IE 597 System Informatics and Control

Harold and Inge Marcus Department of Industrial and Manufacturing Engineering
The Pennsylvania State University, University PA

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OFFICE: 221 Leonhard Building
OFFICE HOURS: TuTh *1:30 - 3:30pm or by appointment*
CLASS TIME & PLACE: TuTh 9:05AM - 10:20AM Willard 219

PREREQUISITE: IE 323: Statistical Methods in Industrial Engineering or equivalent

REFERENCE BOOKS

1. Donald B. Percival, Andrew T. Walden. Wavelet Methods for Time Series Analysis, 2016, ISBN-13: 978-0521685085, ISBN-10: 0521685087
2. Holger Kantz, Thomas Schreiber, Nonlinear Time Series Analysis, 2010, ISBN-13: 978-0521529020,
3. Sutton & Barto, Reinforcement Learning: An Introduction, 1998, ISBN-13: 978-0262193986
4. Martin T. Hagan, Howard B. Demuth, Mark H. Beale, Orlando De Jesús, Neural Network Design, 2014, ISBN-13: 978-0-9717321-1-7. A free eBook can be downloaded from here.

SOFTWARE:

MATLAB® will be used for some homework assignments and projects in this class. It is available in College of Engineering computer laboratories, or obtain the student version for use at home. Tutorials for MATLAB can be found in the following link: http://www.eng.usf.edu/~huiyang/Matlab.htm

OBJECTIVES

Modern industry in the 21st century is investing in a variety of sensor networks and dedicated data centers to increase information visibility and system controllability. Present technological advances are bringing massive data torrents in shorter time scales. This offers unprecedented opportunities to manage, analyze, visualize, and extract useful information from large, diverse, distributed and heterogeneous data sets so as to make better decisions, improve the system performance, and optimize the operational management. Data-driven innovations are motivating a profound transformation in the operation management in every field of engineering and business.

The objective of this course is to train graduate students in the optimal design of sensor networks for process monitoring in modern industry, as well as data mining and reinforcement learning for optimal management and control of engineering systems. Students who complete this course will be exposed to (1) optimal design of industrial sensor networks; (2) sensor informatics and data representation; (3) data analytics with nonlinear dynamics, neuro-dynamic programming; (4) sensor-based learning and planning of control policies; (4) descriptive and predictive modeling with real-world examples from a variety of industries.

TOPICS

1. Advanced sensing and process monitoring
   (Sensor networks and Internet of Things, supervisory control and data acquisition systems, optimal sensor placement, stochastic sensor networks)
2. Sensor informatics and data representation
   (Signal and weight vector space, wavelet analysis, state space representation)
3. Nonlinear dynamics modeling and control
   (Recurrence plot, cross-recurrence plot, recurrence quantification analysis, heterogeneous recurrence analysis, fractal theory, self-organizing network)
4. Neuro-dynamic programming
   (Neuron network architecture and training, performance surfaces and optimum points, function approximation, approximate dynamic programming)
5. Sensor-based learning and control
   (Markov decision processes, solving known MDPs: dynamic programming, Monte Carlo learning and temporal difference learning, model-free prediction and control, integrating learning and control)

GRADING POLICY

Homework/Quiz – 35%
Exam – 35%
Project – 30%

Exam dates will be announced as the course progresses. Final grade will be determined based on the student performance in different evaluation elements – as shown above. No make-up exams unless previous arrangements have been made. Students will be expected to attend class and prepare assignments. Habitual failure to do so will result in a reduced grade. An incomplete grade will only be given when a student misses a portion of the semester because of illness or accident. Cheating on examinations, plagiarism and other forms of academic dishonesty are serious offenses and may subject the student to penalties ranging from failing grades to dismissal.

Grading scale will be used: A: 90+; B: 80+; C: 70+; D: 60+, F: <60

CLASS POLICY

- Homework problem sets will be assigned during the semester. Please use the assignment page as the cover page of your homework submission. Homework solutions should be written neatly, and all steps **must** be shown clearly for full credit. Assignments not meeting these specifications will not be accepted.
- Homework is due one week after it is assigned. No late homework will be accepted. **Please submit and upload your solutions as a single PDF file to the CANVAS website. Please DO NOT submit through emails or hardcopies. Email and hardcopy submission will not be accepted and graded.** If you do not submit your homework **on the assigned due date** it will be considered late.
- **Attendance:** Class attendance is strictly required. I ***strongly encourage you to attend class*** regularly and I will take attendance periodically during the course of the semester. Habitual failure to do so will result in a reduced grade. In the event of extenuating circumstances, please submit documentation (printed, signed, and dated by students and relevant authorities) to the instructor at least two days ahead of the class for approval. If it is not a university excuse, it will not be accepted. **Dropping an email to me without any documentation will not be accepted.**
- During class time, please **turn** your cell phones to **SILENT/VIBRATION** mode. Always bring your textbook to class. Also bring your calculator, notebook, pencils/pens, and eraser.
- ***Exams must be taken on the scheduled exam dates.*** Students are required to arrange with the instructor in advance for a make-up exam in the event of extenuating circumstances that prevent them from taking the exam as scheduled. In the event of an unforeseen emergency that prevents the student from taking the exam as scheduled, the student must provide documentation to the instructor before a make-up exam can be arranged.
- Exams will be closed book, closed notes. Please be sure to bring your calculator to the exam. There will be absolutely no sharing among students of calculators. Computer or laptop is not allowed in the exam
- If you believe there was an error in the grading of an exam, you may submit the entire exam for a regrade. This must be done ***within one week*** from the date the exam was returned. The entire exam will be regraded, so that you may gain, or lose, points by resubmitting.

COMMUNICATION AND INSTRUCTION VIA CANVAS

Communication in the course will be through official electronic means: PSU assigned e-mail address and the course website in CANVAS (https://psu.instructure.com/). Students are responsible for all information conveyed during class and on CANVAS. It is the student's responsibility to make sure they are receiving their official PSU email and checking course updates in the CANVAS website.

To access CANVAS, go to: https://psu.instructure.com/

Go to Dashboad and then click on this course. Check this website frequently for: Course syllabus, important announcements, homework sets, lecture notes, emails, grades, and additional resources.

INSTRUCTOR'S COMMITMENT

You can expect your instructor to be courteous, punctual, well-organized, and prepared for the lecture and other class activities; to answer questions clearly; to be available during office hours or to notify you beforehand if he is unable to keep them; and to grade uniformly and consistently according to the posted guidelines.

STUDENTS WITH DISABILITIES SERVICES

Penn State welcomes students with disabilities into the University's educational programs. If you have a disability-related need for reasonable academic adjustments in this course, contact the Office for Disability Services (ODS) at 814-863-1807 (V/TTY). For further information regarding ODS, please visit the Office for Disability Services Web site at http://equity.psu.edu/ods/.

In order to receive consideration for course accommodations, you must contact ODS and provide documentation (see the documentation guidelines at http://equity.psu.edu/ods/guidelines/documentation-guidelines). If the documentation supports the need for academic adjustments, ODS will provide a letter identifying appropriate academic adjustments. Please share this letter and discuss the adjustments with your instructor as early in the course as possible. You must contact ODS and request academic adjustment letters at the beginning of each semester.

ACADEMIC INTEGRITY

Violations of academic honesty will be dispatched in accordance with the university policy (http://www.psu.edu/oue/aappm/G-9-academic-integrity.html).

IMPORTANT DATES

Classes Begin	Monday	August 20
Regular Drop - Deadline	Saturday	August 25 at 11:59 p.m. (ET)
Regular Add - Deadline	Sunday	August 26 at 11:59 p.m. (ET)
Late Drop Begins	Sunday	August 26
Late Registration Begins	Monday	August 27
Labor Day Holiday - No Classes	Monday	September 3
Final Exam Conflict - Filing Period	Monday - Sunday	September 24 - October 14
Late Drop - Deadline	Friday	November 9 at 11:59 p.m. (ET)
Declare Minor - Deadline (Graduating Students)	Friday	November 9
Thanksgiving Holiday - No Classes	Sunday - Saturday	November 18 - 24
Withdrawal - Deadline	Friday	December 7 at 5:00 p.m. (ET)
Classes End	Friday	December 7
Study Days	Saturday - Sunday	December 8 - 9
Final Exams	Monday - Friday	December 10 - 14

Good luck and have a great semester!