Using Excel, Chapter 8: Hypothesis Testing - One Sample

Excel alone does not conduct complete hypothesis tests[^1]. However, once you calculate the test statistic, Excel can get the critical values and the \( P \)-values needed to complete the test. The functions used to get critical values and \( P \)-values are demonstrated here.

- **Chapter 8.2 - Hypothesis Testing About a Proportion**
  The functions demonstrated here use the standard normal \((z)\) distribution.

- **Chapter 8.3 - Hypothesis Tests About a Mean: \( \sigma \) Not Known \((t\text{-test})\)**
  The functions demonstrated here use the \( t \)-distribution.

- **Chapter 8.4 - Hypothesis Tests About a Mean: \( \sigma \) Known**
  The functions demonstrated here use the standard normal \((z)\) distribution.

[^1]: Excel does actually have two functions, \( \text{T.TEST} \) and \( \text{Z.TEST} \), that return a \( P \)-value for a data set but the alternate hypothesis is awkward (it only conducts right-tailed tests) and you need the raw data.
Chapter 8.2 - Hypothesis Testing About a Proportion

- **Notation**
  - Test Statistic \( z_{\hat{p}} = \frac{\hat{p} - p}{\sqrt{\frac{pq}{n}}} \)
  - Significance Level \( \alpha \) (in decimal form)
  - Critical Values \( z_{\alpha} \) or \( \pm z_{\alpha/2} \)

- **Finding Critical Values**
  Here we use the `NORM.S.INV` function.
  `NORM.S.INV` stands for the inverse of the standard normal distribution (\( z \)-distribution).

  Usage: \( \text{NORM.S.INV(area to the left of the critical value)} \)
  This function returns the critical value from the \( z \)-distribution provided you put in the appropriate area.

  - Left-Tailed Tests: \( z_{\alpha} = \text{NORM.S.INV}(\alpha) \)
  - Right-Tailed Tests: \( z_{\alpha} = \text{NORM.S.INV}(1 - \alpha) \)
  - Two-Tailed Tests: \( z_{\alpha/2} = \pm \text{NORM.S.INV}(\alpha/2) \)

- **Finding P-Values**
  Here we use the `NORM.S.DIST` function.
  `NORM.S.DIST` stands for the standard normal distribution (\( z \)-distribution).

  Usage: \( \text{NORM.S.DIST}(z, \text{Cumulative?}) \)
  This function returns the area under the curve to the left of \( z \) when \( \text{Cumulative} = \text{TRUE} \).

  - Left-Tailed Tests: \( P\text{-value} = \text{NORM.S.DIST}(z_{\hat{p}}, \text{TRUE}) \)
    \( z_{\hat{p}} \) should be < 0.
  - Right-Tailed Tests: \( P\text{-value} = 1 - \text{NORM.S.DIST}(z_{\hat{p}}, \text{TRUE}) \)
    \( z_{\hat{p}} \) should be > 0.
  - Two-Tailed Tests: \( P\text{-value} = 2 \times (1 - \text{NORM.S.DIST}(|z_{\hat{p}}|, \text{TRUE})) \)
Chapter 8.3 - Hypothesis Tests About a Mean: \( \sigma \) Not Known (t-test)

- **Notation**
  - Test Statistic = \( t_x = \frac{\bar{x} - \mu}{s/\sqrt{n}} \)
  - Significance Level = \( \alpha \) (in decimal form)
  - Critical Values = \( t_\alpha \) or \( \pm t_{\alpha/2} \)
  - df = degrees of freedom = \( n - 1 \)

- **Finding Critical Values**
  Here we use the T.INV function.
  T.INV stands for the inverse of the t-distribution.
  
  **Usage:** T.INV(area left of critical value, degrees of freedom)
  This function returns the critical value from the t-distribution provided you put in the appropriate area and degrees of freedom.

  - Left-Tailed Tests: \( t_\alpha = \text{T.INV}(\alpha, \text{df}) \)
  - Right-Tailed Tests: \( t_\alpha = \text{T.INV}(1 - \alpha, \text{df}) \)
  - Two-Tailed Tests: \( t_{\alpha/2} = \pm \text{T.INV}(\alpha/2, \text{df}) \)

- **Finding P-Values**
  Here we use the T.DIST function.
  T.DIST stands for the t-distribution.
  
  **Usage:** T.DIST(t, df, Cumulative?)
  This function returns the area under the curve to the left of \( t \) when Cumulative = TRUE.

  - Left-Tailed Tests: \( P\text{-value} = \text{T.DIST}(t_x, \text{df}, \text{TRUE}) \)
  - Right-Tailed Tests: \( P\text{-value} = 1 - \text{T.DIST}(t_x, \text{df}, \text{TRUE}) \)
  - Two-Tailed Tests: \( P\text{-value} = 2(1 - \text{T.DIST}(|t_x|, \text{df}, \text{TRUE})) \)

*New to Excel 2010 and higher
T.DIST.RT(\( t_x \), df) yields the right-tailed P-value.
T.DIST.2T(\( t_x \), df) yields the two-tailed P-value.
Chapter 8.4 - Hypothesis Tests About a Mean: σ Known

• Notation
  - Test Statistic = \( z_\bar{x} = \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} \)
  - Significance Level = \( \alpha \) (in decimal form)
  - Critical Values = \( z_\alpha \) or \( \pm z_{\alpha/2} \)

• Finding Critical Values
  Here we use the NORM.S.INV function.
  NORM.S.INV stands for the inverse of the standard normal distribution (\( z \)-distribution).

  Usage: \( \text{NORM.S.INV(area to the left of the critical value)} \)
  This function returns the critical value from the \( z \)-distribution provided you put in the appropriate area.

  Left-Tailed Tests: \( z_\alpha = \text{NORM.S.INV}(\alpha) \)
  Right-Tailed Tests: \( z_\alpha = \text{NORM.S.INV}(1 - \alpha) \)
  Two-Tailed Tests: \( z_{\alpha/2} = \pm \text{NORM.S.INV}(\alpha/2) \)

• Finding \( P \)-Values
  Here we use the NORM.S.DIST function.
  NORM.S.DIST stands for the standard normal distribution (\( z \)-distribution).

  Usage: \( \text{NORM.S.DIST}(z, \text{Cumulative?}) \)
  This function returns the area under the curve to the left of \( z \) when Cumulative = TRUE.

  Left-Tailed Tests: \( P\text{-value} = \text{NORM.S.DIST}(\bar{x}, \text{TRUE}) \quad \bar{x} \text{ should be } < 0. \)
  Right-Tailed Tests: \( P\text{-value} = 1 - \text{NORM.S.DIST}(\bar{x}, \text{TRUE}) \quad \bar{x} \text{ should be } > 0. \)
  Two-Tailed Tests: \( P\text{-value} = 2 \left(1 - \text{NORM.S.DIST}(|\bar{x}|, \text{TRUE})\right) \)