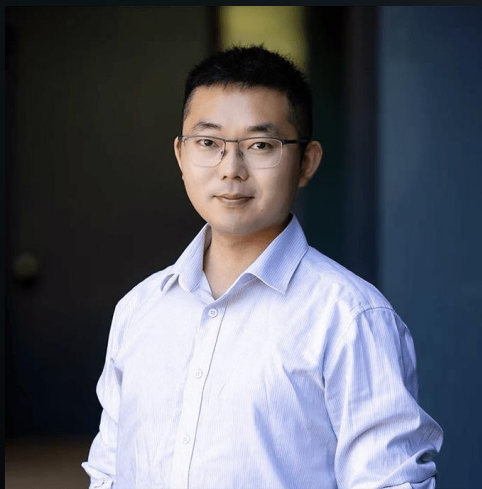


Geospatial Data Analysis, Prediction, and GeoAI: New Theories, Methods, and Software

Topic 8. Geospatial intelligence (GeoAI) for urban sustainability

Lecture website: <https://yongzesong.com/lecture-20260104>



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Lecture outline

Lecture website: <https://yongzesong.com/lecture-20260104>

Password: 20260104

Contents

Part 1. Lecture (1st class)

1. Concepts of GeoAI
2. Example: Machine learning using caret

Part 2. Practice (2nd to 4th classes)

1. Practice (40 min)
2. Assignment (40 min)
3. Submit your assignment (10 min)

Tips:

1. Working in a group of 3 or 4
2. Collecting feedback at each day
3. Individual assignments and working in a group
4. Complete assignments in the class
5. Assignment feedback sections after day 2
6. Install R and Rstudio
7. Sign Up for Google Earth Engine

GeoAI

Geospatial Artificial Intelligence (GeoAI) integrates geospatial data with AI techniques to advance Earth observation, GIS, and spatial decision-making.

GeoAI can address complex challenges in:

- Sustainable urban development
- Infrastructure planning and maintenance
- Environmental monitoring and climate adaptation

Key challenges:

- How to embed unique geospatial characteristics (scale, heterogeneity, spatial association) into AI models.
- Risks of digital divide, where unequal access to data, computing, and skills may deepen social inequities.

GeoAI

Definition

- GeoAI = *Integration of geospatial data/techniques + Artificial Intelligence*
- Aims to **analyse, model, and predict** complex human–environment systems.

Core components

- **Geospatial Data:** Remote sensing, GIS, LiDAR, social media, in-situ observations.
- **AI Techniques:** Machine learning, deep learning, natural language processing, generative models.

Capabilities

- Enhance **mapping, spatial analysis, and prediction.**
- Support **real-time monitoring** of cities, infrastructure, and ecosystems.
- Enable **data-driven decision-making** in planning and policy.

Distinction

- Goes beyond traditional GIS → not only describing “where,” but also explaining “why” and predicting “what next.”

Brief history of GeoAI

1980s – Foundations

- Early GIScience researchers explored AI in geography.
- Symbolic AI approaches (rule-based, expert systems) applied to geospatial problems .

1990s – Statistical & computational models

- Spatial regression, geographically weighted regression (GWR), spatial interaction models.
- Decision-tree and ANN applications in land cover classification .

2000s – Machine learning era

- SVMs, random forests, ensemble models for remote sensing & spatial analysis.
- Increasing access to global geospatial datasets.

2010s – Deep learning revolution

- CNNs and RNNs widely applied to remote sensing, urban computing, and Earth system science.
- Growth of **big geospatial data + GPU/TPU computing** .

2020s – GeoAI Today

- **Geo-foundation models**, large-scale pre-trained AI models for spatial data.
- Emphasis on **explainability, fairness, and ethics**.
- Integration with generative AI (GeoGAI) for autonomous geospatial tasks .

Emerging trends

Heterogeneity-aware and knowledge-guided GeoAI

- Incorporates spatial heterogeneity and expert knowledge into model design

Geo-foundation models and spatial representation learning

- Large-scale pre-trained models for diverse geospatial tasks
- Transfer learning across regions and applications

Fairness, privacy, explainability

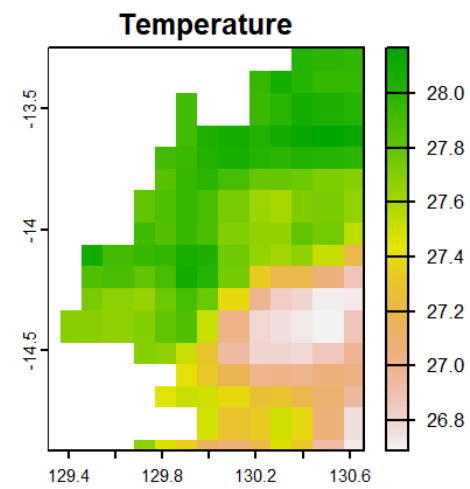
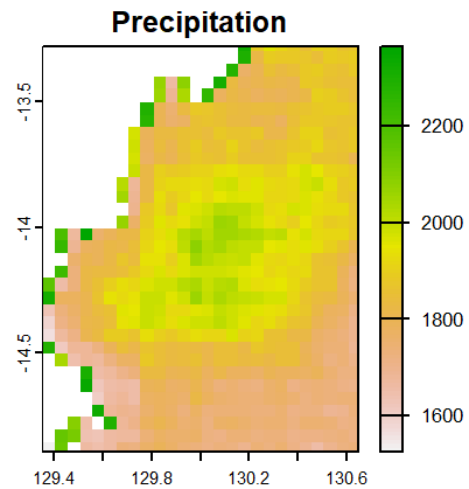
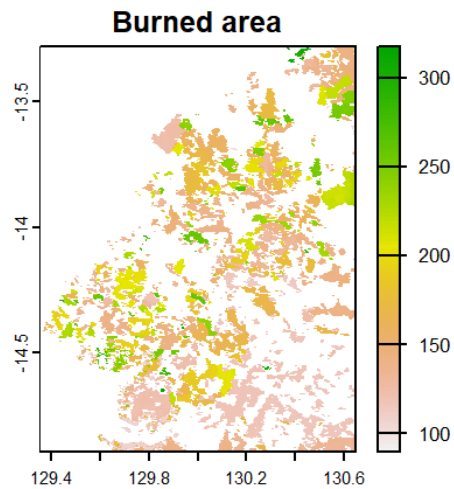
- Ensuring ethical ai for geospatial data
- Promoting transparent, accountable, and socially responsible models

Summary

- GeoAI is evolving from a **mapping tool** to a **scientific paradigm**
- Moving beyond descriptive analysis toward **explainable, predictive, and integrative science**

Practice

- Example: Machine learning using caret
- <https://ausgis.github.io/igarss25ss/sec4.html>



Assignment

You will have 40 min for working on Assignment

Write a 200 word essay on the analysis of GeoAI for assessing climate impacts on bushfire

Any questions?