Indian Institute of Technology, Kanpur

PHY 654 Machine learning in particle physics

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Number of Lectures per week: 3 Lectures [Tutorial: 0, Laboratory: 0]
Credits: 9
Duration of the course: Full Semester

Content of the course

Introduction to machine learning (12 lectures): Supervised vs unsupervised learning, Logistic regression, Binary classification, Cost function, Gradient descent, Vectorisation, Support Vector Machine (SVM), Example usage of SVM in particle physics, K-Means Algorithm, Principal Components Analysis, Anomaly detection.

Deep Neural Network (11 lectures): Hidden layer, Activation function, Forward and backward propagation, Hyperparameter Tuning, Regularization and Optimization, TensorFlow, End-to-end deep learning, Autoencoders, Example usage of neural networks in particle physics.

Convolutional Neural Networks (10 lectures): Edge detection, Padding, Pooling, Residual Network (ResNet), Example usage of ResNet in particle physics, Yolo algorithm, Neural style transfer, Generative Models, Graph Neural Networks.

Sequence Models (6 lectures): Recurrent neural network (RNN), Gated recurrent unit, Long short term memory unit, Example usage of RNN in particle physics.

Recommended Books

- The Elements of Statistical Learning: Data Mining, Inference, and Prediction, by Trevor Hastie, Robert Tibshirani, Jerome Friedman.
- Introduction to Deep Learning: From Logical Calculus to Artificial Intelligence, by Sandro Skansi.
- Neural Networks and Deep Learning: A Textbook, by Charu C. Aggarwal.
- Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow by Aurélien Géron.
- Artificial Intelligence for High Energy Physics by by Paolo Calafiura, David Rousseau, Kazuhiro Terao.
- Deep Learning for Physics Research, by Martin Erdmann, Jonas Glombitza, Gregor Kasieczka, Uwe Klemrad.
- Deep Learning, by Ian Goodfellow, Yoshua Bengio, Aaron Courville.
- Machine Learning: A Probabilistic Perspective, by Kevin P. Murphy.