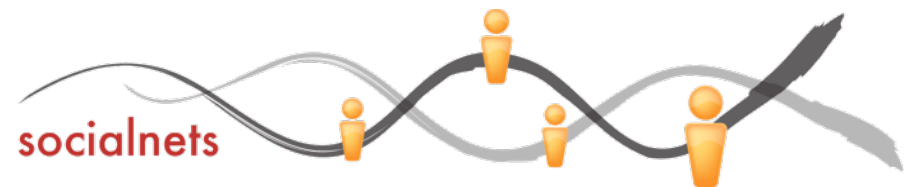


Matt Williams

CS&I Research Retreat
May 2011



Periodic Patterns in Human Encounters

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CS&I Research Retreat
May 2011

Human encounters



Why study human encounters?



opportunistic content sharing



virus spreading patterns

Periodicity and patterns in human encounters



Research questions

- How prevalent are periodic encounter patterns in human networks?
- How does the presence of periodic encounters affect information flow?
- Can periodic patterns be detected and used to improve content sharing in opportunistic networks?

How do we study human encounters?



Smartphone Bluetooth
encounters
(@MIT)



WiFi access point **visits**
(@Dartmouth Campus)



Foursquare venue **visits**
(@Cardiff +others)

How do we study human encounters?



Smartphone Bluetooth
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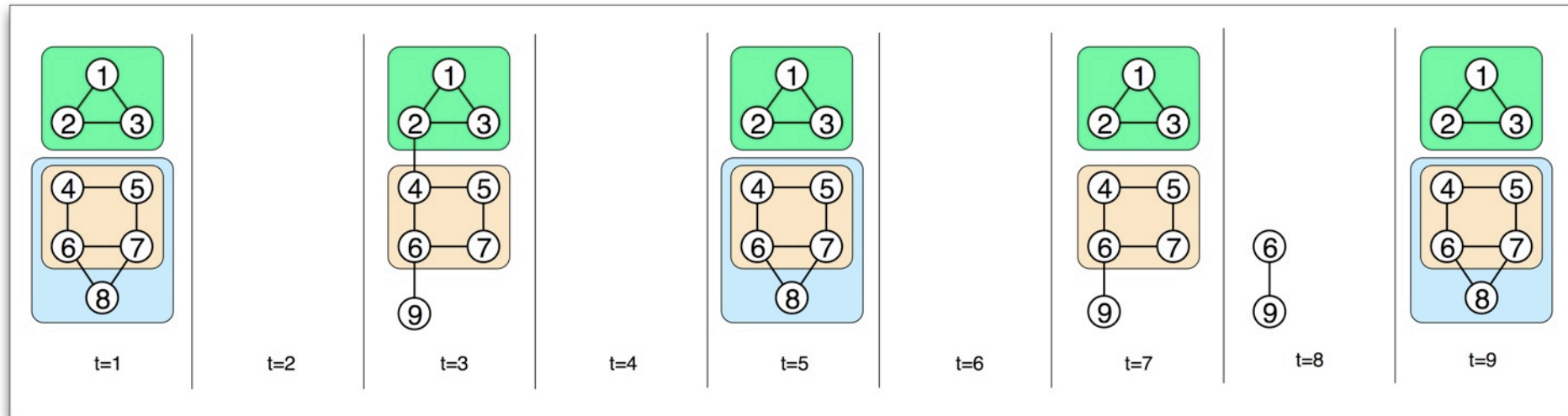


WiFi access point **visits**
(@Dartmouth Campus)



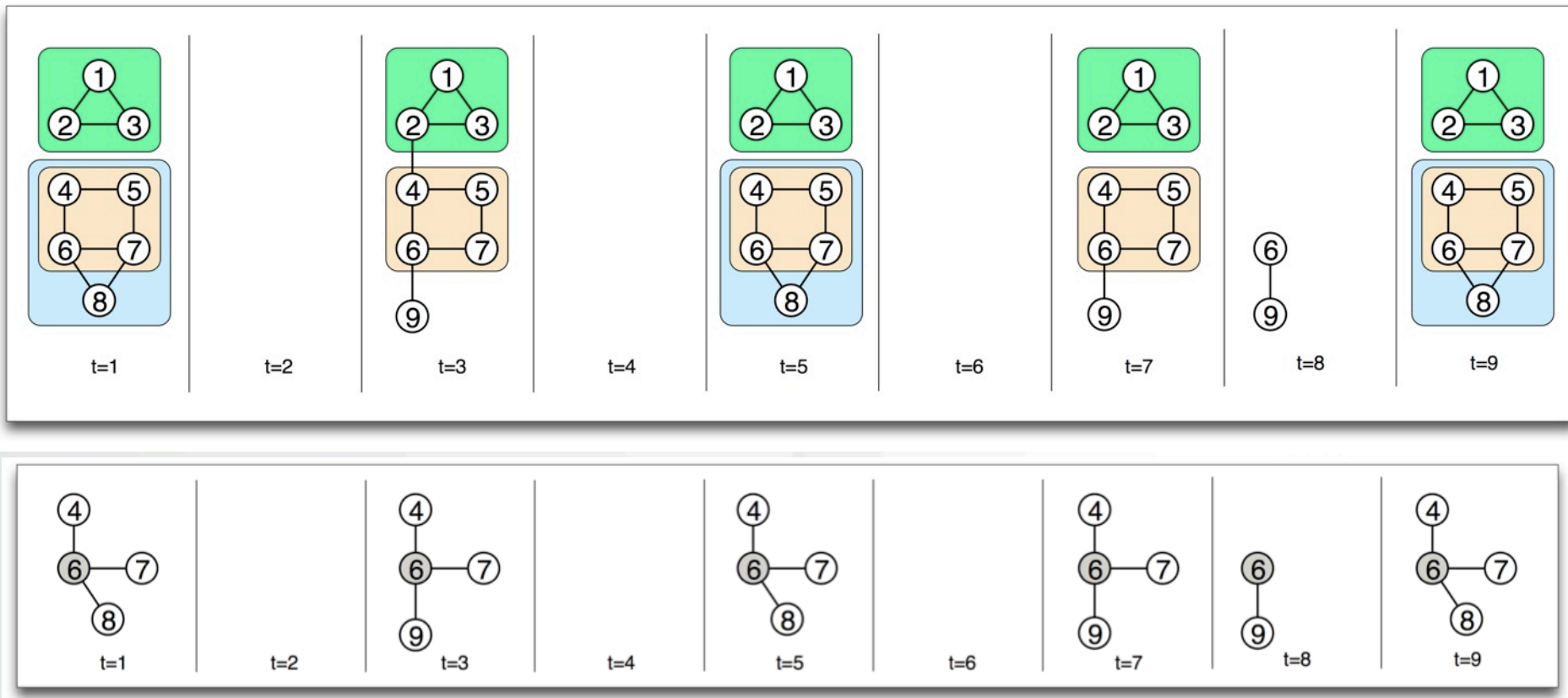
Foursquare venue **visits**
(@Cardiff +others)

Periodic encounter communities (PECs)



- A group of nodes that regularly encounter one another with a given period

Detecting PECs in OppNets



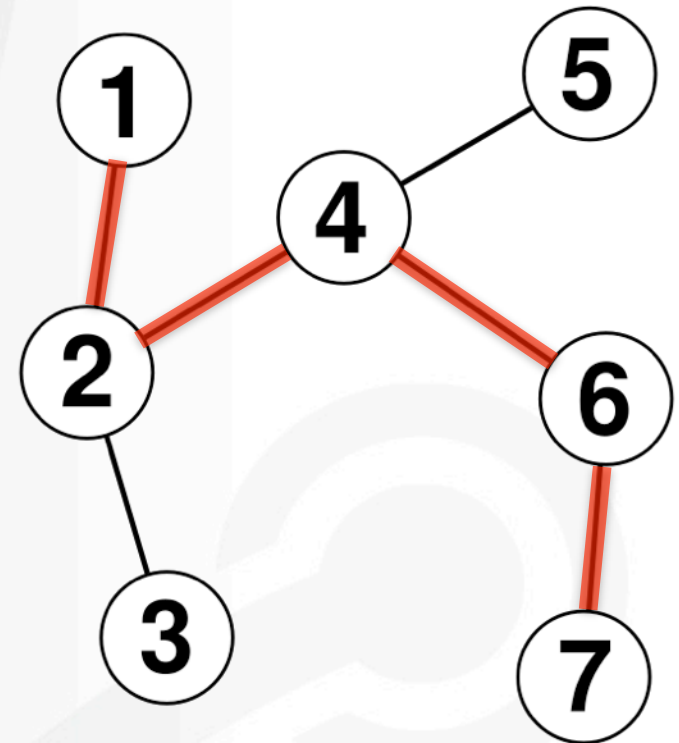
- In opportunistic networks, a **decentralised algorithm** is needed

Detecting PECs in OppNets

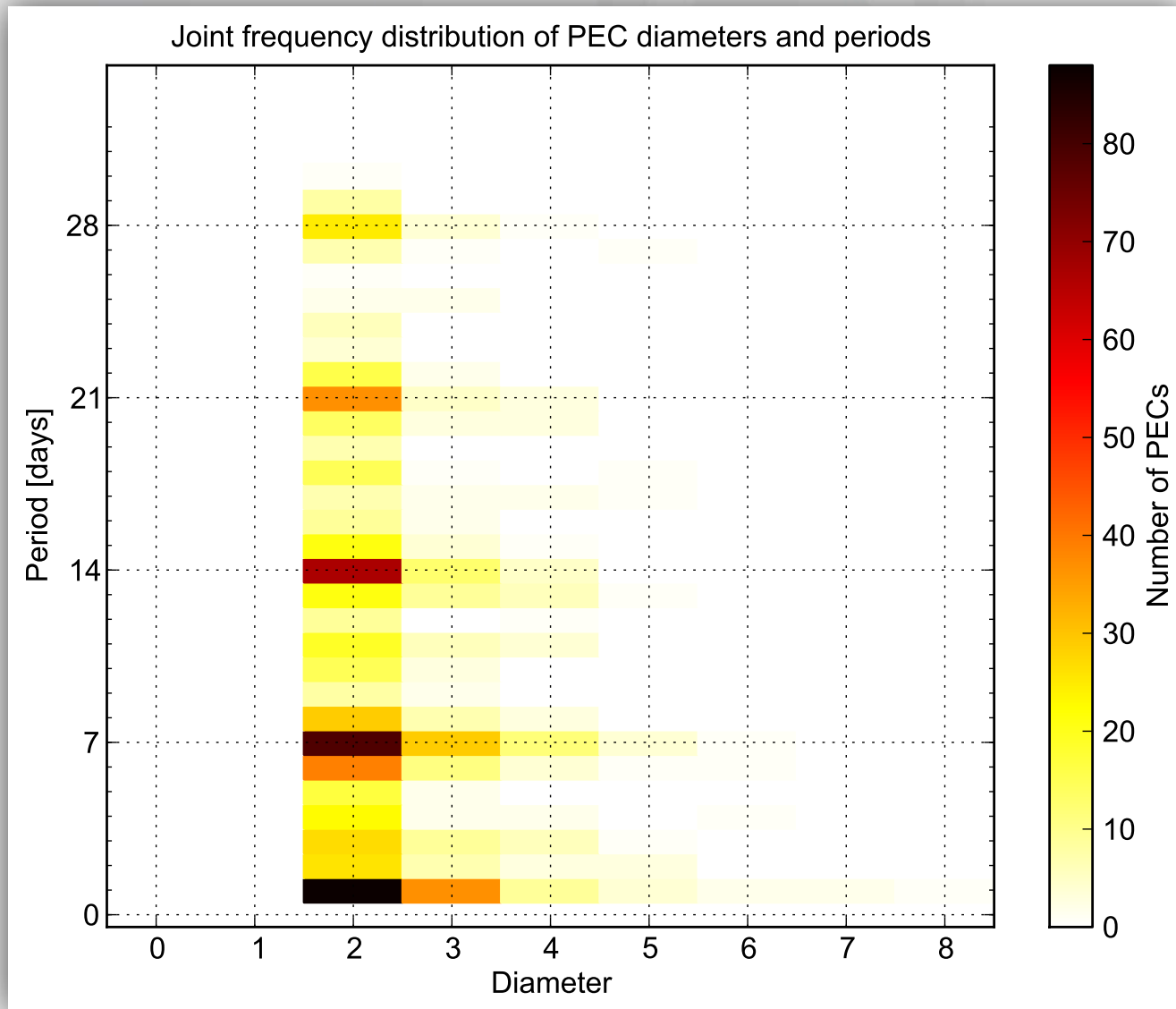


Properties of PECs

- **Period:** the gap between reappearances of the community (24 hrs, 7 days, etc.)
- **Diameter:** the distance between the most distant nodes in the community

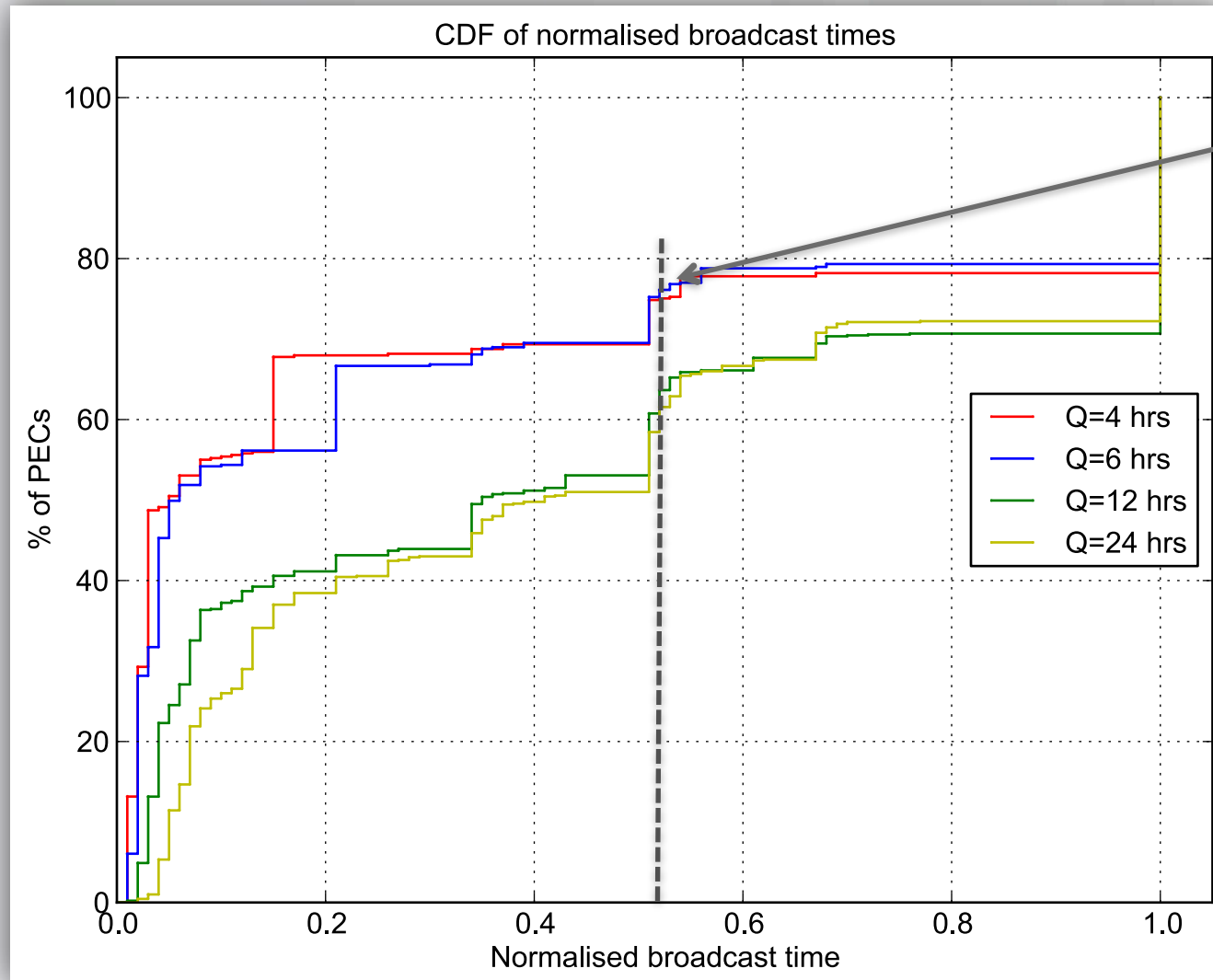


diameter = 4



Information sharing

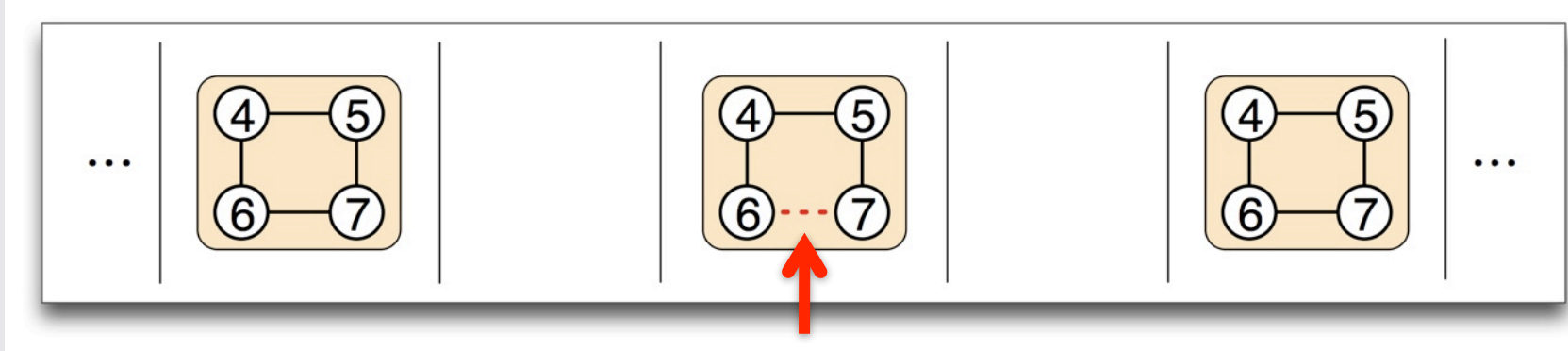
- **Diameter** and **period** give us a **theoretical** worst-case for the time needed for all nodes to send messages to each other
- In **practice**, how does information sharing compare to the worst-case?



in 75% of PECs,
information sharing
took less than 1/2 the
worst-case time

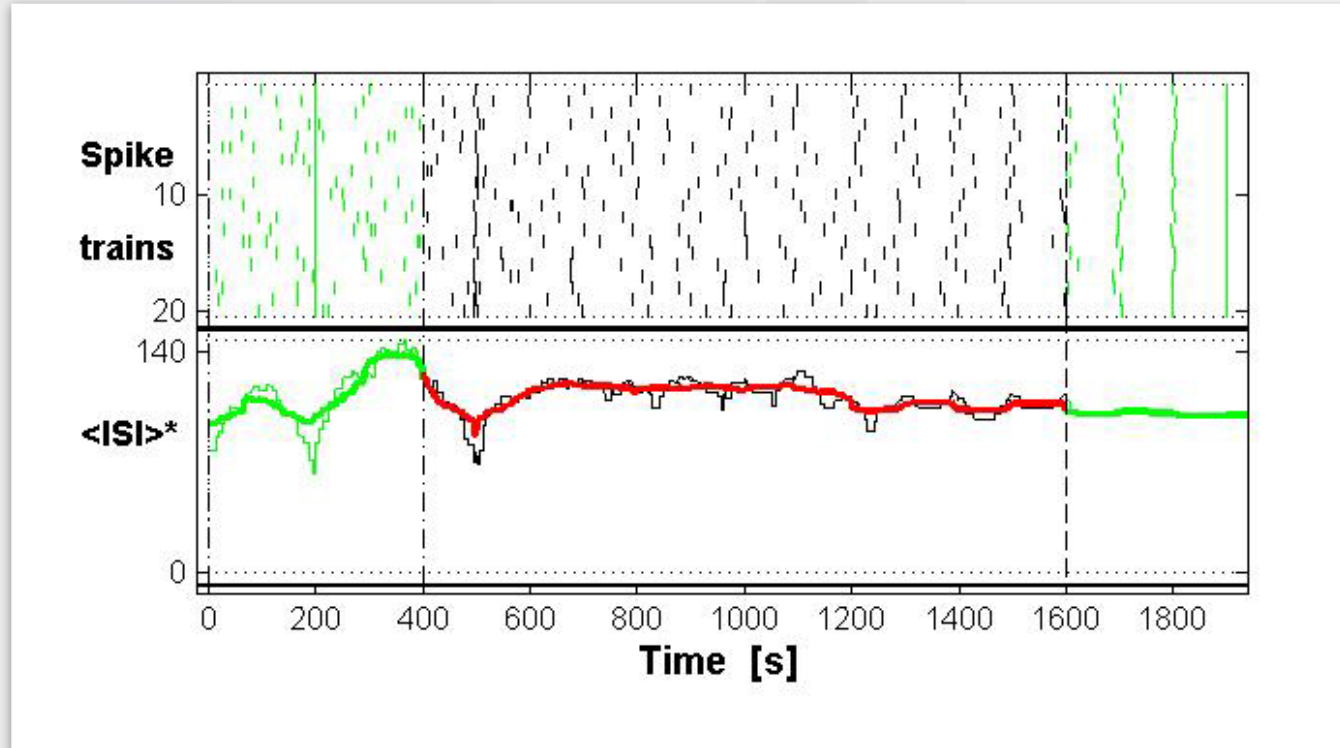
Limitations

- PEC detection relies on a crisp definition
- Inherent **uncertainty** in encounter times poses a problem



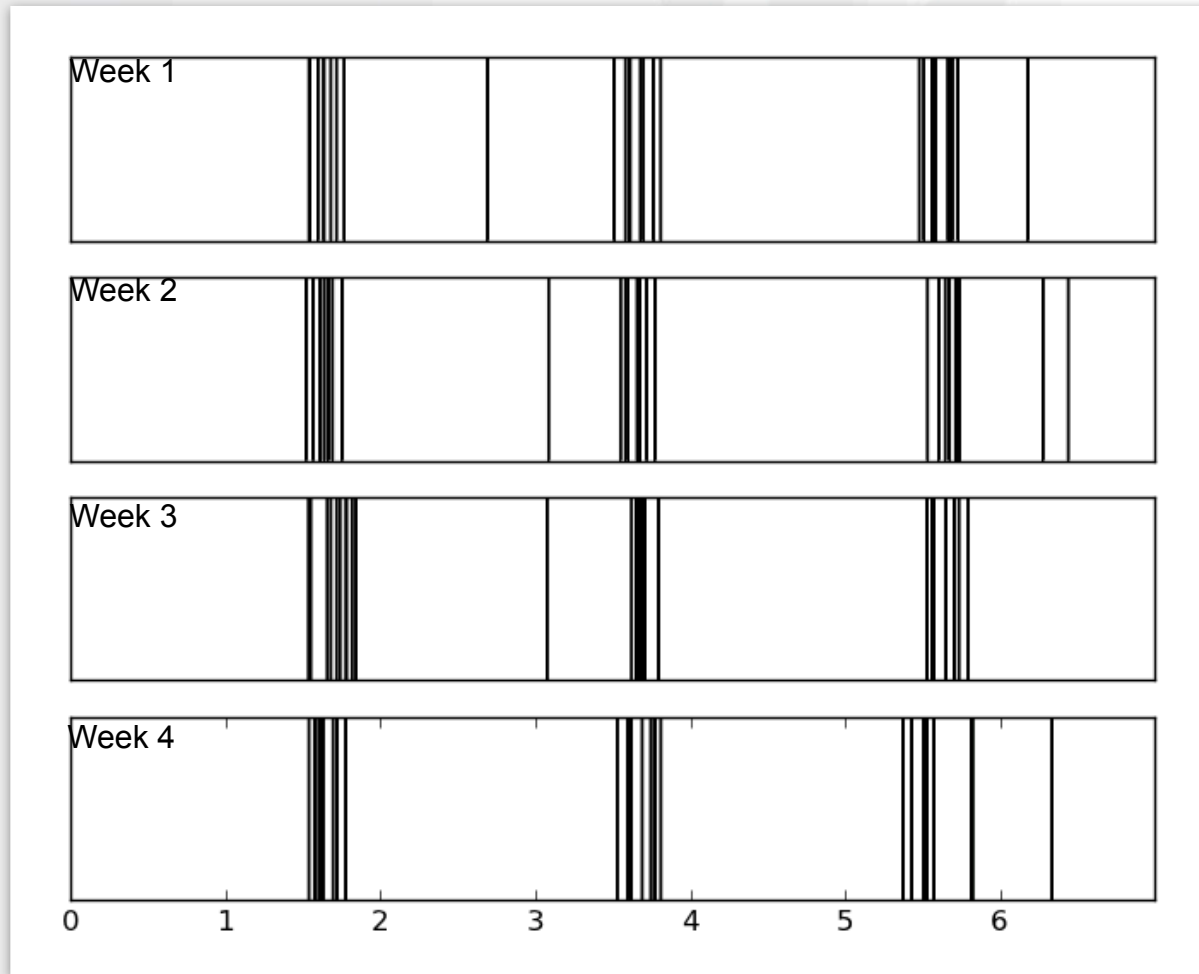
Ongoing work: spike train methods

- Dealing with **fuzziness**: borrow a technique from neuroscience!
- Spike train **synchrony**: measures the similarity of bursting patterns of neurons

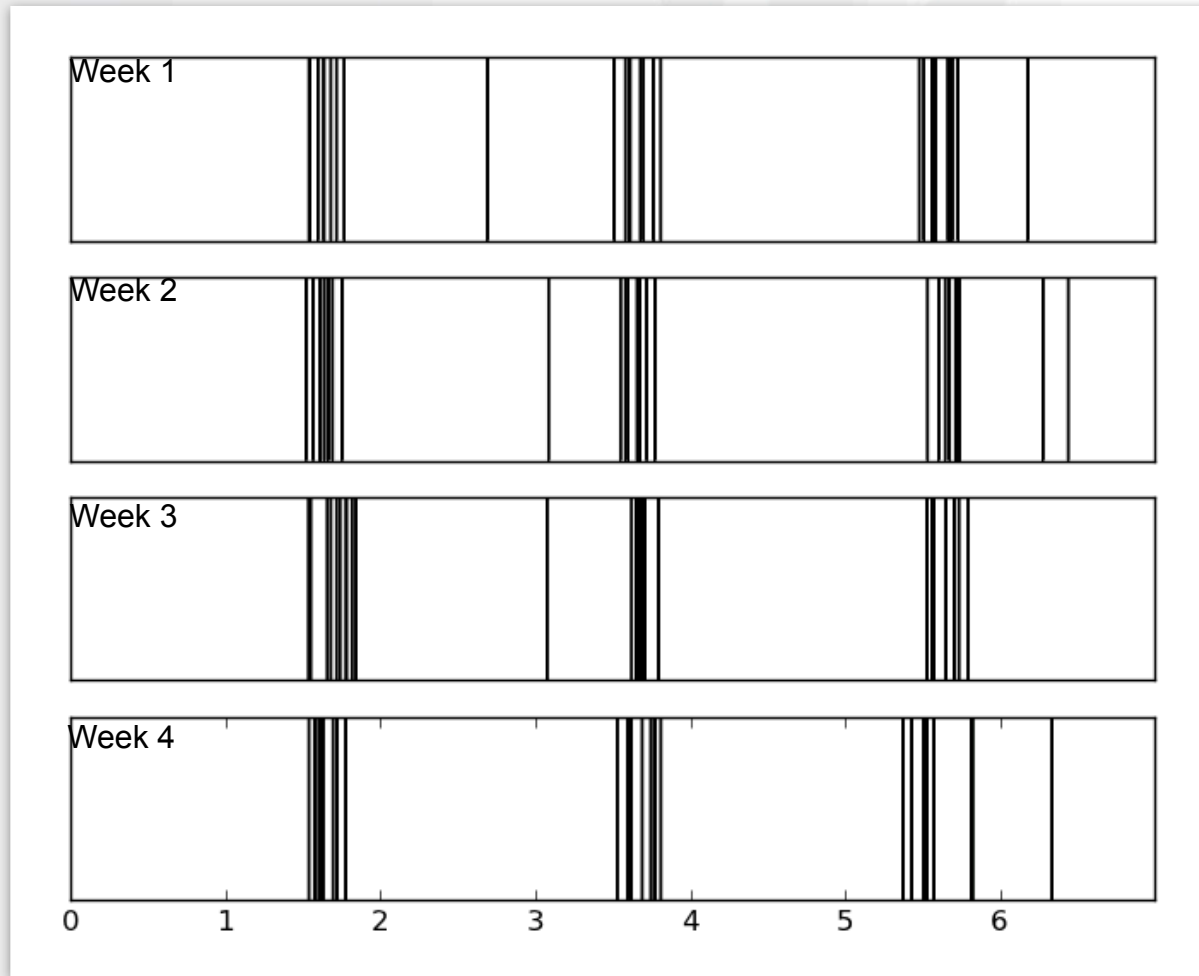


Kreuz et al. 2009

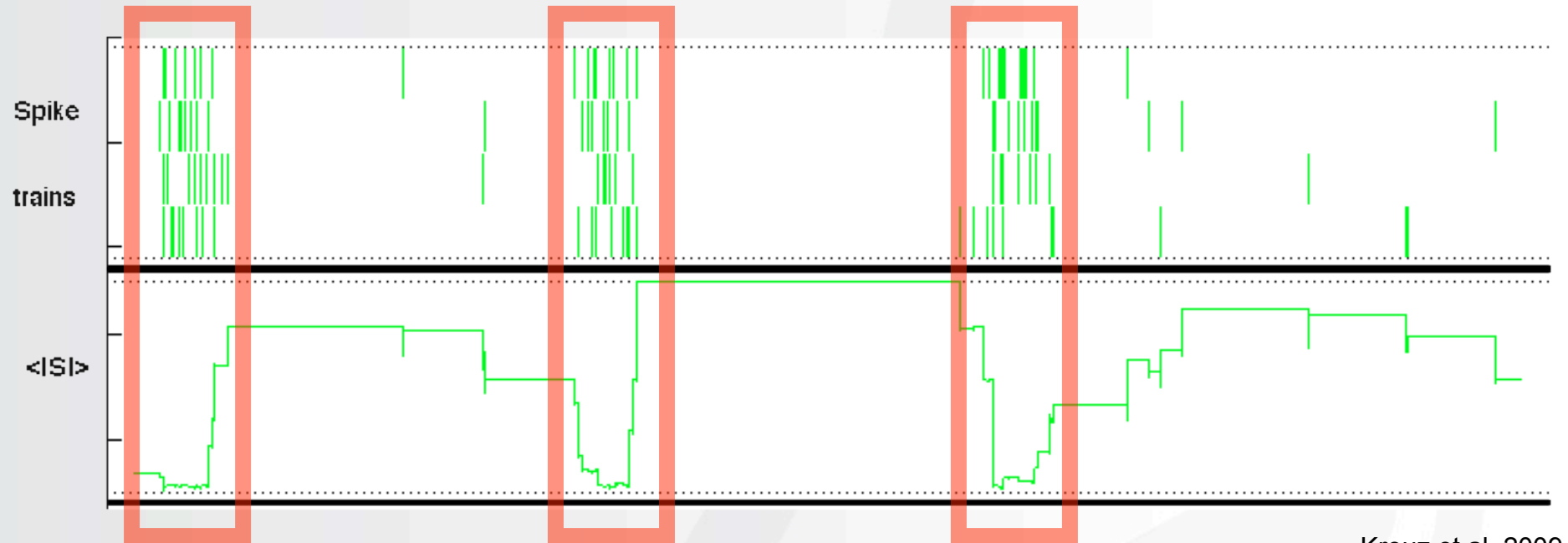
Human encounter 'trains'



Human encounter 'trains'



Regions of regularity



Kreuz et al. 2009

Summary

- **Periodic encounter patterns** exist and can be **automatically detected**
 - Evidence that periodic encounter patterns influence **information flows** in **human encounter networks**
 - **Spike train methods** are a promising solution for the detection of '**fuzzy**' encounter patterns
- Thanks for listening!

References

- M.J. Williams, R.M. Whitaker, S.M. Allen, *Decentralised detection of periodic encounter communities in opportunistic networks*, Ad Hoc Networks, 10.1016/j.adhoc.2011.07.008.
- T. Kreuz, D. Chicharro, R. G. Andrzejak, J. S. Haas, and H. D. I. Abarbanel, *Measuring multiple spike train synchrony*, Journal of Neuroscience Methods, vol. 183, no. 2, pp. 287–299, 2009.

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