Chaotic social contagion

from zombies to hipsters

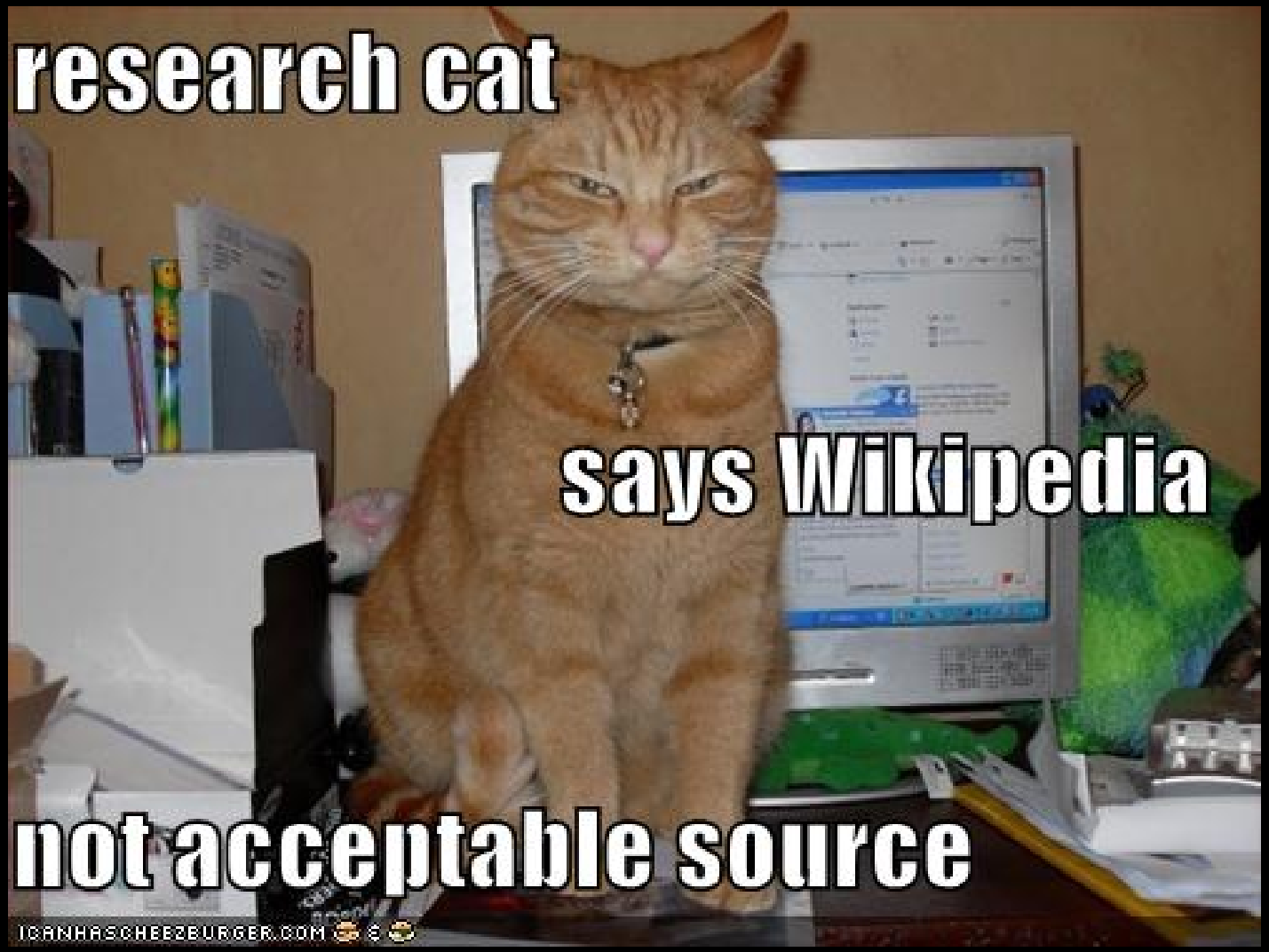
Kameron Decker Harris
with Peter Dodds and Chris Danforth

UVM Math

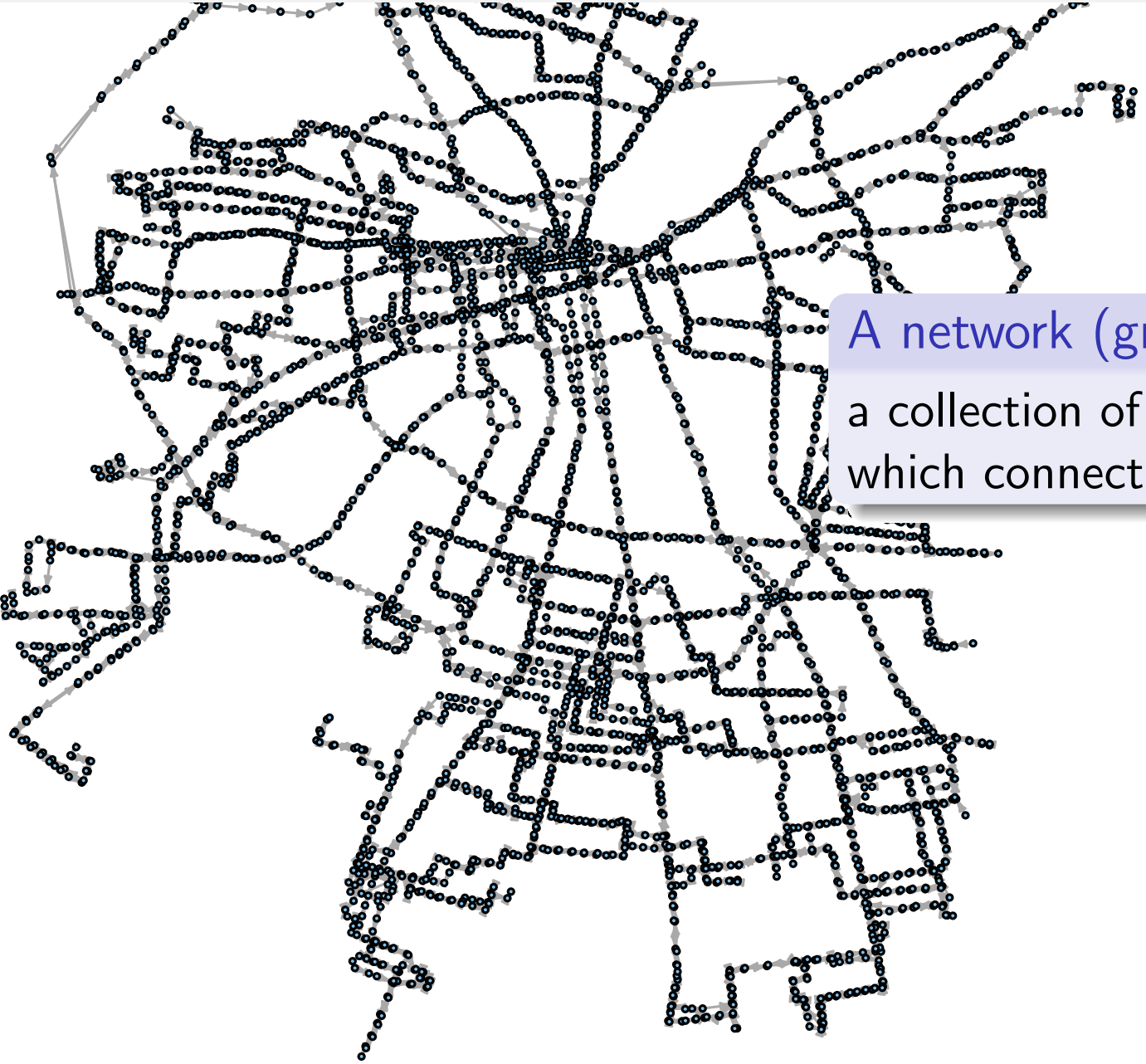
April 19, 2012

You may think

I think


research cat
says Wikipedia
not acceptable source
ICANHASCHEEZBURGER.COM

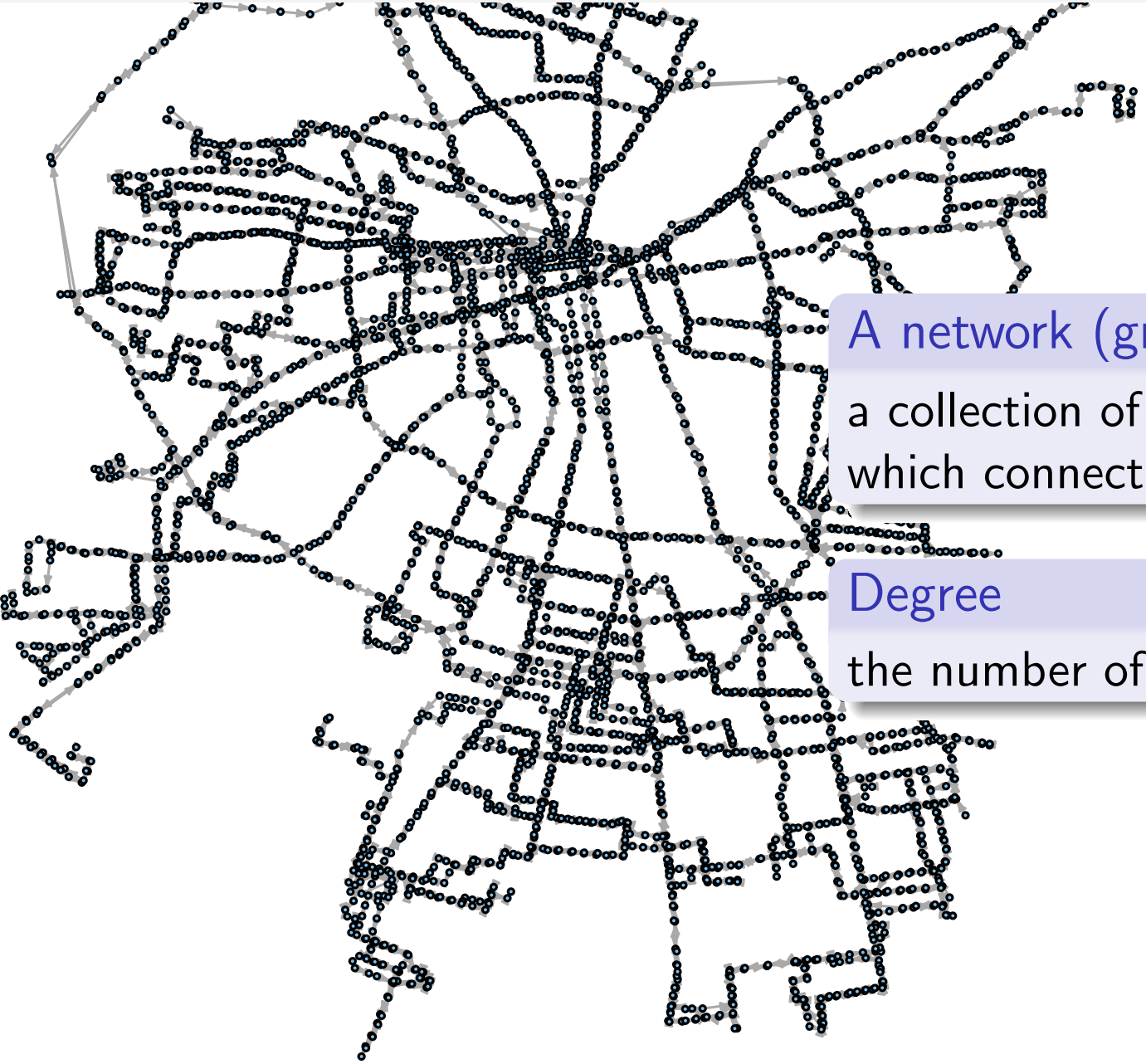
Networks: quick definitions



A network (graph) is

a collection of **nodes** and **links**, which connect the nodes.

Networks: quick definitions



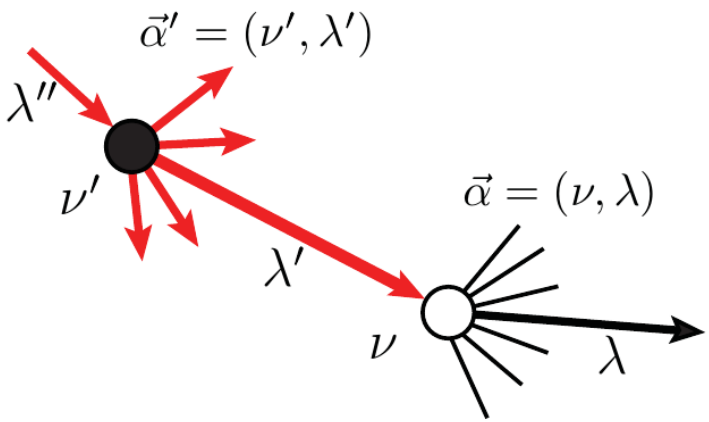
A network (graph) is

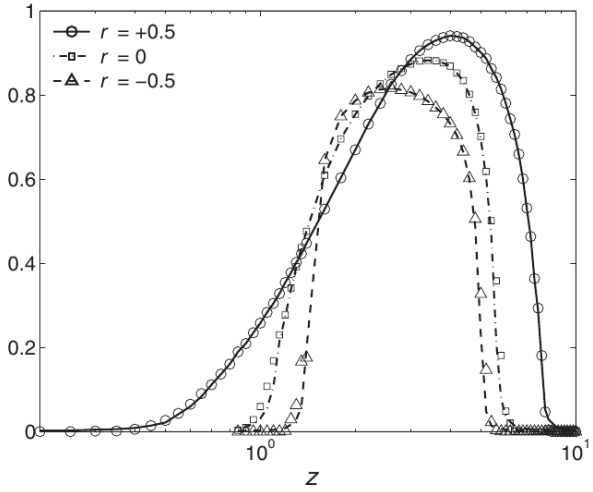
a collection of **nodes** and **links**, which connect the nodes.

Degree

the number of links incident a node

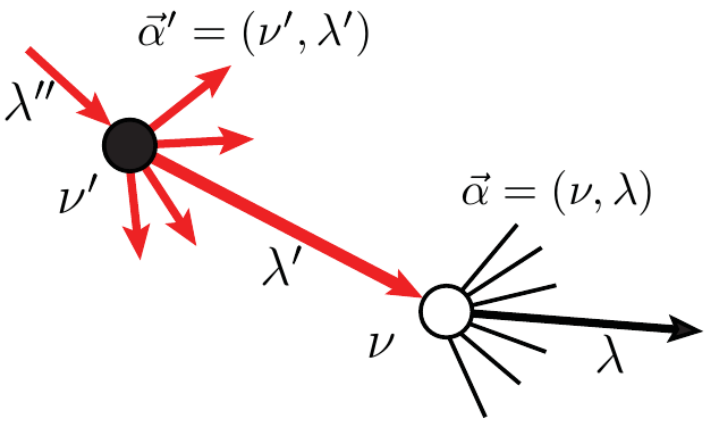
Contagion models

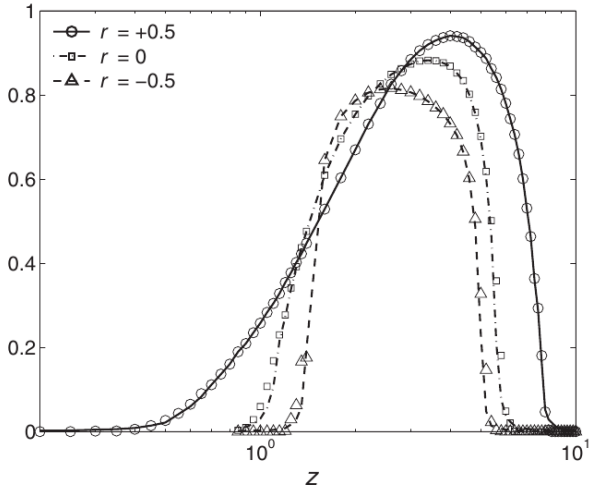




Typical features:

Contagion models

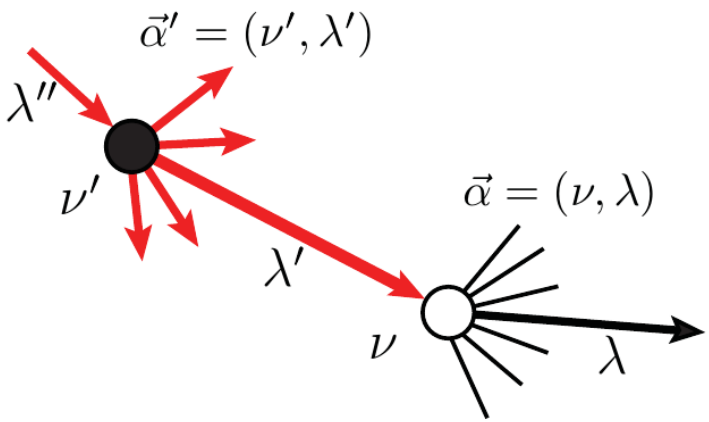


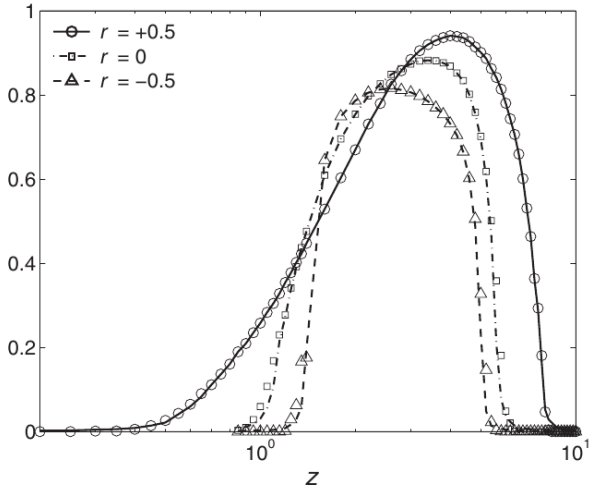


Typical features:

- **Network structure** or fully mixed

Contagion models

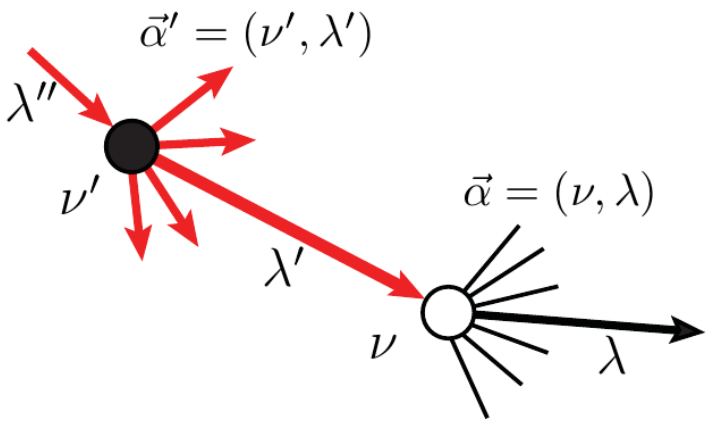


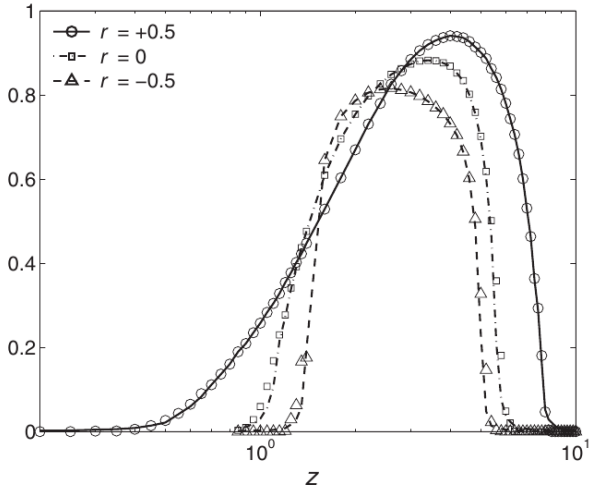


Typical features:

- **Network structure** or fully mixed
- Nodes turn on according to **response function** f and stay on

Contagion models





Typical features:

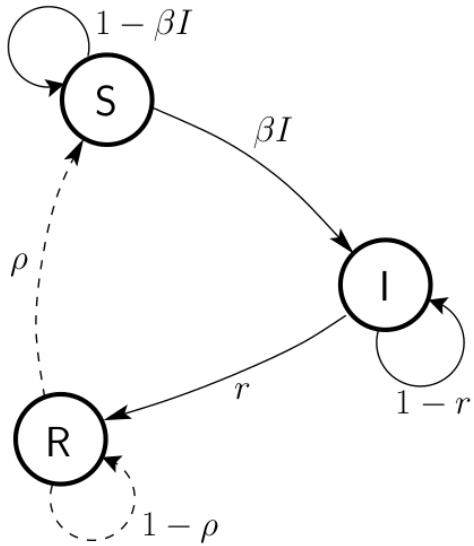
- **Network structure** or fully mixed
- Nodes turn on according to **response function** f and stay on
- **Percolation transition**. Varies with network parameters, contagiosity (f), or initial seed size

Percolation models & Networks (cont'd)

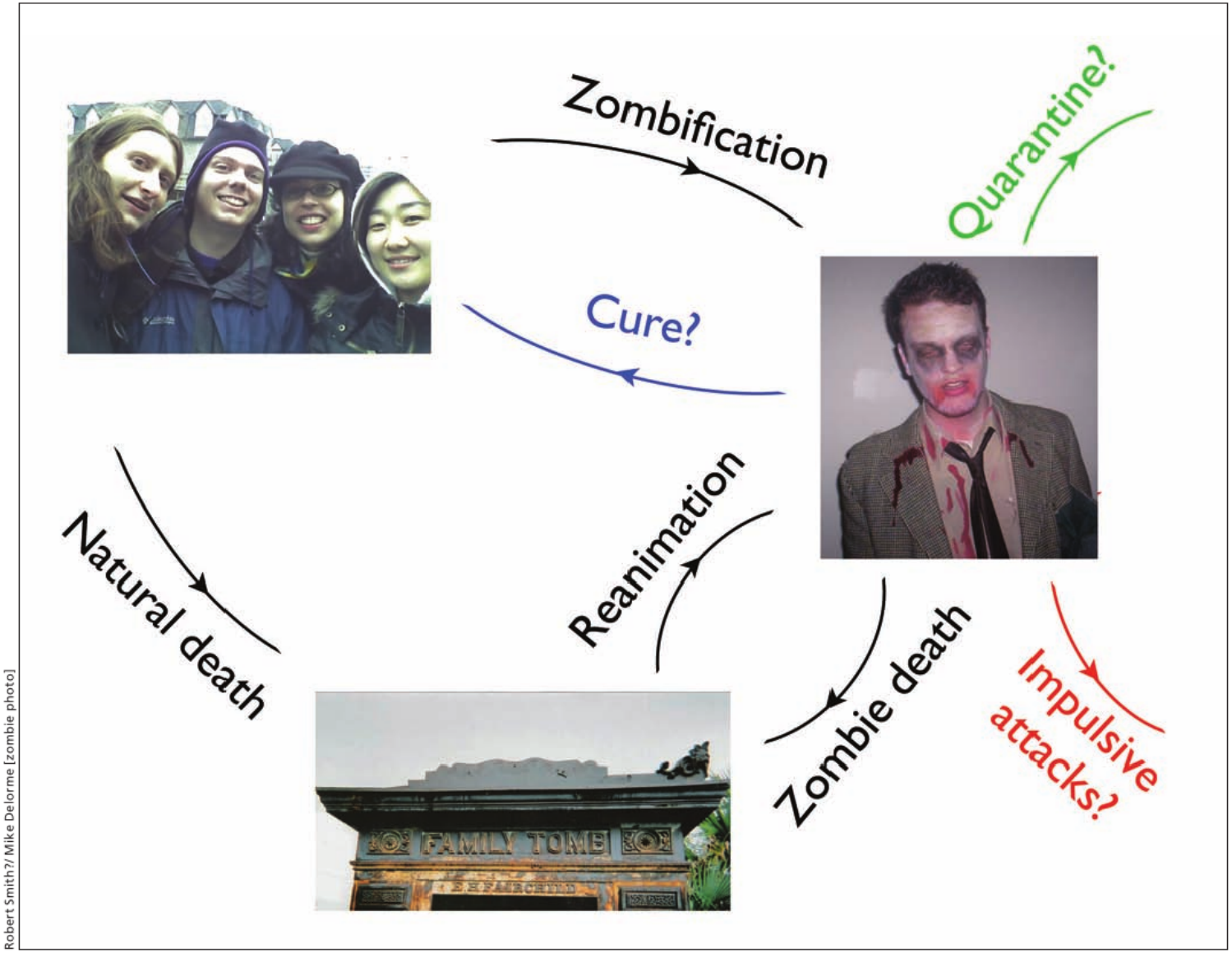
SIR

Most models are

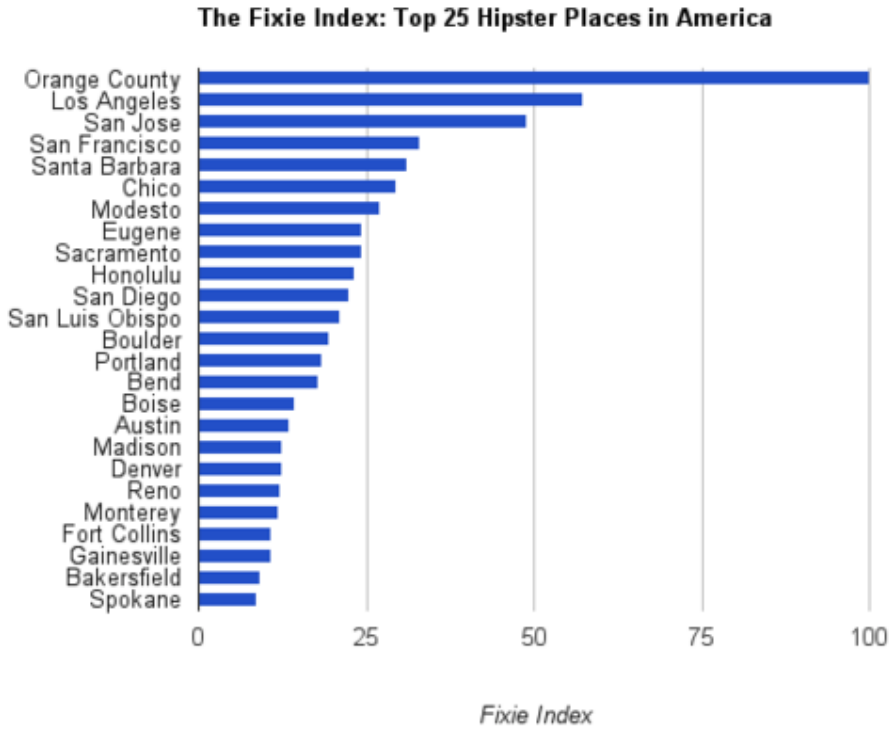
- Susceptible
- Infected
- Removed



Or SZR


Zombification
Quarantine?
Cure?
Reanimation
Natural death
Zombie death
Impulsive attacks?
FAMILY TOMB
Robert Smith?/ Mike Delorme [zombie photo]

Other possible extensions



source: `http://blog.priceonomics.com/post/16013457968/the-fixie-bike-index`

- Social contagion $\rightarrow$ trends?
- Volatility: not something we get from SIR

Chaotic contagion

Main idea

Nodes turn on and off (contact process, SIS, SZS, etc.)

Chaotic contagion

Main idea

Nodes turn on and off (contact process, SIS, SZS, etc.)

How we do this

Non-monotonic response functions

Chaotic contagion

Main idea

Nodes turn on and off (contact process, SIS, SZS, etc.)

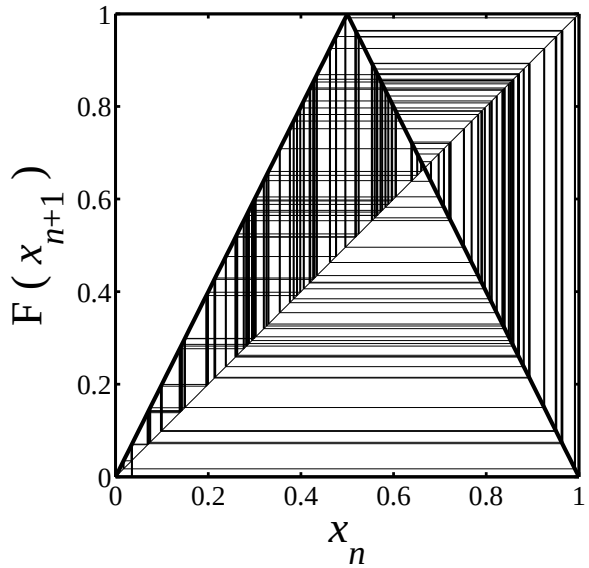
How we do this

Non-monotonic response functions

Ingredients:

Nodes like to imitate up to a limit — don't want to be like everyone else.

An example f:



Chaotic contagion

Main idea

Nodes turn on and off (contact process, SIS, SZS, etc.)

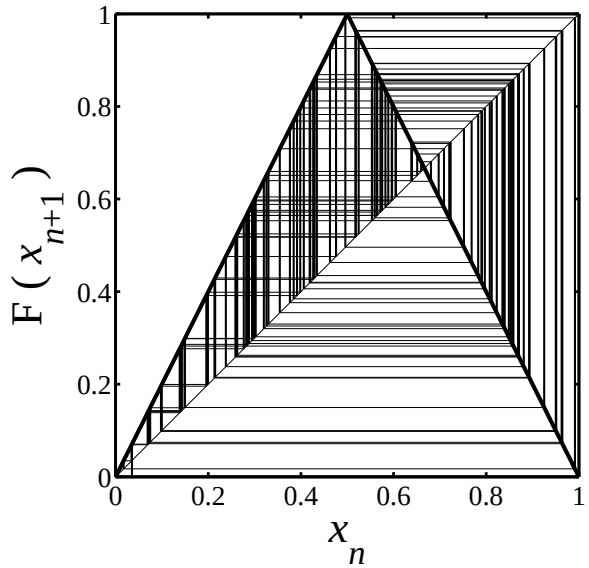
How we do this

Non-monotonic response functions

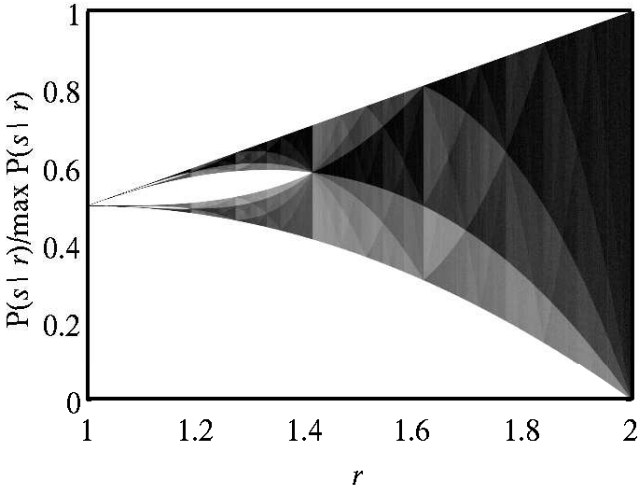
Ingredients:

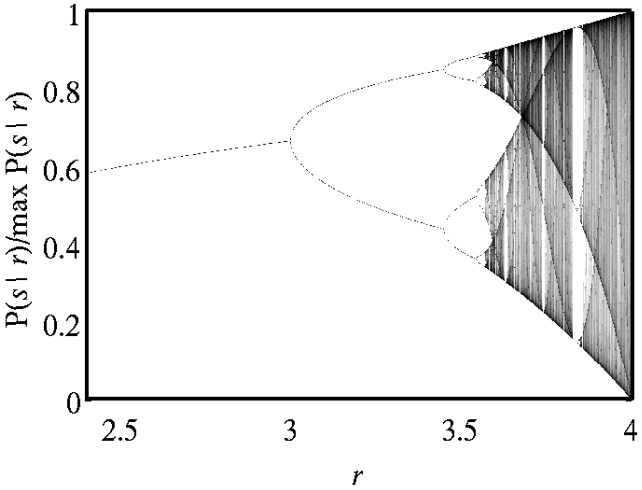
Nodes like to imitate up to a limit — don't want to be like everyone else. (Hipsters!!!)

An example f:

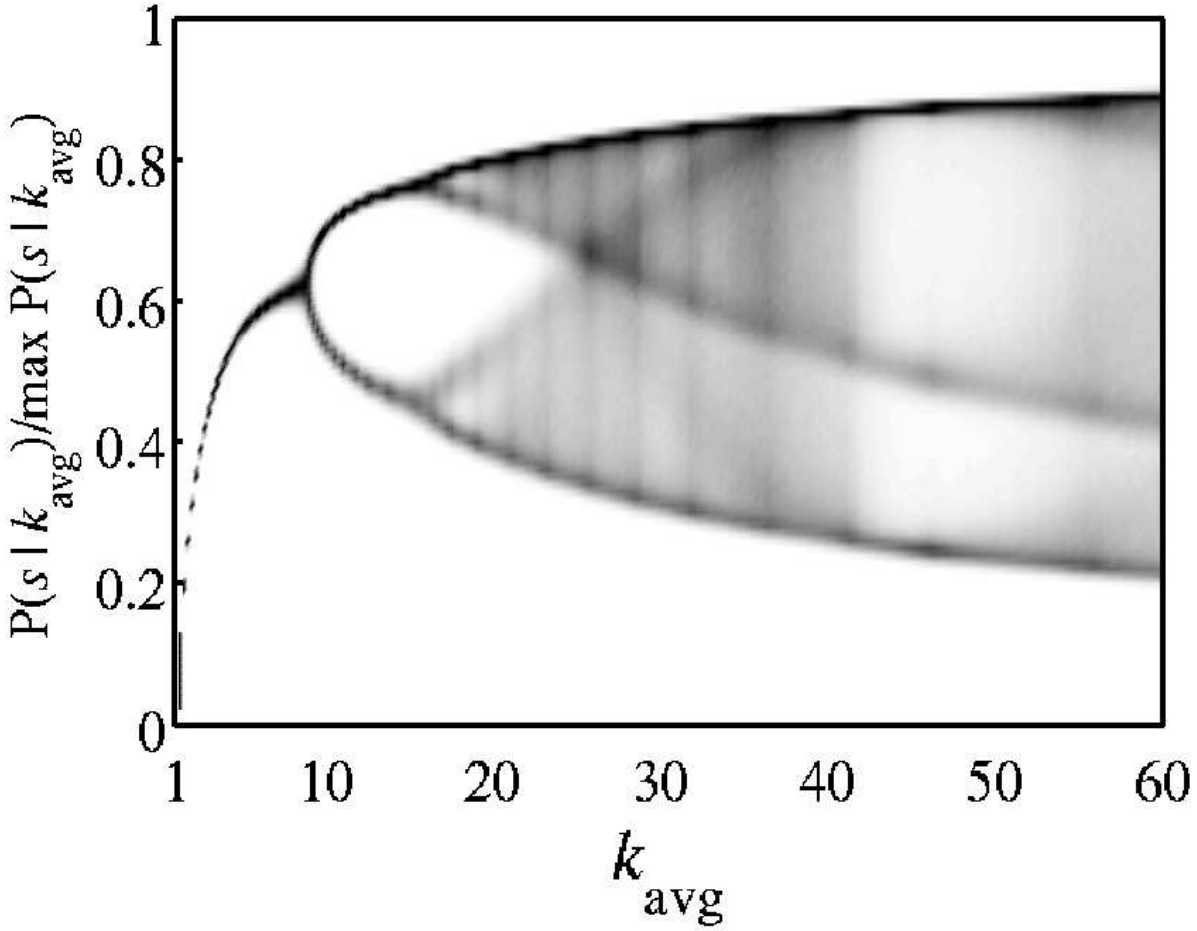


Crazy behavior





Stochastic response functions:



Avenues of attack

How to understand this?

Mean field theory

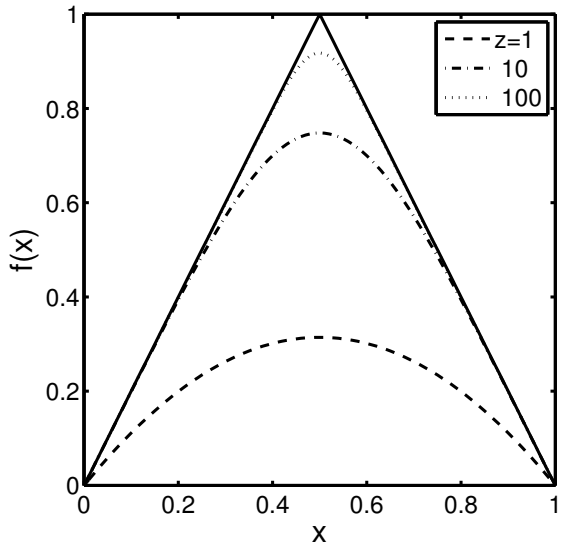
This leads to a 1d, nonlinear map:

$$\rho_{t+1} = \alpha\, g(\rho_t | P, f) + (1 - \alpha)\rho_t \tag{1}$$

Rigorous analytic results

Result 1

As $\langle k \rangle_P = z$ grows, for reasonable P, $g \nearrow f$
(More connected $\implies$ dynamics close to f)



Rigorous analytic results

Result 1

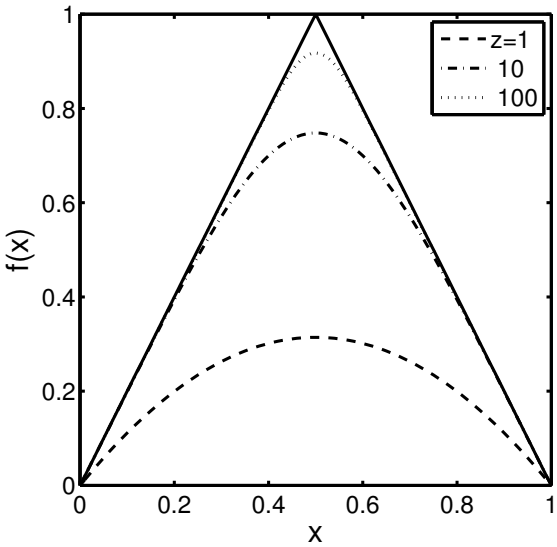
As $\langle k \rangle_P = z$ grows, for reasonable P, $g \nearrow f$
(More connected $\implies$ dynamics close to f)

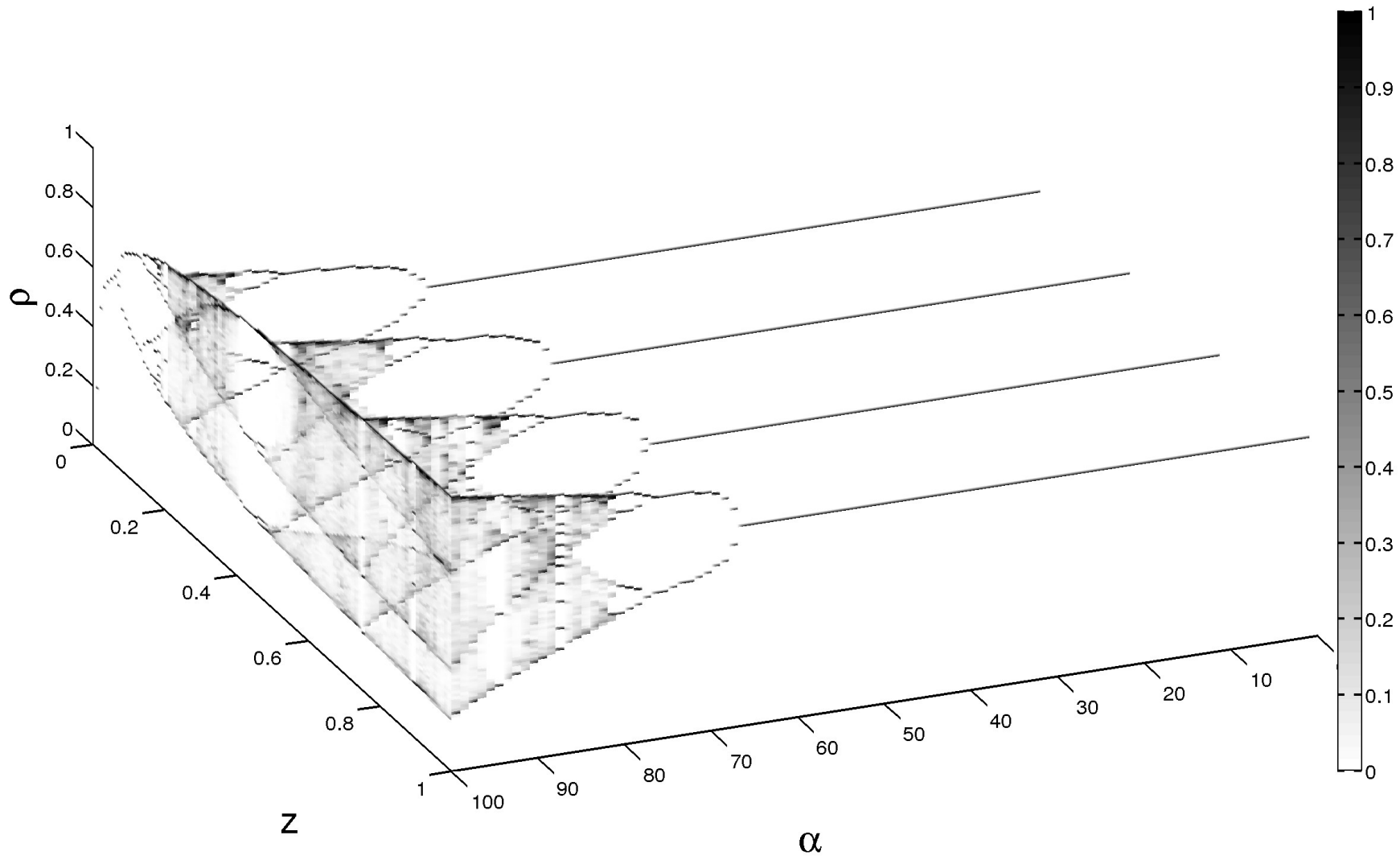
Result 2

For

- quenched Poisson random networks (not mean field)
- in the dense limit

the dynamics also approach f




ρ
1
0.8
0.6
0.4
0.2
0
z
0
0.2
0.4
0.6
0.8
1
α
100
90
80
70
60
50
40
30
20
10
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

Conclusions, to-dos

- Look at individual node dynamics
- Quenched networks, quenched response functions

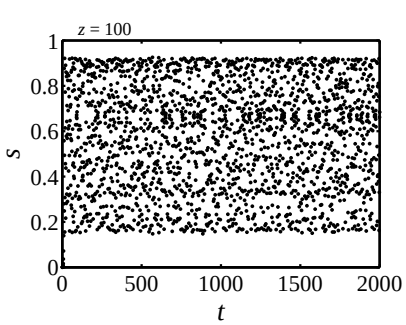
Main conclusion

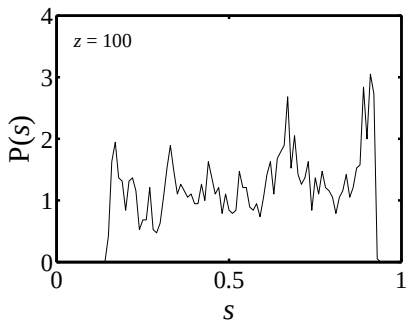
Academics can study anything
(including zombies, hipsters, swearing on Twitter...)

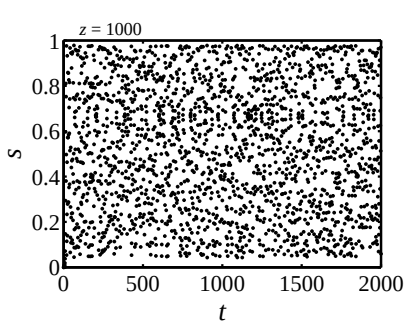
Acknowledgments

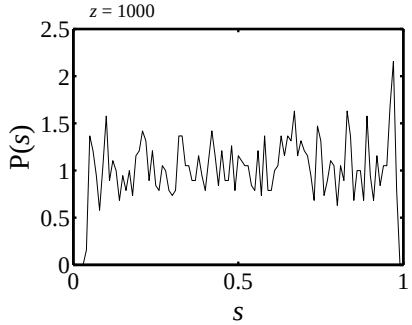
- advisors Peter Dodds and Chris Danforth
- Josh Payne
- the whole Computational Story Lab/Onehappybird team
- Andi Elledge (you rock!)
- the VACC, UVM Complex Systems Center, UVM Math & Stats
- NASA, NSF
- . . . and those of you who came to see this

Invariant densities—stochastic response functions



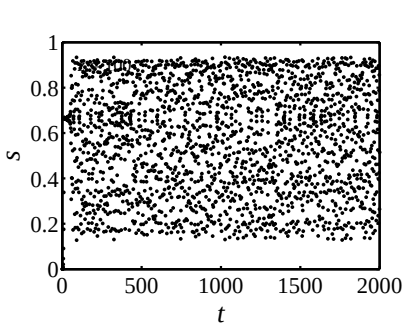


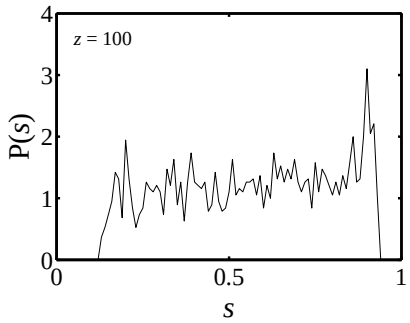


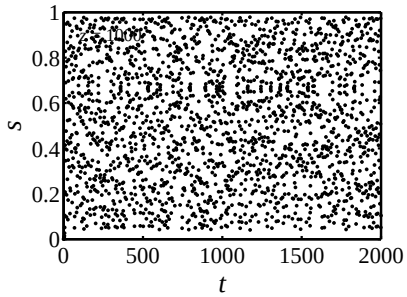


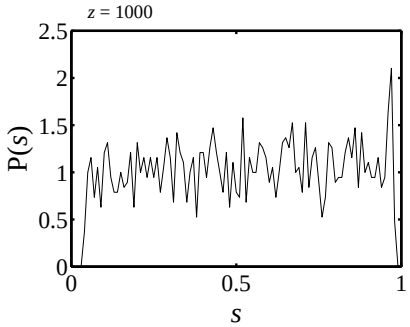
Trying out higher values of $\langle k \rangle$...

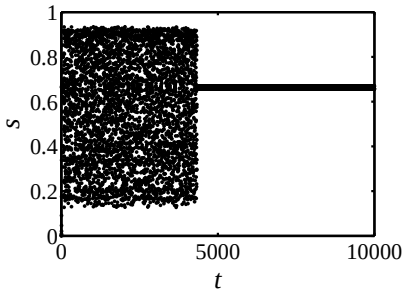
Invariant densities—deterministic response functions

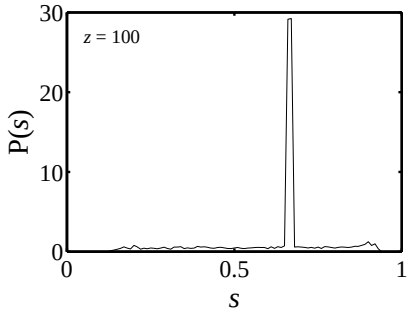












Trying out higher values of $\langle k \rangle$...