## Psychology 318: Final HW, due June 5, 2014

### Chapter 10

An experiment (similar to that described in class last quarter in Psychology 317) is done investigating the effects of nicotine on rat growth.

A pair of rats from each of five different litters of rats are used in the experiment. One member of each pair is assigned to a Control condition in which a benign solution (saline) is administered daily during the rats’ growth period. The other member is randomly assigned to the Experimental condition in which a solution containing nicotine is administered daily.

All rats are weighed as adults. The results (weights in kilograms) are in the table below. Note that various things have been computed for you at the bottom, and room has been left in the table for you to compute other things should you wish.

|  |  |  |  |
| --- | --- | --- | --- |
| Rat Pair | Control (x1) | Nicotine (x2) | Difference |
| 1 | 1.05 | 0.66 | 0.39 |
| 2 | 0.40 | 0.19 | 0.21 |
| 3 | 1.38 | 1.14 | 0.24 |
| 4 | 1.77 | 1.340 | 0.43 |
| 5 | 0.44 | 0.18 | 0.26 |
| 6 | 1.41 | 1.09 | 0.32 |
| 7 | 1.47 | 1.32 | 0.15 |
| 8 | 1.44 | 1.25 | 0.19 |
| xi | 9.36 | 7.71 | 2.19 |
| xi2 | 12.716 | 8.092 | 0.667 |

The experimenter is uncertain whether to view this as a within-subjects design (since the two members of each pair are littermates) or as a between-subjects design (since the two pair members are, of course, different rats).

a) Treat this design as a between-subjects design and assume homogeneity of variance. Test the alternative hypothesis that nicotine and control conditions *differ* against the null hypothesis that the two conditions don't differ. Use a .05 -level. Show all hypothesis testing steps.

b) Continuing to treat this as a between-subjects design (and assuming homogeneity of variance), compute *90%* confidence intervals for the two condition means, and for the mean difference between the two conditions.

c) Treat this design as a within-subjects design. Use the .05 -level. Test the same hypothesis as in Part (a). Show all hypothesis testing steps.

d) Continuing to treat this as a within-subjects design, compute the *90%* confidence interval around the relevant mean.

e) *Briefly* discuss the reasons for any differences in conclusions that you get in Part (c) versus Part (a).

NOTE: You should have found that you rejected H0 in Part (c) and didn't reject H0 in Part (a). If that didn't happen you made a mistake somewhere. Answer *this* part as if you made the correct conclusions in Parts (a) and (c).

### Chapter 11

An experiment is done with J = 4 conditions. All scores (and therefore, of course, Tj's and Sxij's are integers. Below are summary data.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Condition 1 | Condition 2 | Condition 3 | Condition 4 | Relevant Sums |
| nj |  |  |  | 11 | N = 30 |
| dfj |  |  | 2 |  |  |
| Tj |  |  | 34 |  | T = 386 |
| Mj |  |  |  | 13.727 |  |
| Sxij2 |  | 1,274 |  | 2,087 |  |
| SSj |  | 19.600 | 12.667 |  | SSW = 53.282 |
| estjs2 | 1.367 | 2.178 |  |  |  |

a) Fill in all remaining (unshaded) cells in the table. **Show all your work in the space below.** (36 points, i.e., 2 points per cell).

The experiment is carried out again. Below is a table of most of the summary data.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Condition 1 | Condition 2 | Condition 3 | Condition 4 |
| nj | 1 | 11 | 3 | 10 |
| dfj | 0 | 10 | 2 | 9 |
| Tj | 11 | 133 | 45 | 159 |
| Mj | 11.000 | 12.091 | 15.000 | 15.900 |
| Sxij2 | 121 | 1,617 | 683 | 2,555 |
| Tj2/nj | 121.000 | 1,608.091 | 675.000 | 2,528.100 |
| SSj | 0.000 | 8.909 | 8.000 | 26.900 |
| estjs2 | \*\* | 0.891 | 4.000 | 2.989 |
| weights: wj |  |  |  |  |
| 95% CIj (HOV) |  | 0.906 |  | 0.950 |
| 95% CIj (no HOV) |  | 0.634 |  | 1.237 |

b. Compute MSW in three ways: first by using the formulas derived in class for computing SSW and dfW, second by computing and combining SSW and dfW directly from the summary table, and third by computing a weighted estimate of the individual estimated 2’s. As part of your answer to this question, please compute and fill in relevant weights that should go to each of the individual estimated s2’s in the unshaded spaces provided in the table. **Be sure to show your work!**

c. Compute and fill in the missing 95% confidence interval magnitudes in the summary table. Note that some of the required confidence intervals assume homogeneity of variance (HOV), while others do not. Place your results in the indicated, unshaded, table cells. If there is anything you cannot compute, please explain *why* you can't compute it.

d. Carry out an ANOVA on these data. Include SST and dfT in your ANOVA table. Use the .05 -level.

e. Carry out the following hypothesis test:

H0: Homogeneity of variance is true, i.e., the population variance is the same for all four conditions.

H1: The population variances for Conditions 2 and 4 are the same, but the population variance for Condition 3 is *higher* than that of Conditions 2 and 4. **Use the .025 -level**.

f. Suppose that you *know* that the *standard deviation* for Condition 1 is equal to 1 = 1.2. Carry out the following hypothesis test:

H0: the population variance is the same for all four conditions.

H1: The population variance for Condition 3 is *higher* than that of Condition 1. **Use the .01 -level**.

### Chapter 12

UcallitSurvey.com is been asked by Fizz-O Soft-Drink Inc. to evaluate how well four of their soft-drink products are liked by four age groups: 6 year olds, 10 year olds, 16 year olds and 30 year olds. Each of n = 14 randomly selected individuals in each of the resulting 16 groups is asked to rate the drink he or she is given on a scale from 1 (“abysmal”) to 7 (“fantastic”).

Various results are shown in the tables below. Note that the type of result shown in each table is indicated **in bold** near the upper left of the table. Various marginals are also provided.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
|  | Soft-Drink Product | | | |  | |
| Mjk's | PippiPop | FizzMeh | PowerMaster | EnerGiffic | MRk's |
| 6 years | 6.20 | 3.20 | 3.30 | 3.00 | 3.93 |
| 10 years | 1.90 | 2.90 | 4.30 | 4.20 | 3.33 |
| 16 years | 1.80 | 3.30 | 5.30 | 5.40 | 3.95 |
| 30 years | 1.40 | 3.20 | 6.20 | 6.50 | 4.33 |
| MCj’s | 2.825 | 3.150 | 4.775 | 4.775 | M = 3.881 |
|  |  |  |  |  |  |
| Tjk's | PippiPop | FizzMeh | PowerMaster | EnerGiffic | TRk's |
| 6 years | 86.8 | 44.8 | 46.2 | 42.0 | 219.8 |
| 10 years | 26.6 | 40.6 | 60.2 | 58.8 | 186.2 |
| 16 years | 25.2 | 46.2 | 74.2 | 75.6 | 221.2 |
| 30 years | 19.6 | 44.8 | 86.8 | 91.0 | 242.2 |
| TCj’s | 158.2 | 176.4 | 267.4 | 267.4 | T = 869.4 |
|  |  |  |  |  |  |
| ejks2's | PippiPop | FizzMeh | PowerMaster | EnerGiffic |  |
| 6 years | 0.757 | 0.592 | 0.664 | 0.582 |  |
| 10 years | 0.590 | 0.609 | 0.667 | 0.600 |  |
| 16 years | 0.304 | 0.407 | 0.465 | 0.450 |  |
| 30 years | 0.239 | 0.330 | 0.556 | 0.433 |  |
|  |  |  |  |  |  |

For your convenience we have calculated the following:

Tjk2 = 55,074

TCj2 = 199,150

TRk2 = 190,573

xijk2 = 4,041

a) Graph your data as a **line graph** using the axes below (a rough graph will suffice and don't worry about confidence intervals). **Justify why you plotted your data as a line graph and not as a bar graph**.

Be sure to fill in all the relevant information on your graph (obviously the axes provided are just bare bones)

Explain, as if to someone with very little knowledge of statistics, what your data mean. **Be brief.**

b) Assume homogeneity of variance throughout . Compute 95% confidence interval magnitudes around Mjk, MCj, MRk, and M (the grand mean).

c) Carry out a standard ANOVA on these data. Arrange your results in an ANOVA table. Include SST and dfT in your table.

d) Is there a statistically significant effect of age for FizzMeh only? (Continue to assume complete homogeneity of variance).

e) Repeat Part (d) but with the following homogeneity of variance assumption: 2 is the same for each of the four FizzMeh cells; however 2 for FizzMeh is not necessarily the same as it is for the other three cola products.

f) Using the same homogeneity of variance assumption as in Part (e) compute 95% confidence interval magnitudes suitable for each FizzMeh cell mean, i.e., each M2k and the FizzMeh column mean, i.e., MC2. What is the relation between these two confidence intervals, and why is the relation what it is?

g) Suppose that you were to assume that all three null hypotheses—those of cola type, age group, and the interaction—*were all* *true*. Assuming, in addition, homogeneity of variance, compute your *best estimate* of s2. On how many degrees of freedom would this estimate be based?

h) If your computations are for Parts (c) and (g) are correct, then the estimate of 2 that you computed from part (g) is larger than the MSW that you presumably computed and used in your ANOVA in Part (c). Why is this? Be brief in your answer.

i) Assume that what we’ll call 2young is the population variance common to 6 and 10 year olds while 2old is the population variance for the 30 year olds. Use an F-test to test the alternative hypothesis that 2young > 2old against the null hypothesis that 2young = 2old. Use the .05 -level.

### Chapter 13

Starbucks is trying to decide which of four coffee-bag colors—white, brown, green, or red—will be most popular for its new-on-the-market, bags of whole-bean “Caffe Eccsessivo” (sold only at Starbucks outlets).

To address this question, Starbucks carries out an experiment in which it produces coffee in the four bag colors—White, Brown, Green, and Red—and makes them available for sale in each of K = 20 cities chosen randomly from the many, many cities worldwide in which Starbucks operates. For each city, Starbucks picks 28 of its outlets from that city and randomly assigns n = 7 of them to sell each color.

So in summary, there are J = 4 colors, K = 20 cities, and n = 7 outlets within each cell (i.e., city-bag color combination).

Starbucks then records the daily number of bags bought from each of the Starbucks outlets in each of the 20 cities over a year’s period. The means for the four colors across all n = 7 Starbucks outlets across each of the K = 20 cities are:

|  |  |  |  |
| --- | --- | --- | --- |
| White | Brown | Green | Red |
| 4.24 | 2.15 | 7.00 | 10.10 |

Assume that relevant sums of squares are as follows:

SSB (cells) = 10,503

SS columns (Colors) = 4,993

SS rows (Cities) = 3,800

SS Within (cells) = 2,400

a) Compute TJK2, TCj2, TRk2, and xijk2

b) Compute the appropriate “within-cities” **90%** confidence interval that goes around each column mean—that is, the confidence interval suitable for making inferences about *patterns* of the bag-color population means.

c) Compute the “real” **90%** confidence interval that goes around each column mean—the one suitable for making inferences about *actual values* of the bag-color population means. Explain both conceptually and by reference to the confidence intervals you computed in Parts (b) and in this part why the two confidence intervals are different.

d) Perform an ANOVA assuming that you wish to generalize the effects of bag color to all cities in the world that sell Starbucks. Report all sums of squares and degrees of freedom including “total.” Place your results in an ANOVA table.

e) Assume that you're only interested in generalizing to the particular 20 cities used in this experiment. Carry out the three possible hypothesis tests. Show your results either in a new ANOVA table or in an extension to the ANOVA table that you created in Part (d).

f) Under the assumption of Part (e), compute the **90%** confidence interval that goes around each cell mean.

g) Suppose that for each city you averaged the n = 7 scores for each bag color. Thus you end up with a single score for each bag color for each city. Re-do the ANOVA table from Part (d), using the assumptions of Part (d). **Be sure to show your work.** .

h) Under the “averaging” assumption of Part (g) re-compute the confidence interval from Part (b). .

### Chapter 14

Wanda, a criminologist interested in characteristics of American cities, is investigating the relation between the number of churches in a city and the number of murders in the city. She selects 12 cities. For generality she chooses six large cities (the first six listed below) and six small, Washington State cities. She then computes measures of number of churches and number of murders and lists them for all 12 cities, as has been done below.

Based on various considerations, Wanda believes that she will find a negative correlation between number of churches (X) and number of murders (Y).

|  |  |  |
| --- | --- | --- |
| City | X = Number of Churches | Y = Number of Murders |
| New York | 3.64 | 14.91 |
| Los Angeles | 4.52 | 12.68 |
| Houston | 2.93 | 16.11 |
| Chicago | 5.15 | 8.21 |
| Philadelphia | 4.77 | 11.41 |
| Miami | 3.99 | 14.29 |
| Tacoma | 1.01 | 1.22 |
| Moses Lake | 0.95 | 4.44 |
| Wenachee | 0.42 | 5.17 |
| Yakima | 1.03 | 1.03 |
| Bellingham | 1.08 | 0.40 |
| Walla Walla | 1.07 | 3.96 |

Summary data are as follows

 = 12

X = 30.57

X2 = 112.99

Y = 93.82

Y2 = 1,108.99

Y = 325.92

r2 = 0.573

a) Compute the best-fitting values of b and a in the regression equation, Y’ = bX + a.

b) What are the values of r and r2 for the relation between number of churches and number of murders?

c) What are the predicted numbers of murder values for New York and Walla Walla?

d) You should have computed a positive correlation between number of churches and number of murders, as did Wanda. This surprised Wanda. Why might she have gotten this positive correlation even if, intrinsically, the correlation between number of churches and number of murders is negative? What new statistics could you compute that might prove useful in terms of getting a better sense of the true relation between number of churches and number of murders? **Be brief.**

HINT: If you are at a loss in answering this question, try making a scatterplot (even if it’s rough) for the data.

Wanda continues to study cities. Now she is interested in the relation between church prevalence in a city and alcohol prevalence in the city. Below are the data from n = 12 cities: the cities themselves and the X scores are the same as in Exam 4. However, Y is a measure of alcohol prevalence in the city. These data are shown in the table below.

|  |  |  |
| --- | --- | --- |
| **City** | **X = Church prevalence score** | **Y = Alcohol prevalence score** |
| New York | 3.64 | 4.02 |
| Los Angeles | 4.52 | 5.11 |
| Houston | 2.93 | 6.12 |
| Chicago | 5.15 | 5.01 |
| Philadelphia | 4.77 | 3.44 |
| Miami | 3.99 | 7.12 |
| Tacoma | 1.01 | 2.23 |
| Moses Lake | 0.95 | 1.55 |
| Wenachee | 0.42 | 1.02 |
| Yakima | 1.03 | 3.01 |
| Bellingham | 1.08 | 0.40 |
| Walla Walla | 1.07 | 2.19 |

Summary data are as follows

 = 12

X = 30.573

X2 = 112.992

Y = 41.221

Y2 = 189.788

Pearson r = 0.762

e) Compute the upper and lower limits of the **80%** confidence interval around both the Pearson r and the Pearson r2.

f) What is the *variance* of the predicted Y-scores, i.e., the variance of the Y’ scores? NOTE: This should be a relatively easy question to answer with the information provided at the start of the question. You should not have to actually compute the values of all the Y’ scores.

g) Suppose a city’s church-prevalence score were found to be X = 2.00. What would the predicted alcohol prevalence score, Y’, for that city? NOTE: please solve this problem by using the information presented in lecture about applying the concept of “regression to the mean.”

### Chapter 15

Mel a biologist working for A&E Rat Food Inc. is studying the effects of their new “MiracuGrow” rat food on two kinds of rat strains: Foe rats and Bar rats. Mel has a biological theory which predicts that both rat strains grow to adult weights that are proportional to the daily amount of MiracuGrow they are given. Additionally, according to the theory, Bar rats grow to twice the adult weight of Foo rats.

Mel starts with 75 Foo rat pups and 75 Bar rat pups. He randomly divides the 75 pups from each strain into 3 groups of **n = 25 pups per group**. The three groups of each rat strain differ in terms of how much MiracuGrow they are given: 1, 2, or 8 cc’s per day. Data (mean weights in kilograms of adult rats) are as follows:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Daily amount of MiracuGrow (cc’s) | | |
|  | 1 | 2 | 8 |
| Foo rats: | 0.3 | 0.6 | 0.6 |
| Bar rats: | 0.5 | 1.0 | 1.5 |

USEFUL INFORMATION:

We have calculated for you that…

SSB = 23.375

SMjk = 4.50

SMjk2 = 4.31

T = 112.50

Assume that…

SSW = 72.0

a) Make up a *single* set of weights (wjk’s), one wjk for each of the 6 conditions, that reflect the pattern of population means according to Mel’s theory. Use the smallest weights that are all integers.

b) What percentage of SSB is accounted for by your hypothesis and by the residual from the hypothesis? Test two null hypotheses: first that your weights from Part (a) have 0.0 correlation with the six condition population means, and second that your weights from Part (a) have 1.0 correlation with the six condition population means. Make an ANOVA table that shows the results of the above. Make sure that your ANOVA table includes all the usual information, including dfT and SST.

c) Compute the Pearson r2 between your weights and the sample means. Use the equation for Pearson r2 from Chapter 14 to do this. Be sure to show your work. How do your answers for Parts (b) and (c) compare?

d) Compute 2 for these data

### Chapter 16

Do assigned problems from original HW 4 downloadable spreadsheet.