Handout: Using the Binomial Test to answer a research question

1) Identify the *observational units.*
2) Identify the *variable* and its *type*:
   a) The binomial test can only be applied to ***binary*** variables. If your variable isn't binary, try to find one that is or use a different test.
   b) Call one of the two outcomes of your binary variable a "success" and the other "failure".
3) Define the *parameter of interest* π = P(success) in the context of your research question. Be clear as to which *population* this parameter applies to.
4) Determine whether your data gathering process fits the 4 criteria of a *Binomial Process:*
   a) Each trial results in two outcomes (these are the "success" and "failure" you found in 2b).
   b) Each trial's result is independent of the other trials' results.
   c) There are a fixed number of trials, n. Generally n is the number of observational units in 1).
   d) There is a fixed probability of "success" for each trial that does not vary between trials. This is the parameter π you defined in 3).

   If your data gathering process doesn't fit these four criteria, you can't use the Binomial Test.

5) State your null and alternative hypotheses using appropriate notation. The null hypothesis is always of the form H_0: π = (some number) and the alternative hypothesis may be one of three forms:
   a) H_a: π > (some number)
   b) H_a: π < (some number)
   c) H_a: $\pi \neq$ (some number)

   Choose one of >, < or ≠ based on your research question. What you choose for "some number" depends on what value the parameter π would be if the *null model* were true.

6) Collect data from a *sample* of size n.
7) Use descriptive statistics to show your sample results
   a) Compute a *statistic*, in this case the *sample proportion* $\hat{p}$
   b) Create a *graph*, in this case a *barchart*.

Proceed with either a p-value or rejection region

8) Assuming that H_0: π = (some number) is true, compute the probability of seeing a sample result more extreme than your sample. This is called the *p-value.* We have three ways of computing a p-value for the Binomial Test:
   a) *Coin toss Simulation:* use the **One Proportion Inference** applet with a large number of samples.
   b) *Binomial Probability Formula:* use the **One Proportion Inference** applet and check the "Exact Binomial" box.
   c) *Normal Approximation:* use the **One Proportion Inference** applet and check the "Normal Approximation" box.
9) Give a technically correct but jargon-free interpretation of your *p-value* from 8).
10) Use your p-value and a pre-specified level of significance α to make a conclusion about your research question.
    a. If your p-value from 8) is large (more than α) "fail to reject" H_0.
    b. If your p-value from 8) is small (less than α) "reject" H_0 in favor of H_a.

8) Assuming that H_0: π = (some number) is true, compute the rejection region corresponding to a pre-specified level of significance. We have three ways of computing a rejection region for the Binomial Test:
   a) *Coin toss Simulation:* use the **One Proportion Inference** applet with a large number of samples.
   b) *Binomial Probability Formula:* use the **One Proportion Inference** applet and check the "Exact Binomial" box.
   c) *Normal Approximation:* use the **One Proportion Inference** applet and check the "Normal Approximation" box.
9) Give a technically correct but jargon-free interpretation of your *rejection region* from 8).
10) Use your rejection region to make a conclusion about your research question.
    a. If your study result (often in the form of the statistic from 7a) falls outside the rejection region, "fail to reject" H_0.
    b. If your study result falls in the rejection region, "reject" H_0 in favor of H_a

11) State your conclusion in context. Avoid the use of statistical jargon and be clear as to which population your results apply to.