EPRI

# GridEd

The Center for Grid Engineering Education

# *Machine Learning Applications for Time Series Data in Power Systems - a Hands-on Training for Practitioners - 22 PDH's*

## 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.

This 22-hour course focuses on machine learning applications for time series data in power systems that data scientists deal with in their everyday jobs. This includes feature selection, data preprocessing, building machine learning models, training models, tuning hyper-parameters, calculating performance metrics and refining models. The application discussed in the course is related to building and training a model to deal with electric load data. The implementation of the machine learning models to perform time series data analytics using Python will be covered in this hands-on short course.

Participants will learn how to build machine learning models to perform forecasting tasks for time series data and 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 time series applications. Prior knowledge of Python is required and a basic understanding of data science and deep learning are suggested. A basic familiarity with open source libraries such as PyTorch, TensorFlow, and Scikit-Learn are also recommended but not required.

## Registration Information

**Dates and Times:**

**Week 1: 4 hours classroom + assignment time**
September 25 (Monday) 9 am – 12 pm PST.
September 29 (Friday) 11 am – 12 pm PST.

**Week 2: 3 hours classroom + assignment time.**
October 2 (Monday) 1 pm – 3 pm PST.
October 6 (Friday) 11 am – 12 pm PST.

**Week 3: 3 hours classroom + assignment time.**
October 9 (Monday) 9 am – 11 am PST.
October 13 (Friday) 11 am – 12 pm PST.

**Week 4: 1 hour classroom**
October 16 (Monday) 9 am – 10 am PST.

- **Discounts Available*:**
- **20% discount for organizations sending three or more staff**
- **25% discount for government workers (non-utility)**
- **25% discount for college professors***
- **75% discount for graduate students***

  ***University ID required**
  ***Email afeser@epri.com to inquire further.**

**Location:** Online - Live sessions will be recorded and available following the live web conference.

**Fee:** $2200, **Register at: EPRI | U**

**Course Instructors:**

Dr. Nanpeng (Eric) Yu, nyu@ece.ucr.edu

Dr. Wenyu Wang, wwang032@ucr.edu

**Course Coordinator:**

Amy Feser, afeser@epri.com

**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. Sessions will be recorded and provided for 4 weeks for later viewing.**

## Meet the Instructors

**Nanpeng (Eric) Yu** is an Associate Professor in the Electrical and Computer Engineering department at the University of California, Riverside. His research interests are big data analytics and machine learning in smart grid, electricity market design and optimization, distributed energy resources integration, and smart cities. Prior to joining UCR, Dr. Yu was a senior power system planner and project manager for demand response integration at Southern California Edison. Dr. Yu has published more than 80 papers in archival journals and international conference proceedings. Dr. Yu is a senior member of the IEEE. Dr. Yu serves as the vice-chair of distribution system planning and operation subcommittee and the chair of data-driven modeling, monitoring, and control working group of I EEE Power and Energy Society.

Dr. Yu received his M.Sc. in Electrical Engineering and Economics, and Ph.D. degree in Electrical Engineering from Iowa State University. Dr. Yu is the director of Energy, Economics and Environment Research Center at University of California, Riverside. Professor Yu has been awarded over 9 million of research and development funding from National Science Foundation, Department of Energy, California Energy Commission, National Renewable Energy Laboratory, and Electric utility companies. He is also a cooperating faculty member of the department of computer science and department of Statistics. Dr. Yu currently serves as the associate editor for IEEE Transactions on Smart Grid, IEEE Transactions on Sustainable Energy, and International transactions on Electrical Energy Systems.

Dr. Yu is the recipient of the Regents Faculty Fellowship and Regents Faculty Development award from University of California. His received several best paper awards from IEEE Power and Energy Society Grand International Conference and Exposition Asia, the Second International Conference on Green Communications, Computing and Technologies and IEEE Power and Energy Society General Meeting.

Dr. Wenyu Wang received the B.E. degree in automation from Zhejiang University, Hangzhou, China, in 2011, the M.S. degree in electrical and computer engineering from Iowa State University, Ames, IA, USA, in 2015, and the Ph.D. degree in electrical engineering from the University of California, Riverside, CA, USA, in 2021. He is currently a Postdoctoral Scholar with the Department of Electrical and Computer Engineering, University of California. His current research interests include data analytics and machine learning applications in smart grid.



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| Course Schedule | |
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| Week | Activities |
| 1 | ***Topic***<br>Electric Load Forecasting with Feed-forward Neural Network – Model Development |
| | ***Hands-on Problem***<br>Day-ahead Forecast of Electric Load |
| | ***Day 1 (3hrs total) – 1.5hr presentation + 1.5hr code walkthrough***<br>• Overview of feed-forward neural network (FFNN) and load forecasting problem<br>• Types of load forecasting methods<br>• Data preprocessing<br>• Deep neural network-based model<br>• Problem setup and dataset<br>• Assignment walk-through |
| | ***Day 2 (1hr)***<br>Assignment Q&A and discussion |
| | ***Assignment (3hrs)***<br>Build a FFNN-based regression model for load forecasting using a publicly available dataset<br>*Complete sections of code to train the baseline FFNN model.* |
| 2 | ***Topic***<br>Electric Load Forecasting with FFNN – Model Refinement & Assessment |
| | ***Hands-on Problem***<br>Visualize performance and compute metrics for training and assessing regression models |
| | ***Dataset: Validation and Testing dataset*** |
| | ***Day 1 (2hrs total) – 1 hr presentation + 1hr code walkthrough***<br>• Saving and loading models<br>• Metrics assess performance<br>• Hyper-parameter tuning<br>• Loss curve and prevention of overfitting<br>• Assignment walk-through |
| | ***Day 2 (1hr)***<br>Assignment Q&A and discussion |
| | ***Assignment (2hrs)***<br>Run forecasting model on a test dataset and submit the code and forecasting results.<br>Compare performance with existing ARIMA or linear/nonlinear regression model.<br>*The submission file will be evaluated* |

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| 3 | ***Topic***<br>Electric Load Forecasting with Recurrent Neural Network – Model Development |
| | ***Hands-on Problem***<br>Day-ahead Forecast of Electric Load |
| | ***Day 1 (2hrs total) – 1 hr presentation + 1 hr code walkthrough***<br>• Recurrent neural network overview<br>• Long short-term memory model<br>• Problem in context<br>• Assignment walk-through |
| | ***Day 2 (1hr)***<br>*Assignment Q&A and discussion* |
| | ***Assignment (3hrs)***<br>Build a LSTM-based regression model for load forecasting using a publicly available dataset<br>*Complete sections of code to train the LSTM model.* |
| 4 | ***Topic***<br>Electric Load Forecasting with Recurrent Neural Network – Model Refinement & Assessment |
| | ***Hands-on problem***<br>Visualize performance and compute metrics for training and assessing regression models |
| | ***Dataset: Validation and Testing dataset*** |
| | ***Day 1 (1hr)***<br>• Metrics<br>• Visualize and log results<br>• Hyper-parameter tuning<br>• Assignment walk-through |
| | ***Day 2 (1hr)***<br>• Assignment walk-through |
| | ***Assignment (2hrs)***<br>Run forecasting model on a test dataset and submit the code and forecasting results.<br>Compare performance with existing ARIMA or linear/nonlinear regression model.<br>*The submission file will be evaluated* |