

The Past, Present, and Future of Generative AI: Key Innovations and Trends

*Exploring the Evolution and Impact of Generative AI
Technologies*

APIGA 2024
Busan, July 10, 2024

Naufal Suryanto, Ph.D.
Postdoctoral Researcher @ IoT Research Center,
Pusan National University
naufalso@pusan.ac.kr; naufal@islab.re.kr;
naufalsuryanto@gmail.com;

**DIEP
NEP.**

THIS IS NOT MORGAN FREEMAN.

Disclaimer!

Welcome to our presentation, Dear APIGA Participants!
The content of this presentation was **developed with the assistance of Generative AI Technology.**



Scan to access presentation material
https://bit.ly/apiga_genai



CONTENTS

1. Introduction of Generative AI

2. History of Generative AI

3. Recent Advances in Generative AI

4. Applications of Generative AI

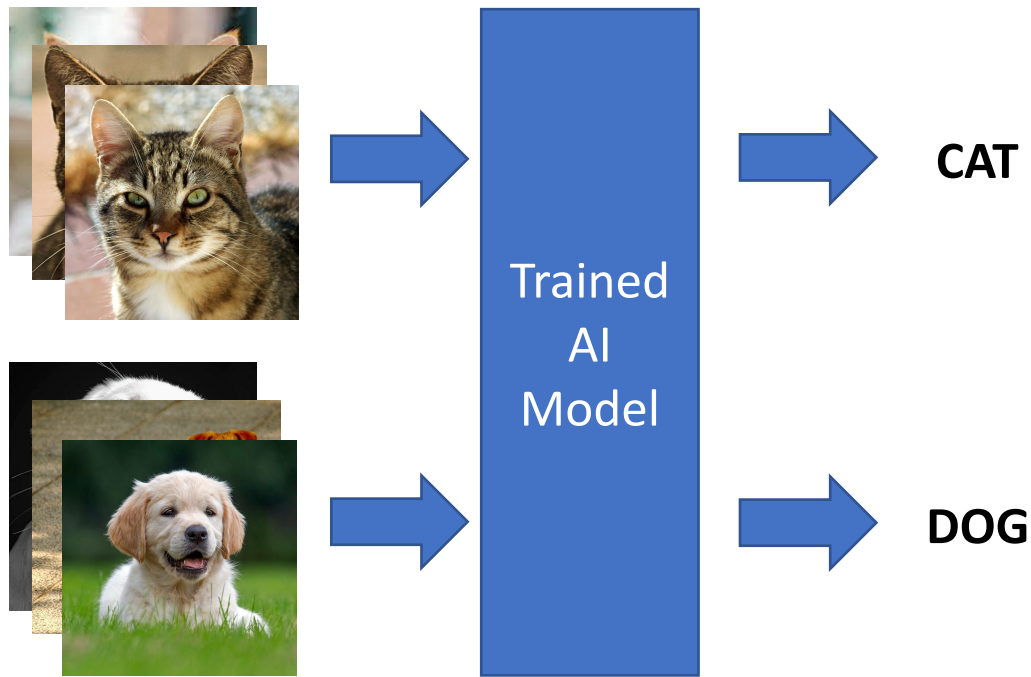
5. Ethical Considerations, Future Directions, and Conclusion

1. Introduction of Generative AI

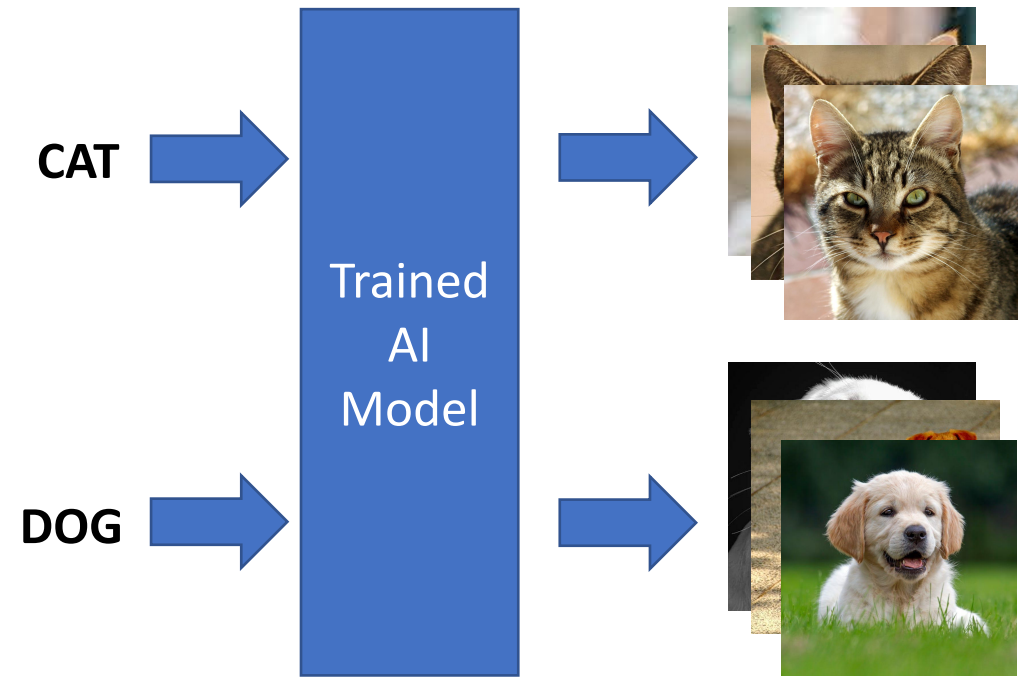
1 Introduction

What is Generative AI?

- Generative AI** refers to a category of **Artificial Intelligence (AI)** algorithms designed to generate new data instances that **closely mimic the training data**.



Discriminative AI

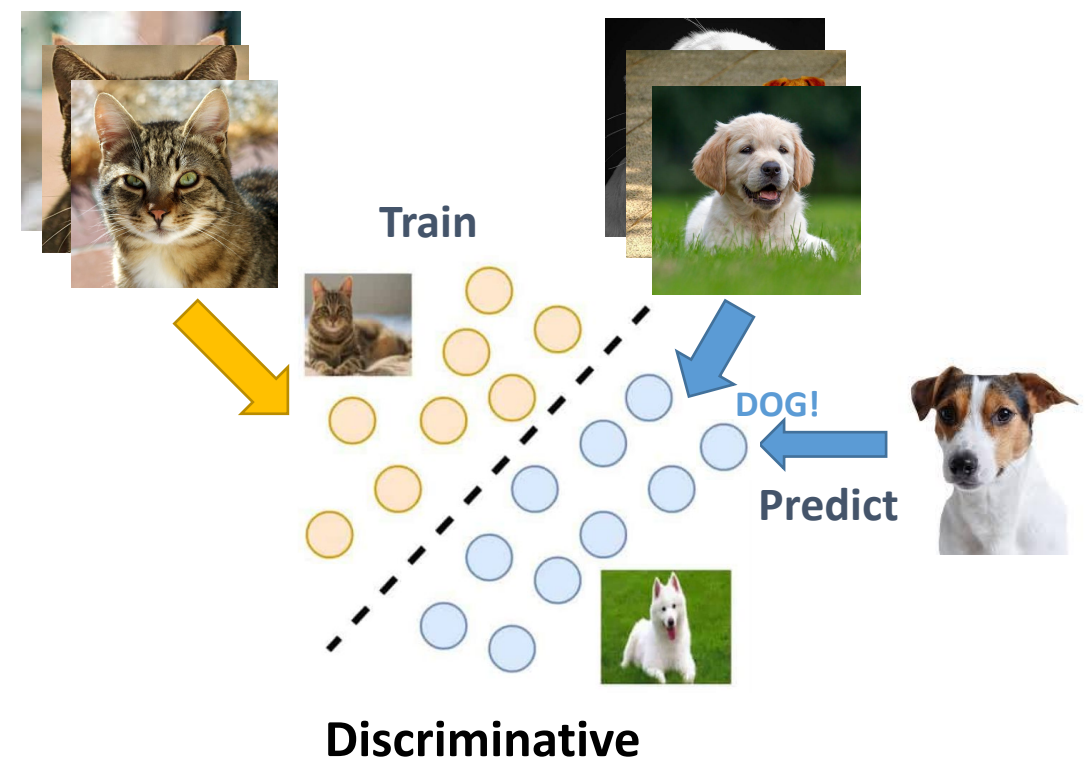
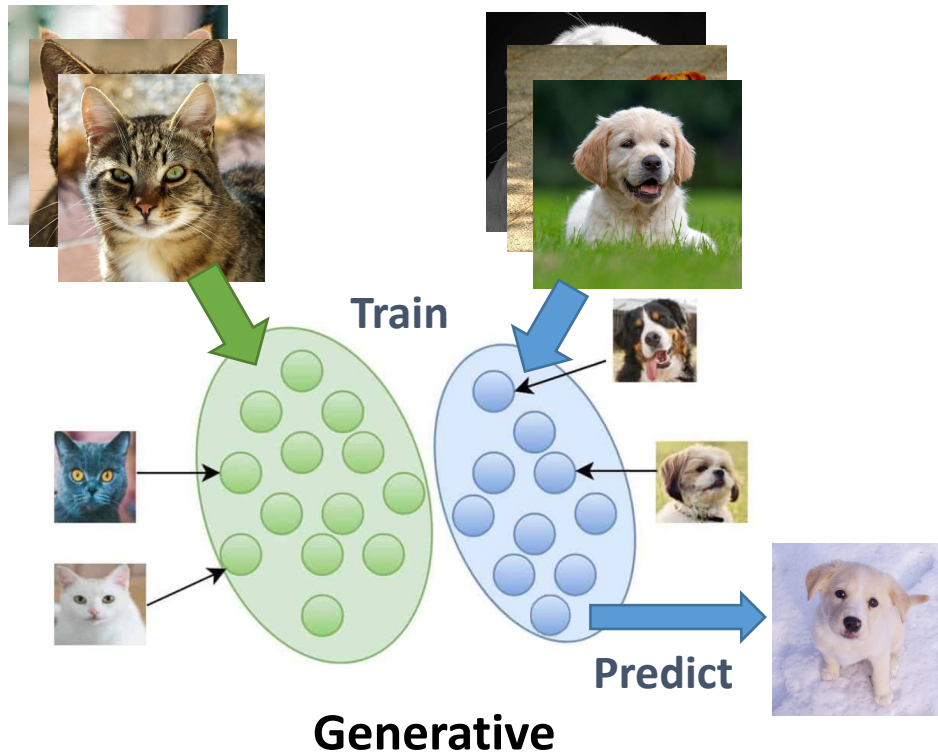


Generative AI

1 Introduction

How Generative AI Works?

- Generative AI model is trained to learn the **patterns** and **structures** within a **dataset**. This allows it to **create new data** that looks similar to the **original** and follows the same underlying **distribution**.



Generative AI Around Us



Text Generation



Image Generation



Video Generation

Auto|complete

Auto Text Completion



Voice Assistant

2. History of Generative AI



▪ The Early Beginning of AI

Alan Turing introduces the **Turing Test** to measure a machine's ability to exhibit intelligent behavior.



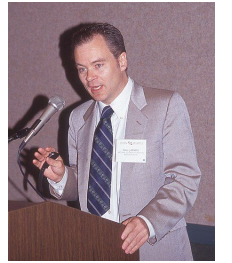
John MacCarthy

1955

Frank Rosenblatt develops the **Perceptron**, the first **Artificial Neural Network**.



Seppo Linnainmaa

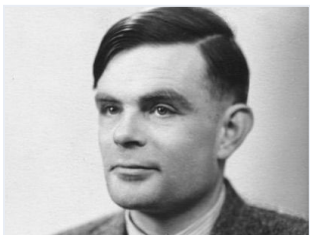


Paul Werbos

1970

1982

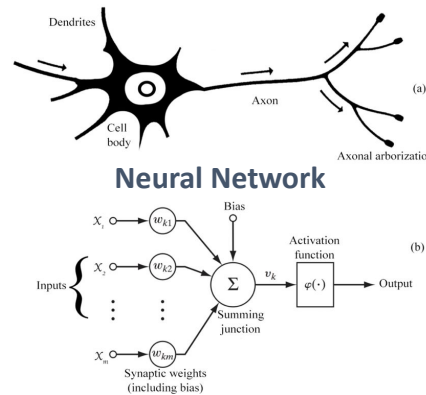
1950



Alan Turing

The term **AI (Artificial Intelligence)** is coined for the first time by John MacCarthy.

1957



Frank Rosenblatt

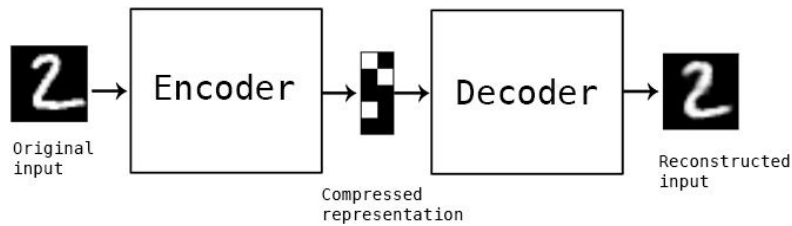
Backpropagation algorithm was formalized and applied to allow neural networks to learn from data.

2

History of Generative AI

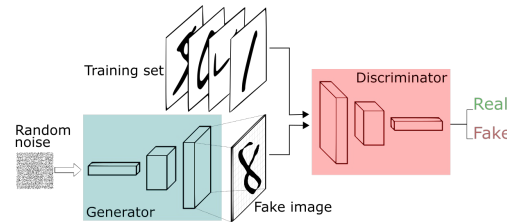
Deep Learning Era - The Key Breakthroughs of Generative AI

*Unsupervised Learning



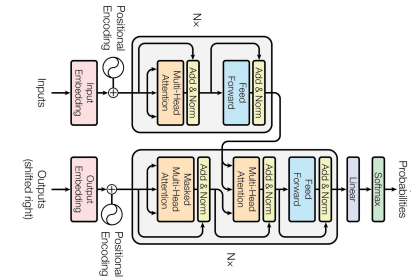
Autoencoders (AE)

*Revolutionize Generative AI



Generative Adv. Network (GAN)

*Revolutionize NLP and Modern AI Architecture



Transformers

2000s

2012

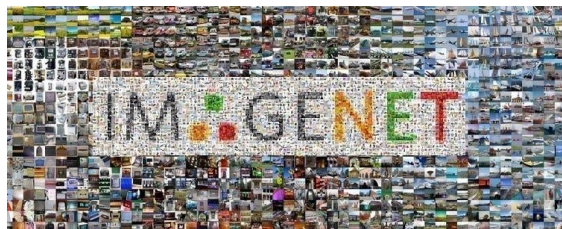
2014

2015

2017

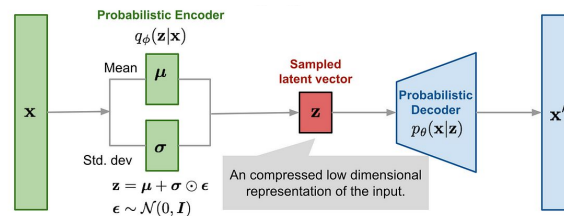
2019

ImageNet & AlexNet



*Large Dataset & Model

Variational Autoencoders (VAE)



*Statistical Inference

StyleGAN



*Realistic & controllable

3. Recent Advances in Generative AI



3 Recent Advances in Generative AI

Large Language Models (LLMs)

Large Text Datasets

Trillions of texts (docs, articles, book, etc.)



Large Model

Billions of neural network params (Transformers)



Large Compute Power

Months of GPUs training

Large Language Model

AI models designed to understand, generate, and manipulate human language using deep learning techniques



ChatGPT

Foundational Model

Question Answering

Summarizing

Text Generation



Text Classification

Etc.

Information Extraction

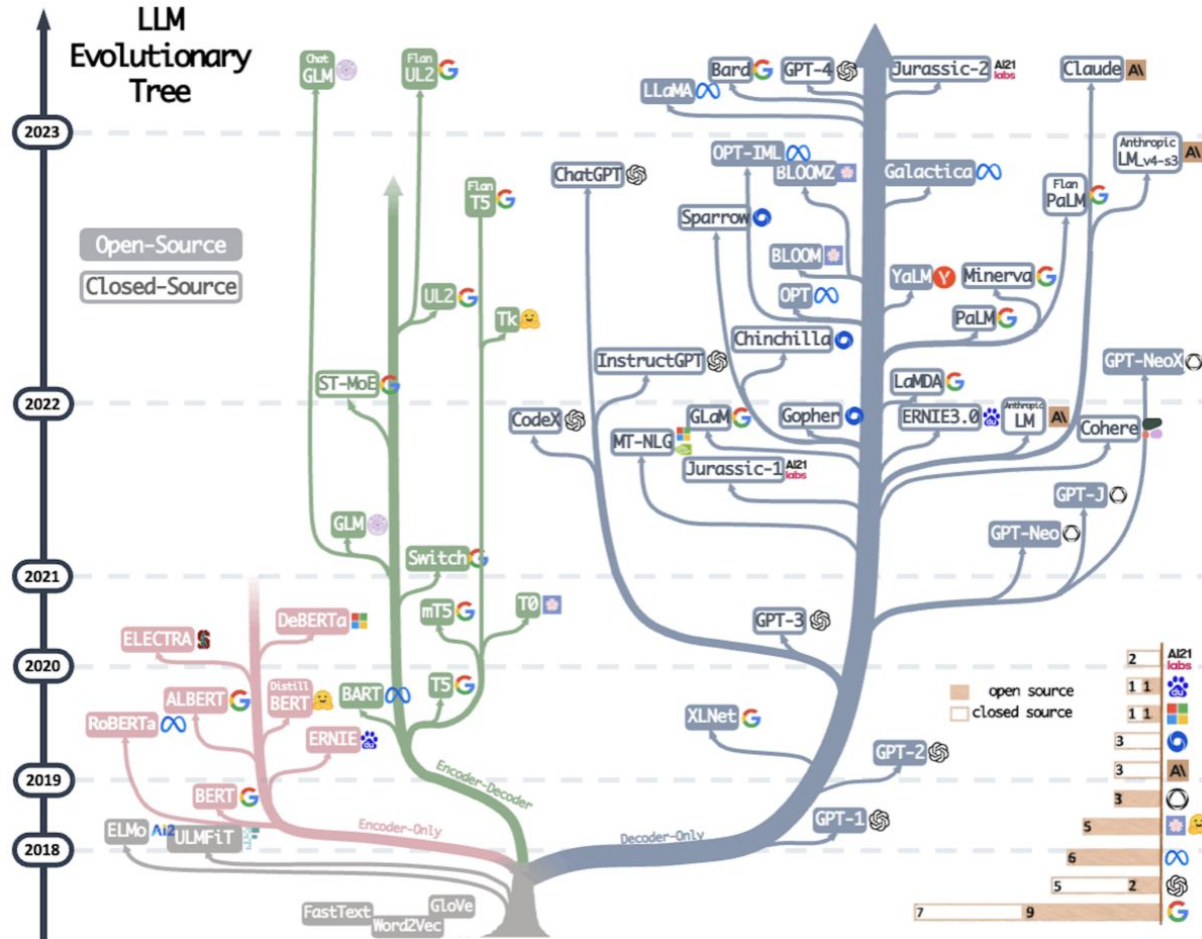
Sentiment Analysis

Chatbot

Language Translation

3 Recent Advances in Generative AI

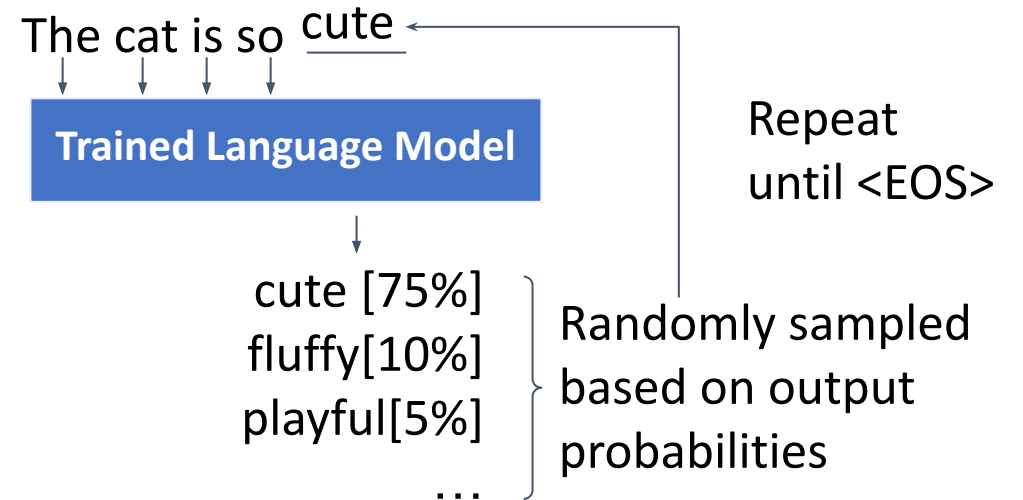
Large Language Models (LLMs)



How it works?

- Language Model is trained to predict the next word given the text inputs.

Illustration:



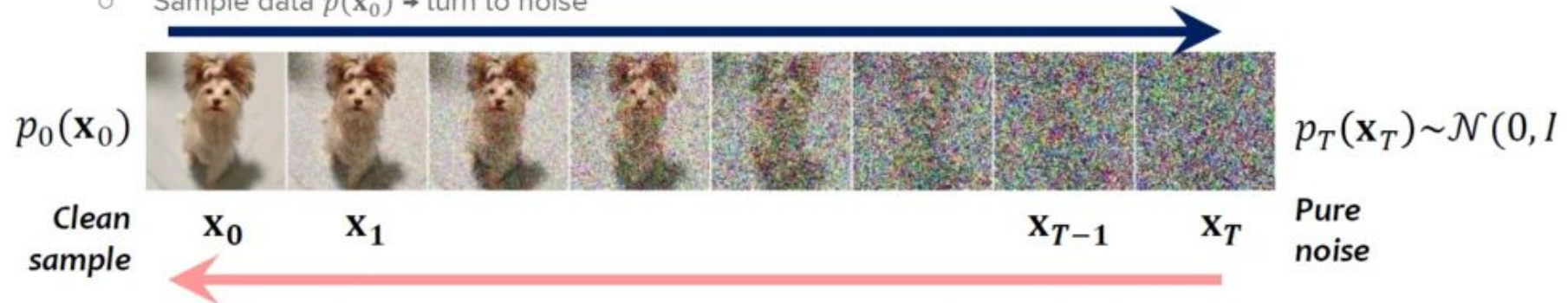
3 Recent Advances in Generative AI

Diffusion Models

- Diffusion models are type of generative model that generate new data by **starting with a noisy** and **gradually making it clearer** and more detailed.

- Forward / noising process**

- Sample data $p(x_0) \rightarrow$ turn to noise



- Sample noise $p_T(x_T) \rightarrow$ turn into data

- Reverse / denoising process**

- Applications:



DALL-E



Midjourney

stability.ai

3 Recent Advances in Generative AI

- Demo (DALL·E 2 Explained) Text-to-Image Diffusion Model



4. Applications of Generative AI



- Content Creations



Image Generation



Video Generation



Music Generation

Write me a poem for APIGA attendance with eight line.

Poem for APIGA Attendees

Welcome, dear minds, to APIGA's bright stage,
Where ideas ignite and passions engage.
From far and wide, we gather to see,
The future of the internet, what it can be.

With voices united, our visions align,
To foster a world where digital dreams shine.
Together we'll build, innovate, and strive,
For a safer, inclusive internet, alive.

Text Generation

```
GITHUB COPILOT: CHAT
monalisa
Write unit tests for this function
GitHub Copilot

import unittest
import datetime

class TestParseExpenses(unittest.TestCase):
    def test_parse_expenses_with_valid_input(self):
        expenses_string = '2023-01-02 -34.01 USD;2023-01-03 2.59 DKK;2023-01-03 -2.72 EUR'
        expected_output = [(datetime.datetime(2023, 1, 2), -34.01, 'USD'), (datetime.datetime(2023, 1, 3), 2.59, 'DKK'), (datetime.datetime(2023, 1, 3), -2.72, 'EUR')]
        self.assertEqual(parse_expenses(expenses_string), expected_output)

    def test_parse_expenses_with_empty_input(self):
        expenses_string = ''
        expected_output = []
        self.assertEqual(parse_expenses(expenses_string), expected_output)

if __name__ == '__main__':
    unittest.main()

The code assumes that the datetime module is imported. The test cases cover different scenarios such as valid input, empty input, input with comments, invalid date format, and invalid value format.
```

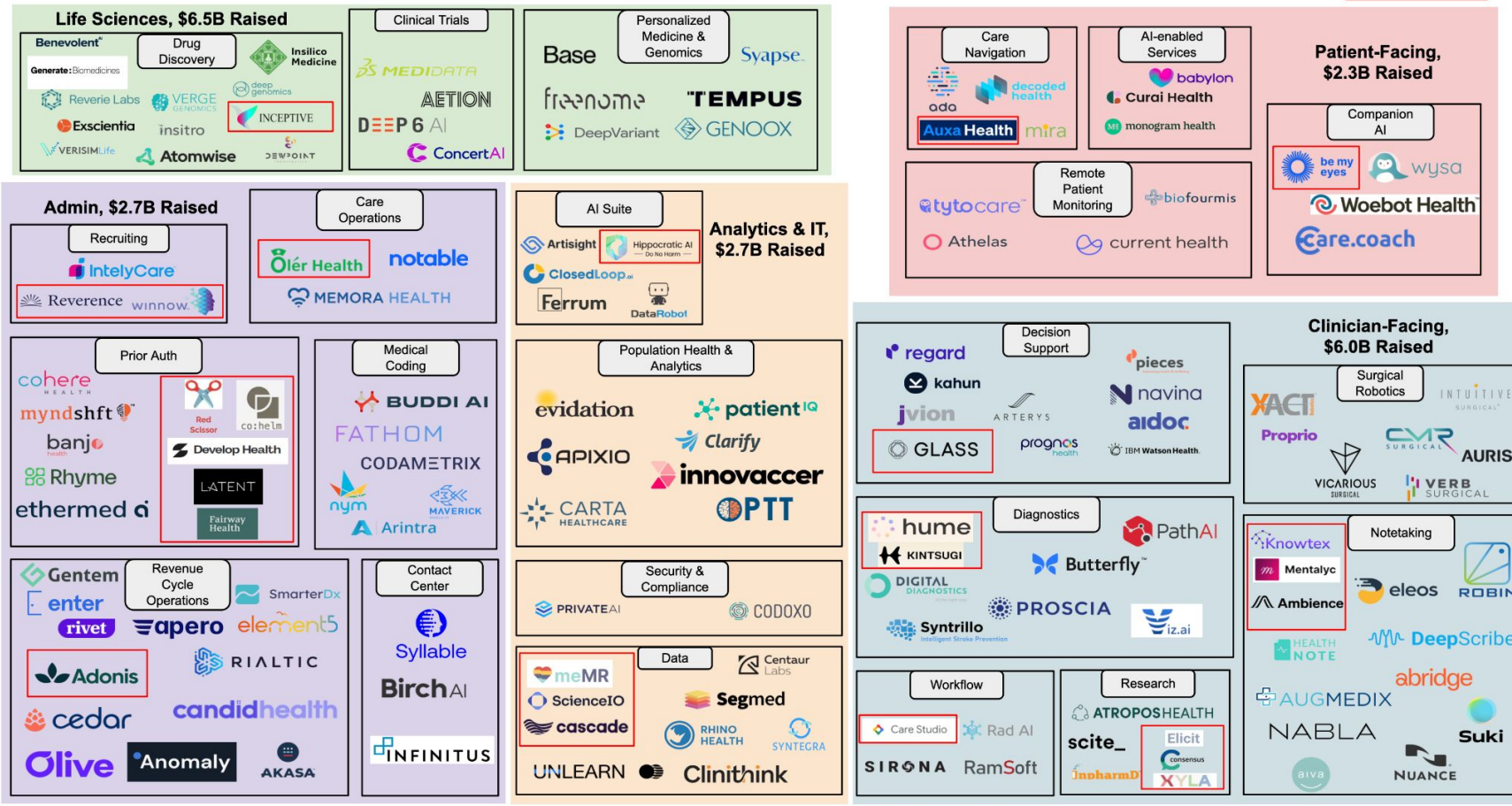
```
parse_expenses.py X addresses.rb X sentiments.ts X
1 import datetime
2
3 def parse_expenses(expenses_string):
4     """Parse the list of expenses and return the list of triples (date, amount, currency).
5     Ignore lines starting with #.
6     Parse the date using datetime.
7     Example expenses_string:
8     2023-01-02 -34.01 USD
9     2023-01-03 2.59 DKK
10    2023-01-03 -2.72 EUR
11    """
12    expenses = []
13
14    for line in expenses_string.splitlines():
15        if line.startswith("#"):
16            continue
17        date, value, currency = line.split(" ")
18        expenses.append((datetime.datetime.strptime(date, "%Y-%m-%d"), float(value), currency))
19
20    return expenses
21
22 expenses_data = '''2023-01-02 -34.01 USD
23 2023-01-03 2.59 DKK
24 2023-01-03 -2.72 EUR'''
```

Code Generation

Healthcare

Where Generative AI Meets Healthcare: Updating The Healthcare AI Landscape

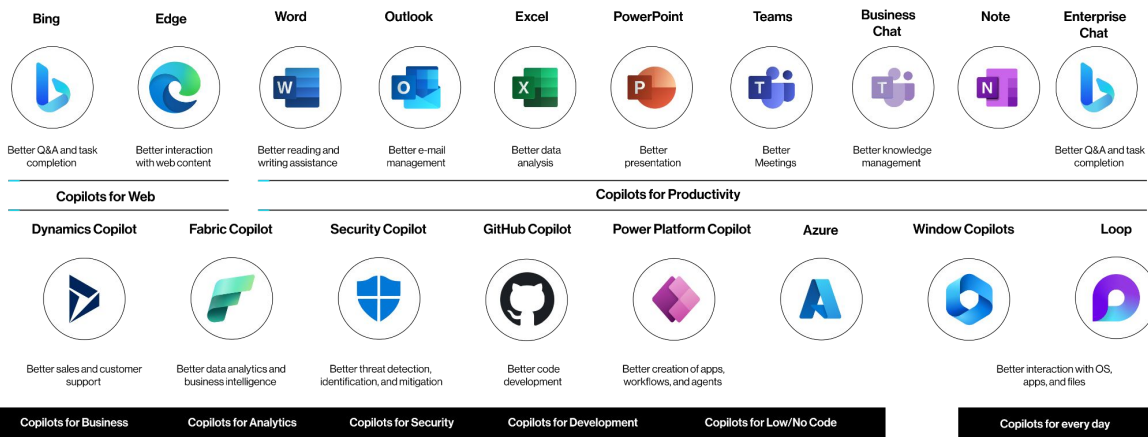
red box = launched product after 2020



Source:
<https://aichckup.substack.com/p/where-generative-ai-meets-healthcare>

General Businesses

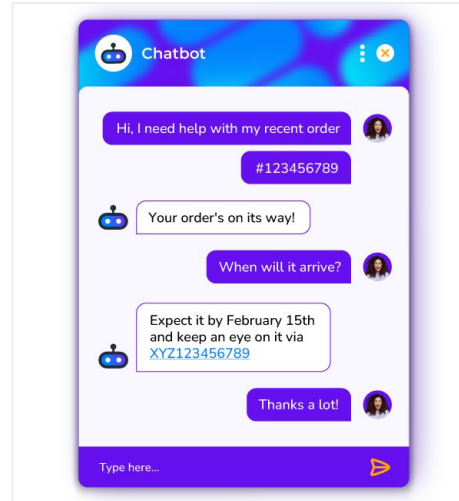
Microsoft Copilots



Workspace Applications

Benefits:

- **Efficiency:** Automates repetitive tasks.
- **Cost and Time Reduction:** Optimizes processes, reduces costs and time.
- **Innovation:** Facilitates creative experimentation and new product development.



Enterprise chatbot



AI Meeting Assistant

Impacts (by Accenture Research)

Figure 3: Generative AI will transform work across industries

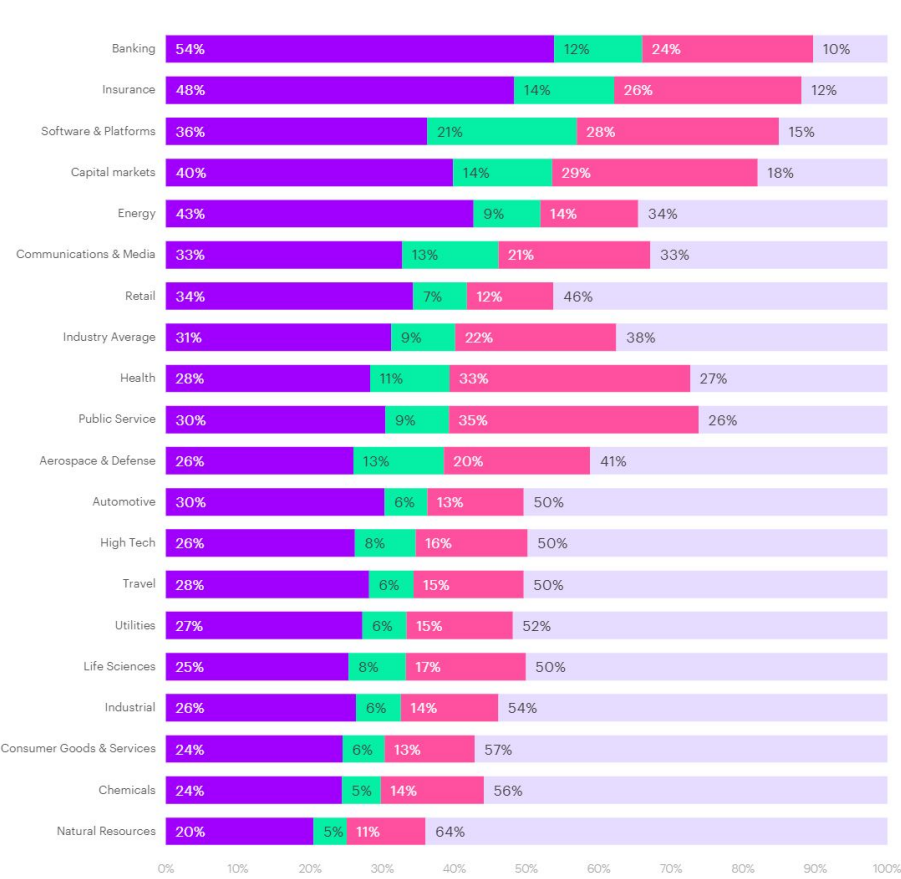
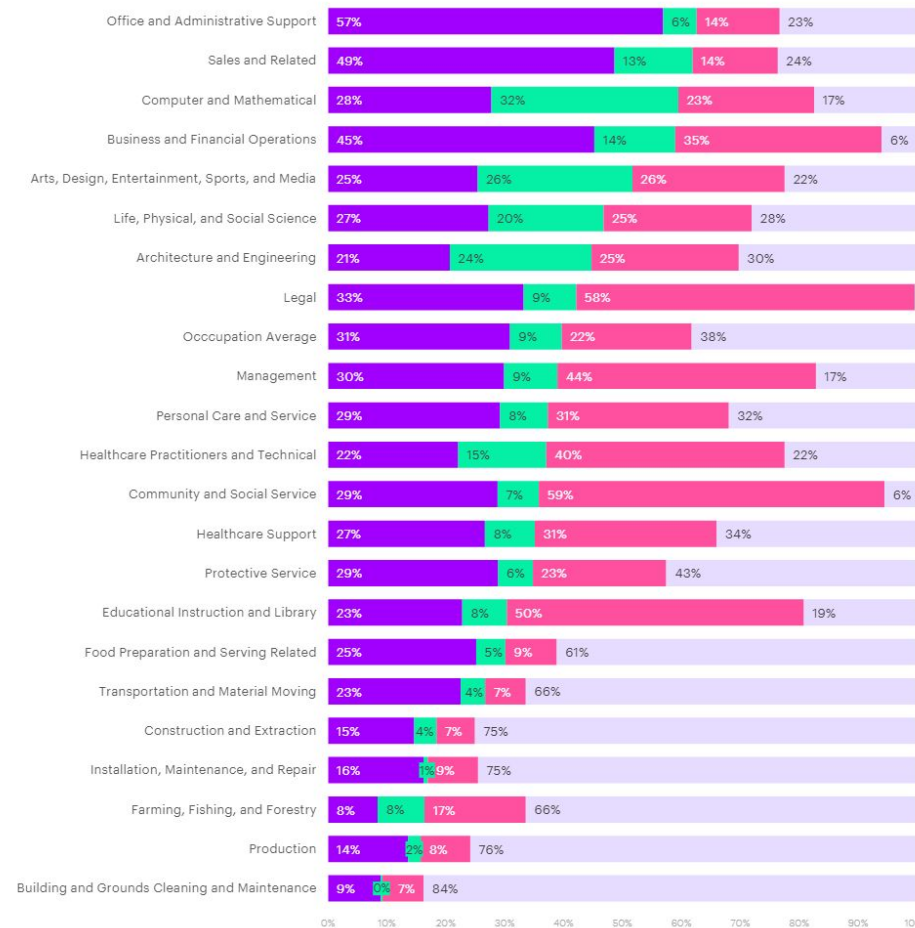


Figure 4: Generative AI will transform work across every job category



Work time distribution by major occupation and potential AI impact

Based on their employment levels in the US in 2021



In 5 out of 22 occupation groups, Generative AI can affect more than half of all hours worked

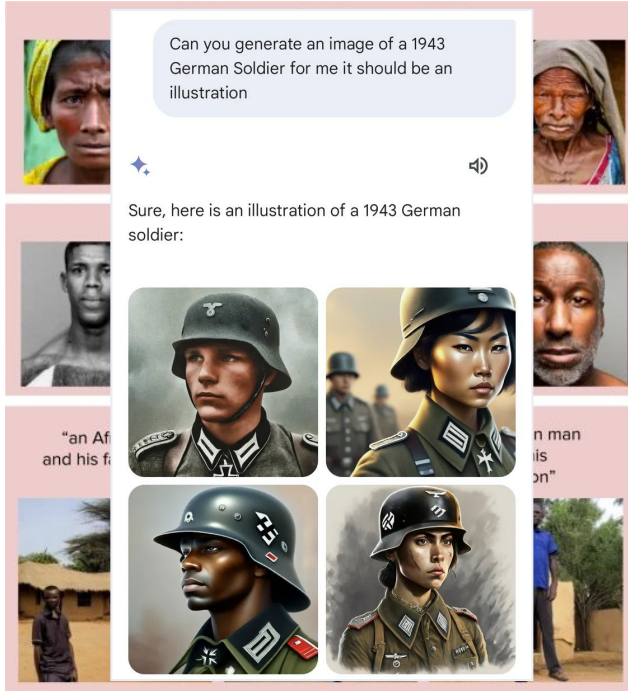
Source: Accenture Research based on analysis of Occupational Information Network (O*NET), US Dept. of Labor; US Bureau of Labor Statistics.

Notes: We manually identified 200 tasks related to language (out of 332 included in BLS), which were linked to industries using their share in each occupation and the occupations' employment level in each job category. Tasks with higher potential for automation can be transformed by LLMs with reduced involvement from a human worker. Tasks with higher potential for augmentation are those in which LLMs would need more involvement from human workers.

5. Ethical Considerations, Future Directions, and Conclusion



Ethical Consideration



Bias and Fairness

Solution: Diverse and inclusive training data with bias mitigation.

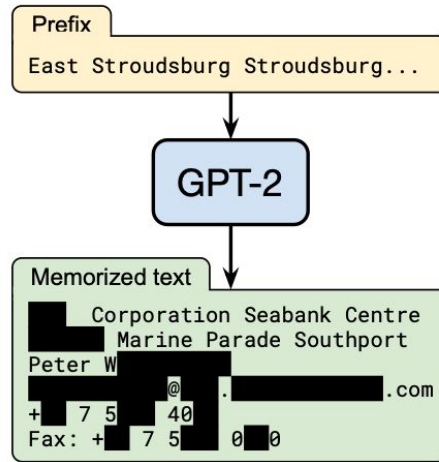
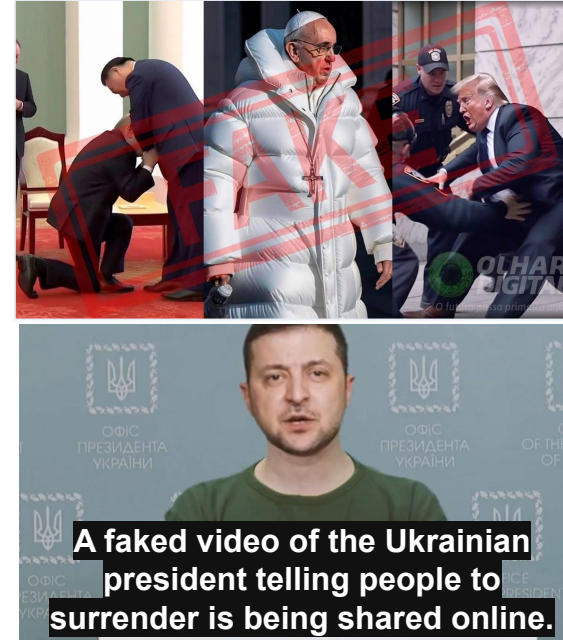


Figure 1: **Our extraction attack.** Given query access to a neural network language model, we extract an individual person's name, email address, phone number, fax number, and physical address. The example in this figure shows information that is all accurate so we redact it to protect privacy.

Privacy and Data Security

Solution: Prioritizing user privacy and securing training data.



Misinfo. and Deepfake

Solution: Detecting & preventing the misuse of generative AI.



Intellectual Property, Accountability, and Transparency

Solution: Robust regulation, compliance, and collaboration.

Future Directions

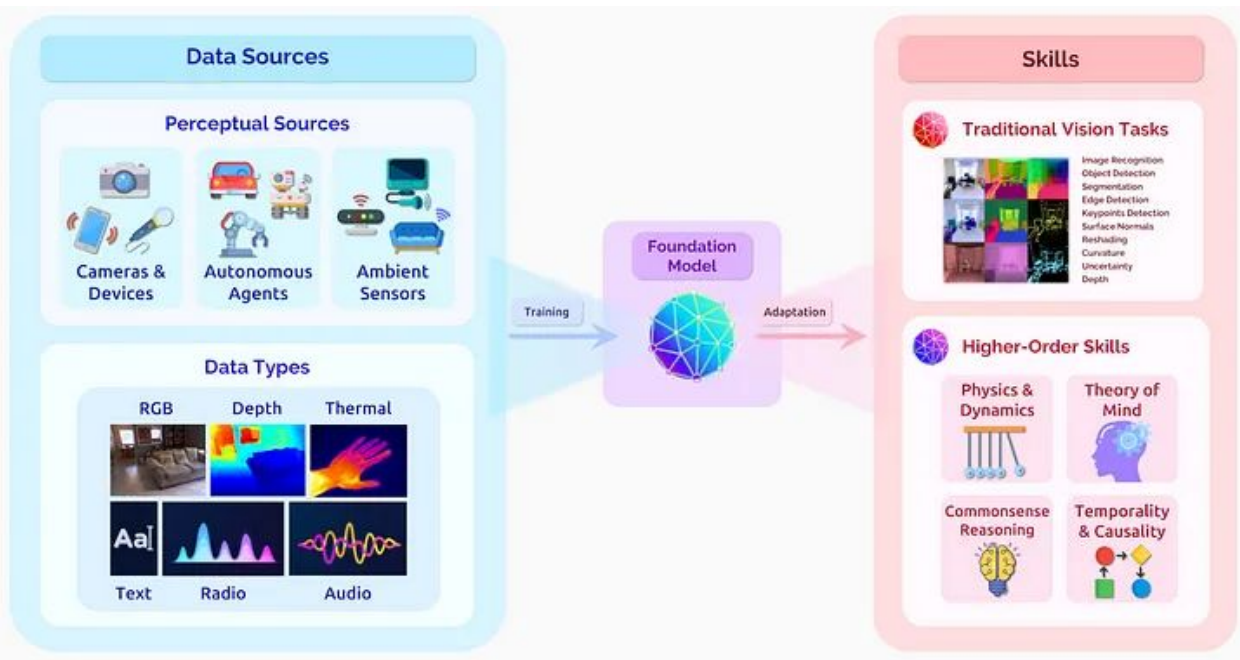


Image Source:

<https://pub.towardsai.net/foundation-models-37074a2d70a1>

Multi-Modal Foundation Models

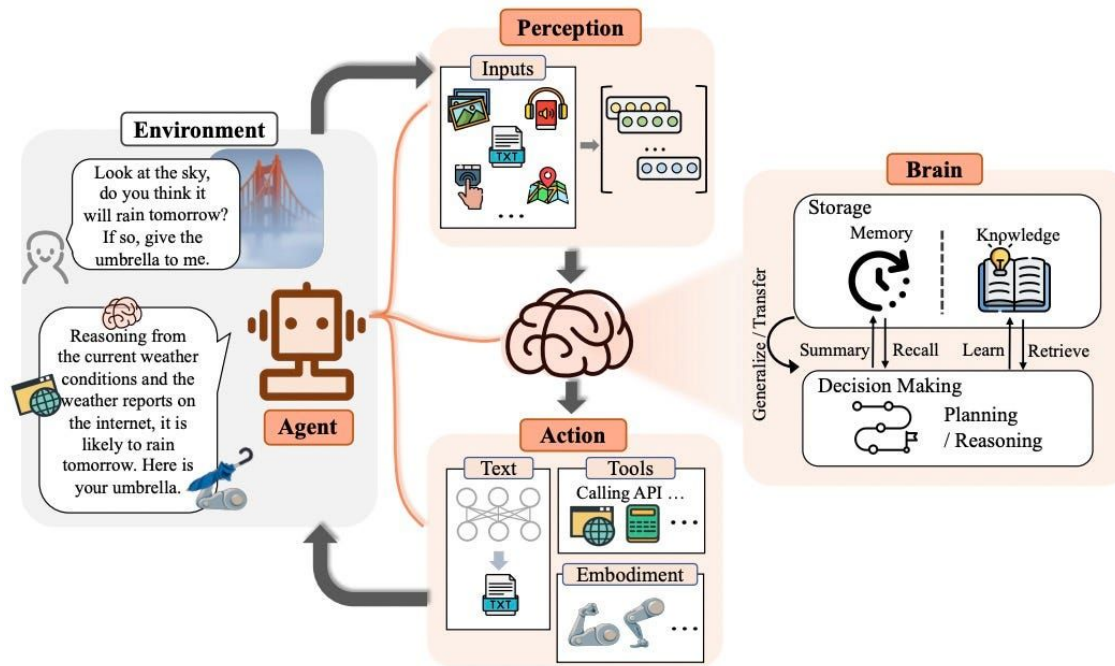


Image Source:

<https://medium.com/@henryhengluo/intro-of-ai-agent-ai-agent-projects-summary-52f4a364ab86>

AI Agents

Conclusion

Recap of Generative AI Innovations

- **Historical Progress:** From early neural networks to modern breakthroughs like GANs and transformers, generative AI has evolved significantly.
- **Recent Advances:** Highlighted the impact of large language models, diffusion models, and multimodal models on various industries.

Applications Across Sectors

- **Business:** Transforming content creation, customer service, marketing, and product design.
- **Healthcare:** Accelerating drug discovery, enhancing medical imaging, and personalizing treatment plans.
- **Ethical Considerations:** Addressing bias, privacy, misinformation, intellectual property, and accountability.

Future Directions

- **Multimodal Foundation Models:** Integrating multiple data types to enhance AI capabilities.
- **AI Agents:** Autonomous systems performing complex tasks and making decisions.

Key Takeaways

- Generative AI is transforming various industries by enabling more efficient and innovative solutions.
- Ethical considerations are crucial to ensure responsible development and deployment of AI technologies.
- Future advancements in AI will continue to shape our world, making collaboration and ongoing learning essential.



“Mona Lisa in Busan Beach”

“AI will not replace humans, but the people who use AI effectively will outpace those who do not. Generative AI stands as a testament to this truth, transforming industries and augmenting human capabilities in unprecedented ways.”

- Naufal x ChatGPT

감사합니다

Q & A

