Hypothesis Testing General

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Hypothesis Testing Strategy: Remember that hypothesis tests are used to test claims by statistically significant evidence for a change or difference from an initially proposed/accepted value. The structure of a hypothesis test is as follows:

I. Carefully read the scenario (problem statement) and decide what it is you are testing a claim about (a mean? A proportion? A comparison of means or proportions across multiple groups/populations?).

II. State the hypotheses for the test

    H_0: The Null Hypothesis (the status quo, the initially proposed value, "nothing to see here" -- "boring" -- always involves the "equals", $=$, symbol)

    H_a: The Alternative Hypothesis (the claim to be tested -- a statement of difference or change -- involves one of the following symbols: $\neq, >, <$)

III. Draw a picture of your alternative hypothesis, shading in the tails corresponding to samples that would satisfy the alternative hypothesis. If your alternative hypothesis uses the $\neq$ symbol then both tails will be shaded while if the alternative hypothesis uses $>$ or $<$ then only the corresponding tail will be shaded.

IV. Set the level of significance (α) for the test. The level of significance is the "cut-off" for a sample being *unusual/unlikely*. Remember that our standard cutoff is $\alpha = 0.05$ unless we are told otherwise.

V. Use the sample data, null value, and any other known information to compute the test statistic (representing the number of *standard errors* above or below the mean -- expected value -- our sample falls).

$$test\ statistic = \frac{(point\ estimate) - (null\ value)}{S_E}$$

   a. Recall that the point estimate comes from the sample data, the null value comes from the null hypothesis, and the standard error formula can be identified from the Standard Error Decision Tree.

VI. Notice that the test statistic is nothing more than a boundary value. We use it to compute a p-value which represents the probability of observing a random sample at least as extreme (at least as favorable to the alternative hypothesis) as ours, under the assumption that the null hypothesis is true.

   a. If the box determining your standard error (S_E) **does not contain** information about degrees of freedom (*df*), then use R's pnorm(boundary, 0, 1) function to determine the area from your sample into the tail of the normal distribution.
   b. If the box determining your standard error (S_E) **does contain** information about degrees of freedom (*df*), then use R's pt(boundary, df) function to determine the area from your sample into the tail of the t-distribution.
   c. If your picture from Step III. has just a single tail shaded, the result from either a) or b) is your p-value. If the picture had two tails shaded, then multiply your result from a) or b) by 2 to obtain the p-value.

VII. Compare your p-value to the level of significance demanded by your test (α).

   a. If $p < \alpha$, we reject the null hypothesis (H_0) and accept the alternative hypothesis (H_a).
   b. If $p \geq \alpha$, we do not have enough evidence to reject the null hypothesis (H_0)
      i. Note that if $p \geq \alpha$, we do not "accept" the null hypothesis -- these tests are not designed to test whether the null hypothesis is true or not, so we can **never accept the null hypothesis**.

VIII. Interpret the result of your hypothesis test in the context appropriate for your scenario.