Exam 2 Review

Note

Suggested answers can be found here, but resist the urge to peek before you go through it yourself.

Part 1 - Employment

A large university knows that about 70% of the full-time students are employed at least 5 hours per week. The members of the Statistics Department wonder if the same proportion of their students work at least 5 hours per week. They randomly sample 25 majors and find that 15 of the students (60%) work 5 or more hours each week.

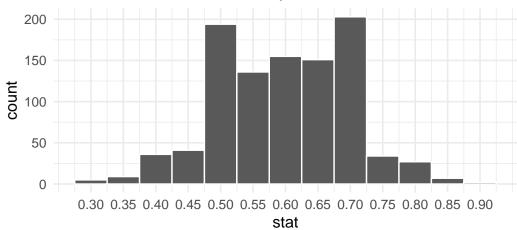
Question 1

Describe how you can set up a simulation to estimate the proportion of statistics majors who work 5 or more hours each week based on this sample.

Question 2

A bootstrap distribution with 1000 simulations is shown below. Approximate the bounds of the 95% confidence interval based on this distribution.





Suppose the lower bound of the confidence interval from the previous question is L and the upper bound is U. Which of the following is correct?

- a. Between L to U of statistics majors work at least 5 hours per week.
- b. 95% of the time the true proportion of statistics majors who work at least 5 hours per week is between L and U.
- c. Between L and U of random samples of 25 statistics majors are expected to yield confidence intervals that contain the true proportion of statistics majors who work at least 5 hours per week.
- d. 95% of random samples of 25 statistics majors will yield confidence intervals between L and U.
- e. None of the above.

Part 2 - Blizzard

In 2020, employees of Blizzard Entertainment circulated a spreadsheet to anonymously share salaries and recent pay increases amidst rising tension in the video game industry over wage disparities and executive compensation. (Source: Blizzard Workers Share Salaries in Revolt Over Pay)

The name of the data frame used for this analysis is blizzard salary and the variables are:

- percent_incr: Raise given in July 2020, as percent increase with values ranging from 1 (1% increase to 21.5 (21.5% increase)
- salary_type: Type of salary, with levels Hourly and Salaried
- annual_salary: Annual salary, in USD, with values ranging from \$50,939 to \$216,856.
- performance_rating: Most recent review performance rating, with levels Poor, Successful, High, and Top. The Poor level is the lowest rating and the Top level is the highest rating.

The top ten rows of blizzard_salary are shown below:

# .	A tibble: 409	x 4		
	percent_incr	salary_type	annual_salary	performance_rating
	<dbl></dbl>	<chr></chr>	<dbl></dbl>	<chr></chr>
1	1	Salaried	1	High
2	1	Salaried	1	Successful
3	1	Salaried	1	High
4	1	Hourly	33987.	Successful
5	NA	Hourly	34798.	High
6	NA	Hourly	35360	<na></na>
7	NA	Hourly	37440	<na></na>
8	0	Hourly	37814.	<na></na>
9	4	Hourly	41101.	Top
10	1.2	Hourly	42328	<na></na>
# .	i 399 more rou	JS.		

i 399 more rows

Question 4

Next, you fit a model for predicting raises (percent_incr) from salaries (annual_salary). We'll call this model raise_1_fit. A tidy output of the model is shown below.

A tibble: 2 x 5

Which of the following is the best interpretation of the slope coefficient?

- a. For every additional \$1,000 of annual salary, the model predicts the raise to be higher, on average, by 1.55%.
- b. For every additional \$1,000 of annual salary, the raise goes up by 0.0155%.
- c. For every additional \$1,000 of annual salary, the model predicts the raise to be higher, on average, by 0.0155%.
- d. For every additional \$1,000 of annual salary, the model predicts the raise to be higher, on average, by 1.87%.

Question 5

You then fit a model for predicting raises (percent_incr) from salaries (annual_salary) and performance ratings (performance_rating). We'll call this model raise_2_fit. Which of the following is definitely true based on the information you have so far?

- a. Intercept of raise_2_fit is higher than intercept of raise_1_fit.
- b. Slope of raise 2 fit is higher than RMSE of raise 1 fit.
- c. Adjusted R^2 of raise_2_fit is higher than adjusted R^2 of raise_1_fit.
- d. R^2 of raise 2 fit is higher R^2 of raise 1 fit.

Question 6

The tidy model output for the raise_2_fit model you fit is shown below.

A tibble: 5 x 5

	term	estimate	std.error	${\tt statistic}$	p.value
	<chr></chr>	<dbl></dbl>	<dbl></dbl>	<dbl></dbl>	<dbl></dbl>
1	(Intercept)	3.55	0.508	6.99	1.99e-11
2	annual_salary	0.00000989	0.00000436	2.27	2.42e- 2
3	performance_ratingPoor	-4.06	1.42	-2.86	4.58e- 3
4	${\tt performance_ratingSuccessful}$	-2.40	0.397	-6.05	4.68e- 9
5	performance_ratingTop	2.99	0.715	4.18	3.92e- 5

When your teammate sees this model output, they remark "The coefficient for performance_ratingSuccessful is negative, that's weird. I guess it means that people who get successful performance ratings get lower raises." How would you respond to your teammate?

Question 7

Ultimately, your teammate decides they don't like the negative slope coefficients in the model output you created (not that there's anything wrong with negative slope coefficients!), does something else, and comes up with the following model output.

#	A tibble: 5 x 5				
	term	estimate	std.error	${\tt statistic}$	p.value
	<chr></chr>	<dbl></dbl>	<dbl></dbl>	<dbl></dbl>	<dbl></dbl>
1	(Intercept)	-0.511	1.47	-0.347	0.729
2	annual_salary	0.00000989	0.00000436	2.27	0.0242
3	<pre>performance_ratingSuccessful</pre>	1.66	1.42	1.17	0.242
4	performance_ratingHigh	4.06	1.42	2.86	0.00458
5	performance ratingTop	7.05	1.53	4.60	0.00000644

Unfortunately they didn't write their code in a Quarto document, instead just wrote some code in the Console and then lost track of their work. They remember using the fct_relevel() function and doing something like the following:

```
blizzard_salary <- blizzard_salary |>
mutate(performance_rating = fct_relevel(performance_rating, ___))
```

What should they put in the blanks to get the same model output as above?

- a. "Poor", "Successful", "High", "Top"
- b. "Successful", "High", "Top"
- c. "Top", "High", "Successful", "Poor"
- d. Poor, Successful, High, Top

Suppose we fit a model to predict percent_incr from annual_salary and salary_type. A tidy output of the model is shown below.

#	A tibble: 3 x 5				
	term	estimate	std.error	${\tt statistic}$	p.value
	<chr></chr>	<dbl></dbl>	<dbl></dbl>	<dbl></dbl>	<dbl></dbl>
1	(Intercept)	1.24	0.570	2.18	0.0300
2	annual_salary	0.0000137	0.00000464	2.96	0.00329
3	salary_typeSalaried	0.913	0.544	1.68	0.0938

Which of the following visualizations represent this model? Explain your reasoning.

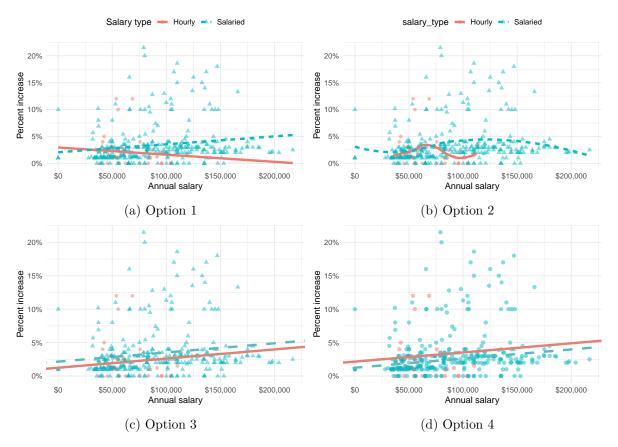


Figure 1: Visualizations of the relationship between percent increase, annual salary, and salary type

Define the term parsimonious model.

Suppose you now fit a model to predict the natural log of percent increase, log(percent_incr), from performance rating. The model is called raise_4_fit.

You're provided the following:

```
tidy(raise_4_fit) |>
select(term, estimate) |>
mutate(exp_estimate = exp(estimate))
```

```
# A tibble: 4 x 3
 term
                                estimate exp_estimate
  <chr>
                                   <dbl>
                                                 <dbl>
                                              0.000786
                                   -7.15
1 (Intercept)
2 performance_ratingSuccessful
                                    6.93
                                          1025.
3 performance_ratingHigh
                                           3534.
                                    8.17
4 performance_ratingTop
                                    8.91
                                          7438.
```

Based on this, which of the following is true?

- a. The model predicts that the percentage increase employees with Successful performance get, on average, is higher by 10.25% compared to the employees with Poor performance rating.
- b. The model predicts that the percentage increase employees with Successful performance get, on average, is higher by 6.93% compared to the employees with Poor performance rating.
- c. The model predicts that the percentage increase employees with Successful performance get, on average, is higher by a factor of 1025 compared to the employees with Poor performance rating.
- d. The model predicts that the percentage increase employees with Successful performance get, on average, is higher by a factor of 6.93 compared to the employees with Poor performance rating.

Part 3 - Miscellaneous

Question 11

Which of the following is the definition of a regression model? Select all that apply.

a.
$$\hat{y} = \beta_0 + \beta_1 X_1$$

b. $y = \beta_0 + \beta_1 X_1$

c.
$$\hat{y} = \beta_0 + \beta_1 X_1 + \epsilon$$

d.
$$y = \beta_0 + \beta_1 X_1 + \epsilon$$

Choose the best answer.

A survey based on a random sample of 2,045 American teenagers found that a 95% confidence interval for the mean number of texts sent per month was (1450, 1550). A valid interpretation of this interval is

- a. 95% of all teens who text send between 1450 and 1550 text messages per month.
- b. If a new survey with the same sample size were to be taken, there is a 95% chance that the mean number of texts in the sample would be between 1450 and 1550.
- c. We are 95% confident that the mean number of texts per month of all American teens is between 1450 and 1550.
- d. We are 95% confident that, were we to repeat this survey, the mean number of texts per month of those taking part in the survey would be between 1450 and 1550.

Bonus

Pick a concept we introduced in class so far that you've been struggling with and explain it in your own words.