GridEd

The Center for Grid Engineering Education

EPRI

Machine Learning Applications for PMU Data
A Hands-on Training for Practitioners – 22 PDHs

Course Description

This course is one in a series of several courses developed and offered through GridEd to enhance workforce readiness through training and education of personnel with needed skill sets at the intersection of power systems and digital systems.

The 22-hour course focuses on machine learning applications for PMU data in power systems. The topics covered in the course include PMU background information, data preprocessing, building machine learning and data mining models, training models to perform power system event detection and classification, tuning hyper-parameters, calculating performance metrics and refining models. The implementation of the machine learning models to perform power system events detection and classification with PMU data using Python will be covered in this hands-on short course.

Participants will learn how to build machine learning models to perform anomaly detection and classification for PMU data assess model performance. They will learn how to tackle specific issues faced by utility data scientists while applying different machine learning algorithms.

Who Should Attend

This course is intended for professionals and practitioners interested in developing deep learning models for PMU data in transmission systems. Prior knowledge of **Python is required and a basic understanding of data science and deep learning are recommended.** A basic familiarity with open-source libraries such as PyTorch, TensorFlow, and Scikit-Learn are also recommended but not required.

Schedule

Week 1a: 4 hours classroom + assignment time

Week 1b: 3 hours classroom + assignment time

Week 2a: 3 hours classroom + assignment time

Week 2b: 2 hours classroom + assignment time

Location: Online - Live sessions via Webex

Fee: $2200

See course outline on page 2 and 3.

For more information contact Amy Feser,
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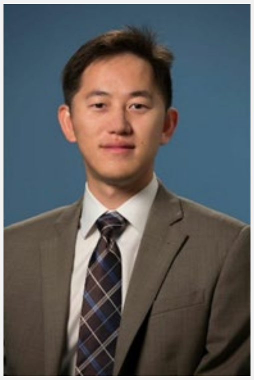
Course Outline

Week	Activities
1a	***Topic*** Power System Event Classification with Convolutional Neural Network Using PMU Data – Model Development
	Hands-on Problem Power System Event Classification
	Day 1 (3hrs total) – 1.5hr presentation + 1.5hr code walkthrough ● Overview of Convolution Neural Network (CNN) and Event Classification Problem ● Types of Power System Events ● Data preprocessing ● Convolutional Neural Network-based Model ● Problem setup and dataset ● Assignment walk-through
	Day 2 (1hr) Assignment Q&A and discussion
	Assignment (3hrs) Build a CNN-based model for event classification using Phasor Measurement Unit Dataset *Complete sections of code to train the baseline CNN model.*
1b	***Topic*** Power System Event Classification with CNN – Model Refinement & Assessment
	Hands-on Problem Improve Baseline CNN model and compute metrics for assessing the performance of the CNN-based model
	Dataset: Validation and Testing dataset
	Day 1 (2hrs total) – 1 hr presentation + 1hr code walkthrough ● Saving and loading models ● Metrics assess performance ● Hyper-parameter tuning ● Loss curve and prevention of overfitting ● Assignment walk-through
	Day 2 (1hr) Assignment Q&A and discussion
	Assignment (2hrs) Run classification model on a test dataset and submit the code and classification results. Compare performance of the baseline and the improved CNN model. *The submission file will be evaluated*
2a	***Topic*** Power System Event Detection Using Graph Signal Processing Using PMU Data

	Hands-on Problem Power System Event Detection
	Day 1 (2hrs total) – 1 hr presentation + 1 hr code walkthrough ● Graph signal processing overview ● GSP-based event detection ● Problem in context ● Assignment walk-through
	Day 2 (1hr) *Assignment Q&A and discussion*
	Assignment (3hrs) Build a GSP-based event detection model using PMU dataset *Complete sections of code to building the GSP-based model.*
2b	***Topic*** Power System Event Detection – Model Assessment
	Hands-on problem Visualize performance and compute metrics for event detection model
	Dataset: Validation and Testing dataset
	Day 1 (1hr) ● Metrics ● Visualize and log results ● Hyper-parameter tuning ● Assignment walk-through
	Day 2 (1hr) ● Assignment walk-through
	Assignment (2hrs) Run event detection model on a test dataset and submit the code and event detection results. *The submission file will be evaluated*

Meet the Instructors



Dr. Nanpeng Yu received his B.S. in Electrical Engineering from Tsinghua University, Beijing, China, in 2006. Dr. Yu received his M.S. degrees in Electrical Engineering and Economics and Ph.D. degree from Iowa State University in 2010. Before joining University of California, Riverside, Dr. Yu was a senior power system planner and project manager at Southern California Edison from Jan, 2011 to July 2014.

Currently, he is an associate professor and vice chair of Electrical and Computer Engineering at the University of California, Riverside, CA. Dr. Yu is the recipient of the Regents Faculty Fellowship and Regents Faculty Development award from University of California. He received multiple best paper and prize paper awards from the IEEE Power and Energy Society General Meetings, IEEE Power and Energy Society Grand International Conference and Exposition Asia and the Second International Conference on Green Communications, Computing and Technologies.

Dr. Yu is the director of Energy, Economics, and Environment Research Center at UC Riverside. Dr. Yu is also a cooperating faculty member of department of computer science and engineering and department of Statistics. He currently serves as the chair of distribution system operation and planning subcommittee of IEEE Power and Energy Society and the chair for IEEE Power and Energy Society Working group of data-driven modeling, monitoring and control for Power Distribution Networks. Dr. Yu currently serves as the associate editor for IEEE Transactions on Smart Grid and IEEE Power Engineering Letters.

Dr. Koji Yamashita is an accomplished professional in the realm of power systems, boasting extensive expertise and a rich background. Holding a Ph.D. in Electrical and Computer Engineering from Michigan Technological University, USA, he built upon his foundational B.S. and M.S. degrees in Electrical Engineering from Waseda University, Japan.

Actively engaged on the international stage, Dr. Yamashita has presented his insights at CIGRE events, receiving commendation for his discussions on load modeling and renewable energy integration. His commitment led to the establishment of a pioneering working group within CIGRE, spearheading research on renewable energy modeling techniques and system stability analysis. The resulting findings, disseminated through numerous publications in multiple languages, have significantly advanced the global understanding of renewable energy integration.

His impactful work, comprising 24 journal articles and 2 book chapters, positions Dr. Yamashita as an authority in power system engineering. His research has not only contributed to academic knowledge but has also influenced industry practices. Currently, he serves as an associate editor for IEEE Transactions on Power Systems, furthering the dissemination of cutting-edge research in the field.

Participants will need access to an internet connection from a standard desktop/laptop computer equipped with speakers, microphone and common web browser, i.e. Internet Explorer, FireFox, Google Chrome, etc. Students will join live, synchronous web conference sessions via WebEx, with two-way voice capability through a telephone bridge.

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