

# **An Introduction to Statistics**

~ Part 2 ~

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Discussed in Part 1

- What a statistician does
- What *is/are* statistics
- Data and information in data tables
- Some of our terminology

# An Introduction to Statistics

~ Part 2 ~

To be considered in Part 2

- Variables
- Level of measurement
- Units of measure

# An Introduction to Statistics

~ Part 2 ~

To be considered in Part 2

- Variables
- Level of measurement
- Units of measure

as well as

- How to “do” Statistics “right”



# Variables

# Variables

- Categorical or Qualitative
- Quantitative

# Variables

- **Categorical or Qualitative variable**
  - is a classification, categorization, or representation
- **Quantitative variable**
  - is a measurement, amount, or count

# Variables

- **Categorical or Qualitative variable**
  - is a classification, categorization, or representation
    - ◉ May be indicated by words such as “type”, words, codes, or symbols
- **Quantitative variable**
  - is a measurement, amount, or count
    - ◉ May be indicated by words “amount” or “number of”

# Variables

- **Categorical or Qualitative variable**
  - is a classification or categorization
    - ◉ Something that is a name (sub-classification – Nominal Variable), word, or code
  - Examples:
    - ◉ Name of country
    - ◉ Type of bill in your wallet
    - ◉ Brand of shoe
    - ◉ Class year
    - ◉ Area code
    - ◉ Social Security Number

# Variables

- Quantitative variable
  - is a measurement, amount, or count
    - ◉ Can be indicated by words “amount” or “number of”
  - Examples:
    - ◉ Amount of money in your wallet
    - ◉ Height of building
    - ◉ Amount of gasoline in your gas tank
    - ◉ Amount of time spent studying
    - ◉ Number of bills in your wallet
    - ◉ Distance traveled from home to FSU

# Variables

- **CAUTION**
  - A thing is not a variable

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- *Time is not the same as*
  - *Amount of time*
  - *The time at this moment*



# Variables

- **CAUTION**
  - A thing is not a variable
- *Time is a thing.*
- *Amount of time is a measurement or a count.*
- *The time at this moment is a reading on a clock (i.e. a representation).*

# Variables

- **CAUTION**
  - A thing is not a variable
- *Time is a thing.*
  - *Time is not a variable.*
- *Amount of time is a*  
*quantitative variable.*
- *The time at this moment is a*  
*qualitative variable.*

# Variables

- CAUTION
  - A thing is not a variable
- The *bills in your wallet* are things.
- The *number of bills in your wallet*  
is a count.
- The *type of the bills in your wallet*  
is a classification.

# Variables

- **CAUTION**
  - A thing is not a variable
- The *bills in your wallet* are things.
  - The *bills in your wallet* is not a variable.
- The *number of bills in your wallet* is a quantitative variable.
- The *type of the bills in your wallet* is a qualitative variable.

# Variables

- **CAUTION**
  - A thing is not a variable
- Shoes are things.
- The *number of shoes* is a count.
- The *type of shoes* is a classification.

# Variables

- **CAUTION**
  - A thing is not a variable
- Shoes are things.
  - Shoes are not a variable.
- The *number of shoes* is a quantitative variable.
- The *type of shoes* is a qualitative variable.

# Level of Measurement

- Nominal
- Ordinal
- Interval
- Ratio

# Level of Measurement

- Nominal – the values of the variable name, label or categorize



# Nominal Level of Measurement

- Examples:
  - Name of country
  - Brand of clothing
  - Class year
  - Gender
  - Color\*

\*Caution: For an artist, color is a thing.

# Level of Measurement

- Ordinal – the values of the variable are can be arranged in a ranked or specific order
  - A ranking or rating

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- Ordinal – the values of the variable are can be arranged in a ranked or specific order
  - A ranking or rating
- CAUTION: Numbers have order, however, not all numbers correspond to *rankings* or *ratings*.

# Ordinal Level of Measurement

- Examples:
  - J.D. Powers customer service rating for cellular phone service
  - National Highway Traffic Safety Administration rating for car safety
  - Course grade
  - Customer service rating for BestBuy Geek Squad Electronic Service

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Note: These variables could be qualitative or quantitative.

# Level of Measurement

- Interval –
  - the values of variable have properties of ordinal level of measurement
  - differences in values of variable have meaning
  - the value zero does not mean the absence of the quantity
  - operations (addition and subtraction) can be performed on values of the variable

# Level of Measurement

- Interval –
  - the values of variable are ordered
  - differences in values of variable have meaning
  - the value zero does not mean the absence of the quantity
  - operations (addition and subtraction) can be performed on values of the variable

# Interval Level of Measurement

- Examples:
  - Altitude
  - Temperature
  - Time of day measured/represented in military time
  - Year (i.e. birth year, year of graduation, or year college/university founded)



# Level of Measurement

- Ratio –
  - the values of the variable have properties of interval level of measurement
  - ratios of the values of the variable are meaningful
  - the value zero means the absence of the quantity
  - operations (multiplication and division) can be performed on values of variable

# Level of Measurement

- Ratio –
  - the values of the variable are ordered, and sums and differences of the values of variable are meaningful
  - ratios of the values of the variable are meaningful
  - the value zero means the absence of the quantity
  - operations (multiplication and division) can be performed on values of variable

# Ratio Level of Measurement

- Examples:
  - Distance from home to FSU
  - Amount of coffee in a cup
  - Number of students in the session
  - Amount of money in your wallet
  - Speed of car

**Quantitative Variables**  
**have *Units of Measure***

# *Units of Measure for Quantitative Variables*

- *Units of measure a.k.a. units*
- *Units are quantities or amounts adopted as standard measurements*

# *Units of Measure for Quantitative Variables*

- *Units are quantities or amounts adopted as standard measurements*
- **Examples**
  - Dollars
  - Hours
  - Years
  - Feet

# Quantitative Variables

- Quantitative variables can be
  - Discrete
  - Continuous

# Quantitative Variables

- *Continuous variable* - a quantitative variable that has an infinite number of possible values that are not countable



# Quantitative Variables

- *Continuous variable* – a quantitative variable that has an infinite number of possible values that are not countable
  - Note: Suppose a continuous variable can take on all values between 0 and 1, inclusive. Then, the values 0.9, 0.99, 0.999, ..., 0.9999999999999999, etc., are all possible values for the variable

# Quantitative Variables

- *Discrete variable* - a quantitative variable that has either a finite number of possible values or a *countable* number of possible values

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# Quantitative Variables

- *Discrete variable* - a quantitative variable that has either a finite number of possible values or a *countable* number of possible values
  - Note: We say that the values for a variable are countable *if you can count all the possibilities*, for example, 1, 2, 3, 4, 5, .... We can say that there are 0 values as well if there are no possible values for the variable.

# Quantitative Variables

- A quantitative variable is discrete *if the variable involves a count*
  - Examples:
    - ◉ The number of students
    - ◉ The number of bills in your wallet
    - ◉ The amount of money in your wallet
    - ◉ The number of minutes
    - ◉ The number of shoes

# Quantitative Variables

- A quantitative variable is continuous *if the variable involves a measurement*
  - Examples:
    - ◉ Height
    - ◉ Distance traveled
    - ◉ The amount of cereal in the box
    - ◉ Amount of gasoline in your gas tank
    - ◉ The weight of a box

# Cautions

- Important to consider what values *mean* and how they are being *used*



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- Important to consider what values *mean* and how they are being *used*
  - Do not treat all numerical data as quantitative
    - ◉ A zip code is a number but is neither a measurement nor a count
    - ◉ A phone number is neither a measurement nor a count
    - ◉ Hair color according to a five-point scale is neither a measurement nor a count
    - ◉ A social security number is neither a measurement nor a count

- For the following two examples,
  - Determine the variables;
  - Classify each variable  
as Qualitative or Quantitative;
  - Determine the level of measurement  
for each variable;
  - Classify each Quantitative variable  
as continuous or discrete;

and

- State the units of measure  
for each Quantitative variable.

**You are hired to analyze the per capita income, in dollars, as well as the percentages of the labor force employed in agriculture, industry, and service occupations for the twenty (20) OECD\* countries for 1960.**

| <b>COUNTRY</b> | <b>Per Capita Income</b> | <b>Agriculture</b> | <b>Industry</b> | <b>Service</b> |
|----------------|--------------------------|--------------------|-----------------|----------------|
| UNITED KINGDOM | 1105                     | 4                  | 56              | 40             |
| BELGUIM        | 1005                     | 6                  | 52              | 42             |
| SWITZERLAND    | 1361                     | 11                 | 56              | 33             |
| NETHERLANDS    | 810                      | 11                 | 49              | 40             |
| CANADA         | 1536                     | 13                 | 43              | 45             |
| SWEDEN         | 1644                     | 14                 | 53              | 33             |
| LUXEMBOURG     | 1242                     | 15                 | 51              | 34             |
| WEST GERMANY   | 1035                     | 15                 | 60              | 25             |
| DENMARK        | 1049                     | 18                 | 45              | 37             |
| FRANCE         | 1013                     | 20                 | 44              | 36             |
| NORWAY         | 977                      | 20                 | 49              | 32             |
| AUSTRIA        | 681                      | 23                 | 47              | 30             |
| ICELAND        | 839                      | 25                 | 47              | 29             |
| ITALY          | 504                      | 27                 | 46              | 28             |
| JAPAN          | 344                      | 33                 | 35              | 32             |
| IRELAND        | 529                      | 36                 | 30              | 34             |
| SPAIN          | 290                      | 42                 | 37              | 21             |
| PORTUGAL       | 238                      | 44                 | 33              | 23             |
| GREECE         | 324                      | 56                 | 24              | 20             |
| TURKEY         | 177                      | 79                 | 12              | 9              |

**\*OECD - Organization for Economic Cooperation and Development**

**<http://www.oecd.org/general/listofocdmembercountries-ratificationoftheconventionontheoecd.htm>**

For your summer internship with U.S. News and World Report, you are asked to analyze data on the Class of 1999 for the top twenty (20) universities in the United States. From your analysis, you obtain information on the percentage of incoming freshmen who graduate within four years (the freshman retention rate), the percentage of students admitted as freshmen who graduated (the graduation rate), determining both the predicted graduation rate and the actual graduation rate, the percentage of freshman applicants who were accepted (the acceptance rate), and the percentage of alumni who made donations to the university after graduation (the alumni giving rate) for this class.

| School                              | Freshman Retention | Predicted Graduation Rate | Actual Graduation Rate | Acceptance Rate | Alumni Giving Rate |
|-------------------------------------|--------------------|---------------------------|------------------------|-----------------|--------------------|
| University of California – Berkeley | 95                 | 81                        | 82                     | 27              | 18                 |
| Johns Hopkins University            | 95                 | 89                        | 87                     | 33              | 28                 |
| Northwestern University             | 96                 | 85                        | 92                     | 32              | 29                 |
| Columbia University                 | 97                 | 89                        | 91                     | 14              | 32                 |
| University of Chicago               | 94                 | 89                        | 81                     | 48              | 35                 |
| Cornell University                  | 96                 | 87                        | 91                     | 33              | 36                 |
| Stanford University                 | 98                 | 91                        | 90                     | 15              | 37                 |
| Washington University in St. Louis  | 96                 | 83                        | 86                     | 34              | 37                 |
| Rice University                     | 95                 | 91                        | 88                     | 27              | 39                 |
| Emory University                    | 92                 | 83                        | 86                     | 42              | 39                 |
| University of Pennsylvania          | 96                 | 87                        | 90                     | 26              | 40                 |
| California Institute of Technology  | 92                 | 96                        | 82                     | 18              | 41                 |
| Brown University                    | 97                 | 87                        | 93                     | 17              | 43                 |
| Massachusetts Inst. of Technology   | 97                 | 94                        | 91                     | 19              | 43                 |
| Duke University                     | 97                 | 89                        | 92                     | 28              | 45                 |
| Harvard University                  | 96                 | 94                        | 97                     | 11              | 47                 |
| University of Notre Dame            | 98                 | 80                        | 95                     | 35              | 48                 |
| Yale University                     | 98                 | 93                        | 94                     | 16              | 49                 |
| Dartmouth College                   | 96                 | 90                        | 94                     | 21              | 52                 |
| Princeton University                | 99                 | 92                        | 96                     | 11              | 66                 |

# Cautions

- Use meaningful identifiers for
  - Variables in data table
    - ◉ May not remember what heading represents later
    - ◉ Keep a code book for data for software that does not allow many characters for column names
    - ◉ Make sure that you have the context for data
- Be skeptical
  - Information, context, and testing questions can be slanted

# To “do” Statistics “right”

- **Think** about the scenario that you are examining
- **Show** through calculating statistics and making necessary displays (graphs and tables)
- **Tell** what you have learned through your analysis so that anyone can understand (meaningful interpretation)

# Caution

- In statistics, there can be **more than one "right answer"** since a statistician interprets the data and the statistics.
- Important for "right answer"
  - Analysis
  - Explanation
  - Tools
    - ◉ Graphs/tables
    - ◉ Calculations