The University of Texas at Austin
Department of Electrical and Computer Engineering
EE 394V - Data Analytics in Power Systems (Unique: 16874)
Spring 2019

Instructor: Hao Zhu, `haozhu@utexas.edu`
Date/time: MW 3:00- 4:20, ECJ 1.222
Office hours: Wed 4:30-5:30 and by appointment, EER 7.868

TA: Yuqi Zhou, `zhouyuqi@utexas.edu`
Office hours: TBD

Course Description: The electric power grid is witnessing significant transformations towards an integrated, active, and ubiquitously-sensed cyber-physical system. The emerging multi-scale data from synchrophasors, smart meters, weather, and electricity markets offers tremendous opportunities as well as scientific challenges to learn the current grid status as well as to actively infer the safety margins to potential failures. Building on mathematical foundations of high-dimensional spaces and statistical analysis, this course aims to provide an overview of data analytics tools in the modeling and operations of modern power systems. Students will work in groups to research and present some recent papers on a specific topic.

Prerequisites: Concepts in power flow modeling and analysis at the level of EE 368L: Power System Apparatus & Lab or EE 369: Power Systems Engineering; working knowledge of linear algebra and probability; and scientific computing proficiency (such as Matlab or Python). Or consent of instructor.

Credit Hours: 3

Textbook: There is no official textbook for this course. Required and suggested reading materials will be posted on Canvas as the course develops.

Course Topics: The course covers basics of machine learning and statistical signal processing, and aims to introduce the tools for data-enabled inference and modeling in power systems. We will discuss the differences between first principle models and data-driven models in real-time operations. Classroom discussion and research projects will prepare the students to understand better how to integrate data-driven and physics-based reasoning in modern power systems.

1. Basic concepts
   - Statistics
   - Estimation theory
   - System identification

2. Dimensionality reduction

   - Principal Component Analysis (PCA)
   - PCA applications in power systems

3. Machine learning techniques

   - Clustering
   - Classification
   - Neural networks

4. Model-free grid modeling

   - Steady-state system modeling
   - Dynamic system modeling
   - Time series Analysis

5. Special Topics

   - Voltage stability monitoring
   - Estimation of power flow Jacobian matrix
   - Distribution system topology verification
   - Energy data disaggregation
   - Inference of dynamic response

Evaluation:

Homework Assignments	20%
Midterm Exam	25%
Classroom Participations	5 %
In-class Presentation	25%
Final Project	25%
No Final Exam	

Course Policy:

- **Grading**

  - There is no final exam.
  - Plus and minus letter grades may be assigned.
  - Request for regrading an assignment must be made in writing within one (1) week of the graded assignment being made available to students in the class. Discussion of homework questions is encouraged. Please submit your own *independent* homework solutions.
  - Late homework will be accepted only in the most extraordinary of circumstances.

- **Midterm exam**

  - In-class exam with closed books and notes scheduled for Wednesday, Mar 13, 2019.
  - One page of formula sheet allowed (both sides)

- **Final Project**

  - All students will conduct a research project on a topic related to data analytics tools used for power systems based on the student's research interest.

- A one-page project proposal that clearly articulates the research question to address, proposed solution techniques, and sources of data if needed, due Wednesday, Feb 27, 2019.
- A max ten-page project final report that documents all project findings, due Friday, May 10, 2019.
- One in-class presentation will be scheduled for each project.

- **Use of Electronics in Lecture**

  - During lecture, please exclusively focus your use of laptops, smart phones and other electronics on following the lecture content.

Additional Information:

- **University Honor Code:** "The core values of The University of Texas at Austin are learning, discovery, freedom, leadership, individual opportunity, and responsibility. Each member of the University is expected to uphold these values through integrity, honesty, fairness, and respect toward peers and community." `http://www.utexas.edu/about/mission-and-values`

- **Religious Holidays:** By UT Austin policy, you must notify the instructor of any pending absence at least fourteen (14) days prior to the date of observance of a religious holy day, or on the first class day if the observance takes place during the first fourteen days of the semester. If you must miss class, lab section, exam, or assignment to observe a religious holiday, you will have an opportunity to complete the missed work within a reasonable amount of time after the absence.

- **Students with Disabilities:** UT provides upon request appropriate academic accommodations for qualified students with disabilities. Disabilities range from visual, hearing, and movement impairments to ADHD, psychological disorders (e.g. depression and bipolar disorder), and chronic health conditions (e.g. diabetes and cancer). These also include from temporary disabilities such as broken bones and recovery from surgery. For more information, contact Services for Students with Disabilities at (512) 471-6259 [voice], (866) 329-3986 [video phone], `ssd@uts.cc.utexas.edu`, or `http://ddce.utexas.edu/disability`.

- **Mental Health Counseling:** Counselors are available Monday-Friday 8am-5pm at the UT's Counseling and Mental Health Center (CMHC) on the 5th floor of the Student Services Building (SSB) in person and by phone (512-471-3515). The 24/7 UT Crisis Line is 512-471-2255.

- **Campus Carry:** "The University of Texas at Austin is committed to providing a safe environment for students, employees, university affiliates, and visitors, and to respecting the right of individuals who are licensed to carry a handgun as permitted by Texas state law." For more information, please see `http://campuscarry.utexas.edu/students`.