

# STATISTICS



THE BASIC PRINCIPLES OF STATISTICS FOR INTRODUCTORY COURSES

#### BASIC DEFINITIONS

STATISTICS: The study of methods for collecting, organizing, and analyzing data

- Descriptive Statistics: Procedures used to organize and present data in a convenient and communicable form
- Inferential Statistics: Procedures employed to arrive at broader conclusions or inferences about populations on the basis of samples

POPULATION: The complete set of actual or potential elements about which inferences are made SAMPLE: A subset of the population selected using some sampling method

- Sampling methods
- Cluster sample: A population is divided into groups called elusters; some elusters are randomly selected and every member in them is observed
- Stratified sample: The population is divided into strata, and a fixed number of elements of each stratum are selected for the sample
- Simple random sample: A sample selected so that each possible sample of the same size has an equal probability of being selected; used for most elementary inference

VARIABLE: An attribute of elements of a population or sample that can be measured; ex: height, weight, IQ, hair color and pulse rate are some of the many

variables that can be measured for people DATA: Values of variables that have been

#### observed \*Types of data

- Qualitative (or "categorical") data are descriptive but not numeric; ex: your gooder, your birthplace, the color of an automobile
- Quantitative data take numeric values.
- Discrete data take counting numbers (0, 1, 2, ...) as values, usually representing things that can be counted, ex: the number of fleas on a dog, the number of times a professor is late in a semester
- Continuous data can take a range of numeric values, not just counting numbers; ex: the height of a child, the weight of a bag of beans, the amount of time a professor is late

#### · Levels of measurement

- -Qualitative data can be escasured at the:
- Nominal level: Values are just names, without any order; ex: color of a car, major in college
- Ordinal level: Values have some natural order; ex: high school class (freshman / sophomore / junior / sepior), military rank.
- -Quantitative data can be measured at the:
- Interval level: Numeric data with no natural zeropoint; intervals (differences) are meaningful, but nation are not; ex: temperature in Fahrenheit degrees; 80°F is 20°F hotter than 60°F, but it is not 150% as hot
  - Ratio level: Numeric data for which there is a true zene: both intervals and ratios are meaningful; ex: weight, length, duration, most physical properties

STATISTIC: A numeric measure computed from sample data, used to describe the sample and to estimate the corresponding population parameter

PARAMETER: A numeric measure that describes a population; parameters are usually not computed, but are inferred from sample statistics

#### FREQUENCY DISTRIBUTION

Provides the frequency (number of times observed) of each value of a variable

Table #1: Students in a driving class are polled regarding number of accidents they've had:

(# of accidents)	(frequency)	(relative frequency)
	-	RF

- 8	- 1	RF
	3	0.0526
- 4	2	0.0351
3	49.0	0.1579
2	1.5	0.2632
1	16	0.2807
0	12	0.2105

GROUPED FREQUENCY DISTRIBUTION: Values of the variable are grouped into classes

Table #2: The scores on a midterm exam are grouped into classes:

class		consulative freq.
90-99	4	80
80-89	18	76
70-79	31	58
60-69	19	27
50-59	7	
40-49	- 1	1

RELATIVE FREQUENCY DISTRIBUTION: Each frequency is divided by the total number of observations to produce the proportion or percentage of the data set having that value; ex: third column of Table 1

CUMULATIVE FREQUENCY DISTRIBUTION-Frequencies count all observations at a particular value or class and all those less. Ex: third column of Table 2

#### MEASURES OF CENTRAL TENDENCY

MEAN: Most commonly used measure of control tendency, usually meant by "average"; sensitive to extreme values.

POPULATION MEAN

SAMPLE MEAN

 $\mu = \frac{1}{N} \sum_{i} \hat{\Sigma}_{i}$ 

 $\mathcal{R} = \frac{1}{R_f} \sum_i x_i$ 

 $\sum_{i=1}^{n} w_{i} x_{i}$ 

- Triesmed means Computed discarding some number of the highest and lowest values; less sensitive than ordinary mean
- \*Weighted mean: Computed with a weight multiplied to each value, making some values influence the mean more beavily than others

MEDIAN: Value that divides the set so the same mamber of observations lie on each side of it; less sensitive to extreme values; for an odd number of values, it is the middle value; for an even number, it is the average of the middle two; ex: in Table 1, the modian is the average of the 28th and 29th observations, or 1.5

MODE: Observation that occurs with the greatest frequency; ex: in Table 1, the mode is 1

#### MEASURES OF DISPERSION

SUM OF SQUARES (SS): The sum of squared deviations from the mean .2

•Population SS: 
$$\sum (x_i - \mu_x)^2 \text{ or } \sum x_i^2 - \frac{(\sum x_i)^2}{N}$$

•Sample SS: 
$$\sum (x_i - \bar{x})^2 ar \sum x_i^2 - \frac{(\sum x_i)^2}{n}$$
  
•VARIANCE: The average of square difference

VARIANCE: The average of square differences between observations and their mean

• Population variance: 
$$\sigma^2 = \frac{1}{N_z} \sum_{i=1}^{N} (x_i - \mu)^2$$

• Sample variance: 
$$s^2 = \frac{1}{m-1} \sum_{i=1}^{m} (x_i - \overline{x})^2$$

- Variances for grouped data:
- -Population:  $\sigma^2 = \frac{1}{N} \sum_{i=1}^{N} f_i(m_i \mu)^2$

-Sample: 
$$x^2 = \frac{1}{n-1} \sum_{i=1}^{n} f_i(m_i - X)^2$$

STANDARD DEVIATION: The square root of the variance, unlike variance, it has the same units as the original data and is more commonly used:

ex: Pop. S.D.: 
$$\sigma = \sqrt{\frac{1}{N}} \sum_{i=1}^{N} (x_i - \mu)^2$$

STANDARD SCORES: Also known as Z-scores; the standard score of a value is the directed number of standard deviations from the mean at which the value is found; that is,  $z = \frac{x - \mu}{c}$ .

\*A positive z-score indicates a value greater than the

- A positive x-score indicates a value greater than the mean; a negative x-score indicates a value less than the mean; a x-score of zero indicates the mean value
- Converting every value in a data set or distribution to a z-score is called standardization; once a data set or distribution has been standardized, it has a new mean µ =0, and a new standard deviation 0 = 1

#### **GRAPHING TECHNIQUES**

BAR GRAPH: A graph that uses bars to indicate the frequency of occurrence of observations

 Histogram: A bar graph used with quantitative, continuous variables

FREQUENCY CURVE: A graph representing a frequency distribution in the form of a continuous line that traces a histogram

- Cumulative frequency curve: A continuous line that traces a histogram where bars in all the lower classes are stacked up in the adjacent higher class; cannot have a negative slope.
- Symmetric curve: The frequency curve is unchanged if rotated around its center; median = mean
- · Normal curve: Bell-shaped curve; symmetric
- Skewed curve: Deviates from symmetry; frequency curve is shifted with a longer "nail" to the left (mean < median) or to the right (mean > median)



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