## Advanced Machine Learning

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- 1. Introduction, Artificial Scientific Discovery
- 2. Basic Neural Network Structure
- 3. Stochastic Gradient Descent, Backpropagation
- 4. Loss functions, Overfitting, Dropout, Adaptive Gradient Descent, Convolutional Networks
- 5. Representation Learning: Goals, Principal Component Analysis
- 6. Basic Autoencoders
- 7. Contractive Autoencoder, Shannon's Information Theory: Compression and Information
- 8. Entropy, Bayes Formula
- 9. Bayes, Gaussian Random Processes
- 10. Inductive Bias, Fisher Information, Information Geometry
- 11. Natural Gradient, Kullback-Leibler Divergence, Mutual Information
- 12. Mutual Information, Learning Probability Distributions, Normalizing Flows
- 13. Invertible Neural Networks, Convolutional and Conditional Invertible Networks
- 14. Boltzmann Machines General Theory
- 15. Restricted Boltzmann Machines, Conditional Sampling, Variational Autoencoder
- 16. Variational Autoencoder, Generative Adversarial Networks
- 17. Generative Adversarial Networks, Recurrent Neural Networks
- 18. Recurrent Neural Networks, Graph Neural Networks
- 19. Graph Neural Networks, Attention Mechanisms Basics
- 20. Attention, Differentiable Neural Computer, Transformers
- 21. Transformers and Examples, Implicit Layers
- 22. Implicit Layers, Hamiltonian and Lagrangian Networks, Reinforcement Learning Overview
- 23. Reinforcement Learning: Policy Gradient and Q-Learning

- 24. Advantage Actor-Critic, Trust Regions, Proximal Policy Optimization
- 25. Reinforcement Learning: Continuous actions, Model-based, Monte Carlo Tree Search
- 26. Active Learning for Network Training: Uncertainty Sampling and other Approaches
- 27. Bayesian Optimal Experimental Design, Active Learning: Gaussian Processes and Networks
- 28. Turing Machines, Algorithmic Kolomogoroff Complexity, Universal Levin Search
- 29. Solomonoff's Algorithmic Probability and Theory of Induction, Conclusions/Outlook
- 30. Materials

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