NEURAL NETWORKS FOR SIGNAL PROCESSING – I

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TYPE OF COURSE : New | Elective | PG
COURSE DURATION : 12 weeks (29 Jul'19 - 18 Oct'19)
EXAM DATE : 17 Nov 2019

PRE-REQUISITES : Basic mathematical background in probability, linear algebra, signals and systems or equivalent
INTENDED AUDIENCE : Graduate level, Senior UG students, Engineers and scientists of related industry
INDUSTRIES APPLICABLE TO : AI based, machine learning based industries

COURSE OUTLINE :

This will be an introductory graduate level course in neural networks for signal processing. It would be part-I of a III part series on neural networks and learning systems that the instructor intends to introduce The course starts with a motivation of how the human brain is inspirational to building artificial neural networks. The neural networks are viewed as directed graphs with various network topologies towards learning tasks driven by optimization techniques.

ABOUT INSTRUCTOR :

Prof. Shayan Garani Srinivasa is an Assistant Professor at the Department of Electronics Systems Engineering, Indian Institute of Science. He earned his PhD from Georgia Institute of Technology. He is chairing IEEEDSTC award committee and Photonic Detection, Optical Society of America.

COURSE PLAN :

Week 1: Introduction, Human brain, models of a neuron, Neural communication, Neural networks asdirected graphs, network architectures (feed-forward, feedback etc.), knowledge representation.

Week2: Learning processes, Learning tasks, Perceptron, Perceptron convergence theorem, relationship between perceptron and Bayes classifiers, Batch perceptron algorithm

Week3: Modeling through regression, Linear and logistic regression for multiple classes.

Week4: Multilayer perceptron, Batch and online learning, derivation of the back propagation algorithm,XOR problem, Role of Hessian in online learning, annealing and optimal control of learning rate

Week5: Approximations of functions, Cross-validation, Network pruning and complexity regularization, convolution networks, non-linear filtering

Week6: Cover's theorem and Pattern separability, The interpolation problem, RBF networks,Hybrid learning procedure for RBF networks, Kernel regression and relationship to RBFs.

Week7: Support vector machines, Optimal hyperplane for linear separability, Optimal hyperplane for nonseparable patterns, SVM as a kernel machine, Design of SVMs, XOR problem revisted revisted, robustness considerations for regression

Week 8: SVMs contd. Optimal solution of the linear regression problem, Representer theorem and related discussions. Introduction to regularization theory

Week 9: Hadamard's condition for well-posedness, Tikhonov regularization, Regularization networks, generalized RBF networks, Estimation of regularization parameter etc.

Week 10: L1 regularization basics, algorithms and extensions

Week 11: Principal component Analysis: Hebbian based PCA, Kernel based PCA, Kernel Hebbian algorithm

Week 12: Deep multi-layer perceptrons, Deep autoencoders and stacked denoising auto-encoders.