PCL 105: Statistical Methods and Algorithms

Semester: Autumn, 2018
Course Co-ordinator: Amrik Sen (Instructor)
Course website: https://amriksen.wixsite.com/amriksen/pcl105-autumn2018
L T P Credit
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Course Objective: The course aims to introduce to the students, fundamental principles as well as advanced topics in statistics and sampling techniques. This course underscores the importance of statistical methods to perform scientific and engineering research.

Lecture Plan

Lecture number	Topics covered
1-1	Introduction to course, policies, plan and organization of lectures, course related resources, brief introduction to probability
2-5	Axioms of probability, concept of probability distributions for continuous and discrete case, introduction to conditional probability, Bayes' theorem, laws of total probability and expectation, examples and practical application of conditional probability.
6-8	Examples of discrete and continuous distributions, joint and marginal distributions, moment generating function.
9-10	Law of large numbers, Central Limit theorem, probability distribution of functions of random variables.
11-12	Introduction to discrete time Markov chains, Multi-step transition probabilities, examples, Chapman Kolmogorov equation, long time distribution of states in Markov processes
13-14	Hitting probabilities, return and exit times, examples
15-15	Mean number of returns to a state, classification of states, periodicity of Markov chains
16-16	Stationary distributions, Detailed Balance, examples
17-21	Time series analysis: autoregressive models: AR(1), AR(p), moving average models: MA(1), MA(q), autoregressive moving average models: ARMA(p,q)

22-28	Introduction to sampling distributions, chi-square, t and F distributions, introduction to hypothesis testing, level of significance, p-value and power of tests, two sample tests for means using t-distributions
29-32	ANOVA (1 way tests, 2 way tests)
33-35	Least squares regression with examples (including matrix-vector form)
36-42	Covariance matrix, engineering application using PCA based on eigenvalue decomposition (including review of relevant topics from matrices and linear algebra).

Total lecture hours: 42
Total tutorial hours: 0
Total lab hours: 28

Recommended books:

1. Durrett, R., *Essentials of Stochastic Processes*, **Springer** (2016).
2. Ross, Sheldon, *Stochastic Processes*, **John Wiley and Sons** (1996).
3. Hogg, R., McKean, J. and Craig, A. *Introduction to Mathematical Statistics*, **Pearson** (2013).
4. Hamilton, James, *Time Series Analysis*, **Princeton University Press** (2012).

Signature of Course Co-ordinator

Signature of Head of Department (Mathematics)