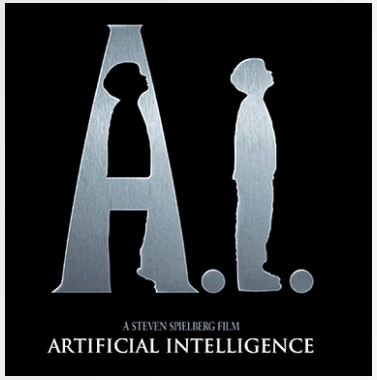
Introduction To Artificial Intelligence

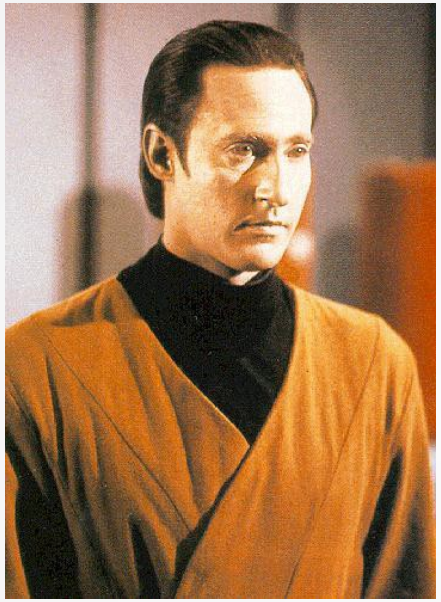
Learning Objectives

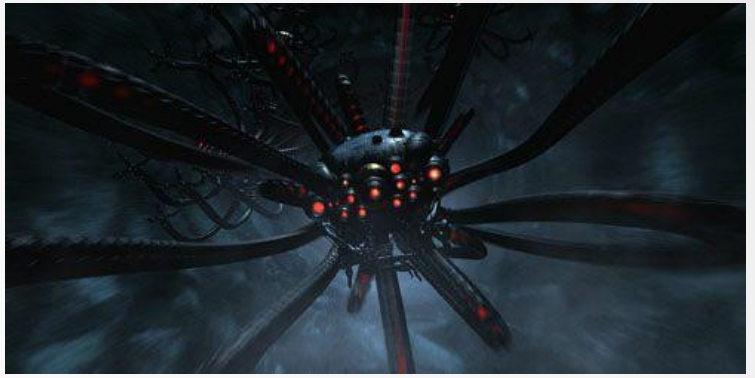
After completing this lecture, you will be able to:-

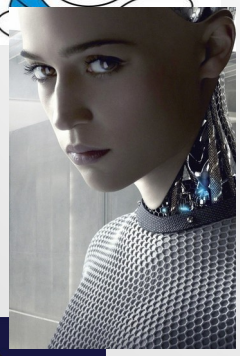
- Describe the 4 categories of AI
- Define and differentiate AI, ML, and DL
- Explain key historical developments in AI, in particular related to the “hype-AI winter” cycle
- Discuss the practical and current applications of AI in an industrial context
- Install and access modern tools for AI

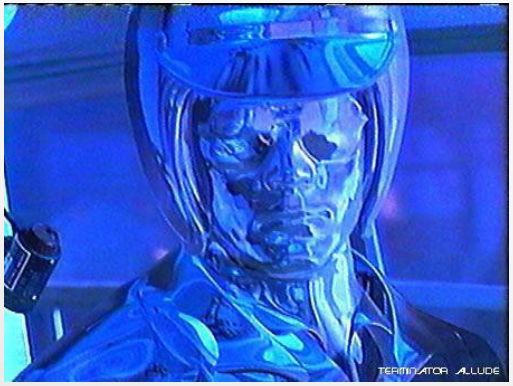
Where can AI be found?











Weak vs Strong AI – Claims

- Weak AI
  - Machines can be made to act ***as if*** they were intelligent
  - Eg. most of today's commercial versions of artificial intelligence (IBM's Deep Blue)
- Strong AI
  - Machines that act intelligently ***and*** have real, conscious minds
  - Eg. movie portrayals (refer slide 2)

What is AI?

- We consider intelligence a particularly human trait
- *Homo sapiens* means “man – wise”, *Sapient* refers to the ability to act with judgement
- Artificial Intelligence then, means creating/building an *intelligent* entity

What is AI?

- Views of AI falls into four categories

Thinking Humanly **Thinking Rationally**

Acting Humanly **Acting Rationally**

Thinking Humanly

- Cognitive modeling – from the 1960's “cognitive revolution”: information-processing psychology
- Requires scientific theories of internal activities of the brain. To validate:-
  - Predict and test behaviour of human subjects (top-down)
  - Directly identify neurological data (bottom-up)
- Both are now separate fields of research from AI (Cognitive Science/Cognitive Neuroscience)

Acting Humanly

- Name the actor, the movie, and the character

Acting Humanly

- Turing (1950) “Computing machinery and intelligence”
- Problem area – “Can machines think?”
- Redefined as – “Can machines behave intelligently?”
- Devised an Imitation Game to test for intelligence

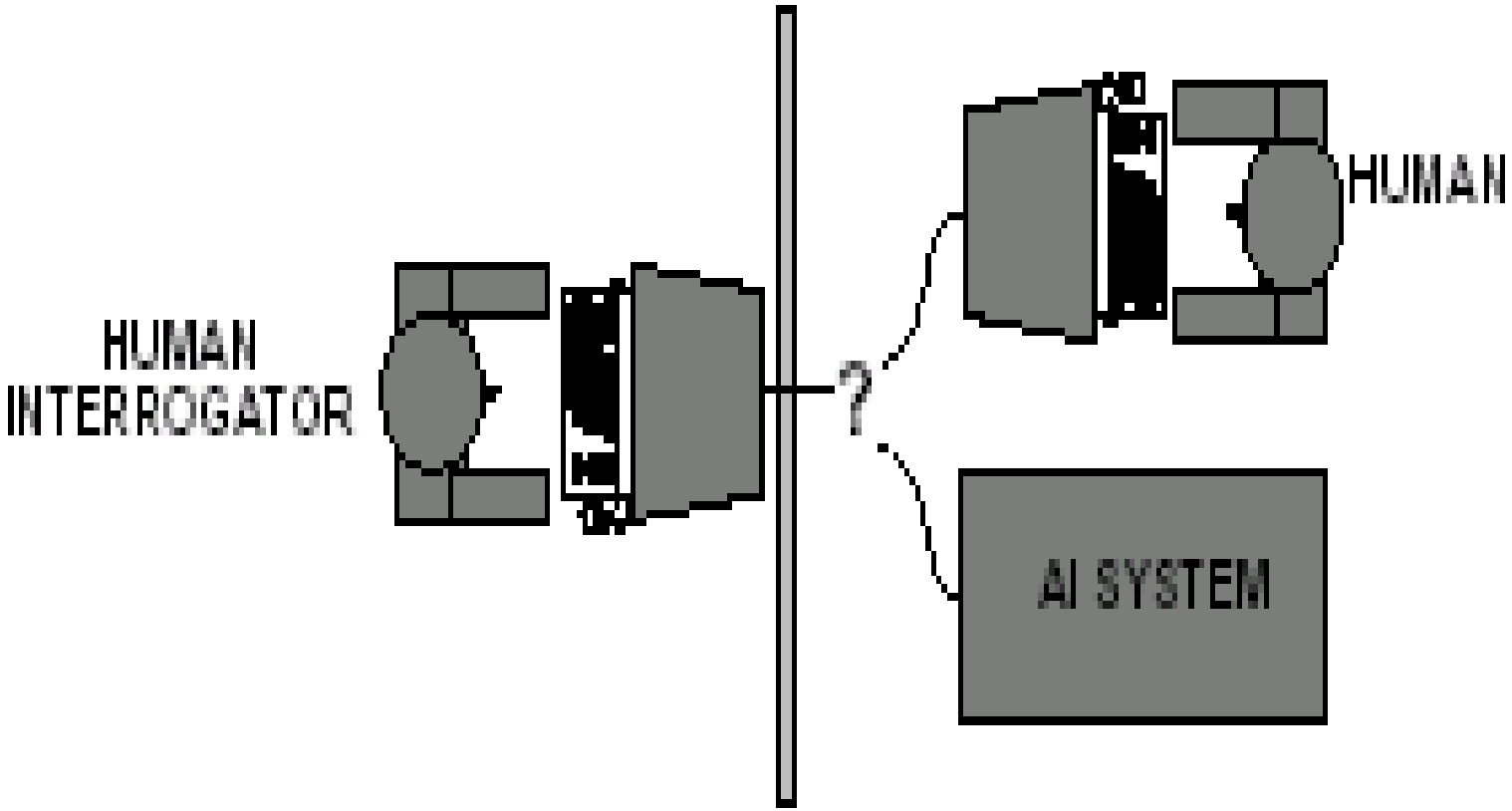
Acting Humanly - The Turing Test

- Developed by Alan Turing in 1950
- Objective: decide whether a particular machine was intelligent or not
- Origin: The Imitation Game
  - Involves 3 people (interrogator, man, woman)
  - Interrogator has to determine the gender of the two persons by asking questions via teletype

Acting Humanly - The Turing Test

- Modification: The Turing Test
  - Replace the man (or woman) with a machine
- The Turing Test takes place between:-
  - A machine
  - A human
  - An interrogator

Acting Humanly - The Turing Test



Acting Humanly - The Turing Test

- Interrogator communicates with the machine and human via teletype
- Objective of each party:-
  - Interrogator – ask a series of questions and determine which is human and which is machine
  - Machine – Confuse the interrogator sufficiently to make the wrong decision
  - Human – Convince the interrogator to make the right decision

Acting Humanly - Total Turing Test

- Turing Test deliberately avoids physical interaction, since physical simulation of a person is unnecessary for intelligence
- Thus, to pass the **Total Turing Test**, computer needs to add:-
  - Computer vision – object perception
  - Robotics – object manipulation and locomotion

Unreal AI Game Bots – Turing Test

http://www.eurekalert.org/pub_releases/2012-09/uota-aig092612.php

Unreal AI Game Bots – Turing Test

Unreal AI Game Bots – Turing Test

- Competition sponsored by 2K Games in UT2004
- Aim – have robots achieve a humanness rating > 52%
- Points scored by eliminating (killing) opponents
- Players also have a 'judging gun' to tag an opponent as human or bot

Unreal AI Game Bots – Turing Test

- Team from University of Texas submitted UT^2
- Computer Scientist Mihai Polceanu submitted MirrorBot
- Both achieved 52%
- Average human player ratings – 40%

Unreal AI Game Bots – Turing Test

- Requirements – mimic humans
  - Moving in 3-D space
  - Engage in combat against multiple opponents
  - Reason about best strategy in real-time
- Also
  - Exhibit irrational behaviour (grudge kill)
  - Imperfect aim (constraints on long distance accuracy and rapid movements)

Thinking Rationally

- Aristotle - “What are correct arguments/thought processes?” giving rise to “laws of thought”
- Logic – to think/behave reasonably
- Various forms of logic including *notation* and *rules of derivation* for thoughts – theoretically any solvable problem can be solved using logic-based programs

Thinking Rationally

- Arithmetic – statements about **numbers**
- Logic – statements about **objects**
- Directly gives rise through mathematics and philosophy to modern AI
- Problems:-
  - Not all intelligence is logical (missing information)
  - 'Can be' solved does not imply anything on the cost of finding the solution (time or otherwise)
  - What is the purpose of thinking?

Acting Rationally

- **Rational** behaviour – doing the right thing
- The 'right' thing – that which is expected to maximize goal achievement, given the information currently available
  - Often but not always logical
  - May not even involve thinking (reflex actions)
- Relies on skills required by Turing Test
- Performed by a **Rational Agent**

Acting Rationally – Rational Agents

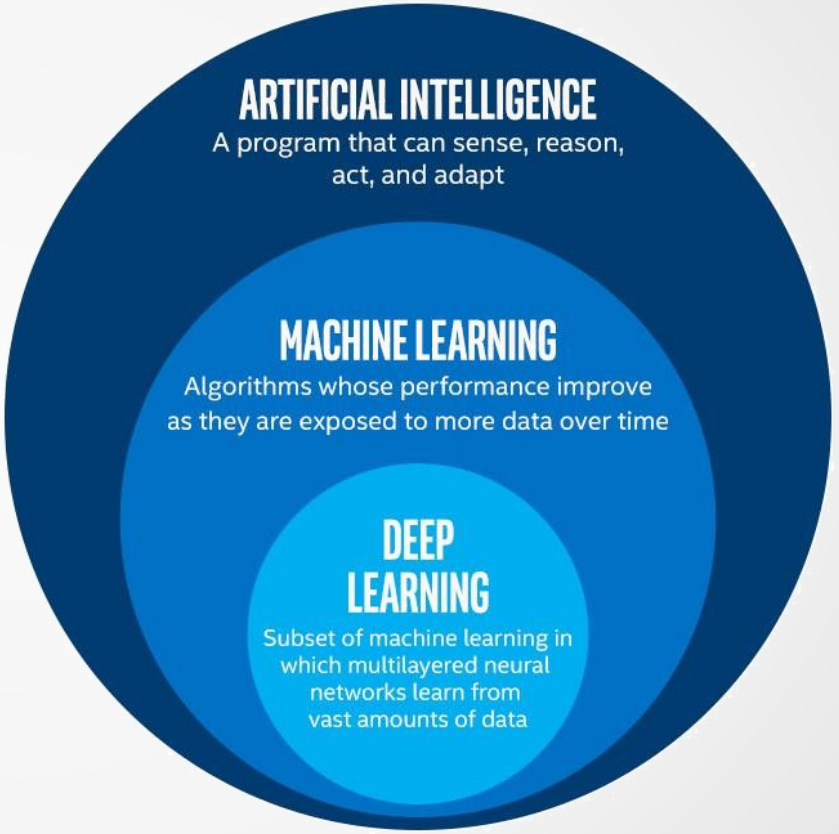
- Agent – an entity that perceives and acts
- This course is about designing rational agents
- In abstract, an agent is a function from percept histories to actions:

$$[f \cdot P^{\star} \rightarrow A]$$

- For any given class of environments/tasks, we seek the agent (or class of agents) with the best performance
- Caveat: computational limitations make perfect rationality unachievable
  - Design best program for given machine resources

AI, ML, and DL defined

- Artificial Intelligence
- Machine Learning
- Deep Learning

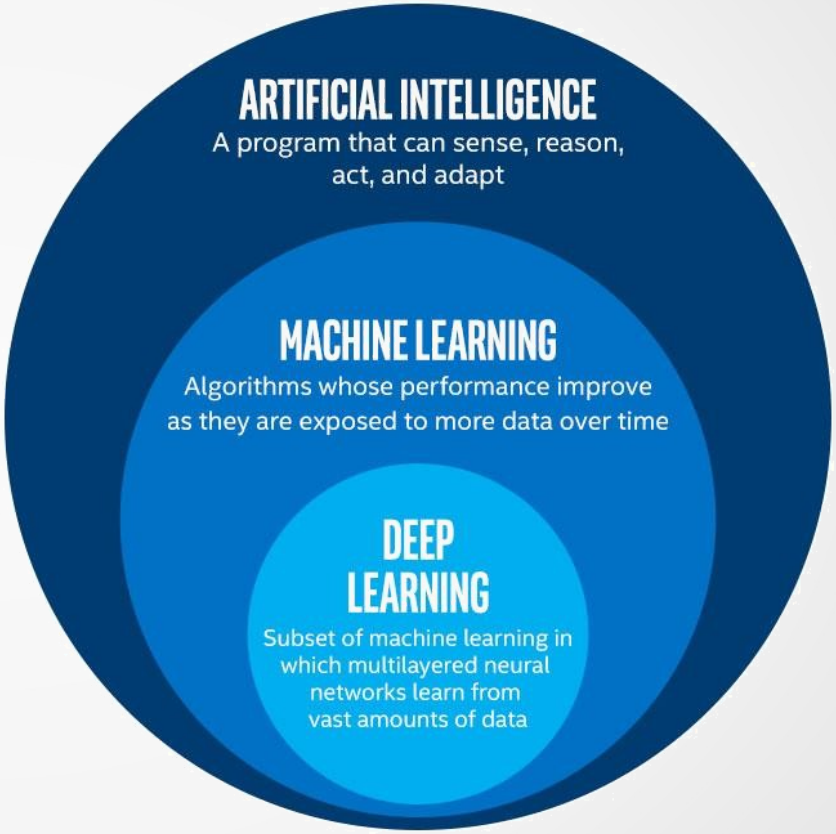


Artificial Intelligence Defined

- A branch of computer science dealing with the simulation of intelligent behavior in computers – Merriam-Webster
- A program that can sense, reason, act, and adapt – Intel
- Colloquially, the term ‘artificial intelligence’ is applied when a machine mimics ‘cognitive’ functions that humans associate with other human minds, such as ‘learning' and ‘problem solving’ – Wikipedia

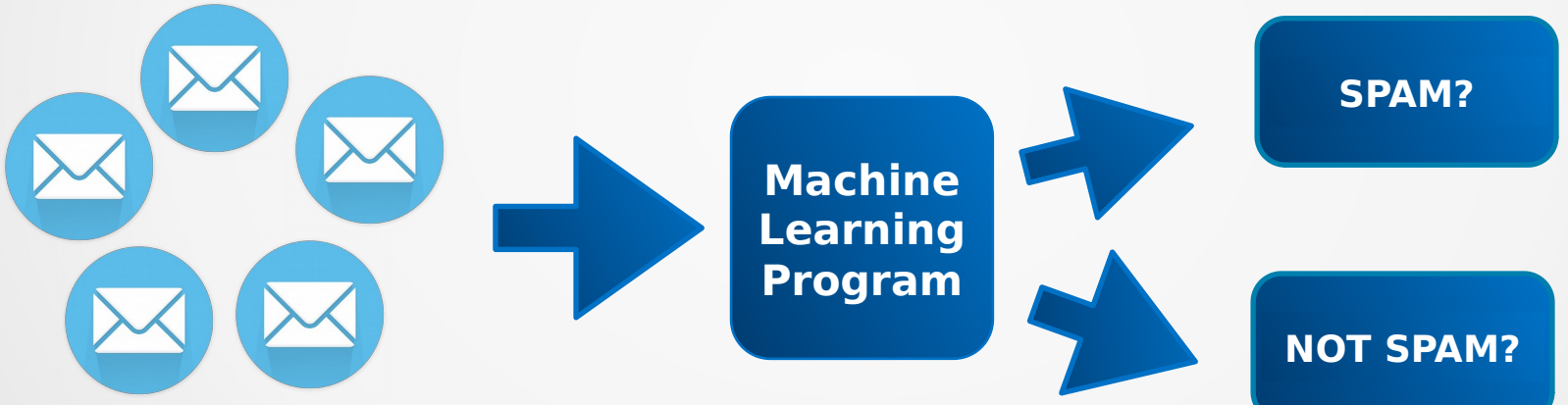
Machine Learning Defined

- The study and construction of programs that are not explicitly programmed, but learn patterns as they are exposed to more data over time – Intel



Machine Learning Defined

- ML programs learn from repeatedly seeing data, rather than being explicitly programmed by humans



Emails are labeled as spam vs. not

The more emails the program sees...

...the better it gets at classification

Machine Learning Terminology

- For example, when classifying flower species from a set of measurements...

Features:
Attributes of the data.

Target:
Column to be predicted.

sepal length	sepal width	petal length	petal width	species
6.7	3.0	5.2	2.3	virginica
6.4	2.8	5.6	2.1	virginica
4.6	3.4	1.4	0.3	setosa
6.9	3.1	4.9	1.5	versicolor
4.4	2.9	1.4	0.2	setosa
4.8	3.0	1.4	0.1	setosa
5.9	3.0	5.1	1.8	virginica
5.4	3.9	1.3	0.4	setosa
4.9	3.0	1.4	0.2	setosa
5.4	3.4	1.7	0.2	setosa

Machine Learning Terminology

- There are two main types of machine learning

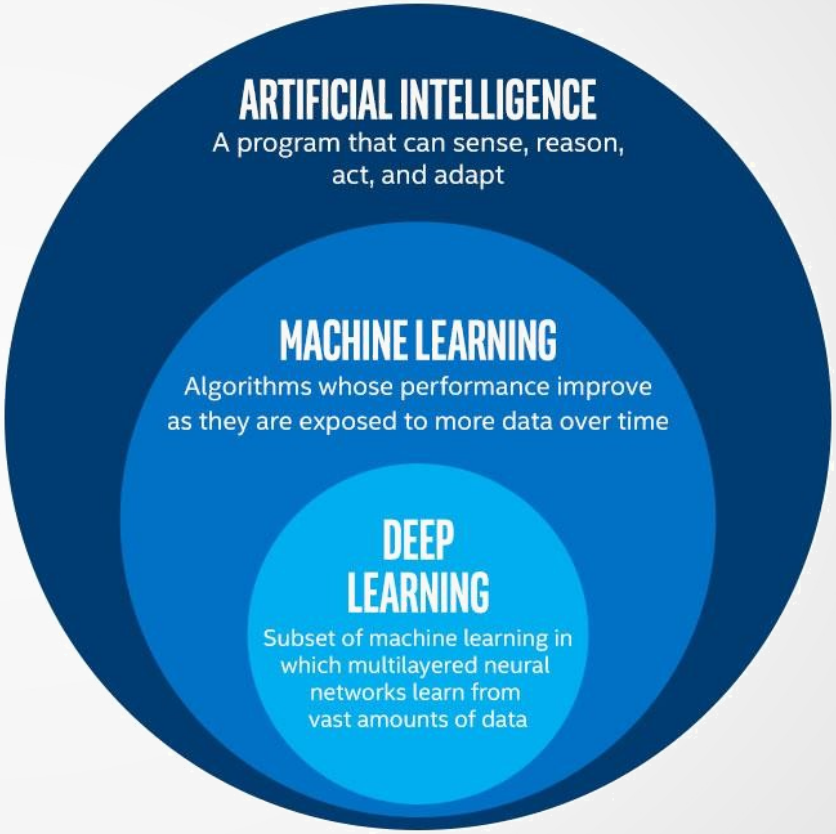
	Dataset	Goal	Example
Supervised Learning	Has a target column	Make predictions	Fraud detection
Unsupervised Learning	Does not have a target column	Find structure in the data	Customer segmentation

Machine Learning Limitations

- Machine Learning uses features (based on data) to achieve the target classification or value
- Defining these features is easy for some problems, but almost impossible for others
- Suppose you want to determine an image is that of a cat or a dog. What features would you use?

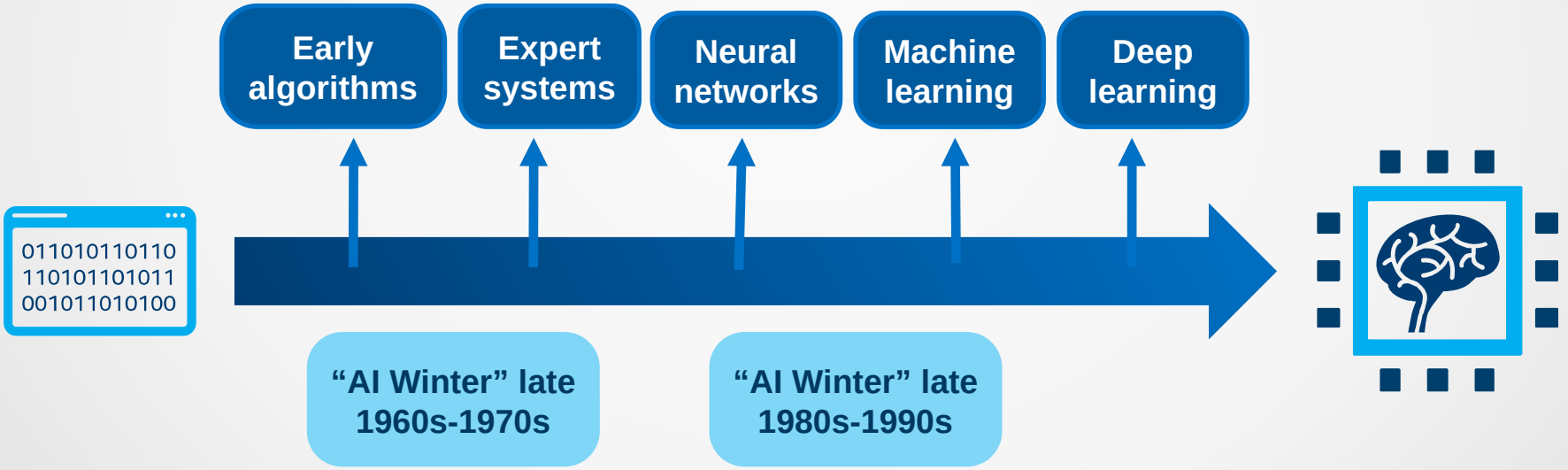
Deep Learning Defined

- Machine learning that involves using very complicated models called “deep neural networks” – Intel
- ***Models*** determine best representation of original data; in classic machine learning, humans must do this.



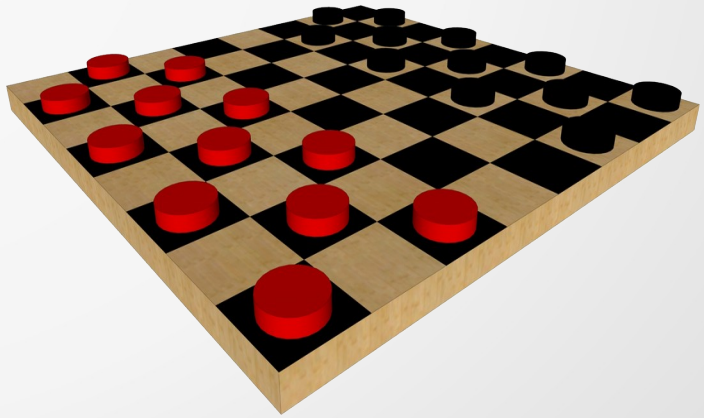
History of AI

- Artificial Intelligence has experienced several hype cycles, oscillating between periods of excitement and disappointment



History of AI – 1950s (Early AI)

- 1950: Alan Turing developed the Turing test to test a machines ability to exhibit intelligent behavior.
- 1956: Artificial Intelligence was accepted as a field at the Dartmouth Conference.
- 1957: Frank Rosenblatt invented the perceptron algorithm. This was the precursor to modern neural networks.
- 1959: Arthur Samuel published an algorithm for a checkers program using machine learning.



History of AI – First AI Winter

- 1966: ALPAC committee evaluated AI techniques for machine translation and determined there was little yield from the investment.
- 1969: Marvin Minsky published a book on the limitations of the Perceptron algorithm which slowed research in neural networks.
- 1973: The Lighthill report highlights AI's failure to live up to promises.
- The two reports led to cuts in government funding for AI research leading to the first "AI Winter."

John R. Pierce, head of ALPAC

History of AI – 1980s (AI Boom)

- Expert Systems - systems with programmed rules designed to mimic human experts.
- Ran on mainframe computers with specialized programming languages (e.g. LISP).
- Were the first widely-used AI technology, with two-thirds of "Fortune 500" companies using them at their peak.
- 1986: The “Backpropogation” algorithm is able to train multi-layer perceptrons leading to new successes and interest in neural network research.

Early expert systems machine

History of AI – Second AI Winter

- From late 80s to early 90s
- Expert systems' progress on solving business problems slowed.
- Expert systems began to be melded into software suites of general business applications (e.g. SAP, Oracle) that could run on PCs instead of mainframes.
- Neural networks didn't scale to large problems.
- Interest in AI in business declined.

History of AI – Classical ML

- Advancements in the SVM algorithm led to it becoming the machine learning method of choice.
- AI solutions had successes in speech recognition, medical diagnosis, robotics, and many other areas.
- AI algorithms were integrated into larger systems and became useful throughout industry.
- The Deep Blue chess system beat world chess champion Garry Kasparov.
- Google search engine launched using artificial intelligence technology.

IBM supercomputer

History of AI – Rise of Deep Learning

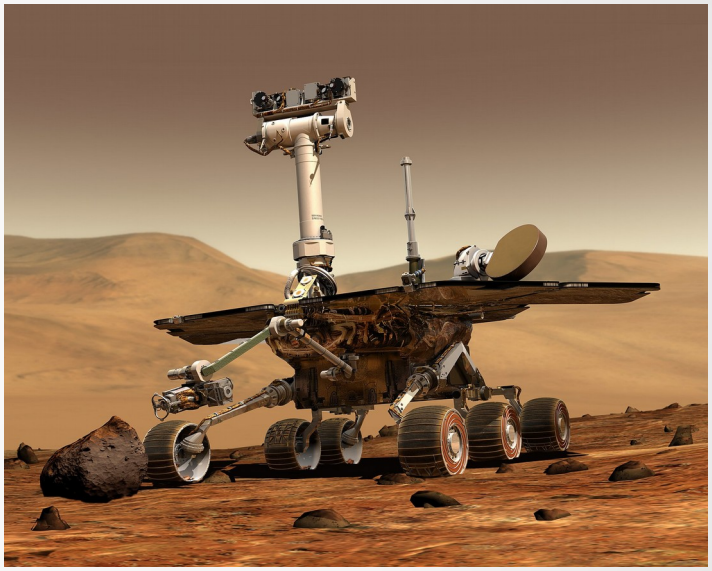
- 2006: Geoffrey Hinton publishes a paper on unsupervised pre-training that allowed deeper neural networks to be trained.
- Neural networks are rebranded to deep learning.
- 2009: The ImageNet database of human-tagged images is presented at the CVPR conference.
- 2010: Algorithms compete on several visual recognition tasks at the first ImageNet competition.

History of AI – Rise of Deep Learning

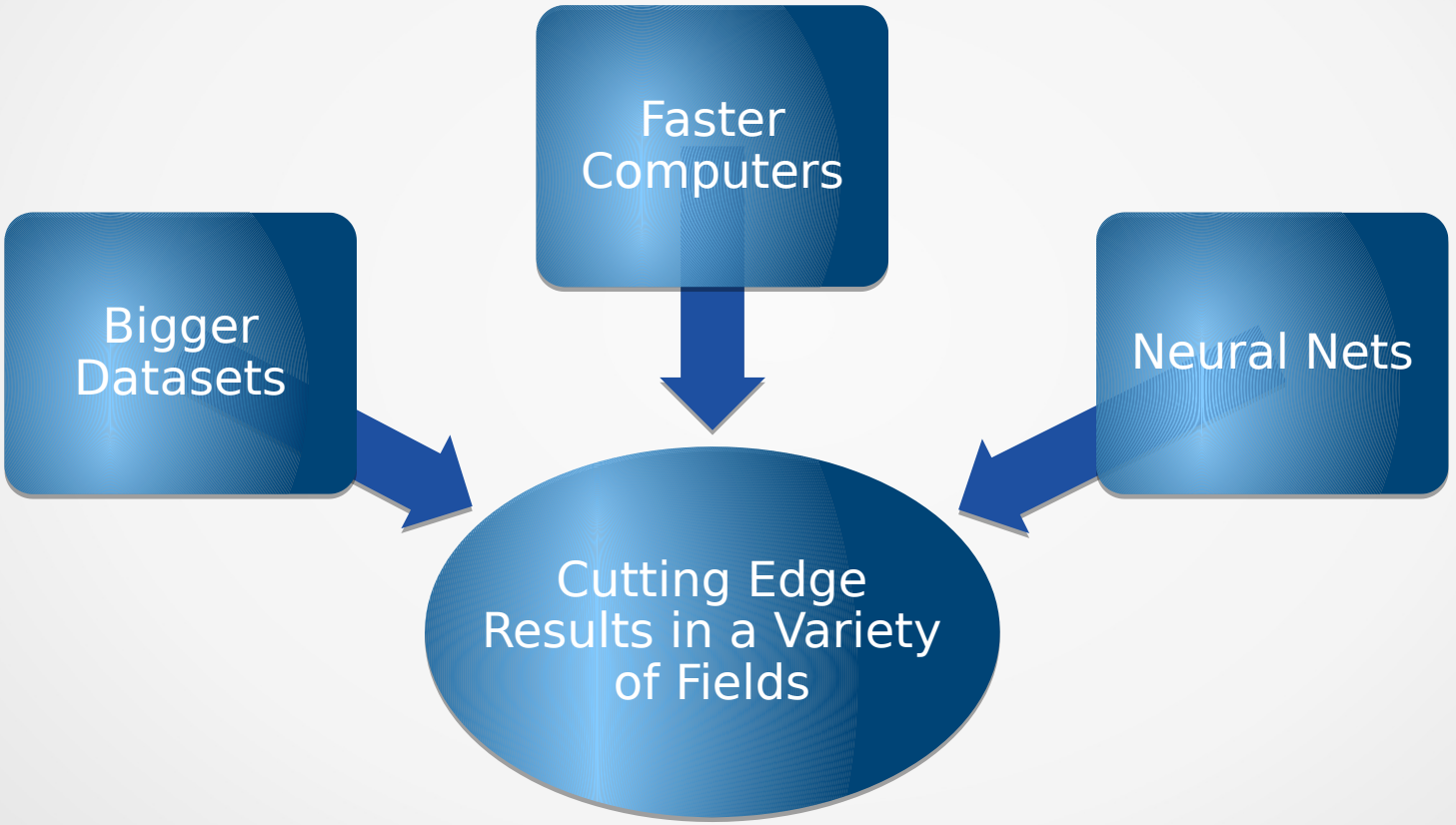
- In 2012, deep learning beats previous benchmark on the ImageNet competition.
- In 2013, deep learning is used to understand “conceptual meaning” of words.
- In 2014, similar breakthroughs
- appeared in language translation.
- These have led to advancements in Web Search, Document Search, Document Summarization, and Machine Translation.

History of AI – Rise of Deep Learning

- In 2014, computer vision algorithm can describe photos.
- In 2015, Deep learning platform TensorFlow* is developed.
- In 2016, DeepMind* AlphaGo, developed by Aja Huang, beats Go master Lee Se-dol.



Modern AI – What's the difference?



Modern AI – What's the difference?

- Continued expansion of open source AI, especially in Python, aiding machine learning and big data ecosystems.
- Leading deep learning libraries open sourced, allowing further adoption by industry.
- Open sourcing of large datasets of millions of labeled images, text datasets such as Wikipedia has also driven breakthroughs.

Industrial Examples of AI's Impact