

# TCSL-70130 Lecture 05: Artificial Intelligence & Machine Learning in Education 人工智慧與機器學習之教育應用

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## Lecture Topics

- An overview of **Artificial Intelligence (AI)**
- Introduction to **Machine Learning (ML)**
- AI & ML technologies in education
- AI & ML instructional tools case studies

### 3 What is Artificial Intelligence?

- ▶ “The science and engineering of making intelligent machines, especially intelligent computer programs”.  
— John McCarthy (Father of AI)
- ▶ “the ability of a digital computer or computer-controlled robot to perform tasks commonly associated with intelligent beings.”  
— Encyclopedia Britannica
- ▶ As machines become increasingly capable, tasks considered "intelligence" are often removed from the definition of AI. (the AI effect)

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### 4 AI Quotes

- ▶ “Our sole responsibility is to produce something smarter than we are; any problems beyond that are not ours to solve.” (Eliezer S. Yudkowsky)
- ▶ “... the question of whether Machines Can Think ... is about as relevant as the question of whether Submarines Can Swim.” (Edsger W. Dijkstra)
- ▶ “Artificial intelligence will reach human levels by around 2029. Follow that out further to, say, 2045, we will have multiplied the intelligence, the human biological machine intelligence of our civilization a billion-fold.” (Ray Kurzweil)

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## AI Quotes

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- "You insist that there is something a machine cannot do. If you tell me precisely what it is a machine cannot do, then I can always make a machine which will do just that." (John von Neumann)
- "No computer has ever been designed that is ever aware of what it's doing; but most of the time, we aren't either." (Marvin Minsky)
- **Tesler's Theorem:** AI is whatever hasn't been done yet. (Larry Tesler)

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## Goal of AI

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- The end goal of AI was (and still is) to build an Artificial Generalized Intelligence holistically mimicking human intelligence.



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## Two General Approaches

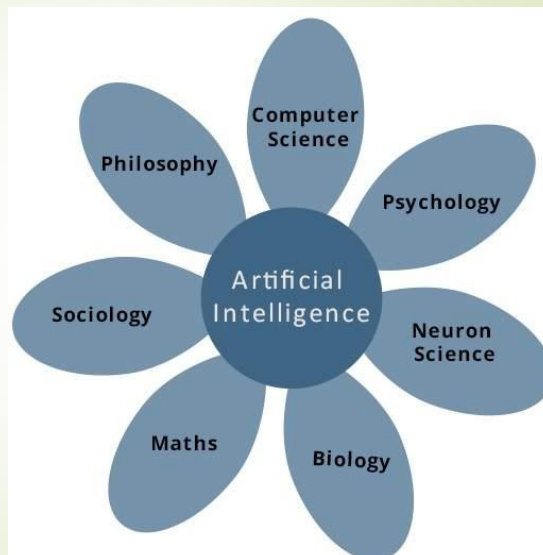
- To understand **human intelligence** and **cognitive mechanisms**. Then build machines that **mimic human mind** (with the goal of achieving similar cognitive functions).
- Build “**intelligent agent**” that **perceives** its environment and **takes actions** that **maximize** its **chance** of successfully achieving its **goals** (using any mechanism).
- Both are useful and help the advancements in AI technologies.

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## What Contributes to AI?

- Artificial intelligence is a science and technology based on many disciplines.



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## 9 AI Hype Cycles and AI Winters

- AI was founded as an academic discipline in 1955.
- Since then, the field has experienced several **hype cycles** of optimism, followed by disappointment and the loss of funding (an "**AI winter**"), followed by new approaches, success and renewed funding. (next slide)
- In **21 century**, AI tech have experienced a resurgence following advances in **computer power, big data, and theoretical understanding**; and AI have become an essential part of the technology industry, helping to solve many challenging problems. (currently in hype)

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## 10 AI Hype Cycles and AI Winters

- The history of AI is a history of successive hype cycles and AI winters about the prospects of different techniques.

Connectionism      Markov Models      Expert Systems      ...      Deep Learning ?

1960's      1970's      1980's      2012

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## AI Research & Challenges

- Reasoning, problem solving
- Knowledge representation
- Planning
- Learning
- Natural language processing
- Perception (sound, vision, smell, touch, taste)
- Motion and manipulation (robotics)
- Social intelligence (cooperative agents)
- General intelligence

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## What is Machine Learning?

- "Field of study that gives computers the capability to **learn without being explicitly programmed**".
  - Arthur Samuel (coined the term in 1959)
- A **subfield of AI** to make machines more effective in their behavior and decisions by giving them the ability to **learn** and **develop their own programs**.


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## A Paradigm Shift within AI


➤ ML is particularly interesting in that it represents a paradigm shift within AI

**Traditional AI techniques**



- **Static** – hard-coded set of steps and scenarios
- **Rule Based** – expert knowledge
- **No generalization** – handling special cases difficult

**Machine Learning**



- **Dynamic** – evolves with data, finds new patterns
- **Data driven** – discovers knowledge
- **Generalization** – adapts to new situations and special cases

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## ML Example: Go playing



Symbolic AI

Mathematical/Statistical AI

Machine Learning approach

“Let’s sit down with the world’s best Go player, Lee Sedol, and put his knowledge into a computer program”

“Let’s simulate all the different possible moves and the associated outcomes at each single step and go with the most likely to win”

“Let’s show millions of examples of real life and simulated games (won and lost) to the program, and let it learn from experience”

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## ML Timeline

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ML is not a new concept. Neural networks were first introduced in 1943!

**1950**  
Alan Turing created a test to check if a machine could fool a human being into believing it was talking to a machine.

**1952**  
The first computer learning program, a game of checkers, was written by Arthur Samuel.

**1957**  
First neural network for computers (the perceptron) was invented by Frank Rosenblatt, which simulated the thought processes of the human brain.

**1967**  
The Nearest Neighbor Algorithm was written.

**1979**  
Students of Stanford University, California, invented the Stanford Cart which could navigate and avoid obstacles on its own.

**1997**  
IBM's Deep Blue beats the world champion at Chess.

**2002**  
A software library for Machine Learning, named Torch is first released.

**2016**  
AlphaGo algorithm developed by Google DeepMind managed to win five games out of five in the Chinese Board Game Go competition.

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## Applications of ML

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**APPLICATIONS OF MACHINE LEARNING**

**Machine Learning Applications**

- Virtual Assistant**: INTELLIGENT AGENTS, NATURAL LANGUAGE PROCESSING ETC.
- Social Media**: SENTIMENT ANALYSIS, FILTERING SPAM ETC.
- Transport**: SAFETY MONITORING, AIR TRAFFIC CONTROL ETC.
- Financial Services**: ALGORITHMIC TRADING, PORTFOLIO MANAGEMENT, FRAUD DETECTION
- Healthcare**: DRUG DISCOVERY, DISEASE DIAGNOSIS, ROBOTIC SURGERY
- eCommerce**: CUSTOMER SUPPORT, PRODUCT RECOMMENDATION, ADVERTISING,

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## How Machines Learn?

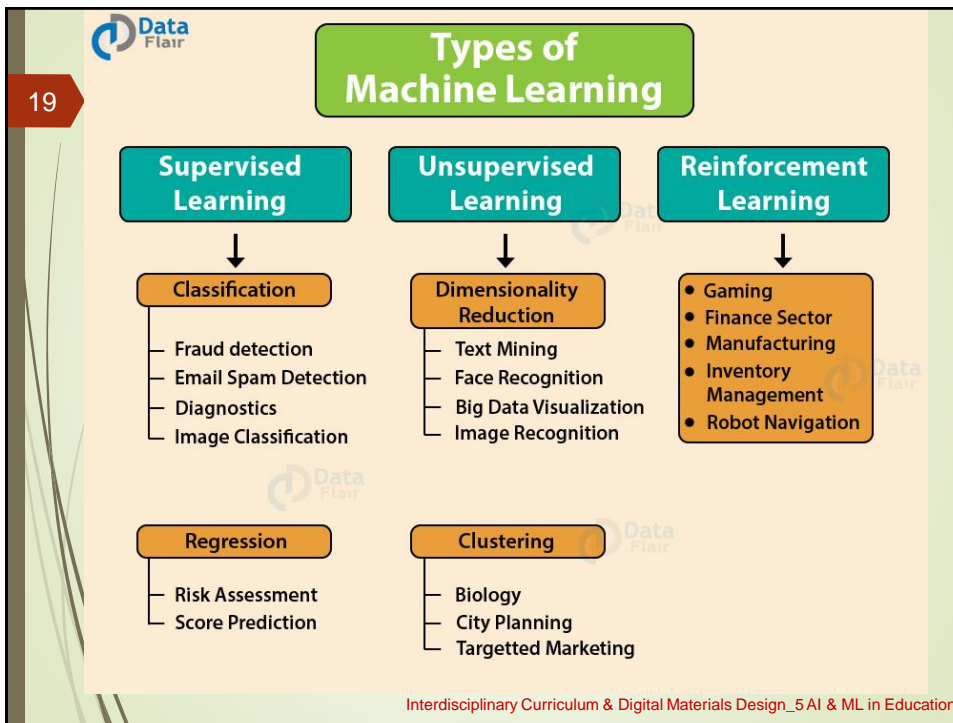
- **Supervised learning:** The learning algorithm is given **labeled data** and the **desired output**. The algorithm learns the **rules of classification**.
- **Unsupervised learning:** The **data** given to the learning algorithm is **unlabeled**, and the algorithm is asked to **identify patterns** in the input data.
- **Reinforcement learning:** The algorithm interacts with a **dynamic environment** that provides **feedback** in terms of **rewards** and **punishments**.

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## Types of ML Techniques

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- ## ML Algorithms
- Regression
  - Decision Tree
  - Support Vector Machines (SVMs)
  - Association Rule Learning
  - Artificial Neural Network (ANN)
  - Inductive Logic Programming (ILP)
  - Reinforcement Learning
  - Clustering
  - Similarity and Metric Learning
  - Bayesian Networks
  - Representation Learning
  - Sparse Dictionary Learning
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## Deep Learning, ML, & AI

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- Deep learning is a subset of ML based on ANN. It is deep because the structure of ANN consists of multiple (deep) layers.

**Artificial Intelligence**  
 Any technique that enables computers to mimic human intelligence. It includes *machine learning*

**Machine Learning**  
 A subset of AI that includes techniques that enable machines to improve at tasks with experience. It includes *deep learning*

**Deep Learning**  
 A subset of machine learning based on neural networks that permit a machine to train itself to perform a task.

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## Why the New Hype?

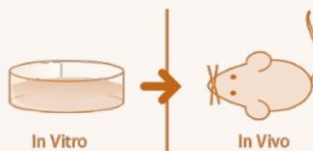
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- In the past 5 years, we've seen unprecedented progress in solving tough problems that defied our best efforts for 50+ years.

Unprecedented Progress

AI is Leaving the Lab and Being Deployed in the Wild






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## Factors behind New AI Renaissance

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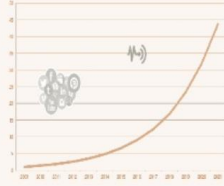
60 years of Research / Mature Algorithms




More Computing Power



More Data



Open Source Frameworks/Libraries




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## Where are we now?

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➔ We are seeing AI systems reaching **equal to above** human performance at **narrow tasks**.

Performance at Given Narrow Task Over Time



Source: Sunshyne

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## AI & ML in Education

- **Personalized and differentiated learning:** to tailor and personalized learning for each individual student (smart content)
- **Assisting and collaboration with teachers:** classroom mgnt, LMS, testing/grading, ...
- **Intelligent tutoring systems:** help students
- **Voice assistants:** Amazon Alexa, Google Home, Apple Siri, Microsoft Cortana
- **Universal, on-demand access:** on-line learning, global classrooms, language trans

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## AI & ML in Education

- **VR/AR with AI & ML:** provide life-like experience for students in diverse subjects
- **Chatbots:** help in multiple ways
- **Adaptive learning:** adapting the learning content and methods based on progress
- **Assessment and analytics tools:** to assess learning effectiveness and analyze learning obstacles.
- Helping both **slow** and **specially-abled students**.

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## Duolingo: Voice recognition for language learning

- **Duolingo** is a learning environment for language learning.
- Employ voice recognition for easy learning
- Available on Web, Android, iOS, ...



duolingo

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## ITS: Intelligent Tutoring System

- ITS aims to provide **immediate** and **customized** instruction or feedback to learners.
- Used in both formal education and professional settings
- [https://en.wikipedia.org/wiki/Intelligent\\_tutoring\\_system](https://en.wikipedia.org/wiki/Intelligent_tutoring_system)

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## Recognition Apps

- Employ **smartphone** to **decode the world** for learners.
- Help students in recognizing flowers, animals, clothes, stars, ...
- Generates excitement and motivates students.
- Enhances hands-on science activities
- Can even use AR in real environments

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## Learning Analytics

- Help students in self-regulated learning
- Assists students in course and learning content selection
- Understand students' learning status, identify those with high risk of failure
- Provide a broad range of **insight** into course **materials**, student **engagement**, and student **performance**.

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## Automated Essay Grading

- Within a single prompt, the models are able to make predictions that closely match those made by human graders.
- For essays of intermediate writing level (7-10<sup>th</sup> grades) and given enough human graded training examples for a writing prompt, the system can automate the grading process for that prompt with fairly good accuracy.

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