19 Smart Economy & Governance

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Outline

- Smart cities for sustainable & resilient development
  - Sustainability & resiliency
- Smart governance
  - Smart party building on campus
  - Urban planning
  - Support vector machine
- Concluding remarks
  - Project instructions
  - Summary and looking ahead

Smart cities for sustainable & resilient development

- Zhu, S., Li, D., & Feng, H. (2019). Is smart city resilient? Evidence from China. *Sustainable Cities and Society*, *50*, 101636.

China's economy

Shanghai 1990

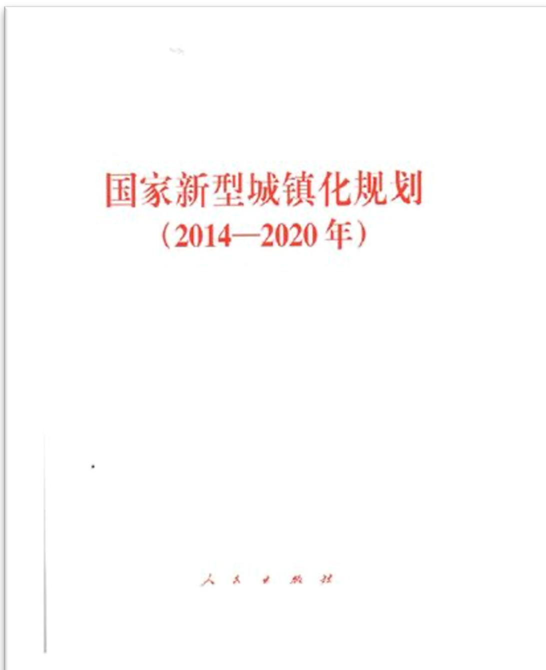
Shanghai 2020

Sustainability & resiliency

Smart city is originally aimed at dealing with various urban problems due to rapid urbanization, like energy shortage, congestion, and environmental pollution...

Smart cities in China

Great efforts to promote the development of smart city have been made by the Chinese government by implementing a series of policies and measures during the last decades...

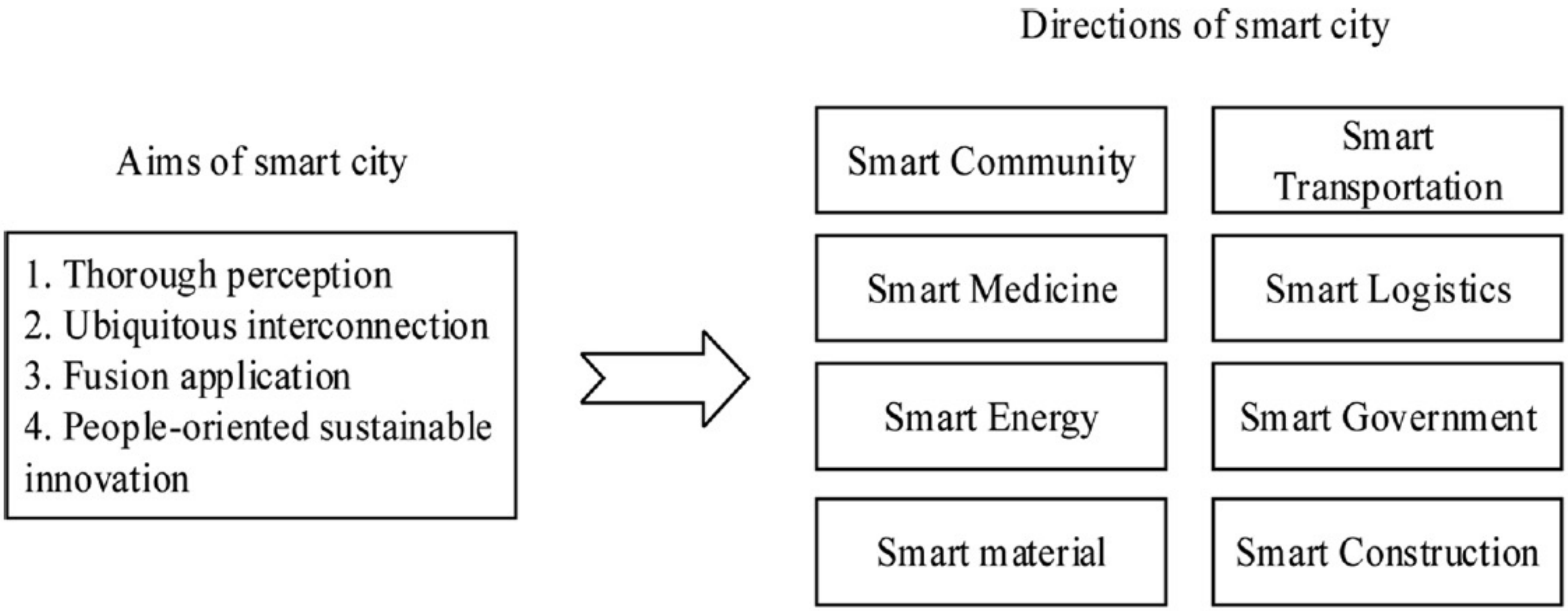


Pilot smart cities in China

Till now, there are 290 pilot smart city programs endorsed by the Ministry of Housing and Urban-Rural Development in China since 2013.

Pilot smart cities in China

Pilot smart cities in China



Smart cities in China

The Chinese government also performs an assessment of smart city every year since 2011 and the reports are open to the public.

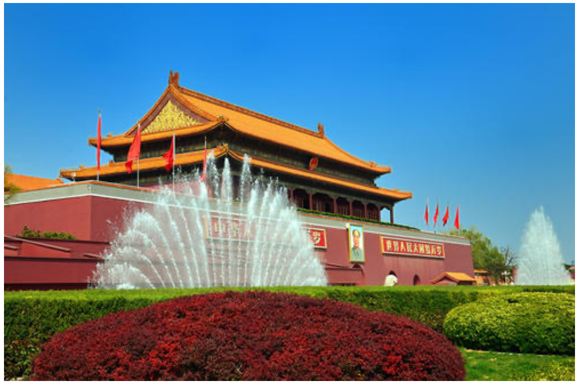
- Smart infrastructure
- Smart governance
- Smart people
- Smart economy
- Security system

Resilient cities

Significant investments in the economy, infrastructure, and social system have been destroyed by disasters every year

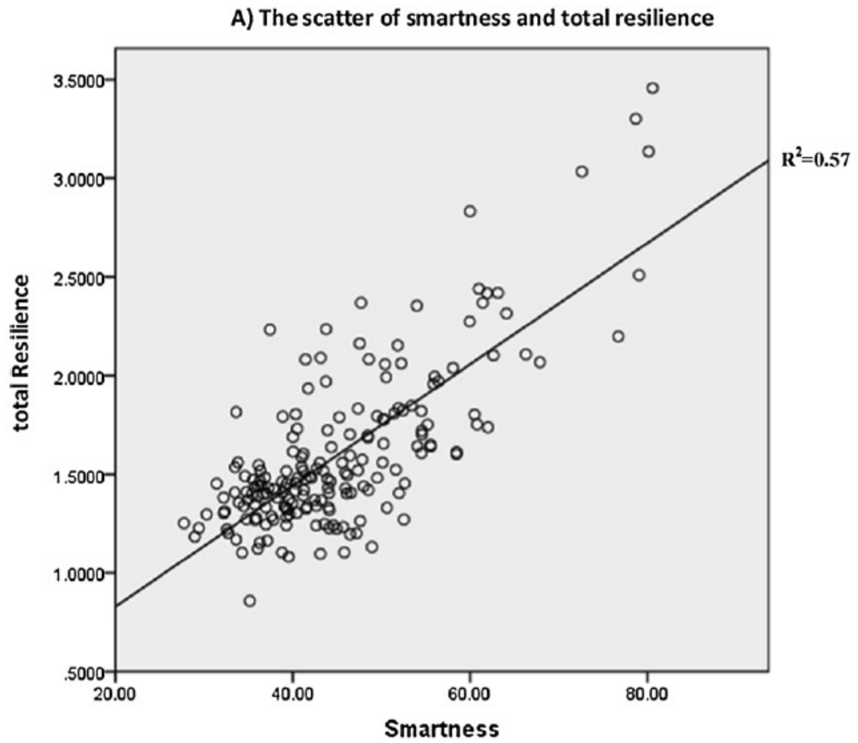
Quantification of smartness & resiliency

Smart Cities	Smartness	C^{InfR}	Rank	C^{EcR}	Rank	C^{SR}	Rank	C^{InsR}	Rank	C^{EnR}	Rank	$C^{Overall}$	Overall Rank
Beijing	78.68	0.3136	8	0.6492	4	0.6324	8	1.0000	1	0.7055	136	3.3007	2
Tianjin	53.97	0.2921	9	0.5183	14	0.3901	39	0.3604	9	0.7931	96	2.3540	12
Shijiazhuang	38.86	0.1242	54	0.3181	68	0.3676	49	0.1099	36	0.8717	10	1.7916	45
Tangshan	42.09	0.0887	85	0.3142	74	0.2891	115	0.1109	35	0.6791	146	1.4820	94
Qinhuangdao	41.16	0.1007	72	0.3801	43	0.2956	104	0.0414	96	0.7866	101	1.6043	68
Handan	36.46	0.0686	121	0.2016	169	0.2784	136	0.0697	58	0.8259	62	1.4442	105
Baoding	40.28	0.0568	145	0.1875	177	0.2799	133	0.0669	62	0.8255	63	1.4166	116
Cangzhou	36.98	0.0633	131	0.2712	103	0.3022	96	0.0459	80	0.6495	153	1.3322	143
Langfang	40.99	0.0563	148	0.3205	65	0.3069	89	0.0438	87	0.8587	22	1.5861	71
Taiyuan	41.39	0.2519	14	0.4150	32	0.6733	4	0.1332	26	0.6083	160	2.0818	24
Datong	36.16	0.0967	77	0.2999	83	0.3488	58	0.0477	78	0.7536	115	1.5467	77
Yangquang	36.06	0.1043	69	0.2731	99	0.3391	63	0.0207	148	0.3860	186	1.1232	181
Changzhi	36.98	0.0662	124	0.2356	140	0.3226	70	0.0372	105	0.5836	165	1.2453	164
Jingcheng	32.18	0.0686	120	0.2300	147	0.3124	84	0.0248	138	0.7453	118	1.3812	129
Shuozhou	34.78	0.0616	135	0.3169	71	0.2801	131	0.0128	165	0.6015	162	1.2729	157



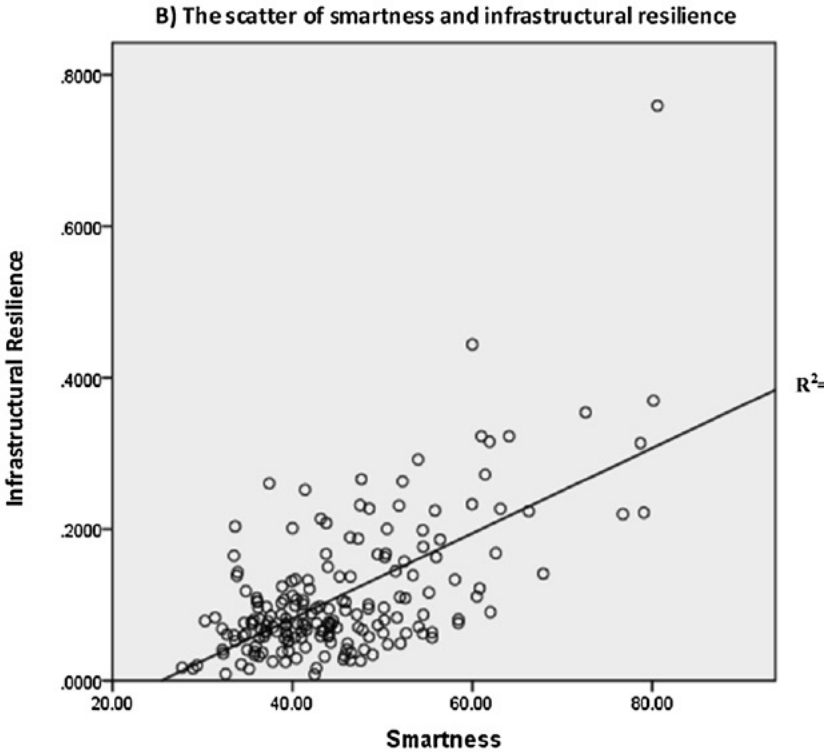
Relationship between smartness and resilience of a city

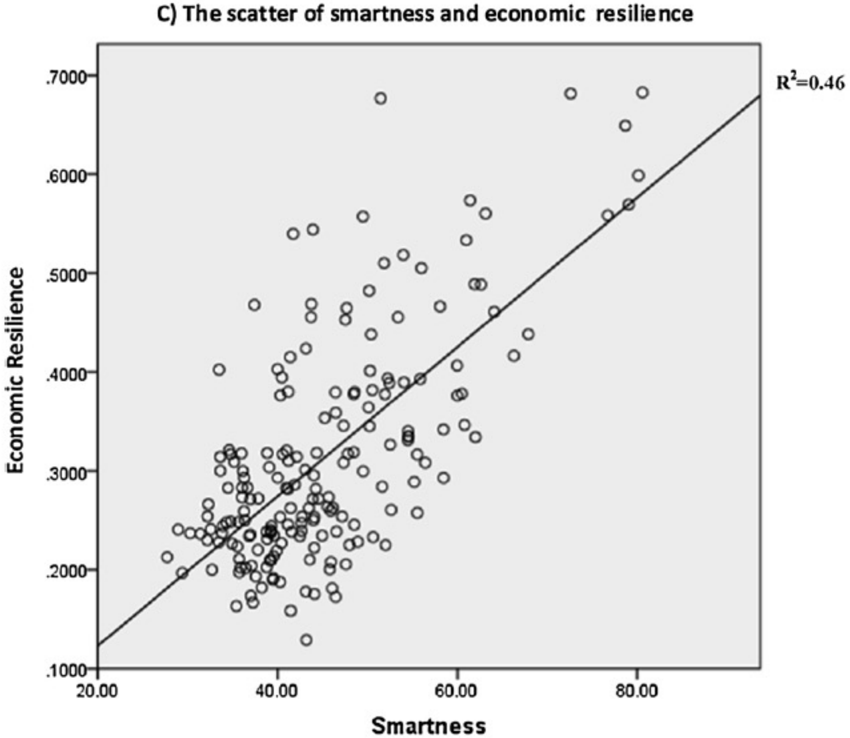
- There are a large amount of cities presenting low level in both smartness and resilience.
- Very few cities presented high resilience but low smartness, while several cities showed low resilience but high smartness.



Strong relations

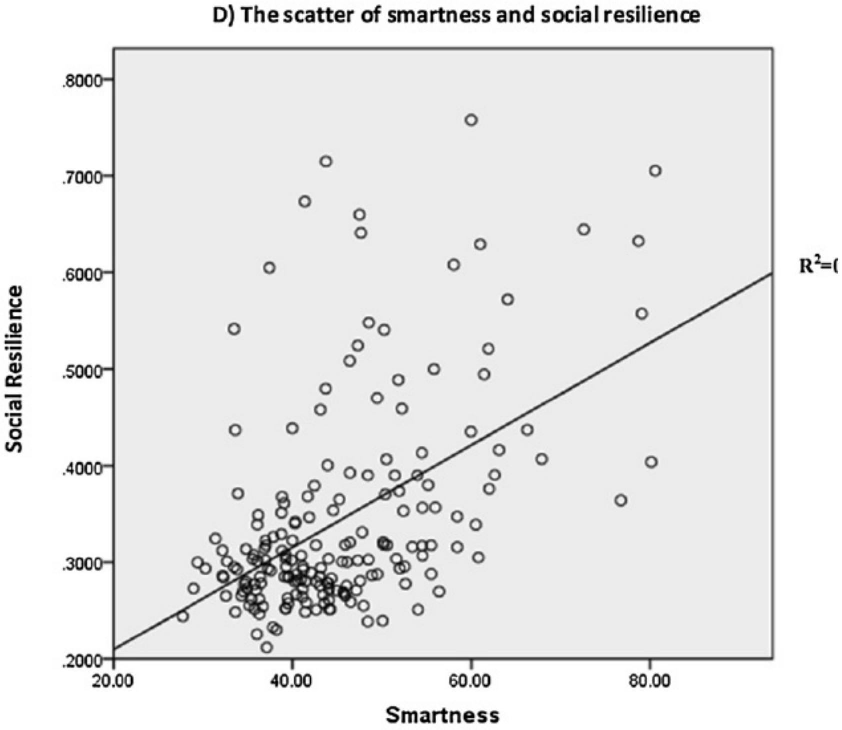
- The urban smartness and ICT solutions are mainly contributed to the urban resilience in infrastructural, economic and institutional aspects.
- The impact of smartness on social and environmental resilience varies a little.

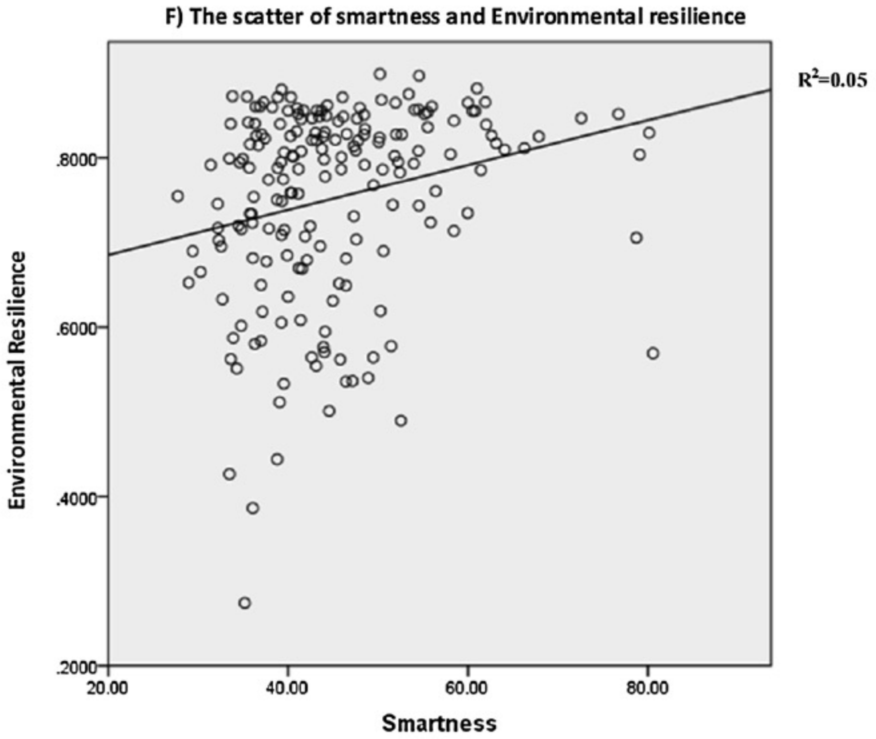




Weak relations

- The urban smartness and ICT solutions are mainly contributed to the urban resilience in infrastructural, economic and institutional aspects.
- The impact of smartness on social and environmental resilience varies a little.





Smart governance

- Smart party building on campus
- Urban planning

- Zhang X., Qian T. and Ren H., 2015. Exploration and practice of the online democratic evaluation for graduate student Party members. Degree and graduate student research. (In Chinese)
- Zhu, Y. and Newsam, S., 2015, November. Land use classification using convolutional neural networks applied to ground-level images. In *Proceedings of the 23rd SIGSPATIAL International Conference on Advances in Geographic Information Systems* (p. 61). ACM.

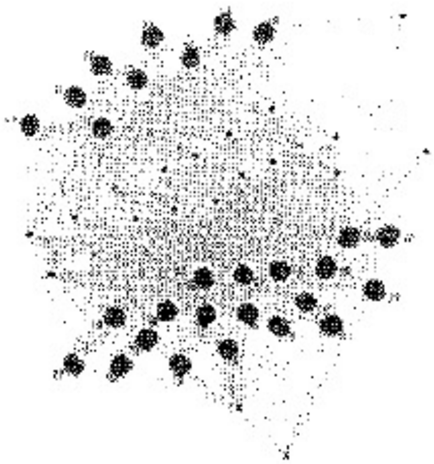
Smart Party building on campus

Smart Party building on campus

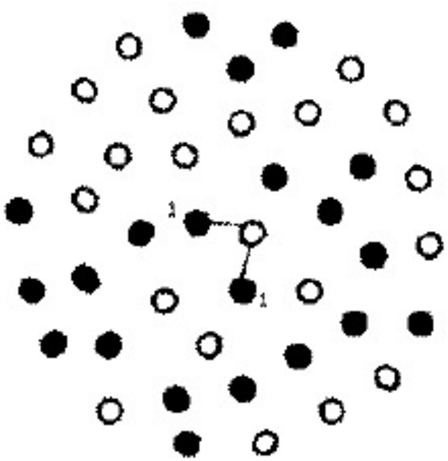
- Consider the democratic evaluation process at Party branches for university graduate students
- Characteristics of post-90-generation graduate students:
  - Heavy workload due to coursework and research
  - High fluidity; strong desire to explore alternatives
  - Weaker collectivity and sense of group
- Conventional democratic evaluation process:
  - Paper survey or democratic life meetings
  - Limited degree of participation and inefficient feedback channels
- Solution given by Tsinghua people: do it online

Smart Party building on campus

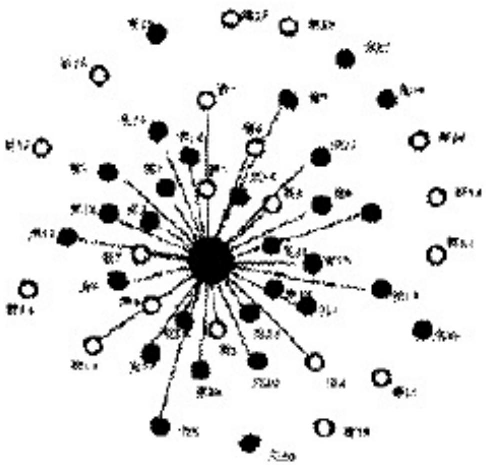
- An online system with extensive information collection and analysis capabilities
- Analysis 1: visualization of the evaluation results of a Party branch
- Methodology: analogous to network science-based methods invented for general social networks



Party-mass closeness diagram



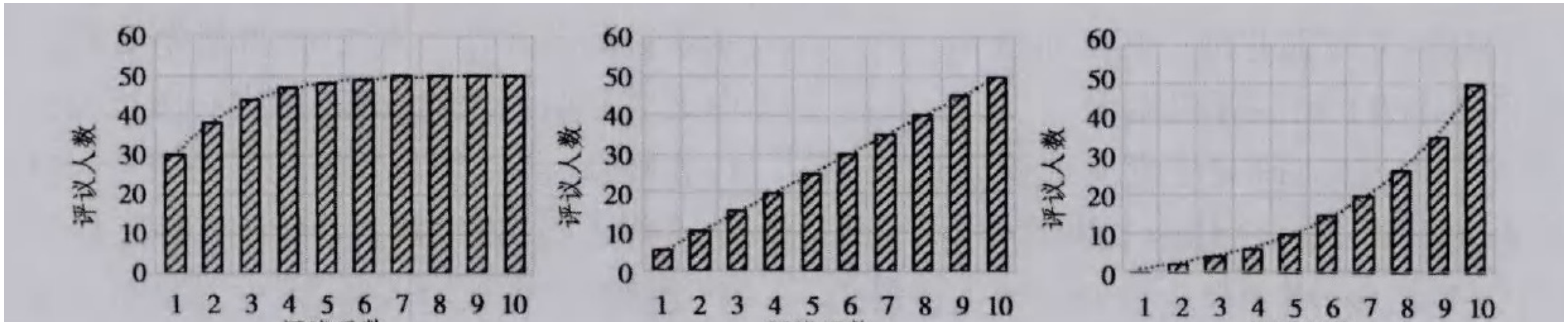
Party-mass warning diagram



Party branch focus diagram

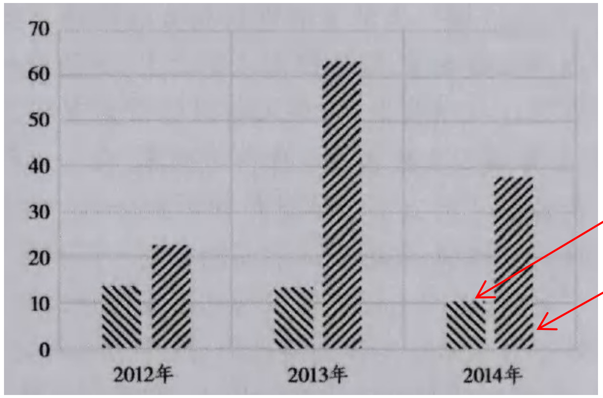
Smart Party building on campus

- Analysis 2: response times



day (early response) | day (normal response) | day (last-minute response)

- Analysis 3: variance of evaluation



Party member results
mass results

Smart Party building on campus

After two years of online democratic evaluation

- Party members' satisfaction with the Party team: 72% -> 81%
- Non-Party mass' satisfaction with the Party team: 76% -> 80%
- Party members perceived to be "non-existent": 2% -> 0.2%

Smart urban planning

Example: Land Use Classification

Example: Land Use Classification

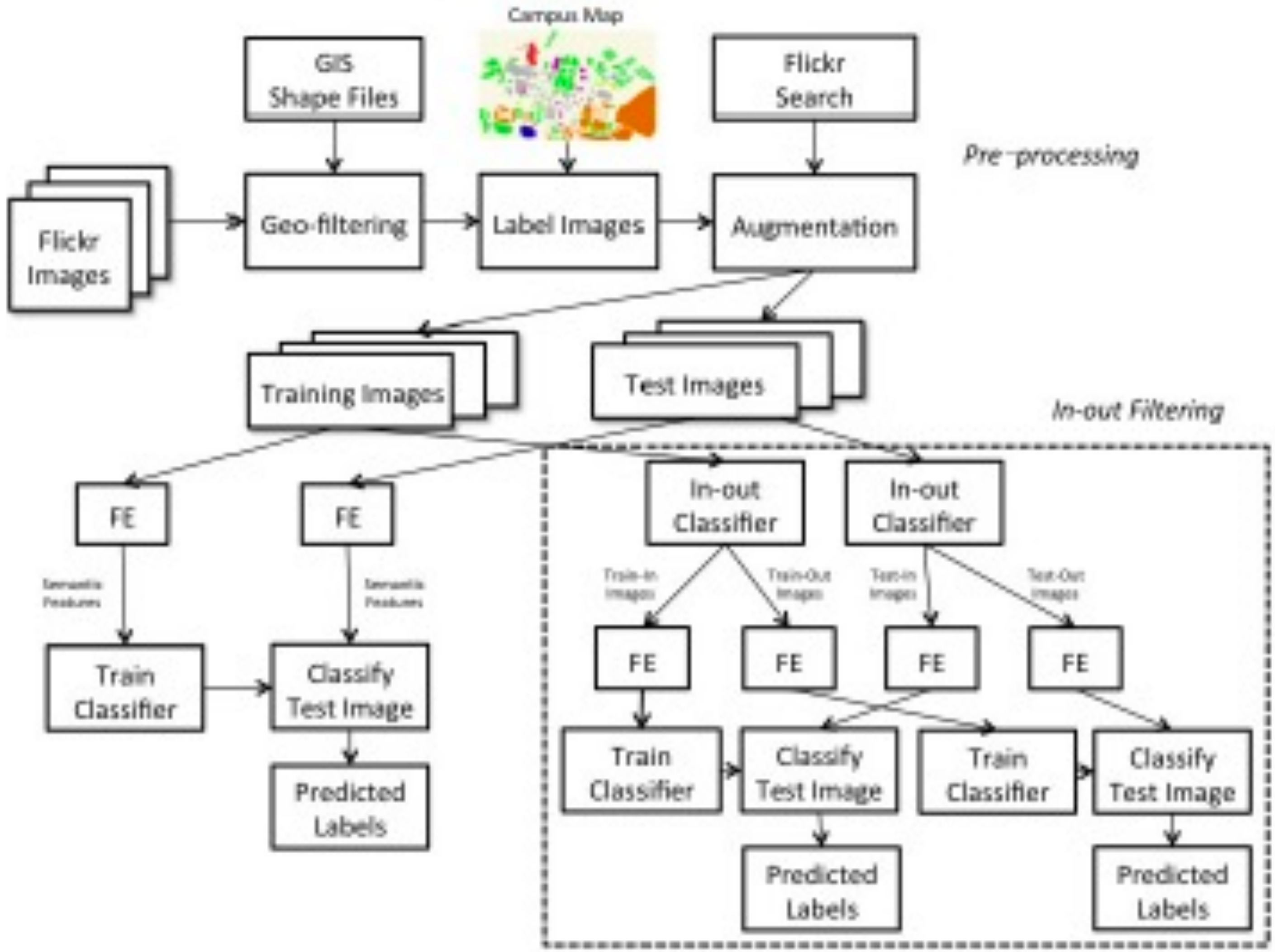
Focus: challenging problem of mapping land use.

- Map a broader range of land use classes than previous work
- Utilize semantic image features learned by training convolutional neural networks, a form of deep learning on a large collection of scene images.
- Develop an indoor/outdoor image classier which achieves state-of-the-art performance. It helps correct for image location errors.
- Region shape are used to further correct for image location errors as well as to create precise maps.
- A base set of training images is generated in an automated fashion and then augmented in a semi-supervised fashion to address class imbalance.

Overview

- Focus on land use classification on a university campus (Stanford) since it represents a compact region containing a range of classes
- manually generating a ground truth is feasible.
- Study, Residence, Hospital, Park, Gym, Playground, Water and Theater.

Workflow


Campus Map
GIS
Shape Files
Flickr
Search
Pre-processing
Flickr
Images
Geo-filtering
Label Images
Augmentation
Training Images
Test Images
In-out Filtering
FE
FE
In-out
Classifier
In-out
Classifier
Semantic
Features
Semantic
Features
FE
FE
FE
FE
Train
Classifier
Classify
Test Image
Predicted
Labels
Train
Classifier
Classify
Test Image
Train
Classifier
Classify
Test Image
Predicted
Labels
Predicted
Labels

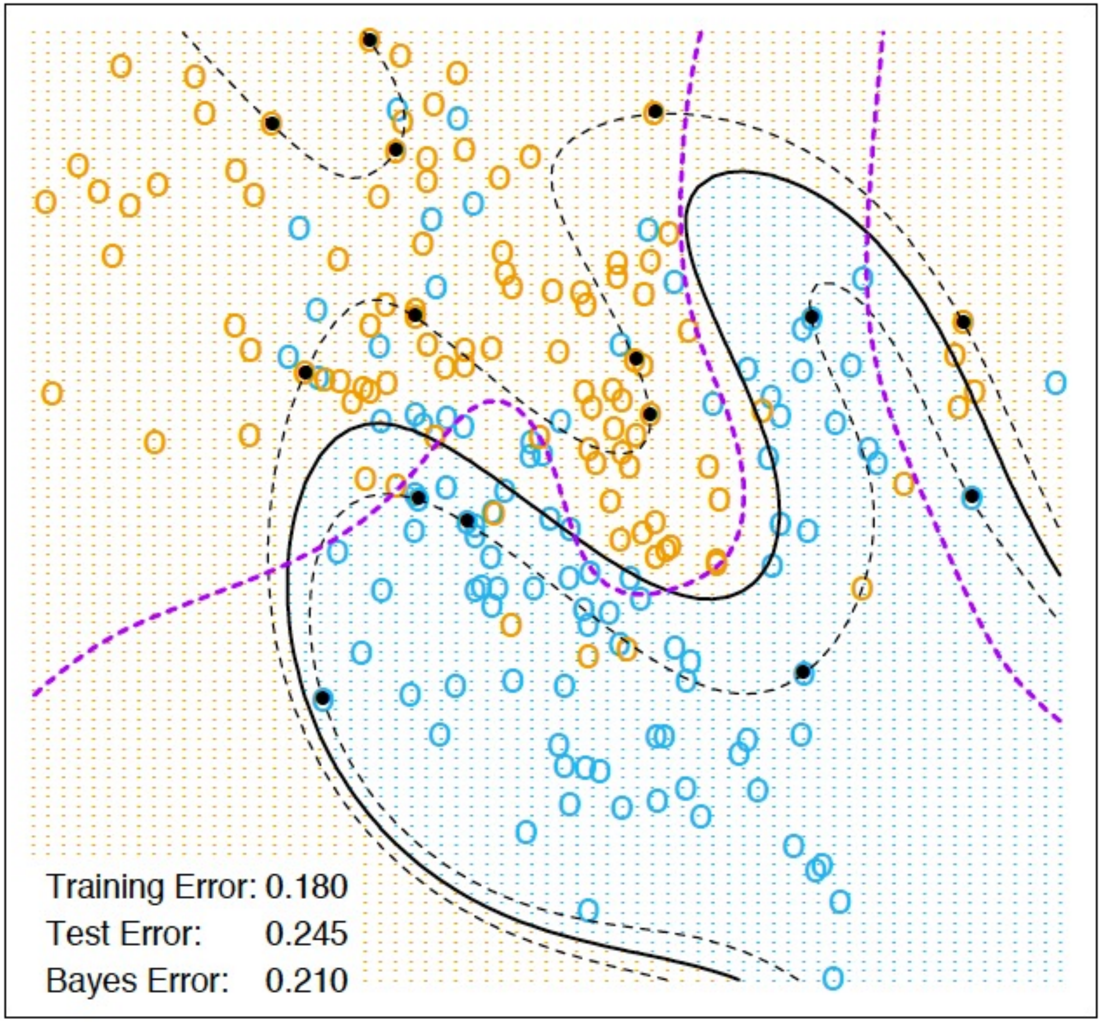
Data

- use the Flickr API to download images located within the campus region
- each downloaded image is assigned a land use label according to its geographic location on the ground truth map.
- 16,789 images
- Augmentation:
  - Original data is unbalanced in terms of land use and location
  - Such imbalance can lead to a biased classifier (very critical issue!)
  - To address this, artificially adjust the ratio
  - Reduce the more frequent ones, increase the less frequent ones

Land use classification

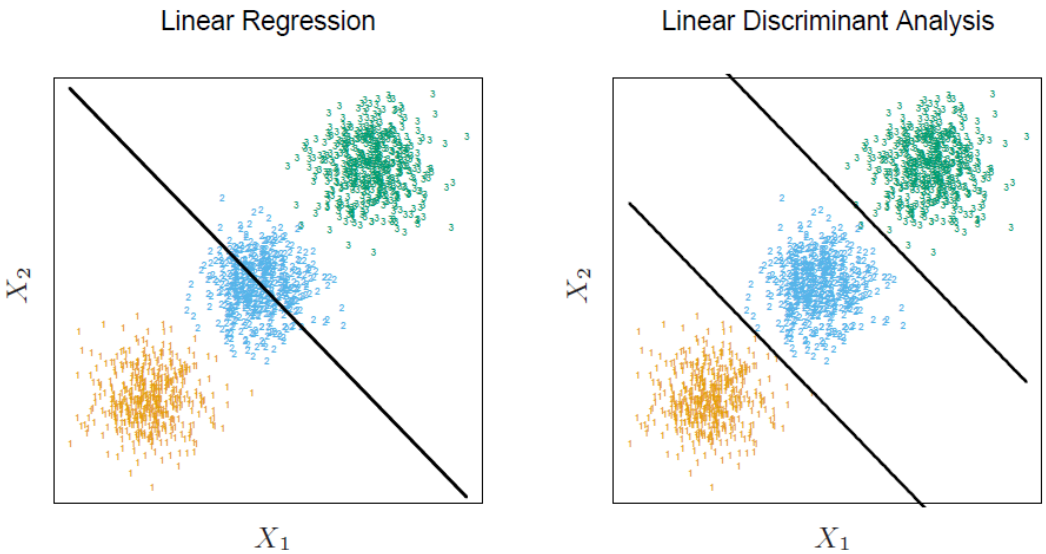
- Use a $f_k(x)$ model called support vector machine (SVM)
- Basic idea: separate point groups that are far away
- 65% prediction accuracy
- Fine-tune SVM with validation set


Support vector machine



Separating hyperplanes

- Linear decision boundaries that explicitly try to separate the data into different classes as well as possible
- Naïve example: linear regression for classification

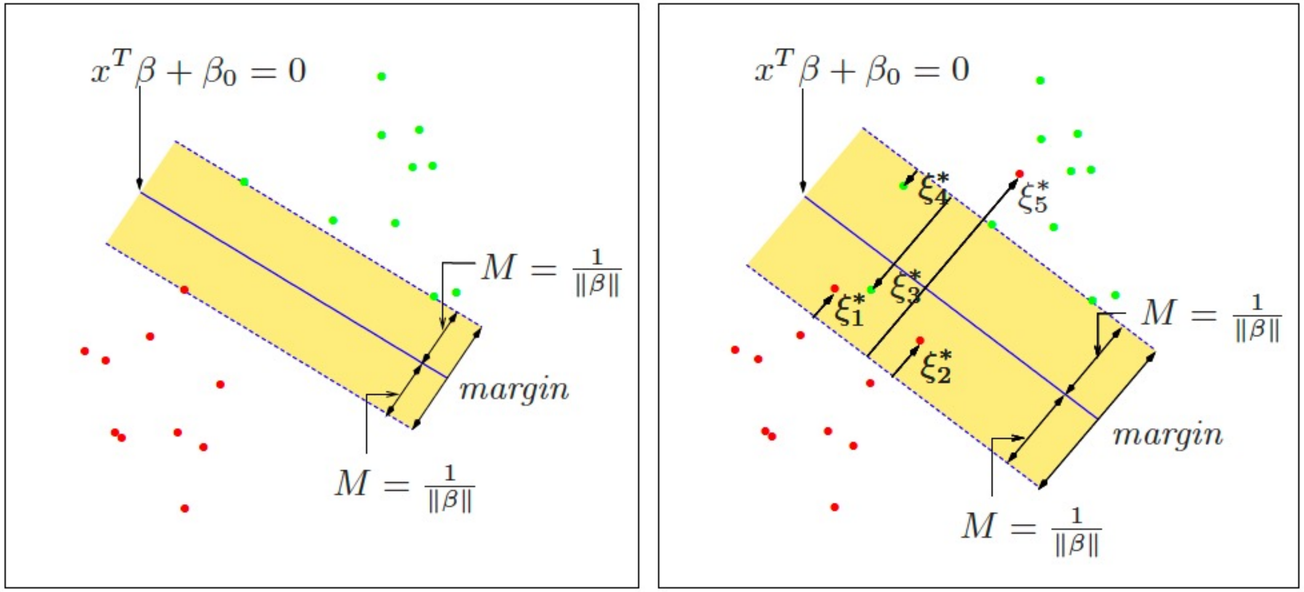


Support vector classifier

- Consider continuous predictor $x \in \mathbb{R}^p$ and categorical response $y \in \{-1,1\}$
- A hyperplane is given by
$$f(x) = \beta^T x + \beta_0 = 0$$
- A classification rule:
$$\hat{y} = \mathrm{sgn}[f(x)]$$
- Note that there may be multiple hyperplanes that can separate different categories.
- We select the hyperplane that creates the biggest margin between the training points for class 1 and – 1

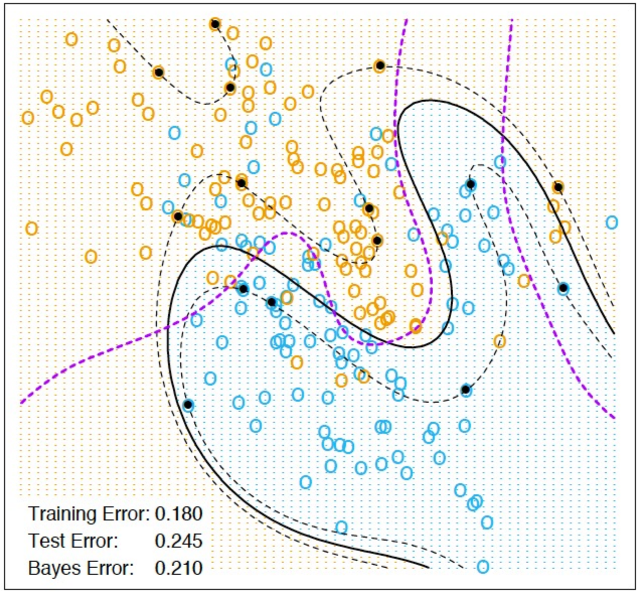
Support vector classifier

- Find the hyperplane such that M is maximized
- M is called the margin
- A key relation: $M = 1/\|\beta\|$
- Sometimes we allow a tolerance of ξ



Support vector machine

- Now, suppose that we replace the predictor x with a nonlinear transformation $h(x)$
- Instead of x, we input $h(x)$ to the hyperplane model that we saw
- This will lead to nonlinear boundaries (or surfaces) separating the data



Further refinement

- Two layers of classification (hierarchical)
- First layer: indoor or outdoor
  - Indoor: study, residence, hospital, gym, theater
  - Outdoor: park, playground, water
- Second layer: specific land use
- Prediction accuracy: 99%, 76%



Concluding remarks

- About project
- About this course

Final presentation

- Every group member is supposed to get involved
- Suggestion: 2 people present, and 1-2 people answer questions.
- Bring your own computer and share your slides via Feishu to the whole class
- Also send me the slides (in pdf format) via email before presentation

Final report

- Final project report is due on 8/6 23:59; late submissions will be discounted by 20%. The report should **not exceed 8 pages with everything included**.
- To submit the report, please have one team member **email** me the pdf file, with the other team members copied.
- Every one also needs to submit a peer evaluation through CANVAS. You only need to indicate the team member(s) that contribute(s) **significantly more or significantly less** than the others. Otherwise, just say that "every one contributes about equally". This will partially affect the distribution of credits awarded to your team, so think about this carefully before responding.

Final remarks

Thanks for taking part in my first course offered at SJTU!

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