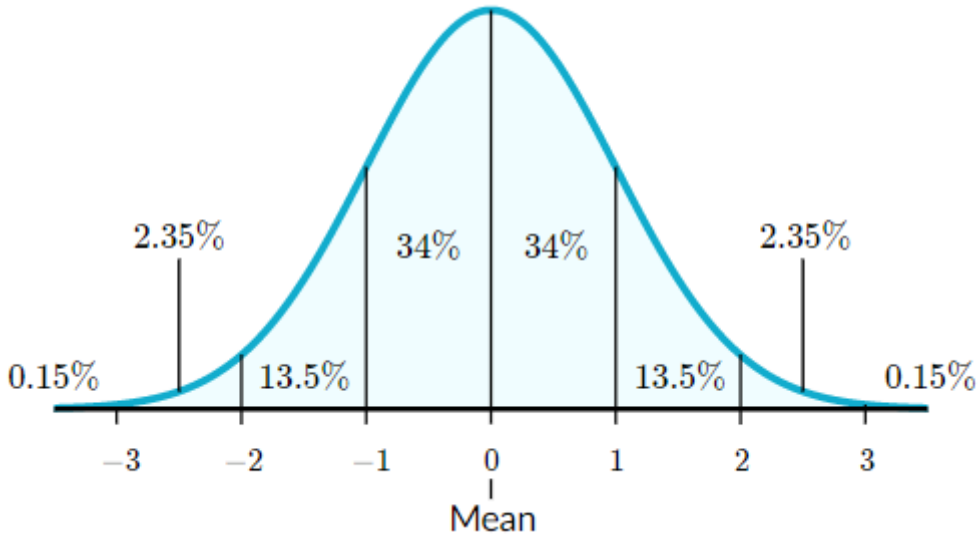
Feature Engineering: Feature Scaling

Having features that are not scaled appropriately can cause Gradient Descent to take a longer time minimizing the cost function $J(\theta)$ as well as *noise* in a dataset. The ideal range for any feature is between -1 and 1 such that $-1 \leq x \leq 1$. This is called a *normal* or *Gaussian distribution*. If we have a feature that is too large or too small we will need to scale them to optimize Gradient Descent.



Normal distributions have the following features:

- symmetric bell shape
- mean and median are equal; both located at the center of the distribution
- $\approx 68\%$ of the data falls within 1 standard deviation of the mean
- $\approx 95\%$ of the data falls within 2 standard deviations of the mean
- $\approx 99.7\%$ of the data falls within 3 standard deviations of the mean

Z-Scaling is used to scale features up or down to a normal distribution range of $-1 \leq x \leq 1$ where we take the sum of the features (x_i), subtract the mean (μ_i) and then divide by the standard deviation (σ_i). A *Z-Scale* that has a range up to $-3 \leq x \leq 3$ could still considered to be within the normal range.

> $$\hat{x} = \frac{x_i - \mu_i}{\sigma_i}$$