Smart Cities

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Saturday, 22 June 2019

The lecture is in three parts

- Smart Cities: Definitions, History, Big Data
- Ideas About How Computers are Being Embedded in Cities, in particular networks and transit
- Ideas About How we Use Computers in Developing Understanding and Planning Cities: Models

Smart Cities: Definitions, History, Big Data

- The Emergence of Smart Cities: The Timeline: The Computer and Communications Revolution
- Embedding and Sensing
- The Low and High Frequency City
- Data: Big, Open and VGI Crowdsourcing
- The Initial Understanding of New Data: Dashboards and Control Centres
- Disrupting

The Emergence of Smart Cities: The Timeline: The Computer and Communications Revolution

I want to provide some sense of where we have come from and the best way to do this is to construct a timeline from the time when the digital computer was invented ~ 1940 to today 2020 – 80 years

My key themes are: Miniaturisation ---- Hardware to Software to Orgware Universalisation ---- Convergence of Computers and Communications ---- Embedding Computers into Other Objects, Ourselves and Nature

There timelines have continued remorselessly since the beginning

The Timeline(s)

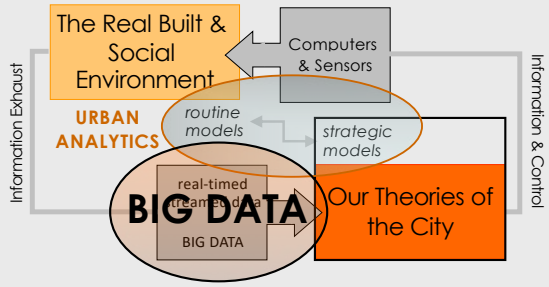
Embedding and Sensing

During this history, computers have been associated with sensors, needed to process large amounts of digital data

Traditionally sensors were analogues measuring volumes and quantities but now they are mainly digital. As computers got ever smaller they could be linked directly to sensors and embedded into all kinds of things

Let me take a look at the city in terms of sensors and computers and first I will show a block diagram of how we used to do things before the advent of embedding computers into the urban fabric

Let me introduce the framework



The Low and High Frequency City

Until the end of the last century, we looked at the city largely as a low frequency set of events. Our plans were for 20 years or more, we dealt with long terms change through planning.

Of course short term change was looked at as purely management – we didn't have any sense of theory or methods to deal with high frequency events

Now as devices got smaller and smaller, we go to the point where quite suddenly we could communicate with each other cheaply as well as compute at the same time. We could generate loads of data quickly –

The happened quite suddenly in 2007 ! Why then ?

Let me give one example of the high frequency city to show you what I mean



Thus to some extent the smart city is the high frequency city – to some extent the 24hr city

- The way we access the smart city is through technologies that let us generate and use data and its useful equivalent – information (data) is key
- Access through *mobile and fixed devices* like phones, smart cards, through *fixed sensors* which record transactions and so on
- These usually complement rather than substitute for data which we collected and used in the past
- This has *introduced time into our thinking*
- This is all part and parcel of increasing complexity; more time scales, more opportunities, more diversity ……

Data: Big, Open and VGI Crowdsourcing

The smart city has heralded new ideas about data; first big data but also open data – the fact that data can be managed so much more easily has made it easier to access – to make open

And data too is easier to generate from the crowd if we are all connected in some way

Mike (Goodchild) talked about this a lot yesterday in his work on VGI

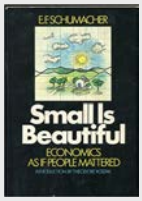
Let us begin with some ideas about big data – largely generated from sensors

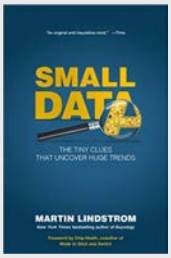
Note that such data is captured in real time and this makes it big – it goes on forever !!!

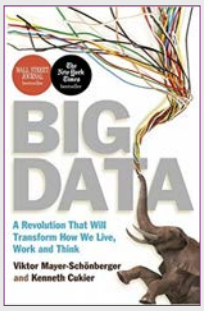
How Big is Data? Big Can Be Small & Small Big

- Data is big with respect to its volume. I know there are other definitions – velocity, variety etc. but to me, data is big if it requires large use of computer memory implying volume.
- The conventional definition in business is the Five V's – volume, velocity, variety, veracity, value
- In cities, data usually implies numbers of locations and their attributes but locations imply interactions.
- Thus data are relations between locations and in essence if we have ***n locations***, we have ***n^2 interactions***. Thus small data can become big – we will have a look at this in a minute but first a qualification as to how big is big?

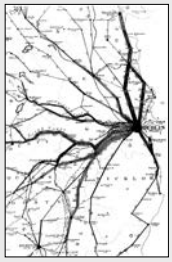
There is still controversy about how big is big







Some Historical example of big data from the past: Dublin 1837, Ireland 1888, London 1955



Harness, 1837



Ravenstein 1888





https://www.youtube.com/watch?v=pcBJfkE5UwU

An Interlude about Flow Data as Big Data

After our break I am going to shift from ideas about computers inside cities to using computers to understand cities

This is quite big switch but when it comes to data especially big data our models have always dealt with it and as I implied as soon as you look at interactions, you are dealing with big data, so in a sense we have always had big data.

Let me just throw some examples into the table so you can see what I mean but I will leave them to be explained after the break

Understanding and Visualising Flows

An early model circa 1967-8 Central and NE Lancs



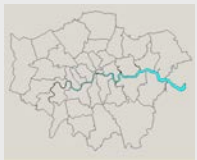


M. Batty (1976)
Urban Modelling
Cambridge UP



$n^2=33^2=1089$, not so big but hard to visualise











$n^2=633^2=400,689$, bigger but impossible to visualise

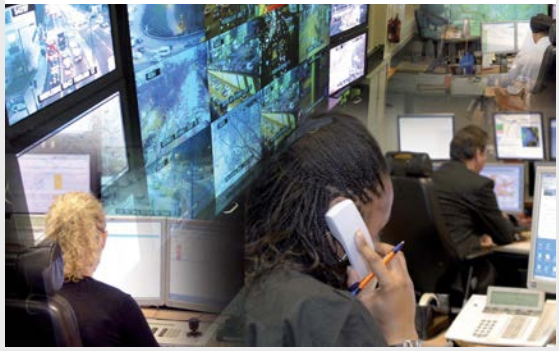
The Initial Understanding of New Data: Dashboards and Control Centres

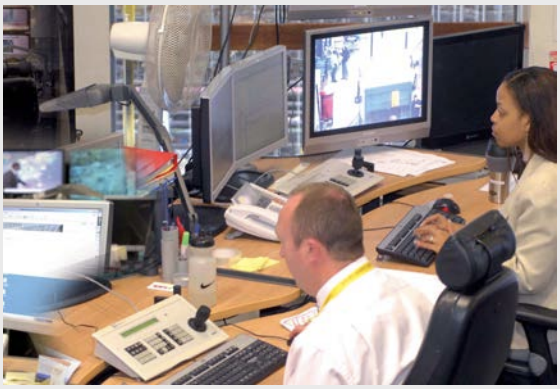
Ok now all this data which is being streamed in real time – how do we manage it – well we have to archive it but we have to act on it if it is in real time

In the smart city, what have emerged are control centres – many different types, weather, traffic, pollution, even one might include finance and so on

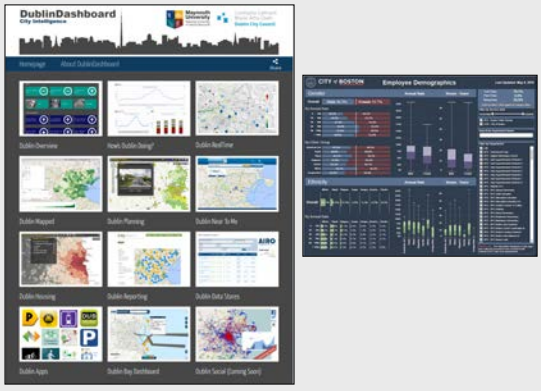
Here are some examples but we still haver to make sense of the data and that is what my next set of ideas is all about – in particular how we can make sense of transit in cities – one of the most obvious applications

The modern day – traffic control systems in London









Real-Time Streaming: What Sort of Data ?



http://www.citydashboard.org/



http://vis.oobrien.com/panopticon/

Disrupting

I could spend the rest of the morning on these issues but I hardly need to say that all of these features of my time line reinforce one another to suggest that at each stage of the computer revolution there has been disruption

Witness the famous phrases by Thomas Watson of IBM after WW2, Ken Olson of DEC in the 1970s, Bill Gates on the Internet in 1993

Uber is disrupting public transportation, Airbnb is disrupting the housing market in London, the digital library is disrupting the way we produce, read, and sell books, the high street in Britain is in free fall due to the activities of Amazon and so on …. I leave you to speculate



http://www.spatialcomplexity.info/archives/3026

