ECE PMP Course

Data Science for Energy Systems

Time

Instructor: Baosen Zhang
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Office: EEB M310
Office Hours: by request
TA:

Course Description: Upon completing this course, the student should be able to:

- Explain how data is generated in energy systems and how are new technologies impacting the amount and quality of datasets
- Understand popular data processing and analytic techniques
- Implement existing packages to solve problems
- Use machine learning methods to answer questions about power and energy system operations
- Choose appropriate methods based on objective and datasets

Prerequisite(s): This class requires basic knowledge of circuits, probability, linear algebra and calculus. Familiarity with a programming language such as R or Python is preferred. Some knowledge of optimization is helpful, but not necessary.

Text(s): We will not have a required textbook for this class, but some of the following books (plus abundant online tutorials of data analytic methods) are helpful:

- "Electric Energy: An Introduction", by Mohamed A. El-Sharkawi
- "Power System Analysis and Design", by Glover, Sarma and Overbye
- "Applied Linear Regression Models", by Kutner, Nachtsheim and Neter
- "Deep Learning", by Goodfellow, Bengio and Courville

Exams and Assignments:

1. Homework Assignments: Weekly homework assignments
2. Final project: due last week of class

Grade Distribution:

1. Homework, 50%
2. Project, 50%

Notes: This class is very much "hands-on" in the sense that you need to do the homework exercises and participate in a meaningful project. Simply listening to lectures and reading books won't be enough to gain a useful understanding of how to apply data analytics and machine learning methods to practical power system problems.
Software: You will program a lot in this class. You should makes sure that you are familiar with Python or a similar language.

Website: The main website is `http://zhangbaosen.github.io/teaching/EE559_2019`. We use the Canvas website only for grading.

Tentative Course Outline:
The weekly coverage might change depending on the progress of the class.

Week	Content
Week 1	• Introduction to power systems • AC circuit analysis • Power flow
Week 2	• Understanding different datasets in power systems • PMU and SCADA data • Sampling theorems
Week 3	• Introduction to time series analysis • Linear and nonlinear regression
Week 4	• Data analytics I • State estimation • Understanding the impact of data rates
Week 5	• Cybersecurity • Privacy and customer data
Week 6	• Introduction to Machine Learning • Review of optimization • Learning physical operations in power systems from data
Week 7	• Classification and Estimation • Fault detection • Load forecasting
Week 8	• Different architectures of neural networks • Data generation
Week 9	• Working with Heterogenous Data • Application to Buildings
Week 10	• Decision Making with Data • Monte Carlo Simulations • Understanding generalization capability of machine learning algorithms
Week 11	• Project Presentations