Br(AI)n City [I] :

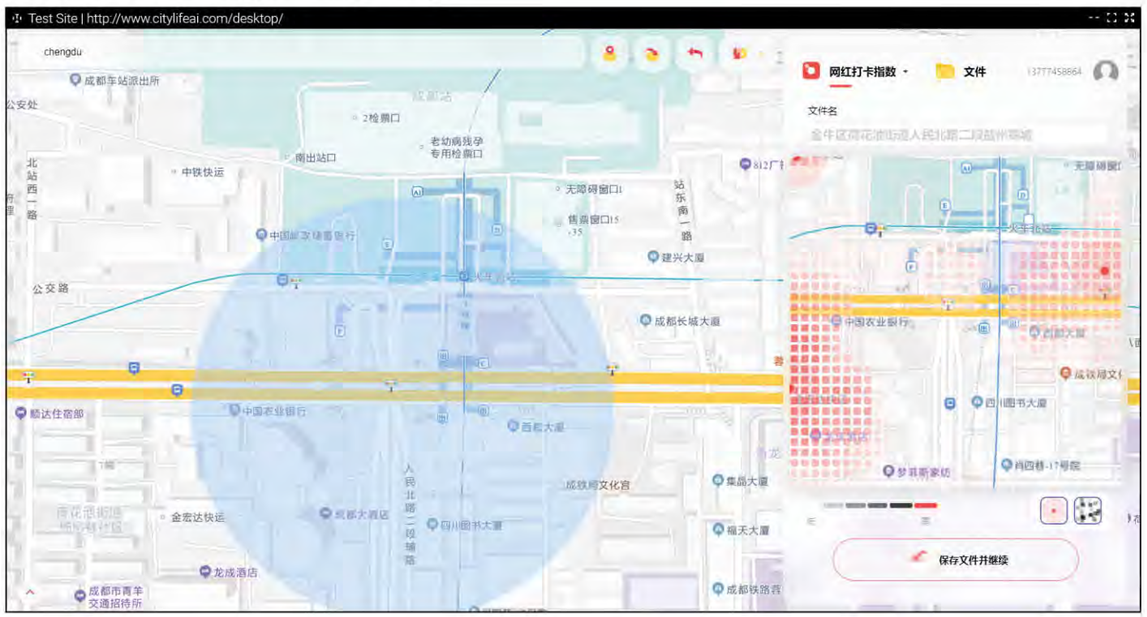
A Computing Platform Based on Urban Morphology to Help Preceive City Images

My Role: ***Concept, Back-end Development, Cloud Computing Deployment, Image Processing, Data Crawling, Rest API Programming & Documentation.*** *You can find more information including the instruction about the website through clicking on this button.*

The Instruction for Web Application

Contents

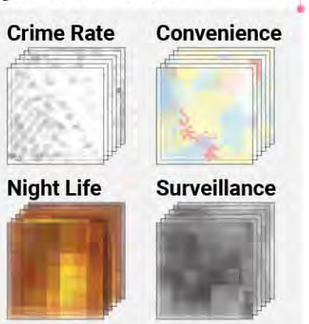
Test Site: The Digital City Image



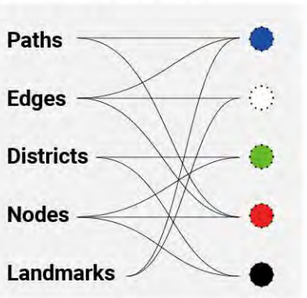
"... analysis of existing form and its effects on the citizen is one of the foundation stones of city design, and in the hope that some useful techniques for field reconnaissance and citizen interview might be developed as a by-product." *(Kevin Lynch)*

Computational Design System Based on Public Image

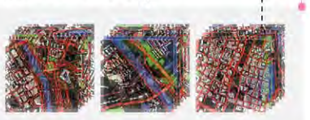
Perceptual Maps Generated by Professionals



Urban Elements



Labeled Maps



Identity

- RESIDENT
- ENGINEER
- RESEARCHER
- DESIGNER
- DECISION MAKER

Data Source

Data Collection

Data Cleaning

Data Analysis
Sort data
Construct table, graphs
Look for patterns
Hypothesis generation

Conclusion
Interpretation
Conclusions
New ideas
Communications

Computational Model
Construct features
Models Training
Accuracy Validation
Feedback, Suggestions

Problem
Understanding and defining the problem

How do we go about answering this question?

Plan
What to meature and how?

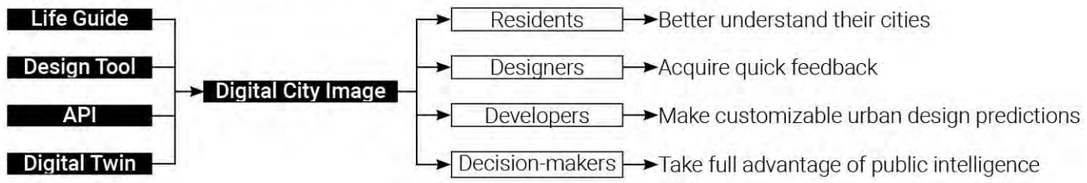
Study design?
Recording? Collecting?

Our Cities
Plan
Construction
Management
Operation
Maintenance
Renovation

Based on the public image proposed by Kevin Lynch, we've developed a prototype web application called "Digital City Image", which is a map of urban sensations in the context of the contemporary digital age aiming to help more individuals participate in a process of visually communicating their urban perceptions.

01 Highlights

- As an city image forecasting tool, "The Digital City Image" can provide designers or citizens with an assessment of urban current state in various aspects, for sites with or without built environment data.
  - It serves as a guide to our urban life, allowing users to have a better understanding about the place where they live and work.
  - As a design aid tool, it can also provide quick feedback to designers on the distribution of areas with insufficient or high vitality, etc.
  - The API of our web application can help developers make more freely customizable urban design predictions.
- *(Further Study)* As a form of digital twin of cities, in the future, the platform can record user preferences and the whereabouts of groups, thereby helping city decision-makers to make decisions based on public intelligence.



02 Background

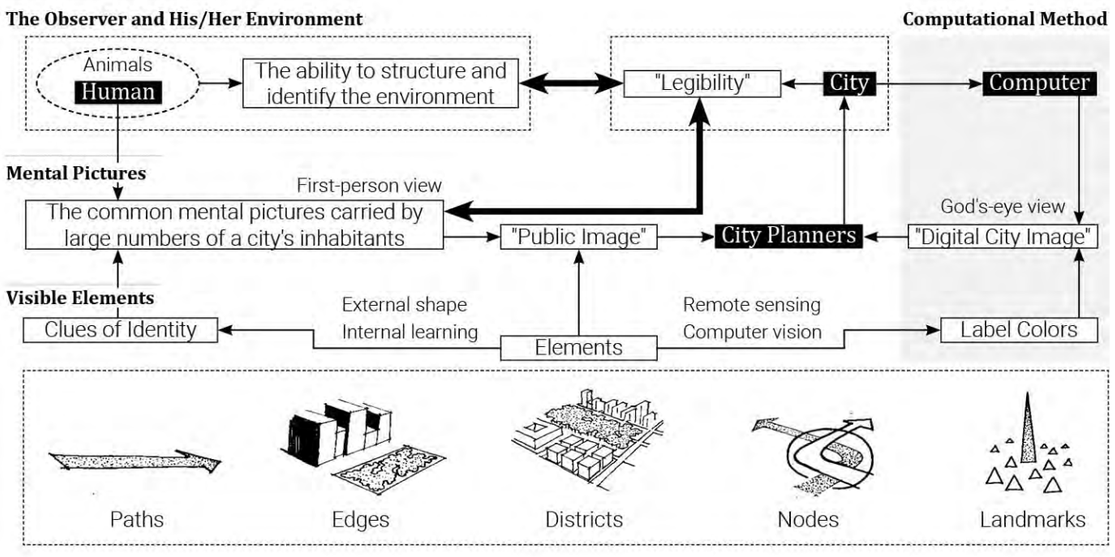
In his book "The Image of the City", Kevin Lynch explains that our cities has "legibility", which can be consciously remolded through manipulating the physical settings. Meanwhile, structuring and identifying the environment is a vital ability among all mobile animals. More specifically, for us, the inhabitants of the city, the complexity of the city itself compels us to to develop our image of the environment by operation on the external physical shape as well as by an internal learning process.

Most residents have a common mental image of the city, and it is this mental image that can help planners to create a physical environment that can give the public a sense of emotional security.

However, past approaches to finding urban images are no longer sufficient to cope with the current digital era, and we need computer tools to expand our limited perceptual capacity to cope with an increasingly complex and rapidly changing urban cultural environment.

"The Image of the City": The "legibility" of the environment avoids the sense of anxiety and terror from "lost".

03 Concept Brainstorm



04 Clues of Identity in Different Conditions

The identifiable characteristics of the same type of places are not consistent in different regions or periods.

Identifiable characteristics of sacred space:

1. In the the primitive period, campfires and stone piles mark the temporary ritual function of the space.

2. Built in 1713 to pray that the Viennese would never again suffer from the plague of the Black Death, the church's central layout, baroque frescoes, and light over the altar clearly identify the function and intent of the setting.

Identifiable characteristics of the residential areas:

3. The north elevation of an old neighborhood in China in the 1990s, the water pipes on the building facade, the security windows and air conditioning units built by residents on their own initiative afterwards.

4. A modern Japanese residence of the last few years, with a minimalist façade and a south-facing balcony.

Identifiable characteristics of the street market:

5. A contemporary Japanese night market with dense storefront light signs on both sides of the street with high and low staggering.

6. A market bridge from the Northern Song Dynasty in China, with bazaars arranged on both sides of the arched bridge.

05 The City Image's Elements in the Eyes of AI: Label Color and Shape

255,0,0

Red is **"paths"**, which are the dominant urban elements, while the intersecting shapes identify the nodes, and the wide carriageways can become **"edges"** for pedestrians.

0,0,255

Blue is water, for some lakes, it is possible to be **"landmarks"**, while canals are also **"paths"** in the city, and the boundaries where blue meets other colored areas are possible **"edges"**.

0,255,0

Green are green areas and parks, which are obvious **"districts"** or even remarkable **"nodes"**.

255,255,255

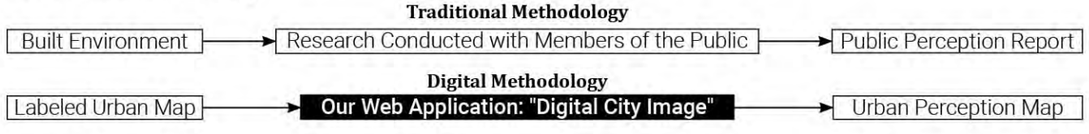
White for buildings, which becomes **"landmarks"**, scattered in the city; too enclosed and continuous graphics, which may also become walls and **"edges"** in the city.

0,0,0

Black, whose correspondence with urban elements is also related to its shape. It can be courtyards and squares, i.e., **"districts"**, or **"nodes"**.

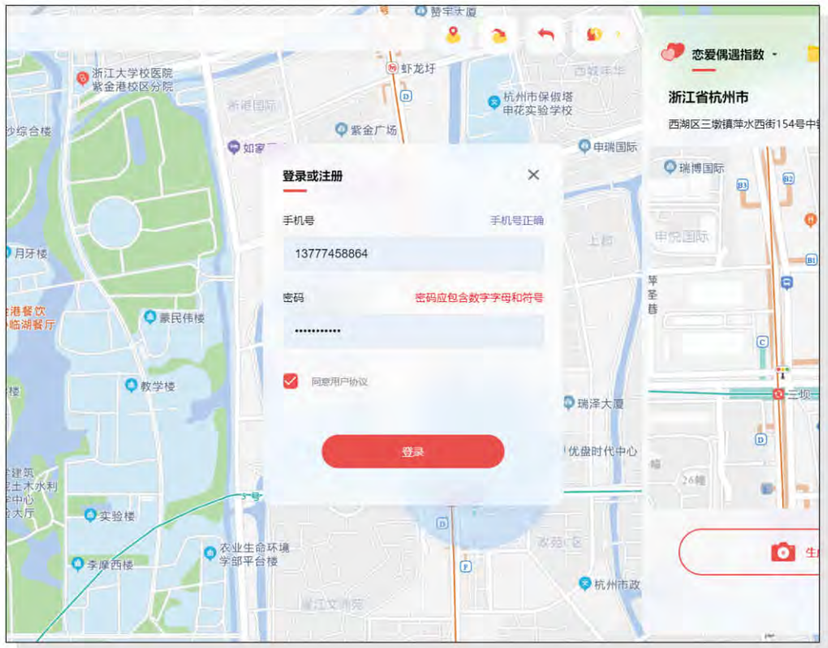
06 The New Opportunity

With the help of computers and remote sensing technology, we can have a God's-eye view of the whole "mountain", not just the sides of Everest like the Sherpa.



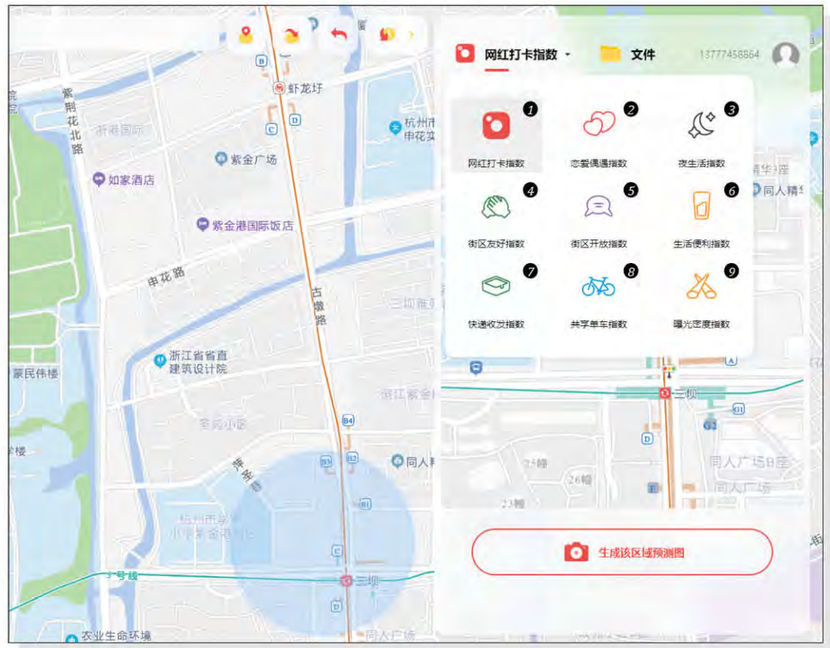
This section describes how to use "Digital City Image" we have developed and the potential interaction of different identities of urban-development participants with the digital map.

07 Brief Interaction of "Digital City Image"



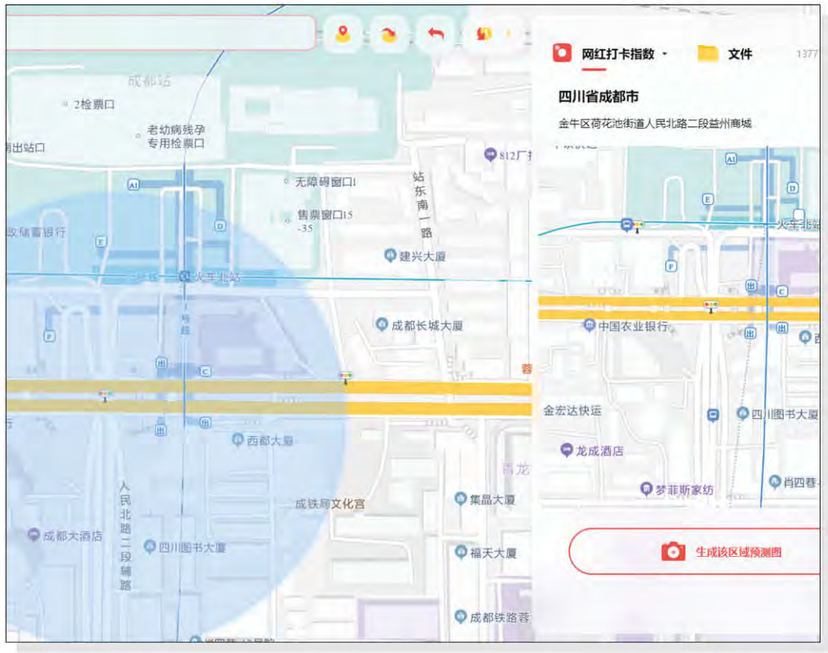
(i) Log in

You can log-in with a Test Account: 13888888864 (Password: zixun363837). Or enter any 11-digit number to create a new account. *If there is any problem, please check the complete usage instructions again.*



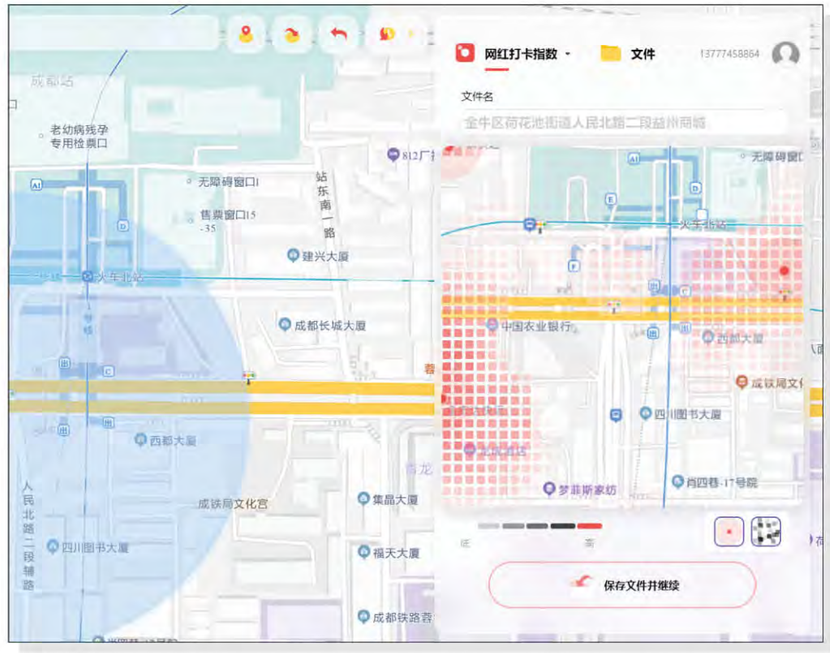
(ii) Select category

You can select the map of your desired city intentions, in numbered order such as the indices of influencer density, love encounter, nightlife, neighborhood friendliness, life convencience, express delivery, bike sharing, surveillance density.



(iii) Locate

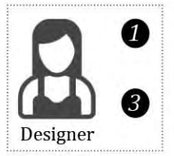
You can use the search bar or move the translucent blue circle cursor to select the area you want to predict; the circle cursor has a diameter of 300m on the map.



(iv) Predict

The floating panel on the right side of the screen is used to display the prediction results and you can click on the long bar at the bottom to start the prediction. After a short wait, the corresponding heat distribution will be displayed above.

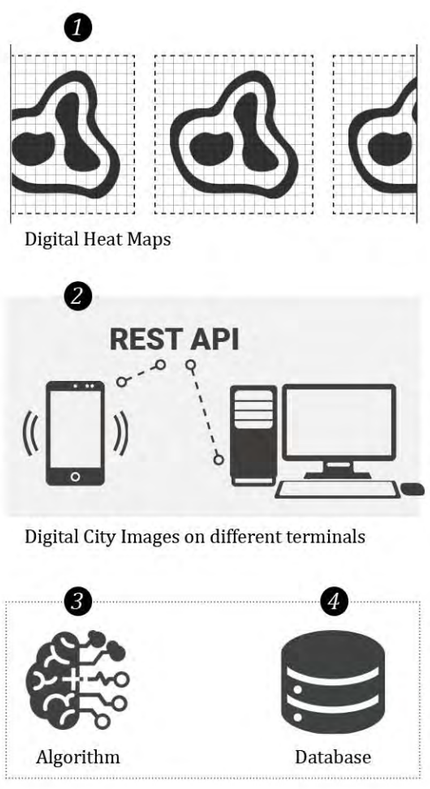
08 Different Professional Participants



Researchers and designers select data based on their own research and experience with cities, define metrics, and use econometric or artificial intelligence algorithms to build predictive models.
At the same time, they can access the visualization results of other researchers' urban prediction models in the visualization interface. The open communication platform can facilitate the exchange between researchers and designers and prompt them to identify more problems in cities.

Developers and engineers build algorithm management systems, deploy fully validated models on the server side, and open the predictive models to other developers and residents in the city through Web development and API deployment.

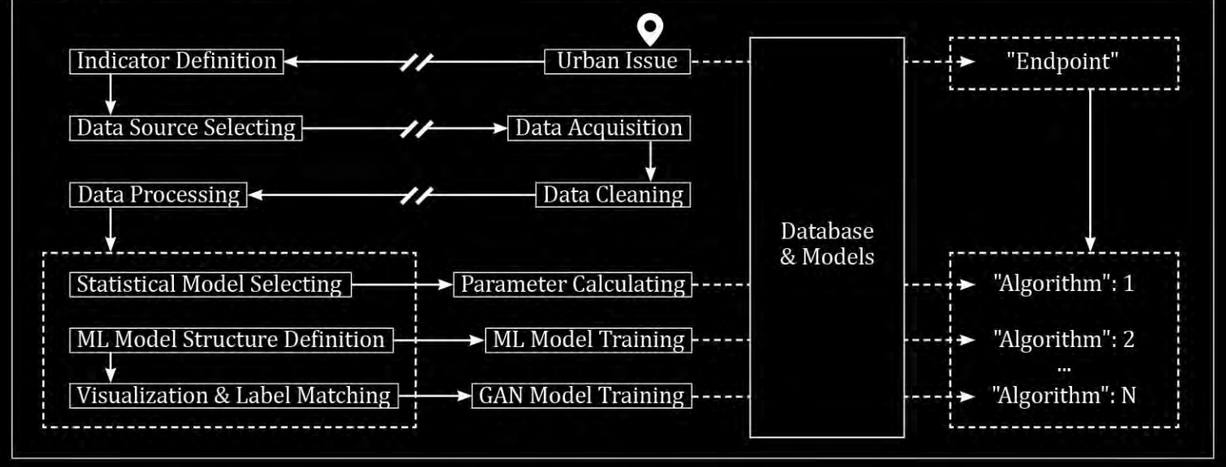
Residents of a city can access a wide variety of city impressions to learn more about the city they live in, the city they want to visit, and possible places to work. At the same time they are the source of data on city behavior, laying the foundation for public intelligence.



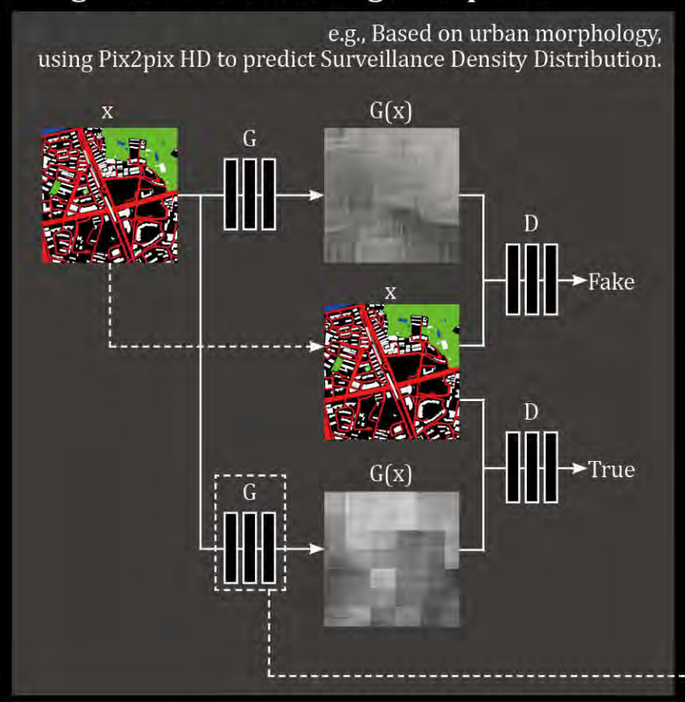
Algorithm Definition & Web Development

I designed the entire architecture of the application prototype. An urban problem can be comprehended by researchers into a variety of algorithms, which are associated with the corresponding issue endpoints in the database.
ABTest is used to find and iterate over the relatively better algorithms. In the case of pix2pix HD, the generator produced by researchers is embedded in a custom class variable and stored in the variable space of the server memory, waiting to be called.
Algorithms and problem endpoints are programmed into the Django framework, and predictive models are translated into APIs to communicate with interactive pages written on the front-end. The complete web application is made available to the public network through Nginx and Frp proxies.

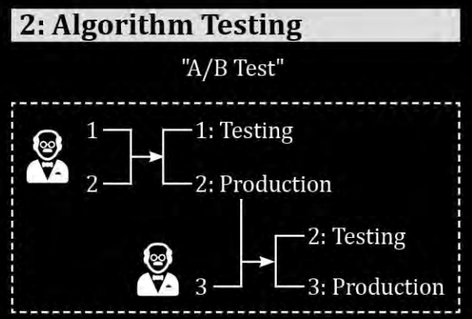
1: Algorithm Definition



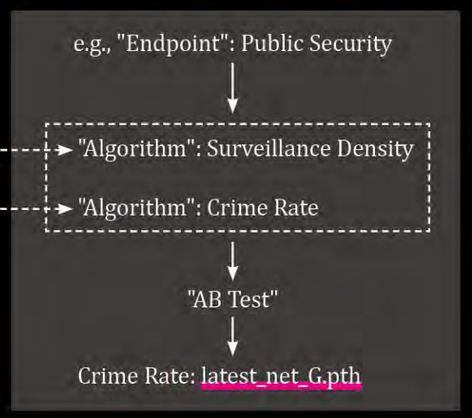
Algorithm Definition, e.g., Pix2pix HD



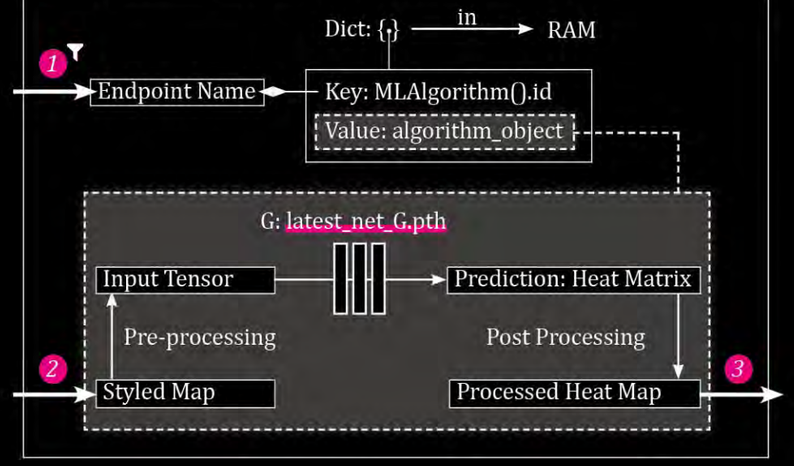
2: Algorithm Testing



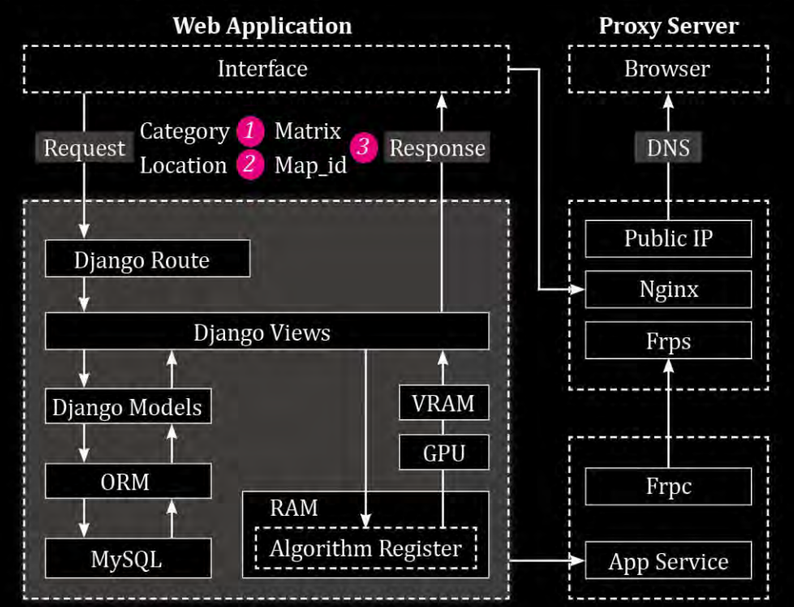
A/B tests, also known as split tests, allow us to compare 2 versions of something to learn which is more effective. We will iterate on our algorithm in the future by collecting user access counts and feedback.



3: Algorithm Register in Server Memory



4: Web Development



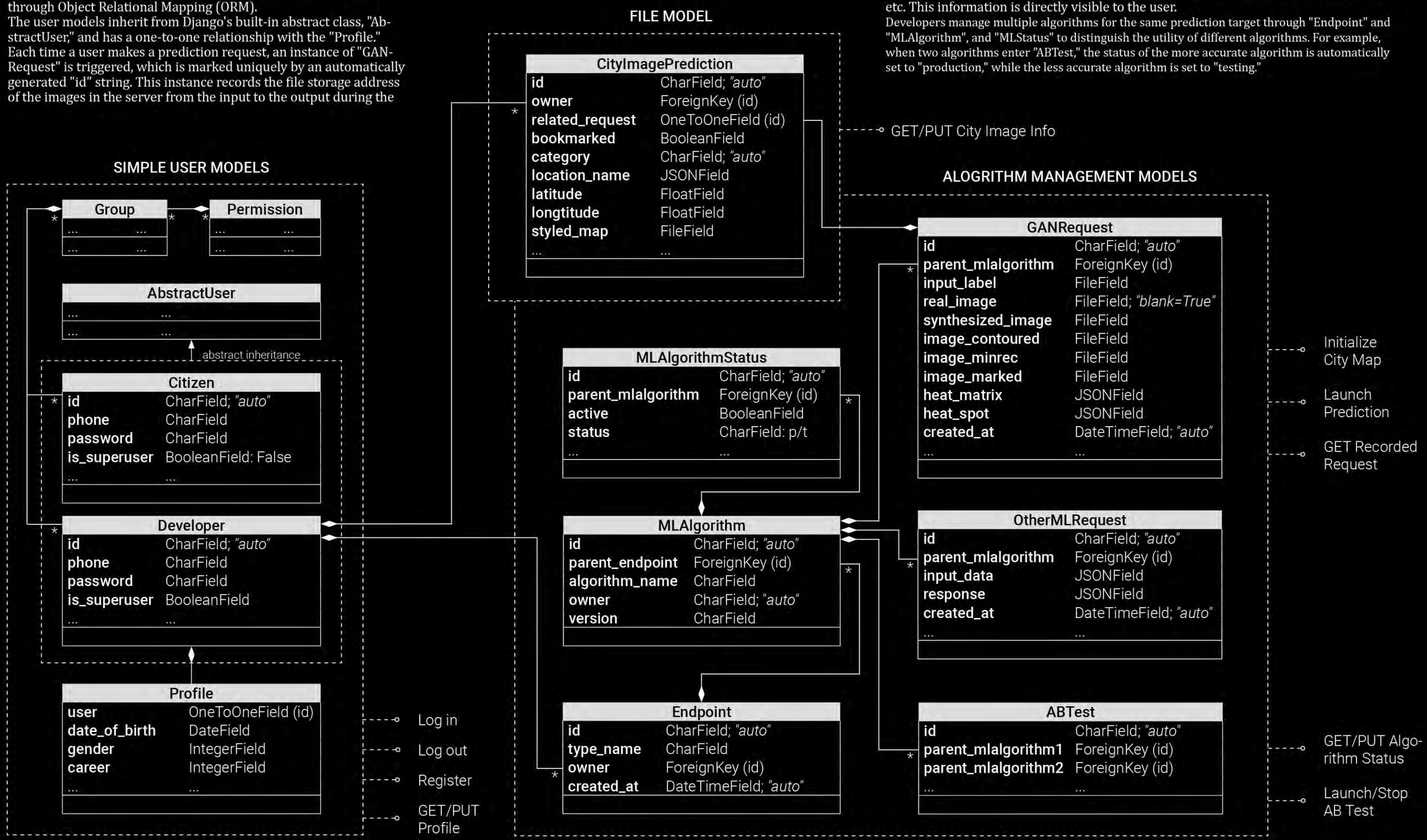
Tools

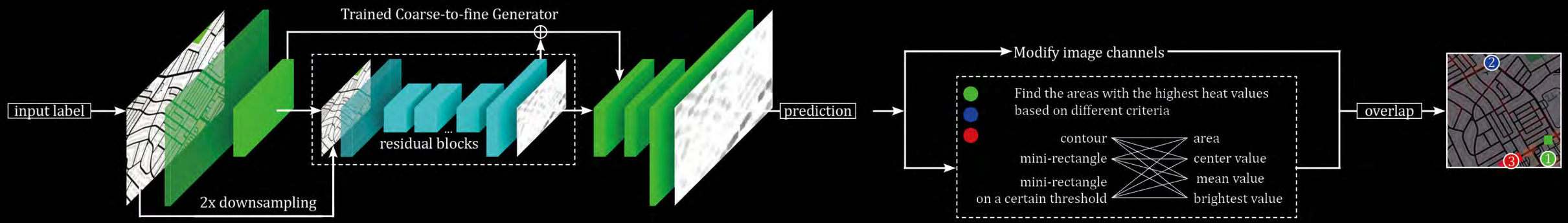
NGINX · React · Redis · MySQL · django · Python

Frp Version Demonstration

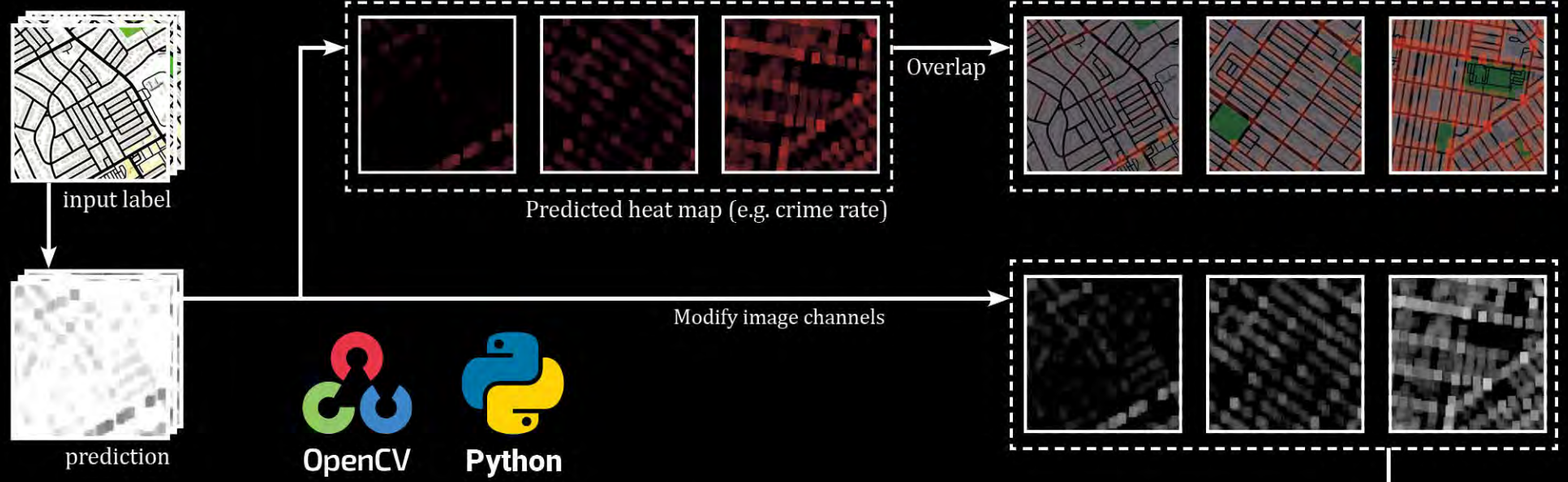
DataBase & Models

The back-end data logic is divided into three parts, user, file, and algorithm, each consisting of multiple interrelated custom classes, which are meanwhile linked to the relational database MySQL through Object Relational Mapping (ORM).
The user models inherit from Django's built-in abstract class, "AbstractUser," and has a one-to-one relationship with the "Profile." Each time a user makes a prediction request, an instance of "GANRequest" is triggered, which is marked uniquely by an automatically generated "id" string. This instance records the file storage address of the images in the server from the input to the output during the prediction process, as well as the specified algorithm instance.
More information about the prediction is recorded in the model "CityImagePrediction", such as latitude and longitude of the predicted points, styled maps, heat matrix, etc. This information is directly visible to the user.
Developers manage multiple algorithms for the same prediction target through "Endpoint" and "MLAlgorithm", and "MLStatus" to distinguish the utility of different algorithms. For example, when two algorithms enter "ABTest," the status of the more accurate algorithm is automatically set to "production," while the less accurate algorithm is set to "testing."



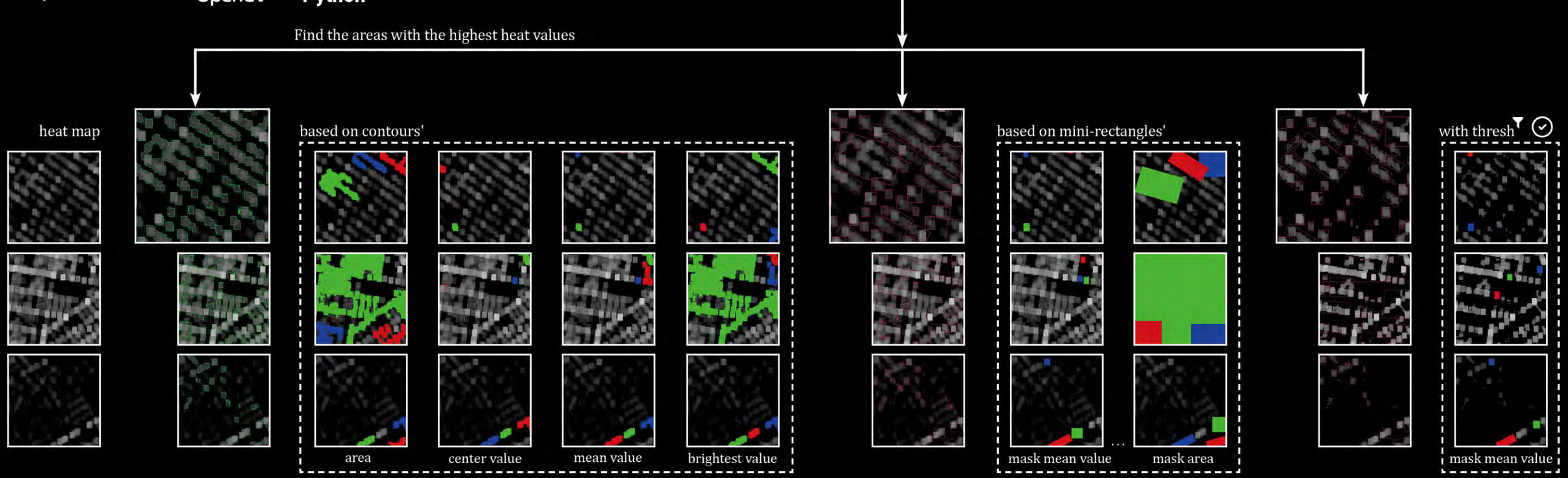


Here's an example of how I found a general algorithm for filtering the highest heat areas from a variety of heat maps.



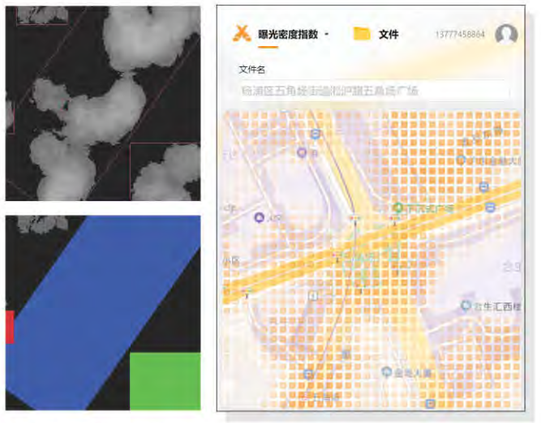
Post Processing

After the labeled image of the map is sent to the server, the trained generator network produces a corresponding heat map based on the labeled image.
This heat map can be overlaid with the original map by transforming the image channels to generate a transparent map to convey the distribution of urban impressions to the citizen who publish the request.
Meanwhile, through the image processing algorithm, the heat regions are extracted with contour lines (cv2.findContours), or contour lines of areas above a certain threshold (cv2.THRESH_BINARY + cv2.THRESH_OTSU).
Then the contour lines are further extracted with the corresponding minimum outer rectangle.
By sorting the area, geometric center color value, average color value, and brightest color value of the contour lines or outer rectangles. The algorithm is able to filter out the three areas with the highest heat values, which are then labeled as green, blue, and red.



(i) Express Delivery

The courier delivery in Wujiao Square is mainly gathered in the upper right corner of the area, which is a mixture of offices and hotels.

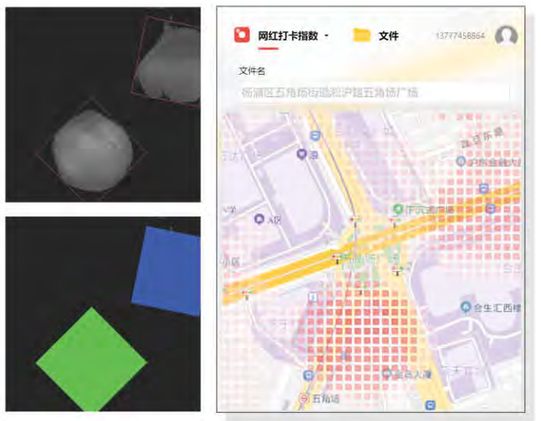


(ii) Surveillance Density

The plaza itself, the upper right corner, and the area below all have relatively high monitoring densities, while areas with lower surveillance densities are more likely to have crime.

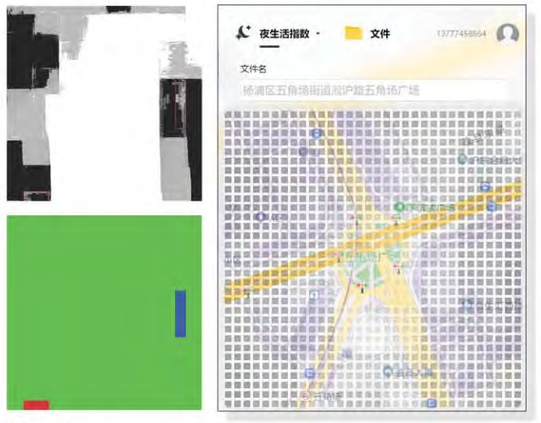
(iii) Life Convenience

The road leading northwest from the sunken plaza is considered to be the most convenient, with more stores along the street here.



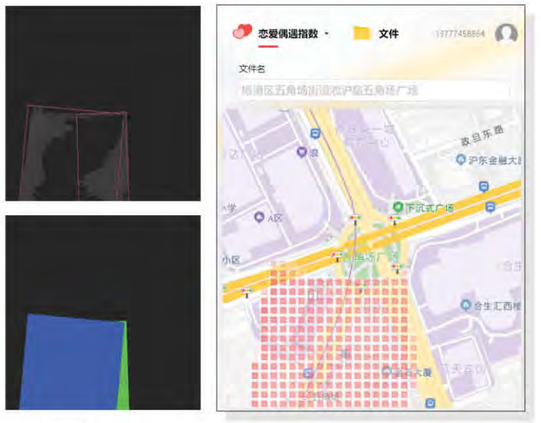
(iv) Influencer Density

There is a clear heat set below and to the right of the plaza for shared offices and shopping centers. This judgment is contrary to my subjective intuition.



(v) Nightlife

The nightlife index for the whole region is considerable, while the square itself has a lower heat value compared to the surrounding malls, shopping centers or office areas.



(vi) Love Encounter

Social media messages sent in the lower left area contain more positive love semantics.

We organised a workshop at Tongji University to find out how digital methods can be used to engage with urban planning.

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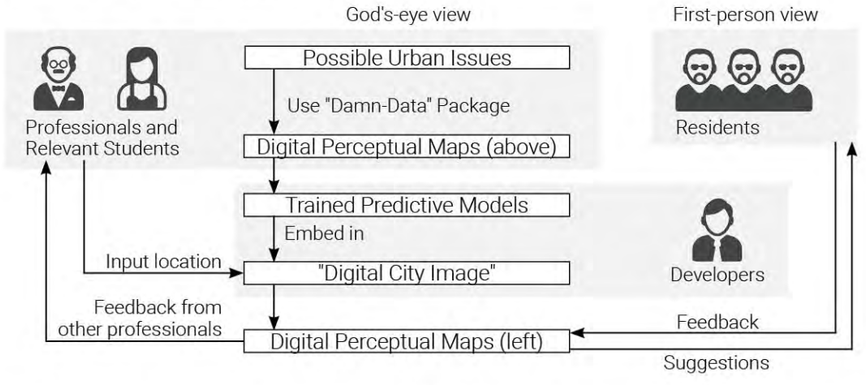
09 A Feasibility Study Conducted in DigitalFUTURES 2021

In order to explore our digital approach and web applications for engagement models in the act of urban planning. We organized a workshop in DigitalFUTURES 2021, which gathered a considerable number of professionals and relevant students from around the world to help us drive the digitization of public perceptions of cities.

I packaged the data collection code I developed in another study related to urban travel demand into a third-party software package (*Damn-Data*) for participants to create personalized perceptual maps. As shown above is a monitored heat map of some areas in Shanghai; the warmer the color, the greater the sense of safety. Participants were also asked to select an important public image in a contemporary city and to define metrics and train neural network models based on their subjective professional understanding.

10 A Possible Engagement Model in Urban Planning



Instructor

Hao Zheng

Teaching Assistant

Zixun Huang
Back-end Development,
Cloud Computing Deployment,
Image Processing,
Data Crawling,
API Programming
& Documentation;

Hang Gao
Front-end Development,
Interactive Design;

Jingyi He
Neural Network Training;

Participants

50+ People On-site
50+ People Online