17:56 Thu Oct 8

Q1 4

Note Oct 8, 2020
Oct 8, 2020 at 16:24

Q1). $N = 500$, $\alpha = 0.05$, $\beta = 0.2$

20% true relationships 5% 20%

∴ true mean
$= (.20)(500)$
$= 100$
$500 - 100 = 400$

1a). est. # of articles w/ type I errors $= 5\% \times 400 = \boxed{20}$

1b). est. # of articles w/ type II errors $= 20\% \times 100 = \boxed{20}$

1c). est. # of articles non sig $= 400 - 20 = 380 + 20 = \boxed{400}$

1d) est. # of articles sig $= 80\% \cdot 100 = 80 + 20 = \boxed{100}$

Q2 1.5

B[illegible]ught question: Do we have any way of knowing what proportion of relationships / h[illegible]es under investigation reflect true relationships?

- **Yes we do, if the standard deviation is zero or very close to zero, then the hypothesis reflect true relationships.**

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Q3 2.5

$$\text{Phi}(\phi) = \sqrt{\frac{\text{Group } SS_q}{K S^2}}, \quad S^2 = \text{error mean sqr.}$$

$$= \sqrt{\frac{127.2}{1 \times (63.62)}}$$

Check your k and s^2 values -0.5

$$\phi = 1.41399$$

Phi = 1.53 -1

$$\boxed{\phi = 1.41}$$

$$\text{power} = \boxed{0.5}$$

$$\text{Type II error rate} = (\text{Power})(100\%)$$

$$= 0.5 \times 100\%$$

$$\boxed{= 50\%}$$

3 / 5

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Q4 2

Q#4)

$n = 30$

$n_1 = 15$ (control

$n_2 = 15$ (drink cider)

#variables = # levels = 7 = C

$\alpha = 0.05$

Find actual propability of making type I error rate

$$\text{Realized } \alpha = 1-(1-\alpha)^c$$

$$\alpha = 1-(1-0.05)^7 = 0.30166$$

$$\approx 0.302$$

The realized α value is 0.302.

Type I error = 30.2%

Remember that the question asked for the probability (%) of making a type I error

Q5 (2 points)

Q5 0.5

Gi sidual diagnostic plots shown in the pdf below, what can you say about whether or not the tions of normality and equal variance were met?

- Residuals vs Fitted graph show that there are 2 points that are outliers. From this graph, it looks like normality is met because the red line is very close to the standard line of normality in the middle. The Normal QQ plot further confirms as we can see that majority of the data points lie in the expected normal residual line. A few outliers that lie beyond 2 standard deviation units are present in the graph but overall the data points follow linearity.
- The assumption of equal variances is also met based on the Scale-location graph because we observe a line that has a positive slope. The Constant Leverage: Residuals vs Factor levels further confirms this equality in variances. The majority of the data points reasonably lie inside the small boxes, meaning that the sample residuals are not significantly different and have equal variances. There are no points that lie in the extreme high. We might need to do a rerun of the analysis and the outlier datapoints from row 9, 27, and 29 might need to be removed to further confirm this.

The normal QQ plot: transform ranted because many upper re much higher than would be ex distribution were normal

Residuals versus fitted plot and Scale-Location plot: indicates equal variance is violated because variances increase with mean fitted values

A. What type of statistical test will you use to determine if the red or blue pill differ in their effectiveness at providing these students more sleep? Why did you choose that specific type of test? **(2 points)**

Q6 10

- To determine if the red or blue pill differ in effectiveness, paired t-test will be used. Paired t-test will be used because each of the students is subjected to 2 different treatments and we're taking the before and after observations.

What type of paired t-test? One-sided or Two-sided? -1

B. Write the null hypothesis and alternate hypothesis that you will test. (2 points)

H_0: mu(before) = mu(after); There is no difference between the numbers of sleeping time before and after taking the red pills.

H_A: Taking red pills will make a difference in the sleeping time.

Which pill did the researchers hypothesize would perform better? The red pill or the blue pill? -0.5

Open recovered workbooks? Your recent changes were sa… Yes No

MIN fx +/-1.833

	A	B	C	D	E	F
1	Student	Blue_pill	Red_pill	difference	(diff-mean)squared	
2	1	0.7	1.9	1.2	0.1444	
3	2	-1.6	0.8	2.4	0.6724	
4	3	-0.2	1.1	1.3	0.0784	
5	4	-1.2	0.1	1.3	0.0784	
6	5	-0.1	-0.1	0	2.4964	
7	6	3.4	4.4	1	0.3364	
8	7	3.7	5.5	1.8	0.0484	
9	8	0.8	1.6	0.8	0.6084	
10	9	0	4.6	4.6	9.1204	
11	10	2	3.4	1.4	0.0324	
12	mean			1.58		
13	variance	1.51288889				
14	standard error	0.38895872				
15	Ssdifferences	13.616				
16	stdev	1.22999548				
17						
18						
19	**test statistic**	4.06212768				
20	**Degrees of freedom**	9				
21	**paired t stat**	4.06212768				
22	**tcrit from the tcrit table**	+/-1.833	Should be positive since a one-tailed t-test would be used **-0.5**			
23						
24						
25						
26						
27						
28						
29						

D. What are your conclusions? Do you accept or reject your null hypothesis? State your answer in terms of the original question as a formal statement of results. **(2 points)**

- There is sufficient evidence to reject the null hypothesis because the tstat (4.062) is greater than the tcrit (1.833), when p-value threshold < 0.05. There is sufficient evidence to say that the red pill makes a difference and improves sleeping time.

Q7 (6 points)

Q7 4

A) You have a single dependent variable that is continuous in nature (ratio data type) and two independent variables that are under the researchers control. There are three treatment groups in the first independent variable (nominal data) and two treatment groups in the second independent variable (binary). What is the appropriate statistical test? Specify the model type (I, II, or III).

a. The appropriate statistical test for this will be one-way ANOVA, Model I – Fixed Effects Model. This is because all the independent variables are under control of the researchers.

A Two-way ANOVA should be used -1

C) You have a single dependent variable that is continuous in nature (ratio data type) and three independent variables. Two of these independent variables are under the researchers control, but the third one is not. Each of the independent variables has three treatment groups (nominal data). What is the appropriate statistical test? Specify the model type (I, II, or III).

   a. The appropriate statistical test for this will be multi-way ANOVA. Model II – Mixed models. This is because there is at least 1 independent variable that is under the researchers' control and at least 1 independent variable that is random or not controlled by the researchers.

Model type III should be used -1

B) You have a single dependent variable that is continuous in nature and one independent variable that is binary in nature. The independent variable is under the researchers control and separates the response variable into two treatment groups. What is the appropriate statistical test?

- The appropriate statistical test for this will be two sample t-tests

Q8 14

K. ([illegible]) What is your conclusion regarding the nutritional value of the various [illegible]ed mixes?

- Null hypothesis is mu(not) = 0, no difference in nestling weight across the three birdseed types
- The F-stat is greater than the F-critical, therefore there is a strong evidence against the null hypothesis. In other words, there is a sufficient evidence that the different birdseed types will have different influences on the nestling weight of Northern Cardinals in the City of Toronto.

					Square differences between observations and grand mean		
1					Square differences between observations and grand mean		
2		Cornseedmix	sunflowermix	peanutberrymix	Cornseedmix	sunflowermix	peanutberrymix
3		243	325	423	1601.905329	1762.000567	19593.3339
4		230	257	340	2811.524376	677.2386621	3246.286281
5		248	303	392	1226.667234	399.0481859	11875.81009
6		327	315	339	1933.905329	1022.476757	3133.3339
7		329	380	341	2113.810091	9404.381519	3361.238662
8		250	153	226	1090.571995	16906.19104	3251.714853
9		193	263	320	8104.286281	400.9529478	1367.238662
10		271	242	295	144.5719955	1682.952948	143.4291383
11		316	206	334	1087.429138	5932.667234	2598.571995
12		267	344	322	256.7624717	3718.095805	1519.143424
13		199	258	297	7060.000567	626.1910431	195.3339002
14		171	296	318	12549.3339	168.3815193	1223.3339
15		158	298	290	15630.95295	224.2862812	48.66723356
16		248	241	319	1226.667234	1766.000567	1294.286281
17	ni	14	14	14			
18	N	42					
19	Group mean	246.4285714	277.2142857	325.4285714			
20	Grand mean	283.0238095					
21	Total Sum of Squares	154380.9762					
22	Total df	41					
23	k	3					
24							
25	Group Sum of Squares (Ssfeedmi	44395.7619					
26							
27	Group (feedmix) df	2					
28	Error Sum of Squares	109985.2143					
29	Error df	39					
30							
31							
32	Group Mean Square (MS$_{\text{feedr}}$	22197.88095					
33	Error Mean Square	2820.1337					
34	Fstat	7.871215806					
35	Critical F	<3.49					
36							

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H. **(1 pt)** Error Mean Square (show calculations) =

2820.1337

$$\text{Error mean sq} = \frac{SS_{Error}}{Error\ DF} = \frac{109985.2143}{39}$$

$$= 2820.1337$$

I. **(1 pt)** Fstat (show calculation) =

7.871215806

$$Fstat = \frac{MS_{feedmix}}{\text{Mean sq. Error}} = \frac{22197.88}{2820.13}$$

J. **(1 pt)** Critical F value (see table on next page) = Because the denominator df is 39, and the maximum denominator df on the table is 20, the F-crit will be <3.49.

1 / 3

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aiai
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n_i	14	14	14
Group mean	246.4285714		
N =	42		
Grand mean	283.0238095		

A. **(2 pts)** Total Sum of Squares = ______________________________

154380.9762

B. **(1 pt)** Total df = 41

C. **(2 pt)** Group Sum of Squares ($SS_{feedmix}$, show calculations below) =

44395.7619

$$SS_{feedmix} = \sum_i^n n_i(\bar{X}_i - \bar{\bar{X}})^2 = [n_i(\bar{X}_{feedtype} - \bar{X}_{grand})^2]$$

$$= [14(246.43 - 283.02)^2 + 14(277.21 - 283.02)^2 + 14(325.43 - 283.02)^2] = 44395.7619$$

D. **(1 pt)** Group (feedmix) df = 2

E. **(1 pt)** Error Sum of Squares (show calculations) =

109985.2143

$$\text{Error } SS = \frac{SS_{Total}}{SS_{feedmix}} = \frac{154380.1762}{44395.7619} = 109985.2143.$$

F. **(1 pt)** Error df = 39

G. **(1 pt)** Group Mean Square ($MS_{feedmix}$, show calculations) =

22197.88095

$$MS_{feedmix} = \frac{SS_{feedmix}}{Group_{feedmix}\ DF} = \frac{44395.719}{2} = 22197.88$$

H. **(1 pt)** Error Mean Square (show calculations) =

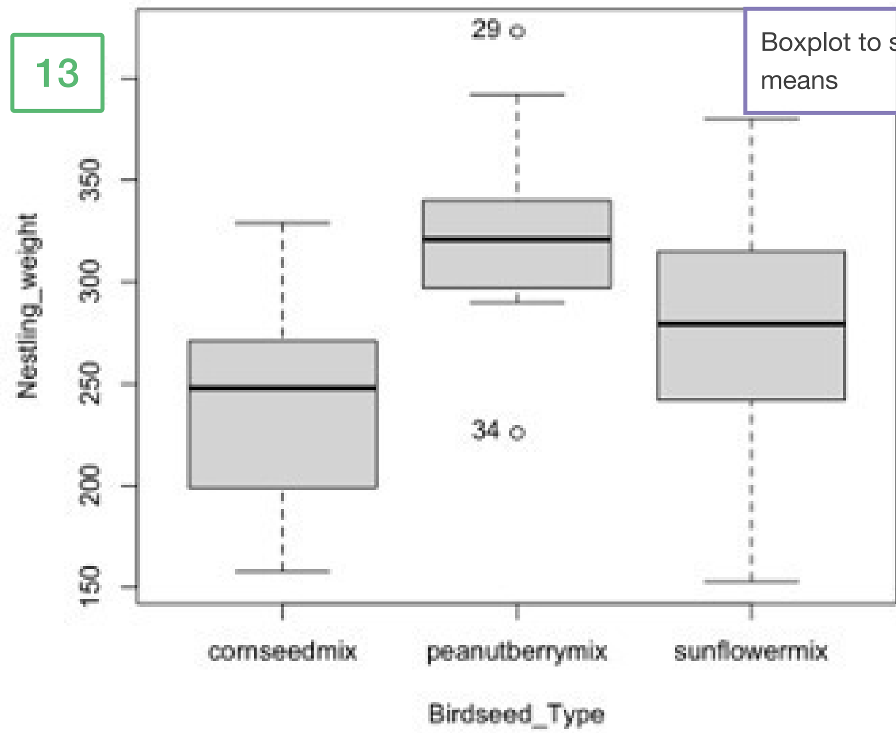
2820.1337

$$\text{Error mean sq} = \frac{SS_{Error}}{Error\ DF} = \frac{109985.2143}{39}$$

$$= 2820.1337$$

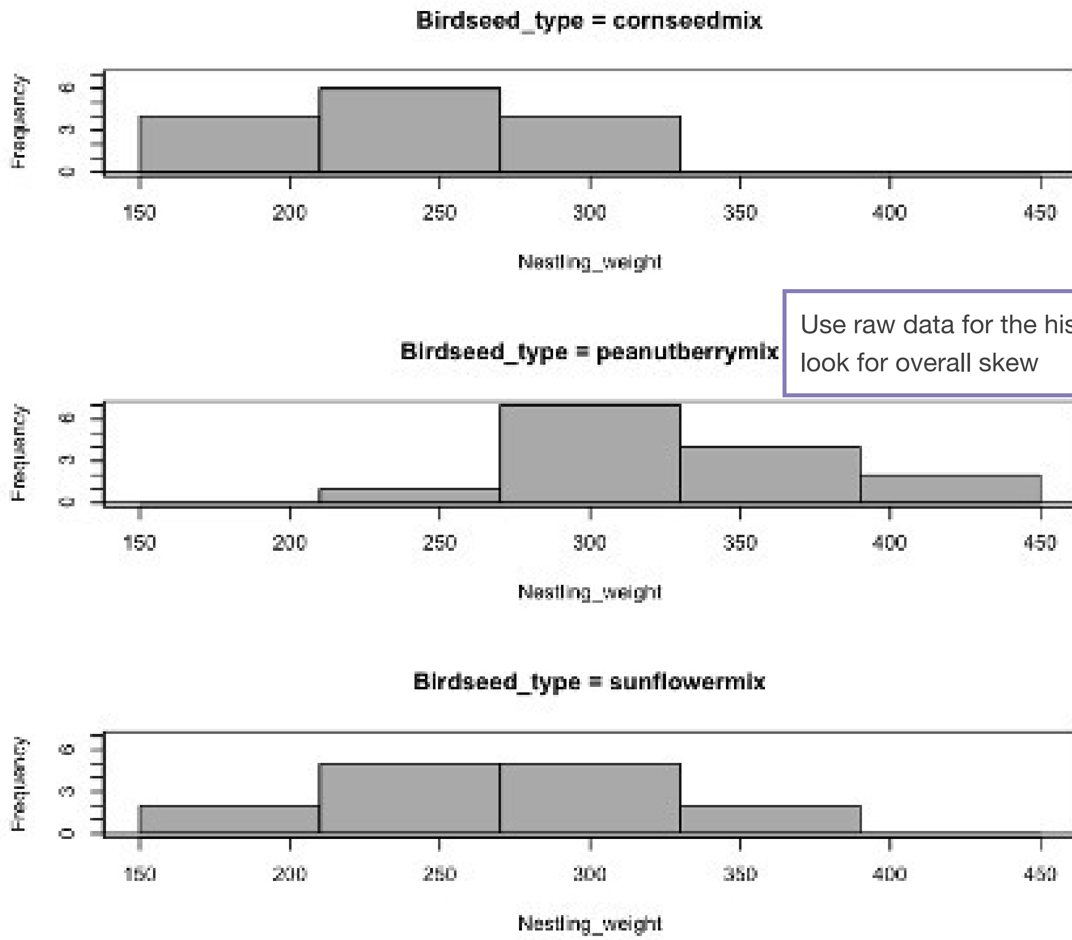
1 / 3

Q9 13



Boxplot to show differences in means 2

Figure 1. The Boxplots with the birdseed type as the independent variable and nestling weight as the dependent variable.



Use raw data for the histogram to look for overall skew

Figure 2. The histograms of the samples. They all suggest normal distribution.

LEVENE'S TEST

leveneTest(Nestling_Weight ~ Birdseed_type, data=urban_nestling, center="mean")
Levene's Test for Homogeneity of Variance (center = "mean")

```
      Df F value Pr(>F)
group  2  0.7058 0.4999
      39
```

Checked for equal variance (Levenes &/ Bartlett's test) 2

ONE WAY ANOVA

```
> AnovaModel.3 <- aov(Nestling_Weight ~ Birdseed_type, data=urban_nestling)

> summary(AnovaModel.3)
          Df Sum Sq Mean Sq F value  Pr(>F)
Birdseed_type_2  44396   22198   7.871 0.00134 **
Residuals     39 109985    2820
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

> with(urban_nestling, numSummary(Nestling_Weight, groups=Birdseed_type,
statistics=c("mean",
+  "sd")))
              mean       sd data:n
cornseedmix   246.4286 54.12907    14
peanutberrymix 325.4286 46.14145    14
sunflowermix  277.2143 58.32163    14

> oneway.test(Nestling_Weight ~ Birdseed_type, data=urban_nestling) # Welch test

        One-way analysis of means (not assuming equal variances)

data:  Nestling_Weight and Birdseed_type
F = 8.7473, num df = 2.000, denom df = 25.739, p-value = 0.001263
```

ANOVA to check significance **2**

```
Simultaneous Tests for General Linear Hypotheses

Multiple Comparisons of Means: Tukey Contrasts


Fit: aov(formula = Nestling_Weight ~ Birdseed_type, data = urban_nestling)

Linear Hypotheses:
                        Estimate Std. Error t value Pr(>|t|)
peanutberrymix - cornseedmix == 0    79.00      20.07   3.936  <0.001 ***
sunflowermix - cornseedmix == 0      30.79      20.07   1.534   0.286
sunflowermix - peanutberrymix == 0  -48.21      20.07  -2.402   0.054 .
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
(Adjusted p values reported -- single-step method)


        Simultaneous Confidence Intervals
```

posthoc test for difference between means **2**

Multiple Comparisons of Means: Tukey Contrasts

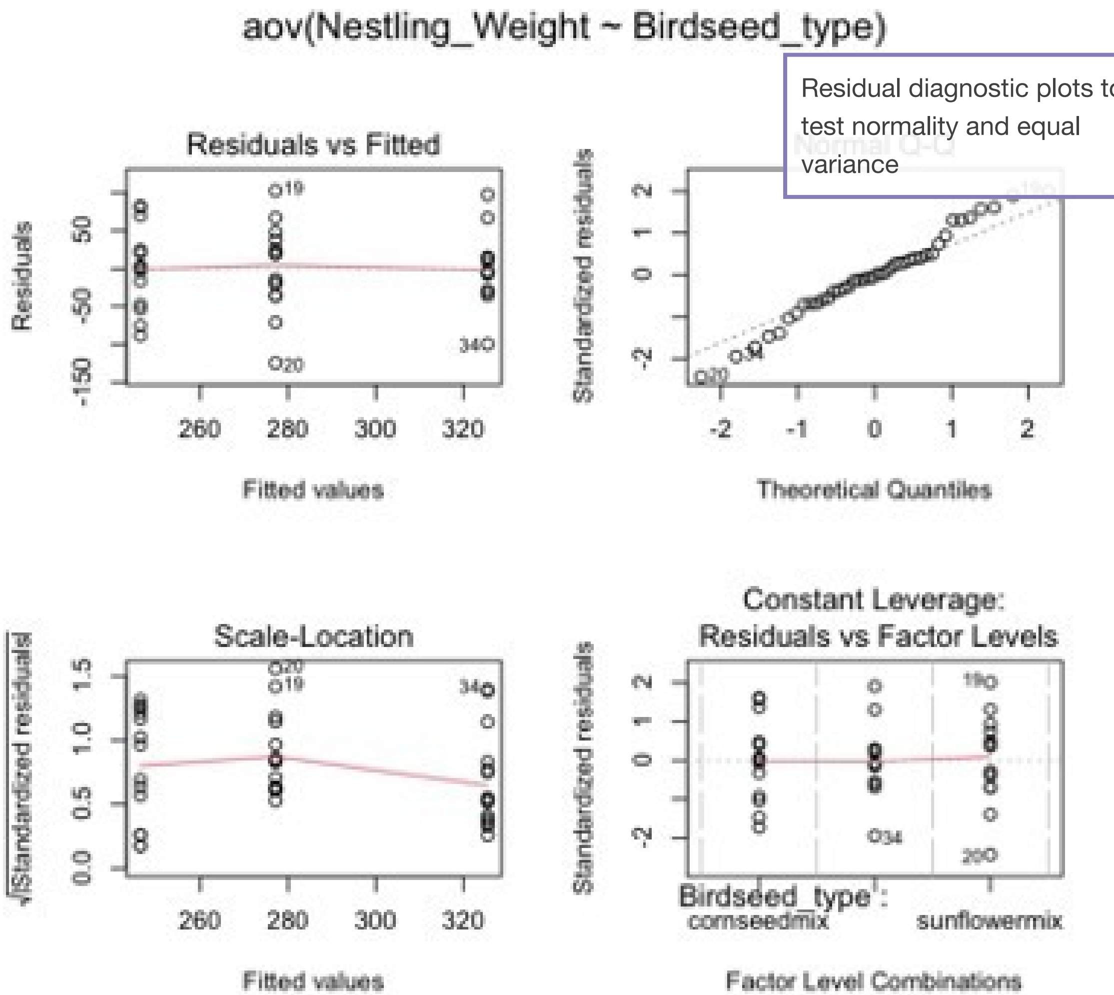
Fit: aov(formula = Nestling_Weight ~ Birdseed_type, data = urban_nestling)

Quantile = 2.4359
95% family-wise confidence level

Linear Hypotheses:

	Estimate	lwr	upr
peanutberrymix - cornseedmix == 0	79.0000	30.1069	127.8931
sunflowermix - cornseedmix == 0	30.7857	-18.1074	79.6788
sunflowermix - peanutberrymix == 0	-48.2143	-97.1074	0.6788

cornseedmix	peanutberrymix	sunflowermix
"a"	"b"	"ab"



Residual diagnostic plots to test normality and equal variance 2

Figure 3. The Residual graphs of the experiment data.

First and foremost, we need to check if all the assumptions are met. We do this by checking if each sample population is normal first. The figure 1 boxplots suggest normalcy of each distribution but we further investigate using histograms. The histograms also suggest normalcy of the distribution. Next is the Levene's test, The F-value is 0.7058 – this is a considerably low number, suggesting that the sample means are very close to the true mean value of the population, and thus normal distribution across the samples. In addition, the one-way ANOVA analysis in R, as highlighted in blue above, shows zero difference between the sample of all the means. Finally, we confirm these assumptions using the residuals graph in figure 3. The Normal QQ plot show that the datapoints follow linearity and lie along the normal line of best fit, suggesting that the sample distributions are normal. The scale-location graph shows a slope that is close to zero (straight horizontal line), suggesting that all the sample means have equal variances. In conclusion, all the assumptions are met.

The F value is 7.871 with a p-value of 0.00134. The p-value is less than 0.05, therefore we have suffiecient evidence to reject the null hypothesis. To conlude, we confirmed our analysis on Q8 that different birdseeds bear different nestling weights.

Reported on ANOVA data (Fstat, p-value) 2

Noted differences in birdseed mixes 1