Meta-Analysis of Diagnostic Tests and some R Simulations

Xiying Chen
Supervisor: Dr Tamás Kói

Budapest, June 2025

Abstract

Meta-analysis is a statistical tool to merge and summarise data from individual previous scientific studies with a common research question to generate an overall picture of the results. Nowadays, it is getting more and more popular since this statistical technique is commonly used as one of the best scientific evidence. This is a huge topic to be explored. It has frequently been applied to various areas such as education, economics, psychology, criminology, and other disciplines. One of the most well-known uses is the meta-analysis of diagnostic tests in the medical and healthcare fields. The trade-off between sensitivity and specificity can be assessed, which helps support clinical decision-making. It is meaningful to learn and apply meta-analysis to real-life cases to discover patterns and solve problems. Hidden information behind the large amount of data might be found with the help of meta-analysis.

In this thesis, the main concepts of meta-analysis will be introduced, as well as the ideas about the application to diagnostic tests will be discussed. The structure of the common effect model and the random effects model will be considered. The focus is on the bivariate random effects model of Reitsma et al. It uses normal approximation, which might cause some problems in case of small sample sizes or extreme values of sensitivity and specificity. In addition, some data will be generated by R to apply meta-analysis using the bivariate model of Reitsma et al. During the R coding, the functions from the package "mada" are used. The performance of the applied meta-analysis based on the simulations will be evaluated. Some statistical tools, such as box plots, will be used to evaluate the behaviour of the performance.

The aim of the thesis is to investigate whether the normal approximation in the model of Reitsma et al. is reliable. In the few performed simulations, the normal approximation was not problematic even for small sample sizes and high sensitivities.