

## *S13. Confidence Intervals*

### *Introduction*

We use the statistics we obtain from samples to make inferences or estimates about the population from which the sample was drawn.

For example:

1. A batch may be selected in a factory production process to assess how the process is operating.
2. Surveys of consumers are used to determine the preferred brands in the population.
3. Polls are conducted on samples of the voting population before elections to predict the result of the election.

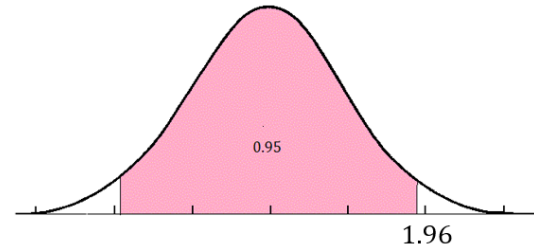
### *Confidence Intervals*

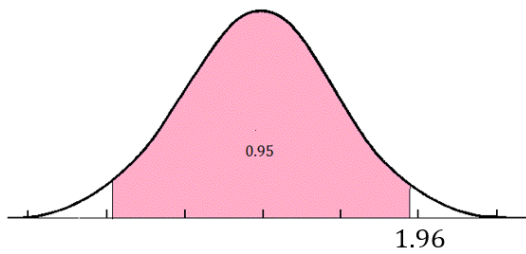
Together with our estimate of the population parameter it is often helpful to provide a confidence interval. After constructing a confidence interval we are able to make statements such as: “we are 95% confident that the true mean weight of boxes of cocobix cereal labelled 450g is in the interval [449.5, 453.8]”.

For large samples ( $n \geq 30$ ) we can use the mean of a sample,  $\bar{x}$ , to find an interval estimate for the mean of the population,  $\mu$ , using the formula:

$$\mu = \bar{x} \pm z \times \frac{\sigma}{\sqrt{n}} \quad \text{or} \quad \mu = \bar{x} \pm z \times \frac{s}{\sqrt{n}} \quad \text{when } \sigma \text{ is not known}$$

The value of  $z$  is determined by the level of confidence and can be found using normal tables, a graphics calculator or an online statistics program.





For a 95% confidence interval,  $z = 1.96$

For a 99% confidence interval,  $z = 2.575$

For a 90% confidence interval,  $z = 1.645$

### Example

36 of a certain type of fish were caught in Port Phillip Bay. This sample had a mean length of 30 cm. and a standard deviation of 3 cm.

(a) What is the 95% confidence interval for the true mean length of this type of fish?

(b) What is the 98% confidence interval for the true mean length of this type of fish?

Solution:

(a) 95% confidence interval for  $\mu$

$$\begin{aligned} &= \bar{x} \pm z \times \frac{s}{\sqrt{n}} \\ &= 30 \pm 1.96 \times \frac{3}{\sqrt{36}} \\ &= 30 \pm 0.98 \\ &= [29.02, 30.98] \end{aligned}$$

We can state with 95% confidence that the mean of the entire population of fish will be between 29.02cm and 30.98cm

(b) 98% confidence interval for  $\mu$

$$\begin{aligned} &= \bar{x} \pm z \times \frac{s}{\sqrt{n}} \\ &= 30 \pm 2.326 \times \frac{3}{\sqrt{36}} \\ &= 30 \pm 1.163 \\ &= [28.84, 31.16] \end{aligned}$$

We can state with 98% confidence that the mean of the entire population of fish will be between 28.84 cm and 31.16 cm.

### Exercises

1. In an effort to improve appointment scheduling, a doctor agreed to estimate the average time spent with each patient. A random sample of 49 patients yielded a mean of 30 minutes and a standard deviation of 7 minutes.

(a) Construct a 95% confidence interval for the true mean.

(b) Construct an 80% confidence interval for the true mean.

Answer: (a) [28.04, 31.96] (b) [28.72, 31.28]

2. To estimate the average weight of males in the town of Cityville a random sample of 100 men was drawn from the population of 10,000 men and weights recorded. The mean weight was found to be 83 kg and the standard deviation 12 kg.

(a) What is the 99% confidence interval for the mean weight of the male population?

(b) In two of the suburbs of Cityville, Subtown and Tubtown, the mean weights for males were found to be 80kg and 88kg respectively. Comment on these results.

Answer: (a) [79.91, 86.09] (b) The mean weight for Subtown men is within the expected range but men who live in Tubtown appear to be extremely heavy compared with the general population. This may reflect lifestyle differences or a failure to select a random and representative sample.

3. A market research company conducted a randomised survey of 50 regular smokers to find the amount spent on cigarettes per week. They found that the smokers spent on average \$22 each week and the standard deviation was \$4.50. Using a 95% level of confidence calculate the confidence interval for the true mean amount spent on cigarettes by regular smokers.

Answer: [20.75, 23.25]

4. After randomly sampling 400 individuals and obtaining a sample mean of 56.5 a research company was able to claim they were 90% certain that the true mean of the population was between 56.089 and 56.911. What was the standard deviation of the sample?

Answer: 5