Palestine Polytechnic University

Deanship of Graduate Studies

Probability and Statistics for Intelligent systems
First Semester 2019-2010

Lecture Schedule	Mon. 14:00-17:00	**Semester**	Fall 2019/2020
Credit Hours	Three	**Pre-requisite**	Linear Algebra, Signals and Systems and Probability
Instructor	Ghandi Manasra, and Monjed Samuh	**Contact**	ghandi@ppu.edu monjedsamuh@ppu.edu
Office	**Manasra**: **Samuh**: B+503	**Office Hours**	**Manasra**: Mon. 17:00-18:00 **Samuh**: Wed. 14:00-15:00 or by appointment (via email).

Course Description: Probability and Statistics for Intelligent Systems

Goals: This course aims to introduce the fundamentals of probability and statistics applicable to intelligent systems (IS). Its objective is to provide the students with the necessary mathematical tools to analyze and develop probabilistic and statistical models related to estimation and testing.

The course covers the following topics: fundamentals of probability, random variables and processes, conditional distributions, Bayesian analysis, representations for stochastic processes and Markov processes. Descriptive statistics (graphs, tables, and descriptive measures including measures of central tendency and measures of dispersion), Inferential statistics (Confidence interval, Hypothesis testing and Regression analysis). Understand the concepts needed for data science with Python and R.

Expected Outcomes and ILOs:

- The students will be able to differentiate and use probability models.
- They will learn to make decisions based on probability and statistics.
- How to utilize statistical software to visualize and analyze data.
- How to study the association between different types of variables using regression analysis.

In other words student should be able to:

- Become familiar with discrete and continuous probability distributions.
- Able to transform, densities and expectations of random variables and processes.
- Become familiar with random processes and the second moment theory.

More information: This is a pre-requisite for almost all graduate level courses in communications, signal processing, controls and networks. The course will assume an introductory knowledge of probability. We will first have a quick review of: axioms of probability, random variables, distributions densities and functions of one random variable. Then functions of several random variables, moment generating functions, linear transformations and central limiting theorem will be discussed. After covering the topics related to random variables we will talk about stochastic processes, and their classifications.

The course also requires from each student critical reading and presentation of one relevant and recent research paper published in a reputed journal (e.g. IEEE, Elsevier, and Springer).

Textbooks:

1. **Probability, Random Variables and Stochastic Processes**, Athanasios Papoulis and S. U. Pillai, 4th Edition, McGraw Hill, 2002.
2. **Introduction to probability Models**, S. M. Ross, 10th Ed., Academic Press, 2009.
3. **Probability and Statistics for Data Science**, Carlos Fernandez-Granda, 2017.
4. **A Tiny Handbook of R**, Mike Allerhand, Springer-Verlag Berlin Heidelberg, 2011.

Required Software: R or RStudio.

Lecture Plan

Weeks	Topics
1*	**Basic Concepts:** Axiomatic Probability Theory, Discrete and Continuous Probability Space, Independent Events
2*	**Concept of a Random Variables:** Single and Multiple Events, Distribution and Density Functions, Conditional density functions
3*	**Functions of one and Two Random Variables:** One function of two random variables, Two functions of two random variables, First and Second order Moments Conditional Moments, Characteristic Functions
1*	**Sequence of random Variables:** Sum, Product, Random Vector, Correlation and Covariance Matrices
1*	**Sequence of Random Variables:** Sum, Product, Random Vector, Correlation and Covariance Matrices
2*	**Stochastic Processes and Stationarity:** Introduction to stochastic processes, Strict Sense Stationary, Wide Sense Stationary and Cyclo-stationary, Autocorrelation, Linear Systems, Power Spectral Density, Convergence
1*	**Mean Square Estimation**: 13-1 Introduction *I* 13-2 Prediction *I* 13-3 Filtering and Prediction *I* 13-4 Kalman Filters *I* Problems.
11	**Descriptive statistics**: Graphs, tables, descriptive measure, order statistics.
12	**Frequentist statistics**: Finding point estimators, evaluating estimators (Baisedness, MSE, consistency), Confidence intervals, coverage probability.
13	**Bayesian statistics**: Bayesian estimators.
14	**Hypothesis testing**: Likelihood ratio test, Neyman-Pearson Lemma, Power function, permutation testing.
15	**Regression Analysis**: Least squares estimation, simple and multiple linear regression, inference concerning the regression coefficients.

Grading Policy:

- Assignments 10%
- Exam-I 20%
- Exam-II 20%
- Final 40%
- Project 10%