Excel 2007 BASICS

for Elementary Statistics: Looking at the Big Picture

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Preview

The first part of **Elementary Statistics: Looking at the Big Picture**, on Data Production, does not call for the use of statistical software. For this reason, our first chapter consists of basic tips, such as how to enter and manipulate data. Parts 2, 3, and 4 of this guide parallel Parts II, III, and IV of the textbook, presenting examples and activities on Displaying and Summarizing, Probability, and Inference. Within Part 2 on Displaying and Summarizing, and Part 4 on Statistical Inference, methods are presented in sequence for each of the five variable situations: **C**, **Q**, **C→Q**, **C→C**, **Q→Q**.

Part 1: Warming Up with Excel

After starting Excel, you'll see a **sheet**, named Sheet1. At the bottom of the screen, you'll see tabs for two other sheets, Sheet2 and Sheet3, as well as a tab to create new sheets. These three worksheets, along with any other worksheets you create are part of the workbook. The worksheet is where we enter, name, view and edit. The Office button is located in the top left corner. The **Office button** contains menu items to open a new or existing workbook, save the current workbook, print a worksheet, access Excel options among other options. When the save option is selected, Excel will save the entire workbook, not as individual worksheets. However, when printing, Excel will only print the currently selected worksheet, not the entire workbook.

To the right of the Office button, is the menu bar. The menu bar contains the main menus: Home, Insert, Page Layout, Formulas, Data, Review and View. To access help for Excel, click the question mark on the right side of the menu bar. Clicking on any of the main menu titles opens several menu options beneath the menu bar. The menu bar is also where submenus appear to edit graphics.

We will often use the Insert Function option, available under the Formulas main menu. The Insert Function option will open a dialog box where you can find and select the function you would like to use. If the function that you would like to use is not already listed in Select a function box, you can search for the function in the Search for a function box by simply typing the name of the function and pressing Go.

Entering and Manipulating Data

Each variable is stored in a **column**, designated by a letter. For example, A is the first column, B is the second, etc. The column designations are displayed along the top of the worksheet.

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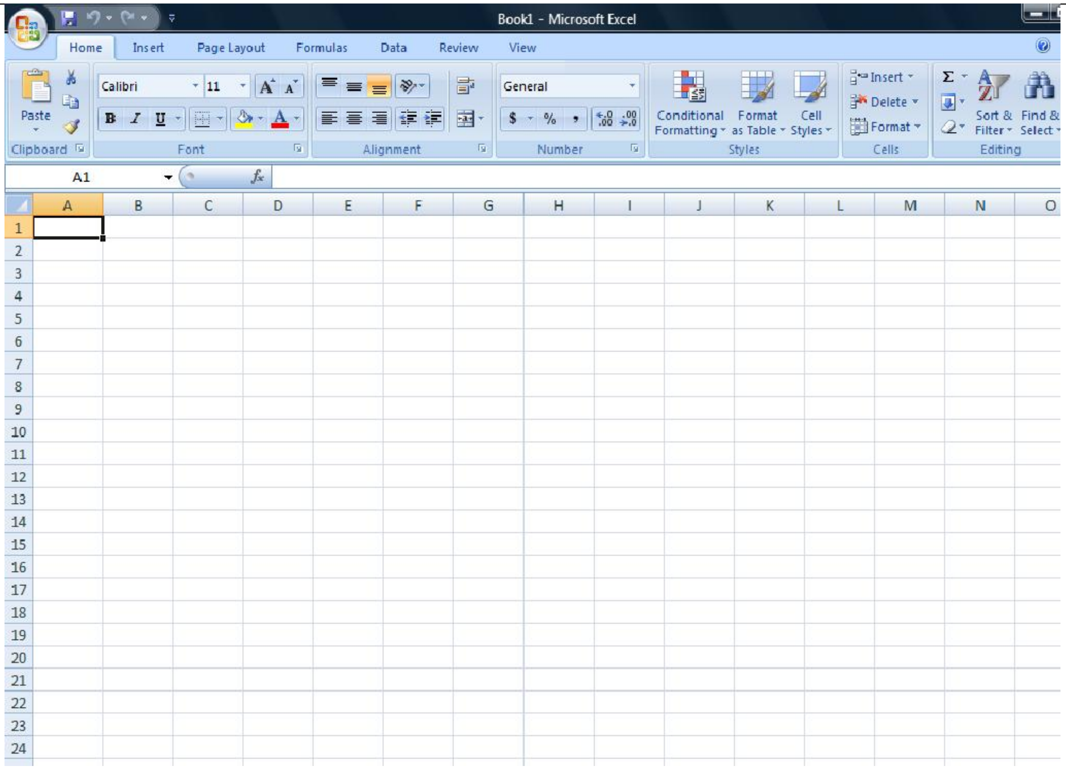

The numbers at the left of the worksheet represent positions within a column and are referred to as **rows**. Each rectangle occurring at the intersection of a column and a row is called a **cell**. It can hold one observation. Each row in a column usually represents a value of the variable represented by that column.

The **active cell** has the worksheet cursor inside it and a dark rectangle around it. To enter or change an observation in a cell, we first make the cell active and then type the value.

There are no special cells used for naming in Excel. To name the column, we click on the cell in Row 1 of that column and type the desired name. Because context is so important in statistics, it is a good idea to always name the columns you are working with.

Examples for Warming Up with Excel 2007

Example 1.1: Installing the Analysis Toolpack.

1. Click the **Office button** and select **Excel Options**
2. In the left pane, click **Add-ins**
3. At the bottom of the window, click **Go**
4. Check the box next to Analysis Tookpack and Analysis Tookpack - VBA
5. Click **OK**

6. Click Yes to install the feature

7. Once installed, you will find the **Analysis Toolpack** under the **Data** menu. It will be listed as **Data Analysis**.

Example 1.2: Suppose we want to store heights, in inches, of female class members [59, 65, 60, 66, 62, 66, 66, 65, 68, 64, 63, 65, ...] into column A and name the column "*FHts*";. Just click in cell A1 and type FHts, and press the "Enter" key. Then type 59, Enter, 65, Enter, 60, Enter, and so on. Note that a height of "5 foot 5" would be entered as 65, and "6 foot 4" would be 76.

To store male heights, name column B "*MHts*" by typing this in B1 and enter those data values [76, 68, 75, 66, 67, 68, 71, 72, ...] in this column.

Example 1.3: To combine and sort female and male class members' heights,

1. In C1, type the header *Hts*

2. Click A2 and drag to highlight all *FHts* data **Note:** Do NOT select the name cell.

3. Right click on the selection and click copy.

4. Then in the **Hts** column right click on C2 and click paste.

5. Select and copy the *MHts* data and paste it under the existing data in the *Hts* column.

6. Highlight Column C

7. Click **Data** and click **Sort**

8. Select "Continue with current selection".

9. Click **Sort**

10. Click **OK**.

Example 1.4A: To change the formatting of a cell (ie, numeric to text, text to numeric, etc.):

1. Select the cells you wish to change formatting on by clicking and dragging

2. Right click the selection and choose Format Cells

3. On the Number tab, select the category that you would like to change the format to

4. Click **OK**

Example 1.4B: Suppose we have Zip code information stored in Column C. We may want to change the formatting of these cells to text so that we are reminded that this isn't numeric data we want to work with.

1. Select the cells containing the zip codes
2. Right-click on the selection and choose Format cells
3. On the Number tab, select text
4. Click OK

Lab Activities for Warming Up with EXCEL

1.1. Create a column *PG* for the lengths, in minutes, of seven movies rated PG: 100, 99, 106, 115, 90, 140, 90. Sort the column in ascending order.

1.2 Create a column *R* for the lengths, in minutes, of eight movies rated R: 134, 173, 113, 108, 98, 118, 102, 123. Stack the columns of movie lengths, PG and R, into a column called *Lengths* and sort them in ascending order.

1.3 Create a column *PG-13* for the lengths, in minutes, of three movies rated PG-13: q130, 143, 102, where the typographical error "q130" is to be entered as is. Then re-type it correctly as 130 and change the data type from text to numeric.

Part 2: Displaying and Summarizing Data

The remaining examples work with existing data contained in the file surveydata.xlsx. Note that this file contains real data and some values are missing. When a value is missing, the cell representing the missing value is blank. The examples that follow give the appropriate steps to follow when there is missing data. Occasionally, the procedures for dealing with missing data are different from those that can be used when data is not missing. When this occurs, you will see a note referring you to the Appendix which will provide details on how to complete the procedure when data is not missing. Note that these procedures may provide more information and nicer displays.

Examples for Part Two: Displaying and Summarizing Data

C Single Categorical Variable

Recall: Pie charts and bar charts are appropriate for displaying single categorical variables.

Excel does not have the ability to view data as categorical and separate data into categories automatically to complete bar charts and pie charts. In order to successfully create these types of displays, we must first create a Pivot Table. A Pivot Table will allow us to summarize data based on categories. We will then use this to create appropriate displays of categorical data.

Example 2.1A: Create a Pivot table to tally the counts and percentages of students' color preferences.

1. Click **Insert**
2. Click **Pivot Table**
3. Click the selection button next to the Table/Range textbox and select the data you wish to summarize by clicking and dragging to outline all the cells you wish to include. Be sure to select the label Color along with all the data points.

   Note: You may continue with the entire table selected (default selection) as you will select the variables that you want to summarize later.
4. Ensure that New Worksheet is selected and click **OK**. A new sheet will appear with an empty Pivot Table.
5. Click and drag the variable *Color* from the **Pivot Table Field List** into the **Row Labels** box. You should now see all the colors listed in the Pivot Table.
6. Click and drag *Color* from the **Pivot Table Field List** into the **Values** box. It will automatically choose Count of Color and you will see the counts appear in Pivot Table.
7. Click and drag the variable *Color* from the **Pivot Table Field List** into the **Values** box. Count of Color 2 appears in the Values box.

8. Click the arrow next to Count of Color 2
9. Select **Value Field Settings**
10. Select the Show values as Tab
11. Under Show values as, select % of total from the drop down menu
12. Change the Custom name to % of total
13. Click **OK**

Example 2.1B: Create a pie chart for students' color preferences.

1. First create a Pivot table with appropriate counts as above.
2. Click anywhere inside the Pivot table and click Insert
3. Click Pie and select Pie (the top left option). The pie chart will appear in a graph window.

   Note: To edit the graph, you can use the PivotChart Tools submenu that appears in the menu bar when the graph is selected. This submenu will allow you to complete tasks such as edit the titles, legends and overall appearance of the graph.

Example 2.1C: Create a bar chart for students' color preferences.

1. First create a Pivot table with appropriate counts as above. **Note:** Do not include the % of total column in the Pivot Table, only include the Count of Color.
2. Click anywhere inside the Pivot table and click Insert
3. Click Column and select Clustered column (the top left option). The bar chart will appear in a graph window.

   Note: If you choose Bar rather than Column, you will obtain the same graph, except the bars will be horizontal rather than vertical.

Q Single Quantitative Variable

Recall: Histograms and boxplots are appropriate display methods for single quantitative variables.

For a histogram (A), 5-number summary for a boxplot(B), and boxplot (C) of students' numbers of siblings,

Example 2.2A:

1. First click the tab to create a new sheet. We will store all our information for the next few examples on the Sibs Data in this new worksheet. Double click the sheet name and type Sibs Data.
2. In cell A1 on the Sibs Data worksheet type Bins.

3. In cell A2 type 0, in cell A3 type 1, in cell A4 type 2, in cell A5 type 3, in cell A6 type 4 and in cell A7 type 5
4. Click **Data**
5. Click **Data Analysis**
6. In the dialog box that pops up, select Histogram and click **OK**
7. Click the selection button in the textbox next to Input range. Click the surveydata worksheet tab and select the *Sibs* data **Note:** If you selected the label Sibs, you will need to check the box next to Labels in Histogram dialog box, otherwise leave the box unchecked.
8. Click the selection button in the textbox next to Bin Range. Click the Sibs Data worksheet tab and select cells A1 through A7. **Note:** If you leave this textbox blank, Excel will automatically select bins for you.
9. Check the box next to Chart Output
10. Click **OK**
11. To remove the gaps, right-click a bar in the histogram
12. Click Format Data Series
13. Slide the gap width slider to No Gap
14. Click Close

Example 2.2B:

1. On the Sibs Data worksheet, select cell C1, type 5 number summary for Sibs, in C2 type Q1, in C3 type Min, in C4 type Median, in C5 type Max and in C6 type Q3
2. Select D2 and click Formulas
3. Click Insert Function
4. Find and select QUARTILE and click OK
5. In the Array textbox, select the data for Sibs (click on the surveydata worksheet tab then click and drag to select the data). (Note: Do not select the label Sibs.) In the Quart textbox, type 1 and click OK
6. Select D3 and click Insert Function
7. Find and select MIN and click OK
8. In the Number1 textbox, select the data for Sibs and click OK
9. Select D4 and click Insert Function
10. Find and select MEDIAN and click OK
11. In the Number1 textbox, select the data for Sibs and click OK

12. Select D5 and click Insert Function
13. Find and select MAX and click OK
14. In the Number1 textbox, select the data for Sibs and click OK
15. Select D6 and click Insert Function
16. Find and select QUARTILE and click OK
17. In the Array textbox, select the data for Sibs. In the Quart textbox, type 3 and click OK

Note: It is important to keep the 5 number summary in the order listed above. Failing to calculate the 5 number summary in this order will lead to problems producing a boxplot correctly.

Example 2.2C

1. Select the values you calculated in Example 2.2B and their labels. **Note:** Do not select cell C1.
2. Click Insert
3. Click Line and select Line with Markers (1st column, 2nd row)
4. Click Switch Row/Column from the menu bar
5. Right click any data point and click Format Data Series
6. Click Line Color
7. Click No Line and click Close
8. While any data point is selected, click Layout from the submenu bar (at the top of the screen) for Chart Tools
9. Click Lines and select High-Low lines
10. Click Up/Down Bars and select Up/Down bars
11. Right click on the box and click Format Up Bars
12. Select No fill and click OK

Example 2.2D: This example produces mean, standard error for mean, median, mode, standard deviation, sample variance, kurtosis, skewness, range, minimum, maximum, sum, count, Q1 and Q3.

1. Click **Data**
2. Click **Data Analysis**
3. Select Descriptive Statistics from Analysis Tools
4. Click **OK**

5. In the Input Range textbox, select the data for *Sibs* **Note:** If you selected the label Sibs, you will need to check the box next to Labels in Histogram dialog box, otherwise leave the box unchecked.
6. Check Summary statistics
7. Click **OK**
8. To add Q1 to the output, click the cell under Count and type Q1
9. Select the cell to the right of Q1 and click **Formulas**
10. Click **Insert Function**
11. Select QUARTILE from the list
12. In the Array textbox, select the data for *Sibs.* In the Quart textbox, type 1
13. Click **OK**
14. Under Q1, type Q3
15. Select the cell to the right of Q3 and click **Formulas**
16. Click **Insert Function**
17. Select QUARTILE from the list
18. In the Array textbox, select the data for *Sibs.* In the Quart textbox, type 3
19. Click **OK**

C→Q Relationship between Categorical Explanatory and Quantitative Response Variables

Recall: Side-by-side boxplots are an appropriate display for a categorical explanatory variable and a quantitative response variable.

Example 2.3A: (Paired design) To display and summarize the single sample of differences, ages of dads minus ages of moms, we first notice that these columns may contain missing data. We do not want to summarize the pairs of data that are missing one or both of their values, so we will first need to create a list of differences for which both MomAge and DadAge are not missing

1. Create a new worksheet called MomDadAge Data
2. In A1 type Difference, in B1 type Missing and in C1 type Nonmissing Data
3. In A2 type =
4. Select the surveydata worksheet and select cell X2
5. Type -
6. Select the surveydata worksheet and select cell W2
7. Press Enter
8. Right click cell A2 and click copy

9. Select cells A3 through A447, right click and click paste
10. Select cell B2 and type =if(or(surveydata!X2="", surveydata!W2=""), TRUE, FALSE)
11. Right click cell B2 and click copy
12. Select cells B3 through B447, right click and click paste
13. Select column B and click **Data**
14. Click Filter (an arrow appears in cell B1)
15. Click the arrow in cell B1 and uncheck the box next to TRUE
16. Click **OK**
17. Select all the data showing in column A (without selecting A1), right click and click copy
18. Right click in the cell under Nonmissing Data and click paste
19. Click Filter
20. Right click in cell C2 (this cell should be empty) and click Delete
21. Select Shift cells up and click **OK**
22. Follow the procedure from Example 2.2A to create a histogram for the data in column C

Example 2.3B: (Two-sample design) To compare heights of students in the two gender groups with summaries and a side-by-side boxplot,

1. Select the Female and Male Data worksheet
2. In H1 type Female and in I1 type Male
3. In G2 type Q1, in G3 type Min, in G4 type Median, in G5 type Max and in G6 type Q3
4. Follow the procedure from Example 2.2B to find the 5 number summary for both the female data (put these values in H2 through H6) and for the male data (put these values in I2 through I6)
5. Select cells G1 through I6
6. Click **Insert**
7. Select **Line** and select Line with Markers
8. Click Switch Row/Column
9. For each line (5 total), right click on an endpoint and select Format Data Series
10. Click Line Color and select No Line then click Close
11. Click **Layout** and click Lines and select High-Low Lines

12. Click Up/Down bars and select Up/Down bars
13. Right click in one of the boxes and select Format Up bars
14. Select No fill
15. Click Close

Example 2.3C: (Several-sample design) To compare earnings of students in Years 1 to 3 only (if for some reason the 4th year students are to be omitted),

1. Click on the Earned Data worksheet
2. In cell G1 type Year1, in cell H1 type Year2, in cell I1 type Year3
3. In cell F2 type Q1, in cell F3 type Min, in cell F4 type Median, in cell F5 type Max and in cell F6 type Q3
4. Follow the procedure from Example 2.2B to find the 5 number summary for each category of data
5. Select cells F1 - I6
6. Follow the procedure in Example 2.3A to produce side-by-side boxplots of the Earned data for Years 1, 2 and 3

C→C Relationship between two Categorical Variables

Recall: A contingency table is an appropriate display method for two categorical variables.

Example 2.4: To check for a relationship between major being decided or not, and living situation (on or off campus),

1. Select the surveydata worksheet
2. Click **Insert**
3. Click **Pivot Table**
4. Select all the data in the spreadsheet including labels
5. Ensure New Worksheet is selected and click **OK**
6. Click and drag Dec? into Row labels
7. Click and drag Live into Column labels
8. In the Choose fields to add to report: box, click Dec? and then click on the arrow on the right
9. Uncheck the box next to (blank) and click **OK**
10. In the Choose fields to add to report: box, click Live and then click on the arrow on the right
11. Uncheck the box next to (blank) and click **OK**

12. Click and drag Dec? into Values twice
13. Click the drop down arrow next to Count of Dec?2
14. Select Value Field Settings
15. Click the Show values as tab
16. From the drop down menu select % of row
17. Change the Custom Name to % of row
18. Click OK
19. Click anywhere inside the Pivot Table and click Insert
20. Click Column and choose Clustered Column

Q→Q Relationship between two Quantitative Variables

Recall: A scatterplot is an appropriate display for two quantitative variables.

Example 2.5:

To examine the relationship between ages of students fathers and ages of their mothers, first produce a scatterplot (and verify its linearity):

1. Select the surveydata worksheet
2. Select all data for MomAge and DadAge (you may include the labels)
3. Click **Insert**
4. Click **Scatter**
5. Choose Scatter with Markers only

Example 2.5 (continued): Another way to examine the relationship between ages of students fathers and ages of their mothers is to produce a fitted line plot:

1. Create a scatterplot of MomAge and DadAge as above
2. While the chart is selected, find Chart Layouts at the top of the screen
3. Click Layout 3
4. If you wish to display the equation of the line, right click the line and click Format Trendline
5. Check Display equation on chart
6. Click OK

Lab Activities for Part Two: Displaying and Summarizing Data

2.1. This activity considers method of transportation (bike, bus, car, or walking) for the surveyed students who lived off campus.

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: ________________type: ________________
- second variable (if there are two): ________________type: ________________

(b) **Before you even look at the data**, try to make a rough guess as to which mode of transportation will be most common __________and which will be least common __________.

(c) You can find Transportation for Off-Campus students on the Transportation worksheet. **Use Example 2.1** to produce an appropriate display and summaries; report the proportion in each category: bike __________, bus __________, car __________, walk __________.

(d) **Summarize** your findings in one or two sentences. Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your guesses in (b).

2.2 This activity considers how many credits surveyed students were taking.

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: ________________type: ________________
- second variable (if there are two): ________________type: ________________

(b) **Before you even look at the data**, try to make a rough guess for each of the following: [If you have no idea, just answer with a "?".]

i. (center) mean:__________median: __________

ii. (spread) standard deviation: __________ range: __________to __________

iii. shape:________________
Do you expect outliers? (Explain briefly.)

(c) **Use Example 2.2** to produce an appropriate display and summaries; report the following:
Five Number Summary:______ ______ ______ ______ ______
mean__________standard deviation __________
shape ________________

(d) **Summarize** your findings in one or two sentences. Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your guesses in (b).

2.3A For surveyed students, how does the number of minutes students spent exercising the day before compare with the number of minutes spent on the phone?

(a) In this situation, we should consider type of activity to be one variable, and time spent on the activity to be a second variable. For each of these variables, tell whether it is quantitative or categorical, and whether its role is explanatory or response. Report the explanatory variable first:

- first variable: ____________________type: ____________________
- second variable: ____________________type: ____________________

(b) **Before you even look at the data**, try to make a reasonable guess for each of the following:

i. (center) Do you suspect the students spent more time exercising or on the phone? Do you think the sample of differences, time spent exercising minus time spent on the phone, will average out to a negative number, zero, or a positive number?

ii. (spread) Do you think the typical distance of the differences from their mean will be just a few minutes or at least an hour? ____________________

iii. (shape) Do you expect the distribution of differences to be left-skewed or right-skewed? ____________________Do you expect outliers? ____________________

(c) **Use Example 2.3A** to produce an appropriate display and summaries to make a comparison:

i. On average, did the sampled students spend more time exercising or on the phone? ____________________

ii. Report and interpret the standard deviation of the time differences. ____________________

iii. Report and interpret the shape of the distribution of time differences. ____________________

(d) **Summarize** your findings in one or two sentences. Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your guesses in (b).

2.3B For surveyed students, how do the shoe sizes of males compare to those of females?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: ____________________type: ____________________
- second variable (if there are two): ____________________type: ____________________

(b) **Before you even look at the data**, try to make a reasonable guess for each of the following:

i. Which group will have a higher center (or about the same)?____________

ii. Which group will have more spread (or about the same)?____________

iii. What shapes do you expect?
Do you expect outliers?

(c) **Use Example 2.3B** to produce an appropriate display and summaries to make a comparison:

i. Does one group have a considerably higher center? __________________

ii. Does one group have more spread? __________________

iii. Compare the shapes. __________________

(d) **Summarize** your findings in one or two sentences. Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your guesses in (b).

2.4 Does living on or off campus depend at all on whether a surveyed student is male or female?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: __________________type: __________________
- second variable (if there are two): __________________type: __________________

(b) **Before you even look at the data**, do you expect the variables to be related?____________
If so, for which explanatory group do you expect to see a higher proportion living on campus? __________________

(c) **Use Example 2.4** to produce an appropriate display and summaries. Does one group have a considerably higher proportion living on campus? __________________

(d) **Summarize** your findings in one or two sentences. Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your guesses in (b).

2.5 How are surveyed students' heights and weights related?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: __________________type: __________________
- second variable (if there are two): __________________type: __________________

(b) **Before you even look at the data**, try to make a reasonable guess for each of the following: [If you have no idea, just answer with a "?".]

i. form (linear or curved): ___________________

ii. direction (positive, negative, or none):___________________

iii. strength (strong, moderate, or weak):___________________
Do you expect outliers or influential observations? (Explain briefly.)

(c) **Use Example 2.5** to produce an appropriate display and summaries in order to answer the following:
Does the form appear roughly linear?____________
What is the regression line equation?__________________
What is the value of the correlation r? ____________
What is the typical residual size s? ____________

(d) **Summarize** your findings in one or two sentences. Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your guesses in (b).

For more practice with techniques from this section, try these exercises from your text: Exercises 4.13 - 4.16, Exercises 4.41 - 4.45, Exercises 4.65 - 4.67, Exercises 4.85 - 4.86, Exercises 4.98 - 4.99, Exercises 5.84 - 5.90, Exercises 5.99 - 5.101, Exercises 5.115 - 5.119, Exercises 8.65 - 8.68, Exercises 8.80 - 8.83

Part 3: Probability

Examples for Part Three: Probability

Example 3.1 Generate a random sample of 10 heights from given data.

1. Select cell D449 and click Formulas
2. Click Insert Function
3. Find the RANDBETWEEN function and click OK
4. In the Bottom textbox, type 2
5. In the Top textbox, type 447 (the # of observations you have)
6. Click OK
7. Find the observation corresponding to the random number that appeared in the cell and record it. This is your first observation in your random sample.
8. Continue this process until you have sampled 10 heights.

   Note: In order to sample without replacement, if your RANDBETWEEN function produces the same number more than once during your sample, simply ignore it and try again.

Lab Activities for Part Three: Probability

3.1 **Use Example 3.1** to randomly sample (without replacement) 5 values from the column **Cash** and report the total amount of cash carried by the five selected students.

____

3.2 The probability that at least two people in a group of 23 have the same birthday is approximately 0.50; the probability that at least two people in a group of 60 have the same birthday is approximately 0.99?

1. **Use Example 3.1** to sample dates of the year, reprented by the numbers 1 through 365.
2. Sample 23 dates with replacement, sort them, and check if there are duplicates. Take a total of twenty such samples with replacement, and report what proportion contain duplicates: ____________Is it close to 0.50? __________________
3. Sample 60 dates with replacement, sort them, and check if there are duplicates. Take a total of twenty such samples with replacement, and report what proportion contain duplicates: ____________Is it close to 0.99? __________________

Part 4: STATISTICAL INFERENCE

Examples for Part Four: Statistical Inference

C Single Categorical Variable

Recall: A Z-test is used when testing hypotheses about population proportions.

Example 4.1A: Use Excel to do inference about the population proportion of males/females; specifically, test if the sample represents a population with less than 40% males. Including a display is a good habit to acquire in using software to perform inference.

1. Create a Pivot chart summarizing the counts of males and females
2. Create a Pie Chart from this Pivot table
3. In D3 (on the worksheet containing the Pivot table) type Sample size n then in E3 input the total number of observations (Grand total from Pivot table)
4. In D4 type successes and input the number of males E4
5. In D5 type Sample proportion and in E5 type =E4/E3
6. In the D6 Null hypothesis and type .4 in E6
7. In D7 type Standard error and type =sqrt((E6*(1-E6))/E3)
8. In D8 type Z test statistic and in E8 type = (E5-E6)/E7
9. In D9 type p-value
10. Select E9 and click Formulas then click Insert function
11. Find and select NORMDIST and click OK
12. In the X textbox, select E8, in the Mean textbox type 0, in the Standard_dev textbox type 1, in the Cumulative textbox type TRUE
13. Click OK

Q Single Quantitative Variable

Recall: A Z-test is used to test hypotheses about a single population mean (or construct confidence intervals) when σ is known. A t-test is used to test hypotheses about a population mean (or construct confidence intervals) when σ is unknown.

Example 4.2A: (σ known) Assume Verbal SAT scores of surveyed students to be a random sample taken from scores of all students at a particular university, whose mean score is unknown and standard deviation is 100. Use sample scores to obtain a 90% confidence interval for the unknown population mean score, after producing a histogram of the scores.

1. Create a histogram as described above
2. Select cell C449 and click **Formulas**

3. Click **Insert Function**
4. Find and select AVERAGE
5. In the Number1 textbox, select the data for *Verbal* and click **OK**(Do not select the label.)
6. Select cell C450 and click **Formulas**
7. Click **Insert function**
8. Find and select CONFIDENCE and click **OK**
9. In the Alpha textbox, input .10
10. In the Standard_dev textbox, input 100
11. In the Size textbox, input 391 (total number of nonmissing values) and click **OK**
12. To create the upper value, select C451 and type =C449+C450
13. To create the lower value, select C452 and type =C449-C450

Example 4.2A: (continued) Next, test the null hypothesis that Verbal SAT scores of surveyed students are a random sample taken from a population with mean 600 against the alternative that the mean is less than 600. Assume the population standard deviation to be 100. [If population standard deviation were **not** assumed to be known, a **1-Sample** *t* test would be used, and **Standard deviation** would not be specified.]

1. Select C453 and Click Formulas
2. Click Insert Function
3. Find and select ZTEST
4. Click OK
5. In the array textbox, select all data for Verbal excluding the column name
6. In the X textbox, enter 600 (the hypothesized value to test)
7. In the Sigma textbox, enter 100
8. Click OK
9. For a one sided test, select C454 and type =1-C453
10. For a two sided test, select C454 and type =2*(1-C453)

NOTE: To find the z value associated with the above p-value, use the NORMINV function, inputting the p-value in the Probability textbox and 0 in the Mean textbox and 1 in the Standard_dev.

Example 4.2B: (σ unknown) Now assume Verbal SAT scores of surveyed students members to be a random sample taken from scores of all students at a particular university, whose mean **and** standard deviation are unknown. Use sample scores to obtain a 99% confidence interval for the population mean score.

1. Select C455 and click **Formulas**
2. Click **Insert Function**
3. Find and select STDEV
4. Click **OK**
5. In the Number1 textbox, select the data for *Verbal*
6. Click **OK**
7. Select C456 and click Formulas
8. Click Insert Function
9. Find and select TINV
10. Click OK
11. In the Probability textbox, type .01
12. In the Deg_freedom textbox, type 390 and click **OK**
13. To find the upper bound of the confidence interval, in C457 type =C449+C456*C455
14. To find the lower bound of the confidence interval, in C458 type =C449-C456*C455
15. To find the p-value for a t-test for the mean, select C459 and click **Formulas**
16. Click **Insert Function**
17. Find and select ZTEST
18. In the Array textbox, select the values for *Verbal*
19. In the X textbox, type 600
20. Leave the Sigma textbox empty
21. For a one-sided test, click in C460 and type=1-C459
22. For a two-side test, click in C460 and type=2*(1-C459)

C→Q Relationship between Categorical Explanatory and Quantitative Response Variables

Recall: A paired t-test is used to test hypotheses involving two population means when the two samples involved are dependent. A two-sample t-test is used to test hypotheses involving two population means when the two samples involved are independent. An ANOVA is used to test hypotheses involving more than two population means.

Example 4.3A: (Paired design) [Note: If the data has no missing values you can use the procedure in Appendix A Example Ap 4.3A.] Do students' dads tend to be older than their moms? Test the null hypothesis that the mean of differences (ages of dads minus ages of moms) for the larger population is zero, against the alternative that the mean of differences is positive.

1. Select C452, and click **Formulas**
2. Click **Insert Function**
3. Find and select TTEST
4. Click OK
5. In the Array1 textbox, select the values for DadAge (do not select the name of the column)
6. In the Array2 textbox, select the values for MomAge (do not select the name of the column)
7. In the Tails textbox, type 1
8. In the Type textbox, type 1
9. Click OK (The value provided is the p-value.)

Note: To find the t value associated with the above p value, use the TINV function, inputting the p value in the Probability textbox and 430 for Deg_freedom.

Example 4.3B: (Two-sample design) [Note: If the data has no missing values you can use the procedure in Appendix A Example Ap 4.3B.]

Use Excel to check if, on average, there is a difference between amount of cash carried by female and male students. Procedure may or may not be pooled.

1. Select the Worksheet titled Female and Male data
2. Create side-by-side boxplots as above using the *Female Cash* and *Male Cash* columns
3. Select O2 and click **Formulas**
4. Click **Insert Function**
5. Find and select TTEST
6. In the Array1 textbox, select the Female Cash data
7. In the Array2 textbox, select the Male Cash data
8. In the Tails textbox, type 2
9. In the Type textbox, type 3 to run a test with unequal variances
10. Click OK (the value obtained is the pvalue)
11. Since the sample standard deviations are fairly close, repeat the test using a pooled procedure: once again, click Insert Function and find and select TTEST, input the same information, except in the Type textbox, type 2.
12. Click OK

Note: To find the t value associated with this p value, use the TINV function as above.

Example 4.3C: (Several-sample design) Use Excel to see if there is a significant difference in mean earnings of freshmen, sophomores, juniors, and seniors in the class. Include side-by-side boxplots to display the data.

1. Select the Earned Data worksheet
2. Click Data
3. Click Data Analysis
4. Select Anova: Single Factor
5. Click OK
6. Select all the data excluding the labels
7. Click OK

C→C Relationship between two Categorical Variables

Recall: A χ^2 test is used to determine if two categorical variables are independent or dependent.

Example 4.4: Use Excel to check for a relationship between major being decided or not, and living situation (on or off campus).

1. Create a Pivot table with counts of Dec? and Live
2. In G3 type Expected Counts, in H3 type Off, in I3 type On, in G4 type No and in G5 type Yes
3. In H4 type =(E5*B8)/E8
4. In I4 type =(E5*C8)/E8
5. In H5 type =(E6*B8)/E8
6. in I5 type =(E6*C8)/E8
7. Click G7 and click **Formulas**
8. Click **Insert function**
9. Find CHITEST and click OK
10. In the Actual range box, select B5:C6
11. In the Expected range box, H4:I5
12. Click OK (the value obtained is the p-value)

Q→Q Relationship between two Quantitative Variables

Recall: Correlation and testing to determine if the slope of the regression line is 0 are methods to determine if a linear relationship exists between two quantitative variables.

Example 4.5: Use Excel to examine the relationship between ages of students fathers and ages of their mothers; after verifying the linearity of the scatterplot, find the correlation r and the regression equation.

[**Note:** If the data has no missing values, you can use the procedure in Appendix A Example Ap 4.5]

1. Create a scatterplot as in Example 2.5
2. Click **Data**
3. Click **Data Analysis**
4. Find Correlation and select it
5. Click **OK**
6. Select your data and check Labels in the first column if you have include the labels in your selection
7. Click **OK**

   Note: The correlation between the two variables will appear in the table where the two variables cross.
8. In cell W449, type Slope and in cell W450, type Intercept
9. Select cell X449, click Formulas
10. Click Insert Function
11. Find and select the SLOPE function
12. Click OK
13. In the Known_Y's textbox, select the data for DadAge without selecting the header
14. in the Known_X's textbox, select the data for MomAge without selecting the header
15. Click OK
16. Select cell X450, click Formulas
17. Click Insert Function
18. Find and select the INTERCEPT function
19. In the Known_Y's textbox, select the data for DadAge without selecting the header
20. in the Known_X's textbox, select the data for MomAge without selecting the header
21. Click OK

Lab Activities for Part Four: Statistical Inference

4.1 The proportion of American adults who smoked at the time the students were surveyed was 0.25. Was the proportion significantly lower for university students?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: ___________________type: ___________________
- second variable (if there are two): ___________________type: ___________________

(b) **Before you even look at the data**, give a rough guess for the population proportion of students who smoked ____________. Then formulate null and alternative hypotheses to test if the population proportion was necessarily less than 0.25.
H_0 :
H_a :
Do you suspect that there will be enough evidence to reject H_0?____________

(c) **Use Example 4.1** to display the data. ___________________
Test your hypotheses, making sure to opt for the correct alternative: the P-value is ____________. Do you reject H_0?____________

(d) **State your results**: since you did or did not reject H_0, what do you conclude about the unknown population proportion? Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your suspicions in (b).

4.2A (σ known) Math SAT scores are assumed to have a standard deviation of 100. Is the mean Math SAT score of all intro Stat students at a particular university 600?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: ___________________type: ___________________
- second variable (if there are two): ___________________type: ___________________

(b) Before you even look at the data, formulate null and alternative hypotheses about the population mean μ.
H_0 :
H_a :
Do you suspect that there will be enough evidence to reject H_0?____________

(c) **Use Example 4.2A** to carry out a z test, specifying σ and making sure to opt for the correct alternative ($<$, $\neq$, or $>$); include a display of the data. What is

the P-value?____________
Do you reject H_0?____________
Give a 95% confidence interval for μ:__________________

(d) **State your results**: based on the outcome (you did or did not reject H_0), what do you conclude about the unknown population mean? Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your suspicions in (b).

4.2B (σ unknown) Adults in the U.S. average 7 hours of sleep a night. Is this also the mean for the population of students at a particular university?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: __________________type: __________________
- second variable (if there are two): __________________type: __________________

(b) **Before you even look at the data**, formulate null and alternative hypotheses about the population mean μ.
H_0 :
H_a :
Do you suspect that there will be enough evidence to reject H_0?____________

(c) Note: When σ is unknown, you should carry out a test of your hypotheses using a t procedure, not z. Use **Example 4.2B** to carry out the one-sample t procedure, making sure to opt for the correct alternative ($<$, $\neq$, or $>$); include a display of the data. What is the P-value?____________
Do you reject H_0?____________
Give a 95% confidence interval for μ:__________________[Note: this was automatically provided if your alternative was $\neq$; otherwise, repeat the t procedure, this time opting for a two-sided alternative.]

(d) **State your results**: based on the outcome (you did or did not reject H_0), what do you conclude about the unknown population mean? Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your suspicions in (b).

4.3A Overall, is there a positive mean difference between the number of minutes students spend on the computer versus the number of minutes they spend exercising? (The initial suspicion is that students spend more time on the computer than they do exercising.)

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: ___________________type: ___________________
- second variable (if there are two): ___________________type: ___________________

(b) **Before you even look at the data**, formulate null and alternative hypotheses about the population mean difference μ_d.
H_0 :
H_a :
Do you suspect that there will be enough evidence to reject H_0?____________

(c) **Use Example 4.3A** to carry out a paired t procedure, making sure to opt for the correct alternative ($<$, $\neq$, or $>$); include a display of the data. What is the P-value?____________
Do you reject H_0?____________

(d) **State your results**: based on the outcome (you did or did not reject H_0), what do you conclude about the unknown population mean difference? Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your suspicions in (b).

4.3B Is the mean number of credits taken the same for all on- and off-campus students at a particular university?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: ___________________type: ___________________
- second variable (if there are two): ___________________type: ___________________

(b) **Before you even look at the data**, formulate null and alternative hypotheses about the difference $\mu_1 - \mu_2$ between population means for the two groups. [The null hypothesis usually states that this difference is zero.]
H_0 :
H_a :
Do you suspect that there will be enough evidence to reject H_0?____________

(c) **Use Example 4.3B** to carry out a two-sample t procedure, making sure to opt for the correct alternative ($<$, $\neq$, or $>$); include a display of the data. What is the P-value?____________
Do you reject H_0?____________

(d) **State your results**: based on the outcome (you did or did not reject H_0), what do you conclude about the unknown difference between population means? Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your suspicions in (b).

4.3C In general, is mean age the same for students who wear contact lenses, glasses, or neither?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: ____________________type: ____________________
- second variable (if there are two): ____________________type: ____________________

(b) **Before you even look at the data**, formulate null and alternative hypotheses about the population means.
H_0 :
H_a :
Do you suspect that there will be enough evidence to reject H_0?____________

(c) **Use Example 4.3C** to carry out an ANOVA procedure; include a display of the data. What is the P-value?____________
Do you reject H_0?____________

(d) **State your results**: based on the outcome (you did or did not reject H_0), what do you conclude about the various population means? Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your suspicions in (b).

4.4 Is there a statistically significant relationship between whether or not a student smokes and whether the student lives on or off campus?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: ____________________type: ____________________
- second variable (if there are two): ____________________type: ____________________

(b) **Before you even look at the data**, formulate null and alternative hypotheses about the relationship between those variables.
H_0 :
H_a :
Do you suspect that there will be enough evidence to reject H_0?____________

(c) **Use Example 4.4** to construct a two-way table of counts and row percents, and carry out a chi-square test; include a display of the data. What is the P-value?____________
Do you reject H_0?____________

(d) **State your results**: based on the outcome (you did or did not reject H_0), do you conclude that those variables are related? Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your suspicions in (b). ____________

4.5 Is there a relationship between the heights of students' fathers and mothers?

(a) What variable or variables are involved? For each variable, tell whether its type is quantitative or categorical. If the situation involves two variables, report the explanatory variable first.

- first variable: __________________type: __________________
- second variable (if there are two): __________________type: __________________

(b) **Before you even look at the data**, formulate null and alternative hypotheses about the slope β_1 of the population regression line.
H_0 :
H_a :
Do you suspect that there will be enough evidence to reject H_0?____________

(c) **Use Example 4.5** to display the data and verify that the form is reasonably linear. Then carry out a regression procedure to test your hypotheses. What is the P-value?____________
Do you reject H_0?____________

(d) **State your results**: based on the outcome (you did or did not reject H_0), do you conclude that the population variables are related? Be sure to express your results specifically in terms of the variable(s) of interest, and mention to what extent the results match your suspicions in (b).

For more practice with techniques from this section, try these exercises from your text:

Exercises 9.32 - 9.35, Exercises 9.68 - 9.71, Exercises 9.93 - 9.95, Exercises 10.73 -10.85, Exercises 11.50 - 11.51, Exercises 11.70 - 11.73, Exercises 11.80 - 11.103, Exercises 12.44 - 12.54, Exercises 13.50 - 13.58

1 Appendix A

Example Ap 4.3A To complete a t-test for paired samples:

1. Click **Data**
2. Click **Data Analysis**
3. Select t-Test: Paired Two Sample for Means
4. Click **OK**
5. In the Variable 1 Range textbox, select the data for the first sample
6. In the Variable 2 Range textbox, select the data for the second sample
7. In the Hypothesized Mean Difference type the value to be tested
8. In the Alpha textbox, type the appropriate value for the significance level
9. Click **OK**

Return to Example 4.3A

Example Ap 4.3B To complete a two sample t-test assuming equal variances (unequal variances):

1. Click **Data**
2. Click **Data Analysis**
3. Select t-Test: Two-Sample Assuming Equal Variances (Unequal Variances)
4. Click **OK**
5. In the Variable 1 Range textbox, select the data for the first sample **Note:** If you selected the label for the data, you will need to check the box next to Labels in Histogram dialog box, otherwise leave the box unchecked.
6. In the Variable 2 Range textbox, select the data for the second sample **Note:** If you selected the label for the data, you will need to check the box next to Labels in Histogram dialog box, otherwise leave the box unchecked.
7. In the Hypothesized Mean Difference type the value to be tested
8. In the Alpha textbox, type the appropriate value for the significance level
9. Click **OK**

Return to Example 4.3B

Example Ap 4.5

To examine the relationship between two quantitative variables by producing the regression equation:

1. Click **Data**
2. Click **Data Analysis**
3. Select Regression
4. Click **OK**
5. In the textbox for Input Y Range, select the response (dependent) variable
6. In the textbox for Input X range, select the explanatory (independent) variable
7. Check the box next to Residuals
8. Click **OK**

Return to Example 4.5