Displaying spatial epistemologies on web GIS

Using visual materials from the Chinese local gazetteers as an example

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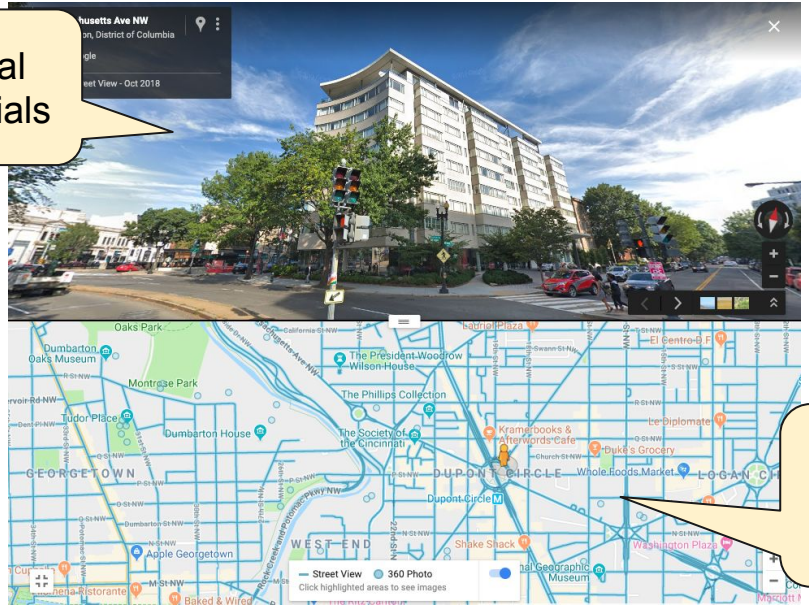
Outline

- Motivation
- Problems
- Methods
  Visual materials on GIS
  Machine Learning Approach
- Examples
- Conclusion

Motivation

Google Street View

Visual materials



Modern cartographic map

How to apply to the Historical Research?

The image source: Google Map

Problems

- Developed ground
- GIS data modeling
  - Scalability

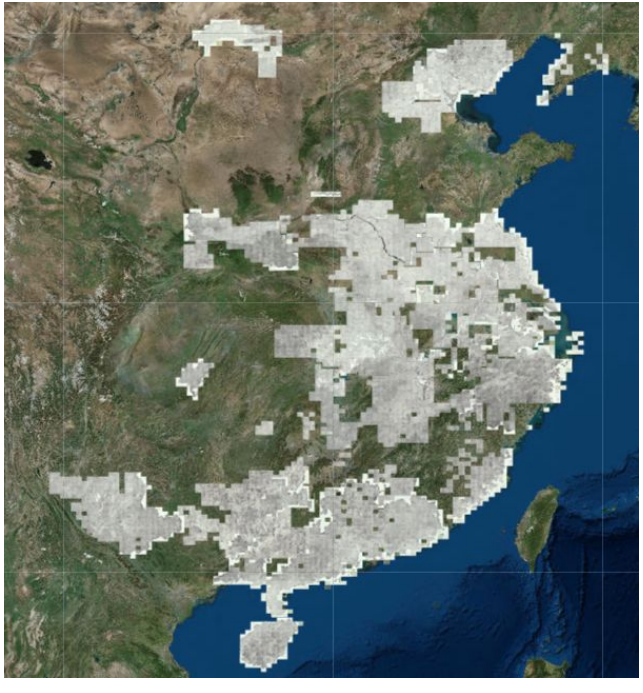
2018 Satellite Images: Yuyao city, Zhejiang Province, China
The Satellite source: Google Earth

Methods

1. Modern cartographic techniques map
   Land Survey Maps of China (1885-1945)
2. Historical visual materials - normal or spatial images
   Images in Chinese Local Gazetteers (8th and the 19th centuries)
3. Search
   locations and visual materials - text & images

1.Map - Land Survey Maps of China(1885-1945)

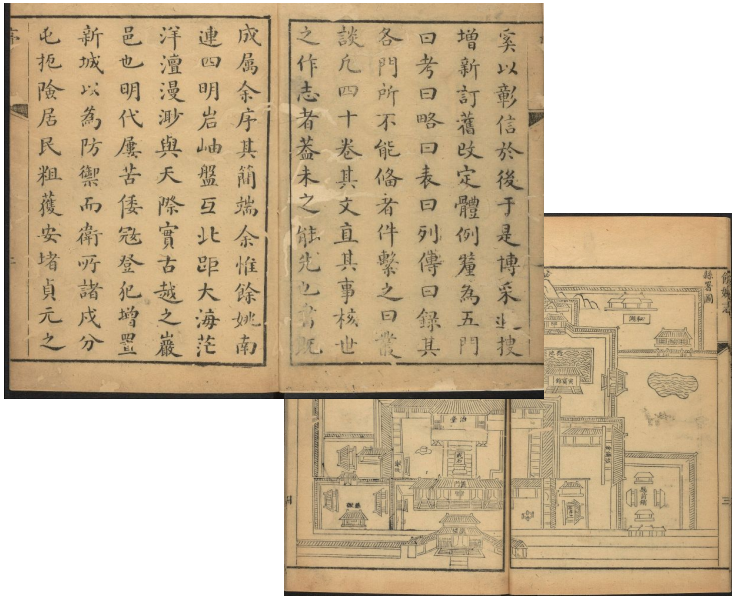
- Modern cartographic techniques military map - China and Japan
- Land surface is closest to an undeveloped historical China, due to the limited progress of architectural technology before China's full modernization(1950)
- Over 4,088 of these maps were compiled and published



中国大陸五万分の一地図集成 (Collection of 1:50,000 maps of China). 8 vols. Tokyo: Kagaku Shoin, 1986-1998. Fujian, Guangdong, Guangxi, Guizhou, Yunnan, Hainan, Hebei, Hubei, Hunan, Jiangsu, Jiangxi, Liaoning, Shanxi, Zhejiang, Anhui, Henan, Inner Mongolia, Shaanxi, and Sichuan.

2. LG - Chinese Local Gazetteers (*difangzhi, 地方志*)

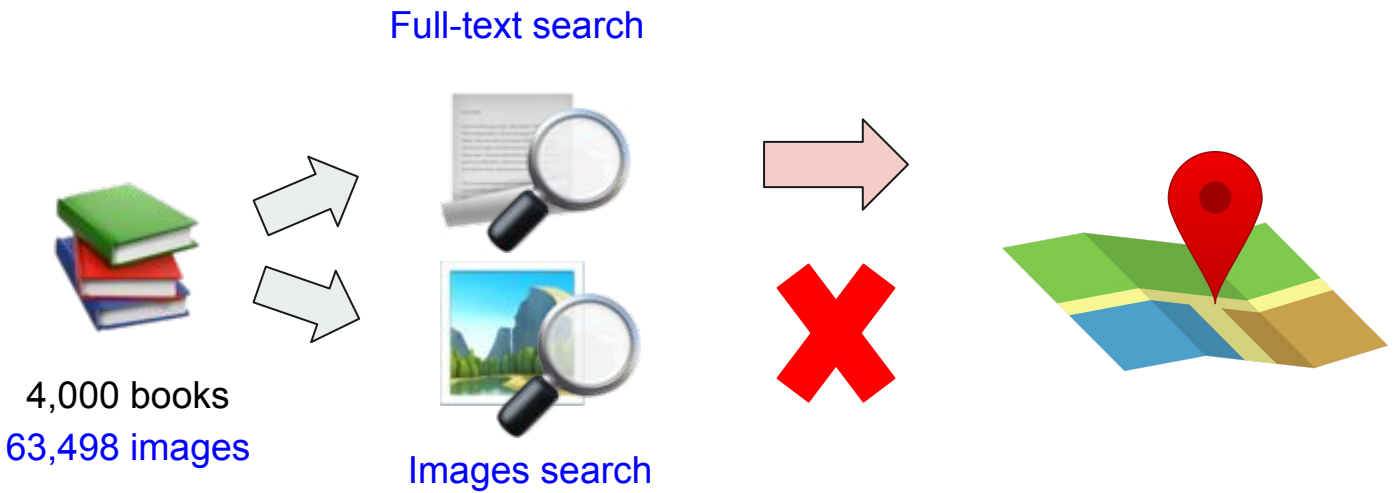
- Chinese local history produced between the 8th and the 19th centuries
- Local knowledge about places, geographical, temporal, and coverages are pervasive across historical China at all scales
- A significant portion of extant local gazetteers has been digitized as scanned pages and **searchable full texts**
- These images are extracted from a larger set of 4 million scanned pages from 4,000 titles of Chinese local gazetteers
- Each book has a WGS84 coordinate
- Historical visual materials - 63,498 images in LG



The images source: Harvard Yenching library

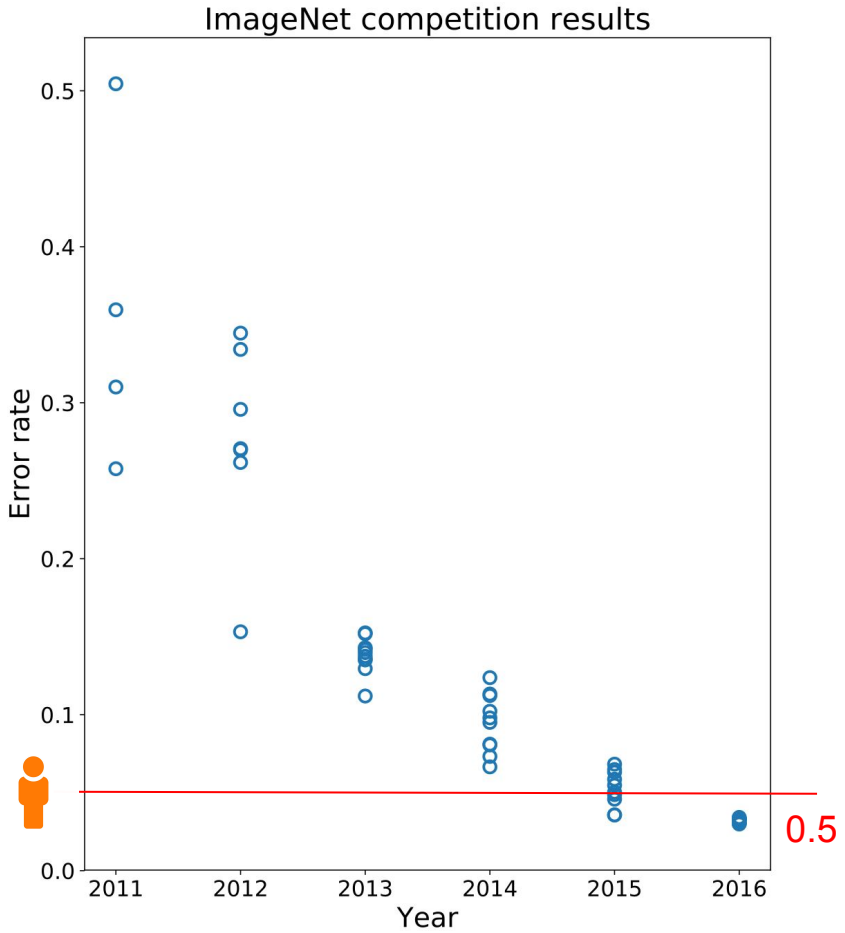

The coverage of Local Gazetteers
0
500
1000
1500
2000 km

3. Search in Local Gazetteers Books



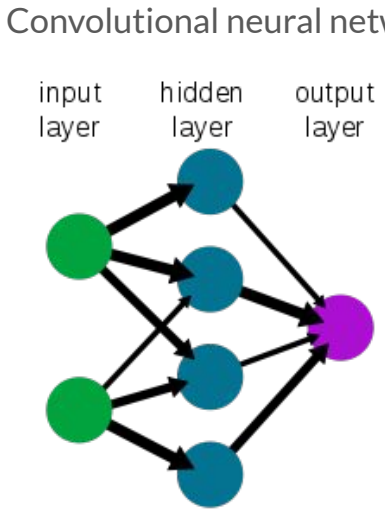
The ImageNet project

- A large visual database designed for use in visual object recognition software research
- More than 14 million images have been hand-annotated by the project to indicate what objects are pictured and in at least one million of the images
- By 2015, researchers reported that software exceeded human ability at the narrow ILSVRC tasks
- In 2017, 29 of 38 competing teams got fewer than 5% incorrect. The error rate in image recognition is lower than human's rate



The image source: https://en.wikipedia.org/wiki/ImageNet

Machine Learning Approach
Neural Network



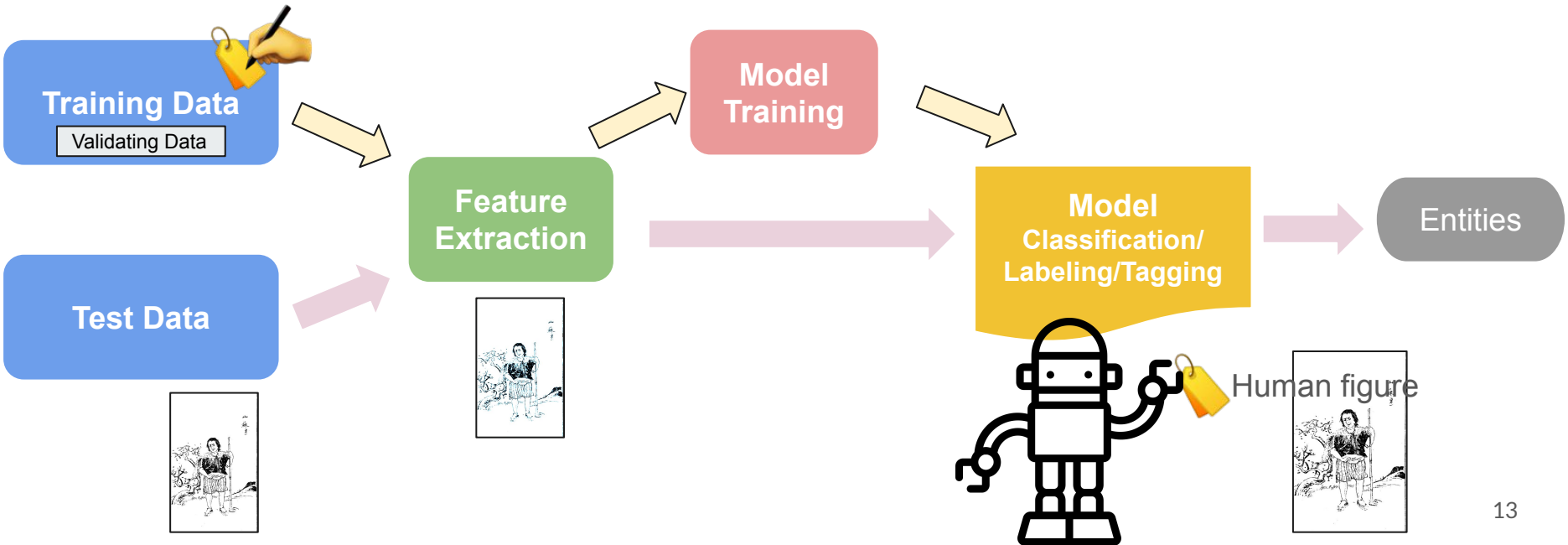
The image source:https://en.wikipedia.org/wiki/Neural_network

Tensorflow.org

- Brain team within Google's AI
- Machine learning and deep learning
- Open source software library
- High performance numerical computation
- Flexible architecture: CPUs, GPUs, TPUs, desktops , clusters of servers, mobile and edge devices.

The image source: https://www.tensorflow.org

Machine Learning Flow



Training Data

9 Tags, total: 210 images

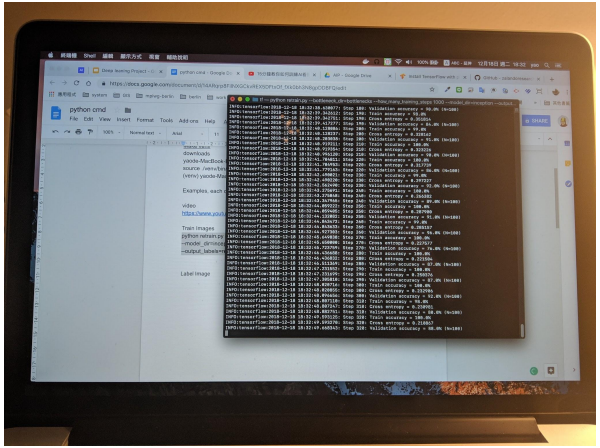
Spatial

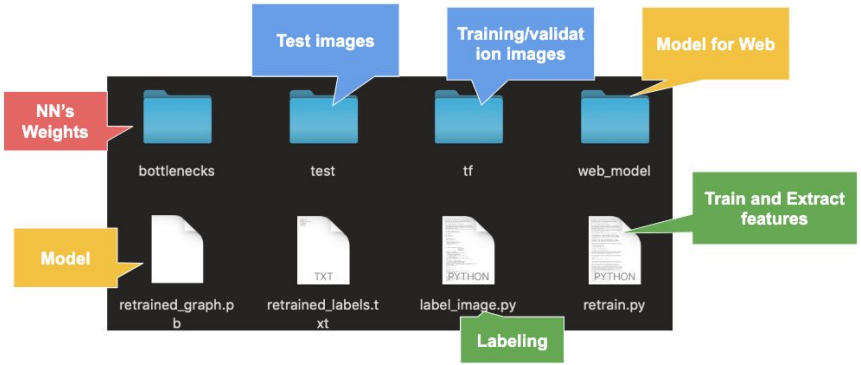
1. Administrative_map: 24
2. City layout map:22
3. Building or building complex:24
4. Layout diagram:24
5. Astronomy star map:22

Non-spatial

6. Flora and fauna:23
7. Agriculture:21
8. Chart or graph:22
9. Human figure:28

Validation accuracy: 87.1%

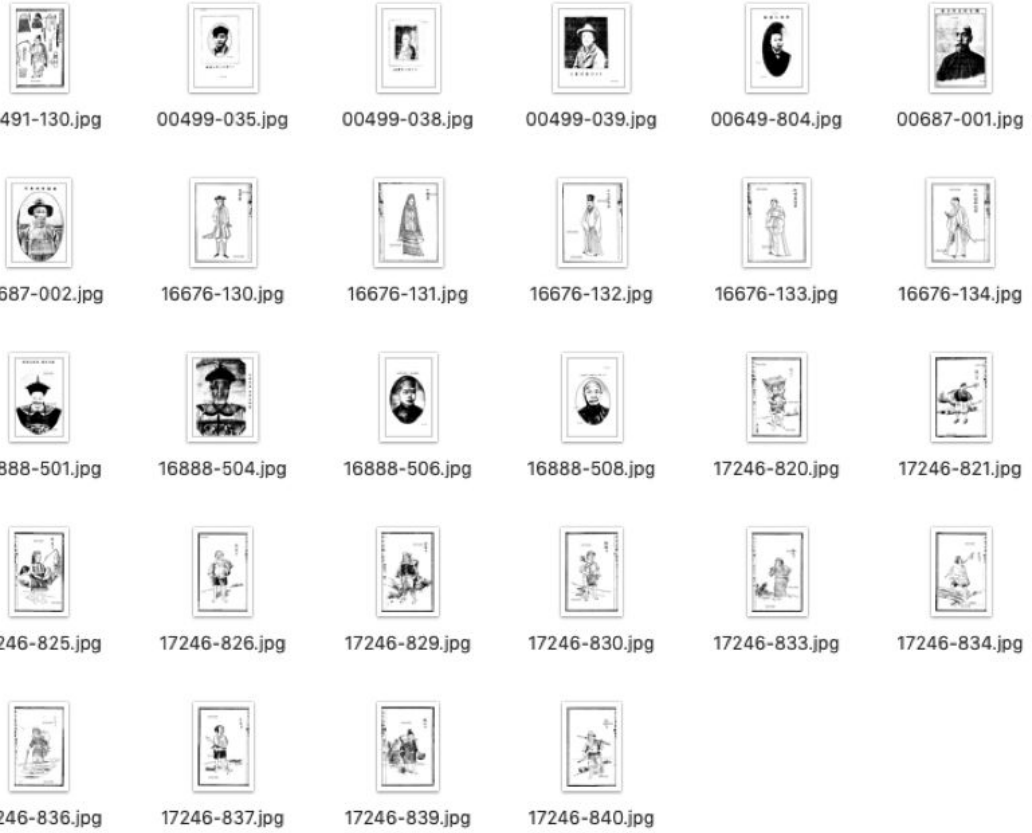




Test Image #1 - Shansu(man)

Test images

Training images: human figure



Tagging Results by scores

1. human figure 0.9549137
2. flora and fauna 0.02948038
3. agriculture 0.0069578495
4. city layout map 0.0038564065
5. building or building complex 0.0024247305

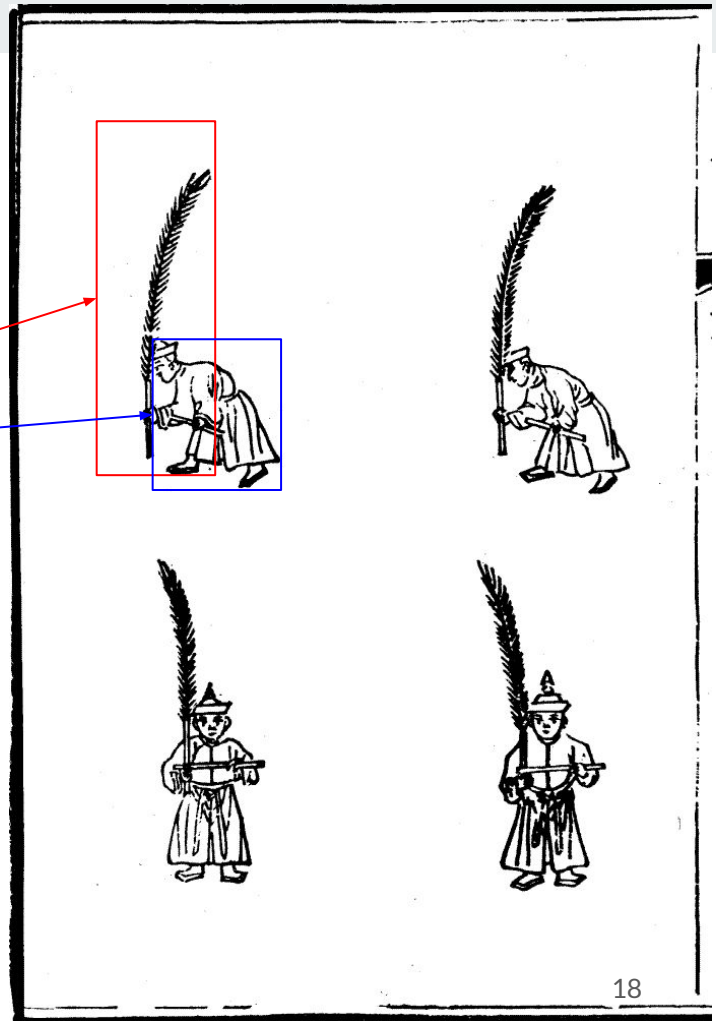
Test Image #2: combine 2 tags

1. building or building complex 0.2709857
2. human figure 0.2579405
3. agriculture 0.1482565
4. city layout map 0.13971138
5. flora and fauna 0.076684184

Test Image #1 :New tag -Ritual

without pre-training

1. flora and fauna 0.86387473
2. human figure 0.06678757
3. agriculture 0.028676374
4. administrative map 0.020739162
5. city layout map 0.006175356



Tags Results

Type	Tag	Amount	Amount used for training
Spatial	Administrative map	20,119	24
	City layout map	10,542	22
	Building or building complex	11,241	24
	Layout diagram	926	24
	Astronomy star map	1,082	22
Non-spatial	Agricultural	495	21
	Human figure	631	28
	Flora and fauna	162	23
	Chart or graph		22
Total amount		63,498	210

Examples

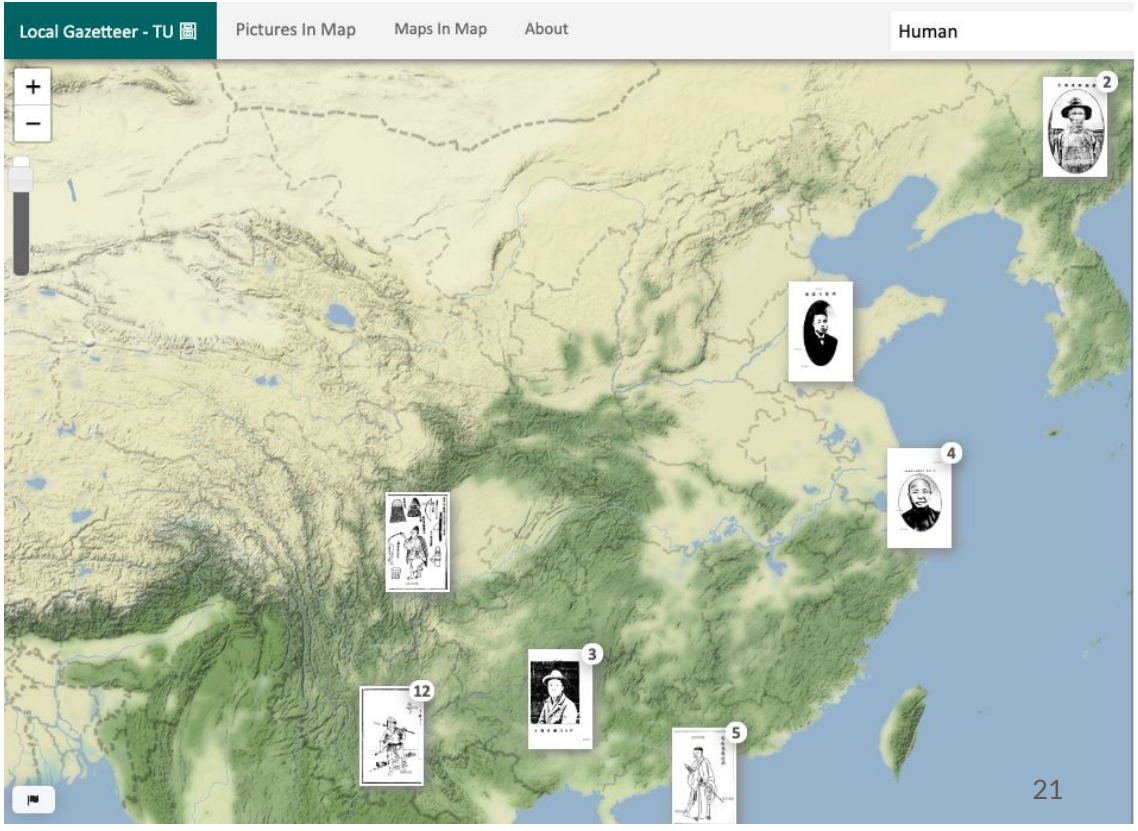
Displaying spatial epistemologies on the web GIS of LG Tu

Visual materials on GIS

- Images-in-Map
  Non-spatial images on GIS layer
- Maps-in-Map
  Spatial images on GIS layer

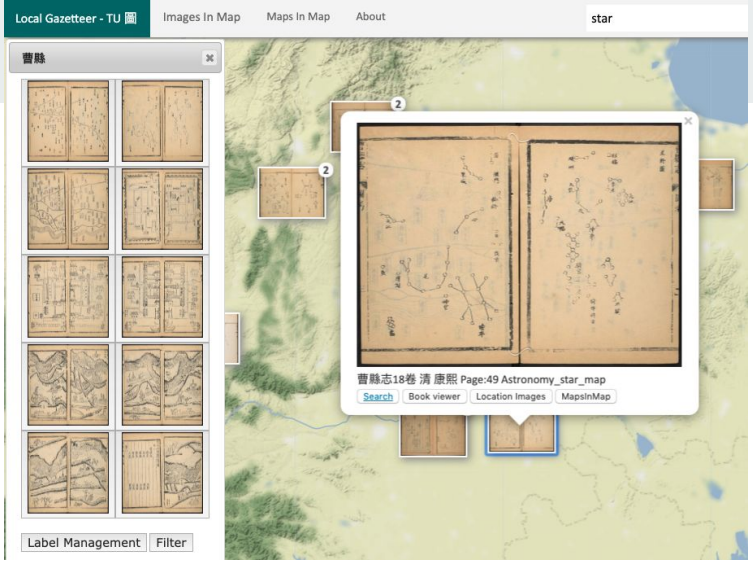
Images-in-Map: search for “Human”

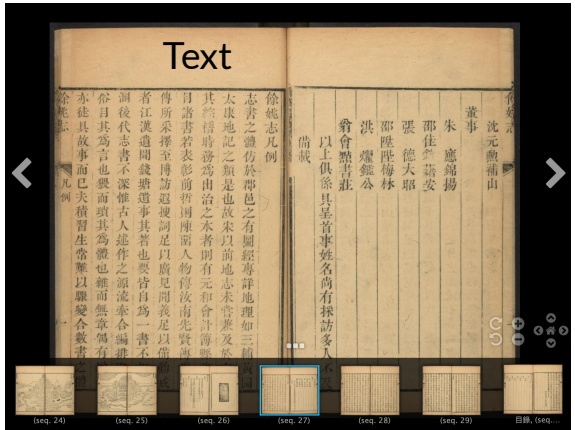
1. Spatial pattern
2. Images content

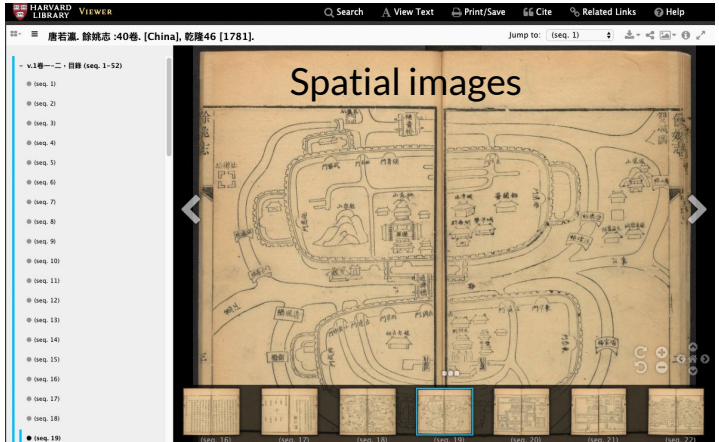


Other functions

- Search Images by Location
- IIIF(International Image Interoperability Framework) link to whole book viewer







Where is Yuyao county?

Yuyao county, Zhejiang Province, China
130 km(80.8mi), south of Shanghai

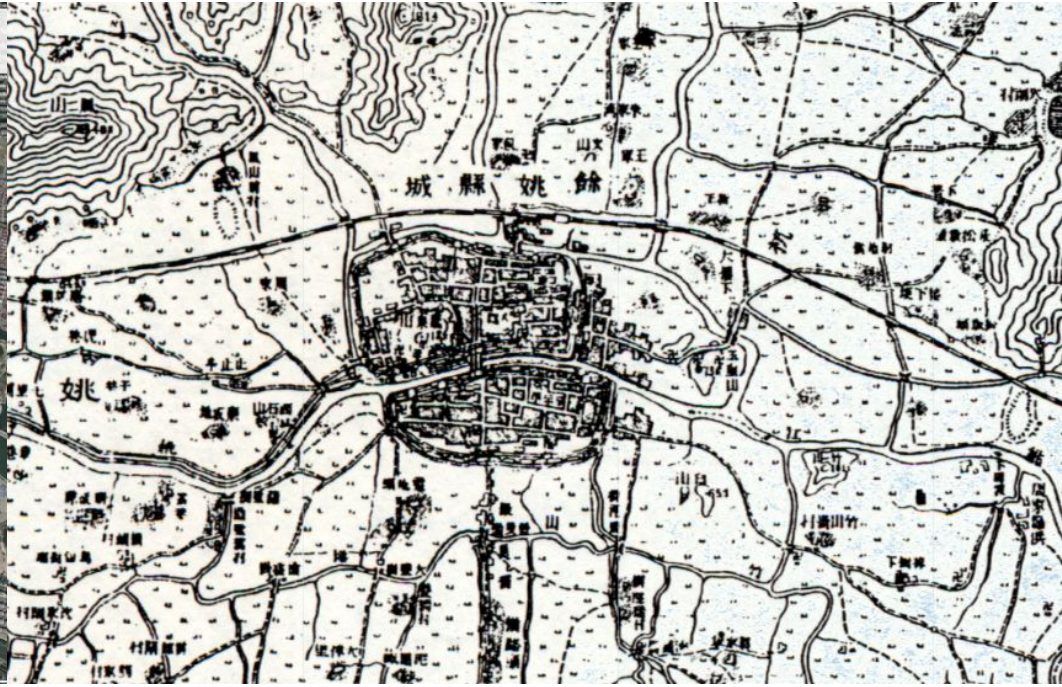
The image source: Google Map

2018 Satellite map

2018 Population：1,442,544

1916 Land Survey Maps of China

1910 Population：630,416 / 1791 population 472,916

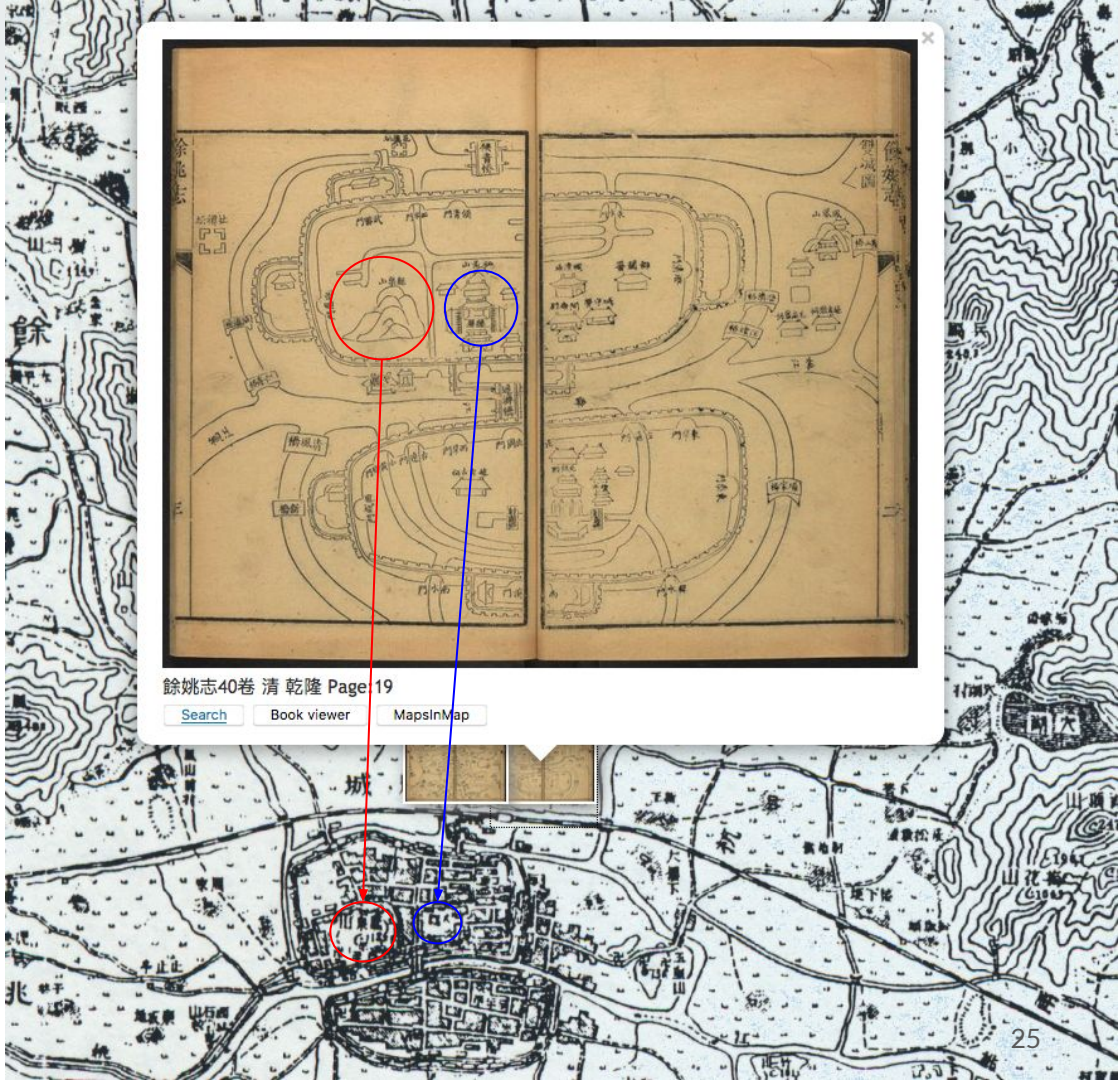


The Satellite source: Google Earth

Maps-in-Map

"City layout" tags in 1781 LG

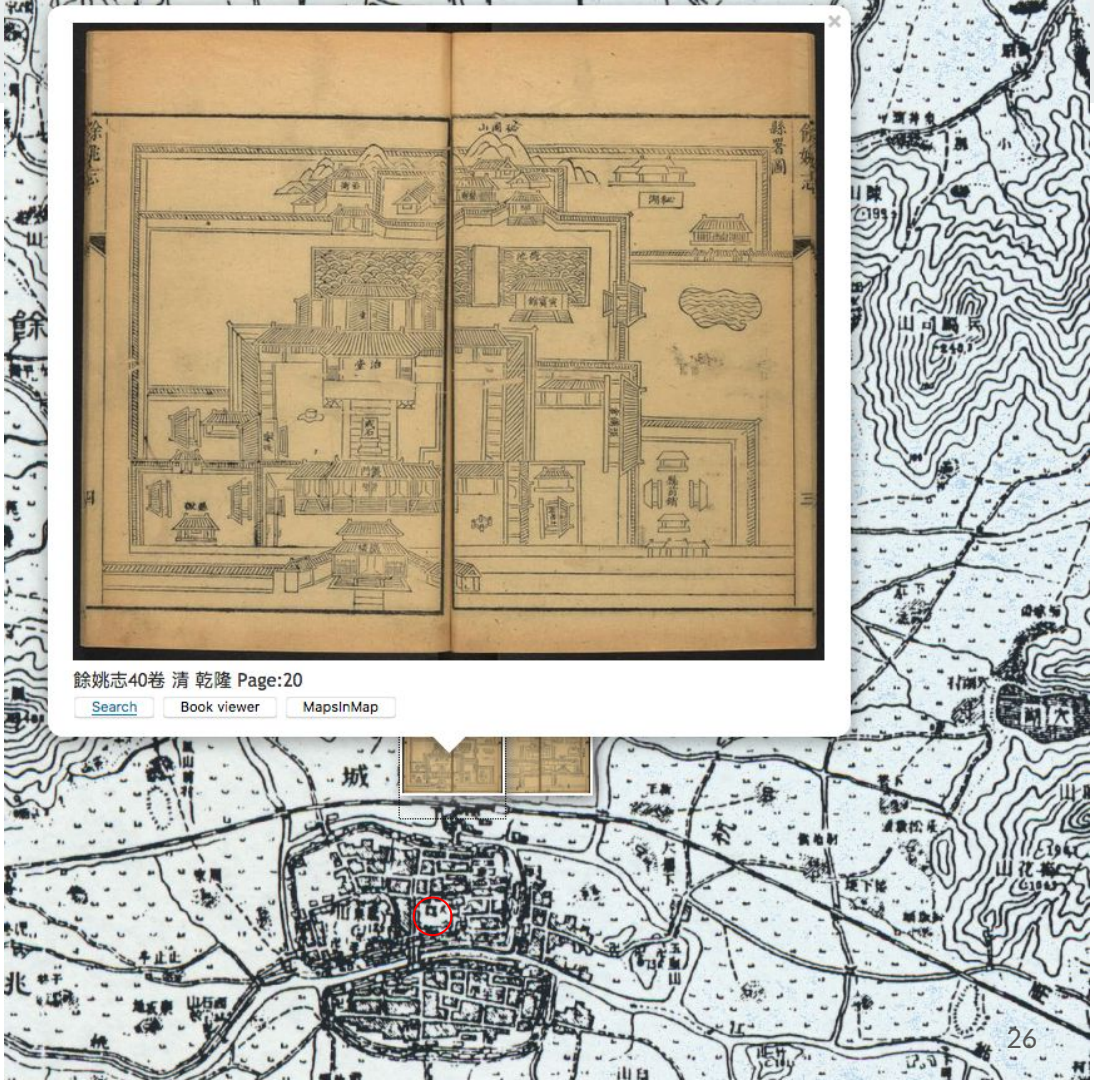
1. Spatial pattern
2. Images content
3. Spatial context
   a. Spatial Image (relative position) without modern cartographic techniques
   b. GIS Layers (precise location) modern cartographic techniques



Maps-in-Map

"Buildings" tags in 1781 LG

County government buildings



Maps-in-Map

Yaozhuo and Henyang county

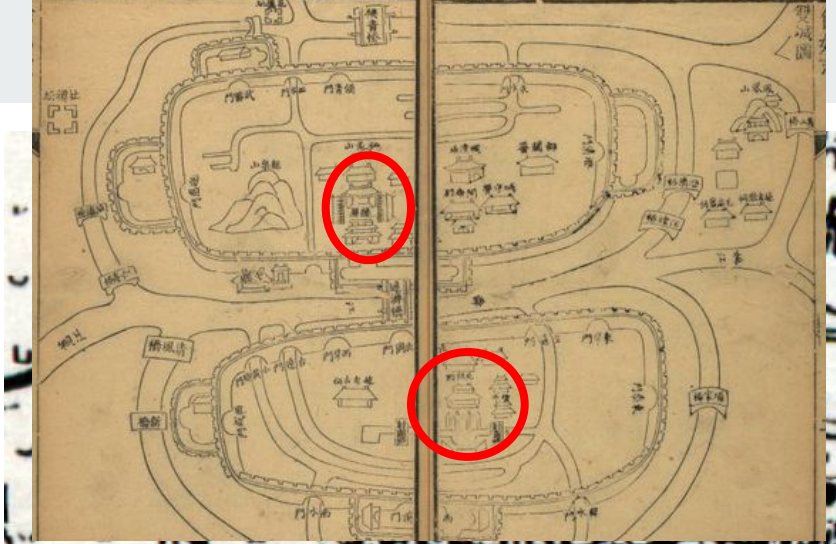
The indoor ritual layout of temple

Future works:
More precise location

Land Survey Maps - Legends:

- 🔲 Government
- 文 School
- ✉️ Post offices
- 帀 Confucius temples
- 卐 temples

: :



Conclusion

1. Lower cost and labor to create metadata for each image in a large collection
2. The digital humanities scholars can focus on both images and texts
   Read distantly and filter massive images on GIS
   Explore the relationship of text and images
3. Search historical images or maps on GIS
   Spatial patterns, image content or spatial context could answer or raise research questions
4. This method could apply to other corpus or visual materials

The End

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Thank you for your attention