***Likelihood worksheet***

*Don’t worry if you can’t complete everything.* Much of the material here is adapted from Chapter 11 of my book:

Baguley, T. (2012). *Serious stats: A guide to advanced statistics for the behavioral sciences*. Palgrave Macmillan.

Alternatively there is similar coverage in:

Dienes, Z. (2008). *Understanding psychology as a science: An introduction to scientific and statistical inference*. Palgrave Macmillan.

**Working with likelihoods in R (binomial example)**

*Imagine that someone is given a two-alternative-forced-choice recognition test with 25 trials. The chance of getting any item right by chance alone is .50. What is the evidence that their memory is above chance (they are not guessing)?*

There are several ways to calculate likelihoods in R. If you have an equation for the likelihood function, you can use this directly[[1]](#footnote-1) - the likelihood for 19 successes and 6 fails from a binomial distribution if the probability of success (*P*) is .76 is:

.76^19 \* .24^6

The corresponding likelihood for *P* = .5 is:

.5^19 \* .5^6

The likelihood ratio is therefore:

(.76^19 \* .24^6)/(.5^19 \* .5^6)

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| Q1 If typical performance on the forced choice recognition test is 85%. *Calculate a likelihood ratio for the hypothesis that the performance is below typical levels.* |

Any quantity proportional to this is also likelihood function, meaning that *pmf* and *pdf* functions can be used. Here you could use the dbinom(x, size, prob) function:

dbinom(x=19, size=25, prob=.76)

dbinom(19, 25, .50)

dbinom(19, 25, .76)/dbinom(19, 25, .85)

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| Q2 *How would you form a likelihood ratio to test the hypothesis that performance was typical rather than at chance when the observed level was 19 out of 25?*  Q3 These function calls are identical except for the third term (e.g., .76 or .50).  *What does that term represent and why is it the only one to vary?* |

**Likelihood intervals in R**

Calculating or plotting likelihood intervals is trickier than likelihood ratios. Baguley (2012) includes functions for calculating likelihood ratios and intervals (including graphs) for various distributions.[[2]](#footnote-2) For example, the binom.lik() function for a binomial proportion is reasonably versatile and called by

binom.lik(successes=19, trials=25)

it returns the *MLE* () and the intervals. If you add plot=TRUE it also plots the intervals: binom.lik(19, 25, plot=TRUE). Other functions do the same for the Poisson and *t* distributions. The pois.lik(count) and t.lik.int(mean, SE, df, independent=TRUE) for an independent design or t.lik.int(mean, SE, df, independent=FALSE) for a paired design.

The function LR.t(mu1, mu2, mu.obs, SE, df, independent=TRUE) also provides likelihood ratios based on the profile likelihood for normal means when the variance is unknown. In this case the first two arguments are the hypothesized values of the parameter, mu.obs is the observed parameter (either a mean or difference in means).

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| Q4 *Use the* LR.t() *function to decide between two competing hypotheses for some of your own data.*  [If you don’t have appropriate data try the following input (from a later example):  mu1 = 0, mu2 = 0.06, mu.obs = 0.142, SE = 0.0703, df = 183]  Q5 If you have time, explore how to get a likelihood interval for a t test using the t.lik.int() function from Baguley (2012):  e.g.,  t.lik.int(mean = 10, SE = 2, df = 28, independent = TRUE, plot=TRUE) |

1. A quick refresher may be helpful. The probability of a *x* successes out of *n* trials from a binomial distribution is equal to the binomial coefficient times *P*x \* (1 - *P*)*n*-*x.* The binomial coefficient is a constant for any particular set of data, so the likelihood is proportional to this simple function of P and the number of ‘successes’ (*x*) or ‘fails’ (*n*-*x*). [↑](#footnote-ref-1)
2. The functions are available at <http://www2.ntupsychology.net/seriousstats/SeriousStatsAllfunctions.txt>

   You can also use load the functions directly into R using the source() function:

   > source('http://www2.ntupsychology.net/seriousstats/SeriousStatsAllfunctions.txt') [↑](#footnote-ref-2)