# Course Trivia

Instructor:

Preethi Jyothi, Office hours: 5 pm to 6 pm (Wed) Venue: 221 CC

Teaching Assistants / Office hours:  
(Note: TAs can all be reached via MS Teams)  
  
Tejomay Kishore Padole, Tue 2:30 pm to 3:30 pm, CFILT (New CSE building, CC 401)   
Prateek Chanda, Fri 5:30 pm to 6:30 pm, New CSE building, CC 101  
Poulami Ghosh, Thu 6 pm to 7 pm, CFILT (New CSE building, CC 401)   
Darshan Prabhu, Mon 10 am to 11 am, New CSE building, CC 402  
Sona Elza Simon, Wed 4 pm to 5 pm, CMInDS Lab, KreSIT 4th floor  
Sameer Anil Pimparkhede, Mon 2 pm to 3 pm, CFILT (New CSE building, CC 401)   
Soumen Kumar Mondal, Tue 11:30 am to 12:30 pm, CMInDS seminar room, KreSIT 4th floor  
A. Snegha, Thu 2 pm to 3 pm, CMInDS Lab, KreSIT 4th floor

# Evaluation/Grading

* Two Programming Assignments (10 + 13 = 23%)
* Project (12%)
* Midsem Exam (25%)
* Final Exam (35%)
* Moodle Quizzes/Participation (5%)

# Resources

Probability and linear algebra for ML, and other resources:

* <https://www.deeplearningbook.org/> (Part I)
* [Review of basics in linear algebra](http://www.ekof.bg.ac.rs/wp-content/uploads/2016/09/Ponavljanje-matematike-Wayne-Winston-Operations-Research-Applications-and-Algorithms-4-edition.pdf)
* [Review of basics in probability](https://see.stanford.edu/materials/aimlcs229/cs229-prob.pdf)
* [Excellent animated explanations of concepts in linear algebra](https://www.3blue1brown.com/essence-of-linear-algebra-page)
* [Some practice problems in probability and linear algebra](https://moodle.iitb.ac.in/pluginfile.php/113650/mod_label/intro/PSet-Prob-LA.pdf)

Books for ML:

* [Understanding Machine Learning](http://www.cs.huji.ac.il/~shais/UnderstandingMachineLearning/) (Shai Shalev-Shwartz and Shai Ben-David. Cambridge University Press. 2017)
* [The Elements of Statistical Learning](https://web.stanford.edu/~hastie/ElemStatLearn/) (Trevor Hastie, Robert Tibshirani and Jerome Friedman. Second Edition. 2009)
* [Pattern Recognition and Machine Learning](https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf) (Christopher Bishop. Springer. 2006)
* [Mathematics for Machine Learning](https://mml-book.github.io/book/mml-book.pdf) (Marc Peter Deisenroth, A. Aldo Faisal, Cheng Soon Ong. 2020)

Practice Problems:

* [Tutorial problems from past iterations (2019-2022)](https://moodle.iitb.ac.in/pluginfile.php/113650/mod_label/intro/Tutorialproblems.pdf?time=1724916392398)
* [All practice problems from class (2024)](https://moodle.iitb.ac.in/pluginfile.php/113650/mod_label/intro/Practice-Qs.pdf?time=1730978869786)
* [Quiz-1 from CS725 (2022)](https://moodle.iitb.ac.in/pluginfile.php/113650/mod_label/intro/CS725_2022_Quiz1.pdf) ([Solution sketches](https://moodle.iitb.ac.in/pluginfile.php/113650/mod_label/intro/CS725_2022_Quiz1_solutions.pdf))
* [Midsem from CS725 (2022)](https://moodle.iitb.ac.in/pluginfile.php/113650/mod_label/intro/CS725_2022_Midsem.pdf) ([Solution sketches](https://moodle.iitb.ac.in/pluginfile.php/113650/mod_label/intro/CS725_2022_Midsem_solutions.pdf))
* [Endsem from CS725 (2022)](https://moodle.iitb.ac.in/pluginfile.php/113650/mod_label/intro/CS725_2022_Endsem.pdf) ([Solution sketches](https://moodle.iitb.ac.in/pluginfile.php/113650/mod_label/intro/CS725_2022_Endsem_Solutions.pdf))

# Prerecorded Video Lectures (2021)

* Basics of probability and linear algebra for ML: [Prob-1](https://drive.google.com/file/d/16mlPRqjpxqR_41qyoXwJOB-k5d00e6iB/view?usp=sharing) / [Prob-2](https://drive.google.com/file/d/17AcGRSL9hWAzJoHYVkPHGW15gJdwrFHH/view?usp=sharing) / [LA-1](https://drive.google.com/file/d/12yfxTZkUOrcbVnQhZlGIkzspMcmke_At/view?usp=sharing) / [LA-2](https://drive.google.com/file/d/1YyGD95NLwrmR4CY8r4fcym2dsNJB6RsF/view?usp=sharing)
* Linear Regression: [Introduction](https://drive.google.com/file/d/1gDQtUazi5avbDohfZikyZzO1OcuImG6b/view?usp=sharing) / [Basis functions/Geometrical Interpretation](https://drive.google.com/file/d/1pbkUtsN3xTWkPVWOqGVgP_5t2XvtiMWg/view?usp=sharing) / [Probabilistic Interpretation/Gradient Descent](https://drive.google.com/file/d/1AEHIYJdGalKbnZ-NMT7vMtcOArELKGE7/view?usp=sharing)
* Linear Regression (contd): [MAP estimation, Conjugate Priors](https://drive.google.com/file/d/1-f2BfiFD7J8Udlodov6_ENZg2VGS7sQg/view?usp=sharing) / [Bias and Variance](https://drive.google.com/file/d/1DeQS5TZV0gZBudI10XZuboEw7zZLnjdv/view?usp=sharing) / [Regularized Linear Regression (Ridge and Lasso Regression)](https://drive.google.com/file/d/15ENzAkADMc3Fv5FqUSuHmiwSPv6jRg7q/view?usp=sharing)
* Linear Classification: [Naive Bayes Classification (NB)](https://drive.google.com/file/d/1ZcjYkCBP4fMJmfTPVN_Aec4sVMiqw39x/view?usp=sharing) / [Logistic Regression (LogR)](https://drive.google.com/file/d/13L4VVt-BWG0L2vIofT7NIKqF-vkQadU5/view?usp=sharing) / [Relationship between NB and LogR](https://drive.google.com/file/d/1AoWHExFlM1nTkLk0F1n50TZJAKEhM8W2/view?usp=sharing)
* Decision Tree+Perceptron: [Perceptron Algorithm](https://drive.google.com/file/d/1C1ctwhqJZDtTgSzW1RY8ejUdxcZnHuUJ/view?usp=sharing) / [Decision Trees](https://drive.google.com/file/d/1TSCrKquYRz49iQ48PO3ipdlc5GVcI-CN/view?usp=sharing)
* Feedforward Neural Networks: [Introduction to NNs](https://drive.google.com/file/d/1vA4m93YSx6CKqSAXa6jhXbBc5g5bpPUn/view?usp=sharing) / [Backpropagation and Regularization of NNs](https://drive.google.com/file/d/1g0Gbbk-qazLhu9PMWvZfk37SYdA4XtBV/view?usp=sharing)
* Other NNs: [Recurrent NNs](https://drive.google.com/file/d/1oTGQOWZDIAi61ZyWnrKDsDDRjHnOKNb8/view?usp=sharing) / [Convolutional NNs](https://drive.google.com/file/d/1VoWMgOjREtQpEKaMGnE9KY9HKcdIZj-E/view?usp=sharing)
* Support Vector Machines and Kernel Methods: [SVMs](https://drive.google.com/file/d/1TvhcyA9uNapwkno3XQXeR-dH4vqEleL5/view) / [SVMs and Kernels](https://drive.google.com/file/d/1zOUYZHRhWWj6YUK-FLzD4reY2MXtdeb5/view)
* Clustering: [k-means clustering](https://drive.google.com/file/d/1hT8kD9heqhGz3DJszO8Haw_TglNfAxKg/view)
* Dimensionality Reduction: [PCA](https://drive.google.com/file/d/1r-5yPrYtHmBvopr7o6hYWJLhbNE8MUEx/view?usp=sharing) / [LDA](https://drive.google.com/file/d/1JliPRa7fMHHqF-XzxGcqgGZu-zhNywIz/view?usp=sharing)

# Project Abstracts (from previous years)

* [List of project abstracts from 2022](https://docs.google.com/spreadsheets/d/17JqQX7bxpp_7ZRmN1za1DE4biO_XMf7HYN7I0bIP4lg/edit?usp=sharing)
* [List of project abstracts from 2021](https://docs.google.com/spreadsheets/d/1g1JFQhK_9PLpJGfyBvhJtGAEXtweR5AdlO6gMG-8mEM/edit?gid=123101811#gid=123101811)

# Slides (Lectures 1, 2)

* + Lecture 1 (Introduction to Learning / Course Logistics): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/116045/mod_label/intro/lecture1.pdf?time=1722319933624))
  + Lecture 2 (Introduction to Linear Regression): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/116045/mod_label/intro/lecture2.pdf?time=1722784007709)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/116045/mod_label/intro/lec2_whiteboard.pdf))

# Reading (Linear Regression)

* + [[Book] Elements of Statistical Learning (Chapters 3.1, upto 3.2.1)](https://web.stanford.edu/~hastie/Papers/ESLII.pdf)
  + [Notes on Basis Functions by Ryan Adams, Princeton](https://www.cs.princeton.edu/courses/archive/fall18/cos324/files/basis-functions.pdf)
  + [Notes on Linear regression and Maximum Likelihood by Cosma Shalizi, CMU](http://www.stat.cmu.edu/~cshalizi/mreg/15/lectures/04/lecture-04.pdf)

Slides (Lectures 3, 4)

* Lecture 3 (Basis Functions / Gradient Descent for Linear Regression): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/120984/mod_label/intro/lec3.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/120984/mod_label/intro/lec3_whiteboard.pdf))
* Lecture 4 (Gradient Descent contd, Probabilistic model of regression): Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/120984/mod_label/intro/lec4_whiteboard.pdf))

Reading (Linear Regression)

* [[Book] Elements of Statistical Learning (Chapters 3.1, upto 3.2.1)](https://web.stanford.edu/~hastie/Papers/ESLII.pdf)
* [Notes on Basis Functions by Ryan Adams, Princeton](https://www.cs.princeton.edu/courses/archive/fall18/cos324/files/basis-functions.pdf)
* [Notes on Linear regression and Maximum Likelihood by Cosma Shalizi, CMU](http://www.stat.cmu.edu/~cshalizi/mreg/15/lectures/04/lecture-04.pdf)

Slides (Lecture 5)

* Lecture 5 (Regularization, Ridge/Lasso Regression, Introduction to MAP): Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/123885/mod_label/intro/lec5_whiteboard.pdf?time=1725173061114))

Reading (MLE, MAP, Bias/Variance)

* [[Book] Elements of Statistical Learning (Chapter 3.4)](https://web.stanford.edu/~hastie/Papers/ESLII.pdf)
* [Peter Robinson's slides on MLE vs. MAP](http://www.mi.fu-berlin.de/wiki/pub/ABI/Genomics12/MLvsMAP.pdf)
* [Sebastian Raschka's notes on Bias and Variance](https://sebastianraschka.com/pdf/lecture-notes/stat479fs18/08_eval-intro_notes.pdf)

Slides (Lectures 6, 7)

* Lecture 6 (Conjugate priors, MAP for LR, Bias/Variance of Predictors): Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/125075/mod_label/intro/lec6_whiteboard.pdf))
* Lecture 7 (Logistic Regression): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/125075/mod_label/intro/lecture7.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/125075/mod_label/intro/lec7_whiteboard.pdf))
* Solution to homework MLE/MAP question from lecture 6: [pdf](https://moodle.iitb.ac.in/pluginfile.php/125075/mod_label/intro/MLE-MAP-Q.pdf)

Reading (MLE, MAP, Bias/Variance)

* [[Book] Elements of Statistical Learning (Chapter 3.4)](https://web.stanford.edu/~hastie/Papers/ESLII.pdf)
* [Peter Robinson's slides on MLE vs. MAP](http://www.mi.fu-berlin.de/wiki/pub/ABI/Genomics12/MLvsMAP.pdf)
* [Sebastian Raschka's notes on Bias and Variance](https://sebastianraschka.com/pdf/lecture-notes/stat479fs18/08_eval-intro_notes.pdf)

Slides (Lectures 8, 9)

* Lecture 8 (Decision Tree Classifiers): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/127140/mod_label/intro/lecture8.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/127140/mod_label/intro/lec8_whiteboard.pdf))
* Lecture 9 (Decision Tree Classifiers contd): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/127140/mod_label/intro/lecture9.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/127140/mod_label/intro/lec9_whiteboard.pdf))

Reading (Logistic Regression, Decision Trees)

* [Book chapter on Logistic Regression](https://web.stanford.edu/~jurafsky/slp3/5.pdf), Dan Jurafsky and James Martin, "Speech and Language Processing"
* [Book chapter on Naive Bayes and Logistic regression,](https://www.cs.cmu.edu/~tom/mlbook/NBayesLogReg.pdf) Tom Mitchell, "Machine Learning"
* [Book chapter on Decision Trees](https://www.cs.princeton.edu/courses/archive/spr07/cos424/papers/mitchell-dectrees.pdf) by Tom Mitchell
* [Visualization of Bias and Variance using Decision Trees](http://www.r2d3.us/visual-intro-to-machine-learning-part-2/)

Assignment 1 Submission

Slides (Lectures 10, 11)

* Lecture 10 (Logistic Regression, Perceptron): Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/129660/mod_label/intro/lec10_whiteboard.pdf))
* Lecture 11 (Perceptron contd. + Midsem Prep): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/129660/mod_label/intro/lec11.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/129660/mod_label/intro/lec11_whiteboard.pdf))

Reading (Perceptron)

* [Book chapter on Logistic Regression](https://web.stanford.edu/~jurafsky/slp3/5.pdf), Dan Jurafsky and James Martin, "Speech and Language Processing"
* [Book chapter, "The Perceptron"](http://ciml.info/dl/v0_99/ciml-v0_99-ch04.pdf) by Hal Daume III

# MIDSEM EXAM

[Midsem exam (with solution sketches)](https://www.cse.iitb.ac.in/~pjyothi/cs725/midsem.pdf)

Slides (Lectures 12, 13)

* Lecture 12 (Introduction to Neural Networks): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/131518/mod_label/intro/lec12.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/131518/mod_label/intro/lec12_whiteboard.pdf))
* Lecture 13 (NNs training, Backpropagation): Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/131518/mod_label/intro/lec13_whiteboard.pdf))

Reading (Feedforward Neural Networks)

* [Deep Feedforward Networks (Chapter 6 of "Deep Learning" by Ian Goodfellow, Yoshua Bengio and Aaron Courville)](https://www.deeplearningbook.org/contents/mlp.html)

Slides (Lectures 14, 15)

* Lecture 14 (Backpropagation continued): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/132698/mod_label/intro/lec14.pdf))
* Lecture 15 (Optimizers): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/132698/mod_label/intro/lec15.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/132698/mod_label/intro/lec15_whiteboard.pdf))

Reading (Feedforward Neural Networks)

* + [Deep Feedforward Networks (Chapter 6 of "Deep Learning" by Ian Goodfellow, Yoshua Bengio and Aaron Courville)](https://www.deeplearningbook.org/contents/mlp.html)
  + [An Overview of Gradient Descent Optimization Algorithms (by Sebastian Ruder)](https://www.ruder.io/optimizing-gradient-descent/)

Slides (Lectures 16, 17)

* Lecture 16 (Convolutional Neural Networks): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/133328/mod_label/intro/lec16.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/133328/mod_label/intro/lec16_whiteboard.pdf))
* Lecture 17 (Recurrent Neural Networks): Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/133328/mod_label/intro/lec17_whiteboard.pdf))

Reading (Convolutional/Recurrent Neural Networks)

* + [Convolutional Networks (Chapter 9 of "Deep Learning" by Ian Goodfellow, Yoshua Bengio and Aaron Courville)](https://www.deeplearningbook.org/contents/convnets.html)
  + [Sequence Modeling: Recurrent and Recursive Nets (Chapter 10 of "Deep Learning" by Ian Goodfellow, Yoshua Bengio and Aaron Courville)](https://www.deeplearningbook.org/contents/rnn.html)
  + [What are recurrent neural networks? How do they work? Lecture slides by Yoav Goldberg](https://moodle.iitb.ac.in/2022/pluginfile.php/335043/mod_label/intro/RNNs_yoav.pdf)

Slides (Lectures 18, 19)

* Lecture 18 (RNNs + Encoder/Decoder models + Attention): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/134760/mod_label/intro/lec18.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/134760/mod_label/intro/lec18_whiteboard.pdf))
* Lecture 19 (Support Vector Machines, SVMs): Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/134760/mod_label/intro/lec19_whiteboard.pdf))

Reading (RNNs/Attention/SVMs)

* + [Sequence Modeling: Recurrent and Recursive Nets (Chapter 10 of "Deep Learning" by Ian Goodfellow, Yoshua Bengio and Aaron Courville)](https://www.deeplearningbook.org/contents/rnn.html)
  + [What are recurrent neural networks? How do they work? Lecture slides by Yoav Goldberg](https://moodle.iitb.ac.in/2022/pluginfile.php/335043/mod_label/intro/RNNs_yoav.pdf)
  + [Encoder-Decoder Models, Attention, Speech and Language Processing, D. Jurafsky and J. Martin](https://web.stanford.edu/~jurafsky/slp3/old_oct19/10.pdf)
  + [Notes by Tengyu Ma and Andrew Ng on SVMs and Kernels](http://cs229.stanford.edu/notes2020fall/notes2020fall/cs229-notes3.pdf)

Slides (Lectures 20, 21)

* Lecture 20 (SVMs + Kernels): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/135357/mod_label/intro/lec20.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/135357/mod_label/intro/lec20_whiteboard.pdf))
* Lecture 21 (Kernels wrap-up + k-means): Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/135357/mod_label/intro/lec21_whiteboard.pdf))

Reading (SVMs/Kernels/k-means)

* + [Notes by Tengyu Ma and Andrew Ng on SVMs and Kernels](http://cs229.stanford.edu/notes2020fall/notes2020fall/cs229-notes3.pdf)
  + [Chapter 9, PMRL by Christopher Bishop [CB06]: k-means Clustering, mixture models and the EM algorithm](https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf)
  + [Slides by Prof. Andrew Rosenberg on k-means and mixture models](https://davidrosenberg.github.io/ml2015/docs/13.mixture-models.pdf)

Slides (Lectures 22)

* Lecture 22 (PCA): Slides (k-means solved question, [pdf](https://moodle.iitb.ac.in/pluginfile.php/136384/mod_label/intro/lec22.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/136384/mod_label/intro/lec22_whiteboard.pdf))
* Institute holiday on October 31st

Reading (PCA)

* + [Tutorial on PCA by Jonathon Schlens](https://arxiv.org/pdf/1404.1100.pdf)

Slides (Lectures 23/24)

* Lecture 23 (Boosting/Bagging): Slides ([pdf](https://moodle.iitb.ac.in/pluginfile.php/137077/mod_label/intro/lec23.pdf)), Whiteboard ([pdf](https://moodle.iitb.ac.in/pluginfile.php/137077/mod_label/intro/lec23_whiteboard.pdf))
* Lecture 24 (Wrap-up with Practice Qs): [pdf](https://moodle.iitb.ac.in/pluginfile.php/137077/mod_label/intro/lec24.pdf)

Reading (Boosting / Bagging)

* + [Chapter 14 (14.1-14.3), Pattern Recognition and Machine Learning by Christopher Bishop](https://www.microsoft.com/en-us/research/uploads/prod/2006/01/Bishop-Pattern-Recognition-and-Machine-Learning-2006.pdf)
  + [Video lecture and accompanying notes by Prof. Kilian Weinberger on bagging/random forests](http://www.cs.cornell.edu/courses/cs4780/2018fa/lectures/lecturenote18.html)