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| **Machine Learning**  **10-701/15-781, Spring 2011**  **Carnegie Mellon University** [**Tom Mitchell**](http://www.cs.cmu.edu/~tom)  [**Tuan Le Dinh**](https://tuan-ld.github.io/) **(Lecture notes – Homework solutions)** |  |
| |  | | --- | |  | | |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | [**Home**](http://www.cs.cmu.edu/~tom/10701_sp11/) | [**People**](http://www.cs.cmu.edu/~tom/10701_sp11/ppl.shtml) | [**Lecture notes**](http://www.cs.cmu.edu/~tom/10701_sp11/lectures.shtml) | [**Recitations**](http://www.cs.cmu.edu/~tom/10701_sp11/recitations.shtml) | [**Homework solutions**](http://www.cs.cmu.edu/~tom/10701_sp11/hws.shtml) | [**Project**](http://www.cs.cmu.edu/~tom/10701_sp11/proj.shtml) | [**Previous material**](http://www.cs.cmu.edu/~tom/10701_sp11/prev.shtml) | | |  | | |  |  |  |  |  | | --- | --- | --- | --- | --- | | **Date** | **Lecture** | **Topics** | **Lecture otes** | **Handouts** | | Jan 11 | Intro to ML Decision Trees [Slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/DTreesAndOverfitting-1-11-2011_final.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=257476ca-e66a-4cdb-9ffc-8abdd3129954) | * Machine learning examples * Well defined machine learning problem * Decision tree learning | lecture-note 1 |  | | Jan 13 | Decision Tree learning  Review of Probability  [Annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/Overfitting_ProbReview-1-13-2011-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=ad6574d4-b695-4940-8449-2e09096ed16c) | * The big picture * Overfitting * Random variables, probabilities |  | [HW1](http://www.cs.cmu.edu/~tom/10701_sp11/hws.shtml) out Jan 14 | | Jan 18 | Probability and Estimation  [Annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/MLE_MAP_1-18-11-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=49482c13-0a60-4b02-8220-cf70f20ecf3a) | * Bayes rule * MLE * MAP |  |  | | Jan 20 | Naive Bayes  [Annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/NBayes-1-20-2011-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=a666b6e6-ad23-4fa3-96ce-ae50a42f45a3) | * Conditional independence * Multinomial Naive Bayes |  |  | | Jan 25 | Gaussian Naive Bayes [Slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/GNB_1-25-2011.pdf) [Annotated Slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/GNB_1-25-2011-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=7cd3bb34-558a-4f64-9cec-e5ff9b2b4ad1) | * Gaussian Bayes classifiers * Document classification * Brain image classification * Form of decision surfaces |  | HW1 due HW2 out | | Jan 27 | Logistic Regression  [Slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/LR_1-27-2011.pdf) [Annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/LR_1-27-2011-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=f7eac1e6-5416-4b35-aaf1-12e0a8eadbfd) | * Naive Bayes - the big picture * Logistic Regression: Maximizing conditional likelihood * Gradient ascent as a general learning/optimization method |  |  | | Feb 1 | Linear Regression  [Slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/GenDiscr_2_1-2011.pdf) [Annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/GenDiscr_2_1-2011-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=70a936ec-7e96-4719-ad3c-2d2f87f2c0e0) | * Generative/Discriminative models * minimizing squared error and maximizing data likelihood * bias-variance decomposition * regularization |  |  | | Feb 3 | Practical Issues | * Feature selection * Overfitting * Bias-Variance tradeoff |  |  | | Feb 8 | Graphical models 1 [Annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/GrMod1_2_8_2011-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=bc507778-7a18-4121-b345-83d9bab72f55) | * Bayes nets * representing joint distributions with conditional independence assumptions |  | HW3 out | | Feb 15 | Graphical models 2 [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/GrMod2_2_15_2011-ann.pdf) [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=16197605-aafd-4d2c-bcb3-c6a00be0757d) | * D-separation and Conditional Independence * Inference * Learning from fully observed data * Learning from partially observed data |  |  | | Feb 17 | Graphical models 3  [annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/GrMod3_2_17_2011-ann.pdf) [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=5a472d59-ce0d-4775-9b10-b9e8df68e343) | * EM |  |  | | Feb 22 | Graphical models 4 [annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/GrMod4_2_22_2011-ann.pdf) [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=0b841b34-250b-44f4-ac65-98b42c86287e) | * Mixture of Gaussians clustering * Learning Bayes Net structure - Chow Liu |  | HW3 due HW4 out | | Feb 24 | Computational Learning Theory [annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/PAC-learning1-2-24-2011-ann.pdf) [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=07cb3ba8-bea9-41e6-ba9f-50d7b1c87bf0) | * PAC Learning |  |  | | Mar 1 | Midterm Review [PAC learning slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/PAC-learning2_3-1-2011-ann.pdf) [midterm review slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/Midterm-review-3-1-2011-ann.pdf) [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=558031db-3afe-461a-8c04-8f417fa66dd2) |  |  | HW4 due | | Mar 3 | Midterm Exam | * in class * open notes, open book, no internet |  | [Midterm](http://www.cs.cmu.edu/~tom/10701_sp11/midterm.pdf) [Solution](http://www.cs.cmu.edu/~tom/10701_sp11/midterm_sol.pdf) | | Mar 15 | Computational Learning Theory [annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/PAC-learning3_3-15-2011_ann.pdf) [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=a8eedb53-a516-4e58-99fe-768361da9bf4) | * Mistake bounds * Weighted Majority Algorithm |  |  | | Mar 17 | Semi-Supervised Learning slides: [CoTraining](http://www.cs.cmu.edu/~tom/10701_sp11/slides/LabUnlab-3-17-2011.pdf) [NELL](http://www.cs.cmu.edu/~tom/10701_sp11/slides/NELL_March2011.pdf) [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=1533c941-093a-459f-8302-90b1ecf63de6) | * CoTraining / Multi-view Learning * Never ending learning (NELL) |  |  | | Mar 22 | Hidden Markov Models [annotated slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/HMMs_3_22-2011_ann.pdf) | * Markov models * HMM's and Bayes Nets * Other probabilistic time series models |  |  | | Mar 24 | Neural Networks [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/NNets-701-3_24_2011_ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=5d22928c-f3b4-4346-9702-24d306e17ef9) | * Non-linear regression * Backpropagation and Gradient descent * Learning hidden layer representations |  | Project proposals due | | Mar 29 | Learning Representations I [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/DimensionalityReduction_03_29_2011_ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=6c1ae619-01be-44e6-be66-4d78070823a2) | * Artificial neural networks * PCA |  |  | | Mar 31 | Learning Representations II [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/DimensionalityReduction_03_31_2011_ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=bca303c3-e7b7-49d9-8358-bb97e335386d) | * Deep belief networks * ICA * CCA |  |  | | Apr 5 | Learning Representations III [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/DimensionalityReduction_04_5_2011_ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=1fda61dd-2162-45f2-a179-1ce6153e40a6) | * Fisher Linear Discriminant * Latent Dirichlet Allocation * Intro to Kernel Functions |  |  | | Apr 7 | Kernel Methods and SVM's [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/Kernels_SVM_04_7_2011-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=99142e30-208b-4655-9be1-573583025a2a) | * Regression: Primal and Dual forms * Kernels and Kernel Regression * SVMs |  |  | | Apr 12 | SVM's II [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/Kernels_SVM2_04_12_2011-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=3c9a2813-8d74-400c-bb9b-fa261c93067b) | * Maximizing the margin * Noise and soft margin SVM's * PAC learning and SVM's * Hinge loss, log loss, 0-1 loss |  | Project midway report due | | Apr 14 |  | No CMU classes today |  |  | | Apr 19 | Active Learning [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/settles-2.active.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=61b35cef-b2c0-4f1e-9438-545373d760d7) | Guest lecture: Dr. Burr Settles   * Uncertainty sampling * Query by committee |  |  | | Apr 21 | ML in Computational Biology [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/Ziv_CompBio.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=64916f95-d11c-4d82-8901-badf36ee2a7c) | Guest lecture: Prof. Ziv Bar-Joseph |  |  | | Apr 26 | Reinforcement Learning I [slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/MDPs_RL_04_26_2011-ann.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=edf82c04-e170-4e8e-a55b-7de353225001) | * Markov Decision Processes * Value Iteration * Q learning |  |  | | Apr 28 | Reinforcement Learning 2 [RL slides](http://www.cs.cmu.edu/~tom/10701_sp11/slides/MDPs_RL_04_28_2011.pdf) [Final study guide](http://www.cs.cmu.edu/~tom/10701_sp11/slides/FinalExamStudyTopics.pdf)  [video](http://cc-web.isri.cmu.edu/CourseCast/Viewer/Default.aspx?id=ae14075d-069b-405e-b509-00b15da25726) | * Q learning in non-deterministic domains * RL as model for learning in animals * Final exam review |  |  | | May 6 (Friday) | Final Exam | * 1-4pm * Location: Gates Hillman 4401 * open notes, open book, no internet | [**Final study guide**](http://www.cs.cmu.edu/~tom/10701_sp11/slides/FinalExamStudyTopics.pdf) |  | | |  | | |