Voter model and interevent time distributions

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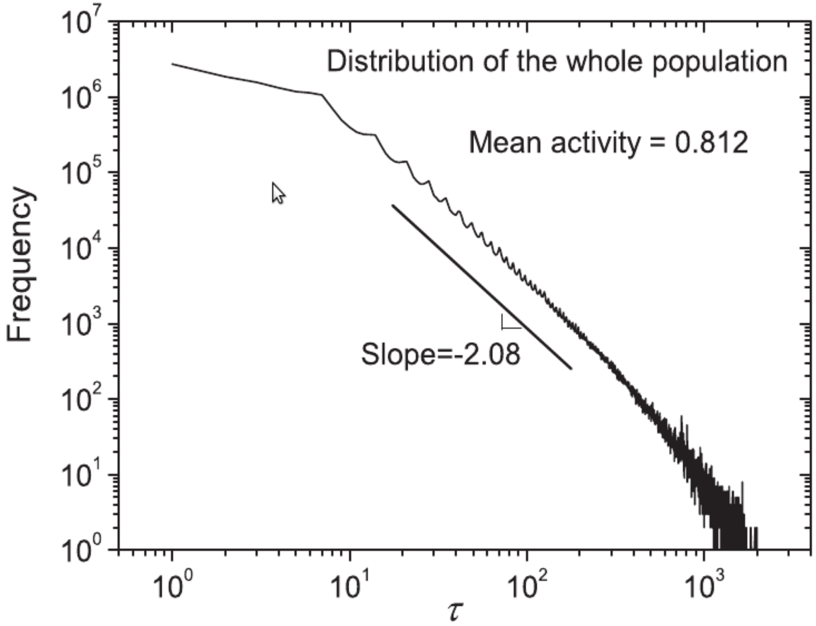
OUTLINE

- Real interevent time distributions.
- Typical update rules in agent based modeling.
- New rule introduction.
- Review on Voter model with different update rules.
- Application of the rule to the voter model.
- Conclusions.

Observed Interevent times distributions in human activities

Most of the interevent time distributions for different human activities display power law behaviour or at least heavy tails

Ex.: e-mail communications, surface mail communications, timing of financial trades, visits to public places, long-range travels, online games, response time of internauts, printing processes, phone calls...



Questions

- What's the origin of this particular timing?
  - Priority Queing Model (Barabási et al.)
  - Non-homogeneous Poisson process with cascades (Amaral et al.)
  - ...
- What's the effect of this timing on processes such as disease spreading, consensus formation...?
  - Effects on information diffusion(E.Moro, …)
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Typical update rules in agent based modeling

- Asynchronous update: at each step the state of just one node is updated. Nodes are updated in a certain order that can be:

  Random or Sequential.
- Synchronous update: All nodes are updated at the same time.

These update rules are implementing a homogeneous pattern of interaction, where the distribution of times between consecutive updates is either Poissonian or a delta function.

New update rule

Agents have an extra variable that is the time since their last change of state. τ

We will try to update the state of all nodes synchronously, but each node will update its state with certain probability p(τ).

How do we have to choose p(τ) so that we get a certain interevent time distribution?

Approximation for the interevent time distribution

We try to guess what kind of probability to choose by neglecting the specific dynamics.

$M(\tau)$: Desired interevent time distribution

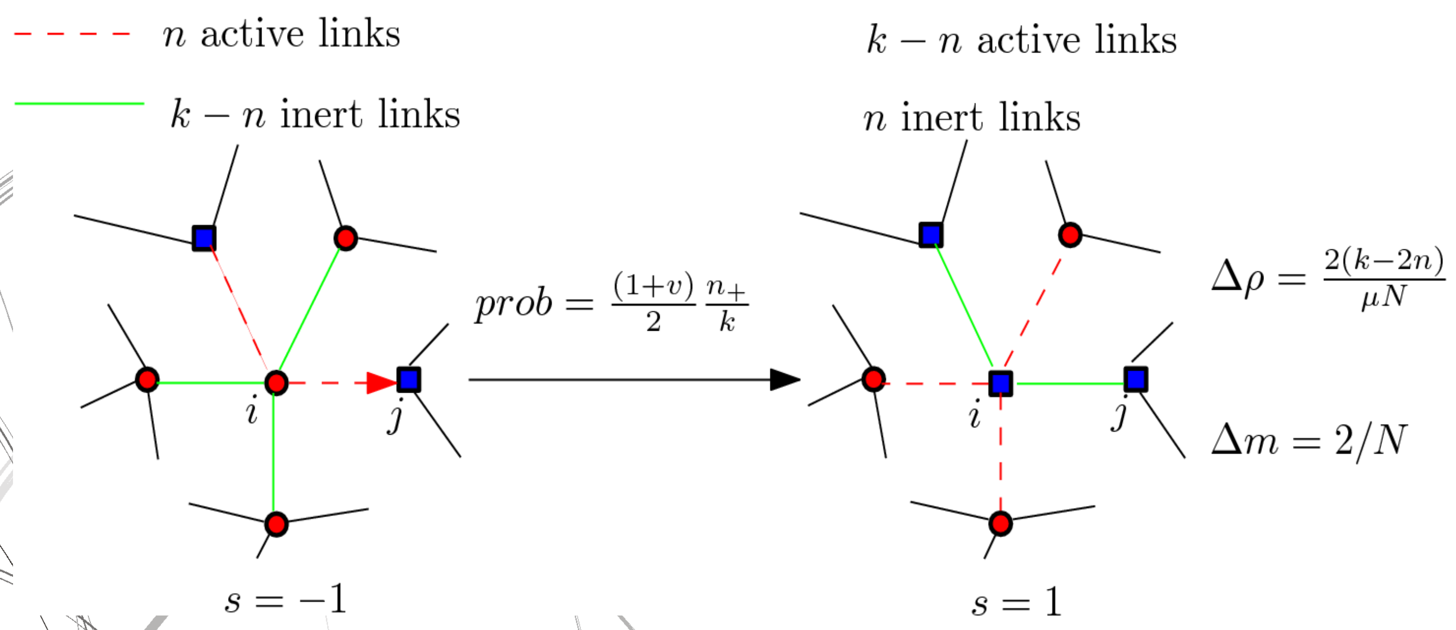
$$M(\tau) = p(\tau)(1 - \sum_{j=1}^{\tau-1} M(j))$$

Continuum limit:

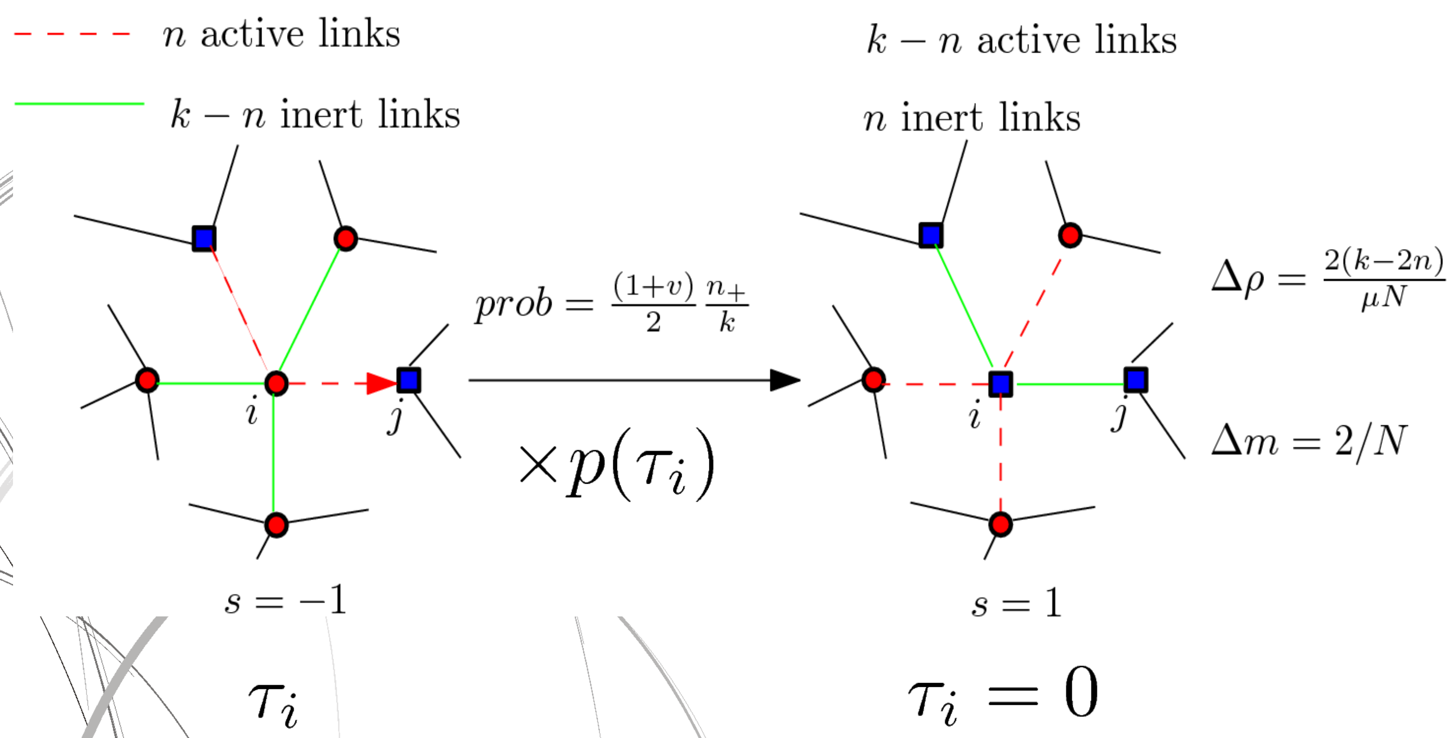
$$C(\tau) = 1 - \int_{\tau_{\min}}^{\tau} M(t)dt$$

$$\frac{d\ln(C(\tau))}{d\tau} = -p(\tau) \longrightarrow C(\tau) \propto \tau^{-\beta} \Rightarrow p(\tau) = \frac{\beta}{\tau}$$

Application: the voter model

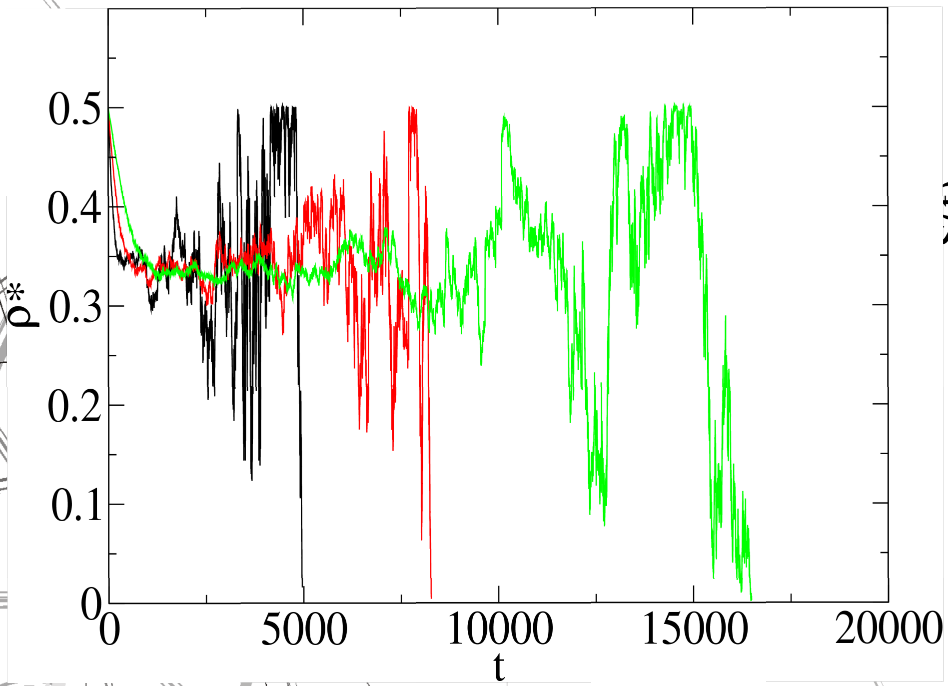


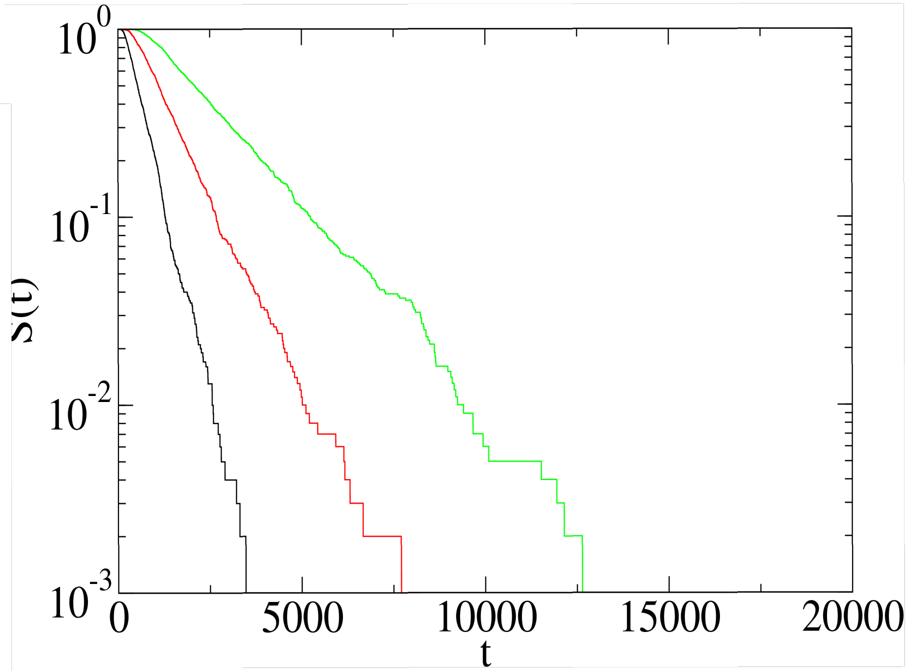
Application: the voter model



Results on a complete graph

Usual update rules





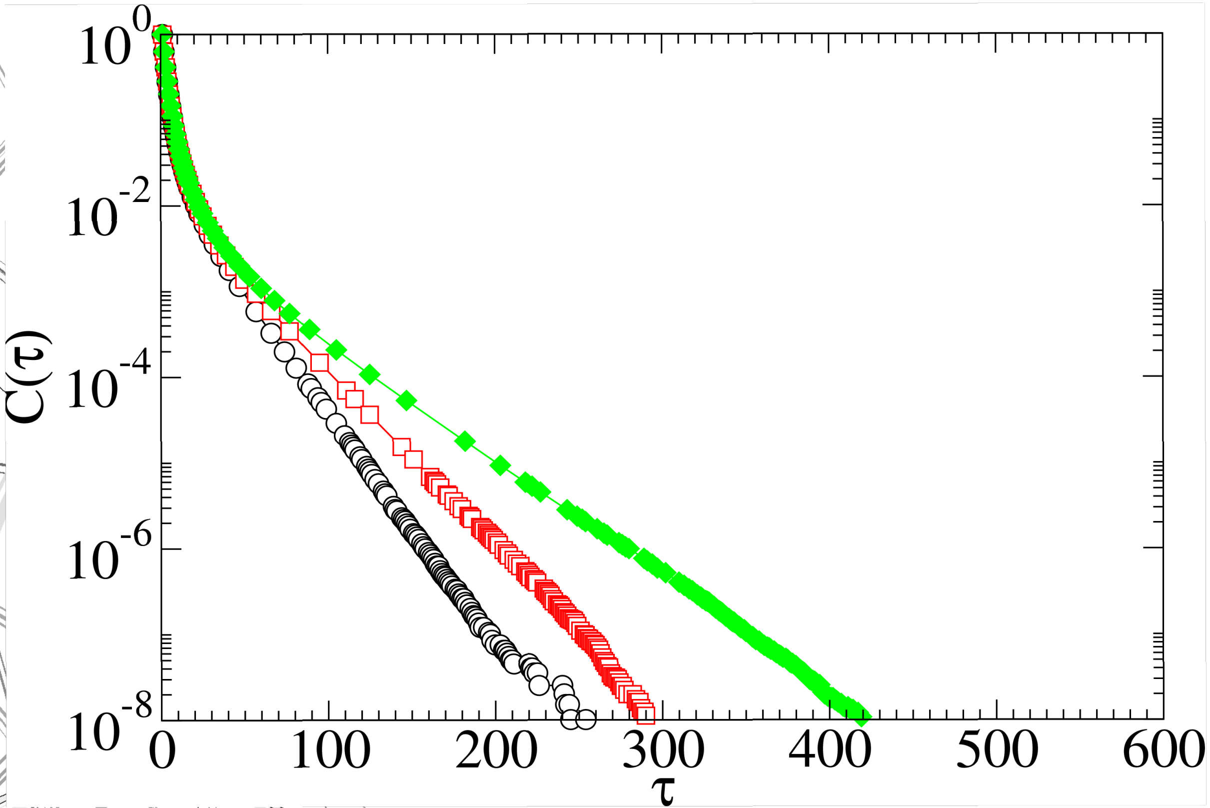
$$S(t) \propto e^{-t/\tau_{char}(N)}$$

$$\tau_{char} \propto N$$

Results on a complete graph

Usual update rules

$$C(\tau) \propto e^{-t/\tau_{char}(N)}$$

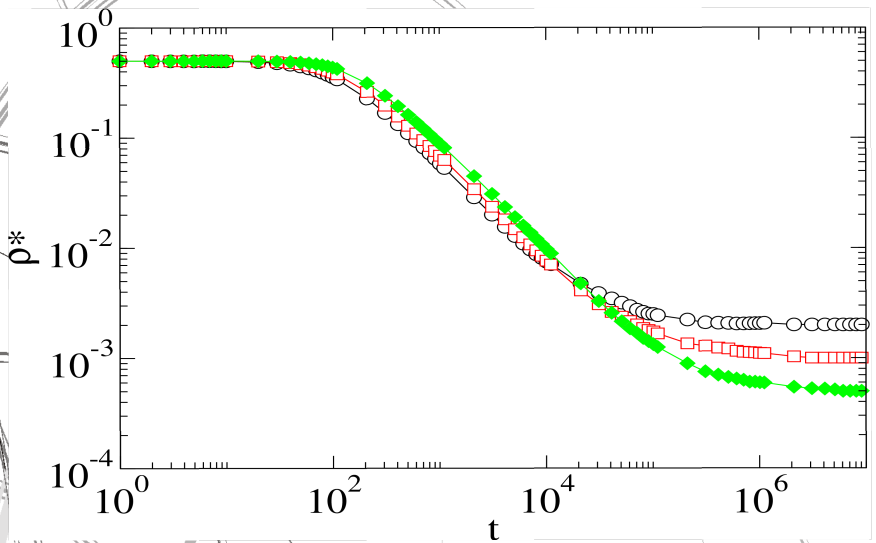


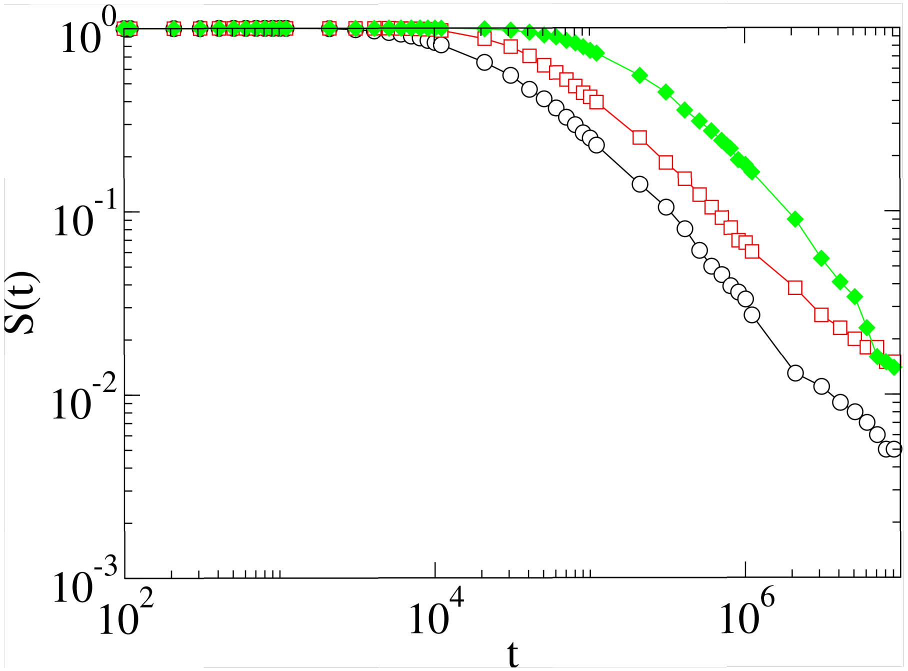
$$\tau_{char} \propto \sqrt{N}$$

Results on a complete graph

Memory update rule

$$p(\tau) = 1/\tau$$



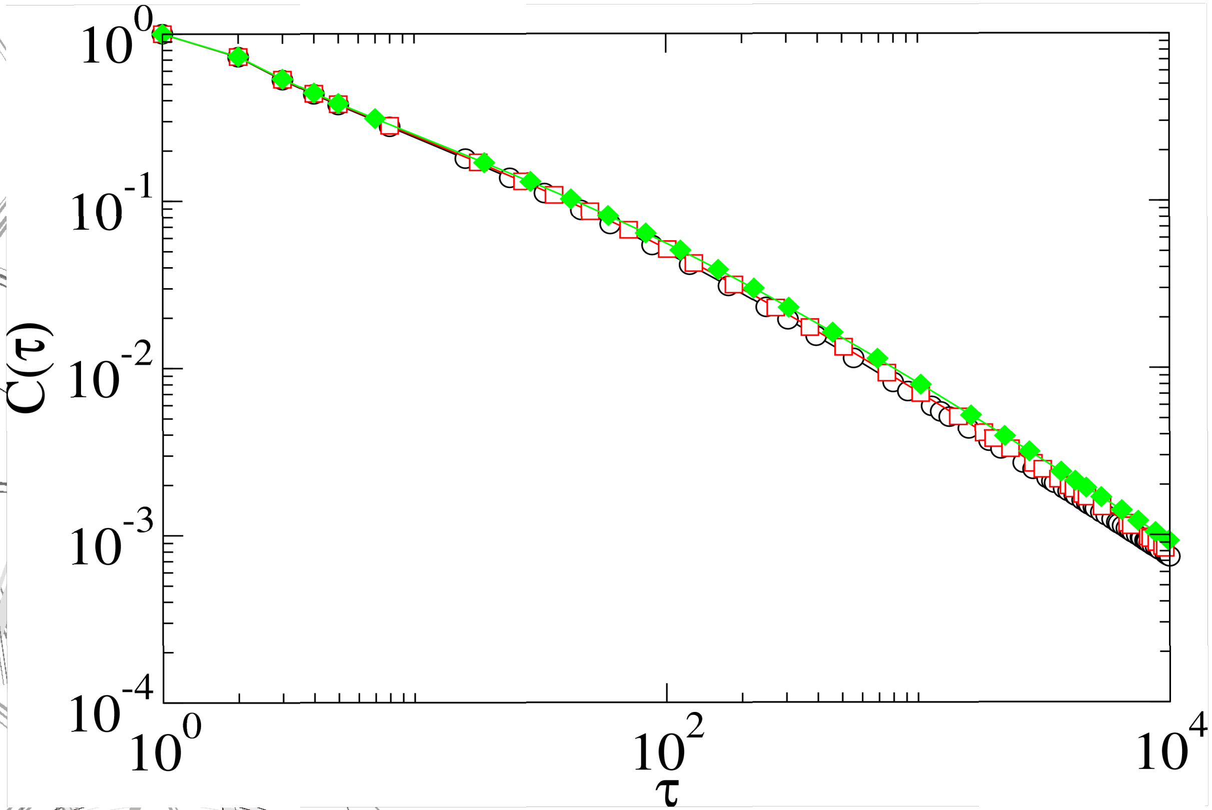


$$\alpha = 0.95$$

Results on a complete graph

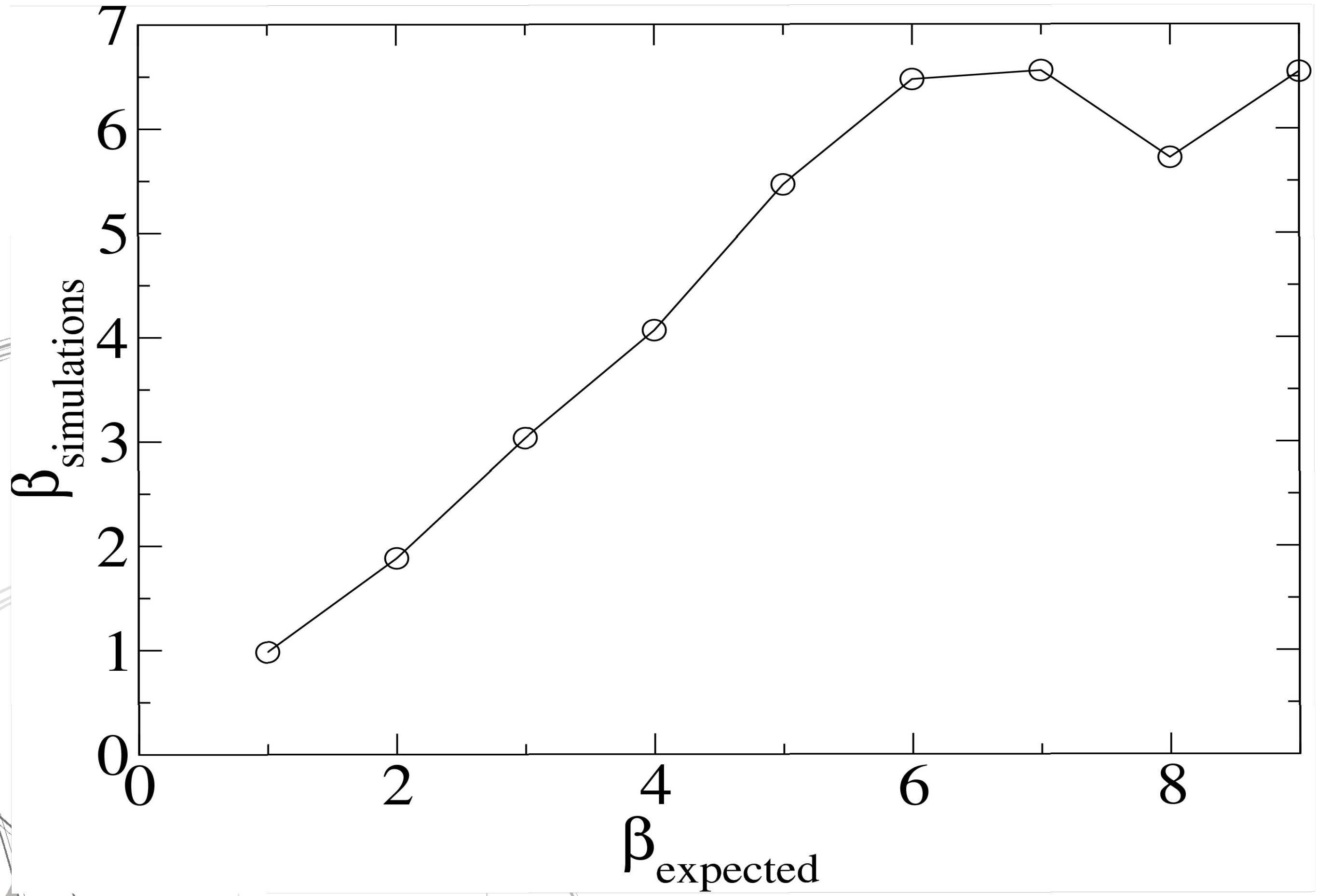
Memory update rule

$$p(\tau) = 1/\tau$$



$$C(\tau) \propto \tau^{-\alpha}$$

$$\alpha = 1$$



$$p(\tau) = \beta/\tau$$

Conclusions

- With the modified update rule we are able to account for broad interevent time distributions, though not able of controlling it totally.

- This special timing of interactions does make a difference in the macroscopic outcome of the model studied, so it should be taken into account before drawing any conclussions for real-life systems.

Thanks for the attention!