If the mean and standard deviation are not 0 & 1 respectively, we must apply a transformation:

$$\text{Z-score} \rightarrow \boxed{Z = \frac{X - \mu}{\sigma}}$$

Mean

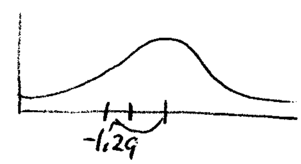
standard deviation

This will transform the curve back to the standard normal curve.

Example 1: Hailey runs 24.95 s at Vancouver with a standard deviation of 0.62 s and a mean of 25.75 s. In Kelowna, she runs at 24.80 s with a standard deviation of 0.60 s and a mean of 25.45 s. Determine at which location Hailey's run time was better, when compared with the club results.

Vancouver

$$Z = \frac{24.95 - 25.75}{0.62} = -1.29$$



Kelowna

$$Z = \frac{24.80 - 25.45}{0.60}$$

$\boxed{= -1.08}$ Smaller better run (closer to middle)

When comparing to the population we can use Z-scores to determine the percentage of people are below a certain data point.

Example 2: IQ scores are normally distributed, with a mean of 100 and a standard deviation of 15. If a person scores 119 on an IQ test, how does this score compare with the scores of the general population?

$$Z = \frac{119 - 100}{15} = 1.27$$

from chart an IQ of 119 is 89.8% better than the population.

Example 3: Running shoes lose their shock-absorption after a mean distance of 630 km, with a standard deviation of 155 km. Zack is an elite runner and wants to replace his shoes after 25% of their natural life. At what distance should he replace his shoes?

↳ look at chart for 0.25

$$Z = \frac{X - \mu}{\sigma}$$

$$\Rightarrow Z = -0.68$$

$$-0.68 = \frac{X - 630}{155}$$

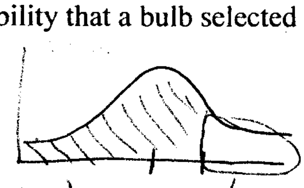
$$155(-0.68) = X - 630$$

$$-105.4 = X - 630$$
$$+630 \qquad +630$$

$$524.6 = X$$

Example 4: A new light bulb has a mean lifetime of 98 hours and a standard deviation of 13 hours. What is the probability that a bulb selected at random will last more than 111 hours?

$$Z = \frac{111 - 98}{13} = 1.00$$



on chart 0.8413 (84.13%)

100 − 84.13

15.87%