"Statistical Pattern Recognition"

Objectives and outcomes

The concept of pattern recognition has been recognized as an important factor in the design and analysis of modern computerized information system. The applicability of such design and analysis is observed in varied field such as engineering, computer science, information science, statistics, biology, medicine, linguistics, and psychology. ***The course could cater a wide audience*** *from computer science, electrical, electronics & communication and information technology departments. This course is aiming towards the study of automatic pattern recognition and classification techniques. Starting from the Bayesian decision theory, the concept of classifier, both supervised and unsupervised, will be covered. The concept and the study of feature evaluation and indexing will also be covered. Some advanced topics such as graphical models and kernel based techniques will also be discussed. After completing the course, the students may expect to have the knowledge needed to read and understand the more advanced topics and current research literature, and the ability to start academic research.*

Prerequisite

Basic Mathematics - Knowledge of and ability to use calculus, analytical solid geometry and linear algebra (matrix theory) is essential. Knowledge of elementary probability theory will also be needed.

Basic Topics

1. ***Quick review of probability theory (5h)***
   Axiomatic definition of probability, conditional probability (Bayes rule), concept of random variables, single variate Normal distribution, multivariate Normal distribution
2. ***Bayesian decision rule (7h)***
   Bayesian decision rule under Normality assumption, minimum distance classifier, Bayesian decision rule for minimum risk
3. ***Nearest neighbour decision rule (2h)***
   Nearest neighbour for density estimation, nearest neighbour classifier
4. ***Unsupervised classification rule (5h)***
   M-means algorithm, Linkage algorithm, ISODATA method
5. ***Feature selection (2h)***
   Optimal, Sub-optimal

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Advanced Topics

6. ***Mixture models and parameter estimation (6h)***
   Maximum Likelihood, Expectation Maximization, Bayesian learning
7. ***Graphical Models (4h)***
   Bayesian Networks representation, parameter learning, structure learning
8. ***Kernel Methods (4h)***

Constructing kernels, Radial Basis Function, maximum margin classifiers (SVM)

Assignments:

1. *Simulation of generating Gaussian probability density function (single, multivariate and mixture)*
2. *Simulation of Bayes decision rule for different mixture probability density functions*
3. *Applying NN classifier for bench mark data (IRIS)*
4. *Applying M-Means classifier for bench mark data (IRIS)*
5. *Parameter estimation of mixture models for simulated data (mostly Gaussian)*
6. *Solving small problems using Bayesian network toolbox in MATLAB*
7. *Applying SVM in real data*

Books/References

1. *R. O. Duda, P. E. Hart and D. G. Stork, Pattern Classification, John Wiley, NY, 2006.*
2. *C. M. Bishop, Pattern Recognition and Machine Learning, Springer, 2006.*
3. *N. Sebe, I. Cohen, A. Garg, T.S. Huang, Machine learning in computer vision, Springer, 2005*

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