

Machine Learning

Introduction to the Course

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This set of notes is based on internet resources.

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- Machine learning is the science of getting machines to learn and act in a **similar way to humans** while also autonomously **learning from real-world interactions** and sets of **training data** that we feed them.
- Machine learning is an application of artificial intelligence (AI) that provides systems the ability to **automatically learn and improve from experience without being explicitly programmed**. Machine learning focuses on the development of computer programs that can **access data and use it** learn for themselves.

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- Machine Learning is a set of methods that automatically **detect patterns in data**, **use the uncovered patterns** to for prediction or decision making.

Machine Learning (and AI) is Very Hot

Countries and companies invest heavily in ML and AI.

Who will capture the value of AI?*

7	Nations	     								
6	Corporates	<table><tr><td>Healthcare  </td><td>Finance & Insurance   J.P.Morgan</td><td>Tech & Telco  Microsoft   </td><td>Agriculture MONSANTO  </td><td>Automotive  </td><td>Legal & Compliance ALLEN & OVERY </td><td>Industrials, GENERAL ROBOTICS  BOEING </td><td>Retail, media, other Disney  TARGET</td></tr></table>	Healthcare  	Finance & Insurance   J.P.Morgan	Tech & Telco  Microsoft   	Agriculture MONSANTO  	Automotive  	Legal & Compliance ALLEN & OVERY 	Industrials, GENERAL ROBOTICS  BOEING 	Retail, media, other Disney  TARGET
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5	Industry solutions	<table><tr><td>Healthcare & Life Sciences  TEMPUS  BABYLON DeepMind</td><td>Finance & Insurance  Affirm NUMERA</td><td>Agriculture prospera BENSON HILL FarmersEdge</td><td>Automotive drive.ai ZOX WAYMO</td><td>Legal & Compliance onfido Luminance casetext ROSS</td><td>Industrials, Robotics & Logistics brainrobotics deepvu Qntrl VEKTA LEGILITY</td></tr></table>	Healthcare & Life Sciences  TEMPUS  BABYLON DeepMind	Finance & Insurance  Affirm NUMERA	Agriculture prospera BENSON HILL FarmersEdge	Automotive drive.ai ZOX WAYMO	Legal & Compliance onfido Luminance casetext ROSS	Industrials, Robotics & Logistics brainrobotics deepvu Qntrl VEKTA LEGILITY		
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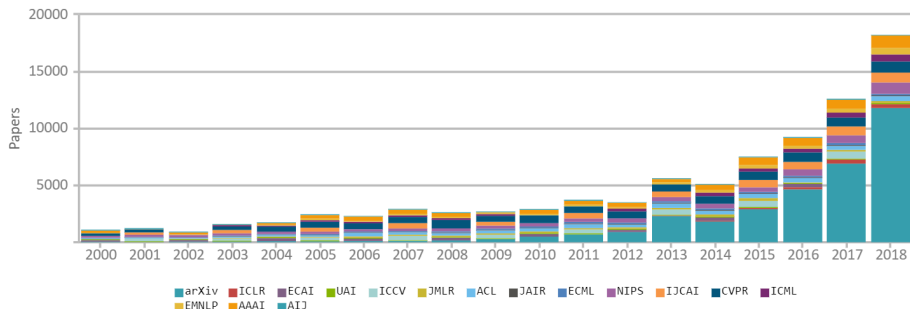
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The number of research papers on AI and Machine Learning has been increasing sharply in the past few years.



<http://aipano.cse.ust.hk/>

Overview of topics: <http://home.cse.ust.hk/~lzhang/topic/ai-tree.pdf>

Coverage of this Course

Deployment	Adversarial Attack (Security)	XAI (Trust/Fairness)		Federated Learning(Privacy), Meta-learning (Learn to Learn), Domain Adaption/Generalization, ...	
	General Issues	Supervised	Self-Supervised	Unsupervised	Reinforcement
Deep Learning	Dropout Normalization Optimizers	Feedforward NN Convolutional NN	Recurrent NN Transformer BERT	VAE GAN	DQN Policy gradient Actor-critic
Machine Learning	Overfitting Bias, variance Regularization Validation	Linear Regression Logistic Regression Generative models SVM		Finite Mixtures	Q-learning
Foundation Principles Algorithms	Probability Theory Likelihood, Bayes theorem		Information Theory Cross entropy Divergence		Optimization Theory Gradient Descent Newton Primal-dual

Objective: This course is designed to be a second course on machine learning. We will emphasize the theoretical foundation of machine learning (depth) and will cover important recent developments (breadth).

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We will **focus mostly on the first three questions**. We will **explain the math behind the objective functions and how the steps are derived from principles**. So, we will do a fair amount of math derivations. Hands-on experiences are to be gained via tutorials, self-practice, programming assignment and term project.