Chapter 1: Why is my evil lecturer forcing me to learn statistics?

Self-test answers

SELF-TEST Based on what you have read in this section, what qualities do you think a scientific theory should have?

A good theory should do the following:

1. Explain the existing data.
2. Explain a range of related observations.
3. Allow statements to be made about the state of the world.
4. Allow predictions about the future.
5. Have implications.

SELF-TEST What is the difference between reliability and validity?

Validity is whether an instrument measures what it was designed to measure, whereas reliability is the ability of the instrument to produce the same results under the same conditions.

SELF-TEST Why is randomization important?

It is important because it rules out confounding variables (factors that could influence the outcome variable other than the factor in which you're interested). For example, with groups of people, random allocation of people to groups should mean that factors such as intelligence, age and gender are roughly equal in each group and so will not systematically affect the results of the experiment.

SELF-TEST Compute the mean but excluding the score of 234.

First, we first add up all of the scores:

$$\sum_{i=1}^{n} x_i = 22 + 40 + 53 + 57 + 93 + 98 + 103 + 108 + 116 + 121 + 811$$

We then divide by the number of scores (in this case 10):

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n} = \frac{811}{10} = 81.1$$

The mean is 81.1 friends.

SELF-TEST Compute the range but excluding the score of 234.

Range = maximum score − minimum score = 121 − 22 = 99.

SELF-TEST Twenty-one heavy smokers were put on a treadmill at the fastest setting. The time in seconds was measured until they fell off from exhaustion: 18, 16, 18, 24, 23, 22, 22, 23, 26, 29, 32, 34, 34, 36, 36, 43, 42, 49, 46, 46, 57 Compute the mode, median, mean, upper and lower quartiles, range and interquartile range

First, let's arrange the scores in ascending order: 16, 18, 18, 22, 22, 23, 23, 24, 26, 29, 32, 34, 34, 36, 36, 42, 43, 46, 46, 49, 57.

The mode: The scores with frequencies in brackets are: 16 (1), 18 (2), 22 (2), 23 (2), 24 (1), 26 (1), 29 (1), 32 (1), 34 (2), 36 (2), 42 (1), 43 (1), 46 (2), 49 (1), 57 (1). Therefore, there are several modes because 18, 22, 23, 34, 36 and 46 seconds all have frequencies of 2, and 2 is the largest frequency. These data are multimodal (and the mode is, therefore, not particularly helpful to us).

The median: The median will be the (n + 1)/2th score. There are 21 scores, so this will be the 22/2 = 11th. The 11th score in our ordered list is 32 seconds.

The mean: The mean is 32.19 seconds:

$$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$$
$$= \frac{16 + 2(18) + 2(22) + 2(23) + 24 + 26 + 29 + 32 + 2(34) + 2(36) + 42 + 43 + 2(46) + 49 + 57}{21}$$
$$= \frac{676}{21}$$
$$= 32.19$$

The lower quartile: This is the median of the lower half of scores. If we split the data at 32 (not including this score), there are 10 scores below this value. The median of 10 scores is the 11/2 = 5.5th score. Therefore, we take the average of the 5th score and the 6th score. The 5th score is 22, and the 6th is 23; the lower quartile is therefore 22.5 seconds.

The upper quartile: This is the median of the upper half of scores. If we split the data at 32 (not including this score), there are 10 scores above this value. The median of 10 scores is the 11/2 = 5.5th score above the median. Therefore, we take the average of the 5th score above the median and the 6th score above the median. The 5th score above the median is 42 and the 6th is 43; the upper quartile is therefore 42.5 seconds.

The range: This is the highest score (57) minus the lowest (18), i.e. 39 seconds.

The interquartile range: This is the difference between the upper and lower quartiles: 42.5 − 22.5 = 20 seconds.

SELF-TEST Assuming the same mean and standard deviation for the Beachy Head example above, what's the probability that someone who threw themselves off Beachy Head was 30 or younger?

As in the example, we know that the mean of the suicide scores was 36, and the standard deviation 13. First we convert our value to a *z*-score: the 30 becomes (30−36)/13 = −0.46. We want the area below this value (because 30 is below the mean), but this value is not tabulated in the Appendix. However, because the distribution is symmetrical, we could instead ignore the minus sign and look up this value in the column labelled 'Smaller Portion' (i.e. the area above the value 0.46). You should find that the probability is .32276, or, put another way, a 32.28% chance that a suicide victim would be 30 years old or younger. By looking at the column labelled 'Bigger Portion' we can also see the probability that a suicide victim was aged 30 or more! This probability is .67724, or there's a 67.72% chance that a suicide victim was older than 30 years!