

Statistical Significance and Univariate and Bivariate Tests

BUS 735: Business Decision Making and Research

1 Goals and Agenda

1.1 Goals

Goals

- Specific goals:
 - Re-familiarize ourselves with basic statistics ideas: sampling distributions, hypothesis tests, p-values.
 - Be able to distinguish different types of data and prescribe appropriate statistical methods.
 - Conduct a number of hypothesis tests using methods appropriate for questions involving only one or two variables.
- Learning objectives:
 - LO1: Be able to construct and test hypotheses using a variety of bivariate statistical methods to compare characteristics between two populations.
 - LO6: Be able to use standard computer packages such as SPSS and Excel to conduct the quantitative analyses described in the learning objectives above.

Agenda

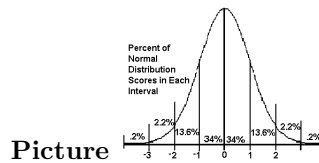
Learning Objective	Active Learning Activity
Re-familiarize ourselves with basic statistics ideas: sampling distributions, hypothesis tests, p-values.	Lecture / Discussion
Be able to distinguish different types of data.	Lecture / Discussion
Learn and conduct hypothesis tests on single variables.	Learn by doing: work together on examples using SPSS.
Learn and conduct hypothesis tests for differences between two variables.	Learn by doing: work together on examples using SPSS.
Practice makes perfect!	Worksheet, work with your neighbor.
More practice!	Homework assignment, due Tuesday, Sept 10 (if we get far enough)

2 Statistical Significance

2.1 Sampling Distribution

Probability Distribution

- **Probability distribution:** summary of all possible values a variable can take along with the probabilities in which they occur.
- Usually displayed as:



Picture

z	0.00	0.01	0.02	0.03	0.04	0.05
0.0	0.5000	0.5040	0.5080	0.5120	0.5159	0.5199
0.1	0.5398	0.5438	0.5478	0.5517	0.5557	0.5596
0.2	0.5793	0.5832	0.5871	0.5910	0.5948	0.5987
0.3	0.6179	0.6217	0.6255	0.6293	0.6331	0.6368
0.4	0.6554	0.6591	0.6628	0.6664	0.6700	0.6736
0.5	0.6915	0.6950	0.6985	0.7019	0.7054	0.7088
0.6	0.7257	0.7291	0.7324	0.7357	0.7389	0.7422
0.7	0.7600	0.7633	0.7664	0.7693	0.7724	0.7754
0.8	0.7881	0.7910	0.7938	0.7967	0.7995	0.8023
0.9	0.8129	0.8156	0.8182	0.8212	0.8239	0.8269
1.0	0.8413	0.8438	0.8461	0.8485	0.8508	0.8531
1.1	0.8643	0.8665	0.8686	0.8708	0.8729	0.8749

Table

Formula

$$f(x|\mu, \sigma) = \frac{1}{\sigma\sqrt{2\pi}} e^{-\left(\frac{(x-\mu)^2}{2\sigma^2}\right)}$$

- **Normal distribution:** often used “bell shaped curve”, reveals probabilities based on how many standard deviations away an event is from the mean.

Sampling distribution

- Imagine taking a sample of size 100 from a population and computing some kind of statistic.
- The statistic you compute can be anything, such as: mean, median, proportion, difference between two sample means, standard deviation, variance, or anything else you might imagine.
- Suppose you repeated this experiment over and over: take a sample of 100 and compute and record the statistic.
- A **sampling distribution** is the probability distribution *of the statistic*
- Is this the same thing as the probability distribution of the population?

Example

- [Sampling Distribution Simulator](#)
- In reality, you only do an experiment once, so the sampling distribution is a hypothetical distribution.
- Why are we interested in this?

Desirable qualities

What are some qualities you would like to see in a sampling distribution?

- The average of the sample statistics is equal to the true population parameter.
- Want the variance *of the sampling distribution* to be as small as possible. Why?
- Want the *sampling distribution* to be normal, regardless of the distribution of the population.

2.2 Central Limit Theorem

Central Limit Theorem

- Given:
 - Suppose a RV x has a distribution (it need not be normal) with mean μ and standard deviation σ .
 - Suppose a *sample mean* (\bar{x}) is computed from a sample of size n .
- Then, if n is sufficiently large, the sampling distribution of \bar{x} will have the following properties:
 - The sampling distribution of \bar{x} will be normal.
 - The mean of the sampling distribution will equal the mean of the population (consistent):

$$\mu_{\bar{x}} = \mu$$

- The standard deviation of the sampling distribution will decrease with larger sample sizes, and is given by:

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

Central Limit Theorem: Small samples

If n is small (rule of thumb for a single variable: $n < 30$)

- The sample mean is still consistent.
- Sampling distribution will be normal if the distribution of the population is normal.

Example 1

Suppose average birth weight is $\mu = 7lbs$, and the standard deviation is $\sigma = 1.5lbs$.

What is the probability that a sample of size $n = 30$ will have a mean of $7.5lbs$ or greater?

$$z = \frac{\bar{x} - \mu_{\bar{x}}}{\sigma_{\bar{x}}} = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$$
$$z = \frac{7.5 - 7}{1.5/\sqrt{30}} = 1.826$$

The probability the sample mean is greater than $7.5lbs$ is:

$$P(\bar{x} > 7.5) = P(z > 1.826) = 0.0339$$

Example 2

Suppose average birth weight is $\mu = 7lbs$, and the standard deviation is $\sigma = 1.5lbs$.

What is the probability that a randomly selected baby will have a weight of $7.5lbs$ or more? What do you need to assume to answer this question?

Must assume the population is normally distributed. Why?

$$z = \frac{x - \mu}{\sigma} = \frac{7.5 - 7}{1.5} = 0.33$$

The probability that a baby is greater than $7.5lbs$ is:

$$P(x > 7.5) = P(z > 0.33) = 0.3707$$

Example 3

- Suppose average birth weight of all babies is $\mu = 7lbs$, and the standard deviation is $\sigma = 1.5lbs$.
- Suppose you collect a sample of 30 newborn babies whose mothers smoked during pregnancy.
- Suppose you obtained a sample mean $\bar{x} = 6lbs$. If you assume the mean birth weight of babies whose mothers smoked during pregnancy has the same sampling distribution as the rest of the population, what is the probability of getting a sample mean this low or lower?

Example 3 continued

$$z = \frac{\bar{x} - \mu_{\bar{x}}}{\sigma_{\bar{x}}} = \frac{\bar{x} - \mu}{\sigma/\sqrt{n}}$$
$$z = \frac{6 - 7}{1.5/\sqrt{30}} = -3.65$$

The probability the sample mean is less than or equal to 6lbs is:

$$P(\bar{x} < 6) = P(z < -3.65) = 0.000131$$

That is, if smoking during pregnancy actually does still lead to an average birth weight of 7 pounds, there was only a 0.000131 (or 0.0131%) chance of getting a sample mean as low as six or lower. This is an extremely unlikely event if the assumption is true. Therefore it is likely the assumption is not true.

2.3 Hypotheses Tests

Statistical Hypotheses

- A **hypothesis** is a claim or statement about a property of a population.
 - Example: The population mean for systolic blood pressure is 120.
- A **hypothesis test** (or **test of significance**) is a standard procedure for testing a claim about a property of a population.
- Recall the example about birth weights with mothers who smoked during pregnancy.
 - Hypothesis: Smoking during pregnancy leads to an average birth weight of 7 pounds (the same as with mothers who do not smoke).

Null and Alternative Hypotheses

- The **null hypothesis** is a statement that the value of a population parameter (such as the population mean) *is equal to* some claimed value.
 - $H_0: \mu = 7$.
- The **alternative hypothesis** is an alternative to the null hypothesis; a statement that says a parameter differs from the value given in the null hypothesis.
 - $H_a: \mu < 7$.
 - $H_a: \mu > 7$.
 - $H_a: \mu \neq 7$.
- In hypothesis testing, assume the null hypothesis is true until there is strong statistical evidence to suggest the alternative hypothesis.
- Similar to an “innocent until proven guilty” policy.

Hypothesis tests

- (Many) hypothesis tests are all the same:

$$z \text{ or } t = \frac{\text{sample statistic} - \text{null hypothesis value}}{\text{standard deviation of the sampling distribution}}$$

- Example: hypothesis testing about μ :
 - Sample statistic = \bar{x} .
 - Standard deviation of the sampling distribution of \bar{x} :

$$\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$$

P-values

- The P-value of the test statistic, is the area of the sampling distribution from the sample result in the direction of the alternative hypothesis.
- Interpretation: If the null hypothesis is correct, than the p-value is the probability of obtaining a sample that yielded your statistic, or a statistic that provides even stronger evidence against the null hypothesis.
- The p-value is therefore a measure of *statistical significance*.
 - If p-values are very small, there is strong statistical evidence in favor of the alternative hypothesis.
 - If p-values are large, there is insignificant statistical evidence. When large, you fail to reject the null hypothesis.
- Best practice is writing research: report the p-value. Different readers may have different opinions about how small a p-value should be before saying your results are statistically significant.

3 Univariate Tests

3.1 Types of Data/Tests

Types of Data

- Nominal data: consists of categories that cannot be ordered in a meaningful way.
- Ordinal data: order is meaningful, but not the distances between data values.
 - Excellent, Very good, Good, Poor, Very poor.
- Interval data: order is meaningful, *and* distances are meaningful. However, there is *no natural zero*.
 - Examples: temperature, time.
- Ratio data: order, differences, and zero are all meaningful.
 - Examples: weight, prices, speed.

Types of Tests

- Different types of data require different statistical methods.
- Why? With interval data and below, operations like addition, subtraction, multiplication, and division are *meaningless!*
- Parametric statistics:
 - Typically take advantage of central limit theorem (imposes requirements on probability distributions)
 - Appropriate only for interval and ratio data.
 - More **powerful** than nonparametric methods.
- Nonparametric statistics:
 - Do not require assumptions concerning the probability distribution for the population.
 - There are many methods appropriate for ordinal data, some methods appropriate for nominal data.
 - Computations typically make use of data's *ranks* instead of actual data.

3.2 Hypothesis Testing about Mean

Single Mean T-Test

- Test whether the population mean is equal or different to some value.
- Uses the sample mean its statistic.
- Why T-test instead of Z-test?
- Parametric test that depends on results from Central Limit Theorem.
- Hypotheses
 - Null: The population mean is equal to some specified value.
 - Alternative: The population mean is [greater/less/different] than the value in the null.

Example: Public School Spending

- Dataset: average pay for public school teachers and average public school spending per pupil for each state and the District of Columbia in 1985.
- Download dataset `eduspending.sav`.
- Conduct the following exercises:
 - Show some descriptive statistics for teacher pay and expenditure per pupil.
 - Is there statistical evidence that teachers make less than \$25,000 per year?
 - Is there statistical evidence that expenditure per pupil is more than \$3,500?

SPSS Step-by-step: Hypothesis Testing for a Single Mean

Opening the data:

1. Save `eduspending.sav` somewhere.
2. Go find and double click `eduspending.sav` to open the file in SPSS.

Descriptive Statistics

1. Click **Analyze** menu, select **Descriptive Statistics**, then select **Descriptives**.
2. Click on **Pay** and click right arrow button.
3. Click on **Spending** and click right arrow button.
4. Click **Options**.
 - (a) Check any options you find interesting.
 - (b) Click **OK**
5. Click **OK**

Test Hypotheses - Is average teacher pay less than \$25,000 per year?

1. Click **Analyze** menu, select **Compare Means**, then select **One-Sample T test**.
2. Select **Pay**, then click right arrow.
3. Enter in **Test Value** text box 25000.
4. Output tables show descriptive statistics for pay, and hypothesis test results.

Test Hypotheses - Is expenditure per pupil more than \$3,500 per year?

1. Conduct an analysis similar to that above for expenditure per pupil.

3.3 Hypothesis Testing about Proportion

Single Proportion T-Test

- **Proportion:** Percentage of times some characteristic occurs.
- Example: percentage of consumers of soda who prefer Pepsi over Coke.

$$\text{Sample proportion} = \frac{\text{Number of items that has characteristic}}{\text{sample size}}$$

Example: Economic Outlook

- Data from Montana residents in 1992 concerning their outlook for the economy.
- All data is ordinal or nominal:
 - AGE = 1 under 35, 2 35-54, 3 55 and over
 - SEX = 0 male, 1 female
 - INC = yearly income: 1 under \$20K, 2 20-35\$K, 3 over \$35K
 - POL = 1 Democrat, 2 Independent, 3 Republican
 - AREA = 1 Western, 2 Northeastern, 3 Southeastern Montana
 - FIN = Financial status 1 worse, 2 same, 3 better than a year ago
 - STAT = 0, State economic outlook better, 1 not better than a year ago
- Do the majority of Montana residents feel their financial status is the same or better than one year ago?
- Do the majority of Montana residents have a more positive economic outlook than one year ago?

SPSS Step-by-step: Converting Data to Binary and Hypothesis Testing for a Proportion

- Open the dataset *econoutlook.sav*.
- If the variable is a zero or one, the *sample mean* is the same as the *proportion of the sample* that has a value equal to 1.
- Convert Financial Status (FIN) to a 0 if worse, and 1 if same or better:
 1. Click **Transform** menu, select **Recode into Different Variables**.
 2. Select FIN on left and click right arrow button.
 3. Click **Old and New Values** button.
 4. First transform FIN=1 into value 0:
 - (a) On the left under **Old Value**, click radio box for **Value**. In textbox enter 1.
 - (b) On the right under **New Value**, click radio box for **Value**. In textbox enter 0.
 - (c) Click **Add** button.
 5. Next transform FIN=2 or FIN=3 into value 1:
 - (a) On the left under **Old Value**, click radio box for **Range**. In textboxes enter 2 and 3.
 - (b) On the right under **New Value**, click radio box for **Value**. In textbox enter 1.
 - (c) Click **Add** button.
 6. Click **Continue**
 7. In original Recode window, under **Output Variable**, type a name.
 8. Click **Change**
 9. Click **OK!**
- Hypothesis testing for a proportion:
 - Do simple one-sample t-tests for a mean.
 - Typically use a null hypothesis: $H_o : \mu = 0.5$, which means the proportion is equal to 50%. This way, you may find statistical evidence for a *majority* or a *minority* of the population having a given characteristic.

3.4 Nonparametric Testing about Median

Single Median Nonparametric Test

- Why?
 - Ordinal data: cannot compute sample means (they are meaningless), only median is meaningful.
 - Small sample size and you are not sure the population is not normal.
- Single-Sample Wilcoxon Signed Rank Test.
- Hypotheses
 - Null: The population median is equal to some specified value.
 - Alternative: The population median is different than the value in the null.

Example: Attitudes Grade School Kids

- Dataset: 438 students in grades 4 through 6 were sampled from three school districts in Michigan. Students ranked from 1 (most important) to 5 (least important) how important grades, sports, being good looking, and having lots of money were to each of them.
- Open dataset `gradschools.sav`. Choose second worksheet, titled `Data`.
- Answer some of these questions:
 - Is the median importance for grades is greater than 3?
 - Is the median importance for money less than 3?

SPSS Step-by-step: Single-Sample Wilcoxon Signed Rank Test

1. Click **Analyze** menu, select **Nonparametric Tests**, select **One Sample**
2. Click on **Fields** Tab.
3. Move all of the variables *out of the Test Fields* box.
4. Move **Grades** (or a different variable of interest) back to the **Test Fields** box.
5. Click on the **Settings** tab.
6. Click on the **Customized tests** radio button
7. Click on the **Compare median to hypothesized (Wilcoxon signed-rank test)**.
8. In the textbox for the hypothesized median, enter 3.
9. Click **Run!**

4 Bivariate Tests

4.1 Difference in Populations (Independent Samples)

Difference in Means (Independent Samples)

- Suppose you want to know whether the mean from one population is larger than the mean for another.
- Examples:
 - Compare sales volume for stores that advertise versus those that do not.
 - Compare production volume for employees that have completed some type of training versus those who have not.
- Statistic: Difference in the sample means ($\bar{x}_1 - \bar{x}_2$).

Independent Samples T-Test

- Hypotheses:
 - Null hypothesis: the difference between the two means is zero.
 - Alternative hypothesis: the difference is [above/below/not equal] to zero.
- Different ways to compute the test depending on whether...
 - the variance in the two populations is the same (more powerful test), or...
 - the variance of the two populations is different.
 - To guide you, SPSS also reports Levene's test for equality of variance (Null - variances are the same).

Example

- Dataset: average pay for public school teachers and average public school spending per pupil for each state and the District of Columbia in 1985.
- Test the following hypotheses:
 - Does spending per pupil differ in the North (region 1) and the South (region 2)?
 - Does teacher salary differ in the North and the West (region 3)?
- Do you see any weaknesses in our statistical analysis?

SPSS Step-by-step: Independent Samples T-test for a Difference in Means

1. Open *eduspending.sav* in SPSS.
 2. Click **Analyze** menu, select **Compare Means**, then select **Independent-Samples T test**.
 3. Select **Pay** or **Spending**, depending on which you are currently interested in.
 4. Click the right arrow that is just to the left of **Test Variables**.
 5. Select **Area** and click on right arrow to the left of **Grouping Variable**.
 6. You need to tell SPSS what your grouping variable means and what groups you are interested in:
 - (a) Click on **Define Groups**
 - (b) Click radio button **Use specified values**.
 - (c) Enter in the appropriate numbers for Group 1 and Group 2 (i.e. if you want the North to be group 1, type a 1 in Group 1 text box, and if you want the West to be group 2, type a 3 in the Group 2 text box.
 - (d) Click **Continue**.
 7. Click **OK!**
- The first output table shows some descriptive statistics for each group.
 - The next output table shows:
 - Statistical evidence about whether the variances are different.
 - Statistical evidence about whether the means are different.
 - Descriptive statistics about the difference in the means.
 - Confidence intervals for the difference in the means.

Nonparametric Tests for Differences in Medians

- Mann-Whitney U test: nonparametric test to determine difference in *medians*.
- Assumptions:
 - Samples are independent of one another.
 - The underlying distributions have the same shape (i.e. only the location of the distribution is different).
 - It has been argued that violating the second assumption does not severely change the sampling distribution of the Mann-Whitney U test.
- Null hypothesis: medians for the two populations are the same.

- Alternative hypotheses: medians for the two populations are different.

SPSS Step-by-step: Mann-Whitney U-Test (Independent Samples test for a Difference in Medians)

1. Use the same Education Spending dataset as above.
 2. Click **Analyze** menu, select **Nonparametric Tests**, then select **2 Independent Samples...**
 3. Move **Pay** (or whatever you are interested in) into **Test Variable List**
 4. Move **Area** into **Grouping Variable**
 5. Define groups as before.
 6. You can get exact p-values if absolutely necessary (takes more time).
 7. Click **OK**.
- The value of the Mann-Whitney test statistic can be huge and this does not have much interpretation (it's equal the smaller of the two sums of ranks).
 - The Significance is the p-value.
 - What is your conclusion?

4.2 Paired Samples

Dependent Samples - Paired Samples

- Use a **paired sampled test** if the two samples have the same individuals or sampling units.
- Many examples include before/after tests for differences:
 - The Biggest Loser: Compare the weight of people on the show before the season begins and one year after the show concludes.
 - Training session: Are workers more productive 6 months after they attended some training session versus before the training session.
- Examples besides before/after tests for differences:
 - Do students spend more time studying than watching TV?
 - Does the unemployment rate for White/Caucasian differ from the unemployment rate for African Americans (sampling unit = U.S. state).
- These are dependent samples, because you have the same sampling units in each group.

Paired Samples Parametric vs Nonparametric

- Parametric test: Paired-samples t-test.
 - Measurement is taken from the sample sampling units (eg: individuals) in each group.
 - Interval/ratio data.
 - Assumptions of CLT must be met.
- Nonparametric test: Wilcoxon Signed Rank Test for Paired Samples
 - Good for *ordinal* and interval/ratio.
 - Good when assumptions of CLT are violated.

SPSS Step-by-step: Paired-Samples T-test for a Difference in Means

- Dataset: Job Satisfaction measures for Israeli public workers.
 - Includes information on a number of measures of job satisfaction including, (1) overall, (2) colleagues, (3) supervision, (4) salary, and (5) promotion.
 - Includes background information like ethnicity, years experience, and marital status.
 - Includes workplace information like location and workload.
- Open dataset `JobSatisfaction.sav`.
- Answer some of these questions:
 1. Are employees' mean level of satisfaction different for colleagues versus supervision?
 2. Are employees' mean level of satisfaction different for salary versus overall?
- 1. Click **Analyze** menu, select **Compare Means**, then select **Paired Samples T Test**.
- 2. Move **Colleague** and **Supervision** into the **Paired Variables** list.
- 3. Click **OK**.
- The first table of output shows the sample means for **Colleague** and **Supervision**.
- The second table shows the correlation between the two variables - ignore this.
- The third table shows:
 - The average difference between the two variables.
 - The standard deviation of the difference.
 - A confidence interval for the difference.
 - A t-statistic (similar to a z-statistic) for the null hypothesis that the difference=0.
 - A p-value for the null hypothesis that difference=0, versus the alternative hypothesis that the difference $\neq 0$.

SPSS Step-by-step: Wilcoxon Signed Rank Test for a Difference in Medians between Paired-Samples

- Dataset: sample `JobSatisfaction.sav`.
- Answer one of these questions:
 - Are employees' median levels of satisfaction different for colleagues versus supervision?
 - Are employees' median level of satisfaction different for salary versus overall?
- 1. Click **Analyze** menu, select **Nonparametric Tests**, select **Legacy Dialogs**, select **2 Related Samples**.
- 2. Move **Colleague** and **Supervision** into the **Test Pairs** list.
- 3. Make sure **Wilcoxon** is checked.
- 4. Click **OK**.
- Null hypothesis: Medians are the same.
- Alternative hypothesis: Medians are different.
- P-value is given in the last row of the last table.

In-class exercise: Bivariate Statistics

Learning Objectives:

- LO1: Construct and test hypotheses using a variety of bivariate statistical methods to compare characteristics between two populations.
- LO6: Be able to use standard computer packages such as SPSS and Excel to conduct the quantitative analyses described in the learning objectives above.
- LO7: Have a sound familiarity of various statistical and quantitative methods in order to be able to approach a business decision problem and be able to select appropriate methods to answer the question.

Directions: Work in groups of two to three people and answer the following questions. Type up your answers in a Word Processing document that includes the relevant SPSS output and upload your submission to the appropriate D2L Dropbox. For any questions that involve conducting a hypothesis test, be sure to 1) state the null and alternative hypothesis, 2) state the p-value, 3) state the decision regarding rejection of the null hypothesis, and 4) state the conclusion of the hypothesis test in plain English.

Everyone must type up and submit their own work. No copying and pasting from each other! Please put your name first, and all your group members names on your document. I will randomly select one submission from you group, evaluate that submission, and assign everyone the same grade. Please be sure that everyone is working together and understanding everything.

The dataset *electricity.sav* includes data on the average retail price of electricity (expressed in cents per kilowatthour) for residential customers, commercial customers, industrial customers, and overall for each of the lower 48 U.S. states in 2004 and 2005. The dataset also includes the average temperature in each state, the gross domestic product per capita (closely related to average income) by state, and an indicator for the area of the country for each state (area = East, Midwest, South, and West).

1. Is there a difference in the average overall price for electricity between Eastern states and Midwestern states in 2005? If so, which area pays more and what is the average difference in price?
2. Is there a difference in the average price for electricity between residential and industrial customers in 2004? If so, who pays more and what is the average difference in price?
3. Is there a relationship between the average overall price in 2005 and the average temperature in the state? If so, is it a positive or negative relationship?
4. Is there a relationship between the average overall price in 2005 and the GDP per capita for the state? If so, is it a positive or negative relationship?

Conclusions

- Ideas to keep in mind:
 - What is a sampling distribution? What does it imply about p-values and statistical significance?
 - When it is appropriate to use parametric versus non-parametric methods.
 - Most univariate and bivariate questions have a parametric and non-parametric approach.
- Homework assignment due next week.
- Next: Regression Analysis - looking at more complex relationships between more than 2 variables.

Homework: Introductory Statistics
Fall 2014
Deadline: Monday, September 15 (Maybe)

1. The following questions use the dataset `euointernet.sav` on the class website. This is annual data for 32 European countries on the percentage of individuals in the population that have used the Internet to purchase items for personal usage within the last three months.
 - (a) The last column is a dummy variable for whether each country was one of the original members of OECD (Organization for Economic Cooperation and Development), originally signed on December 14, 1960 (most European countries have since joined). Test whether or not original OECD European countries have a higher average Internet commerce usage in 2008 than European countries who did not originally join.
 - (b) Test whether or not the average Internet commerce usage among European countries in 2006 is greater than 20%.
 - (c) Test whether or not the average Internet commerce usage increased in European countries from 2009 to 2010.
2. The director of training for an electronic equipment manufacturer is interested in determining whether different training methods affect the productivity of assembly line employees. She randomly assigns 42 recently hired employees into two groups of 21. The first group (`Training=0`) receives a computer-assisted, individual-based training program and the second group (`Training=1`) receives a face-to-face team-based training program.

Upon completion of the training programs the employees are evaluated on the time (in seconds) it takes to assemble a part. After one month, each employee is also given a questionnaire with a single question, “How confident are you in your ability to perform you assembly line duties? Select one (Not Confident [1] / Somewhat Confident [2] / Very Confident [3]). The data for these variables is given in *training.sav* on the class website.

- (a) Is there evidence that one training program is more effective than the other in terms of time to assemble a part? Be sure to state your hypotheses, what tests you decide to run, report your p-value and report in plain English a description of your result.
- (b) Is there evidence that one training program leads to greater confidence in employees’ abilities to perform their job? As always, state your hypotheses, what tests you decide to run, report your p-value and report in plain English a description of your result.