Artificial Intelligence (CS303)

Lecture 0: Introduction

Course Information

- **People**

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- Main reference:

S. Russel & P. Norvig, Artificial Intelligence – A Modern Approach (3rd Edtition)

Please do **not** expect **immediate** response from us, although we will do our best to support your study as much as possible.

Outline of this lecture

- What is AI? (state-of-the-art, history, etc…)
- What you can (or cannot) expect to learn from this course?
- Preliminary knowledge
- Course structure and requirements

What is AI?

- Which figure is consistent with your imagination about AI?



- All of them can be claimed as AI, while are quite different.

What is AI?

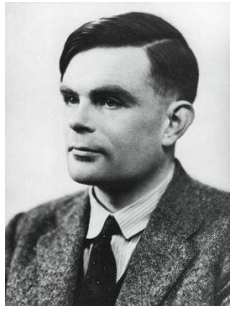
- In traditional AI literature, all the 4 cases are referred to as Agents.
- Agent is an abstract concept, it can be everything, similar to a point (object) in a high school physics textbook.
- Agent is the most basic terminology, as well as the entity to investigate, in many classical AI literature.
- Recently, different sub-areas of AI have started using more domain-specific terminology, rather than agent, e.g., “learner” in machine learning.

What is AI?

Agent Type	Performance Measure	Environment	Actuators	Sensors
Medical diagnosis system	Healthy patient, reduced costs	Patient, hospital, staff	Display of questions, tests, diagnoses, treatments, referrals	Keyboard entry of symptoms, findings, patient's answers
Satellite image analysis system	Correct image categorization	Downlink from orbiting satellite	Display of scene categorization	Color pixel arrays
Part-picking robot	Percentage of parts in correct bins	Conveyor belt with parts; bins	Jointed arm and hand	Camera, joint angle sensors
Refinery controller	Purity, yield, safety	Refinery, operators	Valves, pumps, heaters, displays	Temperature, pressure, chemical sensors
Interactive English tutor	Student's score on test	Set of students, testing agency	Display of exercises, suggestions, corrections	Keyboard entry

What is AI? – The Origin

- The rough idea of AI can be dated back to 1950, by **Alan Turing** in his paper "Computing machinery and intelligence. Mind, 49:433-460, 1950."



- The Dartmouth Artificial Intelligence (AI) Conference in 1956, initiated by **John McCarthy** gave the birth of the AI area.

What is AI? – The Origin

AI is not a rigorously defined concept since 1956.

Basically, Artificial Intelligence is about how to make machines (computers) handle intelligent tasks that could only be handled by human.

What is AI? - Motivation

- Most of us believe that human beings are *intelligent*.
- An ambitious question: can the intelligent human beings *build* other entities (agents) that are at least as intelligent as we are?
- What is intelligence and how can we measure it? Sounds like a philosophical question…
- No unique answer.

What is AI? – As time goes by

Thinking like a human

- Intelligent Search
- Machine Learning
- Logical Reasoning

Listening like a human

- Speech Recognition
- Machine Translation

Seeing like a human

- Machine Vision
- Autonomous Driving

Acting like a human

- Walking Control

What is AI? – As time goes by

- Some (not exhaustive) definition of AI.

Thinking Humanly	**Thinking Rationally**
"The exciting new effort to make computers think . . . *machines with minds*, in the full and literal sense." (Haugeland, 1985) "[The automation of] activities that we associate with human thinking, activities such as decision-making, problem solving, learning . . ." (Bellman, 1978)	"The study of mental faculties through the use of computational models." (Charniak and McDermott, 1985) "The study of the computations that make it possible to perceive, reason, and act." (Winston, 1992)
Acting Humanly	**Acting Rationally**
"The art of creating machines that perform functions that require intelligence when performed by people." (Kurzweil, 1990) "The study of how to make computers do things at which, at the moment, people are better." (Rich and Knight, 1991)	"Computational Intelligence is the study of the design of intelligent agents." (Poole *et al.*, 1998) "AI . . . is concerned with intelligent behavior in artifacts." (Nilsson, 1998)

What is AI? – As time goes by

- Some (not exhaustive) definition of AI.

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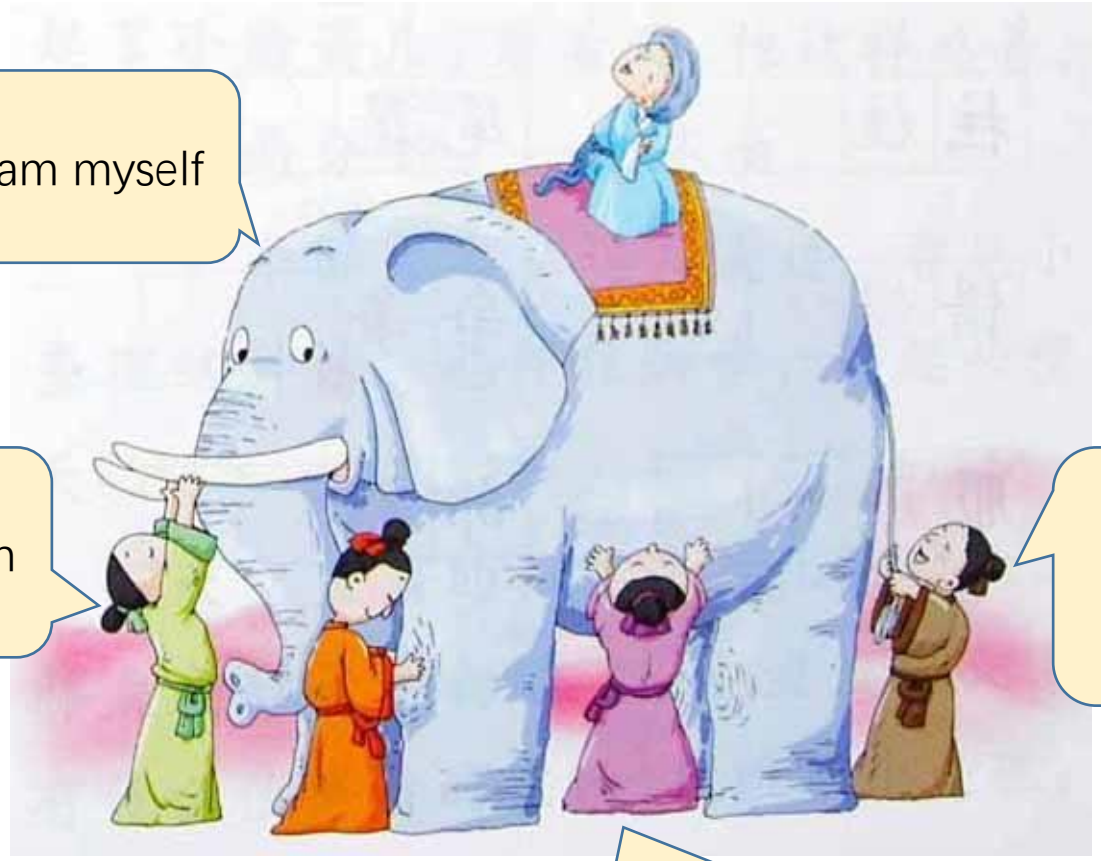
What is AI? – After 60 years



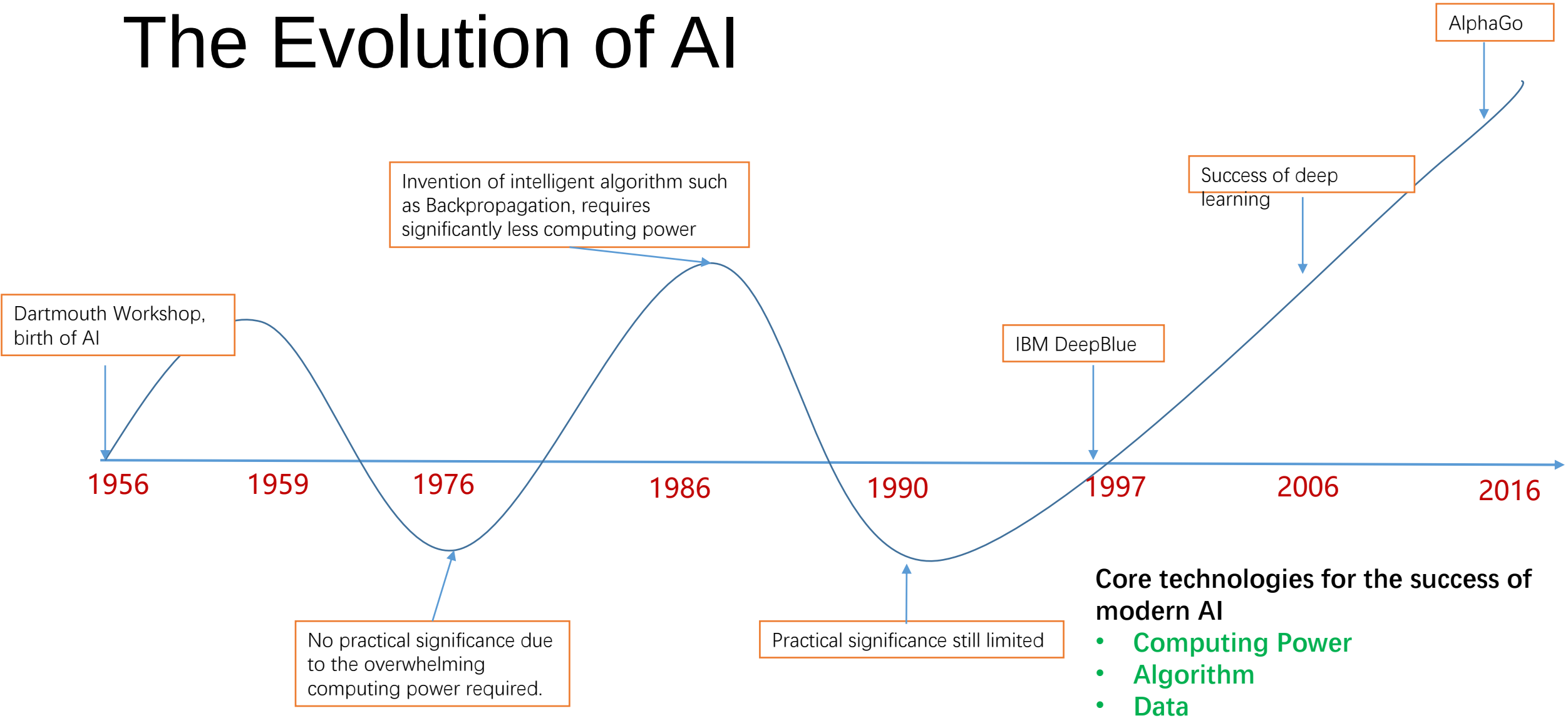
AI: I am myself

Biologist: we should understand how brain works!

Engineer: I just want to build an intelligent system/agent that functions properly…

Logician & Mathematician: AI should be rigorously provable!

The Evolution of AI



Core technologies for the success of modern AI

- **Computing Power**
- **Algorithm**
- **Data**

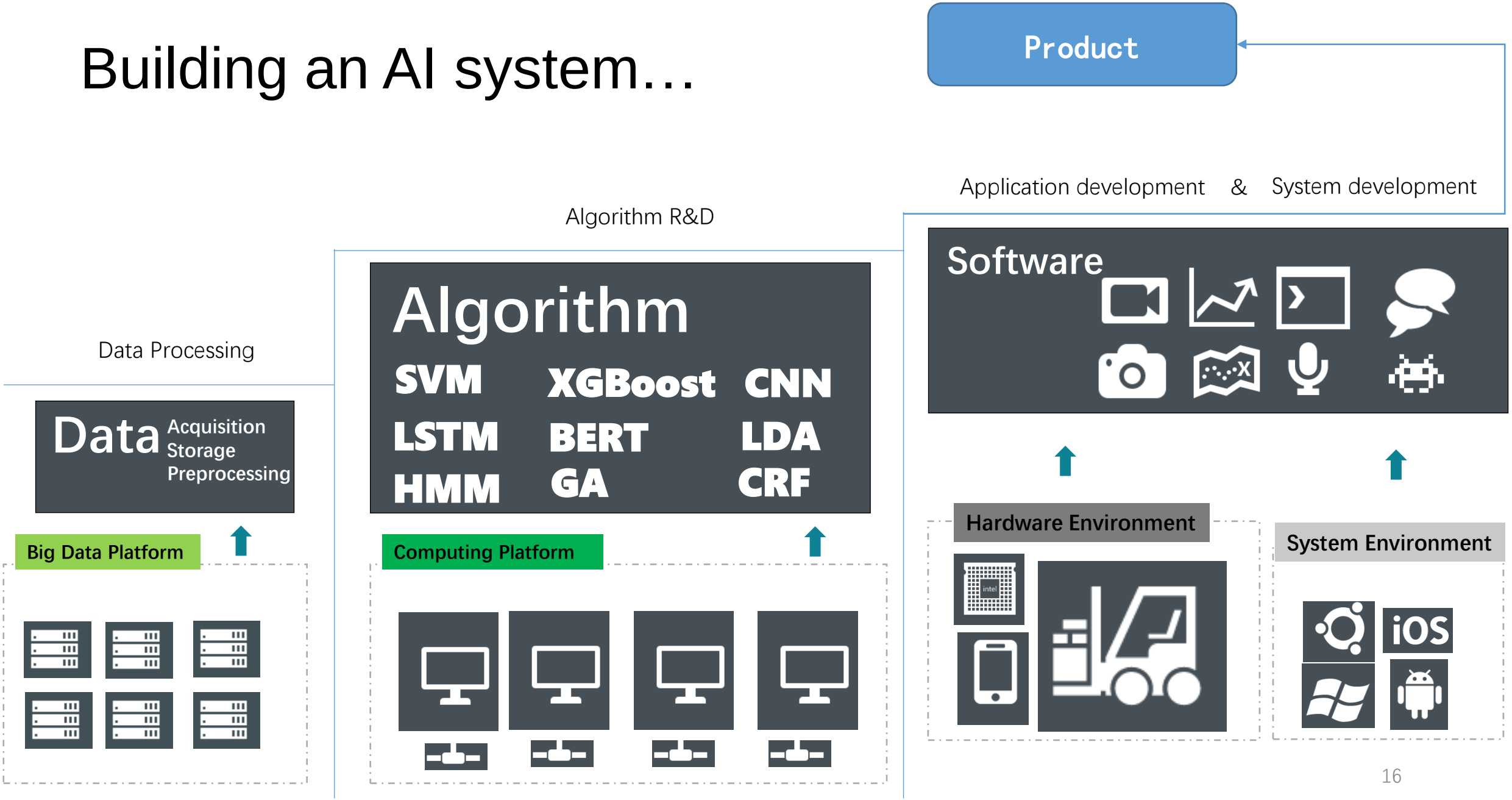
Why is AI hot again?

- Making our life easier (more convenient)

What is AI? – What's this course about?

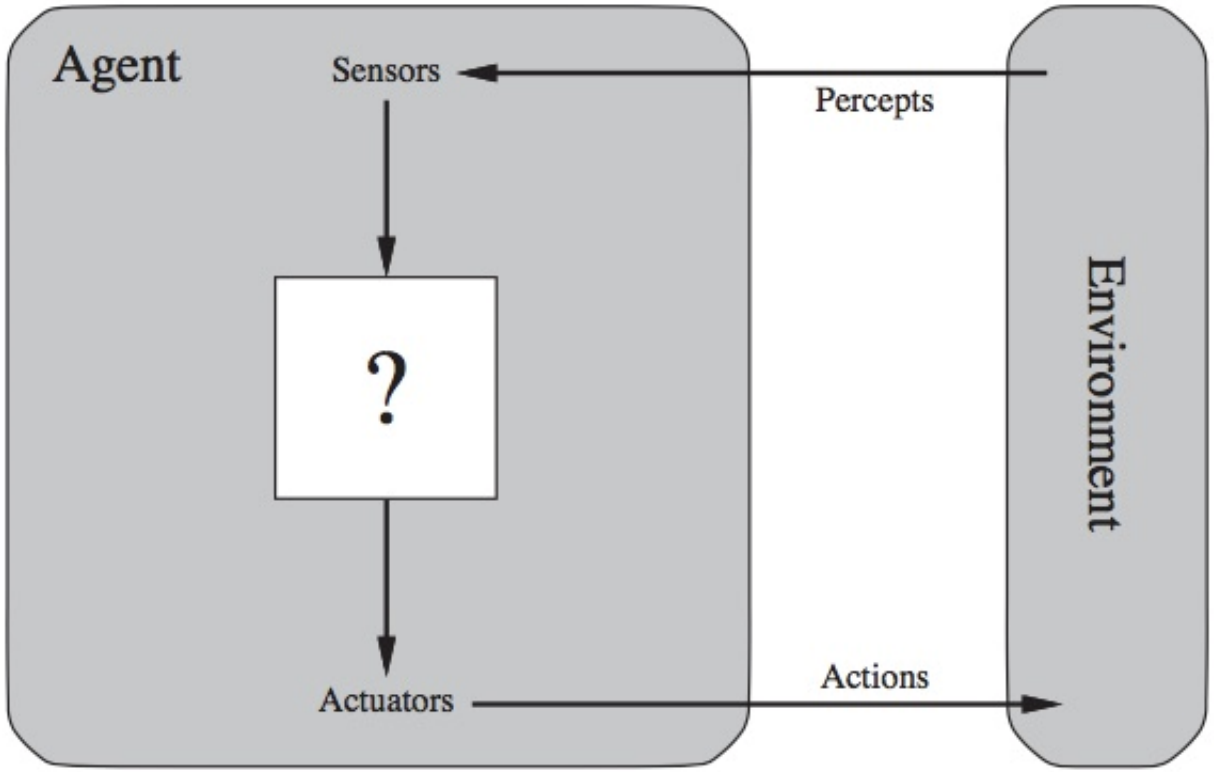
- We take the engineering perspective.
- We concern building **computing systems** for **applications** that needs **some level of intelligence**.
- We start from some very abstract concepts.

Building an AI system…



Basic Concepts

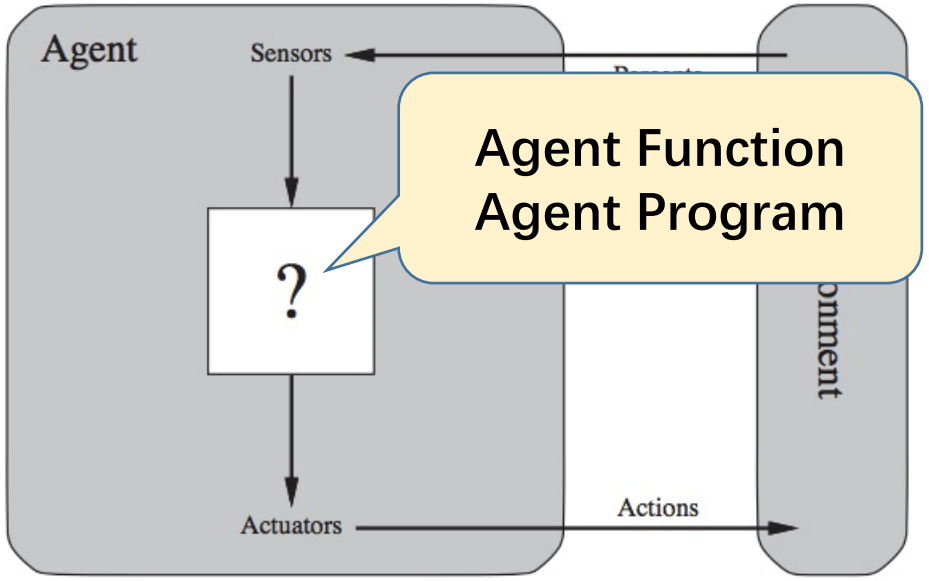
An agent is anything that can be viewed as perceiving its environment through sensors and acting upon that environment through actuators.



For human

- Sensors: eye, ears
- Actuators: hand/leg…
- ?: brain

Basic Concepts



$$F_9(\mathbf{x}) = \sum_{i=1}^{D} (z_i^2 - 10\cos(2\pi z_i) + 10)$$

Function

```
1   import ...
5
6   # tags for file
7   file_tag='train' #train/test
8
9   # The board size of go game
10  BOARD_SIZE = 9
11  COLOR_BLACK=-1
12  COLOR_WHITE=1
13  COLOR_NONE=0
14  POINT_STATE_CHECKED=100
15  POINT_STATE_UNCHECKED=101
```

Program

- an agent's behavior is described (mathematically) by the agent function that maps any given percept sequence to an action.
- the agent function for an artificial agent will be implemented by an agent program.

Basic Concepts

- What is intelligence and how can we measure it?

Thinking Humanly	Acting Humanly	Thinking Rationally	Acting Rationally
Needs to understand mind	**Turing Test**	Needs to define the term "**Rationally**"	

- Turing Test: A computer passes the test if a human interrogator, after posing some written questions, cannot tell whether the written responses come from a person or from a computer.

- Rationality: For each possible percept sequence, a rational agent should select an action that is expected to maximize its performance measure, given the evidence provided by the percept sequence and whatever built-in knowledge the agent has.

Basic Concepts

- Rationality maximize the expected performance, not the actual one, and thus is different from omniscience (perfection).

- Expected and actual performance is different because the action is selected based on limited information, i.e., the percept sequence and built-in knowledge.

- The agent should be able to gather information and learn from information, in order to be autonomous.

Basic Concepts

- PEAS: **Specification** of a rational agent (task environment)

Human defined

Agent Type	Performance Measure	Environment	Actuators	Sensors
Taxi driver	Safe, fast, legal, comfortable trip, maximize profits	Roads, other traffic, pedestrians, customers	Steering, accelerator, brake, signal, horn, display	Cameras, sonar, speedometer, GPS, odometer, accelerometer, engine sensors, keyboard

Human designed/ implemented

Basic Concepts

Agent Type	Performance Measure	Environment	Actuators	Sensors
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Lots of task environments

- Fully observable vs. Partially observable
- Deterministic vs. Stochastic
- Static vs. Dynamic
- Discrete vs. Continuous
- Episodic vs. Sequential
- Etc.

Representation

- Computing is our main approach to realize an AI (or rational agents or intelligent system).
- A software/program relies on data structure, algorithm and code.
- In the context of AI, “data structure” is usually referred to as **representation**.
- Representation means formal definitions of the PEAS, based on which computing can be conducted.

Representation

- Representation involves many aspects, e.g., data representation, model representation, etc.

- Think how to represent the following task environments
  - Fully observable vs. Partially observable
  - Deterministic vs. Stochastic
  - Static vs. Dynamic
  - Discrete vs. Continuous
  - Episodic vs. Sequential

How to represent an agent?

- Simple reflex agent: if-then rules
  - If-Then rules
  - hard to enumerate all cases
  - No history information is considered (no learning, implicitly assume episodic)

- Model-based reflex agent
  - Involves a model to describe the environment (and how it evolves)
  - Can still be if-then-rules
  - Use history information

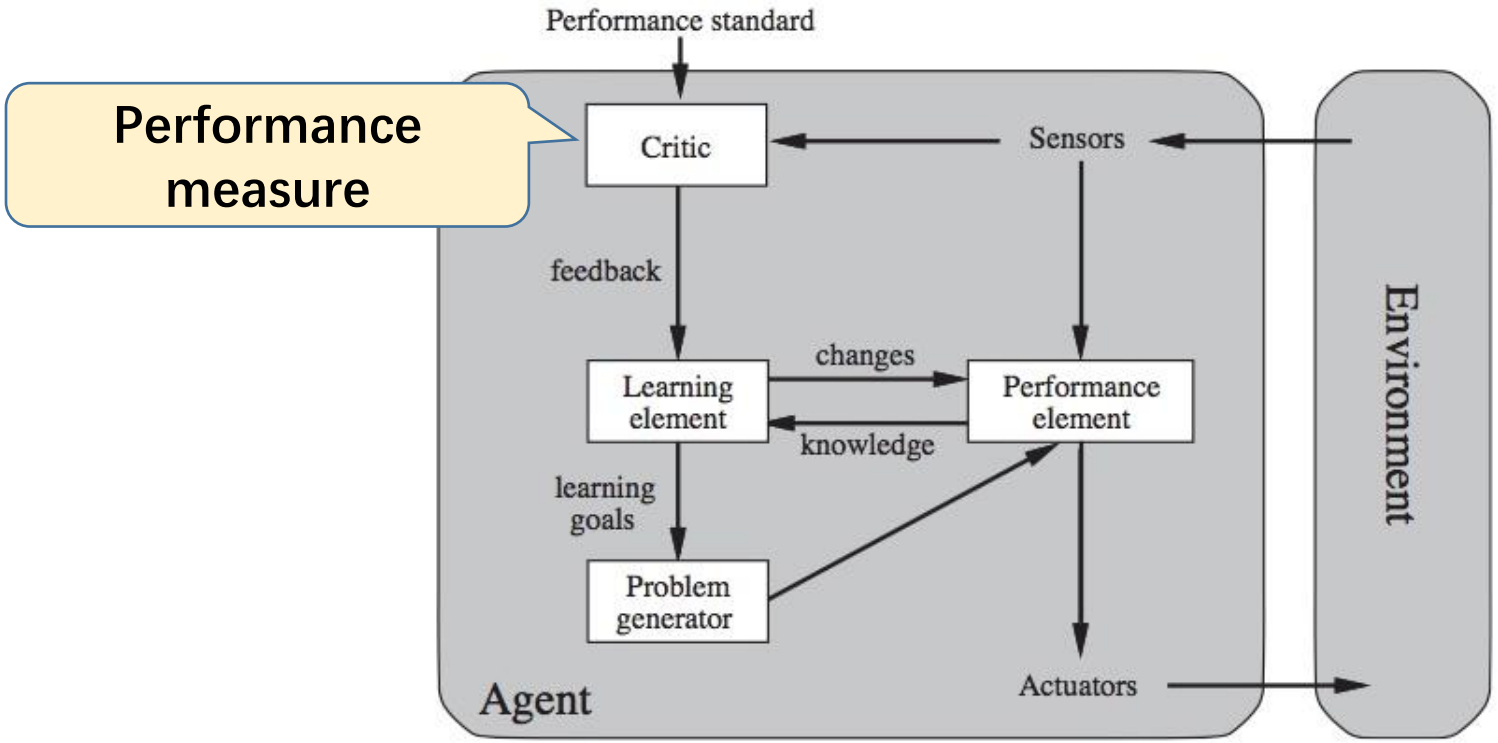
How to represent an agent?

- Goal-based agent
  - Take an additional goal information as input
  - The goal information is a decision function (binary)

- Utility-based reflex agent
  - The “goal information” is a utility function (i.e., not binary)

How to represent an agent?

- Learning agent
  - The agent iteratively learn from interaction with the environment to improve its performance.



Summary - What's this course about?

- Recall our perspective (build intelligent computing systems)
- Computing systems: hardware (architecture) + software (program/code/algorithm/data structure)
- Since general purpose computers can be easily obtained, we focus on **software**.

Summary - What's this course about?

More concretely, this course is truly about:

- Given a formal specification of PEAS
- How data, model, uncertainty, etc, is **represented (or digitalized)**.
- The **algorithms** (or how to design them) for solving intelligent tasks.
- Do Remember: programming/coding is as important as algorithms, otherwise an intelligent system can never been actually built.

Summary - What's this course about?

Seemingly restricted, the software part has played a key role in almost all important AI applications that we heard about, including:

- Pattern recognition and computer vision
- Natural language processing and machine translation
- Game playing
- Autonomous driving
- Medical diagnosis
- Web search

Course Structure

Lectures: 4 sections

- Problem Solving: AI as *search*
- Knowledge and Reasoning: represent your knowledge *logically*.
- Uncertain Knowledge and Reasoning: ideas for work with the *uncertain* world
- Learning: *gain experience/knowledge* from data

Projects: 3 near-industry/academia-level projects

Course Requirements - General

- Final Score depends on:
  - final-exam
  - Homework + project
  - The weights are approximately 1:1

- Please **do not negotiate** for more scores (no matter for what reason), unless we make a mistake in calculating your scores.

- Please join the Sakai site of this course: CS303A fall2020

- Note: Homework and the 3 projects are **crucial**.
  - e.g., if you never attend and submit only 1 out of 3 projects, you probably will fail.

Course Requirements - Projects

- 3 projects in total.
- We can elaborate on the project requirements in lab, but will **not** provide technical support (you can search for and use any online materials though).
- Please finish the 3 projects **independently** (good chance to practice/prepare for your postgraduate study or job).
- Project report/program submitted **after the deadline** will be **marked 0**.
- Discussions and sharing are encouraged, but duplicated submissions, either program or report, will be **marked 0** for all involved submissions.

Hints on how to pass

- Data for fall 2018
- Total students: 181 = 133 (pass) + 48 (fail)
- In 48 who failed, 17 accomplished 0 project, 6 accomplished 1 project, 7 accomplished 2 projects.
- In 133 who passed, 132 accomplished all 4 projects, 1 accomplished 3 projects.

To be continued