Bayesian Approaches to Testing "Null" Hypothesis

Shubham Gupta

May 29, 2019

1 Introduction

- We will descibe bayesian approaches to Null hypothesis testing.
- Suppose we want to check if a coin is fair i.e θ =0.5.
- We can check if $\theta = 0.5$ falls in the HDI of the posterior.
- For the prior, we can:
  - Take a prior which only allows $\theta = 0.5$
  - Take a prior which allows many values of θ.
- We will compare the models using Bayesian model comparison i.e Bayes factor.

2 Estimation approach

2.1 ROPE

- **Region of Practical Equivalence**: Values around the initial null hypothesis that are considered equal for practical purposes.
- If ROPE lies outside 95% HDI, then we will reject the null hypothesis.
- When HDI and ROPE overlap, and ROPE does not contain HDI completely, we **withhold a decision.**
- Marginal distributions of two parameters do not indicate the relationship between the parameter values.(It might have positive or negative corelalation. Hence, values should be examined closely.)

3 Model Comparison Approach

- Model comparsion will be **extremely** sensitive to the chosen *uninformed* distribution.
- In this approach, one model has a prior equal to the null value. Other model has a uniform prior. The aim is to find which of the two models will give an output that is most credible(or least incredible).

3.1 Bayes factor can accept poor null decision

- **Do not** use only Bayes factor when deciding whether to accept the null hypothesis or not. Always look at the HDI of the posterior.
- Example on the effect of music on the retention of words for people is demonstrated.
- Demonstrate effect of 4 different types of background music. For the first model, we use different parameters for each genre of music. For the 2nd model, we consider all genres the same and use one model.
- Since there will always be some difference between the music presented, we should go with the model that uses a different parameter for each group.

3.2 Relation of parameter estimation and model comparison

- For assessing null value, we have the following two appraches:
  - **Model comparison**: Use a threshold value for the Bayes factor.
  - **Parameter comparison**: Add threshold on the parameters to be estimated(using ROPE and HDI).

3.3 Estimation or Comparison

- Generally, estimation approach is better.
- For model comparison, **both** priors should be meaningful and informed.