Sample Statistics

The sample $\{x_1, x_2, \ldots, x_n\}$ is data obtained by taking measurements of some variable from a sample of size n from the total population X.

Definition. The *sample mean* is $\bar{x} = \dfrac{x_1 + x_2 + \cdots + x_n}{n} = \dfrac{\sum_{i=1}^{n} x_i}{n}$

Definition. The *sample median* is the middle value in the ordered sample. If the sample size is even, the average of the middle to values is taken.

Definition. The concept of median can be generalized to the *p-th percentile.* Where $p \in (0,1)$ and $\tilde{x}_p$ will either be the $p(n+1)$-th value in the ordered sample, or the weighted contribution of the nearest values, relative to how close they are the integer part of $p(n+1)$

Note: For easier computation of quantiles, just use medians of the lower and upper halves of the ordered sample.

Definition. The *sample variance* is $s^2 = \dfrac{1}{n-1}\displaystyle\sum_{i=1}^{n}(x_i - \bar{x})^2 = \dfrac{1}{n-1}\left[\sum_{i=1}^{n} x_i^2 - n\bar{x}^2\right]$. And the *sample standard deviation (SD)* is $s = \sqrt{s^2}$.

Note: We like standard deviation because its units match the units of the sample.

Definition. The *standardized z-score* for a data value is $z_i = \dfrac{x_i - \bar{x}}{s}$

Definition. If x and y are samples of size n, the *sample correlation coefficient* is $r = \dfrac{s_{xy}}{s_x s_y}$ where

$$s_{xy} = \sum_{i=1}^{n}(x_i - \bar{x})(y_i - \bar{y}) = \sum_{i=1}^{n}(x_i y_i - n\bar{x}\bar{y})$$

Note: We can also express r as the average of the products of the standardized z-scores:

$$r = \frac{1}{n-1}\sum_{i=1}^{n}\left(\frac{x_i - \bar{x}}{s_x}\right)\left(\frac{y_i - \bar{y}}{s_y}\right)$$

When performing linear regression using the *least squares method* we get the line

$$\frac{y - \bar{y}}{s_y} = r\left[\frac{x - \bar{x}}{s_x}\right] \qquad \text{or} \qquad y = r\frac{s_y}{s_x}x + (\bar{y} - b\bar{x})$$

Hypothesis Testing

Confidence Intervals

A confidence interval is an interval about a sample statistic within which we have some confidence that the true population parameter lies.

$$\text{Point Estimate} \pm \text{Margin of Error}$$
$$\text{Point Estimate} \pm \text{Critical Value} \cdot \text{Standard Error}$$
$$\bar{x} \pm z_{\alpha/2}\frac{\sigma}{\sqrt{n}}$$
$$\hat{p} \pm z_{\alpha/2}\sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$$