Chapter 2: Measurement and Numbers

Chapter Outline

A. Questions to ask about test scores.
   1. Scale
   2. Pattern
   3. Location
   4. Spread
   5. Relative position
   6. Association
   7. Description versus inference
B. Scales
   1. Nominal
   2. Ordinal
   3. Interval
   4. Ratio

C. Preparation of frequency distributions.
   1. Raw frequency distributions
   2. Grouped frequency distributions
      a) How many groups
      b) Interval width

D. Graphic representations.

E. Measures of central tendency.
   1. The mode.
   2. The median.
   3. Scores as continuum.
   4. The concept of the interval
   5. Percentiles
   6. The arithmetic mean.
   7. Central tendency and the shape of the distribution

F. Measures of variability.
   1. Range
   2. Semi-interquartile range.
      a) Computing the standard deviation.
      b) Sample value and population estimate

G. Interpreting the standard deviation.
   1. Normal distribution
   2. Percent of cases

H. Interpreting the score of the individual.

I. Measures of relationship.
   1. Scatter plot.
   2. Information provided by the correlation coefficient.
      Sign.
      Magnitude.
   3. Correlations in measurement.
      a) Determining the consistency and precision of a measurement procedure.
      b) Comparing two procedures to determine whether one is a good predictor.
         Describing the relationship between two variables.

J. Summary
Study Questions and Answers

1. How are descriptive and inferential statistics different?
   Descriptive statistics are used to describe the characteristics of a set of scores. Inferential statistics involve the use of sample statistics to estimate the characteristics of a population.

2. What is the name we give to a table that indicates how many times each score has occurred?
   A frequency distribution.

3. How can the frequency distribution be improved in order to make the presentation more concise?
   The scores can be grouped into broader categories.

4. How many categories should be used in a grouped frequency distribution?
   A practical rule of thumb is to select groups of a size that will result in 15 categories.

5. Explain how to determine the mode, median, mean?
   a. Mode – Select the score that occurs most frequently.
   b. Median – This is the point at which there are as many scores above as below. If there are an odd number of scores and no tied scores at the middle of the distribution the median is the middle score. In other cases the computation of this value is complex. See pages 37 and 38 in the textbook for an explanation of how to accomplish this.
   c. Mean – Compute the total of all of the scores and divide this value by the number of scores.

6. When would you use the median rather than the mean?
   If a distribution is skewed the median might be selected since extreme scores do not affect its value.

7. What is the purpose of measures of variability?
   They tell us how clustered together or spread apart a set of scores is.

8. What are three methods of determining variability?
   Range, semi-interquartile range, and standard deviation.

9. To what family of statistics does the semi-interquartile range belong?
   The same family as the median.

10. What is the standard deviation?
    It is the square root of the average of the squared deviations from the mean.

11. What are the two forms of the standard deviation? When would each be used?
    a. The sample standard deviation is:
       \[ SD = \sqrt{\frac{\sum (X - M)^2}{N}} \]
    b. The estimate of the population SD is:
       \[ SD = \sqrt{\frac{\sum (X - M)^2}{N-1}} \]
We use the sample value when we wish to describe the scores we have and are not concerned with a population. We use the population estimate when we wish to get a best guess about the spread of scores in a population based on data on a sample from the population.

12. What is the relationship between the standard deviation and the variance?
The standard deviation is the square root of the variance.

13. Under what circumstances would the variance be used?
It is used in more advanced statistical procedures.

14. Why do we square the deviations and then turn around and find the square root of the sum of the squares?
So that the deviations around the mean will all have positive values (so they won’t sum to zero) which permits further statistical treatment.

15. What is the relationship between the normal curve and the standard deviation?
If a set of scores has a normal distribution there will be a precise mathematical relationship between the standard deviation and the number of cases.

16. What is the purpose of scatter plots?
To provide a graphic representation of the relationship between two variables.

17. What is the possible range of the correlation coefficient?
Between -1.0 and +1.0

18. What two types of information does the correlation coefficient provide?
a. The sign of the correlation tells us whether two variables rank people in the same direction or in different directions.
b. The magnitude of the correlation tells us the strength of the relationship.

19. What are the three important settings in which correlation coefficients will be encountered in connection with testing and measurement?
a. To determine the consistency and precision of a measurement instrument (reliability).
b. When we are interested in the degree of relationship between two variables and when we want to evaluate the usefulness of one as a predictor of the other (validity).
c. In order to quantify the relationship between variables that in turn can help us understand how behavior is organized.

Important Terms

The following are important terms mentioned in Chapter 2:

a. Correlation  j. Mode
b. Cumulative frequency  k. Normal curve
c. Deviation  l. Percentile
d. Descriptive statistics  m. Range
e. Frequency distribution  n. Score interval
f. Histogram  o. Semi-interquartile range
g. Inferential statistics  p. Standard deviation
h. Mean  q. Variance
i. Median

12
Match the description below with one of the terms listed above.

_____ 1. The score below which a given percentage of the group falls.

_____ 2. A symmetrical curve having a bell like shape.

_____ 3. One-half of the difference between the first and third quartiles.

_____ 4. The point in a distribution of scores at which there are as many scores above as there are below.

_____ 5. The range of scores grouped together when constructing a frequency distribution.

_____ 6. The difference between the mean and a score, obtained by subtracting the mean from a score.

_____ 7. The most often used method of determining the average.

_____ 8. The typical score.

_____ 9. A graphical representation of the distribution of scores in which the vertical height of a column represents the number of scores in each interval.

_____ 10. An index that indicates the relationship between two variables.

_____ 11. How much each score typically deviates around the mean.

_____ 12. The total number of individuals having a score equal to or less than the highest score in an interval.

_____ 13. Statistics used to describe a set of scores.

_____ 14. Difference between the highest and lowest score.

_____ 15. The average of the squared deviations.

_____ 16. Use of samples to understand populations.

_____ 17. Score that occurs most frequently.

_____ 18. A table that shows the frequency of each score.

Answers to Important Terms

1. l   6. c   11. b   16. j
2. k   7. h   12. d   17. e
3. o   8. f   13. m
4. i   9. a   14. q
5. n   10. p  15. g
Multiple Choice Questions

b. 1. What do we call statistics that use samples to provide information about a population?
   a. descriptive
   b. inferential
   c. non-parametric
   d. theoretical
   e. population based

c. 2. You have cognitive ability test scores for 350 children and are preparing to make a frequency distribution. The scores range from 62 to 134. Which would be the most satisfactory way to group the scores?
   a. 62 – 63, 64 – 65, 66 – 67a, etc.
   b. 61 – 63, 64 – 66, 67 – 69, etc.
   c. 62 – 67, 68 – 72, 73 – 77, etc.
   d. 60 – 65, 65 – 70, 70 – 75, etc.
   e. 60 – 69, 70 – 79, 80 – 89, etc.

a. 3. In preparing a histogram score intervals are shown along the:
   a. abscissa.
   b. ordinate.
   c. Y – axis.
   d. tangential plane.
   e. polygon function.

a. 4. What is the mode of the following scores: 2,2,3,4,6,7:
   a. 2
   b. 3
   c. 5
   d. 6
   e. 10

c. 5. According to your text, a score of 25 should be thought of as meaning:
   a. more than 24, but not more than 25.
   b. from 25 to just not quite 26.
   c. from 24.5 to 25.5.
   d. exactly 25.

c. 6. What is the median of the following scores: 25,12,29,12,57?
   a. 5.
   b. 12.
   c. 25.
   d. 29.
   e. 57.

c. 7. The 50th percentile is always the same as the:
   a. mode.
   b. mean.
   c. median.
   d. standard deviation.
   e. interquartile range.
b. 8. The mean and the median will be identical for what kind of distributions:
   a. leptokuric distributions.
   b. symmetrical distributions.
   c. bimodal distributions.
   d. skewed distributions.
   e. all distributions.

c. 9. What is the mean of the following scores: 2,2,3,4,9?
   a. 2
   b. 3
   c. 4
   d. 5

a. 10. In most cases, the mean is a better measure of central tendency than the mode or median because:
   a. all scores are used in the computation of the mean.
   b. the most frequently occurring score is given more weight.
   c. it is the score below which 50 percent of the scores are located.
   d. only typical scores are used in its computation.
   e. it is not an algebraic function of the scores.

d. 11. In the case of a distribution of scores containing a few scores considerably above or below the rest, the best method of obtaining a measure of central tendency not affected by these scores would be to use the:
   a. mean.
   b. variance.
   c. mode.
   d. median.
   e. percentiles.

d. 12. Which of the following is NOT a measure of variability?
   a. range
   b. semi-interquartile range
   c. variance
   d. standard variation
   e. standard deviation

c. 13. The standard deviation is based on:
   a. the difference between the highest and lowest scores.
   b. the deviation of each individual’s performance from the lowest score.
   c. the deviation of each score from the group mean.
   d. the range of the middle 50% of scores.
   e. the number of scores above the mean.

c. 14. What is the relative size of the semi-interquartile range (Q) and the standard deviation (S.D.)?
   a. They are essentially equal.
   b. Q is uniformly larger.
   c. S.D. is uniformly larger.
   d. Sometimes one is larger, and sometimes the other.
   e. It is impossible to tell without computing them.
b.15. The standard deviation is to the semi-interquartile range as the mean is to the:
   a. range.
   b. median.
   c. mode.
   d. percentile rank.
   e. variance.

e.16. Which of the following measures will be most affected by two or three extreme scores?
   a. Interquartile range.
   b. Median.
   c. Quartile deviation.
   d. Mode.
   e. Mean.

a.17. In high school, a teacher gave two sections of a class the same arithmetic test. The results were as follows:
   - Section I: Mean 45, Standard deviation 6.5.
   - Section II: Mean 45, Standard deviation 3.1.
Which of the following conclusions is correct?
   a. Section I is more variable than Section II.
   b. Section II is more variable than Section I.
   c. Both sections are equally variable.
   d. Section II has brighter students than Section I.

he.18. A student who obtains a score 65 in a group where the mean is 74 and the standard deviation is 6 would be:
   a. one standard deviation below the mean.
   b. two standard deviations above the mean.
   c. two standard deviations below the mean.
   d. one-and-a-half standard deviations above the mean.
   e. one-and-a-half standard deviations below the mean.

c.19. To say that a student fell one-half standard deviation above the group mean on a test in which the scores had a normal distribution would be about the same as saying that the student fell at the:
   a. 95th percentile.
   b. 85th percentile.
   c. 70th percentile.
   d. 30th percentile.
   e. 15th percentile.

e.20. The standard deviation of scores on a certain test is 8. The variance would therefore be:
   a. 2
   b. 8
   c. 16
   d. 24
   e. 64
c.21. Suppose in a history course you took two tests. On Test I, which had a mean of 35 and a standard deviation of 3 you obtained a score of 38. On test II which had a mean of 60 and a standard deviation of 15, you obtained a score of 75. On which test did you do better?
   a. Test I.
   b. Test II.
   c. Same on both.
   d. The two tests can not be compared.
   e. The answer cannot be determined without the frequency distributions.

c.22. In a normal distribution if you are one standard deviation above the mean, what is your approximate percentile rank?
   a. 50
   b. 75
   c. 84
   d. 95
   e. 99

d.23. The number 3.12 could not be a:
   a. mean.
   b. standard deviation.
   c. median.
   d. correlation coefficient.
   e. variance.

d.24. An individual reported a correlation of 1.25 between form A and form B of an intelligence test. From this coefficient one would conclude that:
   a. the test is unusually reliable.
   b. the test would be a good predictor of school achievement.
   c. there are no errors of measurement.
   d. a person scoring above the mean on one form of the test will almost surely score above the mean on the other form.
   e. a mistake has been made in computing the correlation coefficient.

d.25. A research worker gave a scholastic aptitude test to a sample of eighth graders. Then she correlated the aptitude test scores with the chronological ages of the subjects. She found a correlation of -.42. How should this result be interpreted?
   a. She had obviously made a computational error.
   b. Her sample was composed of dull pupils.
   c. The relationship between age and intelligence decreases as people reach the age of 14.
   d. The older members of the grade tended usually to be dull pupils and vice-versa.
   e. None of these interpretations is justified.

c.26. A personality test with four different scales was correlated with success in a job situation, with results as shown below. Which scale would permit the most accurate prediction of job success?
   a. Ascendance r=+.35
   b. Introversion r=-.20
   c. Neurotic tendency r=-.50
   d. Self-Sufficiency r=+.40
c.27. For making predictions, a test that yields a large negative correlation with a criterion could be characterized by which of the following:
   a. worse than useless.
   b. no better than one with a zero correlation.
   c. as useful as one with the same sized positive correlation.
   d. preferable to any other.
   e. any of the above, depending on the test’s empirical validity.

a.28. Which of the following correlations would indicate that two tests were measuring unrelated skills?
   a. .00
   b. -.23
   c. .50
   d. .85
   e. −1.00

b.29. The correlation coefficient is obtained between academic aptitude test scores and academic achievement: (1) among students in general and (2) among honor students. Other things being equal, which statement is most likely to be true?
   a. The two coefficients will be the same.
   b. The first will be higher.
   c. The second will be higher.
   d. One will be negative, the other positive.
   e. They will be unequal, but we have no basis for knowing which will be higher.