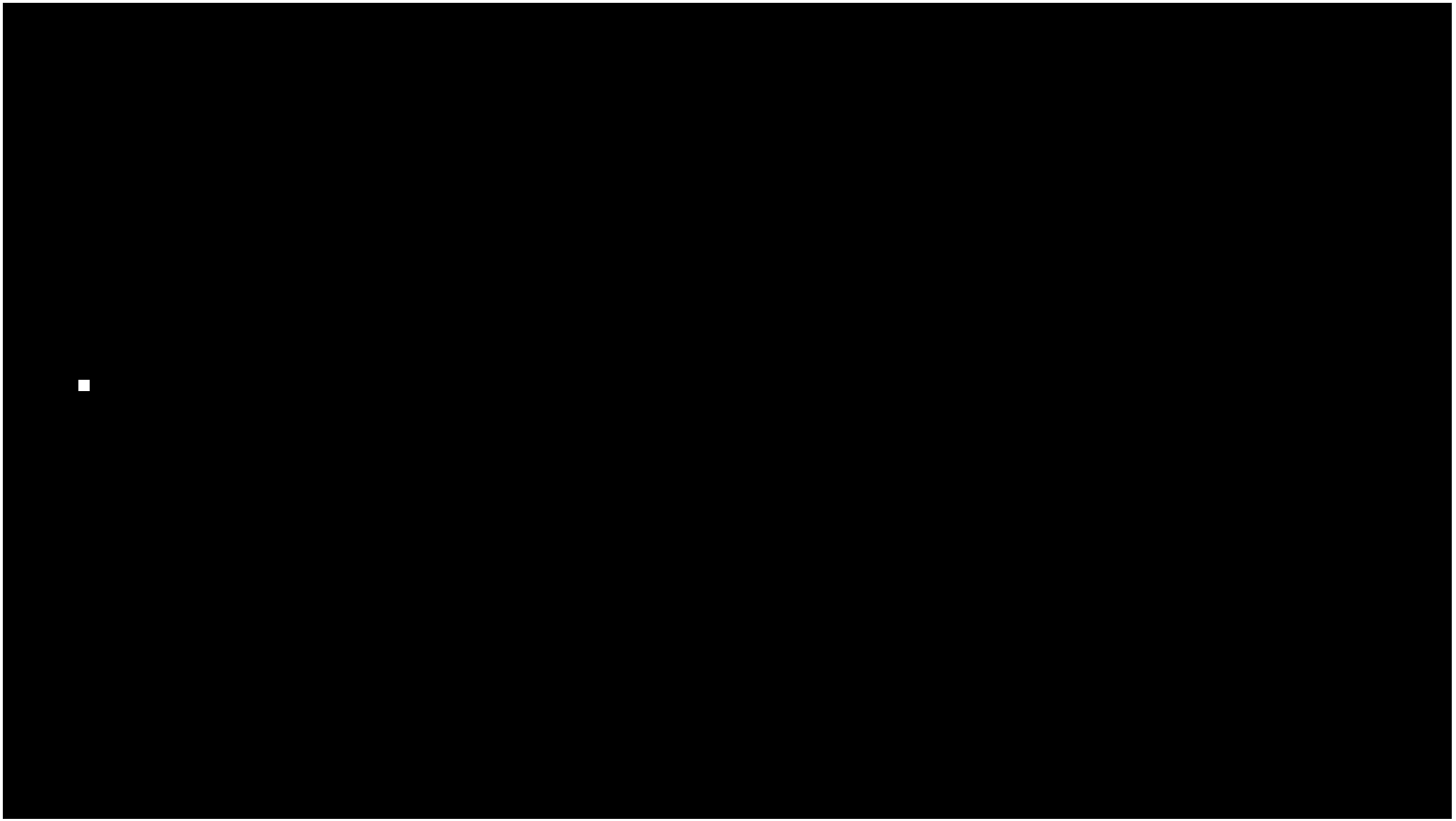


NOKIA Bell Labs

Inventing the Future X Network

Creation of Bell Labs
The engineering departments of the American Telephone and Telegraph Company (AT&T) and Western Electric were consolidated into Bell Telephone Laboratories. Their mission was to research and design communication technologies for the rapidly expanding telephone network and to explore fundamental areas of science that could shape the future of the industry. Over the years, many cornerstone technologies of modern society have been invented at Bell Labs and 8 Nobel Prizes have been awarded to its researchers

1925

1930's

1937
Electron Diffraction
Demonstrating wave nature of matter

1940's

1948
"A Mathematical Theory of Communications"
By showing that all communications channels – of any type – have a fundamental capacity limit, Claude E Shannon founded the field of information theory

1950's

1954
Solar cells

1956
Transistor
To replace the vacuum tube, Bardeen, Brattain and Shockley created a working point-contact transistor. This basic building block for all digital products is the foundation for our information society

1958
LASER
In their 1958 paper, Schawlow and his brother-in-law Townes described in detail a proof of concept for the LASER. The laser enables a wide variety of applications: fiber-optic communications, digital storage, barcode scanners, precision surgery and industrial cutting tools

1960's

1962
Telstar
Transatlantic live TV broadcast via satellite

1970's

1973
UNIX and C Language
Thompson and Ritchie's elegant design made it an immediate hit with the programming community when it was released in 1974. UNIX would later on become the Internet's foundation

1976
Fiber Optic Network
First demonstration of 45 Mbit/s transmission

1977
Electronic Structure of Magnets and Glasses

1978
Cosmic Microwave Background Radiation
Pioneering work on radio communications using the Holmdel Horn Antenna provides support for the Big Bang Theory

1978
Commercial Cellular Network
Invention of the cellular concept and creation of the first commercial network

1980's

1980
Demonstration of DSP
Large-scale integrated circuit for digital signal processing

1995
Commercial DWDM
Pioneering work on wavelength multiplexing in optical fibers

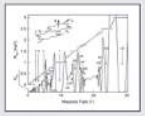
1995
Integrated ADSL Chip
After co-inventing ADSL technology, follow-up innovations like vectoring continued to generate world records for high speed data transfer over copper telephone lines, fueling the Internet

1997
Laser-Based Cooling and Trapping of Atoms
To understand the fundamental limits of materials and matter

1990's

1998
Wireless MIMO Spatial Multiplexing
Invention of wireless transmission based on multiple spatial paths

1998
Fractional Quantum Hall Effect
Discovery of a novel collective quantum fluid state of matter



2006
Software Defined Routing
Predecessor of Software Defined Networks (SDN)

2009
CCD
Boyle and Smith's picture phone research realized the enormous potential of the Charge Coupled Device as an imaging device, leading to the invention of the digital photo, video cameras, scanners, satellite surveillance and ultra-sensitive astronomical telescopes

2009
Coherent 100G Optics
Invention of the future of high speed optical communications with coherent processing

2000's

2009
World's first standard compliant LTE call

2011
lightRadio Cube
First demonstration of building block of future small cell wireless networks

2014
Fluorescence Microscopy
Ground-breaking work on sub-wavelength optical microscopy leads to super-resolution microscopy at cellular level

2014
XG-FAST
First demonstration of 10 Gbps over copper telephone wires

2010's

2015
GreenTouch
International consortium delivers new technologies to improve energy efficiency in wireless networks by more than 10,000X

2015
Optical MIMO-SDM
Pioneering work on utilizing the spatial dimension in fiber, showing greater than 10X increase in optical network capacity

2015
The Future X Network: A Nokia Bell Labs Perspective
First Nokia Bell Labs book written

2016
5G Massive Connectivity
First demonstration of 1M simultaneous, ultra-low latency connections in a single cell for 5G and IoT

The Future

Nokia Bell Labs continues to solve the great industry challenges, producing disruptive innovations for the next phase of human existence

NOKIA Bell Labs

Social Dynamics

Daniele Quercia

Luca Aiello

We are hiring interns, postdocs, senior scientists

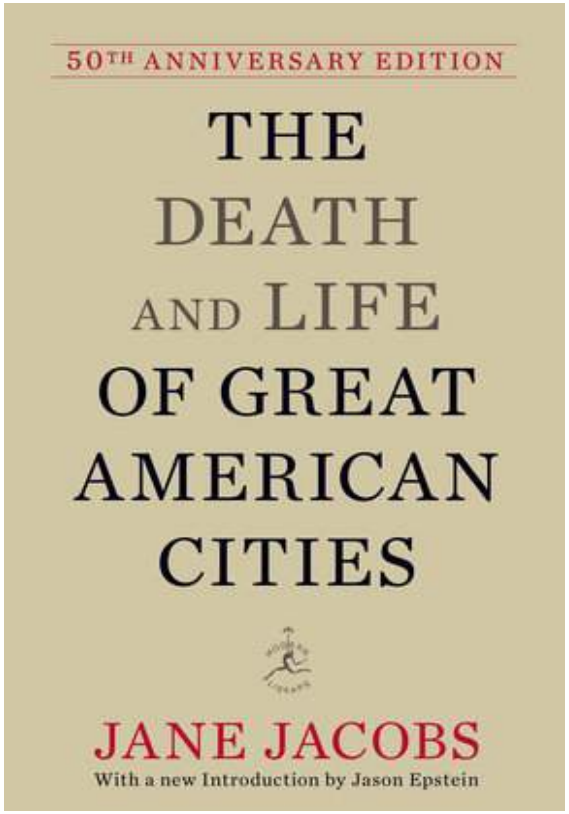
researchswinger.org/hiring.html

smart city


goodcitylife.org


Jane Jacobs
Stanley Milgram
Kevin Lynch
goodcitylife.org
Photo: Ginny

The theory: Jane Jacobs



Jacobs' diversity conditions

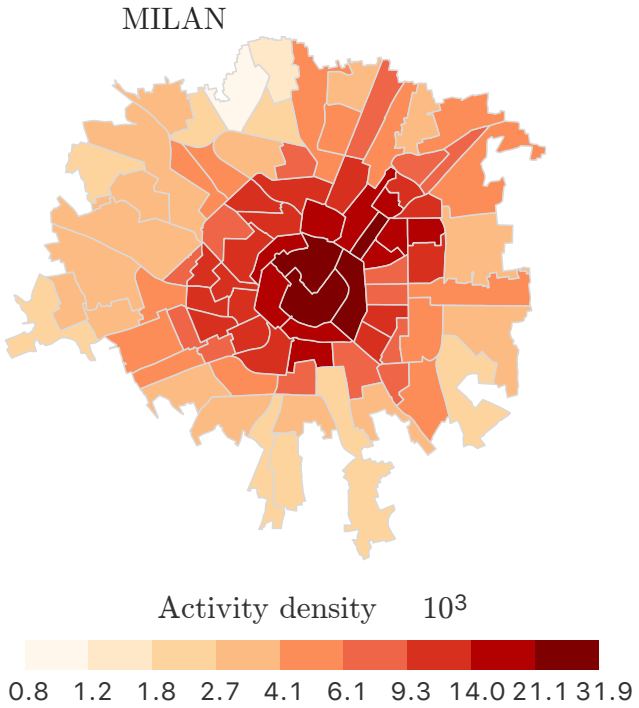
LAND USE	SMALL BLOCKS
AGED BUILDINGS	DENSITY

Urban vitality = diversity

There are **4 diversity conditions**:

1. Land use mix
2. Small blocks
3. Aged buildings
4. Sufficient density of people an enterprises

"Operationalize" Vitality

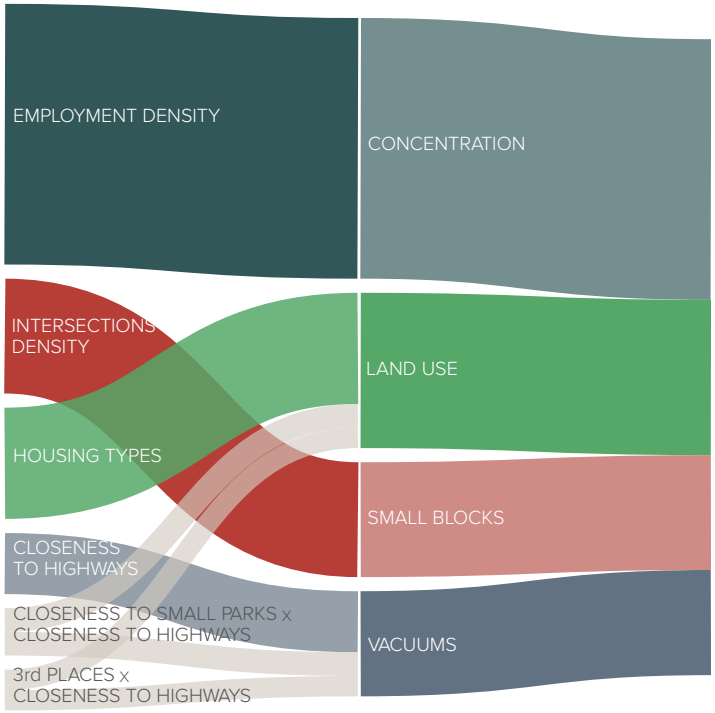


- Mobile Internet activity as a proxy for urban vitality
- We calculate the activity density in each district

TIM

Urban diversity to urban vitality

URBAN INDEXES



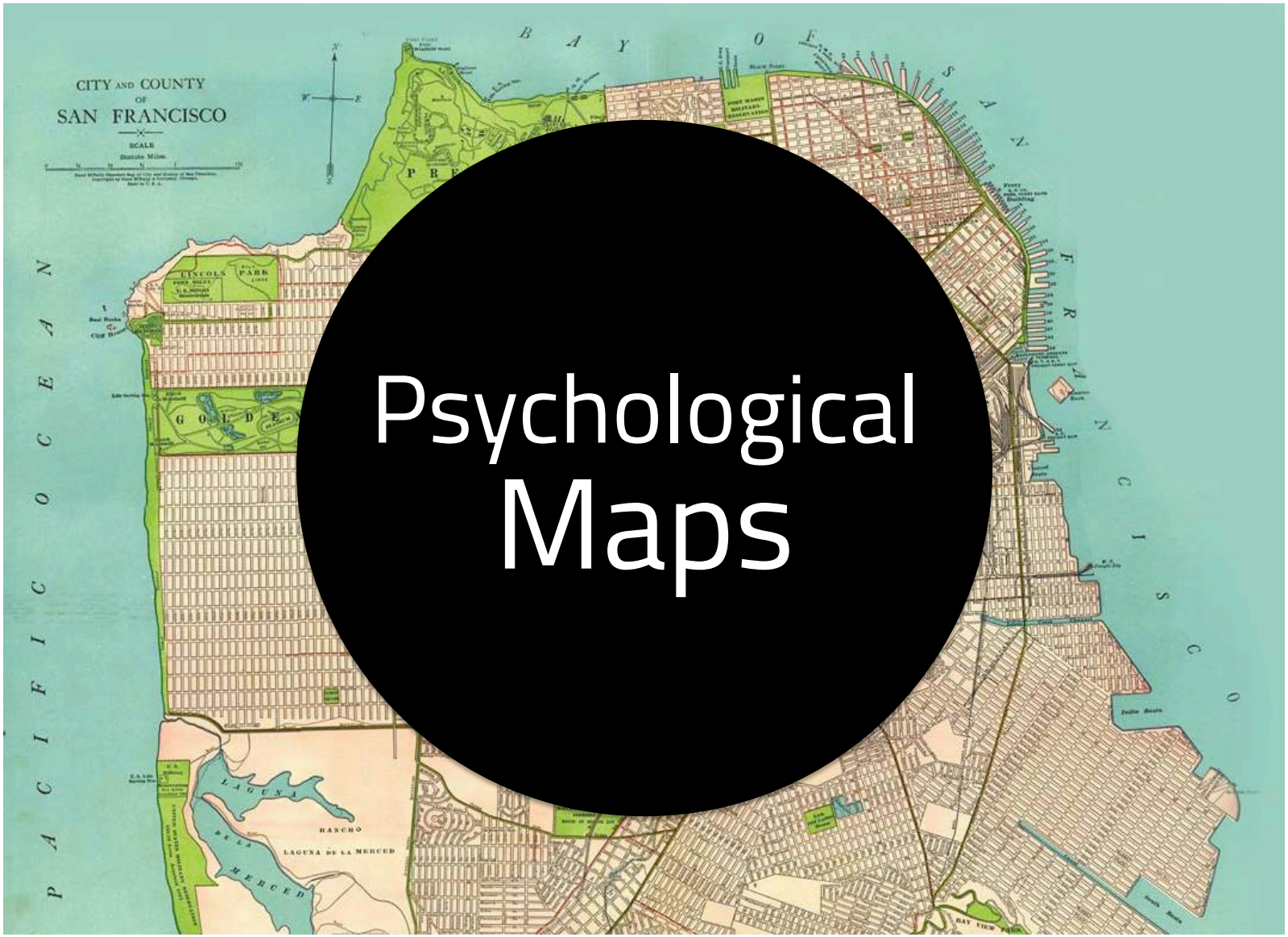
URBAN DIVERSITY CONDITIONS

Predict

URBAN VITALITY

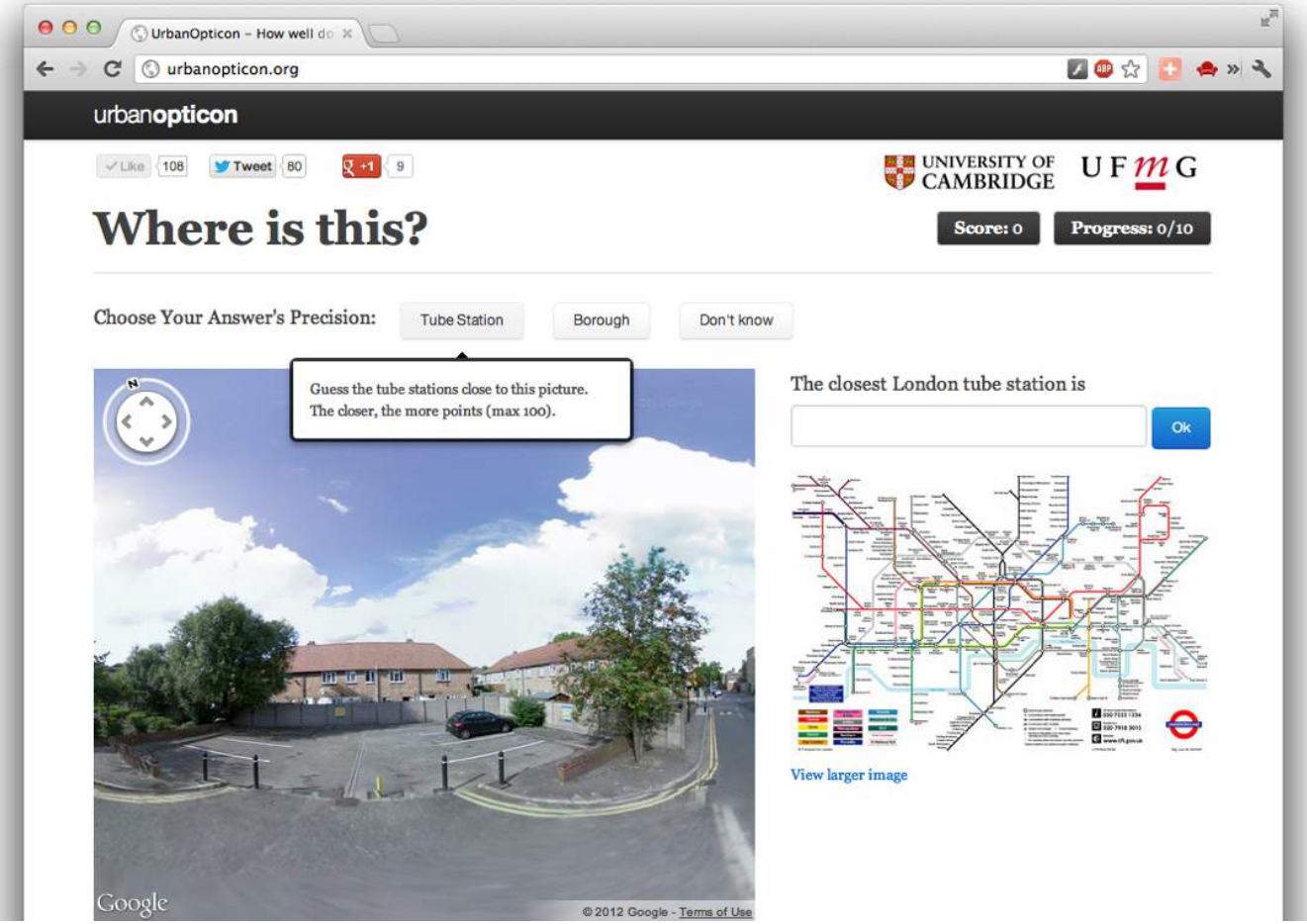
R^2: 0.77

What they **remember**



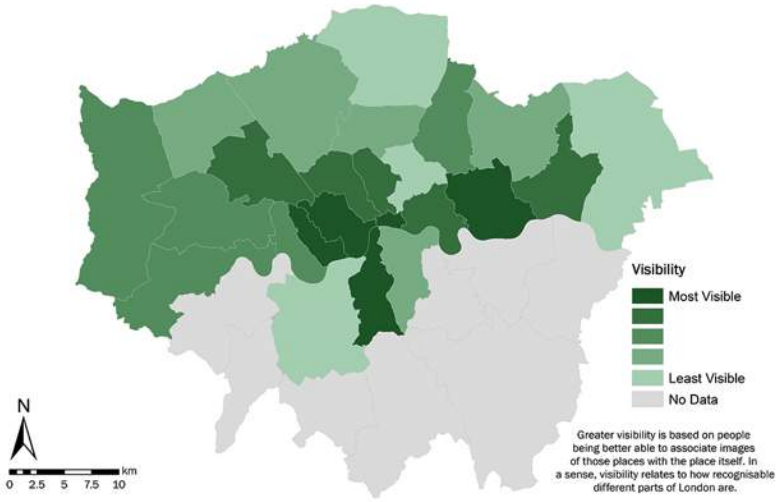
Psychological Maps

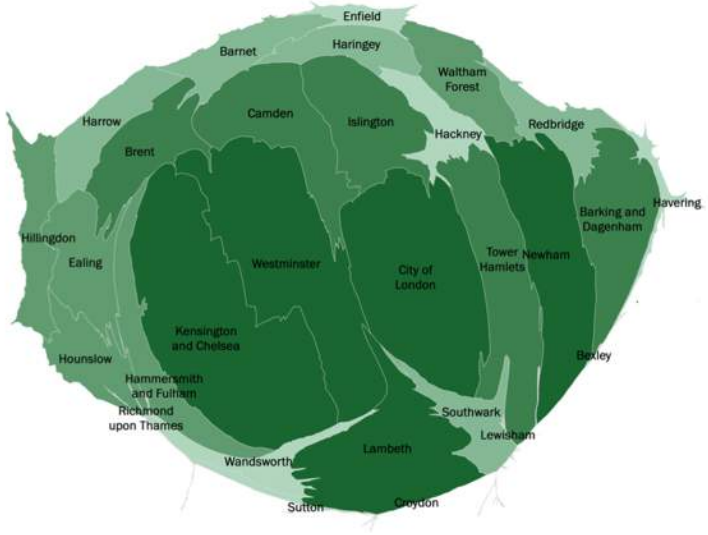
urban**opticon.*org***




Recognizability
regents park
hyde park
green park
WESTMINSTER
LAMBETH
CHELSEA
BETHNAL GREEN
Bermondsey
ALDGATE
STRAND
OXFORD ST
ST JAMES
KENT ROAD

Collective
Recognizability Map



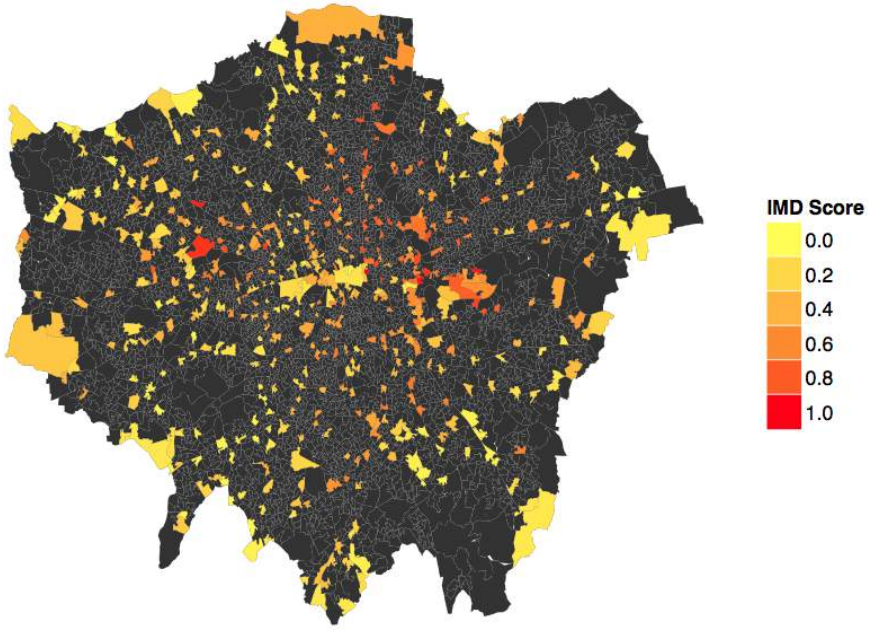



Recognizability
vs
Well-Being

IMD

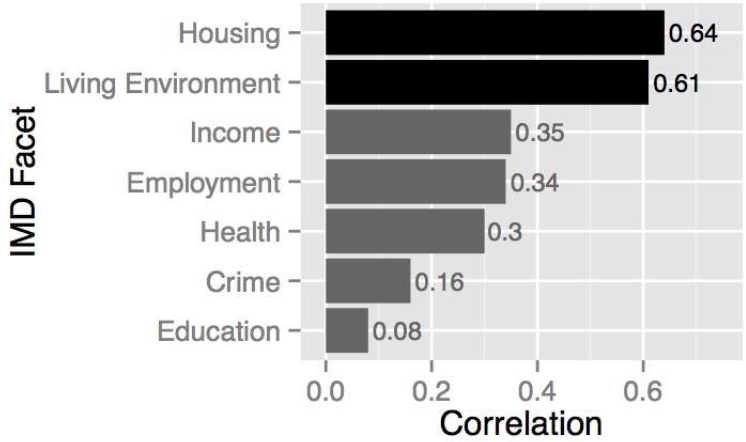
(Index of Multiple Deprivation)

1. Income
2. Employment
3. Health
4. Education
5. Housing
6. Crime
7. Living Environment



Recognizability *vs* Well-being

borough-level



[*ACM cscw'14*] Aesthetic Capital: What Makes London Look Beautiful, Quiet, and Happy?

[*ACM cscw'14*] Aesthetic Capital: What Makes London Look Beautiful, Quiet, and Happy?

A

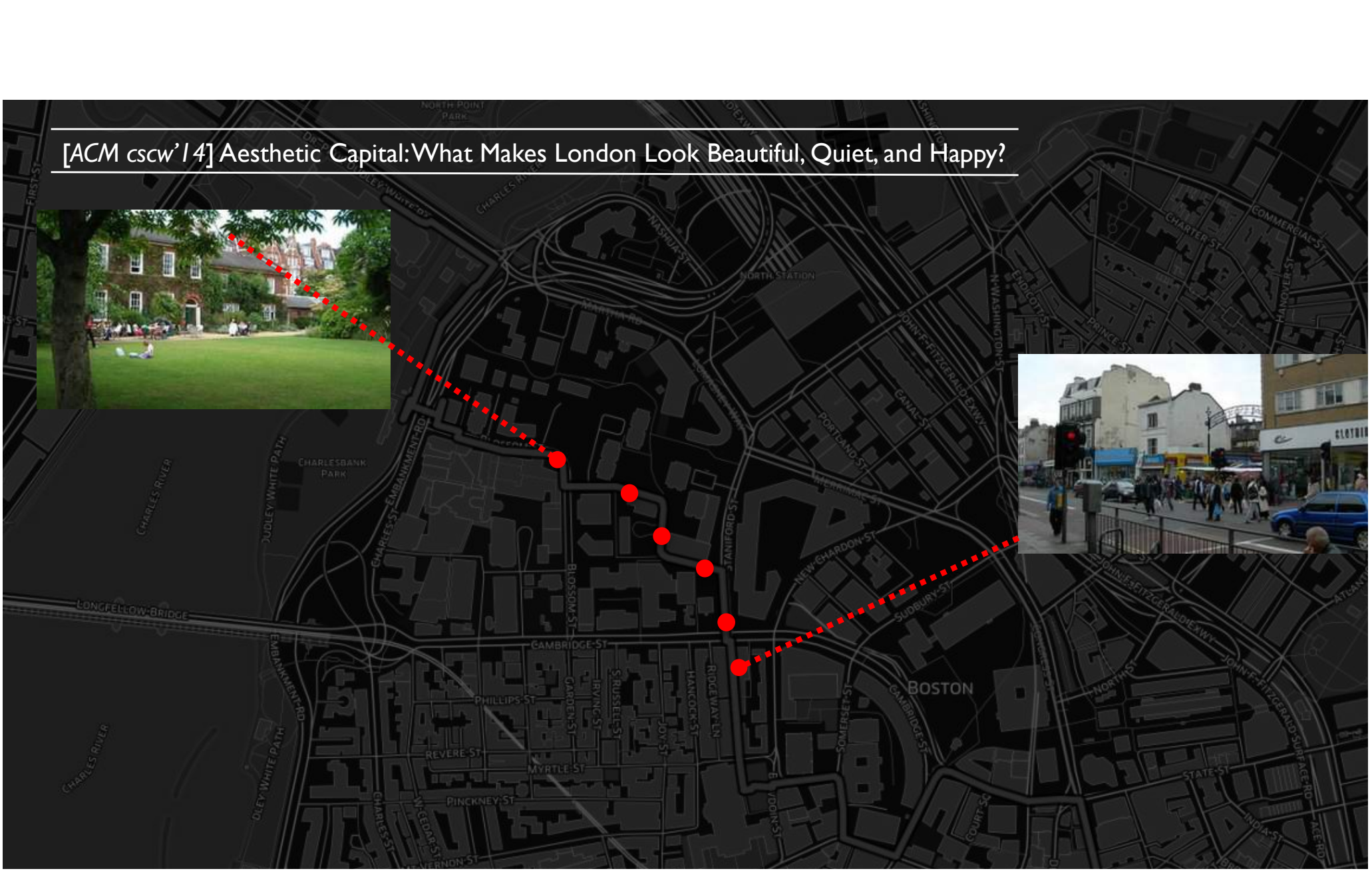
B

[*ACM cscw'14*] Aesthetic Capital: What Makes London Look Beautiful, Quiet, and Happy?

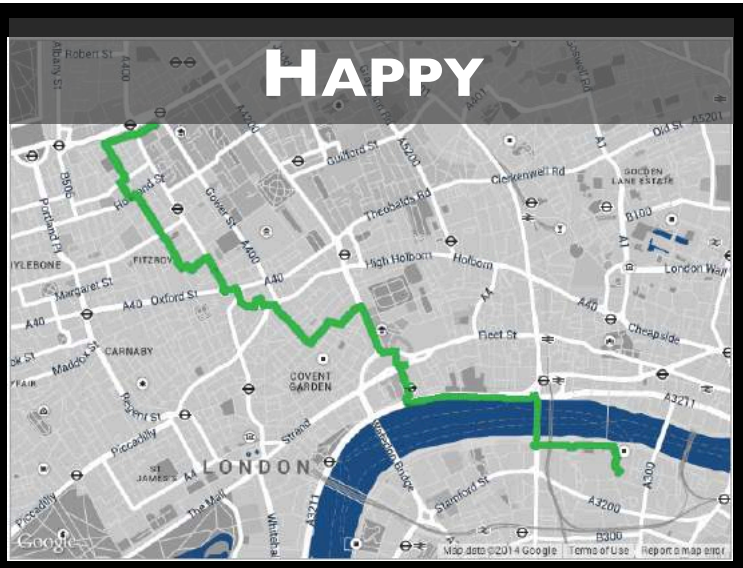
most
beautiful

least
beautiful

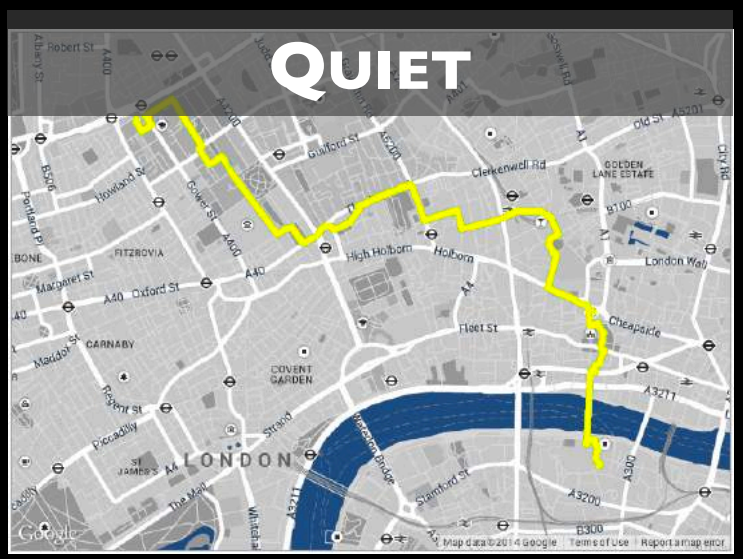
[*ACM cscw'14*] Aesthetic Capital: What Makes London Look Beautiful, Quiet, and Happy?



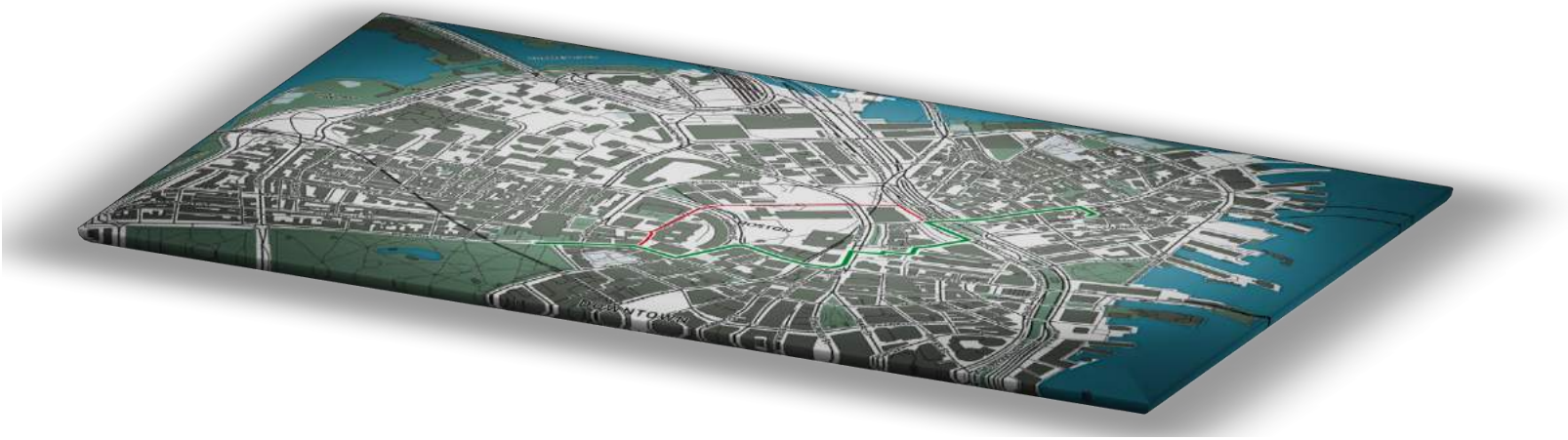

SHORTEST
LONDON
Google


HAPPY
LONDON
Google


BEAUTY
LONDON
Google

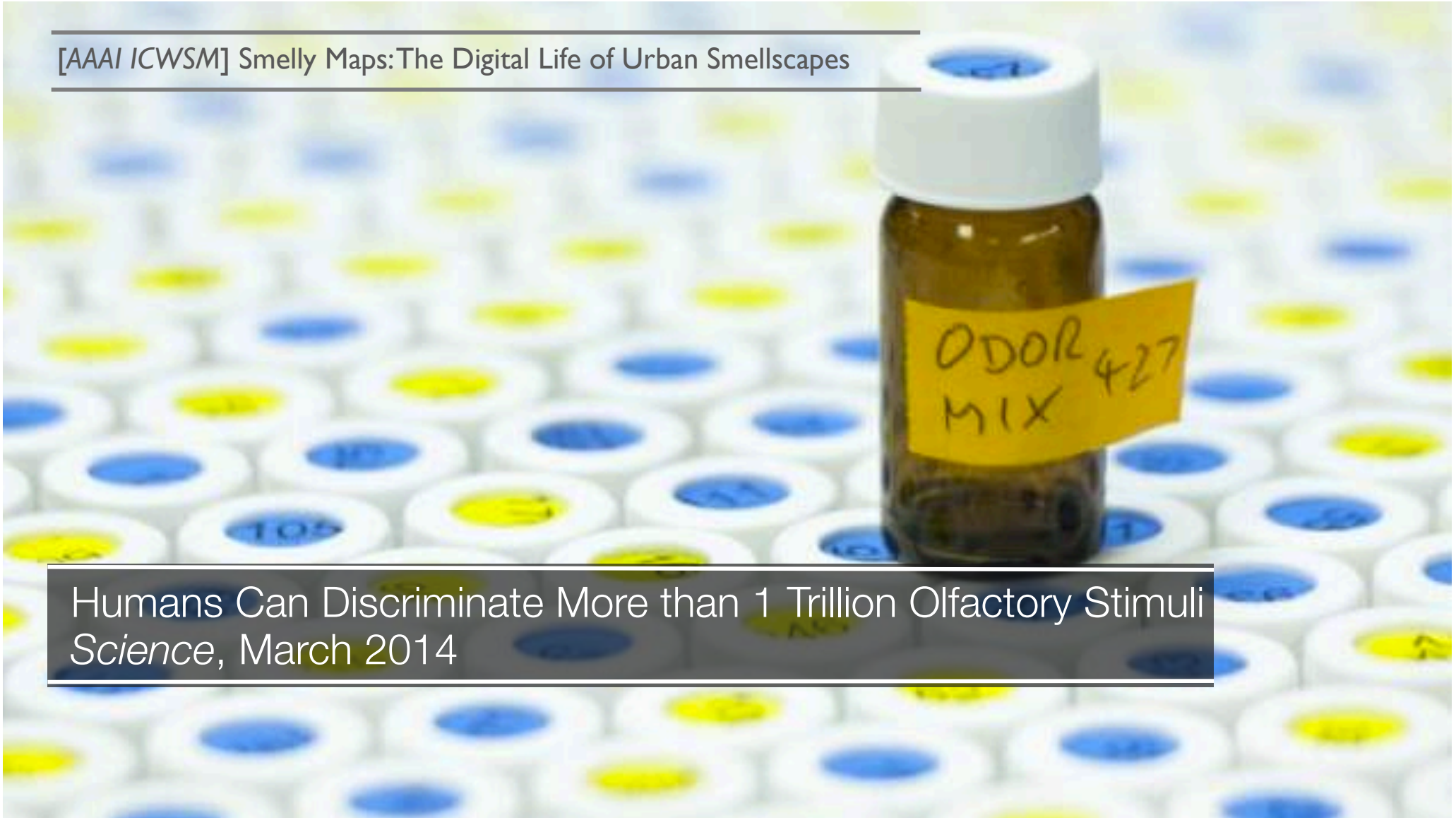

QUIET
LONDON
Google

[ht'15] The shortest path to happiness: Recommending beautiful, quiet, and happy routes in the city



SIGHT

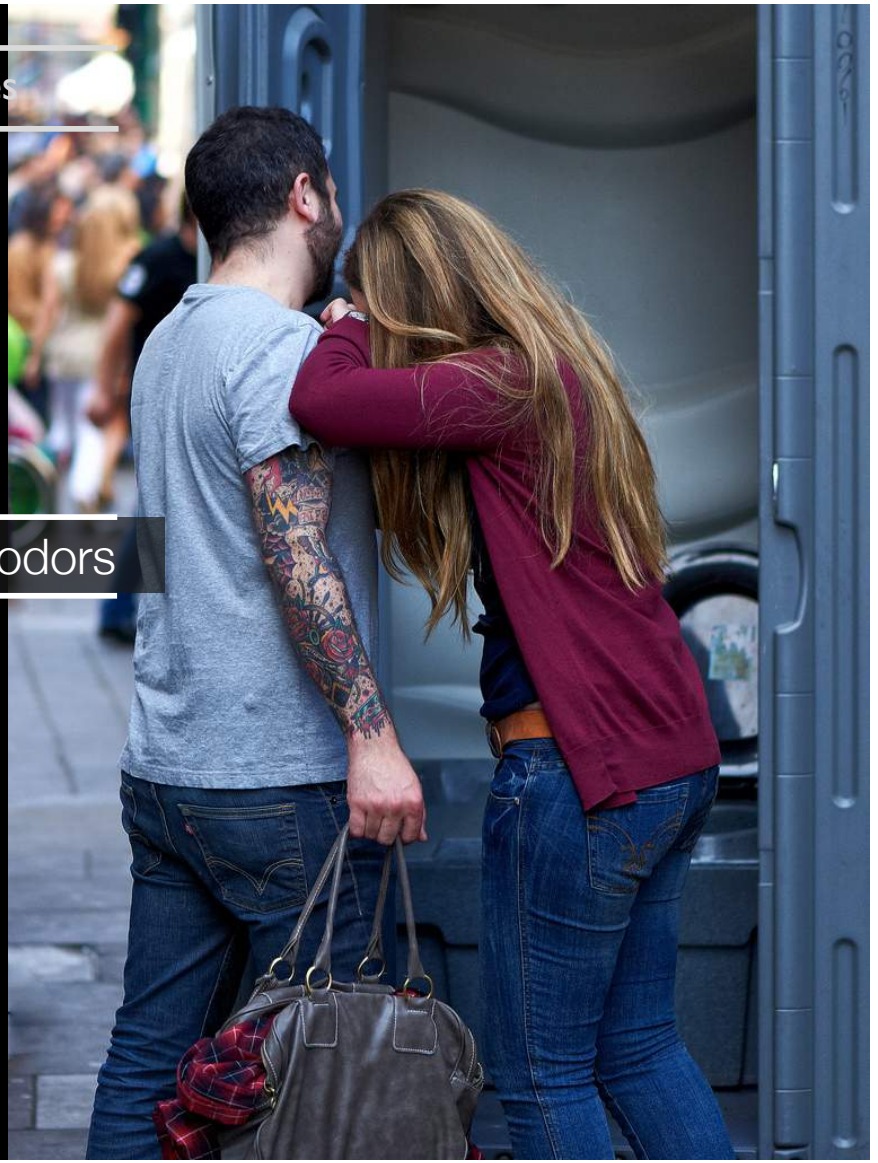
SENSES



Humans Can Discriminate More than 1 Trillion Olfactory Stimuli
Science, March 2014

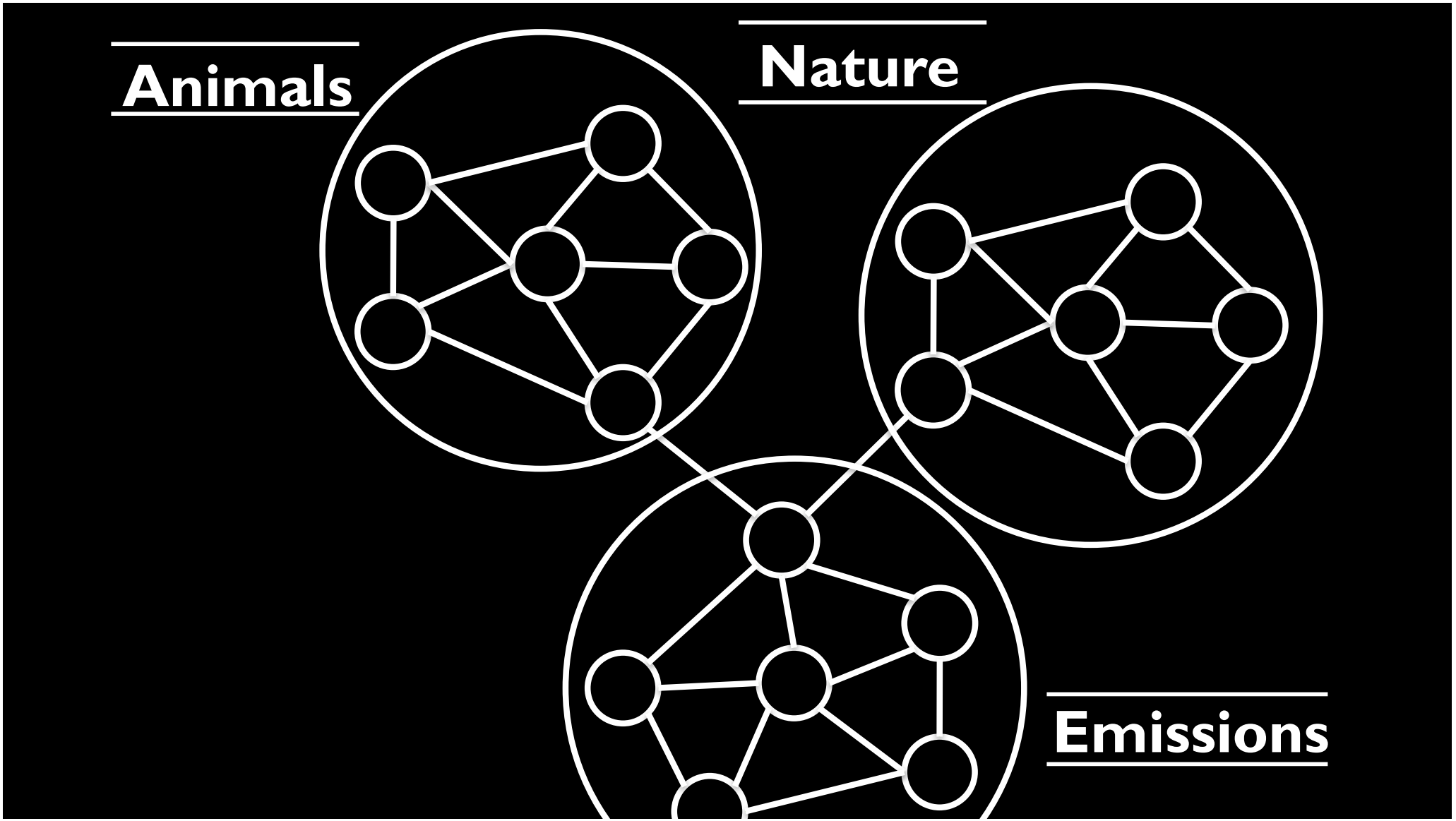
[*AAAI ICWSM*] Smelly Maps: The Digital Life of Urban Smellscapes

Yet, city planning can discriminate only a few bad odors

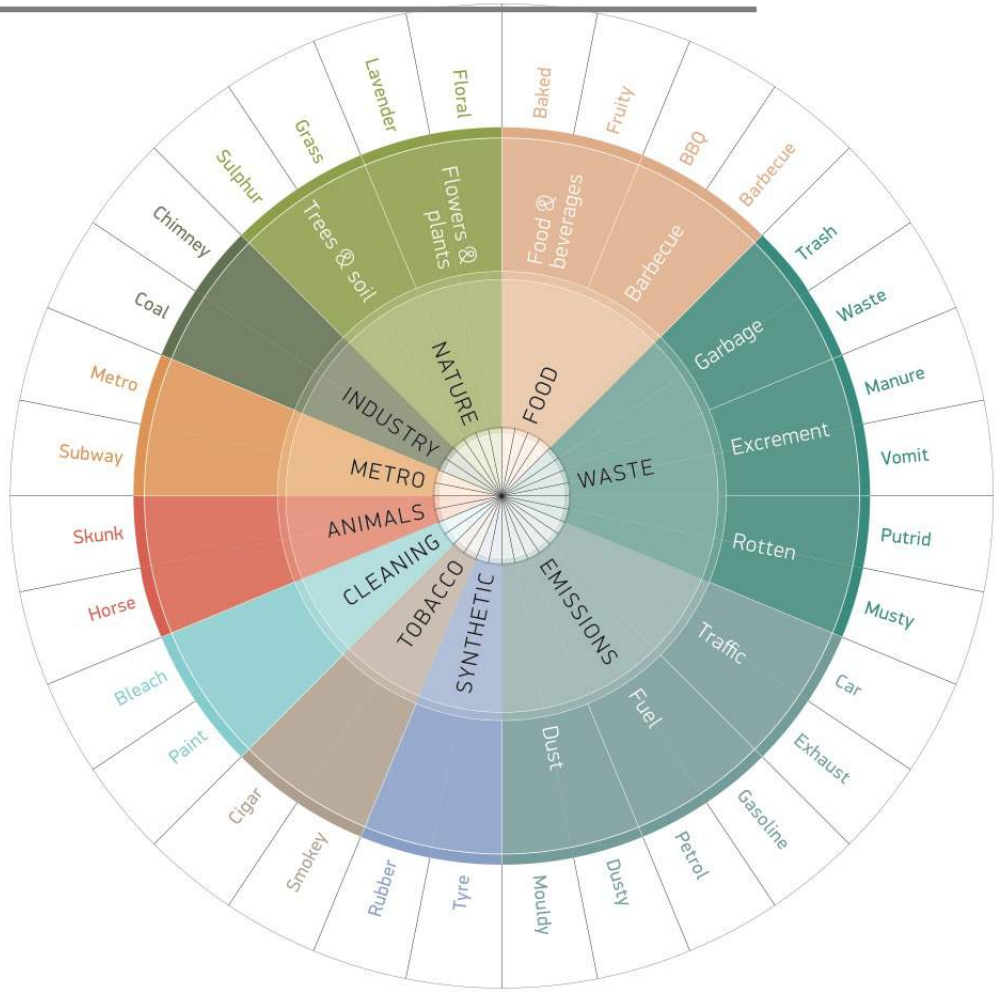


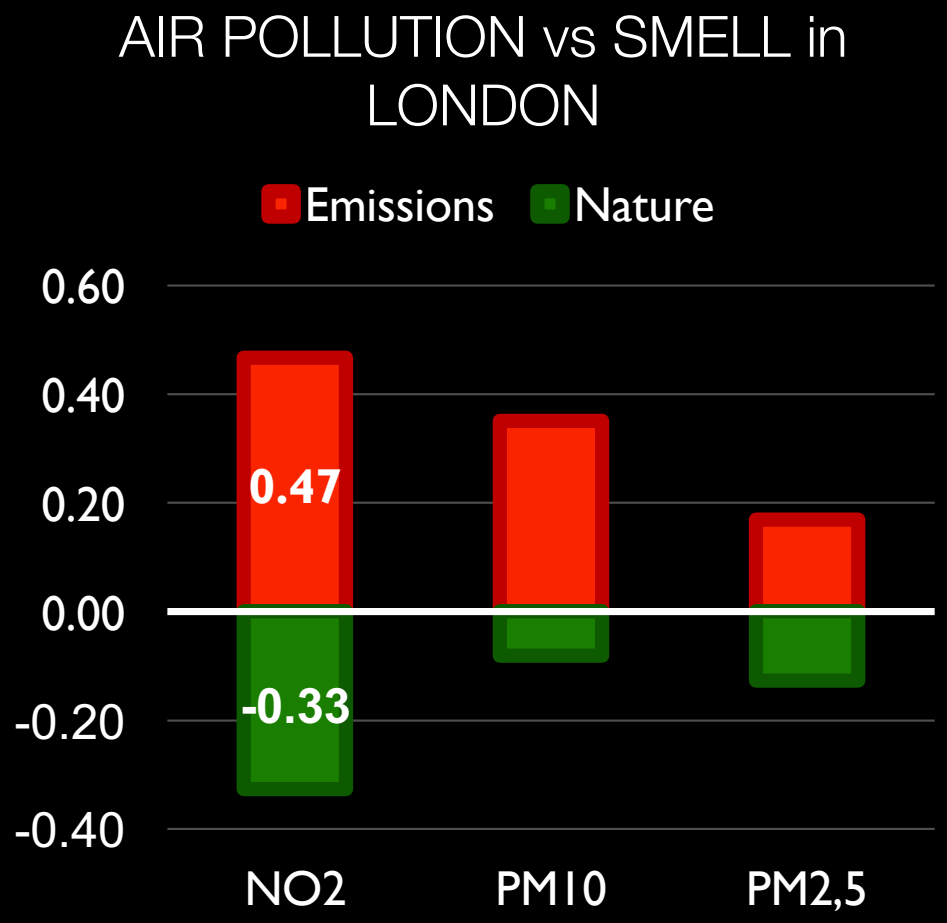

smell walks
Amsterdam,
Pamplona, Glasgow,
Edinburgh, Newport,
Paris, New York.

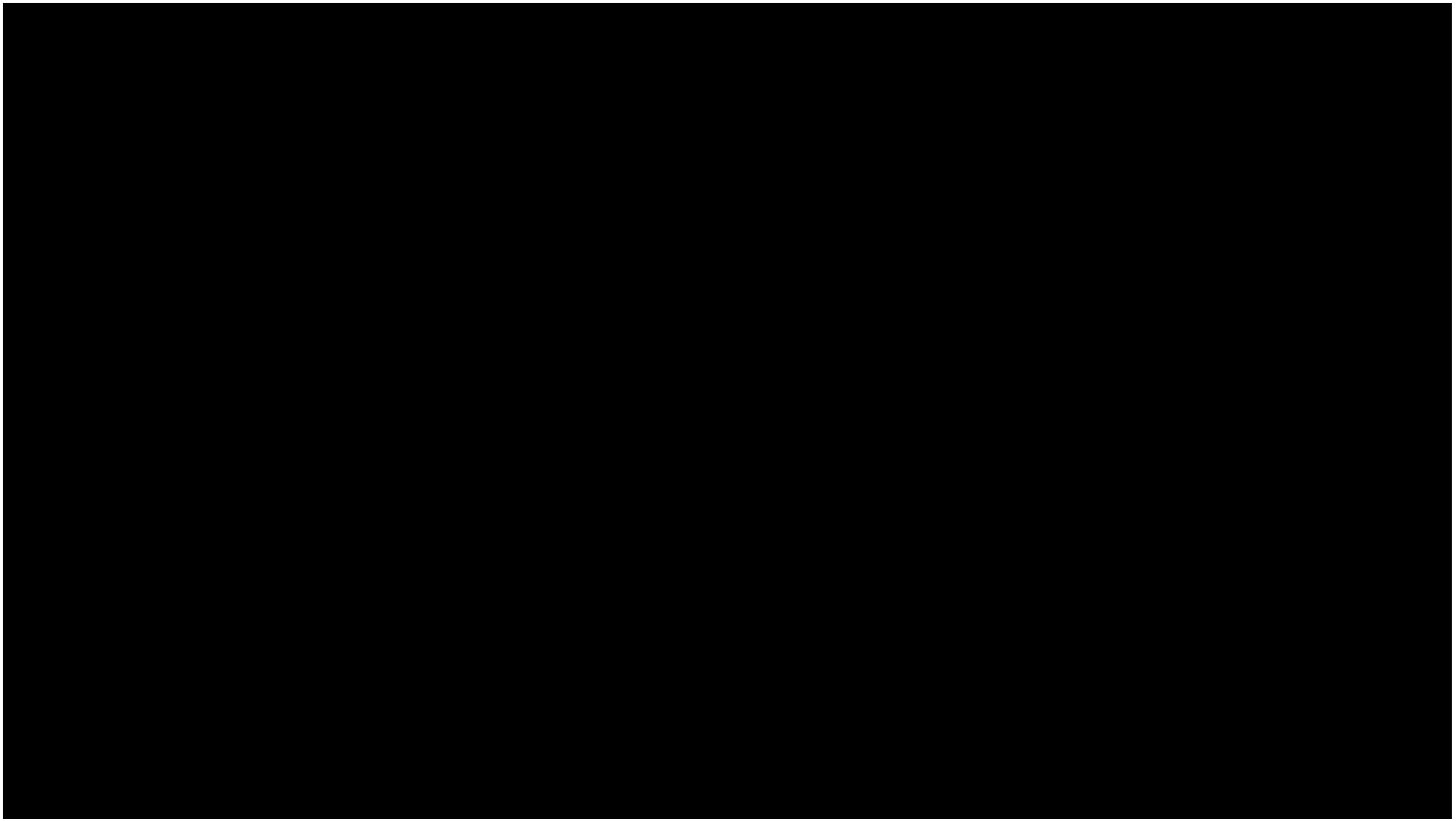
Match collected words to social media


Animals
Nature
Emissions

[*AAAI ICWSM*] Smelly Maps: The Digital Life of Urban Smellscapes




AIR POLLUTION vs SMELL in LONDON
Emissions
Nature
0.60
0.40
0.20
0.00
-0.20
-0.40
0.47
-0.33
NO2
PM10
PM2,5



Happy Maps

Smelly Maps

Chatty Maps

missing 1 touch

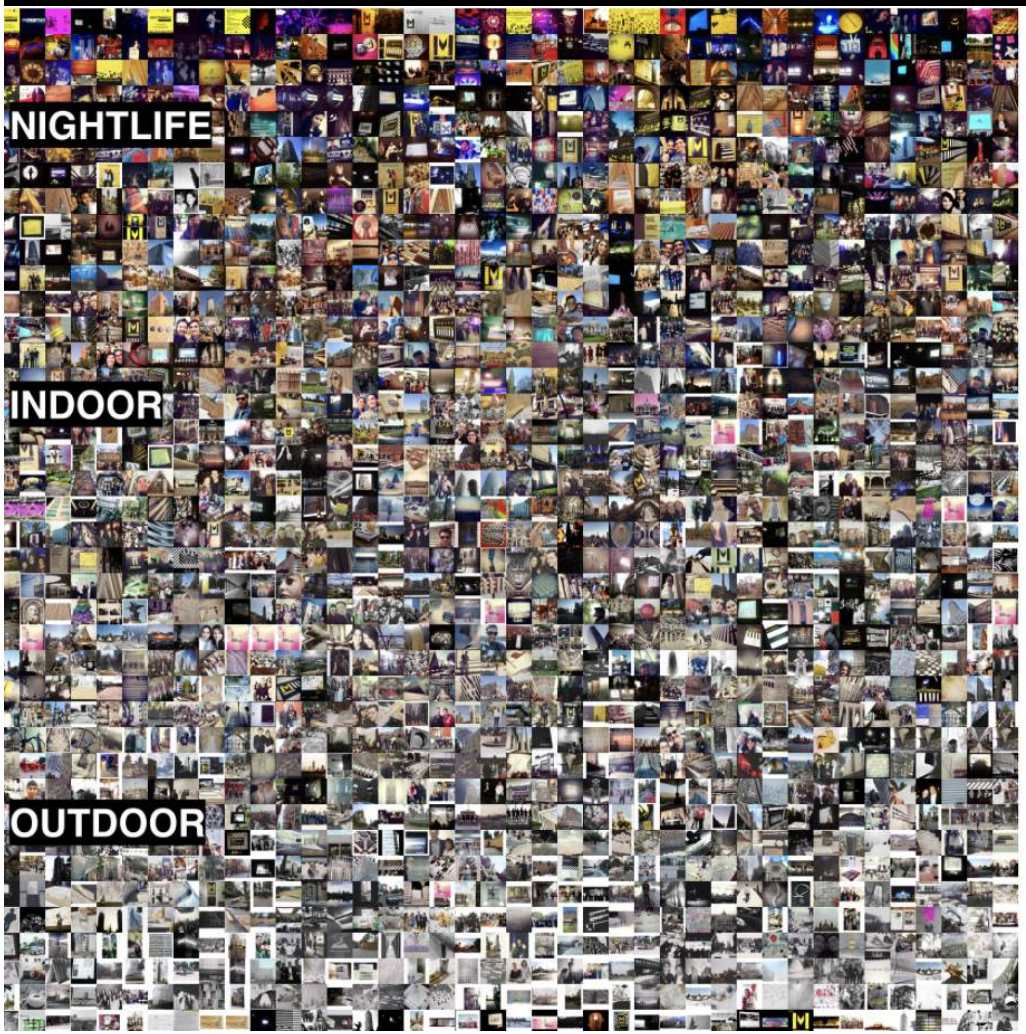
Touch

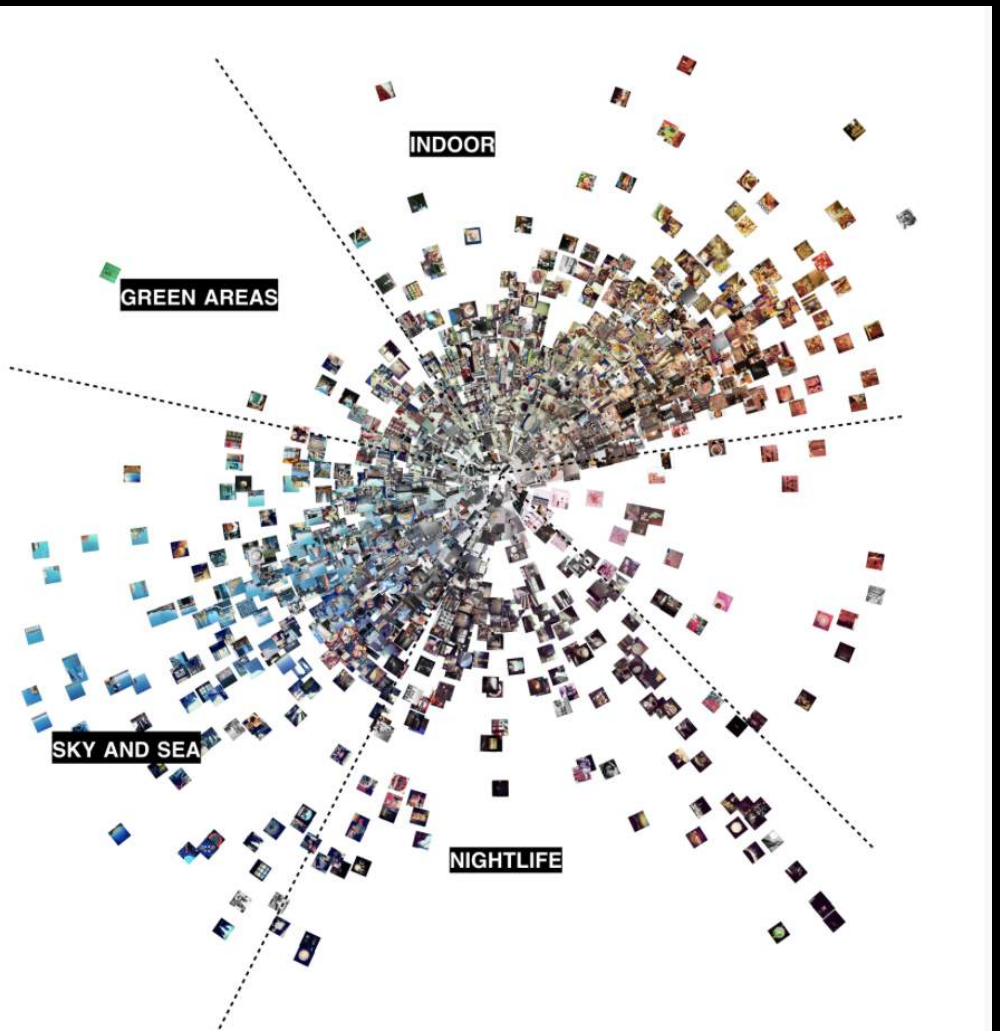
Taste

missing 2
senses & **memories**

missing 3
interventions

300+ cities in Russia | from metrics to planning briefs





Deep Learning 2.0

(not only) **learns** beauty
(but also) **explains** & **generates** it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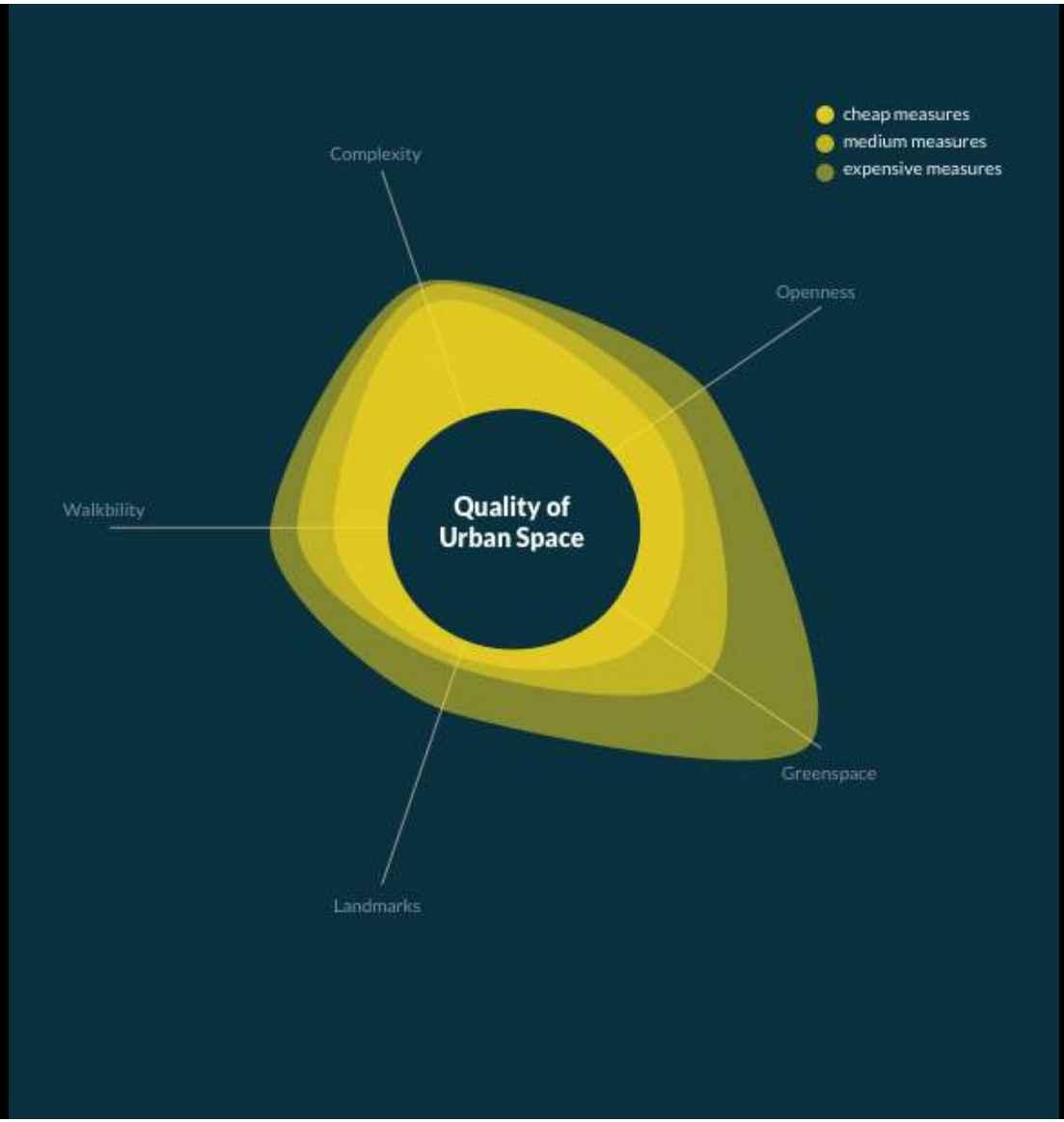
CHEAP
Trees, Fences, Road Marking and Vehicles

MEDIUM
Pavement, Sign Symbols and Poles

EXPENSIVE
Buildings and Roads


cheap measures
medium measures
expensive measures
Complexity
Openness
Walkbility
Quality of Urban Space
Greenspace
Landmarks

facelift | beautifying the world

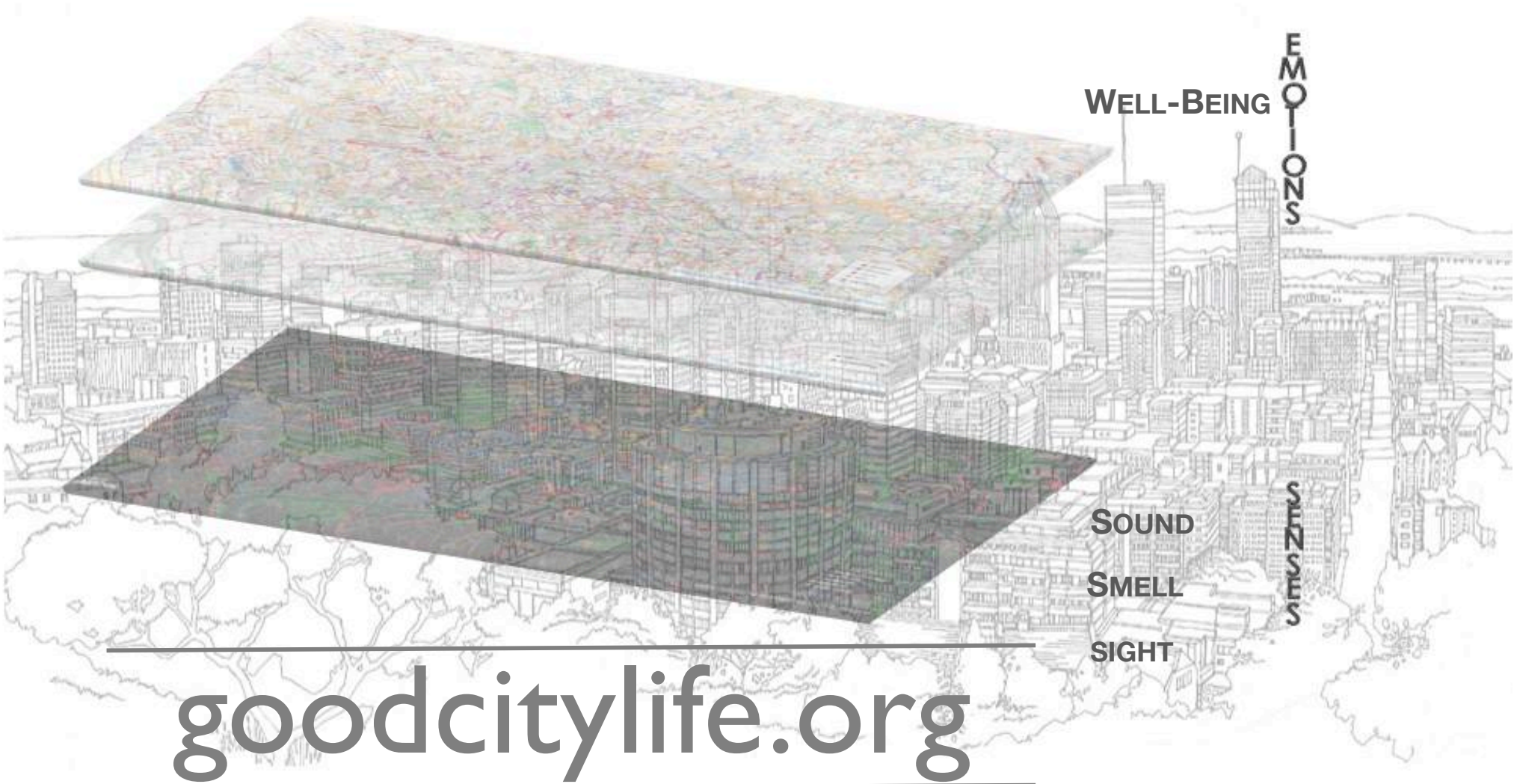
cute

~~cute~~ shift.

social media

mixed method

language to express sensory perceptions



goodcitylife.org