Big Data for Urban Design and Planning

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The use of ‘big data’ as an enabler of the smart city vision

Technology itself can’t automatically transform and improve cities and the lives of their inhabitants
Some characteristics of big data (Laney, 2001)

Volume (a huge amount of data)
Variability (heterogeneous and often unstructured formats of data)
Velocity (an almost real-time processing of incoming data)
In the context of design support

Variability (heterogeneous and often unstructured formats of data)
Design is a data and information intensive process
Design data and information have many interrelationships and dependencies.
Data and information support design decision making
Designers switch between various scales
Designers frame and solve various problems consecutively, simultaneously

Providing designers with
  multi-source
  multi-scale
  multi-time
information, or evidence
an important contribution of big data to design support
EVIDENCE BASED DESIGN SUPPORT

Designers use evidence from existing situations in projects
Gain insights to improve these projects and gain insights for new designs

Evidence does not lead to a linear translation into design solutions

EBDS can replace some of the assumptions made during design by grounded evidence
EVIDENCE BASED DESIGN SUPPORT

The research challenge:

Which behavioral hypotheses can be drawn from specific urban data sets and their combination?

What is the relationship of these hypotheses with spatial and organizational aspects of urban spaces?
URBAN BIG DATA

Various sources for data, including:
- sensor data for all types of urban infrastructures
- [real-time] transport tracking data
- social network data [information about events or opinions]
- public app data
- user volunteered data [including geographic data]
- phone data
- open data provided by government [e.g., air pollution data, crime data, meteorological data, land use data]
INFORMED DESIGN LAB @ SUTD & FCL

Multi-disciplinary group consisting of architects, engineers, data scientists
Big Data gathering and analytics

Quantification of design characteristics and qualities

Evidence-informed Design Tools

INFORMED DESIGN LAB

(FCL) FUTURE CITIES LABORATORY
Can we integrate big data, user preferences, and designer knowledge for urban design and planning support?

Multi-source, multi-scale, multi-time data collection
Data analytics and visualization
Deriving insights for designers from evidence
Creating and/or ranking design options building on this evidence
LIVEABLE PLACES: INFORMED DESIGN FOR ADAPTIVE PUBLIC SPACE

Bige Tunçer, Hexu Xin, Linlin You
LIVEABLE PLACES: INFORMED DESIGN FOR ADAPTIVE PUBLIC SPACE

**Data**
- Participatory Workshops
- Surveys, Interviews
- People-centric Sensing
- Space-centric Sensing
- Demographic Data
- Telco Data
- Social Media Data

**Designers' needs / interests**
- Coarse population-level human flow patterns
- Perceived place characteristics / qualities
- Space usage frequency / timestamps
- Public / semi-public spaces of interest
- Fine mobility patterns in certain areas
- Usage activities
- Demographic composition of users
- Sensed characteristics of places

**ANALYTICS**

**Informed Design Platform**
- Information Visualizations
- 2D Maps
- 3D Models
- ArcMap

**Logos**
- Singapore University of Technology and Design (SUTD)
- Institute for Infocomm Research (I²R)
- Singtel
- Housing & Development Board (HDB)
- Urban Redevelopment Authority (URA)
Some questions designers may want to answer through use of the Informed Design Platform:

Which spaces are being used, how, and how much?

How do the people who use these spaces perceive them?

Are any spaces over- or under-utilized?

What can be additional/alternative uses for spaces that increase livability?

How could spaces be modified (new- or re-design) to improve them in terms of the issues above?
YOUR CURRENT LOCATION
Yuhua Community Club

RATING
ACTIVITY
I AM
ALONE
PLAYING CYCLING
EXERCISING
SITTING
TALKING
WALKING

YOUR CURRENT LOCATION
Yuhua Community Club
INTERCONNECTED DATA MODEL
NATIONAL SCIENCE EXPERIMENT

Bige Tunçer, Nils Ole Trappenhauer, Francisco Benita, Francisco Scandola, Garvit Bansal, Darshan Virupaksha
90,629 students
265 schools including 5 polytechnics & 3 ITEs
EXPLORING ART PRODUCTION AND CONSUMPTION THROUGH SOCIAL MEDIA

Ludovica Tomarchio
HOW DO SOCIAL MEDIA AFFECT ART?

Can we develop tools and methodologies for responsive cultural city planning?

SOCIAL MEDIA DATA
• How can we describe Hybrid Art Venues?
• What kind of aesthetic results from the mix of art and social media?
• How effective are current cultural planning practices?

MAPPING ART LOCATIONS
• How can we define and map art venues through SM?
• Which types of analyses could be useful?

RESPONSIVE CULTURAL PLANNING
• What information from social media is useful?
• How can it be implemented in decision making?
STREET NETWORK
RUNABILITY

Özgün Balaban
Can we define a ‘runability’ score for streets, networks, and neighbourhoods?

**WHAT DETERMINES WHERE PEOPLE RUN?**

- Climate comfort
- Time of day
- Experience of the runner
- Gender of the runner

**RUNNING DATA**

- Connectivity
- Street types
- Distance to Points of Interest

**STREET NETWORK**

- Amount of traffic
- Amount of green space

**ROUTE CHARACTERISTICS (qualities)**
VISIT POTENTIAL MODEL (VPM)

Pieter Hertogs, Peijun He, in collaboration with Marcus Schlaepfer
The Visit Potential Model estimates the potential presence of people in public spaces or in buildings, and the effect of design qualities on this potential.
Good scores channel liveliness.
Bad scores act as barriers.

Evaluating qualities using spatial Multi Criteria Assessment

**Sensory experience**
- Climatic conditions (temperature, shading, ...)
- Green space and vegetation

**Physical attributes**
- Urban furniture (benches, tables, lights, ...)
- Geometric properties (sky-view factor, isovist...)
- Distance to traffic

**Activity**
- Number of amenities/commercial spaces
- Diversity/Flexibility/Accessibility
- Crowdedness
- Etcetera
Within one hour of the day, the number of people outside of their building is a percentage of the maximum capacity.

This distribution is different for different types of buildings.
A weighted graph model calculating interactions, proximities, and accessibilities
SUTD
CITIES CLUSTER:
DATA DRIVEN DESIGN
SOLUTIONS FOR CITIES

Bige Tunçer, Costas Courcoubetis, Ricky Ang, Erwin Viray, Sam Joyce, Micheal Budig

Cities

integrated complex systems
physical, social, economic, ecological ... subsystems
with countless interdependencies and interactions
complex, adaptive, self-organizing systems that have
some basic properties and hidden structures that are
pervasive to all cities depending on some
parameters

New science of cities
Livable Privately Owned Public Spaces in Asian Cities

Predicting the Effects of the Sharing Economy on Mobility in Asian Cities

Dynamics and Scaling Laws of the Growth of Cities

Vertical Mobility

Design Practice Immersion

Integrating ML and AI into Design Practice

Situated Building Tools

Agencies
Companies
EDUCATION

SUTD as a regional hub for “CITIES”

A global educational network that generates interaction, exchange, and collaboration

Nurture technically grounded leaders ready to operate in ASEAN+

Changi AeroCity Implementation Testbed Site and Competition

Parallel and joint multidisciplinary studios and workshops

Overseas field trips to ASEAN countries for students

Workshop and seminar series to support these educational components

Courses in SUTD Academy

Undergraduate Research program
SOME LIMITATIONS

Data collected may not represent all users of spaces

Evidence and insights derived shed light on only a subset of design parameters that are important for design

Data privacy concerns
SOME CONCLUSIONS

Deep understanding of both real and perceived utilization and appreciation of existing public spaces

Starting to relate these to physical attributes of places

Developing the methodology and technical infrastructure for this

Ongoing work