

TTIC 31230, Fundamentals of Deep Learning

David McAllester, Winter 2019

The History of Deep Learning

and Moore's Law of AI

Early History

1943: McCullock and Pitts introduced the linear threshold “neuron”.

1962: Rosenblatt applies a “Hebbian” learning rule. Novikoff proved the perceptron convergence theorem.

1969: Minsky and Papert publish the book *Perceptrons*.

The Perceptrons book greatly discourages work in artificial neural networks. Symbolic methods dominate AI research through the 1970s.

80s Renaissance

1980: Fukushima introduces the neocognitron (a form of CNN)

1984: Valiant defines PAC learnability and stimulates learning theory. Wins the Turing Award in 2010.

1985: Hinton and Sejnowski introduce the Boltzman machine

1986: Rumelhart, Hinton and Williams demonstrate empirical success with backpropagation (itself dating back to 1961).

90s and 00s: Research In the Shadows

1997: Schmidhuber et al. introduce LSTMs

1998: LeCunn introduces convolutional neural networks (CNNs) (LeNet).

2003: Bengio introduces neural language modeling.

Current Era

2012: Alexnet dominates the Imagenet computer vision challenge.

Google speech recognition converts to deep learning.

Both developments come out of Hinton's group in Toronto.

2013: Refinement of AlexNet continues to dramatically improve computer vision.

Current Era

2014: Neural machine translation appears (Seq2Seq models).

Variational auto-encoders (VAEs) appear.

Generative Adversarial Networks (GANs) appear.

Graph neural networks appear (GNNs) revolutionizing the prediction of molecular properties.

Dramatic improvement in computer vision and speech recognition continues.

Current Era

2015: Google converts to neural machine translation leading to dramatic improvements.

ResNet (residual connections) appear. This makes yet another dramatic improvement in computer vision.

2016: Alphago defeats Lee Sedol.

Current Era

2017: AlphaZero learns both go and chess at super-human levels in a matter of hours entirely from self-play and advances computer go far beyond human abilities.

Unsupervised machine translation is demonstrated.

Progressive GANs demonstrate high resolution realistic face generation.

Current Era

2018: Unsupervised pre-training significantly improves a broad range of NLP tasks including question answering (but dialogue remains unsolved).

AlphaFold revolutionizes protein structure prediction.

2019: Vector quantized VAEs (VQ-VAE) demonstrate that VAEs can be competitive with GANs for high-resolution image generation.

Super-human performance is achieved on the GLUE natural language understanding benchmark.

2019: Natural Language Understanding

GLUE: General Language Understanding Evaluation

ArXiv 1804.07461

BERT and GLUE

BERT and SuperGLUE

Generative Adversarial Nets (GANs)

Goodfellow et al., 2014

Moore's Law of AI

ArXiv 1406.2661, 1511.06434, 1607.07536, 1710.10196, 1812.04948
Goodfellow, ICLR 2019 Invited Talk

GANs for Imagenet

BigGANs, Brock et al., 2018

Variational Auto Encoders (VAEs, 2015)

[Alec Radford, 2015]

VAEs in 2019

VQ-VAE-2, Razavi et al. June, 2019

VAEs in 2019

VQ-VAE-2, Razavi et al. June, 2019

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