Human-centered Generative AI for Advancing Sense of Place

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Human-centered Geospatial Data Science

Understand human experience

- Human *perceptions* of place
- Human *emotions* at place
- Human *cognition* of place
- Human *creativity*
- …

Develop *trustworthy* and *ethical* GIScience technology

- Mitigate *bias*
- Protect human *geoprivacy*
- Enhance explainability of GeoAI
- Build *inclusive* GeoAI
- …

The Recent Boom of Large Language Models

Large Language Models

ChatGPT

Gemini Google

Claude

Diffusion Models

DALL·E 2

Stable Diffusion

Midjourney

Communicate with people

KK What is cartography?

Cartography is the science and art of making maps. It involves the representation of spatial data in a way that communicates information effectively to users. A cartographer is someone who practices cartography and designs or produces maps.

The process of map-making has evolved significantly over time, from ancient hand-drawn maps to the sophisticated digital maps of today. Cartographers today utilize a variety of tools, including Geographic Information Systems (GIS), to create detailed and accurate maps.

Create graphics

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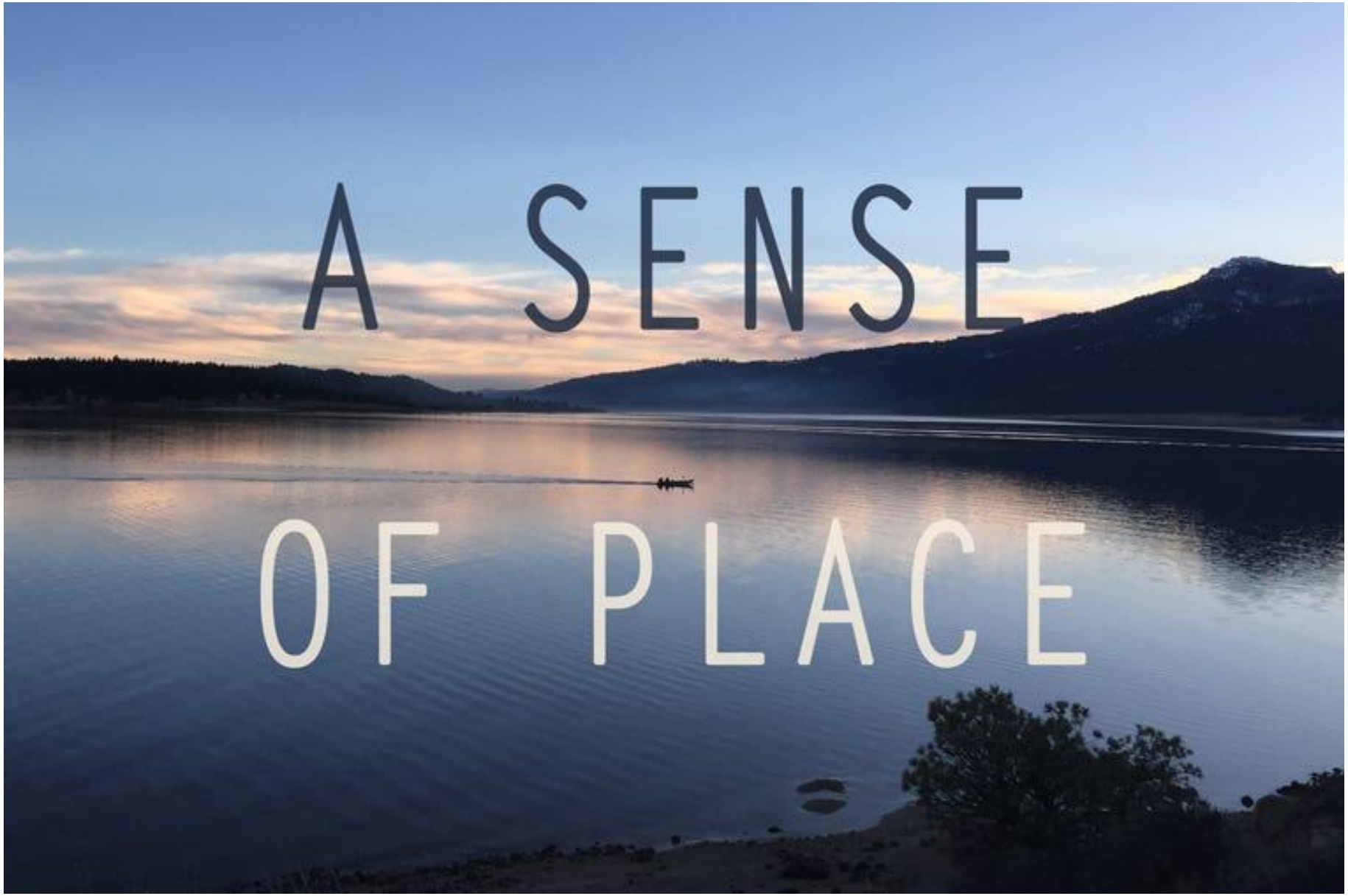
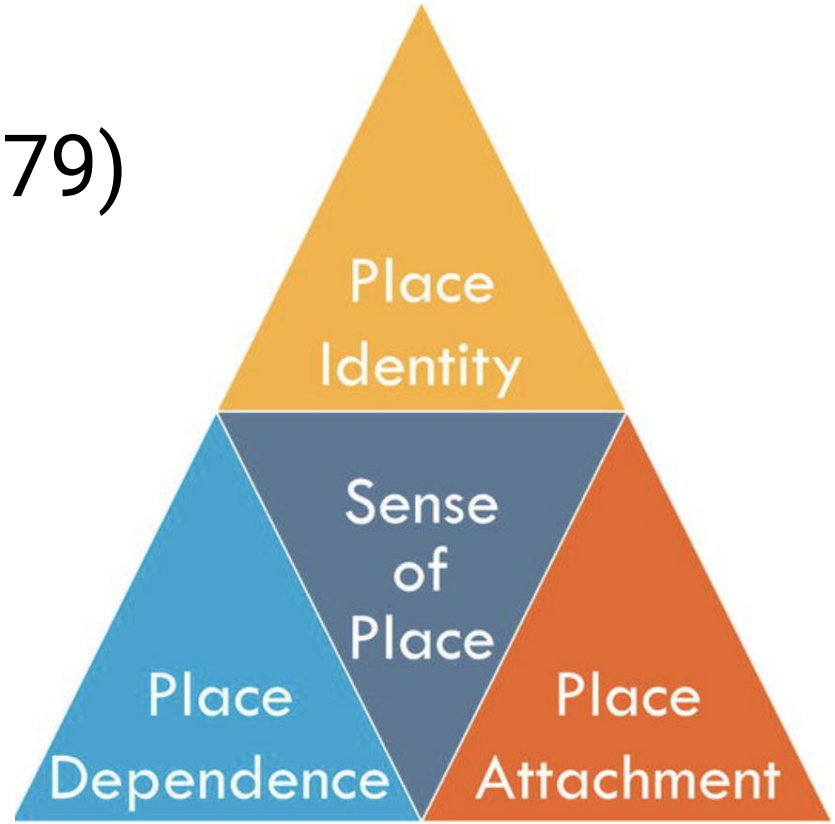
Sense of Place



Sense of Place

Place = Space + Human Meaning (Tuan, 1979)

Sense of place denotes those nebulous human meanings such as subjective feelings and perceptions that evoke different emotions, experiences, and identities attached to the place (Kang, 2021)



Can we enrich our understanding of human sense of place using generative artificial intelligence (GenAI)?

Kang, Y., Zhang, F., Gao, S., Peng, W. and Ratti, C., 2021. Human settlement value assessment from a place perspective: Considering human dynamics and perceptions in house price modeling. *Cities*, *118*, p.103333.

Measuring Human Perception of Place

Traditional Methods

- Self-reports
- Surveys
- Mental maps

- Lively
- Safe
- Beautiful
- ...

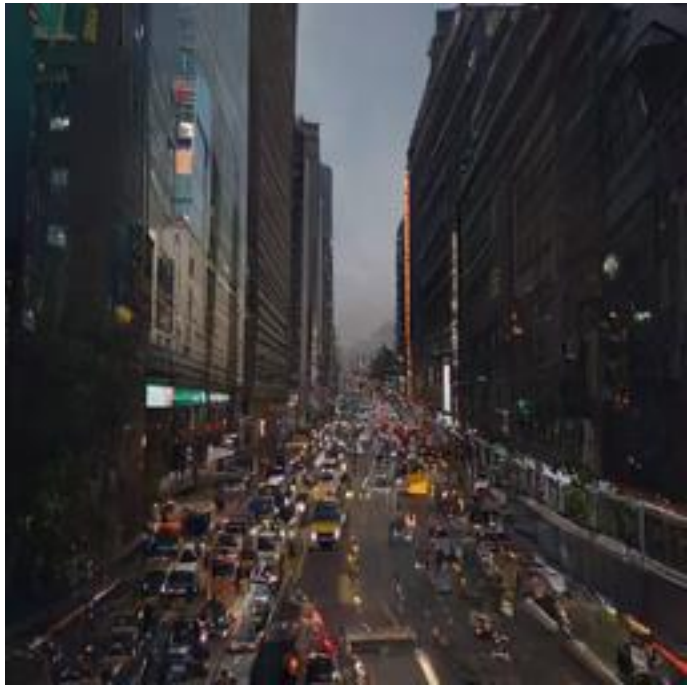
Sense of Place

- Small scales
- Labor-intensive
- Time-consuming

Are there better ways to measure and understand human sense of place?

Linking Auditory and Visual Perceptions

Audio 1



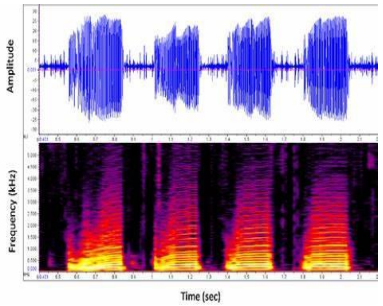
Audio 2

No Effective Way to Visualize Auditory Perceptions!

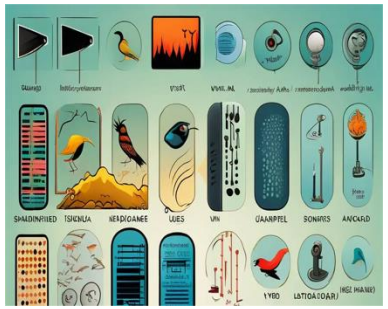
Challenge

Lack of intuitive ways to effectively and vividly characterize the acoustic environment, especially when compared with those methods for visual perceptions

Auditory Perceptions



Spectrograms



Acoustic Signal Attributes

Visual Perceptions

Image Analysis

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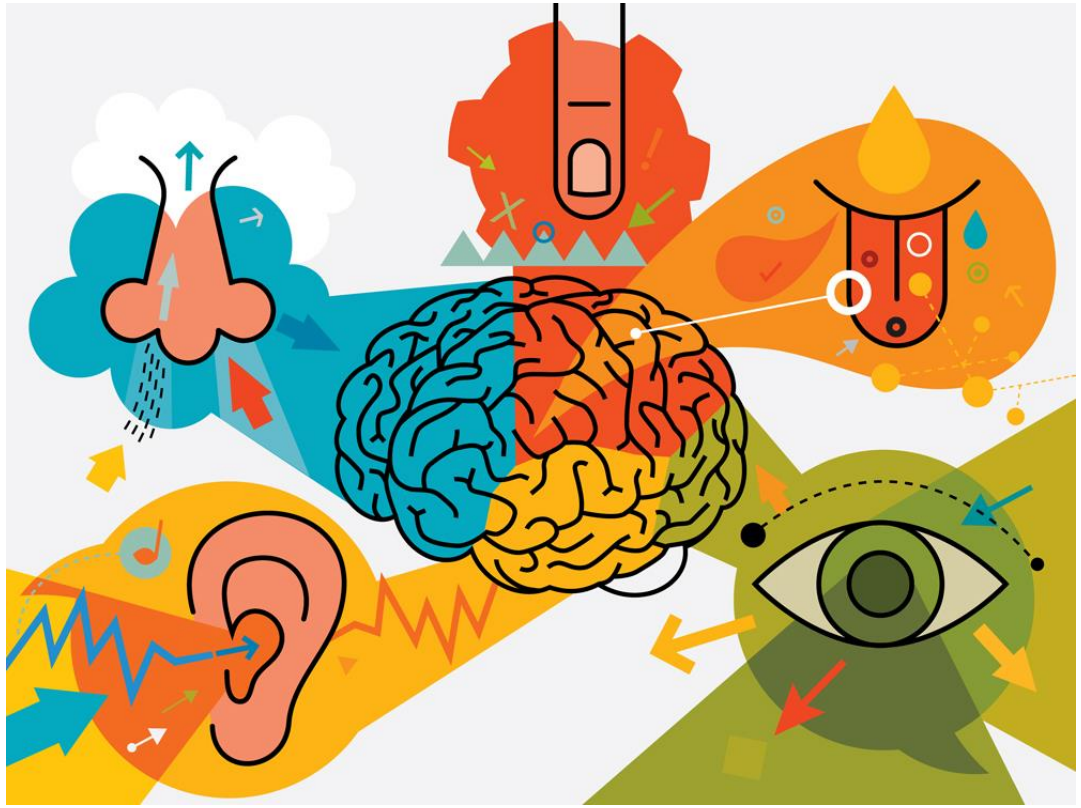
We Experience the World with All Senses Simultaneously!

Challenge

Most existing studies have focused on a singular dimension of the human sense of place while overlooking the complexity and depth of human-environment interactions, which are inherently shaped by multi-sensory experiences

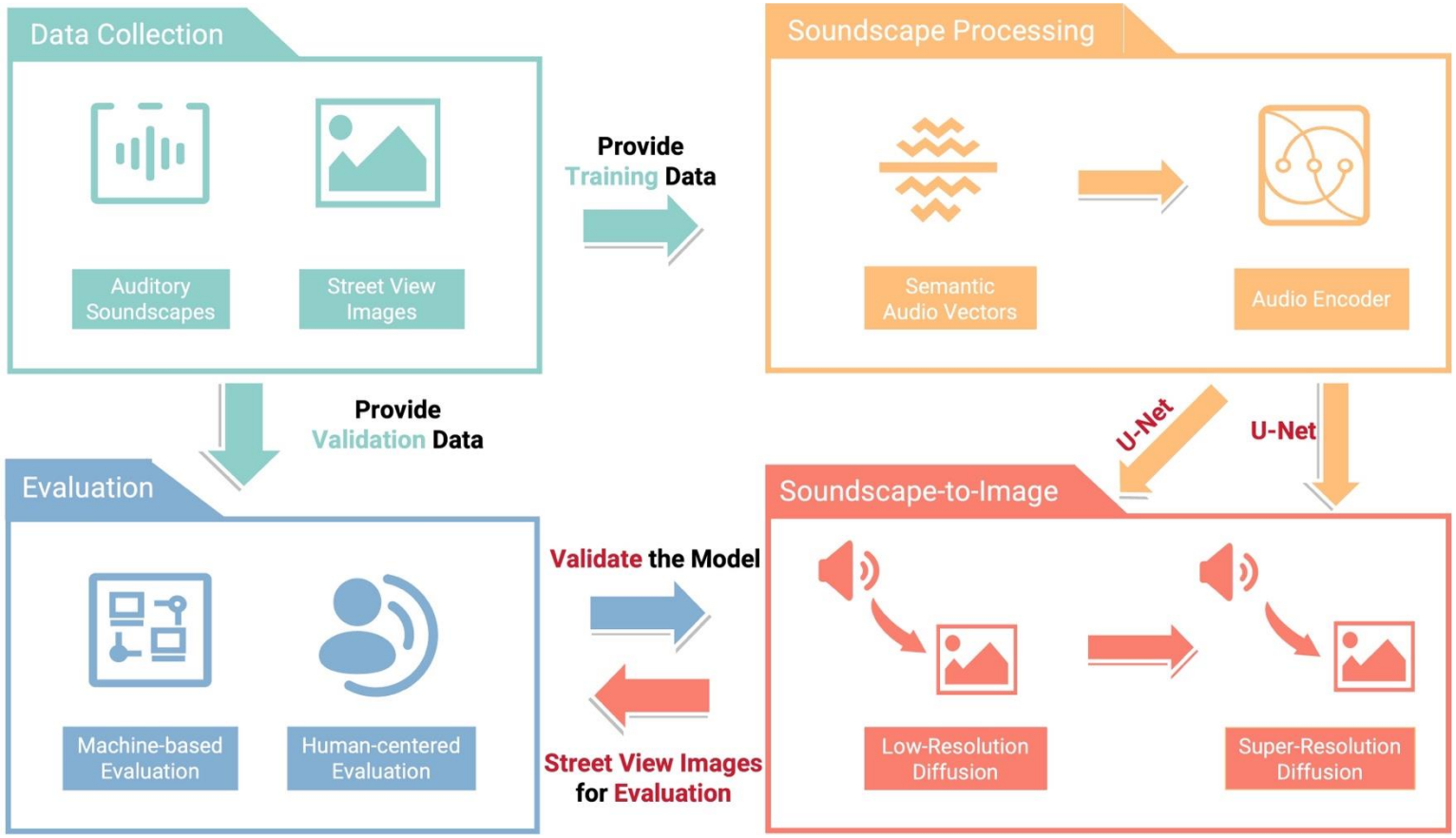


A multi-sensory experience at Austin

Can We Visualize What We Hear?

Auditory Soundscapes → Input → Soundscape-to-Image Diffusion → Translate → Street View Images

A Soundscape-to-Image Computational Framework



Zhuang, Y., Kang, Y., Fei, T., Bian, M. and Du, Y., 2024. From hearing to seeing: Linking auditory and visual place perceptions with soundscape-to-image generative artificial intelligence. *Computers, Environment and Urban Systems*, 110, p.102122.

YouTube

Keywords

- “street walk”
- “city walk”
- “village walk”

Videos
1,667 mins

10,000 Audio-Image Pairs

GitHub

https://github.com/GISense/Soundscape-to-Image

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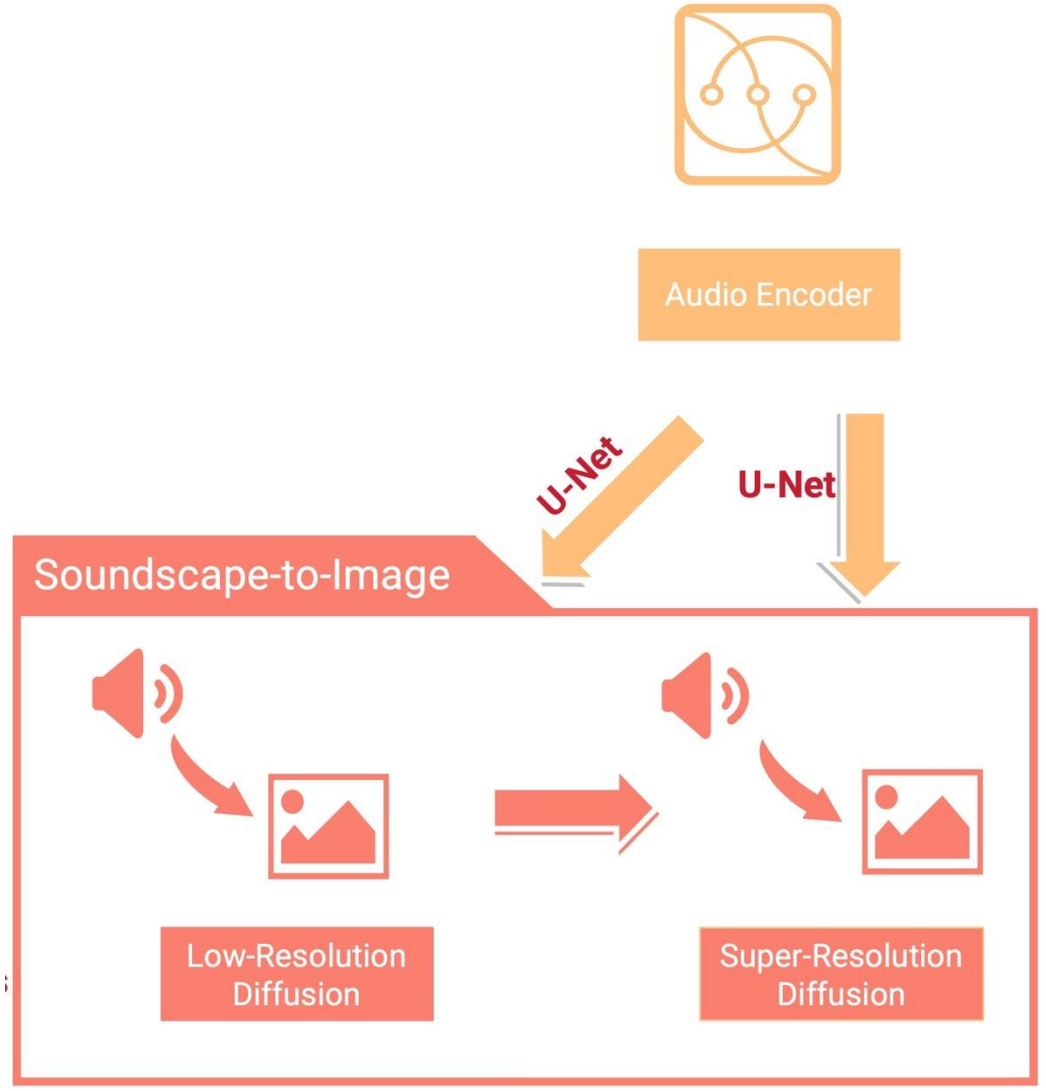
Translate What We Hear to What We See

Soundscape-to-Image Diffusion Model

- Extends Imagen, a text-to-image diffusion model released by Google Research
- Translate natural language text descriptions to photorealistic images using diffusion model

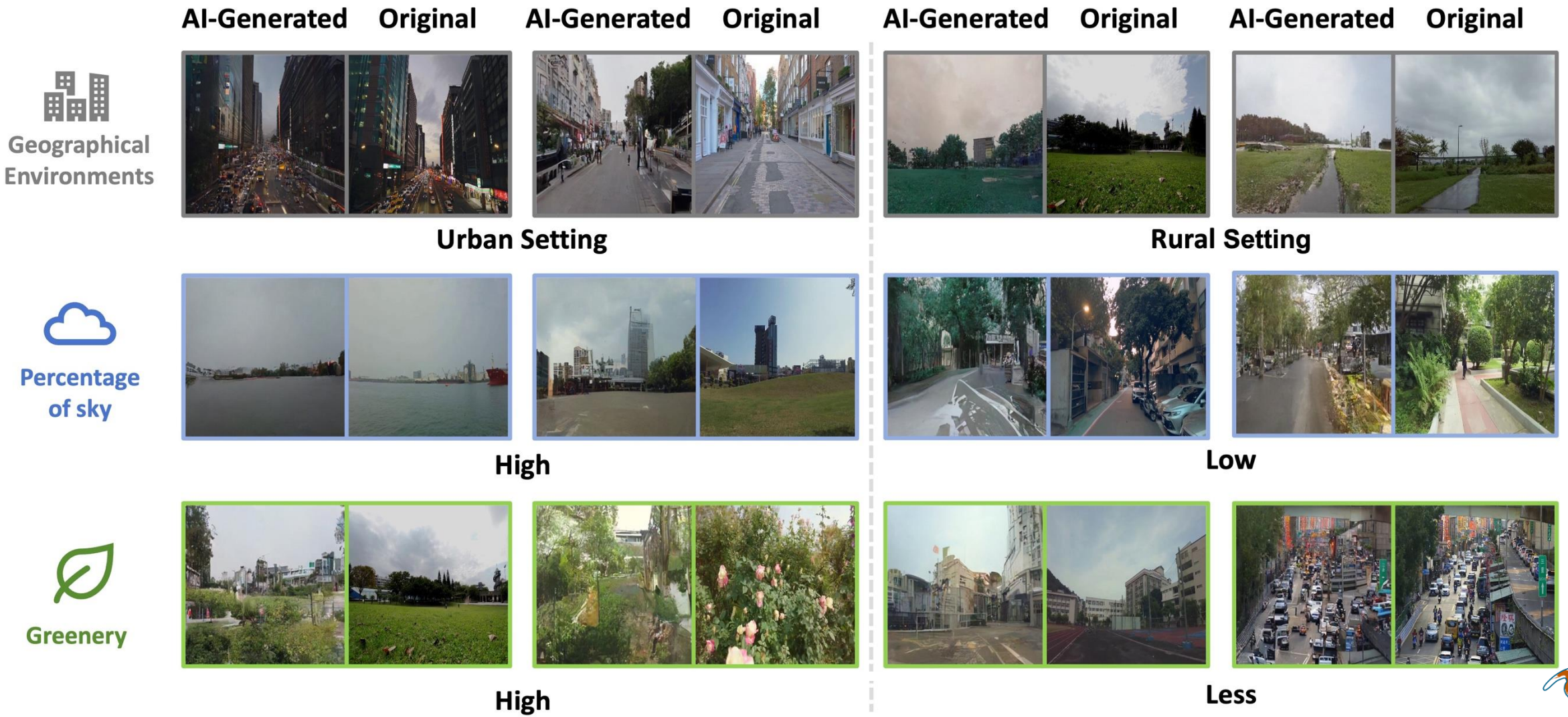
An example of the prompt "A brain riding a rocketship heading towards the moon."



Soundscape-to-Image Diffusion Model

Google Imagen. https://imagen.research.google/

AI-Generated Images

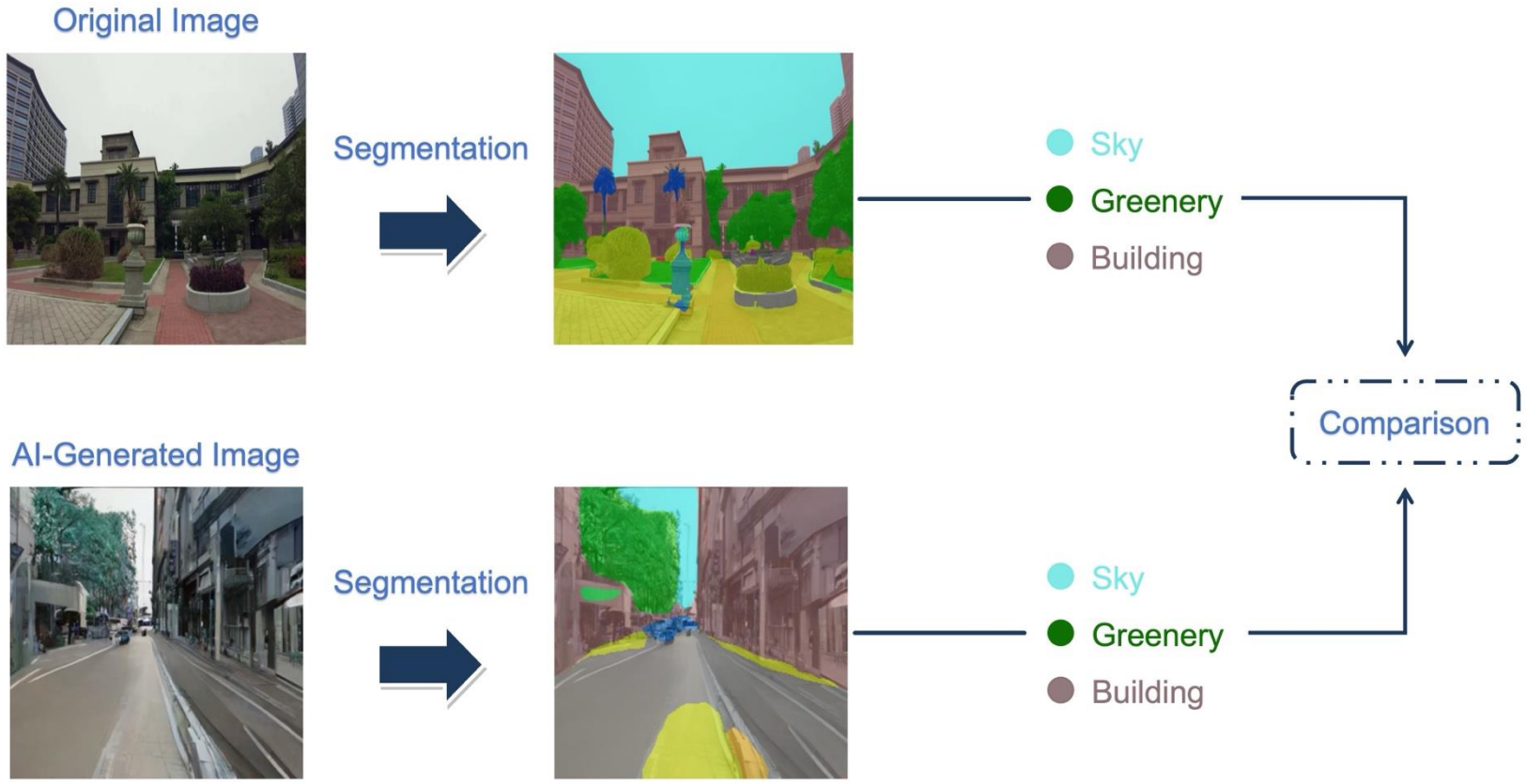


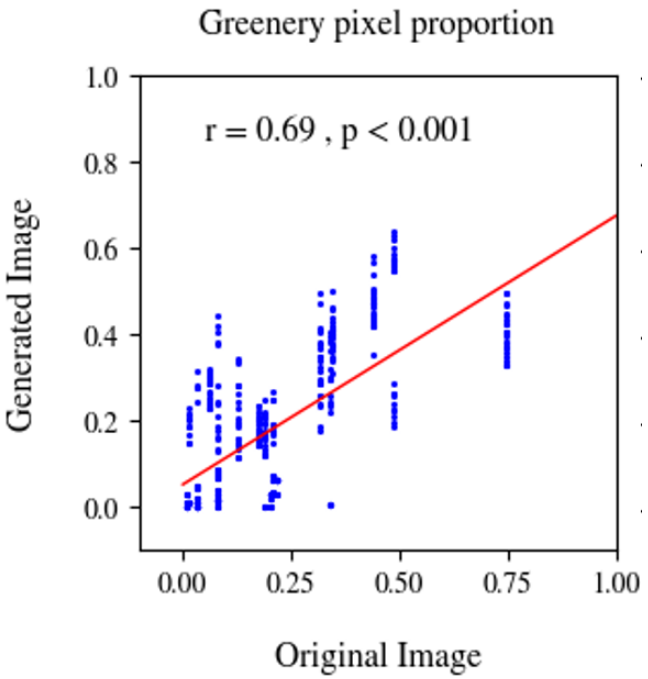
Evaluations

Prior studies in image generation have faced challenges in evaluating the quality of generated samples, due to the significant differences between the generated and original images

Evaluations – Machine-Based Approach

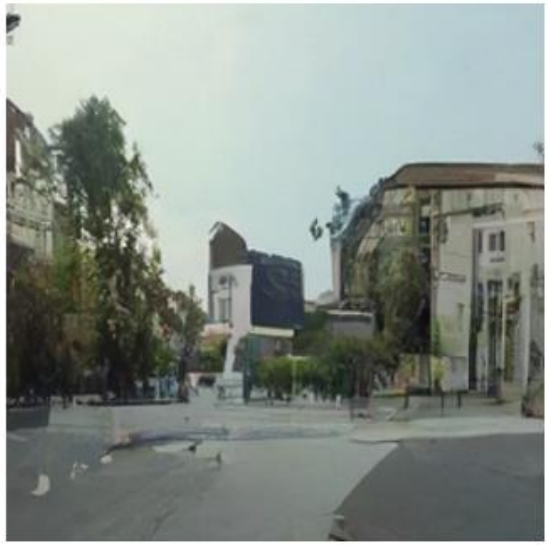
We performed both machine-based and human-centered approaches to evaluate the image synthesis performance of our Soundscape-to-Image Diffusion model





Evaluations – Human-centered Approach

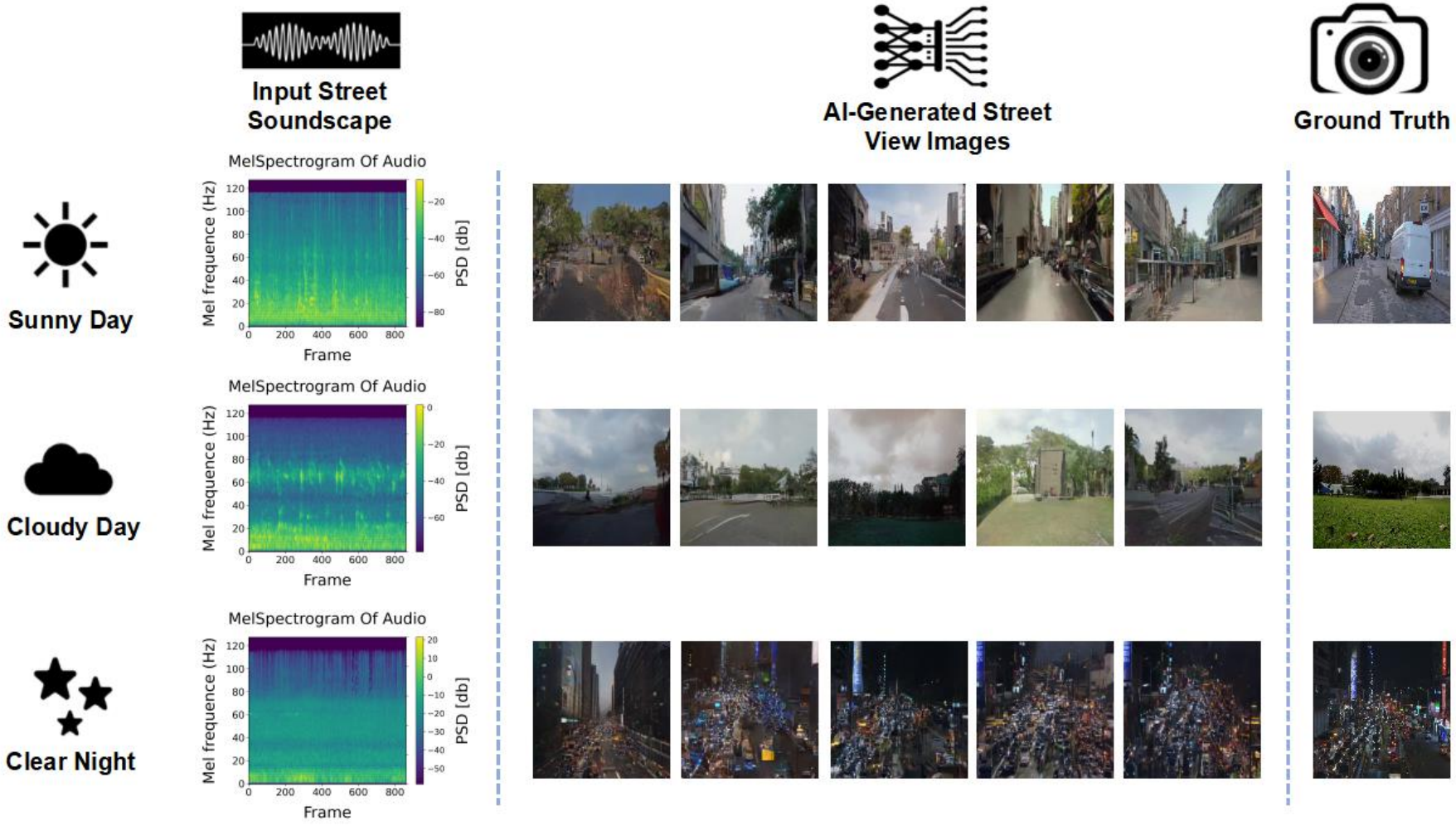
1. Which one matches the audio the most?



A B C

Participants achieve a matching rate of 80.455%

Findings – Lighting Conditions



The Soundscape-to-Image Diffusion Model generate images with different lighting conditions based on acoustic environment

Diffusion Models (DALLE) Perceive Beijing and London…

Beijing

London

Jang, K.M., Chen, J., Kang, Y., Kim, J., Lee, J., Duarte, F. and Ratti, C., 2024. Place identity: a generative AI's perspective. *Humanities and Social Sciences Communications*, *11*(1), pp.1-16.

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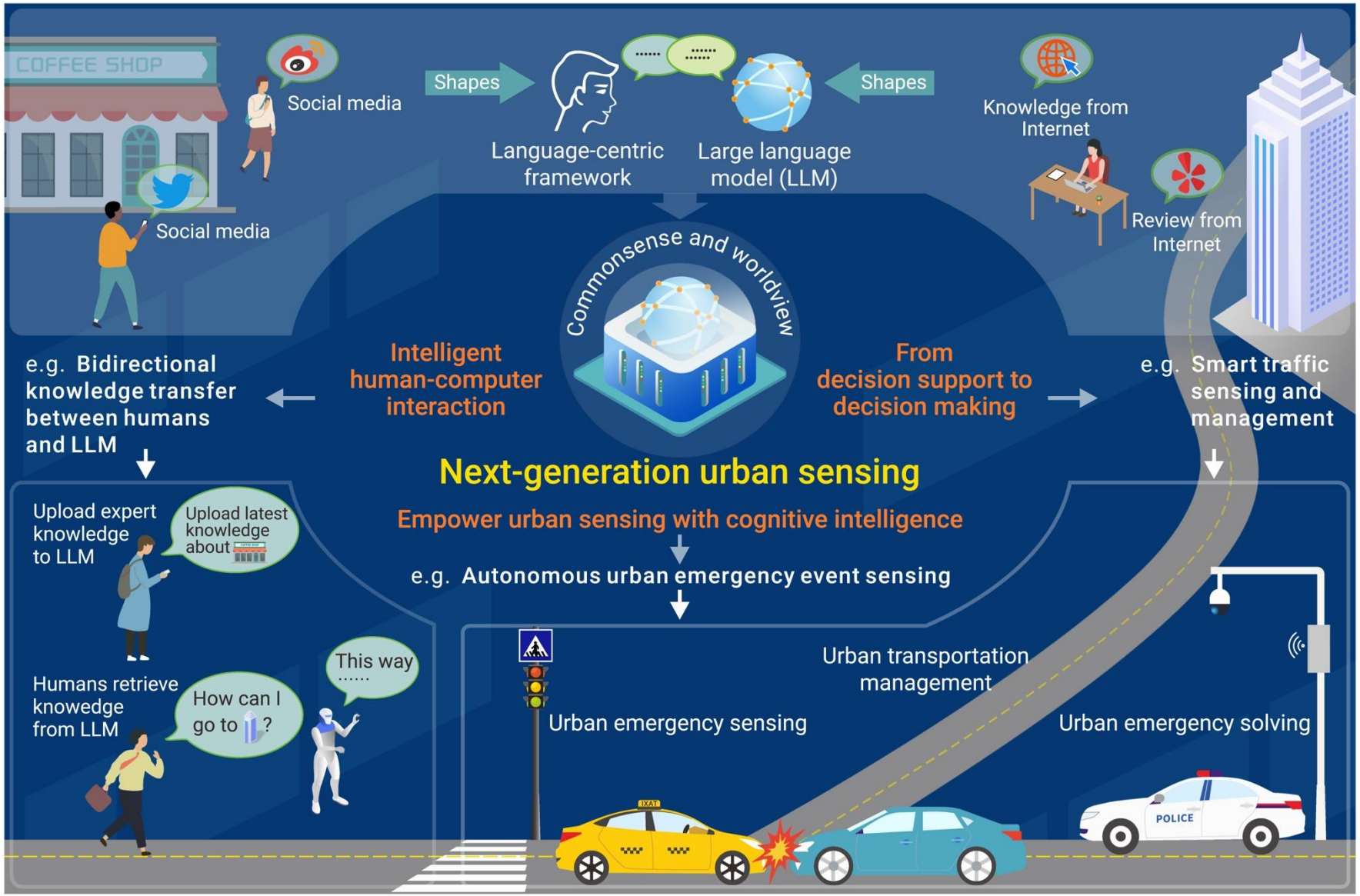
Opportunities



Hou, C., Zhang, F., Li, Y., Li, H., Mai, G., Kang, Y., Yao, L., Yu, W., Yao, Y., Gao, S. and Chen, M., 2025. Urban sensing in the era of large language models. *The Innovation*, *6*(1).

Challenges

1. Bias in training data and algorithms may lead to discrepancies between LLM and its idealized outcomes in human society

2. Lack of fine-grained spatiotemporal cognition

3. Challenges in capturing cultural and value diversity

Thank You!

Empower Future Smart Place with Human-centered Geospatial Data Science

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