CS5590 Foundations of Machine Learning

Instructor: J. SakethaNath

July 31, 2022

About the course

This is the basic foundations course on machine learning for CSE students. The course assumes no prior exposure to machine learning. However, it assumes the student has good understanding of basic engineering math subjects like probability & statistics, linear algebra, multivariate Calculus etc.

The focus of this course is on understanding basic principles and concepts, rather than on giving a hands-on overview of state-of-the-art. Students interested in the later are encouraged to credit the "Applied ML" course.

The syllabus of this course is:

1. Overview of machine learning, challenges, terminology and definitions, Supervised Learning (6 hrs)

2. Basic probabilistic and non-probabilistic models:

    (a) Loss composed Linear Models and parameter estimation using ERM (4 hrs)

    (b) Generative models and parameter estimation using method of moments, maximum likelihood (3hrs)

    (c) Discriminative models and maximum conditional likelihood estimation (2 hrs)

3. Generalized models:

    (a) Exponential models, and kernel methods (3 hrs)

4. Model selection (1.5 hrs)

5. Non-parametric modeling (3 hrs)

    (a) k-NN, KDE

    (b) variants for generative, discriminative classification and regression

6. Unsupervised Learning (3 hrs)

    (a) 1-class SVM, SVC

(b) Mixture models, EM algorithm, k-means

7. Representation Learning (9 hrs)

    (a) PCA, probabilistic PCA, supervised PCA,

    (b) neural networks and SGD

8. Online Learning (2 hrs)

9. Reinforcement Learning (4.5 hrs)

10. Other popular paradigms: Boosting, Bagging, trees (3 hrs)

References

The textbooks for this course are:

1. For probabilistic models and neural networks [1][1].

2. For kernel methods [2].

3. In general, part2 and part 3 of [3][2].

Evaluation

Date	Name & Duration	Percentage
06-Sep-2022 (Tue)	Quiz-1 7pm-8:30pm (90 min.)	15% (Closed book/laptop; No cheat-sheets)
19-Oct-2022 (Wed)	Quiz-2 7pm-8:30pm (90 min.)	15% (Closed book/laptop; No cheat-sheets)
1-Dec-2022 (Thu)	EndSem 9:30am-12:30pm (3hrs.)	40% (Closed book/laptop; No cheat-sheets)
End of Segment	6 Assignments	12%
1-Dec-2022 (Thu)	Coding Exam 2:30pm-8:30pm (2hrs)	18% (Closed book/laptop; No cheat-sheets)

Tutorial sessions will be conducted for help in assignments.

Contact

The course page is at http://www.iith.ac.in/ saketha/teaching/cs5590.html. All official communication and technical interactions outside lecture hours will be through Google classroom: "4accobi". The instructor can be contacted via email: saketha at iith. The typical working hours of the instructor are 9am to 12:30pm and 2:30pm to 5:30pm. His office is C-519. You are welcome to drop-by anytime for clarifying doubts during these working hours. Technical interaction (outside and in lecture hours) is highly encouraged.

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[1]Available at https://probml.github.io/pml-book/book1.html.
[2]This is freely available at https://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/understanding-machine-learning-theory-algorithms.pdf.

References

[1] Kevin P. Murphy. *Probabilistic Machine Learning: An introduction.* MIT Press, 2022.

[2] Bernhard Scholkopf and Alexander J. Smola. *Learning with Kernels: Support Vector Machines, Regularization, Optimization, and Beyond.* MIT Press, Cambridge, MA, USA, 2001.

[3] Shai Shalev-Shwartz and Shai Ben-David. *Understanding Machine Learning: From Theory to Algorithms.* Cambridge University Press, New York, NY, USA, 2014.