Dynamical systems on complex networks

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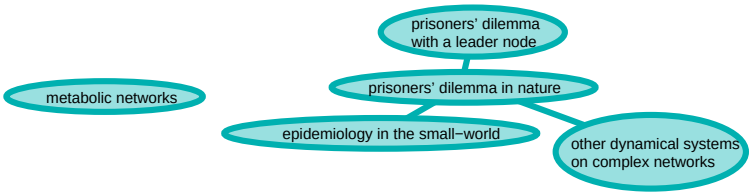
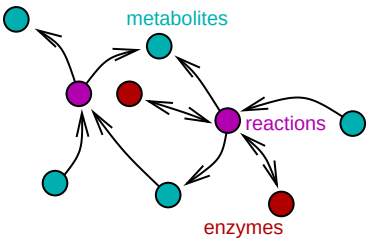
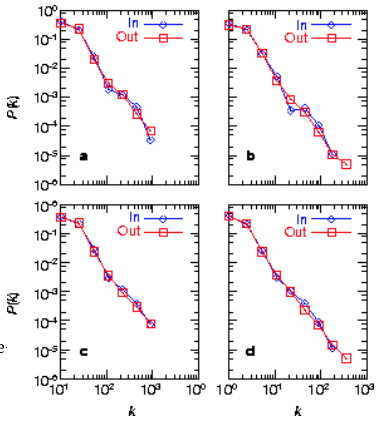
March 19, 2002



METABOLIC NETWORKS

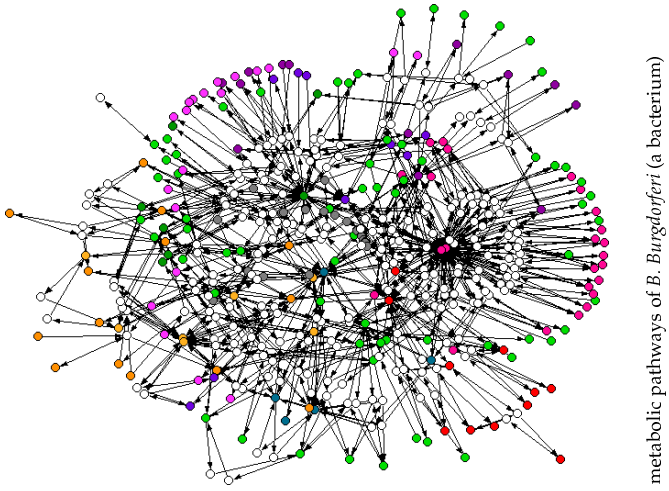




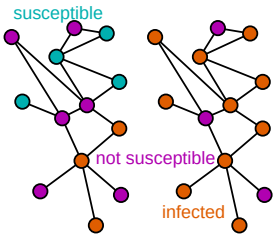
- Scale-free distribution of in- and out-degree.
- Correlation between essentialness and degree.

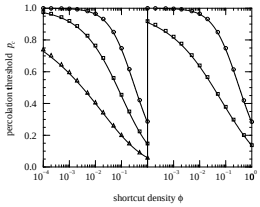
H. Jeong *et al.*, *The large scale organization of metabolic networks* Nature **411**, 651 (2001); *Lethality and centrality in protein networks* Nature **411**, 41 (2001).

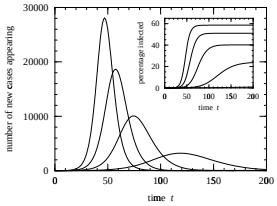
Metabolic networks *(continued)*



Statics: Percolation





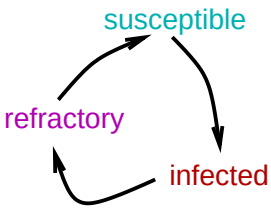


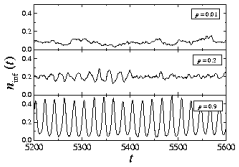
C. Moore and M. E. J. Newman, *Epidemics and percolation in the small world network model*, Phys. Rev. E **61**, 5678 (2000).

M. Ozana, *Incipient Spanning Cluster on Small-World Networks*, Europhys. Lett. **55**, 762 (2001).

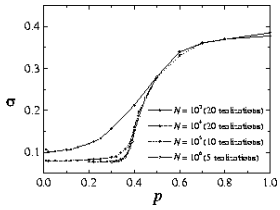
Epidemiology on Small-World Networks (continued)

Dynamics: The SIRS Model





Time evolution.



Synchronization vs. P.

M. Kuperman and G. Abramson, *Small World Effect in an Epidemiological Model*, Phys. Rev. Lett. **86**, 2909 (2001).

The Prisoners' Dilemma

Payoff matrix:

me \ opponent	C	D
C	R	T
D	S	P

If $T > R > P > S$ we have a Prisoners' dilemma.

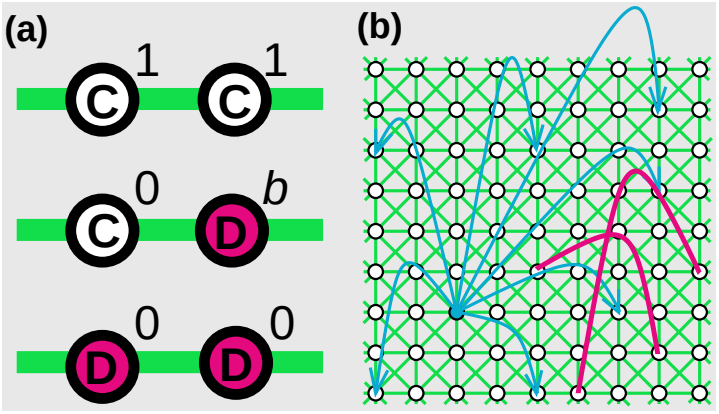
PD among RNA viruses

- Co-infection of a cell by more than one virus creates conflicts.
- Cooperating (defecting) corresponds to manufacturing (sequestering) shared intermolecular products.

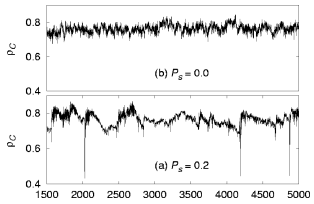
me \ opponent	C	D
C	1	1.99
D	0.65	0.83

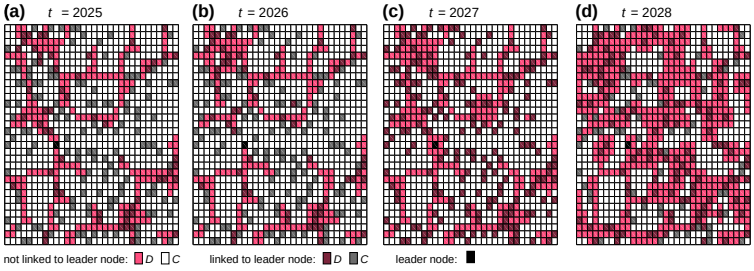
P. E. Turner and L. Chao, *Prisoner's dilemma in an RNA virus* Nature **398**, 441 (1999).

The Spatial Prisoners' Dilemma with leader node

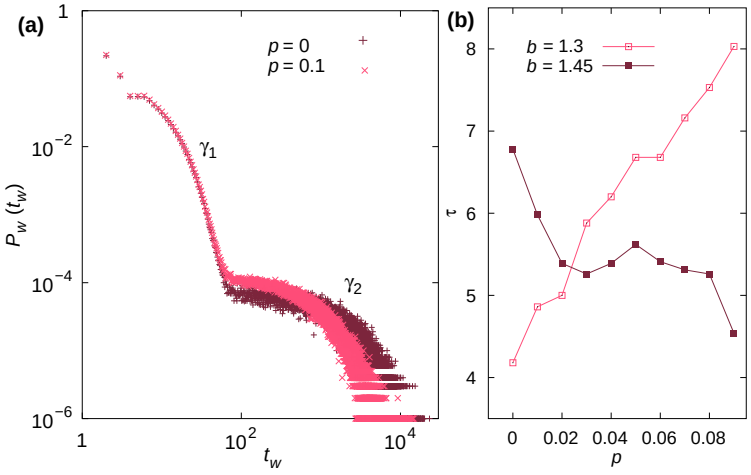


The Prisoners' Dilemma *(continued)*





The Prisoners' Dilemma *(continued)*



Coupled oscilators on small-world networks

- mean-field transition for finite P and σ (coupling strength).

H. Hong, M. Y. Choi, and Beom Jun Kim, Phase ordering on small-world networks with nearest-neighbor edges, to appear in Phys. Rev. E.

Ising Model on small-world networks

- mean-field transition for finite P.

A. Barrat and M. Weigt, Eur. Phys. J. B **13**, 547 (2000); M. Gitterman, J. Phys. A: Math. Gen. **33**, 8373 (2000).

***XY* model on small-world networks**

- mean-field transition for finite P.

Beom Jun Kim *et al.*, Phys. Rev. E **64**, 056135 (2001).

Other dynamical systems on complex networks (continued)

Hodgkin-Huxley neurons on small-world networks
L. F. Lago-Fernández, R. Huerta, F. Corbacho, and J. A. Sigüenza, Phys. Rev. Lett. **84**, 2758 (2000).

Random Walks on small-world networks
J. Lahtinen, J. Kertész, and K. Kaski, e-print cond-mat/0110365.

Epidemics on scale-free networks
R. Pastor-Santorras and A. Vespigiani, e-print cond-mat/0202298.

Syncronization on scale-free networks
S. Jalan and R. E. Amritkar, e-print cond-mat/0202298.

Syncronization on scale-free networks
S. Jalan and R. E. Amritkar, e-print cond-mat/0202298.

The Bak-Sneppen Model on Scale-Free Networks
Y. Moreno and A. Vazquez, Europhys. Lett. **57**, 765 (2001).

and so on . . .