Chapter 22: Application of Bayesian Statistics

Open the Student Grades.csv file. This contains before and after intervention test scores for the same group of students. Conduct a classical paired sample *t* test to assess if there is a significant difference in the mean scores before and after intervention. Then use the test's Bayesian equivalent.

What are the null and alternative hypotheses?

H0 (null hypothesis): There is no significant difference between the average students’ scores before and after intervention class.

H1 (alternative hypothesis): There is a significant difference between the average students’ scores before and after intervention class.

What are the results of the *t* and Bayesian tests?

This is the result of the classical *t* test:



This is the result of the Bayesian equivalent:



What is your interpretation of the results?

 As suggested by Jeffreys (1961), a Bayes factor that is between 10 and 30 represents strong evidence towards the alternative hypothesis which is the case in this analysis. Thus, this supports the *t* test result supporting the rejection of the null hypothesis with a *p* value of less than 0.05.

A Bayes factor of 1.00 represents equal odds for either model (the null and alternative hypotheses), a Bayes factor greater than 1.00 represents evidence for the one model (e.g. the null hypothesis), and a Bayes factor less than 1.00 represents evidence for another model (e.g. the alternative hypothesis). The interpretation of magnitude for a Bayes factor, like traditional effect size estimates, involves some flexible categories (suggested by Jeffreys, 1961). For instance, a Bayes factor between (roughly) 1.00 and 3.00 (or between 1 and 0.30) represents scarce evidence, a Bayes factor between (roughly) 3.00 and 10.00 (or between 0.30 and 0.10) represents substantial evidence, a Bayes factor between (roughly) 10.00 and 30.00 (or between 0.10 and 0.03) represents strong evidence, and a Bayes factor between (roughly) 30.00 and 100.00 (or between 0.03 and 0.01) represents very strong evidence (Jeffreys). It is important to note; theoretically, there is no limit to the magnitude of a Bayes factor, Jeffreys suggested that a Bayes factor greater than 100.00 (or less than 0.01) would represent decisive evidence. So, the benefits of taking a Bayesian perspective (beyond the general reasons for choosing a Bayesian perspective over a frequentist perspective) are that in these simple situations, a Bayes factor is one number which is easily interpreted for both identifying an effect and measuring the magnitude of the effect. By contrast, the frequentist p value is easily confused, controversial, and would involve another statistic to express the magnitude of effect (i.e. effect size; e.g. Cohen’s d).

From Dr Jon Starkweather, 'Bayes Factors for t tests and one way Analysis of Variance; in R', University of North Texas. Source: <https://it.unt.edu/sites/default/files/bayesfactors_jds_mar2011.pdf>