Dynamics of Link States
in Complex Networks

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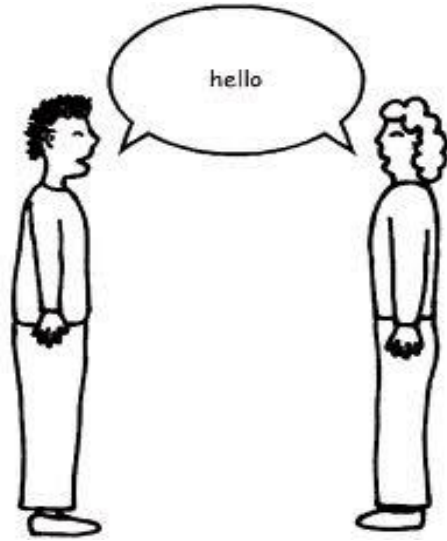
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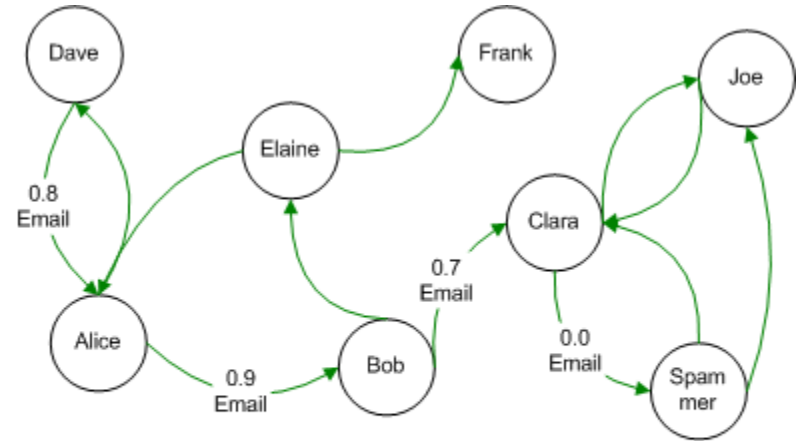
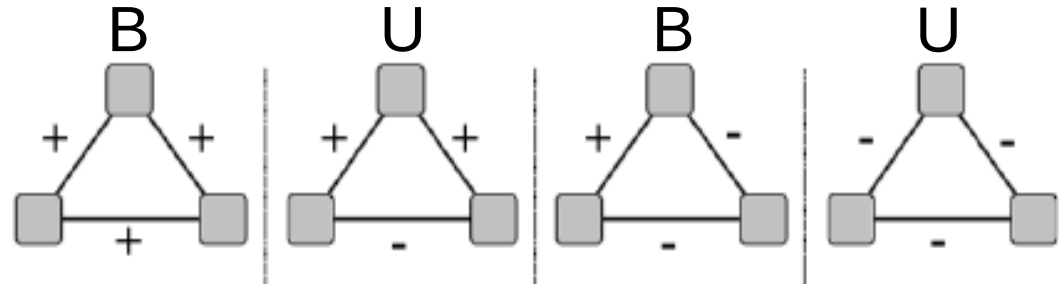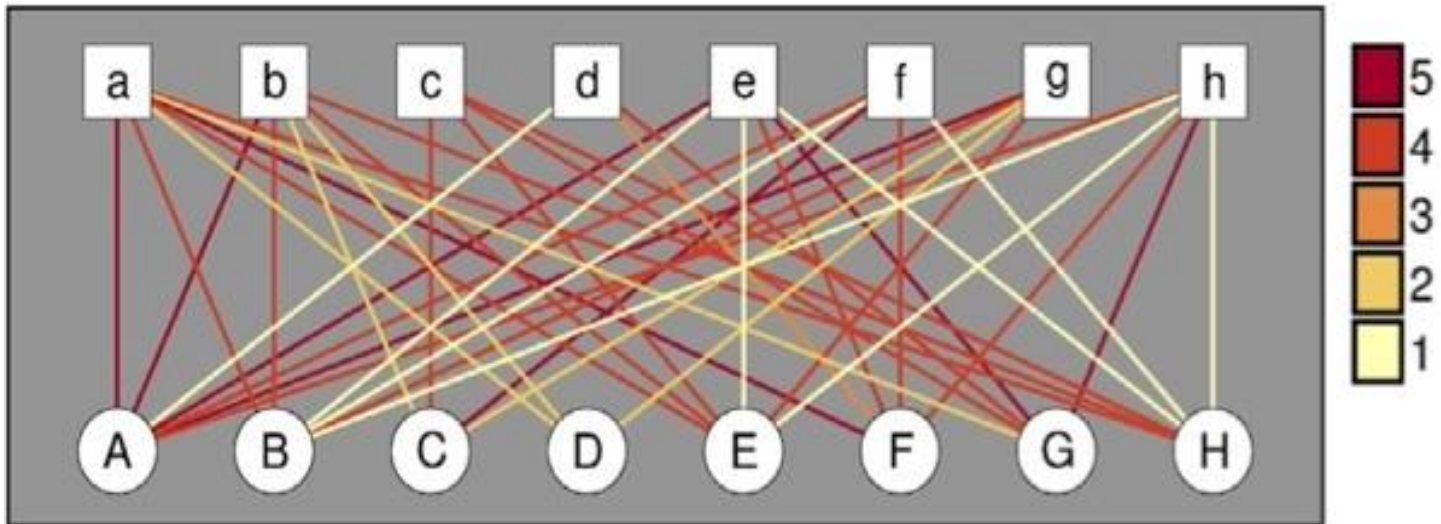CSIC   Universitat de les Illes Balears
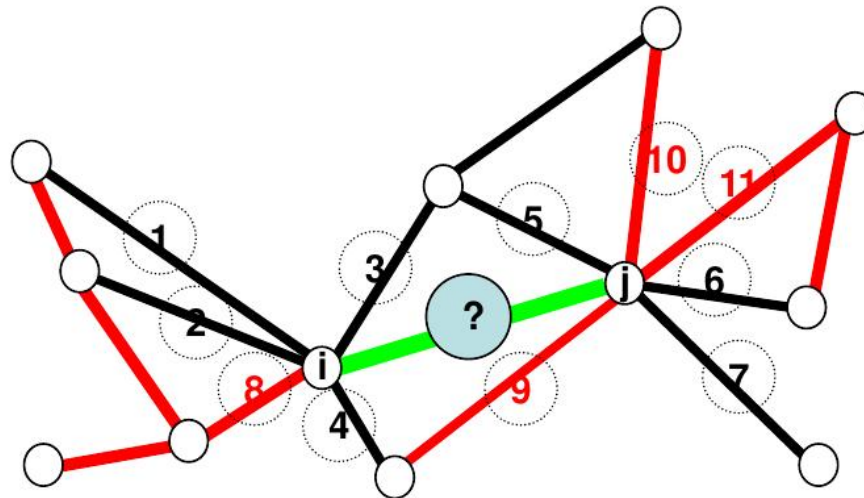
Language use

Trust Link

Trust

Friendship
(Social balance theories)

B U B U

Nice example by Marta Sales-Pardo:

Rating systems

LINK Dynamics: Language is a link, not an agent property
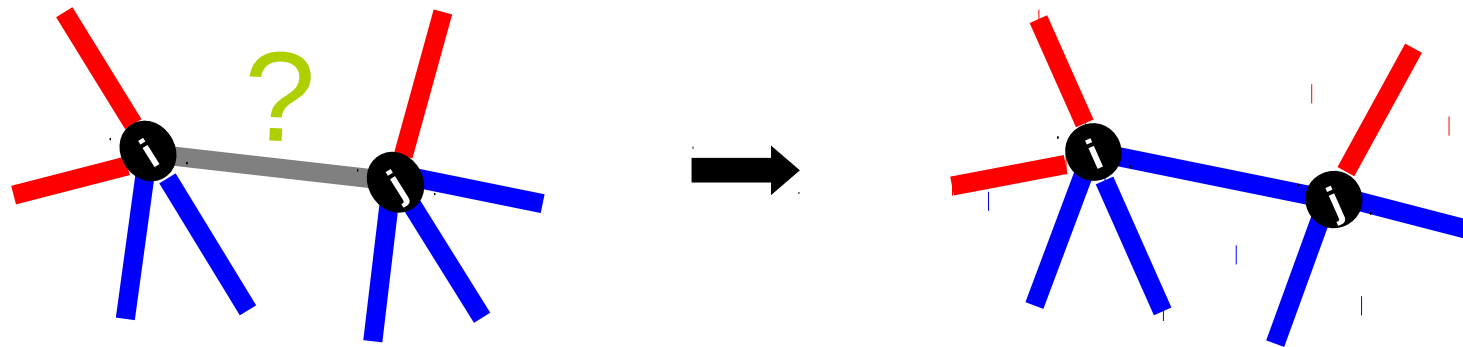
Agents
Active link
Language A
Language B

Types of agents

Monolingual A   100% A-links
Monolingual B   100% B-links
Bilingual agent   q % A-links 100-q % B-links

↳ different degrees of bilingualism

Is this relevant?

For a given dynamics,
is there any fundamental difference
between running it
on the nodes
or on the links
of the network?
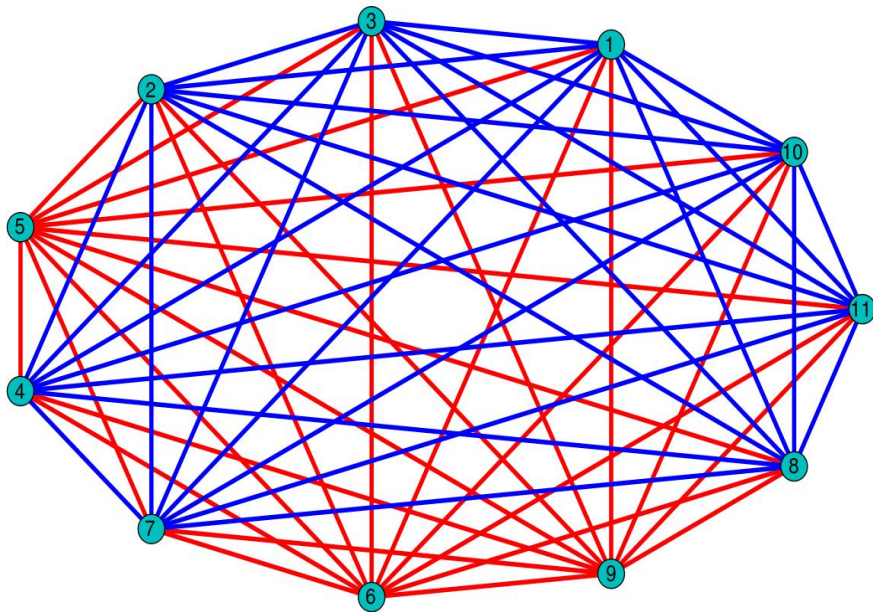
Link dynamics used: majority rule

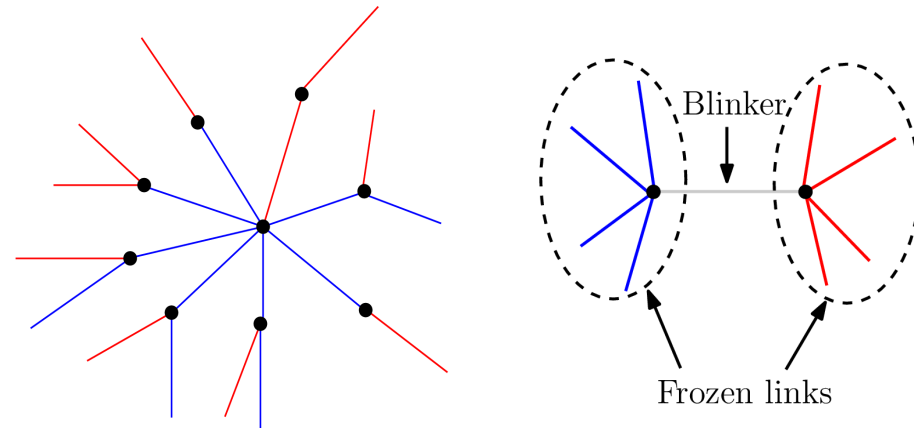*   Ties solved by random update

Language competition example:

for a given link, both nodes try to impose the language in which
they hold the majority of their conversations

Much richer space of possible final configurations: non-consensual final states!

FC net: Frozen states

Random net: Frozen or dynamical traps

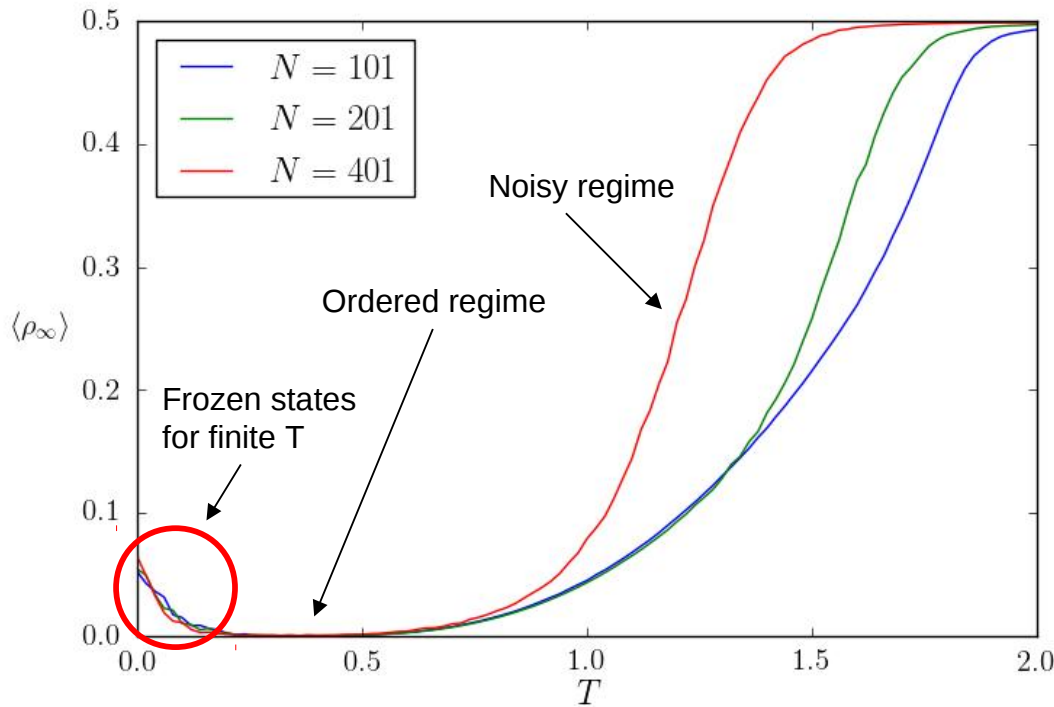Ok, ok, but... are those new states stable to perturbations?

What if I...

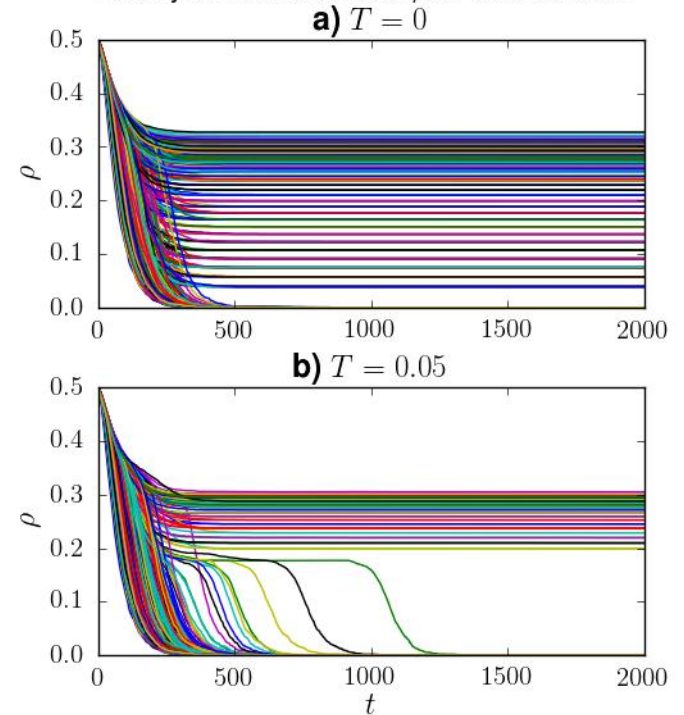- Add some noise in the form of a temperature?

- Add some rewiring mechanism?

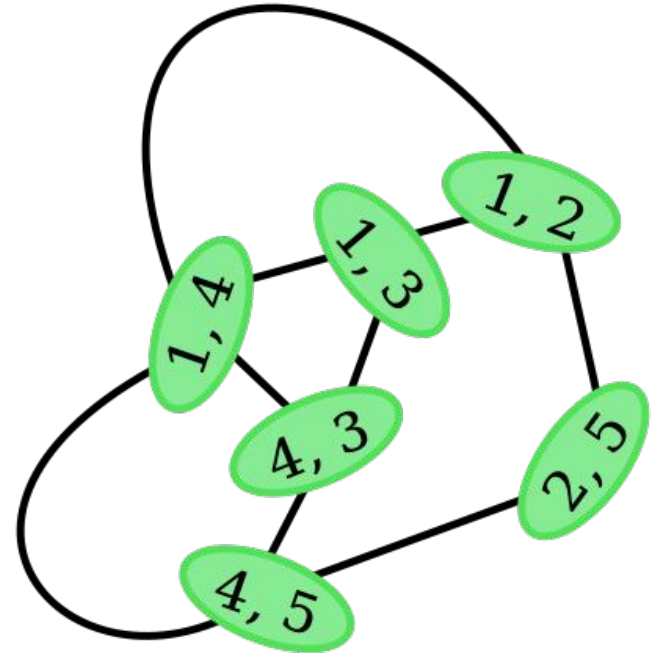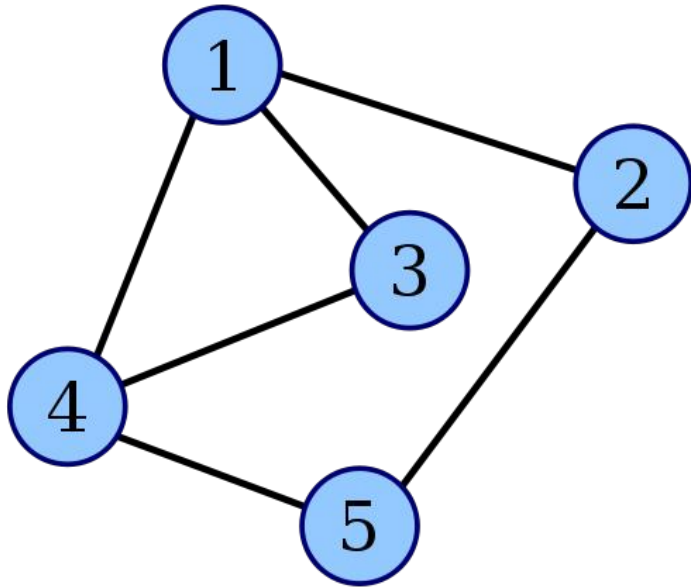# FC and random net: Frozen states are robust for small T

Average asymptotic density of nodal interfaces $\langle\rho_\infty\rangle(T)$

Density of nodal interfaces ρ for different runs

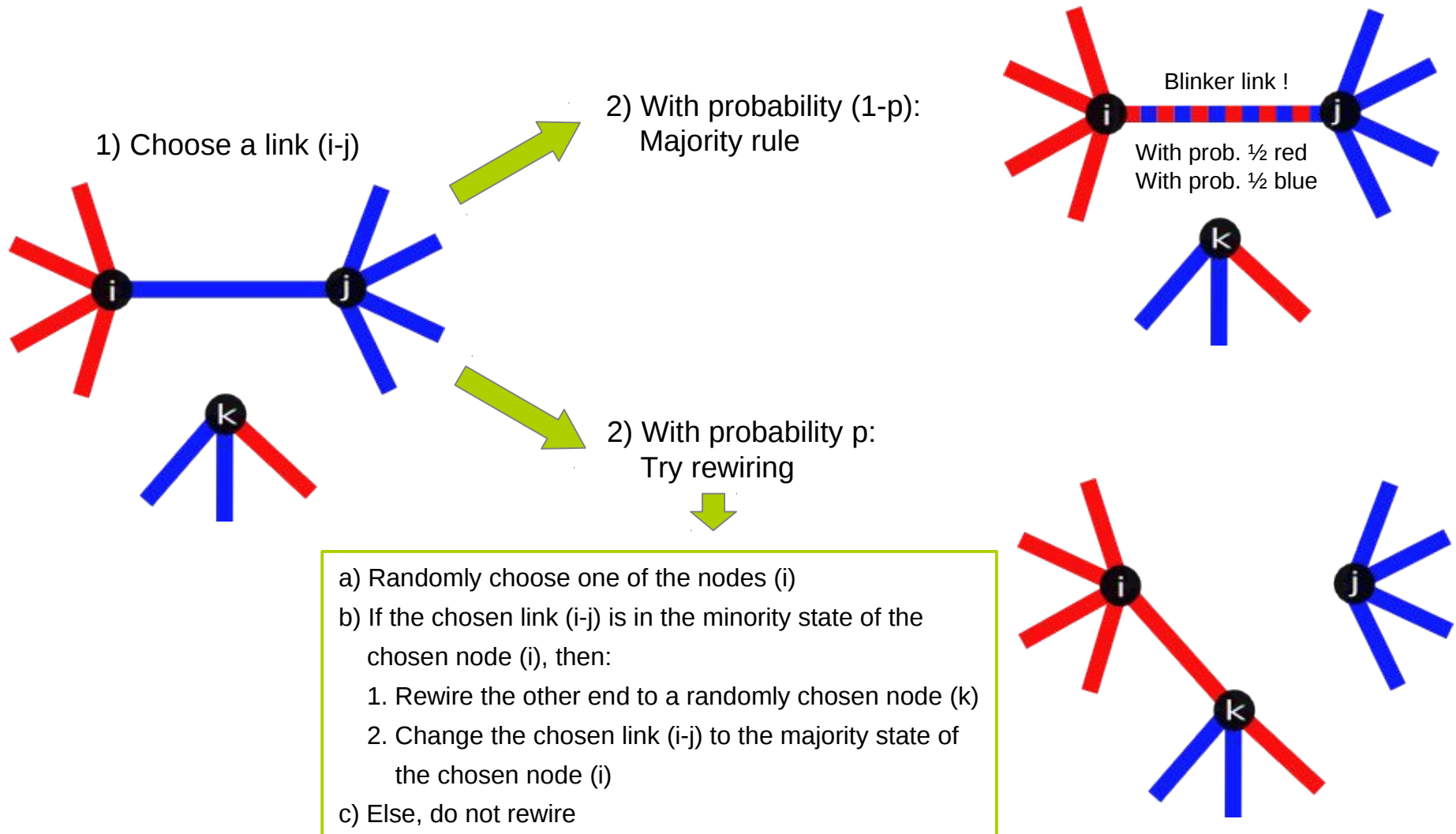Noisy regime

Ordered regime

Frozen states for finite T

Dynamics is actually taking place in
the Line Graph of the original network

Each node in the original network becomes
a fully connected clique in the line graph!

Coevolution: Link dynamics majority rule + rewiring

Example: two languages competition

1) Choose a link (i-j)

2) With probability (1-p):
Majority rule

Blinker link !

With prob. ½ red
With prob. ½ blue

2) With probability p:
Try rewiring

a) Randomly choose one of the nodes (i)

b) If the chosen link (i-j) is in the minority state of the
chosen node (i), then:

  1. Rewire the other end to a randomly chosen node (k)

  2. Change the chosen link (i-j) to the majority state of
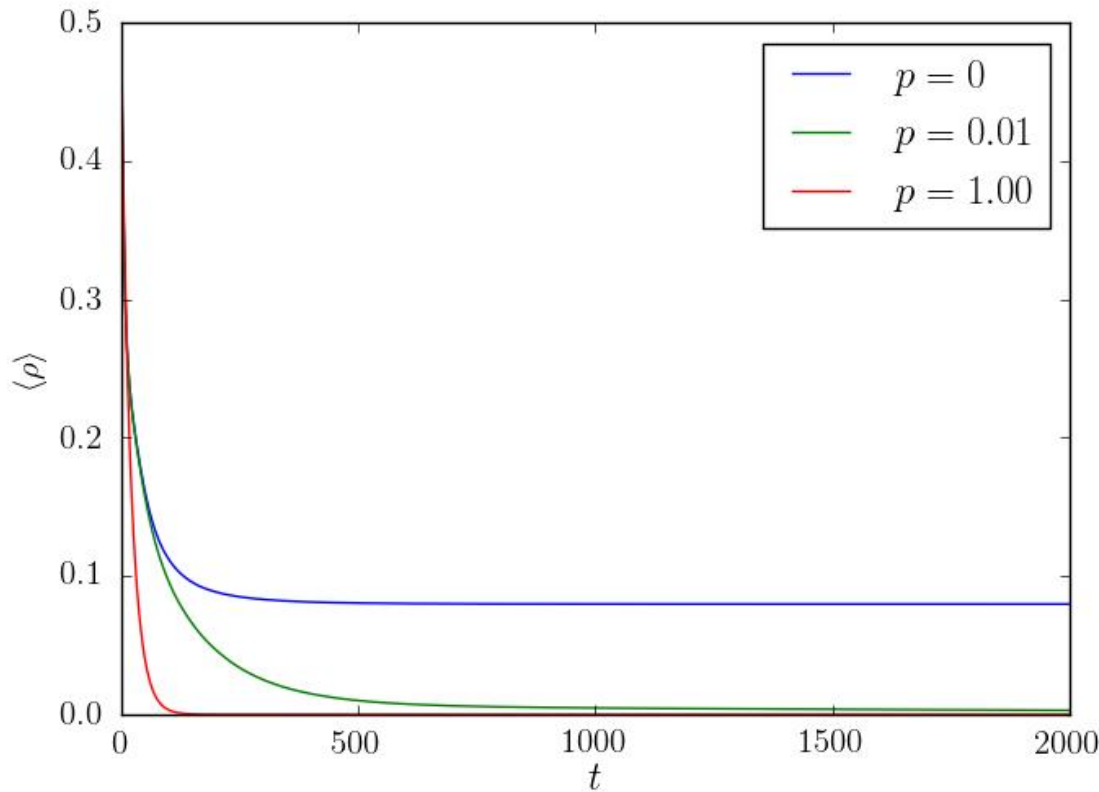   the chosen node (i)

c) Else, do not rewire

Coevolution: Link dynamics majority rule + rewiring
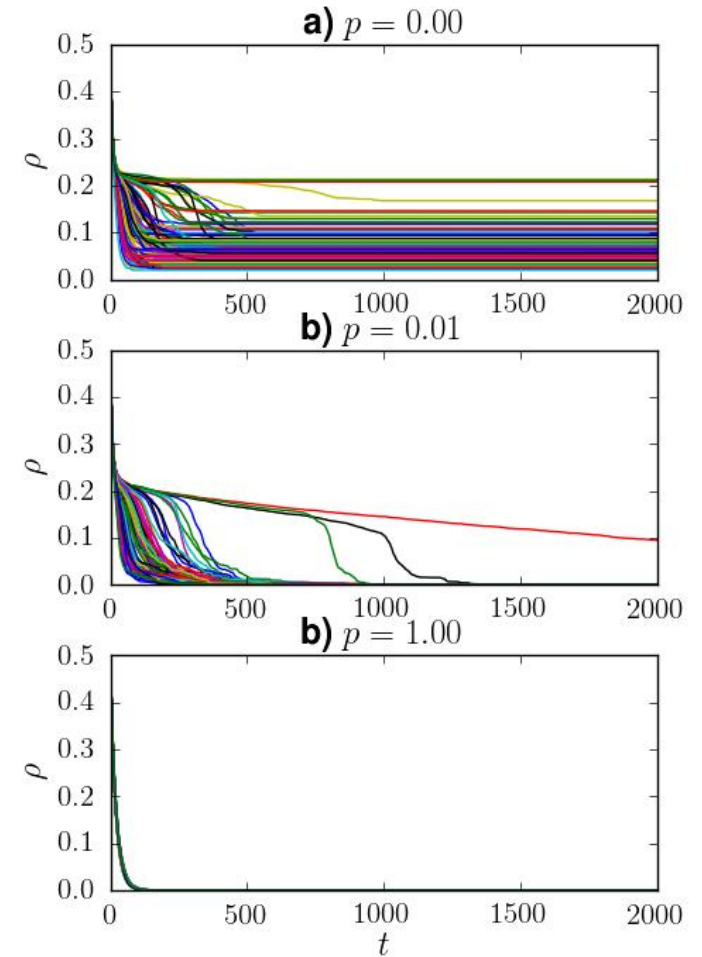
Random net: For any p ≠ 0 the system reaches an absorbing state

Frozen or trapped states are not robust under network evolution
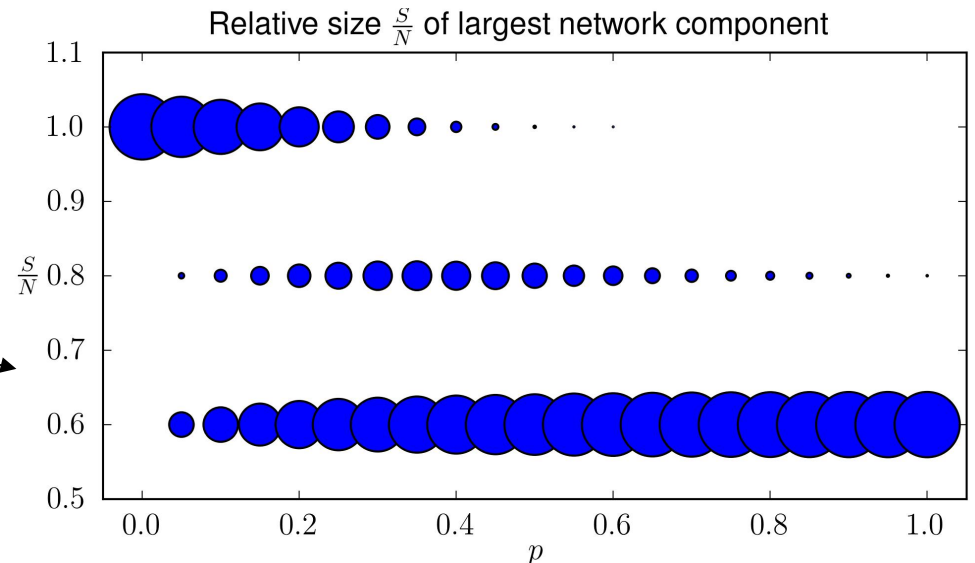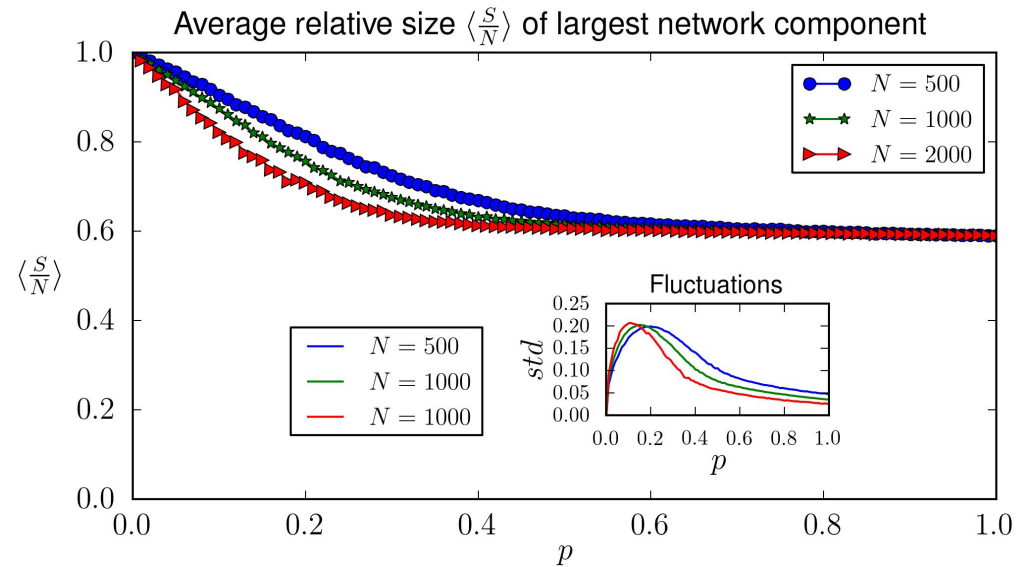

Average density of nodal interfaces $\langle\rho\rangle$

Density of nodal interfaces ρ for different runs

Coevolution: Link dynamics majority rule + rewiring

Average relative size $\langle \frac{S}{N} \rangle$ of largest network component

Fragmentation transition
in two network components

Size of points proportional to the percentage
of runs ending in one of the three possible
bins [0.5,0.7), [0.7,0.9), [0.9,1.0]

Relative size $\frac{S}{N}$ of largest network component

Thanks !