Pattern Recognition and Neural Networks - Video course

COURSE OUTLINE

Introduction to pattern recognition, introduction to classifier design and supervised learning from data, classification and regression, basics of Bayesian decision theory, Bayes and nearest neighbour classifiers, parametric and non-parametric estimation of density functions, linear discriminant functions, Perceptron, linear least-squares regression, LMS algorithm.

Fisher linear discriminant, introduction to statistical learning theory and empirical risk minimization, non-linear methods for classification and regression, artificial neural networks for pattern classification and regression, multilayer feedforward networks, backpropagation, RBF networks, Optimal separating hyperplanes, Supoort Vector Machines and some variants, Assessing generalization abilities of a classifier, Bias-variance trade-off, crossvalidation, bagging and boosting, AdaBoost algorithm, brief discussion of feature selection and dimensionality reduction methods.

The course is designed for graduate students (i.e. first year ME or research students). The course is intended to give the students a fairly comprehensive view of fundamentals of classification and regression. However, not all topics are covered.

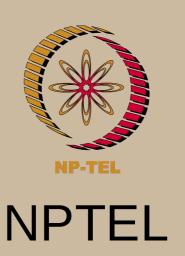
For example, we do not discuss Decision tree classifiers. Also, the course deals with neural networks models only from the point of view of classification and regression. For example, no recurrent neural network models (e.g., Boltzman machine) are included. The main reason for leaving out some topics is to keep the course content suitable for a one semester course.

COURSE DETAIL

Module1 - Overview of Pattern classification and regression

Lecture 1 - Introduction to Statistical Pattern Recognition

- Lecture 2 Overview of Pattern Classifiers
- Module2 Bayesian decision making and Bayes Classifier
- Lecture 3 The Bayes Classifier for minimizing Risk
- Lecture 4 Estimating Bayes Error; Minimax and Neymann-



http://nptel.iitm.ac.in

Electronics & Communication Engineering

Pre-requisites:

1. Probability Theory Some knowledge of optimization methods.

Additional Reading:

1. C.M. Bishop, "Pattern Recognition and Machine Learning", Springer, 2006.

Coordinators:

Prof. P.S. Sastry Department of Electrical EngineeringIISc Bangalore Pearson classifiers

Module3 - Parametric Estimation of Densities

Lecture 5 - Implementing Bayes Classifier; Estimation of Class Conditional Densities

Lecture 6 - Maximum Likelihood estimation of different densities

Lecture 7 - Bayesian estimation of parameters of density functions, MAP estimates

Lecture 8 - Bayesian Estimation examples; the exponential family of densities and ML estimates

Lecture 9 - Sufficient Statistics; Recursive formulation of ML and Bayesian estimates

Module4 - Mixture Densities and EM Algorithm

Lecture 10 - Mixture Densities, ML estimation and EM algorithm

Lecture 11 - Convergence of EM algorithm; overview of Nonparametric density estimation

Module5 - Nonparametric density estimation

Lecture 11 - Convergence of EM algorithm; overview of Nonparametric density estimation

Lecture 12 - Nonparametric estimation, Parzen Windows, nearest neighbour methods

Module6 - Linear models for classification and regression

Lecture 13 - Linear Discriminant Functions; Perceptron --Learning Algorithm and convergence proof

Lecture 14 - Linear Least Squares Regression; LMS algorithm Lecture 15 - AdaLinE and LMS algorithm; General nonliner

least-squares regression

Lecture 16 - Logistic Regression; Statistics of least squares method; Regularized Least Squares

Lecture 17 - Fisher Linear Discriminant

Lecture 18 - Linear Discriminant functions for multi-class case; multi-class logistic regression

Module7 - Overview of statistical learning theory, Empirical Risk Minimization and VC-Dimension

Lecture 19 - Learning and Generalization; PAC learning framework

Lecture 20 - Overview of Statistical Learning Theory; Empirical Risk Minimization

Lecture 21 - Consistency of Empirical Risk Minimization

Lecture 22 - Consistency of Empirical Risk Minimization; VC-Dimension

Lecture 23 - Complexity of Learning problems and VC-Dimension

Lecture 24 - VC-Dimension Examples; VC-Dimension of hyperplanes

Module8 - Artificial Neural Networks for Classification and regression

Lecture 25 - Overview of Artificial Neural Networks Lecture 26 - Multilayer Feedforward Neural networks with Sigmoidal activation functions;

Lecture 27 - Backpropagation Algorithm; Representational abilities of feedforward networks

Lecture 28 - Feedforward networks for Classification and

Regression; Backpropagation in Practice Lecture 29 - Radial Basis Function Networks; Gaussian RBF networks Lecture 30 - Learning Weights in RBF networks; K-means clustering algorithm Module9 - Support Vector Machines and Kernel based methods Lecture 31 - Support Vector Machines Introduction, obtaining the optimal hyperplane Lecture 32 - SVM formulation with slack variables; nonlinear SVM classifiers Lecture 33 - Kernel Functions for nonlinear SVMs; Mercer and positive definite Kernels Lecture 34 - Support Vector Regression and ε-insensitive Loss function, examples of SVM learning Lecture 35 - Overview of SMO and other algorithms for SVM; v -SVM and v-SVR; SVM as a risk minimizer Lecture 36 - Positive Definite Kernels; RKHS; Representer Theorem Module10 - Feature Selection, Model assessment and cross-validation Lecture 37 - Feature Selection and Dimensionality Reduction; Principal Component Analysis Lecture 38 - No Free Lunch Theorem; Model selection and model estimation; Bias-variance trade-off Lecture 39 - Assessing Learnt classifiers; Cross Validation;	
Module11 - Boosting and Classifier ensembles Lecture 40 - Bootstrap, Bagging and Boosting; Classifier Ensembles; AdaBoost Lecture 41 - Risk minimization view of AdaBoost	
References:	
1. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley, 2002.	
2. C.M.Bishop, Neural Networks and Pattern Recognition, Oxford University Press (Indian Edition), 2003.	
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