

Essential Tools for Understanding Statistics & Probability • Rules, Concepts, Variables, Equations, Problems, & Helpful Hints • Common Pitfalls

## DESCRIPTIVE STATISTICS

Methods used to simply describe data sets that have been observed

### KEY TERMS & DEFINES

- Quantitative data:** data variables that represent some numerical quantity (e.g., height, test scores)
- Categorical/Qualitative data:** data variables with values that reflect some quality of the element, one of several categories, and a human measurement
- Population:** "the whole", the entire group of which we seek to learn or that we intend to measure
- Sample:** "the part", a representative subset of the population
- Simple random sampling:** the most commonly assumed method for selecting a sample; samples are chosen so that every possible sample of the same size is equally likely to be the one that is selected
- $N$ :** size of a population
- $n$ :** size of a sample
- $x$ :** the value of an observation
- $f$ :** the frequency of an observation (e.g., the number of times it occurs)
- Frequency table:** a table that lists the values observed in a data set along with the frequency with which it occurs
- Population parameter:** some numeric measurement that describes a population, generally not known, but estimated from sample statistics
  - $\mu$ : population mean;  $\sigma$ : population standard deviation;  $\rho$ : population proportion;  $\rho$ : population standard of  $\rho$
- Sample statistic:** some numeric measurement used to describe data in a sample; used to estimate or make inferences about population parameters
  - $\bar{x}$ : sample mean;  $s$ : sample standard deviation;  $\hat{p}$ : sample proportion;  $\hat{\rho}$

### Application & Solution

- A student receives the following exam grades on a course: 87, 88, 75, 82, 78
  - Compute the mean:  $\bar{x} = \frac{87 + 88 + 75 + 82 + 78}{5} = 82$
  - What is the median exam grade?  
In order, the scores are: 75, 78, 82, 88, 87; middle element = 82
  - What is the range? Range = maximum - minimum = 88 - 75 = 13
  - Compute the standard deviation:  
 $s = \sqrt{\frac{(87-82)^2 + (88-82)^2 + (75-82)^2 + (82-82)^2 + (78-82)^2}{5-1}} = \sqrt{\frac{25 + 36 + 49 + 0 + 16}{4}} = \sqrt{27.5} = 5.24$
  - What is the z score for the exam grade of 88?  $z = \frac{88 - 82}{5.24} = 1.15$
- The results of a placement exam only are displayed as follows. Many times they are listed inverted; the results are given in the following frequency table:
 

Score	Frequency
95	2
90	3
85	4
80	5
75	6
70	7
65	8
60	9
55	10
50	11
45	12
40	13
35	14
30	15
25	16
20	17
15	18
10	19
5	20

  - Compute the mean:  $\bar{x} = \frac{\sum fx}{n} = \frac{1100}{20} = 55$
  - Compute the median. Since  $n = 20$  is even, the median is the average of the observations with ranks  $\frac{n}{2}$  and  $\frac{n}{2} + 1$  (i.e., the 10<sup>th</sup> and 11<sup>th</sup> observations)
    - While we could count from either side of the distribution from 20 or from 0, it is easier here to count from the bottom. The first 10 observations in rank order are all 5; the next 10 (the 11<sup>th</sup> through the 20<sup>th</sup>) are all 6; the 10<sup>th</sup> through the 10<sup>th</sup> are all 5; the 11<sup>th</sup> through the 11<sup>th</sup> are all 6; the average is  $(5 + 6) / 2 = 5.5$
  - Compute the IQR. To find the IQR, we must first compute Q1 and Q3. If we divide  $n$  in half, we have a lower 10 and an upper 10 observations; the "median" of each would have rank 10 = 20; the 10<sup>th</sup> observation in the lower half is a 5, so Q1 = 5 and the 10<sup>th</sup> observation in the upper half is a 6, so Q3 = 6; therefore, IQR = Q3 - Q1 = 6 - 5 = 1

### Formulating Hypotheses

Type	Feature	Formula	Important Properties
Measures of center (measures of central tendency) indicate which value is typical for the data set	mean	From raw data: $\bar{x} = \frac{\sum x}{n}$ From a frequency table: $\bar{x} = \frac{\sum fx}{n}$	ensitive to extreme values; appropriate and influencing the mean; more useful for symmetric data
	median	middle; median has rank $\frac{n+1}{2}$ Average of values with ranks $\frac{n}{2}$ and $\frac{n}{2} + 1$	not sensitive to extreme values; more useful when data are skewed
	mode	the observation with the highest frequency	only measure of center appropriate for categorical data
	mid-range	$\frac{\text{maximum} + \text{minimum}}{2}$	not often used; highly sensitive to unusual values; easy to compute
Measures of variation (measures of dispersion) reflect the variability of the data (i.e., how different the values are from each other)	sample variance	$s^2 = \frac{\sum (x - \bar{x})^2}{n - 1}$	not often used; only use the square of these for the data
	sample standard deviation	$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n - 1}}$	square root of variance; sensitive to extreme values; commonly used
	interquartile range (IQR)	IQR = Q3 - Q1 (see quartile, below)	less sensitive to extreme values
	range	maximum - minimum	not often used; highly sensitive to unusual values; easy to compute
Measures of relative standing of relative position indicate the z position value (compared to the others in the same data set)	percentile	data divided into 100 equal parts by rank (i.e., the $n^{\text{th}}$ percentile is that value greater than $k\%$ of the others)	important to apply to normal distributions; less probability distributions
	quartile	data divided into 4 equal parts by rank; Q2 (first quartile) is the value greater than 25% of the others; Q3 (third quartile) is greater than 75%; Q2 is identical to the median	used to compute IQR (see IQR, above); Q2 is often viewed as the "median" of the upper half, and Q1 as the "median" of the lower half; Q2 is the median of the data set
	z score	$z = \frac{x - \bar{x}}{s}$ to find the value of some observation, $x$ , when the z score is known: $x = \bar{x} + z \cdot s$	measures the distance from the mean in terms of standard deviation

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**Annelies Wilder-Smith**



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