Lab Normal

Abhi Thanvi, Paul Holaway

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Welcome

Just like learning a new spoken language, you will not learn the language without practice. Labs are an important part of this course. Collaboration on labs is **extremely encouraged**. If you find yourself stuck for more than a few minutes, ask a neighbor or course staff for help. When you are giving help to your neighbor, explain the **idea and approach** to the problem without sharing the answer itself so they can figure it out on their own. This will be better for them and for you. For them because it will stick more and they will have a better understanding of the concept. For you because if you can explain it to other students, that means you understand it better too.

The Idea of this Lab

The idea behind this lab is to understand different distributions and how to calculate respective probabilities for each distribution. These distributions are a huge part of the statistical world, especially considering how many of the probability questions boil down to identifying distribution. In this class, we focus on small, yet important slice of the distributions. This lab consists of Binomial, Bernoulli, and Normal distribution and it is key to understand the importance of identifying the differences among these distributions and how to calculate their respective probabilities. Distributions might seem intimidating at first, but with some practice and an open mind, it is very doable. We personally think you all are more than capable at succeeding with the distributions we present! :)

"The key to understanding statistics is to understand the distribution. . . of the topics in the textbook" - Silly Abhi

Problem 1: TSA Pre-Check!

It is the year 2030, and the airport officers have become cautious of some Data Scientist who are a menace to the society because of how knowledgeable they are. The officers said it cannot be Abhi, because "he ain't a menace". Abhi feels offended by this and wants prove he is good with distributions! He feels rusty, but he has his apple watch where he can see some answers. Help him out in identifying some distributions. Help Abhi prove that he can also be a "menace to the society" ;)

Abhi: Hey guys and girls! Thanks for the help, I am running out of time so let's dive in!

Question 1: Bob has 39 coins in his pocket. He makes a bet with his sister, Jill, of how he can randomly pull a coin out of his pocket, toss it in the air, and get heads. Jill is naive and thinks this is impossible! She thinks the chances of Bob pulling it off is very low. Consider the success to be Bob pulling it off successfully. What kind of a distribution is this and why?

Answer: (Student Response Here) This is a Bernoulli distribution since the coin could land on heads (success) or tails (failure) and only one toss is done by Bob, in other words only one trial. Therefore, it is Bernoulli Distribution.

Question 2: What is the probability of Bob pulling it off successfully? Jill is young so she needs to see some numbers plugged into equation. So, show your work!

Answer: (Student Response Here)

$$P(Heads) = 0.5^1(1-0.5)^{1-1} = 0.5$$

Question 3: Is Jill correct about the chances of Bob successfully pulling it off is very low?

Answer 3: (Student Response Here) No, she is not correct! The probability of 0.5 which means there is a 50% chance of success. So yeah, it's not too low!

Question 4: Bob is smart, he wants to increase his chances of winning the bet. He changes his bet and states that he will now be pulling a coin and tossing them 10 times. He says that he will get 3 heads and 7 tails, in any order of the 10 tosses. How has bob changed the distribution?

Answer 4: (Student Response Here) Bob has changed the distribution into a Binomial Distribution.

Question 5: What is the probability of Bob winning the bet. In other words, what is the probability of getting 3 Heads in some order within the 10 tosses. Consider heads to be success and tails to be failure.

*Hint: To do 5! (factorial) in R, you can code `factorial(5)`. **Answer 5:**

```
#Using R is optional, but it is helpful
comb_part = factorial(10) / (factorial(3)*factorial(7))
comb_part
```

```
## [1] 120
```

```
bern_part = (0.5)^(3)*(0.5)^(7)
bern_part
```

```
## [1] 0.0009765625
```

```
prob_answer = comb_part*bern_part
prob_answer
```

```
## [1] 0.1171875
```

Question 6: Oh boy! Did Bob just put an axe on his feet! In other words, did Bob really increase his chances of winning the bet when he changed the conditions of his bet?

Answer 6: (Student Response Here) Nope, his probability of winning was reduced by approximately 40%. From 0.5 -> 0.117. I am sorry Bob!

Problem 2: The Normal Life

Question 1: Rex and Stacy have taken the SAT and wanted to compare their scores. The issue is that Rex took his SAT when the SAT was out of 2400. Stacy's SAT was the newer one and out of 1600. Think about how we can compare their scores. Discuss this with your group and report how you can compare their scores.

Answer: (Student Response Here) We can standardize their scores using the z-values and compare their z-scores.

Question 2: Rex received a 2100 on the test. College Board stated that the mean of scores during Rex's year was 1950 and standard deviation of 120. Calculate the z-score for Rex.

Answer:

```
##Using R is optional but helpful
z = (2100 - 1950) / 120
z
```

```
## [1] 1.25
```

Question 3: Stacy received a 1500 on the test. College Board stated that the mean of scores during Stacy's year was 1350 and standard deviation of 100. Calculate the z-score for Stacy.

Answer:

```
##Using R is optional but helpful
z = (1500 - 1350) / 100
z
```

```
## [1] 1.5
```

Question 4: What is the probability that Rex and Stacy would receive a score that is at least what they got? We already have the Z-scores so this part should be quick.

Answer: (Student Response Here)
$P(Rex > 2100) = P(Z > 1.25) = 1 - P(Z < 1.25) \approx 0.1056$
$P(Stacy > 1500) = P(Z > 1.5) = 1 - P(Z < 1.5) \approx 0.0668$

Question 5: Who did better on the SAT? Why?

Answer: (Student Response Here) Stacy did better on the SAT than Rex because the probability of her getting at least her score of 1500 is much lower than Rex.

Feedback

Hey this is Abhi! As the halfway mark is completed, I would like to know (again) whether you are liking the course or you hate your summer because of us (hopefully not!).

Please give some feedback of what you like about the course and what you would like to change about this course! Do you like something in particular or do not like something? We are open to all ideas and want to have the best time together! Have a great weekend and Paul and I will see you on the other side :)

Feedback: (Student Feedback)

Submission

Once you have finished your lab...

1. Go to the top left and click `File` and `Save`.
2. Click on the `Knit` button to convert this file to a PDF.
3. Submit **BOTH** the `.Rmd` file and `.pdf` file to Blackboard by 11:59 PM tonight.