BMED 2400 Introduction to Bioengineering Statistics

Credit: 3-0-3

Prerequisite(s): MATH 1501 (w/minimum grade of "C") and CS 1371

Catalog Description
Introduction to statistical modeling and data analysis in bioscientific and bioengineering applications. Topics include estimation, testing, regression and experimental design.

Text
Bernard Rosner, *Fundamentals of Biostatistics*, Duxbury Press; 6 Ed, ISBN 0534418201

Objectives
The overall objective of this course is to provide students basic concepts and approaches in biomedical data analysis. The approach is practical and students are expected to become proficient in applying selected software to real-life data collected in BME labs.

Outcomes
At the end of the course the students should be able to:

1. Translate real life inferential problems to proper statistical models.
2. Understand the use of Bayes theorem in the context of medical testing: sensitivity, specificity, positive predicted value, and ROC curves.
3. Summarize and describe data, identify parameters and calculate their point and interval estimates.
4. Formulate and test statistical hypotheses involving locations, variances and proportions in one, two, and more than two populations.
5. Analyze correlations and apply linear regression methodology.
6. Apply logistic regression in the biomedical context.
7. Test for independence of factors and for agreement between theoretical and empirical distributions.
8. Implement basic Bayesian models and understand the philosophy behind Bayesian approach to inference.

Topical Outline
1. Data and data summaries. Overview of descriptive statistics
2. Probability distributions as models for experimental observations
3. Basic discrete and continuous distributions. Properties and software implementations. Examples of biomedical problems in which such distributions are appropriate models
4. Gaussian distribution. Normal tables, z-scores, Gaussian approximations to binomial and Poisson distributions, application in parametric bioengineering designs

5. Estimation. Point and interval estimators for the normal mean, normal variance, and binomial proportion
6. Testing hypothesis. Sensitivity and specificity. One sample and two sample problems, z- and t-tests, Designing the sample size, p-values, power, multiple comparisons. Applications in testing accuracy of medical equipment with and without gold standard
7. ANOVA and elements of statistical experimental design. Randomization and blocking. Paired comparisons and contrast testing. Sample size determination. The BME1300 data analysis assignments revisited
8. Correlation and regression. Multivariate regression. Logistic regression. Applications in prediction
9. Chi-Square Theory: Goodness of fit tests and contingency tables
10. Fundamentals of Bayesian inference. Bayesian estimation and testing. Priors. MCMC methodology. Use of BUGS software. Applications in biomedical experiments in which prior information is available
11. Overview, feedback and review

*ISYE/CEE/MATH 3770 Statistics and Applications may be taken in place of BMED 2400