MAT 271
Probability and Statistics
Spring 2017-2018

Asst. Prof. N. Kemal Ure
Aerospace Research Center
Istanbul Technical University

Lecture Times and Office Hours

Time: Tuesdays 11:30-14:30
Place: Faculty of Aeronautics and Astronautics, D-215
Prof. Ure Office Hours: By appointment
Teaching Assistants: Yunus Bicer (biceryu@gmail.com)

Course Objectives

- To provide students with a solid understanding of fundamentals of probability theory.
- To provide students with the mathematical tools required to perform data analysis for engineering applications.
- To present students a gentle introduction to machine learning.

Prerequisites

An undergraduate level exposition to calculus and linear algebra is sufficient.

Lecture Topics

Introductory Lectures

- **Lecture 0:** Class Logistic
- **Lecture 1:** Introduction to Probability Theory Data Science

Part I: Probability Theory

- **Lecture 2:** Sample Space and Probability
  - Sets
  - Probabilistic Models
  - Conditional Probability
  - Total Probability Theorem and Bayes' Rule
  - Independence
  - Counting
- **Lecture 3:** Discrete Random Variables
  - Basics of Random Variables
  - Probability Mass Functions

  - Functions of Random Variables
  - Expectation, Mean and Variance
  - Joint PMFs of Multiple Random Variables
  - Conditioning
  - Independence
- **Lecture 4:** General Random Variables
  - Continuous Random Variables
  - Probability Density Functions
  - Cumulative Distribution Functions
  - Normal Random Variables
  - Joint PDFs of Multiple Random Variables
  - Conditioning
  - Continuous Bayes' Rule
- **Lecture 5:** Further Topics on Random Variables
  - Derived Distributions
  - Covariance and Correlation
  - Conditional Expectation and Variance
  - Transforms
  - Sum of Independent Random Variables
- **Lecture 6:** Limit Theorems
  - Markov and Chebysev Inequalities
  - Weak Law of Large Numbers
  - Convergence in Probability
  - The Central Limit Theorem
  - Strong Law of Large Numbers
- **Lecture 7:** Bernoulli and Poisson Processes
  - Bernoulli Process
  - Poisson Process
- **Lecture 8:** Markov Chains
  - Discrete Time Markov Chains
  - Classification of States
  - Steady State Behaviour
  - Absorption Probabilities
  - Continuous Time Markov Chains

Part II: Statistics

- **Lecture 9:** Classical Statistical Inference
  - Parameter Estimation
  - Linear Regression
  - Binary Hypothesis Testing
  - Significance Testing
- **Lecture 10:** Bayesian Statistical Inference
  - Bayesian Inference and Posterior Distribution
  - Point Estimation and MAP Rule
  - Bayesian Least Mean Squares Estimation
- **Lecture 11:** Introduction to Machine Learning

Textbooks

Main Textbook:

- *Bertsekas, Dimitri P., and John N. Tsitsiklis. Introduction to Probability. Vol. 1. Belmont, MA: Athena Scientific, 2002.*

Additional Textbooks:

- *Casella, George, and Roger L. Berger. Statistical Inference. Vol. 2. Pacific Grove, CA: Duxbury, 2002.*
- *Koller, Daphne, and Nir Friedman. Probabilistic Graphical Models: Principles and Techniques. MIT press, 2009.*

Grading

- Problem Sets 30%
- Midterm Exam 30%
- Final Exam 40%

Grading Policies

- Cheating is strictly monitored and the penalty is -100 (minus hundred) points per assignment.
- Late assignments get -30 (minus thirty) points for each day after the deadline.
- No team work is allowed on problem sets.
- Reports typeset with LaTeXget +10 bonus points.
- Each problem set will also contain a bonus problem, which will earn the student +10 bonus points if solved correctly.

Classroom Policies

- No attendance is required.
- Coming late to the class is tolerated.
- Bringing computers to the class is welcome.
- Unregistered listeners are welcome.
- Interacting with the the instructor is strongly recommended.