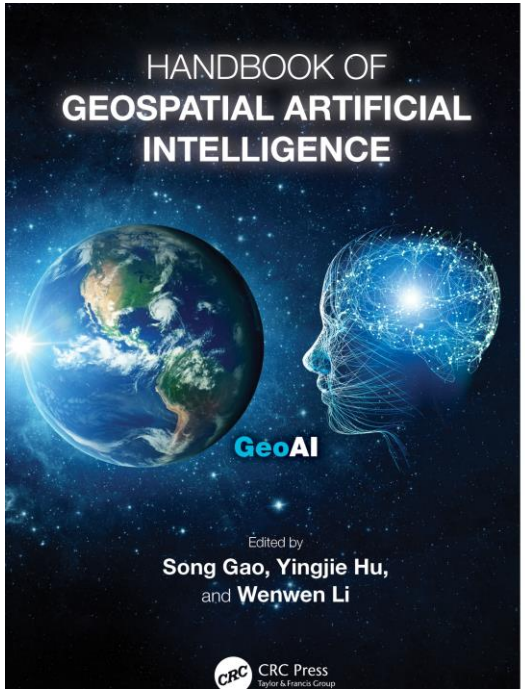
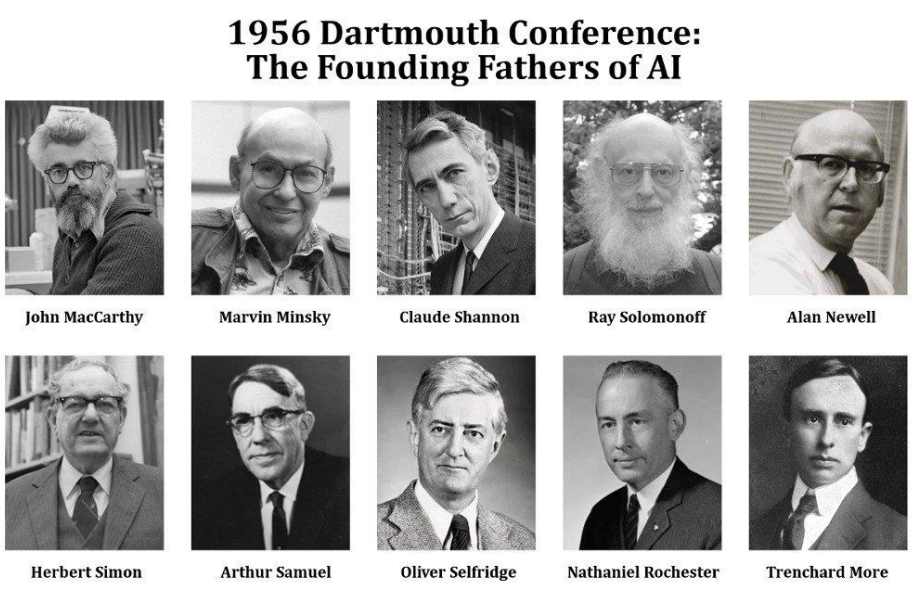


Chapter 1: Introduction to GeoAI
Chapter 2: GeoAI's Thousand-Year History
Chapter 3: Philosophical Foundations of GeoAI

https://doi.org/10.1201/9781003308423

Birth of AI

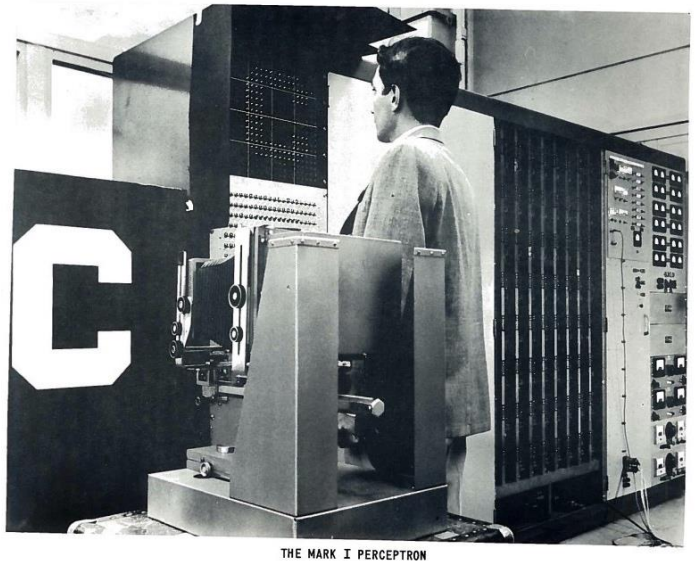
- 1940s-1950s: Theoretical foundations in cognitive science and computer sciences
- 1956 Dartmouth Workshop for AI
- “Can machines think like human?”



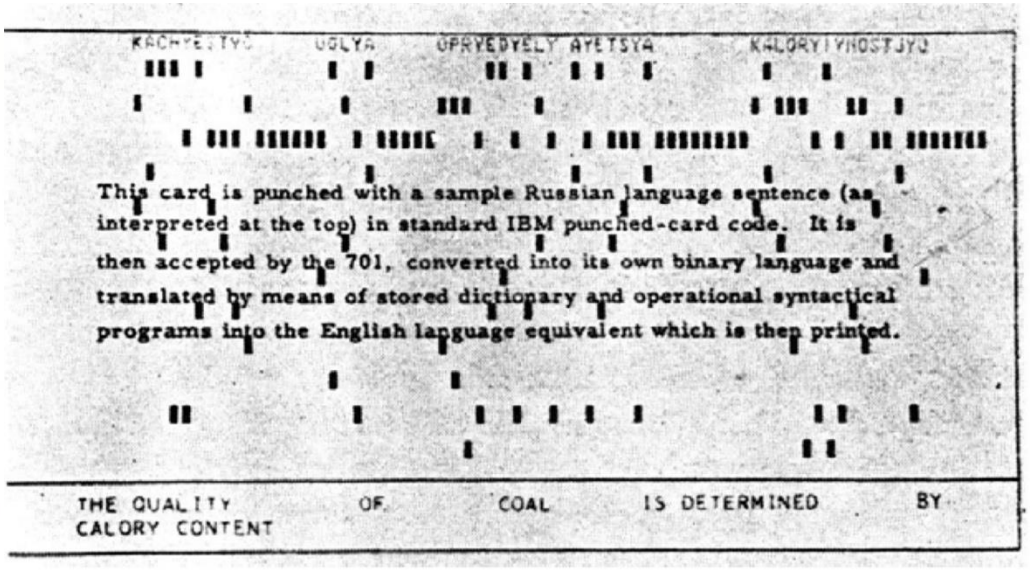
https://towardsdatascience.com/history-of-the-first-ai-winter-6f8c2186f80b

Strong AI and Weak AI

- **Strong AI:** a sufficiently programmed computer would be intelligent and would think in the way that human do.
- **Weak AI:** the use of methods on intelligent behavior to make computers more efficient at solving problems.



THE MARK I PERCEPTRON



https://towardsdatascience.com/history-of-the-first-ai-winter-6f8c2186f80b

Classes of AI Problems

- **Cognitive approach:** models of human memory structure and reasoning process (e.g., cognitive maps for route-finding decisions)

- **Engineering approach**: construct computer programs with respect to specific problem solving (e.g., knowledge-based GI systems); or have the capabilities for understanding, processing, and generating natural language.

Smith, T. R. (1984). Artificial intelligence and its applicability to geographical problem solving. The Professional Geographer, 36(2), 147-158.

Systematic Research in AI

- **Search:** find procedures that minimize required search effort, especially for large spaces of objects; led to development of knowledge-based systems

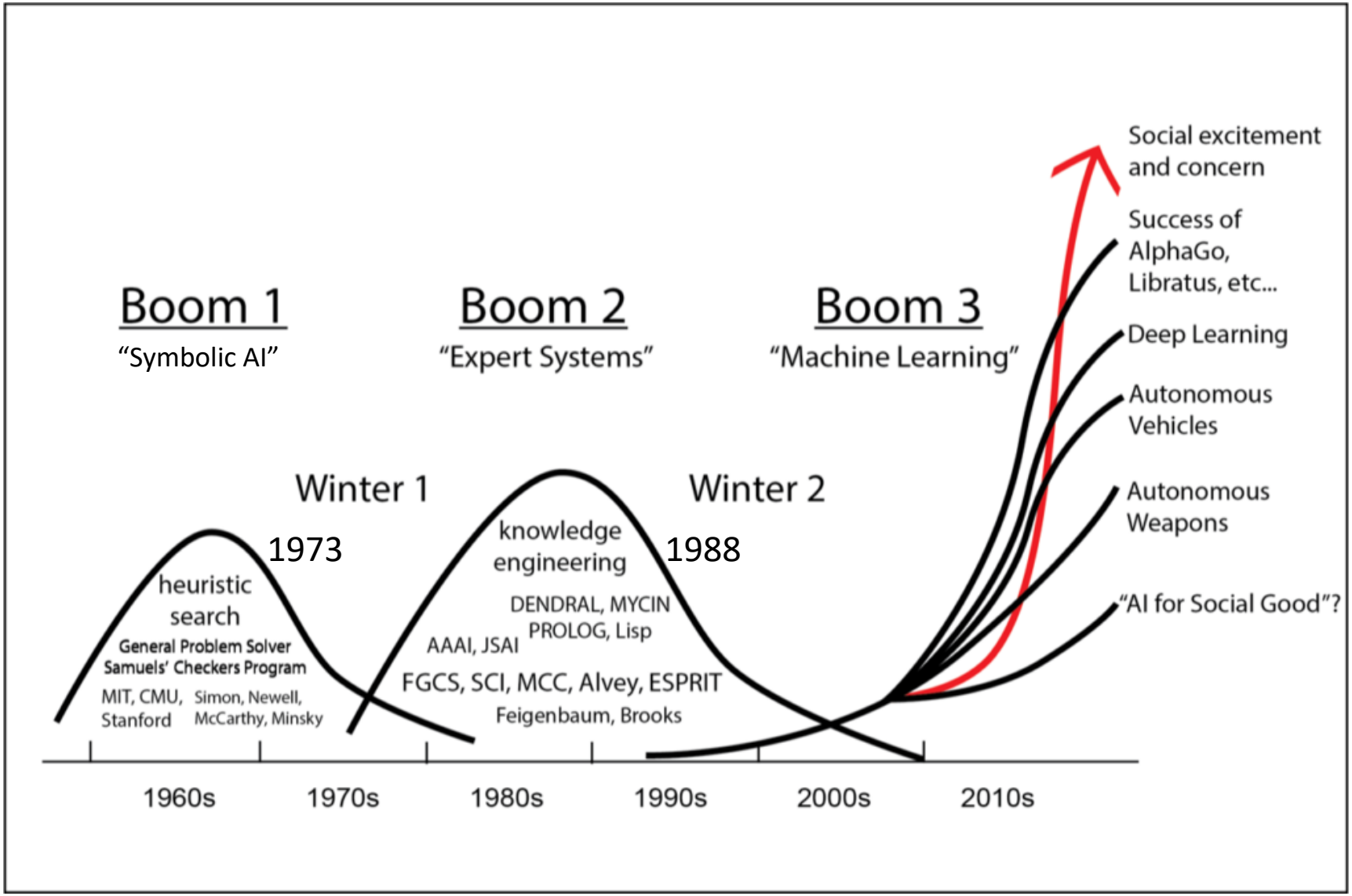
- **Representation**: efficient representation, storage, and retrieval of domain knowledge;
- using “semantic network” or “frame structure”

- **Learning:** learning from experience and learning from analogy

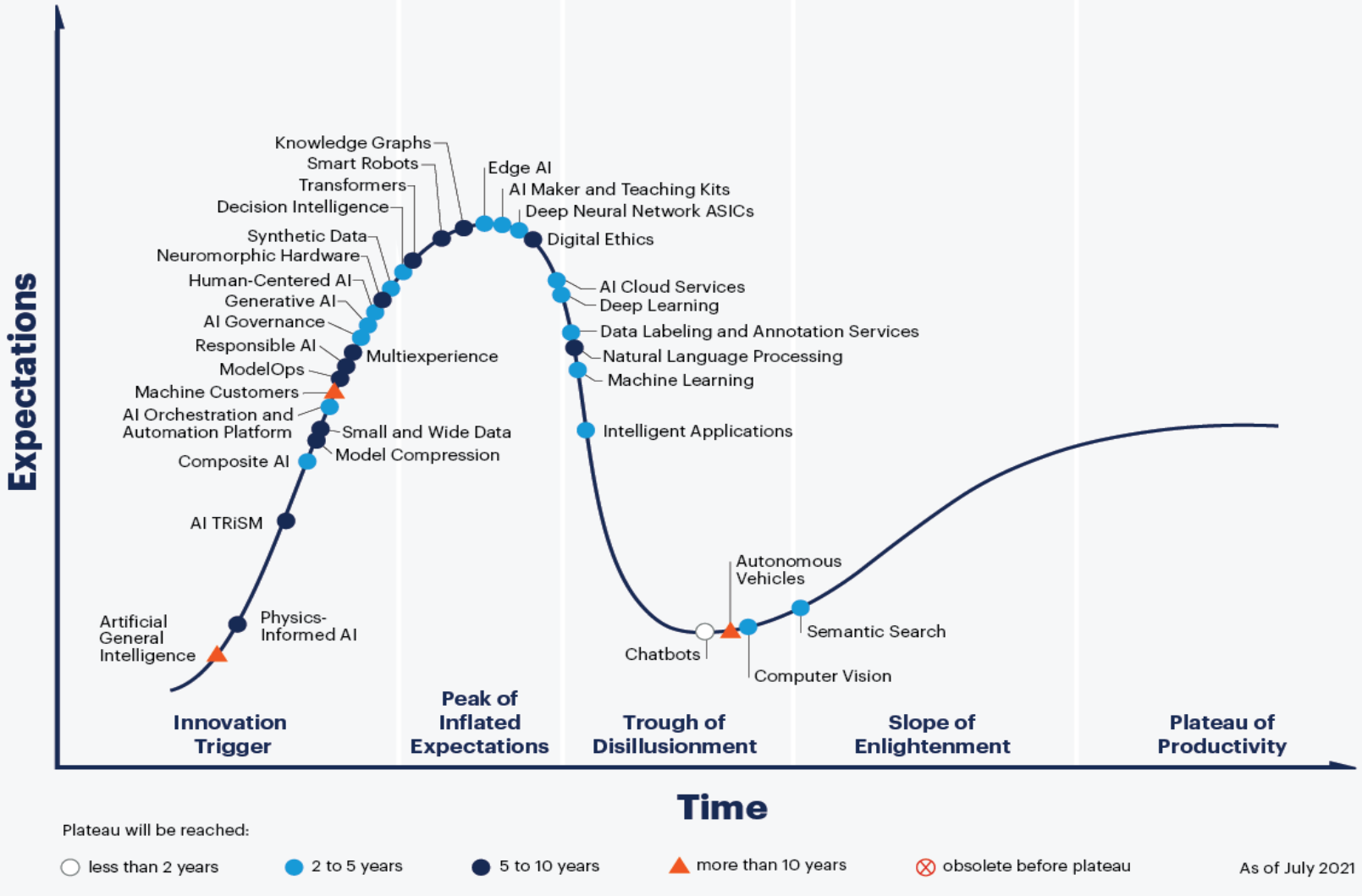
- **Decision-Making:** planning for a sequence of actions

Smith, T. R. (1984). Artificial intelligence and its applicability to geographical problem solving. The Professional Geographer, 36(2), 147-158.

Booms and Winters of AI periods



Hype Cycle for Artificial Intelligence, 2021



Plateau will be reached:

○ less than 2 years ● 2 to 5 years ● 5 to 10 years ▲ more than 10 years ⊗ obsolete before plateau

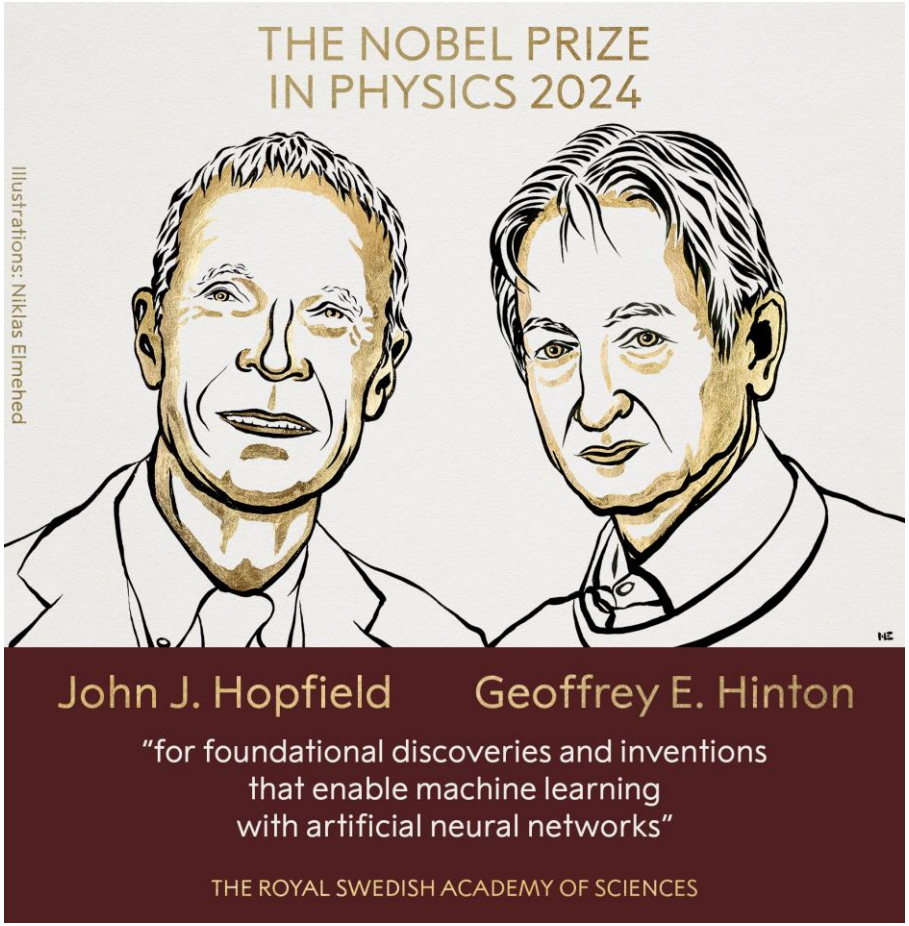
As of July 2021

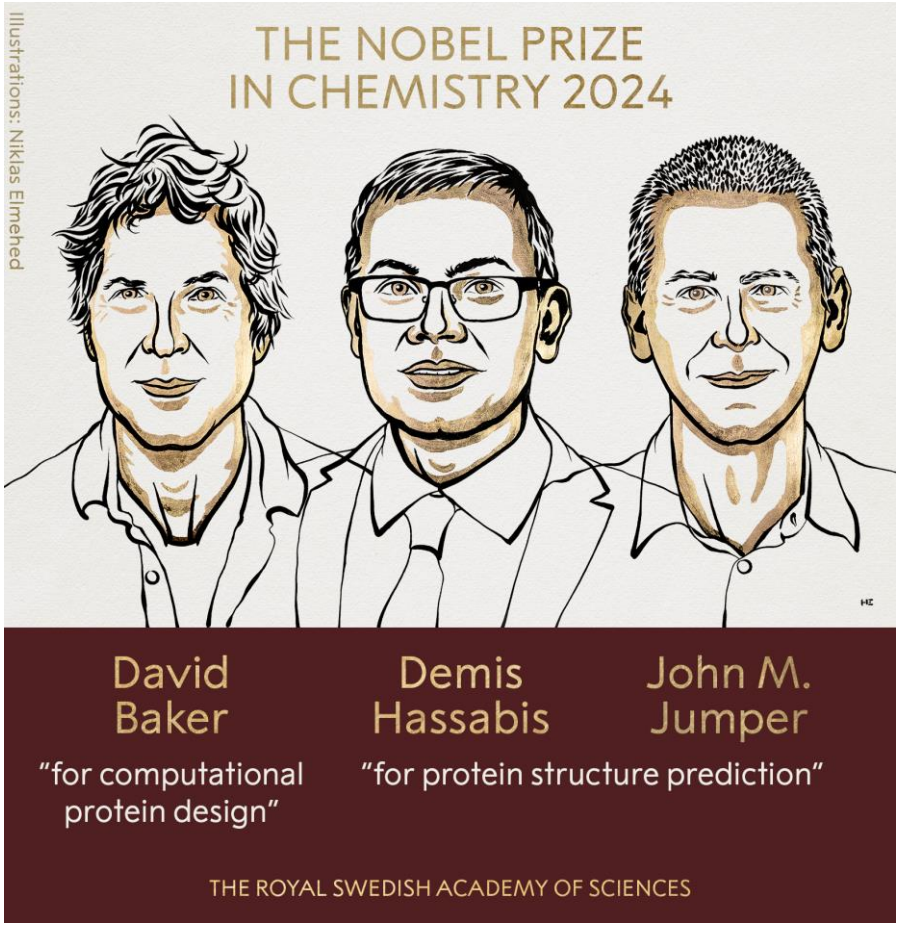
gartner.com

Source: Gartner

Gartner®

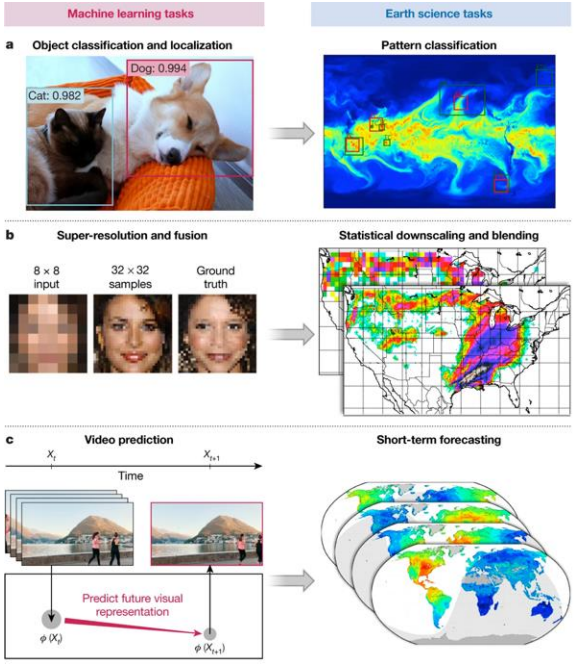
Science for AI and AI for Science

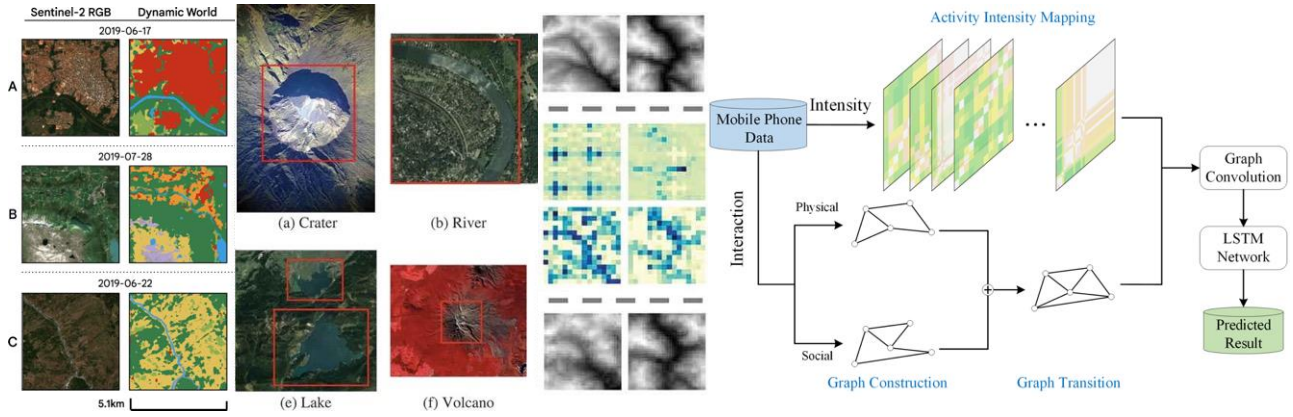




AI in Geographical Sciences

- Spatial scene classification
- Geographic object detection and localization
- Spatial interpolation and downscaling
- Spatiotemporal predictions and modeling
- Multisource and multimodal data fusion
- Linking physical models and machine learning



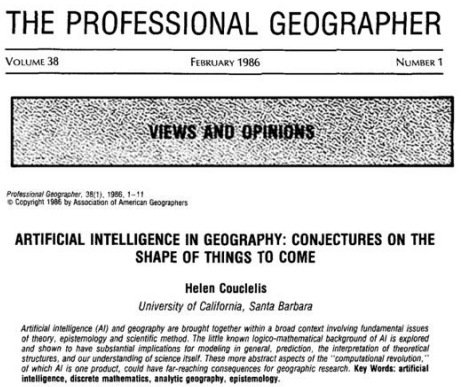


Reichstein et al. (2019, Nature)
Brown et al. (2022, Sci. Data)
Li & Hsu (2020, IJGIS)
Zhu et al. (2020, IJGIS)
Li, Gao et al. (2021, IJGIS)

AI in Geography

- "It is not often that geography is touched by a development having the potential to affect substantially all of the practical, technical, methodological, theoretical and philosophical aspects of our work."

- "… as an integral part of a wider intellectual enterprise that is already revolutionizing many of our views about science and the world."



THE PROFESSIONAL GEOGRAPHER

VOLUME 38 FEBRUARY 1986 NUMBER 1

VIEWS AND OPINIONS

Professional Geographer, 38(1), 1986, 1–11
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ARTIFICIAL INTELLIGENCE IN GEOGRAPHY: CONJECTURES ON THE SHAPE OF THINGS TO COME

Helen Couclelis
University of California, Santa Barbara

Artificial intelligence (AI) and geography are brought together within a broad context involving fundamental issues of theory, epistemology and scientific method. The little known logico-mathematical background of AI is explored and shown to have substantial implications for modeling in general, prediction, the interpretation of theoretical structures, and our understanding of science itself. These more abstract aspects of the "computational revolution," of which AI is one product, could have far-reaching consequences for geographic research. **Key Words: artificial intelligence, discrete mathematics, analytic geography, epistemology.**

Couclelis, H. (1986). Artificial intelligence in geography: Conjectures on the shape of things to come. The professional geographer, 38(1), 1-11.

AI in Geography

- Program: symbolic phase
- Neural Nets: machine learning phase
- Speculations: science fiction phase
- Being Human: fear, vision of the future

Couclelis (2023, Chapter 2, Handbook of GeoAI)

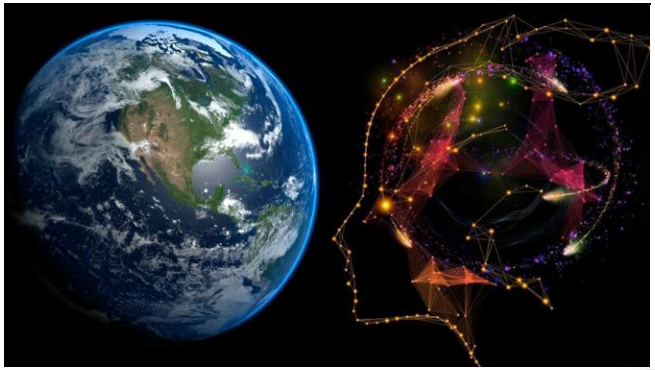
AI in Geography

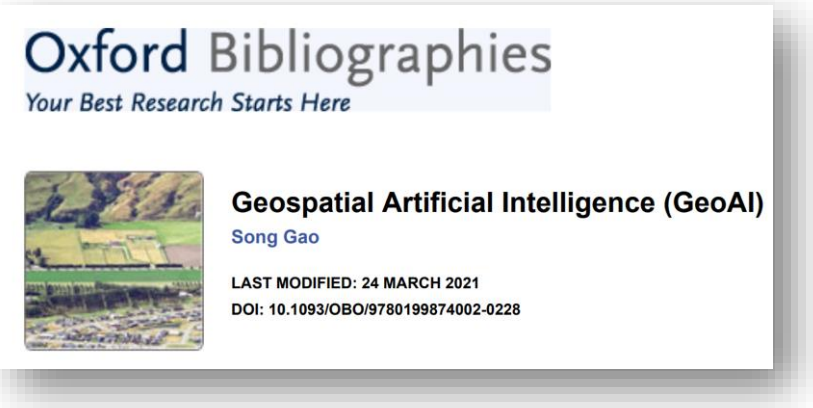
- Why do we need AI in geography and GIS?
- What kinds of geographic research involving AI you learned (explanation, engineering, pedagogy)?
- What are the key geographical questions that we can now address better using AI rather than traditional approaches?
- What are the unsolved problems that can now be solved with AI?
- Are there any new theories or intelligent approaches to building analysis models and data exploration pipelines in geographic information systems?

Openshaw, S. (1992). Some suggestions concerning the development of artificial intelligence tools for spatial modelling and analysis in GIS. The annals of regional science, 26(1), 35-51.

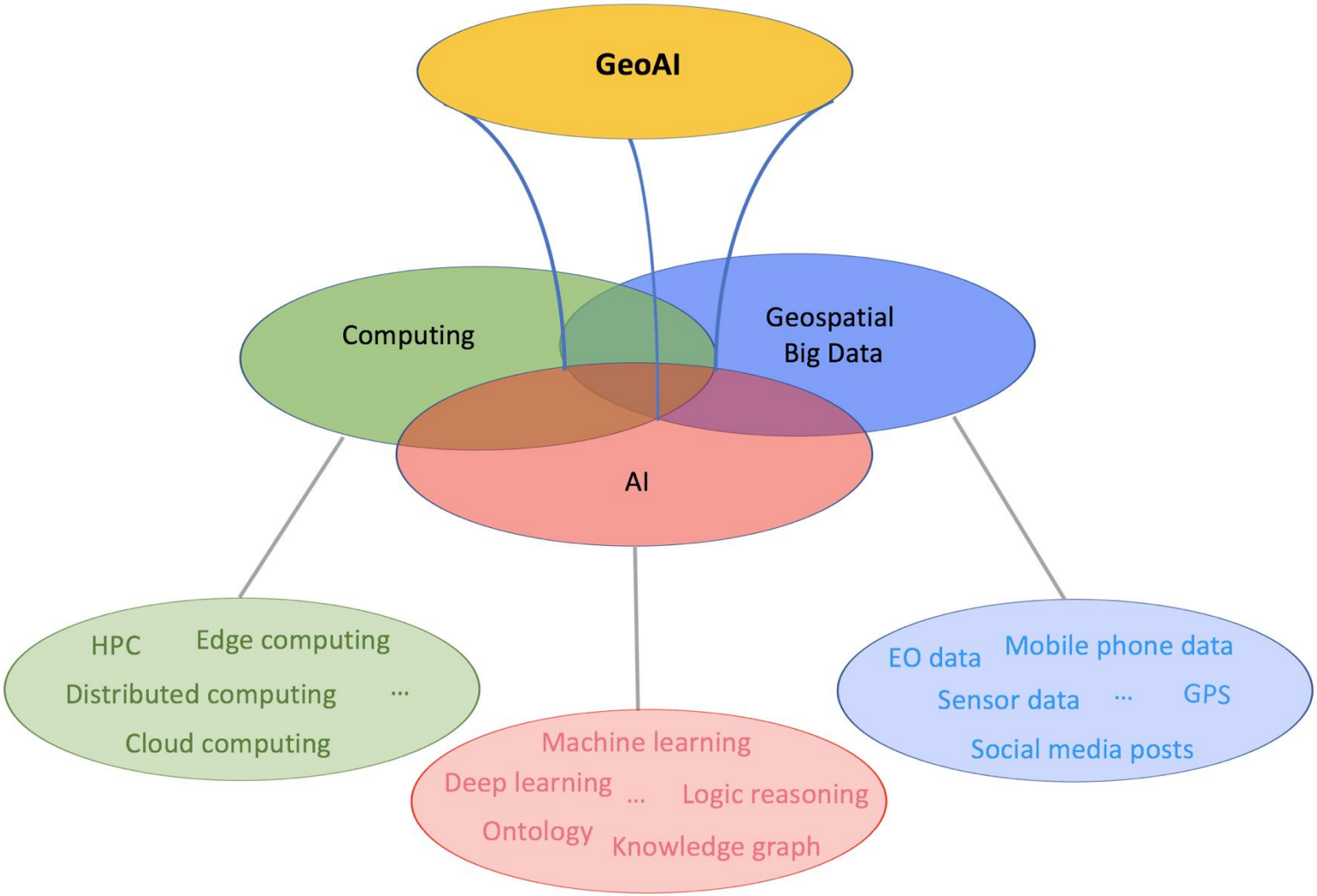
Definitions of GeoAI

- GeoAI is the integration of geospatial studies and AI, especially for developing **data-driven** and **knowledge-guided** machine learning methods.
- GeoAI can be considered as a subject to develop intelligent computer programs to **mimic the processes of human perception, spatial reasoning, and discovery** about geographical phenomena and dynamics.
- GeoAI aims to advance our knowledge and solve problems **in human-environmental interaction** systems using AI, with a focus on **spatial contexts** and roots in geography or geographic information science (GIScience).





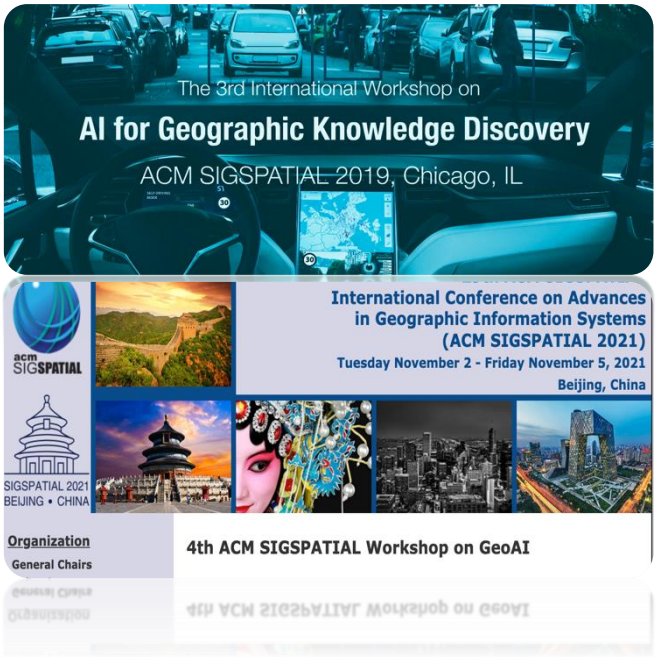
The boom in GeoAI



Li, W. (2020). GeoAI: Where machine learning and big data converge in GIScience. *Journal of Spatial Information Science*, (20), 71-77.

GeoAI Topics in ACM SIGSPATIAL

Research Topics	GeoAI Workshop Proceedings			
	2017	2018	2019	2021
Geospatial image processing	Li, W. et al.[30] Law, S. et al.[27] Collins, C.B. et al. [9] Duan, W. et al. [13]	Xu, Y. et al.[64] Sun, T. et al. [54] Srivastava, S. et al. [52]	Chen et al. [6] Dorji et al. [12] Law et al. [26] Liang et al. [33] Xin et al. (2019) [62]	
Transportation modeling and analysis	Kulkarni, V. et al. [25] Murphy, J. et al.[40] Li, Q. et al.[29]	Sun, T. et al. [54] Van Hinsbergh, J. et al [58] Pourebrahim, N. et al [42]	Yin et al. [70] Krumm, J. et al.[23] Xing et al.[63] Yin et al.[69] Mai et al.[37]	
Digital humanities	Duan, W. et al. [13]		Tavakkol et al. [56]	
Public health		Xi, G. et al. [61]	Yang et al. [68]	
Disaster response			Peng et al. [41]	
Social media and geo-text analysis		Pourebrahim, N. et al[42] Elgarroussi, K., et al.[14]	Yuan et al. [72] Snyder et al. [49]	Kravi, E. et al.[22]
Methods and techniques		Swan, B. et al. [55] Aydin, O. et al. [2]	Soliman et al. [50]	Levering, A. et al. [28] Gurav, R. et al. [17] Ying, C. et al. [7] Bowman, J. et al. [3] Rahman, M. M. et al. [43] Woźniak, S. et al. [60]
Novel applications and visions	Majic, I. et al. [38]	Chow, T. E. [8]	Li and Huang [31]	Rao, J. et al. [44]
GeoAI platforms and systems				Iyer, C. V. K. et al. [20]
Data generation				Chen, Y. et al. [32]



Hu, Y., Gao. S., Lunga, D., Li, W., Newsam, S., and Bhaduri, B. (2019) GeoAI at ACM SIGSPATIAL: Progress, Challenges, and Future Directions. *ACM Newsletter.*

GeoAI Moonshot

- What is the current state-of-the-art in integrating results from AI research into GIScience?
- What are the historical roots of GeoAI?
- Are there core topics that jointly drive this emerging community forward?

International Journal of Geographical Information Science

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GeoAI: spatially explicit artificial intelligence techniques for geographic knowledge discovery and beyond

Krzysztof Janowicz, Song Gao, Grant McKenzie, Yingjie Hu & Budhendra Bhaduri

To cite this article: Krzysztof Janowicz, Song Gao, Grant McKenzie, Yingjie Hu & Budhendra Bhaduri (2019): GeoAI: spatially explicit artificial intelligence techniques for geographic knowledge discovery and beyond, International Journal of Geographical Information Science, DOI: 10.1080/13658816.2019.1684500

To link to this article: https://doi.org/10.1080/13658816.2019.1684500

Moonshot: Can we develop an artificial GIS analyst that passes a domain-specific Turing Test by 2030?

(Janowicz et al. 2020)

https://www.tandfonline.com/toc/tgis20/34/4?nav=tocList

GeoAI for Science and the Science of GeoAI

JOURNAL OF SPATIAL INFORMATION SCIENCE

HOME / ARCHIVES / NO. 29 (2024) / Invited Articles

GeoAI for Science and the Science of GeoAI

Wenwen Li
Arizona State University

Samantha T. Arundel
United States Geological Survey

Song Gao
University of Wisconsin - Madison

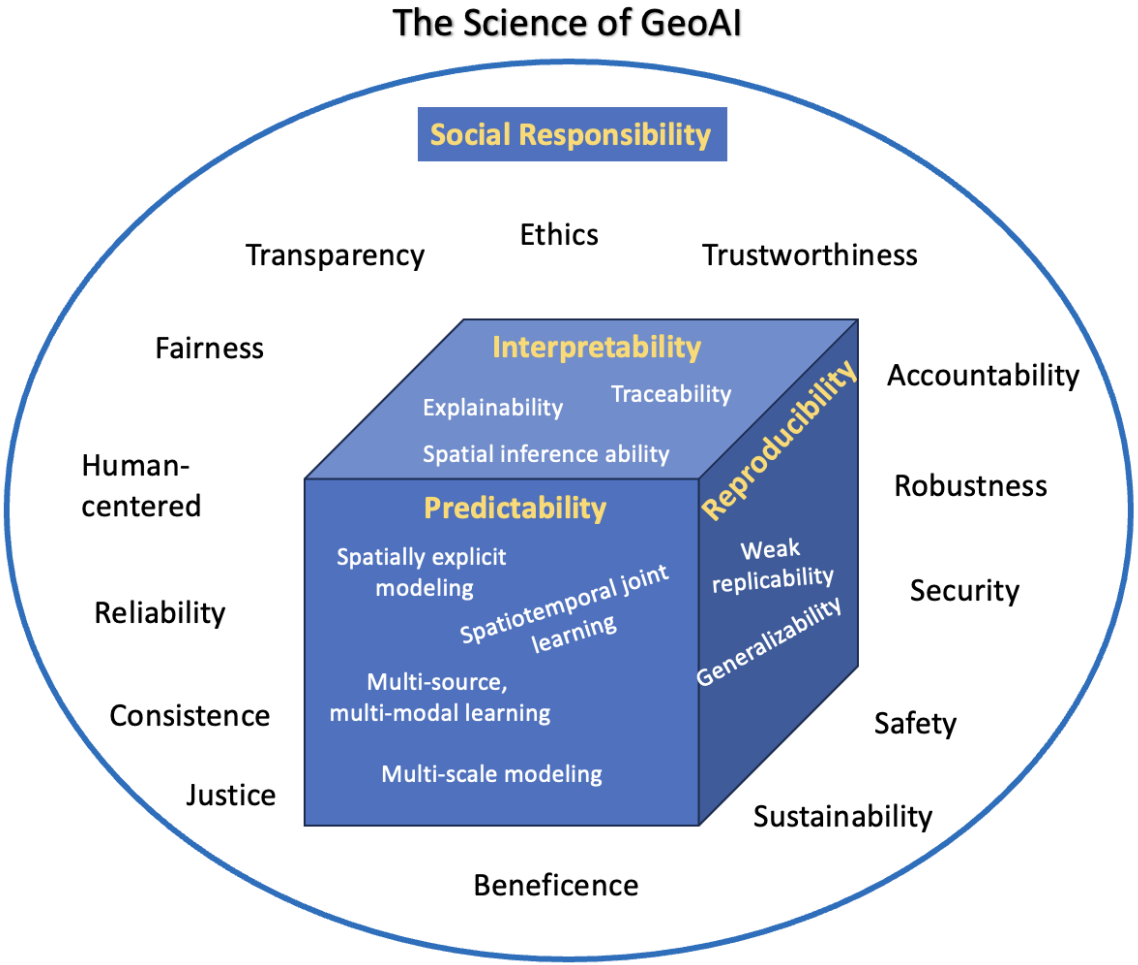
Michael F. Goodchild
University of California, Santa Barbara

Yingjie Hu
SUNY Buffalo

Shaowen Wang
University of Illinois Urbana-Champaign

Alexander Zipf
University of Heidelberg

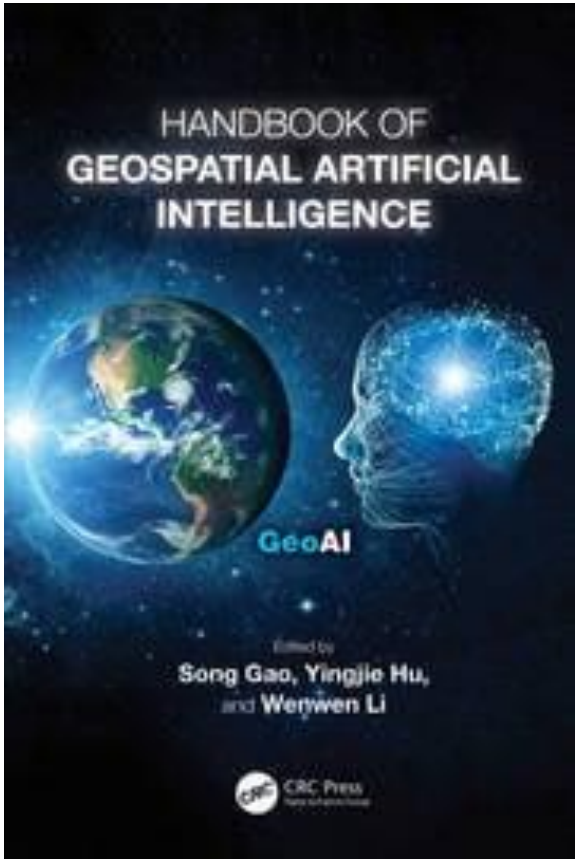
DOI: https://doi.org/10.5311/JOSIS.2024.29.349



(Li et al. 2024)

Ethics of GeoAI

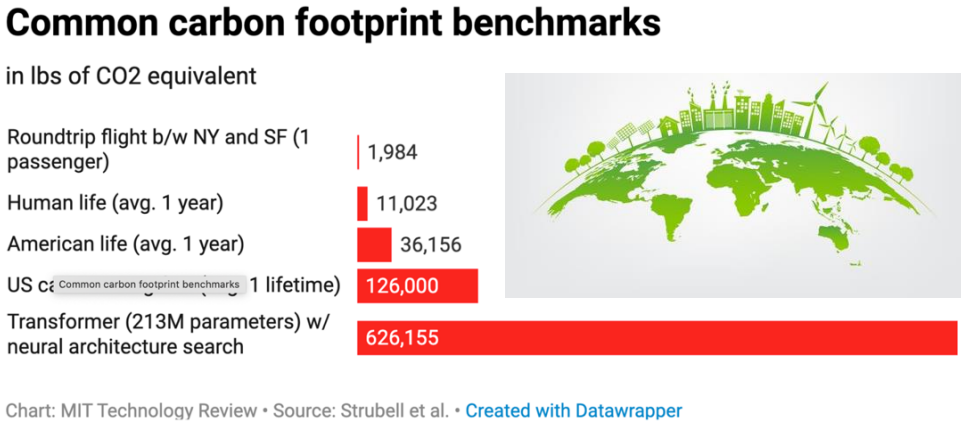
- Independent research (Who benefits)
- Minimizing socioeconomic risks
- Participants and their rights
- Confidentiality and anonymity
- Results dissemination, findability, interoperability, reusability



Janowicz (2023, Chapter 3, Handbook of GeoAI);

Sustainability of GeoAI

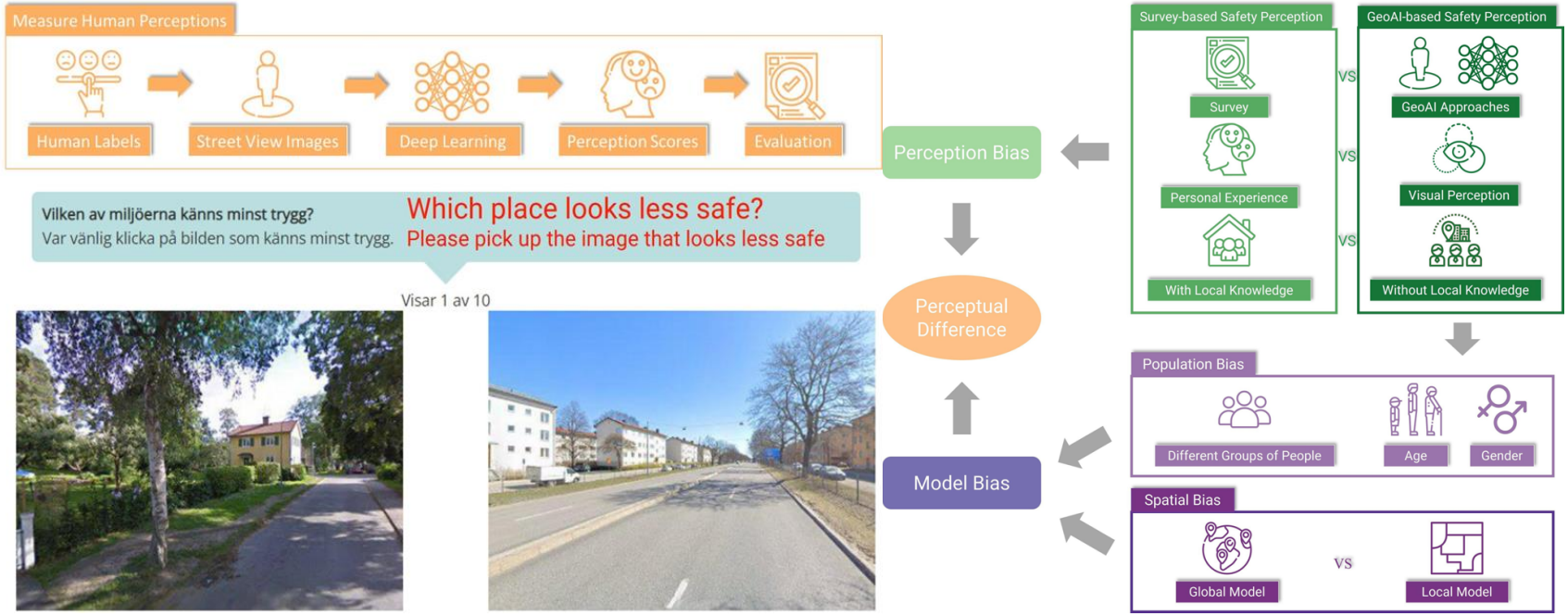
- Carbon emissions, energy and water consumption in AI model training
- Inter-generational prioritization of how to utilize resources across space (**think spatially and sustainably**)



Janowicz (2023, Chapter 3, Handbook of GeoAI); Shi et al. (2023, AGILE)

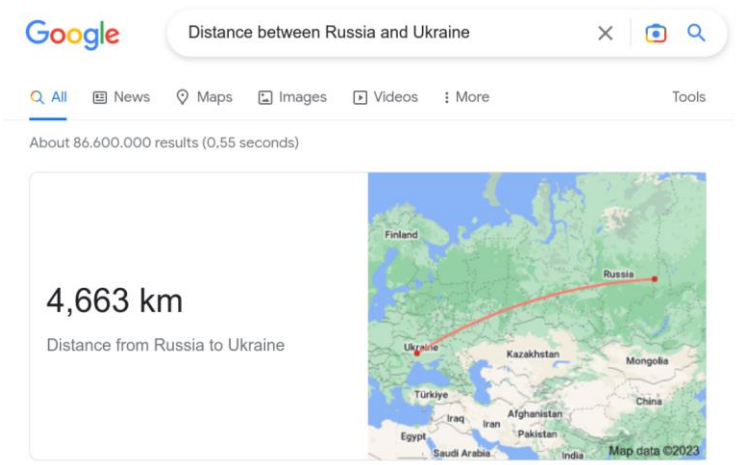
Biases of GeoAI

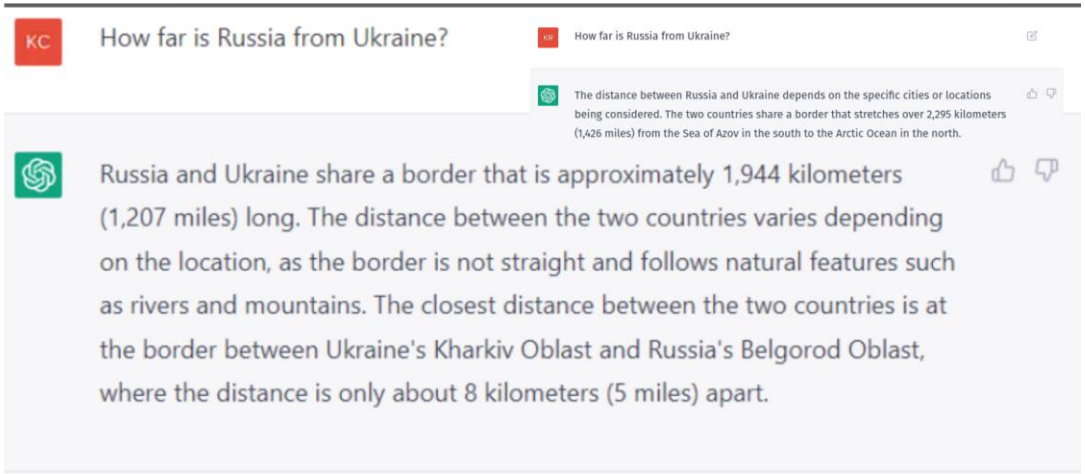
- **Model bias** (data, population demographics, global vs. local)
- **Perception bias** (experience, local knowledge)



Kang et al. (2023, Landscape and Urban Planning)

Geography According to ChatGPT





The distance between Ukraine and Russia according to Google Search and ChatGPT. Note that ChatGPT also changes the border length across queries. The proper answer should be **zero**, even though ChatGPT makes a very convincing statement that at the border where both countries touch, their distance is 5 miles.

Janowicz (2023, Chapter 3, Handbook of GeoAI)