Spring 2013 - Munich School Of Engineering

Modellierung von Unsicherheit in den Ingenieurwissenschaften

Uncertainty Modeling in Engineering

Instructor: P.S/ Koutsourelakis
Fakultät fur Maschinenwesen
Technische Universität München
p.s.koutsourelakis@tum.de

Description

Engineers are constantly faced with the task of producing quantitative estimates and making decisions regarding the safety, reliability and performance of various systems. More often than not, these tasks must be carried out under limited information and significant uncertainty. Despite the progress in mathematical modeling and advances in numerical simulation techniques, our actual predictive ability has not commensurately increased. Engineers must account for the various sources of uncertainty (e.g. environmental effects, physical properties, model parameters) in order to reach rational conclusions. This course presents the necessary tools and methodological framework for dealing with uncertainty.

Objectives

The main objective of the course is to introduce the basic mathematical framework in probability and statistics for formulating and analyzing engineering problems exhibiting random variability. Students will get acquainted with:

- mathematical modeling of random events i.e. random variables and random vectors.
- common distributions of random variables/vectors
- estimation of distribution parameters
- assessment of reliability of engineering systems
- Bayesian decision making and parameter estimation
- design in the presence of uncertainty.

Prerequisites

Mathematical foundations (calculus), Engineering Informatics 1 / 2

Course Webpage

Lecture notes, readings and other relevant material will be posted on Moodle

Course Schedule

Scheduled meetings are on Thursdays, 12.30 - 14.00 (Vorlesung) and 14:15-15:00 (Übung). Please note that no distinction will be made between Vorlesung and Übung, i.e. we will do examples/problems whenever this is reasonable and not necessarily during Übung time.

Office Hours

To be announced or by appointment (please email).

Textbooks

Several books cover the material of the course to various levels of complexity and rigor and students are encouraged to use many sources. We will largely follow the book:

- Faber, M.H. (2012). Statistics and Probability theory: In Pursuit of Engineering Decision Support, Springer.

Note however that at times we will expand upon the material discussed therein. During the course of the semester additional references to books, papers and technical reports will be provided and students are encouraged to study them.

Grading

The final grade will be based on a final exam.

Course Topics/Syllabus

- Motivation - Engineering decision-making under uncertainty: **1 week**
- Basic probability theory: **2 weeks**
- Descriptive Statistics: **1 week**
- Uncertainty modeling: **2 weeks**
- Estimation and model building: **2 weeks**
- Reliability assessment and Monte Carlo: **2 weeks**
- Bayesian decision analysis: **3 weeks**