Deep Learning Overview

Outline

- Introduction
- Transition of AI
- Things dividing a machine and human
- AI and deep learning
- Summary

Introduction

- AI = Artificial Intelligence
- AI is a hot topic
  - Academic
  - Business
- Player: Google, Facebook, Softbank,…
- Deep learning?

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Transition of AI

- Deep learning is…
  - The adaption of neural networks (NNs)
  - NN is one of the algorithms of machine learning
  - NN mimics the structure of human brain
- But deep learning make significant achivements

Definition of AI

- Actual AI does not exist yet
  - So what is AI?
- Take a look at the examples…
  - (people use the word AI for these...)

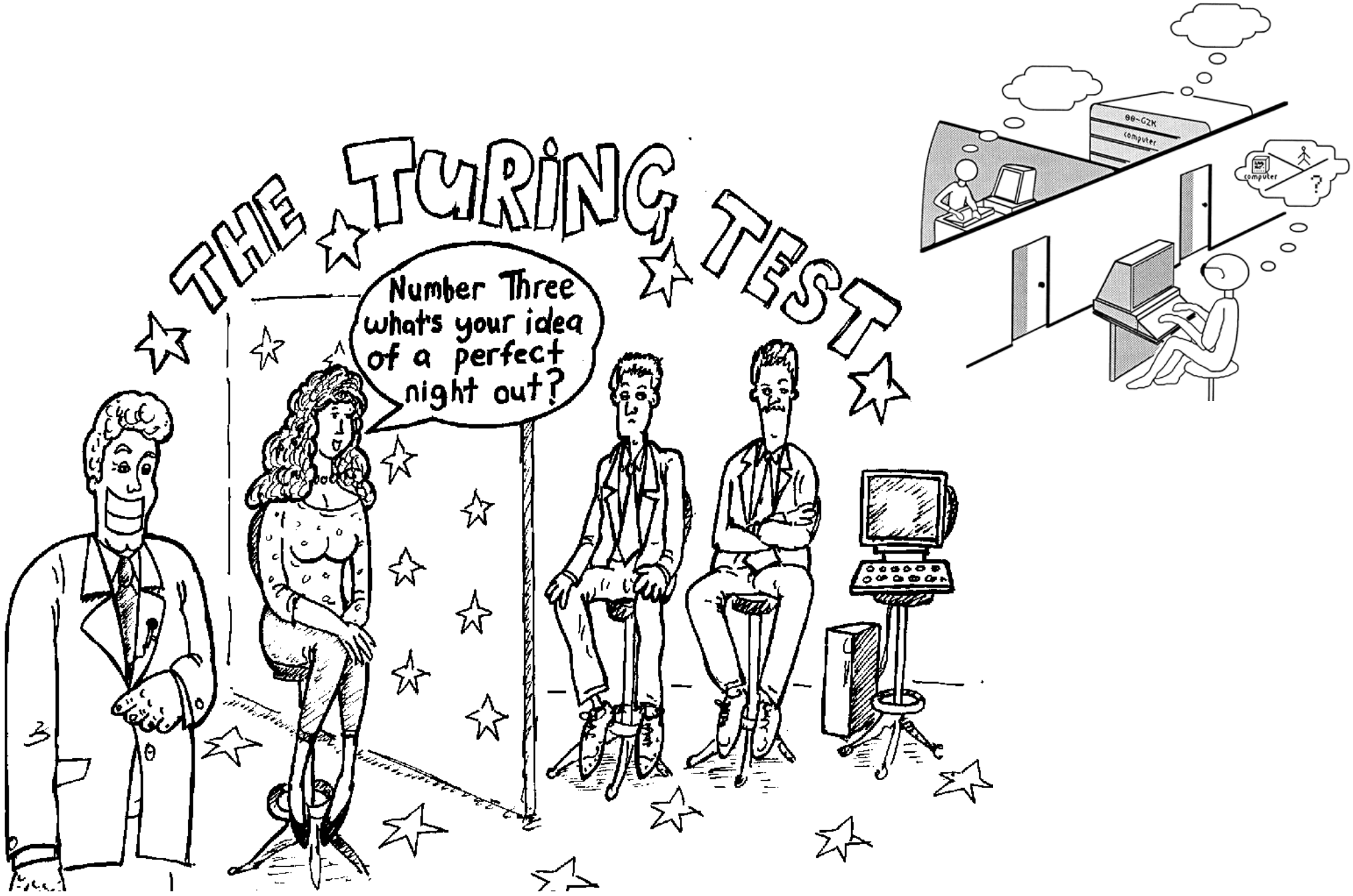
- Simple but high speed repetitive movements by industrial robots

- Searching or guessing room shape by iRobot Roomba

- Recommendation system based on user's purchase history

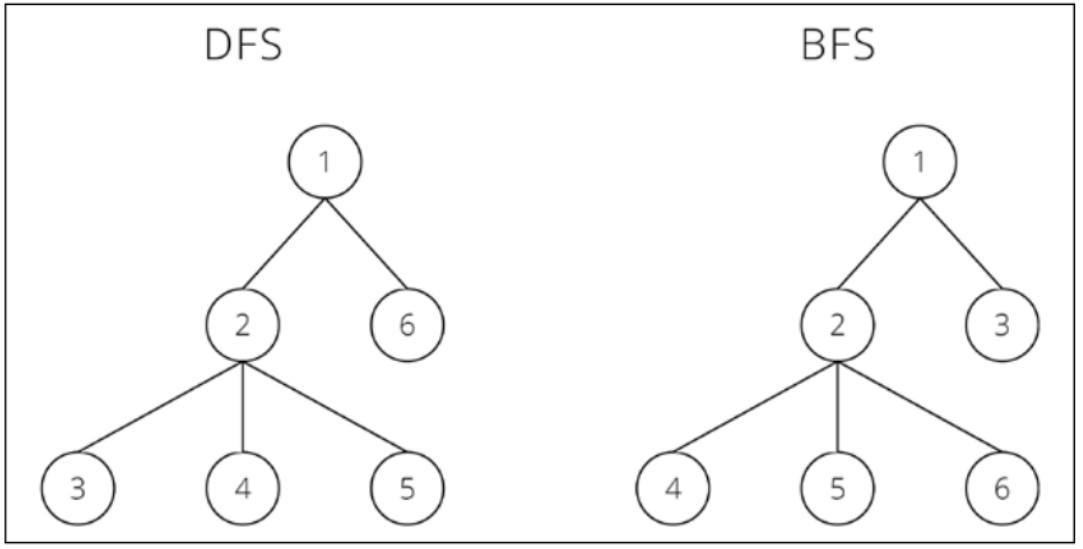
What is AI academically?

- “human-like intelligence that is hard to distinguish from the actual human brain”
- Turing Test?


THE TURING TEST
Number Three what's your idea of a perfect night out?
computer
computer
?

AI Booms in the Past

- The recent boom is the third one
- First AI boom came in the late 1950s
- Search program based on fixed rules
  - Depth-first search (DFS) and breadth-first search (BFS)



First AI Boom

- Search algorithms for specific fields
  - Chess and Shogi
  - Deep game tree
  - It's not surprising that a machine can beat a human
- Reality is more complicated
  - A machine is good at processing things at high speed based on a given set of rules
  - Humans unconsciously evaluate, discard many things/options that are not related to them, and make a choice from millions of things (patterns) in the real world whenever they act

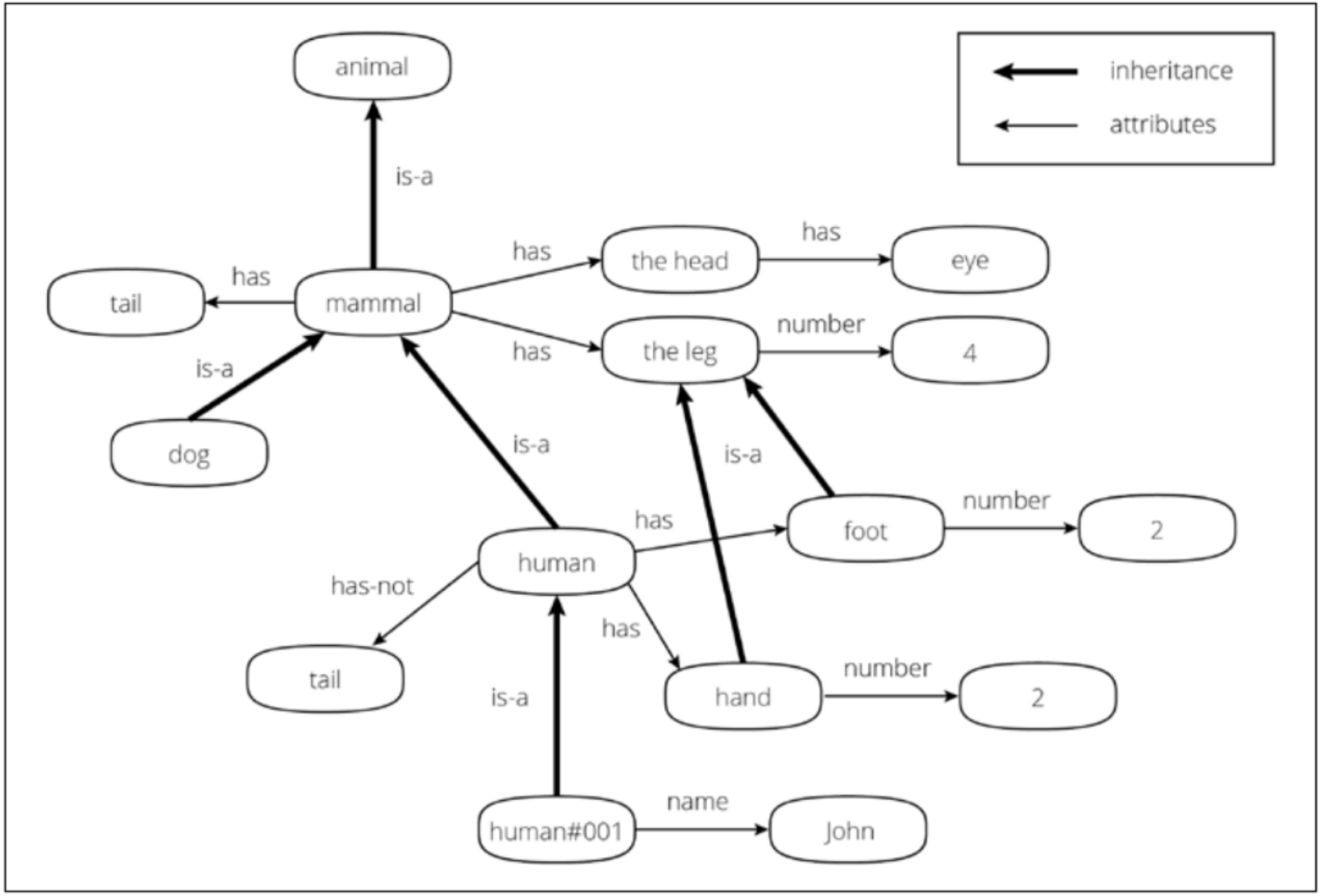
Give it a Try

- If we create a machine that can appropriately consider a phenomenon that happens in the real world, assume 2 possibilities
  - A machine tries to accomplish its task or purpose without taking into account secondarily occurring incidents and possibilities
  - A machine tries to accomplish its task or purpose without taking into account irrelevant incidents and possibilities
- “frame problem”

Second AI Boom

- The second AI boom came in the 1980s
- the movement of so-called Knowledge Representation (KR) was booming
  - Describe knowledge that a machine could easily understand
- Example: semantic web

Semantic Web Example



Second AI Boom

- Making a machine gain knowledge:
  - A machine being able to respond to what humans ask and then answer
  - Example: sentiment analysis, the positive-negative analysis of posts or comments on a social network or blog
- Two high walls
  - Inputting all real-world knowledge requires an almost infinite amount of work now (whole Internet?)
    - Someone is doing: Cyc (http://www.cyc.com/)

Cyc Example

```
(#$isa #$BarackObama #$UnitedStatesPresident)
```

"Barack Obama belongs to the collection of U.S. presidents."

```
(#$genls #$Tree-ThePlant #$Plant)
```

"All trees are plants."

```
(#$capitalCity #$Japan #$Tokyo)
```

"Tokyo is the capital of Japan."

Two High Walls, continue

- It's not that a machine understands the actual meaning of the knowledge
  - A machine understands a piece of knowledge as a mark only and never understands the concept
  - “symbol grounding problem”: one of the biggest problems in the AI field, as well as the frame problem

Machine Learning

- Completely different approach than before
  - A strong tool compared to past AI approaches
  - Focus on how fast a machine could pull out knowledge related to a question from its saved knowledge
  - Will get stuck when a machine faces questions it doesn't know
  - “probabilistic statistical model”

Third AI Boom

- Many open-source data have become available online and researchers can easily experiment with their algorithms using the data
- The word "AI" is usually the case indicates a process done by machine learning

What Machine Learning Can’t Do

- Machine learning has a big weak point
  - Can't correctly predict based on irrelevant data
  - A machine is not able to sort out what is appropriate data and what is not
    - Only if it has the right data can machine learning find a pattern
  - Machine learning can't do feature engineering
    - As the value shows the feature of the object quantitatively, a machine can appropriately handle pattern recognition

Limitation

- Machine learning algorithms can only work well on data with the assumption of the training data
  - Model generalization problem
- Even the well-trained model lacks the ability to make a smart meta-decision
  - Only successful in a very narrow direction

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Human? Machine?

- Three problems of AI:
  - The frame problem is that a machine can't recognize what knowledge it should use when it is assigned a task
  - The symbol grounding problem is that a machine can't understand a concept that puts knowledge together because it only recognizes knowledge as a mark
  - The problem of feature engineering in machine learning is that a machine can't find out what the feature is for objects
- These problems can be solved only if a machine can sort out "which feature of things/phenomena it should focus on and what information it should use"
  - A human is good at catching features

Concept?

- Humans know features
- Based on these features, humans can understand a thing as a "concept"
- Symbol representation => signifier
- The concept that you recognize is the symbol content, labeled by symbol representation => signified
- Sign = signifier+signified

Deep Learning

- The method that a machine can use to find the important feature value from the given data
- Deep learning makes machine be able to find out the feature quantity from the given data and learn

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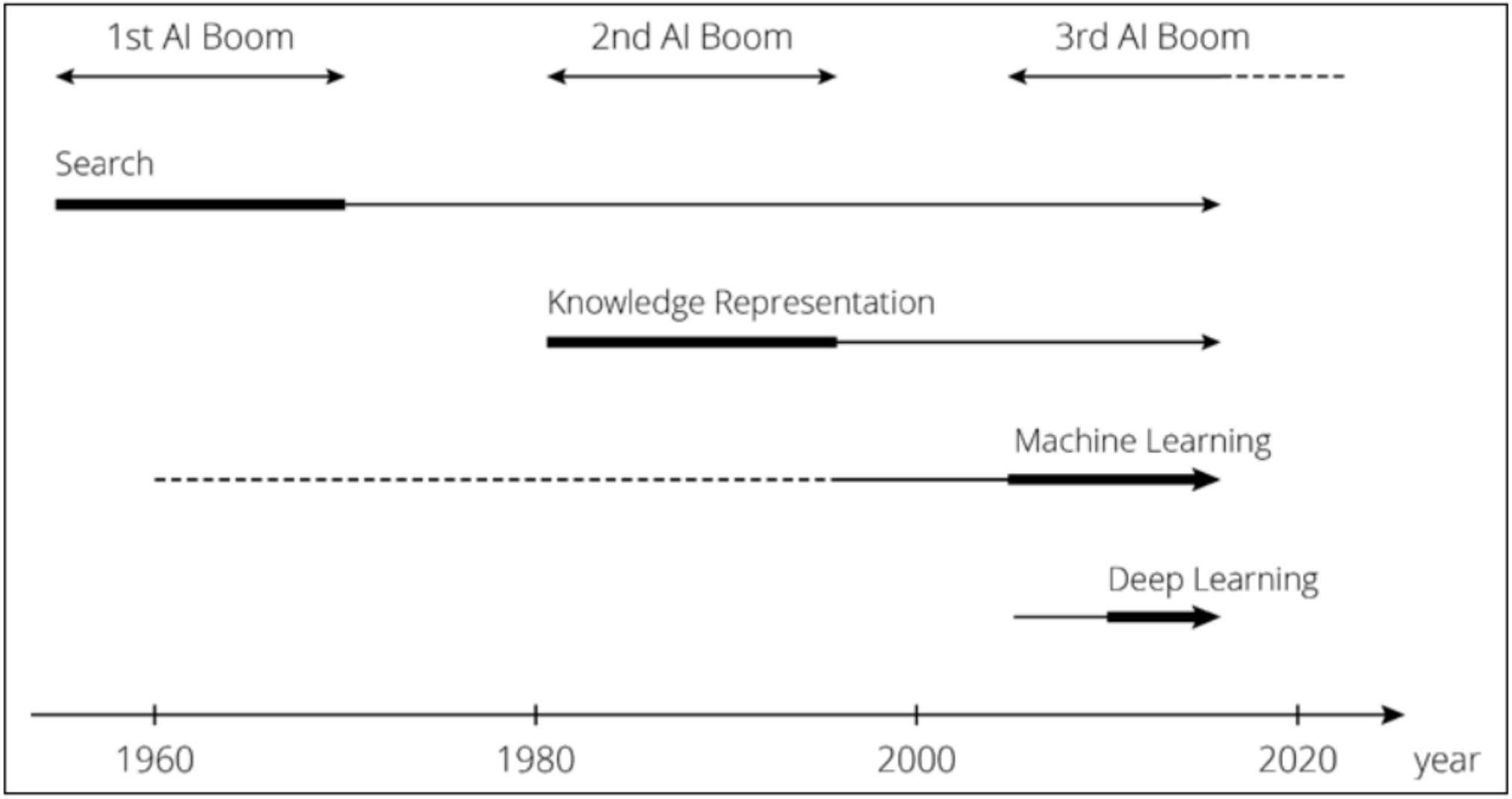
AI and Deep Learning



Deep Learning History

- 2006, Hinton, Toronto Univ., deep belief nets (DBN)
  - https://www.cs.toronto.edu/~hinton/absps/fastnc.pdf
- 2012, Hinton with SuperVision method, won image recognition competition Imagenet Large Scale Visual Recognition Challenge (ILSVRC)
  - 10 million training images and 150,000 test images

2012 Imagenet Result

Rank	Team name	Error
1	SuperVision	0.15315
2	SuperVision	0.16422
3	ISI	0.26172
4	ISI	0.26602
5	ISI	0.26646
6	ISI	0.26952
7	OXFORD_VGG	0.26979
8	XRCE/INRIA	0.27058

Deep Learning History

- 2012, Google, find a cat by training YouTube videos
  - http://googleblog.blogspot.com/2012/06/using-large-scale-brain-simulations-for.html
  - 10 million images from YouTube
  - A machine learned the concept of a cat

Trained Concept

- The characteristics of what deep learning thinks a cat is

Deep Learning History

- 2015, Google, Inceptionism, machine draw a picture
  - http://googleresearch.blogspot.ch/2015/06/inceptionism-going-deeper-into-neural.html

Inceptionism

Inceptionism on Github

- “Deep Dream”
- https://github.com/google/deepdream

Difference in Deep Learning

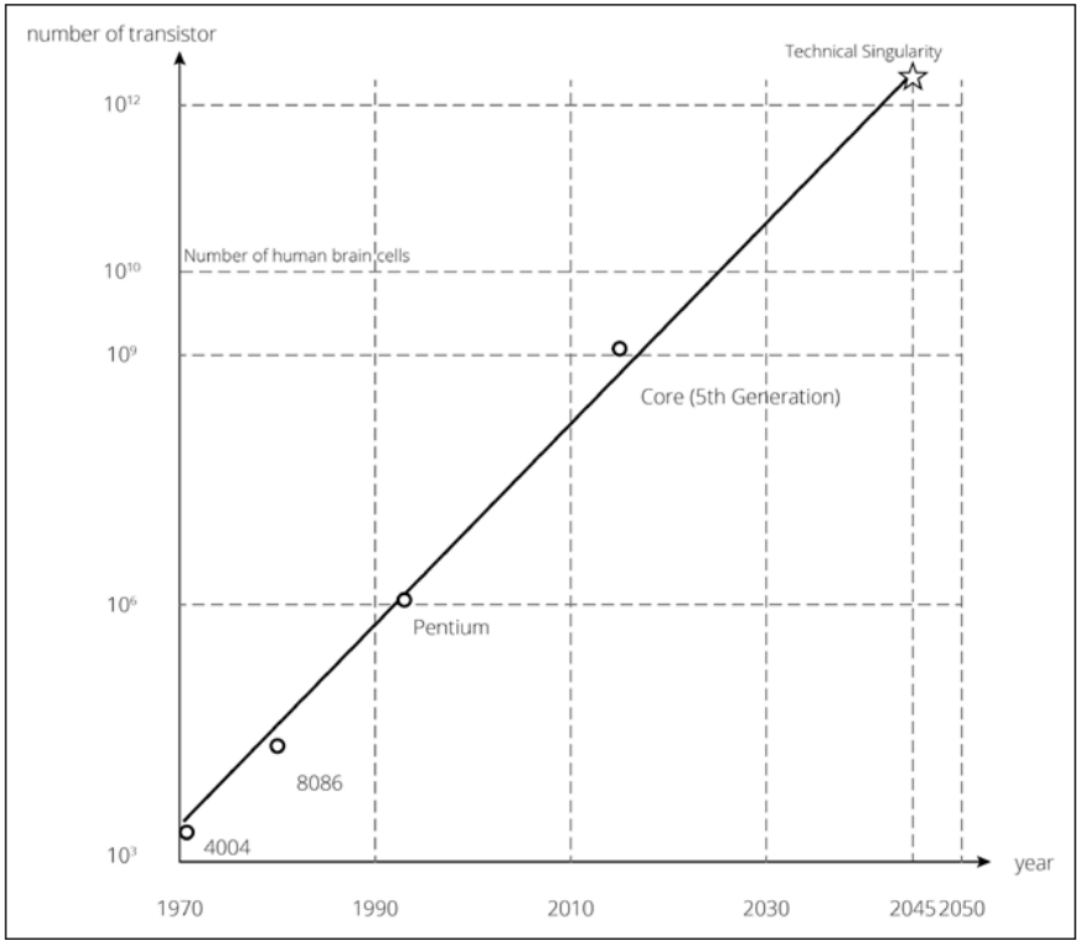
- Pretraining
  - Making each neural layer learn in advance
  - Learning starts from the lower-dimension layer in order, the data that is learned in the lower layer is treated as input data for the next layer
    - Learning feature from low-grade to high-grade

Difference in Deep Learning

- Dropout
  - The network become too dense in deep learning, dropout prevents the density problem
  - Learn by cutting some linkages randomly within the units of networks
    - Make the network sparse
    - Which linkage is cut is random, so a different network is formed at each learning step
    - Intimate human

Moore's Law

- Deep learning costs a lot of computation
- Technical Singularity in 2045
- AI should be ready



Stephen Hawking said...

- “The development of full artificial intelligence could spell the end of the human race”
  - http://www.bbc.com/news/technology-30290540

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Summary

- How techniques in the field of AI have evolved into deep learning
- 3 booms in AI
- The technique required for machine learning is called feature engineering
  - Tell a machine what the features of objects to be classified are
- Deep learning is the evolving technique of machine learning