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Statistics Package Exercise: Calculating Probabilities for Binomial Random Variables

Learning Objective: Fit the binomial model when appropriate, and use it to perform simple calculations.

The purpose of this activity is to give guided practice at solving problems involving binomial random variables and to teach how the same probabilities can be found using a statistical software package.

A multiple choice test has 10 questions, each with 5 possible answers, only one of which is correct. A student who did not study is absolutely clueless, and therefore uses an independent random guess to answer each of the 10 questions.

Let X be the number of questions the student gets right.

Learn By Doing (1/1 point)

X has a binomial distribution. What are the values of the parameters n and p?

Your Answer:

n=10, p=0.2

Our Answer:

n = 10, p = .2

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Learn By Doing (1/1 point)

Give the formula expression for the probability distribution of X. Guidance: apply the general formula for the probability distribution of a binomial random variable to the case in which n = 10 and p = .2.

Your Answer:

10!/n!/(10-n)! * 0.2^(n) * 0.8^(1-n)

Our Answer:

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Learn By Doing (1/1 point)

What is the probability that the student gets exactly 4 questions right, P(X = 4)?

Your Answer:

0.09

Our Answer:
Plugging in X = 4 in the probability distribution from the previous question we get:

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Applying the binomial formula is a good way for "first-timers" to understand the mechanics of binomial probabilities. Once you have mastered the technique, however, it may still be tedious to perform the necessary calculations.

For example, if I would ask you: What is the probability that the student will get at most 4 questions right? Or in other words, if we wanted to find $P(X \leq 4)$, we would need to add $P(X = 0) + P(X = 1) + P(X = 2) + P(X = 3) + P(X = 4)$.

For each of these 5 probabilities, we would need to use the formula, and then add the probabilities. This is very tedious. When calculations involve large n values, calculations become tedious as well. Luckily, any statistical software will do binomial calculations for us.

- R
- StatCrunch
- TI Calculator
- Minitab
- Excel

R Instructions
To find probabilities of the type P(X = k) or P(X ≤ k) in R, we'll use the following function:

```
dbinom(k, n, p) = P(X = k)
```

```
pbinom(k, n, p) = P(X ≤ k)
```

where:

- k is the number of successes in trials
- n is the number of independent trials
- p is the probability of success in each trial

As practice, follow these steps to find P(X = 4) for our example (where n = 10 and p = .2), and verify that you get the same answer as you did in the last question, where you did it "by hand."

Now use R to find the probability that the student gets no more than 4 questions right: P(X ≤ 4).

Learn By Doing (1/1 point)

What is the probability that the student will get no more than 4 questions right, P(X ≤ 4)?

Your Answer:

0.9672065

Our Answer:
RStatCrunchTI CalculatorMinitabExcel R Here is the R output: StatCrunch Here is the StatCrunch output: TI Here is the TI Calculator output: Minitab Here is what the Minitab output gives us: Excel To

find this probability, we use =binom.dist(x, n, p, cumulative). In this case, x = 4, n = 10, p = 0.2, and cumulative = TRUE, so we enter =binom.dist(4, 10, 0.2, TRUE) and Excel returns a probability of 0.967.

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- R StatCrunch TI Calculator Minitab Excel

R Instructions
Use R to find the probability that the student gets more than 2 questions right, P(X > 2).

Guidance: R will calculate for us only probabilities of the type P(X = k) or P(X ≤ k). To find P(X > 2) think about the complement of this event.

Learn By Doing (1/1 point)

What is the probability that the student gets more than 2 questions right: P(X > 2)?

Your Answer:

0.3222005

Our Answer:
RStatCrunchTI CalculatorMinitabExcel R To find P(X > 2) we notice that the complement of the event "X > 2" is X ≤ 2, and therefore, by the Complement Rule, P(X > 2) = 1 - P(X ≤ 2). R gives us: Thus, there is approximately a 32% chance that using the "guessing strategy" the student will get more than 2 questions right on the quiz. StatCrunch To find P(X > 2) we used n = 10, p = 0.2, symbol is >, and k = 2. Here is the StatCrunch output: Thus, there is approximately a 32% chance that using the "guessing strategy" the student will get more than 2 questions right on the quiz. TI To find P(X > 2), we notice that the complement of the event "X > 2" is X ≤ 2, and therefore, by the Complement Rule, P(X > 2) = 1 - P(X ≤ 2). R gives us: Thus, there is approximately a 32% chance that using the "guessing strategy" the student will get more than 2 questions right on the quiz. Minitab To find P(X > 2), we notice that the complement of the event "X > 2" is X ≤ 2, and therefore, by the Complement Rule, P(X > 2) = 1 - P(X ≤ 2). Minitab gives us: and therefore P(X > 2) = 1 - 0.6778 = 0.3222. Thus, there is approximately a 32% chance that using the "guessing strategy" the student will get more than 2 questions right on the quiz. Excel To find P(X > 2), we notice that the complement of the event "X > 2" is X ≤ 2, and therefore, by the Complement Rule, P(X > 2) = 1 - P(X ≤ 2). In Excel, we'll use =binom.dist(2, 10, 0.2, TRUE), and Excel reports a probability of 0.678. Therefore, P(X > 2) = 1 - 0.678 = 0.322. Thus, there is approximately a 32% chance that using the "guessing strategy" the student will get more than 2 questions right on the quiz.

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