

Brief Encounter Networks

Vassilis Kostakos



Oxford University, 16 October 2007

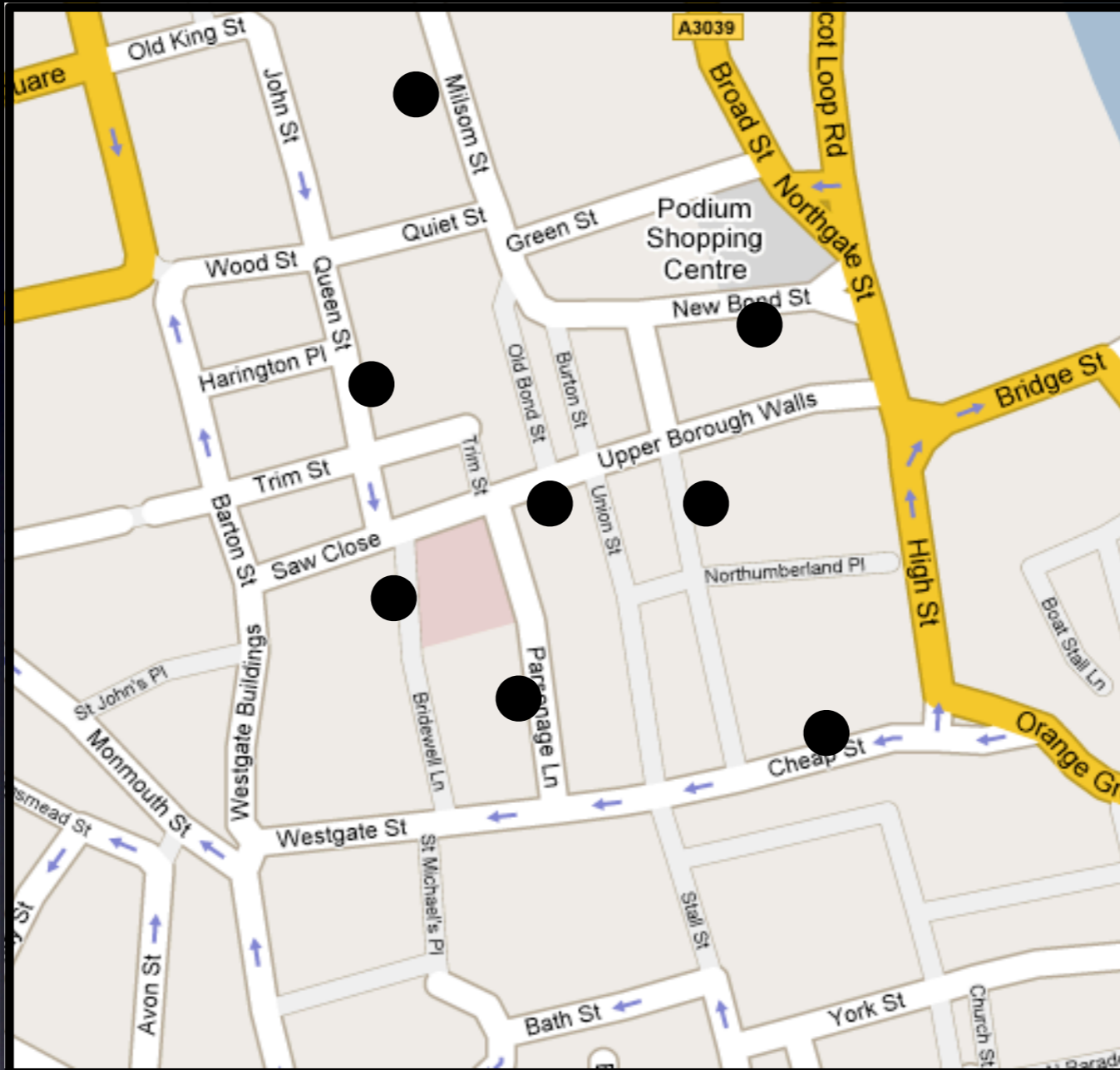
Motivation

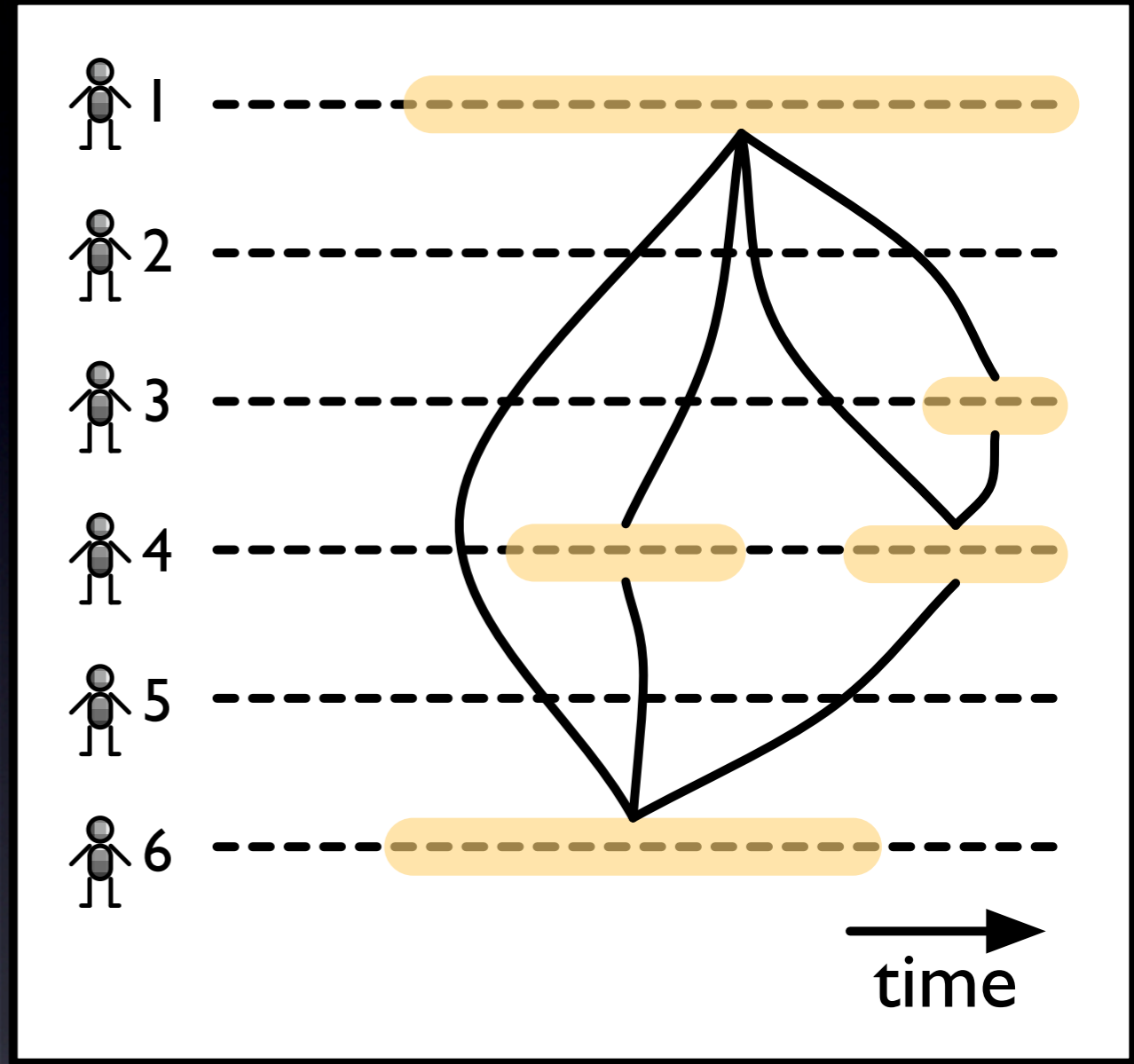
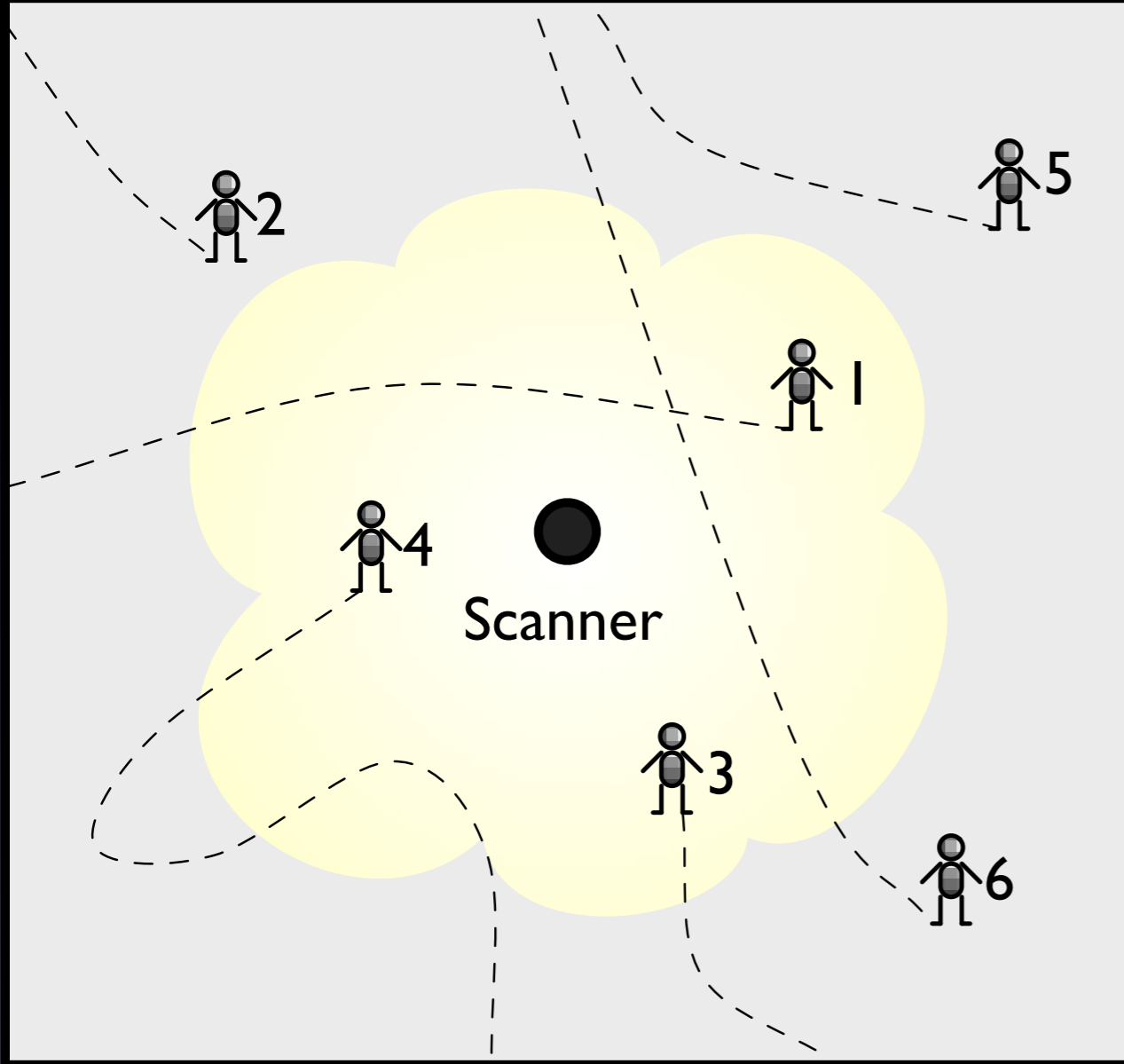
- Understand the “affordances” of people’s mobility, and
- identify opportunities for pervasive systems

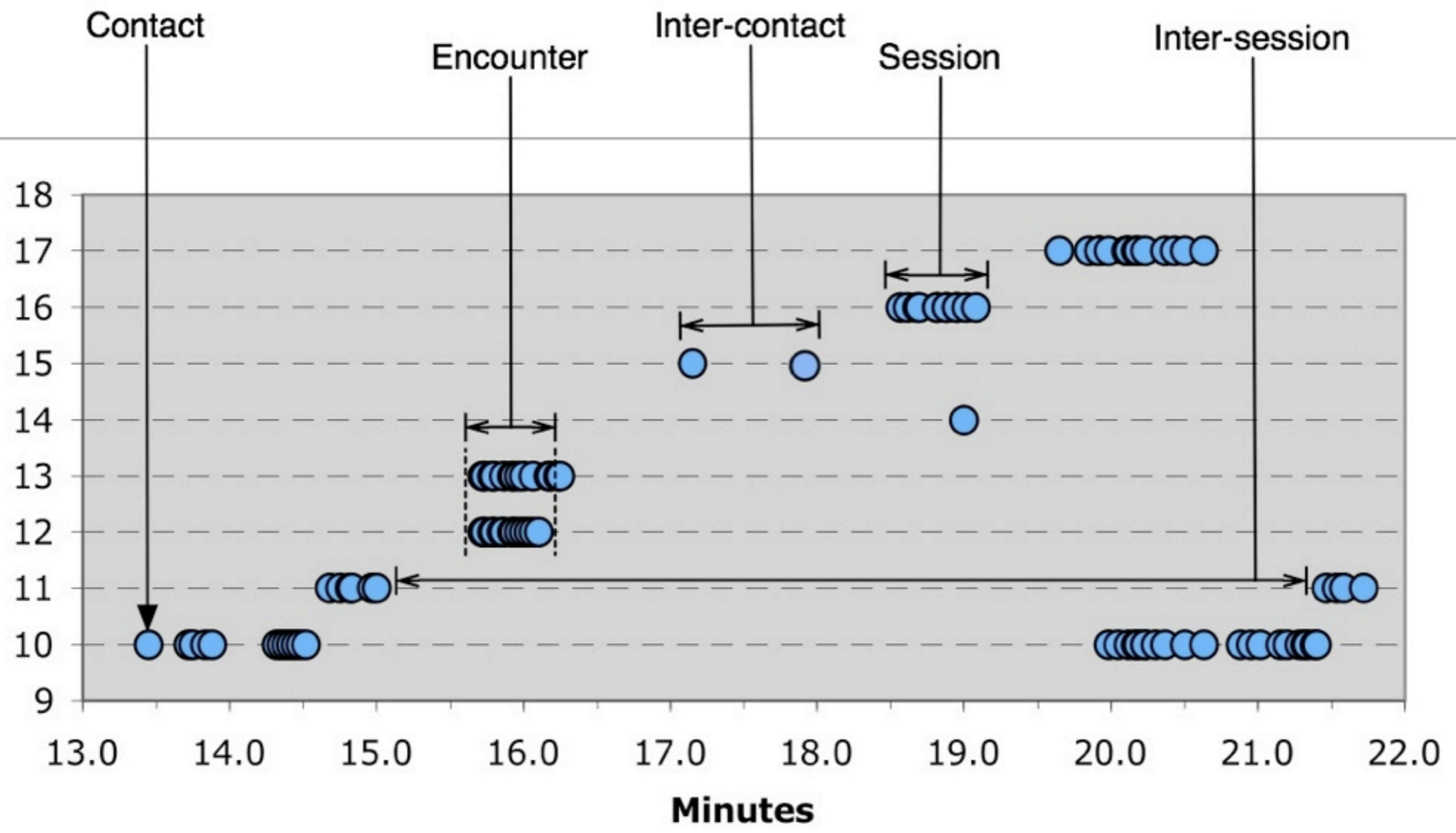
Overview

- Data collection
- Structural properties
- Dynamic properties
- Diffusion
- Ongoing work

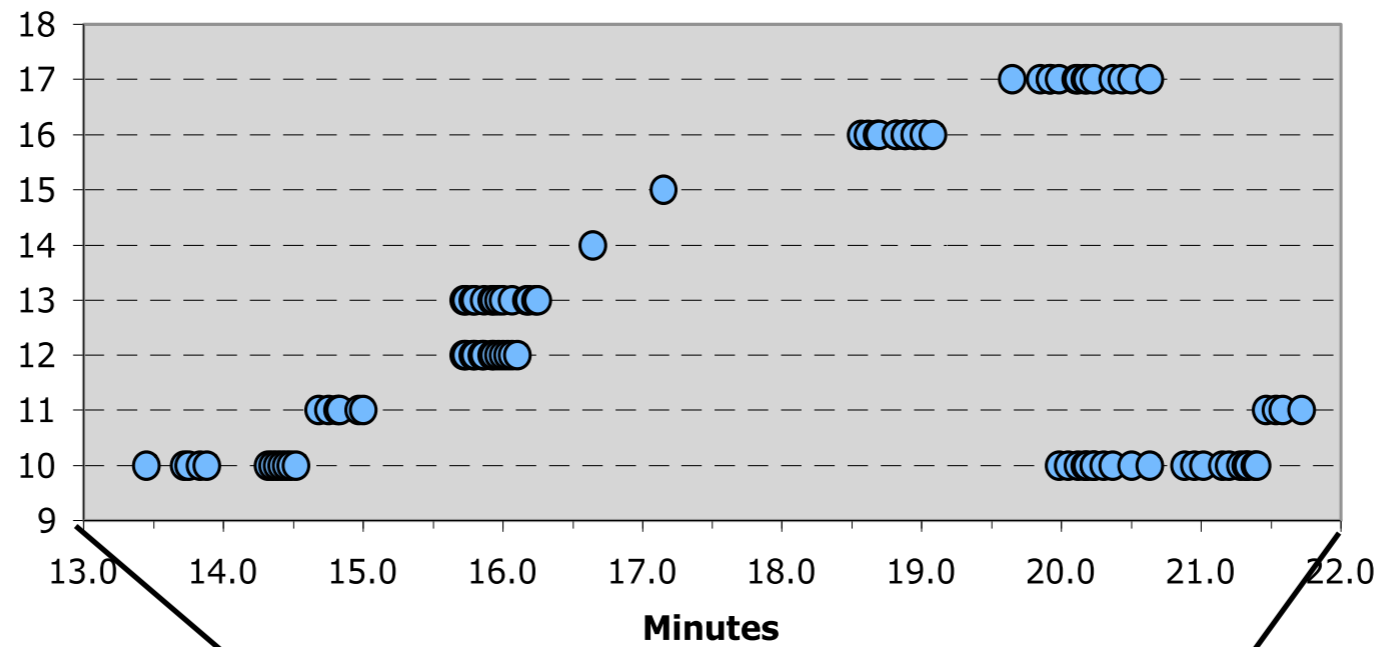
Data collection



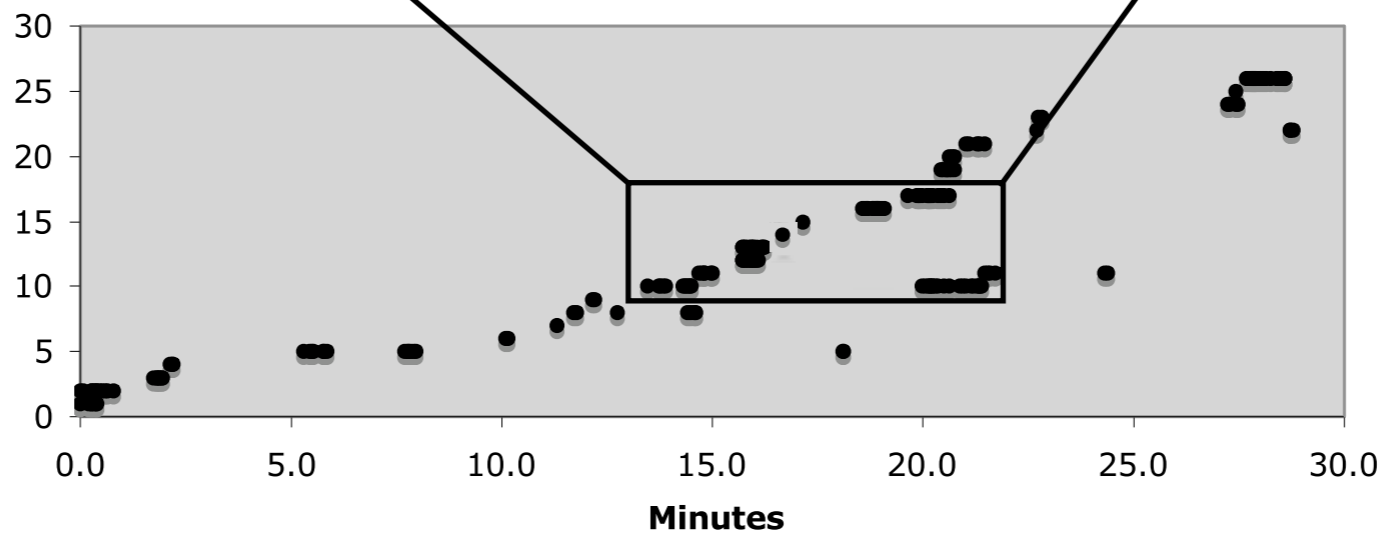




Timeline view



Mobile Gatecount 1



Minutes

0'0

2'0

10'0

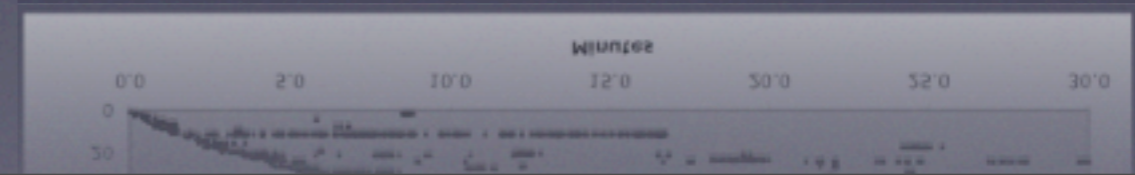
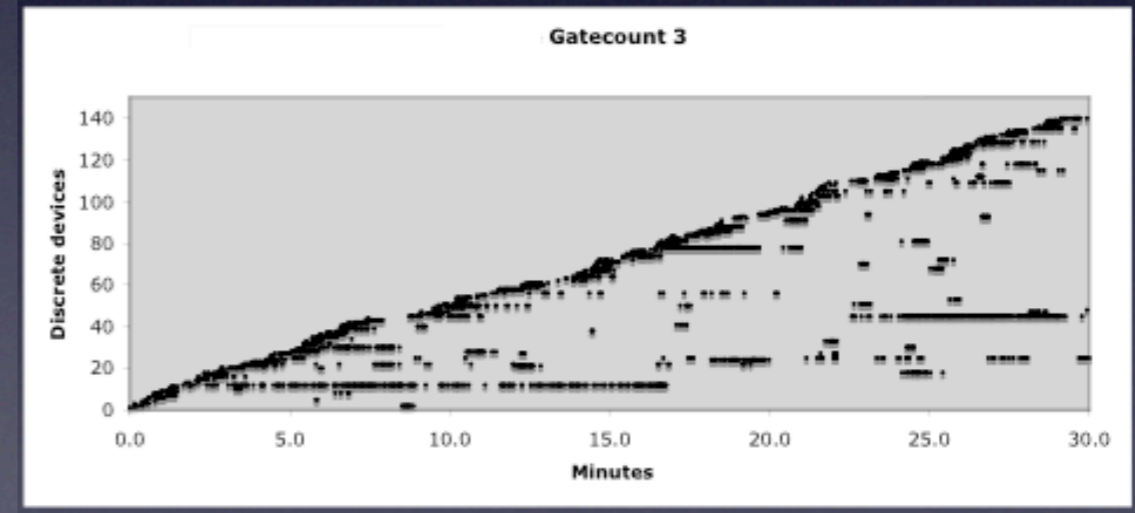
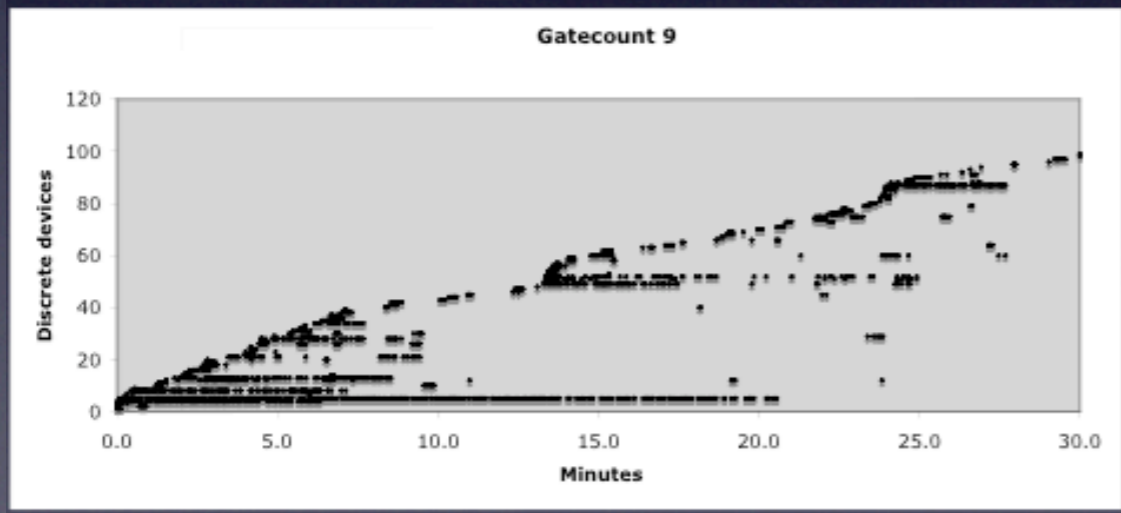
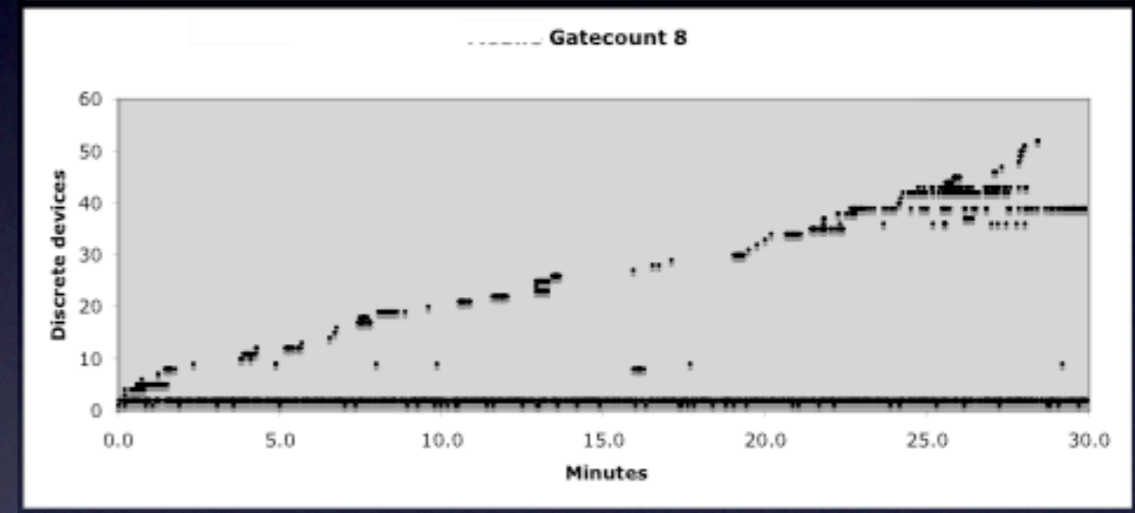
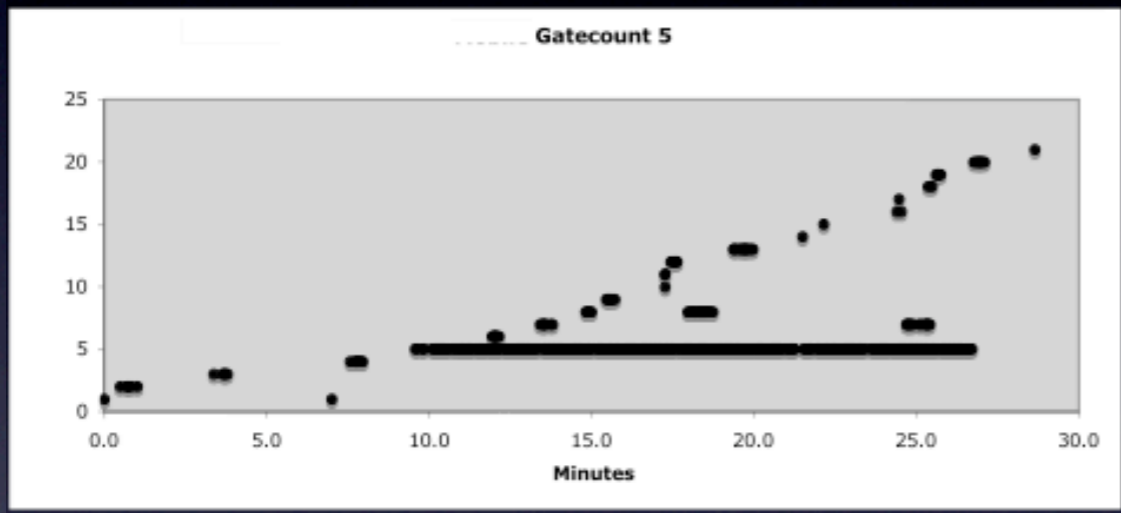
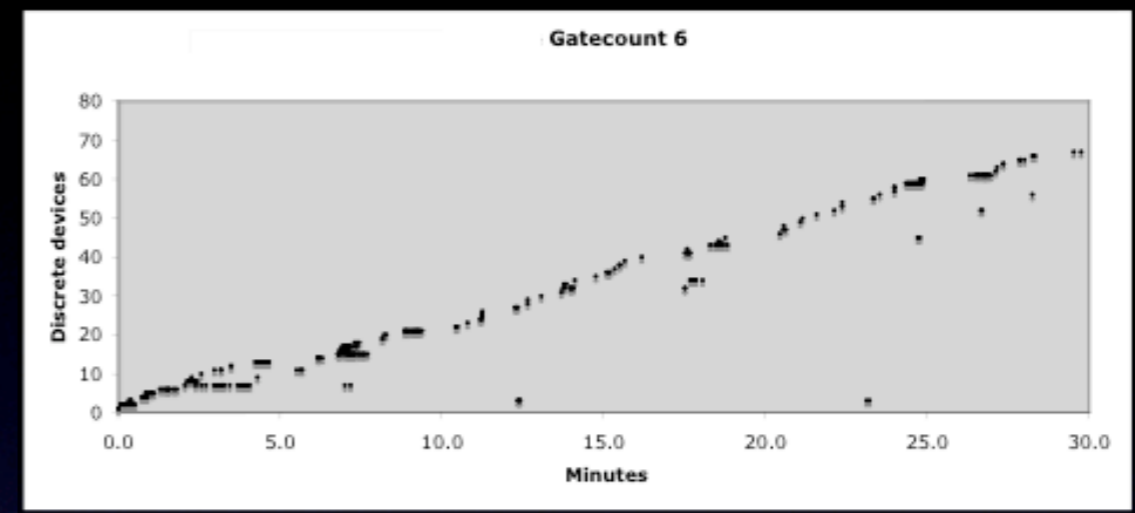
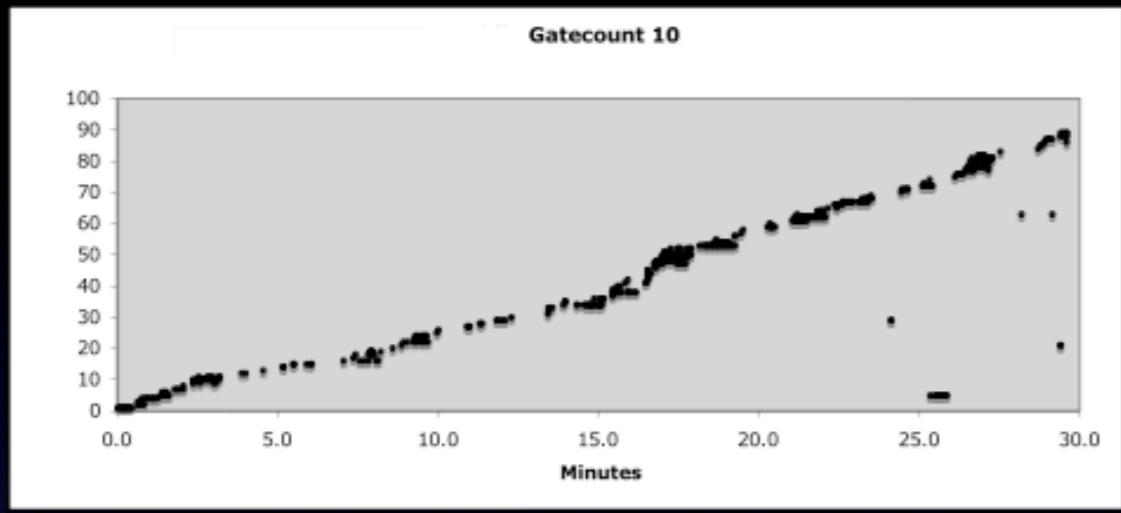
12'0

20'0

22'0

30'0

Gatecount timelines

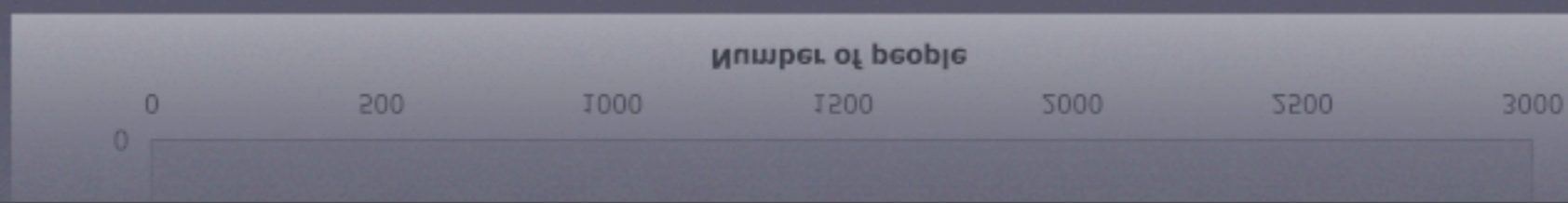
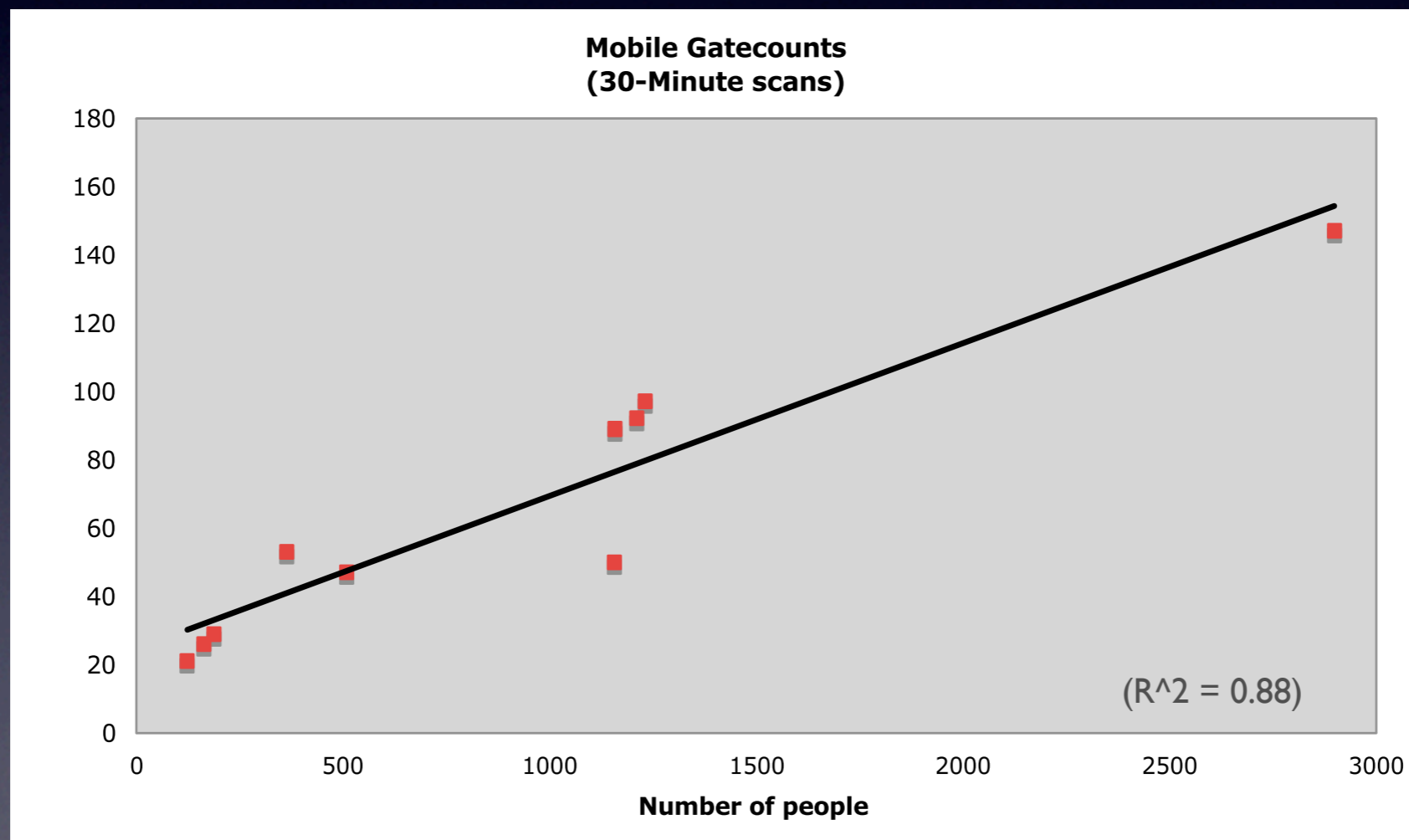


Gatecounts

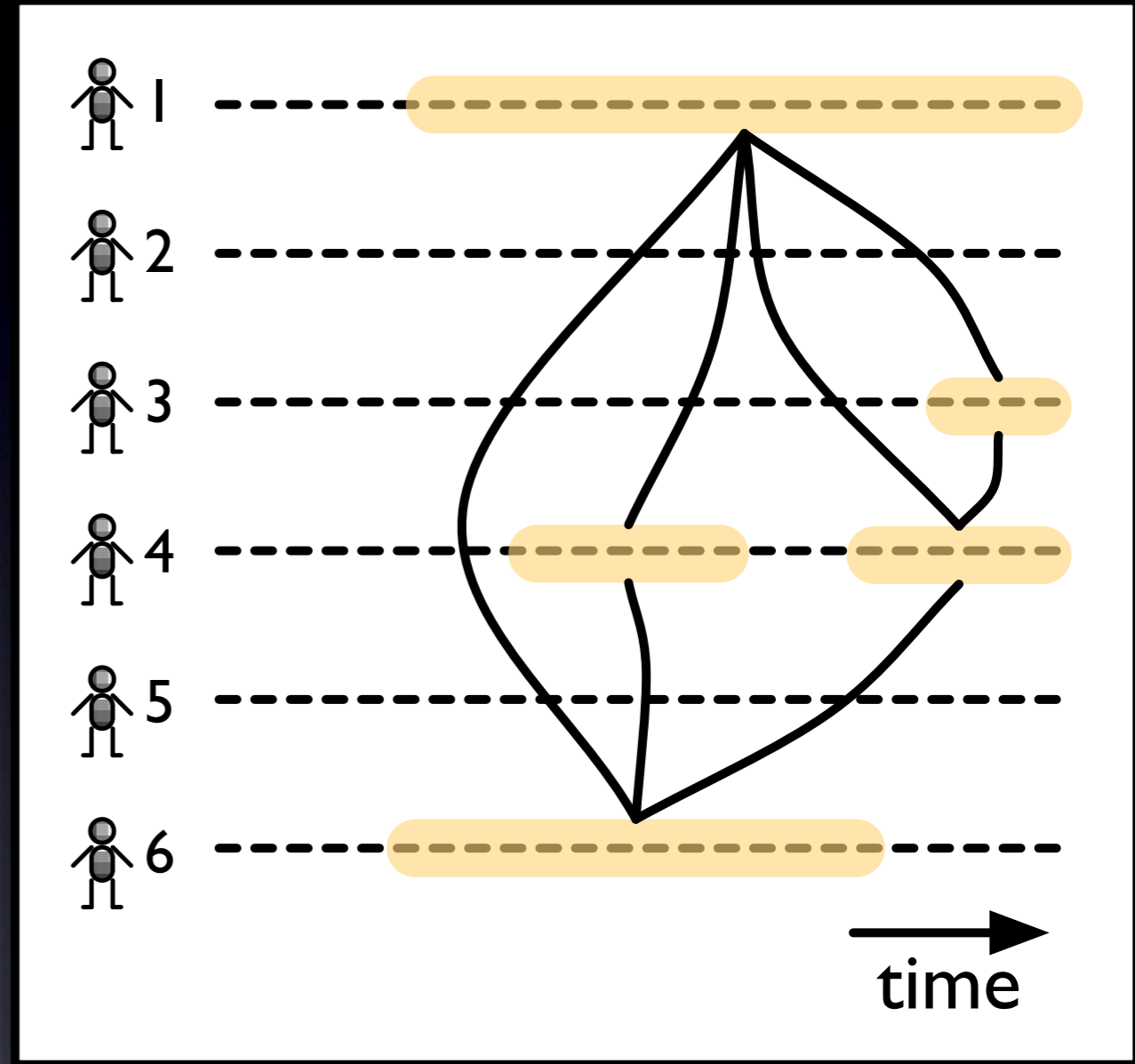
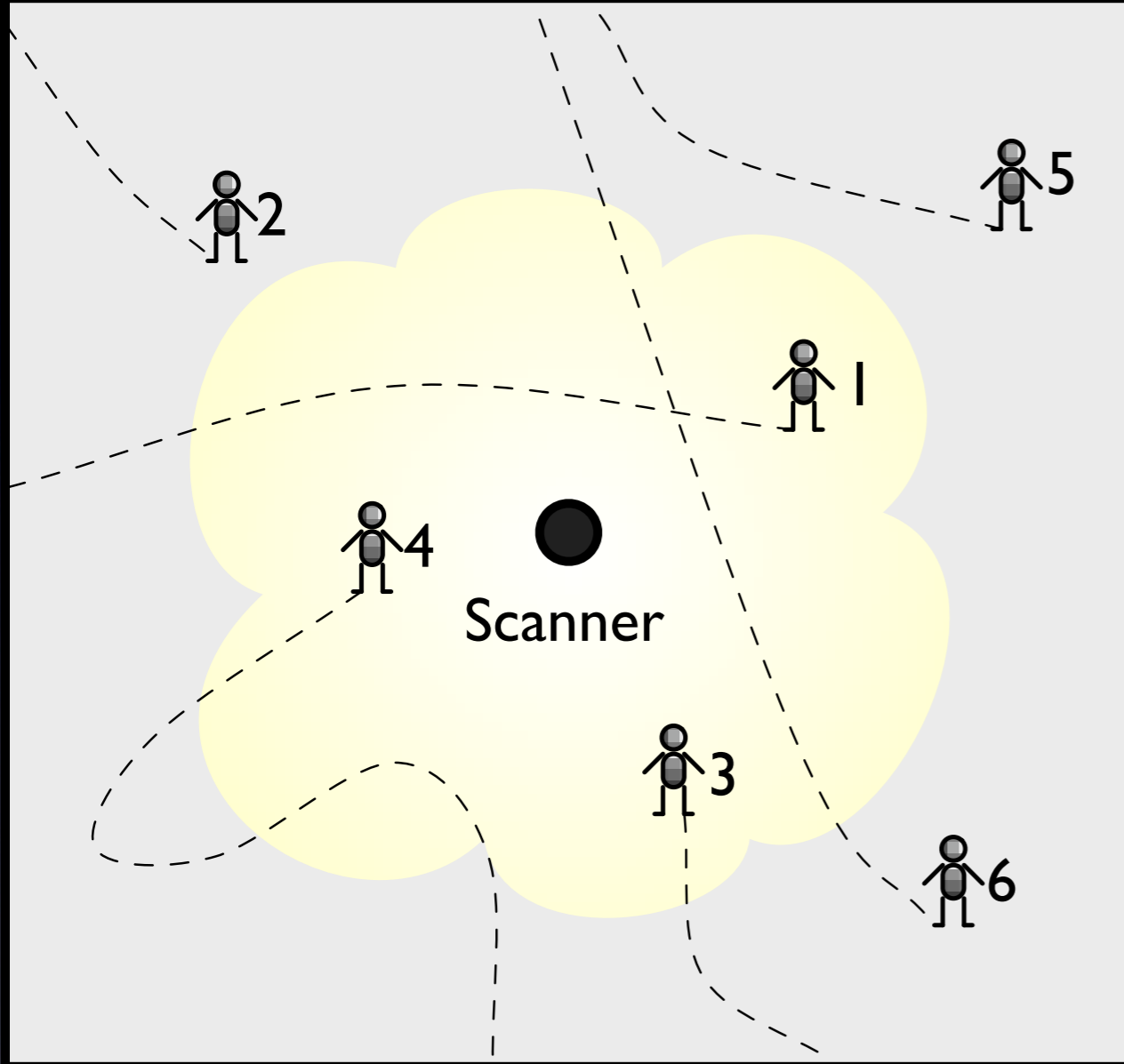


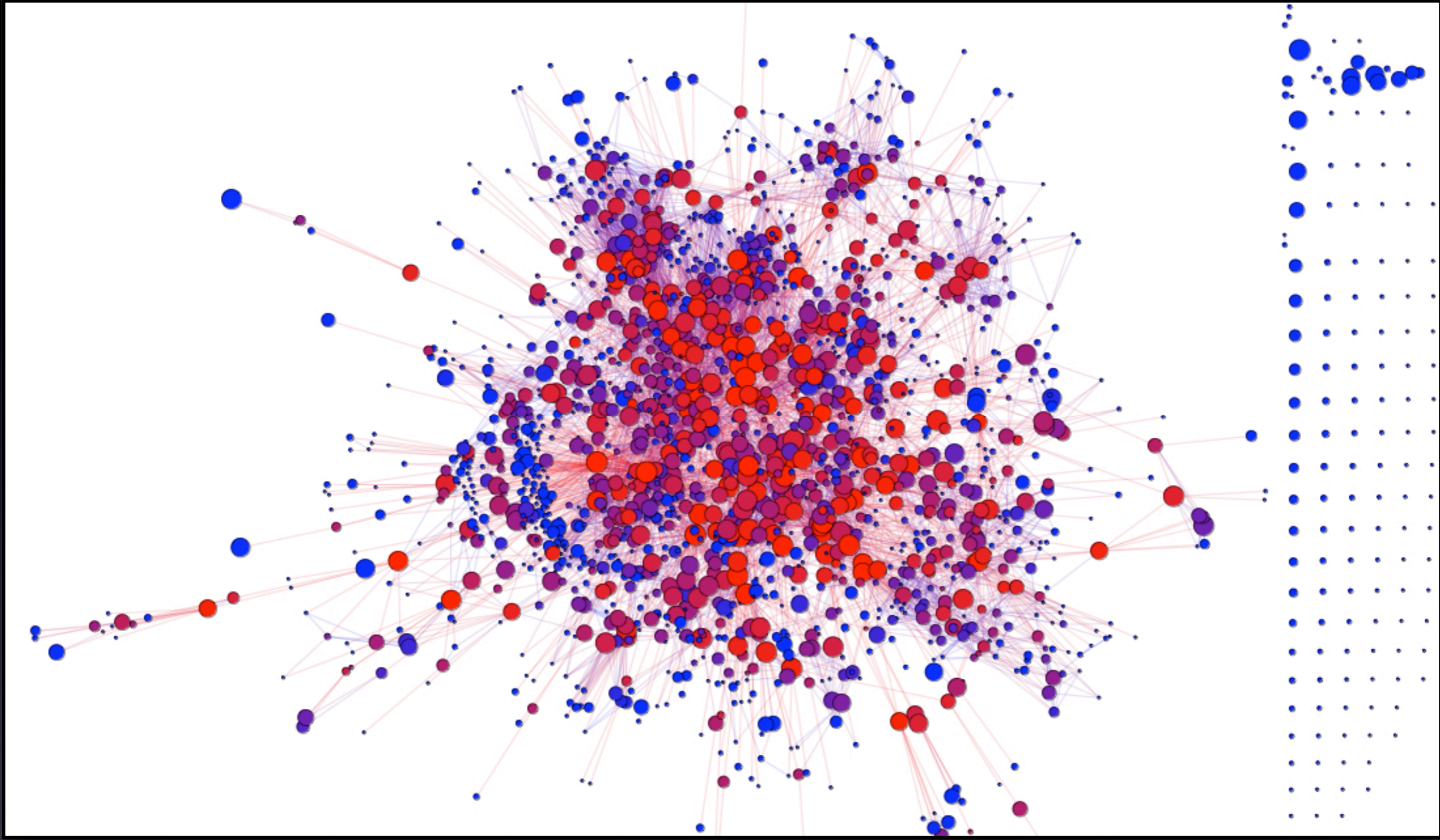
Bluetooth visibility

- Around 7.5% of observed pedestrians had discoverable Bluetooth devices

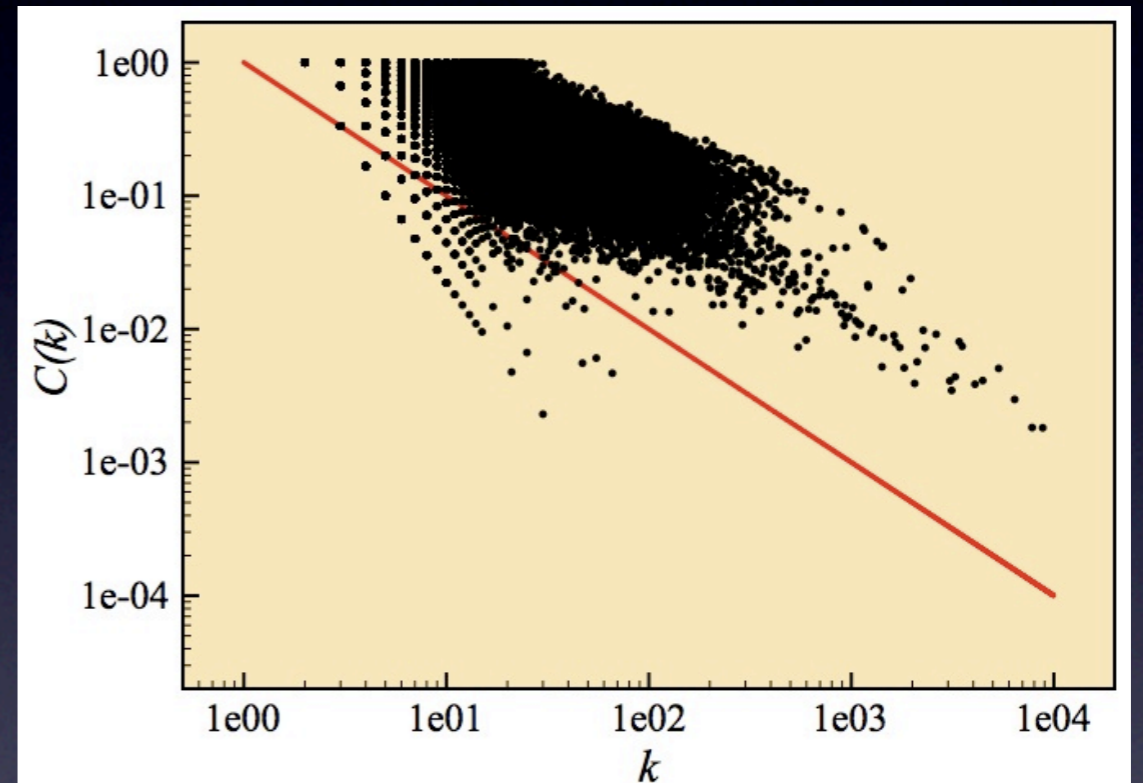
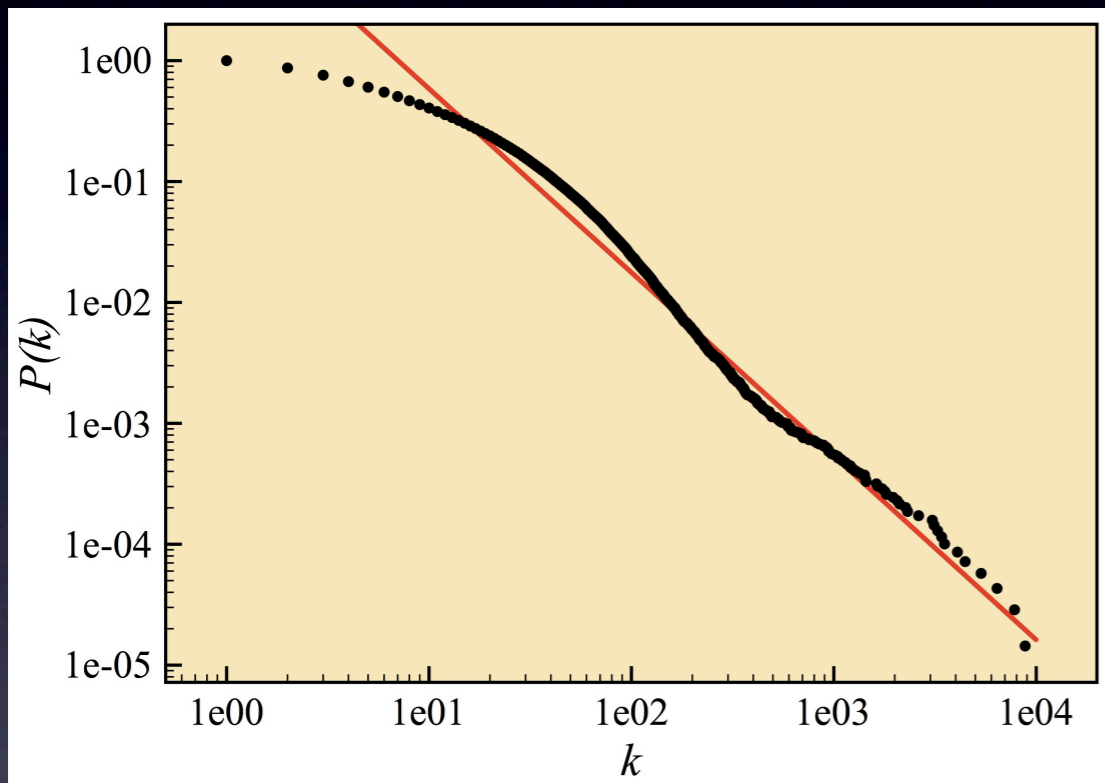


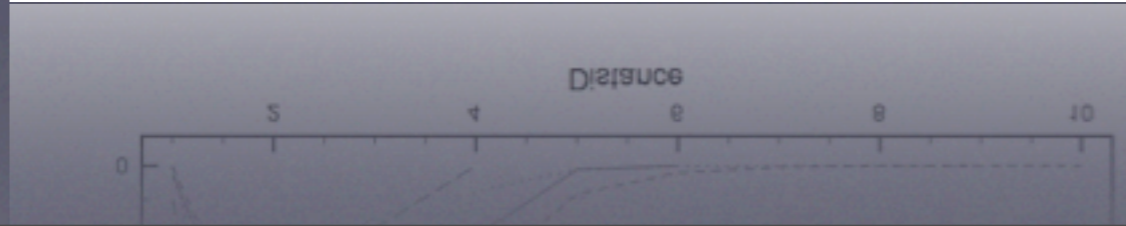
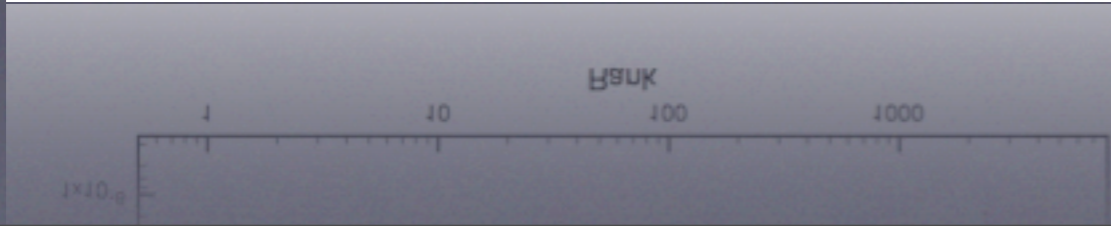
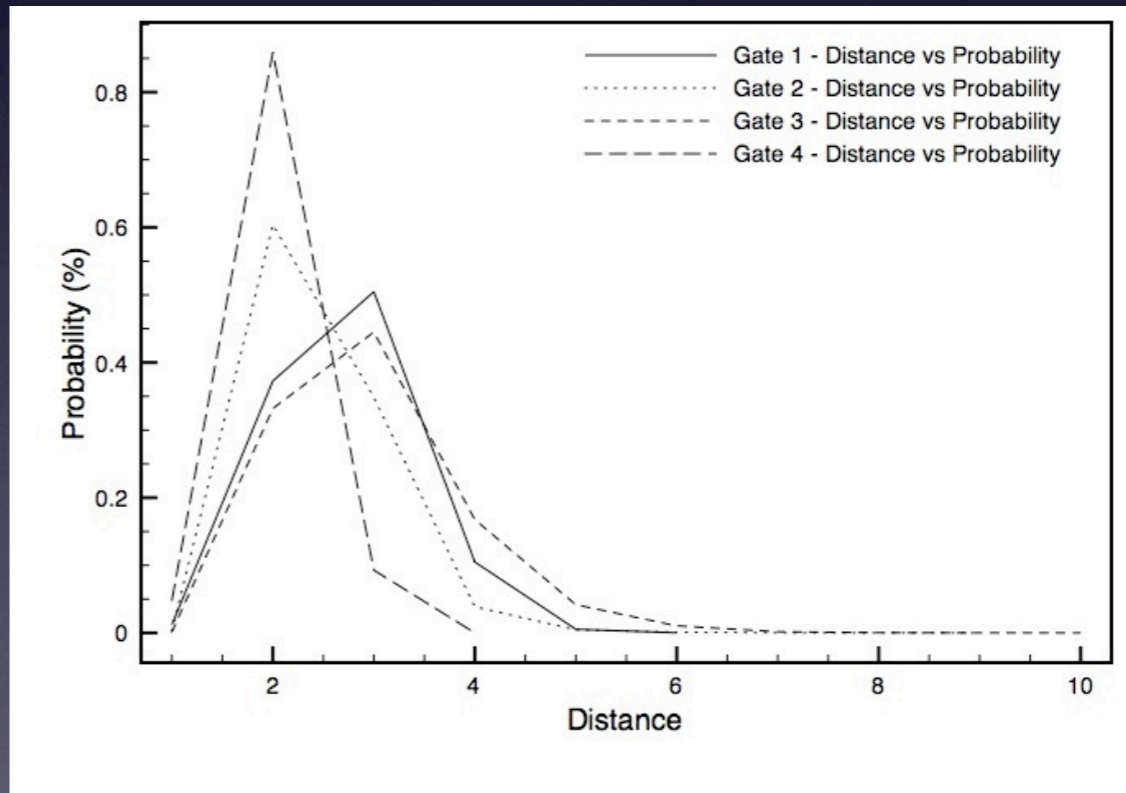
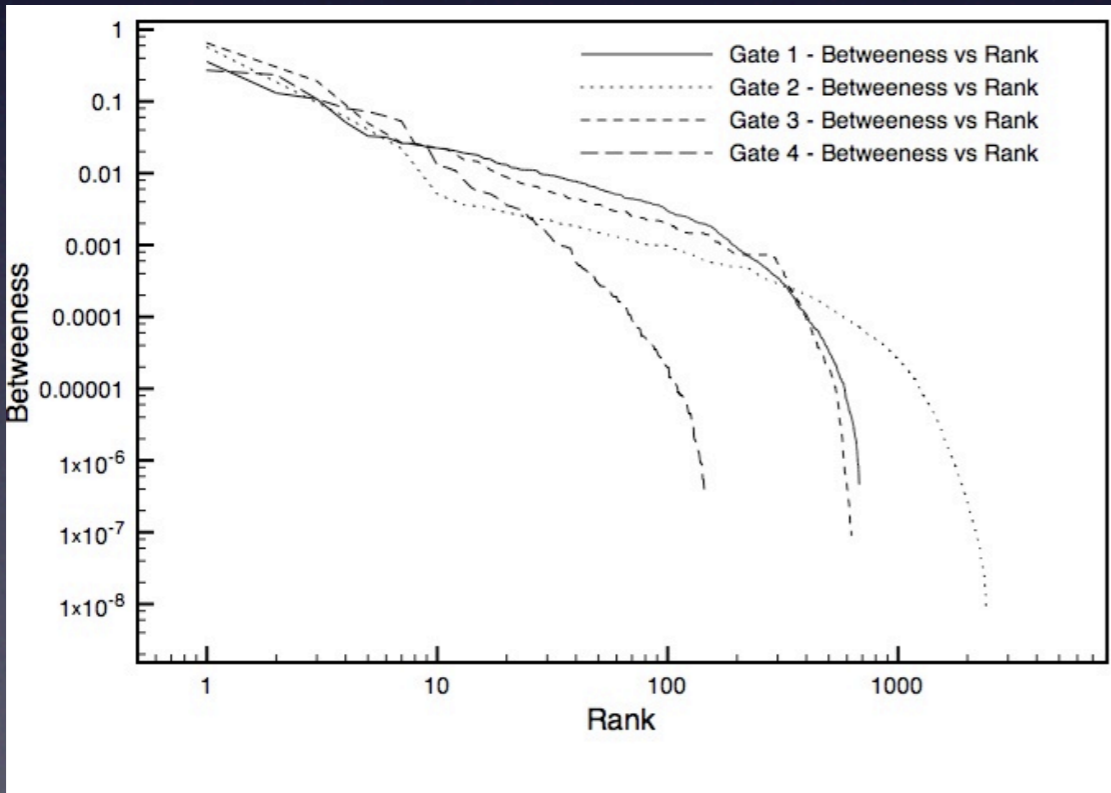
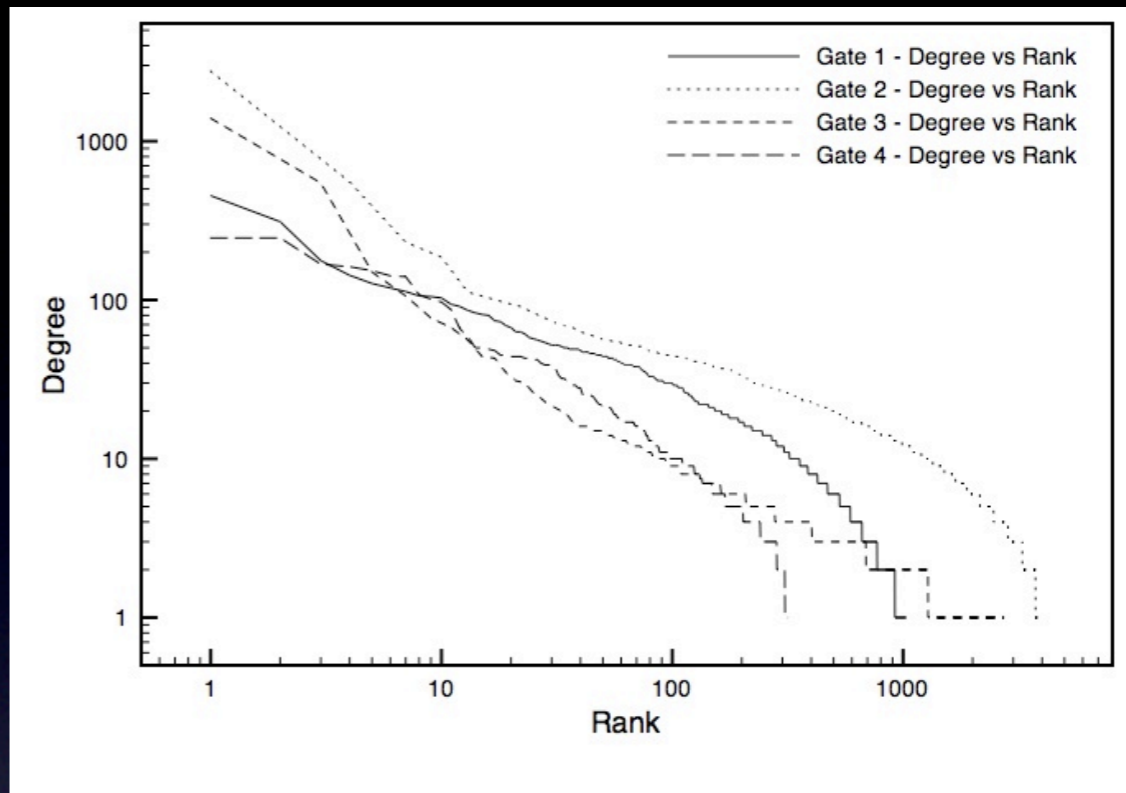
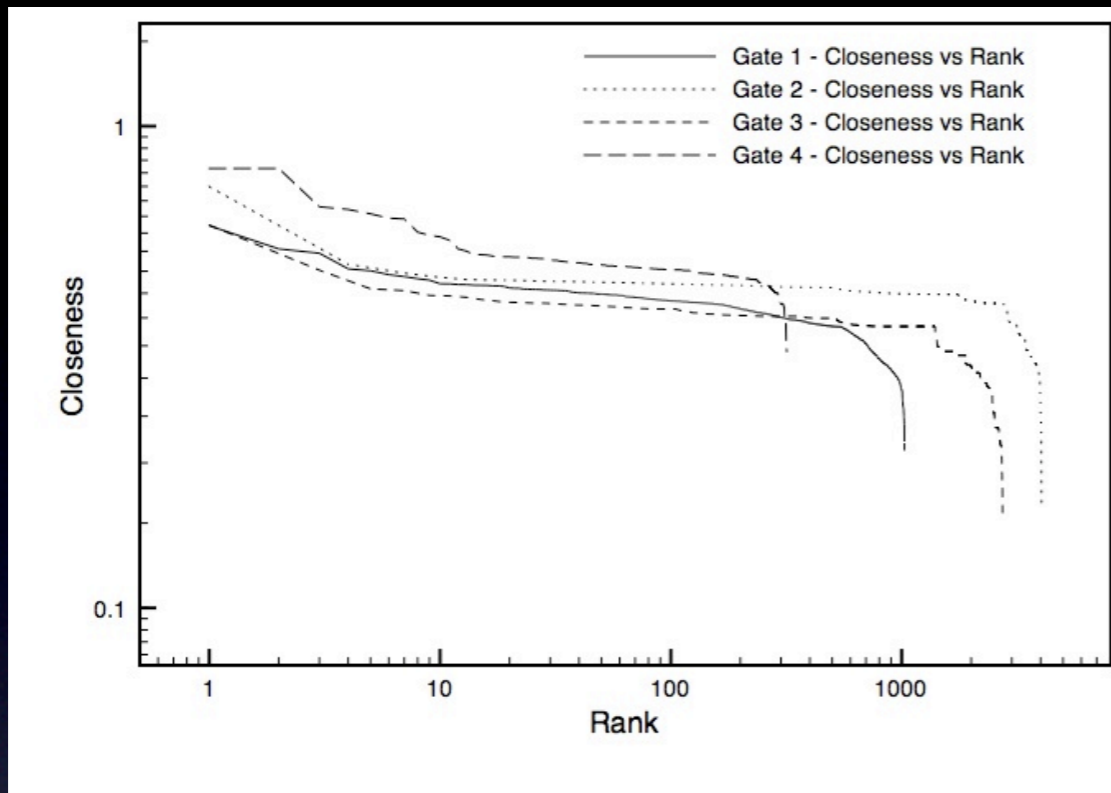
Structural properties





	Size	Edges	Density	Core	\bar{k}	λ_{\max}	λ	C
Bath	70516	652446	0.03%	69655	18.53	11	3.45	0.47
Campus	3109	120273	2.5%	3101	77.37	6	2.57	0.44
Street	11853	58111	0.08%	10584	9.80	12	3.23	0.28
Pub	13476	126768	0.1%	13383	18.81	9	2.61	0.10
Office	321	2419	4.7%	318	15.21	4	2.04	0.82

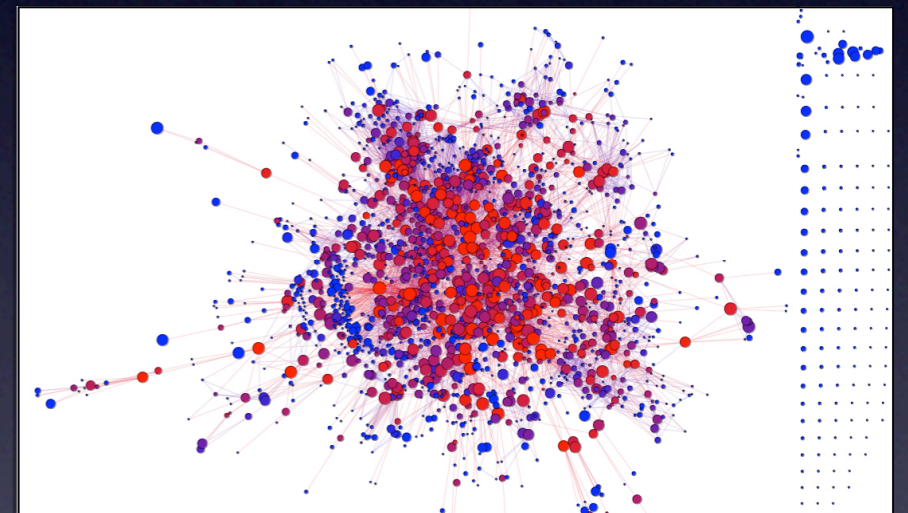


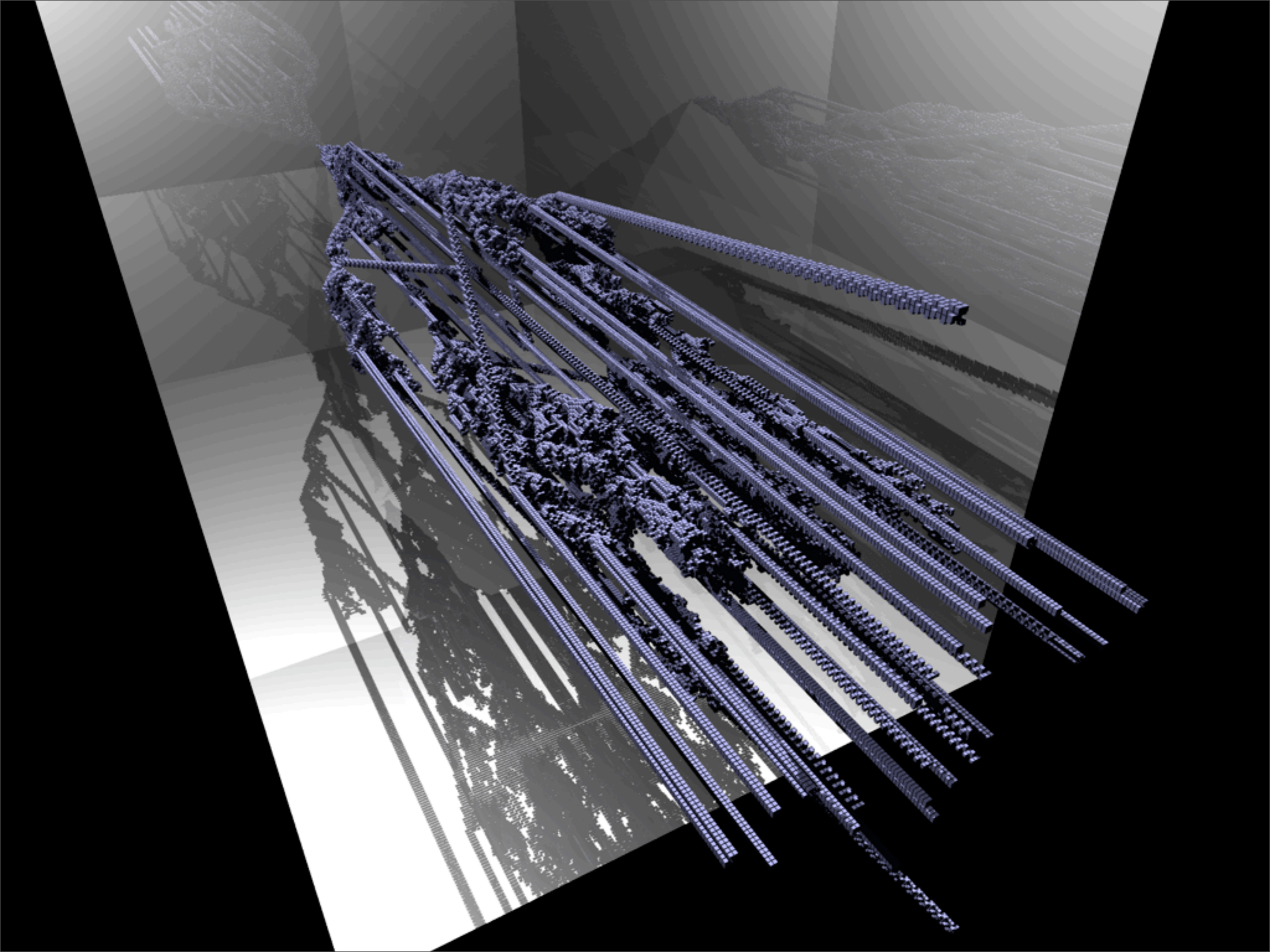


Dynamic properties

Dynamic properties

- Our data is not static
- 3D structure
- Chain of events

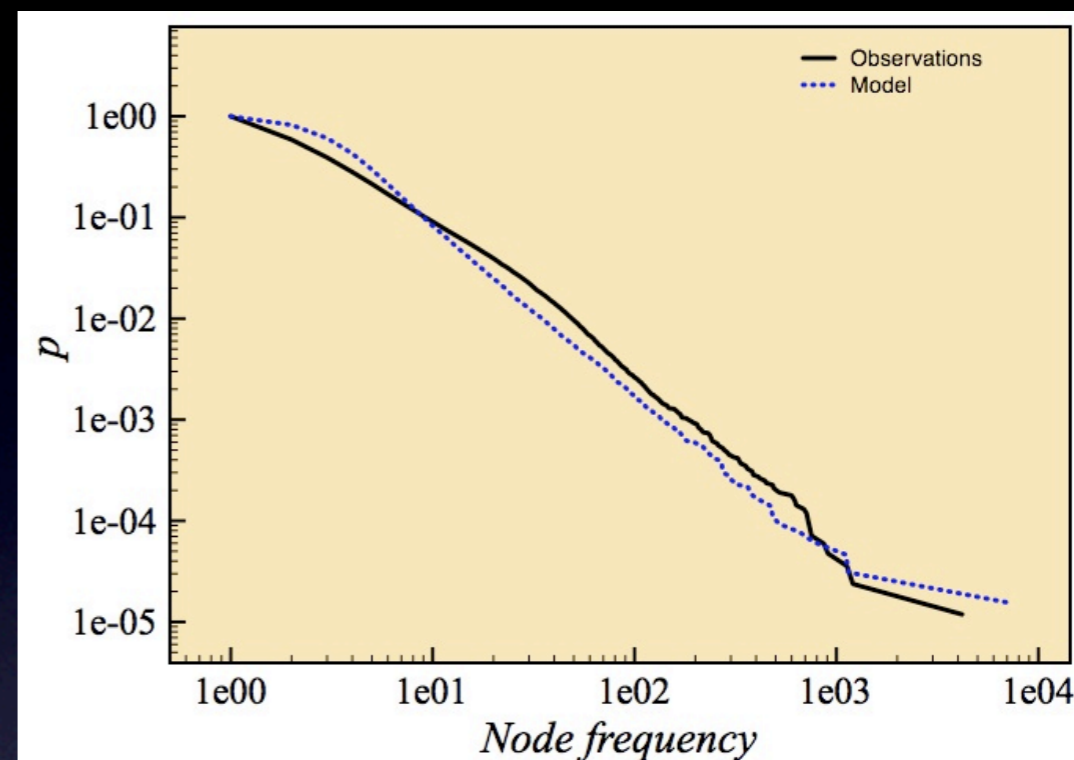
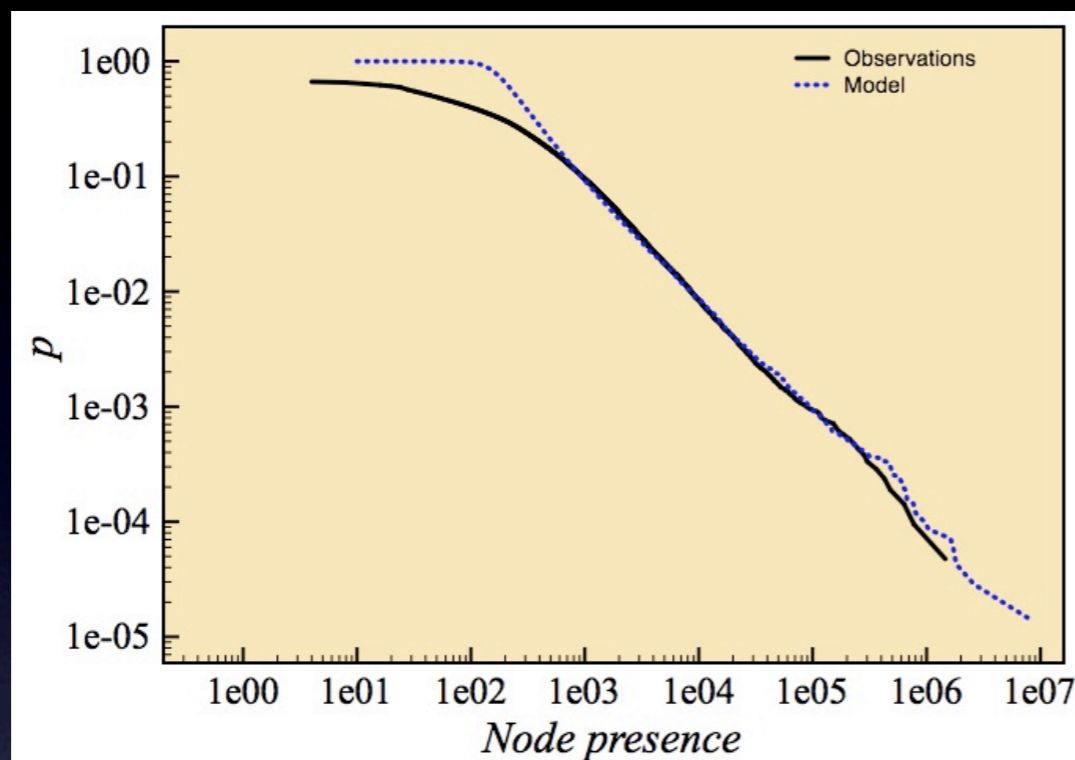




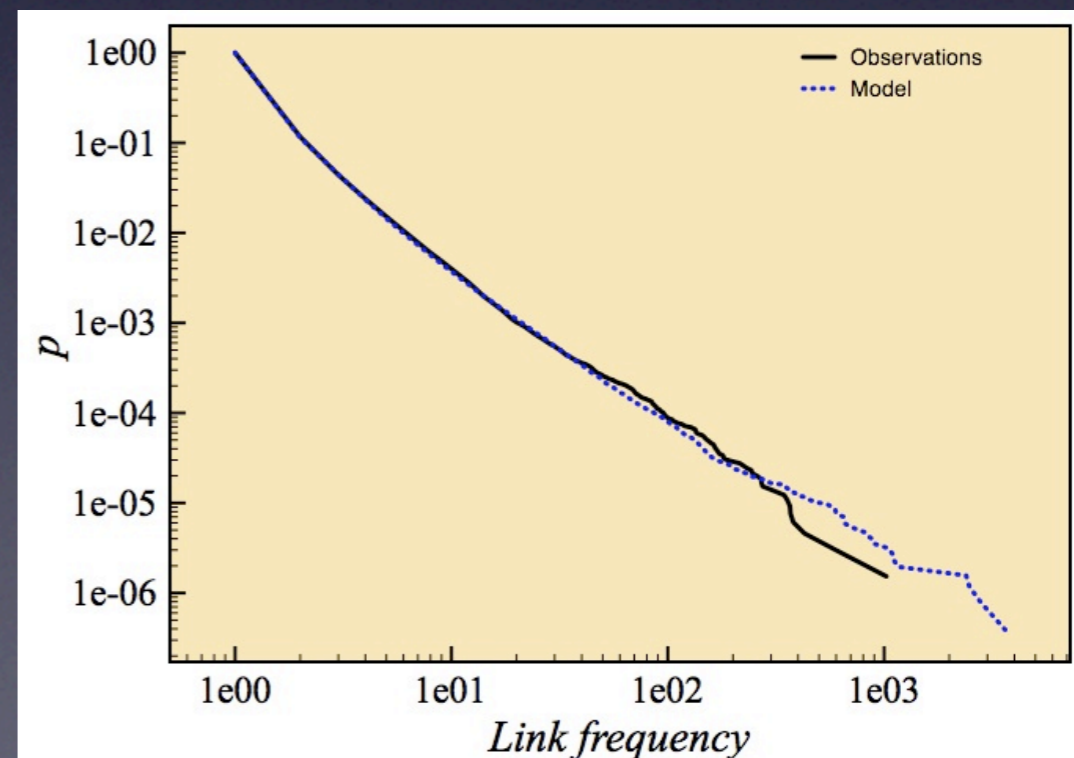
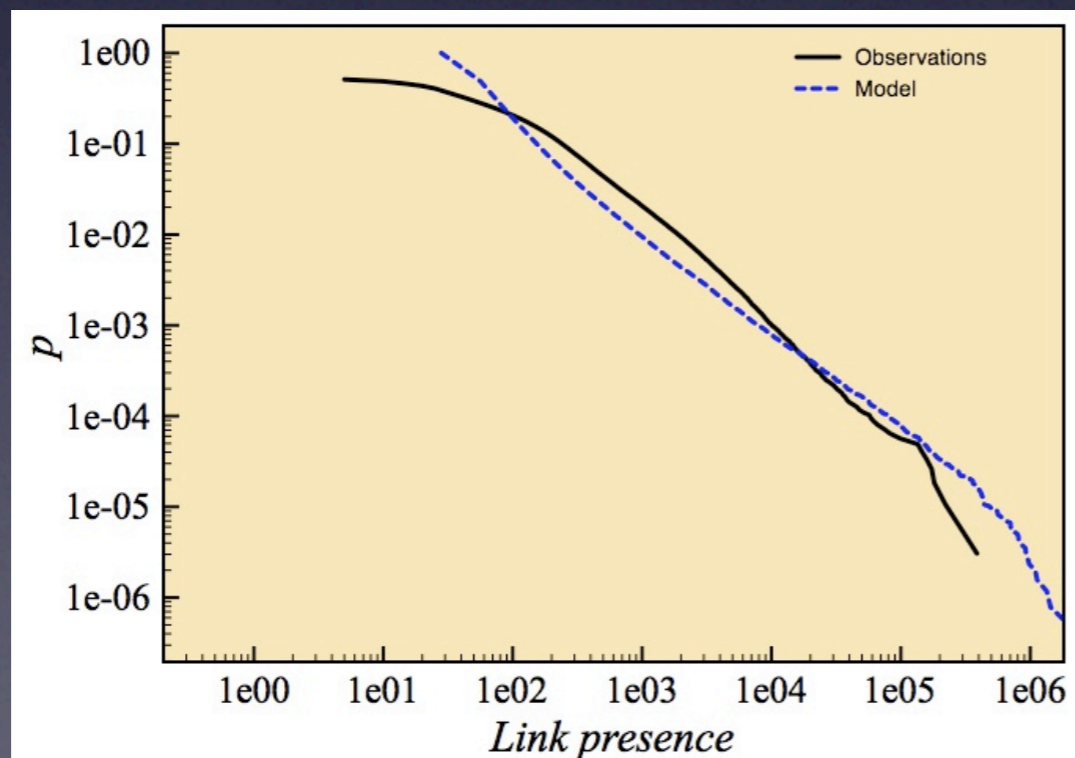
Presence

Frequency

Nodes

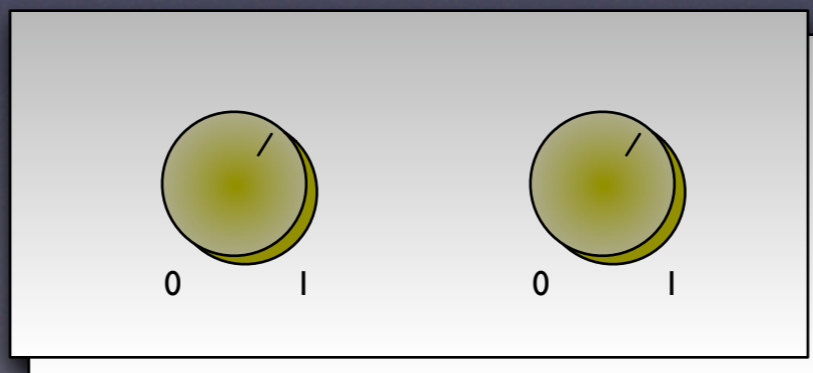


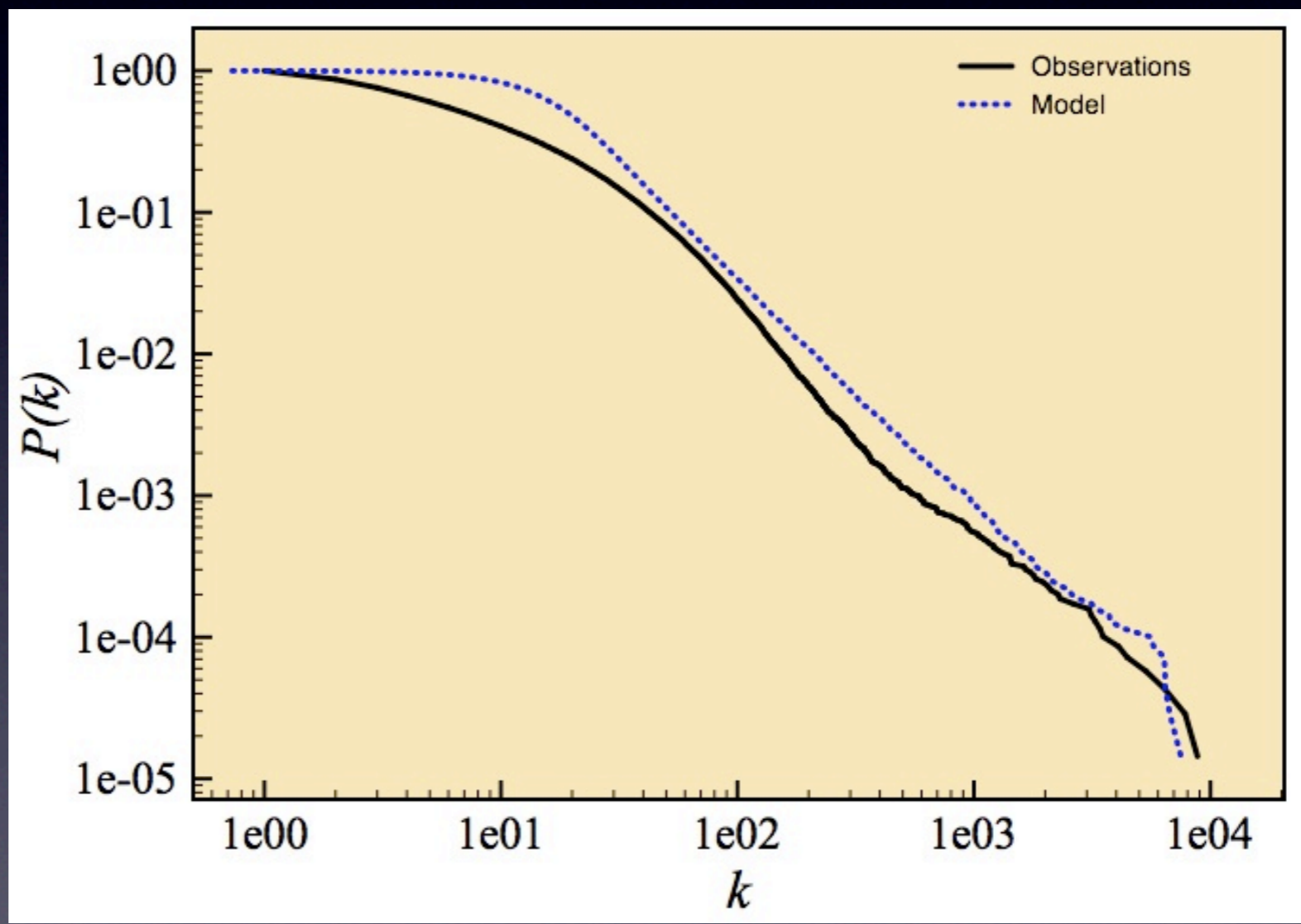
Links



Model

- Fixed population size n
- Each node assigned probability f and p
- At each iteration, node is activated with probability f
- If a node is activated, it remains active for p times length of previous inactivity
- If two nodes are simultaneously active, they are linked to each other





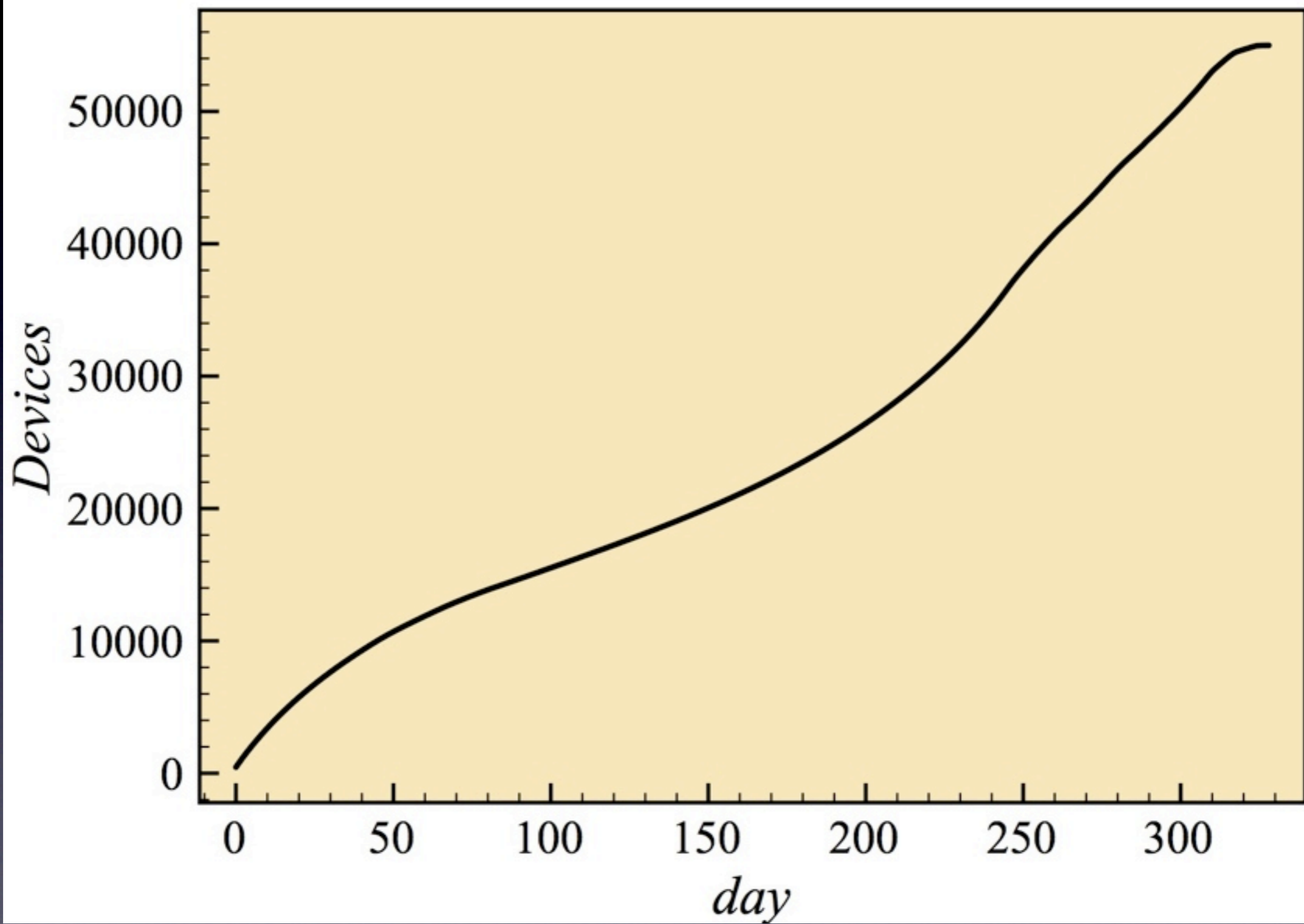
Diffusion

Chain of events

- John, Mary, 14:20:30
- John, Paul, 14:20:32
- Mary, Nick, 14:20:33
- ...

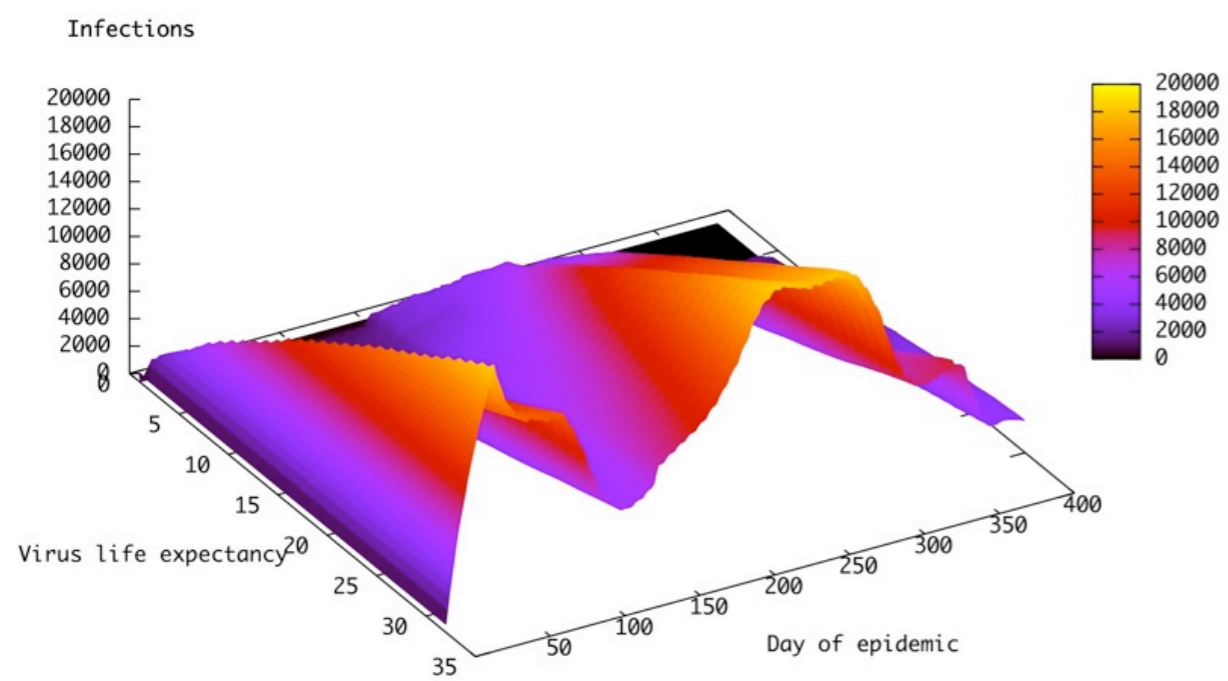
Emulation

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

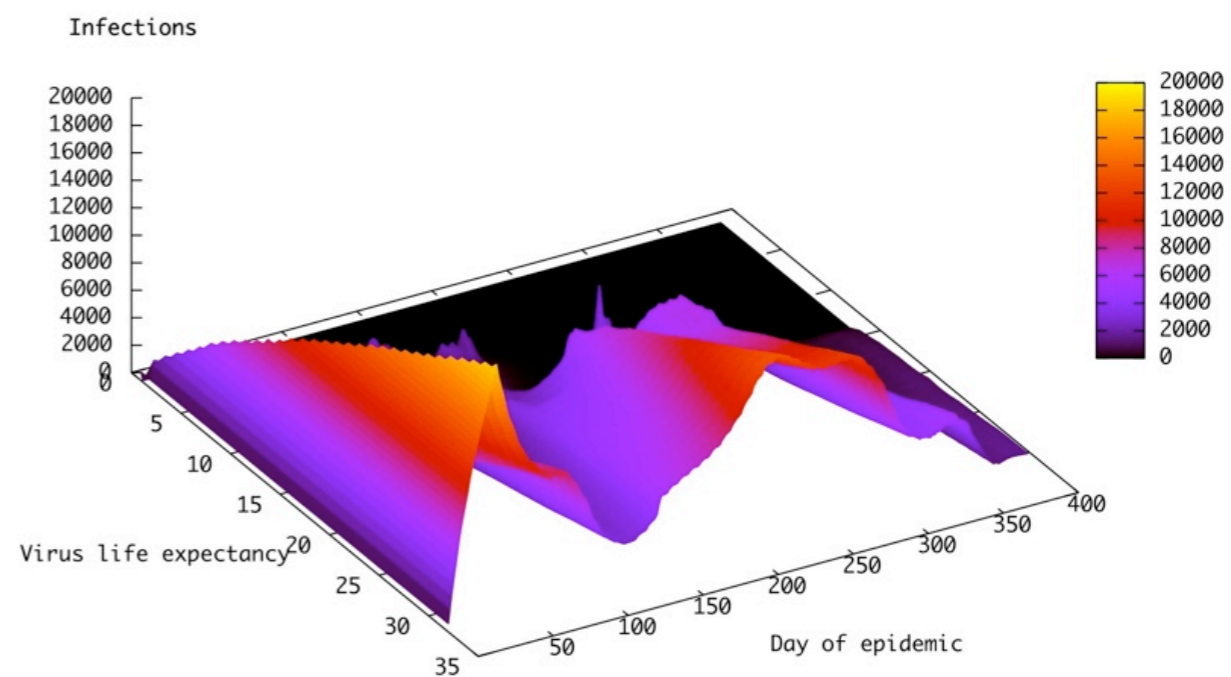


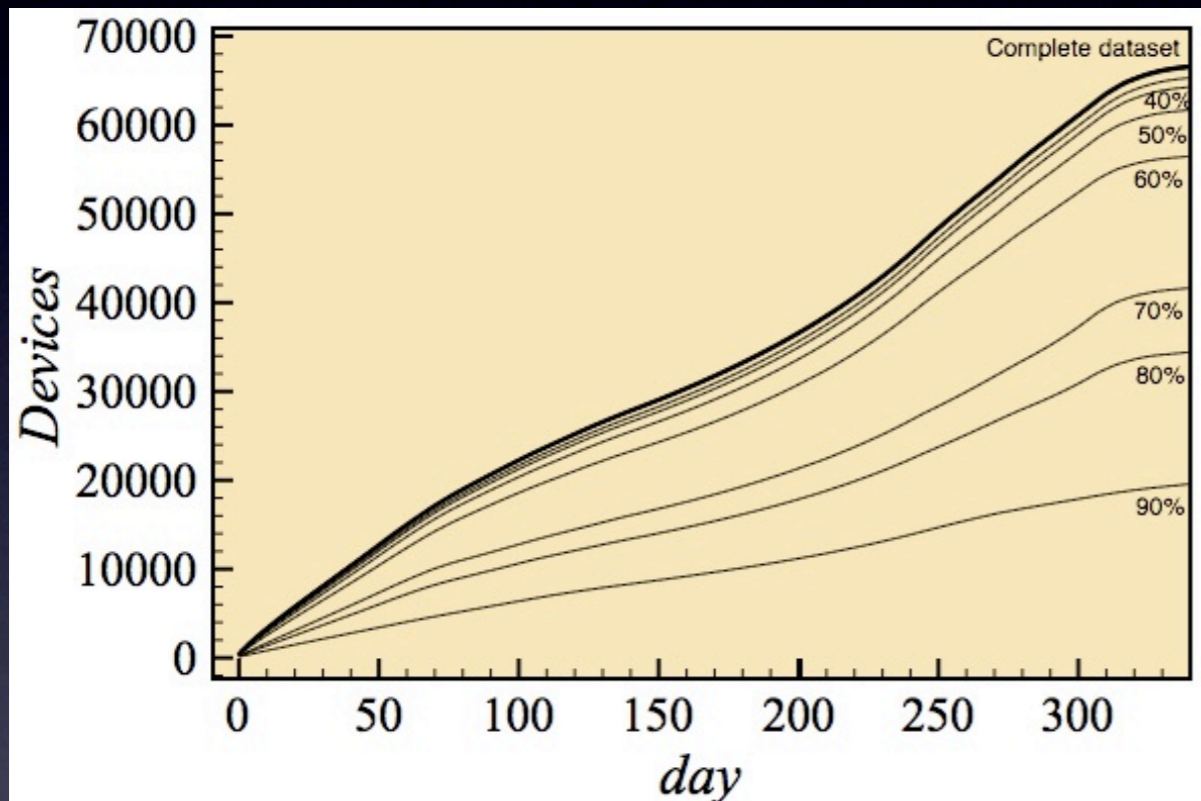
0 20 100 120 500 520 300

Virus spread - bath_sis.txt

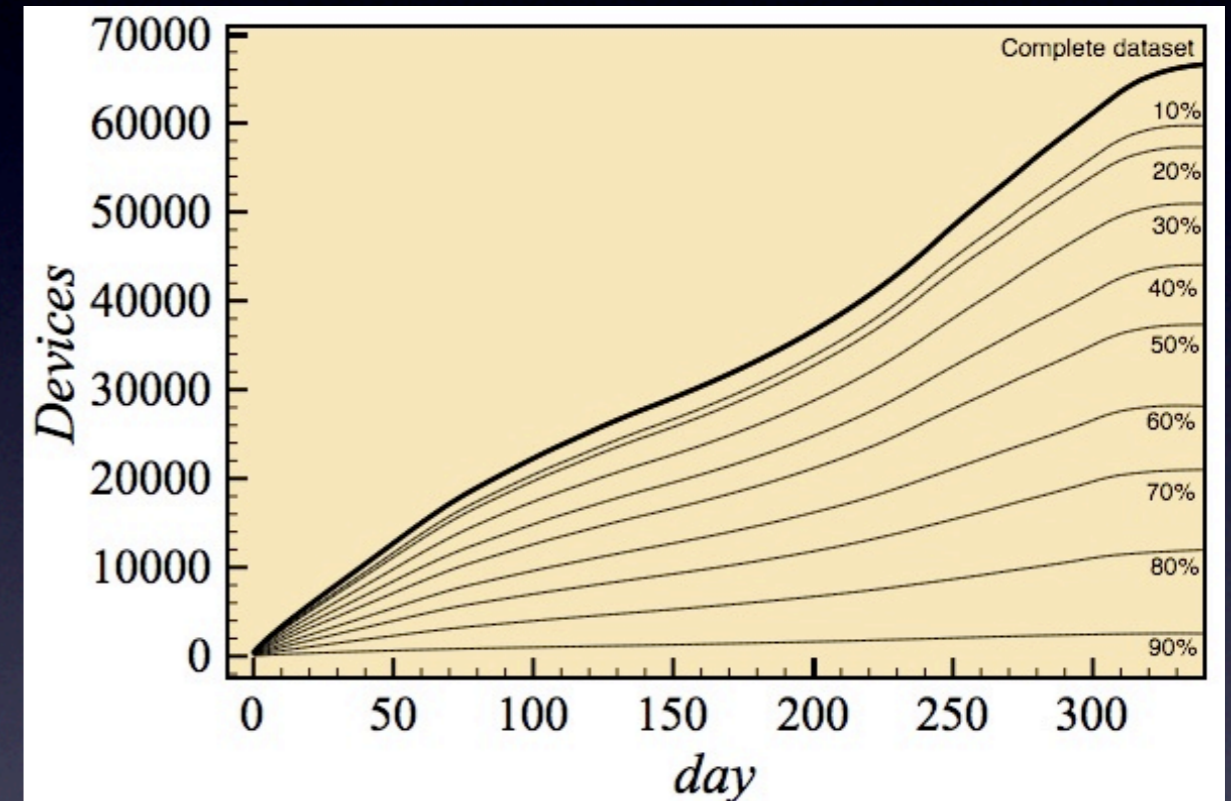


Virus spread - bath_sir.txt





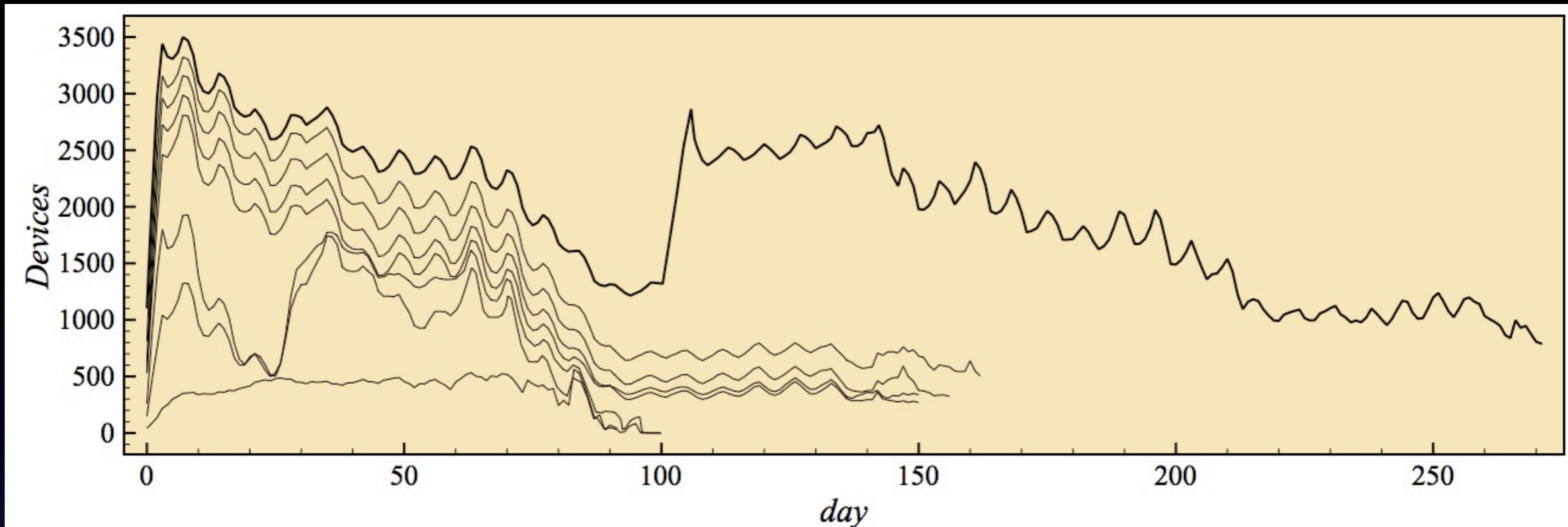
Remove
Persistent Encounters



Remove
Brief Encounters

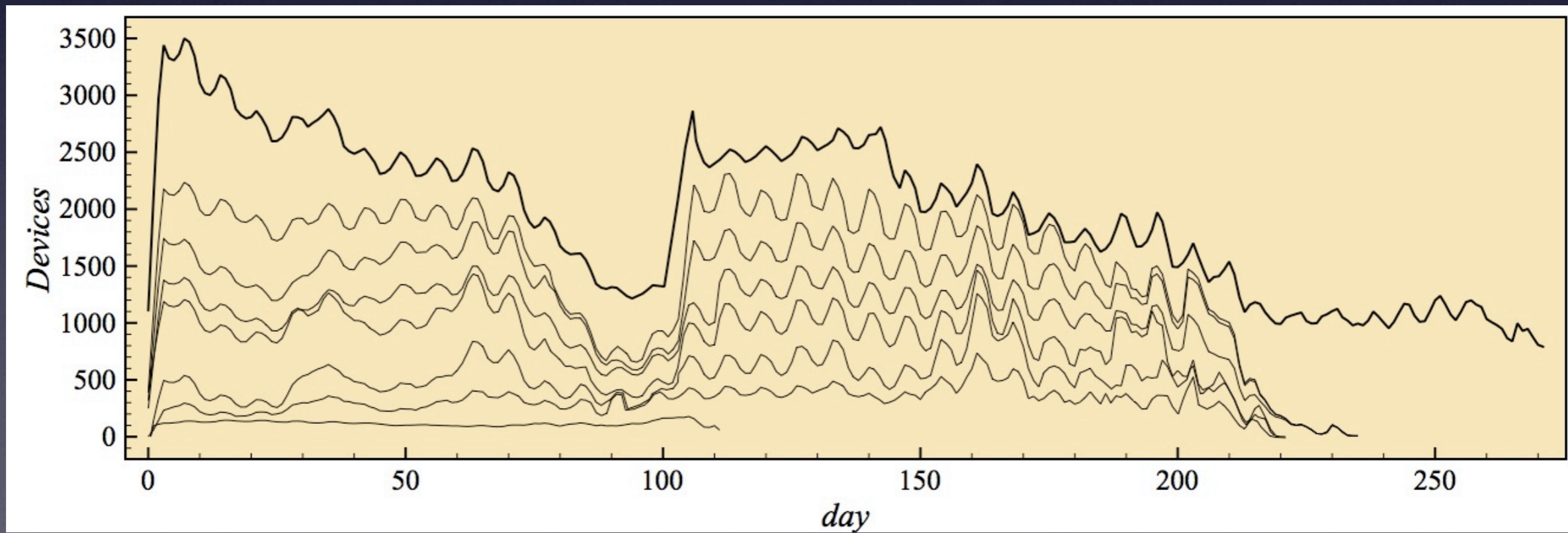
Remove

Persistent Encounters



Remove

Brief Encounters

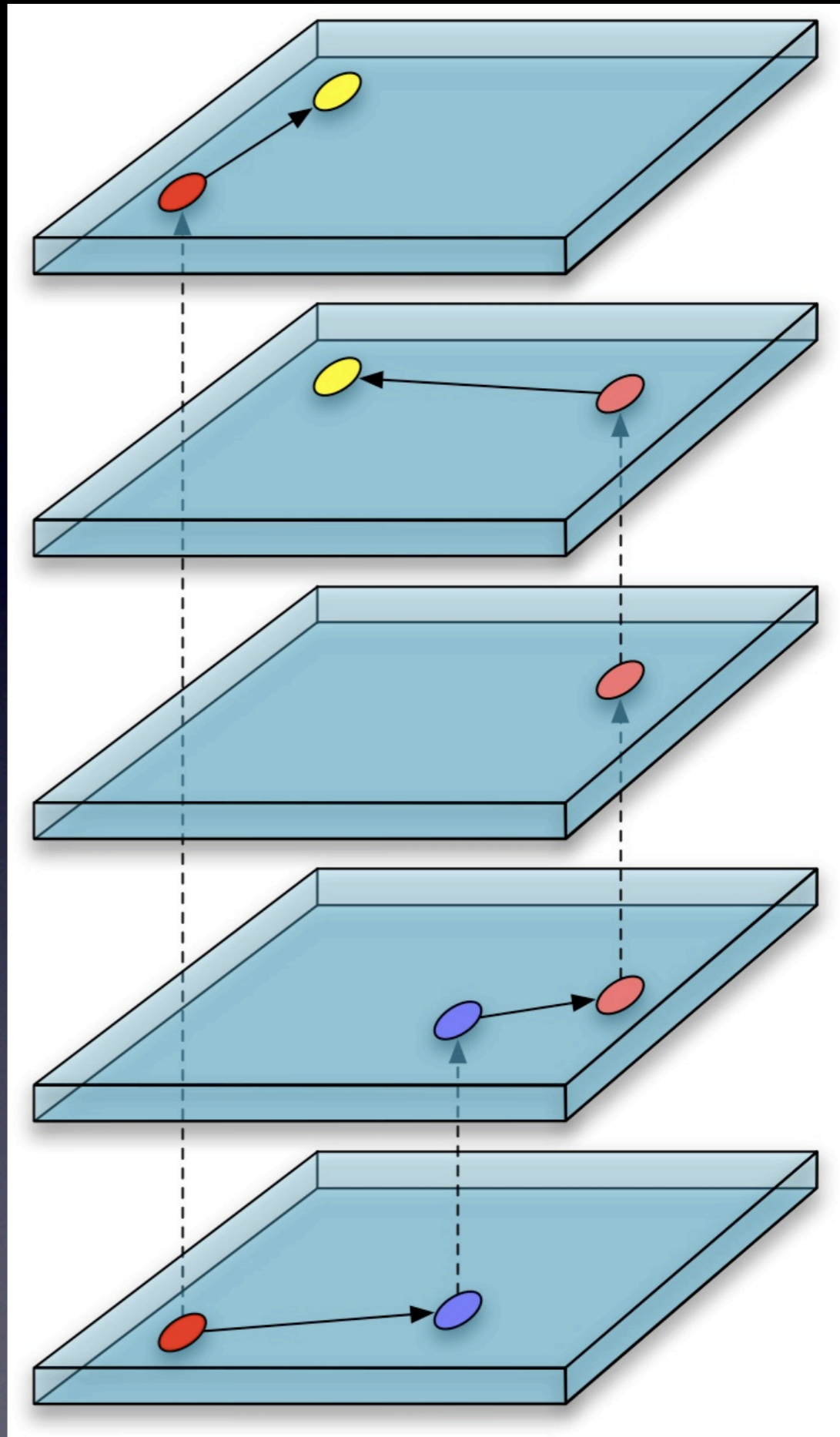


Ongoing work

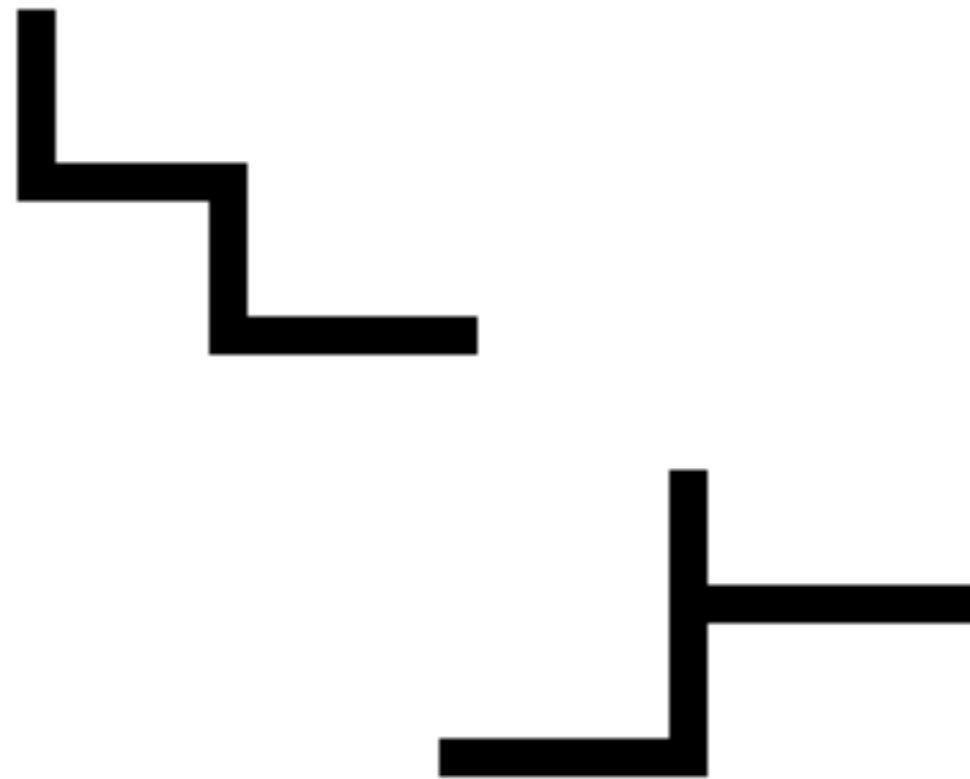
DTN forwarding algorithm

- Static features
 - Node degree
 - Node betweenness
 - Node closeness
 - Average geodesic path (Bath = 3.3)
 - Community detection (21 using Newman)

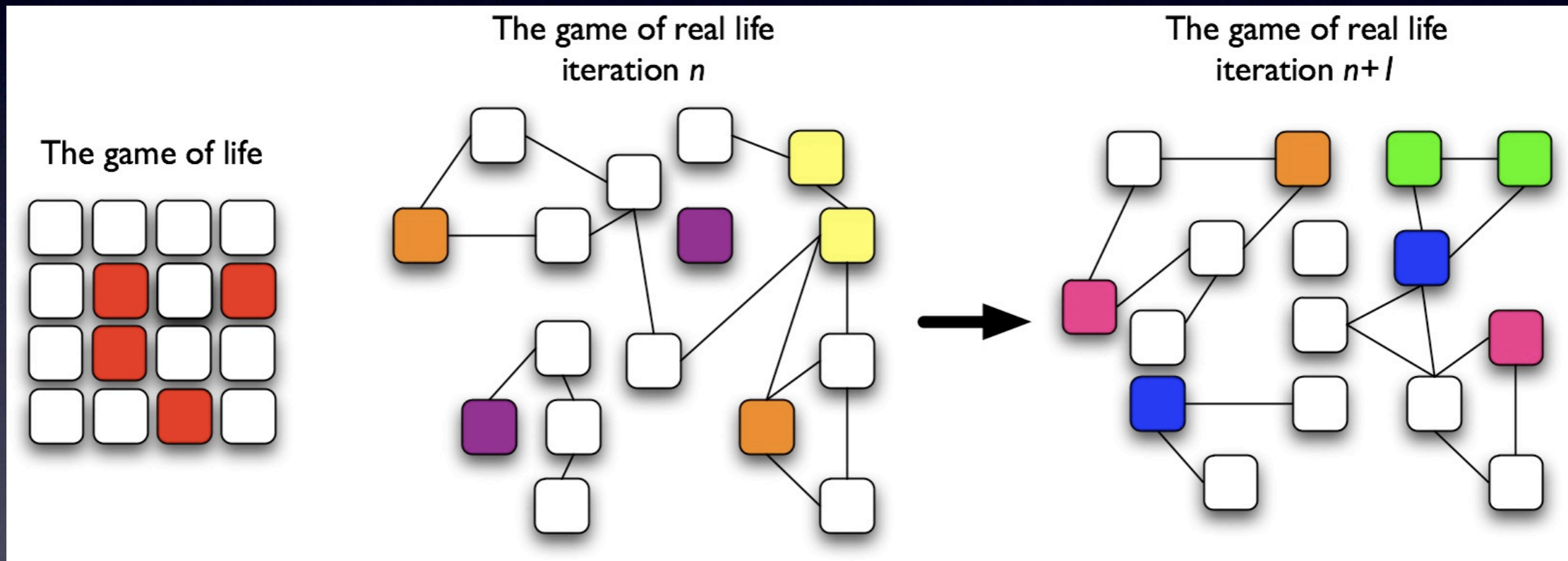
Considering time



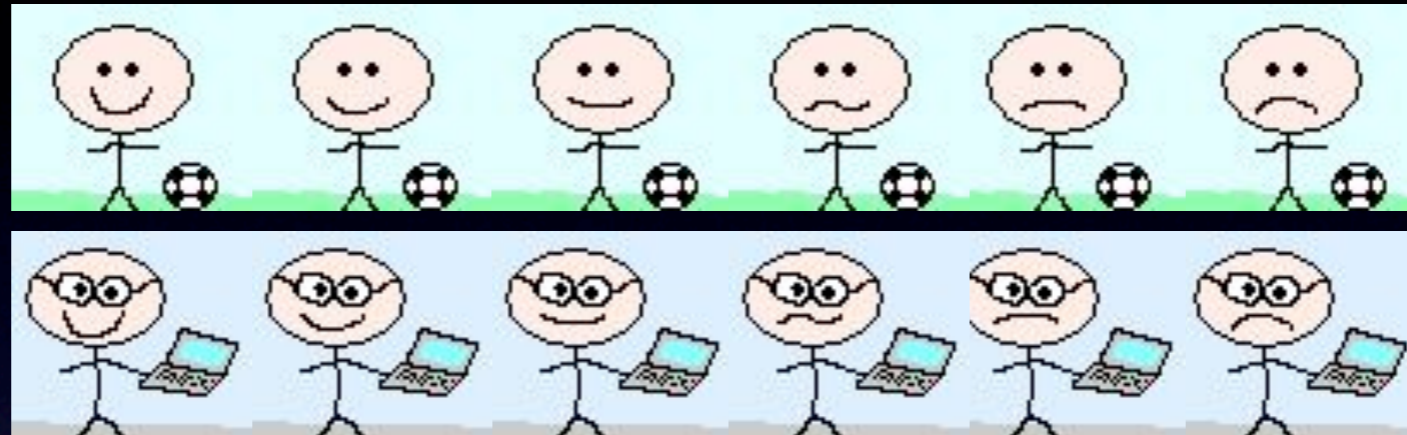
Generation: 1 Creatures: 41



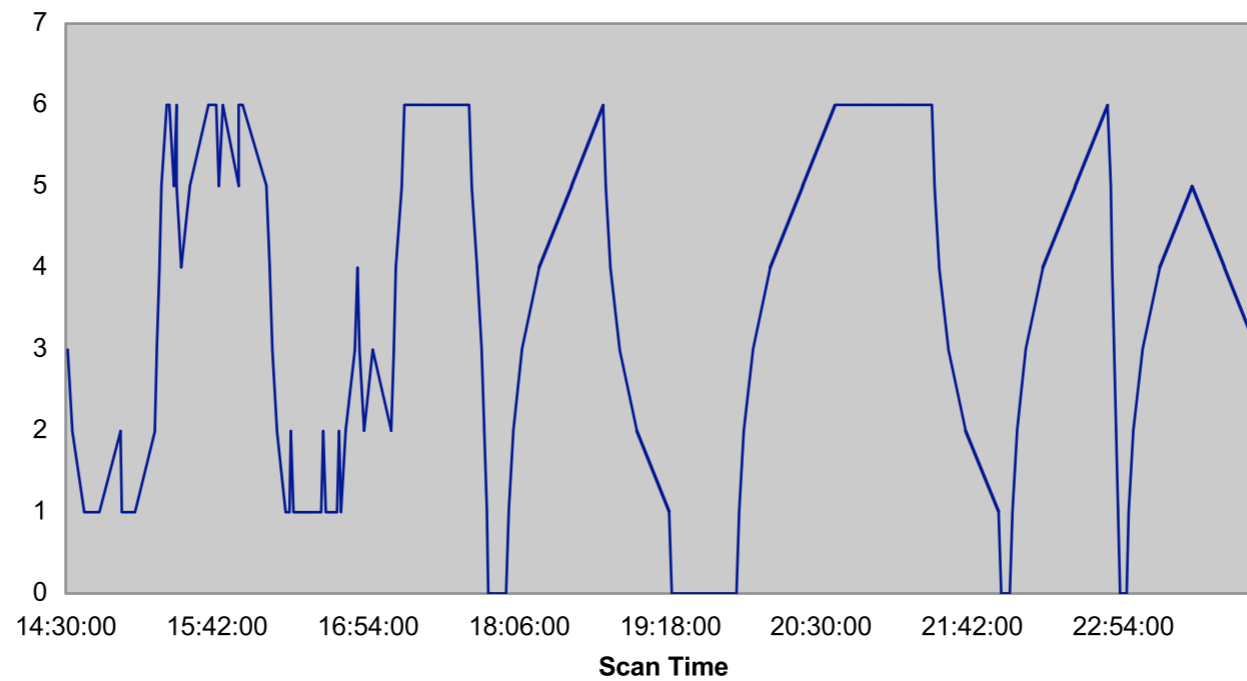
Game of real life

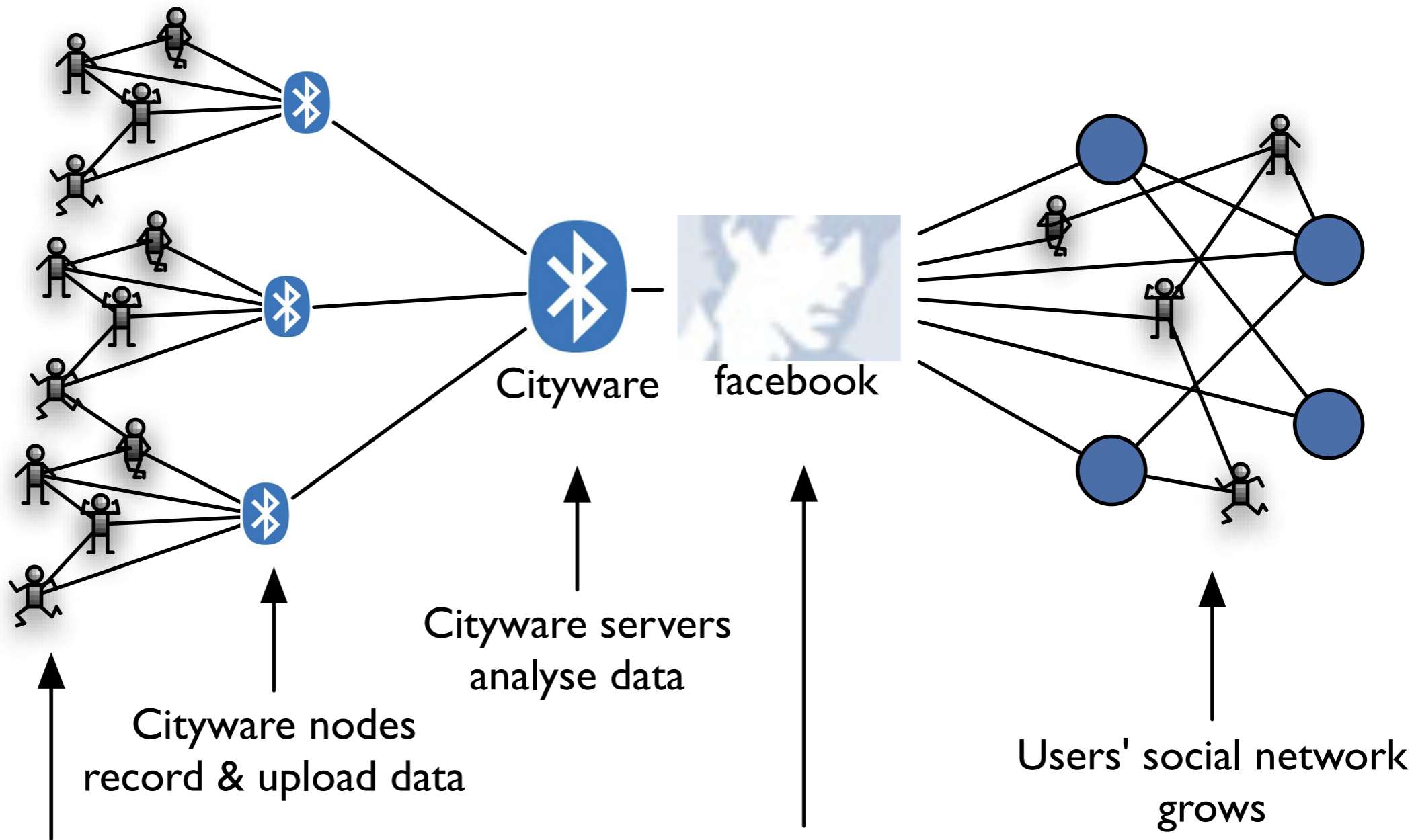


Tamagotchi



Mobile Interactions (Day 3)

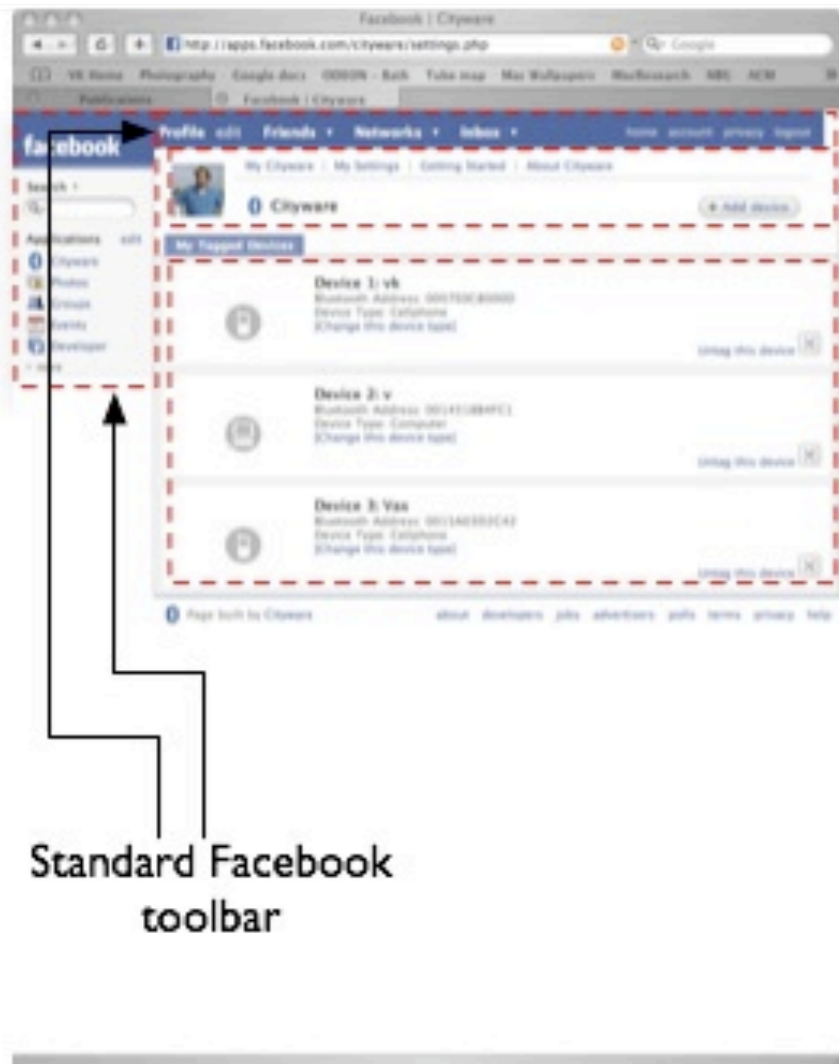




People with Bluetooth devices bumping into each other (shopping, school, work)

Facebook application presents data

Users' social network grows



Standard Facebook toolbar

Cityware toolbar

Bluetooth devices linked to a user's profile

Encounters grouped by recency, duration, frequency

Encounter with a device linked to a profile

Encounter with an unknown device




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Bluetooth helps Facebook friends

A team of UK researchers is combining the power of social network Facebook with communications tool Bluetooth to learn more about human interactions.

Bath University scientists have created a tool which can use the unique ID of Bluetooth devices, like a mobile phone, to build new friendship networks.

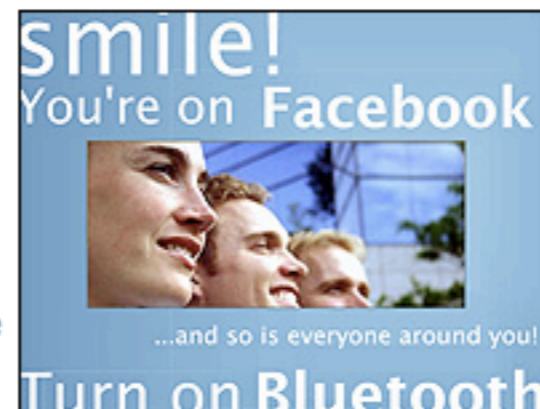
Users register with the Facebook tool, called Cityware, that tracks encounters in the real world via Bluetooth.

It is part of a wider project backed by Nokia, HP Labs and Vodafone.

Dr Vassilis Kostakos, research associate at the University of Bath, said: "Networks are everywhere - social and digital.

"The really nice thing about Bluetooth is that when you are walking down the street, although you are not talking to anyone, your Bluetooth device can be talking to other devices.

"People with Bluetooth devices are actually creating an ad hoc communications infrastructure where information can



Cityware nodes have been set up in Bath and London

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New challenges

- Best utilisation of this platform?
 - Create a “world socio-map”?
- Develop adaptable systems
- Develop more secure systems
- Put numbers on human relationships
- Put numbers on “fabric of everyday life”

The top of the slide features a banner image. On the left, the 'cityware' logo is displayed in a white, lowercase, sans-serif font. Below it, the tagline 'urban design & pervasive systems' is written in a smaller, white, lowercase font. The background of the banner is a warm, golden sunset or sunrise over a city skyline, with silhouettes of three people standing on a balcony or bridge in the foreground, looking out at the view.

cityware

urban design & pervasive systems

Thank you

Vassilis Kostakos
vk @ cs. bath. ac. uk

<http://www.cityware.org.uk>