



CS229

CS229: Machine Learning - The Summer Edition!

Course Description This is the summer edition of CS229 Machine Learning that was offered over 2019 and 2020. CS229 provides a broad introduction to statistical machine learning (at an intermediate / advanced level) and covers supervised learning (generative/discriminative learning, parametric/non-parametric learning, neural networks, support vector machines); unsupervised learning (clustering, dimensionality reduction, kernel methods); learning theory (bias/variance tradeoffs, practical); and reinforcement learning among other topics. **The structure of the summer offering enables coverage of additional topics, places stronger emphasis on the mathematical and visual intuitions, and goes deeper into the details of various topics.**

Full playlist (YouTube)

Syllabus and Course Schedule

Event	Date	Description	Materials and Assignments
Introduction and Pre-requisites review (3 lectures)			
Lecture 1 [YouTube]	6/24	<ul style="list-style-type: none"> • Introduction and Logistics • Review of Linear Algebra 	Class Notes <ul style="list-style-type: none"> • Introduction [pptx] • Linear Algebra (section 1-3) [pdf]
Lecture 2 [YouTube]	6/26	<ul style="list-style-type: none"> • Review of Matrix Calculus • Review of Probability 	Class Notes <ul style="list-style-type: none"> • Linear Algebra (section 4) [pdf] • Probability Theory [pdf] • Probability Theory Slides [pdf]
Lecture 3 [YouTube]	6/28	<ul style="list-style-type: none"> • Review of Probability and Statistics • Setting of Supervised Learning 	Class Notes <ul style="list-style-type: none"> • Supervised Learning [pdf] • Probability Theory [pdf]
Supervised Learning (8 lectures)			
Lecture 4 [YouTube]	7/1	<ul style="list-style-type: none"> • Linear Regression • [Stochastic] Gradient Descent ([S]GD) • Normal Equations • Probabilistic Interpretation • Maximum Likelihood Estimation (MLE) 	Class Notes <ul style="list-style-type: none"> • Supervised Learning (section 1-3) [pdf]
Lecture 5 [YouTube]	7/3	<ul style="list-style-type: none"> • Perceptron • Logistic Regression • Newton's Method 	Class Notes <ul style="list-style-type: none"> • Supervised Learning (section 5-7) [pdf]

Event	Date	Description	Materials and Assignments
Lecture 6 [YouTube]	7/5	<ul style="list-style-type: none"> Exponential Family Generalized Linear Models (GLM) 	Class Notes <ul style="list-style-type: none"> Supervised Learning (section 8-9) [pdf]
Lecture 7 [YouTube]	7/8	<ul style="list-style-type: none"> Gaussian Discriminant Analysis (GDA) Naive Bayes Laplace Smoothing 	Class Notes <ul style="list-style-type: none"> Generative Algorithms [pdf]
Lecture 8 [YouTube]	7/10	<ul style="list-style-type: none"> Kernel Methods Support Vector Machine 	Class Notes <ul style="list-style-type: none"> Kernel Methods and SVM [pdf]
Lecture 9 [YouTube]	7/12	<ul style="list-style-type: none"> Bayesian Methods Parametric (Bayesian Linear Regression) Non-parametric (Gaussian process) 	Class Notes <ul style="list-style-type: none"> Gaussian Processes [pdf] Optional <ul style="list-style-type: none"> The Multivariate Gaussian Distribution [pdf] More on Gaussian Distribution [pdf]
Lecture 10 [YouTube]	7/15	<ul style="list-style-type: none"> Neural Networks and Deep Learning 	Class Notes <ul style="list-style-type: none"> Deep Learning (skip Sec 3.3) [pdf] Optional <ul style="list-style-type: none"> Backpropagation [pdf]
Lecture 11 [YouTube]	7/17	<ul style="list-style-type: none"> Deep Learning (contd) 	
Theory (2 lectures)			

Event	Date	Description	Materials and Assignments
Lecture 12 [YouTube]	7/19	<ul style="list-style-type: none"> Bias and Variance Regularization, Bayesian Interpretation Model Selection 	Class Notes <ul style="list-style-type: none"> Regularization and Model Selection [pdf]
Lecture 13 [YouTube]	7/22	<ul style="list-style-type: none"> Bias-Variance tradeoff (wrap-up) Empirical Risk Minimization Uniform Convergence 	Class Notes <ul style="list-style-type: none"> Bias Variance Analysis [pdf] Statistical Learning Theory [pdf]
Reinforcement Learning (2 lectures)			
Lecture 14 [YouTube]	7/24	<ul style="list-style-type: none"> Reinforcement Learning (RL) Markov Decision Processes (MDP) Value and Policy Iterations 	Class Notes <ul style="list-style-type: none"> Reinforcement Learning and Control (Sec 1-2) [pdf]
Lecture 15 [YouTube]	7/26	<ul style="list-style-type: none"> RL (wrap-up) Learning MDP model Continuous States 	Class Notes <ul style="list-style-type: none"> Reinforcement Learning and Control (Sec 3-4) [pdf]
Unsupervised Learning (3 lectures)			
Lecture 16 [YouTube]	7/29	Unsupervised Learning <ul style="list-style-type: none"> K-means clustering Mixture of Gaussians (GMM) Expectation Maximization (EM) 	Class Notes <ul style="list-style-type: none"> K-means [pdf] Mixture of Gaussians [pdf] Expectation Maximization (Sec 1-2, skip 2.1) [pdf]

Event	Date	Description	Materials and Assignments
Lecture 17 [YouTube]	7/31	<ul style="list-style-type: none"> • EM (wrap-up) • Factor Analysis 	Class Notes <ul style="list-style-type: none"> • Expectation Maximization (Sec 3) [pdf] • Factor Analysis [pdf]
Lecture 18 [YouTube]	8/2	<ul style="list-style-type: none"> • Factor Analysis (wrap-up) • Principal Components Analysis (PCA) • Independent Components Analysis (ICA) 	Class Notes <ul style="list-style-type: none"> • Principal Components Analysis [pdf] • Independent Components Analysis [pdf]
Miscellaneous Topics (3 lectures)			
Lecture 19	8/5	<ul style="list-style-type: none"> • Maximum Entropy and Exponential Family • KL-Divergence • Calibration and Proper Scoring Rules 	Class Notes <ul style="list-style-type: none"> • Maximum Entropy [pdf]
Lecture 20	8/7	<ul style="list-style-type: none"> • Variational Inference • EM Variants • Variational Autoencoder 	Class Notes <ul style="list-style-type: none"> • VAE (Sec 4) [pdf]
Lecture 21	8/9	<ul style="list-style-type: none"> • Evaluation Metrics 	Class Notes <ul style="list-style-type: none"> • Evaluation Metrics [pptx]
Recap and wrap-up (2 lectures)			
Lecture 22	8/12	<ul style="list-style-type: none"> • Practical advice and tips • Review for Finals 	Class Notes

Event	Date	Description	Materials and Assignments
Lecture 23	8/14	<ul style="list-style-type: none">• Review for Finals	Class Notes
Final	8/16		

Other Resources

1. Advice on applying machine learning: Slides from Andrew's lecture on getting machine learning algorithms to work in practice can be found [here](#).
2. Previous projects: A list of last year's final projects can be found [here](#).
3. Data: Here is the [UCI Machine learning repository](#), which contains a large collection of standard datasets for testing learning algorithms. If you want to see examples of recent work in machine learning, start by taking a look at the conferences [NeurIPS](#) (all old NeurIPS papers are online) and ICML. Some other related conferences include UAI, AAAI, IJCAI.
4. Viewing PostScript and PDF files: Depending on the computer you are using, you may be able to download a [PostScript](#) viewer or [PDF viewer](#) for it if you don't already have one.
5. [Machine learning study guides tailored to CS 229](#) by Afshine Amidi and Shervine Amidi.