

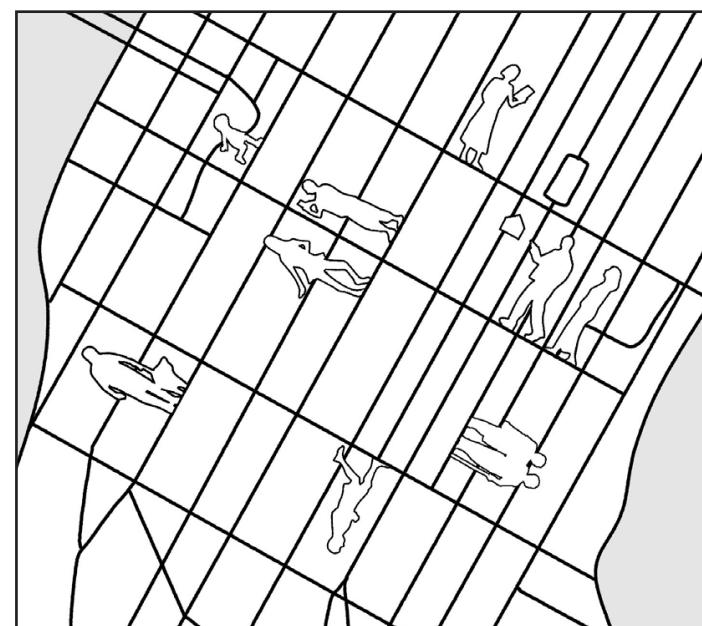
**Human**

**x**

**Computational Design**

**x**

**Urban**



**Xuexin He**  
Selected projects

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Email: 18920451075@163.com

I want to propose a new paradigm  
**for interaction and mutual improvement between individuals and the city,**  
fostering a healthy human-city ecosystem in the future.

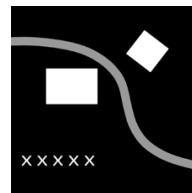


### Puppy Connector

----02-09

Prototype design, Hardware, Machine Learning

A Wearable Device linking Pets, Owners, and Cities, for Pet-Friendly Cities

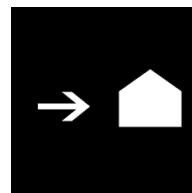


### Text Garden

----10-16

Multimodal machine learning

Generate Semantic Garden Plans from Texts to Preserve the Heritage

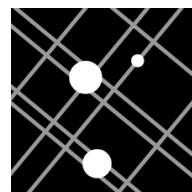


### AI Housing Agent

----17-21

Programming, Large language modeling

An AI Agent that helps Itinerant Workers find Affordable Housing



### Street Diversity Recognizer

----22-27

Urban data, Image classification, Web design

Obtain the Activity Diversity of Crowds to Guide Urbanization

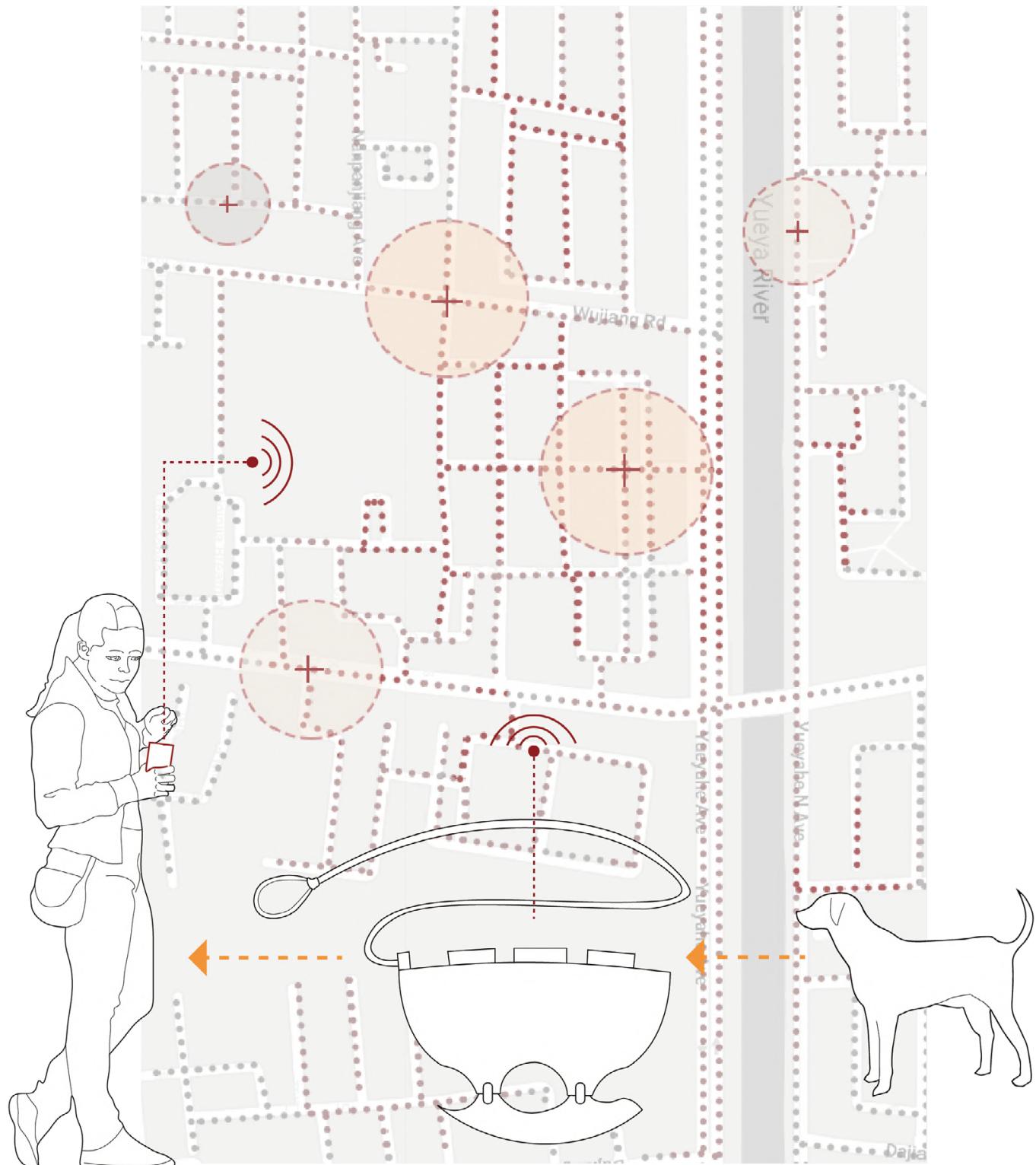


### Other works

----28-29

Parametric architectural design, Style migration machine learning

Neighborhood shared space design, neighborhood façade style migration



## Puppy Connector

A Wearable Device linking Pets, Owners, and Cities, for Pet-Friendly Cities

[TIME]

2023.7-2023.9

[INSTRUCTOR]

Xun Liu, Jieyu Zhou

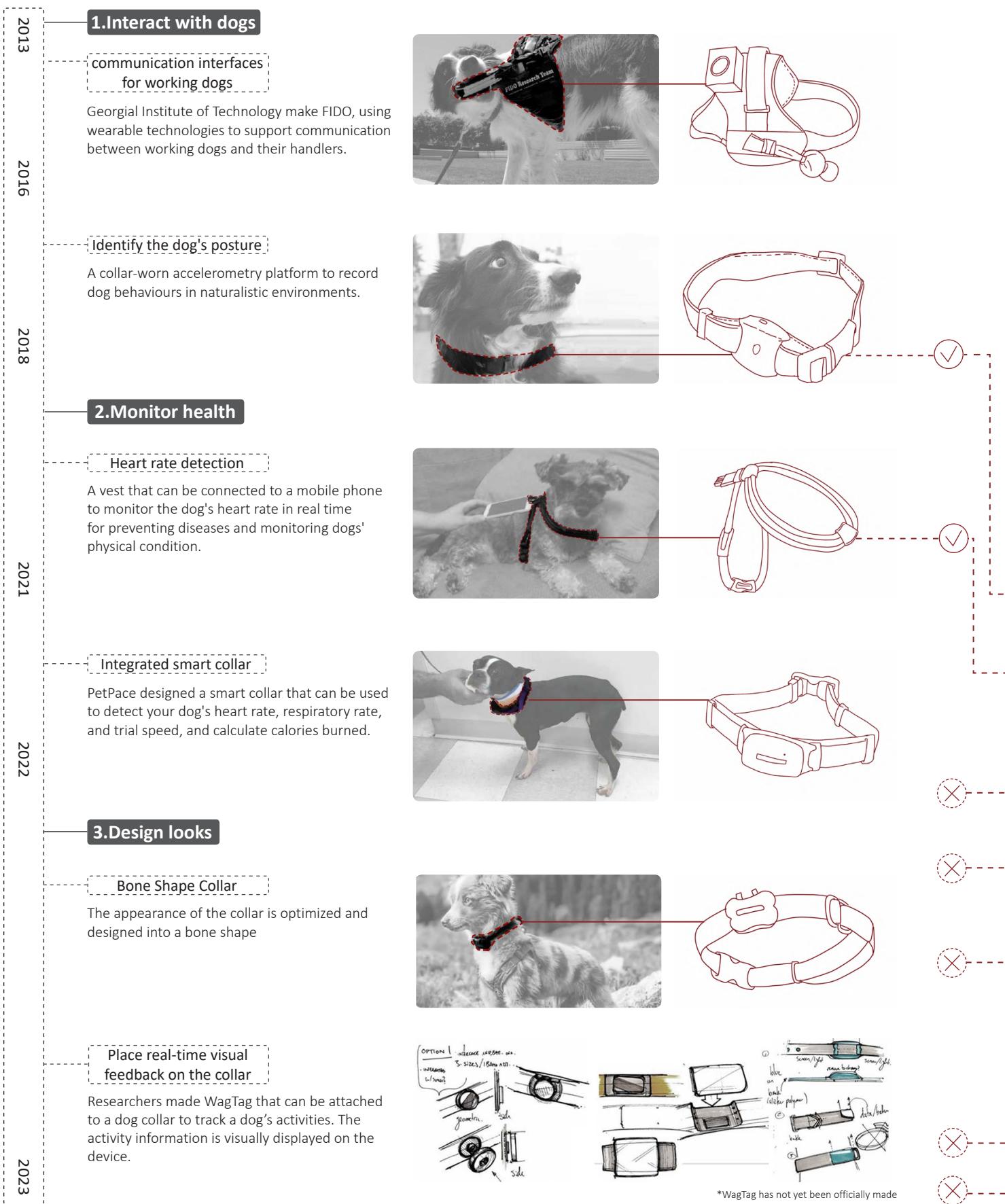
[INDIVIDUAL WORK]

The project was **inspired by my personal experience** that Chinese cities generally lack dog walking parks, so you can only walk your dog on city streets. The **pets are more sensitive to city environment** than people, such as noise and temperature, so owners need to keep an eye on their pets all the time. Therefore, it is very important to choose a **suitable route for dog walking**.

The project uses **hardware sensors** and **software programming**. The device can collect environmental data and dog's physical state data during dog walking through **cameras and sensors**, and transmit signals via wifi. On the one hand, it provides **feedback to the owner** through LED lights and a mobile app, and on the other hand, it uploads this information to the adafruit cloud, providing a **reference for building pet-friendly cities**. I finally made a **prototype** and **experimented with my dog successfully**.

## 1.1 Dog wearable devices development

So far, most of the research on wearable devices for pet dogs has focused on **understanding dogs' emotions** and **monitoring their health**.



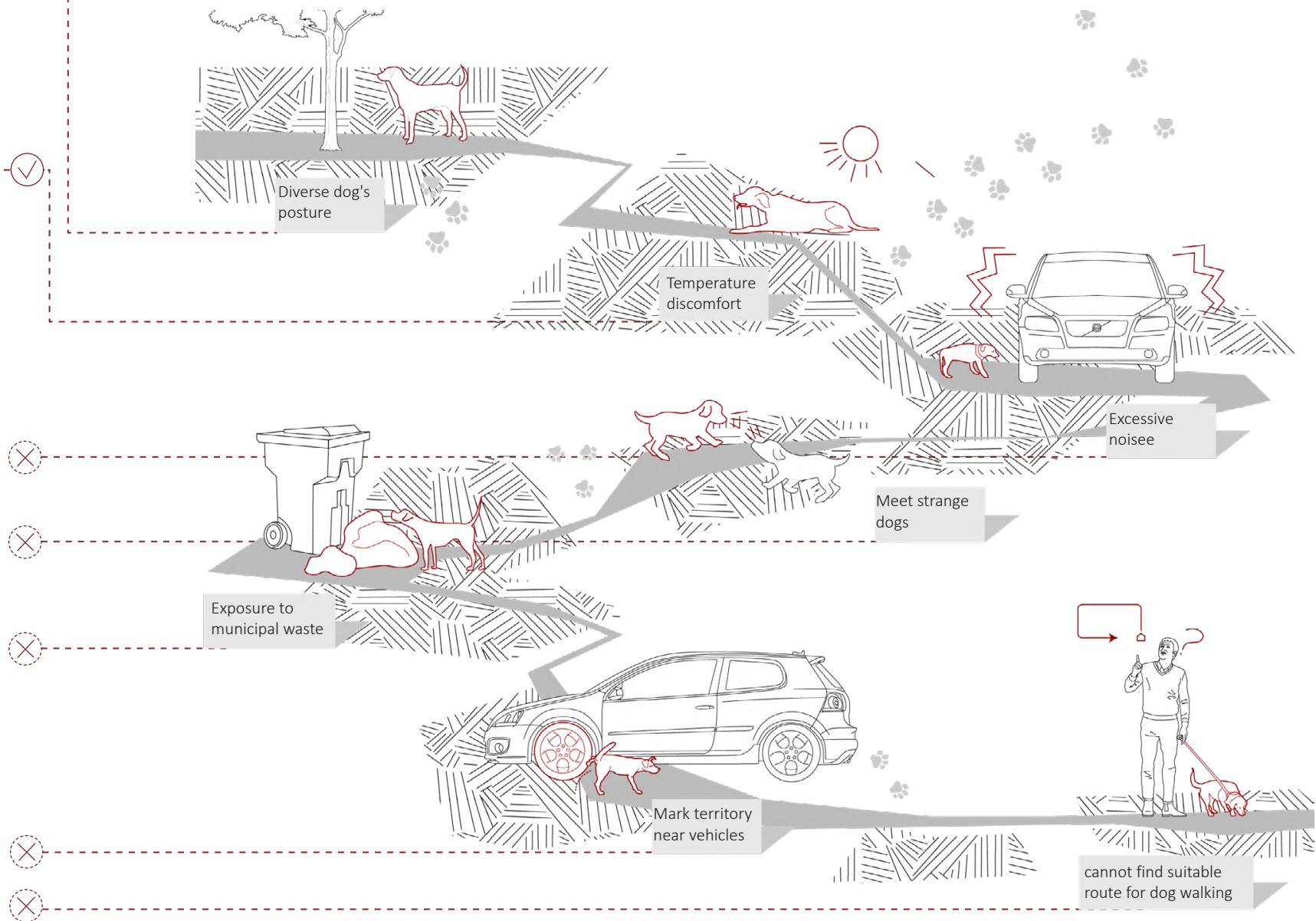
## 1.2 Problems with dog walking in China

However, most dog wearables do not consider **the relationship between dogs and cities**.

In most countries, there are many dog parks, so pet dogs do not need to interact a lot with complex cities. However, in China, dog parks are established in **very few cities**, so **pet dog activities need to be carried out in urban spaces**.

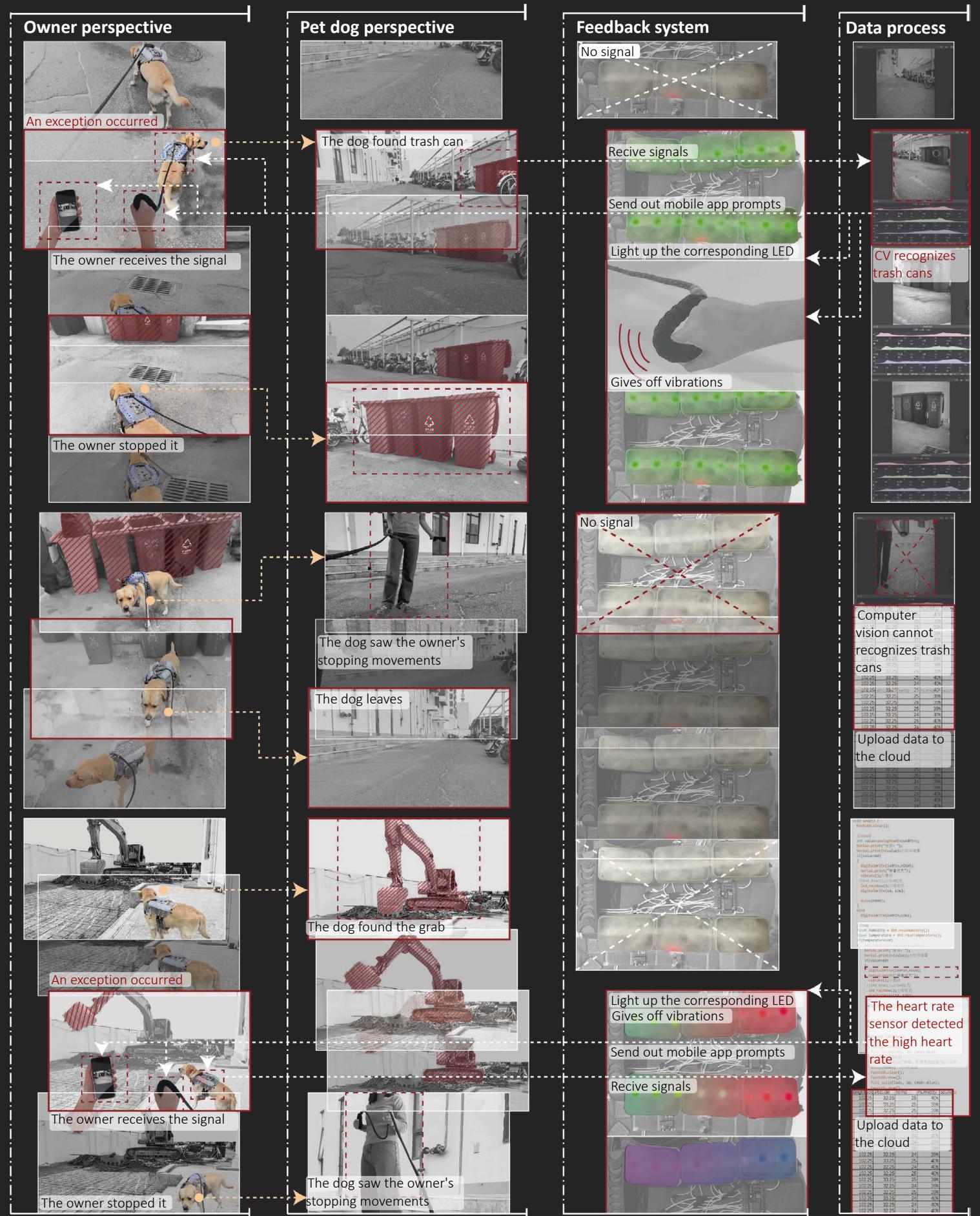
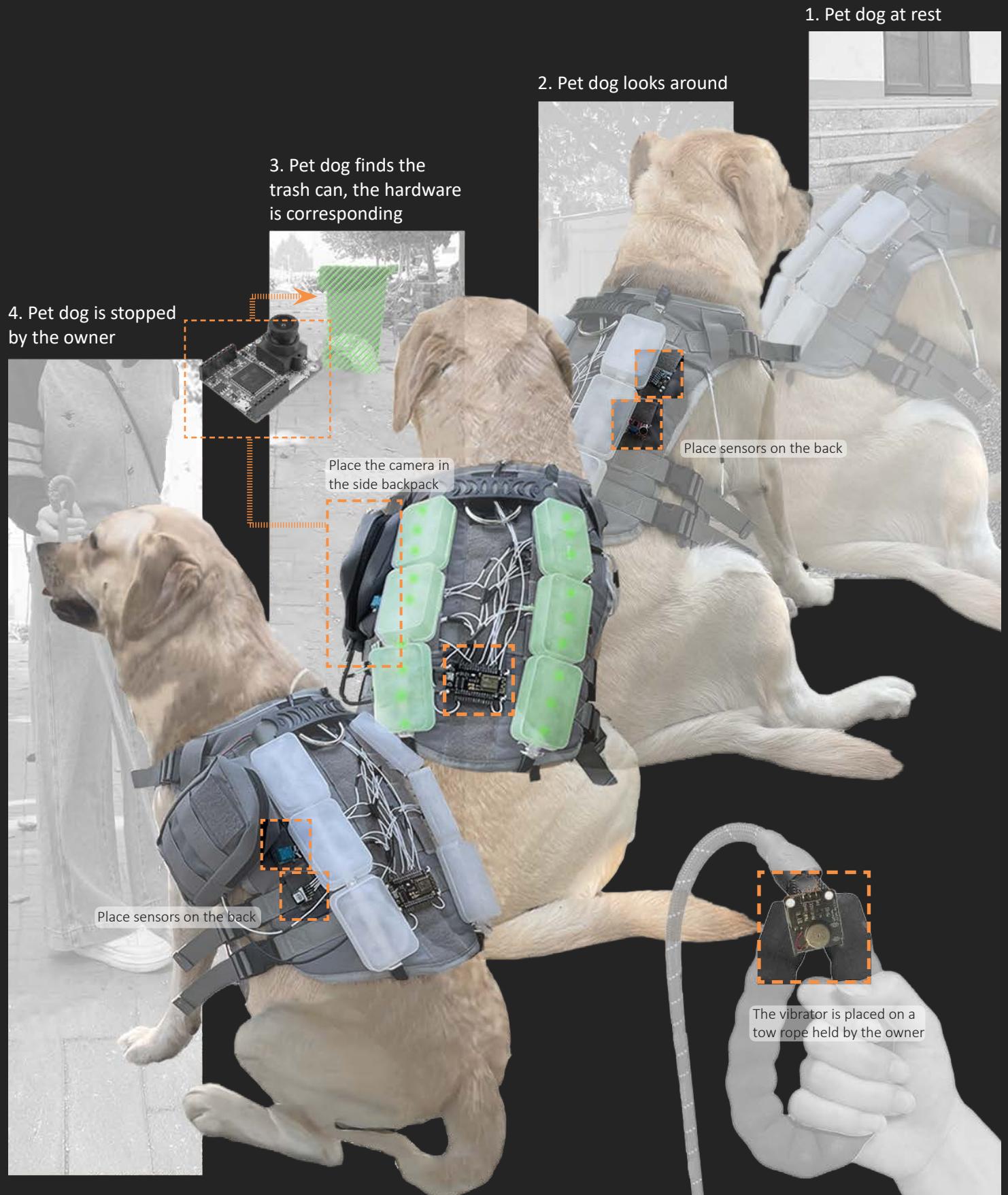


In the process of walking the dog, pet dogs will encounter many problems.

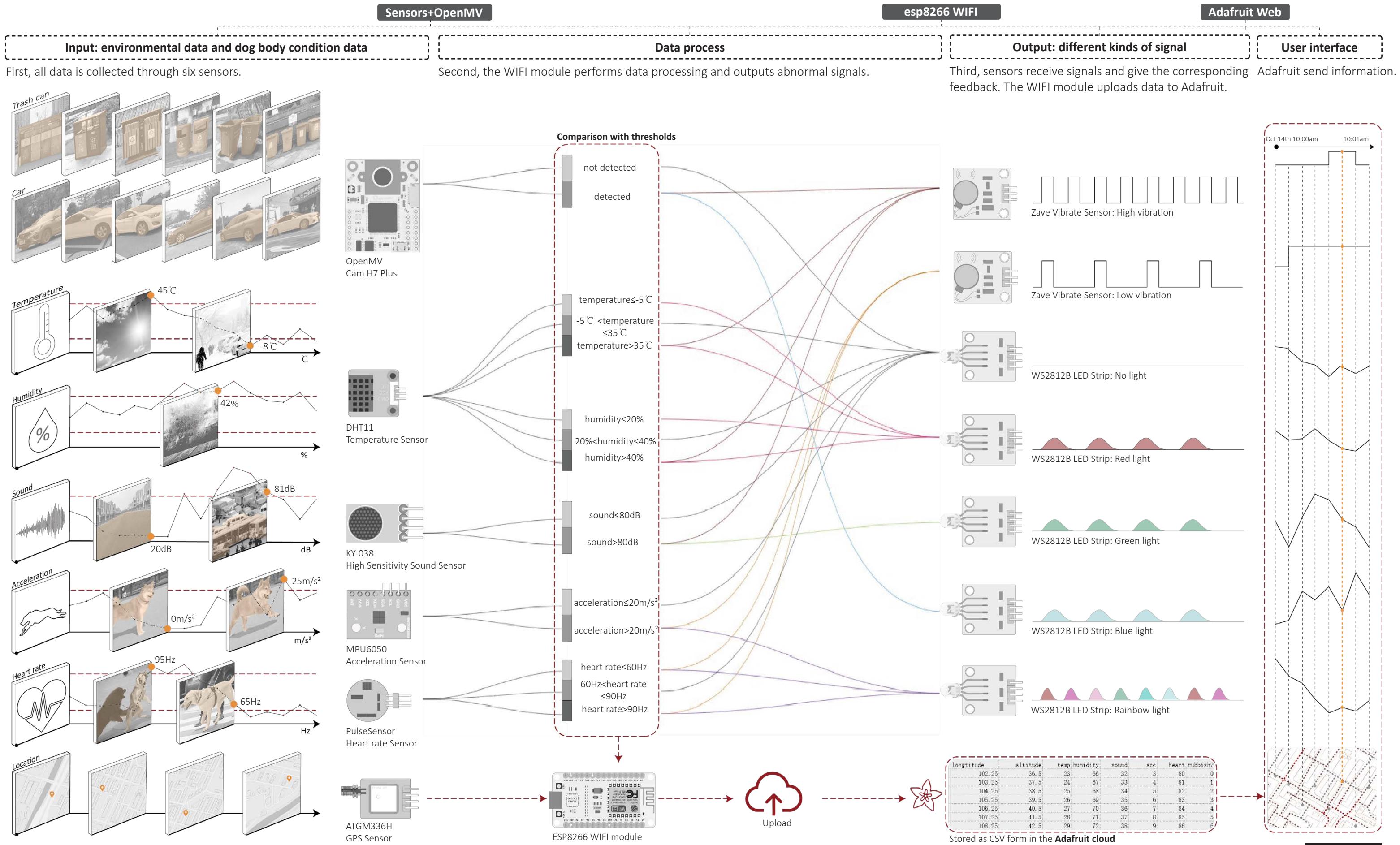


## 2. Prototype demonstration

I made a **wearable device** for my pet dog. The main body is a **vest**, it can **collect the dog's body data and environmental data** and **visualize the information** in real time. Meanwhile, sensors on the vest can **upload data** to the cloud.



### 3. Workflow

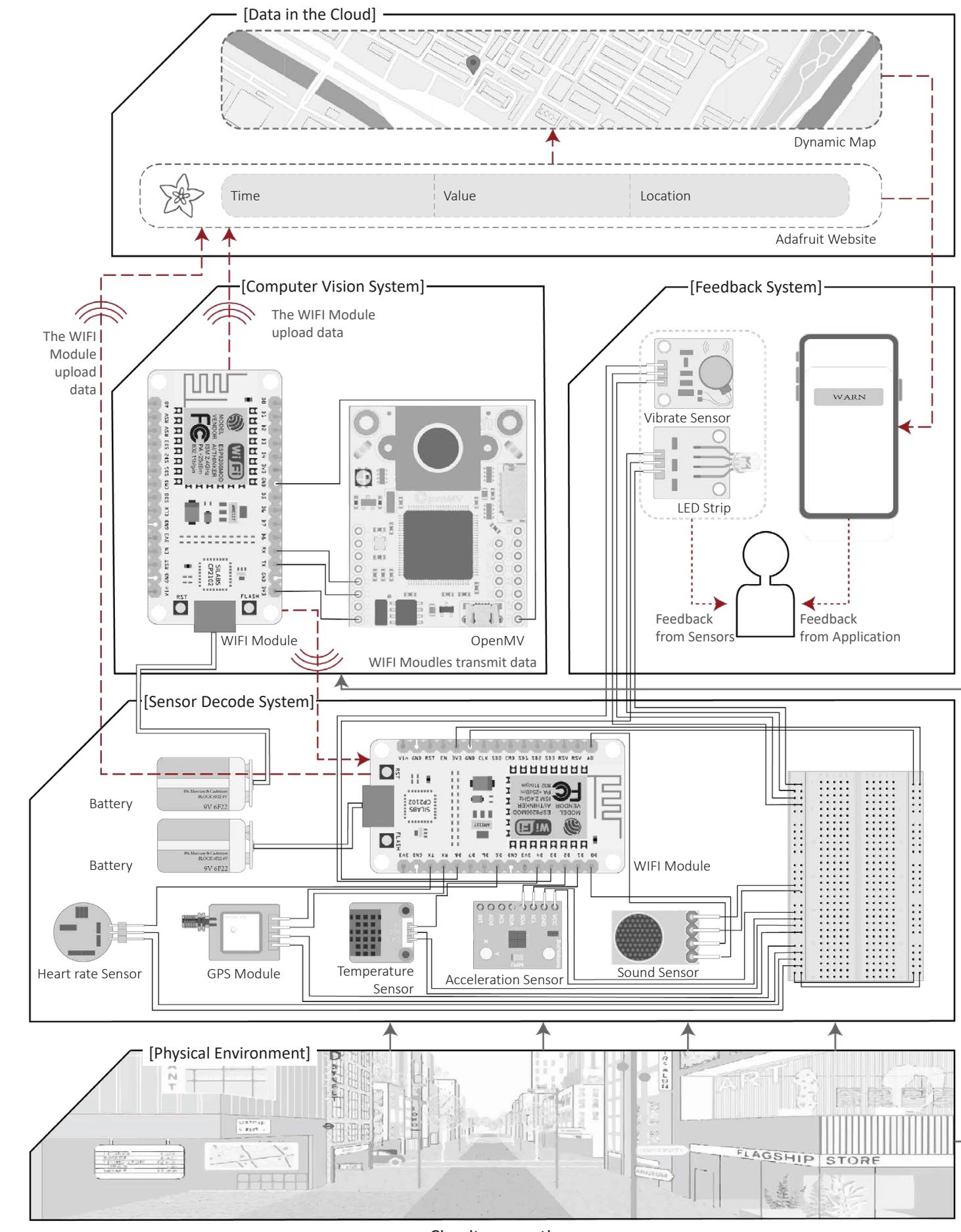
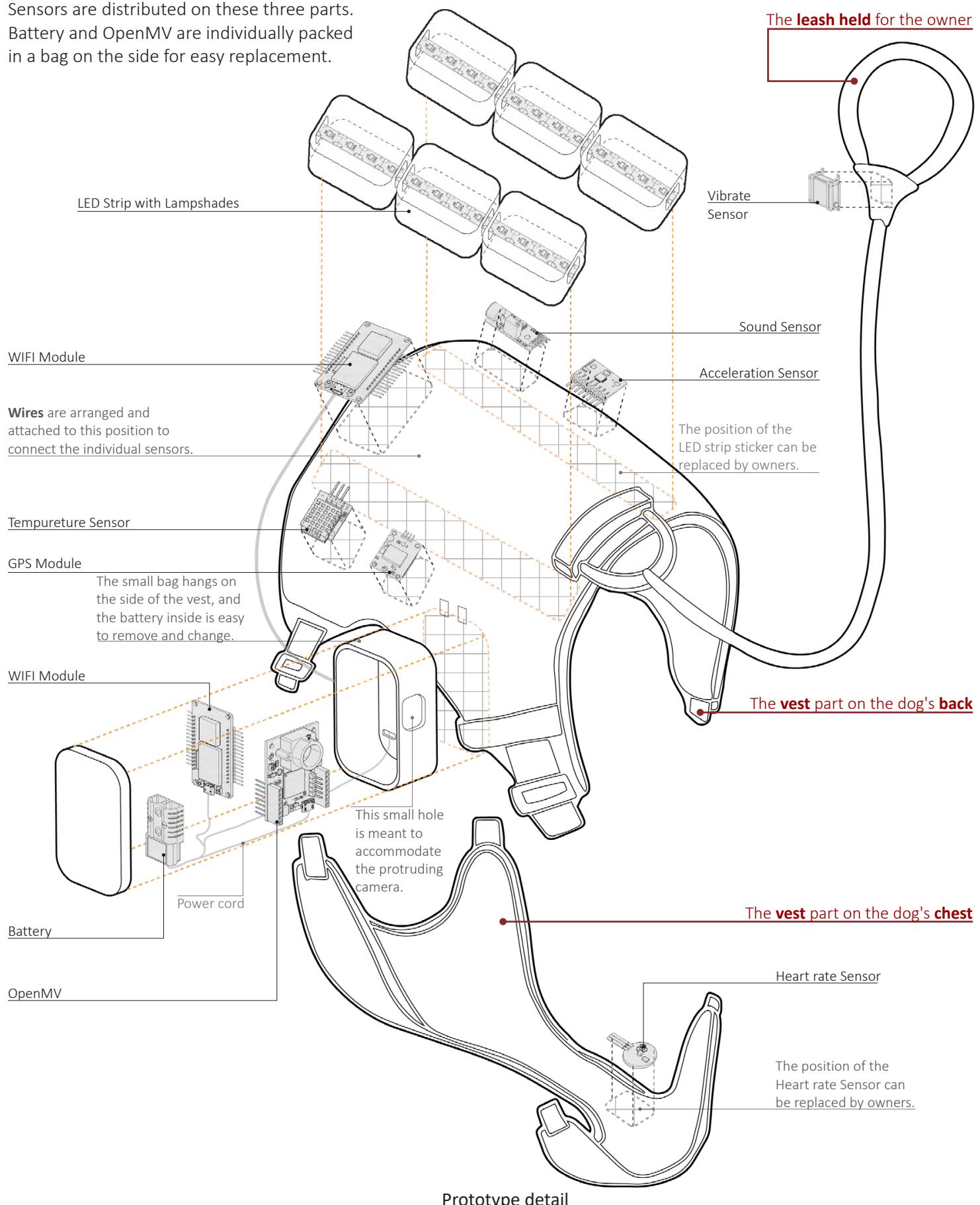


#### 4. Detail design

This wearable device mainly consists of **three parts: a tow rope, a vest on the back, and a vest on the chest**.

Sensors are distributed on these three parts.

Battery and OpenMV are individually packed in a bag on the side for easy replacement.

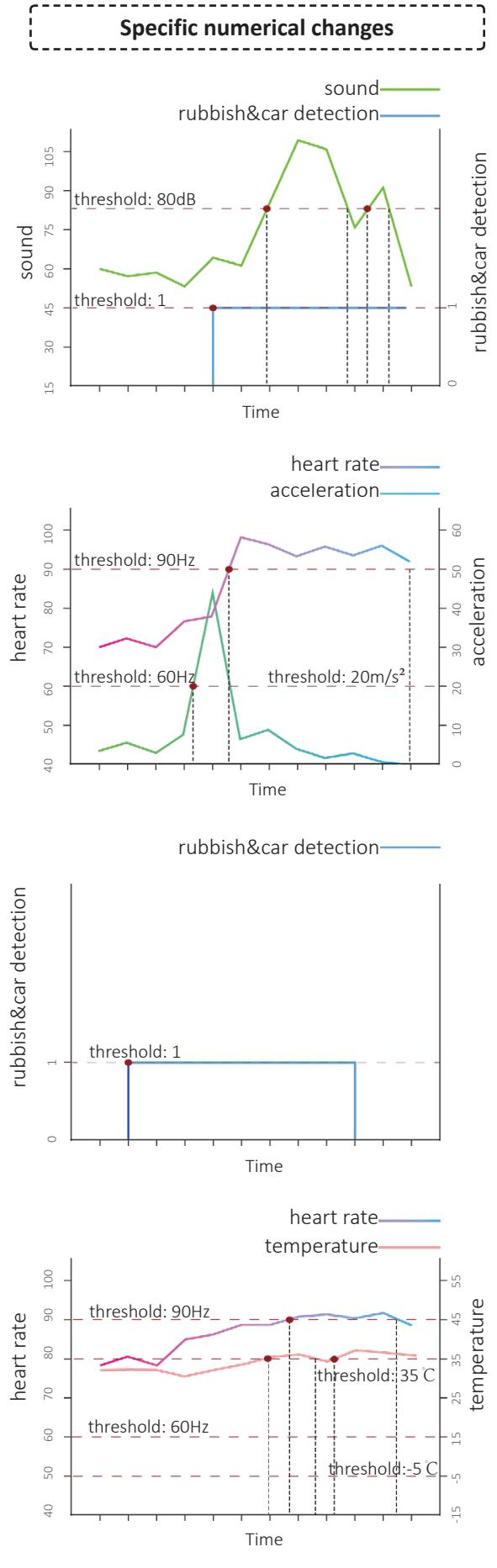
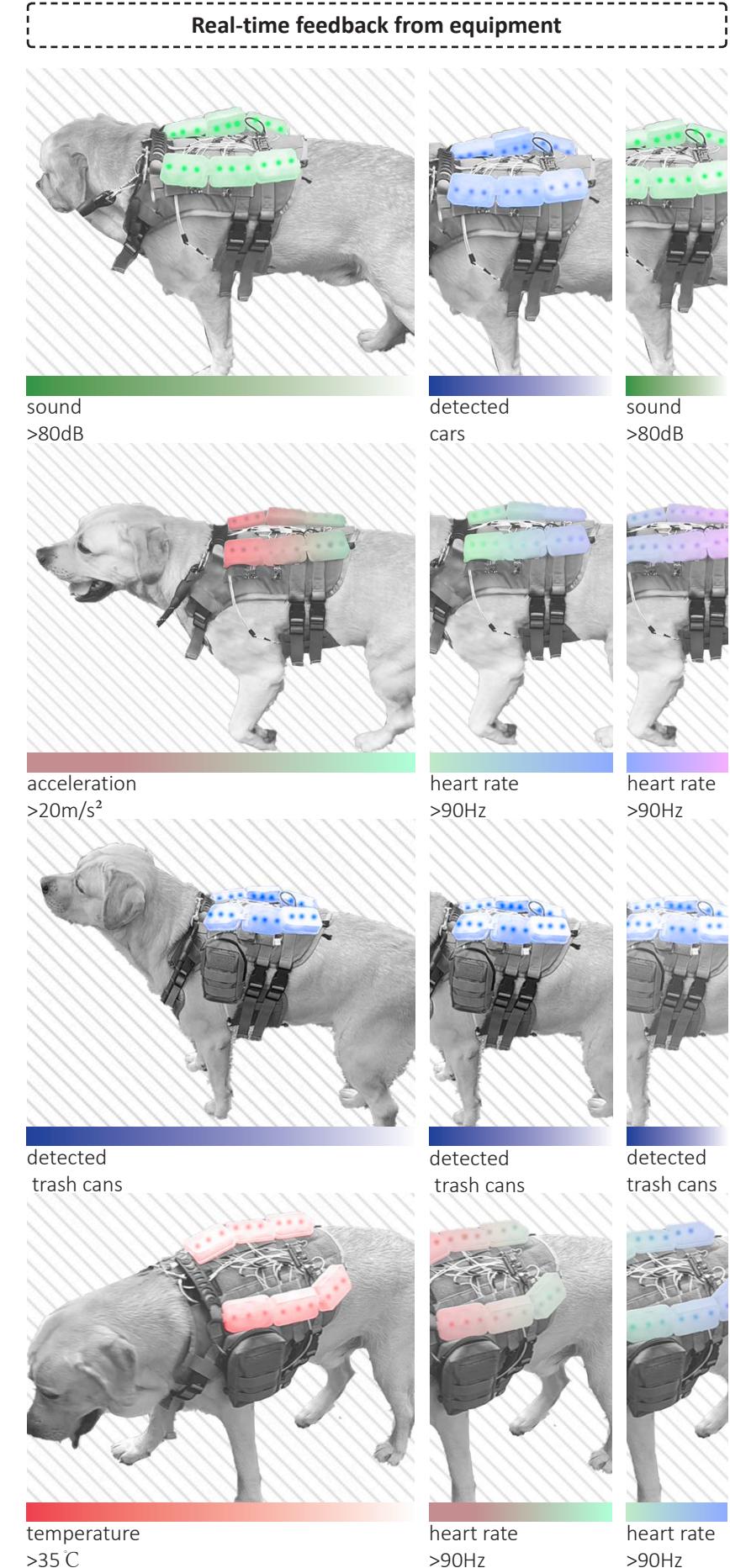
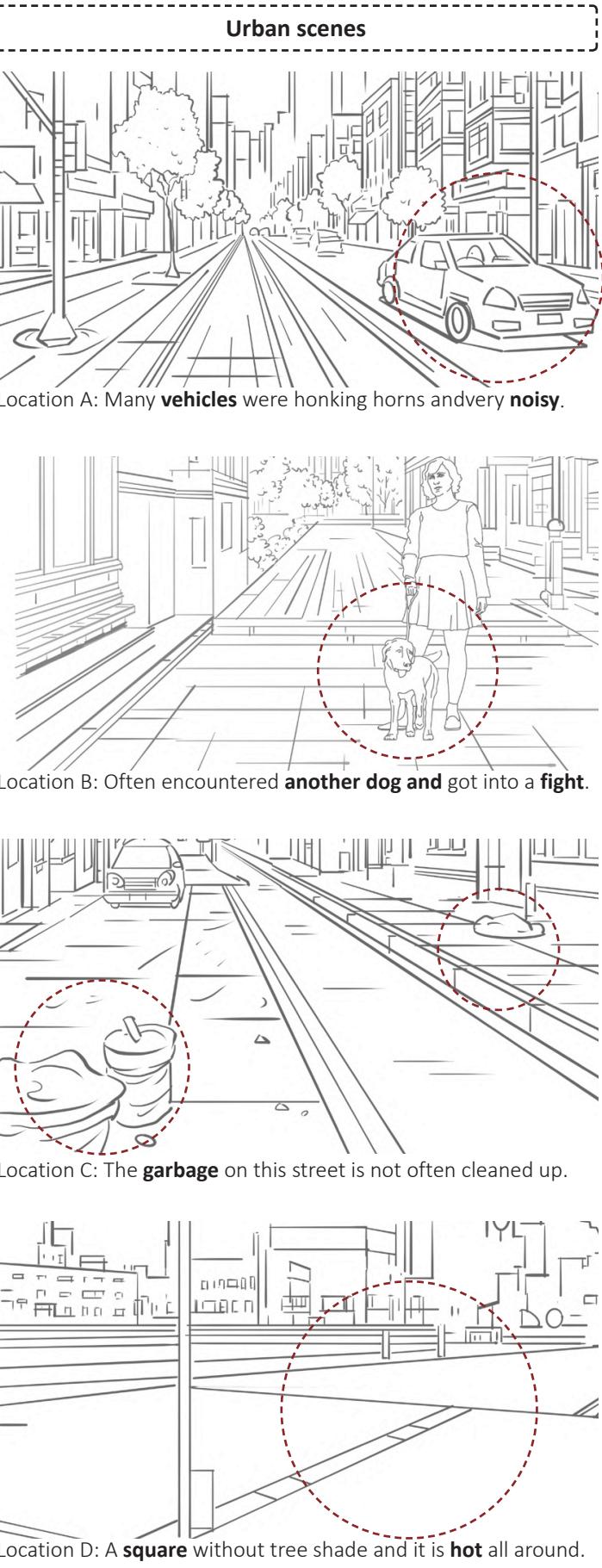


Prototype detail

Circuit connection

## 5. Device response in different scenarios

I put the device on my pet dog and took the same walking route for several days in a row, recording the following data.

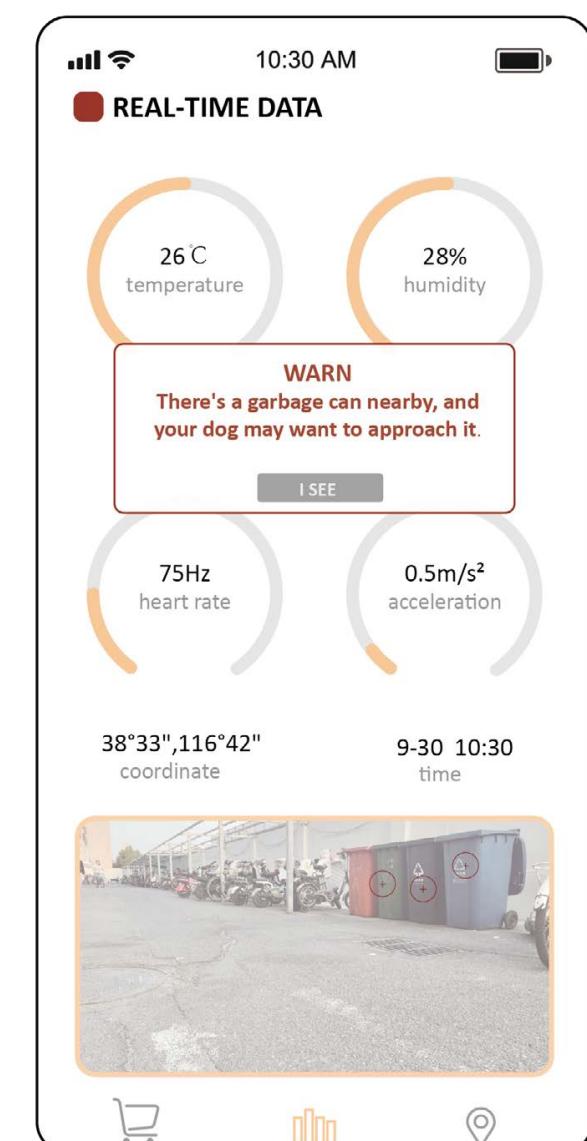
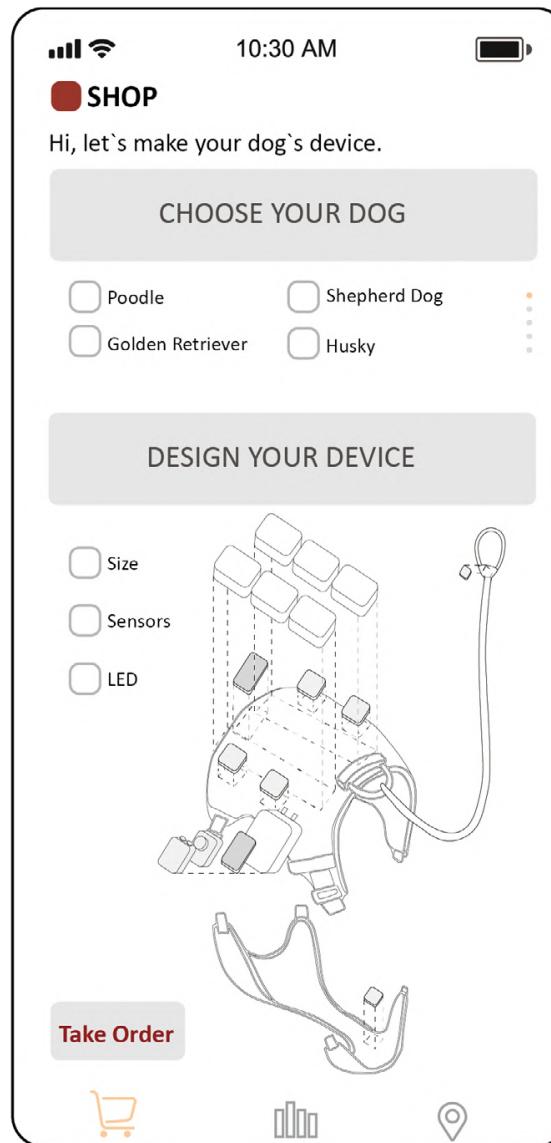


## 6. User interface

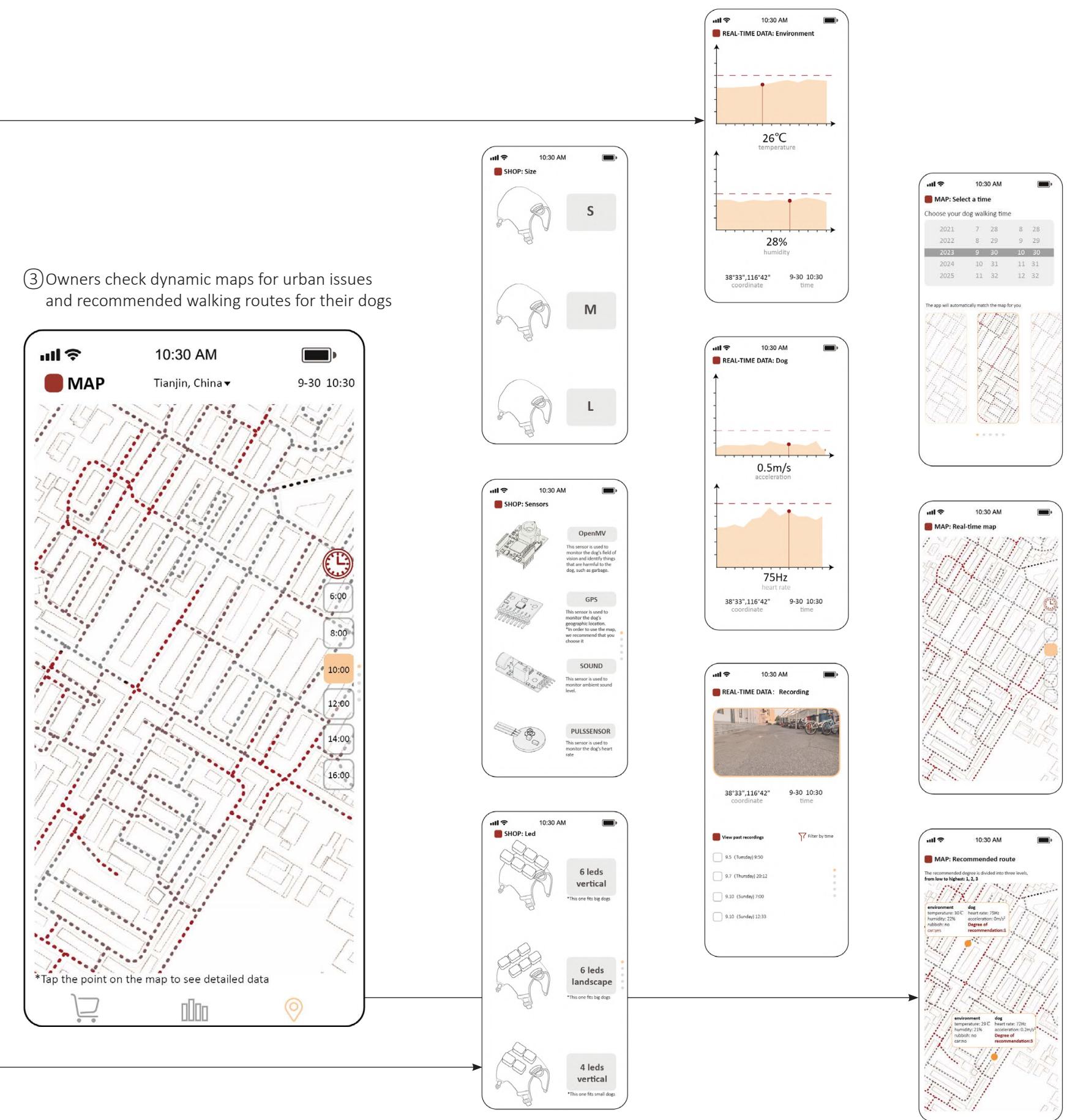
Owners **customize their device** suitable for pet dogs. Besides, they **view real-time environmental data, pet dog physical condition data, and dynamic dog walking maps** through **the app**.

The data of all dogs of the same breed is shared, so the increased amount of data can make the data **more objective and credible**.

① Customized equipment for pet dog owners



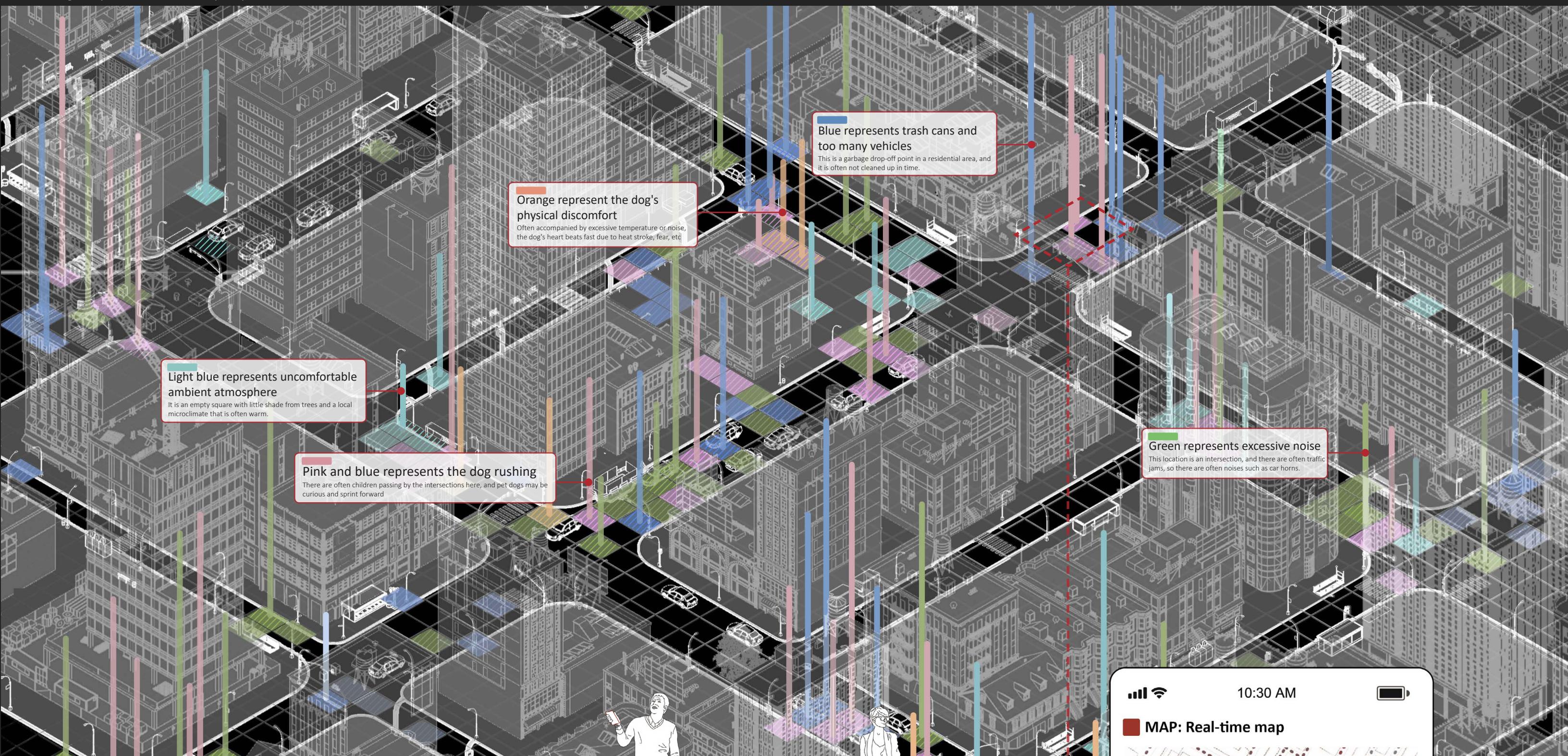
② The owner monitors real-time environmental information and the dog's physical condition



## 7.Pet-Friendly City

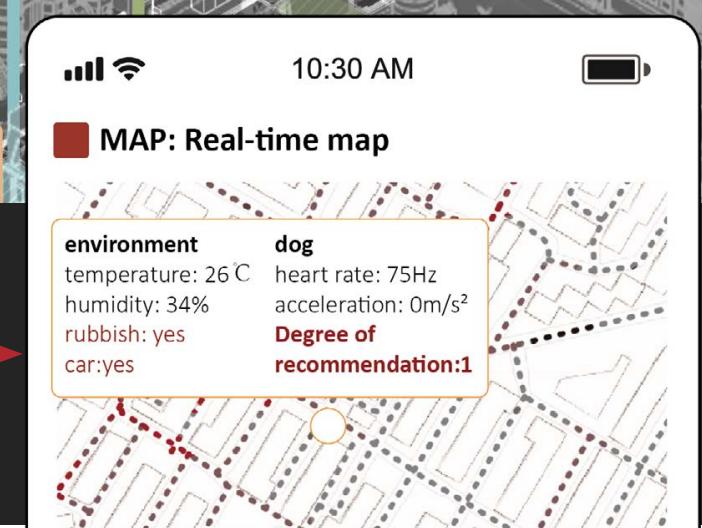
Colors represent different problems that dogs encounter in the city

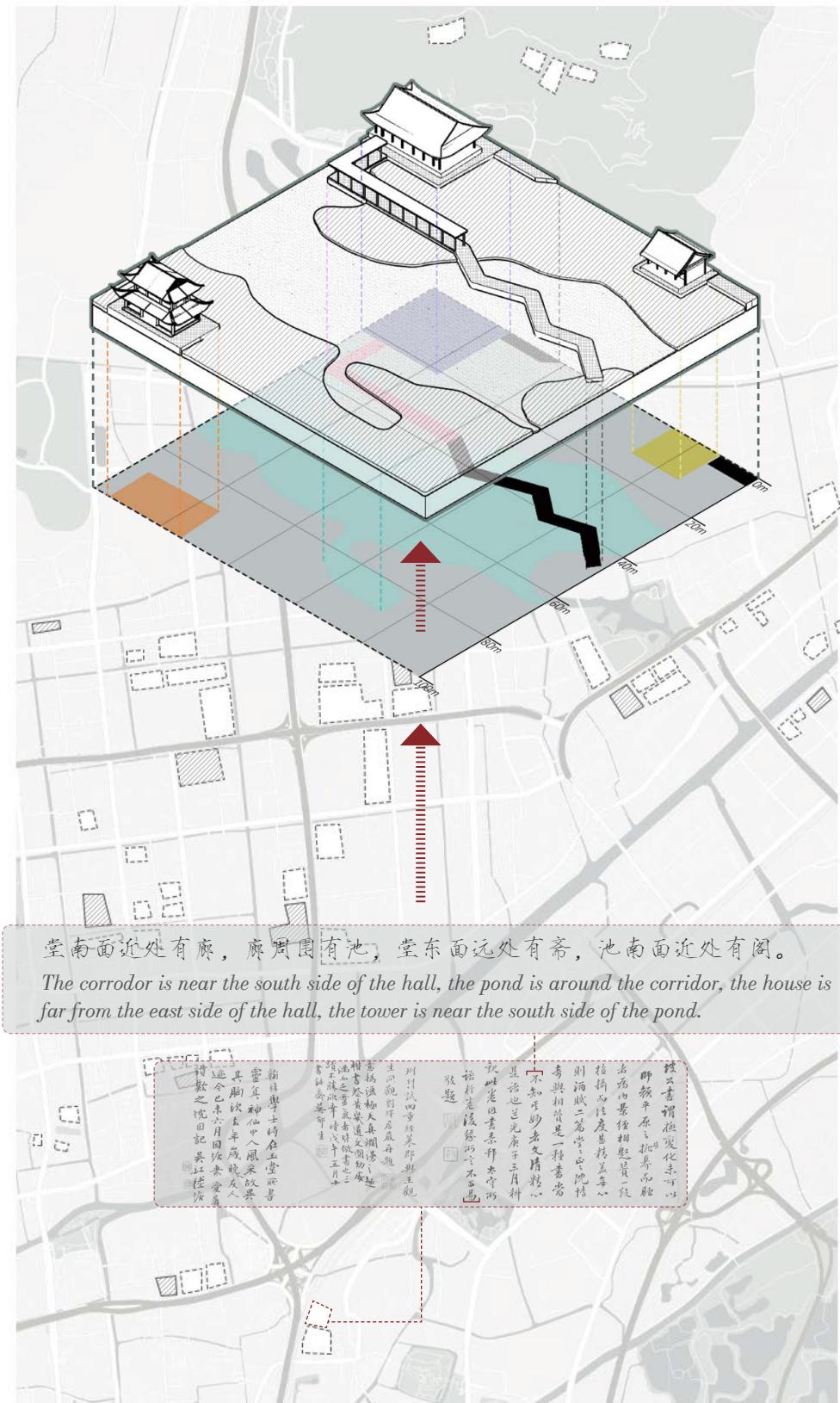
Height represents the severity of problems



When people across the region start using the device, data on walking dogs will accumulate quickly. Eventually, people will not only be able to **learn about their pets' physical condition** based on the device when walking their dogs, but also **get a credible pet walking map**.

People can even follow this map to **establish a pet-friendly city**.





## Text Garden

### Generate Semantic Garden Planes from Texts to Preserve the Heritage

[TIME]  
 2022.3-2022.5

[INSTRUCTOR]  
 Runjia Tian

[MY ROLE]  
 100% Research  
 45% Data Construction  
 50% Model debugging & Model Training  
 80% 3D representation  
 100% Drawing

[GROUP MEMBER]  
 Siyuan Zhang, Siqi Zhang, Yifan Li

**Recovering the plan of traditional Chinese gardens** has always been a difficult task. Although there are **many surviving texts** describing gardens, there are very **few surviving garden plans**, and researchers need to consume a lot of time to recover the layout of gardens based on the surviving texts.

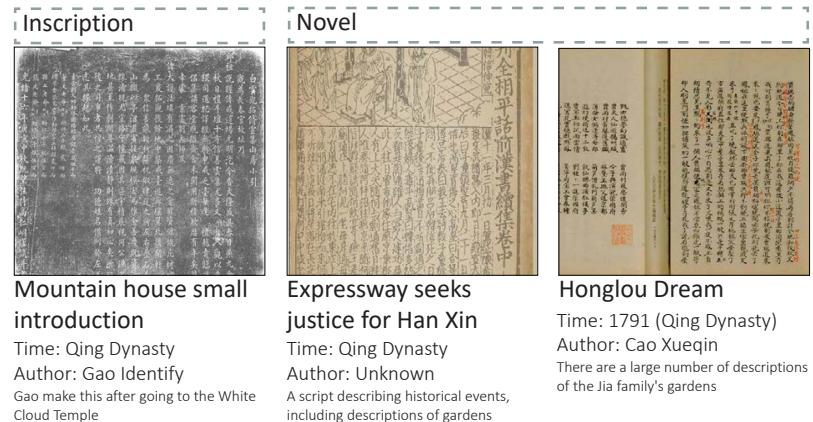
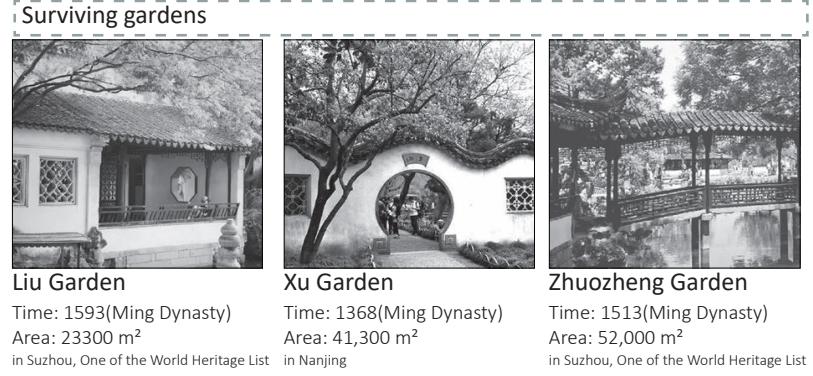
We build the first dataset of Chinese gardens with text-image correspondence. We train a multimodal machine learning model, **DALL-E**, to **generate semantic planes from textual descriptions of gardens**. For these planes, we use **grasshopper** to **generate 3D gardens**. With this technology stream, garden researchers can easily reproduce a large number of classical Chinese gardens.

\* The research result is published as a paper in CAADRIA 2023: Text-to-Garden

## 1. Survival of classical gardens

**Traditional Chinese private gardens** are a valuable architectural and landscape heritage worldwide, but due to wars, many gardens have been severely damaged in the 700 years from the Ming and Qing dynasties to the present.

There are **three main ways to transmit garden heritage: surviving gardens, images, and text:**



**Number in China**

**Surviving gardens ×150**

?

**Images ×400**

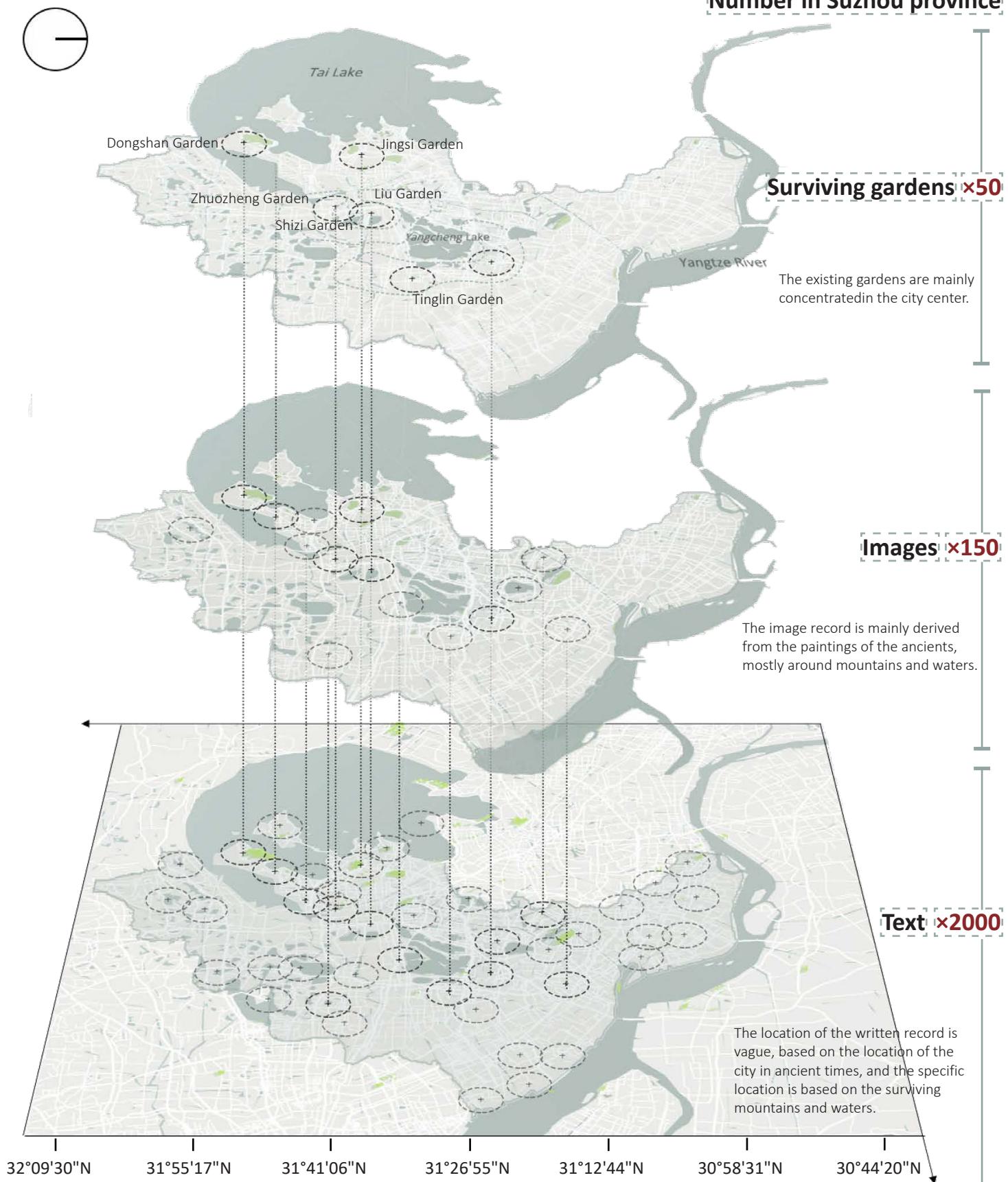
?

**Text ×4000**

Obviously, the use of text to dedicate garden research and conservation is of great significance.  
...

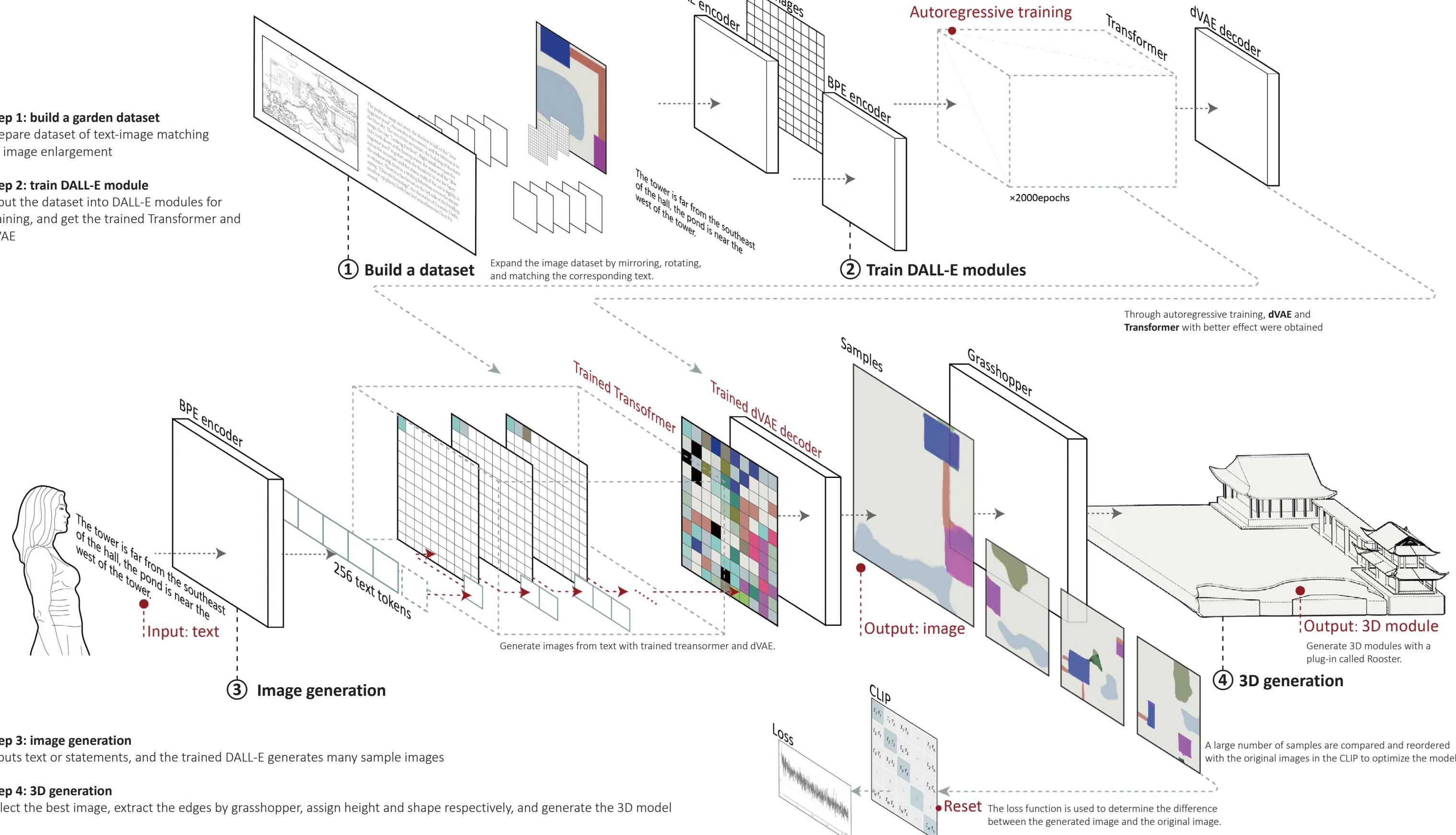
Among them, **in the Suzhou region of China**, which has the largest number of surviving gardens, the preservation of these three types of methods is as follows.

**Number in Suzhou province**



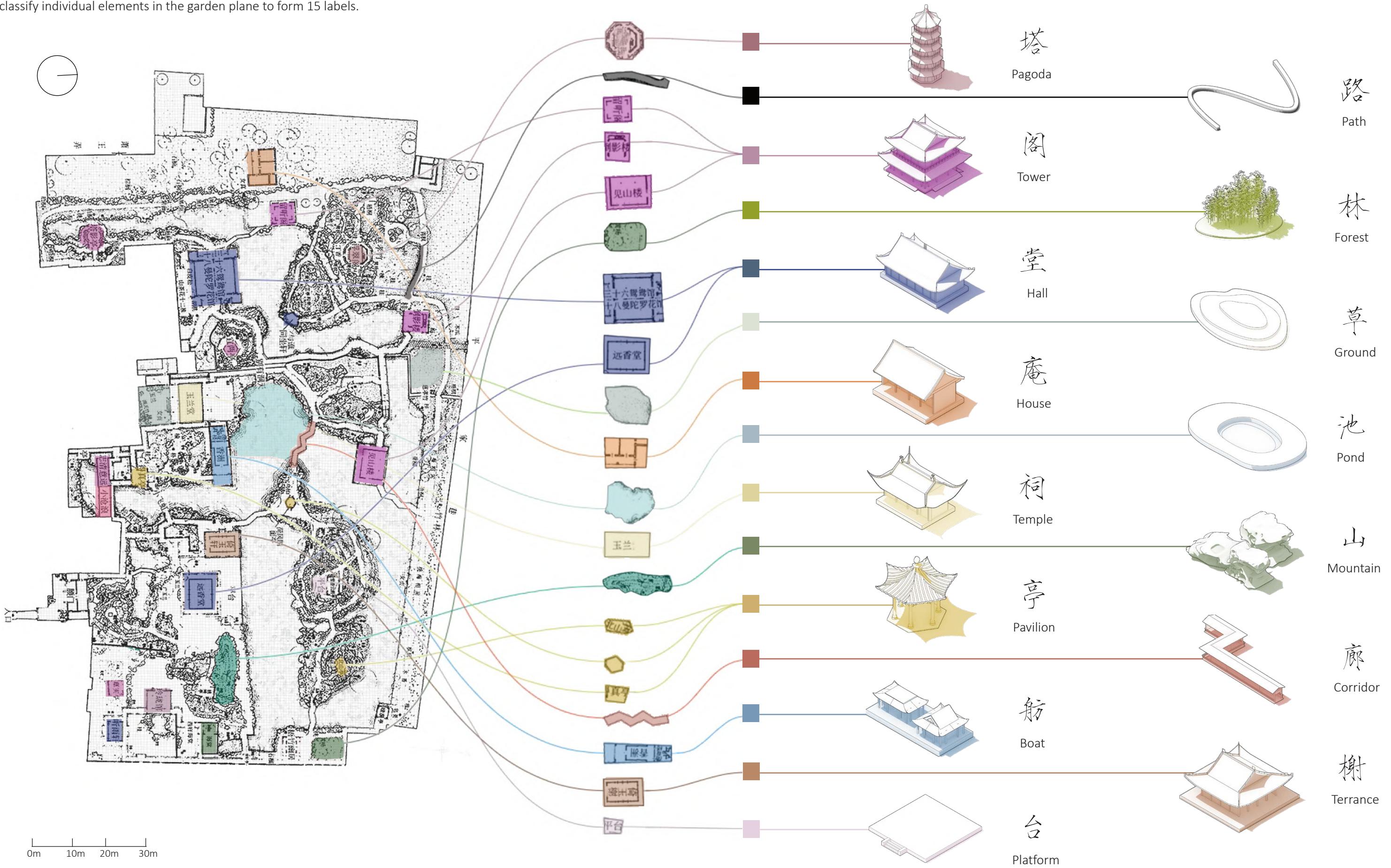
## 2. Workflow

We establish a workflow to **generate garden semantic planes from texts with DALL-E**, and then generate the local 3D garden space.



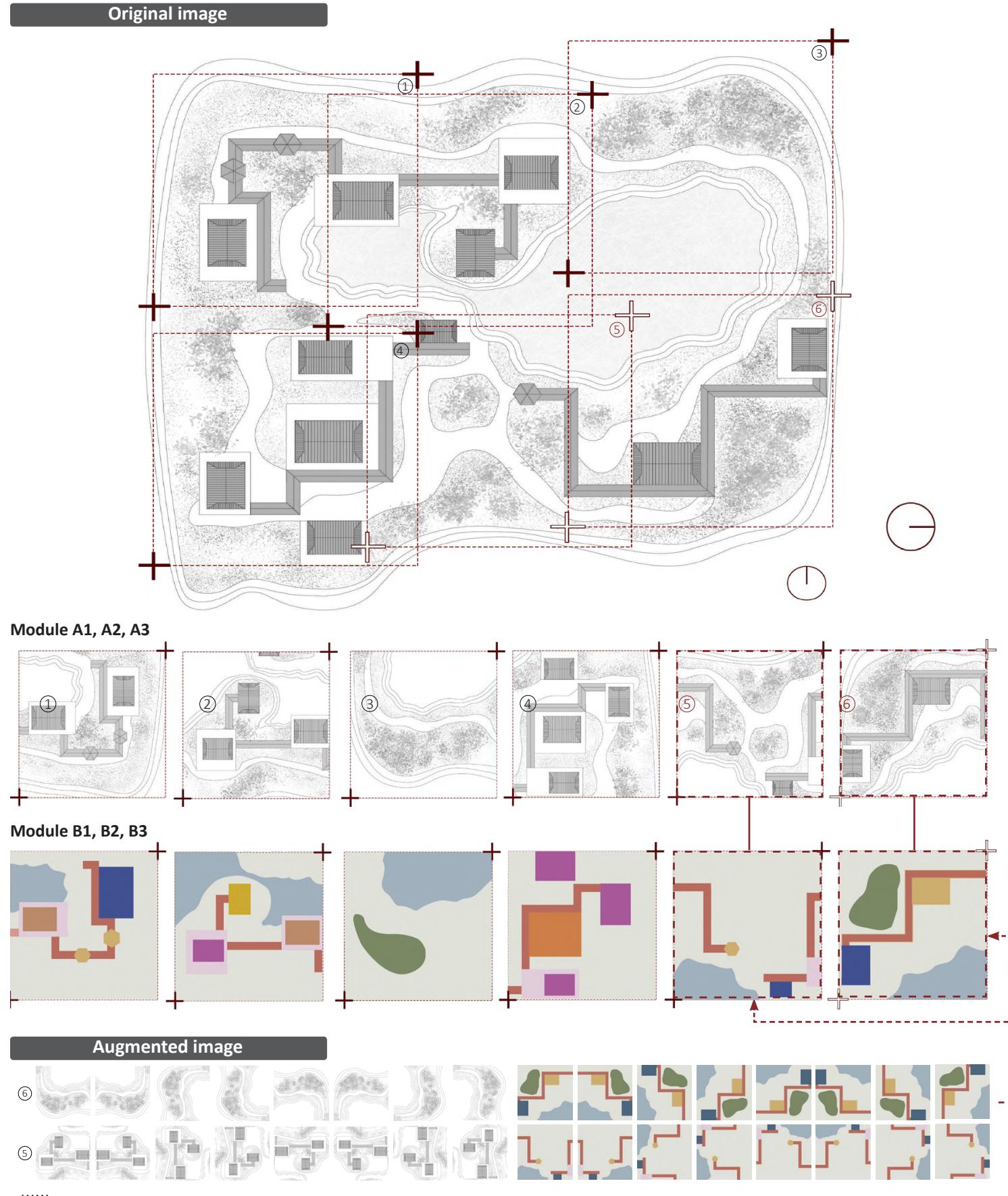
### 3. Dataset Establishment: classification

Reclassify individual elements in the garden plane to form 15 labels.



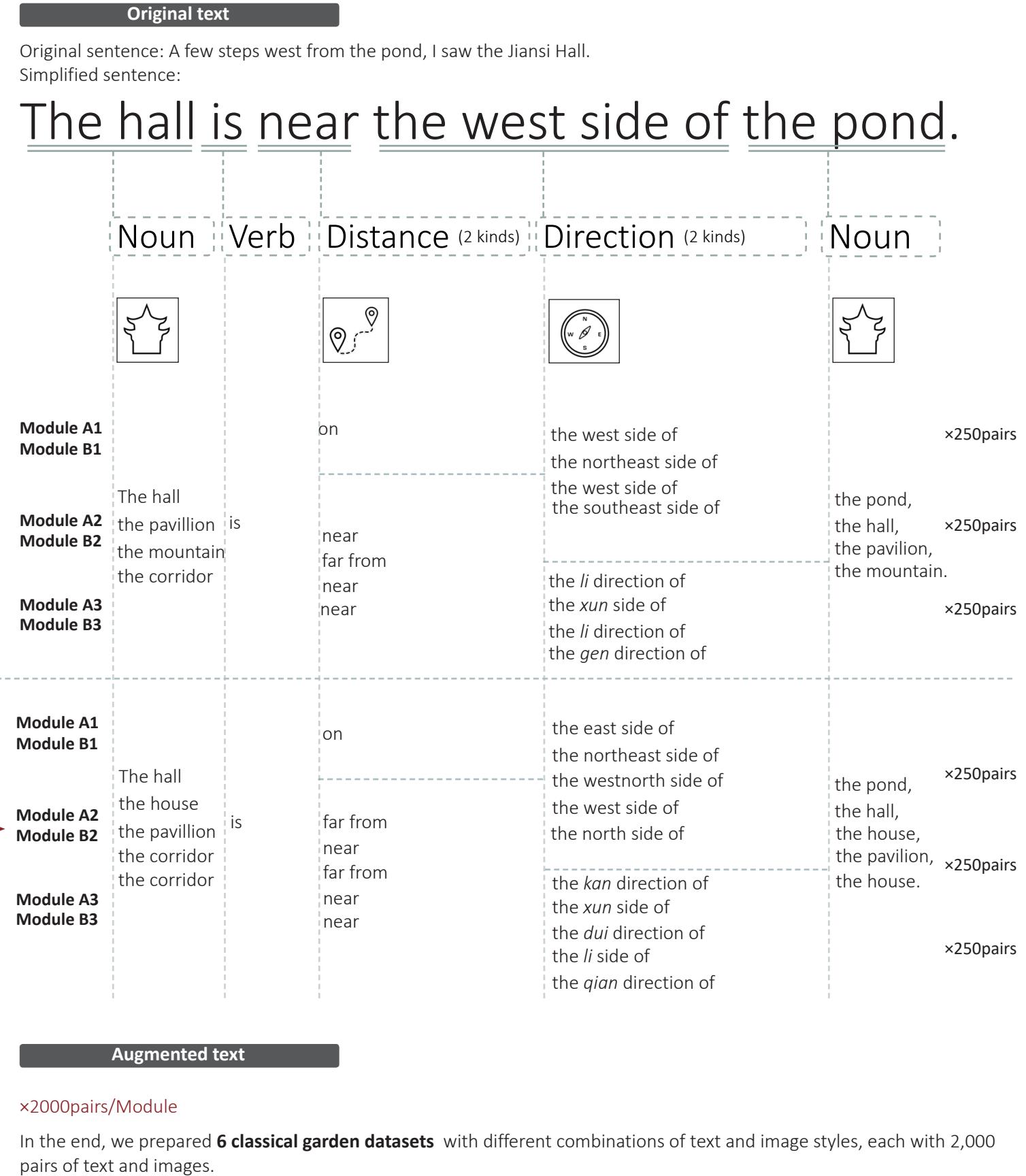
#### 4.1 Dataset Establishment: image processing

70 garden planes were collected. After image processing, we got **2,000 original line drawing images** and **2,000 semantic split images**. In order to find the best image for machine learning, we set **2 image styles**.



#### 4.2 Dataset Establishment: text processing

**40,000 words of descriptive text** corresponding to 70 garden planes were collected from ancient books. In order to find the best text for machine learning, we **simplify the text into 3 text styles**.



## 5. Module testing results & Analysis

Module	Loss score The gap between the generated image and the original image	Test sentences			Fid score The similarity between two images.
		Sentence1: The platform is on the northwest side of the tower, mountains are around the platform. 阁西北面有台,台周围有山。	Sentence2: The temple is near the li side of the pond, the tower is near the dui side of the pond. 池离近处有祠,池兑近处有阁。	Sentence3: The tower is near the north side of the pavilion, mountains are far from the southwest side of the tower. 亭北面近处有阁,亭西南面远处有山。	
Module A1					1.83
Module A2					1.92
Module A3					1.79
Module B1					5.23
Module B2					7.10
Module B3					5.90

According to the loss function and the FID index, **Module B2 is the best.**

The left graph shows the results for all models.

The following figure analyzes the learning efficiency of Module B2.

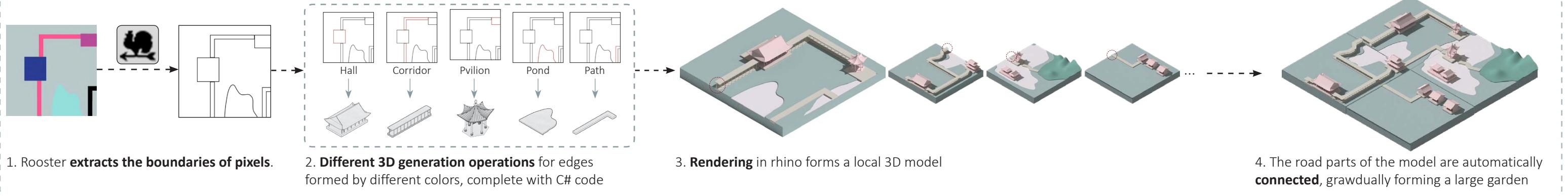


### Conclusion:

- For 15 labels, the more occurrences in the dataset, the better the learning.
- For locative words, the general effect is average, especially the 4 auxiliary directions. The word "around" learns the best.
- For distance vocabulary, the learning effect is poor, which may be because the distance in the dataset is not accurately defined, or it is affected by the size of the label element.

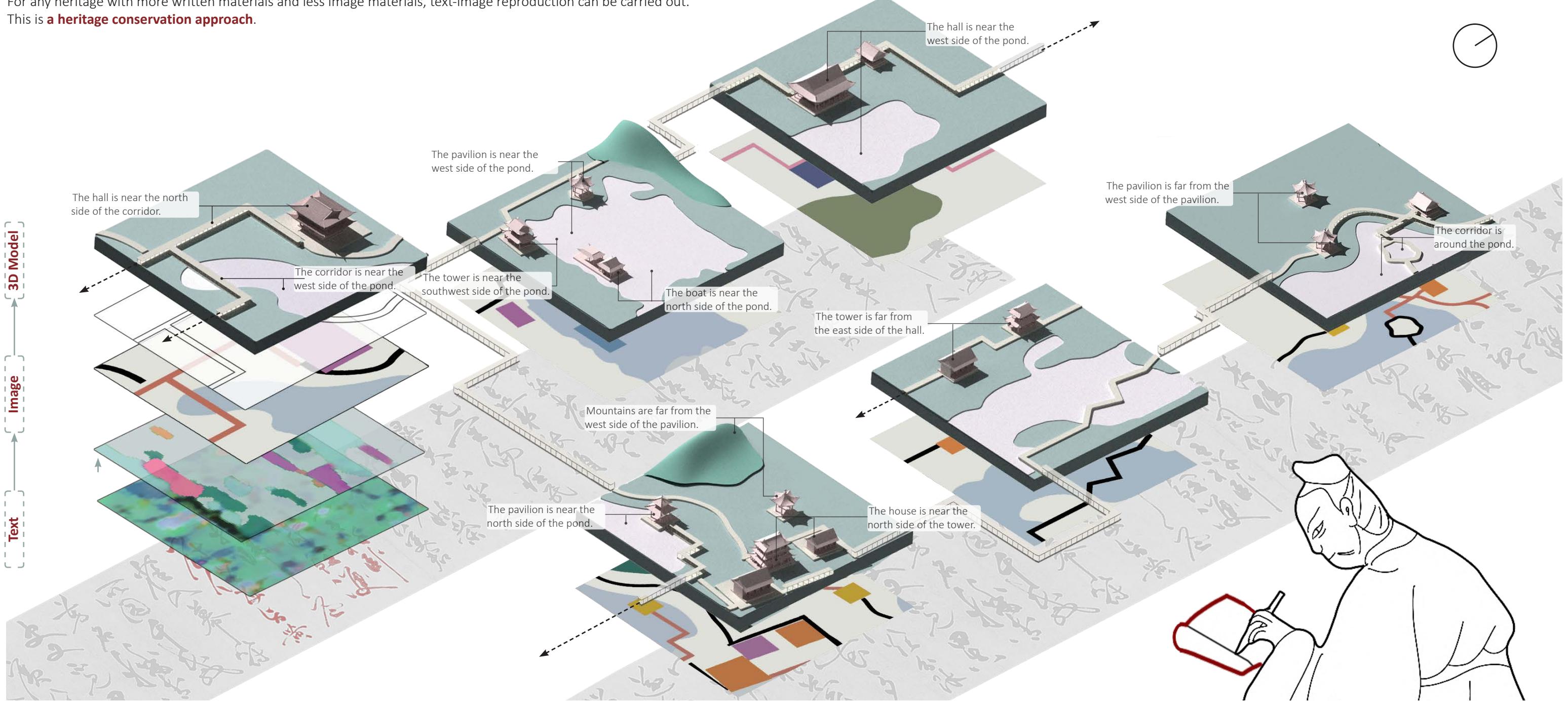
## 6. 3D generation

Automatic batch generation of 3D models with grasshopper.



For any heritage with more written materials and less image materials, text-image reproduction can be carried out.

This is a **heritage conservation approach**.



## AI Housing Agent

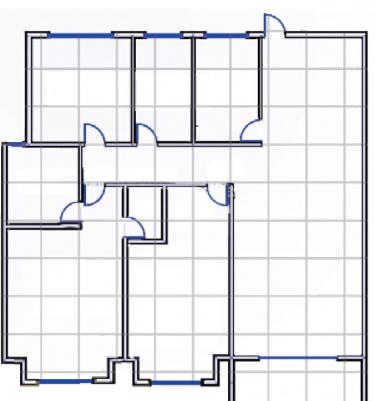
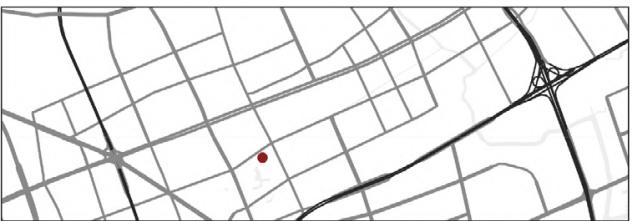
An AI Agent that helps Itinerant Workers find Affordable Housing

I don't need a kitchen but want a bedroom with a toilet.



AI agent

Here's the affordable housing I've found for you:



Four bedrooms, two with their own toilets and no kitchen

Location: Building 25, Dasha Hat Lane, Xuanwu District, Nanjing

[TIME]  
2023.7-2023.10

[INSTRUCTOR]  
Runjia Tian

[MY ROLE]  
50% Concept Design  
45% Data Processing  
55% Model Debugging  
100% Drawing

[GROUP MEMBER]  
Siqi Zhang

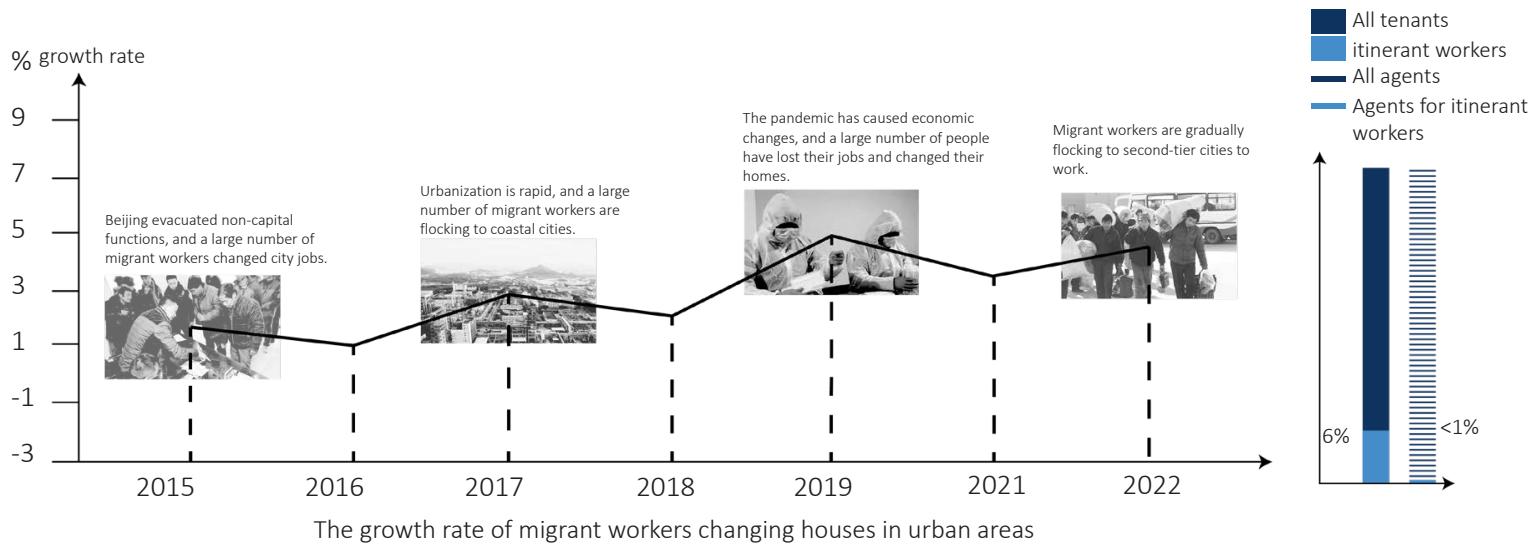
Many of China's net population inflow provinces have a large number of **itinerant workers**, who often change their addresses frequently from city to city due to job instability, and often need to **find rental housing**. However, because of the complexity of their family composition, some alone, some with elderly and children, with different housing requirements, it is difficult for agents to coordinate; coupled with the short term of the lease, the agent from which the profit is small, the **lack of housing agencies for immigrants**.

The project has carried out a lot of **programming work** and developed **a set of evaluation criteria for affordable housing**, so that listing holders can enter the floor plan of the house to get the evaluation of ventilation, lighting, area and so on for each room and the whole house. This data is then fed into a large language model, **llamaindex**. After debugging, tenants can talk directly to the AI and find housing that suits their criteria.

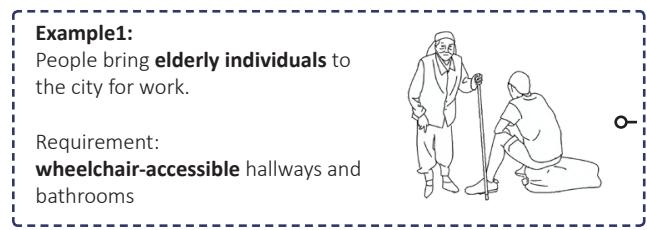
## 1. High housing displacement rate for itinerant workers

In China, there is a demographic: **highly mobile migrant workers entering cities**.

Due to high mobility and low wages, they often need short-term affordable rental housing. This makes it less profitable for real estate intermediaries to operate within this market segment. As a result, there's a **lack of rental agency services for itinerant workers**.



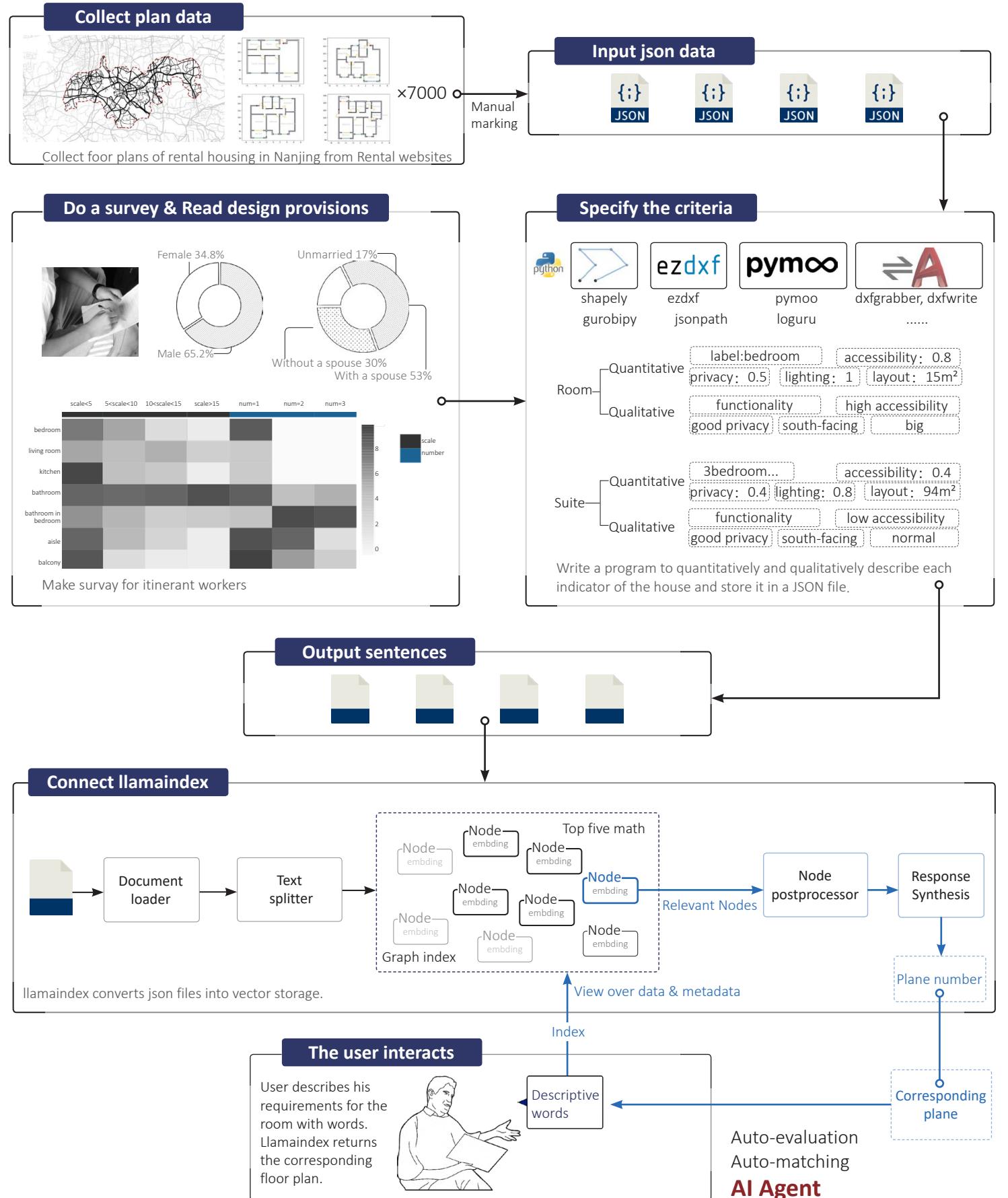
After conducting research, we found that the **people composition of tinerant workers is quite complex**, and their **housing needs vary greatly**. Therefore, they are more urgently in need of intermediaries to help them find accommodation.



No Agent for itinerant workers

## 2. Workflow

We wanted **AI to do the work of agent instead of middlemen**, so we developed a set of rental property evaluation criteria for affordable housing and used the llamaindex to recommend suitable rental properties for tenants.



### 3. Establish standards for evaluating rental housing

We developed a set of standards for evaluating affordable housing. Evaluate the entire suite and each room separately, and give a qualitative and quantitative description of each indicator through python programming.

#### 1. Homeowner uploads floor plan & automatic recognition of wall coordinates

**Landlord interface**

Ower ID +

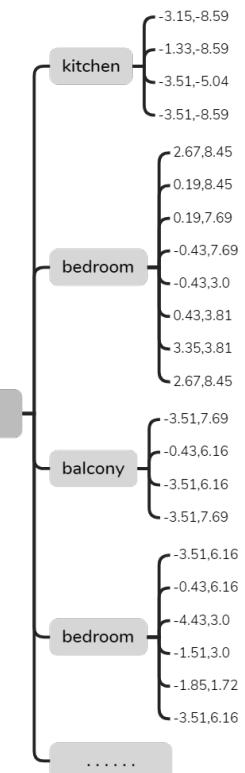
Upload description of the house  
The room is new, there are two kitchens and a toilet, which can accommodate 5-6 people, and it supports shared housing.

Upload photos of the house

Plan +

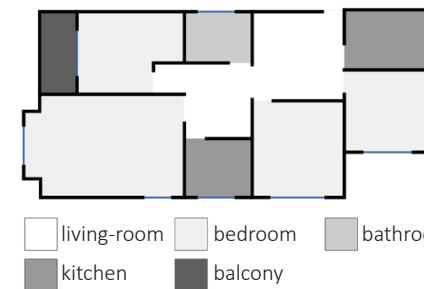
Location +

Room 602, Building 25, Dashamao Lane, Sipailou Street, Xuanwu District, Nanjing City, Jiangsu Province



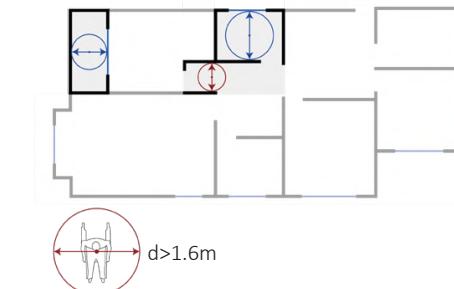
Graphical representation of the remaining indicators:

#### House functions



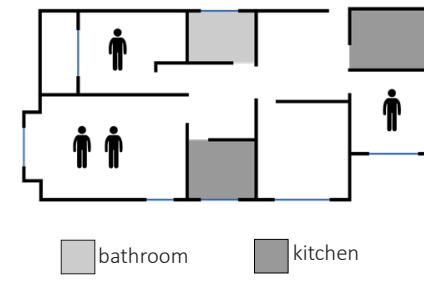
kitchen, bedroom, living\_room, bedroom, bathroom, kitchen, bedroom, balcony, master\_bedroom

#### House accessibility



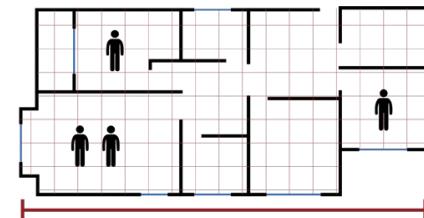
1.15 accessible:  
2.75 narrow,  
4.20 not suitable for the elderly

#### Shared bathroom & Shared kitchen



0.25 shared toilet:  
few, not enough

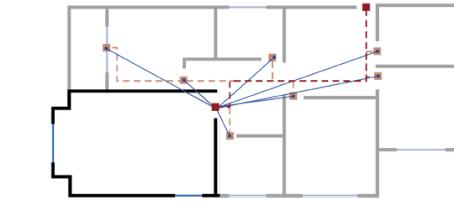
#### Housing area & per capita area



21m<sup>2</sup>  
105.3m<sup>2</sup>

area per people:  
normal  
sum area: big

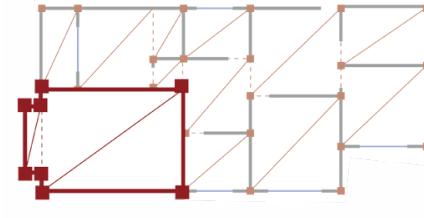
#### Room flow line



9.56 flow:  
privacy, convenient

Calculate the average value of the entire suite

#### Room Space Integrity

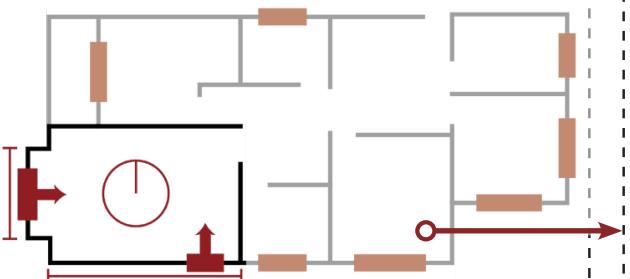


8 room integrity:  
normal

#### 2. Calculated qualitative and quantitative results

The results of each metric were calculated using Python programming.

##### Example: Room lighting



south, west

lighting: good

setence: The bedroom's **lighting is good**

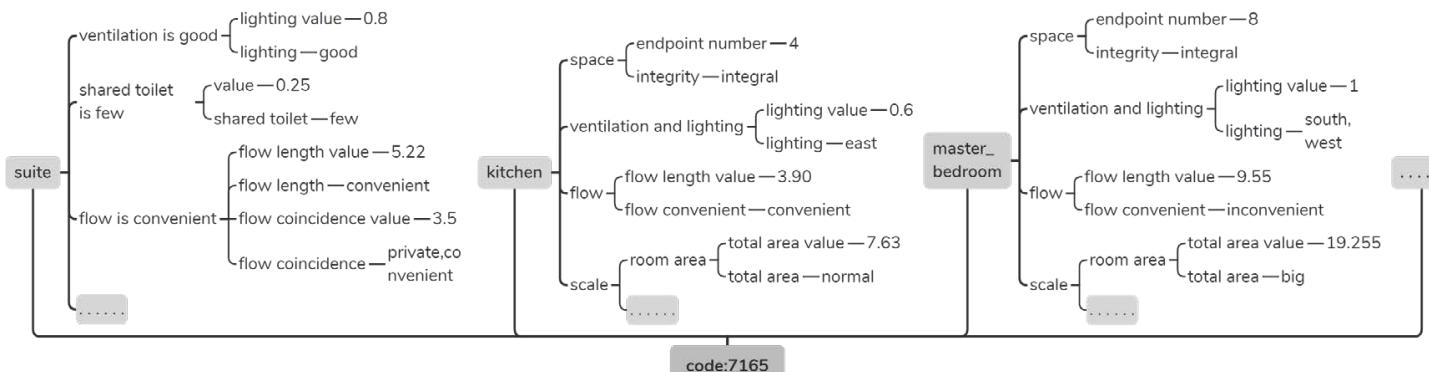
The bedroom has **south**-facing windows

The bedroom has **west**-facing windows

```

Given room_core
def get_window_direction(code7165, i): # Determine window orientation
    edge_mid = []
    z = "non"
    for A in range(0, length(code7165[i]) - 1):
        if A[1]x=A[2]x then
            Vertical windows,
            middle_point=(x1,y1-y2)
        end
        for A in range(0, length(code7165[i]) - 1):
            if A[1]y=A[2]y then
                Horizontal windows
                middle_point=(x1-x2,y1)
            end
            edge_mid.append(middle_point) #List of highlights for room i
list_7165=get_window_mid(code7165) # All windows in house 7165
length=room_core.y-edge_mid.y   length2=room_core.X-edge_mid.X
if length<0 then
    direction= "north"
end
else
    direction= "south"
end
Return direction
  
```

#### 3. Get output json file



#### 4. Convert json file to sentences for llmapiindex

The suite's scale is big, the ventilation is good, the shared toilets are few, the flow is convenient, the accessibility is bad. The bedroom's scale is big, has south-facing windows, has west-facing windows, the flow is convenient, ...

**JSON**  
**PLAN**

The suite's scale is normal, the ventilation is good, the shared toilets are enough, the flow is convenient, the accessibility is good. The bedroom's scale is small, has south-facing windows, ...

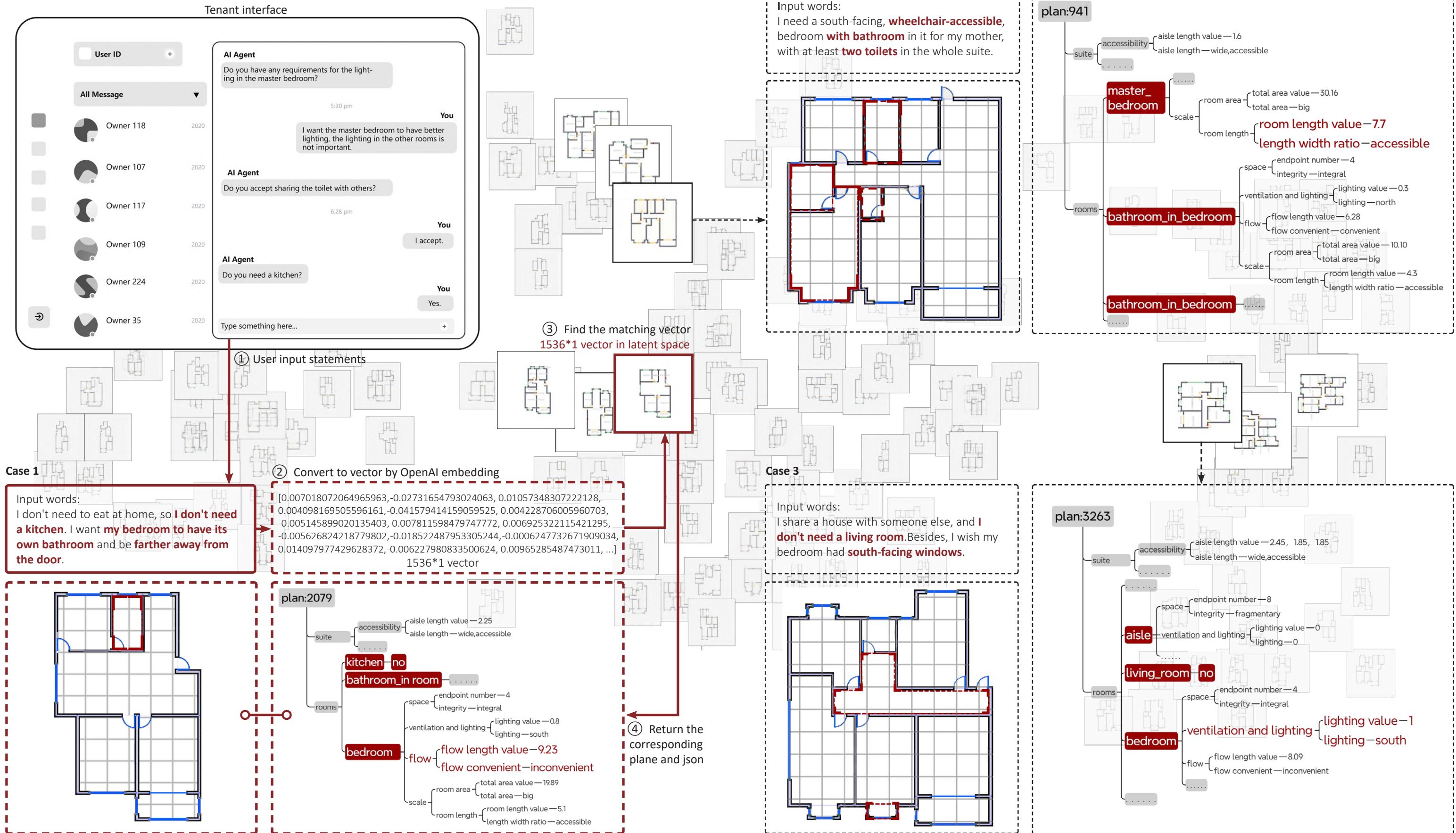
**JSON**  
**PLAN**

The suite's scale is big, the ventilation is good, the shared toilets are many, the flow is inconvenient, the accessibility is good. The bedroom's scale is small, has north-facing windows, ...

**JSON**  
**PLAN**

#### 4. Access to llamaindex for matching

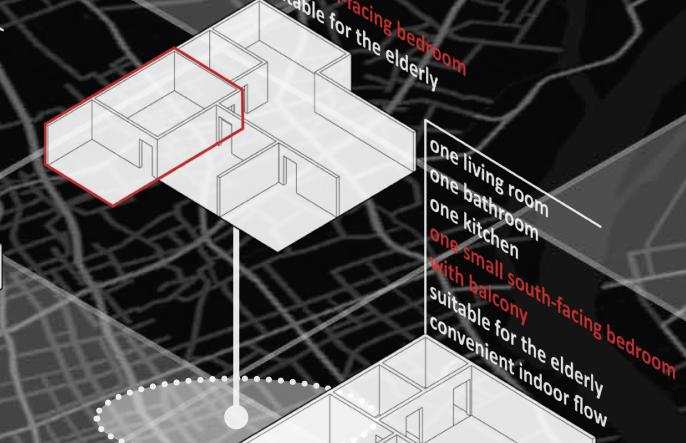
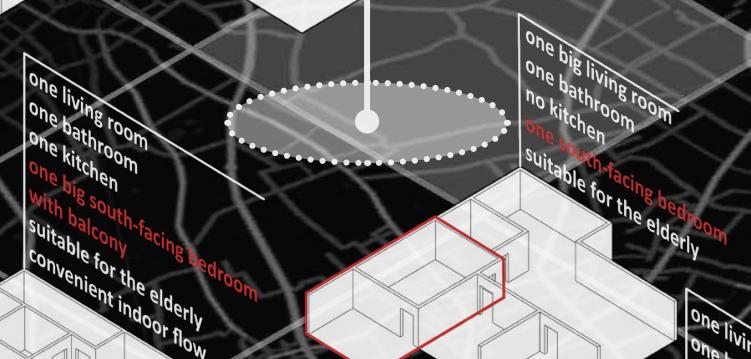
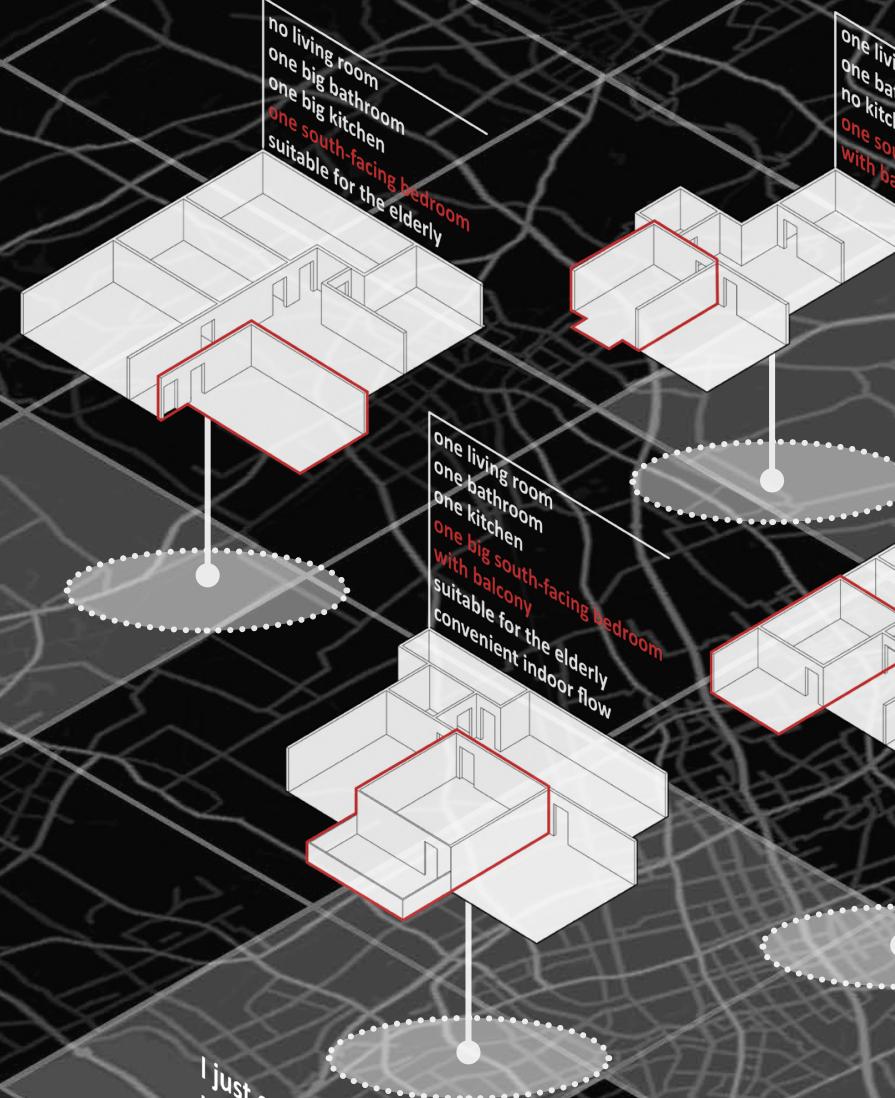
The json file is fed into the database of **llamaindex**, and the **machine finds the plane that best meets the user's requirements** from the latent space according to the user's description.



## 5. Finding a Home for itinerant Workers

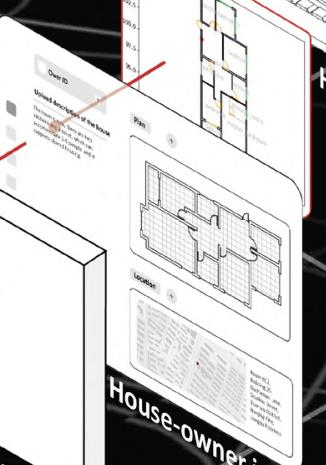
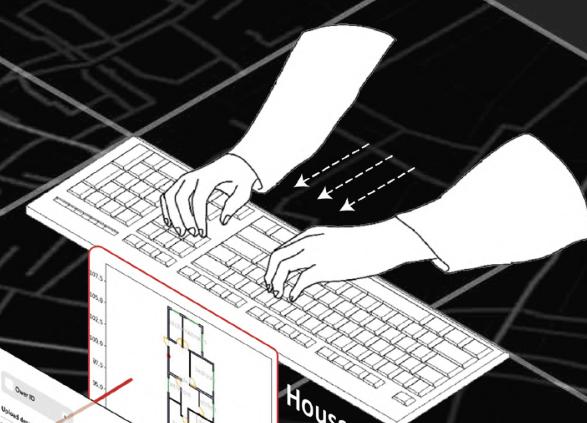
According to the 2022 survey, 10 of China's province have a net inflow of population. Therefore, the AI agent can be applied to these cities. It not only **helps tenants find the right rental**, but also **consumes the city's surplus housing stock**.

In this way, itinerant workers will find a **sense of belonging** and **feel welcomed and accepted by the city**.



I just came to this city, and I don't have a lot of salary, so I can only share a house with others. I didn't care if there was a living room and kitchen, but I wished my own bedroom would get a lot of sunshine.

# Welcome to the city!

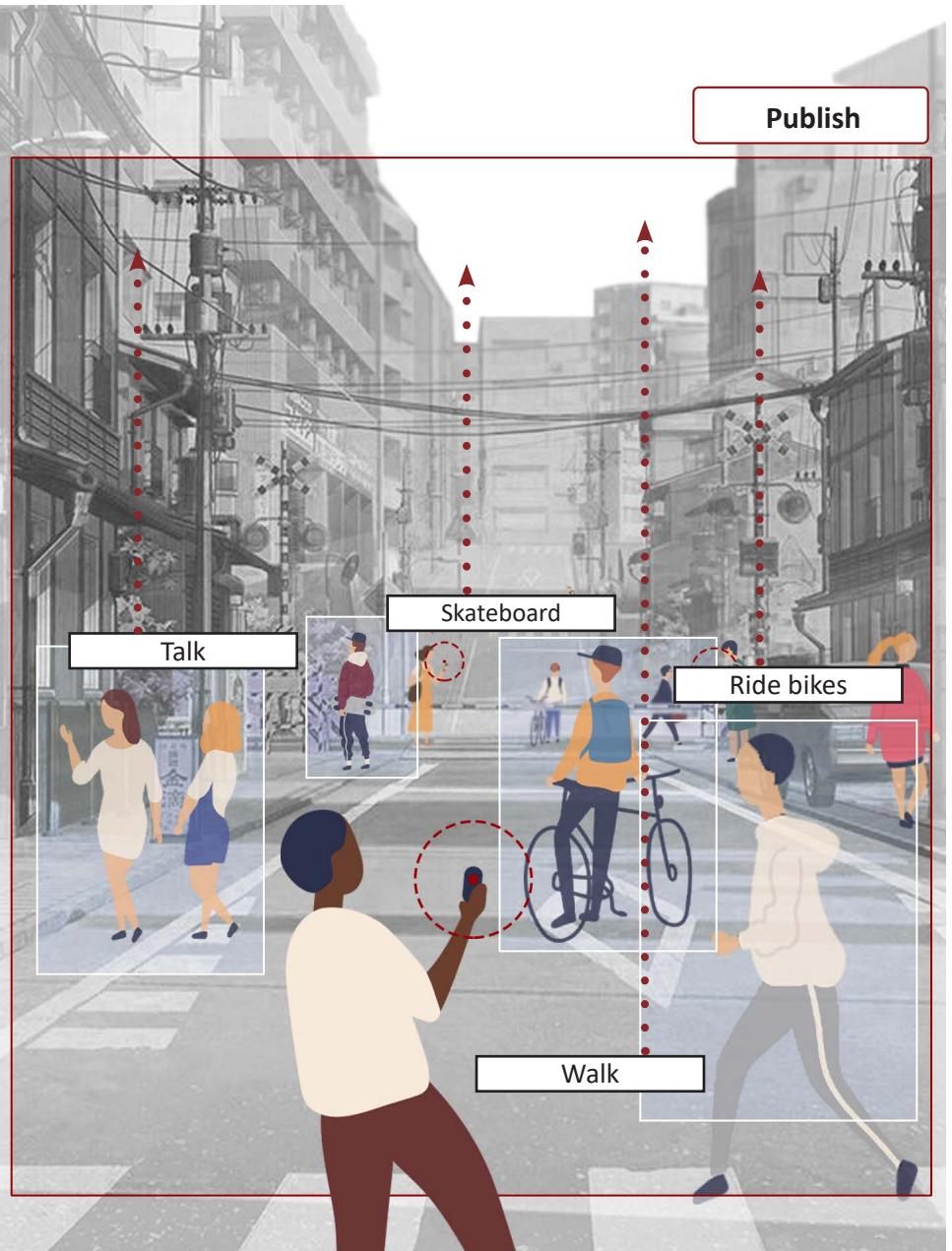


Evaluation

Json file

## Street Diversity Recognizer

Obtain the Activity Diversity of Crowds to guide Urbanization



[TIME]

2023.10-2023.12

[INSTRUCTOR]

Wenjing Li

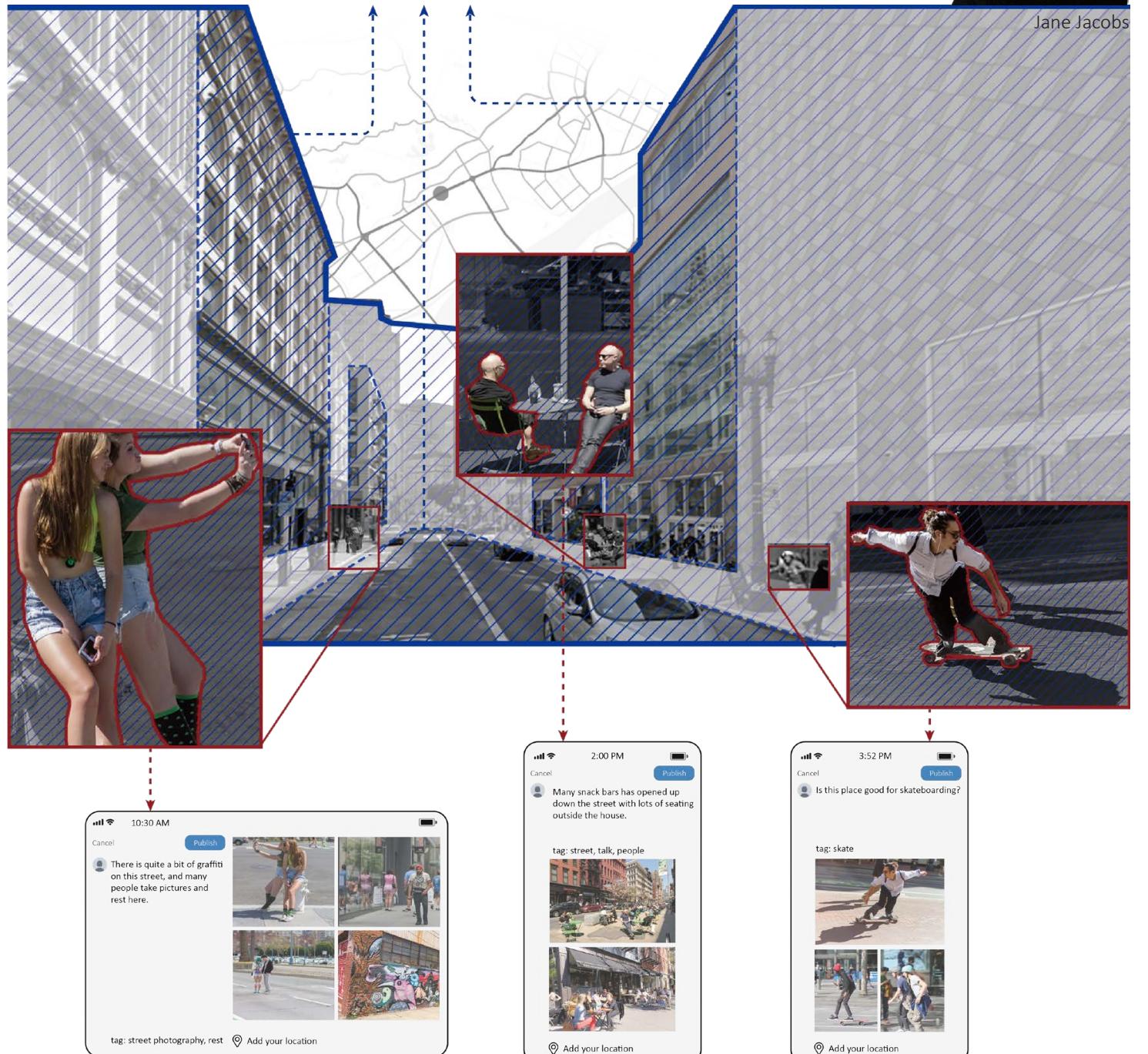
[INDIVIDUAL WORK]

This project is **inspired by some classic theories**: street richness according to **Jacobs** and **William H**'s book: *The Social Life of Small Urban Spaces*. These researchers emphasize the need for **diverse kinds of activities in the street space** in order to make the city more vibrant. In addition, with the development of various AI technologies, we can recognize cities from a more **micro perspective**.

I use **machine learning to categorize images** of crowd activity photos posted by people on **social network**, and get the richness of activity types of people in different neighborhoods through **data processing and data analysis**. This kind of more microscopic data can be the basis for city building, analyzing neighborhoods that are richer in activities and neighborhoods that are more homogeneous. At the same time, residents can view the activities in different neighborhoods in order to find a location that suits them. I created an **interactive webpage** with the results of the analysis for city planners and residents to access.

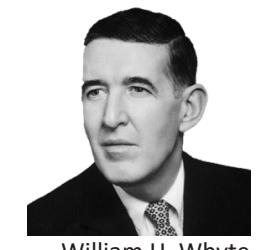
## 1. Urban diversity study

In "The Death and Life of America's Great Cities", Jacobs emphasizes that **streets are the core of the urban community** and the **street diversity** is important, representing the vitality of the city. The diversity is **measured by year of construction, facade styles, architectural function, and street width and density**. They are all **diversity of physical spaces**.

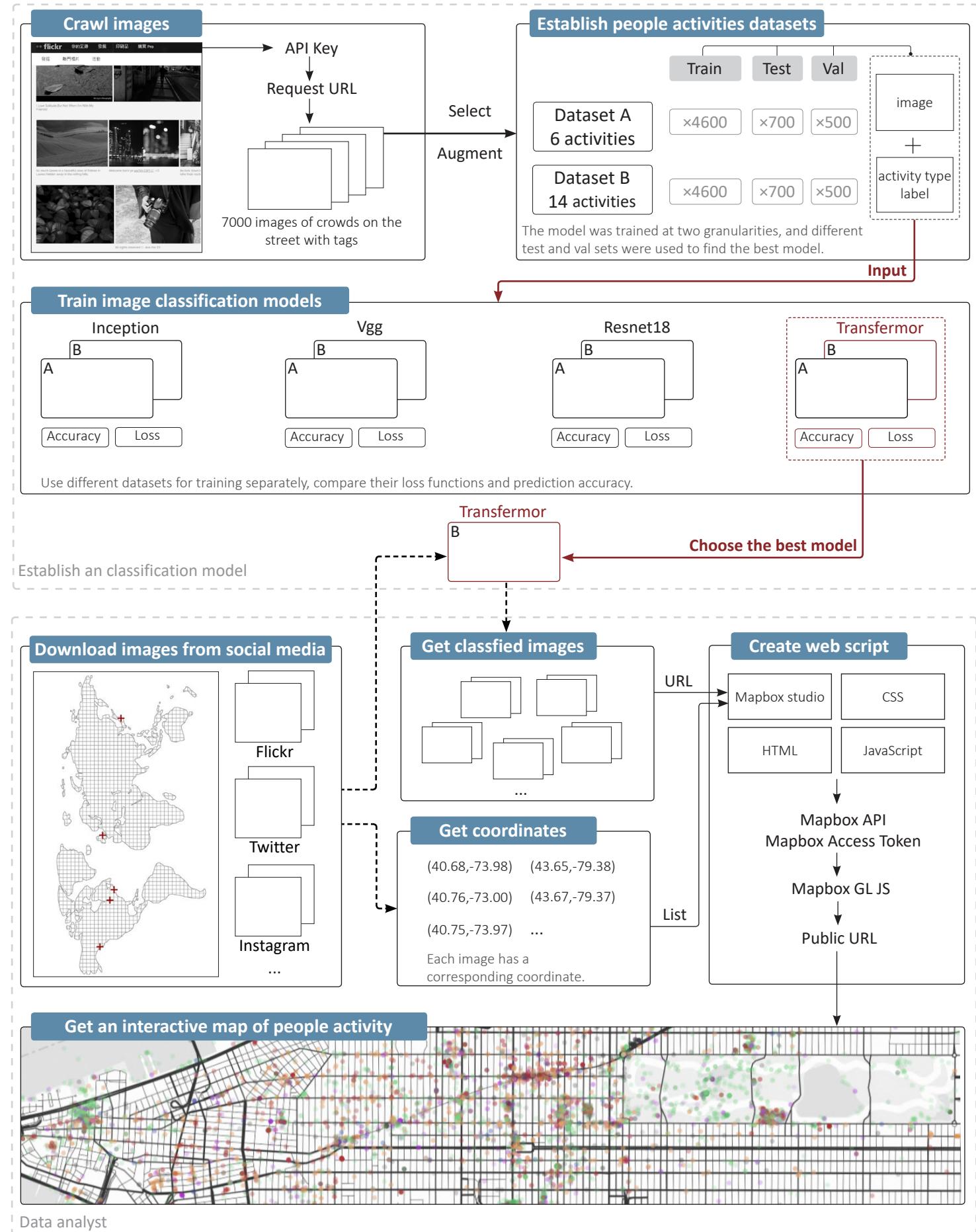


In recent years, the study of street diversity has gradually shifted **from macro to micro, from the physical environment to the people in it**, such as William H. Whyte's book: *The Social Life of Small Urban Spaces*.

I believe that with the popularization of **social networks** and the development of **computer vision technology**, we can identify **the diversity of people's activities**, and evaluate the vitality of neighborhoods.

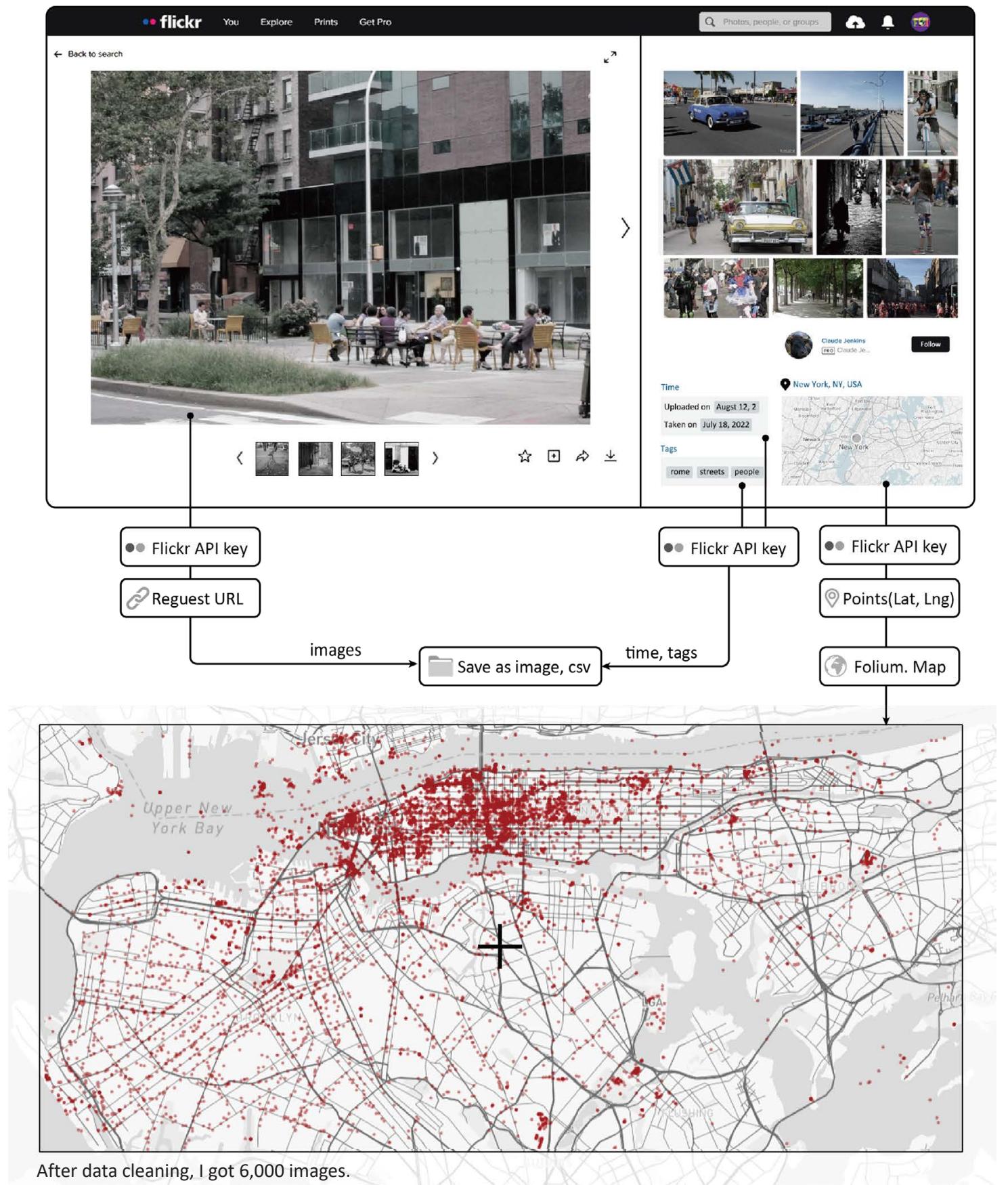


## 2. Workflow



### 3. Flickr image crawling and processing

According to tag and time, I **crawled images related to people street activity** near New York from the Flickr website, and saved the pictures and tag, time, coordinates, user description and other information.



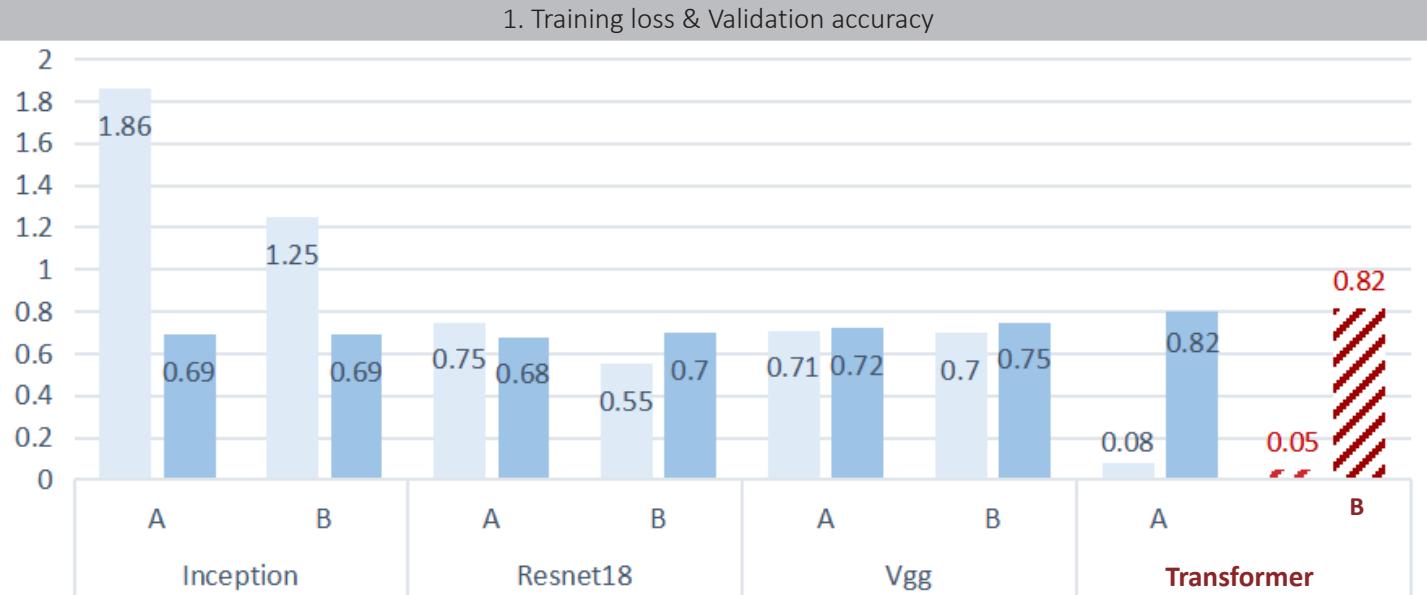
### 4. Activity classification

Reclassify downloads according to tags and contexts of images, and **establish two datasets about categories of people activities with different granularity**. The first is more abstract and has 6 categories, while the second is more concrete and has 14 categories.

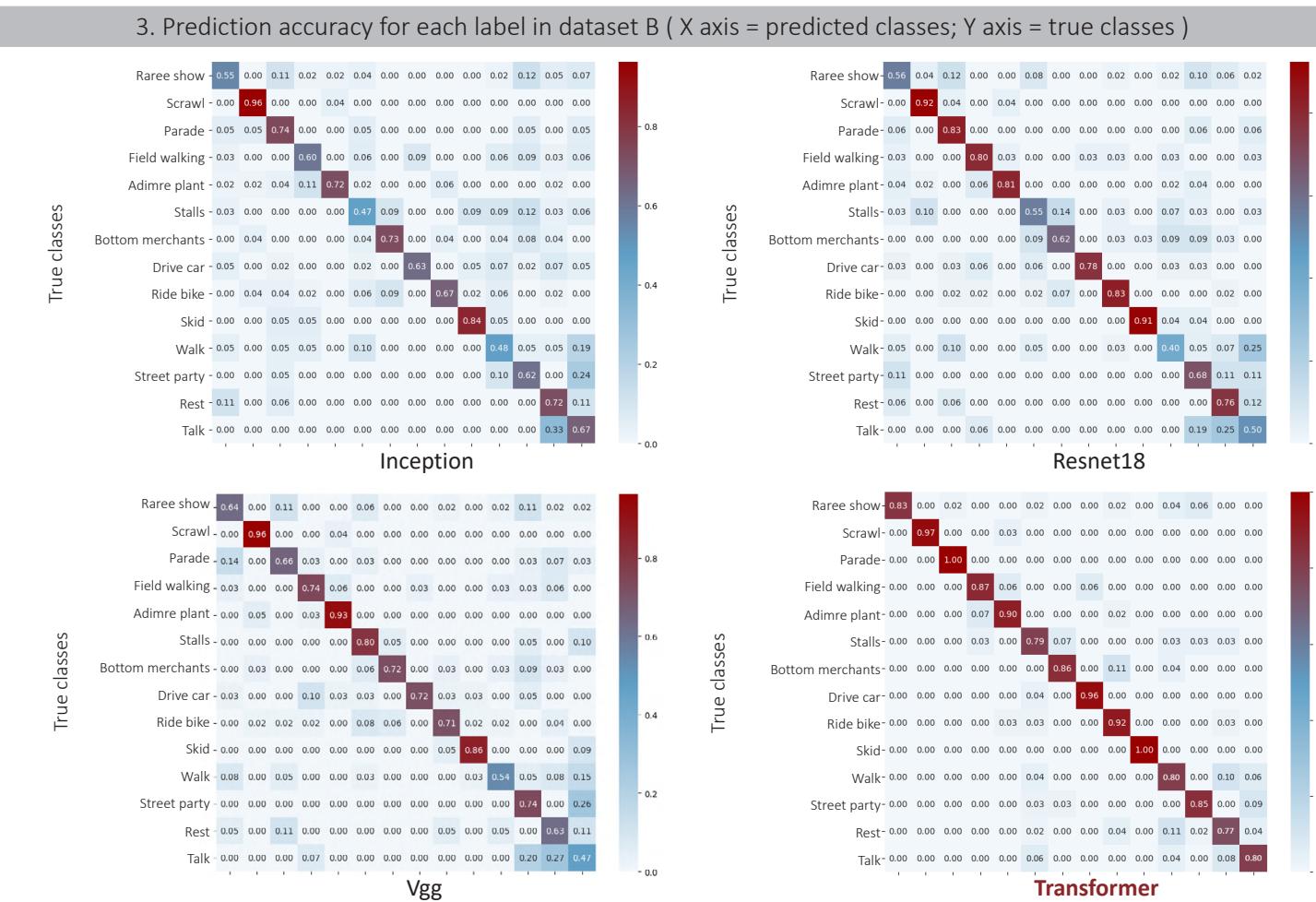
Dataset A: Primary classification	Dataset B: secondary classification	Examples	Tags	Amount
Art	Raree show		Art parade, street music concert, street dance...	x350
Scrawl			Street graffiti, wall graffiti	x350
Political	Parade		Political protest, political march	x350
Nature	Field walking		Strolling in the countryside, enjoying nature, leisurely walk	x350
	Adimre plant		Admiring plants, Appreciating flora, botanical beauty	x350
Commercial	Stalls		Street vending, sidewalk sales, stall selling	x350
	Bottom merchants		Wholesale selling, bulk purchase, trade discount	x350
Traffic	Drive car		Car, automobile, vehicle, bus, transit	x350
	Ride bike		Bicycle, motorcycle	x350
	Skid		Skateboarding, skate, boarding	x350
	Walk		Pedestrian, walker, foot traveler, passerby, pedestrian passerby	x350
	Street party		Street gathering, festival celebration, public festivity	x350
Leisure	Rest		Resting, unwinding, relaxing alone	x350
	Talk		Chat, conversation, small talk, chit-chat	x350

## 5. Image classification model training & Analysis

Using dataset A and dataset B respectively. The results of training and testing of four different image classification models are as follows:

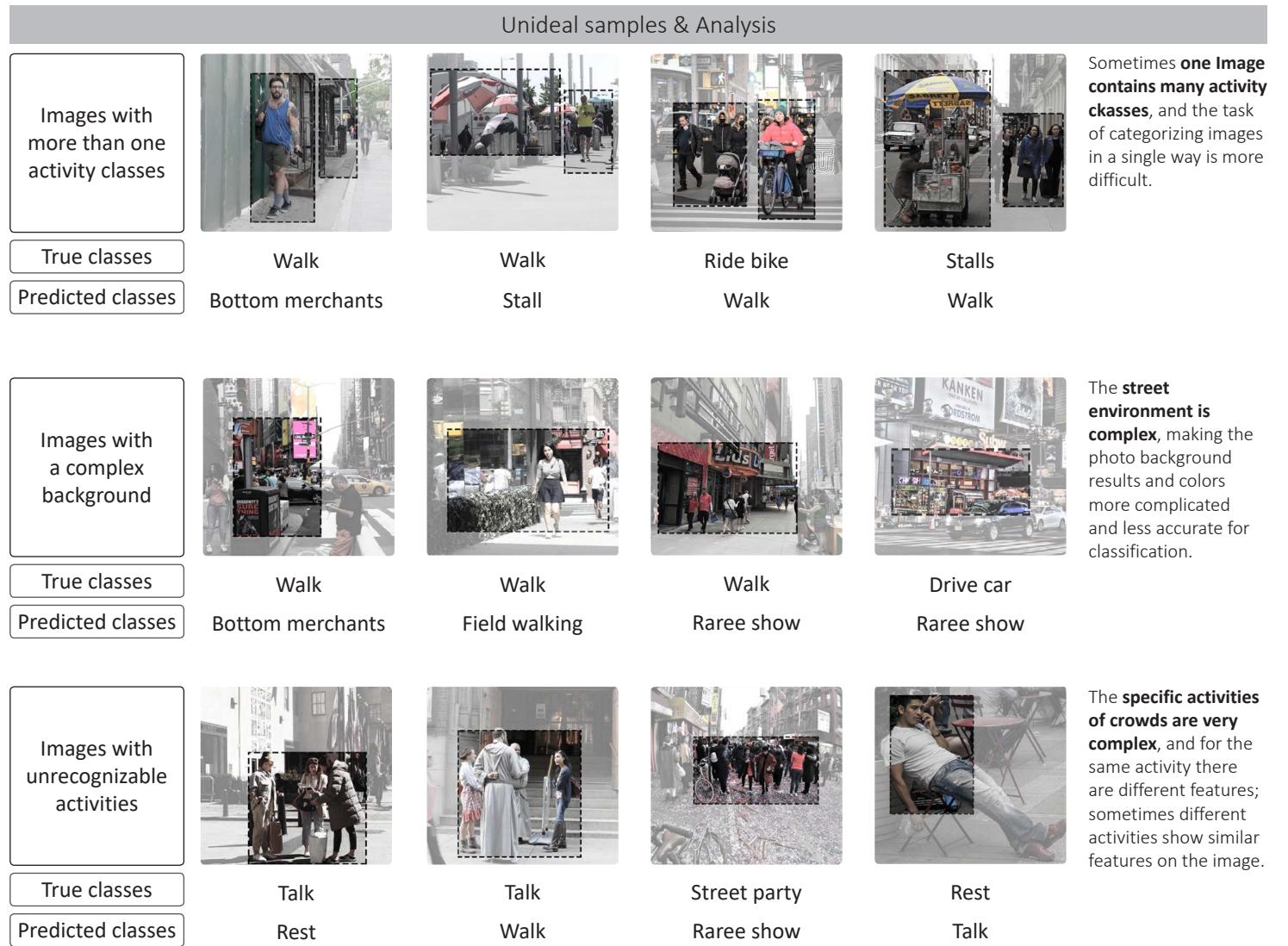
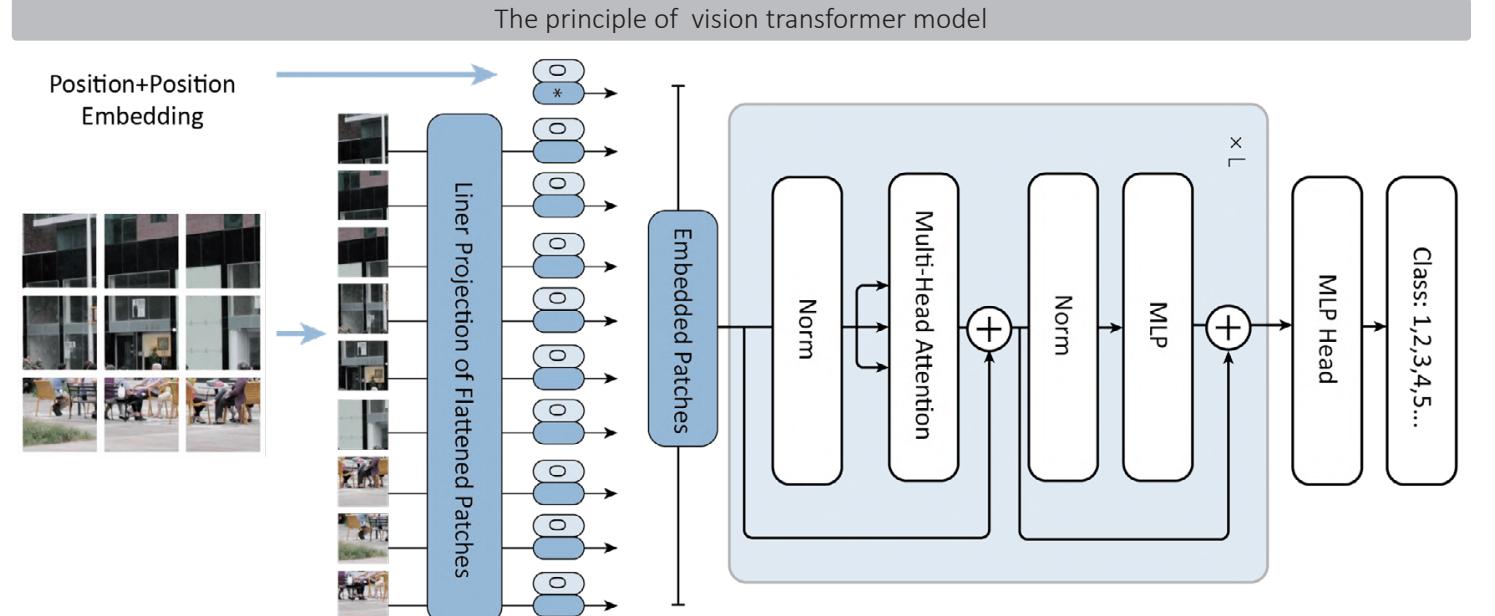


Conclusion 1: Using dataset B consistently yields better results compared to using dataset A. Besides, the classification model based on **Transformer architecture** achieved the lowest loss and highest accuracy.



Conclusion 2: The prediction accuracy is calculated separately for each class of images, and the classification model based on the **Transformer structure** performs the best.

I have chosen the transformer based image classification model for my research. I analyze the principle of the model and the factors in the dataset that affect the learning efficiency of the model.



## 6. Visualizing the activity diversity of crowds in New York

The **trained Transformer model** is used to classify New York photos posted on social media and four representative streets are selected for analysis. The analysis allows us to understand the spatial and temporal distribution of street activity. Urban planners can then rationalize street improvements based on the abundance of street activity.

Calculating abundance using the **Shannon Index**.  $H = - \sum_{i=1}^S p_i \cdot \log_2(p_i)$ ,  $p_i = \frac{n_i}{N}$

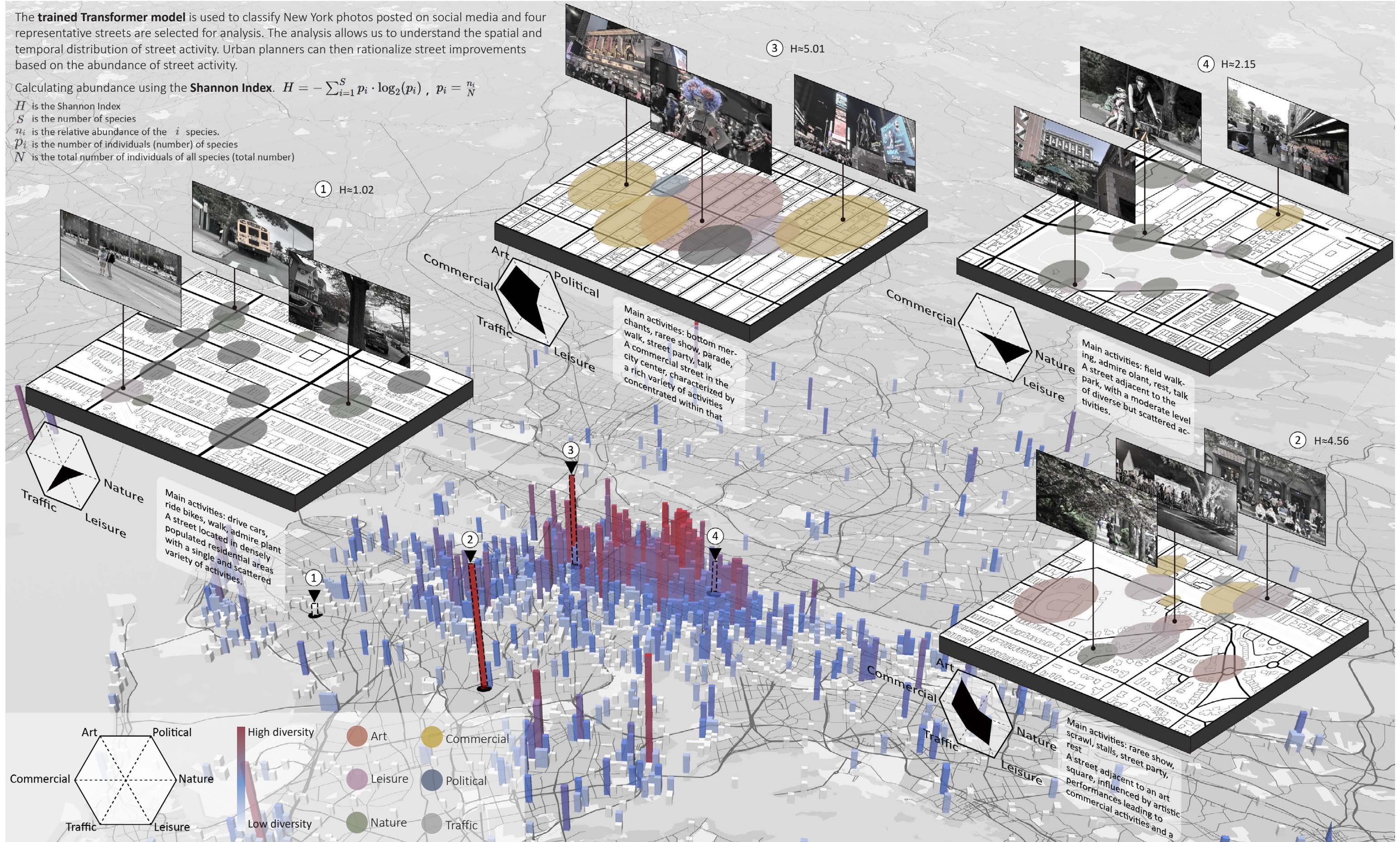
$H$  is the Shannon Index

$S$  is the number of species

$n_i$  is the relative abundance of the  $i$  species.

$p_i$  is the number of individuals (number) of species

$N$  is the total number of individuals of all species (total number)



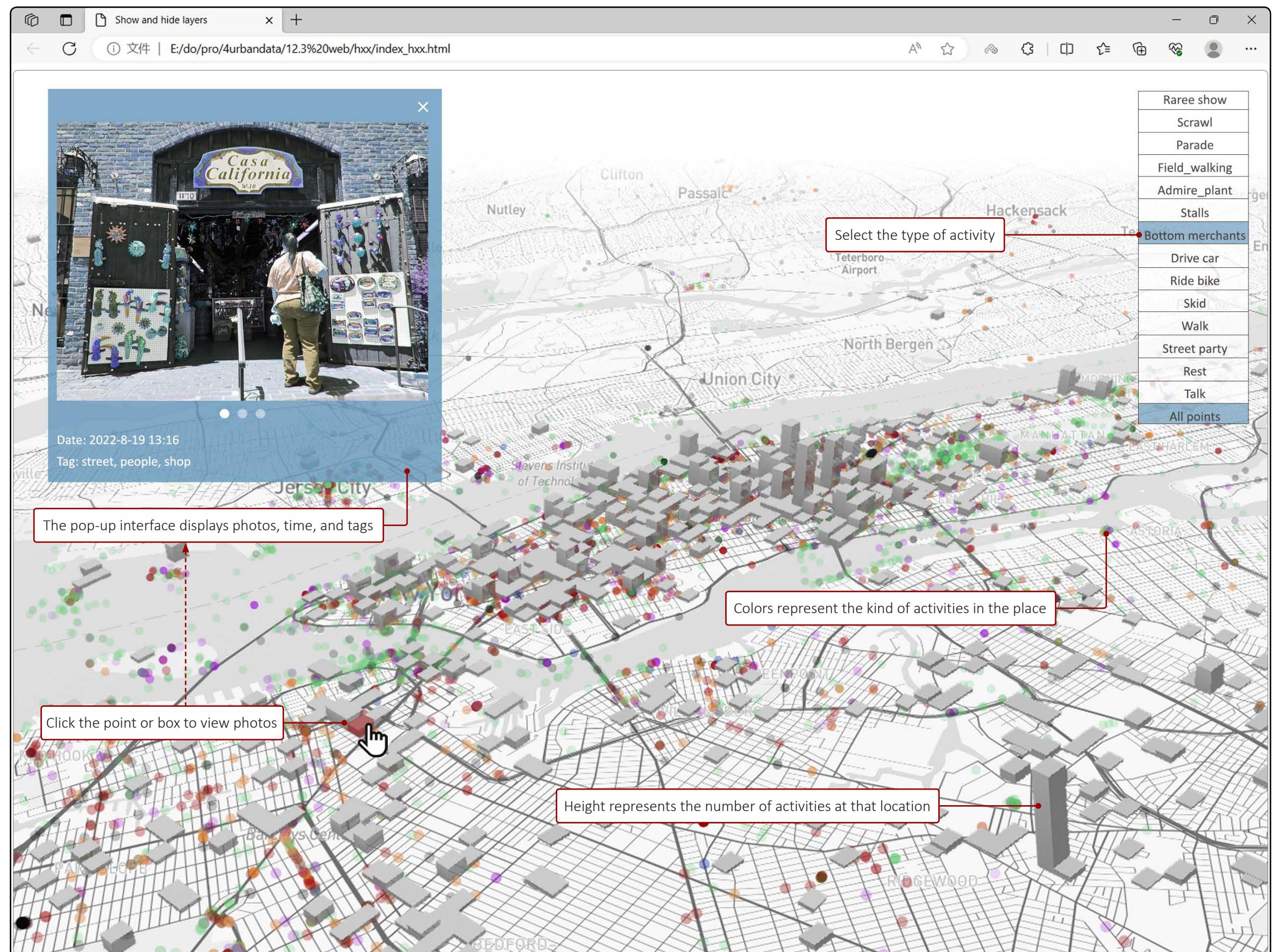
## 7. Interactive webpage

I have used the model's prediction results to create an **interactive webpage** with Mapbox.  
Users can switch between layers to view the location of various activities and click on specific locations on the map to view corresponding crowd photos.

On one hand, this webpage aims to assist city residents in finding streets where **specific activities take place**.



On the other hand, this webpage provides the government with insights into the diversity of activities on city streets, serving as a **reference for city redevelopment**.



## Other work 1

### [TIME]

2023.7-2023.10

### [INSTRUCTOR]

Xiang Zhou

### [TEAM MEMBER]

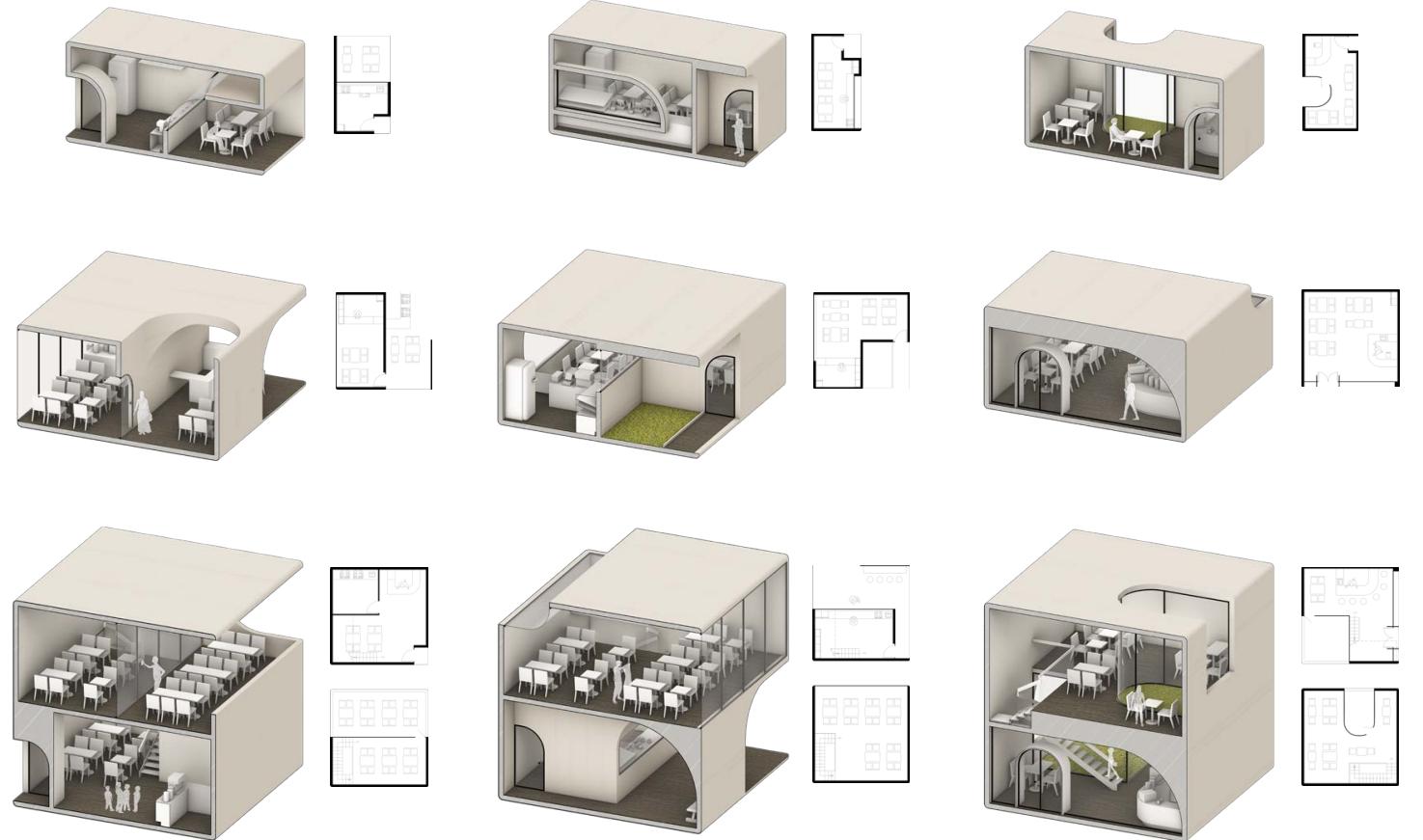
Mai Chi, Yixuan Wu,

Yating Ye

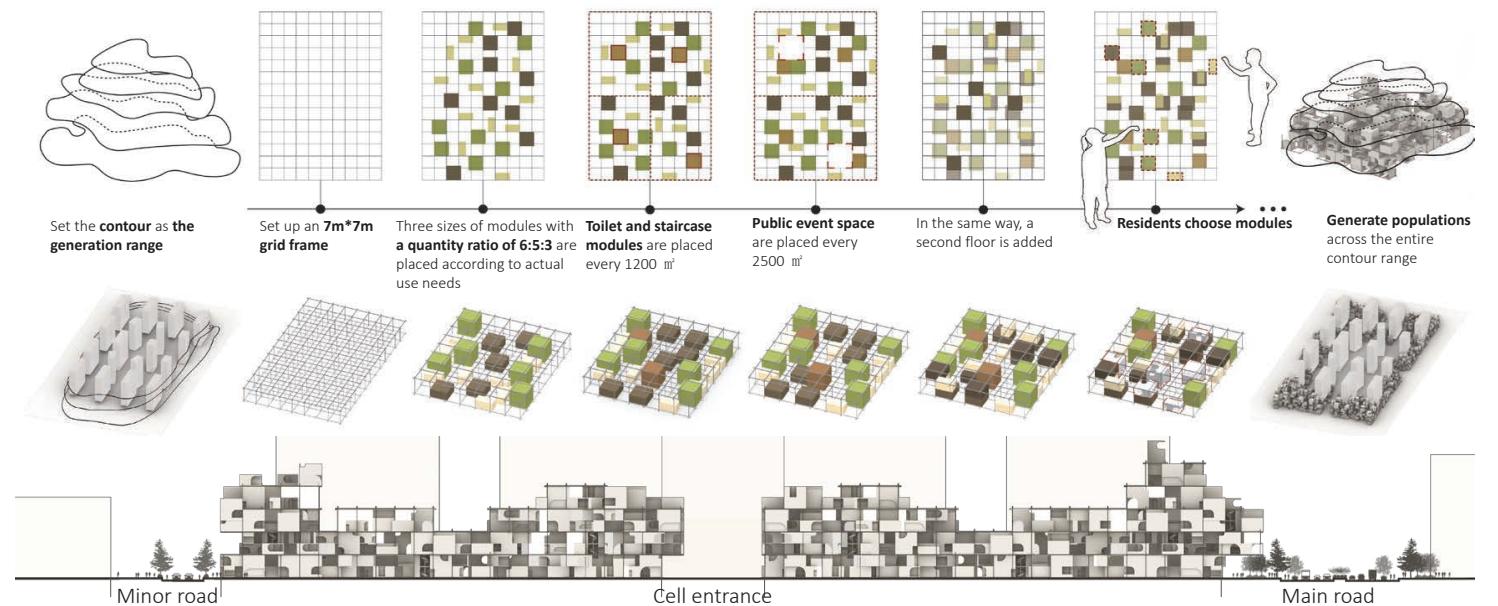
## Parametric architectural design: Farm-to-Table Community Catalyst

Lanzhou New District in Lanzhou City, Gansu Province, China, is the result of rapid urban expansion and is located on the edge of the city, lacking humanized recreational and service facilities and vitality. The goal of our project is to build a set of general-purpose residential peripheral buildings that provide a platform for residents to eat, play and socialize.

In the first step, we extracted the characteristics of Lanzhou's traditional architecture, the kiln, and designed nine standardized modules that encompass a variety of functions and scales.



In the second step, using parametric technology, different combination forms can be generated for different site conditions.



These module combinations can be used anywhere in Lanzhou's new districts where there is a need to increase the vitality of neighborhoods and streets. It becomes an important place of leisure and interaction for urban residents.



## Other work 2

### [TIME]

2022.3-2022.5

### [INSTRUCTOR]

Runjia Tian

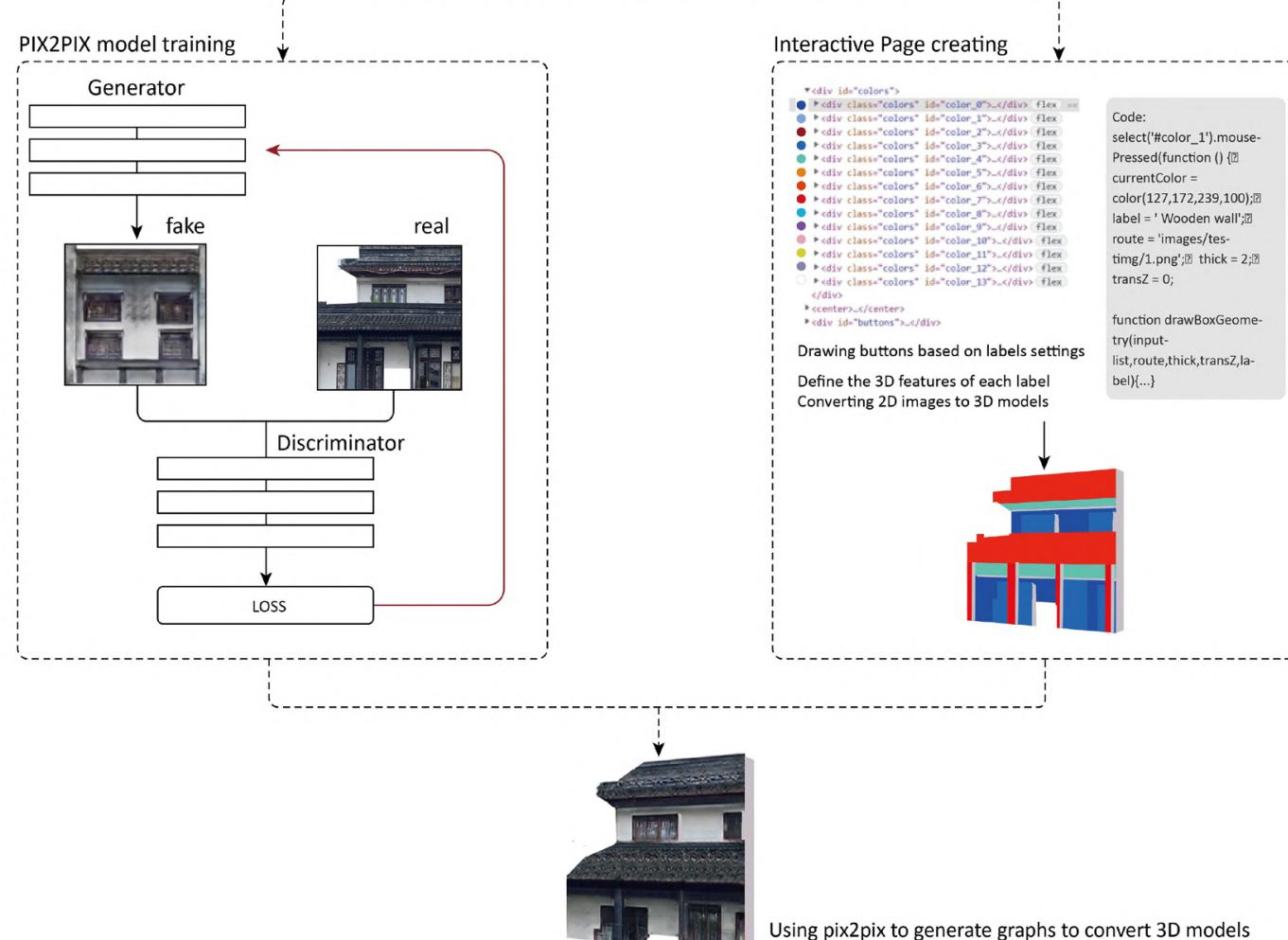
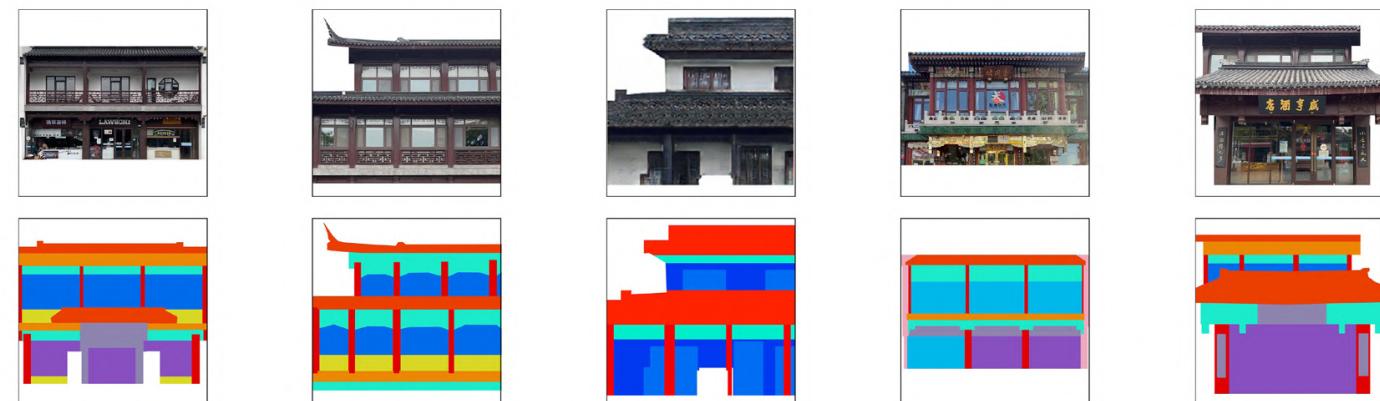
### [TEAM MEMBER]

Qian Wang, Yibei Li,  
Siqi Zhang

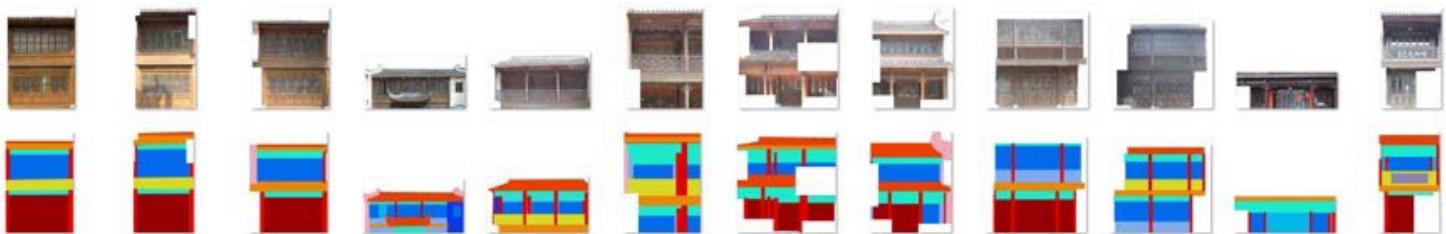
## Style migration machine learning: Migration of architectural styles in southern China

We trained a pix2pix model according to the characteristics of Hui Style architecture in southern China. It can be used for style migration for places that need to be decorated in Chinese architectural style, such as Chinatown in the Netherlands.

It helps designers to design buildings with Chinese facades without changing the local architectural style, creating a sense of belonging for people in that area.



In the first step, we trained a pix2pix model to find the best generated dataset through many label changes.



In the second step, we created a web page where residents or designers could freely draw the facade composition of the building and generate facades in the style of Chinese Huizhou architecture.

