Understanding mobility and encounter in the digital cityscape

www.cityware.org.uk

EPSRC WINES Workshop, 23-24 April 2007, Warwick, UK

Overview

- Understanding the city as a system
- Architectural space & interaction space
  - mobile wireless interaction spaces
- Augmenting space syntax empirical methods to account for the digital forms of the city
- Patterns of Bluetooth presence and encounter
- Representations, analytical methods and applications

The city as system

- Understanding the city as a system - its physical and digital forms and their relationships with people's behaviours
- Development, use and refinement of methods - observing, recording, modelling, analysing
- Space syntax already does much of this - but addresses only the physical forms of the city, relating architectural space to behaviour
- Can we "augment" space syntax to take account of the digital forms of the city?

Wireless interaction spaces

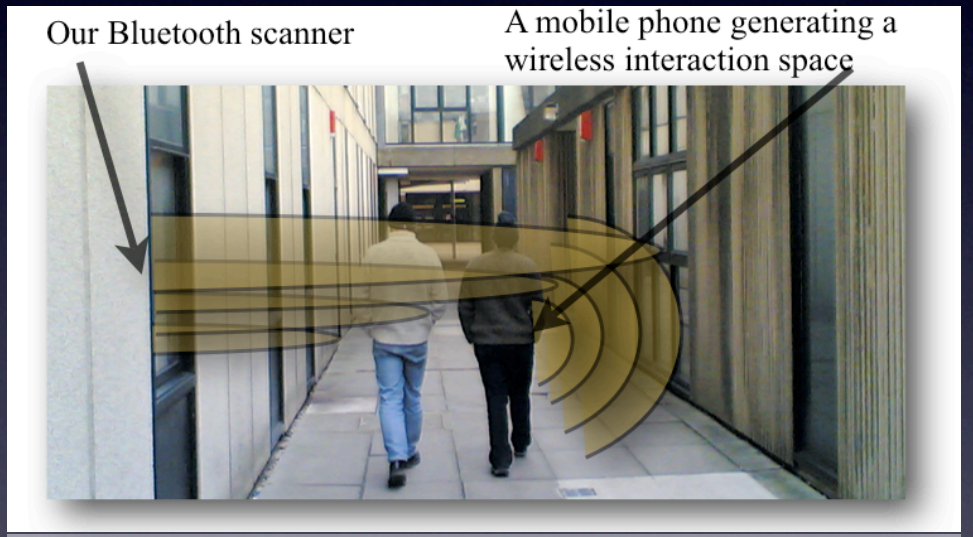
- Humans "join" pervasive systems through interaction spaces created by technologies in the environment
  - visual, auditory, wireless
  - fixed, mobile
- Fixed wireless interaction spaces defined by an access point and characteristics of the environment
  - e.g. 802.11, GSM/GPRS or 3G "hotspot"/coverage
- Mobile wireless interaction spaces typically created by small, personal devices such as mobile phones
  - e.g. Bluetooth, NFC, P2P WiFi

Extending space syntax

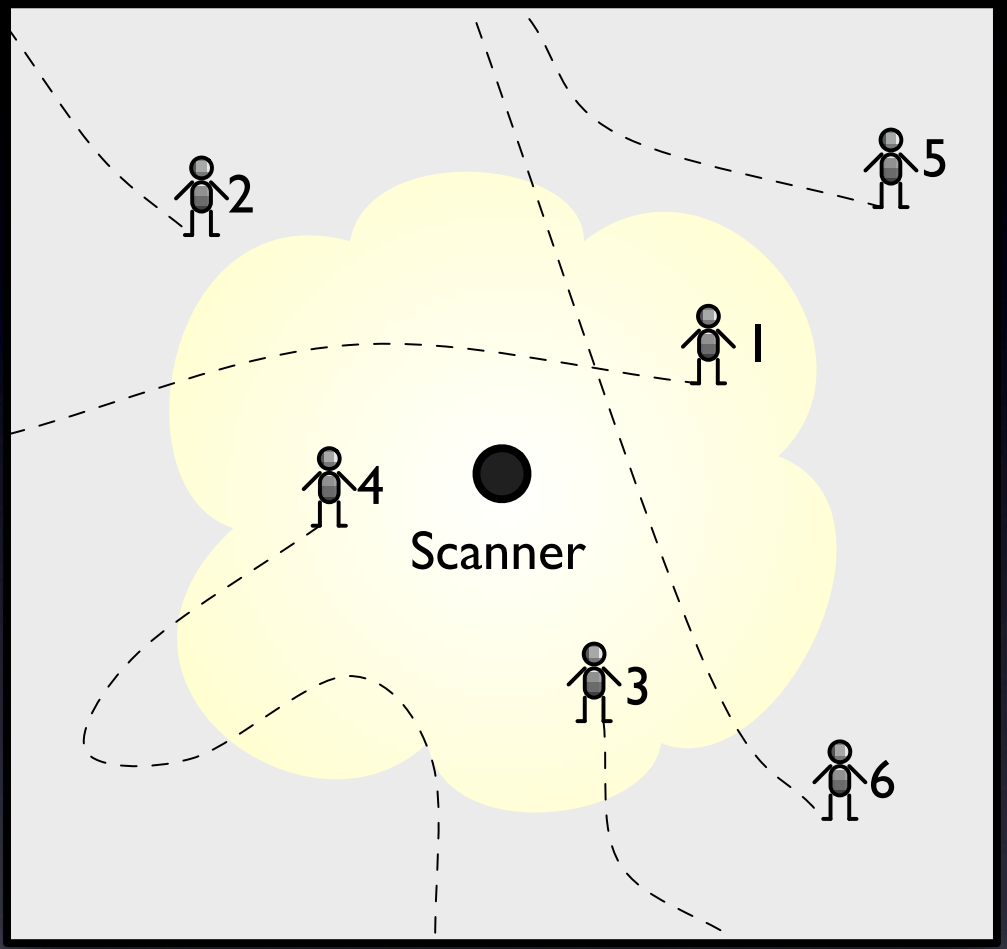
- In contrast to the fixed interaction spaces created by static access points, the wireless interaction spaces created by mobile Bluetooth devices map closely to the movements of people around the city - which are a primary concern of space syntax

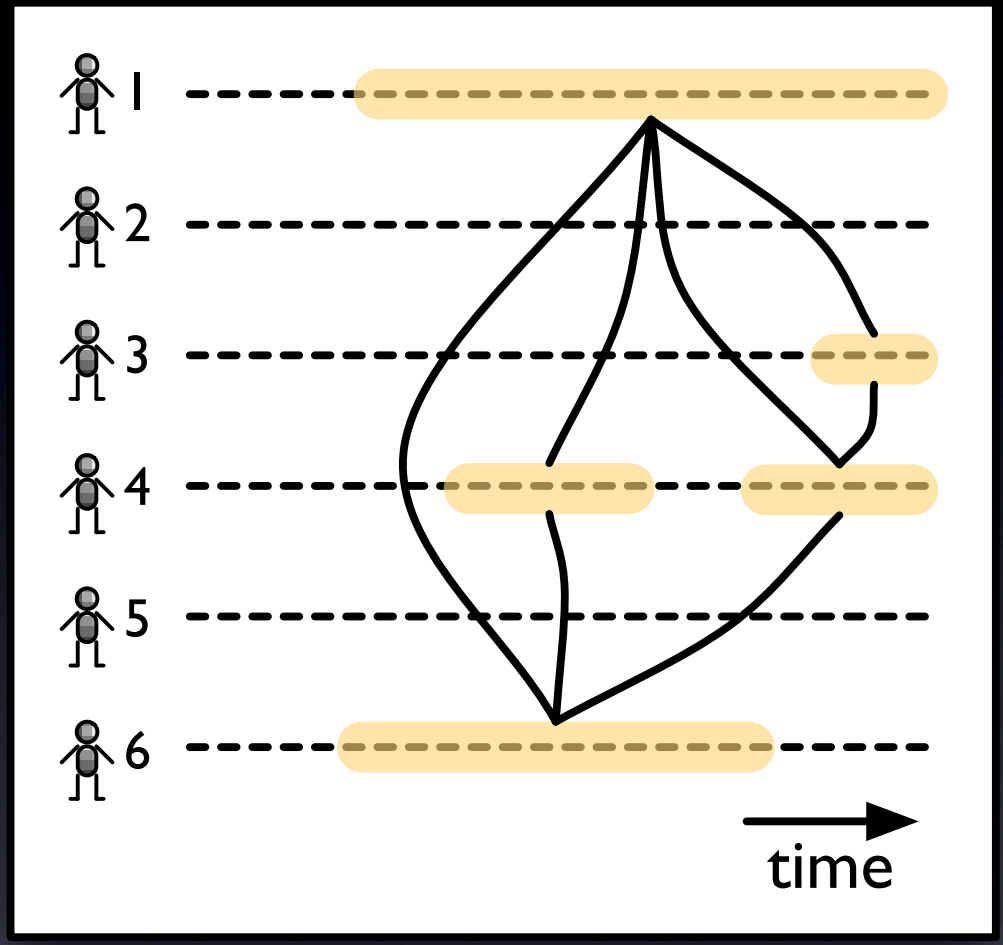
- We augmented space syntax empirical methods (gatecounts & static snapshots) to include observing and recording mobile wireless interaction spaces created by Bluetooth

- 10 long-term gatecounts around Bath

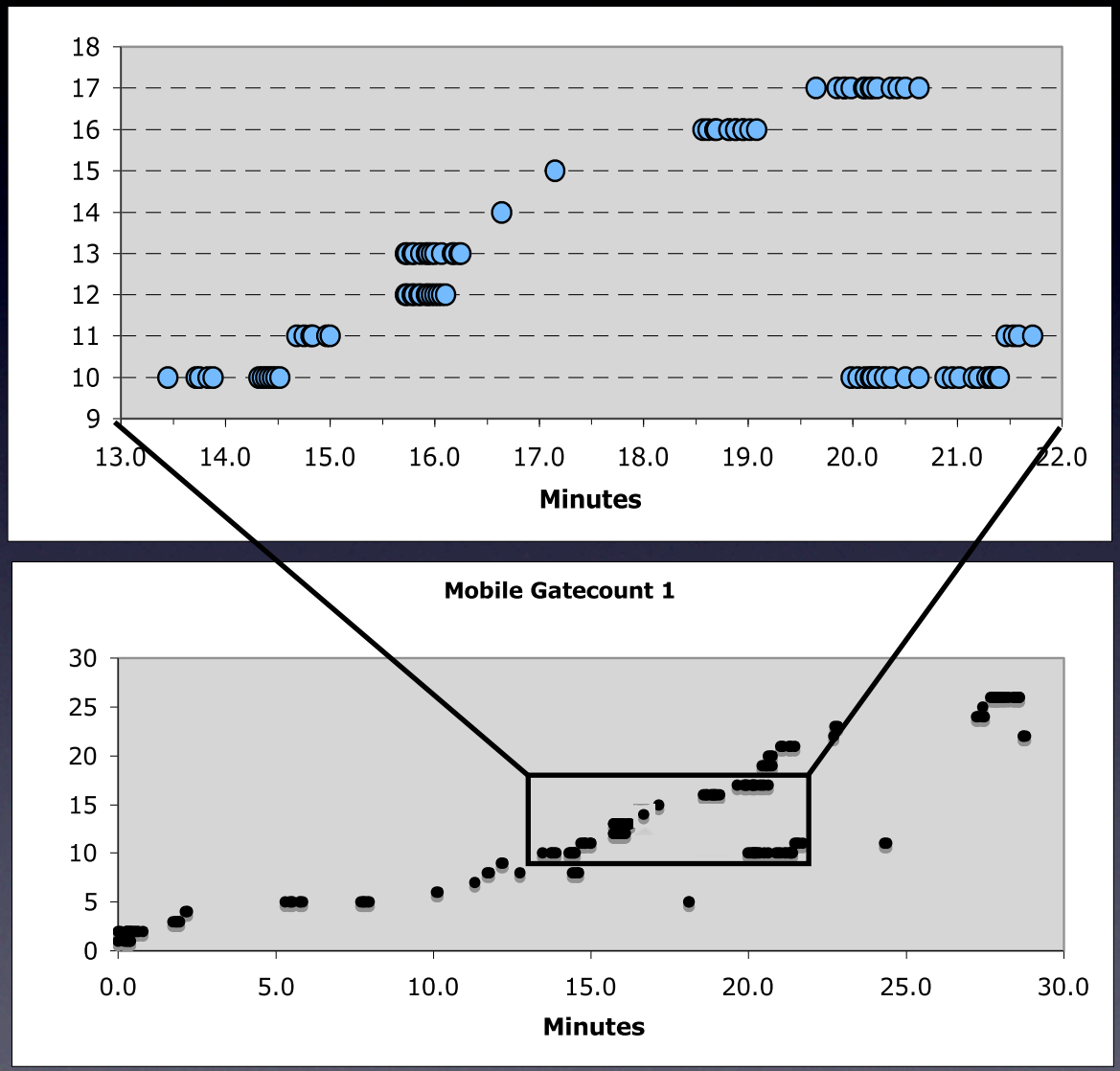


Observing copresence

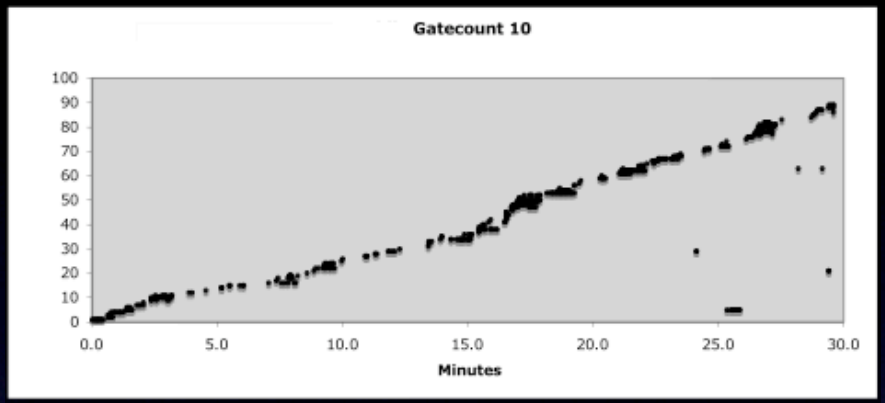


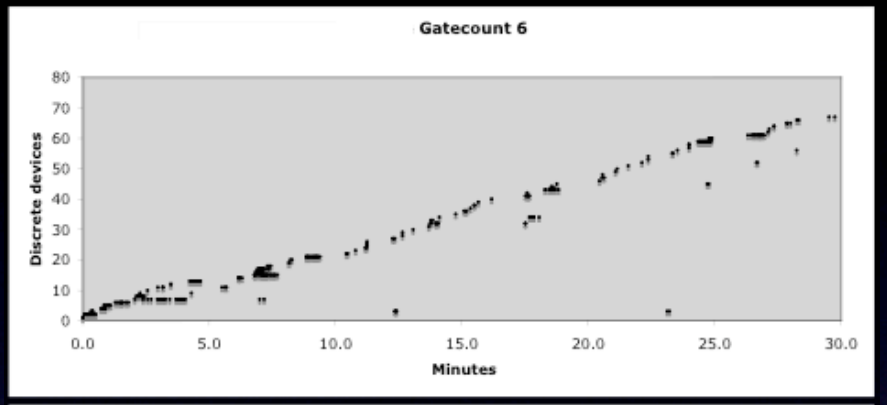


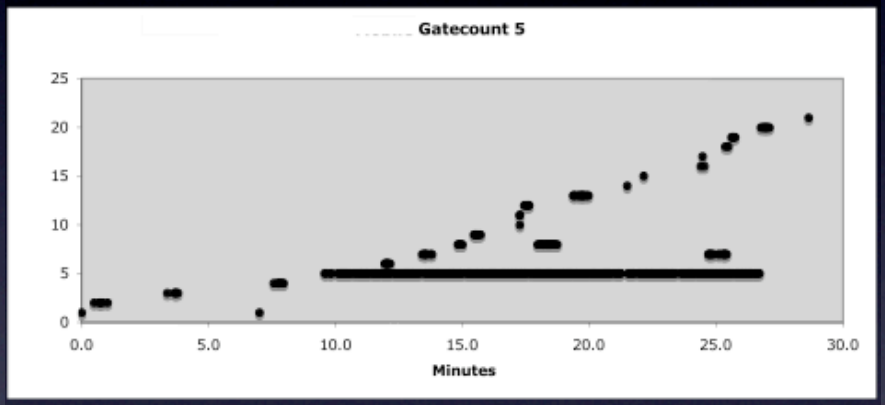
Timeline view

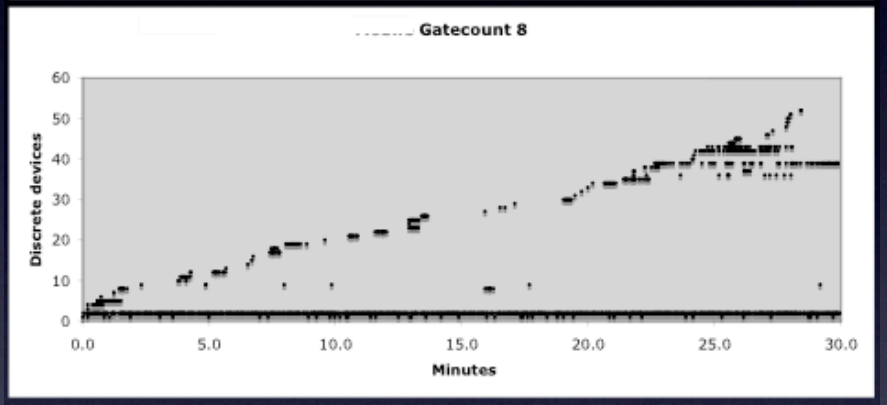


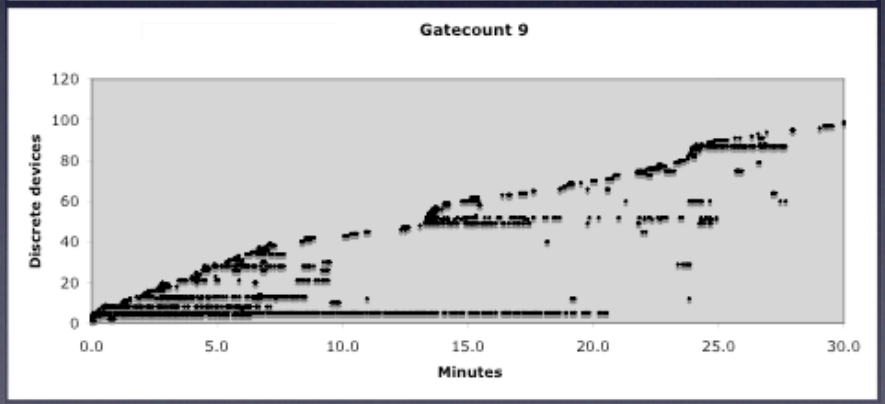
Gatecount timelines

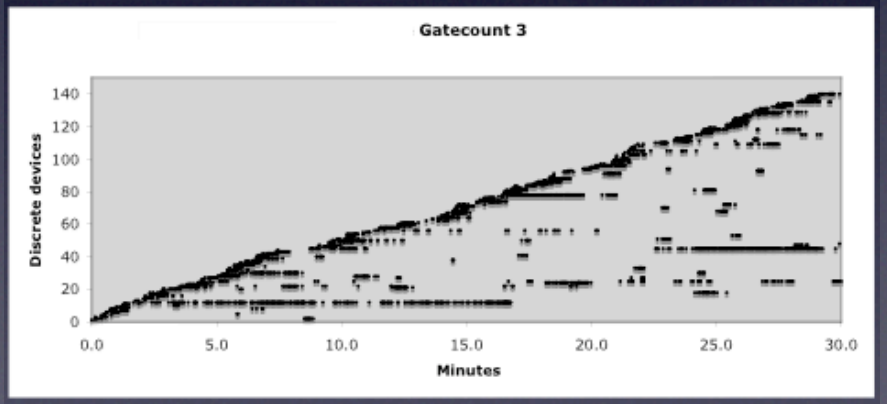




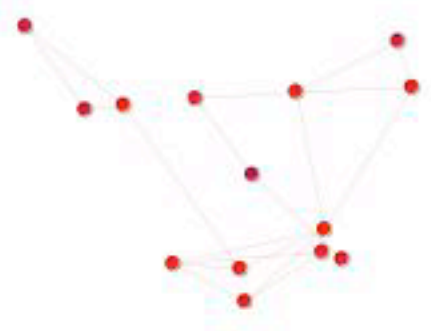




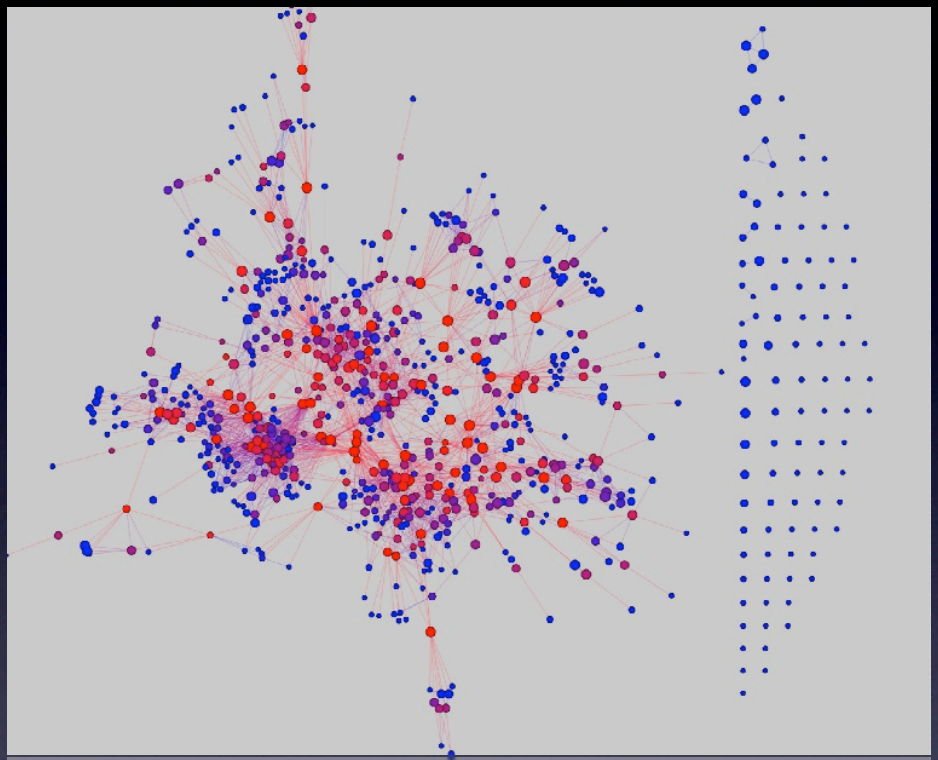


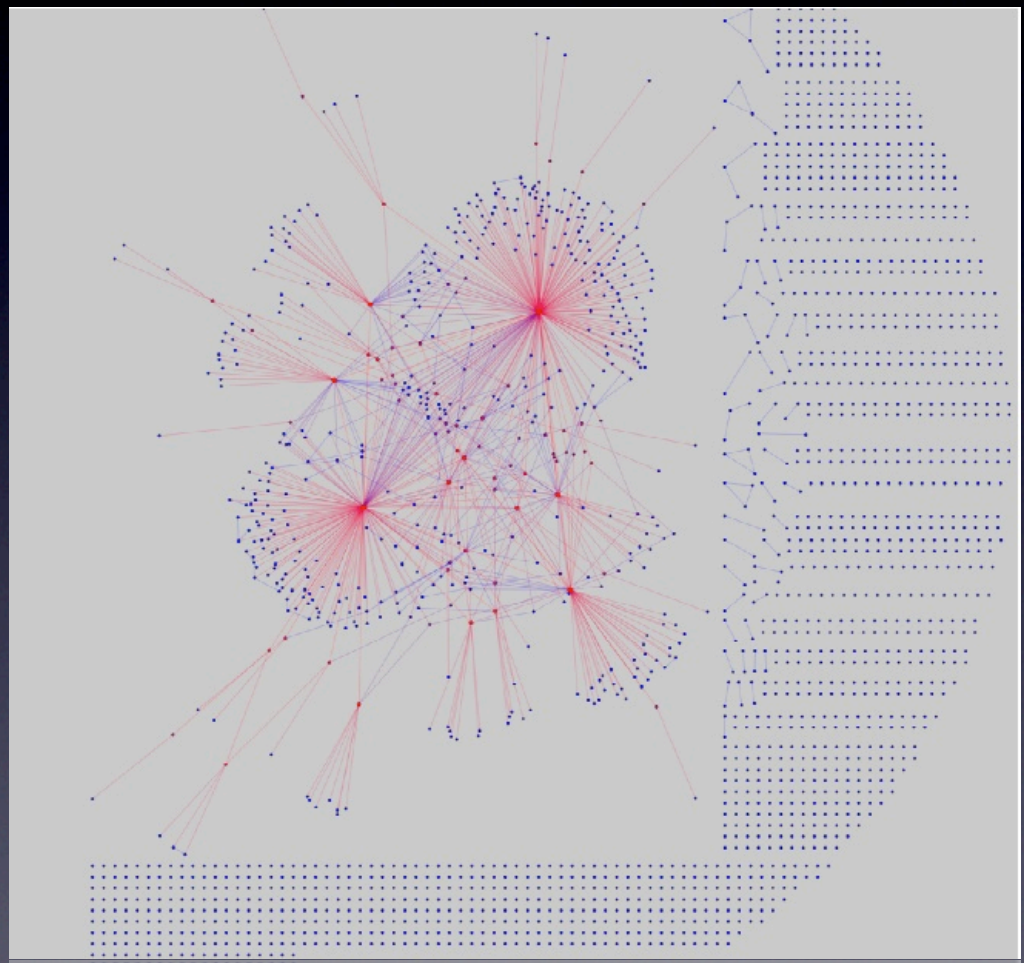


Encounters

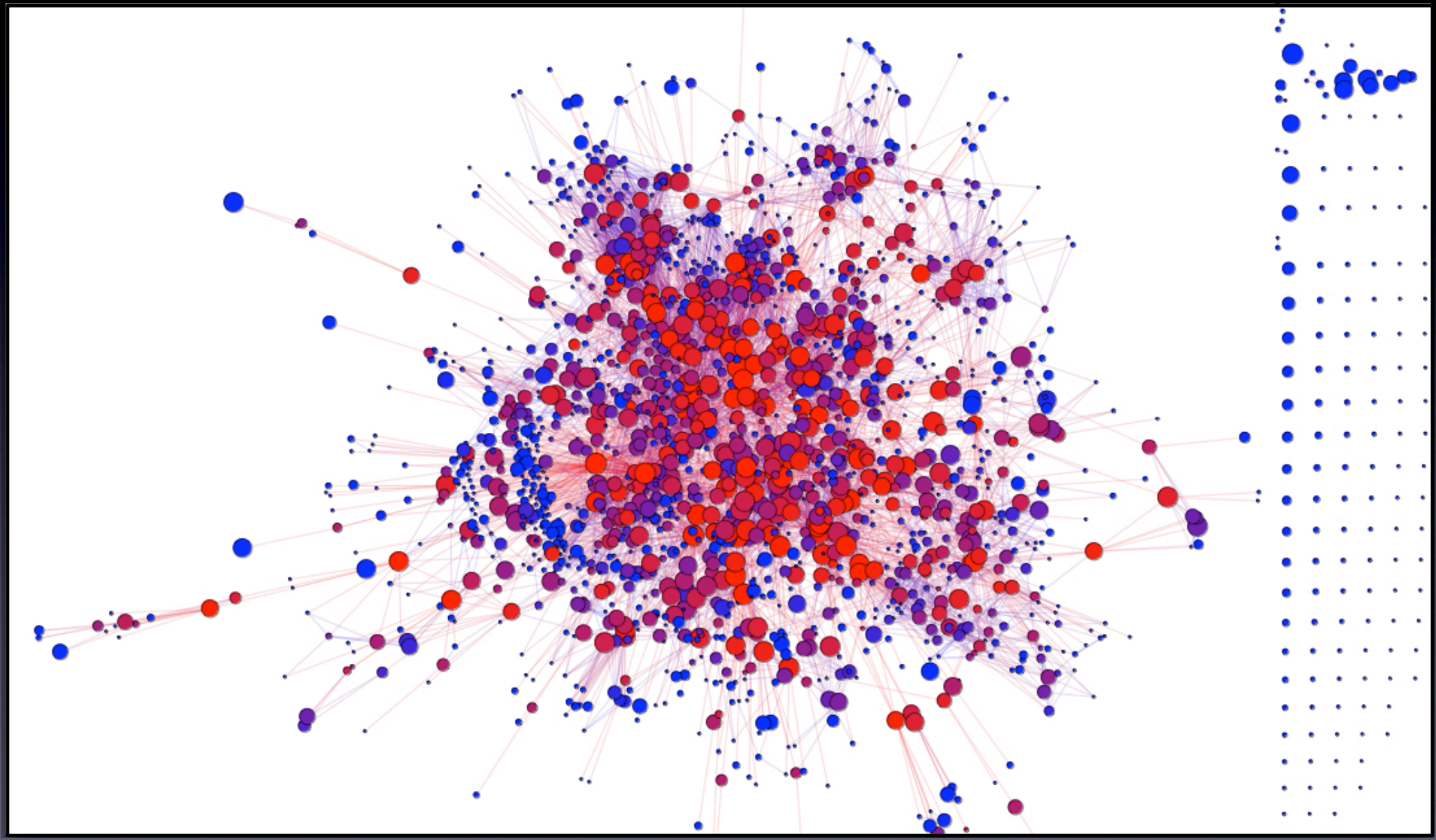


Social networks

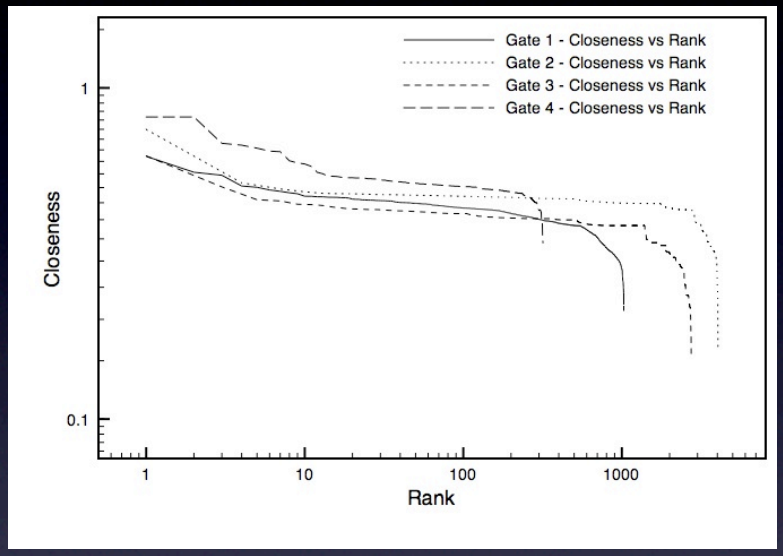


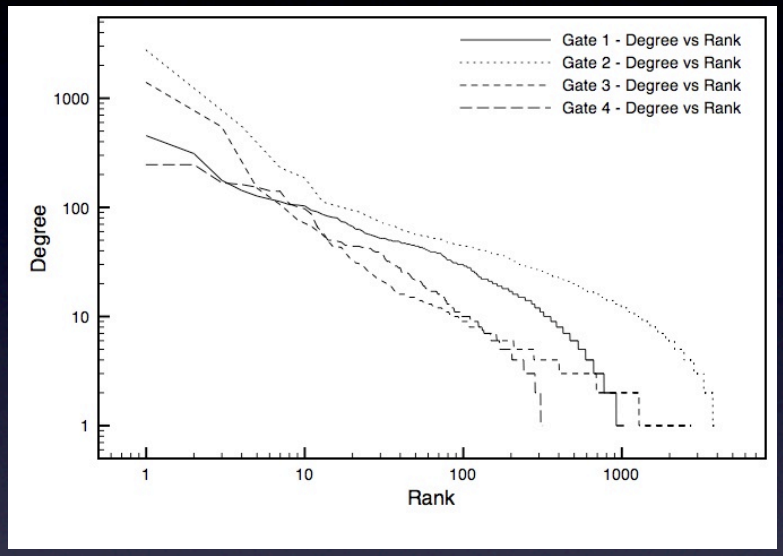


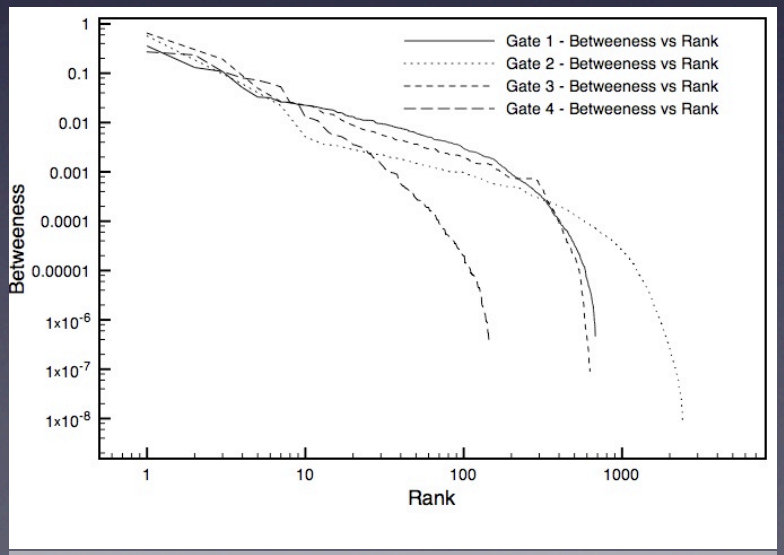
The blob

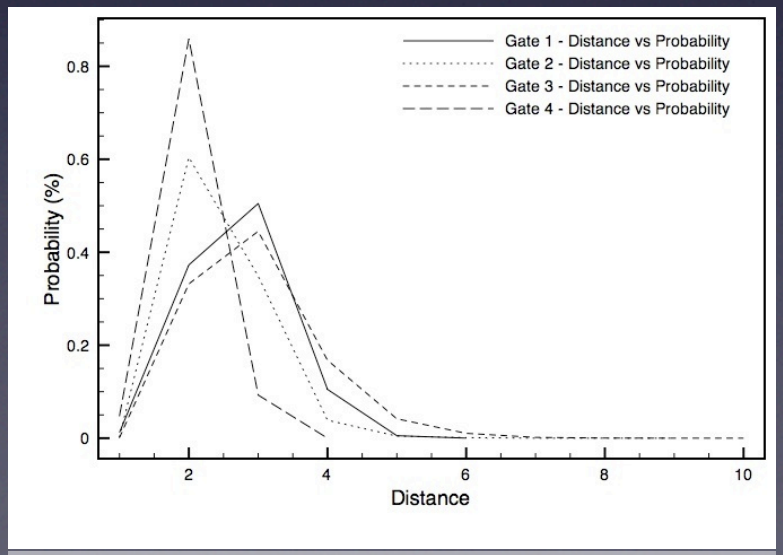


Power laws and exponential decays







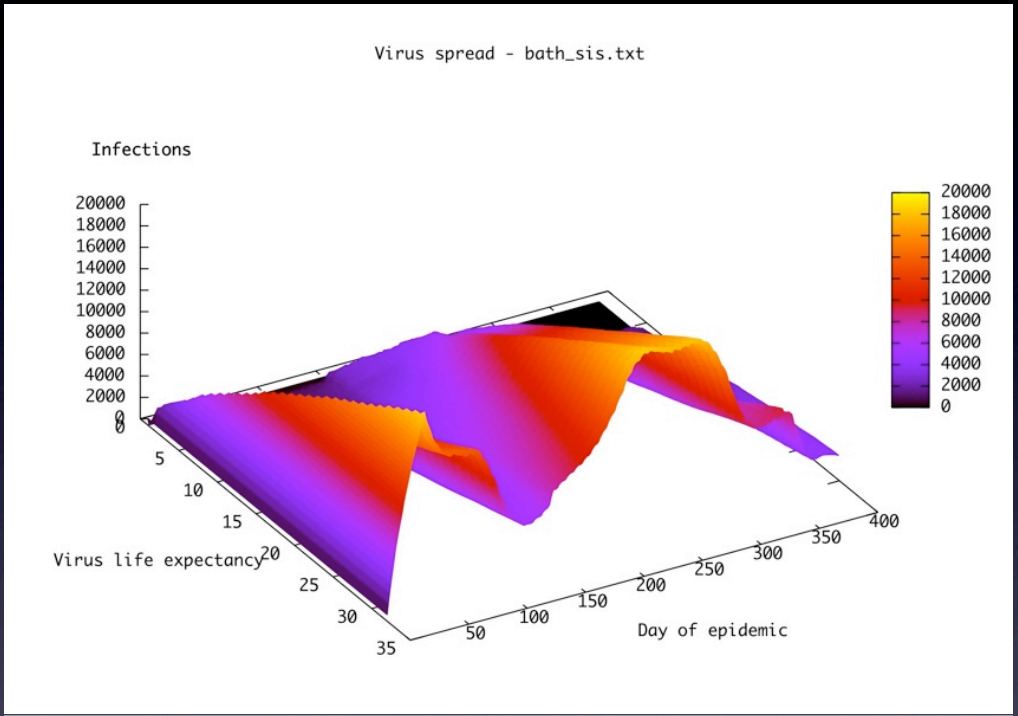


Emulation

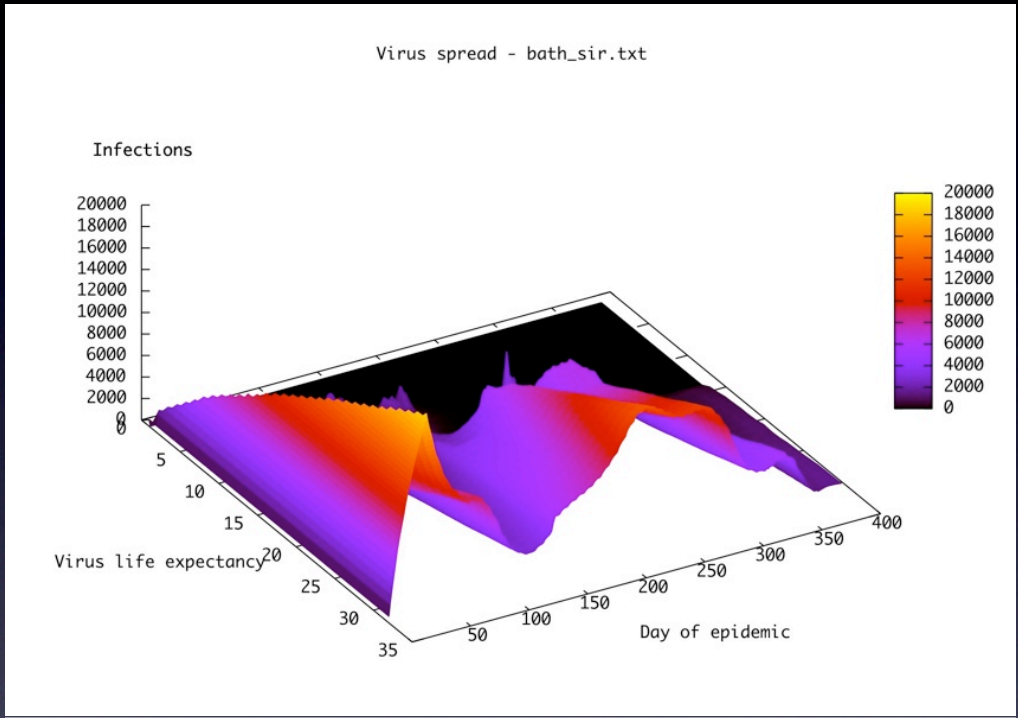
- Taking account of time
- Emulation vs. simulation

- Class “host”
- Class “virus”
- During encounter, virus is transmitted
- Host recovers (SIS) or dies (SIR)

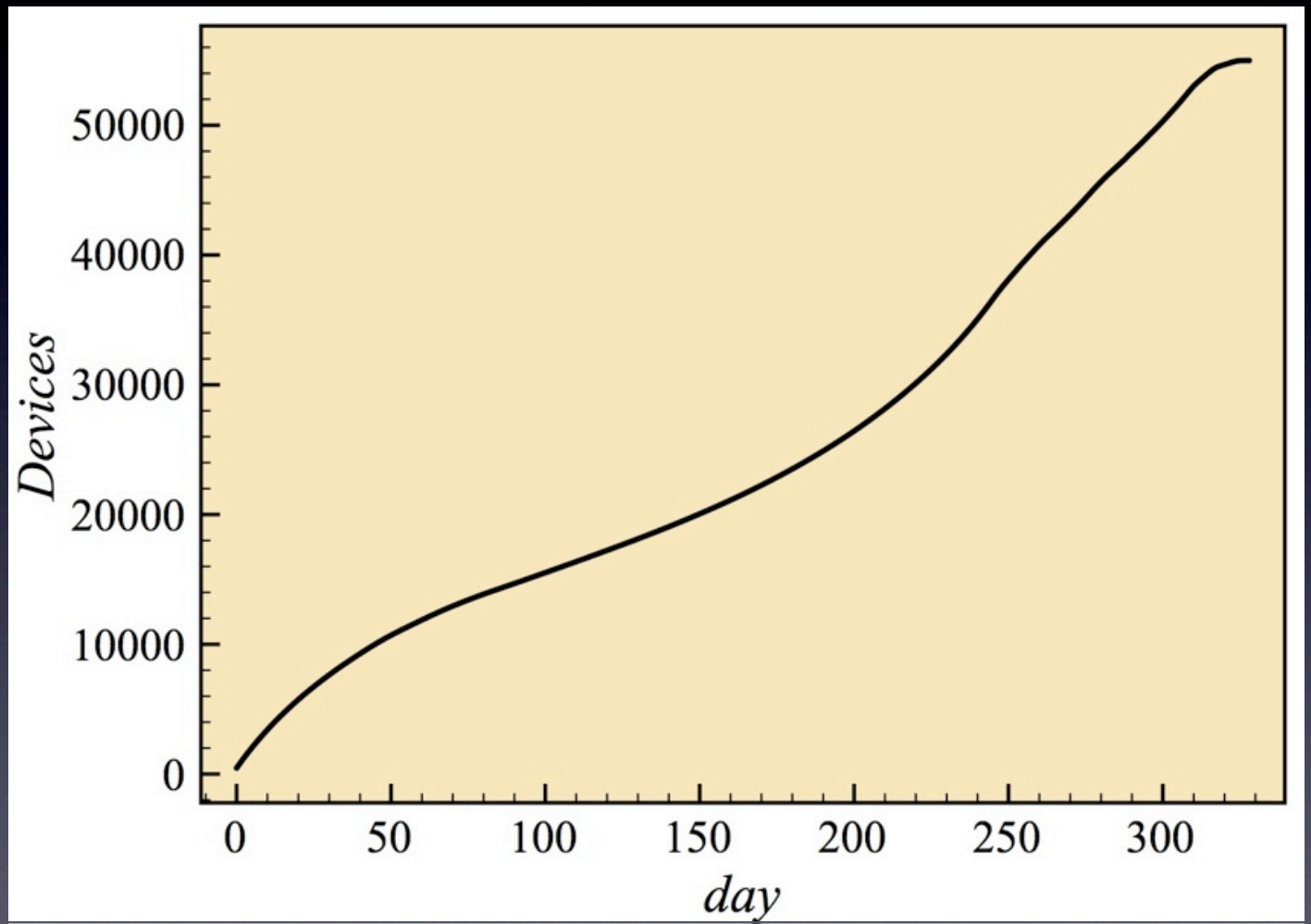
Cold


Virus spread - bath_sis.txt
Infections
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Virus life expectancy
5
10
15
20
25
30
35
Day of epidemic
50
100
150
200
250
300
350
400

Ebola


Virus spread - bath_sir.txt
Infections
20000
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
Virus life expectancy
5
10
15
20
25
30
35
Day of epidemic
50
100
150
200
250
300
350
400

Viral updates



Ongoing work

- DTN forwarding algorithms
- Social network features
  - Node degree
  - Node betweenness
  - Node closeness
- Average geodesic path (Bath = 3.3)
- Clustering coefficient (45%)
- Community detection (21 using Newman's algorithm)

Take home points

- Urban pervasive computing is the development of a system (of systems)
- May be characterised as a system of architectural spaces and interaction spaces
- Augmenting space syntax empirical methods
- Developing data visualisations & analytical methods
- Patterns of Bluetooth presence & encounter
- Implications for epidemiology and DTNs
- www.cityware.org.uk

the end

Bluetooth visibility

- Around 7.5% of observed pedestrians had *discoverable* Bluetooth devices