Review for Midterm 1

About the exam

- Place and date: in class on Wednesday, Mar 1
- Coverage: Sections 4.1-4.2, 4.4-4.7, Sections 5.1-5.3
- Closed-book, closed-notes, only a calculator is allowed. One one-sided 8.5 by 11 inch (Letter size) cheat sheet is allowed for the midterm exam.

Important items

- Sampling and statistics
  - Concepts of random sample, estimator, estimate, unbiasedness, likelihood function, MLE, nonparametric estimator
  - How to compute the bias of an estimator? How to prove an estimator is unbiased?
  - How to find the MLE under a simple parametric model?
  - Histogram estimates of pmfs
- Confidence interval
  - Derive confidence intervals using a pivot
    - mean parameter in normal model
    - variance parameter in normal model
    - probability parameter in binomial model
  - One sample problems: normal sample, binary sample
  - Two sample problems: normal sample (pooled variance?), binary sample
  - prediction interval
- Order statistics and quantiles
  - Joint distribution and marginal distribution of order statistics
  - Derive the distribution of a function of order statistics, e.g. range
  - Point estimate and confidence interval of quantile
- Hypothesis testing

  - Concepts: null hypothesis, alternative hypothesis, critical region, type-I and type-II error, size (significance level), power, power function, pvalue, randomized test
  - Derive the distribution of a test statistic under the null hypothesis or the alternative hypothesis
  - Compute the type-I and type-II error probability, i.e. size and power, for a given test
  - Compute sample size to reach a certain level of power
  - One-sided vs two-sided test
- Chi-square tests
  - How to identify the degrees of freedom for the null chi-square distribution?
  - Application to one-way tables
  - Application to two-way tables
- Convergence in probability
  - Definition
  - Law of Large Numbers
  - Consistency
  - Operation on two sequences: addition, multiplication, smooth transformation
- Convergence in distribution
  - Definition. How is it different from convergence in probability?
  - Operation on two sequences: addition, multiplication, smooth transformation
- Bounded in probability
  - Definition
  - Theorem 5.2.6 (if $X_n \to X$ in distribution, $\{X_n\}$ is bounded in probability)
  - Theorem 5.2.7 (If $\{X_n\}$ is bounded in probability and $Y_n \to 0$ in probability, $X_n Y_n \to 0$ in probability)
- The Δ-method
  - The heuristic idea of the proof
  - Application
  - Variance stabilizing transformation