

# CS6464: Concepts In Statistical Learning Theory

Jan-May Semester 2019

‘K’ Slot; CS 36

**Slots: Wed (1525–1640 HRS), Fri (1400–1515 HRS),**

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Note: The course webpage is [http://www.cse.iitm.ac.in/~vplab/statistical\\_learning\\_theory.html](http://www.cse.iitm.ac.in/~vplab/statistical_learning_theory.html). A google group will be formed for course related communications; please check the e-mail regularly.

## 1 Course Objectives

In the recent past, algorithms of solving many ill-posed problems in the field of multi-dimensional signal processing and big data analytics have gained importance. New methods of signal representation, modeling, optimization and learning have been formulated, which spans over various areas of Machine Learning, Pattern Recognition, Vision and Natural Language Processing. This course will provide an overview of the theories and current practices, required by students and scholars who intend to specialize in this field, to solve complex problems in Machine Learning Applications for image, video, text and bioinformatics.

- To study few optimization methods used to estimate the parameters of a model during training.

## 3 Course prerequisite(s)

CS5011 or equivalent preferable.

## 4 Classroom Mode

Traditional Lectures ( $2 \times [1 \text{ hr. } 15 \text{ mins. slots}]$ ). Tutorials will be taken outside class hours (Tuesday or Saturday preferably). Tutorial problems have to be solved in class.

## 2 Learning Outcomes

- To learn existing statistical algorithms of Machine Learning (ML) and Pattern Recognition (PR).
- To understand the difference between Classification and Regression.
- To be aware of recent advances in the field of ML such as Online Learning, Transfer Learning etc.
- To have hands-on experience in implementing various ML and PR techniques on different datasets.
- To learn how statistical distribution in datasets affect performance of ML and PR techniques.
- To learn to compare the performance of two learning systems.

## 5 Textbooks

- T. Hastie, R. Tibshirani, J. Friedman, “The Elements of Statistical Learning: Data Mining, Inference and Prediction”, Springer Series in Statistics, 2009.
- V. N. Vapnik; “Statistical Learning Theory”, Wiley, 1998.

## 6 Reference Books

- Journal of the Royal Statistical Society: Series B (Statistical Methodology).
- Foundations and Trends in Machine Learning; Now Publishers Inc.
- Journal of Machine Learning Research; JMLR, Inc. and Microtome Publishing (United States).

- Christopher M. Bishop, “Pattern recognition and machine learning”, Springer, 2006.
- Conference Proceedings of ICML, NIPS, ICLR.
- Kevin P. Murphy, “Machine Learning, a Probabilistic Perspective”, MIT Press, 2012.

## 7 Course Requirements

You are required to attend all the lectures. If you miss any of them it is your responsibility to find out what went on during the classes and to collect any materials that may be handed out.

Class participation is strongly encouraged to demonstrate an appropriate level of understanding of the material being discussed in the class. Regular feedback from the class regarding the lectures will be very much appreciated.

## 8 Planned Syllabus

- Learning Problem, Risk functions, Statistical Decision Theory.
- Ill posed and well posed problems.
- Least Square Regression, Bias Variance tradeoff.
- ERM (+Tikhonov Regularization), Iterative regularization by early stopping, SRM.
- Linear Models of Regression, Subset Selection methods, Shrinkage methods, Ridge regression.
- LASSO, LAR
- Bag-of-Words, Online Learning and Transfer Learning.
- SVM, Kernel, VC dimension, RKHS
- ADMM, Proximal gradient

## 9 Tentative Grading Policy

The following allocation of points is tentative. These may change during the semester.

End Sem	35-40
Mid Sem	15-20
Tutorials $\times$ [5]	15-20
Software Assignments $\times$ [2]	25-30
<b>Total</b>	<b>100</b>

## 10 Tentative Dates

The following allocation of points is tentative. These may also change during the semester.

Tutorial Dates	29/01/2019, 12/02/2019, 26/02/2019, 22/03/2019, 06/04/2019, 23/04/2019
Software Assignment 1 Announcement	23/01/2019
Software Assignment 1 Deadline	25/02/2019
Software Assignment 2 Announcement	21/02/2019
Software Assignment 2 Deadline	22/04/2019
Extra Classes	16/03/2019 (11:00-12:30) 20/04/2019 (11:00 - 12:30)
Mid Semester Exam	12/03/2019 (17:00-18:00)
End Semester Exam	27/04/2019 (09:00-12:00)

## 11 Academic Honesty

Academic honesty is expected from each student participating in the course. NO sharing (willing, unwilling, knowing, unknowing) of assignment code between students, submission of downloaded code (from the Internet, Campus LAN, or anywhere else) is allowed.

Academic violations will be handled by IITM Senate Discipline and Welfare (DISCO) Committee. Typically, the first violation instance will result in ZERO marks for the corresponding component of the Course Grade and a drop of one-penalty in overall course grade. The second instance of code copying will result in a 'U' Course Grade and/or other penalties. The DISCO Committee can also impose additional penalties.

Please protect your Moodle account password. Do not share it with ANYONE. Do not share your academic disk drive space on the Campus LAN.

Each proxy in the attendance will be penalized by 5% of (absolute) marks. It becomes 2% each for the donor & beneficiary, if both accept the fault.

**Tutorials are not exams. Occasional exchange of technical ideas is permitted, but not copying. No complaints of copying will be entertained after the tutorial. If you find anybody copying, inform the TAs present immediately. If guilty, their copies will be taken away and they will be marked 0 for that tutorial.**