**EDUR 7130**
**Presentation 4a**

## 1. Descriptive Statistics

### 1a. Descriptive Statistics

What is the purpose of descriptive statistics?

Descriptive statistics represent methods for presenting data to make data easier to understand.

Example

Someone asks – "How did your class do on that test?"

Possible Response Options

- List all scores: 88, 75 ,93 ,99, 61, 79, 83, 85, 91, 92, 73, 100, …
- Present Descriptive Statistics
  - Mean (average) = 86.33, about a B
  - Minimum and Maximum Scores = scores ranged from 61 to 100

Which is easier to comprehend quickly, all scores or descriptive statistics?

What are data?

Data are recorded units of information. Data may be questionnaire responses (your age, income, sex), class grades, recorded study habits, psychological assessments, or this chat recording.

### 1b. Measures of Central Tendency

Descriptive statistics normally focuses on data that are recorded in numeric format. One method for describing such data is through central tendency.

What is central tendency?

Central tendency is typical or average scores.

We will cover three types of central tendency:

- Mode
- Median
- Mean

What is the mode and what is the symbol for mode?

The most frequent score (or category) and is symbolized as Mo.

Here are a set of scores.

1 2 3 1 2 3 3 2 1 1 2 3 2 1 1 2 1 3

Below is a frequency display showing frequency for each of the three scores.

| | | Frequency | Percent |
|---|---|---|---|
| Valid | 1.00 | 7 | 38.9 |
| | 2.00 | 6 | 33.3 |
| | 3.00 | 5 | 27.8 |
| | Total | 18 | 100.0 |

What is the mode for these data?

The Mo = 1

What happens if there is more than one mode? For example:

1 1 1 2 2 2 3 3 3 4 5 6

| Score | Frequency |
|---|---|
| 1 | 3 |
| 2 | 3 |
| 3 | 3 |
| 4 | 1 |
| 5 | 1 |
| 6 | 1 |

There are three modes, so this distribution would be tri-modal (three modes). In such situations, easiest to refer to this type of distribution of scores as multi-modal.

What is the median and the symbol for median?

The median is the middle score in a distribution of ranked scores such that half the scores are below it and half above it. Two common symbols for median are Md and Mdn.

What is the median for these scores?

4, 2, 3, 1, 5

Correct, the median is 3.

What is the median for these scores?

5, 2, 6, 1, 4

Median is the middle score (or the average of the two middle scores if an even number of scores exists).

You must first sort the scores in order, and then find the middle scores. In this case the median is 1 2 *4* 5 6 = 4

What is the median for these scores?

1 2 3 4 5 6

Since even number of scores in this set (6 scores), take the mean of the two middle scores, so Md = 3.5

What is the median for these?

5, 2, 6, 1, 4, 6

Median is 1 2 4 5 6 6 ----- mean of 4+5 = 4.500 (two scores in middle).

What is the mean and the symbol for mean?

Mean is sum of scores divided by number of scores: (Sum X/N). One symbol for mean is M, another is $\bar{X}$. When calculating mean, it is best to carry calculations at least to three decimal places (unless dealing with numbers smaller than that, then go even further with decimal places for more accuracy).

What is the mean for these scores?

1 2 3 4

Sum (1+2+3+4 = 10), so 10/N = 10/4 = 2.500.

**1c. Measures of Variability**

What is variability?

Variability refers to spread or dispersion of scores (amount of difference or change in scores).

One way to quickly comprehend variability is to consider **minimum** and **maximum** scores from a set of scores.

Scores: 1, 2, 3, 4, 5

Maximum (Max) = 5
Minimum (Min) = 1

Minimum and maximum can be used to calculate **range** which is one way to measure score variability.

What is range and what is the symbol for range?

Range (R) is defined as R = Maximum score – minimum score.

Here are two sets of scores. Which set appears to have more variability in scores, why?

Set 1: 1 3 3 3 5
Set 2: 1 2 3 4 5

Set 2 appears to have more variability since every score is different whereas Set 1 has three scores that do not vary (three 3s).

What is the range for these two sets of scores?

Range for both is 5 -1 = 4.

Notice there is no difference in range for the two sets, yet we can see differences in variability across these two sets.

Also notice that range does not help us see this difference; range reports that both sets have the same spread of scores. The range as a measure of variability is limited in that it ignores most scores and only considers two scores at the extreme ends of the distribution.

Better methods for assessing spread of scores, or variability, is the use of

- sample variance (VAR or $s^2$) and
- sample standard deviation (SD or s)

Both measure how far a set of scores lie from the set mean. Importantly, both measures consider all scores, not just the two extreme scores like the range.

Note I prefaced each with "sample" because in most cases these measures will be calculated for sample data. If one has a census – a population of data – then one would use the population formulas for variance and standard deviation. So, these measures have two formulas, one for sample and one for population. It is rare that one has a population, so by default one should use the sample formula if a choice is present.

The larger the VAR or SD, the more variability in the scores – the more the set of scores deviate from their mean.

Loosely defined, the SD represents the average (mean) deviation of scores from the mean.

Example

Find SD for these scores (you don't need to know how to calculate for this course, this is just an illustrative example):

Set 1: 1 3 3 3 5
Set 2: 1 2 3 4 5

See calculations below.

Calculation for Set 1

| | | Deviation Score | Squared Deviation Score | |
|---|---|---|---|---|
| Set 1, X | Mean, M | X - M | (X-M)^2 | |
| 1 | 3 | -2 | 4 | |
| 3 | 3 | 0 | 0 | |
| 3 | 3 | 0 | 0 | |
| 3 | 3 | 0 | 0 | |
| 5 | 3 | 2 | 4 | |
| | | | | |
| | Sum | = | 8 | = SS (sum of squares) |
| | n | = | 5 | |
| df = | n – 1 | = | 4 | |
| Var = | SS / (n-1) | = | 8 / 4 = 2.00 | |
| SD = | SQRT(VAR) | = | SQRT(2) = 1.41 | |

Calculation for Set 2

| | | Deviation Score | Squared Deviation Score | |
|---|---|---|---|---|
| Set 2, X | Mean, M | X - M | (X-M)^2 | |
| 1 | 3 | -2 | 4 | |
| 2 | 3 | -1 | 1 | |
| 3 | 3 | 0 | 0 | |
| 4 | 3 | 1 | 1 | |
| 5 | 3 | 2 | 4 | |
| | | | | |
| | Sum | = | 10 | = SS (sum of squares) |
| | n | = | 5 | |
| df = | n – 1 | = | 4 | |
| Var = | SS / (n-1) | = | 10 / 4 = 2.50 | |
| SD = | SQRT(VAR) | = | SQRT(2.5) = 1.58 | |

The calculated VAR and SD for both sets and the numbers follow:

Set 1: 1 3 3 3 5 SD = 1.41; VAR = 2.00
Set 2: 1 2 3 4 5 SD = 1.58; VAR = 2.50

According to SD and VAR, which set has more variability?

Set 2 shows more variability because all scores are different and both the SD and VAR are larger than for Set 1.

The larger the VAR or SD, the more variability (if both sets of scores are measured using the same measuring device); hence SD and Variance are needed to show differences among scores in between the two ends of a set of scores.

If there were no variability in a set of scores, what would SD equal? For example:
Scores: 3, 3, 3, 3, 3

SD = 0 when scores have no variability.

Is it possible to have a SD that is negative?

SD cannot be less than zero, so cannot be negative. Both SD and VAR can be 0 or greater.

**1d. Relative Position**

Relative position indicates where one score is in a distribution of scores (or a set of scores) relative to other scores.

Many measures of relative position, for example:

- percentile rank
- grade equivalency
- z scores
- Stanines
- T scores

Normative information – relative scores indicate location of one score relative to another score; how one does vs. a norm.

Percentile ranks (PR) represent one measure of relative position.

Interpret the following: PR = 33

There are two definitions used for PR, and both are very similar.

- First, PR = 33 indicates that one scored better than 33% of test takers (less common definition, rarely used).
- Second, PR = 33 indicates that one scored EQUAL TO or better than 33% of test takers (this definition is commonly used throughout USA).

Both definitions are used by testing companies; the first simply indicates one scored better than others, the second indicates that one scored better than or equal to others.

So PR indicates what percentage of people you outperformed, or scored higher than.

Does a PR = 33 mean one has performed poorly on a test?

Not necessarily, for example, on a math test in calculus 99 students completed the test and the scores were calculated as percentage correct. Scores obtained were:

| Math Score | Frequency | Percent | Percentile Rank |
|---|---|---|---|
| 100 | 33 | 33% | 99 (or 100) |
| 99 | 33 | 33% | 66 |
| 98 | 33 | 33% | 33 |

This shows that PR, and other measures of relative position, don't indicate absolute performance, only relative performance. Here the absolute performance was very good – almost perfect – yet still a score of 98 resulted in a PR of 33.

Is it possible to have a PR of 105?

No. Since PR are essentially percentages, they should range from 0 to 100. However, convention holds that PR range between 1 and 99. You won't (or should not) find anyone with a PR less than 1 or greater than 99.