BM5163 Bayesian Inference in Bioengineering

Problem Set 1

Instructions

1. You are expected to work on these problems on your own and not submit the solutions.

Questions

1. Suppose an experimentalist is trying to identify relationships between risk indicators (lifestyle, genetic disposition, etc.) and a particular disease. For this significance tests are employed at significance level α and statistical power $1-\beta$. Suppose there are total p equally probable relationships and the researcher randomly tests one of them
   (a) Create the error matrix and calculate rates.
   (b) If the significance test identifies a relationship to be true, what are the chances of it being true positive?
   (c) Can you estimate bounds on α and β to ensure that the probability of a relationship identified in this experiment is indeed a true relationship is greater than ζ?
2. Once you have solved the first question, read this paper.
3. Suppose a person is tested positive for a condition (with prevalence c) in a diagnostic test with sensitivity s_1 and specificity p_1. On the doctor's recommendation, he/she gets tested again by a different test (s_2, p_2) and is tested positive.
   (a) At the end of the two tests, what is the probability that the person has the particular condition?
   (b) Will the probability change if the order of two tests is reversed?
   (c) Analyze the problem for all possible combinations based on the order of tests and outcomes of two tests.
4. Redo the previous question with n tests (s_i, p_i) out of which m give positive result.