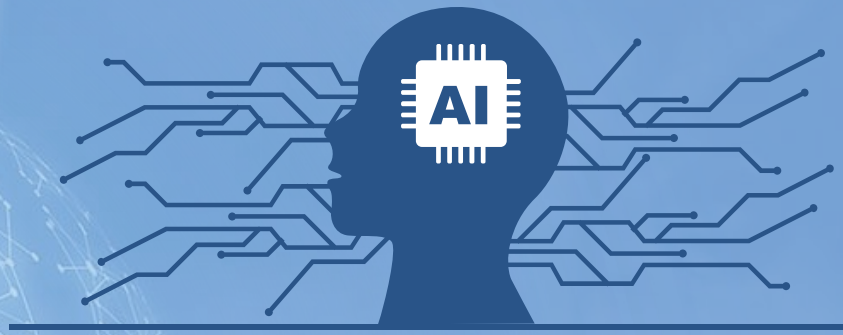
Artificial Intelligence



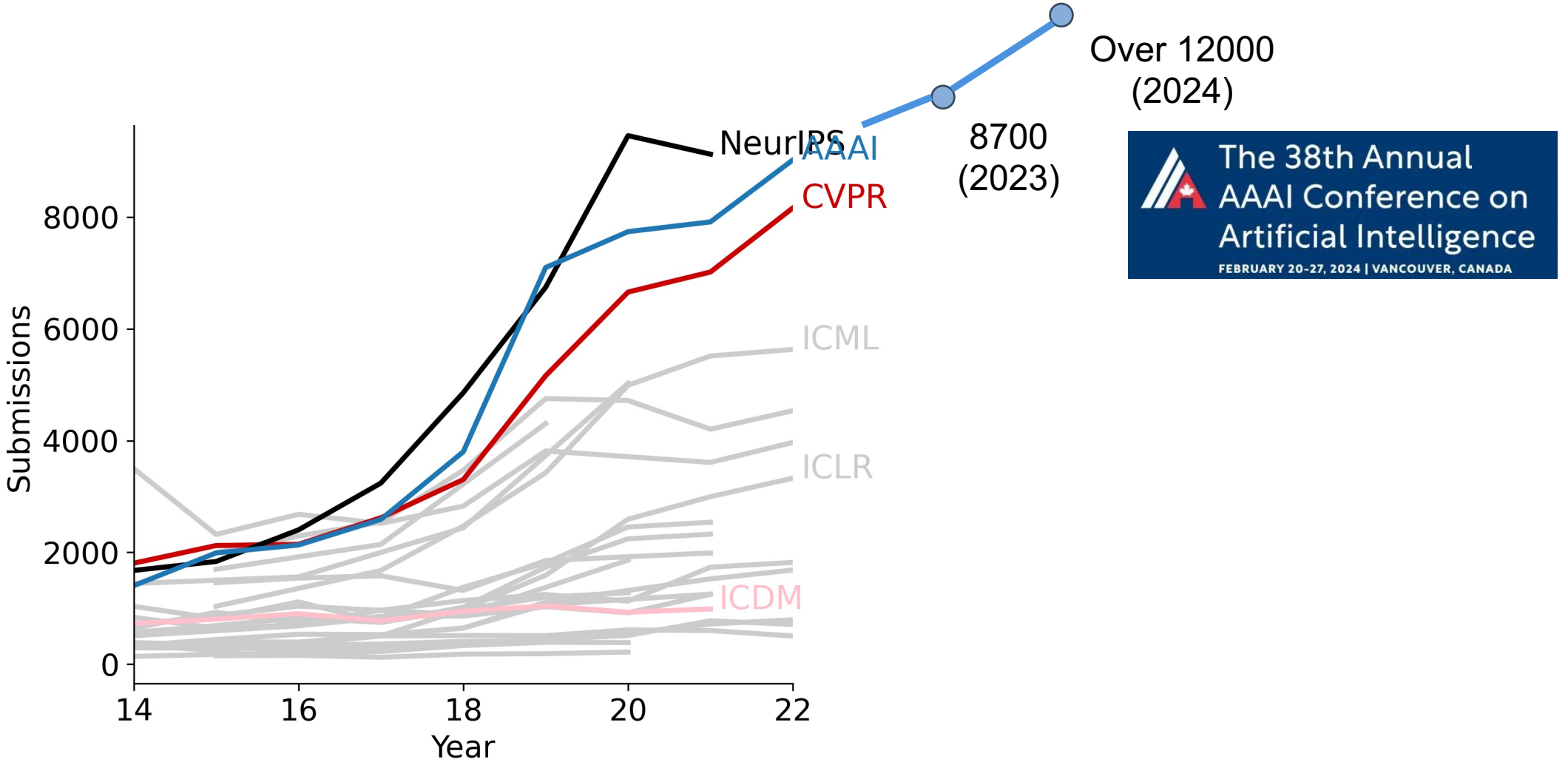
Course Overview

Wen-Huang Cheng (鄭文皇)

National Taiwan University

wenhuang@csie.ntu.edu.tw

Artificial intelligence (AI) is Hot



The 38th Annual AAAI Conference on Artificial Intelligence
FEBRUARY 20-27, 2024 | VANCOUVER, CANADA

Source: https://github.com/lixin4ever/Conference-Acceptance-Rate?tab=readme-ov-file

AAAI-2024 Keywords

- Application Domains (APP)
- Cognitive Modeling & Cognitive Systems (CMS)
- Computer Vision (CV)
- Constraint Satisfaction and Optimization (CSO)
- Data Mining & Knowledge Management (DMKM)
- Game Theory and Economic Paradigms (GTEP)
- Humans and AI (HAI)
- Intelligent Robotics (ROB)
- Knowledge Representation and Reasoning (KRR)
- Machine Learning (ML)
- Multiagent Systems (MAS)
- Philosophy and Ethics of AI (PEAI)
- Planning, Routing, and Scheduling (PRS)
- Reasoning under Uncertainty (RU)
- Search and Optimization (SO)
- Natural Language Processing (NLP)

A **reasoning** example:
Let suppose the knowledge base contains the following **knowledge**:

- Birds can fly
- Penguins cannot fly
- Pitty is a bird

So from the above sentences, we can conclude that **Pitty can fly**.

What is Artificial Intelligence?

What is Artificial Intelligence?

Artificial intelligence (AI) is the ability of a machine to display human-like capabilities such as reasoning, learning, planning and creativity.

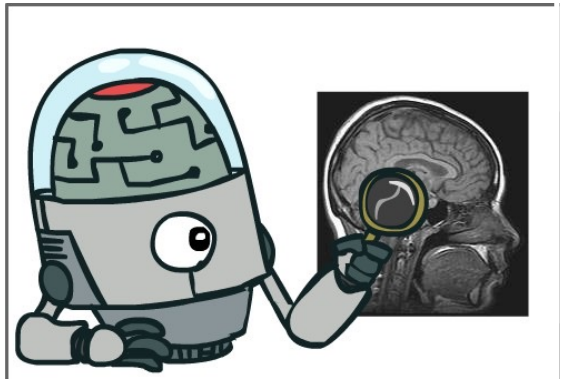
- European Parliament (2023)

Source: https://www.europarl.europa.eu/news/en/headlines/society/20200827STO85804/what-is-artificial-intelligence-and-how-is-it-used

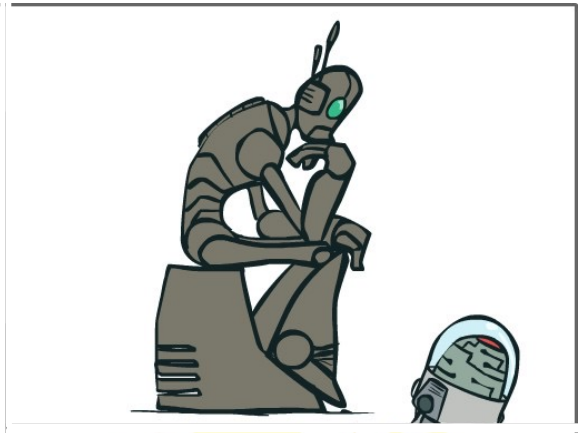
What is Artificial Intelligence?

The science of making machines that:

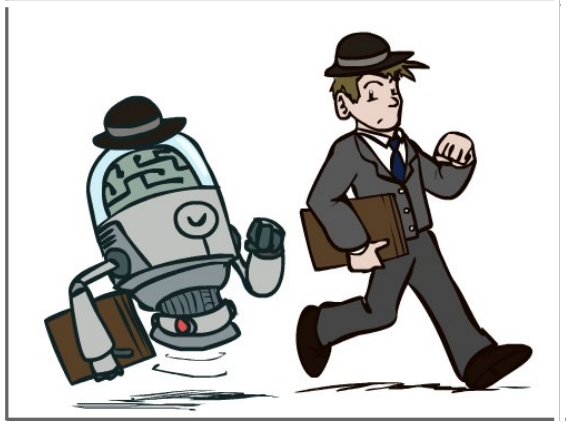
Think like people?



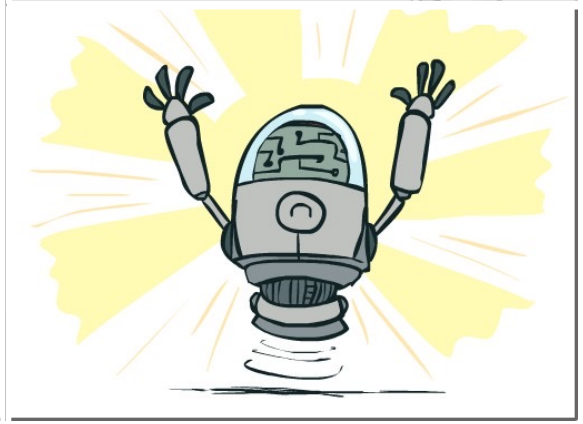
Think rationally?



Act like people?

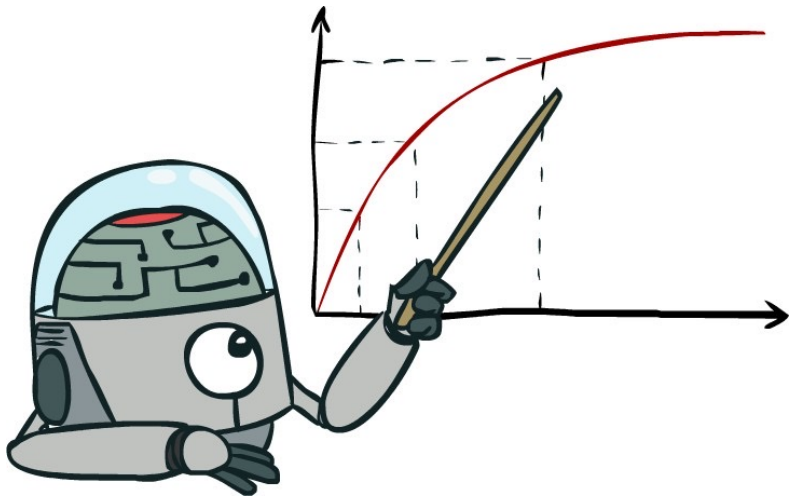


Act rationally

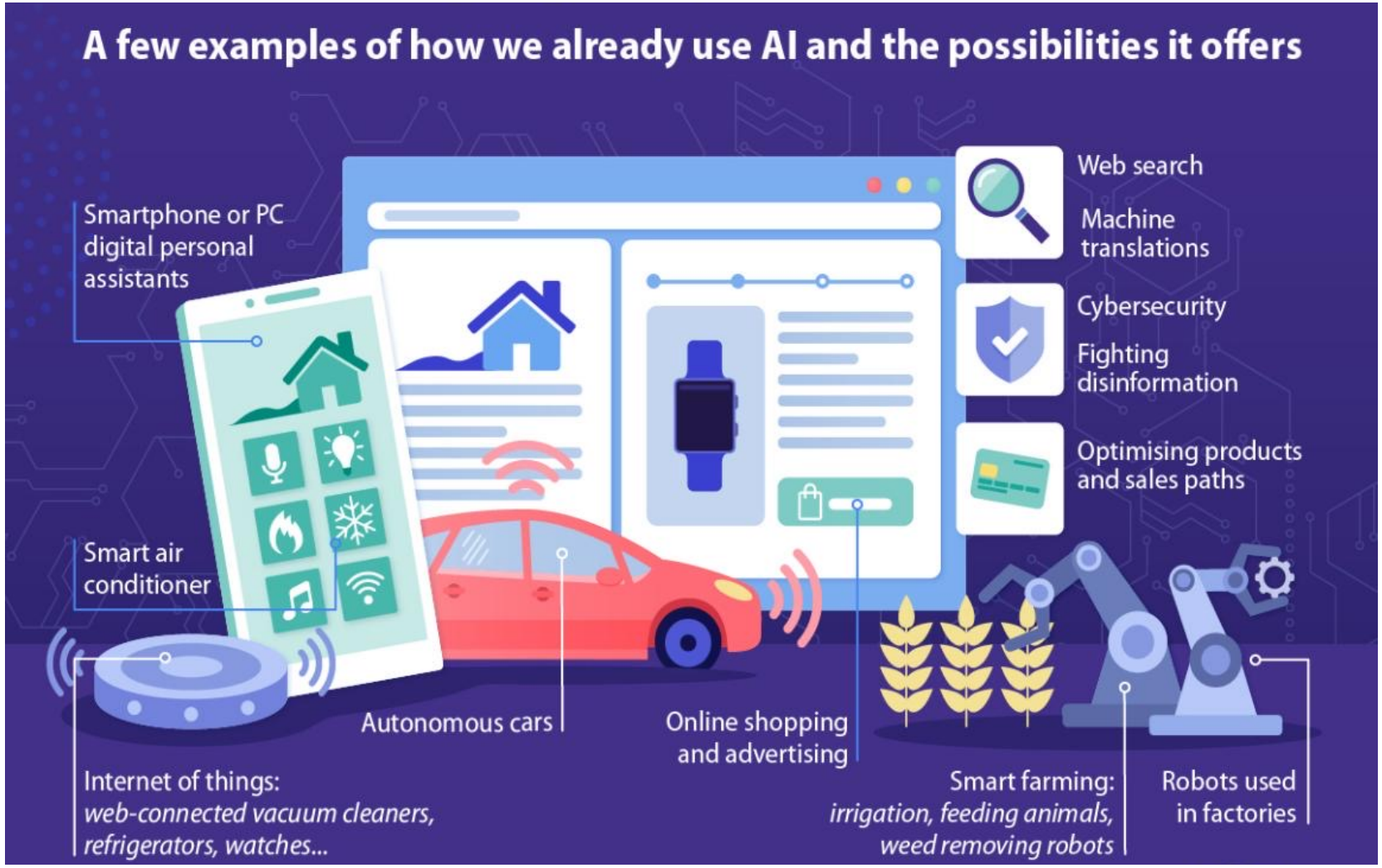


Rational Decisions

- We'll use the term **rational** in a very specific, technical way:
  - Rational: *maximally achieving pre-defined goals*
  - Goals are expressed in terms of the **utility** of outcomes
  - World is uncertain, so we'll use **expected** utility
  - Being rational means acting to **maximize your expected utility**



How is AI being used today?

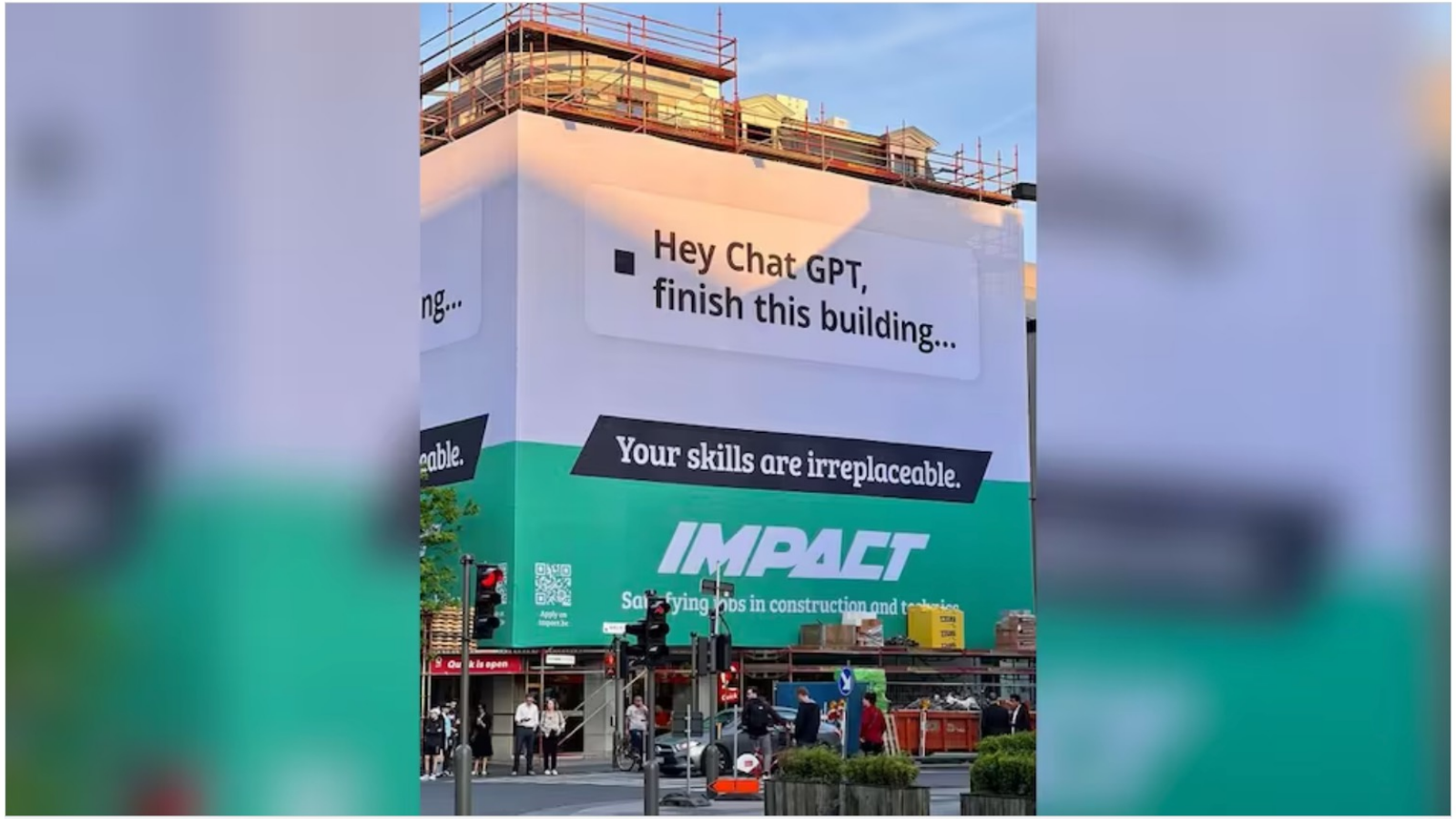


Source: https://www.europarl.europa.eu/news/en/headlines/society/20200827STO85804/what-is-artificial-intelligence-and-how-is-it-used

What AI cannot do?

Anwesha Madhukalya

Updated Jun 06, 2023, 12:34 PM IST

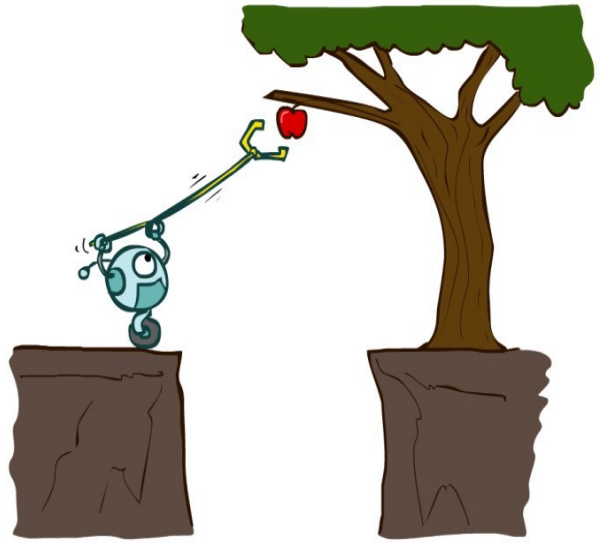


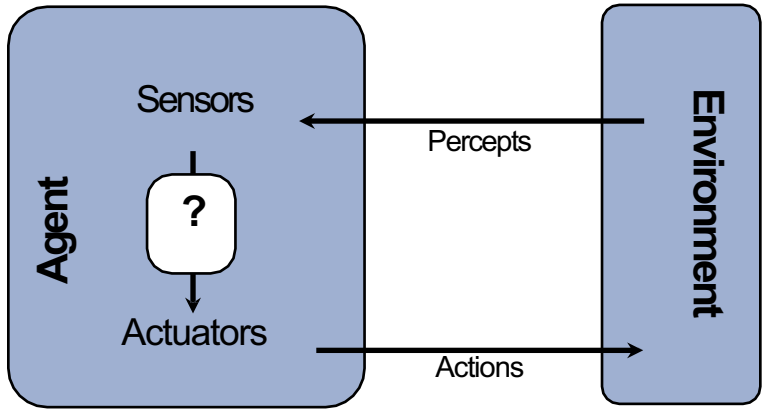
The ad for jobs by agency Impact has gone viral

Source: https://www.businesstoday.in/latest/corporate/story/hey-chatgpt-finish-this-building-this-advertisement-takes-a-wicked-dig-at-ai-enthusiasts-384375-2023-06-06

The scope of this course: Designing Rational Agents

- An **agent** is an entity that perceives and acts.
- A **rational agent** selects actions that maximize its (expected) **utility**.
- Characteristics of the **percepts**, **environment**, and **action space** dictate techniques for selecting rational actions
- This course is about:
  - General AI techniques for a variety of problem types
  - Learning to recognize when and how a new problem can be solved with an existing technique





Course Topics

Core Components of Rational Agents:

- Search & Planning
- Reinforcement Learning
- Probability & Inference
- Supervised Learning

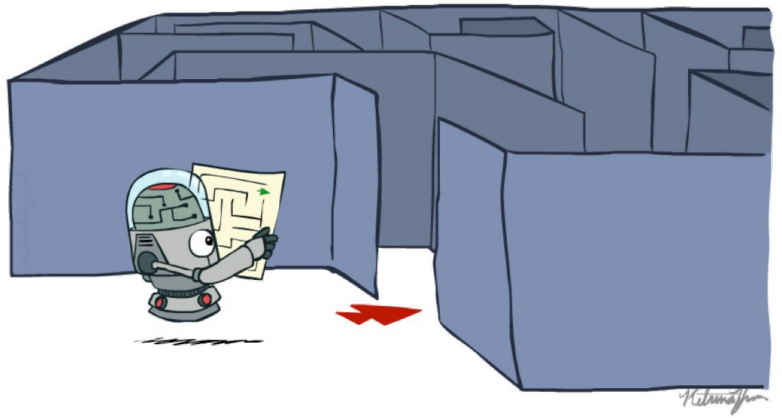
Course Topics

Search & Planning

Reinforcement Learning

Probability & Inference

Supervised Learning



How can I find a ***sequence of best decisions*** for a ***particular*** situation?

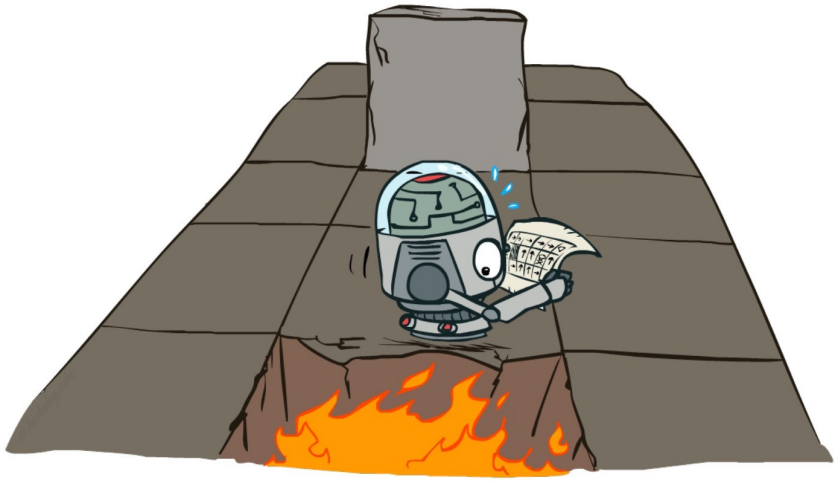
Course Topics

Search & Planning

Reinforcement Learning

Probability & Inference

Supervised Learning



How can I find ***rules*** (***policy***) to make best decisions for ***any*** situation?

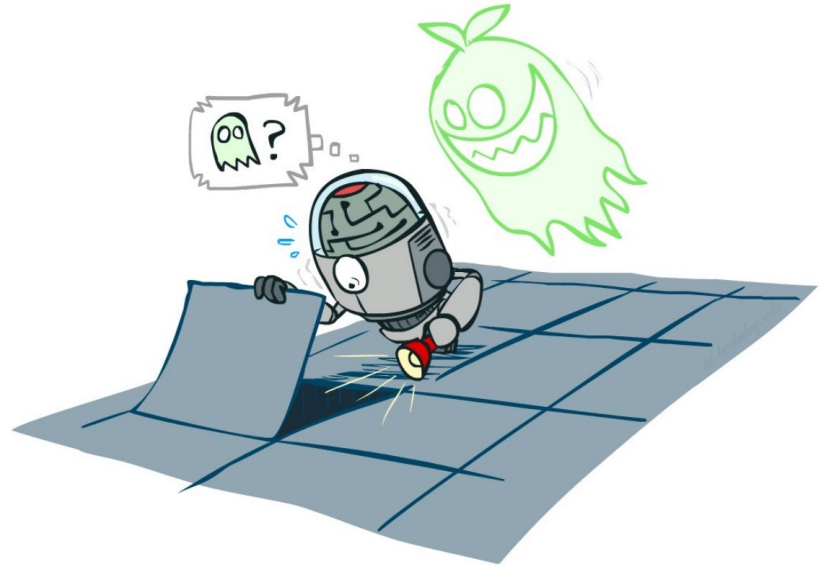
Course Topics

Search & Planning

Reinforcement Learning

Probability & Inference

Supervised Learning



How can I make sense of ***uncertainty*** in the world?

Course Topics

Search & Planning

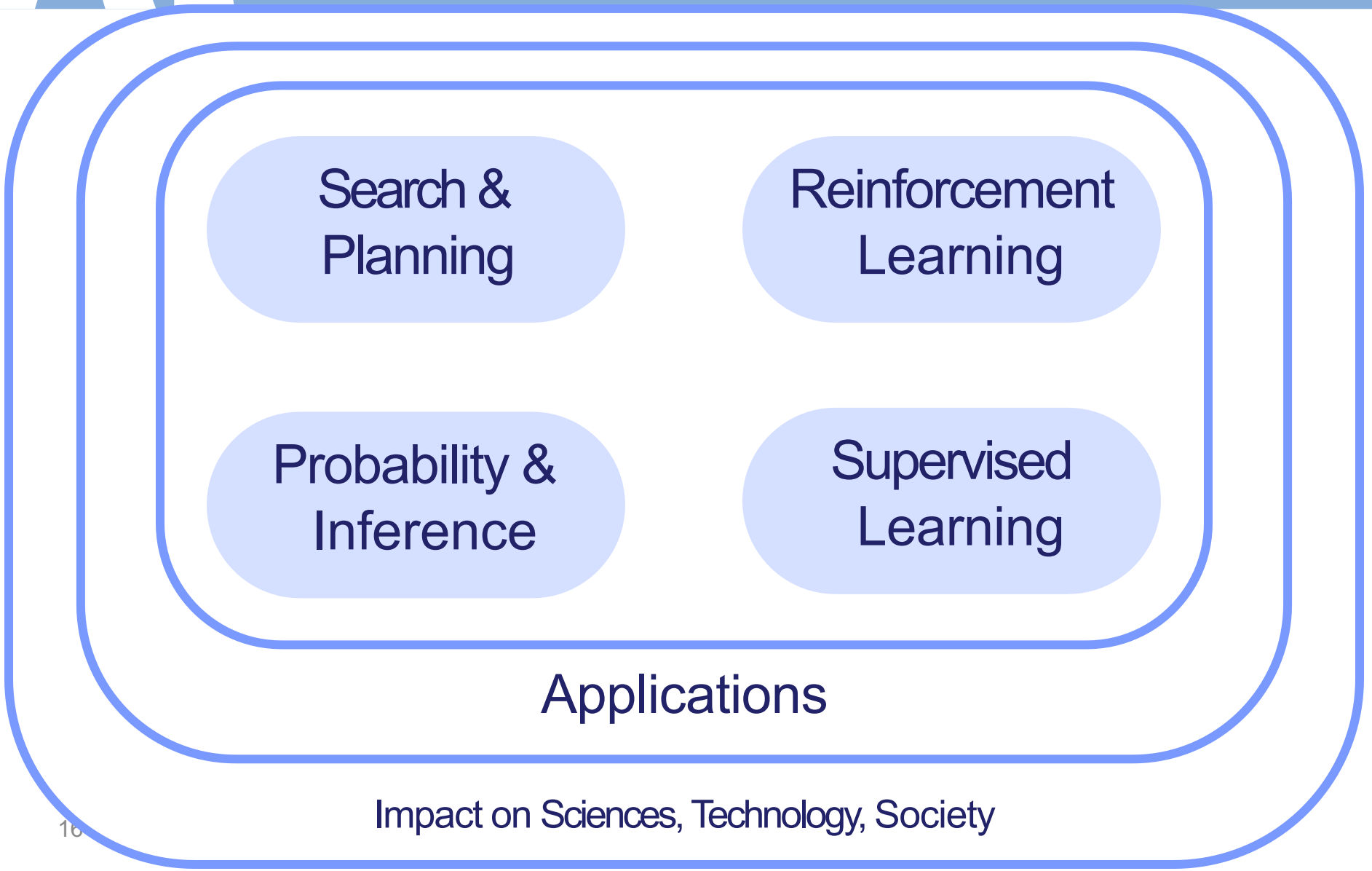
Reinforcement Learning

Probability & Inference

Supervised Learning

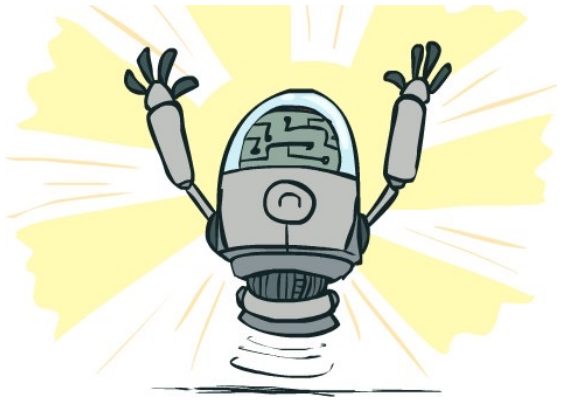
How can I learn a ***model*** of the world from ***data***?

Course Topics

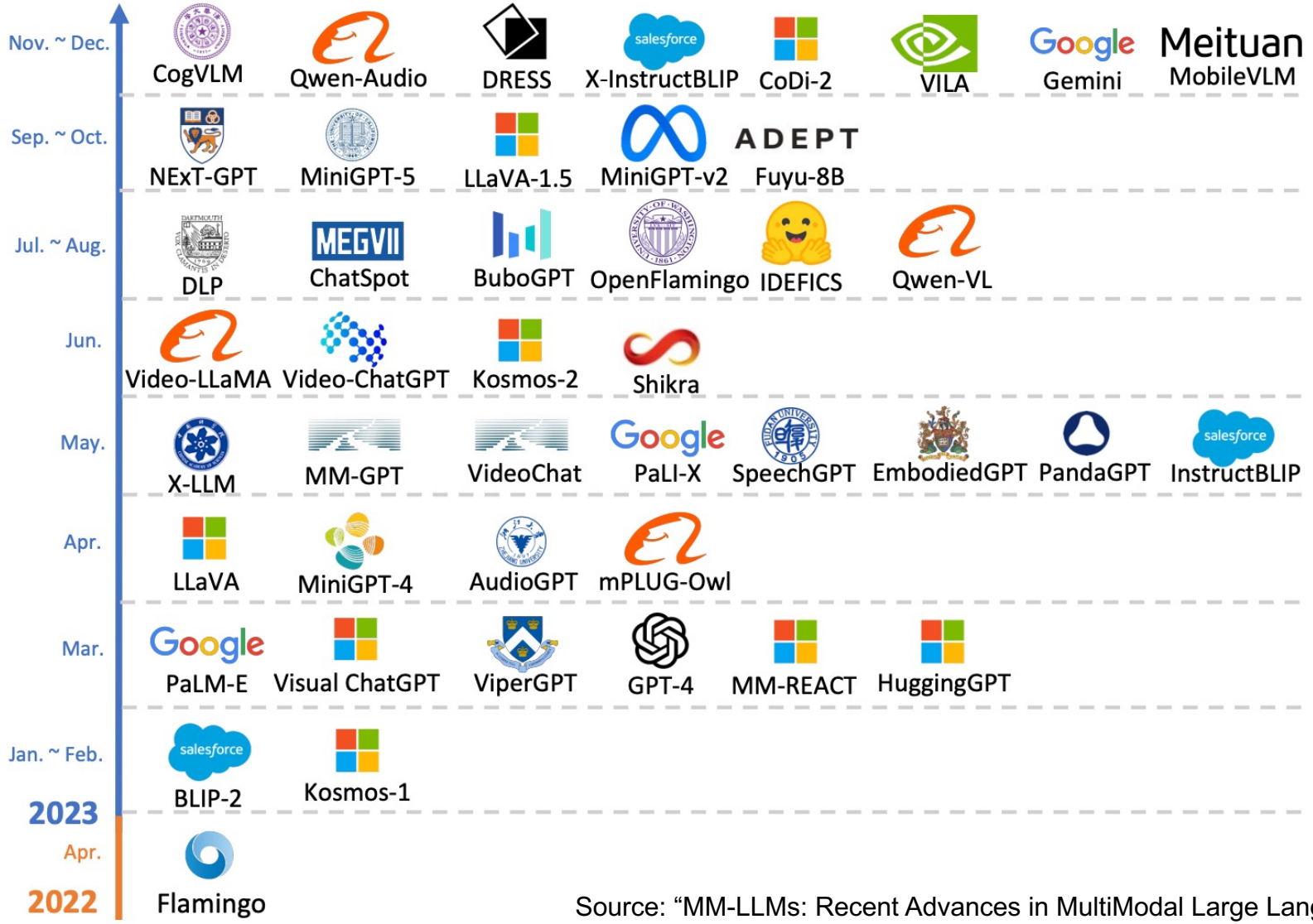


By the end of this course you'll:

- Build and understand math of rational, learning agents
- Select and apply the right AI methods for wide range of problems
- Recognize how these methods are used in modern AI systems
- Be prepared to make decisions on how AI is used in society



We are now in a new AI era of multimodal large language models



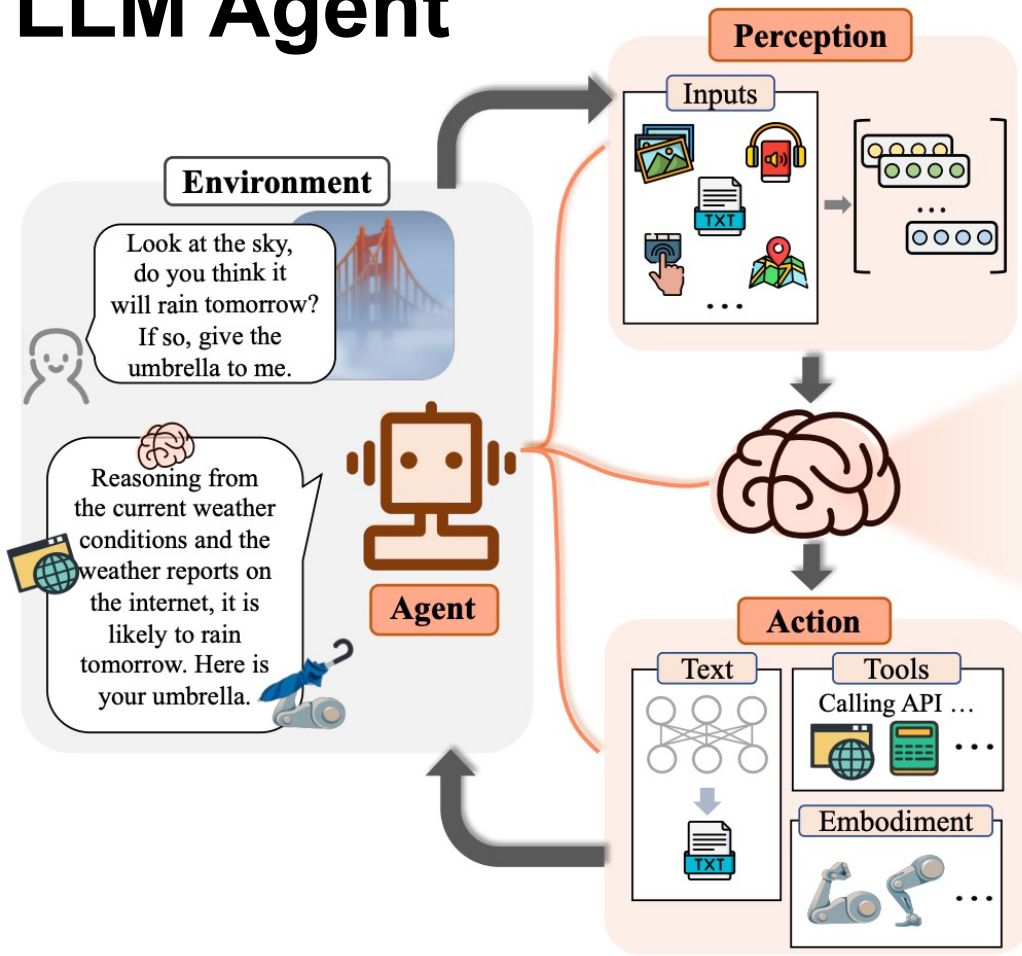
Source: “MM-LLMs: Recent Advances in MultiModal Large Language Models,” arXiv, 2024.

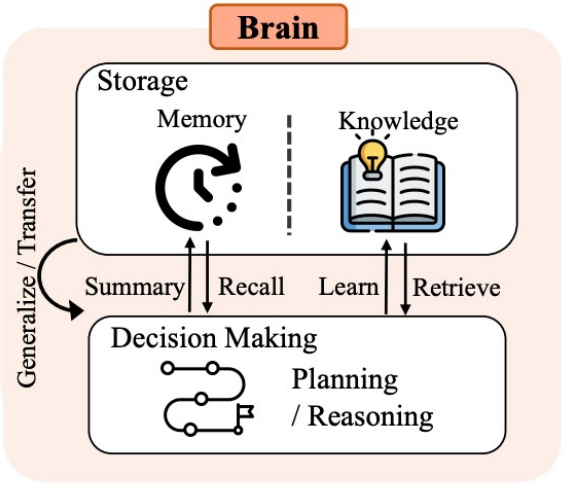
Gemini (DeepMind)

Dec 2023

2024: The New Era of AI Agent

LLM Agent





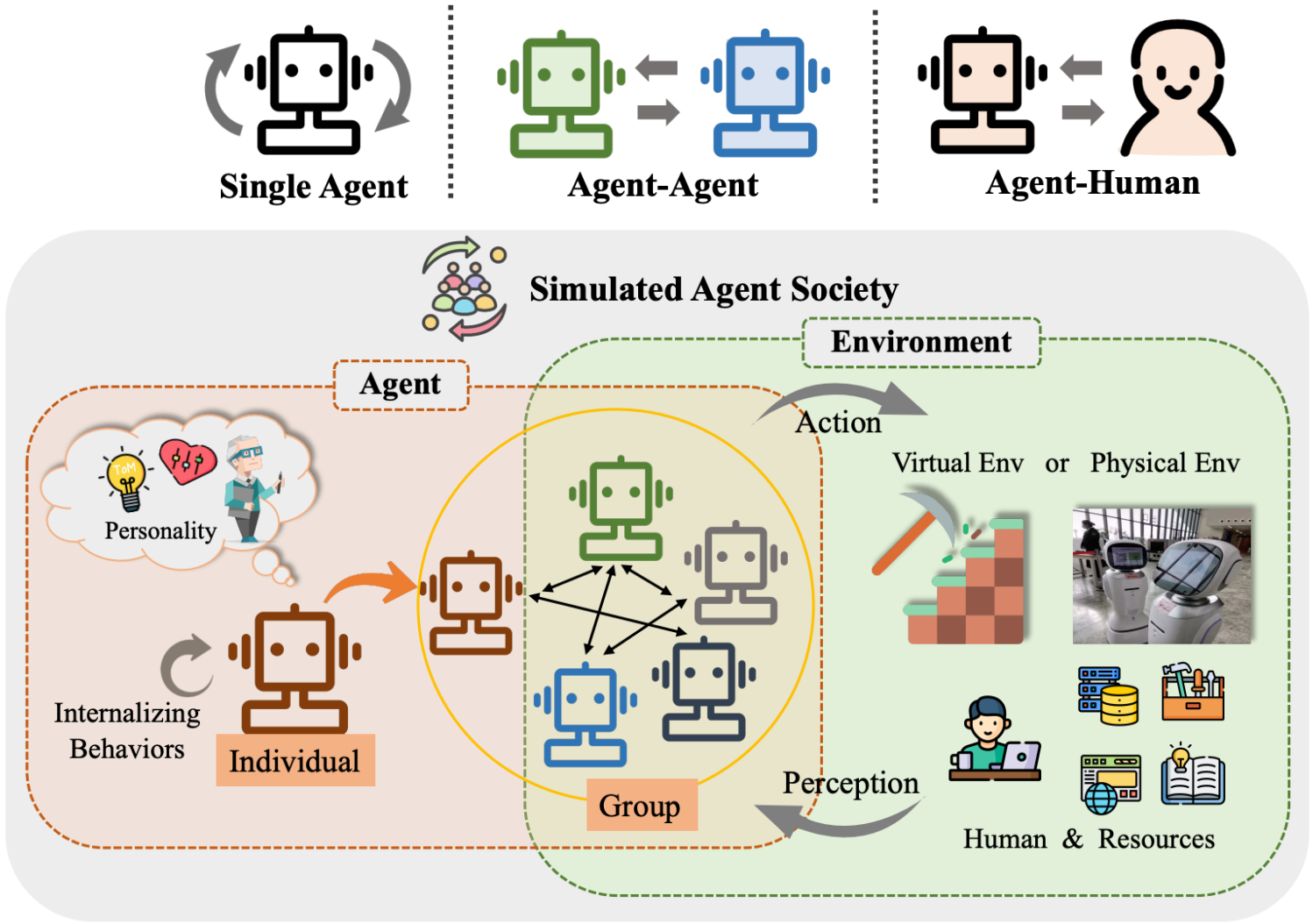
•**Perception**: Interprets external stimuli, which could range from text to more diverse modalities.

•**Brain**: Acts as the agent's memory and decision center.

•**Action**: Executes decisions derived from the 'Brain'.

Source: "The Rise and Potential of Large Language Model Based Agents: A Survey," arXiv, 2023.

Application Scenarios of AI Agent



Source: “The Rise and Potential of Large Language Model Based Agents: A Survey,” arXiv, 2023.

AI agent as part of our life experience

The New York Times

Published Nov. 10, 2023 Updated Nov. 11, 2023

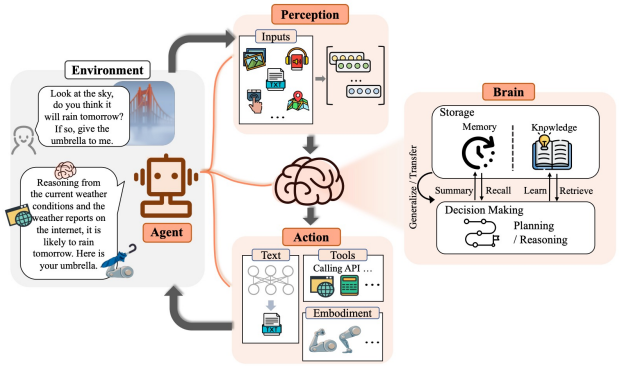
Personalized A.I. Agents Are Here. Is the World Ready for Them?

The age of autonomous A.I. assistants could have huge implications.

ICLR 2024 Workshop on LLM Agents

May 11, 2024 in Vienna, Austria

TOPICS



We will explore a range of topics in this workshop, including, but not limited to, the following areas:

Memory Mechanisms and Linguistic Representation:
This session will analyze the similarities between LLMs and human memory and will discuss the mechanisms of storage and formation of the linguistic representation in LLMs.

Tool Augmentation and Grounding (interaction with environment):
Addressing the enhancement of LLMs through tool augmentation, this session will also include a discourse on grounding – linking natural language concepts to particular contexts.

Reasoning, Planning, and Risks:
This session will discuss the intertwined processes of reasoning and planning in language agents and highlight the potential hazards associated with language agents' ability to autonomously operate in the real world.

Multi-modality and Integration in Language Agents:
This session will explore how language agents can integrate multiple modalities such as vision, sound, and touch to enhance their understanding and interaction with the environment.

Conceptual Framework for Language Agents:
This session will delve into a potential framework for language agents by drawing from both classic and contemporary AI research and related fields such as neuroscience, cognitive science, and linguistics.

SPEAKERS

Denny Zhou
Principal Scientist/Research Director, Google DeepMind

Dilek Hakkani–Tur
Professor of Computer Science, University of Illinois Urbana-Champaign

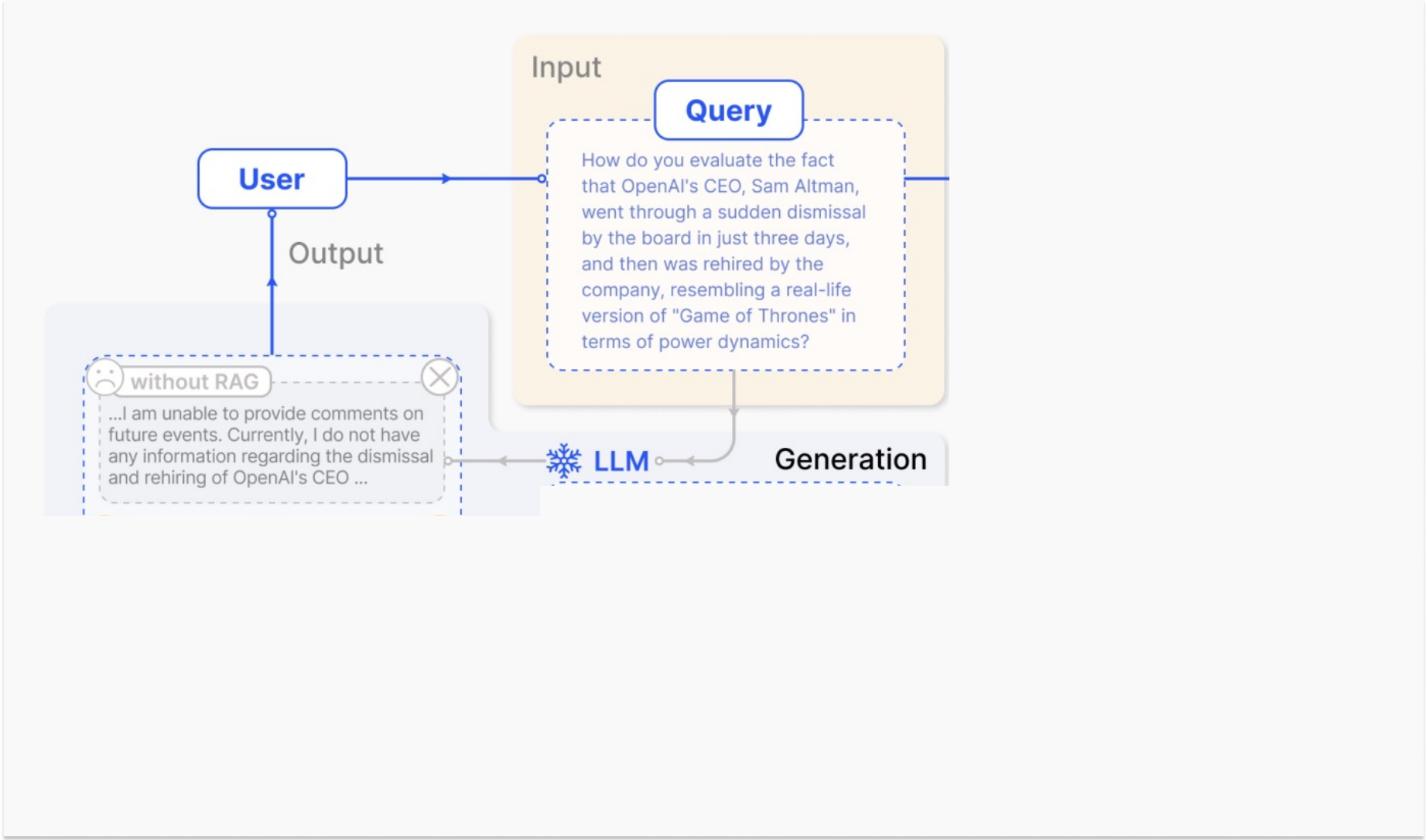
Chelsea Finn
Assistant Professor, Stanford University

Karthik Narasimhan
Assistant Professor, Computer Science, Princeton University

Graham Neubig
Associate Professor, CMU LTI

Joyce Y. Chai
Professor, University of Michigan

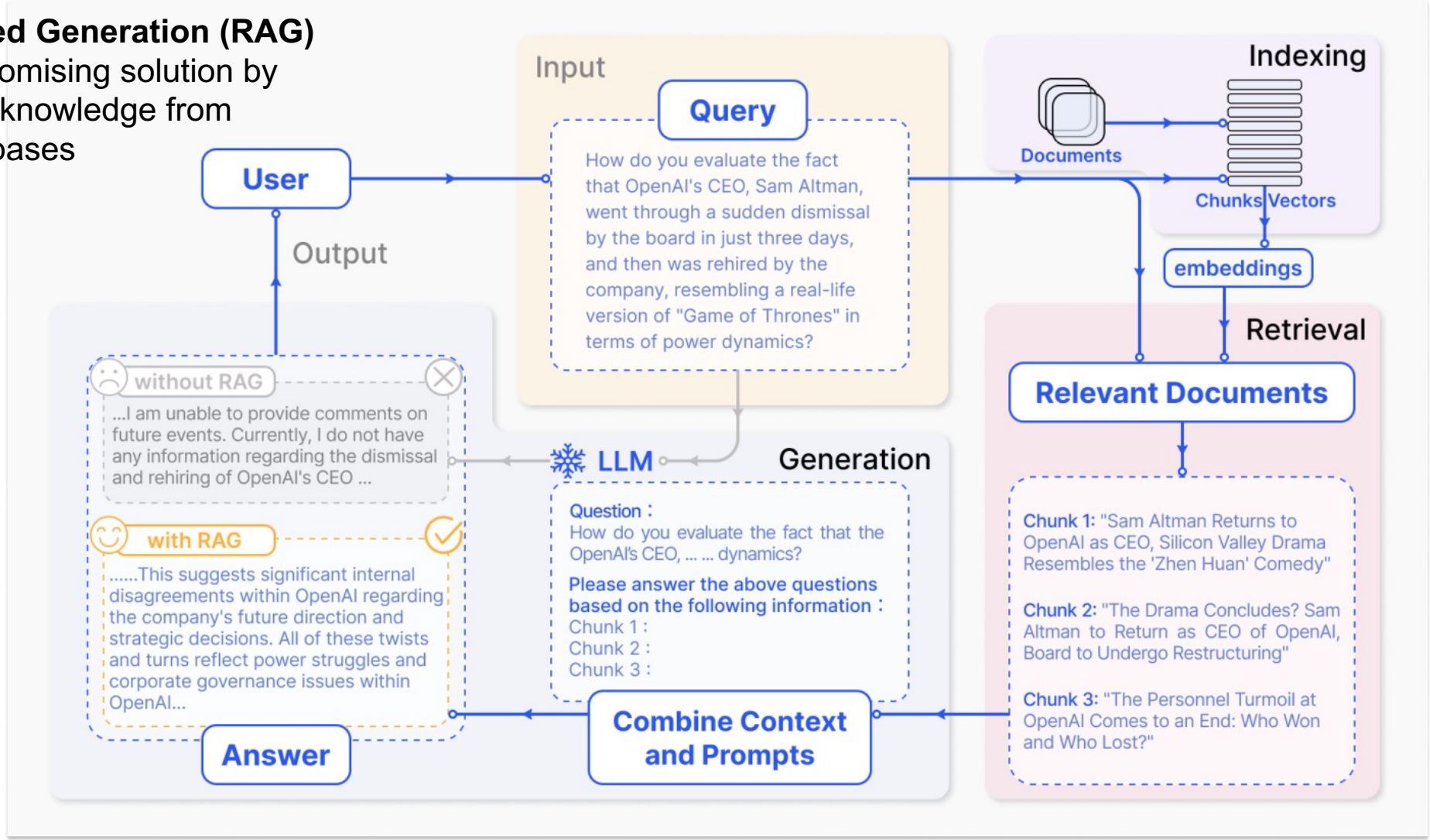
Knowledge Expansion



Source: https://a16z.com/how-are-consumers-using-generative-ai/

Knowledge Expansion

Retrieval-Augmented Generation (RAG) has emerged as a promising solution by retrieving up-to-date knowledge from external knowledge bases



Source: “Retrieval-Augmented Generation for Large Language Models: A Survey,” arXiv, 2024.

Syllabus (1/2)

The following syllabus is tentative and subject to change during the semester.

Dates	Topic
02/21	Course Overview
02/28	和平紀念日(放假日)
03/06	Modern AI: • Search • Knowledge • Uncertainty • Optimization • Learning
03/13 **HW#1**	Modern AI (cont.)
03/20	Modern AI (cont.)
03/27 **HW#2**	Modern AI (cont.)
04/03	Modern AI (cont.)
04/10 **HW#3**	Modern AI (cont.)

Syllabus (2/2)

The following syllabus is tentative and subject to change during the semester.

Dates	Topic
04/17*	Modern AI (cont.)
04/24 **HW#4**	Modern AI (cont.)
05/01	Modern AI (cont.)
05/08 **HW#5**	Modern AI (cont.)
05/15	New Wave of AI: • Generalist Agents • Multimodal Systems
05/22* **HW#6**	New Wave of AI (cont.)
05/29	New Wave of AI (cont.)
06/05	Invited Talks

*The lecture of this week might be conducted using pre-recorded videos rather than an in-person class.

Logistics

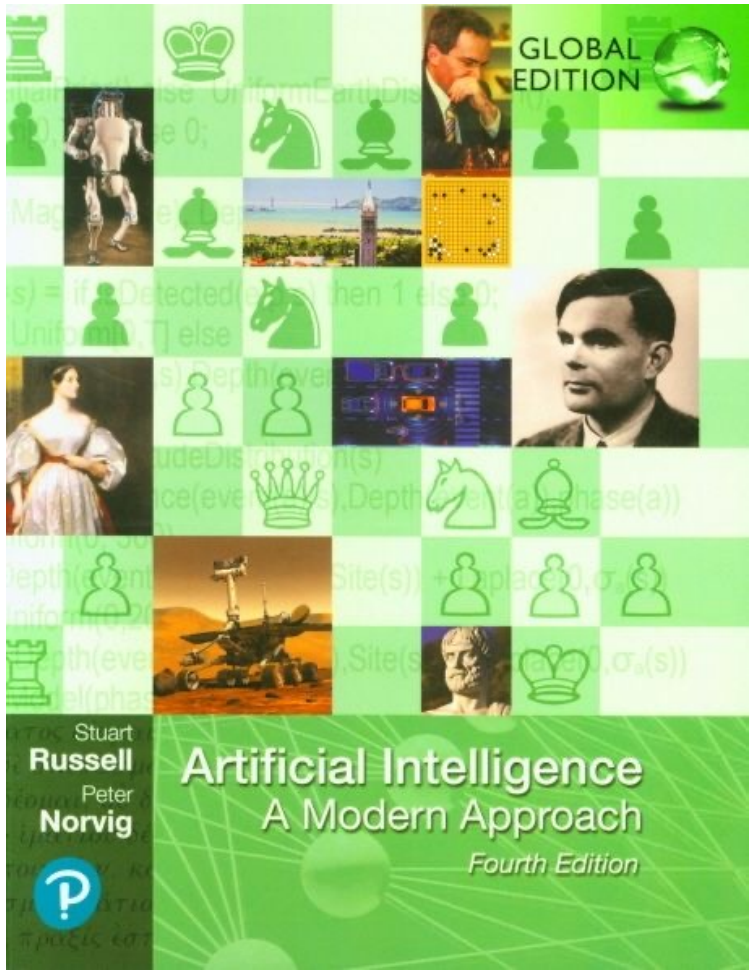
- **Time: Wed789 (2:20pm – 5:20pm, Wednesday)**
- **Classroom: CSIE Building Room No. 103**
- **Course Website: NTU COOL**

- **Instructor: Prof. Wen-Huang Cheng (鄭文皇 教授)**
  - Email: wenhuang@csie.ntu.edu.tw

- **TA#1: Mr. Yu-Wen Tseng (曾昱文)**
- **TA#2: Mr. Kang-Yang Huang (黃康洋)**
  - Email: ai.ta.2024.spring@gmail.com

Recommended Reference Book

- Stuart Russell and Peter Norvig, “Artificial Intelligence: A Modern Approach,” 4th edition, Pearson Education, 2021.



Grading (subject to change)

- **Assignments (90%)**
  - 6 times, announced in class or from the course website
    - Tentatively, all Python programming Assignments
- **Class Participation (10%)**
  - Only applicable for “Invited Talks”

Grading (subject to change)

- **Class Participation (10%)**

訊連科技
CyberLink

玩美移動
Perfect

  - Rules for check-in/check-out
    - Can get 10 points if check-in before the talks (2:20pm) and check-out after the talks (5:20pm)
    - Every 10 minutes short will get -1 point penalty
      - e.g., check-in during 2:20pm-2:30pm and check-out after the talks

Some slides of this course credit to:

University of California, Berkeley - CS 188: Artificial Intelligence

Berkeley
UNIVERSITY OF CALIFORNIA

Harvard University - CS 50: Artificial Intelligence in Python

THIS IS
CS50

HARVARD
UNIVERSITY

Remark

Artificial Intelligence: Designing rational agents

- Modeling the environment
  - Build models of the physical or information environment.
- Evidential reasoning or perception
  - Given observations, determine what the world is like.
- Action
  - Given a model of the world and a goal, determine what should be done.
- Learning from past experiences
  - Learn about the specific case and the population of cases.