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Beijing City Lab

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基于地理信息照片的城市感知地图

C-IMAGE : City Cognitive Mapping Through Geo-Tagged Photos

BCL 2015, 北京

刘刘 | 2015.6

1 Introduction

2 Literature Review

- Cognitive Mapping Stream
 - the image of the city (1960s)
 - the psychological maps (1970s)
 - the evaluative image (1990s)
- Computation Stream
 - City Pulse Project
 - What makes Paris look like Paris

3 Method Statement

- Research Objects
 - texts vs. photos
 - machine-taken photos vs. human-taken photos
 - social net-work based provider vs. geolocation-based provider
- Acquisition of Data
 - preparations
 - download from Panoramio via its data API
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- C-IMAGE as Urban Form Identification



Google Glass by Matthew Clarke, Security Camera by iconoci, iPhone by Jason Schmitt, and iPad by Edward Boatman from The Noun Project

How to extract and understand the holistic image of the city from the public?

如何从公众中提取他们对于城市的全局意象并加以理解？

- 1) How to extract the holistic cognition and collect the scattered perceptions from the public through modern techniques?
- 2) How to apply the abstracted knowledge relates to practical objects, such as urban form, function, or activities?

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C-IMAGE:

To Collaborate Crowd-sourcing data and Create City's Cognition from the Citizens with Computation technology.

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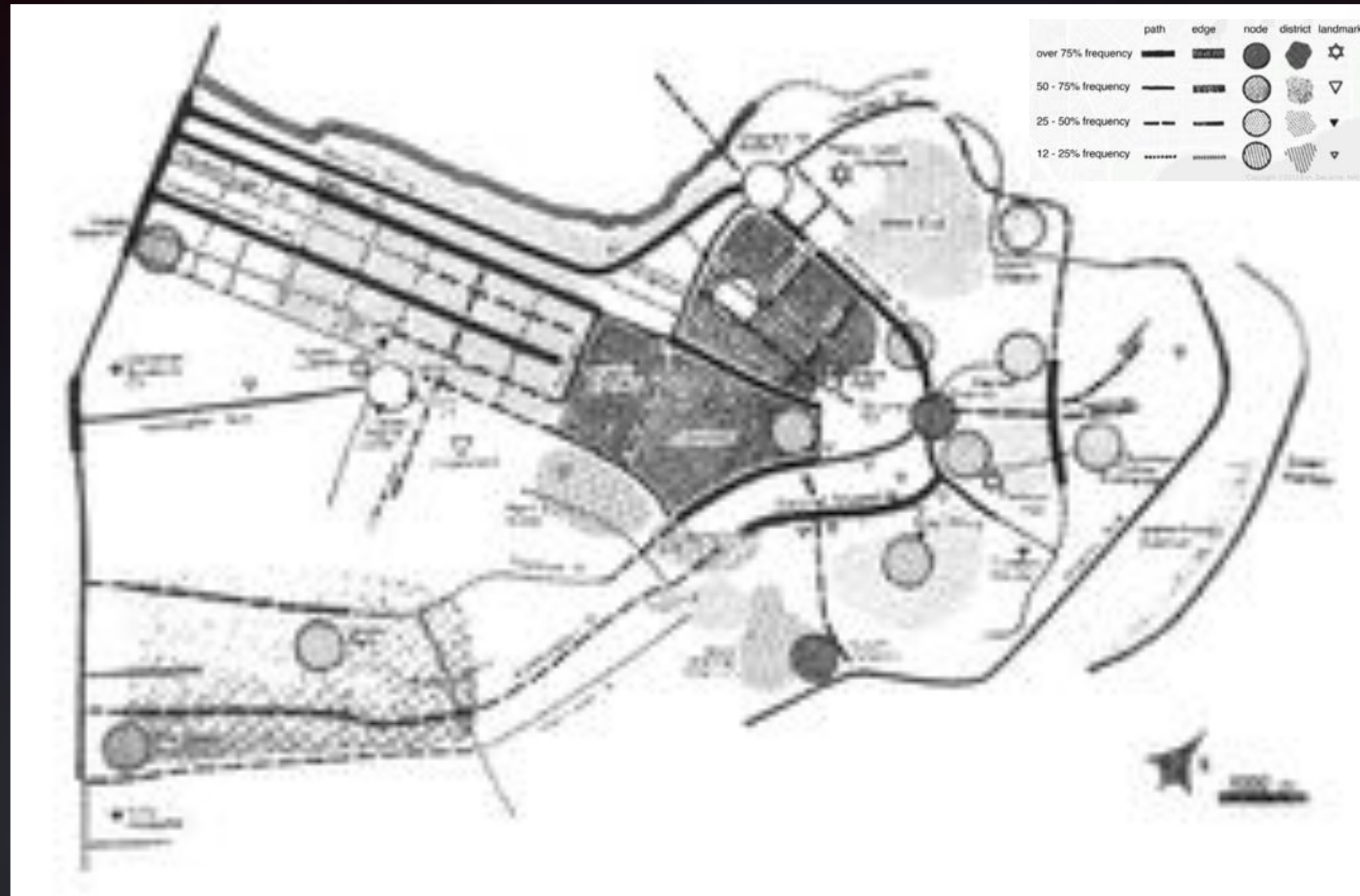
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The Boston Image derived from Verbal Interviews, The Image of the City (Kevin Lynch, 1960, P146)

Path



Edge



District



Node



Landmark

- 1) 基于手绘与访谈的心灵地图 (Mental Map)
- 2) 构成城市意象的五要素
- 3) 在规划实践领域被广泛应用
- 4) 消耗大量的人力与时间成本

小结: 该传统的城市意象方法为 **this conventional city image theory sets a complete example in using cognitive mapping to study public perceptions towards city. But it is relatively low efficient comparing to today's producing rate based on modern technology.**

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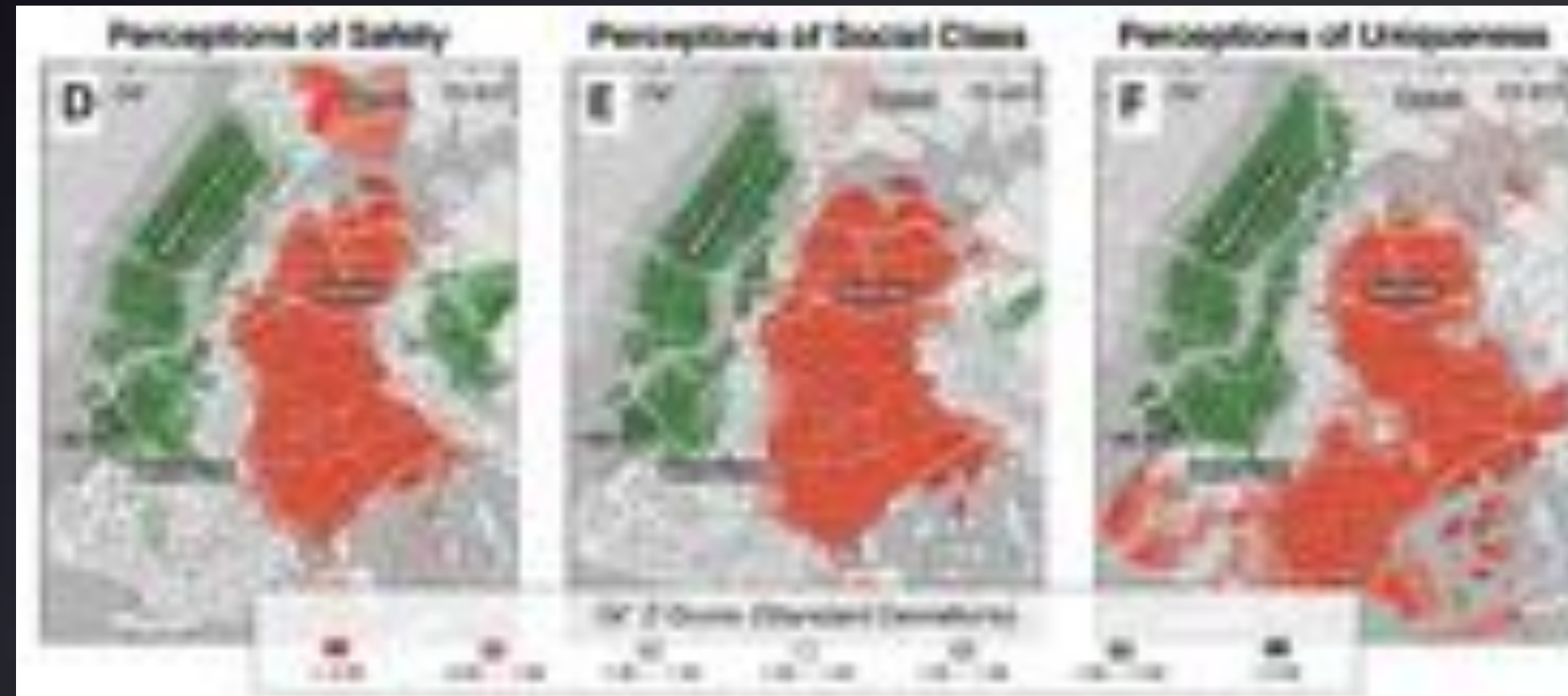
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top left: locations of street views collected from New York City

top middle: the website used to collect votes

right: Identifying places associated with different urban perceptions

bottom left: Map of NYC showing statistically significant clusters of high and low Q score for the perceptions of safety, class, and uniqueness

The Collaborative Image of The City: Mapping the Inequality of Urban Perception, Philip Salesses, Katja Schechtner, Cesar A. Hidalgo, 2013

- 1) **geo-tagged photos (google street)**
- 2) **online survey**
- 3) **safety, class and uniqueness**
- 3) **still relatively low efficient (it may take many years)**

Summary: this project used google street views as its research object and online voting techniques to measure the Inequality of city's perceptions



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image source: <http://www.gettyimages.cn/2857626>

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How to access the subjective cognition of physical environment? (access)

客观环境的主观认知

photos > texts:

closer to perception, no language barrier, no vague words

human-taken photos > machine-taken photos:

cognition of personal preference, wider coverage

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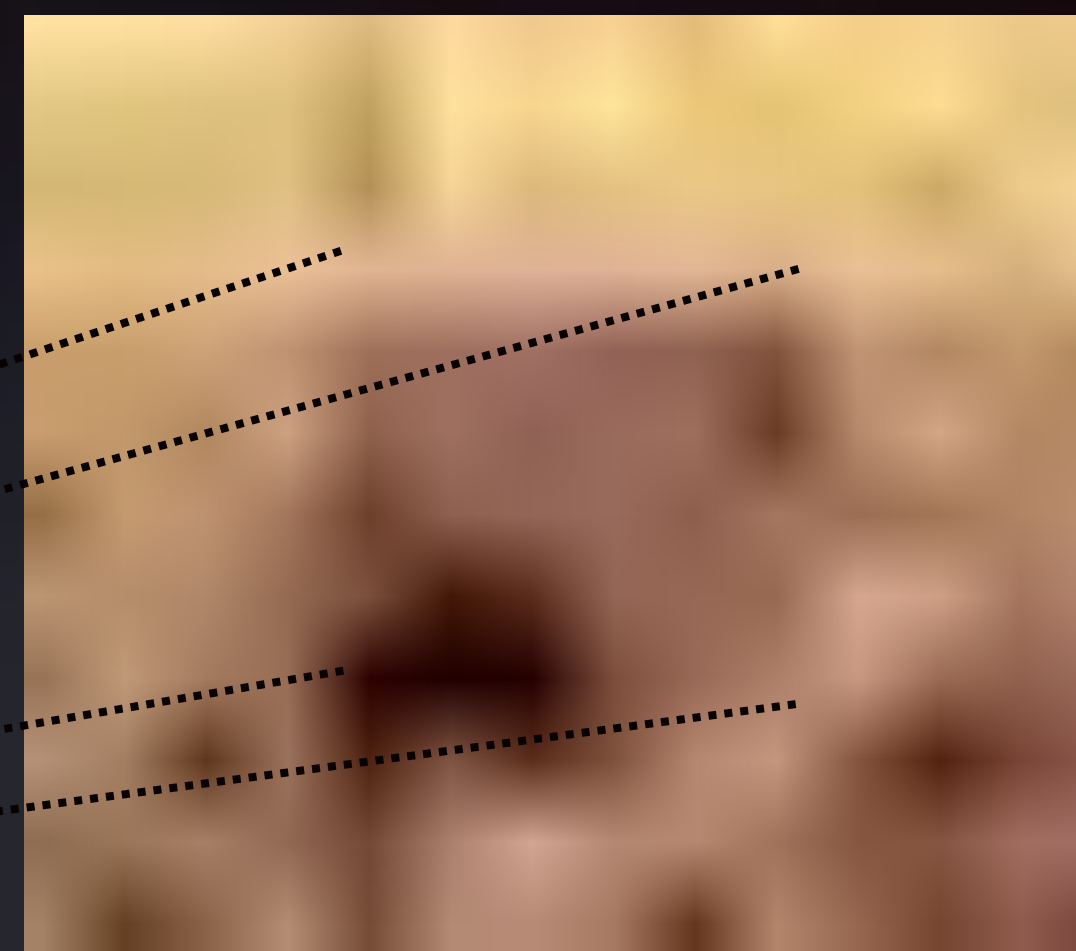
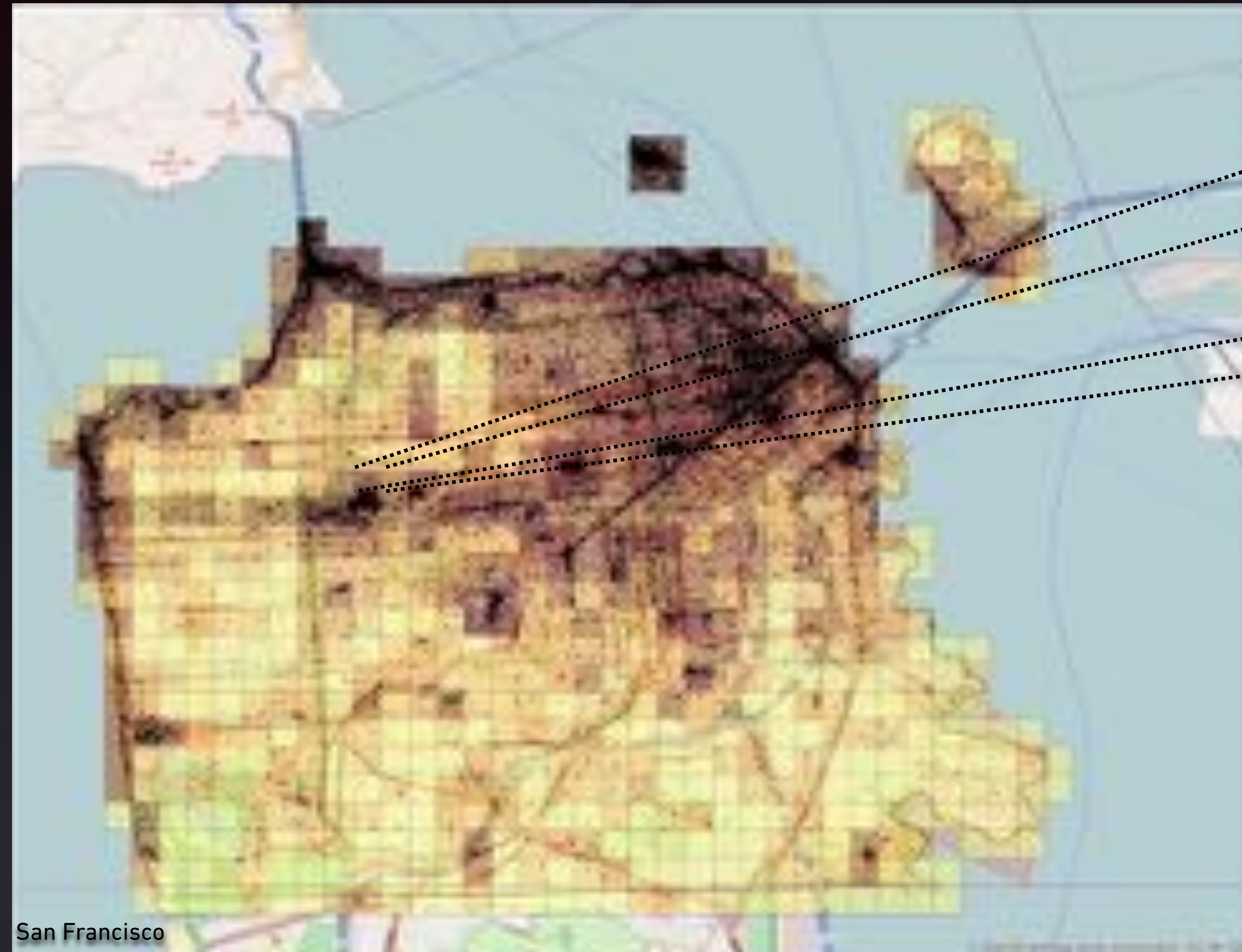
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- 1) find the city boundary and cut into 500 X 500 meter cell**
- 2) send request, and receive Json file to retrieve the data**
- 3) typical data information: upload_date, owner_name, owner_id, photo_id, longitude, latitude, height, width, photo_title, owner_url, photo_url, photo_file_url**

Summary: C-IMAGE has downloaded 26 cities covering North America, Asia, Europe, with over 2 million photos

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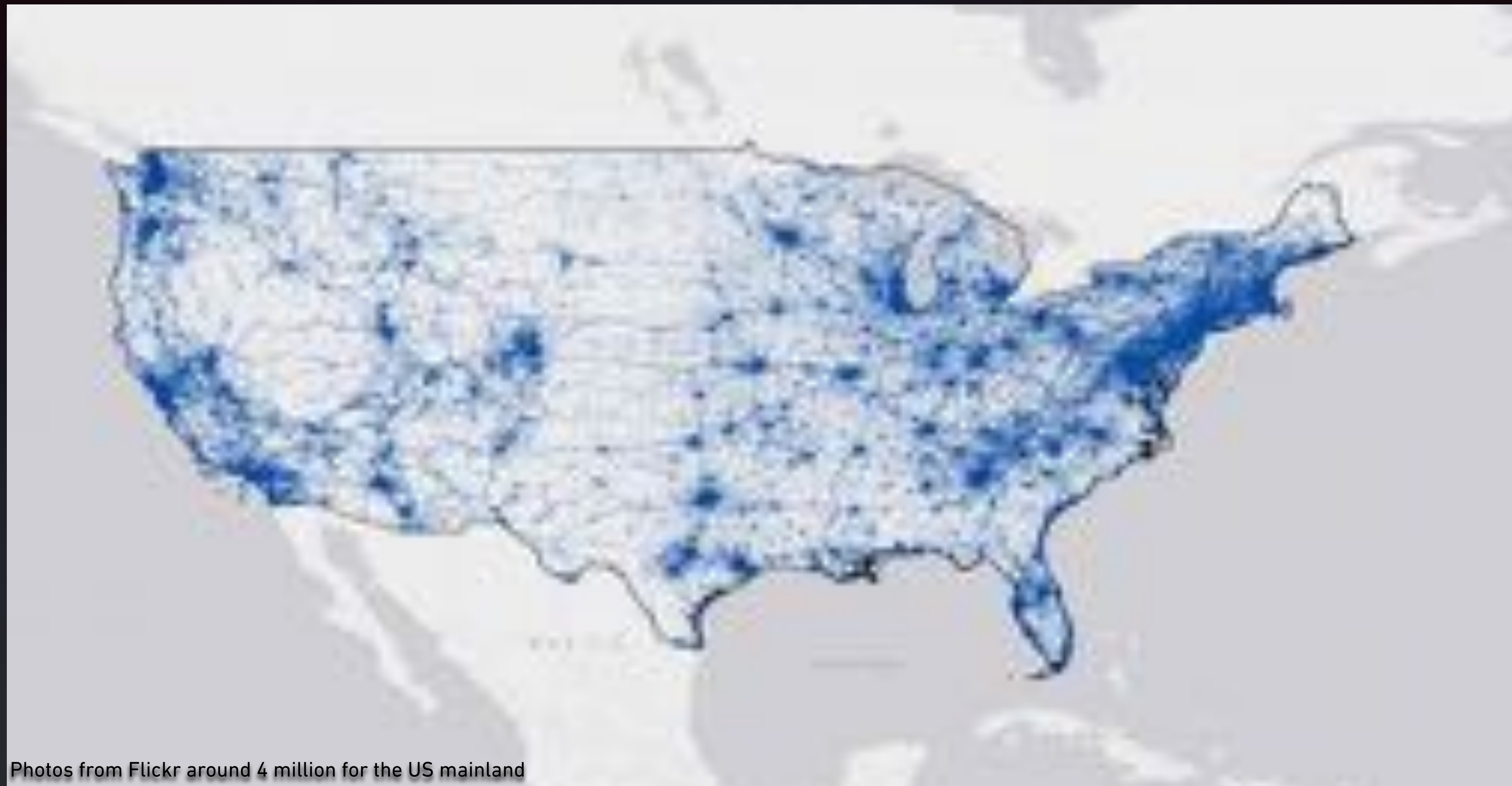
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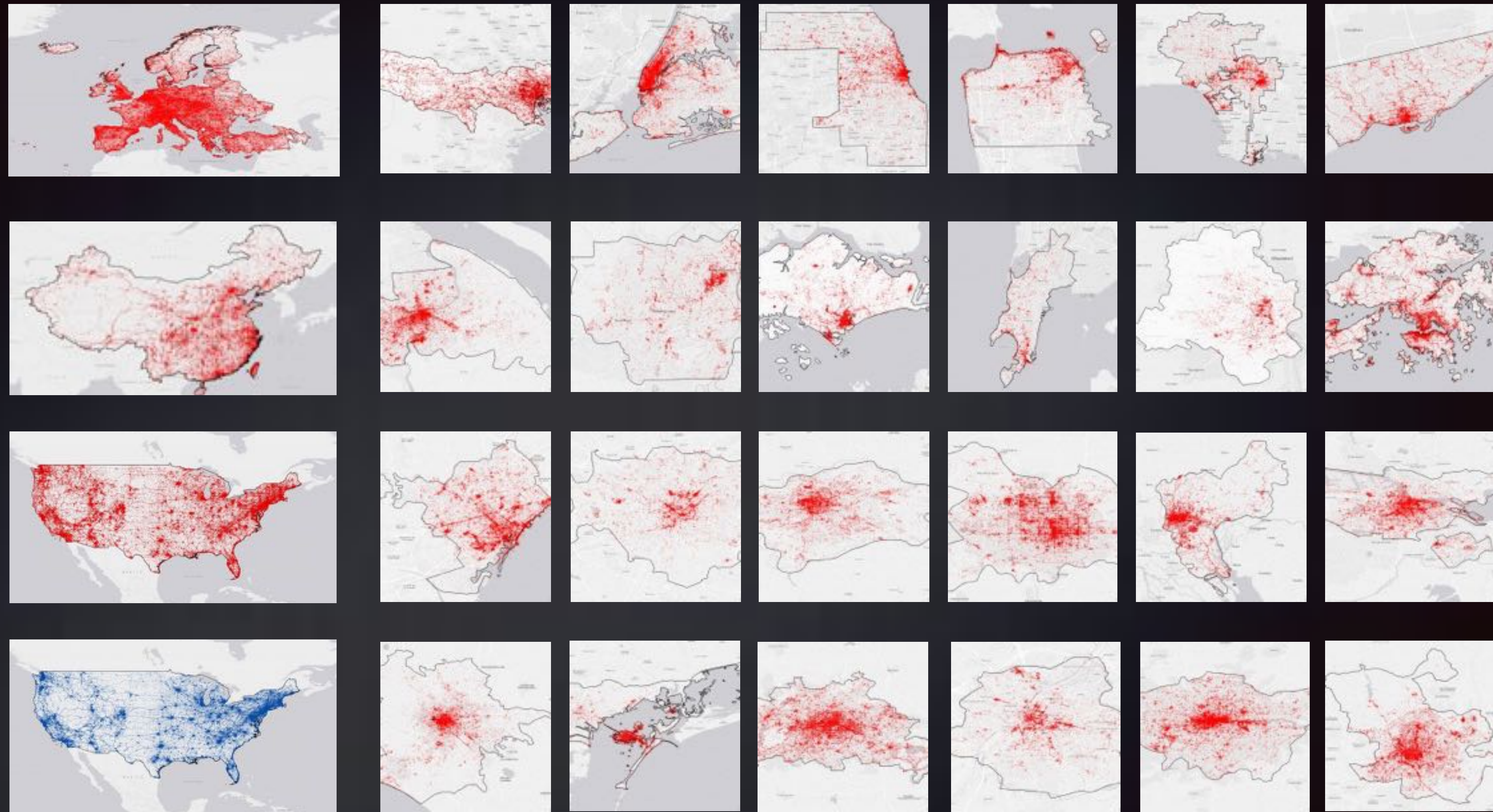
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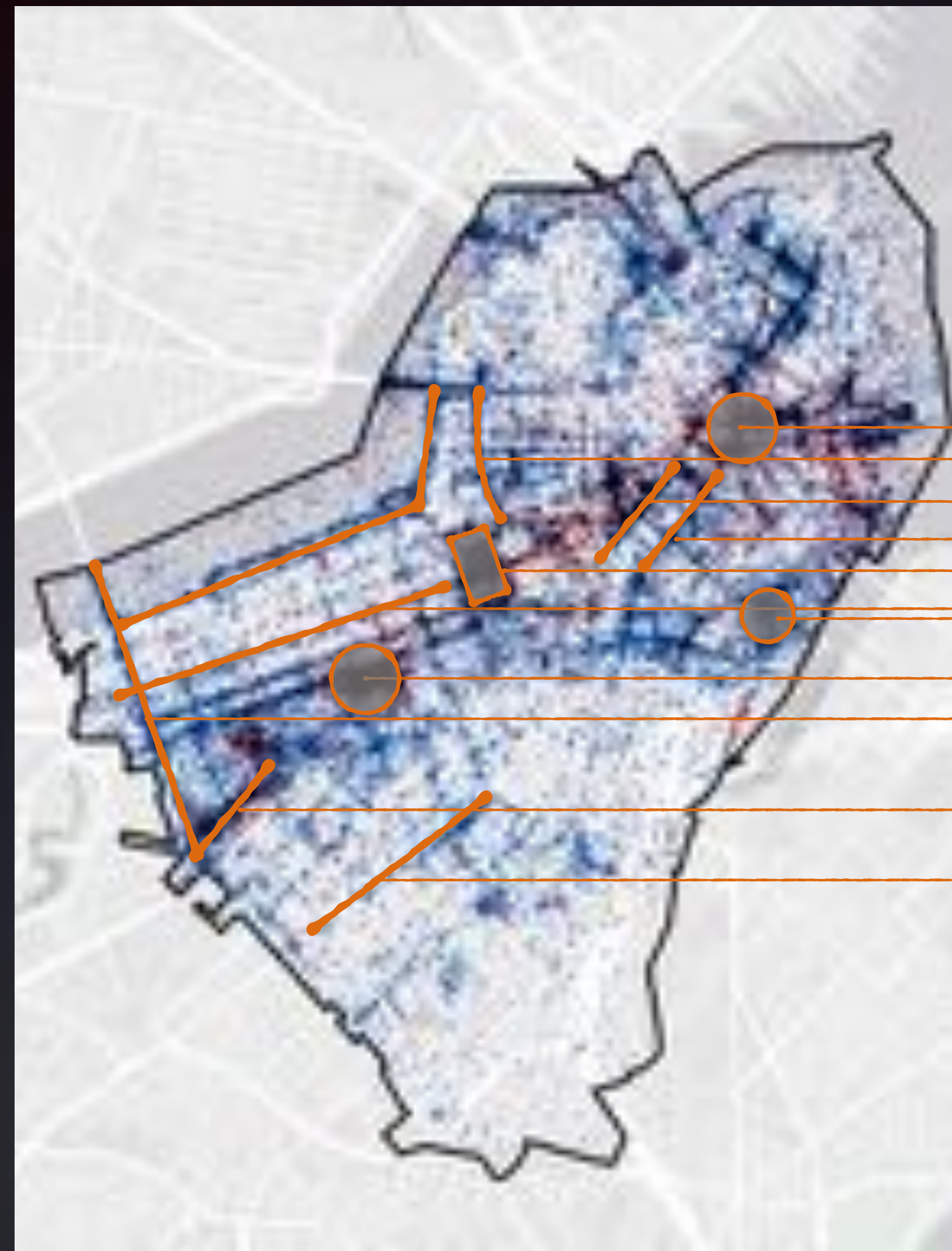
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- Limitations
- Key Moments
- Further Study



The upper lay is the Boston Image derived from verbal interviews (Kevin Lynch, 1960, P146)

How to apply the abstracted knowledge to urban problems? (detecting city changes, planning strategies)

Path (the channels along which the observer customarily, occasionally, or potentially moves) : Lines

Edge (seams, lines along which two regions are related and joined together) : Lines (not often)

Node (spots entitled with unique means, function, or any other uniqueness that enhance its sense of existence) : Clusters

Landmark (external presence with physical shapes such as buildings, sculptures, or mountains) : Clusters, needs image content analysis

District (medium to large sections of the city, conceived of as having two-dimensional extent) : not clearly defined, no clear match(Dense areas or Clusters)

Summary: C-IMAGE is partially comparable to Lynch's "City Image", but particularly difficult in identifying district.

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The upper lay is the map of problems in the Image of Boston (Kevin Lynch, 1960, P146)



Boston Common



Scollay Square

- 1) all the changes in image is a reflection of urban changes during the past six decades
- 2) most of the difference in the comparison can link to a specific planning activity, e.g. Prudential, Big Dig
- 2) some planning activities may not lead to an improvement from the comparison, e.g. West End
- 3) some changes have improved the perceptual environment without being led by an agent, e.g. Southwest Corridor Park

Summary: C-IMAGE is able to detect urban changes both from agent-led and agent-less basis.

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Big Dig (1982-2007)

Renovation of Faneuil Hall Mktpl(1976)

Waterfront Redevelopment(1964-)

Post Office Square(1992, 1997)

Newbury Street (1970s)

Prudential Center (1960 -1964)

Southwest Corridor Park (1970s)

Area	Year	Description	Image
Prudential Center	1960-1964	Construction of Prudential Center (1960-1964), West End (1960)	
Big Dig	1982-2007	Construction of Big Dig (1982-2007), Waterfront Redevelopment (1964-)	
Southwest Corridor Park	1970s	Construction of Southwest Corridor Park (1970s)	
Newbury Street	1970s	Renovation of Newbury Street (1970s)	
Post Office Square	1992, 1997	Renovation of Post Office Square (1992, 1997)	
Faneuil Hall Market Place	1976	Renovation of Faneuil Hall Market Place (1976)	

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1954-1959, image source: <http://hdl.handle.net/1721.3/34336>



google street view, July, 2011

Newbury Street

“During the past decades, Newbury street has developed its distinctive character that makes it one of the most elegant streets in Boston” (The city observed, Boston: a guide to the architecture of the hub, Lyndon & Wingwall, 1982)

Summary: Such agent-less changes often take time and C-IMAGE is ideal monitor to witness its birth.

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The map of Southwest Corridor Park from Southwest Corridor Park Conservancy, <http://www.swcpc.org/swcpmap.asp?whatsection=SE>

Southwest Corridor Park

“The Boston Southwest Corridor began as a highway project and ended as a community design project.” (The Quality of Participatory Design: The effects of Citizen Input on the Design of the Boston Southwest Corridor, Crewe, 2001)

Summary: The comparison from C-IMAGE provides a direct support to the quality of participatory design.

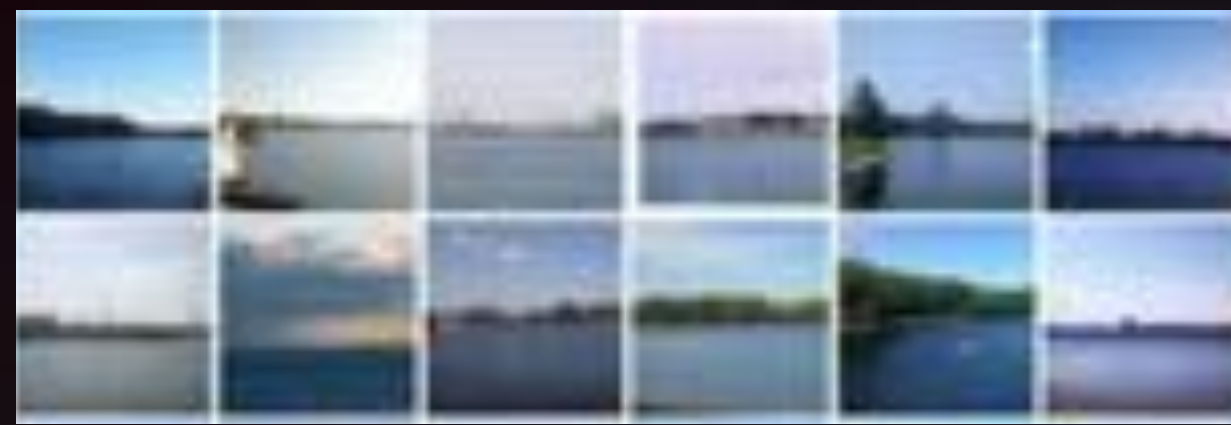
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1 Sailing / Boating



2 Driving



6 Vacationing / Touring



17 Eating



19 Socializing



22 Competing



28 Farming



30 Shopping



32 Working



40 Railroad



41 Trees



48 Asphalt

case of Boston

To see the complete plots of the cities from here: http://wednesday.csail.mit.edu/cityimage/cimage/result_plot/

“Recognizing City Identity via Attribute Analysis of Geo-tagged Images”
Bolei Zhou, Liu Liu, Aude Oliva, Antonio Torralba
Computer Vision - ECCV 2014

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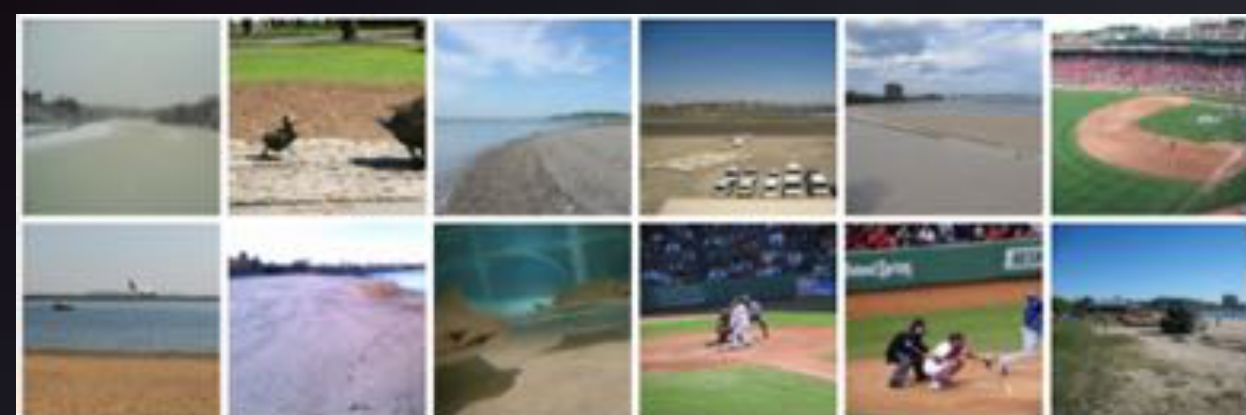
50 Shingles



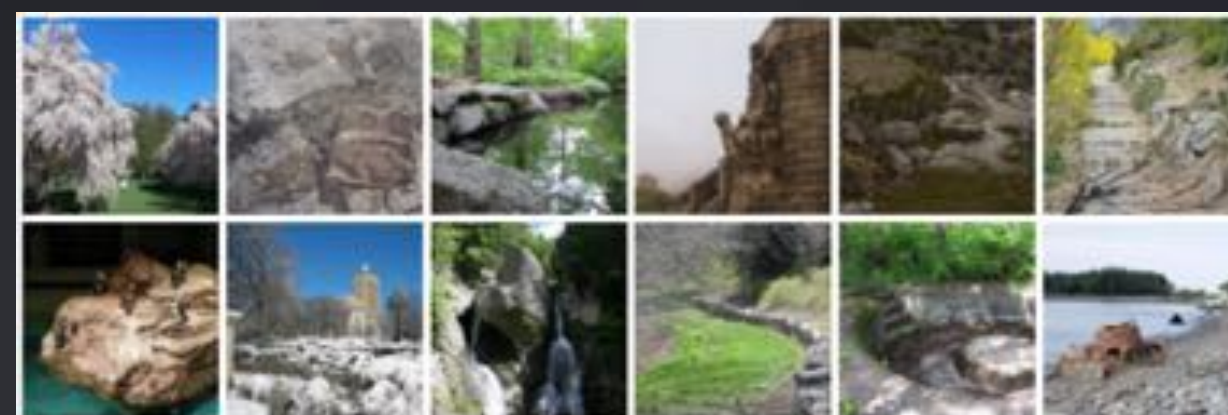
51 Carpet



57 Wood



61 Sand



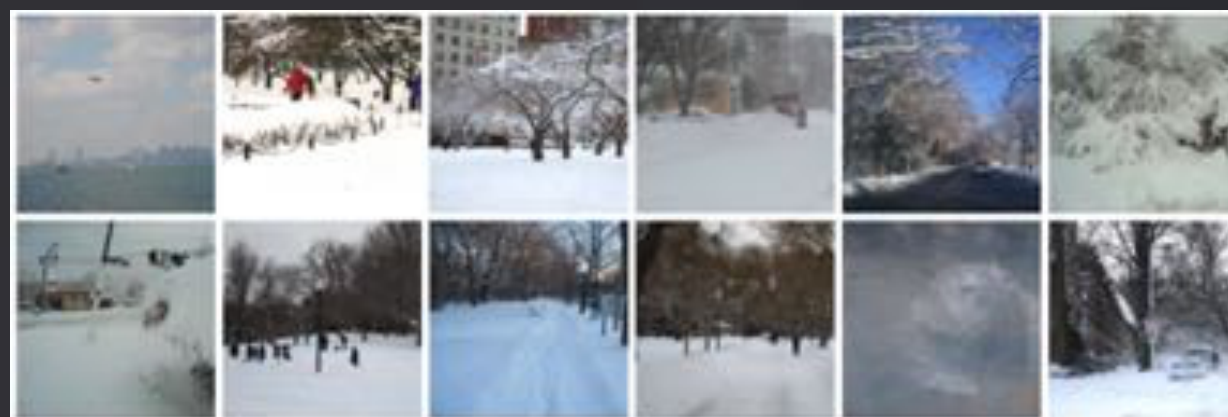
62 Rock / Stone



65 Glass



68 Running Water



70 Ice



71 Snow



80 Matte



83 Dry



96 Mostly Vertical Components

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How to materialize the information from that cognition? (extract)

SUN attribute database: consists of 102 scene attributes labeled on 14,340 images from 717 categories from it ImageNet —> Deep convolutional network —> 4096 deep learning features (vector) —> SVM classifier (lib SVM)

Summary: through this technology, all the photos are tagged with a 102 dimensional vector indicating which scene its content belongs to.

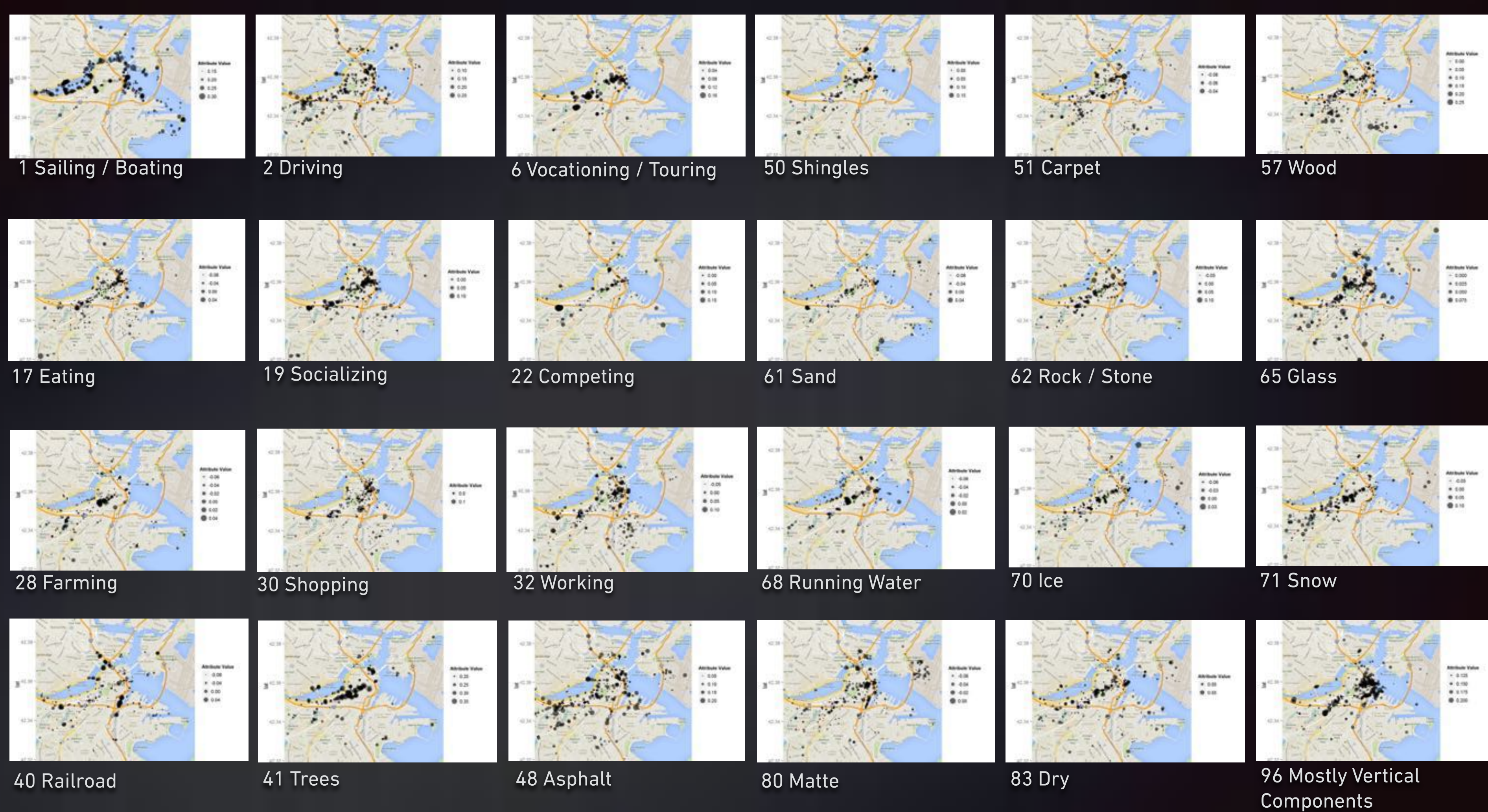
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1 sailing boating	2 driving	3 bilking	4 transporting things or people	5 sunbathing	6 vacationing/ touring	7 hiking	8 climbing	9 camping	10 reading	11 studying/ learning	12 teaching	13 research
14 diving	15 swimming	16 bathing	17 eating	18 cleaning	19 socializing	20 congregating	21 waiting in line/queue	22 competing	23 sports	24 exercising	25 playing	26 gaming
27 spectating/ being in an audience	28 farming	29 constructing/ building	30 shopping	31 medical activity	32 working	33 using tools	34 digging	35 conducting business	36 praying	37 fencing	38 railing	39 wire
40 railroad	41 trees	42 grass	43 vegetation	44 shrubbery	45 foliage	46 leaves	47 flowers	48 asphalt	49 pavement	50 shingles	51 carpet	52 brick
53 tiles	54 concrete	55 metal	56 paper	57 wood (not part of a tree)	58 vinyl/ linoleum	59 rubber/ plastic	60 cloth	61 sand	62 rock/stone	63 dirt/soil	64 marble	65 glass
66 waves/surf	67 ocean	68 running water	69 still water	70 ice	71 snow	72 clouds	73 smoke	74 fire	75 natural light	76 direct sun/ sunny	77 electric/ indoor lighting	78 aged/worn
79 glossy	80 matte	81 sterile	82 moist/damp	83 dry	84 dirty	85 rusty	86 warm	87 cold	88 natural	89 man-made	90 open area	91 semi-enclosed area
92 enclosed area	93 far-away horizon	94 no horizon	95 rugged scene	96 mostly vertical components	97 mostly horizontal components	98 symmetrical	99 cluttered space	100 scary	101 soothing	102 stressful		

Green Perception: this is the most frequent scene, including a wide variety of categories such as vegetation, trees, etc.

Water Perception: it refers to photos that contain a large proportion of water in their contents.

Transportation Perception: it means photos contains vehicles.

High-rises Perception: it only stands for an impression of high buildings, not definitely related to the real height of the building.

Architecture Perception: mostly it is representing historical buildings or traditional characterized buildings, such as churches.

Socializing Perception: this category means photo that are related with a wide range of activities varying from a small group to larger ones.

Athletic Perception: in theory, it is a subset of socializing activities but sometimes it will be treated as green space.

Summary: The principle to the generalization is based on 1) to be related to urban contents, and 2) distinguishable with others

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Architecture Perception: mostly it is representing historical buildings or traditional characterized buildings, such as churches.

Socializing Perception: this category means photo that are related with a wide range of activities varying from a small group to larger ones.

Athletic Perception: in theory, it is a subset of socializing activities but sometimes it will be treated as green space.

Summary: The principle to the generalization is based on 1) to be related to urban contents, and 2) distinguishable with others

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4 Application

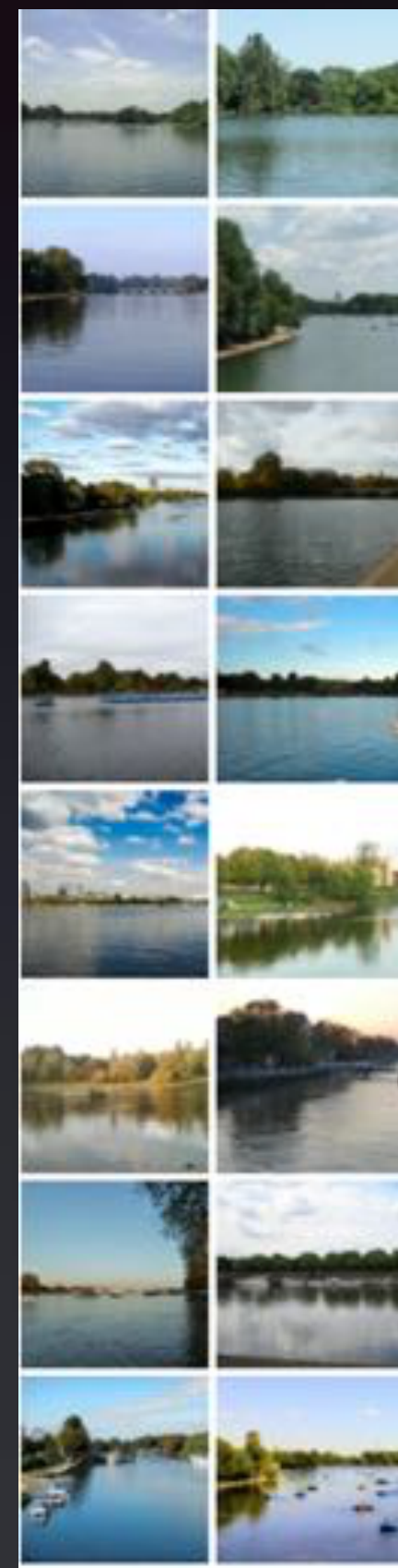
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 - C-IMAGE and Traditional 5 elements
 - Comparison with the City Problem Map
 - Agent-led Changes vs. Agentless Changes
- **C-IMAGE as Urban Function & Activities Identification**
 - **102 Attributes to seven Urban Perceptions**
 - Typology from the seven-perception C-IMAGE
 - Tokyo vs. Shanghai

5 Conclusion

- Limitations
- Key Moments
- Further Study



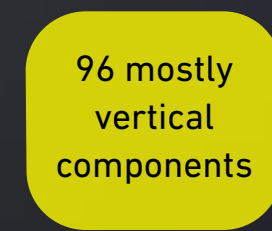
Green Perception



Water Perception



Transportation Perception



High-rises Perception



Architecture Perception



Socializing Perception



Athletic Perception

case of London

To see the complete plots of the cities from here: http://wednesday.csail.mit.edu/cityimage/cimage/result_plot/cityAttribute/

Green Perception: this is the most frequent scene, including a wide variety of categories such as vegetation, trees, etc.

Water Perception: it refers to photos that contain a large proportion of water in their contents.

Transportation Perception: it means photos contains vehicles.

High-rises Perception: it only stands for an impression of high buildings, not definitely related to the real height of the building.

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Paris, France







Toronto, Canada



Hong Kong, China



Tokyo, Japan



Beijing, China



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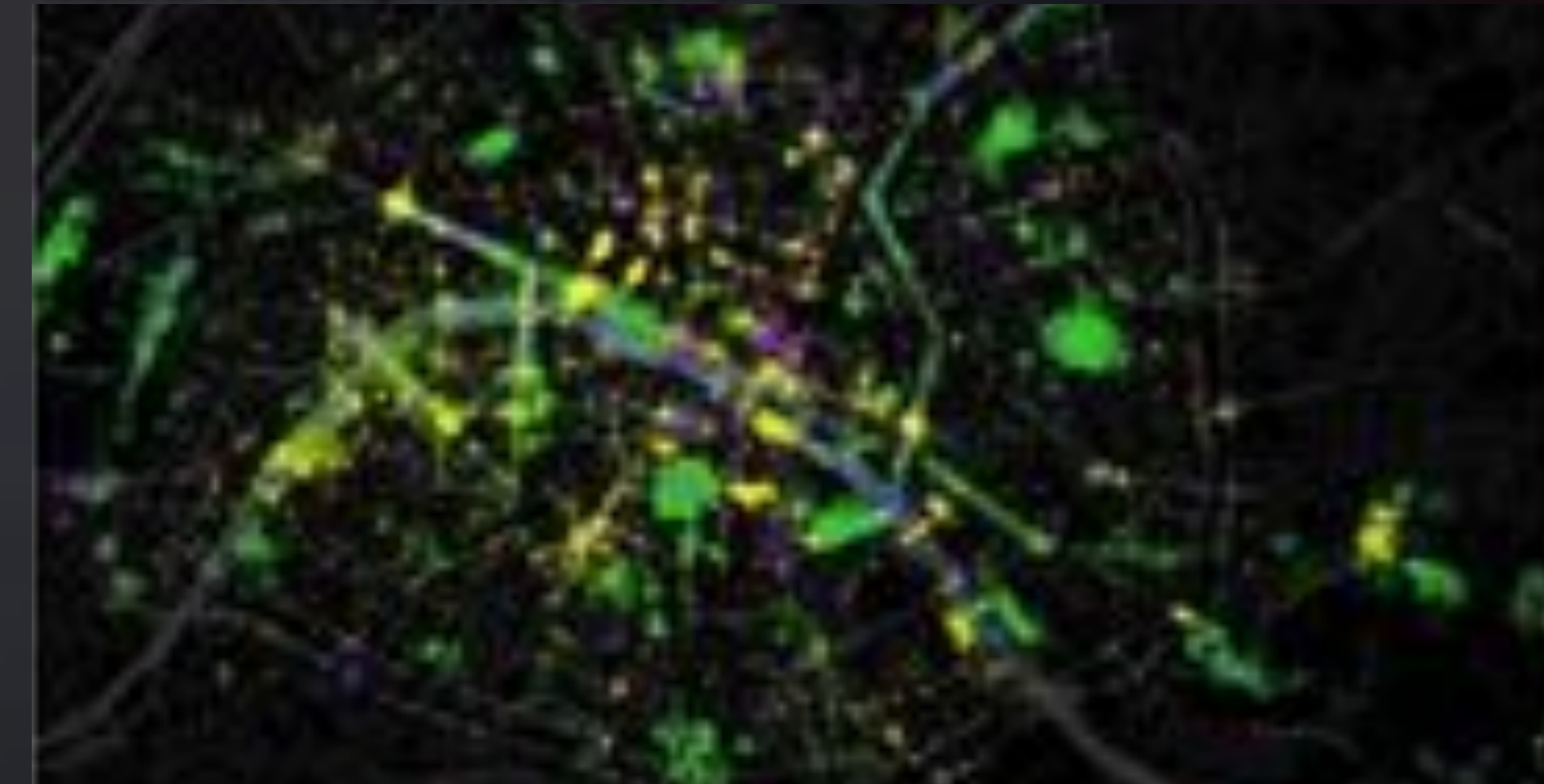
Singapore (Green Perception Dominated City)



Toronto (Green and High-rises Separated city)



Shanghai (High-rises Perception dominated city)



Paris (Green and High-rises Perceptions mixed city)

Infographics based on the seven-category of image contents

- 1) Green Perception Dominated City: it refers to cities full of green perceptions in its center.
- 2) Green and High-rises Separated City: it means the high-rises perceptions and green ones are concentrated separately.
- 3) Green and High-rises Perceptions mixed City: the cities are mixture of both green perceptions and high-rises perceptions.
- 4) High-rises Perception dominated City: it is mostly covered by high-rises perceptions overwhelmingly.

Summary: According to the seven categorized C-IMAGE, cities display different types in its holistic perception.

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Shanghai (proportion of Green Perceptions: 35%)



Tokyo (proportion of Green Perceptions: 53%)



top right image sources: <http://skyblueskye.com/wp-content/uploads/2013/03/DSCN0084.jpg>

bottom left image source: <http://www.panoramio.com/photo/95511176>

bottom right image source: <http://www.panoramio.com/photo/5844316>

Shanghai vs. Tokyo 上海 vs 东京

Similarities: huge population, heavy density, close to ocean, temperature, and GREEN SPACE PER PERSON (Shanghai, 18.1 [2008] > Tokyo, 10.6 [2005])

Difference: 1) planning structures 2) planning strategies 3) planning systems

Summary: C-IMAGE can evaluate the real level of contribution derived from different plans, which cannot be measured by traditional index.

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静安公园 (1:6000)



东京某绿地 (1:6000)

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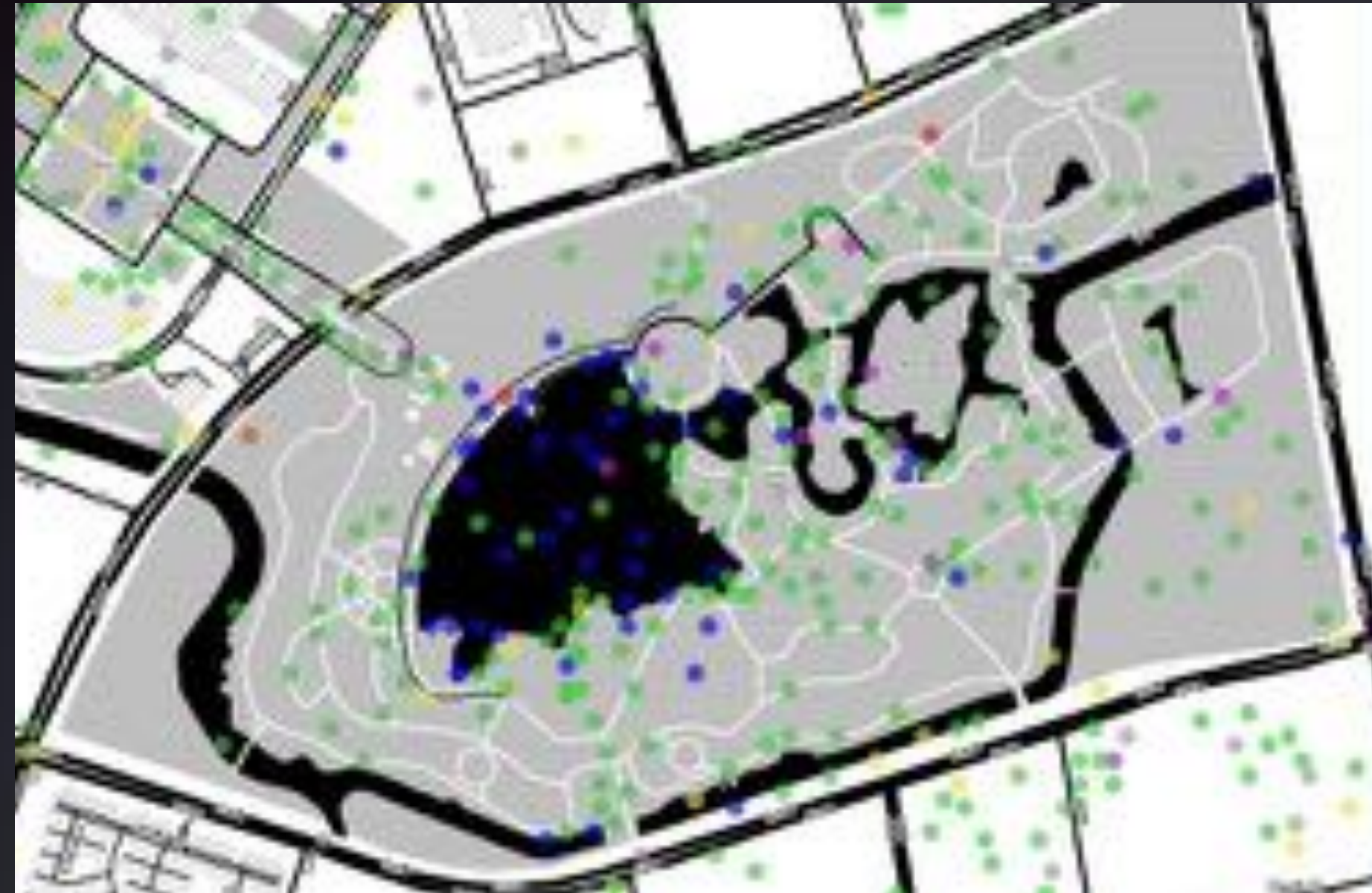
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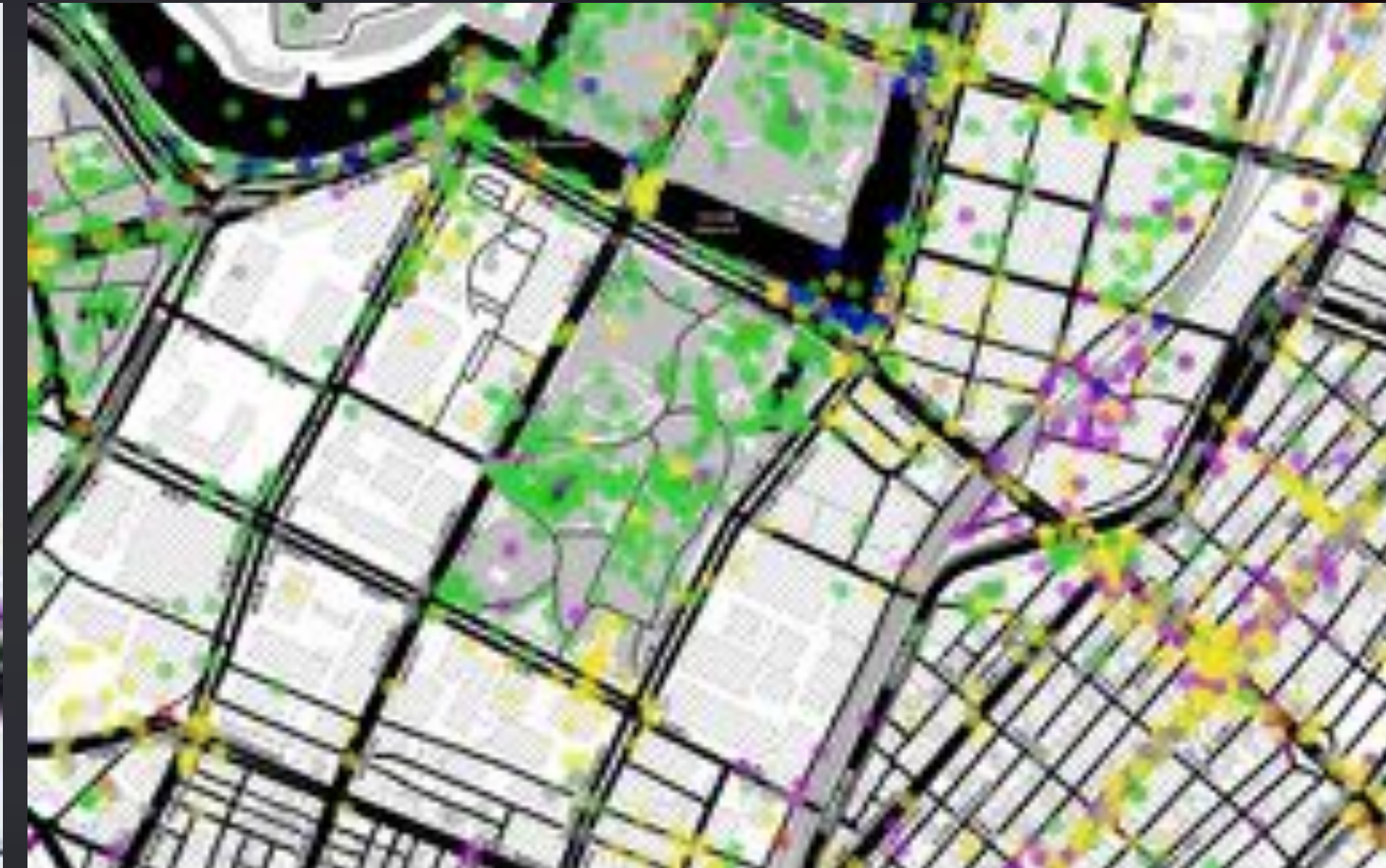
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世纪公园 (1:6000)



东京日比谷公园 (1:6000)

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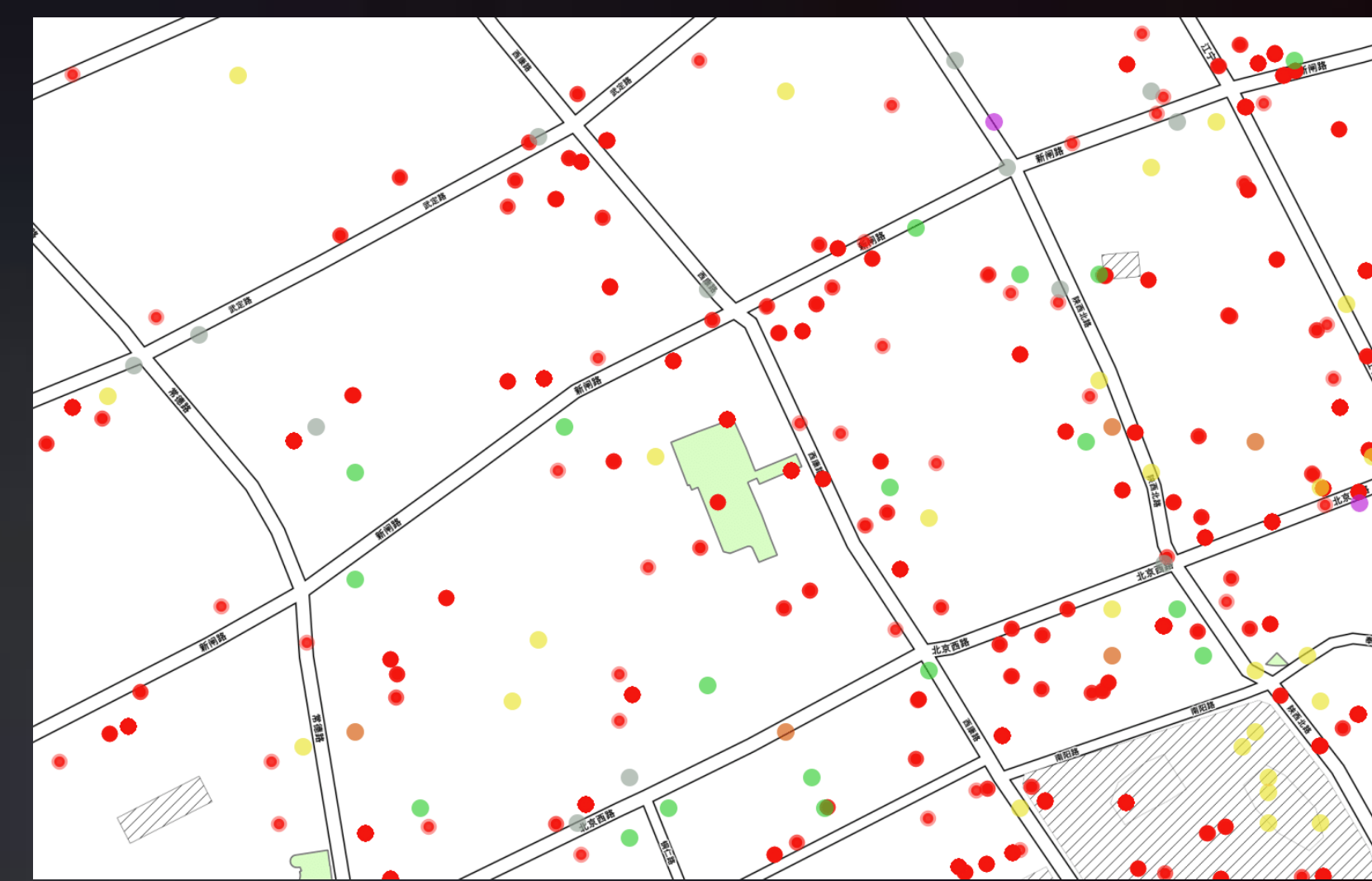
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Thanks!

基于地理信息信息照片的城市感知地图

C-IMAGE : City Cognitive Mapping Through Geo-Tagged Photos

BCL 2014, Beijing

刘浏 | 2014.10

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