

The logo of the Indian Institute of Technology Madras is a circular emblem. It features a central lamp with a flame, a lotus flower, and a lightning bolt. The text "INDIAN INSTITUTE OF TECHNOLOGY MADRAS" is written in a circle around the central elements. At the bottom, there is a Sanskrit motto: "सिद्धिर्भवति कर्मजा".

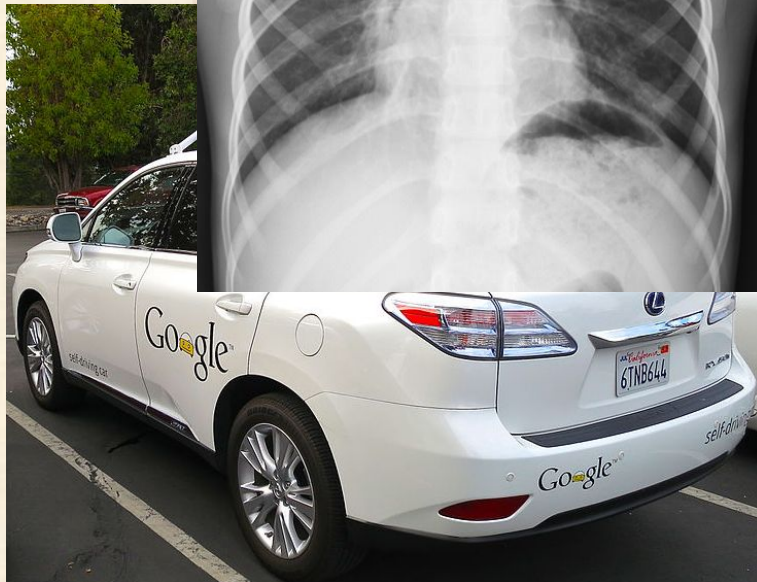
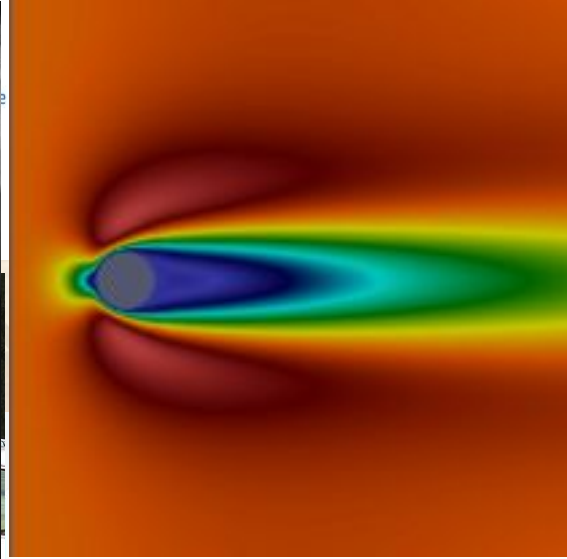
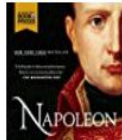
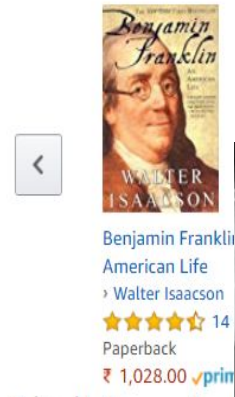
Machine Learning for Engineering and Science Applications

Introduction to the Course
History of Artificial Intelligence

What makes these possible?

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12th, 2018 - Tai: Peace, This is a go... 7:35 AM

☐ King, Darryl

IMPORTANT OFFER - IMPORTANT OFFER There is a donation fo... 5:35 AM

Simplistic Definition -- Machine Learning aims to replicate activities requiring human cognition

Course Aims

1. To understand basic Machine Learning models thoroughly
 - ❑ Specific emphasis on Deep Learning
2. To be familiar with some modern ML techniques
3. To apply these techniques hands-on to problems in Engineering
 - ❑ Examples – Medical Image Diagnosis, Turbulence Modeling
 - ❑ You will have to learn and program in Python.

You should also be able to read and understand applied research papers on Machine Learning

Course Prerequisites

- Mathematical “sophistication”
 - ❑ We will be introducing Linear Algebra, Probability and Optimization ideas required but....
 - ❑ You must be comfortable with Mathematics
- Degree of comfort with programming
 - ❑ We will be using examples from Python, MATLAB so....
 - ❑ You must understand Python, MATLAB syntax
 - ❑ And must be comfortable with programming if you wish to take the course for credit

Course Outline

- Course will be in three broad parts

Part 1 : Artificial Neural Networks and Deep Learning

- Including CNNs and RNNs

Part 2 : Other techniques

- Includes tree based methods, kernel methods, probabilistic methods, etc

Part 3 : Modern/ Advanced methods

- Autoencoders, Generative Models, Reinforcement Learning, etc

- Applications assigned/discussed throughout the course

[illegible]

Reference Books

1. **Deep Learning**, Goodfellow, Bengio, Courville, *MIT Press*, 2016*
2. **Pattern Recognition and Machine Learning**, Bishop, *Springer*, 2009*
3. **Deep Learning With Python**, Chollet, *Manning Publications*, 2017

* The first two books have been made available for free by the publishers on their websites

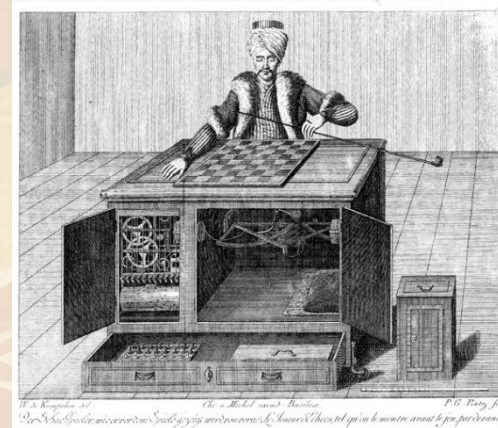
The logo of the Indian Institute of Technology MandRAS is a circular emblem. It features a central lotus flower in red and orange, set against a light blue background. The lotus is enclosed within a larger, stylized blue shape that resembles a flame or a drop. The entire emblem is surrounded by a circular border containing the text "INDIAN INSTITUTE OF TECHNOLOGY MANDRAS" in a light blue, sans-serif font. Below the main text, there is a smaller line of text in Devanagari script: "सिद्धिर्भवति कर्मजा".

History of Artificial Intelligence

Those who cannot learn from history are doomed to repeat it.

Prehistory (Till 1900)

- 11th century – Robots that could replicate human speech and motion (Raja Bhoja)
- Realistic automatons in several parts of the world
- Liebnitz – All human ideas are combinations of a few thoughts
- 1837 – Charles Babbage –
Analytical Engine



Birth of the field of Artificial Intelligence (1900-1960)

1914 First chess playing machine (KR-K endings)

1925 Radio-controlled driverless car (Francis Houdina)

1940s Pitts and McCulloch – **First Artificial Neuron**

Alan Turing – Theory of Computation, Imitation Game

*Shannon (**Information Theory**)*

1950 Wiener – **Cybernetics**

1951 Minsky– (SNARC) First Neural Net Machine

1955 Simon and Newell – Logic Theorist – Theorem Proving machine

1956 Dartmouth conference – **The term “A.I” is coined** with the aim to build thinking machines. **Formal birth of Artificial Intelligence**

1957 Rosenblatt – **Perceptron** – Two-layer Artificial Neural Network

Machine Learning is the field of study that gives computers the ability to learn without being explicitly programmed. – Arthur Samuel, 1959

The golden years (1960-74)

- Appearance of **Expert Systems** – Explicit, rule based, programs
 - ❑ Playing Chess
 - ❑ Helping in constructing organic chemistry models
 - ❑ Solving word problems in algebra
 - ❑ Understanding natural language
 - ❑ General purpose mobile robot
 - ❑ Identifying infections and recommending antibiotics
- Theoretical Progress – **Backpropagation** – 1969 (Bryson and Ho)

Optimism

“Machines will be capable, within twenty years, of doing any work a man can do”

-- H.A. Simon (1965)

"In from three to eight years we will have a machine with the general intelligence of an average human being." – Marvin Minsky (1970)

.....etc, etc

But, we should always remember that, after great times.....

The first A.I. winter (1974- 80)

Problems with A.I

- Results were primarily for toy problems
- Low computational power
- Combinatorial explosion
- Commonsense is nearly impossible to program!
- Minsky's book – *Perceptrons* showed limitations of simple neural networks
- Most importantly, loss of government funding in A.I

A new seasonal cycle (1980-2000)

Boom – Spring -- (1980-87)

- Expert Systems used in businesses with specialized hardware
- First driverless car
- Hopfield networks, popularization of **backpropagation**
- Minsky (1984) – “Winter is coming!”

Bust – 2nd A.I Winter – (1987-93)

- Popularity of the PC.
- Disappointment in lack of spectacular results
- Brutal funding cuts

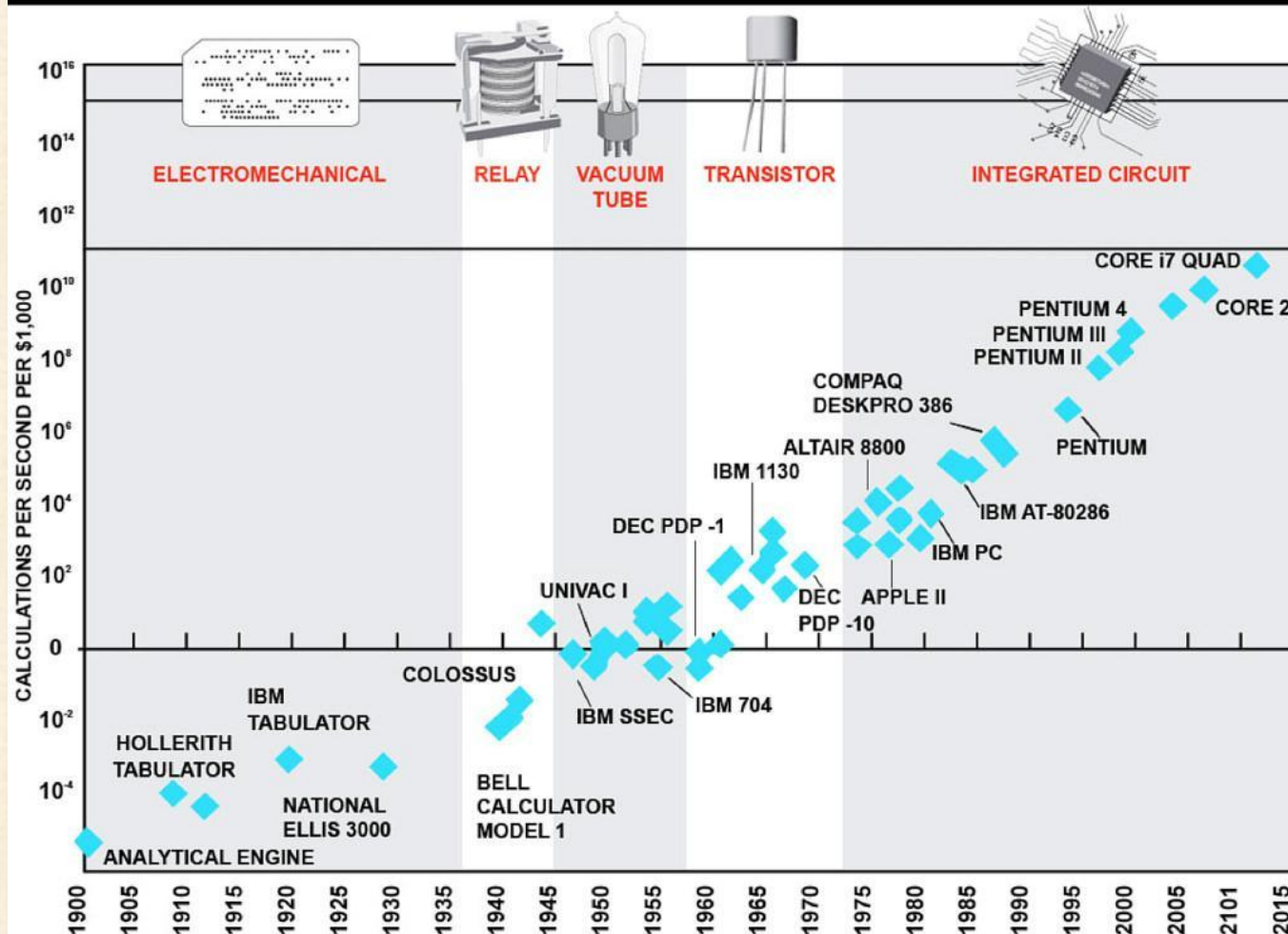
Consolidation – Summer – (1994-2000)

- 1997 Deep Blue beats Kasparov in chess
- Theory – Including probability, information theory, optimization, etc
- Moore’s Law – Rapid growth of processing power

Moore’s Law : Number of transistors doubles every two years

Moore's Law

115 Years of Moore's Law



The quiet years (2000-12)

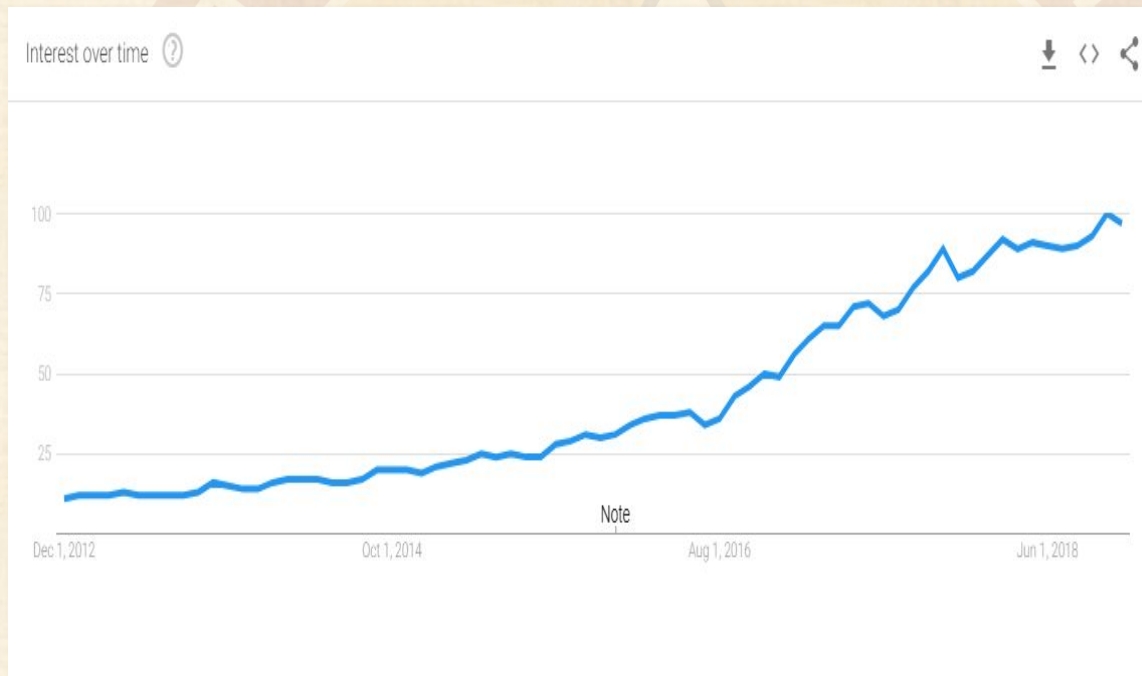
- Google is born.
- Internet Boom
- Shifted emphasis to **big data** – statistical techniques
- Birth of Graphical Processing Units (GPUs)
- Good results in specific problems using **deep networks**
- Research focused on specific outcomes rather than general, all purpose, A.I
- 2005 – Autonomous driving for 135 miles in desert
- IBM's Watson beat the *Jeopardy* champions

And after a long, quiet consolidation

The A.I. Spring (2012 – ??)

- Lots of private funding
 - Google, IBM, Facebook, Microsoft....
- Rapid development in computational power
- Rapid growth of data
 - Data mining
 - Voluntary, distributed work (Amazon Turk, Captchas, Games)

Growth of Machine Learning/A.I

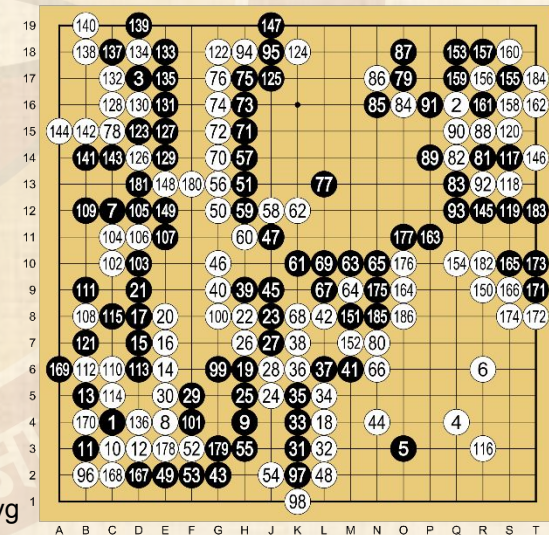


2012 **Convolutional Neural Networks** perform extremely well on image recognition challenge (ImageNet)

Machines vs Humans



https://upload.wikimedia.org/wikipedia/commons/thumb/5/51/IBM_Watson_w_Jeopardy.jpg/800px-IBM_Watson_w_Jeopardy.jpg



Lee Sedol (B) vs AlphaGo (W) - Game 1

[https://commons.wikimedia.org/wiki/File:Lee_Sedol_\(B\)_vs_AlphaGo_\(W\)_-_Game_1.svg](https://commons.wikimedia.org/wiki/File:Lee_Sedol_(B)_vs_AlphaGo_(W)_-_Game_1.svg)

What is different this time?

What is different this time

1. Better technology
 - ❑ Exponentially huge computational power
2. (Really, really) Big Data
3. Democratization of resources
 - ❑ Software and Hardware
4. Better algorithms

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