

List of topics for Probability/Statistics prelim exam

Probability:

Random Events and Probabilities on Sigma-algebras of events,

Independent Events and Conditional Probability, Borel-Cantelli lemma

Random variables :

Probability Distribution, Expectation/Mean, Variance, Cumulative Distribution Function, Moments,

Quantiles

Examples of Discrete Random Variables : Binomial , Geometric, Poisson, ...

Examples of Random variables having a density function : Exponential, Gaussian, Chi², Weibull, Beta, ...

Random Vectors:

Joint Probability Distribution, Joint Density , Marginal Density, Means, Covariances and Correlations

Matrices

Examples: Multinomial distribution, Multivariate Gaussian distributions

Major Limit Theorems : Law of Large Numbers, Central Limit theorem and Characteristic functions

Stochastic Modeling

Simulation of Large Random Samples and applications

Markov Chains with finite state space, Transition matrix, Stationary distribution, Simulations

Applications : Hitting times , Gambler's Fortune,

Poisson processes for time indexed occurrences of specific events

Applications : Stochastic Dynamics of Bacterial Populations

Statistics:

Properties of random samples (including sampling distribution, order statistics and their distributions, convergence in distribution and probability, almost sure convergence)

Principles of data reduction (including sufficiency principle, likelihood principle)

Basics of point estimation (including method of moments, maximum likelihood estimation)

Basics of hypothesis testing (including “common” hypothesis testing methods such as one sample and two sample z or t test, paired t test, chi-squared test, F-test, etc, general concept of p-values and power of a test)

Goodness of fit tests

Interval estimation (including “common” confidence intervals for population mean and proportion based on normal and T distribution)

Basics of linear regression (including least squares principle, inference regarding regression coefficients, prediction)

ANOVA