

Generative AI Curriculum Introductory Brochure



Developed by:



The Chinese University of Hong Kong
Faculty of Engineering
Faculty of Education

Funded by:



The Hong Kong Jockey Club Charities Trust

Published by

CUHK Jockey Club AI for the Future Project

under the CUHK Faculty of Engineering and Faculty of Education

AI Education and Exploration Lab

Rm1105, 11/F, William M. W. Mong Engineering Building (ERB)

The Chinese University of Hong Kong

Shatin, New Territories

Tel.: (852) 3943 0479

Website: <https://cuhkjc-aiforfuture.hk/>

Email address: aiforfuture@cuhk.edu.hk

©CUHK Jockey Club AI for the Future Project

All rights reserved. The intellectual property is owned by The Chinese University of Hong Kong (CUHK) and The Hong Kong Jockey Club Charities Trust (JC). Contents are provided to support AI teaching by collaborating schools. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means—electronic, mechanical, photocopying, recording, or otherwise—without the prior written permission of CUHK and JC.

First draft published in 2024

Produced by CUHK Jockey Club AI for the Future Project

*The cover image is generated with Playground AI.

Preface

Funded by The Hong Kong Jockey Club Charities Trust, the CUHK Jockey Club AI for the Future (AI4Future) Project leverages the expertise of CUHK's Faculty of Engineering and Faculty of Education. The project aims to create a sustainable pre-tertiary AI education framework for Hong Kong, including a comprehensive curriculum, supporting infrastructure, and a collaborative ecosystem. The goal is to advance pre-tertiary education and prepare the younger generation for the future with AI exposure.

In 2021, the project was honoured to receive the Gold Award in The Hong Kong ICT Awards: Smart People Award (Smart Education and Learning). In 2023, an abridged version of the project's content was adopted by the Education Bureau of Hong Kong and became the "Module on Artificial Intelligence for Junior Secondary Level" for use in all publicly-funded local school.

The curriculum consists of the following 12 Chapters that are organised into a pedagogical framework of Awareness, Knowledge, Ethics and Impacts, Interaction and Empowerment: "Introduction to AI", "Fundamentals of AI", "See", "Hear", "Speak", "Read", "AI Reasoning", "Simulation", "Think and Create", "Social Good, Social Impacts and Challenges of AI", "AI and Ethics", and "AI and Future of Work".

2023 marked the breakout year for Generative AI. The ongoing and pervasive discussions surrounding its impact on our daily lives, the potential for AI to replace humans, and the emergence of a new era characterized by coexistence with Generative AI continue to be a major subject of inquiry worldwide.

In response to the students' curiosity and interests, and to prepare them for the Generative AI era, we have developed a supplementary chapter on Generative AI. This brochure presents highlights of selected topics covered in the Generative AI chapter.

*ChatGPT was used to refine the language during the composition of this brochure. We have also applied tools and adapted code from such repositories as GitHub and provided the relevant acknowledgements where appropriate.

Table of Contents

AWARENESS – History, background and development of Generative AI

KNOWLEDGE – Identification of key concepts and impact of Generative AI

Module 1: Text Generation Model – ChatGPT

Module 2: Image Generation Model – Stable Diffusion

INTERACTION – Experimentation of Generative AI in AI Lab

Module 1: Playing with ChatGPT

Module 2: Basic Image Generation

Module 3: Advanced Image Generation

Module 4: Prompt Engineering in Language Models

Module 5: Task Automation Using Language Models

EMPOWERMENT – Acquisition of abilities to design, develop and integrate Generative AI into end-to-end systems

Module 1: Style Transfer Image Generation

Module 2: Exploring Manga Inpainting

Module 3: Illusion Diffusion Image Generation

Module 4: Building an Image Generation App with MIT App Inventor

Module 5: Deep Reinforcement Learning

Module 6: Fine-tuning a Stable Diffusion Model

Module 7: GPT-based Game

Module 8: Text Adventure Game

Module 9: Animated Talking Avatar

Module 10: Animated Music Video Generation

ETHICS – Exploration of Generative AI topics and case studies to promote social good, ethical use of Generative AI and impact on future of work

I. AWARENESS

Generative AI (GenAI), also known as **AI Generated Content (AIGC)**, is a subfield of AI which leverages the power of sophisticated neural networks to generate imaginative and creative content across a variety of formats, including text, images, audio, code, music, and videos, etc.

Analytical AI versus Generative AI

The traditional type of AI which analyses existing data to classify or predict is **Analytical AI**. In contrast, **Generative AI** aims to create new content that resembles the patterns and characteristics of the training data.

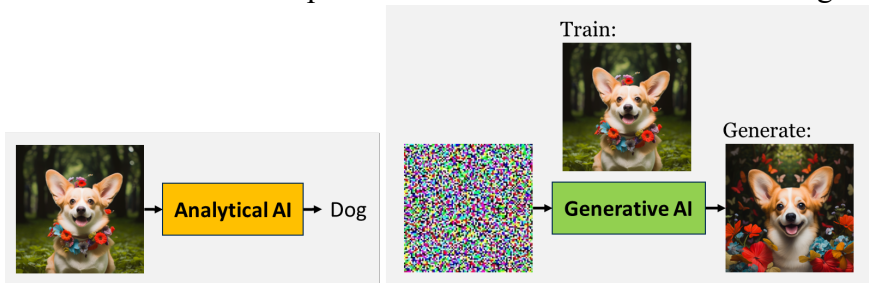


Figure 1.1: (Left) Example of Analytical AI: a model to classify cat or dog images. (Right) Example of Generative AI: a model trained on dog images to generate similar dog images. (Dog images generated using Midjourney).

History of Generative AI

The technologies behind Generative AI have a long history, although use of the technologies began to blossom around 2020.

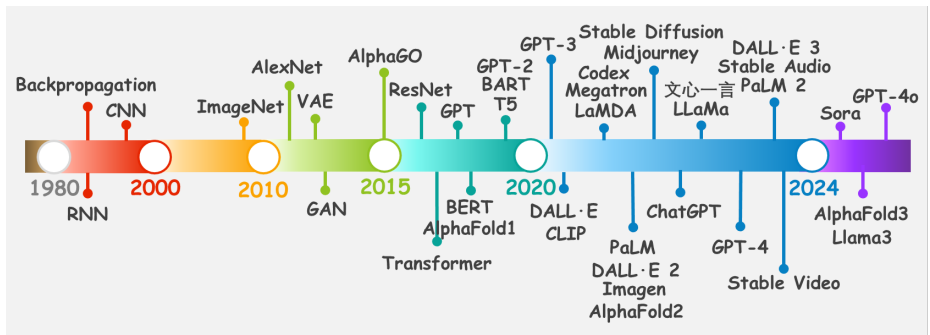


Figure 1.2: History of Generative AI.

II. KNOWLEDGE

Text Generation Model – ChatGPT

ChatGPT refers to **Chat** Generative Pre-trained Transformer. It is a **text generation** model which can understand natural language, code or image input from humans (i.e. prompts) and generate human-like text responses in real-time. This module will answer the following questions:

- In the context of ChatGPT, what do the terms “Generative”, “Pre-trained”, and “Transformer” mean?
- Why is ChatGPT considered revolutionary?
- What is a Large Language Model (LLM)?
- How is ChatGPT trained using Reinforcement Learning from Human Feedback (RLHF)?
- What are some limitations of ChatGPT, such as “hallucination”?
- Can ChatGPT replace human roles?



Figure 2.1: A Large Language Model (LLM) is powerful, similar to how a person becomes knowledgeable from reading a vast quantity of books.

(Images generated using Midjourney).

Image Generation Model – Stable Diffusion

Stable Diffusion is an **image generation** model that creates images based on textual descriptions, known as the prompts. This module will address the following questions:

- What is meant by “diffusion” in the context of “stable diffusion”?
- How are images generated through the reverse diffusion process
- How is training data obtained for the reverse diffusion process using the forward diffusion process?
- What is meant by “stable diffusion” in relation to the latent diffusion model?
- How does the text in a prompt influence the image generated?



Figure 2.2: The reverse diffusion process involves generating images by training a model to incrementally remove noise – similar to how milk is used in latte art – through a series of steps until a clear image of corgi latte art emerges. (Images generated using Midjourney).

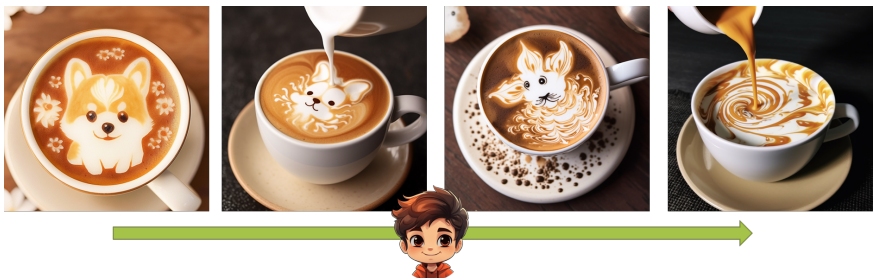
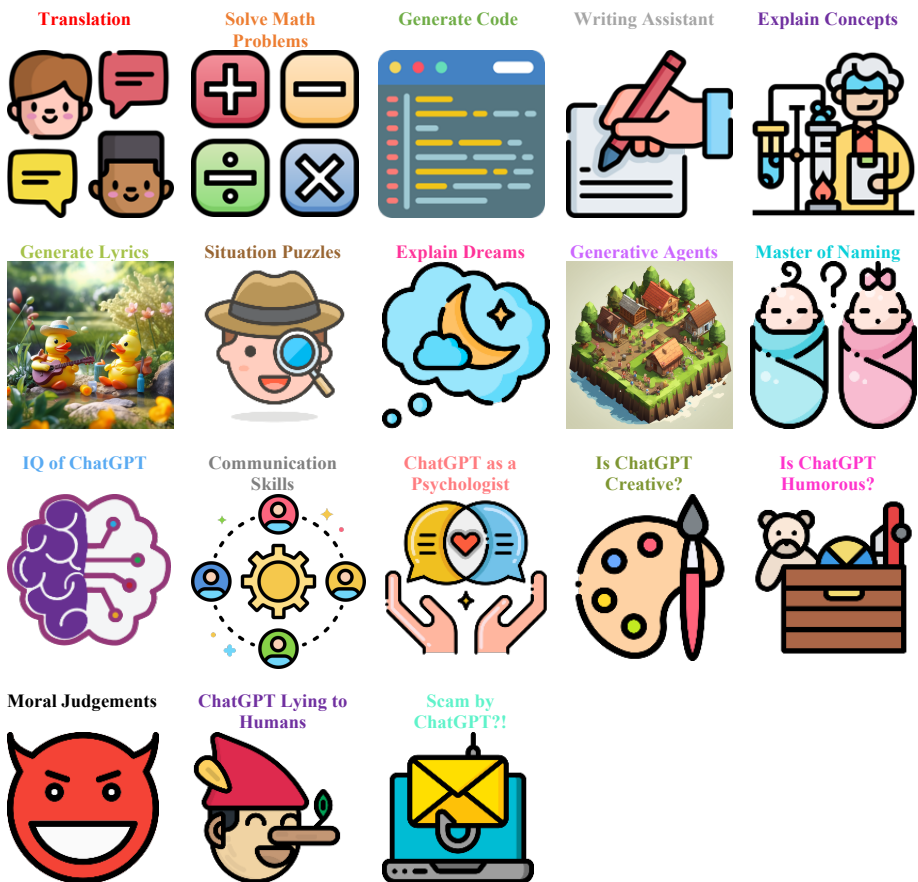


Figure 2.3: The forward diffusion process involves systematically adding noise – comparable to milk in latte art – to an image, such as corgi latte art, in a controlled sequence of steps. This process continues until the image is completely obscured by noise. This method is used to generate training data for the reverse diffusion process. (Images generated using Midjourney).

III. INTERACTION

Module 1: Playing with ChatGPT

In this module, students will explore the capabilities and limitations of ChatGPT. They will start with basic tasks such as translation, then progress to more engaging activities like generating lyrics and interpreting dreams. Next, students will assess ChatGPT's human-like abilities, including its IQ, communication skills, and creativity. Finally, they will discuss ChatGPT's moral judgments, instances of deception, and potential for scams.



*Image Credits: Freepik

Module 2: Basic Image Generation

Students will learn the basic operations (as shown in the figure) in image generation tools and techniques for crafting effective prompts. Various topics are provided, such as images of people, animals, places, food, and objects, allowing students to practice their image generation skills. Ethical considerations in the training and use of these models will also be addressed.



*Images generated using Midjourney

Module 3: Advanced Image Generation

This is for students seeking to further enhance their image generation skills, aiming for better results in terms of aesthetics, alignment with user preferences, and control over desired outcomes. It covers advanced operations in image generation tools and advanced prompt-writing techniques.



*Images generated using Playground AI

Module 4: Prompt Engineering in Language Models

Prompt Engineering involves designing and refining prompts to control the model, improve accuracy, and generate relevant responses. In this module, students will learn prompt engineering strategies and tactics to steer good responses from ChatGPT. They will explore four selected strategies and underlying tactics suitable for school-level understanding, based on the documentation provided by OpenAI.



*Image generated using Lexica

Module 5: Task Automation Using Language Models

Language Models such as ChatGPT can adopt various roles and personas through carefully crafted prompts. Students will develop and utilize example chatbots, exploring the potential of task automation and its implications for the future of work.

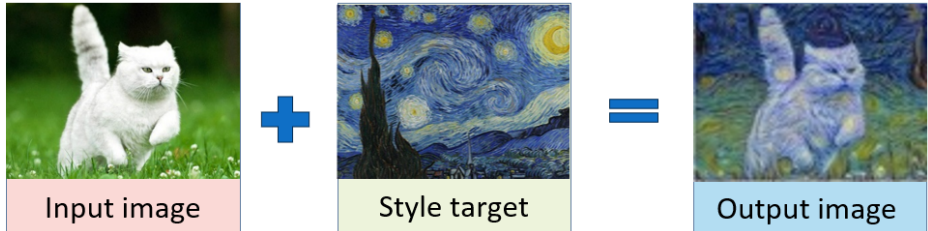
	Hi! I am a positive thinking coach. I am your friend and I will help you always think positively. Wellness Coach		Hello! I am your programming buddy. Give me your problem in your own words and I will provide Python code along with an explanation. Programmer
	Hi, I am there to assist you in learning geography. You can ask me a question. Geography Teacher		Hello, I can suggest marketing tips for your products. How may I help you? Marketing Manager
	Hi! I will help you in writing poetry. Poet		

*Images generated using Lexica

IV. EMPOWERMENT

Module 1: Style Transfer Image Generation

This module uses a generative model known as Variational Autoencoders (VAEs) for style transfer image generation. The objective of style transfer is to generate an image that maintains the original content while incorporating the visual style of a different image.

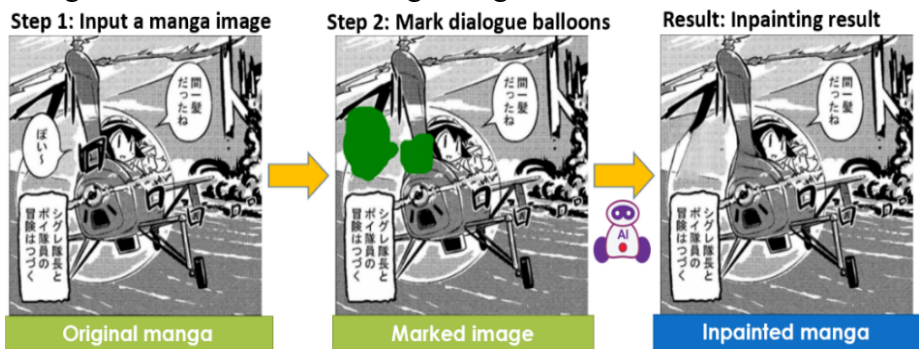


*Image generated by code adapted from akanametov

Module 2: Exploring Manga Inpainting

Automatic image inpainting is a Generative AI technique used for reconstructing lost or deteriorated parts of images. In this module, students will learn about automatic image inpainting and its applications, such as restoration of old or damaged photographs, removal of unwanted objects from images, and filling in missing part of the image.

Manga are series of artwork that tell stories. In this module, students will use an interactive web-based application to explore image-inpainting task, aiming to restore content in manga images.



*Image generated by code adapted from Minshan Xie

Module 3: Illusion Diffusion Image Generation

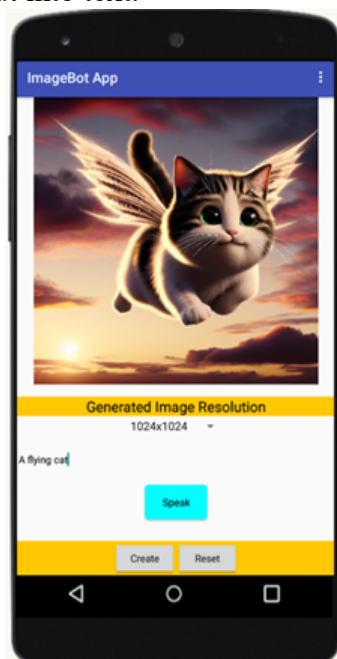
In this module, students will learn how to create an illusion diffusion image by combining a text prompt with a hidden image. Captivating visual illusions can be crafted using various prompts, hidden images, and a diffusion model.



*Image generated by code adapted from camenduru

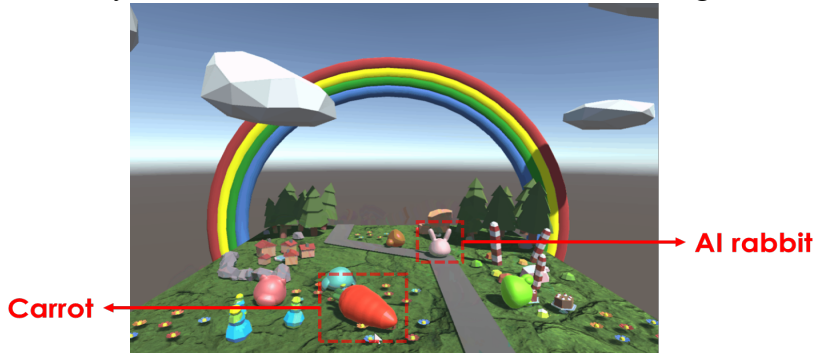
Module 4: Building an Image Generation App with MIT App Inventor

Students will use **MIT App Inventor** to develop an Android mobile image generation app based on the DALL·E 3 model. Input prompts can be either typed or spoken, with Automatic Speech Recognition converting speech input into text.



Module 5: Deep Reinforcement Learning

This module introduces Proximal Policy Optimization (PPO), a Deep Reinforcement Learning algorithm used in training ChatGPT to optimize the model based on human feedback. Using C#, students will build a 3D game in Unity and train an AI rabbit to collect carrots using PPO.



Module 6: Fine-tuning a Stable Diffusion Model

Students will fine-tune a Stable Diffusion model with images of a specific subject using Python and Jupyter Notebook. The custom model can generate images of the subject contextualized in different scenes, artistic rendition, perspectives, color, texture, accessorization and more.



*Image Credit: DreamBooth

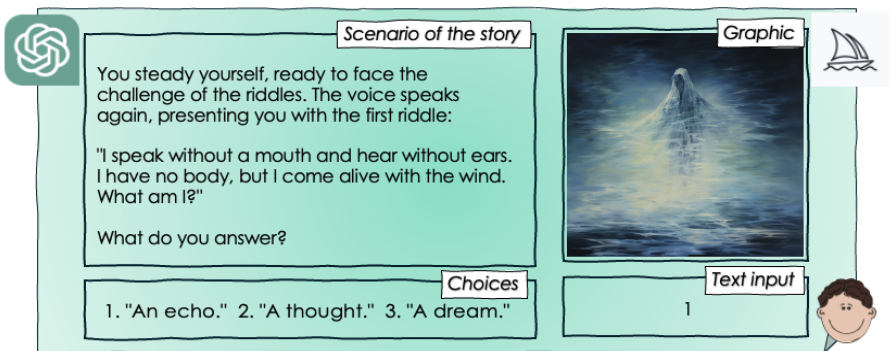
Module 7: GPT-based Game

Students will learn how to integrate GPT models with non-player characters (NPCs) in games, enabling these NPCs to engage in conversations similar to ChatGPT. In addition, these NPCs will be capable of answering questions related to custom tasks and performing custom actions. Students will develop the 3D game using C# and Unity.



Module 8: Text Adventure Game

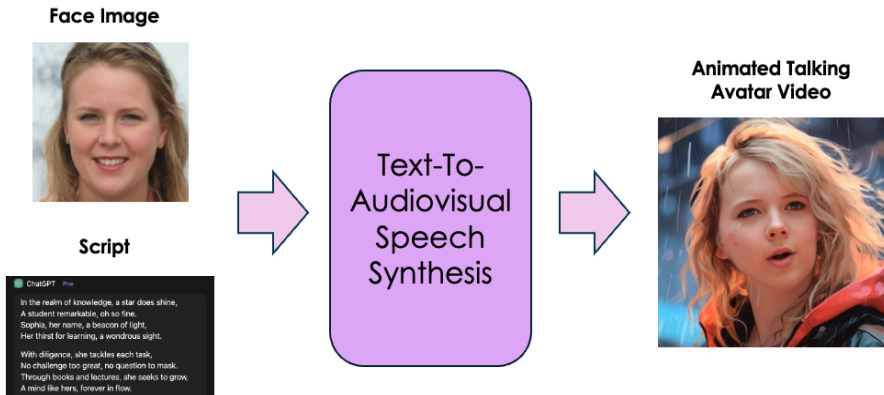
Text adventure games leverage natural language processing technologies to create interactive storytelling narratives. With the advancement of large language models (LLMs) and image generation models, students can now design text adventure games using custom prompts based on their stories and rules, all without the need for coding.



*Image generated using Midjourney

Module 9: Animated Talking Avatar

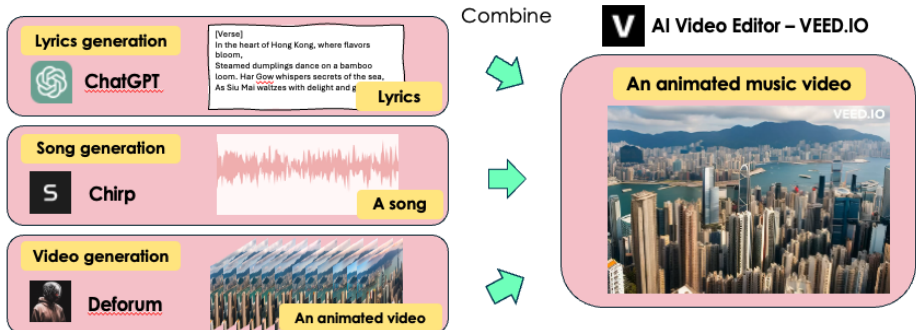
AI avatars have diverse applications across various fields, including customer service, education, marketing, and social media. Utilizing advanced generation tools, students can create personalized anime-style faces to effectively convey your intended message or script. This results in captivating videos where the avatar comes to life, expressing your words with emotion through animation.



*Face image of the fake person generated using BoredHumans, anime face generated using Midjourney, text generated using ChatGPT

Module 10: Animated Music Video Generation

This module explores a range of generative AI technologies, including text, audio and video generation. Leveraging these AI tools, students can craft animated music videos driven by song lyrics, unlocking their creativity and transforming their visions into reality.



*Images generated by code adapted from Deform

V. ETHICS

The AI4Future curriculum outlines five basic ethical principles of AI (Figure 5.1). Students will explore a variety of questions related to these principles to deepen their understanding of ethical considerations:

- When should we avoid using Generative AI?
- Who owns the content created by Generative AI?
- What are the risks and responsibilities of using Generative AI in our studies or work?

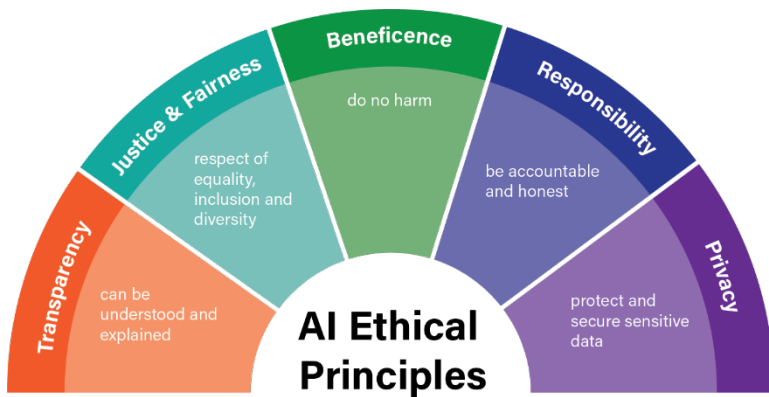


Figure 5.1: Five AI ethical principles

In light of the growing prominence of Generative AI applications, it is crucial for students to remain aware of the key concerns and risks associated with this technology. They will be guided to navigate challenges such as the rise of fake content and copyright uncertainties related to Generative AI (see Figures 5.2 and 5.3).



Figure 5.2: AI-generated video depicting Hong Kong's Chief Executive endorsing an investment scam (Source: OECD).

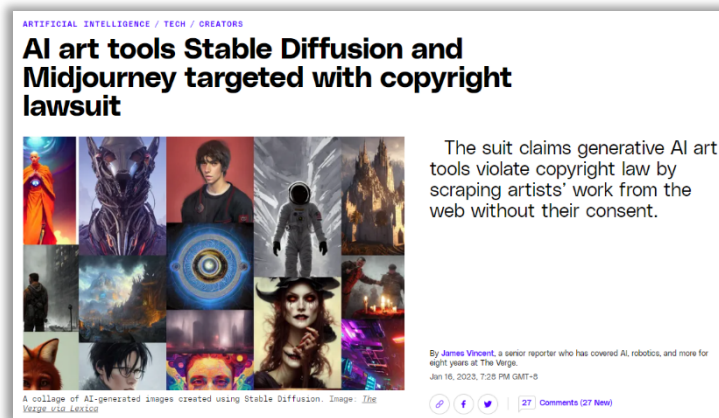


Figure 5.3: Artists have filed lawsuits against Stable Diffusion and Midjourney, alleging copyright infringement by their art-generating technologies.
(Source: The Verge).

Students will learn about the significant environmental impact of training and using Generative AI models, which have billions of parameters. These activities not only lead to the consumption of millions of liters of water, primarily through two channels – onsite server cooling and offsite electricity generation – but also require substantial amounts of power and energy. The high energy demands for operating and maintaining data centers contribute to carbon emissions and environmental degradation, raising serious concerns about environmental sustainability.



*Image Credit: Freepik

The module on the Ethics of Generative AI will equip students with the essential guidelines and principles for the responsible use of Generative AI technologies.

References

<https://openai.com/blog/chatgpt>
<https://platform.openai.com/docs/guides/text-generation>
<https://openai.com/research/openai-baselines-ppo>
<https://docs.midjourney.com/docs>
<https://playgroundai.com/>
<https://dreambooth.github.io/>
<https://oecd.ai/en/incidents/60504>
<https://www.youtube.com/watch?v=uT0-mp6oNFM>
<https://appinventor.mit.edu/explore/resources/ai/imageBot>
<https://github.com/camenduru/IllusionDiffusion-hf>
<https://github.com/deforum-art/deforum-stable-diffusion>
<https://www.theverge.com/2023/1/16/23557098/generative-ai-art-copyright-legal-lawsuit-stable-diffusion-midjourney-deviantart>

Minshan Xie, Menghan Xia, Xueting Liu, Chengze Li, and Tien-Tsin Wong. 2021. Seamless manga inpainting with semantics awareness. ACM Trans. Graph. 40, 4, Article 96 (August 2021), 11 pages. <https://doi.org/10.1145/3450626.3459822>

Contributors from CUHK

Professor Helen Meng
Professor Xing Xing
Dr. Chandni Saxena
Mr. Milton Chan
Mr. Vincent Ho
Mr. Jerry Huen
Ms. Esther Leung
Mr. Muhammad Usman Bin Mujeeb
Mr. Rushat Rai
Ms. Niki Sze
Ms. Sophia Tang
Mr. Liujianfu Wang
Mr. Jiuming Wang
Mr. Silas Wong
Mr. Jeffrey Wu



Join Us as a Participating School!

» Applications Open Year-Round

Responsibilities of Participating Schools

- Enroll at least 84 new students each school year and implement a minimum of 3 chapters of the AI Curriculum (which can be used alongside the EDB's Module on AI).
- Assign one or more teachers to attend our workshops.
- Guide students through assessment exercises and AI literacy tests via the e-platform.
- Monitor student learning progress, actively participate in evaluations, and provide relevant data to the project upon request.

Application Procedures

- Complete the online application form.
- Upon approval, receive AI learning and teaching resources, along with a hardware toolkit to support classroom instructions.

Contact Us

☎ 3943 0479 ✉ aiforfuture@cuhk.edu.hk



 [cuhkjaiforfuture](https://www.facebook.com/cuhkjaiforfuture)

 [cuhkjc_aiforfuture](https://www.instagram.com/cuhkjc_aiforfuture)

 CUHK Jockey Club AI for the Future Project

Learn More

