

AI Unveiled: The Wizardry Behind Chatbots and Intelligent Systems

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In the ever-evolving landscape of the geoprofessional industry, artificial intelligence continues to drive innovation, efficiency, and curiosity. This article, focusing on chatbots and intelligent systems, is the first in a six-part series written to educate Geoprofessional Business Association (GBA) members on the implications of AI on the geoprofessions. The article was prepared by GBA Business Technology Committee member, Enrique Farfan, PhD, PE, ENV SP, of HDR.

Artificial Intelligence (AI) stands at the intersection of various disciplines, crafting machines that mirror human intelligence. This includes learning, problem-solving, and understanding natural language, aiming to match or surpass human capabilities.

Generative AI (AIGC), a subset of artificial intelligence, excels in generating novel content from extensive data pools, including text, images, and more. Its foundation was laid in the 1960s with chatbots, with a significant leap in 2014 through generative adversarial networks (GANs). Large language models (LLMs), leveraging transformer models, epitomize AIGC, mastering natural language tasks and extending to fields like protein structure prediction and code writing. Their pre-training on vast datasets enables applications across healthcare, finance, and entertainment, showcasing their versatility. Figure 1 shows the family tree of AI-generated Content (AIGC) where can be identified the development of ChatGPT (Open AI) and BARD (Google).

AI splits into Engineering AI and Cognitive AI, each finding unique applications in fields like civil engineering.

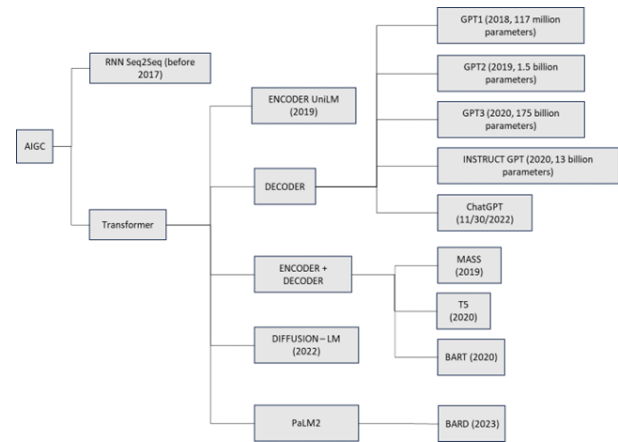


Figure 1. Key AIGC Technology

Despite challenges like data scarcity, the International Society for Soil Mechanics and Geotechnical Engineering highlights machine learning's potential in geotechnical engineering, covering a wide range of applications from site characterization to landslide analysis.

The International Society for Soil Mechanics and Geotechnical Engineering provides a comprehensive reference list for machine learning and its applications in geotechnical engineering:

<https://www.issmge.org/news/reference-list-for-machine-learning-and-its-applications-in-geotechnical-engineering-part-iii-applications-in-geotechnical-engineering>

The following topics are covered in different extents considering artificial neural networks, support vector machine, clustering, feature learning (Dimensionality reduction), outlier detection, and Bayesian machine learning:

- Site Characterization
- Geomaterial Properties and Behavior Modeling

- Pile Capacity and Settlement
- Shallow Foundations
- Tensile Capacity of Anchors
- Liquefaction
- Soil Retaining Structures and Dams
- Slope Stability
- Tunnels and Underground Openings
- Ground Improvement
- Landslide
- Lifeline Engineering
- Offshore Engineering
- Embankments
- Others

AIGC, especially LLMs, heralds a novel approach in geotechnical engineering, promising innovative solutions to its intricate challenges. These applications range from problem-solving in project stages to automatic data extraction from geotechnical reports, showcasing the transformative power of Cognitive AI.

Some of the potential LLM applications in geotechnical engineering could be found in the following list:

- To solve complicated problems in different stages of the project.
- To make decisions in the design field.
- For expert monitoring and optimization of costs in the work system.
- Extract data from geotechnical reports automatically.
- Generation of proposals
- Review of standards and codes
- Review of reports
- Report writing assistance
- Computer program developing
- General reference consultation

“Mastery of AI communication is an indispensable skill for the future.”

In the evolving landscape, engaging with LLMs demands understanding of linguistics and psychology for crafting effective prompts. The distinction between a prompt and a superprompt becomes crucial for eliciting precise responses, underscoring the strategic communication required for leveraging AI's full potential. This nuanced interaction with AI not only paves the way for groundbreaking applications but also emphasizes the critical role of prompt engineering in AI education and application.

Here is a simple example of a prompt and a superprompt in ChatGPT:

Prompt:

> *"Describe soil liquefaction."*

> *Possible response: "Soil liquefaction refers to the process where saturated soil temporarily loses strength and stiffness in response to an applied stress, often during an earthquake, causing it to behave like a liquid."*

Superprompt:

> *"Describe soil liquefaction, detailing its causes, potential hazards, and common mitigation techniques used in construction."*

> *Possible response: "Soil liquefaction is a phenomenon where saturated soil temporarily loses its strength and stiffness due to an applied stress, often resulting from seismic activities like earthquakes. The primary cause is the increase in pore water pressure and the reduction of effective stress between soil grains, often in soils with poor drainage, like silty or sandy soils.*

This can lead to the ground collapsing, tilting of buildings, and the upward flow of water and soil, known as sand boils or mud volcanoes. To mitigate the risks of soil liquefaction, engineers employ various techniques such as soil compaction, vibro-compaction, installing stone columns, or using deep foundations like piles that bypass the liquefiable layer."

In summary, as AI continues to evolve, its integration into specialized fields like geotechnical engineering not only enhances current methodologies but also opens up avenues for unprecedented solutions, making the mastery of AI communication an indispensable skill for the future.

In this series of articles, we will explore how this technology works and its potential uses.

Upcoming Articles

- How LLM Works: In a Nutshell.
- The Ghost in the Machine: Hallucinations.
- Superprompts: How to Talk with the Genie and Keep it in the Bottle.
- Role Play Your Way: How to Talk with Terzaghi
- Applications of LLM in Geotechnical Engineering: Use it or Lose.

ABOUT THE AUTHOR



Enrique Farfan is a Geotechnical and Structural Engineer with a Ph.D. in Engineering and a Master's in Civil Engineering from the University of New Mexico. His expertise spans across various projects in mining, energy, water resources, and transportation, including work on dams, levees, canals, waterfront structures, bridges, foundations, and seismic analysis. Enrique has implemented diverse design solutions using customized computer programs and database implementations. During his graduate years, he developed an interest in fuzzy logic, optimization, inverse problems, neural networks, and computer programming. Now, he enjoys exploring the fascinating universe of AI and its applications.