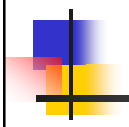

Introduction

Lecture 1

EE 640
Stochastic Systems

Prerequisite

- Signals and Systems
  - Linear Time-Invariant Systems
  - Continuous and Discrete, Sampling theorem
  - Fourier Transform and Convolution
- Linear Algebra
  - Vector and Matrix
  - Orthogonality and Linear independence, Sets
  - Eigenvector/value, Principle Component Analysis
- Probability Theory
  - Binomial, Gaussian distributions
  - Random variable, functions of r.v., Bayes rule

Applications

- System Control
  - State estimation, Optimal feedback
  - System Identification
- Signal/Image Processing
  - Filtering, Detection, Estimation, Compression
  - Tracking, Clustering, Recognition
  - Maximum Likelihood, Maximum A Posteriori, Minmax Decisions
  - Information theory
- Communications
  - Encoding, Decoding, Modulation, Demodulation

Main Topics

- Random Noise Analysis and Synthesis
  - Conditional probability, Bayes theorem
  - Expectations and functions of random variables
  - Bounds and convergence
  - Applications in signal and image processing
- Random Processes
  - Random processes, autocorrelation, power spectrum
  - Linear operation, sampling
- Stochastic signal processing
  - Signal detection and discrimination
  - Optimal signal processing, Matched/Wiener Filters

Historic Perspective

- 1800s, Gauss and Legendre, Least-squares method
- 1940-1945, Wiener and Rice, Wiener filter, signal filtering to de-noise
- Tesla realized that noise signatures could be used to represent “information”.
- 1948, Shannon, Channel capacity for digital communication
- 1960s Kalman, Kalman filter for signal estimation
- Nowadays, noises need to be removed, yet stochastic techniques to be improved in communication, numerical optimization/simulation, printing.

Different types of Probabilities

- Prob. Based on intuition – neural nets
- Prob. Ratio of favorable outcomes
  - n_E/N
- Prob. Measures of frequency of occurrence
  - n_E/N N->infinite
- Prob. Based on axiomatic theory
  - Set theory
- Stochastic systems (Wiener)
  - Ensemble x(t) $f(x_1, x_2, t_1, t_2)$