SAFWAN WSHAH – Biography

2012 Ph.D., Computer Science and engineering, SUNY Buffalo

2012-2013 Research scientist, Xerox Research Center at Webster, NY

2014-2017 Research scientist, PARC a Xerox Company

2017 Assistant Prof., Computer Science Dept. University of Vermont

2023 Associate Prof., Computer Science Dept. University of Vermont

2024 Visiting professor at PSUT on Fulbright scholarship

65+ Peer reviewed papers and 19 Patents

Dr. Wshah research interest His research interests lie at the intersection of machine learning theory and application. He is a main contributor to many machine learning applications in:

- Transportation
- Energy
- Health Care and Biomedical

Prof. Wshah teaches:

- Machine learning
- Deep Learning

Prof. Wshah founded VaiL, Vermont, Artificial intelligent lab consisting of 12+ PhD and master students.

VAIL

Vermont Artificial Intelligent Lab

PARC – Palo Alto Research Center

PARC is a Xerox Company Founded in 1970 that provides custom R&D services, technology, expertise, best practices, and intellectual property to hundreds of Fortune and Global companies, startups, and Government agencies and partners.

More than 16 Focus Areas:

- **Video and image analytics.**
- **Data Analytics.**
- **Process optimization**
- Printed and Flexible Electronics.
- Optics.
- Networking.
- Clean Tech.
- Energy and Clean Water, etc …

http://www.parc.com/

PARC Accomplishments:

- Laser printers
- Graphical user interface
- Featuring Windows and icons
- Mouse
- Ethernet
- Object-oriented Programming

University of Vermont (UVM)

VAIL

Vermont Artificial Intelligent Lab

At the Vermont Artificial Intelligence Laboratory (VaiL) we work at the intersection of machine learning theory and application. Our mission is to improve the adaptability and generalization of machine learning methods, in order to allow higher-quality applications to broader classes of real-life problems. Our core area is object understanding and geo-localization from the ground and satellite images. We also collaborate with groups from other fields such as Medical, Transportation, Energy, and Communication.

- Currently, the lab consists of 8 PhD students + 5 Master students.
- 3 PhD, 7 Master students successfully graduated.
- We are growing if you are interested!

The Power of AI

- AI has been effectively utilized across various domains including medical, healthcare, transportation, energy, education, ect.

- Artificial intelligence is everywhere, fueling a multi-billion dollar industry.

- Radically changing how businesses operate & how people work and play.

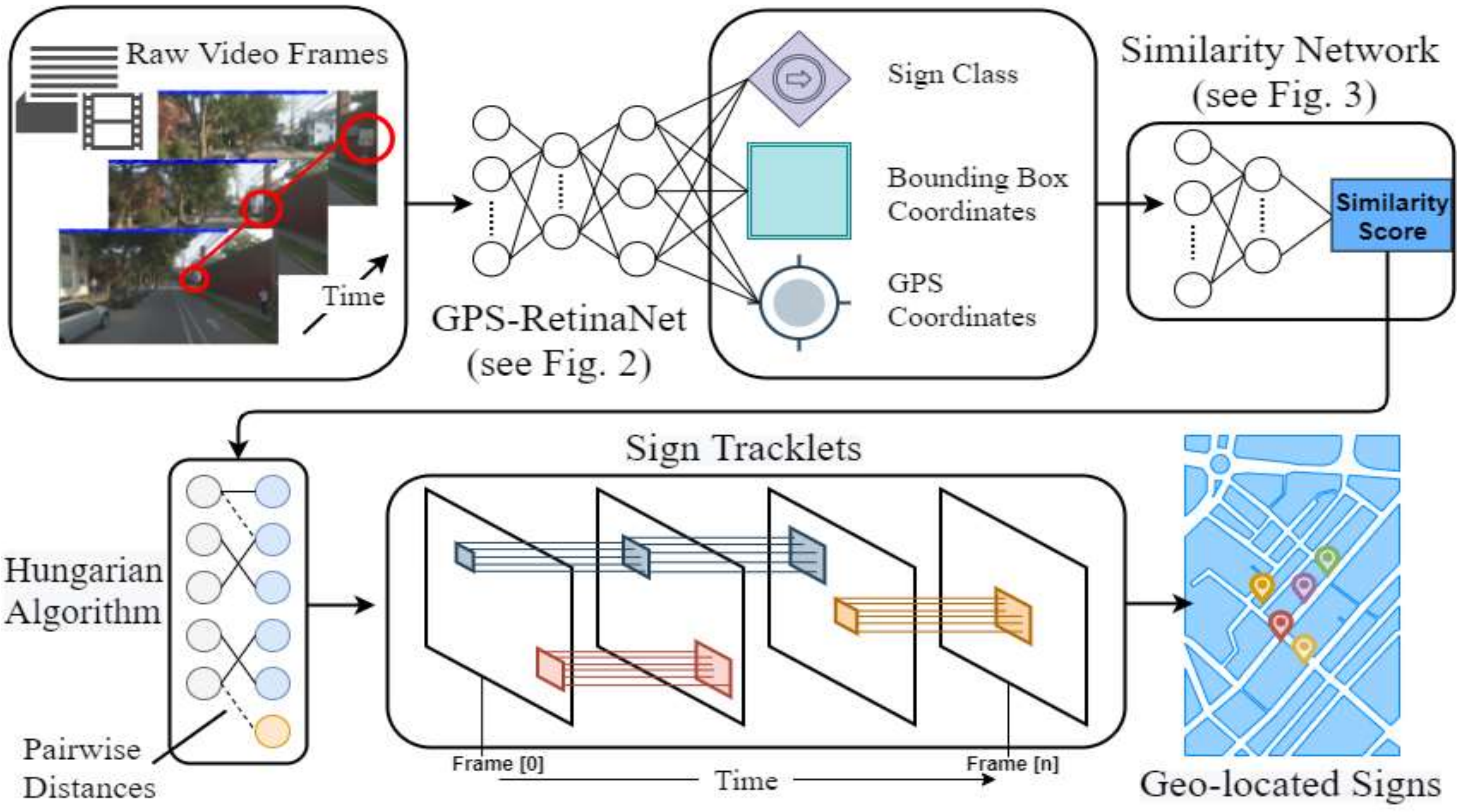
Object Tracking and Geo-Localization from Street Images

- Detecting road signs and estimate their geospatial location on real world map has many applications such as maintaining of road signs, Precise object detection for Autonomous Driving.

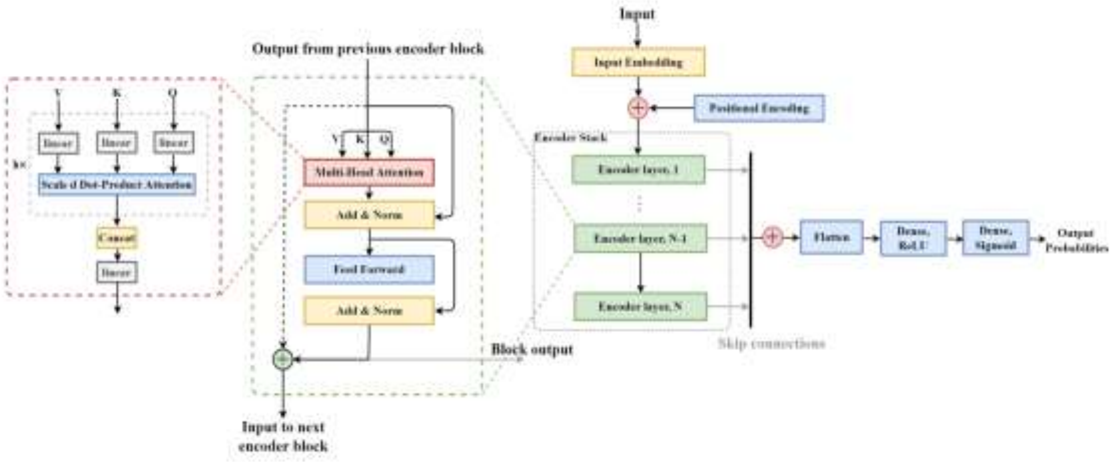
- We proposed a machine-learning approach to map objects to their geospatial location by estimating their GPS coordinates along with their classes.

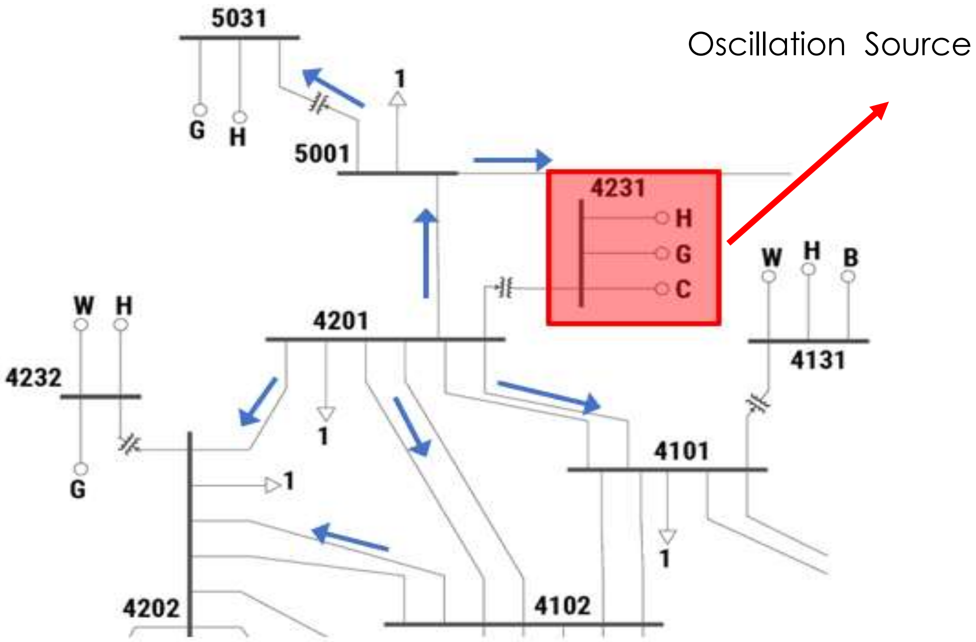
- We host all VERMONT data at UVM and process those using advanced AI systems.

Transportation Application End-to-End Structure



Forced Oscillation Localization





- Forced oscillations (FO) occur when a piece of equipment injects a periodic disturbance into the power system.
- Not easy to localize. Current algorithms takes minutes to localize FO’s with low accuracy.
- We proposed advanced deep learning models that utilize both engineering features and raw data to localize oscillation in ms.

Results

DL Architecture	Training Accuracy (%)	Validation Accuracy (%)
Transformer-Based (Proposed)	99.94	99.37
CNN	92.63	88.31
LSTM	83.42	77.68

Table 1: Leave-One-Out Cross-Validation Results

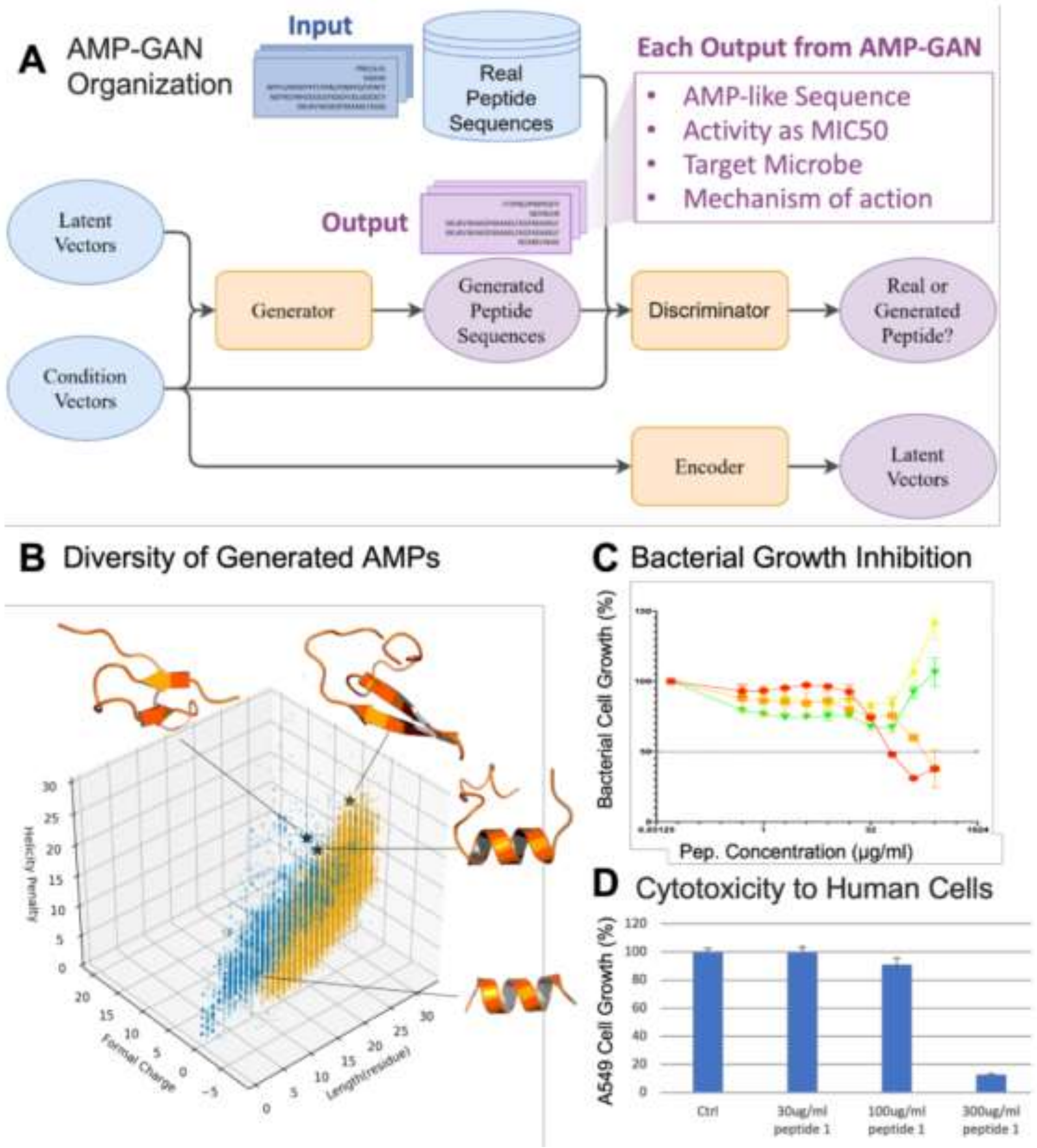
		Actual Oscillation Source(s)		Identified Oscillation Source(s)				
Fold#	Testing Case	Area	Source(s)	Avg. FO Freq (Hz)	F1	AUC	Area	Source(s)
1	Case 1	South	1431	0.821	0.991	1.000	South	1431
2	Case 2	California	2634	1.194	0.978	0.998	California	2634
3	Case 3*	South	1131	0.379	0.996	1.000	South	1131, 1032
4	Case 4*	California	3831	0.379	0.987	0.998	California	3831, 3836, 3835, 2434, 3433
5	Case 5*	North	4231	0.723	0.996	0.997	North	4231
6	Case 6	North	7031	1.267	0.897	0.982	North	7031
7	Case 7	California	2634	0.379	0.996	1.000	California	2634
8	Case 8	North	6333	0.614	0.979	1.000	North	6333
9	Case 9	North	6533, 4131	0.762	0.991	0.999	North	6533, 4131
10	Case 10*	California	3931	1.218	0.979	0.999	California	3931
		North	6335	0.614	0.990	1.000	North	6335
11	Case 11	North	4009	0.614	0.996	1.000	North	4009
12	Case 12	North	6335	0.920	0.996	1.000	North	6335
13	Case 13	North, California	4010, 2619	0.614	0.991	1.000	North, California	4010, 2619
14	A1	North	6333	0.572	0.996	1.000	North	6333
15	A2′	North	6333	0.572	0.991	1.000	North	6333
16	A3″	North	6333	0.572	1.000	1.000	North	6333

Generative models

Which face is generated by computer ? Which one is the fake face ?

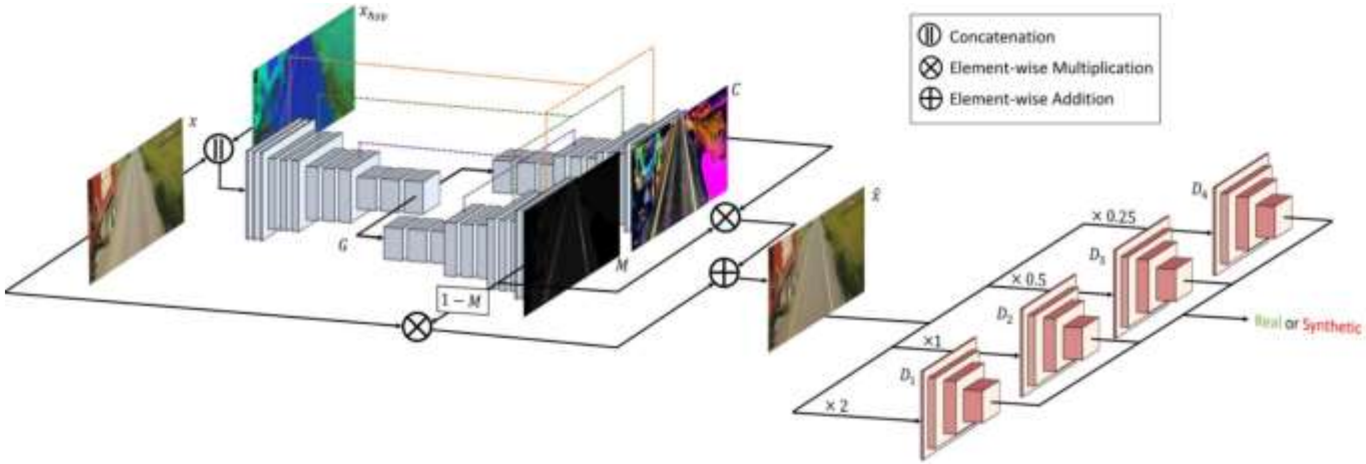
They are all fake and generated by AI.

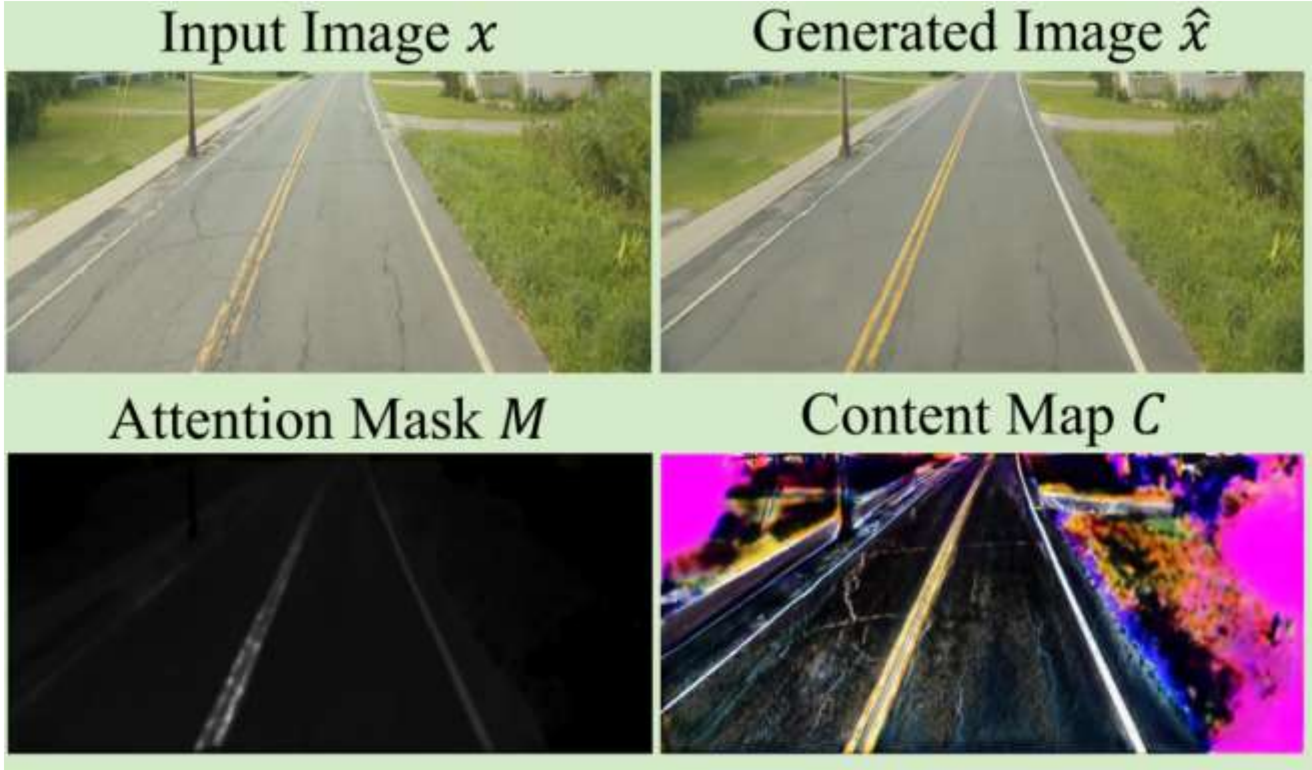
Generative models enhance various fields, including healthcare, art, finance, gaming, marketing, and manufacturing. They aid in drug discovery, create unique art, generate financial data, simulate gaming environments, personalize marketing, and optimize product design, driving innovation and efficiency.



Machine Learning-guided Design of Antimicrobial Peptides (AMP)

- Antibiotic resistance of bacterial pathogens is one of the greatest public health challenges of our time. There is an essential need to discover new therapeutics for treating dangerous bacterial infections.
- Common in the innate immune system of plants and animals, antimicrobial peptides (AMPs) present a promising avenue to combat drug-resistant bacterial pathogens.
- We proposed generative based machine learning models to generate AMP's.





Lane Marks Enhancement via GAN

Current autonomous vehicles assume well-maintained clear lane marks to navigate effectively.

- 65% of the roads in the U.S. do not have reliable lane markings.68% of U.S. total lane-miles are in rural areas.
- It is needed to evaluate and enhance lane detection algorithms operating under degraded lane marks, especially in rural areas.
- We proposed LanePainter, a generative deep-learning model that enhances the quality of lane marks.

Narrow AI

- Current AI technology falls squarely in the "narrow AI" category.
- Highly specialized systems that are very good at specific, well-defined tasks…and nothing else!

This actually limits many applications and makes it difficult to scale. In addition, more limitations, such as the need for a large amount of data, are required.

Narrow AI Example

- Even autonomous vehicles, as impressive as they are, utilize a composite of narrow AI systems.

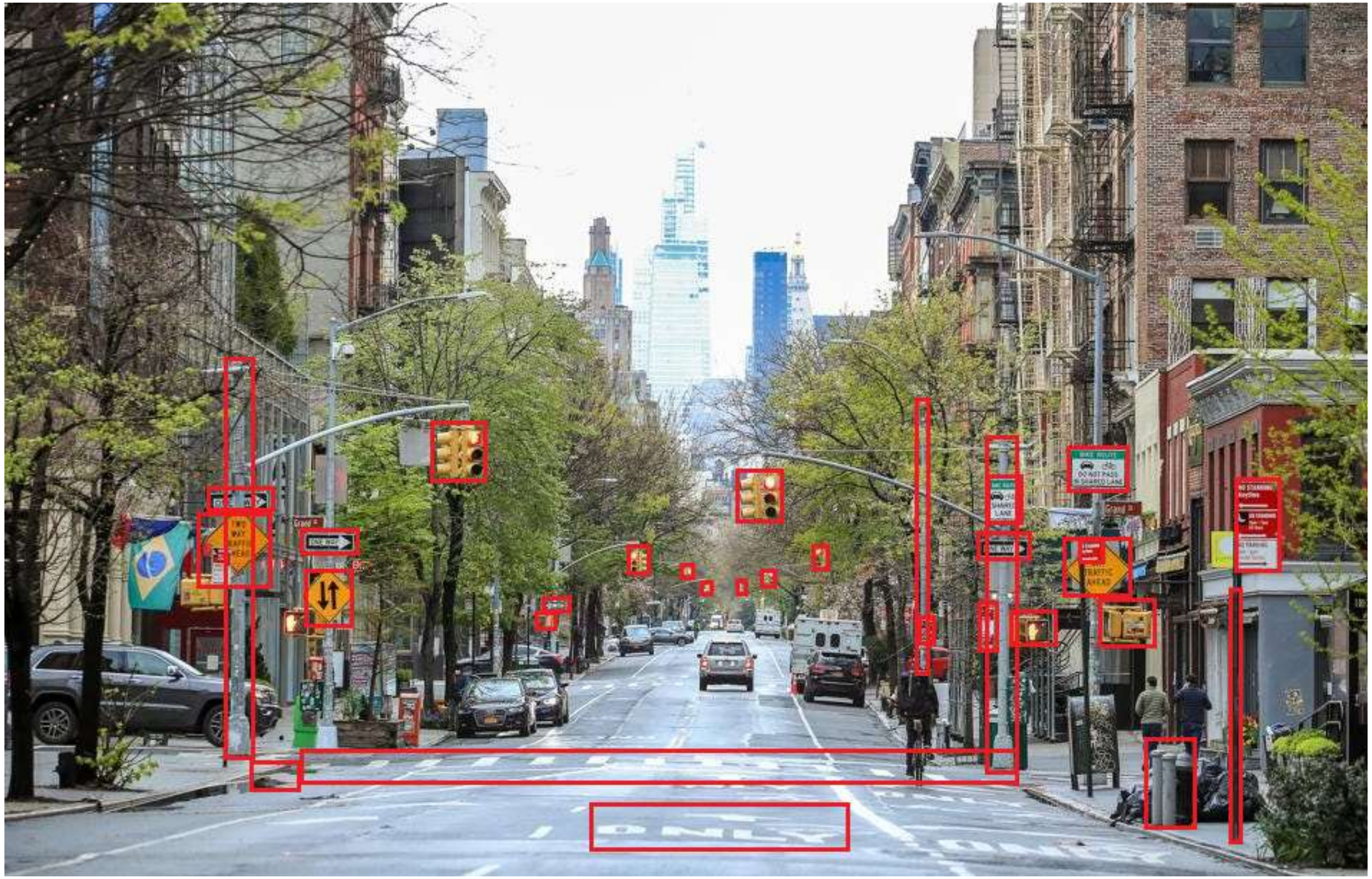
- If you took the software from a self-driving car and put it in a golf cart, it would be useless without reprogramming.
- Humans can drive it easily as we learn from abstractions.

Multi-view geo-spatial understanding

- In my lab we are studying algorithms that combine multi-sources from different views to better understand certain geospatial area.

- This is a very difficult problem due to the heterogeneity of the data from different sources.

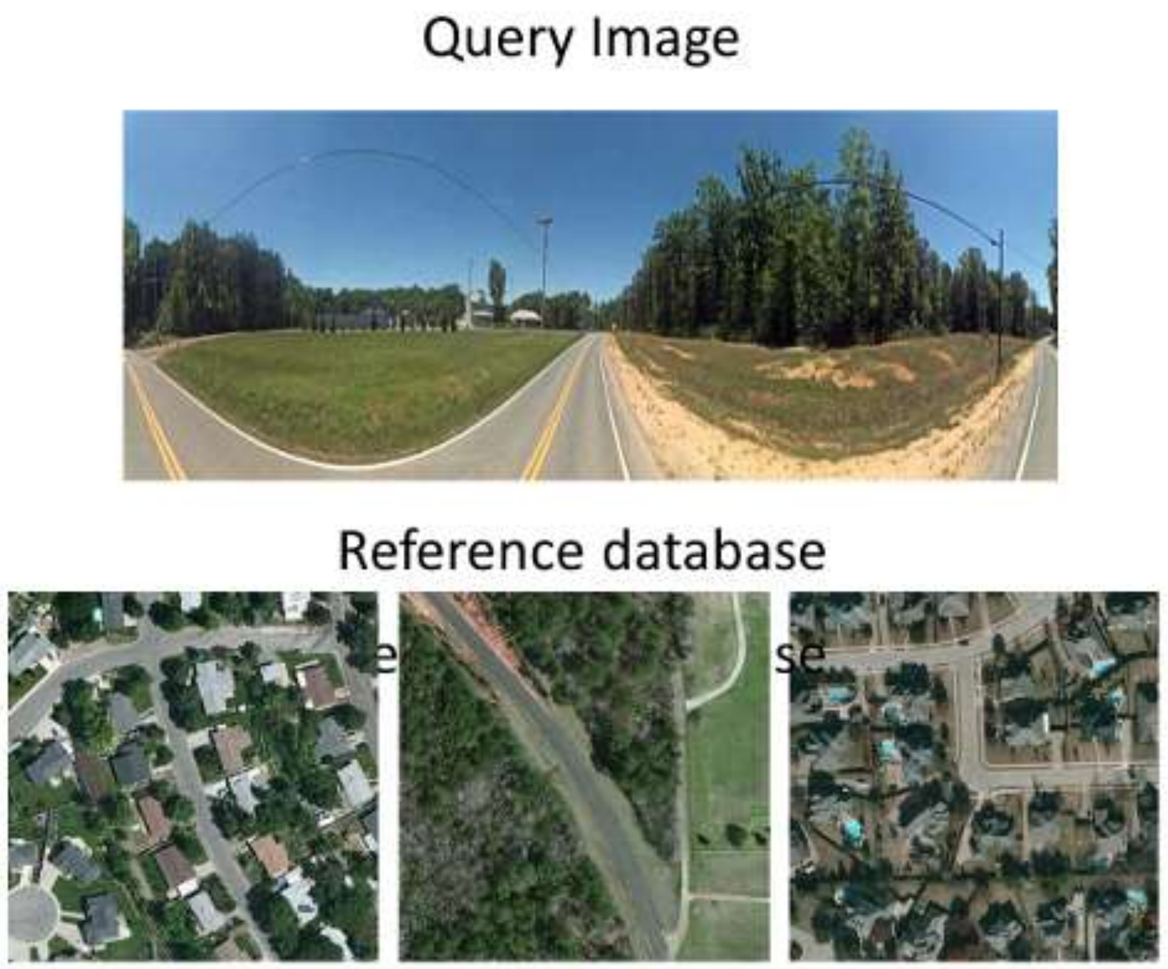
Image geo-localization



- For a given image, determine its location using only visual information. Additionally, identify where the objects are located on the map.

We are state-of-the-art in answering these questions!

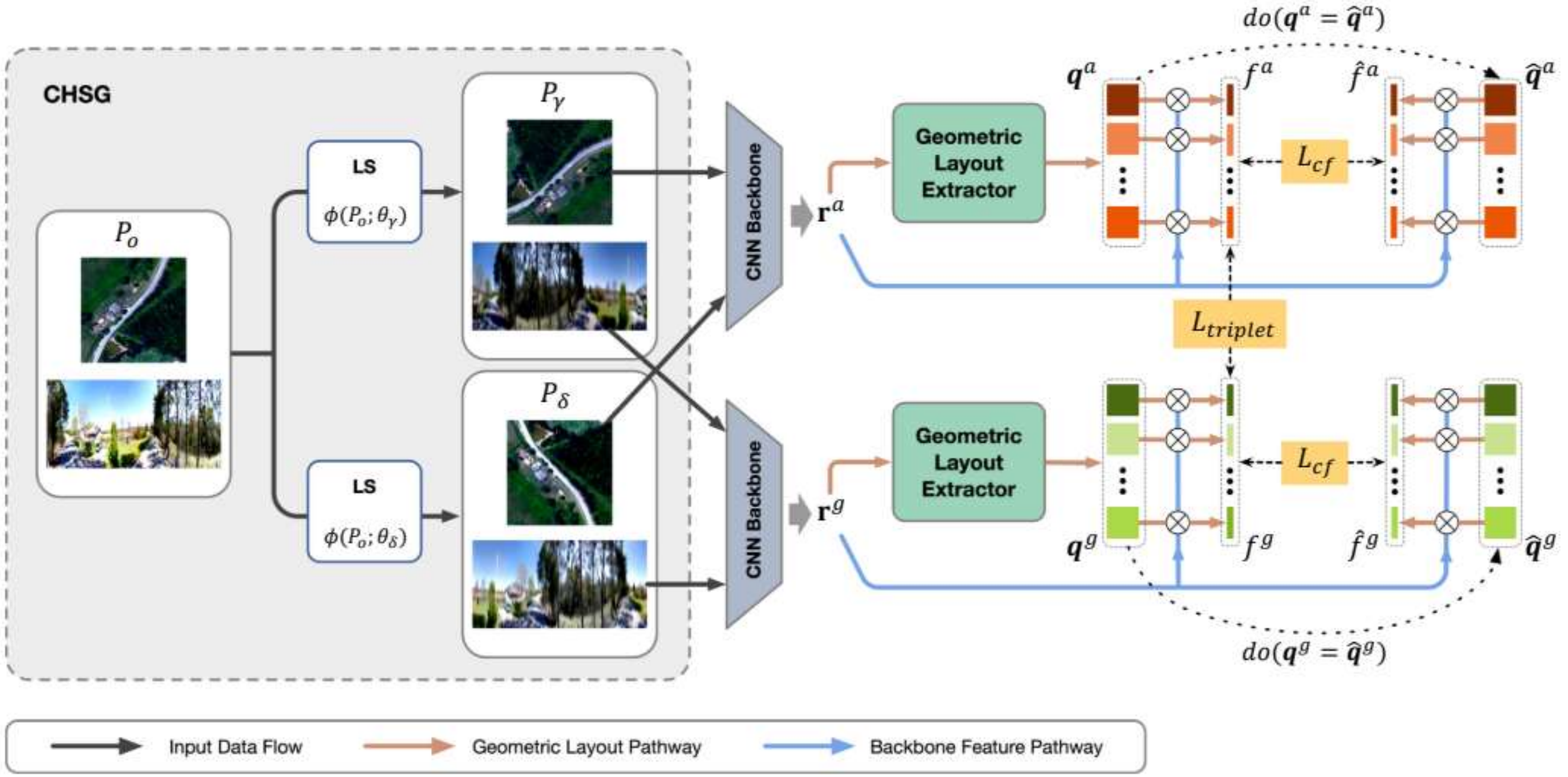
cross view geo-localization

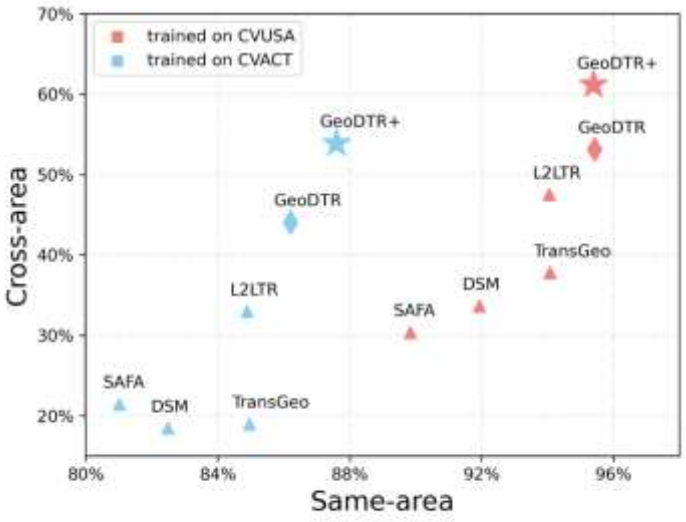


- Most models fail to scale to unseen areas. Our model addresses this issue by explicitly modeling the correlation between cross-modalities.

- To determine the location of an image, we can compare it to a database of previously captured images; this needs a huge amount of data to compare with.
- Given the availability and high accuracy of satellite images, we can match ground images to satellite images to find their location.
- However, the domain shift between ground and satellite images makes this a challenging problem.

Scalability issue





- This is another example of a narrow AI application.

Our state-of-the-art models work perfectly in the areas the system trained on but fail to scale with high accuracy in unseen areas.

AI next wave!

- To overcome this and other limitations and reach its true potential, artificial intelligence must become more humanlike in several aspects.

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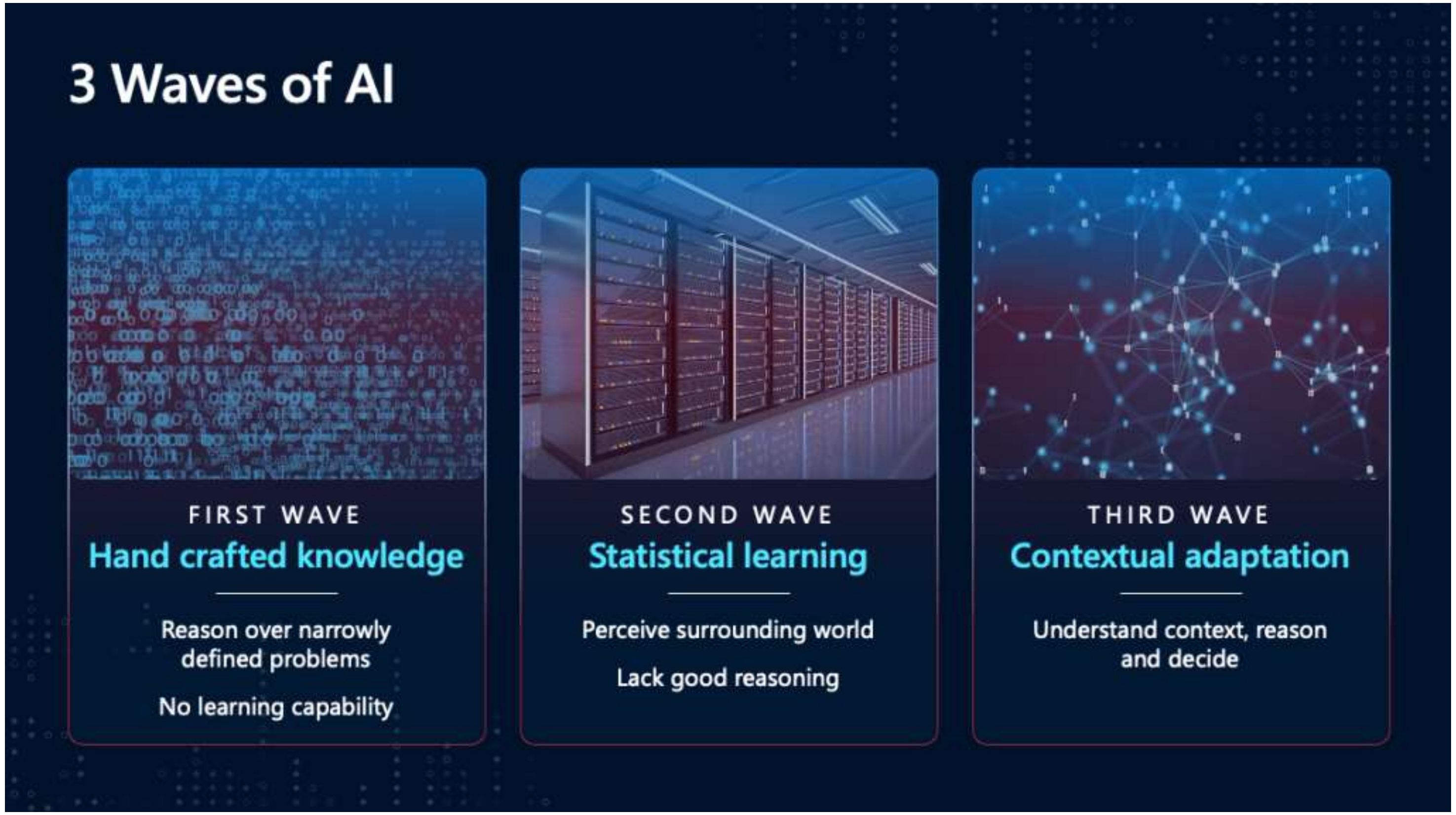
- Entering Third Wave AI.

Third-Wave AI aims to produce contextual adaptation and common sense capabilities.

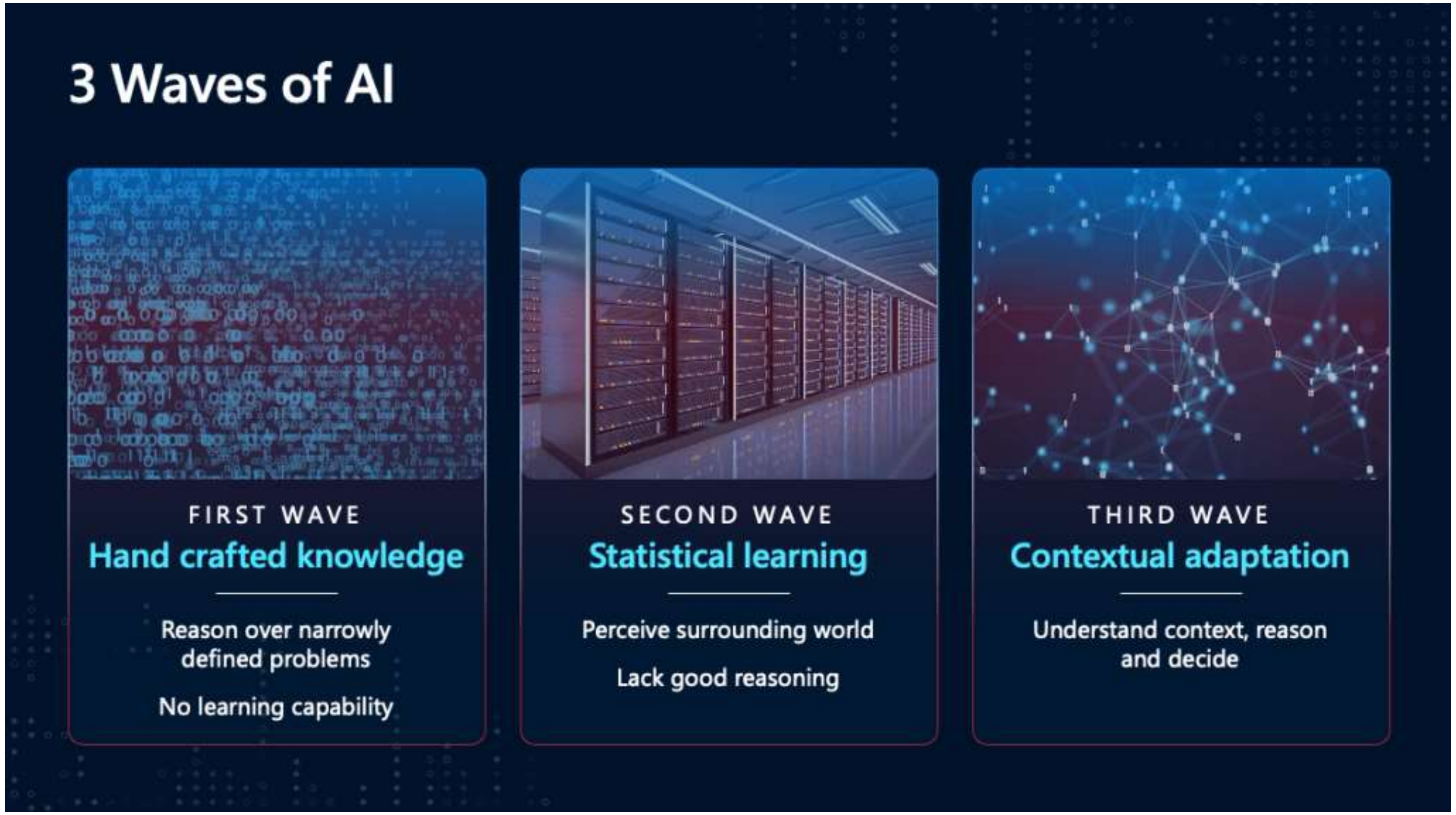


First Wave: Impart human expertise onto hardware, a painstaking process that relied heavily on scripted instructions.

Second Wave: The advent of GPUs ushered in the second wave, accelerating AI's capabilities beyond human levels in recognizing events and objects.

The third wave signifies a significant shift toward contextual adaptation, where AI models possess a broad understanding rather than being tailored to specific applications.

In the third wave, AI can perceive, learn, abstract and reason, paving the way for unprecedented advancements in many applications.



Third-wave AI promises to bring AI systems closer to human-level cognition. This will enable:

- More natural language interactions
- Improved reasoning skills
- Adaptation to new tasks and situations
- Better ability to operate in the open world.

The core benefits of Third-Wave AI include:

- Contextual understanding - ability to incorporate and reason about real-world context
- Common sense reasoning - making sensible inferences about unfamiliar situations
- Adaptability - adjusting to new tasks, users, and environments
- Intuitive interfaces - more natural language and multimodal interactions

Sebastien Bubeck illustrates this point near the end of one of his talks that ChatGPT 4 struggles to provide reliable explanations for its responses. Basically, ChatGPT is not aware of what it generates.

The beginning of the third wave might come soon! Are we ready!

- The third wave of technology could profoundly change how we live and interact in all aspects of life, especially in terms of social interactions.

- While this wave promises significant benefits that could greatly improve our lives, the social impact might be a considerable cost.

- Additionally, we must address the issue of bias in AI models, which are often trained on data from dominant cultures. This bias can lead to unfairness and inequality in various applications of AI technology.


Questions?
Q&A