EE P 555 A Wi 25: Data Science For Power Systems

Meeting Time: Tuesdays and Thursdays 4:00-5:50 p.m. PT

Classroom: ECE 269 Instructor: Dinuka Sahabandu (<u>sdinuka@uw.edu</u>) TA: Yuetai Li (

Instructor Office Hours: Saturdays 3.00 - 5.00 pm PT via Zoom **TA Office Hours**: Mondays 8.00 - 10.00 pm PT via Zoom

COURSE DESCRIPTION

This course provides a comprehensive exploration of data science applications in power systems. Focusing on core data science techniques, students will learn to leverage machine learning (ML) for various power system challenges, including load forecasting, fault prediction, and network state estimation. The course combines theory with practical programming assignments, enabling students to gain proficiency in ML tools and techniques specific to the energy sector. A final project will allow students to apply learned concepts to real-world data, providing hands-on experience with popular data processing frameworks and analytics methods.

Recommended PREREQUISITES:

- Python Programming: Required for data manipulation and ML tasks.
- Linear Algebra and Statistics: Familiarity with statistical modeling and linear algebra.
- Basic Power Systems Knowledge.

LEARNING OBJECTIVES

By the end of this course, students will demonstrate the ability to:

- 1. Apply data science and ML techniques to power system data.
- 2. Implement algorithms for regression, classification, and clustering.
- 3. Utilize Python libraries, including NumPy, Pandas, and Scikit-learn.
- 4. Develop ML models for real-world power system applications.
- 5. Evaluate and interpret model performance for practical deployment.

LECTURE SCHEDULE (Tentative)

- Week 1: Introduction to Data Science in Power Systems Topics: Overview of data science applications, energy data types, course introduction.
- Week 2: Regression Techniques Topics: Linear regression, regularization, applications in load forecasting.

- Week 3: Advanced Regression and State Estimation Topics: Ridge and Lasso regression, state estimation methods.
- Week 4: Classification Basics Topics: Binary and multi-class classification, logistic regression.
- Week 5: Deep Learning for Power Systems Topics: Introduction to neural networks, use cases in energy systems.
- Week 6: Unsupervised Learning Clustering Topics: Clustering for anomaly detection, k-means, applications in demand response.
- Week 7: Optimal Operations and Control of Power Systems Topics: Optimization techniques, Volt-VAR control, reinforcement learning.
- Week 8: Data Sources and Project Planning Topics: Data sources review (NREL, PECAN Street), project guidelines.
- Week 9: Time Series Analysis in Power Systems *Topics*: Load and generation forecasting, anomaly detection, and seasonal patterns in power systems data.
- Week 10: Generative Al Applications in Power Systems *Topics:* Advanced forecasting using transformers (e.g., PatchTST for long-term forecasting), anomaly detection, and resilience modeling.
- Week 11: Project Presentations *Topics*: Final presentations by student teams, peer feedback, and wrap-up discussions.

COURSE MATERIALS

Textbook

• Weng, Y., Xie, L., & Rajagopal, R. (2023). Data Science and Applications for Modern Power Systems. Springer.

References

- Vyas, A. K., Balamurugan, S., Hiran, K. K., & Dhiman, H. S. (2022). Artificial Intelligence for Renewable Energy Systems. Wiley-Scrivener.
- Liu, Y. (2020). Python Machine Learning By Example (2nd ed.). Packt Publishing.

Useful Data Sources:

- 1. NREL <u>Wind Integration StudyLinks to an external site.</u>, <u>Solar Integration Study.</u>
- 2. PECAN Street. (need to register, free with a .edu email)
- 3. ERCOT (Texas) load data

4. IEEE PES Subcommittee on Big Data \& Data Analytics.

GRADING CRITERIA

- **Assignment:** 40% (Total of 4 bi-weekly assignments starting from Week 2)
- Final Project: 50% (Proposal: 5%, Presentation: 20%, Report: 25%)
- Class Participation (via Canvas Quizzes): 10%

COURSE POLICIES

- Please complete the homework by yourself and do not copy code from others or the internet. Any answer from Chat-GPT or any other language model needs to be identified as such. Suppose your homework is identical to others or any sample code snippets online. In that case, you will receive zero scores, and UW mandates us to report it to the College of Engineering.
- You are encouraged to discuss homework content with your classmates offline and on the discussion boards. However, please limit your discussion to ideas and not discuss the code. Specifically, do not copy-paste any homework answers into the discussion boards.
- Students must submit homework and project materials online by the posted due date. Throughout the quarter, we will provide you with six late-day credits for the three homework assignments, which you can use to submit one or more homework without a penalty. However, if you have used all six days, each additional late day will result in a 20% penalty in the corresponding homework.
- Students need to submit project reports and presentations on time. The project does not have any credit days. Any overdue project materials will receive a zero score.

RELIGIOUS ACCOMMODATIONS

Washington state law requires that UW develop a policy for accommodation of student absences or significant hardship due to reasons of faith or conscience, or for organized religious activities. The UW's policy, including more information about how to request an accommodation, is available at

Religious Accommodations Policy

(https://registrar.washington.edu/staffandfaculty/religious-accommodations-policy/).

Accommodations must be requested within the first two weeks of this course using the Religious Accommodations Request form

(https://registrar.washington.edu/students/religious-accommodations-request/).

ACCOMMODATIONS AND ACCESS

If you have already established accommodations with Disability Resources for Students (DRS), please communicate your approved accommodations to me at your earliest convenience so we can discuss your needs in this course. If you have not yet established services through DRS, but have a temporary health condition or permanent disability that requires accommodations (conditions include but not limited to; mental health, attention-related, learning, vision, hearing, physical or health impacts), you are

welcome to contact DRS at 206-543-8924 or uwdrs@uw.edu or disability.uw.edu. DRS offers resources and coordinates reasonable accommodations for students with disabilities and/or temporary health conditions. Reasonable accommodations are established through an interactive process between the student, instructor, and DRS. It is the policy and practice of the University of Washington to create inclusive and accessible learning environments consistent with federal and state law.

ACADEMIC INTEGRITY

Engineering is a profession demanding a high level of personal honesty, integrity and responsibility. Therefore, it is essential that engineering students, in fulfillment of their academic requirements and in preparation to enter the engineering profession, adhere to the College of Engineering Statement of Principles. Any student in this course suspected of academic misconduct (e.g., cheating, plagiarism, or falsification) will be reported to the College of Engineering Dean's Office and the University's Office of Community Standards and Student Conduct to initiate the student conduct process.

TITLE IX

"UW, through numerous policies, prohibits sex- and gender-based violence and harassment, and we expect students, faculty, and staff to act professionally and respectfully in all work, learning, and research environments. For support, resources, and reporting options related to sex- and gender-based violence or harassment, visit UW Title IX's webpage (<u>https://www.washington.edu/titleix</u>), specifically the Know Your Rights & Resources guide.

If you choose to disclose information to me about sex- or gender-based violence or harassment, I will connect you (or the person who experienced the conduct) with resources and individuals who can best provide support and options. You can also access those resources directly:

- Confidential: Confidential advocates

 (<u>https://www.washington.edu/sexualassault/support/advocacy</u>) will not share information
 with others unless given express permission by the person who has experienced the harm
 or when required by law.
- Private and/or anonymous: SafeCampus (<u>https://www.washington.edu/safecampus</u>) provides consultation and support and can connect you with additional resources if you want them. You can contact SafeCampus anonymously or share limited information when you call

Please note that some senior leaders and other specified employees have been identified as "Officials Required to Report." (<u>https://www.washington.edu/titleix/title-ix-officials-required-to-report</u>) If an Official Required to Report learns of possible sex- or gender-based violence or harassment, they are required to call SafeCampus and report all the details they have in order to ensure that the person who experienced harm is offered support and reporting options (<u>https://www.washington.edu/titleix/resources</u>)."