



Spatial Intelligence for Urban Comfort

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Hi, I am Sijie Yang 😊

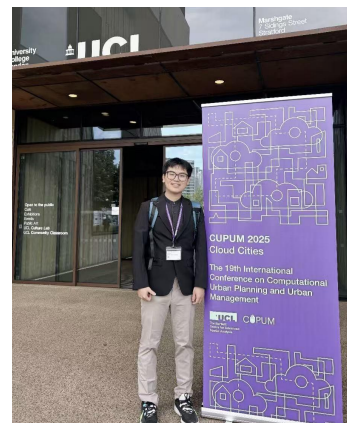
Undergraduate Certificate, Architecture (UC Berkeley, 2018-19);

Bachelor of Architecture (Chongqing Univ, 2016-21);

Master, Space Syntax (UCL, 2021-23);

Master, Computer Science (UPenn, 2022-25);

PhD Candidate, AI for Cities, Urban Comfort (NUS, 2023-present);



How to quantify difference between traditional Chinese imperial and private gardens?

Key conclusion: Traditional Chinese imperial gardens differ from private gardens in their culture-based spatial configurations, resulting in distinct interaction patterns and exploration experiences.

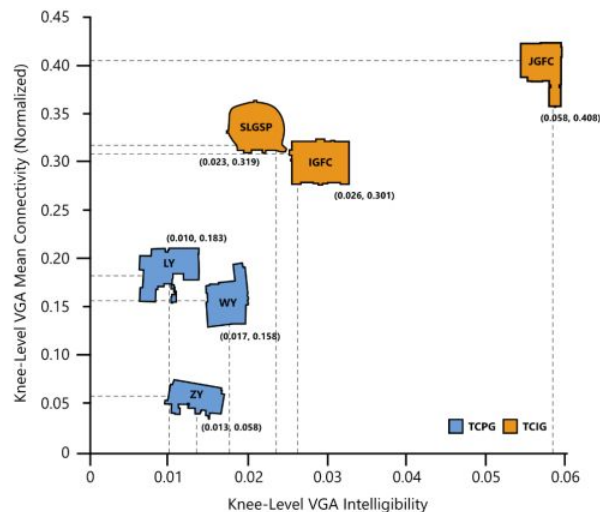
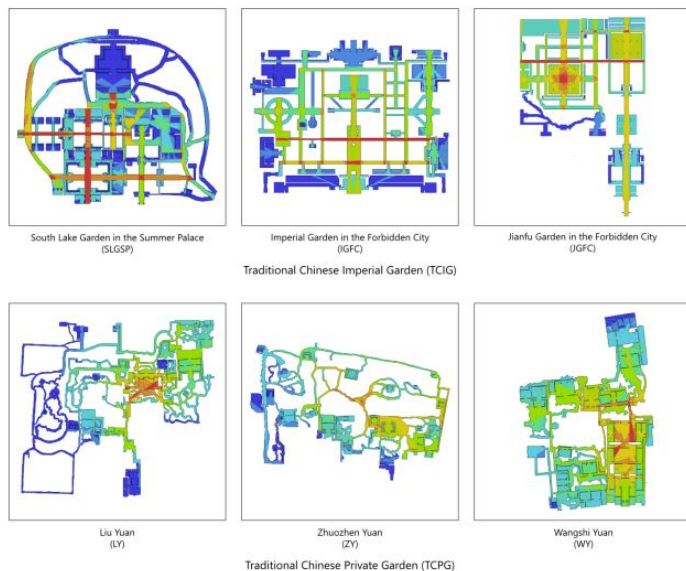
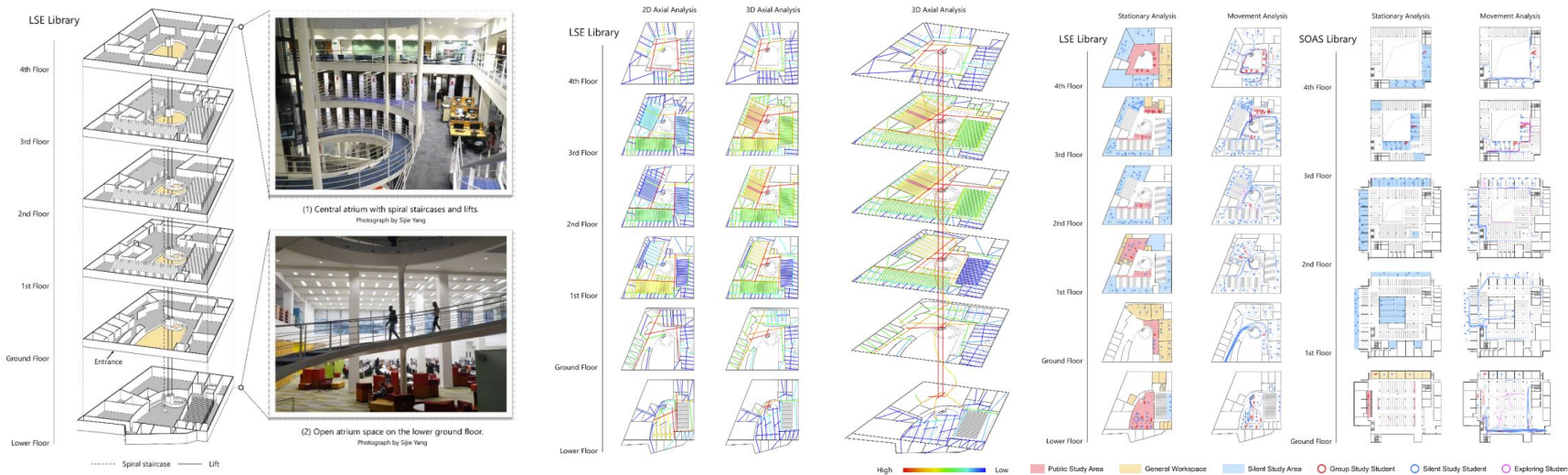


Figure 6. The matrix of three TCIGs' and three TCGPs' layouts, comparing their knee-level intelligibility and mean normalized connectivity.

Spatial configuration metrics —explain—> Cultural and spatial differences between garden types

Does atrium space have special social impacts in multilevel buildings?

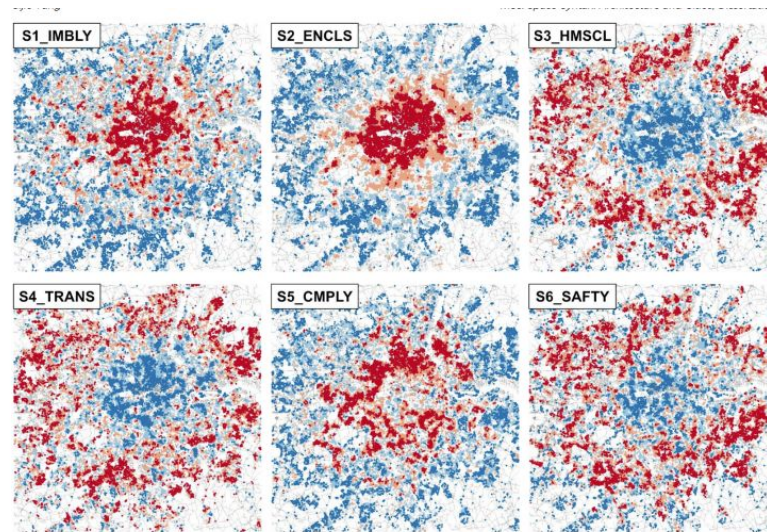
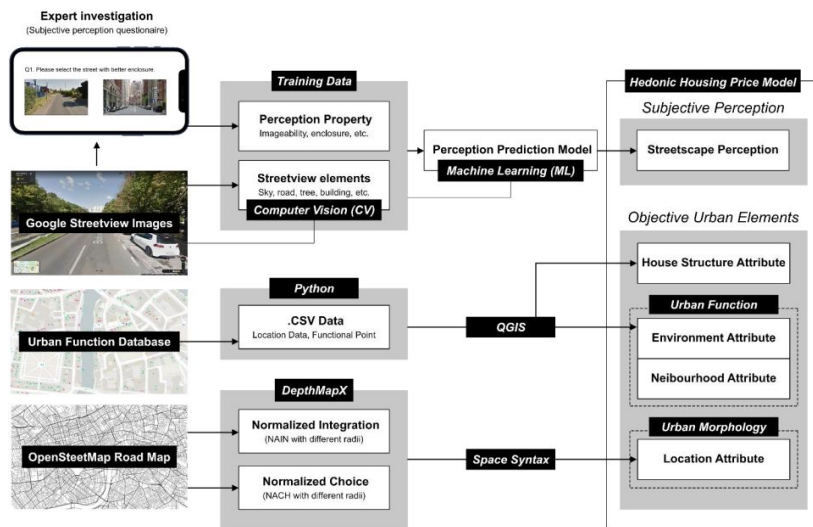
Key conclusion: Libraries featuring atrium spaces offer unique spatial configurations that enhance user engagement and interaction with their functions.



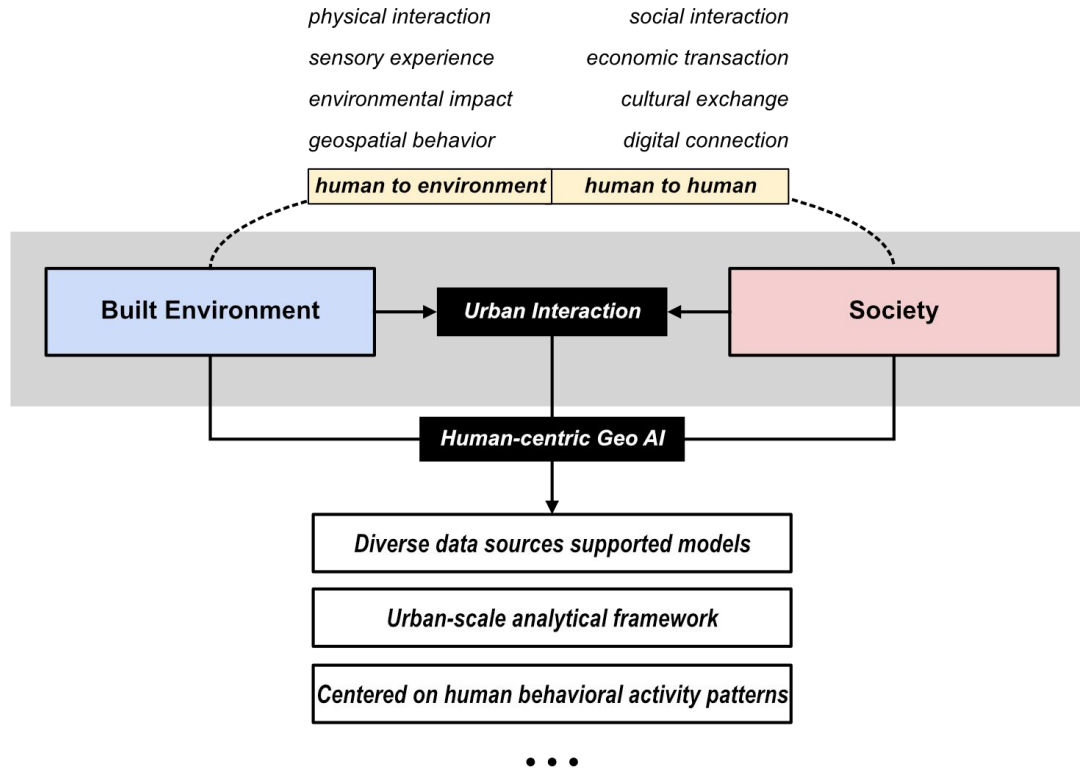
Library atrium space 3D spatial metrics + functions —correlate—> Social behaviour hotspots

How do streetscape perceptions impact house prices in multi-scale network?

Key conclusion: In the context of multi-scale urban morphology, subjective streetscape perceptions variably influence house prices, with more pronounced impacts observed in smaller blocks.



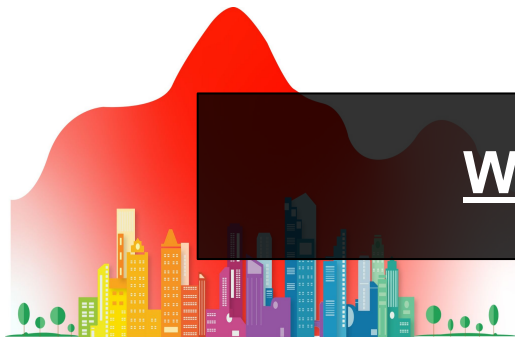
House condition + Streetscape perception + POI + Multi-scale network —modelling—> house prices



How does built environment shape society?

How can computation be applied?

What insights for design & planning?



We have to take actions.



*Climate crisis makes cities **uncomfortable**. Streets are **too hot to stay**.*

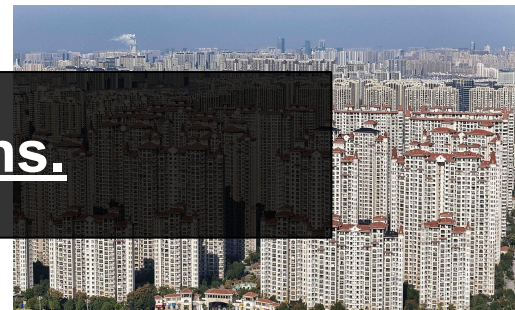
***Inequality** of comfort environment.*



*Poor **accessibility**.*

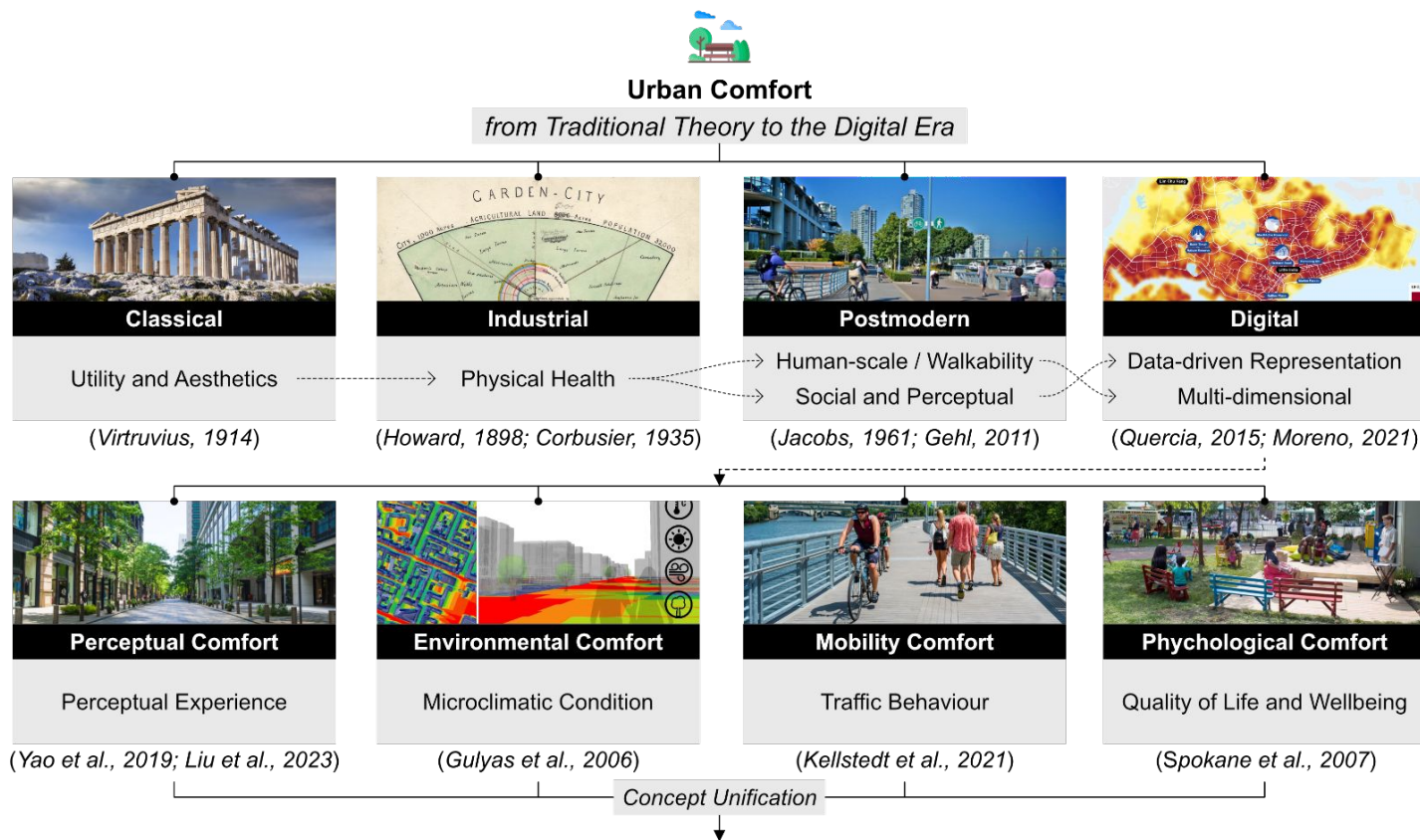


*Traffic **congestion**.*

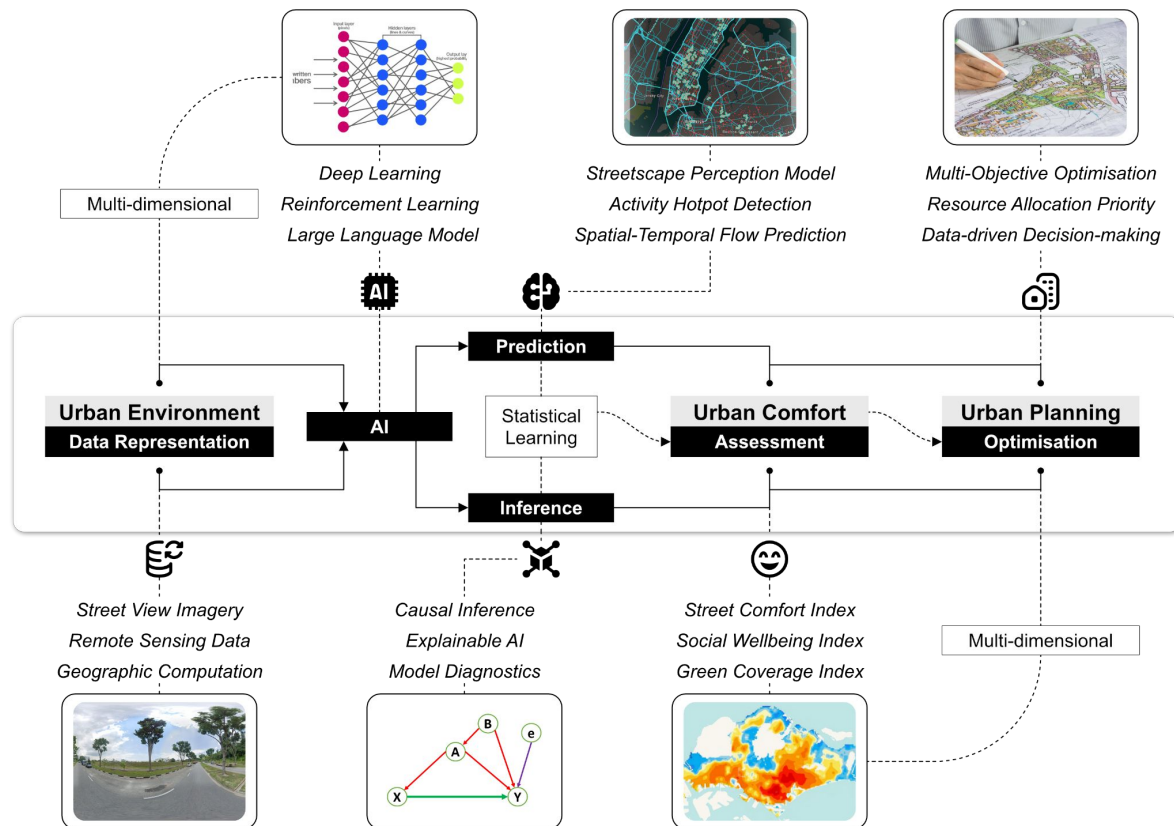


***High-density** housing.*

PhD Research Motivation: **Urban comfort** is no longer optional



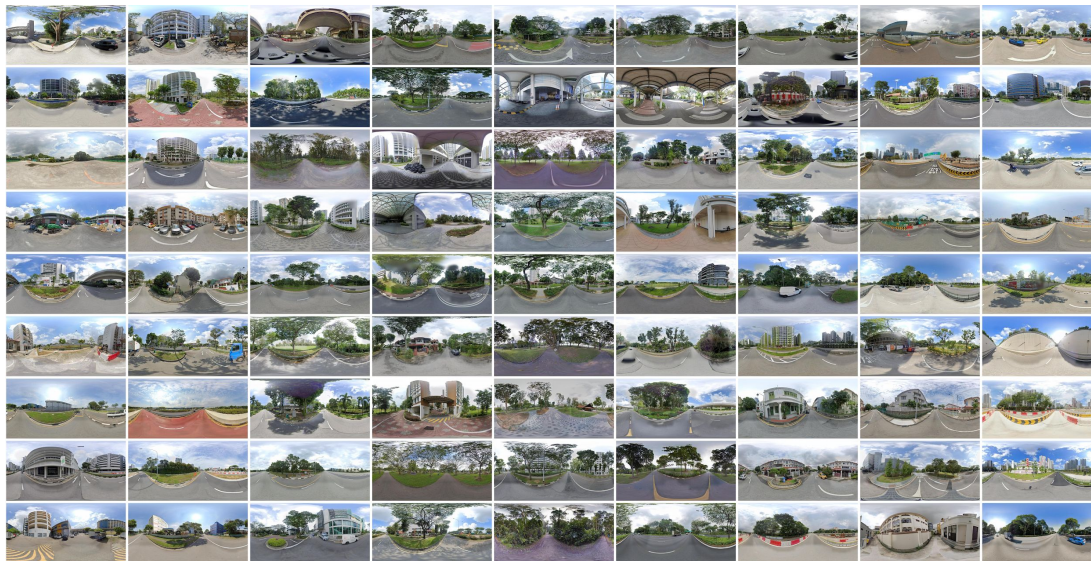
Urban comfort is a multidimensional concept —> Unifying and quantifying it with projects



Methodology: AI-driven urban comfort assessment and optimisation.

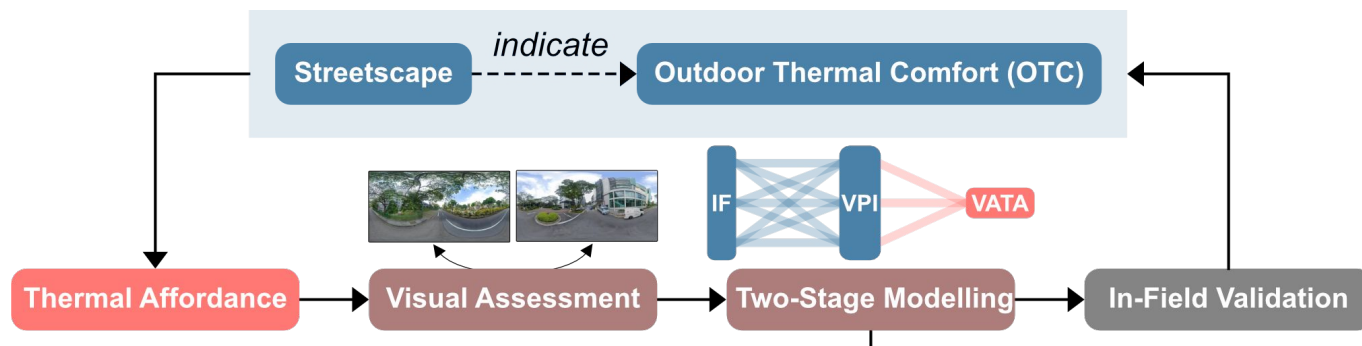
Thermal Comfort in Sight

Thermal Affordance and its Visual Assessment (VATA) for Sustainable Streetscape Design



Can SVI be an efficient way for thermal comfort evaluation?

Thermal Comfort in Sight



Thermal Affordance —*proxy*—> Outdoor Thermal Comfort

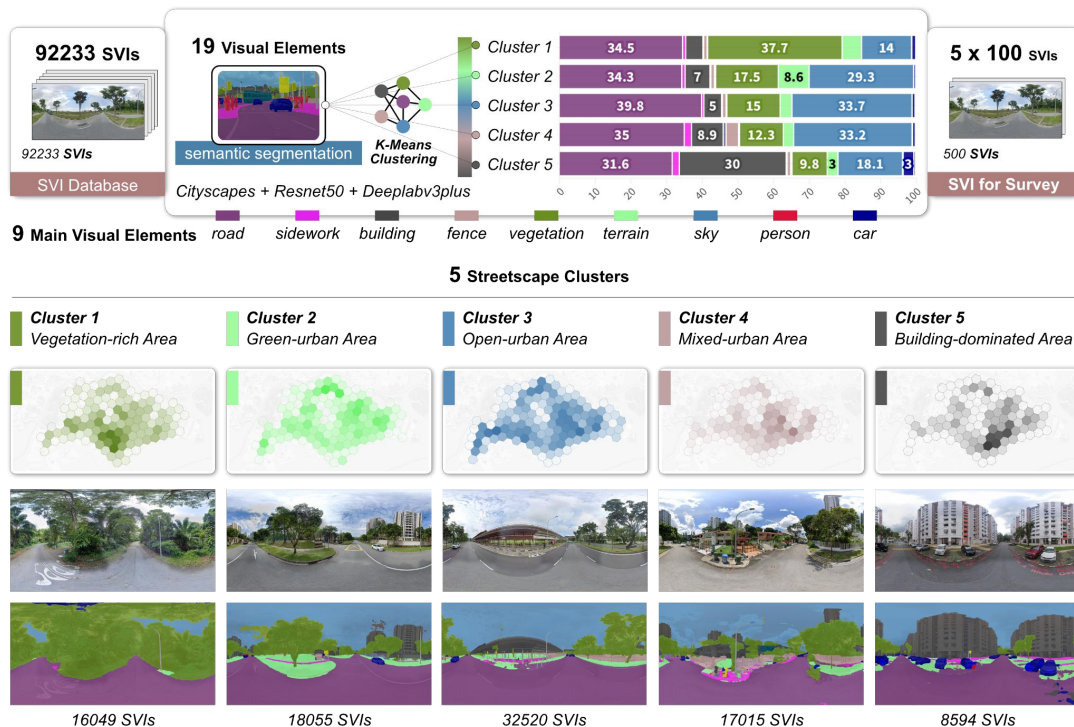
Visual Assessment Survey —*alternative*—> In-Field Comfort Survey

Modelling based on 500 SVIs

Scale-Up based on 92233 SVIs

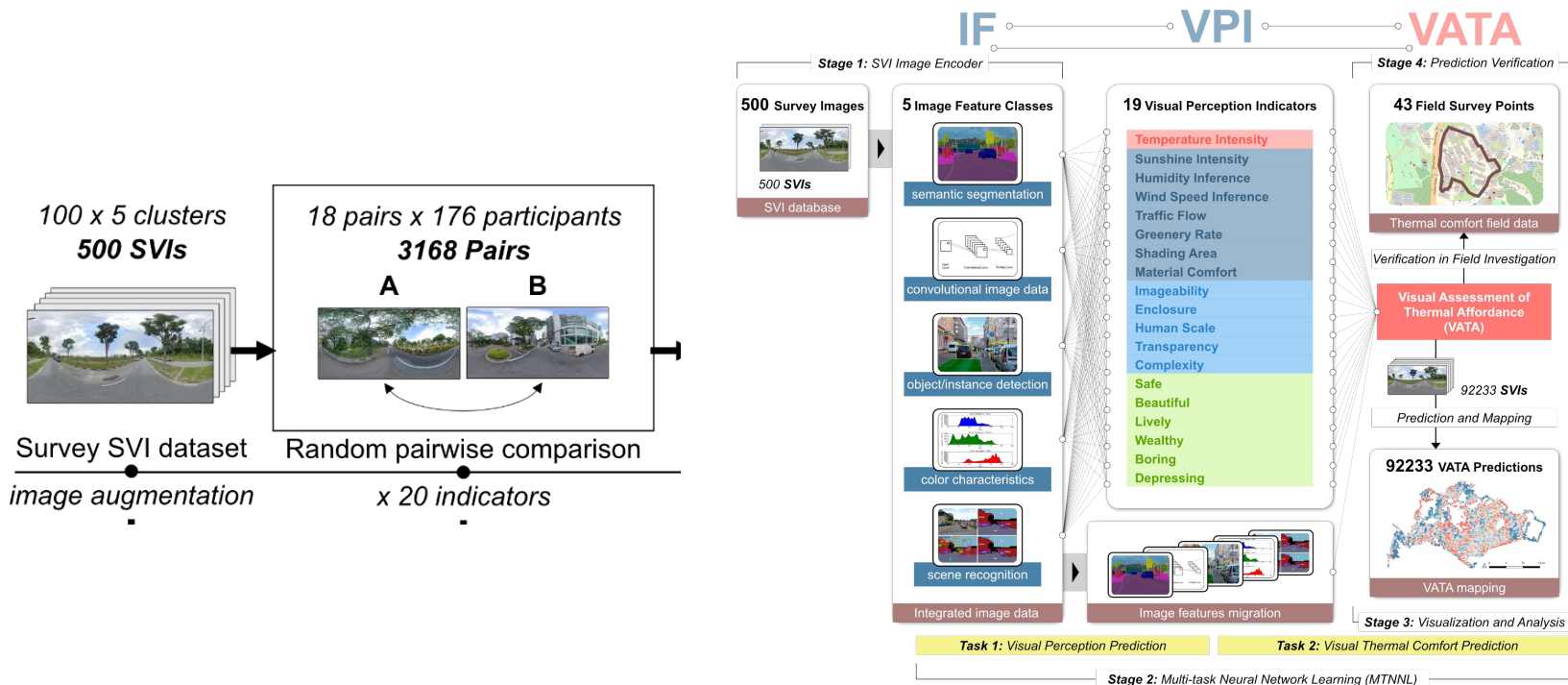
For urban design, explicit thermal comfort modelling may not be strictly necessary.

Thermal Comfort in Sight



Visual assessment survey ---> K-means classifies five types for 92233 SVIs and randomly select 100 SVIs each type = **500 survey images for survey**

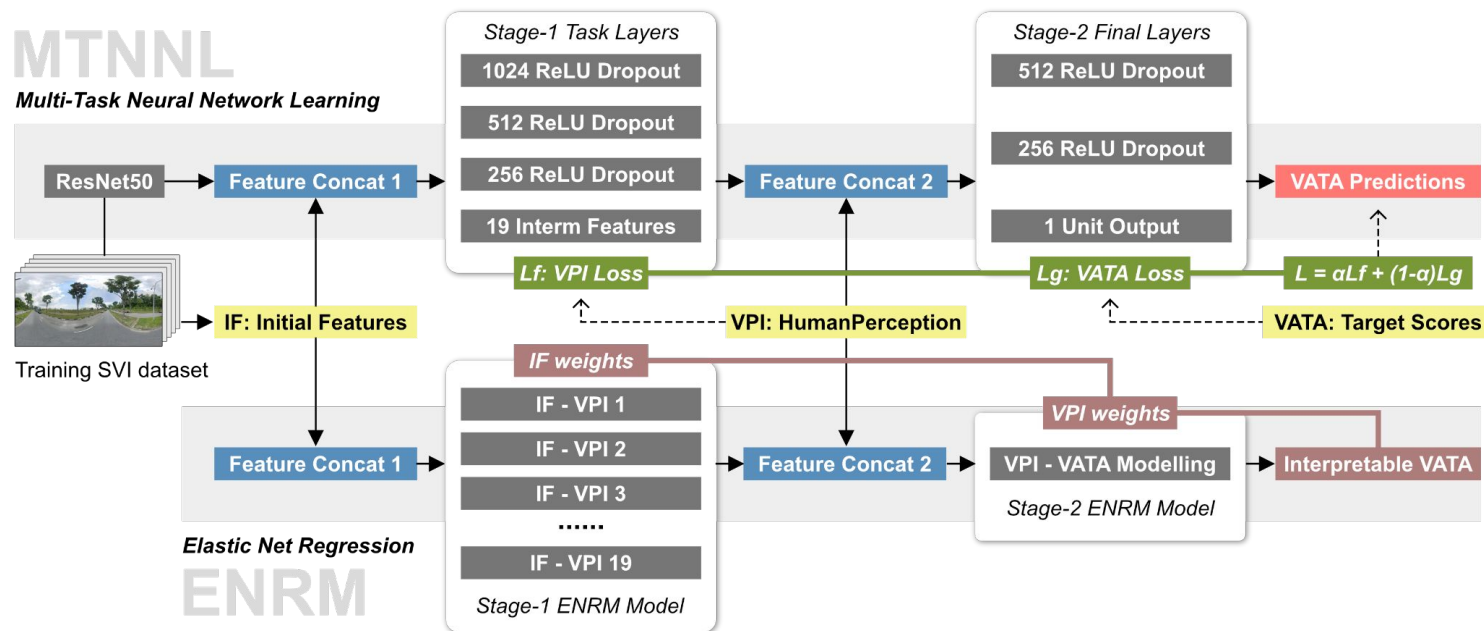
Thermal Comfort in Sight



Visual assessment survey ---> **Thermal affordance scores of 500 SVIs from 176 residents**

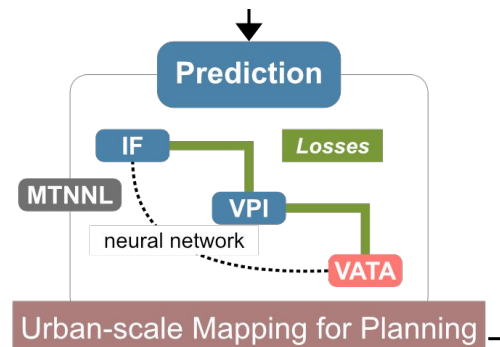
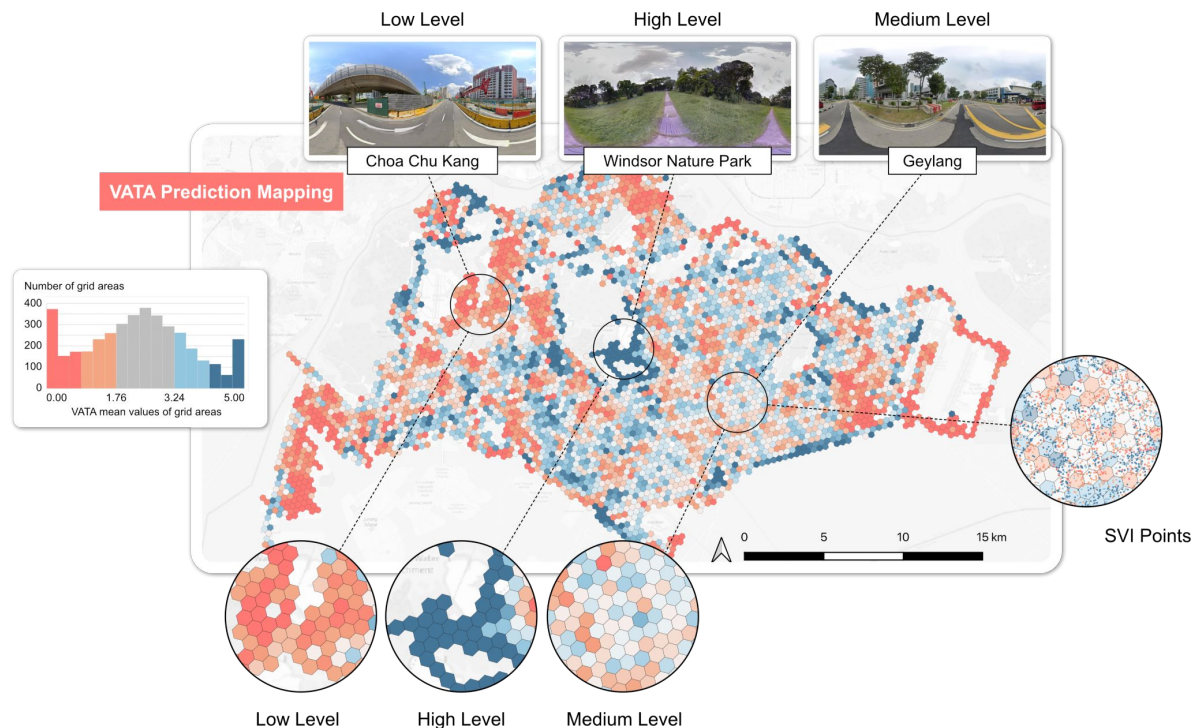
5 types SVI image features + 19 types perceptual scores + thermal affordance scores ---> **Model training**

Thermal Comfort in Sight



Multi-Task Neural Network — **Prediction**
 Elastic Net Linear Regression — **Inference**

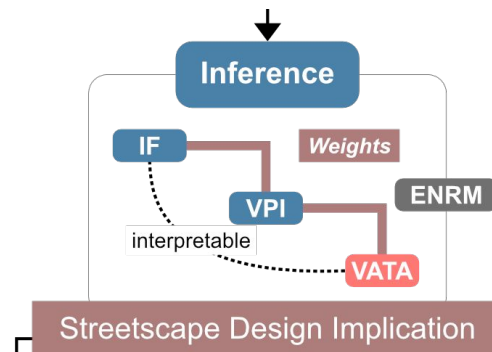
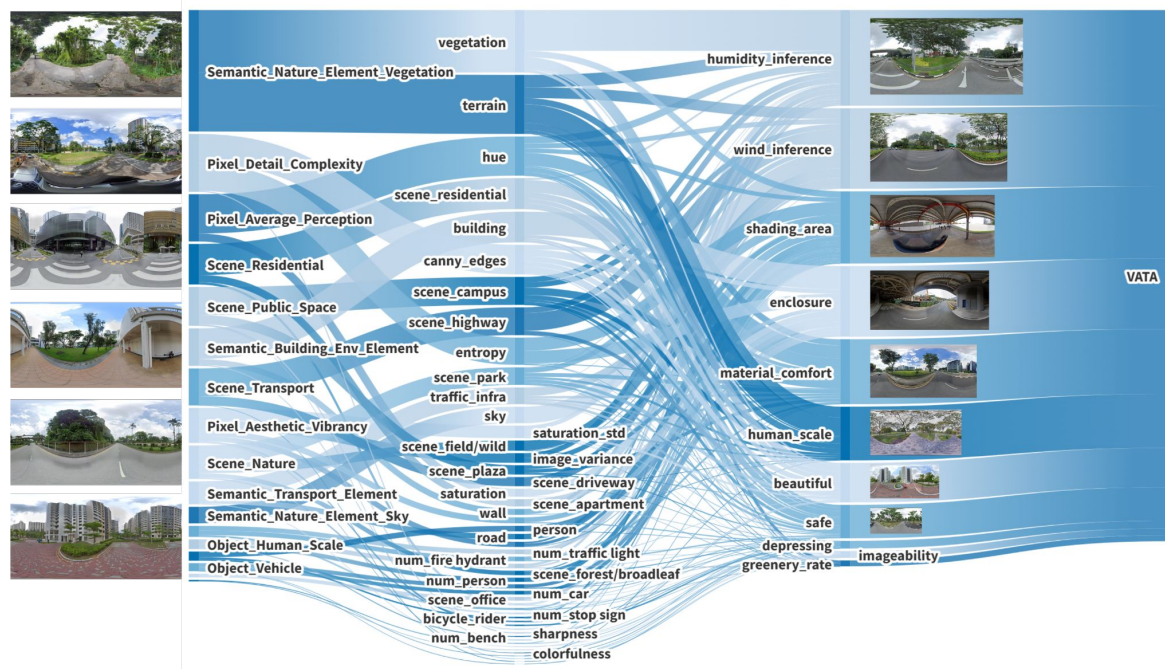
Thermal Comfort in Sight



Prediction (neural network)
model for predictions

Urban-scale thermal affordance mapping ---> provides macro insights to urban planners

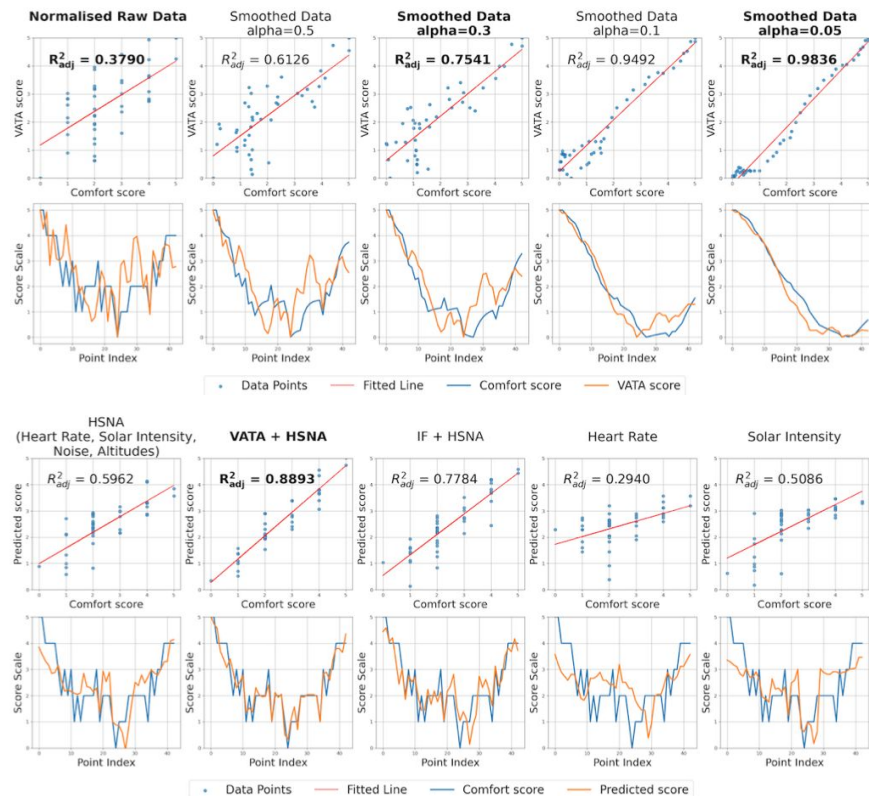
Thermal Comfort in Sight



Inference (linear model)
model for weights

Feature importance ranking ---> provides streetscape design insights to urban planners

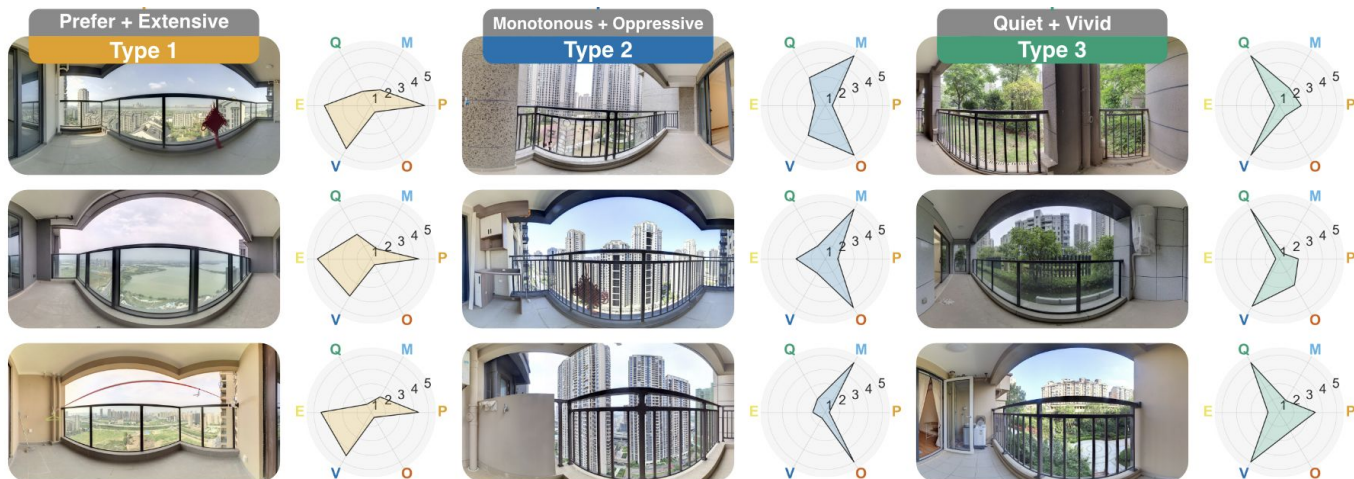
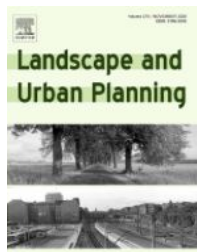
Thermal Comfort in Sight



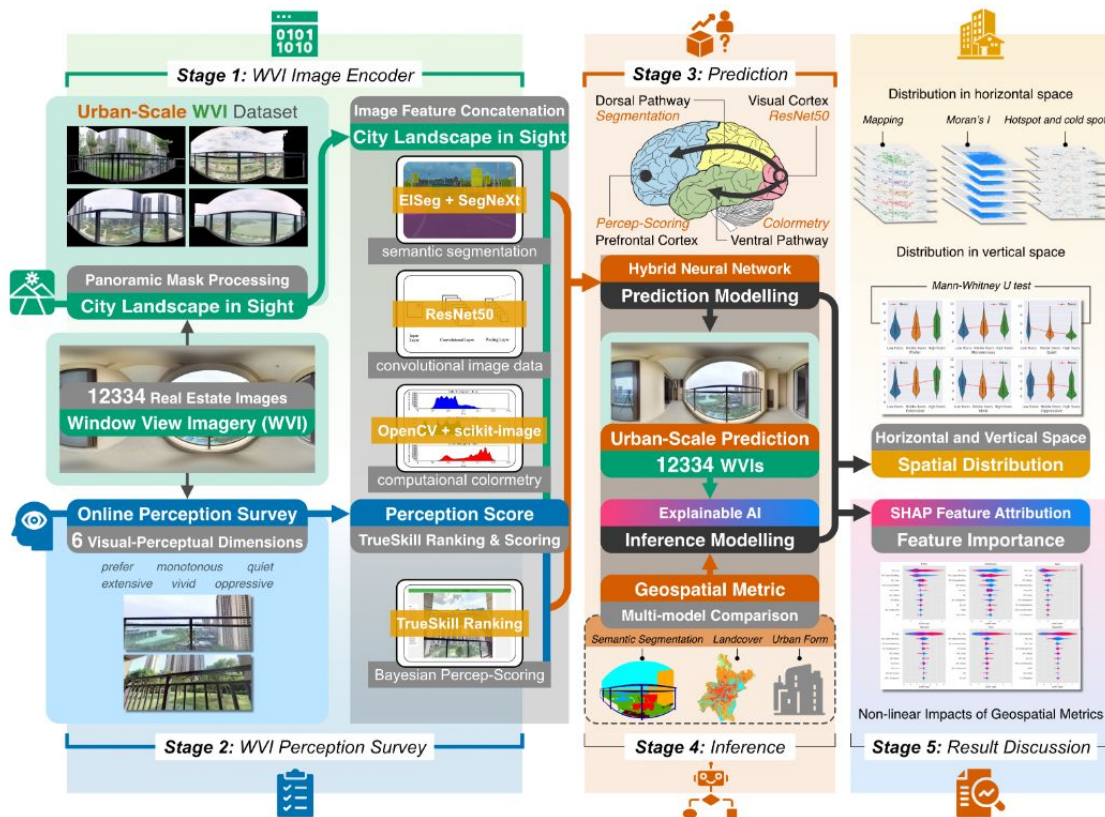
Field Survey Validation ---> visual elements can explain 37.9% of the comfort variance

City Landscape in Sight

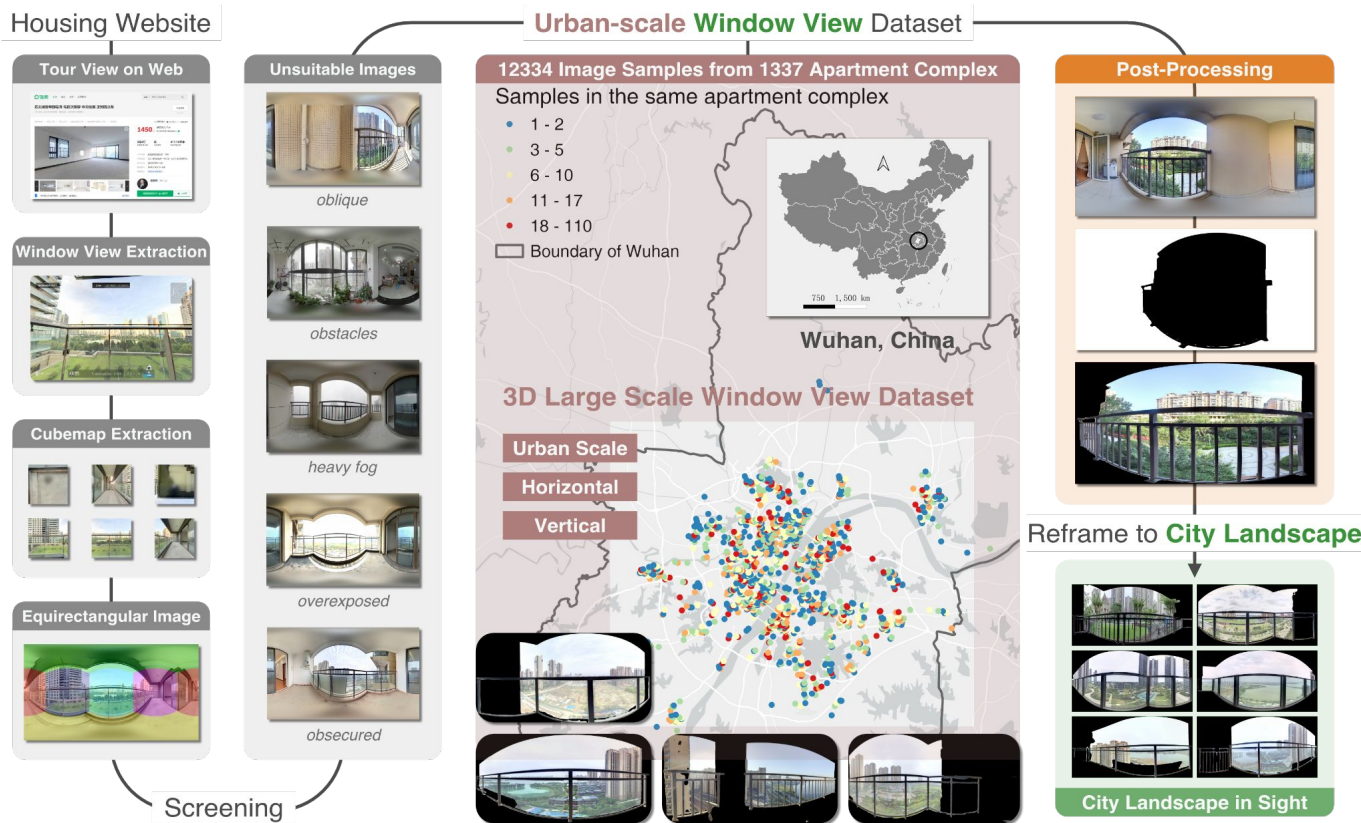
Mapping Subjective Window View Perception from Real Estate Images



What different urban comfort observation can we get from window view?

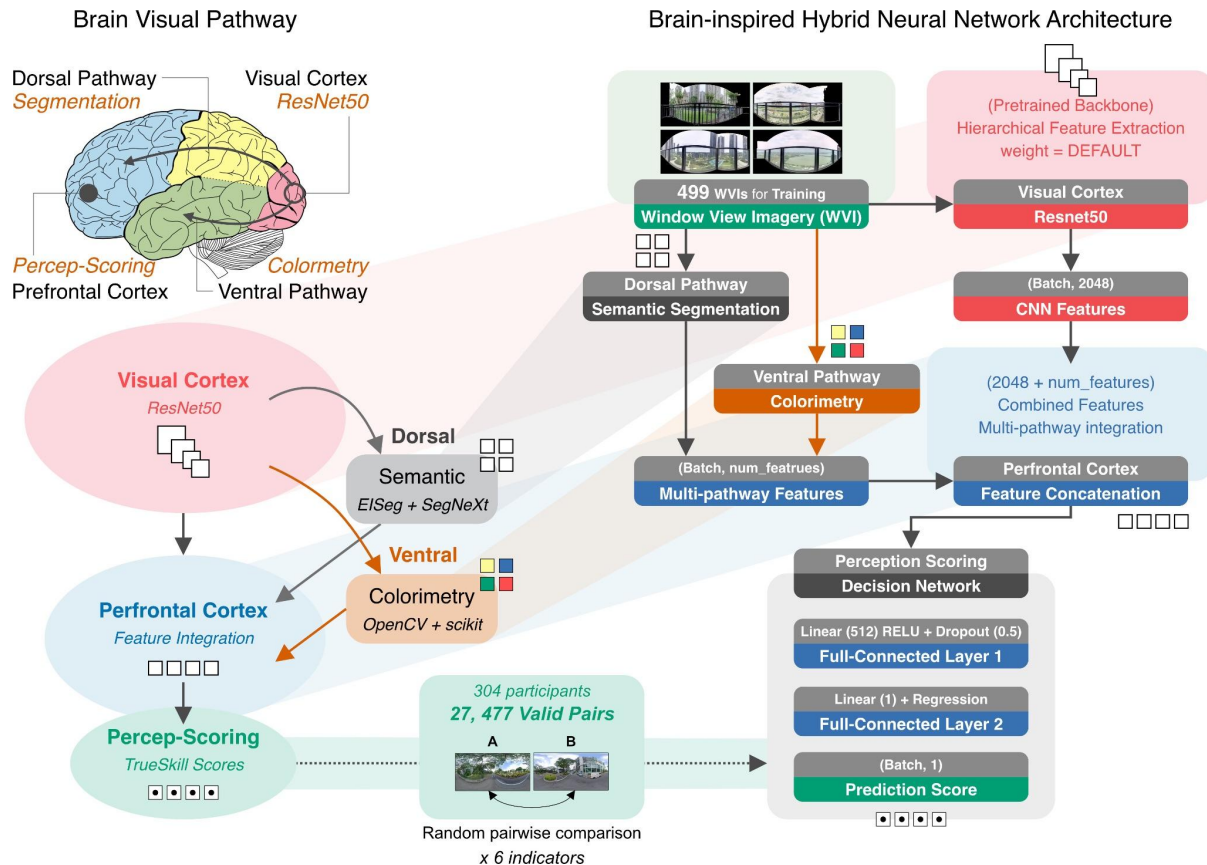


Urban-scale dataset ---> window view images from different floors and places in Wuhan
 Window view perception ---> understand people perception with 12k+ real window view images

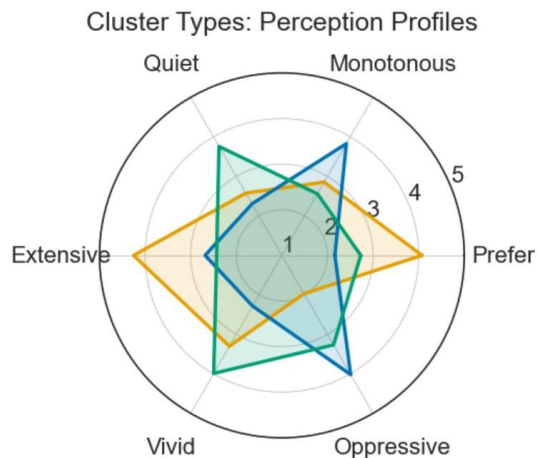


Urban-scale dataset ---> **window view images** from different floors and places in Wuhan

Window view perception ---> **understand people perception with** 12k+ real window view images



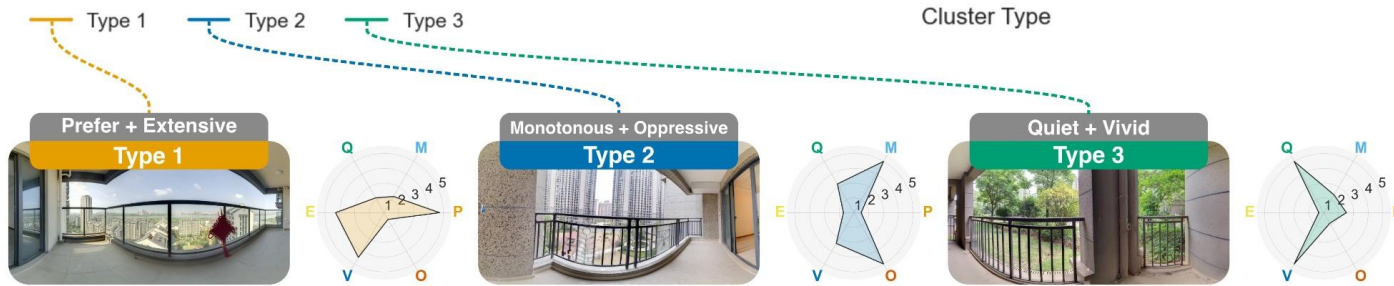
Computation ---> modelling perception following visual pathways in brain with 27477 pairwise visual assessment survey results from 304 participants



Mean Perception Scores by Cluster Type

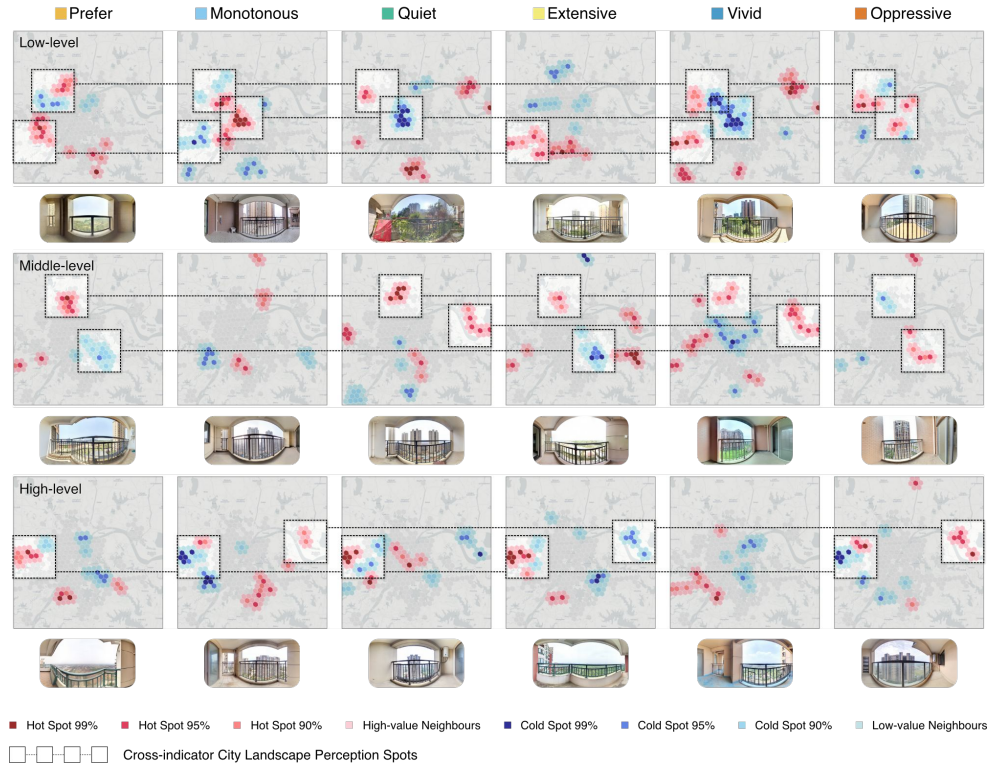
	Type 1	Type 2	Type 3
Prefer	4.07	2.16	2.73
Monotonous	2.86	3.83	2.56
Quiet	2.58	2.31	3.76
Extensive	4.25	2.68	2.43
Vivid	3.30	2.28	3.99
Oppressive	1.97	4.02	3.27
	Cluster Type		

Mean score (1-5)



Result ---> three types of window perception discovered: extensive, oppressive, quiet + vivid

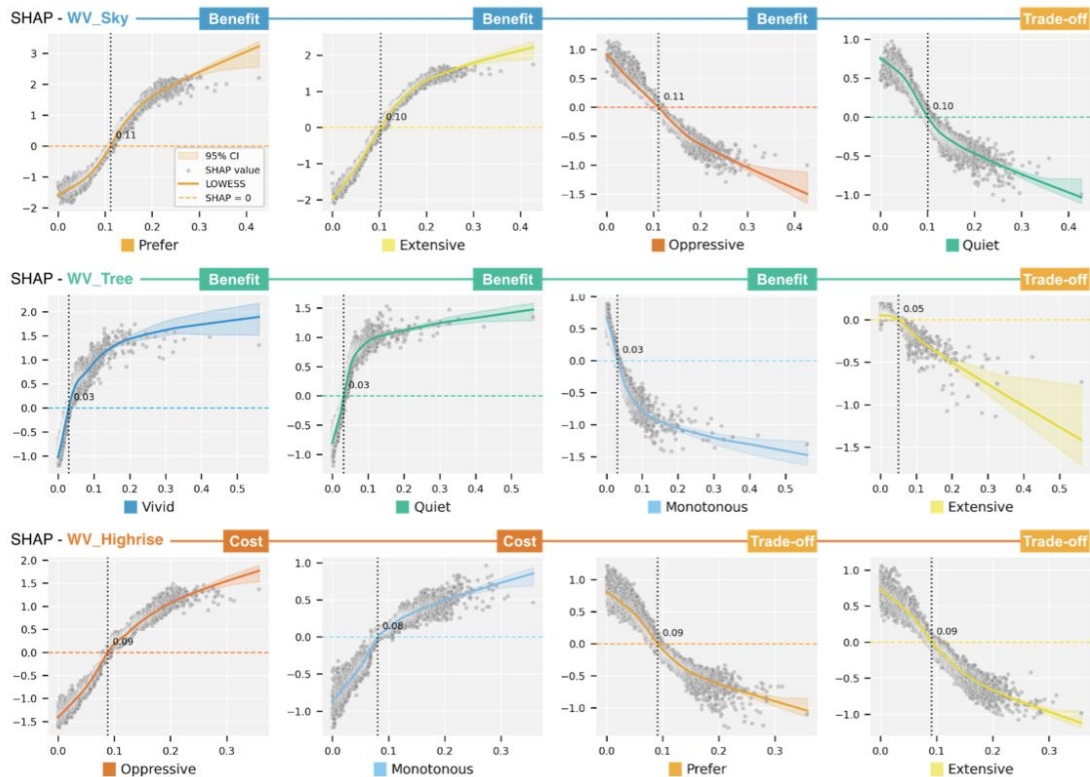
Hotspot & Coldspot Analysis for Window View Perception Indicators



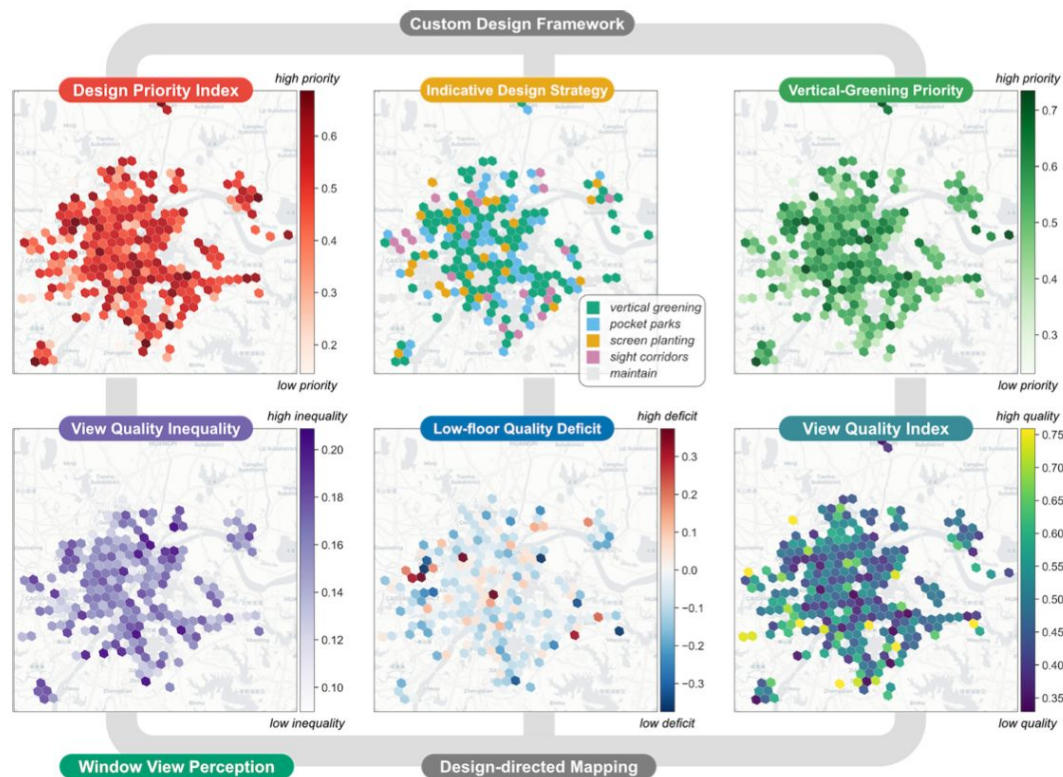
Result ---> high-level floors are better for prefer, extensive, less oppressive views

Result ---> different floors can have different urban-scale perception patterns

Non-linear Relationships Between Related Landscape Features and Window View Perception



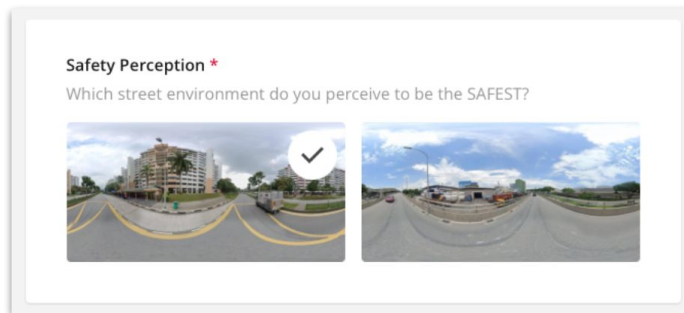
Result ---> non-linear trade off on city landscape elements



Result ---> [urban-scale](#) design strategies as references for urban planners

SP Survey

An Open-source Software Platform for Visual Assessment of Urban Environments



traditional custom urban visual surveys

- ❑ hard to deploy
- ❑ hard to design
- ❑ hard to reproduce



Technical Barriers: Web development skills are often required.

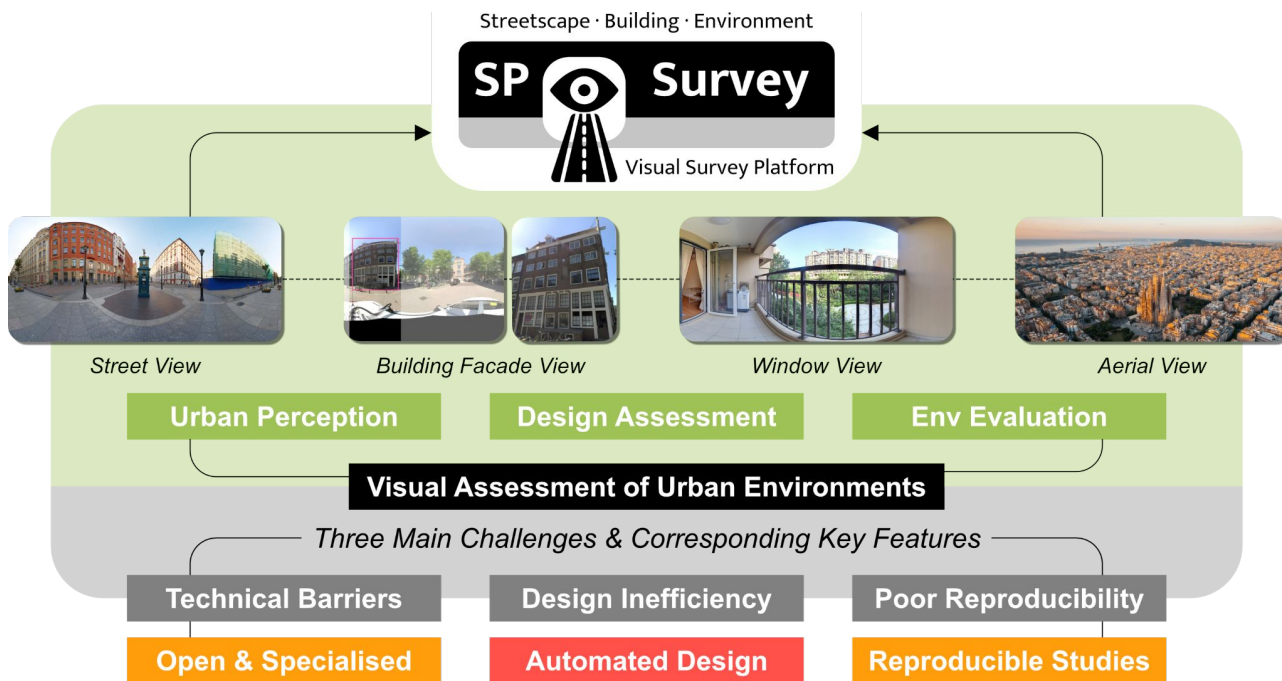


Design Inefficiency: Similar surveys are repeatedly built from scratch.

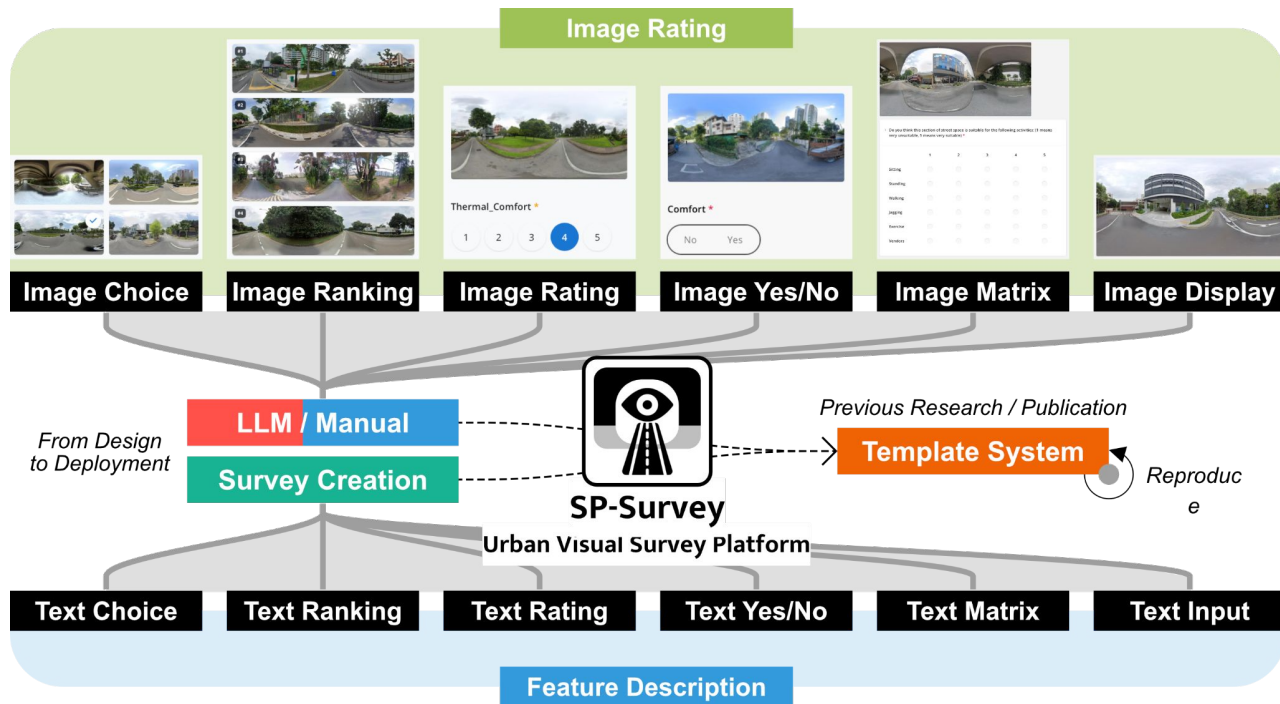


Poor Reproducibility: Survey workflows are difficult to reuse and replicate.

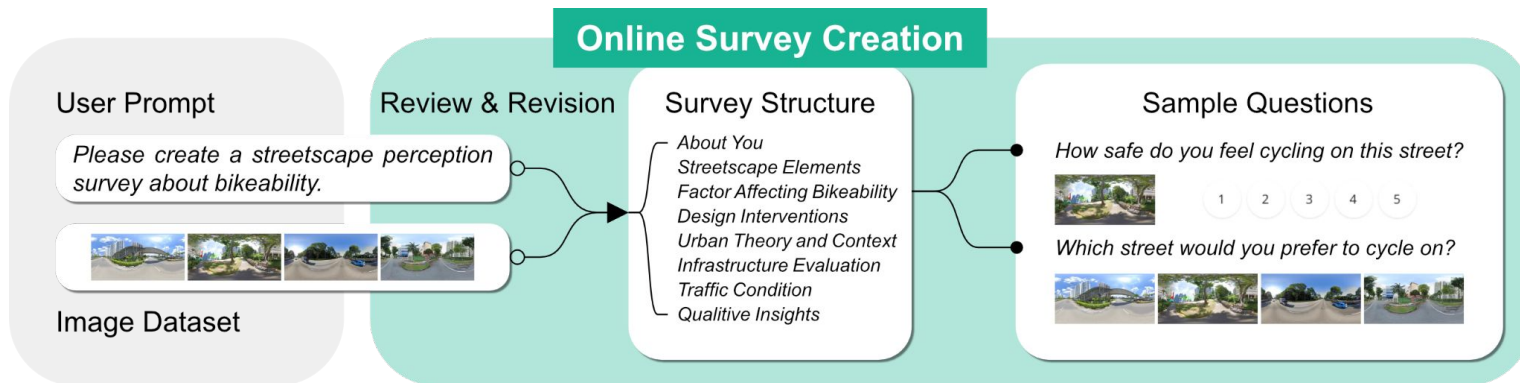
Key gaps in urban visual assessment surveys



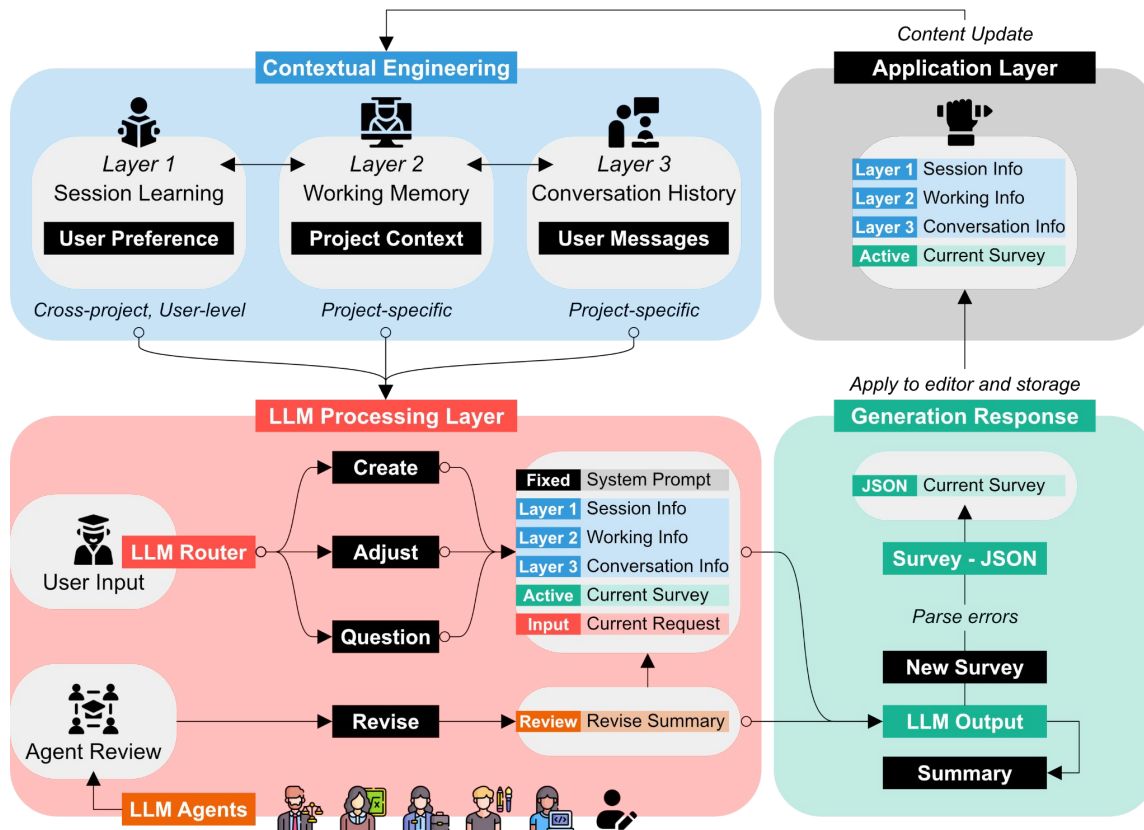
Motivation: Make urban visual surveys easier to design, deploy, and reproduce.



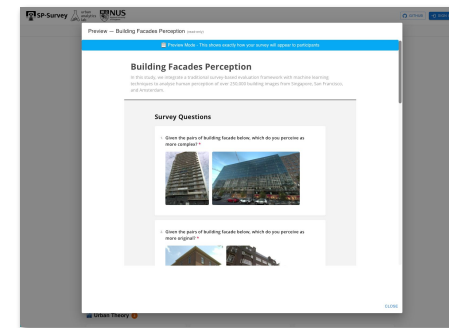
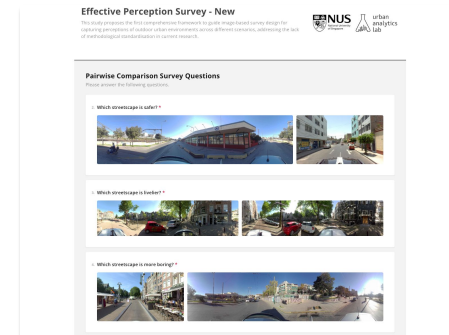
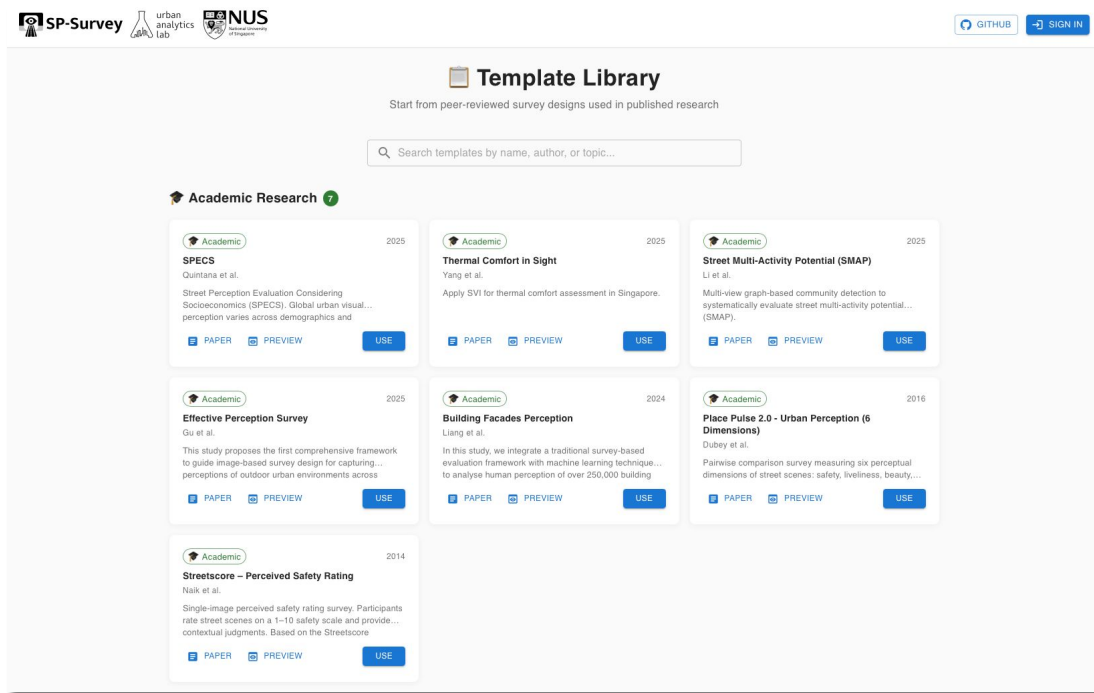
Multiple types of image-text questions for urban visual survey.



Auto-generate a complete urban visual survey with your prompt to LLM and image dataset.



Create and revise your survey with [LLM agents](#).



Replicate prior studies with [preset survey templates](#).

Streetscape · Building · Environment



Visual Survey Platform

Streetscape Perception Survey

A research-grade platform for conducting visual perception surveys on urban streetscapes.

No coding required — build, share, and analyze in minutes.

[START FOR FREE →](#) [READ PAPER](#)

SP-Survey Effective Perception Survey - New

Projects

Project Templates

- ART - Restorative Streetscape Perception
- Building Facades Perception
- City Landmark (AI Generated)
- Effective Perception Survey
- Gen1 - Street Quality Criteria (12 Quality Criteria)
- Place Pulse 2.0 - Urban Perception (6 Dimensions)
- Scenic Beauty of Outdoor Places
- SPICS
- Street Bleakability (AI Generated)
- Street Multi-Activity Potential (SMAP)
- Streetscape - Perceived Safety Rating
- Thermal Comfort in Sight
- Urban Greenery (AI Generated)

My Projects (1)

Effective Perception Survey - New

STEP 1 - IMAGE DATASET

Image Dataset

Upload images to Cloudflare R2. They will be served to survey participants. Huggingface batch import is available as an optional tool.

30 Images in R2 Last upload: 20/05/2024, 17:18:52

Import Template Images

This project was created from Effective Perception Survey, which ships with 90 images. Copy them into this project so the survey can run out of the box — existing files in your project folder are kept unchanged.

Import Images from Template

Upload Images to Cloudflare R2

Select image files to upload to Cloudflare R2. Images over 300 KB are automatically compressed in your browser before upload.

Choose Image Files

Upload to R2

Uploaded Images (preview — first 10):

... and 80 more images

Clear All Images

Huggingface Dataset Import (Optional)

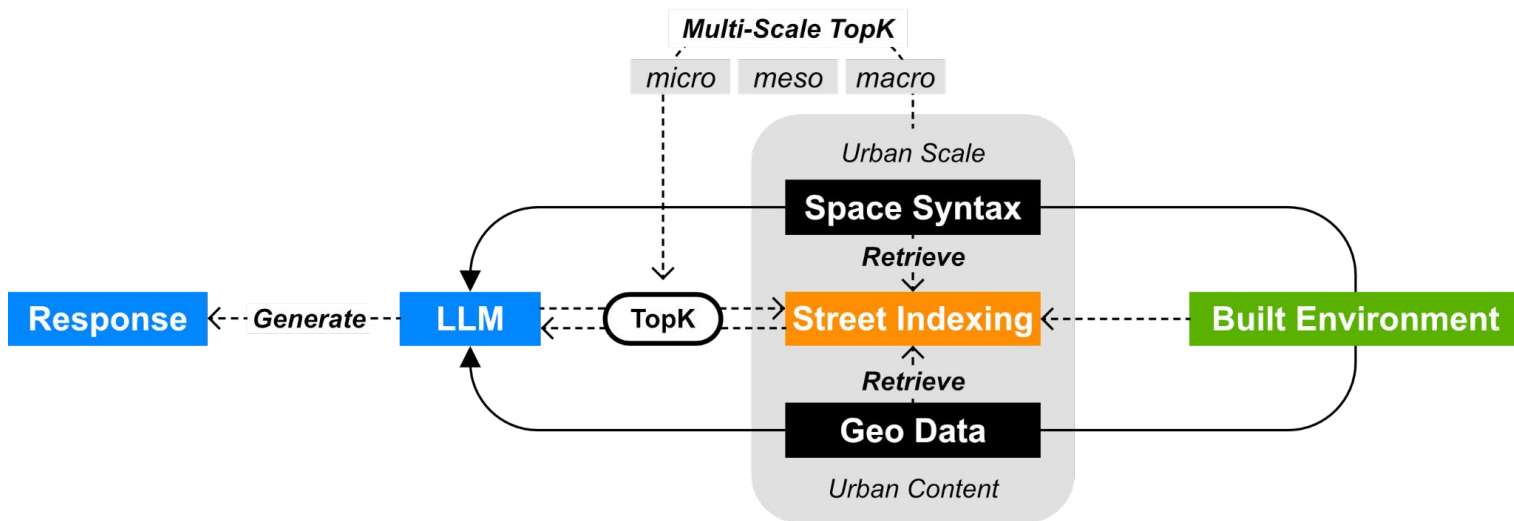
Batch-import images from a Huggingface dataset into Cloudflare R2

Create your urban imagery survey in minutes.

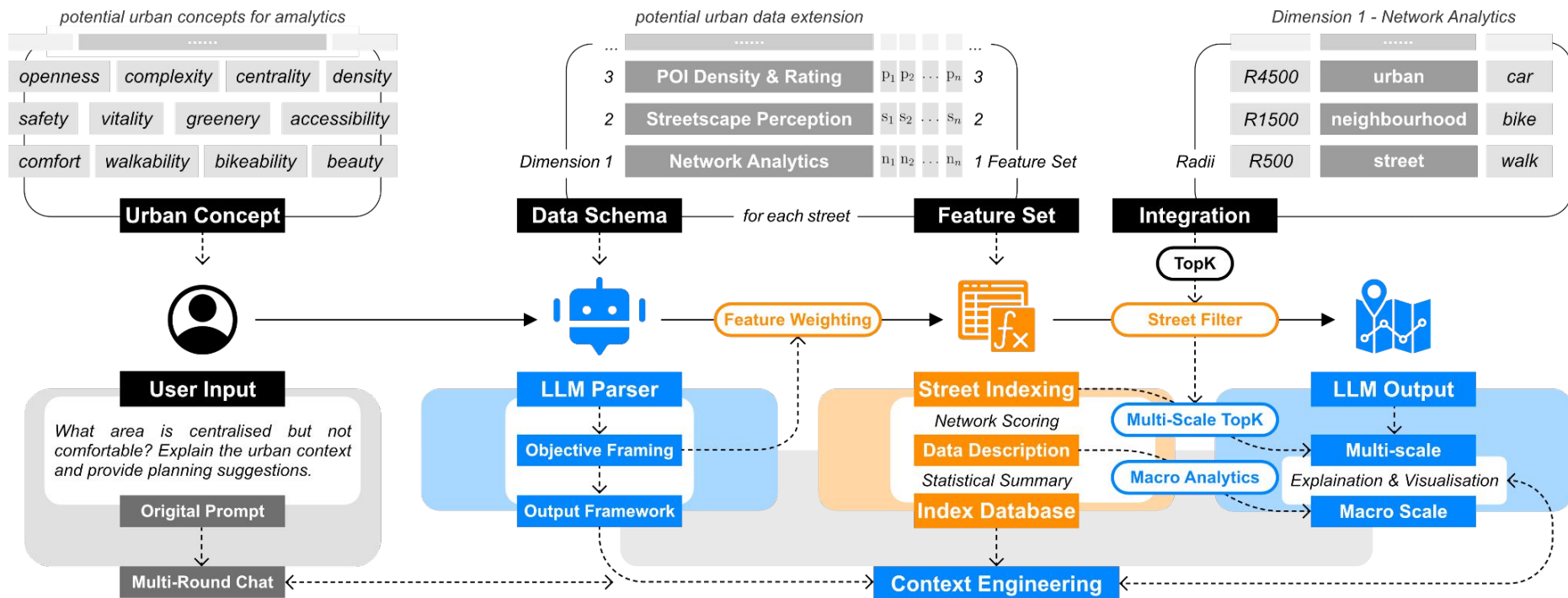
SP-Survey is now online: sp-survey.org.



StreetRAG-Index: Concept-to-Index Retrieval-Augmented Generation over Urban Street Networks



Can LLM understand street network? We need a street memory framework.

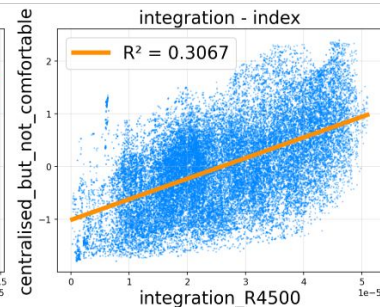
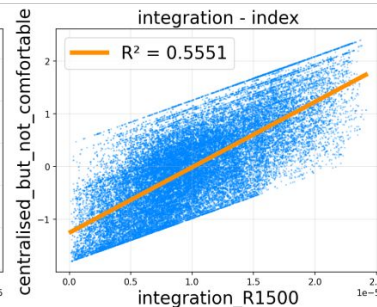
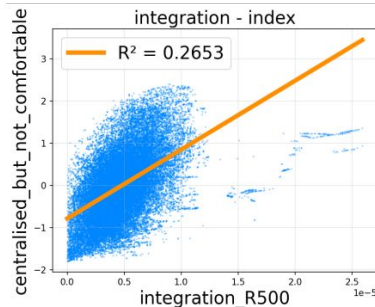


Link urban concept with geospatial data a **street-based LLM memory framework**.

1

What areas are **centralised but not comfortable**?

Composite Index: centralised_but_not_comfortable
(range: -1.566180 to 1.933417)

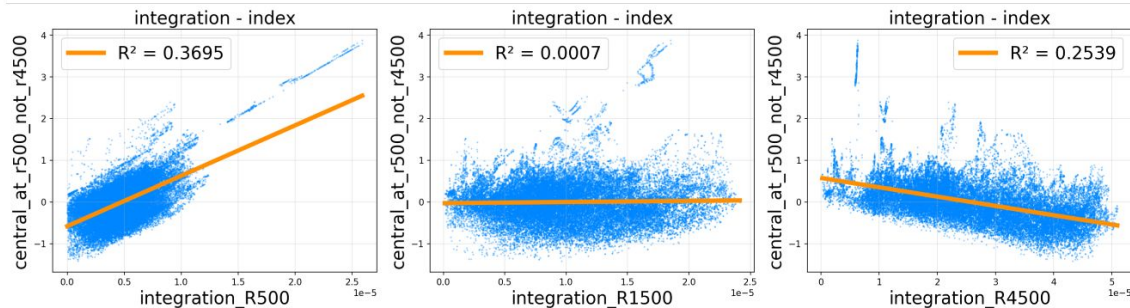


Query to LLM Example 1: Urban Comfort Assessment

2

What areas are **central at R500 but not central at R4500**?

Composite Index: central_at_r500_not_r4500
(range: -0.977420 to 1.582302)

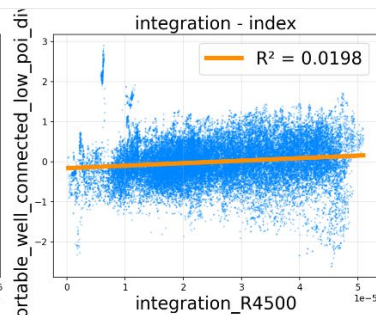
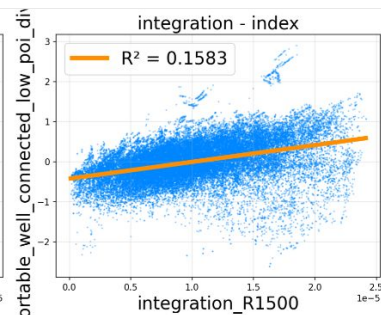
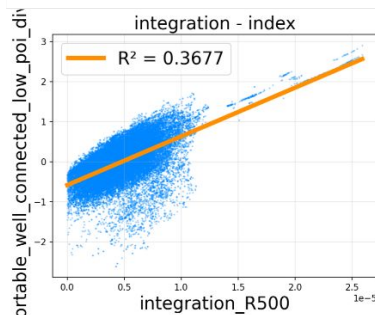


Query to LLM Query Example 2: Urban Centrality Assessment

3

What areas are areas are **comfortable and well-connected but lack POI diversity?**

Composite Index: comfortable_well_connected_low_poi_diversity
(range: -1.300081 to 1.230796)

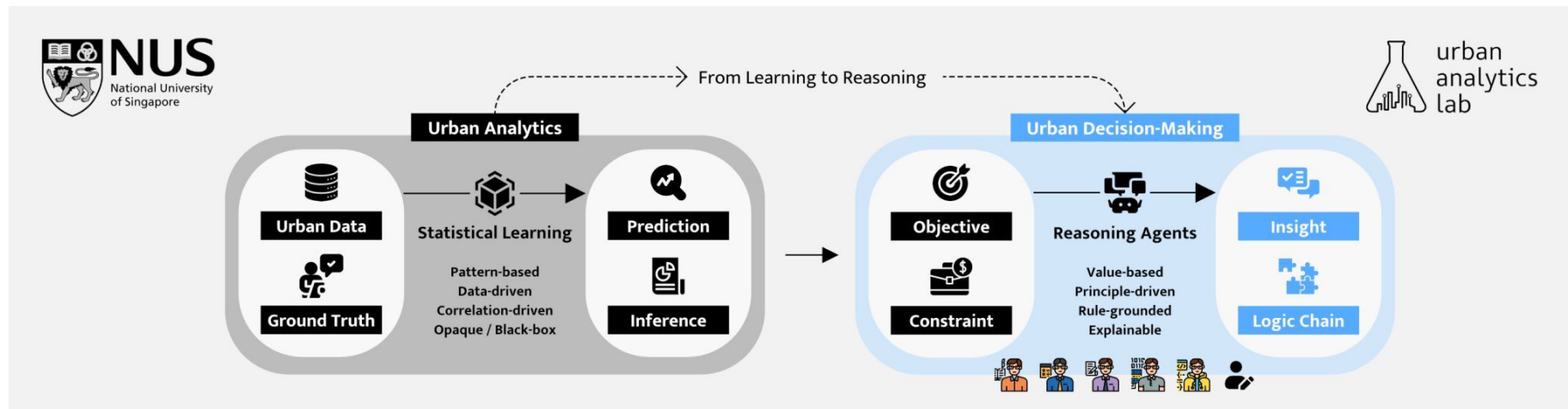


Query to LLM Example 3: Comprehensive urban assessment query

Reasoning is All You Need for Urban Planning AI

A benchmark for urban planning reasoning era, applying LLM agents for urban planning.

Six parts: analysis, generation, verification, evaluation, collaboration, decision.



Reasoning is All You Need for Urban Planning AI

A benchmark for urban planning reasoning era, applying LLM agents for urban planning.

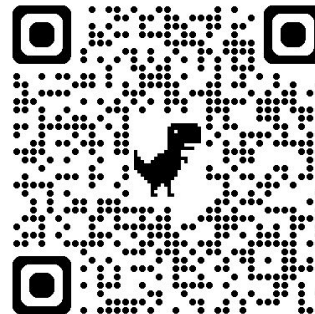
Six parts: analysis, generation, verification, evaluation, collaboration, decision.



Thank you for listening 🙏

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