**Stat 301 – Day 9**

**More power calculations (Investigation 1.7)**

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| **Definitions:*** ***Type I Error* =** rejecting the null hypothesis even though it’s true (e.g., false alarm)
	+ The probability of a type I error is controlled by the level of significance.
* ***Type II Error* =** failing to reject the null hypothesis even though it’s false (e.g., missed opportunity)
	+ The probability of a type II error is often calculated with respect to a specific alternative value for the parameter of interest (e.g., he’s become a 0.300 hitter)
	+ Several factors impact the probability of a type II error
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**Example:** Blindsight is a condition in which people are partially blind but can still respond to things they cannot consciously see. In a 1988 study (Marshall & Halligan, *Nature*), researchers studies a patient (P.S.) who had suffered brain damage causing a loss of vision on the left side of her visual field. In the study, the researchers showed P.S. two cards; each card showed a simple line drawing of a house. However, one of the drawings showed flames coming out of the left side of the house. The researcher shuffled the two cards, placed them down on a table with one card above the other, and asked the patient which house she would rather live in. The patient replied that this was a silly question because “they are the same.” The researcher asked her to choose anyway. The cards were shuffled and placed on the table a total of 17 times. The patient chose the non-burning house in 14 of those 17 showings. Consider carrying out a test of significance.

(a) Would you consider this a “one-sided” or “two-sided” scenario?

(b) Use the [Power Simulation](http://www.rossmanchance.com/applets/power.html) applet, generating 10,000 samples, to determine the rejection region with a level of significance of 0.05. What is the rejection region and what is the estimated probability of a type I error?

(c) Check the **Exact Binomial** box. What is the exact probability of a type I error?

(d) Check the **Show Alternative** box. The default in the applet is to assume the alternative probability of $π$ = 0.60. What is the exact binomial probability of being in this rejection region when $π$ = 0.60?

(e) The *complement* of rejecting the null hypothesis here is failing to reject the null hypothesis even though $π$ = 0.60 (so we should reject H0: $π$ = 0.50), a type II error. The probability of a type II error = 1 – power. But keep in mind, you would not include the rejection region cut-off in this calculation.

Prob(type II error) = P(X < 12) where X ~ Binomial(*n* = 17, $π$ = 0.60) =

(f) One way to increase power is to raise the level of significance. In the applet, specify 0.10 as the level of significance. Report the new rejection region, the new probability of a type I error, and the new power. (Give the “exact” values.)

(g) What is a downside to this adjustment?

Another way to increase power is to raise the sample size. In another study (Persaud et al., 2007, *Nature Neuroscience* ), researchers tested another patient with blindsight (G.Y.) by having him face a video monitor where they would run trials by sometimes having a square appear on the right side of the monitor and sometimes not.

(h) Suppose his probability of answering correctly is actually 0.60. If they plan to give him 200 trials, what is the (exact) probability the researchers will correctly reject the null hypothesis at the 5% level of significance?

(i) Use trial and error (in this applet, press Draw Samples and Count after each change in input) to determine the sample size necessary for the power to be at least 0.95.

Note that power calculations are often carried out in advance of collecting the data. In fact, they are typically used to determine what sample size is necessary in planning a study.

**HW 3 Questions**

(j) Suppose the researchers had conjectured that there would be “interference” and the subject would actually perform worse than guessing in the long run. So they hypothesized

 H0: $π$ = 0.50

 Ha: $π$ < 0.50

Calculate the power assuming an alternative value of 0.45 and a sample size of 150. Include your output.

(k) Suppose the researchers didn’t know in advance whether he would do better or worse than guessing so they hypothesized

 H0: $π$ = 0.50

 Ha: $π$ ≠ 0.50

Calculate the power assuming an alternative value of 0.45 and a sample size of 150. Include your output.

(l) How does the power in (k) compare to (j)? Give an intuitive explanation for why the power has changed this way.

(m) Verify your calculations in (j), (k), and (l) in JMP or R (see p. 60). Include relevant output.

[*Hint*: In JMP, DOE > Design Diagnostics > Sample Size and Power]