Discovering BUSINESS STATISTICS

SECOND EDITION

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CHAPTER PROJECTS

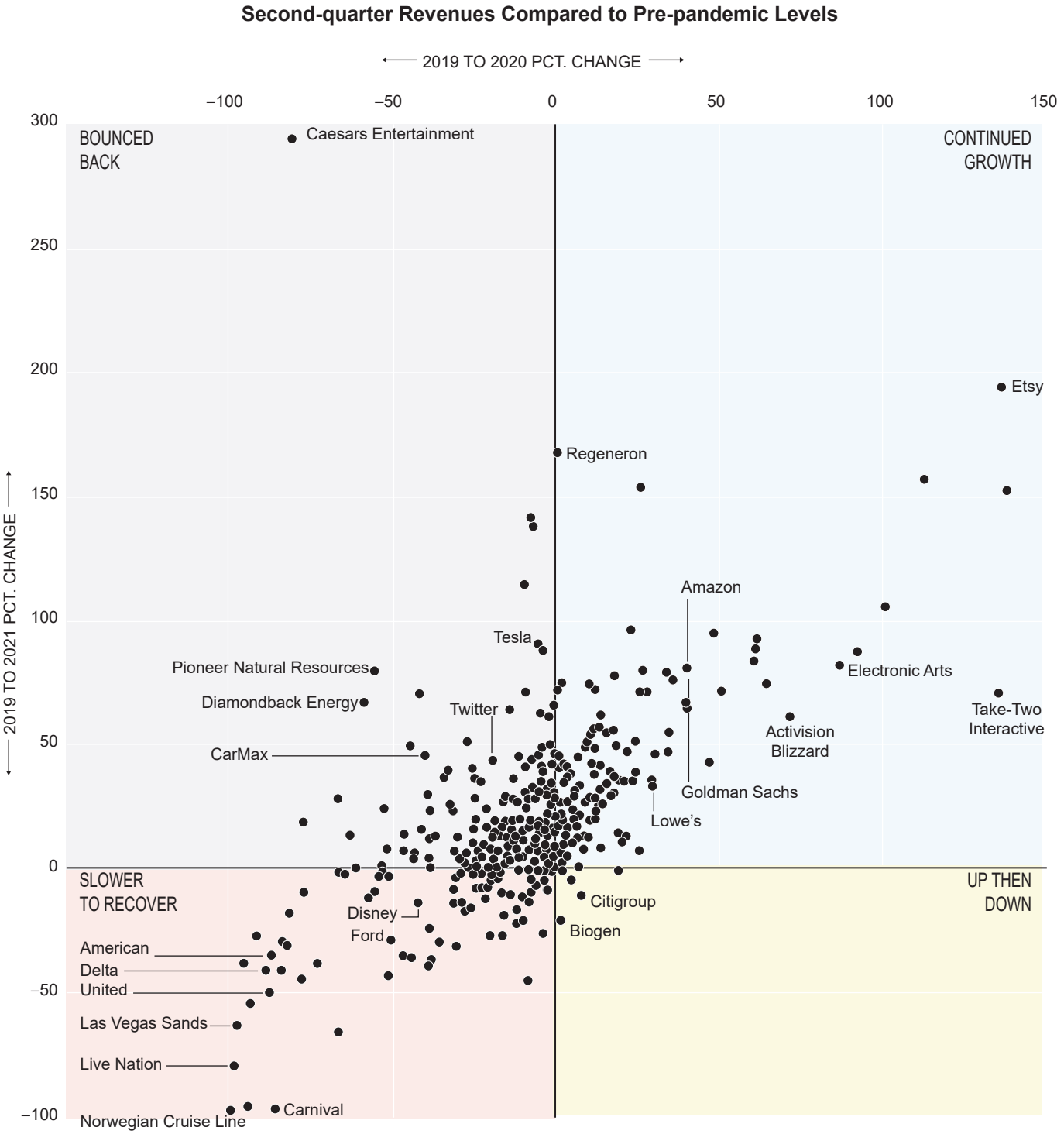
HAWKES LEARNING

P Discovery Project

The Performance of the S&P 500 Companies During the Covid-19 Pandemic

An article published by the Wall Street Journal in August of 2021 summarized the effects of Covid-19 on the performance of the S&P 500 companies. More than three-fourths of the companies reported higher revenues than pre-pandemic levels. Of those reporting higher levels of revenue, 213 reported revenues in the second quarter of 2021 above 2019 levels after undergoing a drop in revenues in 2020. Of the remaining 153 companies that had higher revenues, revenues in the second quarter for the past two years exceeded 2019 levels. There were 101 companies in the S&P 500 that had revenues below 2019 levels and ten companies experienced a drop in revenue in 2021 after having a rise in income in 2020.

The revenue figures are based on FactSet data for the 477 S&P companies that reported their revenue for the second quarter of 2021. Approximately one-third of the S&P 500 have seen steady or rapid growth throughout the pandemic. The companies that have fared the best are the pharmaceutical, retail, and semiconductor companies. Moderna Inc. experienced the largest increase in revenue of all the S&P companies. Moderna's revenue increased 33,187% from the second quarter of 2019 to the second quarter of 2021, a value too large to include in the figure below. The consumer services sector experienced the largest decline in second quarter 2021 revenues, largely due to companies related to travel and tourism.



Note: Moderna is excluded. Its second quarter revenue percentage change since 2019 was 407.3% in 2020 and 33,187% in 2021.

Source: FactSet

Based on the article summary and the figure, answer the following questions.

1. What is the population of interest?
2. What is/are the variable(s) of interest?
3. Which company experienced the largest percentage change from 2019 to 2021?
4. Based on the figure, which company experienced the largest percentage change from 2019 to 2021? Can you think of an explanation of why this is the case?
5. Based on the figure, which company experienced the smallest percentage change from 2019 to 2021? Can you think of an explanation of why this is the case?
6. Based on the figure, which company did a major recovery from 2020 to 2021 based on revenues? Do some research on the internet to find out what caused the company to make such a major recovery.

P Discovery Project

Bachelor's Degrees Conferred by Race/Ethnicity

Review the following graph using data from IPEDS (Integrated Postsecondary Education Data) collected from Fall 2000 through Fall 2016 and answer the questions below.

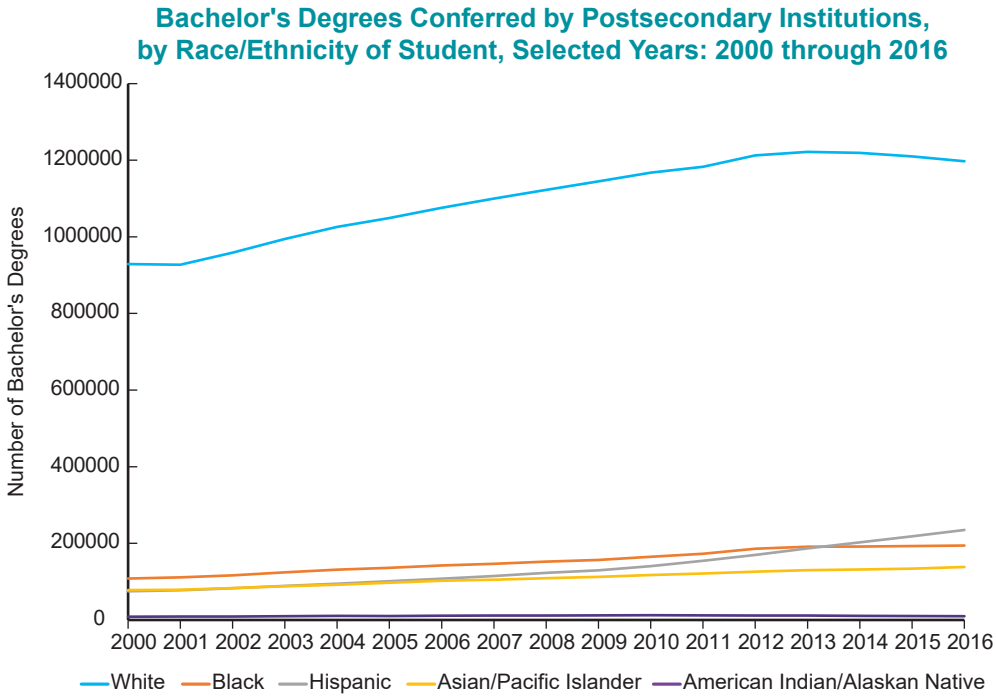
Bachelor's Degrees Conferred by Postsecondary Institutions, by Race/Ethnicity of Student Selected Years: 2000 through 2016

Year	White	Black	Hispanic	Asian/Pacific Islander	American Indian/Alaskan Native
2000	929,102	108,018	75,063	77,909	8,717
2001	927,357	111,307	77,745	78,902	9,049
2002	958,597	116,623	82,966	83,093	9,165
2003	994,616	124,253	89,029	87,964	9,875
2004	1,026,114	131,241	94,644	92,073	10,638
2005	1,049,141	136,122	101,124	97,209	10,307
2006	1,075,561	142,420	107,588	102,376	10,940
2007	1,099,850	146,653	114,936	105,297	11,455
2008	1,122,675	152,457	123,048	109,058	11,509
2009	1,144,628	156,603	129,473	112,581	12,221
2010	1,167,322	164,789	140,426	117,391	12,405
2011	1,182,690	172,731	154,450	121,118	11,935
2012	1,212,417	185,916	169,736	126,177	11,498
2013	1,221,908	191,233	186,677	130,129	11,432
2014	1,218,998	191,437	202,425	131,662	10,784
2015	1,210,071	192,829	218,098	133,916	10,202
2016	1,197,399	194,473	235,014	138,270	9,737

Source: U.S. Department of Education, National Center for Education Statistics, Higher Education General Information Survey (HEGIS), "Degrees and Other Formal Awards Conferred" surveys, 1976-77 and 1980-81; Integrated Postsecondary Education Data System (IPEDS), "Completions Survey" (IPEDS-C:90-99); and IPEDS Fall 2000 through Fall 2016, Completions component. (This table was prepared August 2017).

Data

This data set can be found on stat.hawkeslearning.com under **Discovering Business Statistics, Second Edition > Data Sets > Bachelor's Degrees Conferred by Race and Ethnicity**.



1. Are the data displayed in the graph above discrete or continuous?
2. What is the level of measurement of the data?
3. Are the data above time series or cross-sectional data?
4. Examine the data for each race/ethnicity group. Do the data represent a stationary or nonstationary process? Explain your reasoning for each.
5. Do any of the race/ethnicity groups exhibit a decreasing trend? Try to think of some reasons why this is true.
6. Do any of the race/ethnicity groups show a strictly increasing trend over the entire time period from 2000 to 2016?

P Discovery Project

Your manager asked you to look at your company performance verses other similar companies in your field. You feel that your company has had a successful year. To show this you decide to compare your company's performance with other successful companies. Choose a company that is traded on the United States New York Stock Exchange. This stock will then be considered "your company" for this project. The stock that your company will be compared against is the S&P 500 Information Technology Index or S&P 500 for short.

1. **Download Data**
   - **a.** Download, copy and paste or transcribe the stock data for your company and S&P 500 for the prior year. For example, if it is 2021 then download 1/1/2020 to 12/31/2020 stock performance. Hint: use the internet and search how to download stock data.
     - When downloading your year of data, use the frequency of one week or one data point per week for approximately 52 data points.
     - Only use the Close of market (Close for short) data for this project.
2. **Plotting Time Domain Data**
   - **a.** Create separate plots for your company's stock and the S&P 500 for the year. Remember to label the figure and don't forget to include units such as dollars for the y axis (two graphs).
   - **b.** Create a time series plot including both companies' stocks (one graph).
3. **Hypothetical Investment**
   - **a.** The stock prices of your company and the S&P 500 may vary greatly. To avoid this problem, you decide to make a hypothetical investment of $1,000 at the first of the year. Before doing that, normalize your data by dividing each value by the largest value in your dataset. All your values should be less than or equal to 1. Repeat Part 2 steps A and B plots using the hypothetical investment data (three graphs).
   - **b.** Compare and contrast the plots from Parts 2 and 3.
4. **Report Findings to the Manager**

   After looking at the performance of your company and the S&P 500 write a 1-2 paragraph summary of your findings such as what was learned from the different plots, or how they stocks performed during different time frames. Include other suggestions to further benchmark performance.

P Discovery Project

Data

This data set can be found on stat.hawkeslearning.com under **Discovering Business Statistics, Second Edition > Data Sets > JDC Realty Property Sales Prices**.

Describing Real Estate Data

Answer the following questions regarding the realty data gathered on the selling prices and commissions of properties sold by JDC Realty in Southwest Virginia.

Use the JDC Realty Property Sales Prices data set. This data set contains information about 240 properties sold between January 2020 and November 2020.

Note that the gross commission paid is equal to the commission percentage multiplied by the sales price. Also note that the amount paid to the agent, the amount paid for referrals, agent liability costs, and the net office amount add up to the gross commission paid.

1. Create a histogram of the property sales prices. Do the data appear symmetric or skewed? Are there any outliers?
2. Calculate the following measures of location for sales prices and compare them: mean, median, 10% trimmed mean. Which of these measures do you think gives us the best estimate of the center of the data and why?
3. Calculate the variance and standard deviation of sales prices.
4. Use Chebyshev's Theorem to find the range of values in which at least 75% of the sales price data will reside.
5. Calculate the five summary measures needed to construct a boxplot of sales prices and create the boxplot.
6. Calculate the interquartile range for sales prices and use this value to identify any potential outliers.
7. Create a scatterplot of Pay Agents vs. Sales Price.
8. Calculate the correlation coefficient between Pay Agents and Sales Price. Describe the relationship indicated by the scatterplot and the correlation coefficient. Can you think of any factors that might affect the value of the correlation coefficient?
9. Subset the data to only include the observations that have nonzero values for Pay Agents. Create a new scatterplot and calculate the correlation coefficient for the subsetted data. Describe your results.

P Discovery Project

The cost of higher education at both public and private institutions is increasing and adversely affecting college students. Utilizing an institutional dataset called *Financial Survey of Students 2006* compiled at one of the largest public universities in the southwestern United States, this study examined financial satisfaction among an undergraduate student population. Understanding the financial satisfaction of college students can help improve the efforts of university administrators and educators. The data used come from an online survey that was conducted at a large public university in the southwestern United States. The data were created and administered by the Institutional Research and Informational Management (IRIM) department, in conjunction with the Office of Financial Aid and the Office of the Provost, to examine college students' financial characteristics. All enrolled students (22,851 students) were invited to participate via a mass email, and a link to the online survey was included after a disclaimer and description of the research project. As a participation incentive, the email included a drawing for two $500 scholarships. A total of 1,976 usable responses were received, yielding a response rate of roughly 8.7%. Of those, 1,935 were college students. The sample was further limited to those who responded to the financial satisfaction question *"How satisfied are you with your financial situation right now?"* The possible responses were satisfied, neutral or dissatisfied. After removing neutral responses from the sample, the final sample was 1,498 responses.

Characteristics	*n*	%	% Satisfied	% Dissatisfied
Student Loan				
No Student Loan	575	38.4	49.2	50.8
Student Loan	923	61.6	28.9	71.1
Student Credit Card Debt				
No credit card debt	812	54.2	42.5	57.5
Credit card debt	686	45.8	29.6	70.4
Student Credit Card Amount				
0	812	54.2	42.5	57.5
1-500	209	14.0	36.4	63.6
501-1000	121	8.1	31.4	68.6
1001-2000	122	8.1	30.3	69.7
>2001	231	15.4	25.4	76.6
Missing	3	0.2	0	100

Source: "The relationship of student loan and card debt on financial satisfaction of college students," Solis, O. and Ferguson, R., *College Student Journal*, Volume 51, Number 3, Fall 2017, pp. 329-336(8).

Using the tables above, answer the following questions (give percentages accurate to one decimal place):

1. What percentage of college students who had student loans were dissatisfied with their financial situation?
2. What percentage of college students who had credit card debt were dissatisfied with their financial situation?
3. What percentage of college students who had credit card debt above $1000 were dissatisfied with their financial situation? (First calculate how many such students there are and round it to the nearest whole number, then find the percentage.)

4. What percentage of college students are satisfied with their financial situation? (First calculate how many such students there are and round it to the nearest whole number, then find the percentage.)
5. What percentage of college students are dissatisfied with their financial situation? (First calculate how many such students there are and round it to the nearest whole number, then find the percentage.)
6. If a student is selected at random from this particular college, what is the likelihood that the student was included in the final sample?
7. Given what you know about the data and its collection, what are some limitations of this study?

P Discovery Project

Take Me Out to the Ball Game!

Use the Moneyball data set which contains selected statistics for Major League Baseball teams from 1962–2012.

Data

The data can be found by visiting stat.hawkeslearning.com and navigating to **Discovering Business Statistics, Second Edition > Data Sets > MoneyBall**.

1. Select the variable *Number of wins*, *W*, and compare the distribution of *W* for the American League (AL) with that of the National League (NL). Use side-by-side boxplots as described in Chapter 4.
2. Identify the outliers in both leagues (i.e., the teams that have a total number of wins far from the rest of the teams in their league).
3. Compare the distribution of the *Number of wins, W,* for NYM and TEX using a side-by-side boxplot and by investigating the numerical summaries of each. (Compare the shapes, means, medians, and the variability).
4. Discuss why the discrepancy in variability between the performance of NYM and the performance of TEX didn't cause a similar discrepancy in their respective leagues.
5. Based on historical data, the probability that in a given year the NYM will make the playoffs is $p = 7/47 = 0.149$. Let X be the discrete random variable that gives the total number of Playoffs made by NYM in the last 20 years, i.e., from 1993 to 2012.
   - **a.** Assume that the outcomes for the NYM in these years are unknown for us. Also assume that the outcome in any of the years is independent of the outcome in any other year. Under these assumptions, what would be the distribution of X? Why?
   - **b.** What is the probability that the total number of playoffs made by NYM during this 20-year period is exactly three?
   - **c.** What is the probability that the total number of playoffs made by NYM is at most 3?
   - **d.** What is the probability that the total number of playoffs made by NYM is at most 18?
   - **e.** What is the probability that the total number of playoffs made by NYM is at least 15?
   - **f.** What is the expected number of playoffs that NYM will make in this 20-year period?
   - **g.** Find the variance of the number of playoffs that NYM is expected to make in this 20–year period?
   - **h.** Can we use the Poisson distribution with $\lambda = 2.98$ to model the number of playoffs that NYM will make? Why?

Source: https://www.baseball-reference.com/

P Discovery Project

How are tire mileage warranties calculated?

Data

This data set can be found at stat.hawkeslearning.com by navigating to **Discovering Business Statistics, Second Edition > Data Sets > Tire Manufacturer Warranty**.

At the beginning of this chapter, we discussed the methodology of how automobile tire manufacturers determined the warranties associated with a particular tire that they made. The data set named Tire Manufacturer Warranty contains a sample of 30 tire mileages from each of 12 tire manufacturers. Using these data, please answer the following questions:

1. Determine the mean and standard deviation of the mileages for each of the tire manufacturers.
2. Do the mileages for each of the tire manufacturers follow a normal distribution? Justify your answer using graphical techniques.
3. In the event that the mileages for a tire manufacturer do not follow a normal distribution, will that prevent us from calculating probabilities associated with the average mileages? Justify your answer.
4. What is the distribution for each of the sample means of the mileages for each of the tire manufacturers.
5. Determine the warranty mileage for each manufacturer if they want no more than 1% of the tires to need replacement.
6. Answer question 5. if they want no more than 10% of the tires to need replacement.

P Discovery Project

Data

For an example data set, please visit stat.hawkeslearning.com and navigate to **Discovering Business Statistics, Second Edition > Data Sets > EV Company Financials**.

Industry Statistics

Pick an industry (software companies, computer manufacturers, oil, etc.) and research the financial information about companies in that industry. The internet, your library, and the prospectus from each of the companies may be useful resources to help you with your research. Also, select a statistic to track or follow about the companies such as sales, profit, revenue, etc. Using the information that you gather about the companies, answer the following questions.

1. Identify the population of interest.
2. Select a random sample of 10 companies in the industry that you've selected and record at least three variables of interest for each of the companies.
3. Compute the average and standard deviation of each variable of interest.
4. Compute the standard error of each variable of interest.
5. Discuss what you have learned about the statistics you studied and the companies in your population.
6. Identify the sources used for this project.

P Discovery Project

Home Sweet Home: Using Confidence Intervals to Analyze and Compare Home Prices

Data

The data can be found by visiting stat.hawkeslearning.com and navigating to **Discovering Business Statistics, Second Edition > Data Sets > Mount Pleasant Real Estate Data**.

One of the biggest purchases we make in our lives is a home. As we buy a home we ask ourselves many questions such as:

How much should I spend for a home?

How many bathrooms are there?

What is the cost per square foot?

Suppose you are looking for a house near Charleston in Mount Pleasant, SC, and you have narrowed your search to three subdivisions: Carolina Park, Dunes West, and Park West.

1. Download the Mount Pleasant Real Estate data set.
2. Import the data into Minitab, Excel or other statistical software.
3. For the variable *List Price,* calculate the sample mean, the sample standard deviation, and the sample size for the three different subdivisions. Put the calculations in a table and round to the nearest dollar for the sample standard deviation and the mean.
4. Based on the data set and the information we have, which confidence interval should we use here, a z or a t interval? Why?
5. Find the critical value for a 95% confidence level for each subdivision for the variable *List Price*.
6. Construct an interval to estimate the true average *List Price* for each subdivision with 95% confidence. Based on these confidence intervals, is it possible that Carolina Park and Dunes West have the same average *List Price*. Discuss.
7. Do you think a *List Price* of $520,000 is a reasonable value for the Carolina Park subdivision?
8. Do you think a *List Price* of $670,000 is a reasonable value for the Dunes West subdivision?
9. Do you think a *List Price* of $568,000 is a reasonable value for both the Carolina Park and Park West subdivisions?

P Discovery Project

Wearables in the Sports Industry?

Apolo, a startup which manufactures smart devices, recorded 500 responses from athletes, trainers, coaches, and team physicians regarding their interest in wearing Apolo smart devices and their beliefs on whether wearables improve their performance. These responses are recorded in the Wearables in the Sports Industry data set. As discussed at the beginning of this chapter, the use of wearables is a multibillion-dollar industry worldwide for companies such as Apple, Fitbit, and other organizations that produce wearable technology to track fitness and nutrition.

Data

The data set can be found on stat.hawkeslearning.com under **Discovering Business Statistics, Second Edition > Data Sets > Wearables in the Sports Industry**.

The individuals who participated in the sample were athletes or those who work with athletes. All participants were 18 years or older. The variables measured were Age and Role (coach, team physician, athlete, or trainer), and three questions were asked:

1. Do you use Apolo smart devices to train?
2. Do you feel that Apolo smart devices have helped you improve your performance?
3. Would you recommend the use of Apolo smart devices to train?

The responses to these questions were recorded as 0 (No) or 1 (Yes). If the answer to question 1 was yes, then a fourth question was asked:

4. How many hours per week do you use Apolo smart devices to train?

If the participant did not use Apolo smart devices, then 0 was recorded for the hours.

Using the aforementioned data, please do the following:

1. Summarize the data by role indicating the number of coaches, team physicians, athletes, and trainers that chose to participate in the survey.

2. Summarize the data according to the role of the participants and the first three questions asked of them. That is, create a table indicating the number of people in each role who answered "Yes" to each of the first three questions.

3. Apolo believes that they will be profitable if more than 40% of survey respondents use smart devices. Test that Apolo will be profitable using a significance level of 5%.

4. Some managers at Apolo believe that the responses of the athletes are the only ones that matter. Find the *P*-value for the hypothesis test that at least 40% of the athletes would use Apolo smart devices. Do the data suggest that more than 40% of the athletes will use Apolo smart devices at a 5% level of significance?

5. For Apolo customers (i.e., the survey participants who answered "Yes" to "Do you use Apolo smart devices to train?"), calculate the sample mean and sample standard deviation for the number of hours that they use an Apolo smart device per week.

6. Apolo believes that in order to retain customers, the customers need to be using smart devices more than 6 hours per week. Test the hypothesis that, on average, Apolo customers use their smart device more than 6 hours per week. Use a significance level of 1%.

7. Apolo would like to know a probable range of values for the mean hours customers use a smart device per week. Construct a 99% confidence interval for the mean hours Apolo customers use a smart device per week. What can Apolo conclude about the mean?

Sample of the Data Collected

Gender	Age	Role	Do you use Apolo smart devices to train?	Apolo smart device improved performance?	Recommend use of Apolo smart device?
Male	40	Coach	1	0	1
Male	35	Team Physician	1	1	1
Female	48	Team Physician	0	0	0
Male	60	Team Physician	0	0	1
Female	18	Athlete	1	0	1
Male	47	Team Physician	0	0	1
Female	39	Trainer	0	0	0
Female	20	Athlete	1	0	1

P Discovery Project

Understanding Credit Scores

There are many factors that determine one's eligibility to obtain credit. Several factors are considered such as education level and credit scores. An individual's credit score is a good predictor of one's ability to manage their finances and pay their debts responsibly. See Credit Score: Definition, Factors, & Improving It (investopedia.com) for more information on understanding credit scores. Credit scores are used to determine your eligibility for credit cards, car loans, and even for some types of insurance. Often when an individual has a lower credit score, they will have higher interest rates and lower borrowing capacity for loans and credit cards.

Suppose you are working in the marketing department for a large credit card company. Your company is launching a new credit card and will be mailing information to prospective customers. You are examining information from your current customers and are interested in understanding the differences in credit scores among groups of customers. You are looking at factors such as marital status, how many credit cards are used by the customer, and whether they rent or own their home.

Using the Credit Card Data file, answer the following questions to better understand your current customer base. The data set includes credit scores and data on nine (9) predictor (159 data points).

Data

This data set can be found on stat.hawkeslearning.com under **Discovering Business Statistics, Second Edition > Data Sets > Credit Card Data**.

1. Download the data file and open it in Microsoft Excel.
2. Determine the mean, mode, median, maximum, minimum, standard deviation, and the coefficient of variation of the following variables: age, total credit limit, total balance, credit score, annual household income, and number of children and briefly discuss the results. (Hint: these values can be quickly calculated using the Data Analysis Add-in: Descriptive Statistics in Excel).
3. Fully summarize the qualitative variables (i.e., What percent of the sample has a college degree) and briefly discuss your findings. (Hint: These values can be quickly determined using the Data Analysis Add-in: Histogram in Excel).
4. Determine if there is a difference in credit scores for those that are single (marital status = 0) versus those that are married (marital status = 1) using the appropriate hypothesis test. Use a significance level of 0.05.
5. Is there a higher proportion of customers that own (housing = 1) their home as opposed to renting (housing = 0)? Conduct the appropriate hypothesis test using a significance level of 0.10.
6. Determine if there is a difference greater than $2,000 in the total balance on all credit cards between those that have children versus those that do not have any children using the appropriate hypothesis test. Use a significance level of 0.01.
7. Is there a difference in the proportion of customers that have some college (education level = 2) or a college degree (education level = 3) versus those that have a high school diploma (education level = 1)? Conduct the appropriate hypothesis test using a significance level of 0.05.
8. Determine if customers under 40 have a fewer number of credit cards issued versus those customers 40 or older using the appropriate hypothesis test. Use the 0.10 significance level.

9. Is there a difference in household income based on being married (marital status = 1) or separated/divorced (marital status = 2)? Conduct the appropriate hypothesis test using a significance level of 0.05.

10. Determine whether the variances of the total credit limit differ by housing status (own = 1/rent = 0). Conduct the appropriate hypothesis test using the 0.01 significance level.

11. Briefly summarize your findings from this data set to your manager.

P Discovery Project

Economists use several metrics to understand the state of the economy and what might lie ahead. Some of those metrics specifically focus on consumer spending. One such measure is consumer consumption. This value gives economists an idea of how much consumers are spending and is tracked monthly, in order to understand how consumer spending impacts the overall economy.

One way that consumers choose to pay for goods and services is through using credit cards. Obtaining a credit card is generally simple and most consumers can qualify for some type of card. The terms of the credit issued can vary though based on variables such as household income, credit score, and educational status.

Data

This data set can be found at stat.hawkeslearning.com by navigating to **Discovering Business Statistics, Second Edition > Data Sets > Credit Card Data**.

Using the data set Credit Card Data, answer the following questions to better understand how differences in certain factors can impact spending and credit limits. The data set has nine variables (159 data points).

1. Download the data file and open it in Microsoft Excel.
2. Determine the mean, mode, median, maximum, minimum, standard deviation, and the coefficient of variation of the following variables: age, total credit limit, total balance, credit score, annual household income, and number of children and briefly discuss the results. (**Hint**: These values can be quickly calculated using the Data Analysis Add-in: Descriptive Statistics in Excel.)
3. Fully summarize the qualitative variables (i.e., what percent of the sample has a college degree?) and briefly discuss your findings. (**Hint**: These values can be quickly determined using the Data Analysis Add-in: Histogram in Excel.)
4. Determine if there is a significant difference in credit card balances based on educational status using the appropriate hypothesis test. Use a significance level of 0.05. If significant differences are found, determine which groups are different from each other. (Note: It will be necessary to rearrange the dataset to conduct the hypothesis test.)
5. Choose one of the other qualitative variables (i.e., housing status) and determine if there is a significant difference in credit card limits based on that variable. Use the significance level of 0.01. If significant differences are found, determine which groups are different from each. (Note: It will be necessary to rearrange the dataset to conduct the hypothesis test.)
6. Conduct the appropriate hypothesis test to see if there is a difference in credit card limits by both marital status and housing status. Use the significance level of 0.01. (Note: It will be necessary to rearrange the dataset to conduct the hypothesis test.)
7. Partition and sort the data for credit score based on the marital status and number of children in the household. Randomly select 10 data points where there are no kids in the household, then do the same for those households with children, also include the marital status. This data selection will be used in the next problem.
8. Conduct the appropriate hypothesis test to see if there is a difference in credit scores by both marital status and number of children in the household. Use the significance level of 0.05. Is there any interaction present between the variables? (Note: You will use the data subset you selected in the previous problem. Be sure the data is formatted appropriately for the selected hypothesis test.)
9. Briefly summarize your findings from these analyses and discuss the limitations present in the data set.

P Discovery Project

Gas vs. Oil Prices

Managing expenses is often a critical job duty for Chief Financial Officers (CFOs). Sometimes costs are fairly easy to forecast. Items such as office supplies and staffing costs are generally more manageable costs to estimate for budgeting purposes. Other expenses such as raw materials and utility costs can be harder to forecast because the prices can fluctuate widely during a given time period.

Gasoline is another such expense. Gasoline prices are determined in part by the price per barrel of crude oil. There are two predominate types of crude oil used in the industry to determine the price of gas we see at the pump: West Texas Intermediate (WTI) and Brent Blend. WTI is the benchmark used in the United States and Brent Blend is mostly used in Europe and Africa. An interesting side note is that about 20 gallons of gasoline are made from one barrel of crude oil (Source: Frequently Asked Questions (FAQs) – U.S. Energy Information Administration (EIA)).

Industries that rely heavily on gasoline to provide their product or service can find it difficult to estimate the gasoline expense from month to month and sometimes even from day to day. Some examples of industries that have fluctuating gas price impacts are transportation, landscaping, and logistics. Being able to reliably forecast the gasoline expense is a critical component of estimating company profits.

Imagine you are tasked with determining reliable estimates of the price per gallon of gasoline to be used in forecasting company profits. Using the data file called Gas Prices vs. Oil Prices, answer the following questions to better understand the relationship between the two types of crude oil and their impact on gasoline prices. The data set includes monthly gasoline and crude oil prices between January 2000 and March 2021 (255 data points).

1. Download the data file and open it in Microsoft Excel.
2. Determine the mean, mode, median, maximum, minimum, range, standard deviation, and the coefficient of variation of the price per gallon (to 2 decimal places) and briefly discuss the results. (Hint: These values can be quickly calculated using the Data Analysis Add-in: Descriptive Statistics in Excel).
3. Create scatterplots of each of the crude oils against the price per gallon.
4. Fit a simple linear regression (SLR) model for Brent Blend vs. Reg Gas Price per Gallon and WTI vs. Reg Gas Price per Gallon.
5. Obtain the residuals for each regression analysis and plot them.
6. Validate the assumptions — of linearity, independence, normality, constant variance.
7. Test the slopes for each crude oil model to see if they are statistically significant.
8. Obtain confidence intervals for the slopes using a 5% significance level.
9. Make some predictions. Pick a price per gallon (or barrel) for Brent Blend and WTI and predict the price of a regular gallon of gas.
10. Which crude oil would you recommend as the best predictor of regular gasoline prices for your company to use to forecast expenses?

Data

This data set can be found at stat.hawkeslearning.com by navigating to **Discovering Business Statistics, Second Edition > Data Sets > Gas Prices vs Oil Prices.**

Technology

For instructions on performing a regression analysis using technology, visit stat.hawkeslearning.com and navigate to **Discovering Business Statistics, Second Edition > Technology Instructions > Data Sets > Regression > Simple Linear Regression.**

P Discovery Project

Home Sweet Home: Using Multiple Regression to Analyze and Predict Home Prices

Data

For the full data set visit stat.hawkeslearning.com and navigate to **Discovering Business Statistics, Second Edition > Data Sets > Mount Pleasant Real Estate Data**.

An important problem in real estate is determining how to price homes to be sold. There are so many factors—size, age, and style of the home; number of bedrooms and bathrooms; size of the lot; and so on—which makes setting a price a challenging task. In this project, we will try to help realtors in this task by determining how different characteristics of homes relate to home prices, identifying the key variables in pricing, and building multiple-variable regression models to predict prices based on property characteristics.

Our analysis will be based on the Mount Pleasant Real Estate Data. This data set includes information about 245 properties for sale in three communities in the suburban town of Mount Pleasant, South Carolina, in 2017.

Phase 1: Data Preparation

1. Download the Mount Pleasant Real Estate Data from stat.hawkeslearning.com and open it with Microsoft Excel.
2. Determine the mean, mode, median, maximum, minimum, standard deviation, and the coefficient of variation of the following variables: price, number of bedrooms, number of bathrooms, number of stories, and square footage, and briefly discuss the results. (Hint: these values can be quickly calculated using the Data Analysis Add-in: Descriptive Statistics in Excel).
3. Fully summarize the qualitative variables (i.e., What percent of the sample has a pool?) and briefly discuss your findings.
4. To ensure the data contain comparable properties, eliminate duplexes and properties whose prices are outliers. What limitations does this impose on our analysis? How did you determine which prices were outliers?

   Consider the following variables associated with each property:

   x_1 = number of bedrooms
   x_2 = number of bathrooms
   x_3 = number of stories
   x_4 = subdivision
   x_5 = square footage
   x_6 = age (based on year built)
   x_7 = acreage
   x_8 = new owned

5. For the qualitative variables, adjust this data in a reasonable, quantitative way for use in a regression analysis.
6. Use the following correlation matrix and describe any issues with multicollinearity.

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1		*Bedrooms*	*Baths - Total*	*Baths - Full*	*Baths - Half*	*Stories*	*Subdivision*	*Square Footage*	*Age*	*Acreage*	*New Owned?*	*House Style*	*Covered Parking Spots*	*Fenced Yard*	*Screened Porch?*	*Golf Course?*	*Fireplace?*
2	Bedrooms	1															
3	Baths - Total	0.70	1.00														
4	Baths - Full	0.67	0.95	1.00													
5	Baths - Half	0.06	0.13	-0.18	1.00												
6	Stories	0.43	0.50	0.42	0.24	1.00											
7	Subdivision	0.08	-0.05	-0.04	-0.01	0.06	1.00										
8	Square Footage	0.71	0.74	0.68	0.19	0.44	0.11	1.00									
9	Age	0.05	-0.07	-0.12	0.14	-0.07	0.28	0.18	1.00								
10	Acreage	0.12	0.19	0.16	0.11	0.00	-0.03	0.35	0.33	1.00							
11	New Owned?	-0.14	0.00	0.01	-0.05	0.04	-0.29	-0.22	-0.78	-0.15	1.00						
12	House Style	-0.22	-0.22	-0.22	0.03	-0.15	0.07	-0.22	-0.06	-0.12	0.11	1.00					
13	Covered Parking Spots	0.28	0.35	0.31	0.13	0.16	0.03	0.47	0.14	0.24	-0.15	0.07	1.00				
14	Fenced Yard	0.04	-0.12	-0.13	0.04	-0.11	0.01	-0.03	0.29	-0.10	-0.41	-0.01	-0.04	1.00			
15	Screened Porch?	0.17	0.24	0.23	0.02	0.14	-0.25	0.14	-0.04	0.03	-0.05	-0.18	-0.03	0.12	1.00		
16	Golf Course?	0.30	0.26	0.27	-0.02	0.19	-0.14	0.37	0.34	0.48	-0.19	-0.08	0.23	0.12	0.13	1.00	
17	Fireplace?	0.18	0.18	0.20	-0.08	0.06	0.04	0.22	0.14	0.09	-0.13	-0.17	0.05	0.11	0.30	0.22	1.00
18	Number of Fireplaces	0.16	0.21	0.22	-0.03	0.04	0.11	0.35	0.24	0.14	-0.20	-0.13	0.15	0.13	0.28	0.17	0.80

Phase 2: Constructing Predictive Models

7. Construct the multiple regression model with input variables x_1, x_2, x_3, and x_4.

8. Examine the impact of adding additional variables to the model

- **a.** Add x_5 to the model. Is the addition of x_5 to the model significant? How was the adjusted R^2 impacted? What is the P-value for x_5?
- **b.** Add x_6 to the model. Is the addition of x_6 to the model significant? How was the adjusted R^2 impacted? What is the P-value for x_6?
- **c.** Add x_7 to the model. Is the addition of x_7 to the model significant? How was the adjusted R^2 impacted? What is the P-value for x_7?
- **d.** Add x_8 to the model. Is the addition of x_8 to the model significant? How was the adjusted R^2 impacted? What is the P-value for x_8?

9. Perform a hypothesis test to determine if the model is useful for predicting home values at a significance level of $\alpha = 0.05$. State the P-value and interpret its meaning.

10. Are any variables not useful predictors of home price at a significance level of $\alpha = 0.05$? State the P-values of these variables. Intuitively, what does this mean with respect to pricing properties?

11. State the best model for the data and justify your answer.

Phase 3: Applying and Interpreting the Model

12. Suppose you own a 2000 square foot 2-story house in one of the communities in the data set with 3 bedrooms, 2.5 baths, a pool, and it is located on a golf course, but has no dock or fenced yard. What does the model predict the price of your house to be?

13. A common term in real estate is "comparables," or "comps" for short, which are properties that have similar characteristics. It is common for realtors to look up "comps" for a certain property to get an idea of how to price it. Locate the "comps" for your home in the data set. Create a box plot of the "comps" and estimate a price range for your house on this basis.

14. What advantages and disadvantages does this approach have to the multiple regression model above?

P Discovery Project

The Global Financial Crisis of 2007 – 2008

The global financial crisis of 2007 – 2008 seemed to have been years in the making. By the summer of 2007, financial markets around the world were showing signs that a correction was overdue for several years due to companies (primarily financial institutions) taking advantage of "cheap credit." Several large banks were the first to collapse and investors were being warned that they might not be able to withdraw their money from stock market accounts, retirement funds, or even regular bank accounts. This was a stark reminder of the Great Depression between 1929 – 1932. Even with these warnings, investors did not anticipate the worst financial crisis in nearly 80 years was about to cripple the global financial system. The financial crisis cost many ordinary people their jobs, their life savings, their homes, and for some, all three were lost.

Data

The data set can be found by visiting stat.hawkeslearning.com and navigating to **Discovering Business Statistics, Second Edition > Data Sets > Percentage Change in Real Home Price Index since 1890**.

This global financial crisis will be written about for many, many years to come with many financial experts asking, *Should we have seen this coming*? To shed just a little light on the crisis and to help answer the question, please use the data titled "Percentage Change in Real Home Price Index since 1890" to answer to answer the following questions.

1. Plot the raw data (Percentage Change in Home Price Index (HPI) against Date) from January 1, 1970, through December 1, 2008. Do you see any patterns over the first five years; over the first 15 years; over the first 30 years?
2. Are these data stationary or nonstationary?
3. Do you see any patterns of variation in the data such as trends, cycles, or seasonality? If so, please identify the timeframe and whether these patterns might have been helpful in predicting the crisis (as a function of HPI).
4. Using MS Excel, perform a 12-period moving average to predict HPI. Using these predictions, did you see any evidence that would help you predict the global financial crisis? Is the moving average method good for predicting HPI for this data? Please justify your answer.
5. Using MS Excel, using the adjusted exponential smoothing procedure to predict the HPI for January 1, 2009. Using $\alpha = 0.3$ and $\beta = 0.7$. Using these predictions, did you see any evidence that would help you predict the global financial crisis? Is this forecasting method good for predicting HPI for this data? Please justify your answer.
6. Would the Additive Seasonal Forecasting method be good to use for this data? Please justify your answer.

There are many more questions that could be asked. Please take the time to explore all of the data to find as many "stories" as possible. One can also examine productivity growth and the labor force growth, labor force participation rates, average household incomes, aggregate household debt, just to name a few. This is just one of many sets of data associated with the Global Financial Crisis of 2007 – 2008.

P Discovery Project

Individual Stocks vs. Index-Matching Investments

In stock market investing, the traditional approach is to buy and sell stocks for individual companies, but this is sometimes risky as it is very difficult to predict when large changes to prices may occur. Large upswings or downswings in stock prices may happen for many reasons. Some positive examples leading to large stock price increases include the following.

- Retail sales on Amazon have frequently exceeded expectations.[1]
- Apple introduced its wildly popular iPhone, and continued to introduce new versions.[2]
- Netflix exploded in popularity; a growth of 7.41 million subscribers in the first quarter of 2018 (up from the expected 6.35 million) led to a stock increase of 60% in that quarter.[3]

Some negative events leading to plummeting stock prices include the following.

- Microsoft lost a federal antitrust lawsuit in 1999 and its stock price dropped 14% in a single day.[4]
- In 2015, the Environmental Protection Agency (EPA) discovered Volkswagen had intentionally programmed certain diesel engines to activate emission controls for certain nitrous oxides only during testing, which made It appear as though the vehicles released less than the legal limit of the polluting gases, but the vehicles actually released 40 times the legal limit! In the wake of the scandal, Volkswagen stock prices dropped from $162 to $105 in just three days.[5]

As we see, certain events may cause large fluctuations in stock prices, which may be good or bad for the investor, but in either case, it results in a volatile and sometimes risky investment.

Index-matching funds are portfolios (groups of multiple stocks) structured so that they match a market index, such as the Standard & Poor's 500 Index (S&P 500).[6] Gains or losses to the investment will be (proportionally) the same as that of the whole S&P 500. Such an index tends to be less volatile than investing in individual stocks, therefore index-matching funds are considered less risky investments. These funds are often used as parts of retirement funds or other long-term investments. But, how true is this assumption? Is an S&P 500 index-matching fund actually a safer investment? Our goal for this project is to test that assumption.

1. Daily closing stock prices can be found on the website https://www.macrotrends.net/stocks/stock-screener.

Data

For an example data set, please visit stat.hawkeslearning.com and navigate to **Discovering Business Statistics, Second Edition > Data Sets > Stock Comparison Data.**

The closing price data for three stocks (Amazon (AMZN), Starbucks (SBUX), and Coca-Cola (KO)), along with the S&P 500 index fund (SPY) from the beginning of 2000 to the end of 2017, can be found on our website.

2. We want to determine how the value of certain stocks and the S&P 500 compare over time, so notice that a new column called Price Change was created measuring the daily change in stock price for each stock, i.e.,

Day 2 Price – Day 1 Price

Day 3 Price – Day 2 Price

Day 4 Price – Day 3 Price

etc.

It does not make sense to simply compare stock prices of the different stocks because the prices are on very different scales. For example, if a $100 stock drops by $1, it is less consequential than if a $3 stock drops by $1. A reasonable adjustment is to consider a price change as a percentage of the previous day's price, so the example above would be a 1% drop compared to a 33.3% drop, which allows us to do a more reasonable comparison. A new column for each stock and the S&P 500 index has been created with these percentages and is labelled as *Return*.

3. Can you think of any descriptive statistics that would compare the volatility of the returns?

4. Create box plots of the returns for each stock and the S&P 500 index.

5. Do you notice any patterns in the box plots that suggest a difference in the stocks and the S&P 500 index? Explain their practical significance, if any.

6. Delete the outliers in the data for each stock and the S&P 500 index and create histograms for each on the same scale. [*Hint*. Excel's Data ToolPak add-in allows for easy histograms where we can specify the bins.]

7. Are any differences between the stocks and the S&P 500 index apparent from the histograms? Explain their practical significance, if any.

8. Use a test for goodness of fit to test whether the distributions of the non-outlying stock returns and index returns are different (at least over the range of the S&P 500 returns) at a significance level of $\alpha = 0.2$.

References

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4 https://www.nytimes.com/2000/04/04/business/us-vs-microsoft-overview-us-judge-says-microsoft-violated-antitrust-laws-with.html
5 http://fortune.com/2015/09/23/volkswagen-stock-drop/
6 https://www.investopedia.com/terms/i/indexfund.asp

P Discovery Project

Home Sweet Home: Using Nonparametric Tests to Compare Home Prices

Data

The data can be found by visiting stat.hawkeslearning.com and navigating to **Discovering Business Statistics, Second Edition > Data Sets > Mount Pleasant Real Estate**.

Use the Mount Pleasant Real Estate data which contains information about properties for sale in three subdivisons of Mount Pleasant, South Carolina in the year 2017.

1. Download the Mount Pleasant Real Estate data into a statistical software package like Excel or Minitab.
2. Classify the three variables *List Price*, *Square Footage*, and *Subdivision* as qualitative or quantatitive and provide the level of measurement (nominal, ordinal, interval, or ratio).
3. Which of the quantitative variable(s) should be considered as the dependent variable? Why?
4. Use statistical software to make a histogram for *List Price* and describe the distribution.
5. Can we use the *t*-test to see if the mean home price is significantly more than $500,000? Justify your answer.
6. Assuming that the underlying distribution is not normal, we have an opportunity to use nonparametric methods to analyze the data. Can we conclude that the median *List Price* in Mount Pleasant in 2017 is significantly more than half a million dollars? State your hypotheses and perform a sign test using $\alpha = 0.05$.
7. Create side-by-side boxplots of *List Price* for the three Mount Pleasant subdivisions: Carolina Park, Dunes West, and Park West. Describe the distributions of the three subdivisions and comment about their variability.
8. Use the Wilcoxon rank-sum test to see if the distribution of *List Price* in Park West in 2017 is to the left of that in Dunes West.

P Discovery Project

Using Statistical Process Control to Improve Air Traffic Processes

1. Choose two cities of interest and research/report actual flight times over a particular weekend, Friday through Sunday. Data sets should include at least ten observations and should be organized in a table for later use.
2. Create a Pareto chart for your flight times.
3. Identify the Upper and Lower Control Limits for any of the three days and draw a graph to represent findings.
4. Calculate the mean and standard deviation of flight times for each day and draw an $\bar{x}$ chart.
5. Create a quality control workflow chart to present to air traffic clients on ways to improve tracking data. Ideas can include measurement improvements,
6. Think about Deming's points 7-9. How can you, as a leader, use statistical processes to improve the effectiveness of flight times?
7. Creatively organize all results and write a summary of your findings to be presented to a board for statistical improvement of air traffic processes.
    - **a.** Include charts and label properly.
    - **b.** Interpret your results from parts 1-4.
    - **c.** Use parts 5-6 to write the narrative of your presentation.
    - **d.** Identify different types of variation and reasons for such data points.