STATISTICAL INFERENCE

- 5 statistical methods
  - significance testing
  - hypothesis testing
  - random variable estimation
  - point estimation of a model parameter
  - Confidence interval estimation

Significance Testing

- Hypothesis H_0: certain probability model describes the observations
- significance level α : **error level** - probability of rejecting a true hypothesis
- Design of significance test : given α , determine the rejection region R s.t
  $\alpha = P[s \in R]$

Significance Testing

- 2 types of errors :
  - Type I error : Reject H_0 when H_0 is TRUE
  - Type II error : Accept H_0 when H_0 is FALSE

BINARY HYPOTHESIS TESTING

- 2 hypothetical probability models, H_0 & H_1
- likelihood of x given H_0 : $f_{X|Ho}(x)$
- sample space S = A_0 U A_1
  s □ A_0 : accept H_0
- Accuracy measure : errors
  Type I : $P[A_1| H_0]$, Type II : $P[A_0| H_1]$

BINARY HYPOTHESIS TESTING

- Methods for choosing A_0 based on probability of error :
  - Maximum a posteriori (MAP) probability test
  - Maximum Likelihood (ML) approach

MULTIPLE HYPOTHESIS TESTING

- M hypothetical probability models H_0, .., H_{M-1}
- M^2 conditional probabilities $P[A_i| H_j]$
- MAP, ML generalize

Estimate of a Random Variable

- e.g., want to observe r.v. X, but with noise N in the system we measure Y = X + N
- estimate $\hat{x}$
  mean square err $e = E\left[\left(X - \hat{x}\right)^2\right]$
- Blind Estimate of X [no observations] : the minimum mean square error of r.v X in the absence of observations is $\hat{x}_B = E[X]$

Estimate of a Random Variable

- Estimation of X given an event A
- Minimum Mean Square Estimate of X given Y

Linear Estimate of X given Y

- minimum mean square error linear estimation
  - optimal properties are given in terms of the correlation coefficient $\rho_{X,Y}$

Estimation of Model Parameters

- consistent estimator
- unbiased estimator
- estimation of the expected value of a r.v
  – sample mean
- unbiased estimation of the variance

- maximum likelihood approach
- confidence interval estimation