Multi-Resolution Methods for Modeling and Control of Dynamical Systems

Special Topic Course (MAE 502)
Registration No.: 255154
Day/Time: MW 10:30-11:50am
Location: 120 Baldy
Instructor: Dr. Puneet Singla
Department of Mechanical and Aerospace Engineering
University at Buffalo

Course Content: an advanced level course on mathematical modeling of dynamical systems: multi-resolution analysis, local vs global approximation, curse of dimensionality, polynomial approximants; partition of unity; finite element methods; radial basis functions; and their applications in dynamical system identification, motion planning and modern control.

Course Objectives: The emphasis of this course will be on an intuitive understanding of the subject and practical applications of various approximation methods so that students should be able to apply the discussed methods to real engineering problems with the awareness of potential difficulties that might arise in practice. This course would cover topics from classical finite element methods to adaptive control to neural network approximation at a level of detail compatible with the design and implementation of modern control systems. These diverse topics will be covered in an integrated fashion, using a framework derived from dynamical systems, estimation, optimization, and approximation theory. The formulation and case studies in this course will focus on demonstrating, through analysis, simulation, and design, the applicability and feasibility of a substantial set of recent developed approximation ideas to a rich set of examples. The reliability and limitations of the approximation methods discussed will be assessed by considering various academic and engineering problems. We will discuss in detail the issues related to modeling of large-scale dynamical systems like dimensionality, quality of the measurement data, offline or online learning, approximation accuracy, the computation time associated with the model, complexity of the mathematical model and efficiency of the learning algorithm.

Prerequisites: The course will be self-contained in the sense that it will require only rudimentary knowledge of matrix algebra, statistics, dynamical system theory and control.

Grading: Homework: 30%, Midterm: 30%, Term Project: 40%.

For more information please contact: Dr. Puneet Singla (psingla@buffalo.edu)