**CHAPTER 4**

**Numeric Simulations**

A numeric simulation is a procedure that imitates certain kind of behavior from a physical experiment or process. The goal of a simulation is to estimate certain characteristics or parameters from the process that we are interested to simulate. The simulation imitates only the important characteristics from the experiment and ignores any non-essential behavior.

*Class Exercises*: Practice some simulations that correspond to certain kind of experiments.

1. Generate a sequence of numbers that simulate the gender of 100 newborn babies. Use the code 1 for boys, 0 for females. Assume that the probability of having a boy or a girl is equally likely. Obtain a table that summarizes the total number of babies by gender.

First, let’s open a new data table:

*Figure 4.1*

Then right click over the heading on “Column 1”

*Figure 4.2*
Then click on the box next to “Column Name” and change the name to “Births” next click over “Column Properties” and select “Formula”

Figure 4.3

next, click over “Edit Formula”

Figure 4.4

then, choose “Random” and “Random Binomial”
Figure 4.5

![Image of JMP window](image)

Click over “n” inside the formula

Figure 4.6

![Image of JMP window](image)

Type 1 over $n$, and type 0.5 over $p$, here notice that we are defining a binomial distribution with a single trial and a probability of success of 0.5, (indeed, a binomial distribution with a single trial is called a Bernoulli distribution, but we do not have that specific distribution in JMP)
then, click over OK in this window and the next window, apparently nothing happens, but we still have to add rows in order to be able to see the changes. Next, right click over the first row on the right side and select “Add Rows…”

Figure 4.8

type 100 on the box next to “How many rows to add:”
click over “OK” and you can see a sequence of 100 outcomes that contains either a “0” or “1”,

you can summarize these results by using the option “Tables” and “Tabulate” as follows:
next, drag "Births" over the "Drop zone for columns"

Figure 4.12

select the option “Add Grouping Columns” and you can see a table that contains the counts for “0”’s and “1”’s, please be aware that your numbers may differ from the ones shown here (remember, we generated a sequence of random numbers, thus, results may differ)

Figure 4.13

2- Generate a sequence of numbers that simulate the outcomes from throwing a die 500 times, summarize your outcomes on a table that counts the number of occurrences for each value.

Repeat previous steps from figures 1 and 2. Then click on the box next to “Column Name” and change the name to “Dice” next click over “Column Properties” and select “Formula”
then, click over the option “Edit Formula” as shown

choose from the list “Random” and “Random Integer” as follows:
then, type number 6 inside the parenthesis and hit enter, next click “OK” in this window, and click “OK” again on the second window

Apparently, nothing happens, but we still have to add a number of rows (in this case 500). Next, right click on the leftmost cell at the upper left corner, and click over add rows
next, type 500 in the box next to “How many rows to add” and click OK

at this point you can see the randomly generated numbers on the data table. We can summarize these results by using the option “Tables” and selecting “Tabulate”

drag and drop the variable “Dice” over the “Drop zone for Columns”, then select the option “Add Grouping Columns”
then, you can see a table that summarizes the number of results for each possible outcome, these numbers are approximately equal, remember that this is a simulation, thus, they do not have to be exactly the same.

3- Heights of adult males in the United States follow a normal distribution with a mean of 69” and a standard deviation of 2.9”. Generate 150 heights of males using a normal distribution. Obtain a histogram and summarize this data set. Comment on the characteristics of this dataset.

Repeat previous steps from figures 1 and 2. Then click on the box next to “Column Name” and change the name to “Heights”, next click over “Column Properties” and select “Formula”
click over “Edit Formula”

a new window will open, then select “Random” and “Random Normal”,

a formula is shown in the formula editor window
click inside the parenthesis and type the mean and standard deviation separated by a comma, that is 69, 2.9

click “OK” in this window and in the next window, apparently nothing happens, then right click on the cell at the top on the left side of the screen and select add rows
type 150 on the box next to “How many rows to add”

click over “OK” and you can see the randomly generated data on the data table. Next you can describe this dataset using the “Analyze” and “Distribution” option from that menu. Verify that the mean and standard deviation are close to the parameters that were used to generate these random numbers and that the shape is approximately normal.
Class Exercises:

With the help of your instructor, do the following class activities:

1. Row a pair of dice 80 times and obtain the sum of these outcomes. (Hint: use column one for one die, then column two for the second die, add a third column and write a formula to add the contents of columns one and two). Summarize your results for the sum of two dice in a table.

2. Generate 10 flips of a coin (H=1, T=0), and summarize the results in a table. Then, repeat the same simulation, this time using 100 trials and summarize your results. Repeat the experiment again with 1,000 trials and summarize your results. What do you observe in these results? How can you relate these results to the law of large numbers? (Hint: use a binomial distribution with 1 trial that is equal to a Bernoulli distribution, and use a probability of success of 0.5).

3. IQ scores are normally distributed with a mean of 100 and a standard deviation of 15. Generate a normally distributed sample of these scores and sort your results. Then, summarize your results by using a histogram and the appropriate summary statistics. What can you observe in these graph and summary statistics?

Team Assignment:

Now, assume that you have been awarded an all paid trip to Las Vegas. Congratulations! You have been awarded all travel expenses plus $1,000 in cash to use it as you wish. A classmate suggests that you should gamble all your money hoping to make a big profit. However, you decide to perform some simulations before risking your money. You will use JMP and Excel to perform these simulations. You have to simulate results from the roulette using the following facts:

A bet on one number only, called a straight-up bet, pays 35 to 1. In the USA the wheel has 38 slots representing 36 numbers and two zeros. To play roulette, you place your bet or bets on numbers (any number 1-36) on the table layout. Consider a simulation using a Bernoulli random variable using a probability of winning of 1/38 and a pay-back of 35 (That is; you get 35 times your bet for every time you win). Then perform a simulation using single bets of equal amounts of money that will exhaust the 1,000 dlls. (I do not encourage gambling, this is a cheaper alternative). See what happens when considering these possible scenarios:

(Make as many bets as needed or until you lose all you money)

- straight-up bets of $100
- straight-up bets of $50
- straight-up bets of $10
- straight-up bets of $1

Look at the history of your results. You may need to export these results to Excel to perform some computations and tell me your story. Compare your results with your classmates. Write a summary of your findings and conclude if it makes economic sense to bet on the roulette. How your findings relate to the law of large numbers? Tell me what strategy would you use (if any). Are you still planning to bet your money? If yes, I would wish you good luck (you may need it).