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

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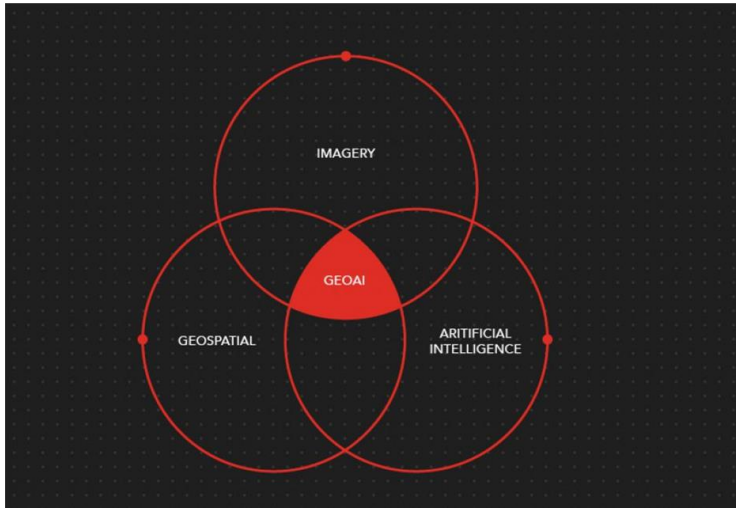
What are we going to talk about ?

- Introduction and History
- Spatially explicit models
- Overview of applications
  - Question-Answering (smart assistants)
  - Social sensing
- Datasets
- Long term goals
- Conclusion

What is GEO AI ?

GEO AI



GeoAI is where geospatial technology, imagery and artificial intelligence converge.

Geospatial AI can also be called a new form of machine learning that is based on a geographic component.

Why Geo AI ?

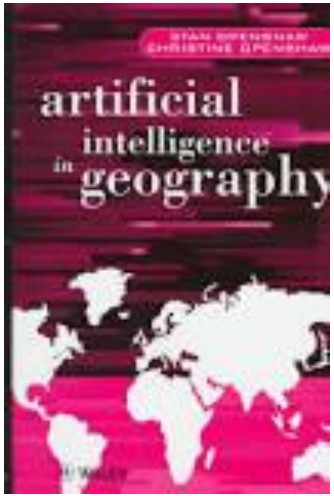
- Progress in Artificial Intelligence (AI) techniques
- large-scale availability of data
- advances in both hardware and software

Is it a new concept ? NO

Idea was developed in 1980s:

Couclelis, H., 1986. Artificial intelligence in geography: conjectures on the shape of things to come.

Smith, T.R., 1984. Artificial intelligence and its applicability to geographical problem solving



Book titled Artificial Intelligence in Geography by Christine Openshaw and Stan Openshaw in 1997

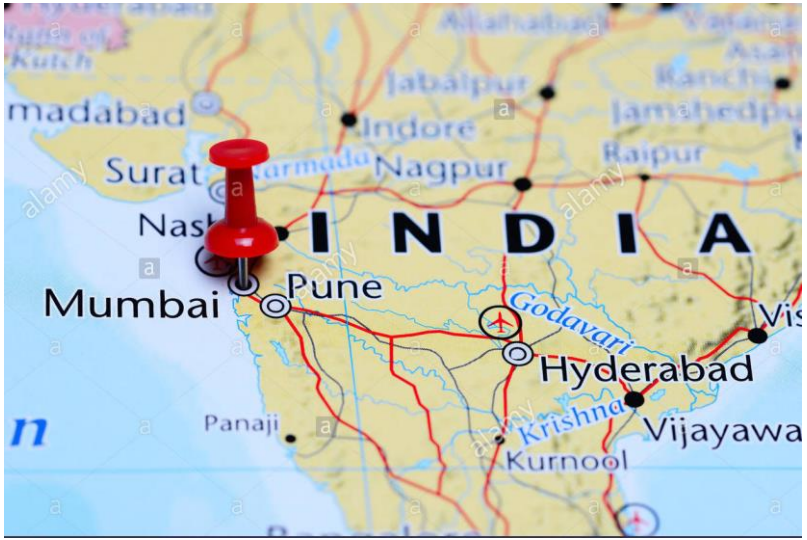
Spatially explicit models

Models that satisfy one or more of the following tests:

- Invariance test
- Representation test
- Formulation test
- Outcome test

Invariance test

The results of spatially explicit models are **NOT** invariant under relocation of the studied phenomena.



Representation test

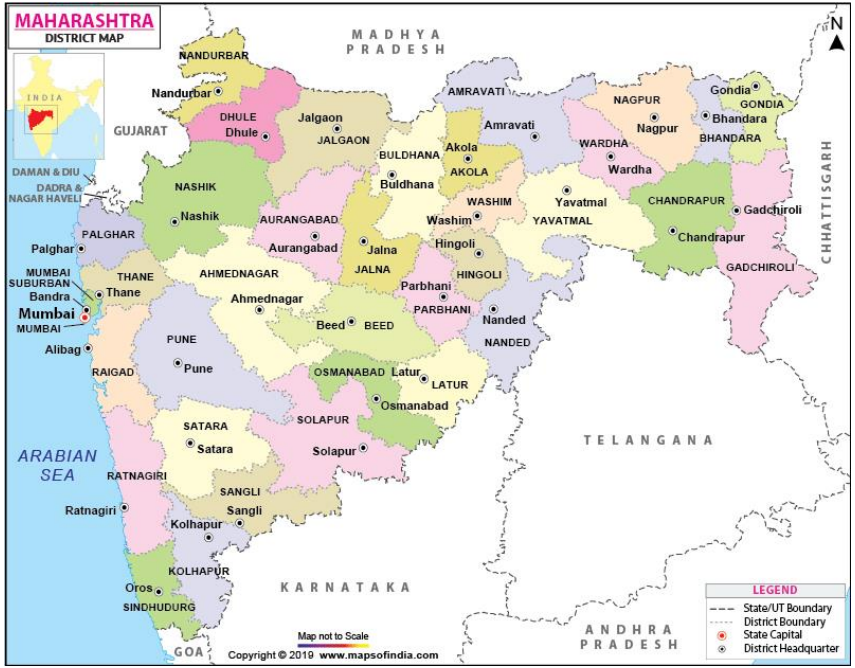
Spatially explicit models contain spatial representations of the studied phenomena in their implementations (this can be in the form of coordinates, spatial relations, place names, and so on).

Formulation test

Spatially explicit models make use of spatial concepts in their formulations, e.g. the notion of a neighborhood.

Outcome test

The spatial structures/forms of inputs and outcomes of the model differ



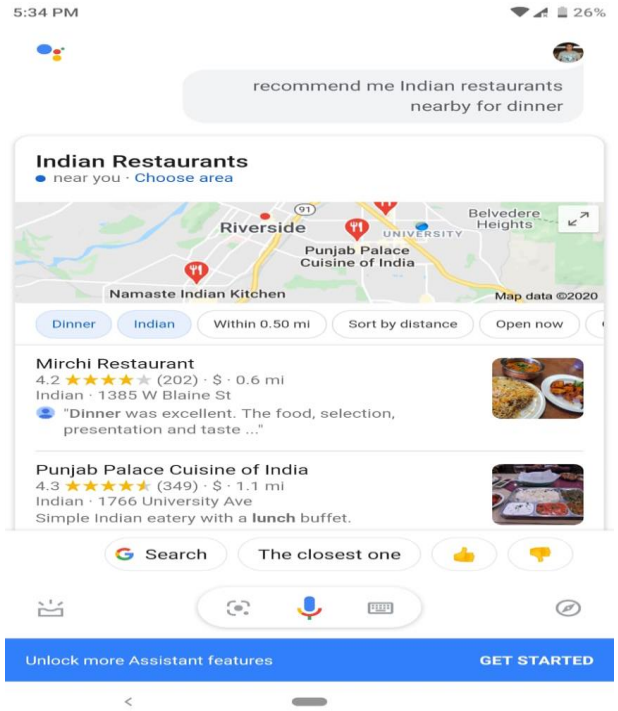
Misunderstandings

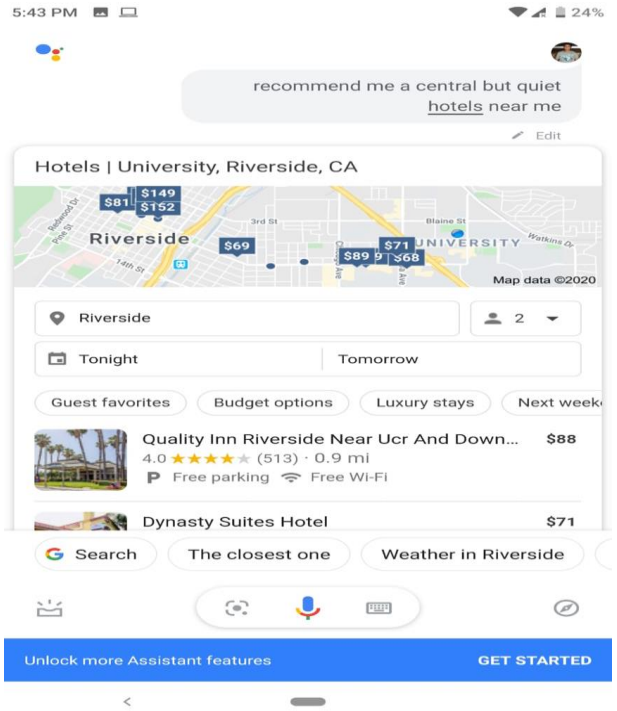
- Confusion with an analysis that may reveal spatial insights without being spatially explicit itself.
- Numerical analysis of spatial data (like population count of a city)

Overview of applications

- Question-Answering (smart assistants)
- Social sensing

Question-Answering (smart assistants)





Why does this happen?

These queries require an additional step, namely identifying a user's location, distances to other features, reasoning about topological relations, understanding vague cognitive regions, and so on. Accounting for both similarity and variance is important in such cases.

LA vs SD

SImilarities:

- Climate
- Beaches
- Both belong to California

Uniqueness:

- LA has Hollywood !

Possible solutions

Discover and share GIS functionality based on the questions they are designed to answer.Rethink the entire interaction with modern GIS and abstract it to a higher level centered around the scientific questions to be answered instead of the technical steps involved in doing so

Relax questions to arrive at an approximate (or at least related) answer

Use user based input data as an addition to already available factual data

Social sensing

It can be defined as the use of (user-generated) digital content to better understand human dynamics.

Social sensing has been applied to a range of tasks from identifying human mobility patterns and exploring structure in social networks, to urban planning solutions with varying degrees of success.

Challenges

The current social sensing is more location based

Does not use social or real life elements in it

Example: Google maps

How a man tricked Google maps by creating fake traffic jams

Prashasti Awasthi | Mumbai | Updated on February 05, 2020 | Published on February 05, 2020

Simon Weckert's little experiment in Berlin where he tricked Google maps into reporting a traffic jam on an empty stretch of a square has gone viral.

Possible solution

With the advancement of drive-by sensors, computer vision and deep learning techniques, street-level images become a new data source for understanding the physical environments and social environments.

It enables the visual representation and exploration of urban environments using semantically segmented scene elements. Spatiotemporal human activity information such as traffic flow, neighborhoods demographic information, and human perceived safety in cities can be inferred from street view images.

Datasets

A trained model is only as good as the quality of the training data

Advancing GeoAI research requires high-quality geospatial datasets.

High quality datasets might not be available

Datasets are not shared and hence analysis becomes difficult

Reproducibility and Replicability

- **Reproducibility** refers to the ability of other researchers to duplicate the results of a prior study using the same data and procedures.
- **Replicability** refers to the ability of duplicating the results of a prior study using the same procedures but new data.

Some openly available datasets

Long term goals

Ideally, research around GeoAI and spatial data science more broadly would be focused around a few grand challenges

Here we discuss one of them !

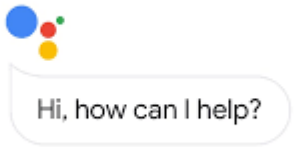
Can we develop an artificial GIS analyst that passes a domain-specific Turing Test by 2030?

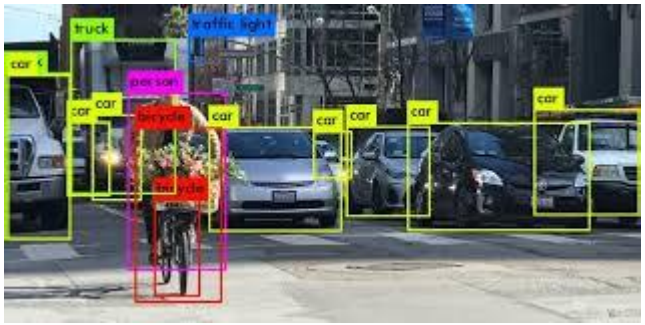
The key here is to open up GIS to Siri-like interaction for the masses, not to replace highly-trained GIS analysts performing complex analysis.

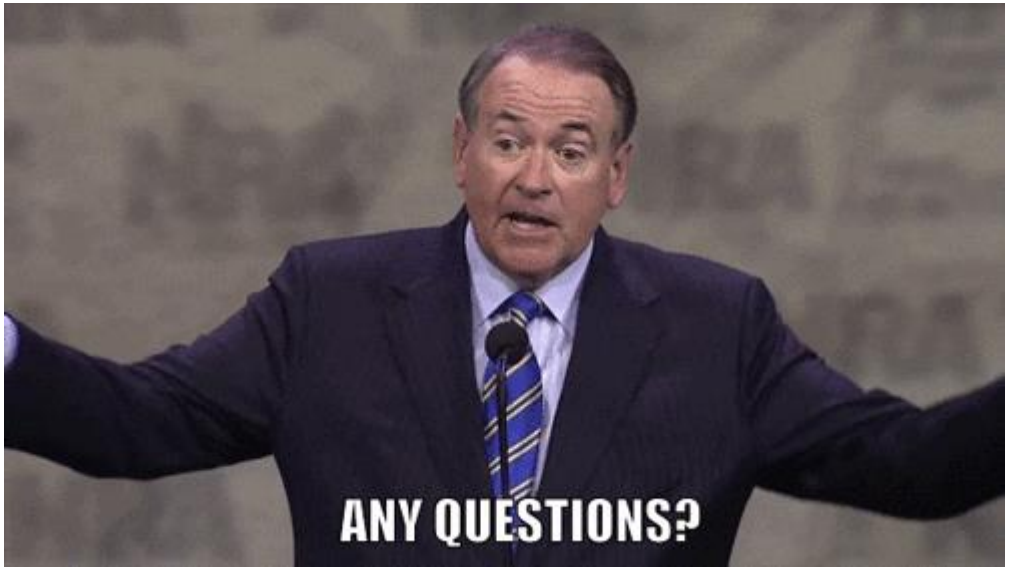
Several large-scale projects such as the NSF funded EarthCube and, more recently, the Open Knowledge Networks track of NSF's Convergence Accelerator address the challenge of designing human and machine-readable and reasonable data repositories.

Conclusion

GeoAI is a subfield of spatial data science utilizes advancements in techniques and data cultures to support the creation of more intelligent geographic information as well as methods, systems, and services for a variety of downstream tasks.






ANY QUESTIONS?


Thank
You