How Should We Face This New Era?

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December 30, 2025

Announcement

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Outline

1. About Me

2. About Biomedical Engineering

3. About AI

4. About You

About Me

- 戴偉璿
- Graduated from YLSH at 112 (YLSH student id: **9**10466)
- Biomedical Engineering, National Taiwan University
- CTBC brothers, Philadelphia Phillies, Manchester City
- Brawl Stars, Core Keeper, Rim World
- Old songs

My exam scores

- 學測
    - 國文：13
    - 英文：13
    - 數學：13
    - 自然：14
- 分科
    - 數學：55
    - 物理：52
    - 化學：37.....（仁祥老師我很抱歉）

- C++ programming
- Datastructures and Algorithms
- Machine Learning and Deep Learning
- Linear Algebra and Statistics

About Biomedical Engineering

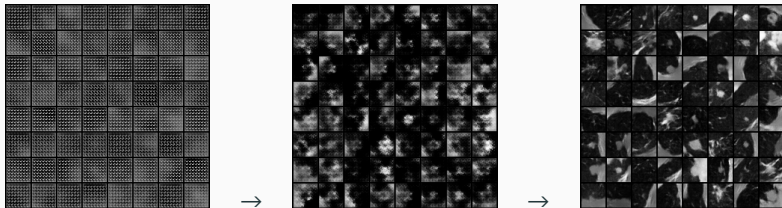Employing deep learning methods to generate synthetic CT images.

Figure 1: CT image generation results across training epochs.
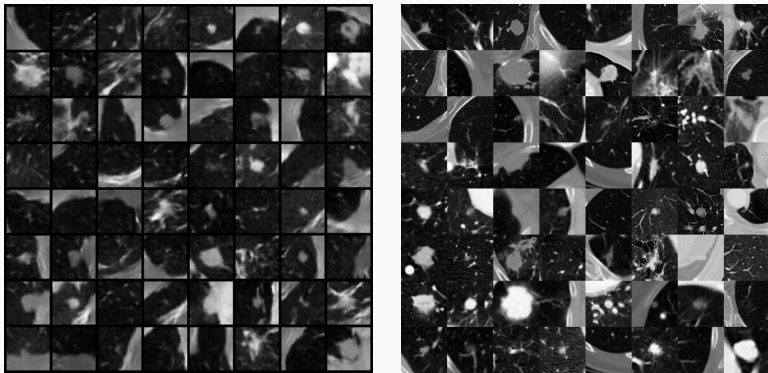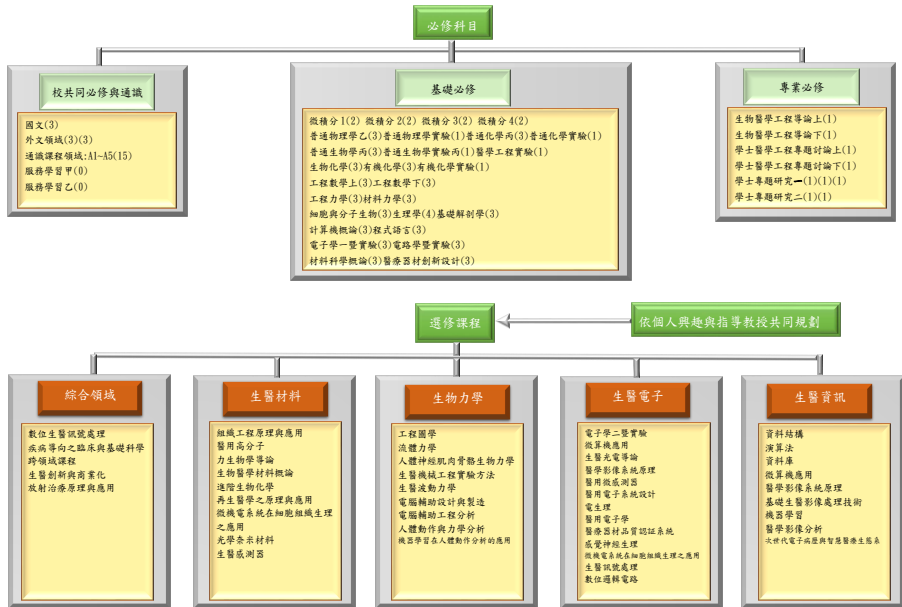
Figure 2: Generated CT image (left) vs. Real CT image (right).

Brief Intro to Biomedical Engineering

- Utilizing engineering principles to solve medical problems.
- Four main areas:
    - 生醫材料
    - 生物力學
    - 生醫電子
    - 生醫資訊
- Learning basic medicine, biology, chemistry, physics, and engineering at Grade 1 and 2.
- Specializing in one of the four areas at Grade 3 and 4.

應修最低畢業 130 學分＝校共同必修與通識 24 學分＋系訂必修 77 學分＋系訂選修 29 學分

必修科目

校共同必修與通識
- 國文(3)
- 外文領域(3)(3)
- 通識課程領域：A1-A5(15)
- 服務學習甲(0)
- 服務學習乙(0)

基礎必修
- 微積分 1(2) 微積分 2(2) 微積分 3(2) 微積分 4(2)
- 普通物理學乙(3)普通物理學實驗(1)普通化學丙(3)普通化學實驗(1)
- 普通生物學丙(3)普通生物學實驗(1)醫學工程實驗(1)
- 生物化學(3)有機化學(3)有機化學實驗(1)
- 工程數學上(3)工程數學下(3)
- 工程力學(3)材料力學(3)
- 細胞與分子生物(3)生理學(4)基礎解剖學(3)
- 計算機概論(3)程式語言(3)
- 電子學一暨實驗(3)電路學實驗(3)
- 材料科學概論(3)醫療器材創新設計(3)

專業必修
- 生物醫學工程導論上(1)
- 生物醫學工程導論下(1)
- 學士醫學工程專題討論上(1)
- 學士醫學工程專題討論下(1)
- 學士專題研究一(1)(1)(1)
- 學士專題研究二(1)(1)

選修課程　◀── 依個人興趣與指導教授共同規劃

綜合領域
- 數位生醫訊號處理
- 疾病導向之臨床與基礎科學
- 跨領域課程
- 生醫創新與商業化
- 放射治療原理與應用

生醫材料
- 組織工程原理與應用
- 醫用高分子
- 力生物學導論
- 生物醫學材料概論
- 進階生物力學
- 再生醫學之原理與應用
- 微機電系統在細胞組織生理之應用
- 光學奈米材料
- 生醫感測器

生物力學
- 工程圖學
- 流體力學
- 人體神經肌肉骨骼生物力學
- 生醫機械工程實驗方法
- 生醫波動力學
- 電腦輔助設計與製造
- 電腦輔助工程分析
- 人體動作與力學分析
- 機器學習在人體動作分析的應用

生醫電子
- 電子學二暨實驗
- 微算機應用
- 生醫光電導論
- 醫學影像系統原理
- 醫用微感測器
- 醫用電子系統設計
- 電生理
- 植入電子學
- 醫用數位訊號認證系統
- 感覺神經生理
- 微機電系統在細胞組織生理之應用
- 生訊號處理
- 數位邏輯電路

生醫資訊
- 資料結構
- 演算法
- 資料庫
- 微算機應用
- 醫學影像系統原理
- 生醫影像系統原理
- 基礎生醫影像處理技術
- 機器學習
- 醫學影像分析
- 次世代電子病歷與智慧醫療生態系

About AI

Artificial Intelligence (AI) refers to systems that can make decisions or perform tasks that are typically associated with human intelligence, such as reasoning, problem-solving, or decision-making.

In a very broad sense, even simple rule-based systems (e.g., a vending machine) can be viewed as a primitive form of AI.

Artificial Intelligence, Machine Learning, Deep Learning

- AI: The broad concept of machines being able to carry out tasks in a way that we would consider "smart".
- ML: A subset of AI that involves the idea that machines can learn from data and improve their performance over time without being explicitly programmed.
- DL: A subset of machine learning that uses neural networks with many layers (hence "deep") to analyze various factors of data.

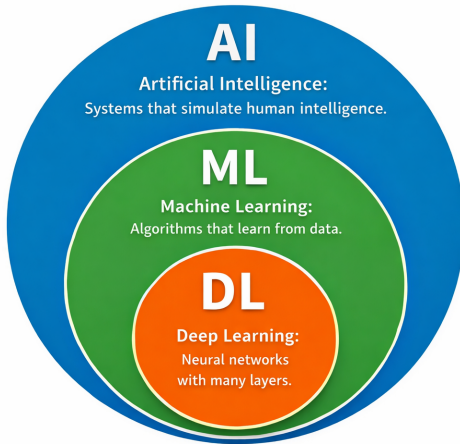It is considered that $DL \subset ML \subset AI$

Figure 3: Relationship between AI, ML, and DL

The principle of Machine Learning

In fact, the core idea of ML is **function approximation**.

Given a set of input data X and corresponding output data Y, the goal of ML is to find a function f such that:

$$Y \approx f(X)$$

Where f is typically represented by a model with parameters that can be adjusted based on the training data.

Thus, we can describe it more precisely as:

$$y = P(answer|input)$$

Three main types of Machine Learning

- Classification: Assigning input data to predefined categories.

$$y = \arg\max_y P(y \mid x)$$

- Regression: Predicting continuous output values based on input data.

$$y = \mathbb{E}[y \mid x]$$

- Generation: Creating new data instances that resemble the training data.

$$x \sim P(x)$$

A simple pipeline to train a ML model

1. Define the model architectures (i.e. define the function f)
2. Define the loss function (i.e. define how to measure the error)
3. Optimize the model parameters to minimize the loss function using training data
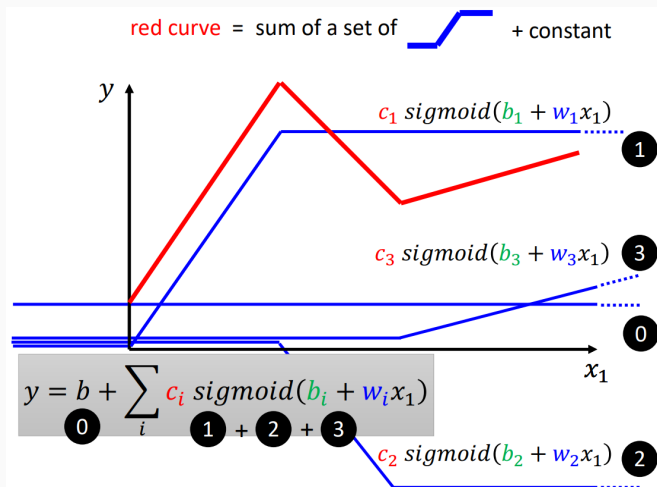
A simple regression model

Figure 4: A simple linear regression model fitting data points.

https://speech.ee.ntu.edu.tw/ hylee/ml/ml2021-course-data/regression%20(v16).pdf

A simple regression model (cont.)

With the trained model, we can predict the output for new input data, and then compute the error (loss) between the predicted output and the actual output. With this error, we can adjust the model parameters to minimize the loss using optimization techniques like gradient descent (using partial derivative).

Why AI now?

- Increase in computational power (e.g. GPUs, TPUs)
- Availability of large datasets (Big Data)
- Advances in algorithms and architectures (e.g. CNNs, RNNs, Transformers)

What are LLMs?

- Large Language Models
- Like a World Chain Game
- Trained on massive text data to predict the next word in a sequence
- $P(word_n|word_1, word_2, ..., word_{n-1})$

What is ChatGPT?

- Generative Pre-trained Transformer
- Developed by OpenAI
- Based on the Transformer architecture
- Fine-tuned for conversational tasks
- One of the earliest well known LLMs

With the brief introduction above, do you think artificial intelligence will replace us?

How should we face this new era?

- This is the best of times, and the worst of times.
- Tools can be double-edged swords
- Embrace the change and adapt (i.e. knowing how to use AI effectively)
- Focus on **uniquely human skills** (e.g. creativity, empathy, critical thinking)
- Ethical considerations and responsible use of AI

What are LLMs good at?

- Help you learn in your preferred way
- Capture and summarize information quickly
- Translate languages
- Collect information
- Teach you a fact or a concept
- Talk to you

What shouldn't LLMs do?

- Finish your homework for you
- Make important decisions for you
- Handling professional tasks without human oversight
- Generate ideas without your input
- Derive complex mathematical formulas

About You

What can you do now?

- Enhance your english skills
- Learn programming (At least you should able to read and understand code)
- Learn basic mathematics (Linear Algebra, Probability, Statistics)
- Learnign how to express your ideas clearly
- **Find a way to release your stress**

- Fundational skills
- Media literacy
- Critical thinking
- Adaptability and lifelong learning
- Courge to try new things

Major or School?

For me, I'm strongly interested in programming, but my score is not good enough for computer science. After careful consideration, I decided to choose school first(NTU).

Biomedical engineering is like an extension of senior high school. We study the basic sciences and engineering in the first two years, and then specialize in biomedical topics in the last two years. This gives me a solid foundation to pursue my interests in programming and AI while still being in a reputable university.

It kind of gives you two more years to decide what you really want to do in the future.

3 tips for doing research projects

- Get ideas by reading and questioning papers
- Properly allocate work and communicate with teammates
- Make good use of tools (e.g. ChatGPT) to search and organize information

Other miscellaneous questions

- Difference between BME, EE, CS, LS(Life Science)
- How to find the balance between academics and extracurriculars(e.g. programming)
- Get start with programming
- How to leverage your advantages
- What can you prepare now for your college life
- Experienced emotions and approaches to coping with them

Any questions?

Contact Information

Here are some of my contact information:

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- By your teacher

Humans won't be replaced by tools.
People who refuse to learn how to use tools might be.