Artificial Intelligence Past, Present, and Future

Paul Rad, Ph.D.

Associate Professor
College of Business School
Information Systems and Cyber Security
Cyber Analytics and AI
210.872.7259

Why AI

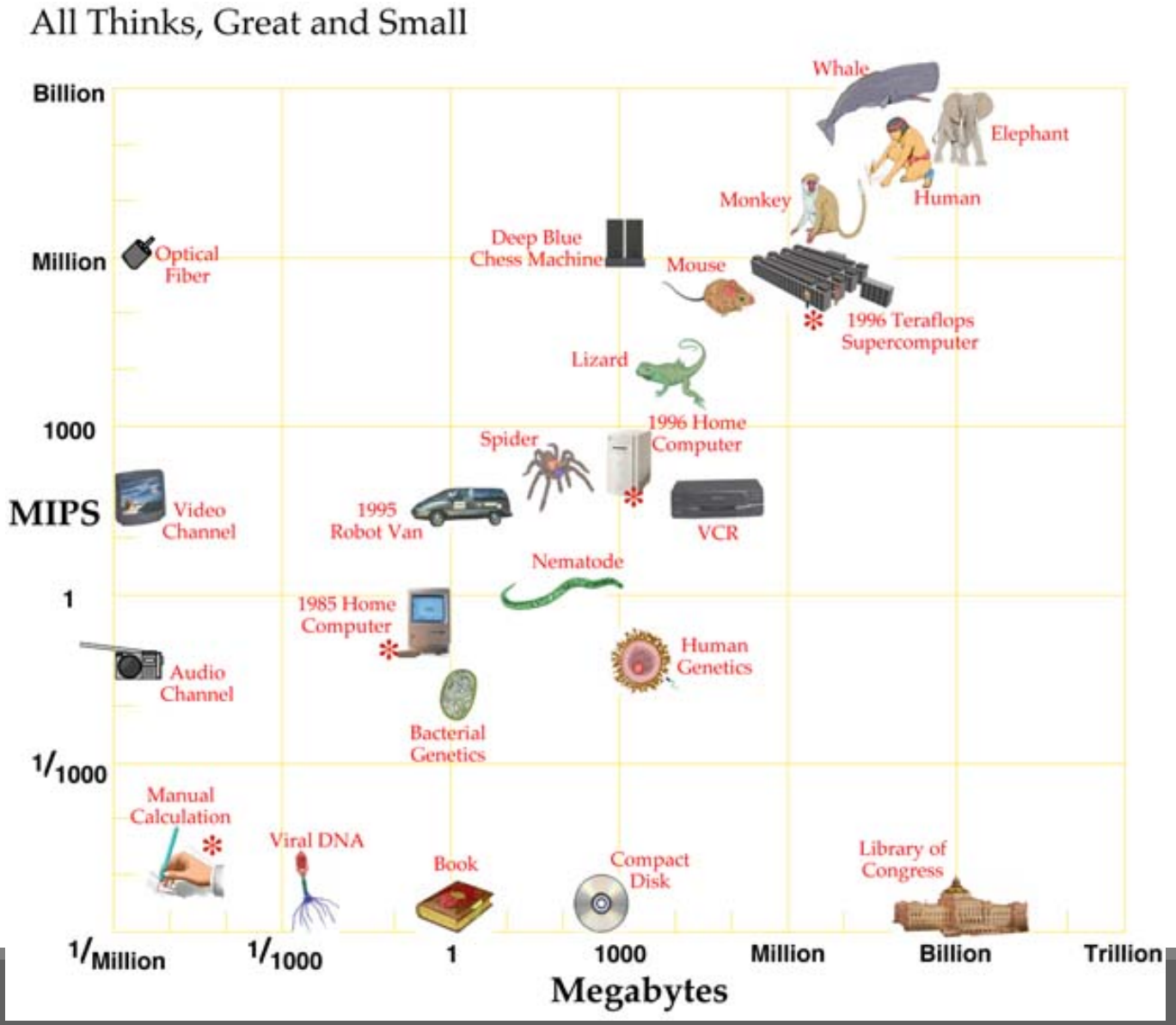
AI can have two purposes. One is to use the power of computers to augment human thinking, just as we use motors to augment human or horse power. Robotics and expert systems are major branches of that. The other is to use a computer's artificial intelligence to understand how humans think. In a humanoid way. If you test your programs not merely by what they can accomplish, but how they accomplish it, then you're really doing cognitive science; you're using AI to understand the human mind.

- Herb Simon

Herbert Alexander Simon (June 15, 1916 – February 9, 2001) was an American economist and political scientist whose primary interest was decision-making within organizations and is best known for the theories of "bounded rationality" and "satisficing".[5] He received the Nobel Prize in Economics in 1978 and the Turing Award in 1975. wikipidia

When will computer hardware match the human brain

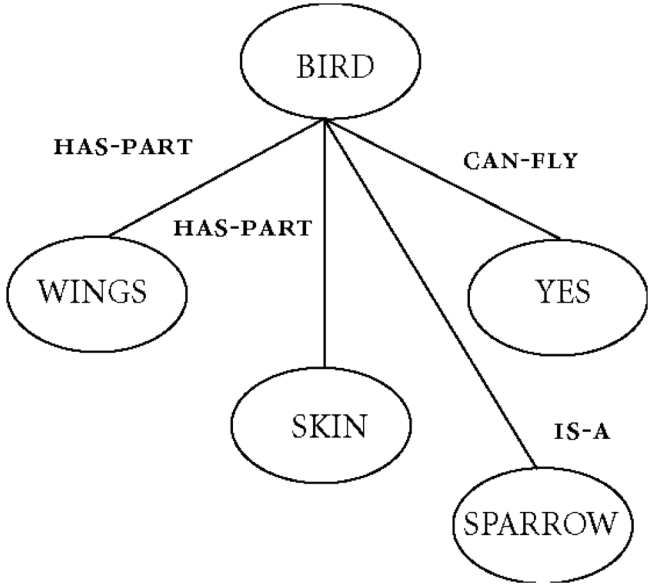
Moravec, Hans. "When will computer hardware match the human brain." *Journal of evolution and technology* 1.1 (1998): 10.



Symbolic vs. Subsymbolic AI

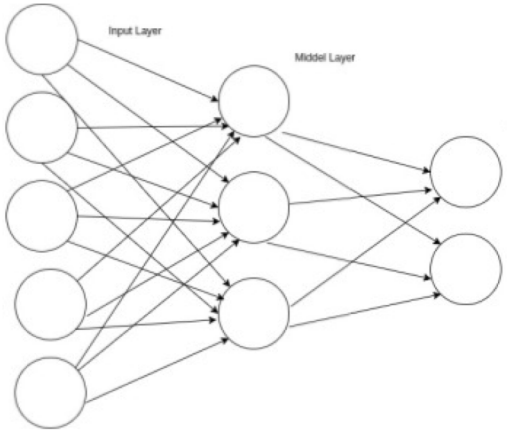
Subsymbolic AI

Statistical learning models such as LDA, SVM, HMM, Bayesian learning, Deep Learning



Symbolic AI

Explicit symbolic, Inference, search algorithms, Rules, Ontologies, Plans, Goals, …



Symbolic - Representation Knowledge

Representing Experience with Scripts, Frames, and Cases

Joe went to a restaurant. Joe ordered a hamburger. When the hamburger came, it was burnt to a crisp. Joe stormed out without paying.

The restaurant script:

Did Joe eat anything?

Rule based – 1st wave of AI systems

Rule based – Handcrafted Knowledge – Logical reasoning

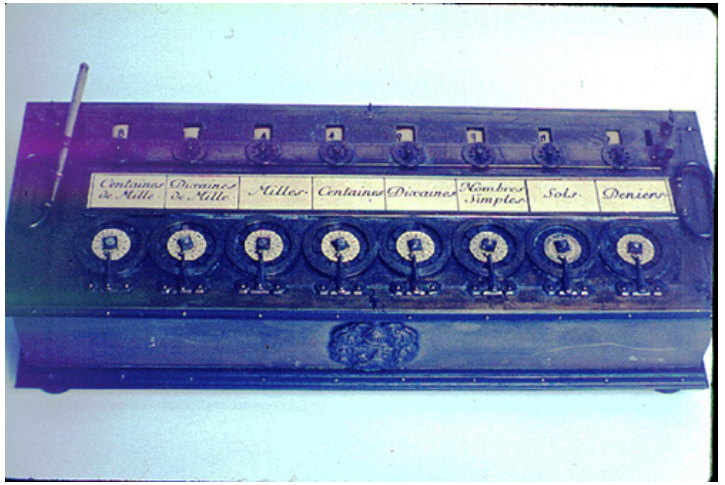
- Enables reasoning over narrowly defined domain
- Can’t handle uncertainty

Characteristics of intelligence

The Roots of Modern Technology

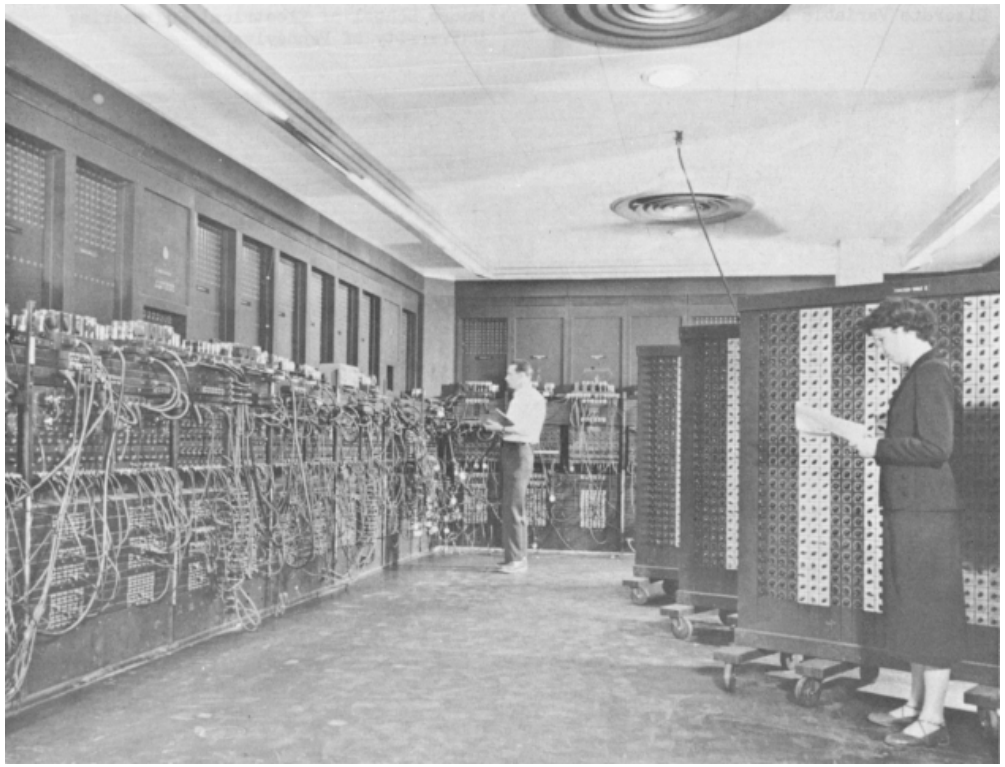
5th c B.C. Aristotelian logic invented

1642 Pascal built an adding machine



The Advent of the Computer

1945 ENIAC *The first electronic digital computer*



Alan Turing, an English Mathematician

- The Turing Test: How Will We Recognize AI?

- 1950 Alan Turing's paper, *Computing Machinery and Intelligence*, described what is now called "The Turing Test" *http://www.abelard.org/turpap/turpap.htm*

The Turing test is a test of a machine's ability to exhibit intelligent behavior equivalent to, or indistinguishable from a human.

- **AT Hype:** Turing predicted that in about fifty years "an average interrogator will not have more than a 70 percent chance of making the right identification after five minutes of questioning".

AI Hype - *A conversation with Jabberwacky, 2003*

Jabberwacky is a chatterbot created by British programmer Rollo Carpenter. Its stated aim is to "simulate natural human chat in an interesting, entertaining and humorous manner".

Jabberwacky: Have you been to the Moon?
***User:* No. Few have. Have you?**

Jabberwacky: Many a time my dear chap!
***User:* What was the most interesting thing you saw?**

Jabberwacky: Fred.
***User:* Why did you find him interesting?**

Jabberwacky: It just came into my head.
***User:* What sorts of things do you generally find interesting?**

Jabberwacky: Nothing but smelly socks.

AI Hype - *A conversation with Alice, 2004*

Who invented paper towels?

ALICE: The Chinese, long before Europeans.

Who invented pet rocks?

ALICE: The Wright Brothers.

Who invented Barbie dolls?

ALICE: Thomas Edison.

Chess Challenge

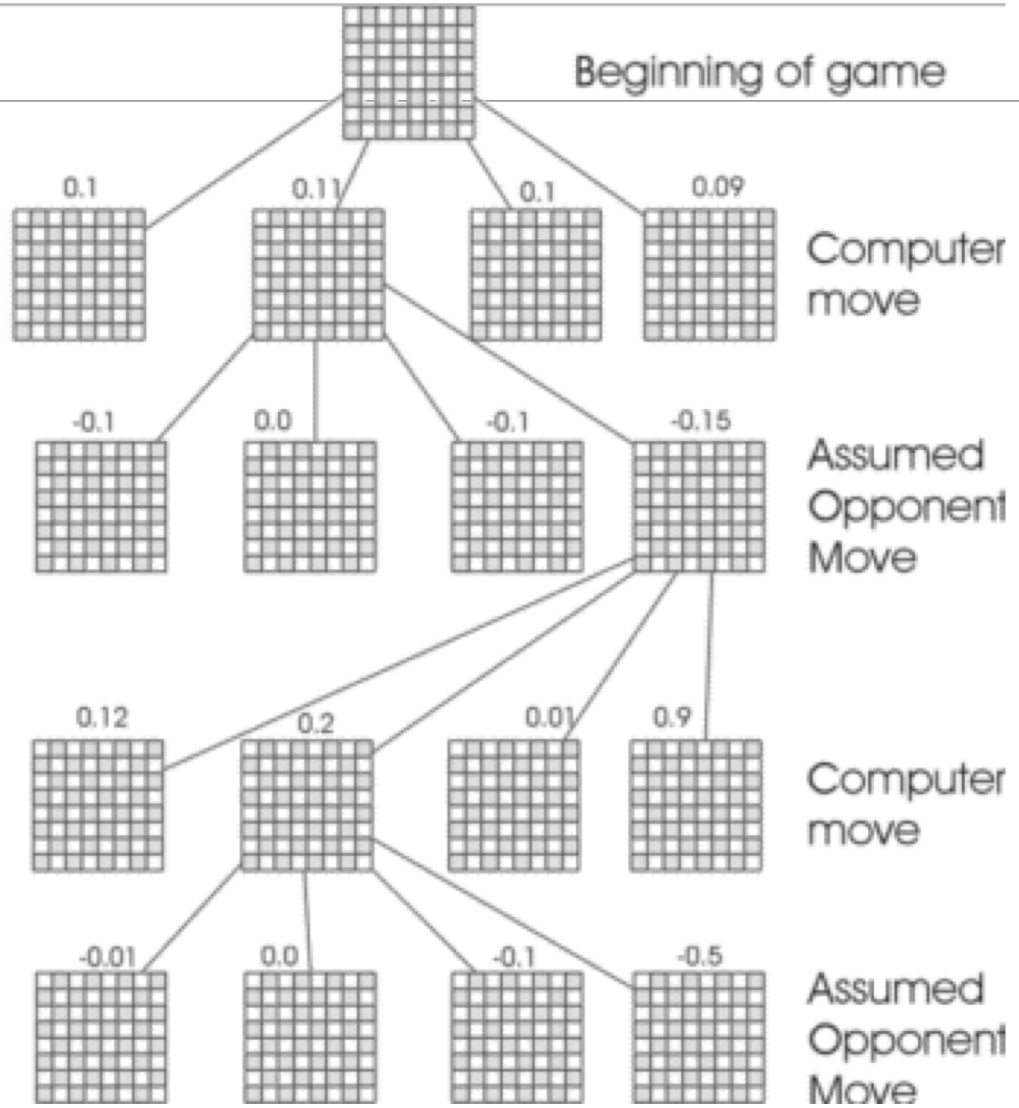
In 1957, Newell and Simon predicted that a computer will beat a human at chess within 10 years.

In 1997, Deep Blue beat Gary Kasparov.

Complexity and Scalability

Solving hard problems requires search in a large space.

To play master-level chess requires searching about 8 ply deep. So about 35^8 or $2 \cdot 10^{12}$ nodes must be examined.

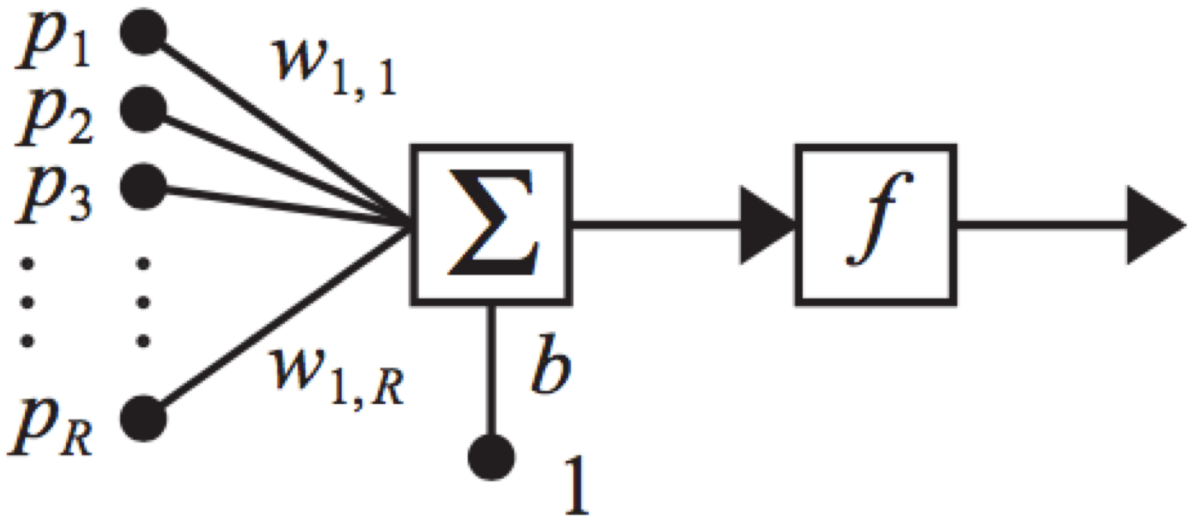


Symbolic AI – Expert Systems

Year	Methods Leading to Expert Systems
1967	Dendral – a rule-based system that infered molecular structure from mass spectral and NMR data
1975	Mycin – a rule-based system to recommend antibiotic therapy
1975	Meta-Dendral learned new rules of mass spectrometry, the first discoveries by a computer to appear in a refereed scientific journal
1979	EMycin – the first expert system shel
1980	XCON (R1) – first real commercial **expert system** at DEC, configures VAX systems
1980	Japanese Fifth Generation project launched as the Expert Systems age blossoms in the US.
1984	Gold Hill Common Lisp

Subsymbolic AI

1943 McCulloch and Pitts *A Logical Calculus of the Ideas Immanent in Nervous Activity.*



Statistical Learning – 2nd wave of AI Systems

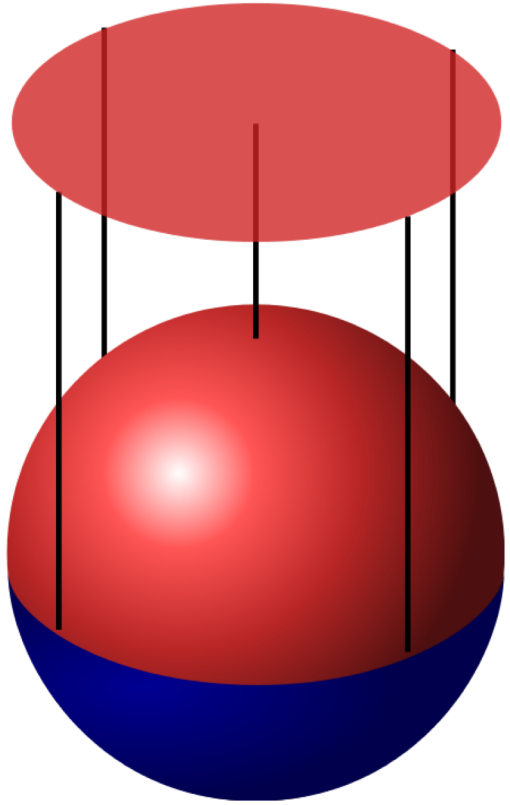
Requires creating statistical models for specific problem domain and train them on big data

- No contextual capability and minimum reasoning ability

Characteristics of intelligence

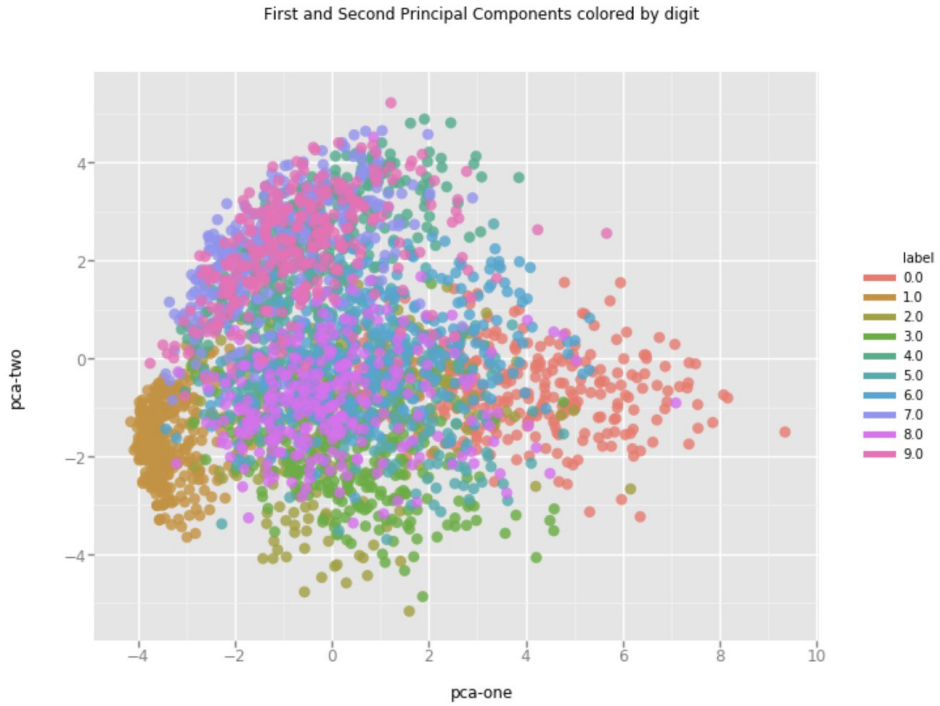
Manifold Hypothesis

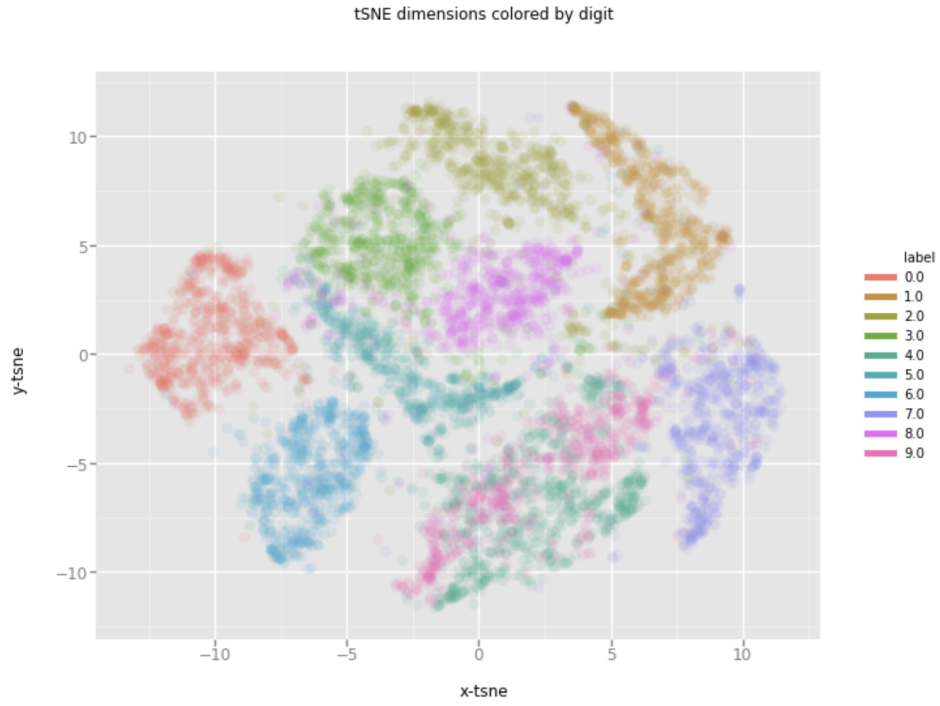
The manifold hypothesis is that real-world high dimensional data such as image lie on low-dimensional manifolds embedded in the high-dimensional space.



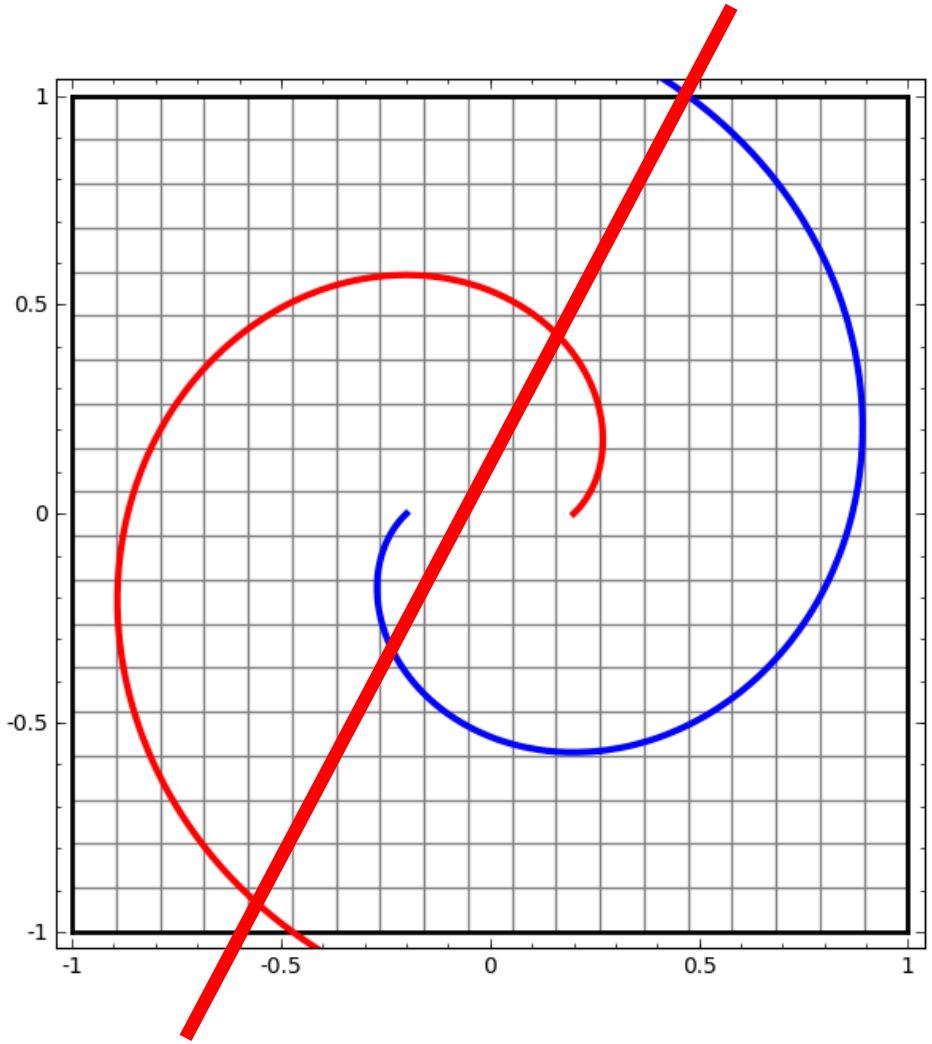
Manifolds

- Each Manifold represents a different entity
- Understanding data comes by separating the manifolds

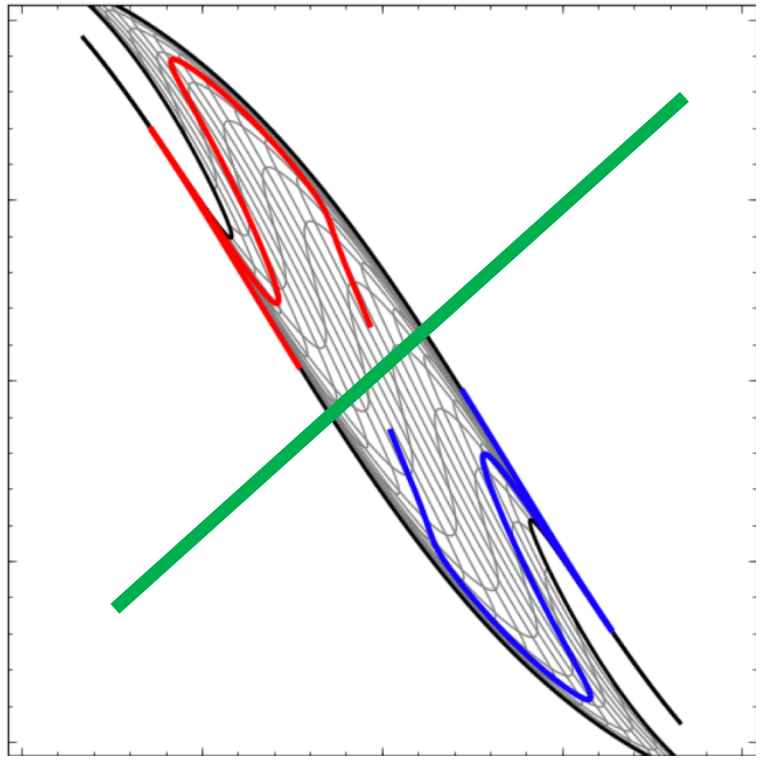




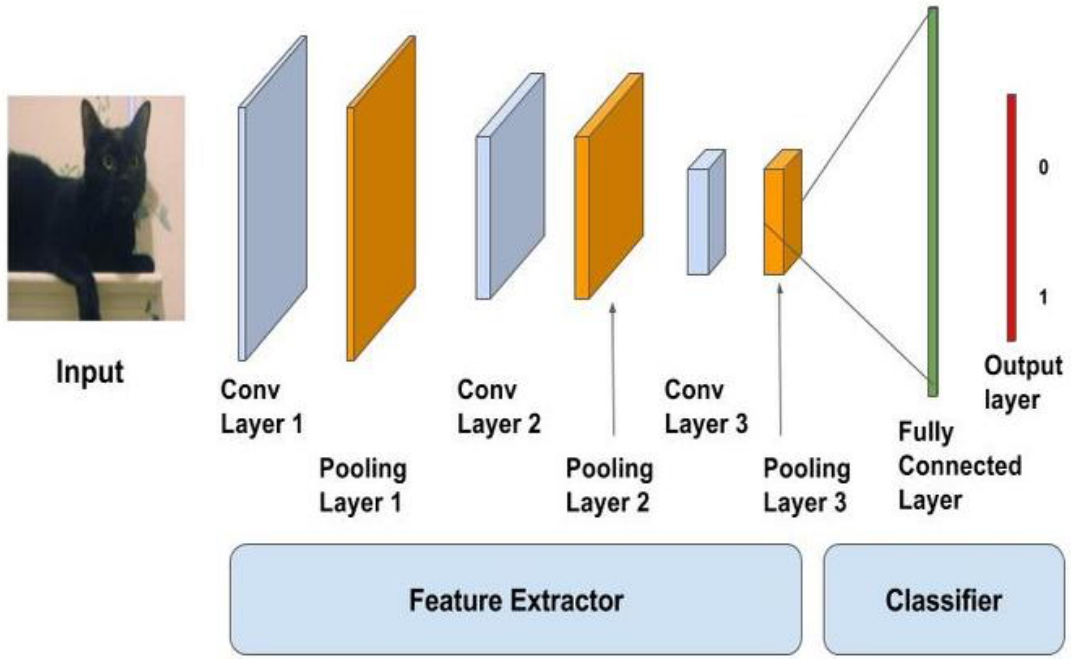
Separating manifolds



Stretch and Rotate



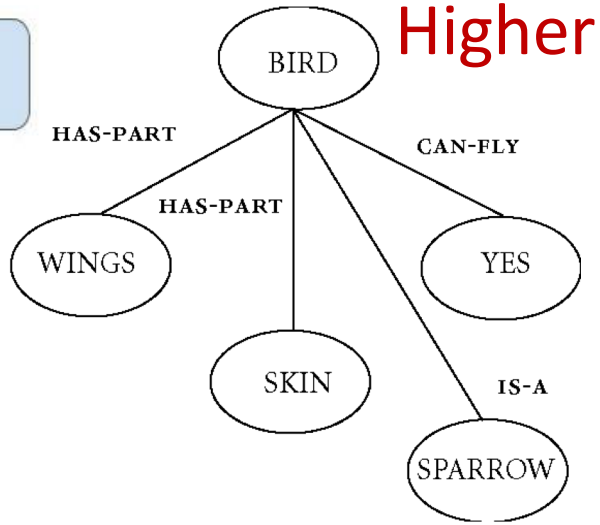
Deep Learning



Each layer stretches and rotates the data space until the manifolds are cleanly separated

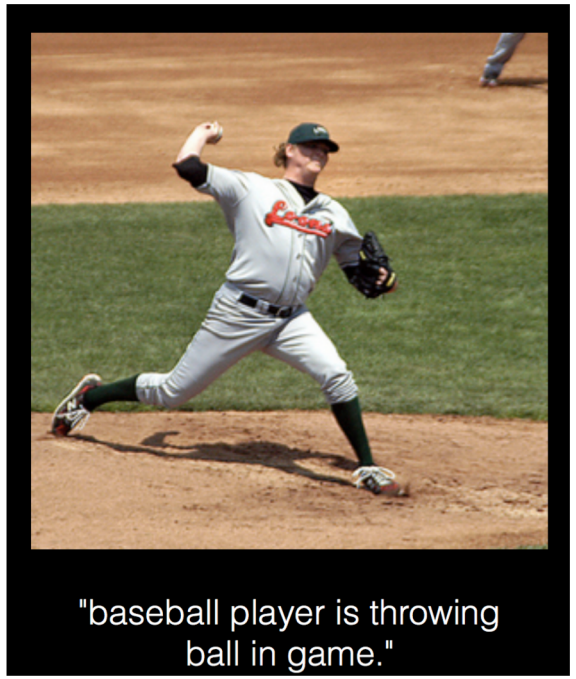
Why this is a CAT or BIRD?

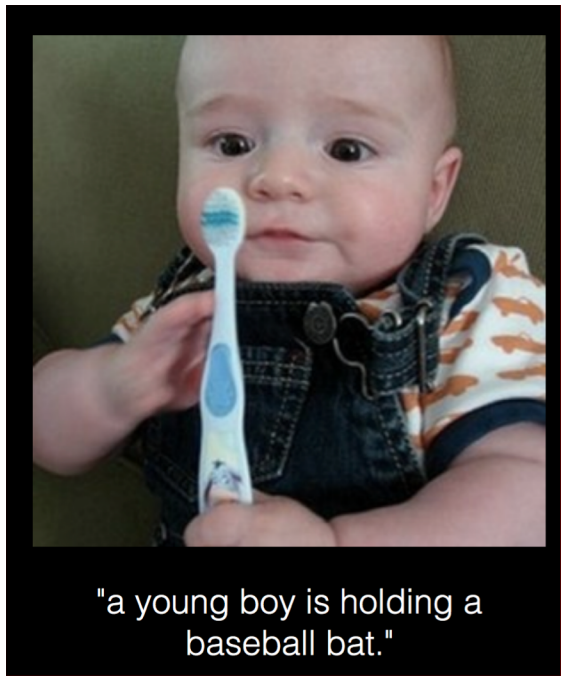
Higher probability



Challenges with 2nd wave systems

Image Captioning





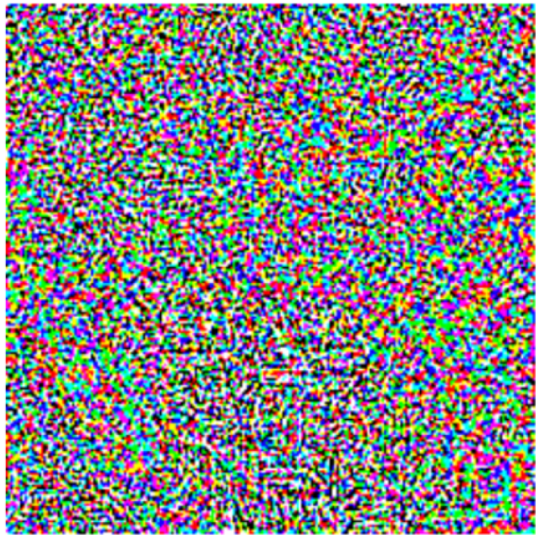
Statistically impressive but individually unreliable

Challenges with 2nd wave systems - Adversarial Attacks

$\boldsymbol{x}$

"panda"
57.7% confidence

$+ .007 \times$



$\text{sign}(\nabla_{\boldsymbol{x}} J(\boldsymbol{\theta}, \boldsymbol{x}, y))$

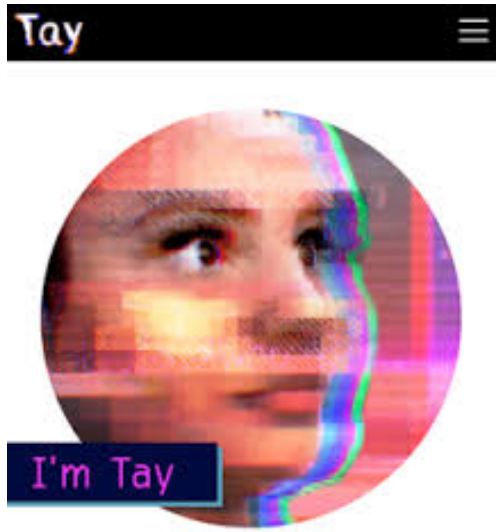
"nematode"
8.2% confidence

$=$

$\boldsymbol{x} + \epsilon \text{sign}(\nabla_{\boldsymbol{x}} J(\boldsymbol{\theta}, \boldsymbol{x}, y))$

"gibbon"
99.3 % confidence

Challenges with 2nd wave systems – Online Learning



Tay was an artificial intelligence chatter bot that was originally released by Microsoft via Twitter on March 23, 2016.

It caused subsequent controversy when the bot began to post inflammatory and offensive tweets through its Twitter account, forcing Microsoft to shut down the service only 16 hours after its launch.

With Online Systems:

Skewed training data creates maladaptation

Future: 3rd wave of AI

Contextual Adaptation

Models to explain decisions - Systems construct explanatory models for classes of real world phenomena

Abstraction of ideas.

Training with Less Data. neural nets currently need to be trained on tens to hundreds of thousands of examples to perform decent classification

Three proposed models:

1) Generative models & Meta Learning
2) Energy-Based Models (EBMs)
3) Neural networks with “capsules”

References

1) www.wikipedia.com

2) DARAP AI perspectives

3) Ian Goodfellow, Berkely (Adversarial Image)

4) 1943 McCulloch and Pitts *A Logical Calculus of the Ideas Immanent in Nervous Activity.*

5) 1950 Alan Turing's paper, *Computing Machinery and Intelligence*, described what is now called "The Turing Test"

6) Rad, Paul, et al. "AI Thinking for Cloud Education Platform with Personalized Learning." *Proceedings of the 51st Hawaii International Conference on System Sciences*. 2018.