa/Bur oak is approximately 1/3 or 0.33 (33%) as well. The first removal of the one acorn you put in your pocket out of the thousands on the ground does not really affect the probability of the second acorn you pick up to be of Bur oak species (just due to the sheer number of acorns available).

b) If you already know that the acorn in your left pocket is *Q. alba (White oak)*, what is the probability that the acorn in your *right pocket* is also *Q. alba (White oak)*?

We can still assume that there are thousands of acorns of an approximate even distribution of the three species of oak still on the ground. Given the first acorn in left pocket is white oak (q.alba), it might be slightly less likely that the second acorn picked up will also be white oak since you have already removed one. However, given the sheer number of acorns on the ground, the probability is still approximately 1/3 or 0.33 for the acorn in your right pocket to be Q.alba.

Q6. What is the probability that both acorns are *Q rubra (Red oak)*?

This refers to the idea of joint probability since we are talking about happening to pick up two Northern Red oak acorns right after one another. The probability of BOTH acorns you picked up being of Northern red oak is as follows: 1/3 (0.33) for red oak on the first event * approximately 1/3 (0.33) again for picking red oak on the second event too. So 1/3 * 1/3 = 1/9 (or 0.11) This means there is approximately an 11% chance or probability of 1/9 that both of the acorns you picked up are of Q.rubra/Red Oak.

Q7. What is the probability that you collected exactly one each of *Q. alba* (White oak) and *Q. rubra (Red oak)*?

2/3 * 1/3 = 2/9 (or 0.22) The first acorn you pick could be either White oak OR Red Oak. There is a probability of 2/3 that it will be either red or white oak the first time. Assuming the first acorn chosen was white oak, the second acorn must now be a red oak (or vice versa). The probability of it being ONLY red oak the second time, so that in the end you have one of each, is 1/3. Multiply the probability of each of the events (2/3 * 1/3) to get 2/9 (or 0.22).

Q8. What is the probability that the acorn in your *left* pocket is *Q. alba (white oak)* and you have an acorn of *Q. rubra* (red oak) in your *right* pocket?

1/3 * 1/3 = 1/9 (0.11). The first acorn you put in your left pocket must be white oak. The probability of this is 1/3. The second acorn you put in your right pocket must be red oak. The probability of this is also 1/3. Multiply the probability of each event (1/3 * 1/3) to get 1/9.

Q9. Consider a Poisson distribution with λ=6. Which of the following is the size of the sample space of this distribution? (10,11,0,2,6,∞)

The size of the sample space of a poisson distribution is always always infinity. The lambda value of 6 only refers to the mean and standard deviation values of the data. Lambda (λ) is the total number of events (k) divided by the number of units (n) in the data (λ = k/n). For the poisson distribution, we actually will always have a countably infinite sample space.

Q10. Consider a Binomial distribution with n=10 and p=0.6. Which of the following is the size of the sample space of this distribution? (10,11,0,2,6,∞)

The sample space for this binomial distribution (n=10) is **11.** This is because binomial distributions always have a sample space size of n+1. This incorporates all of the possible outcomes of a particular experiment. You must account for a potential "no outcome" or "zero" value. That is why we add 1 to the value of n, the number of trials.

Q11. Which common characteristics of the Binomial and Poisson distributions make them good models for counts?

Both the Binomial and Poisson distributions measure the number of certain random events (or "successes") within a certain frame. This common characteristic makes both of these good models for counts. The Binomial, however, is based on discrete events, while the Poisson is based on continuous events. In other words, with a binomial distribution gives you the number of successes in a sample given a certain number, n, of "attempts" or "trials," each of which has the same probability of success. This is therefore a good model of counts given you have a set number of finite trials. With a Poisson distribution, you essentially have infinite attempts, with a very low probability of success. When the sample size (number of trials) gets large/infinite and the probability of success per trial decreases, the binomial distribution approaches the Poisson distribution. The Poisson distribution also reports the total number of events (or successes) in a given unit (space or time) of sampling effort if each event is independent. This also makes the Poisson distribution a good model for counts and has many ecological applications.

Q12. Describe a scenario in which a Binomial distribution may be a better count model than a Poisson distribution.

The Poisson distribution is used when you expect the number of events to be effectively unlimited. If the number of events, or your trial size, **is limited**, you may want to use the binomial distribution instead. For example, if you have a sample of a fixed number of plots to determine marsh grass species presence/absence in a specific marsh site, you will have a binomial distribution by design. Since the trial size is not an infinite number of plots, you will not want to use the Poisson distribution.