Course Syllabus

STAT 512:
Statistical inference
Autumn 2020

Instructor: Yen-Chi Chen
e-mail: yenchic@uw.edu
Office hour: Monday 2:30-3:30 pm PT.

Teaching Assistant 1: Gang Cheng
e-mail: gangc@uw.edu
Office hour: Friday 1-2 pm PT.

Teaching Assistant 1: Zhen Miao
e-mail: zhemm@uw.edu
Office hour: Monday 7-8 pm PT.

Course Website:
On Canvas: https://canvas.uw.edu/courses/1402407.

Class Schedule: There will be two sessions a week:

- (Remote Lecture) MWF 10:30-11:20 am
- (Remote Quiz session) W 12:30-1:20 pm
  - The TAs will review exercises/homework in the quiz session.

Course Textbook:


- Useful readings:

Course Overview: STAT 512-513 will cover much of the “classical” theory of statistical inference (but not all; for example the theory of linear models is mainly treated in BIOSTAT/STAT 533/570.) We will begin with a brief review of univariate probability (CB Chapters 1, 2, and 3), then move to bivariate and multivariate distributions, especially the multinomial and multivariate normal distributions (CB Ch. 4-5). This should occupy the first 7-8 weeks (approximately.) The remainder of 512 and 513 will cover CB Ch. 5-8, 10, and possibly part of 9: topics include properties of random samples, limit theorems and asymptotic distributions, propagation of error (= delta method = first-order Taylor expansion), sufficient statistics, estimation theory including maximum likelihood estimation, unbiased estimation, nonparametric estimation, and large sample properties of estimators, elementary decision theory, hypothesis testing including likelihood ratio and chi-square tests, and Bayesian inference. (Linear models and regression, the topics of the final two chapters of CB, are covered in 533/570.)

Prerequisites: Multivariable calculus (limits, infinite series, partial derivatives, and multiple integrals). Linear algebra (vectors, matrices, determinants, inverses, Cauchy-Schwartz inequality, orthogonal and positive definite matrices, eigenvalues). Some familiarity with elementary probability theory, e.g., probability distributions, expected values, random variables, conditional probability (Math/Stat 394-5).

Grades:

- Homework assignments (30%)
- Midterm exam (30%)
- Final exam (40%)

Schedule

- Midterm exam: take-home exam in Nov. 5 (tentative).
Course contents:

- **Topic 1: Introduction to probability and statistics (week 1; 3 lectures + 1 quiz).**
  - sample space and probability measures, random variables, common distributions, conditionals, independence, Bayes theorem

- **Topic 2: Transforming continuous random variables (week 2: 2 lectures).**
  - one function of one random variable, one function of two or more random variables, exponential distribution and memoryless properties

- **Topic 3: Expectation and basic convergence theories (week 2-3: 4 lectures + 2 quizzes).**
  - expectation, moment generating functions, convergence theory, weak law of large numbers, central limit theorem, concentration inequality, Hoeffding’s inequality

- **Topic 4: Conditional expectation and conditional distribution (week 4: 3 lectures + 1 quiz).**
  - conditional distribution for mixed random variables, conditional expectation, law of total expectation, law of total variance, inverse probability weighting

- **Topic 5: Correlation, prediction, and regression (week 5: 3 lectures + 1 quiz).**
  - correlation, mean-square error prediction, linear prediction, best linear predictor, multivariate linear predictor, classification

- **Topic 6: Estimators (week 6: 3 lectures + 1 quiz).**
  - maximal likelihood estimator, method of moments, empirical risk minimization, Bayes estimator (posterior mean and maximum a posteriori)

- **Topic 7: Multinomial distribution (week 7: 2 lectures + 1 quiz).**
  - multinomial distribution, conditionals in multinomials, exponential family, Bernoulli representation of multinomials

- **Topic 8: Linear models and the multivariate normal distribution (week 7-8: 4 lectures + 1 quiz).**
  - review of matrix, the Jacobian method, polar coordinate, random vector and covariance matrix, multivariate normal distributions, chi-square distributions, non-central chi-square distributions

- **Topic 9: Order statistics (week 9: 2 lectures).**
  - order statistics, Beta-binomial relation, spacings in uniform random variables

- **Topic 10: Asymptotic theories and statistical functionals (week 9-10: 4 lectures + 2 quizzes).**
  - statistical functions, consistency, empirical distribution function, plug-in estimate, the delta method, variance-stabilizing transformations, asymptotic theory of sample covariance matrix, asymptotic theory of quantiles, asymptotic efficiency

**Accommodation.** Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UWs policy, including more information about how to request an accommodation, is available at Religious Accommodations Policy. Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form.