Uncovering the structure and dynamics of information flow on the Telegram network

Thomas Louf, Aurora Vindimian, Riccardo Gallotti

June 25, 2025

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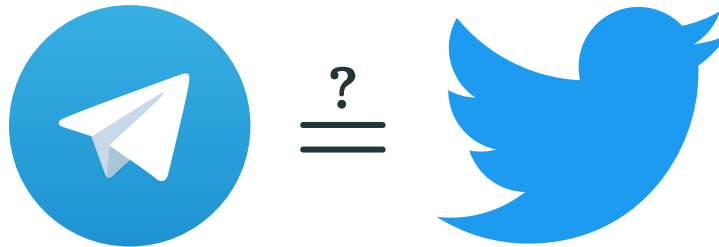
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Telegram CEO arrested
BBC NEWS

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→ Lots of work to be done

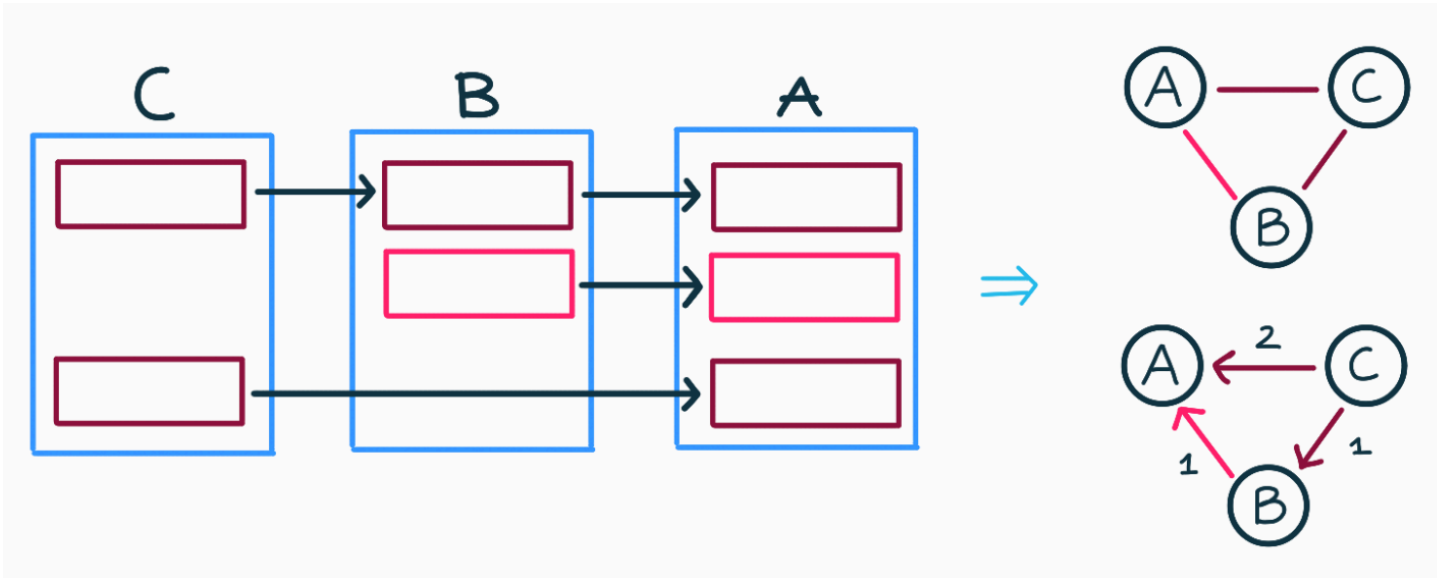Is the network of Telegram channels anything like a social network?

What are the main mechanisms giving rise to it?

→ Analysis of the Telegram network using the Pushshift dataset (Baumgartner et al., 2020)

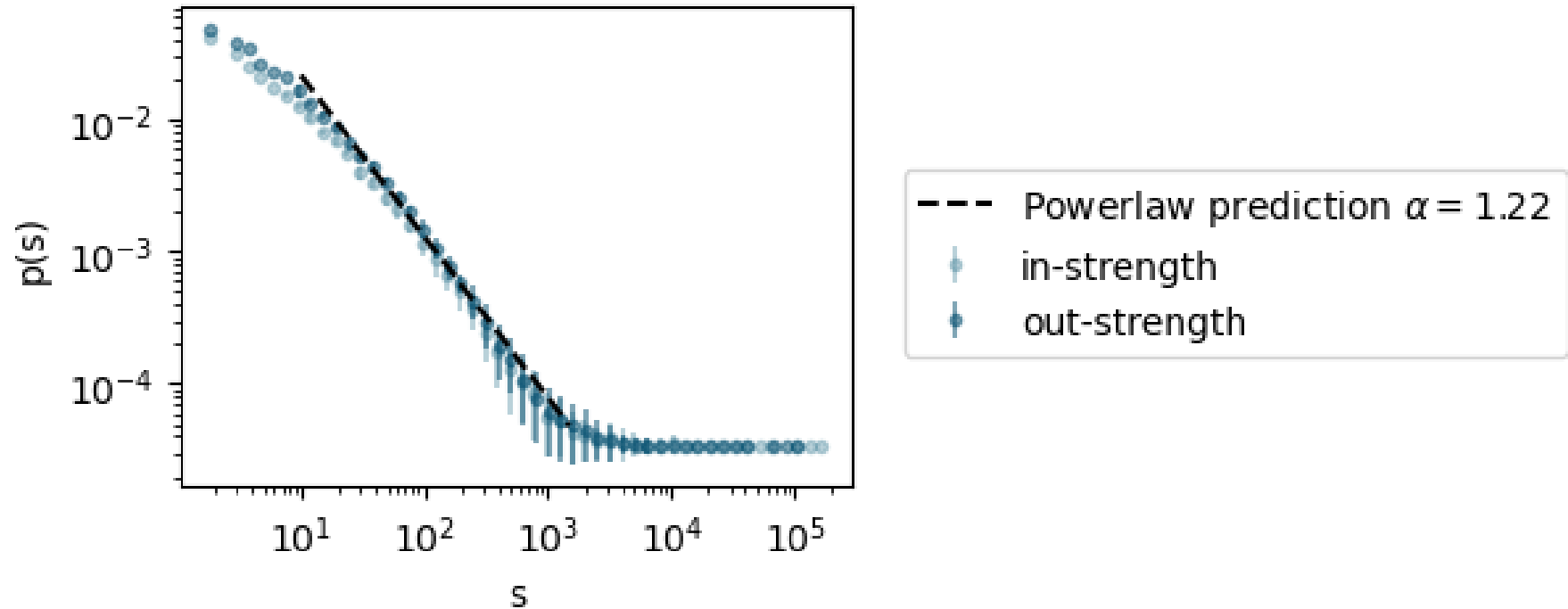→ Model that reproduces its *topological* and *temporal* features

- Nodes: $29\,609$ channels
- Edge from B to A when A forwards a message from B ➜ $501\,897$ directed edges

➜ Network of information flow
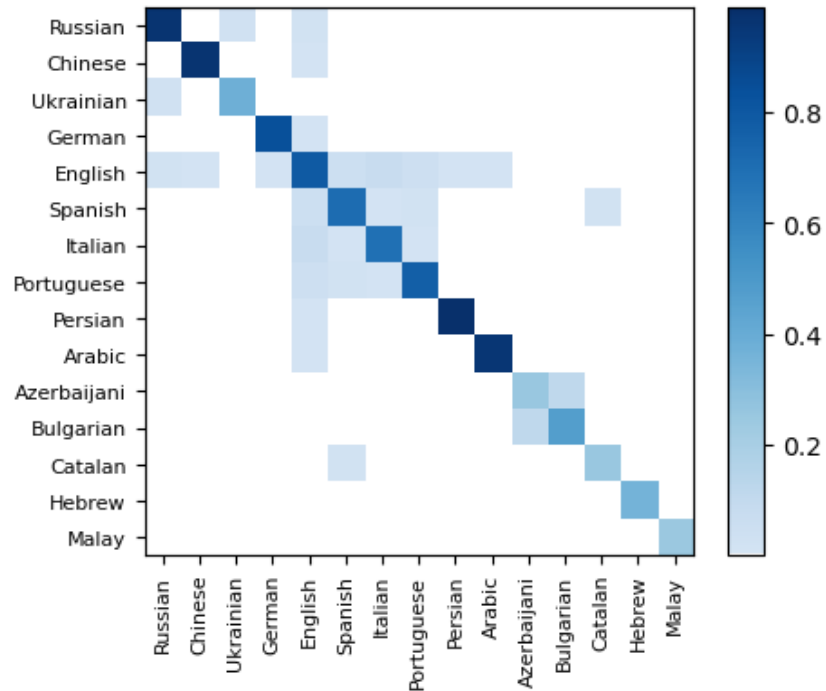
Do we have the usual rich club?
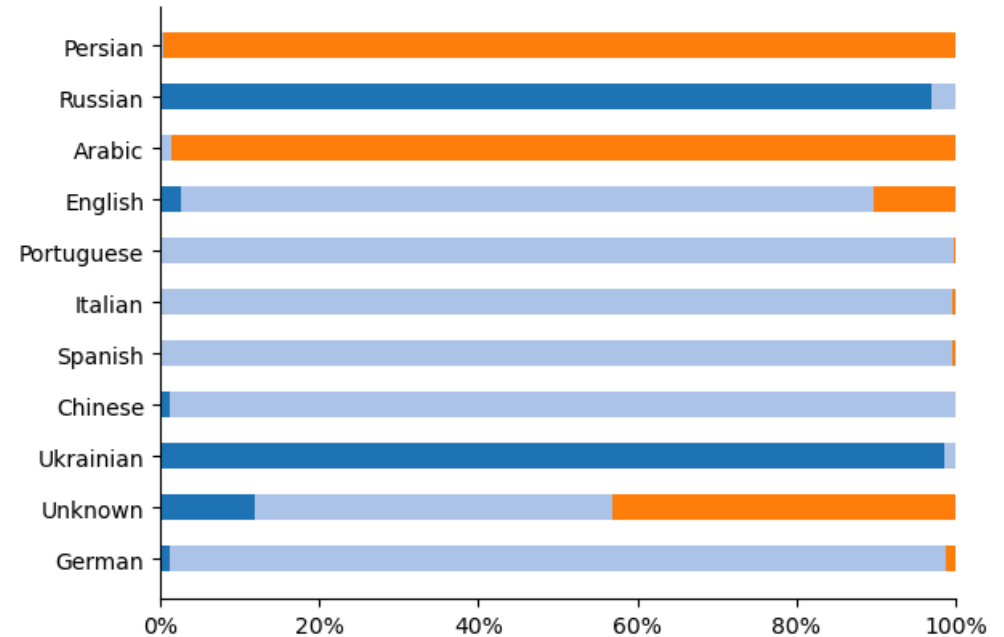
Tendency to forward from friends of my friends?
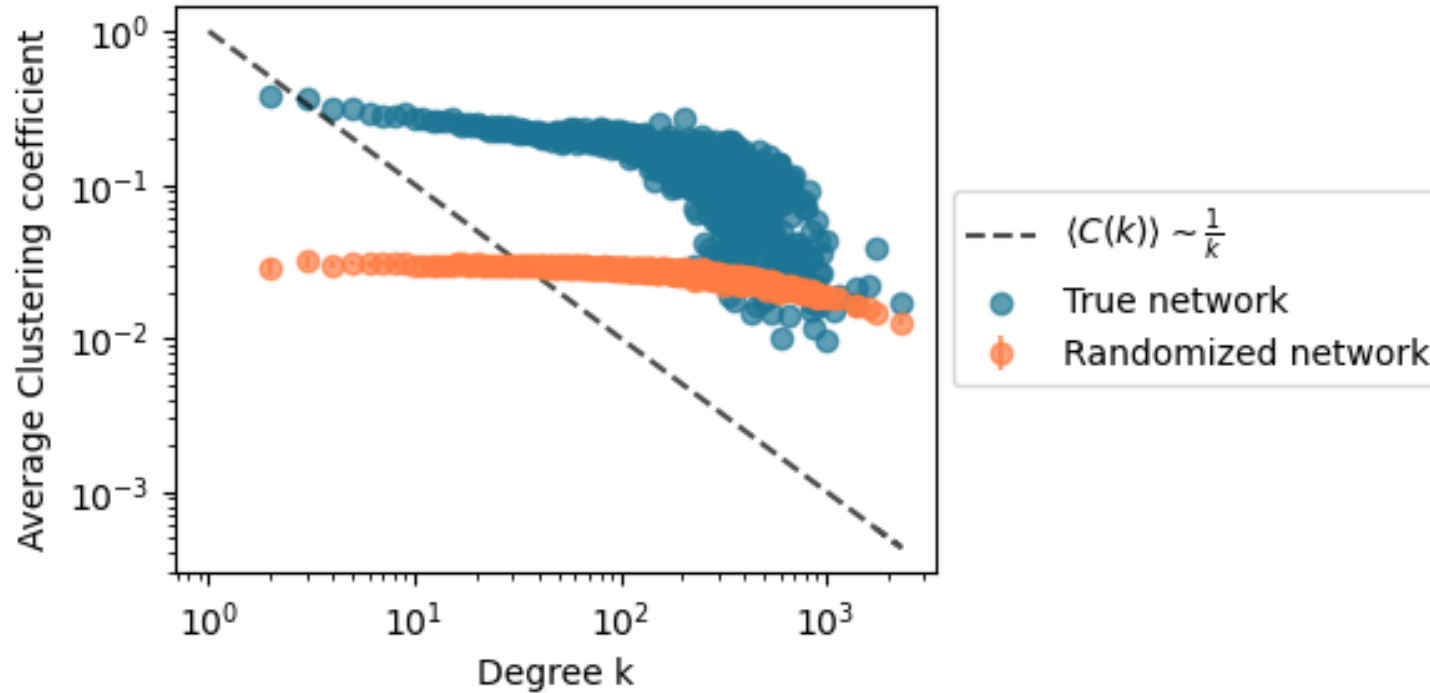
Ties formed preferably with same language…

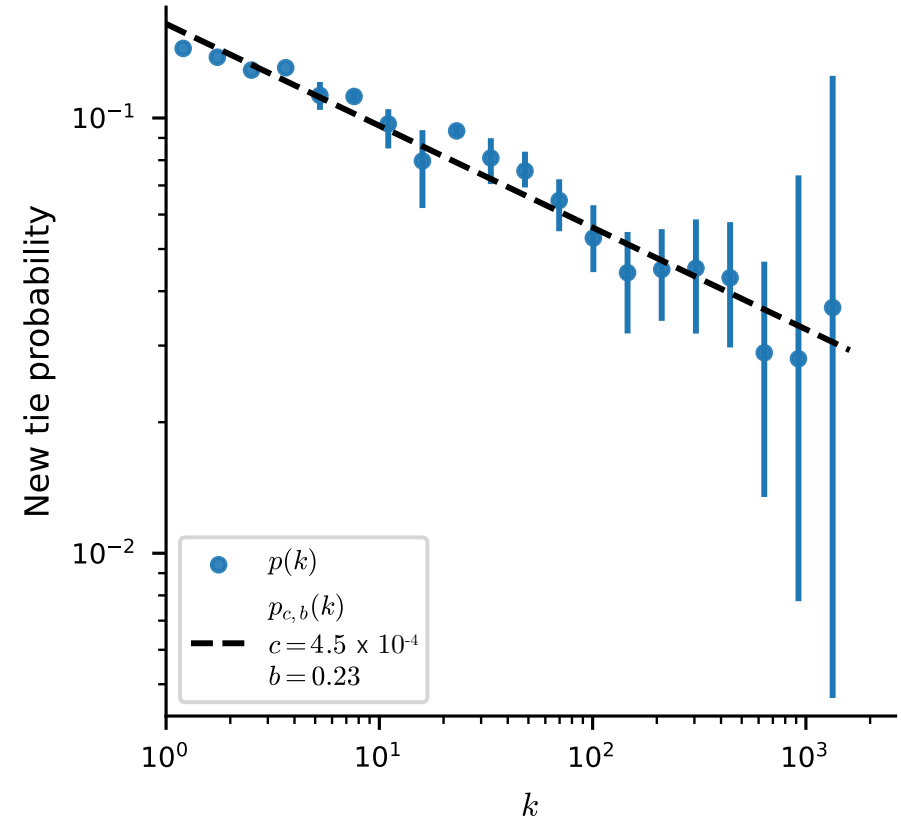## …also reflected in community partition (SBM)

Aversion to form too many ties
→ probability to form new ties should decrease with in-degree k_{in}.
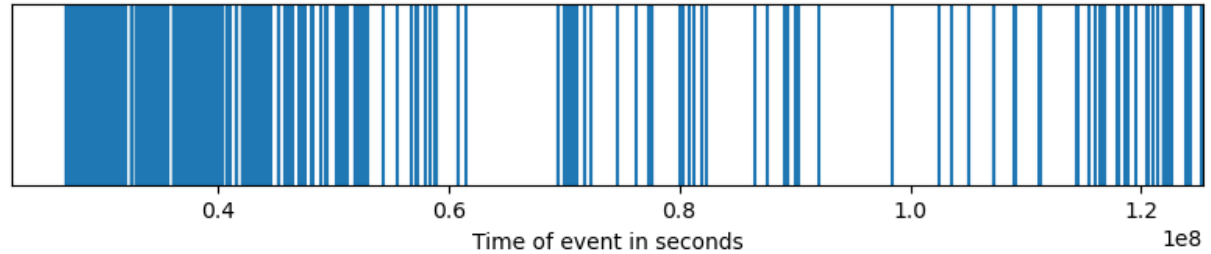
Model from (Ubaldi et al., 2016)

$$p_{\mathrm{new}}(k_{\mathrm{in}}) = \left(1 + \frac{k_{\mathrm{in}}}{c}\right)^{-b}$$

Legend:
- $p(k)$
- $p_{c,b}(k)$
- $c = 4.5 \times 10^{-4}$
- $b = 0.23$

Axis labels: New tie probability (y-axis), k (x-axis)

8

For all channels, get times between two forwarded messages = *inter-event times* τ

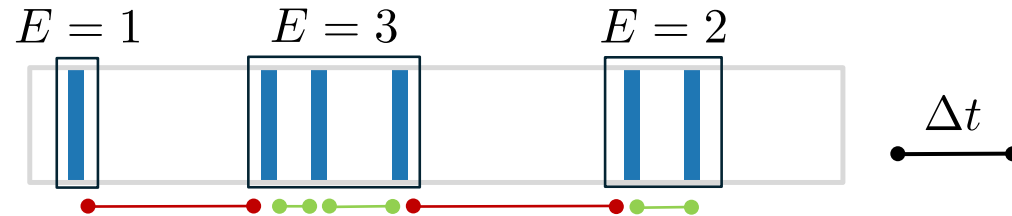↪ $f(\tau)$ is piecewise power-law, with two main regimes separated by $\tau = 1 \text{ day}$
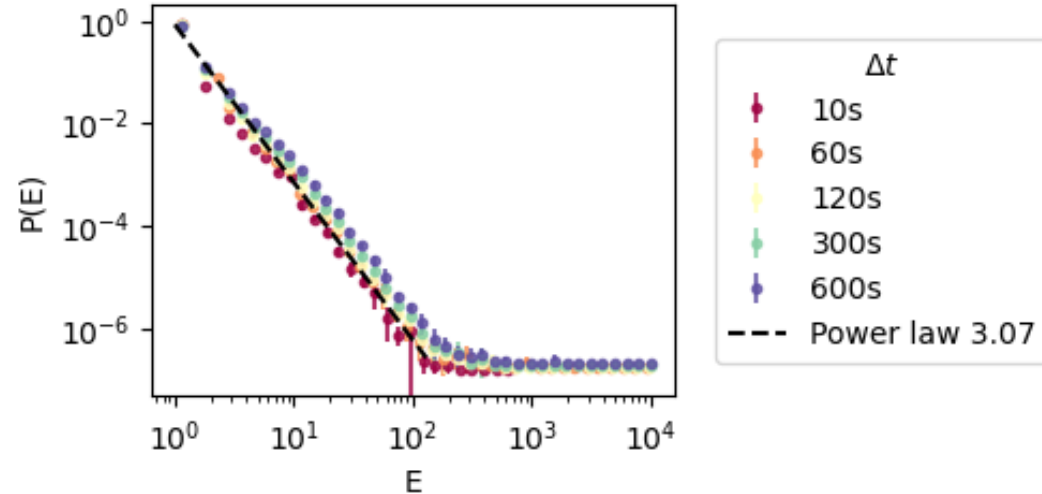

9
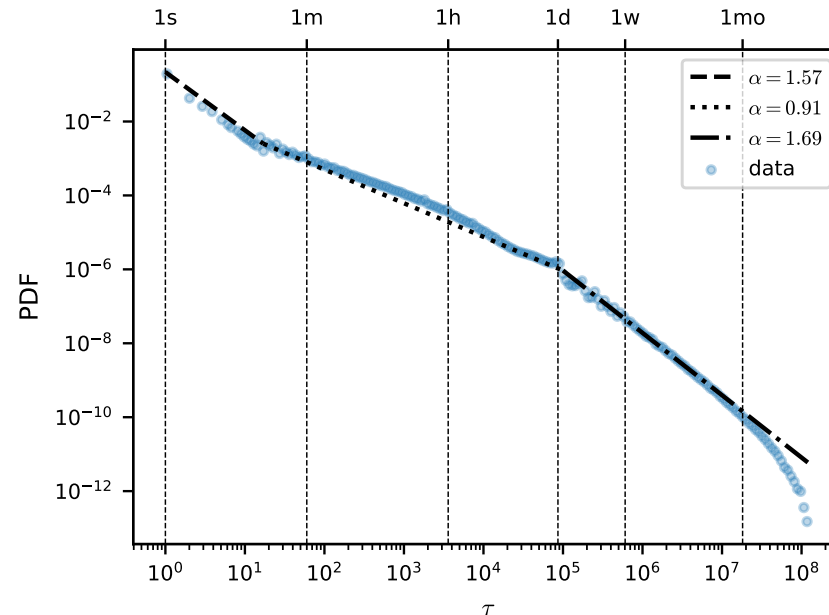
Investigate shape of distribution of *burst train sizes* E (Karsai et al., 2012):

We do have

$$p(E) \sim E^{-\beta}$$

↪ forwarding is bursty

Topology

- clustering
- power-law in/out-strength distributions
- language assortativity
- tendency to reinforce existing ties

Time

- two regimes
- burstiness

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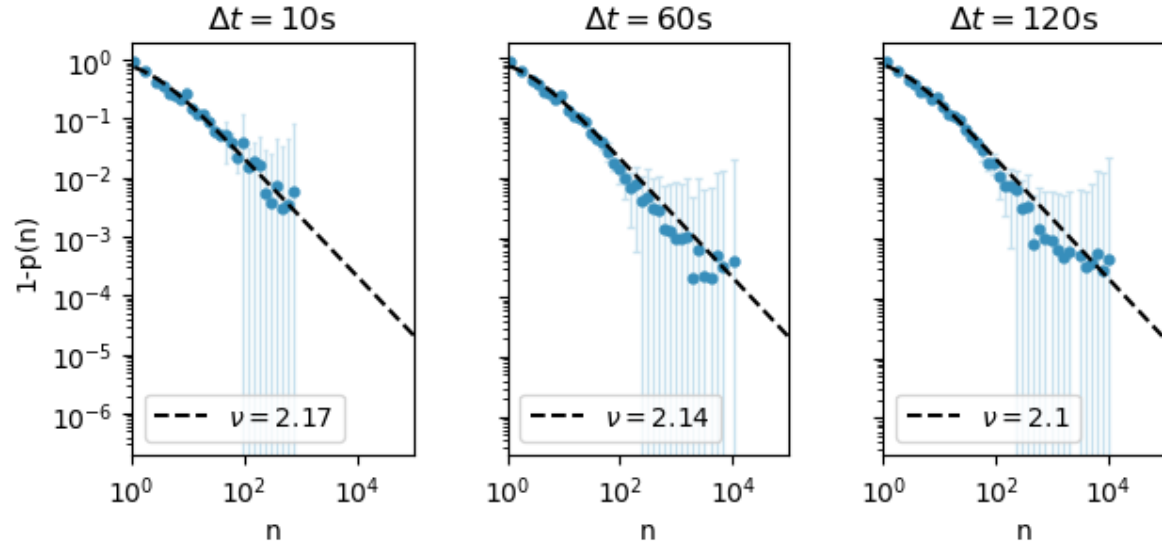- tendency to reinforce existing ties

Time

- two regimes
- burstiness

Simple-enough model that can reproduce these features?

↳ Could help simulate contagion model or equivalent and test effect of interventions on synthetic networks
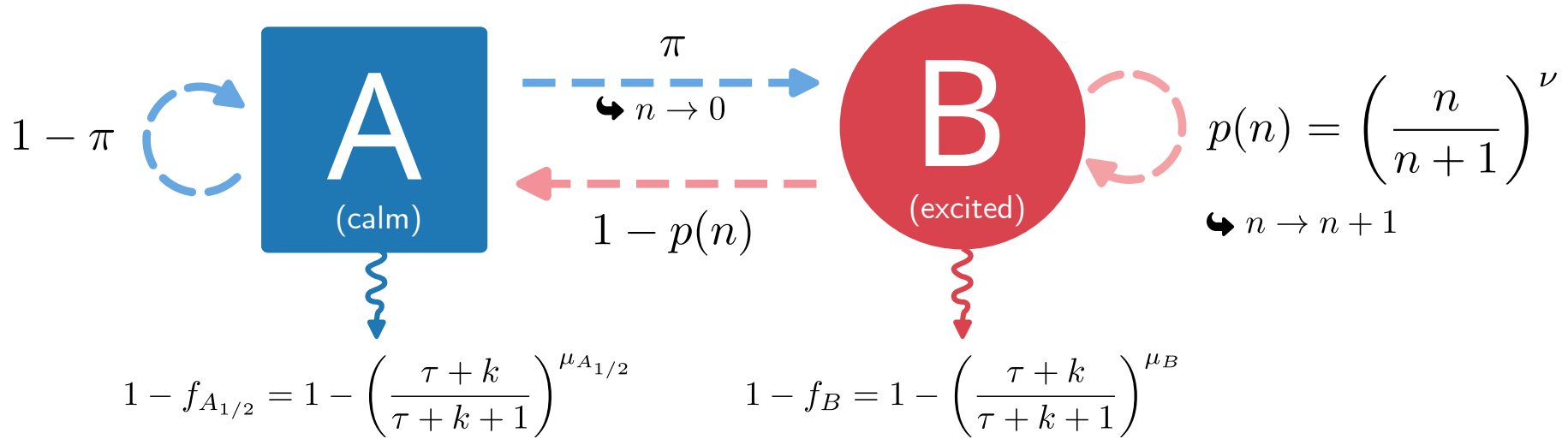
With already n events in a burst train, probability $p(n)$ to generate another within the same train?

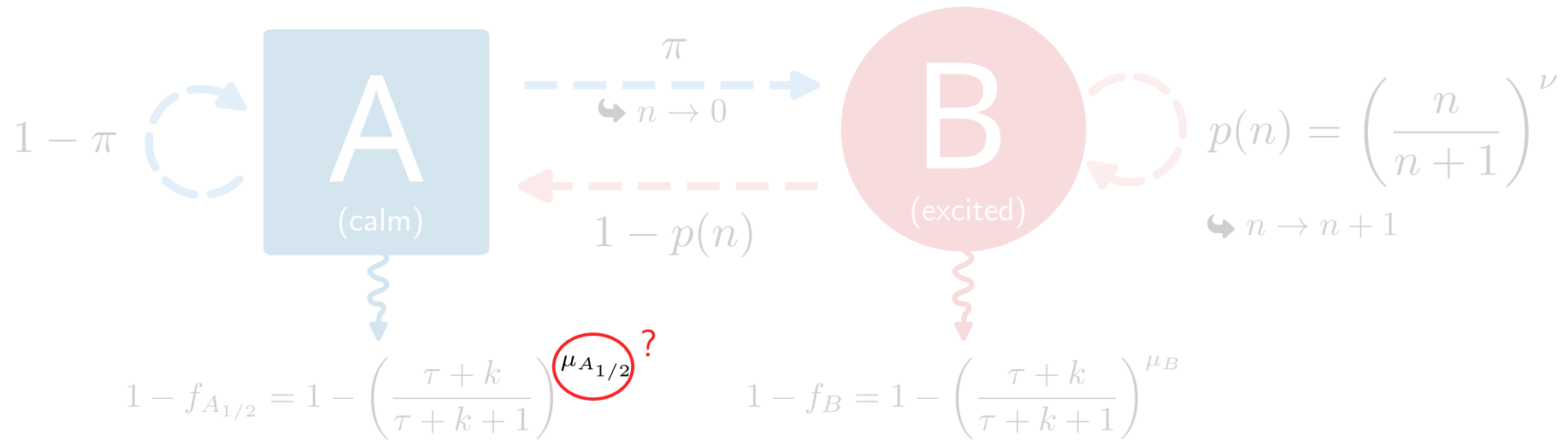
→ Train size distribution generated from memory process (Karsai et al., 2012)

$$p(E) \sim E^{-\beta} \Leftrightarrow p(n) = \left(\frac{n}{n+1}\right)^{\nu} \quad \text{with } \nu \approx \beta - 1$$

Generalisation from (Karsai et al., 2012)

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$$1 - \pi$$

$$\pi$$

$$\hookrightarrow n \to 0$$

A
(calm)

B
(excited)

$$1 - p(n)$$

$$p(n) = \left(\frac{n}{n+1} \right)^{\nu}$$

$$\hookrightarrow n \to n+1$$

$$1 - f_{A_{1/2}} = 1 - \left(\frac{\tau + k}{\tau + k + 1} \right)^{\mu_{A_{1/2}}} \text{ ?}$$

$$1 - f_{B} = 1 - \left(\frac{\tau + k}{\tau + k + 1} \right)^{\mu_{B}}$$

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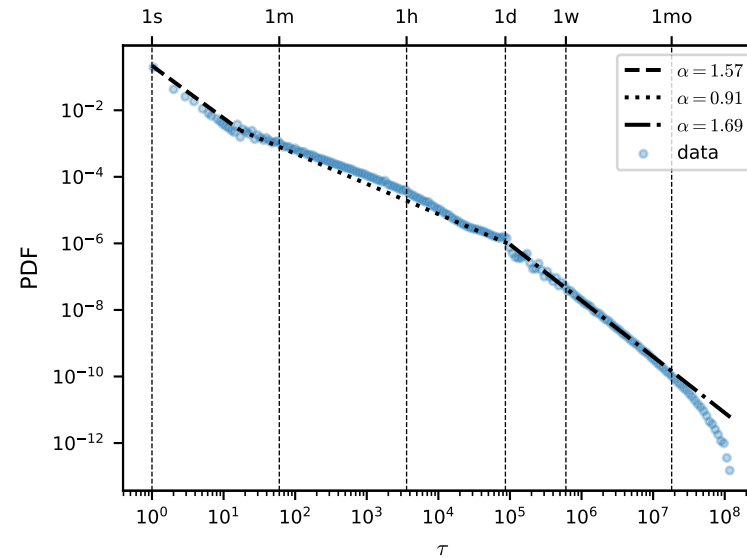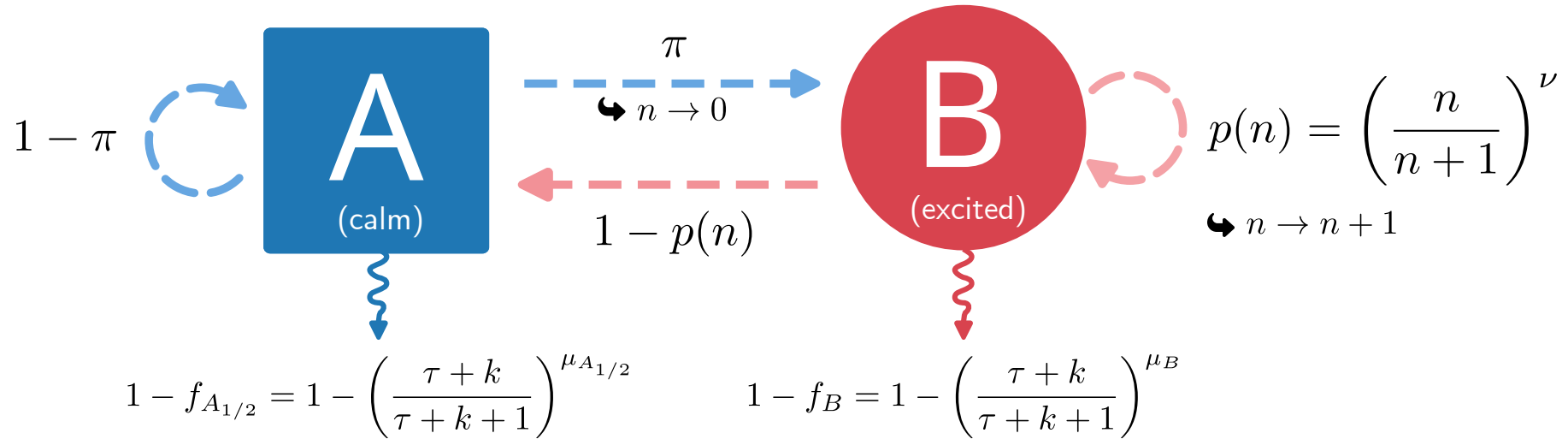
Adapted from (Laurent et al., 2015)
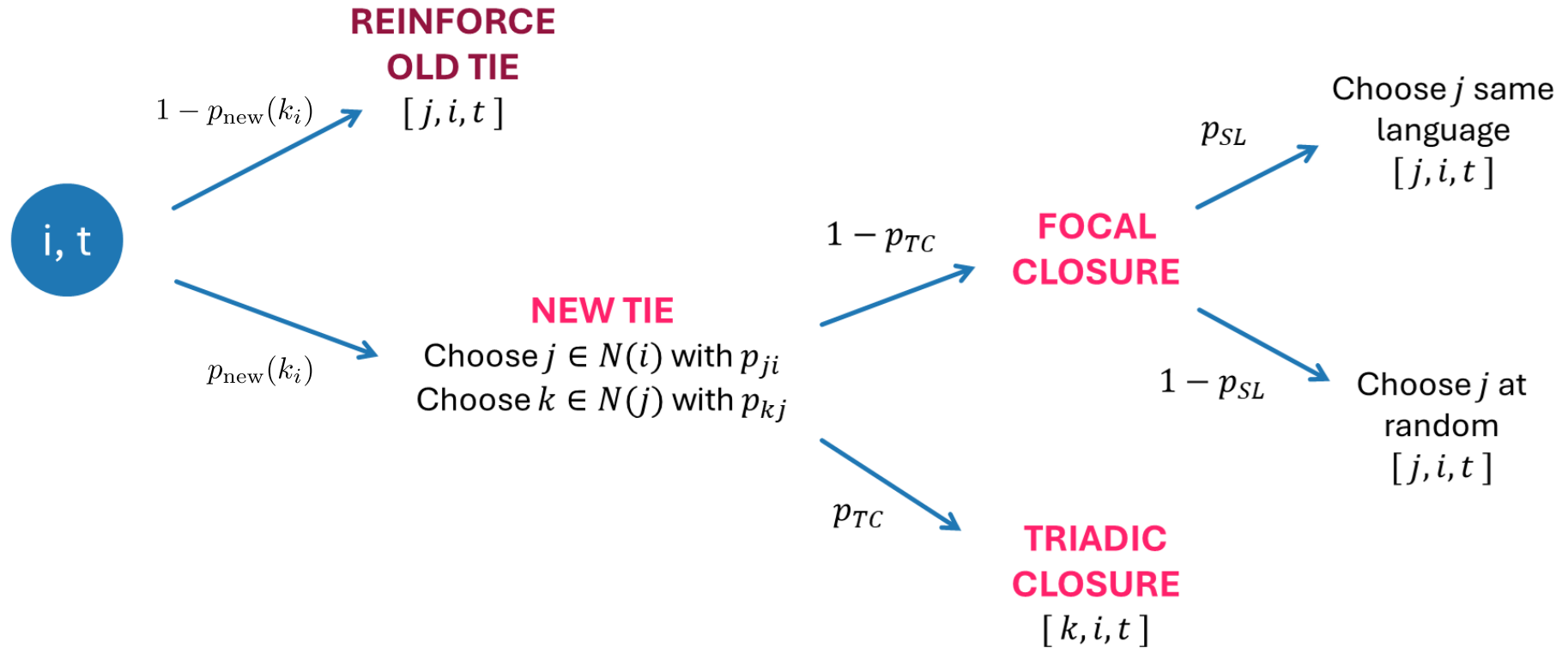
Fitted time model (π, $\mu_{A_{1/2}}$, μ_B, k) to reproduce piecewise power-law $p(\tau)$
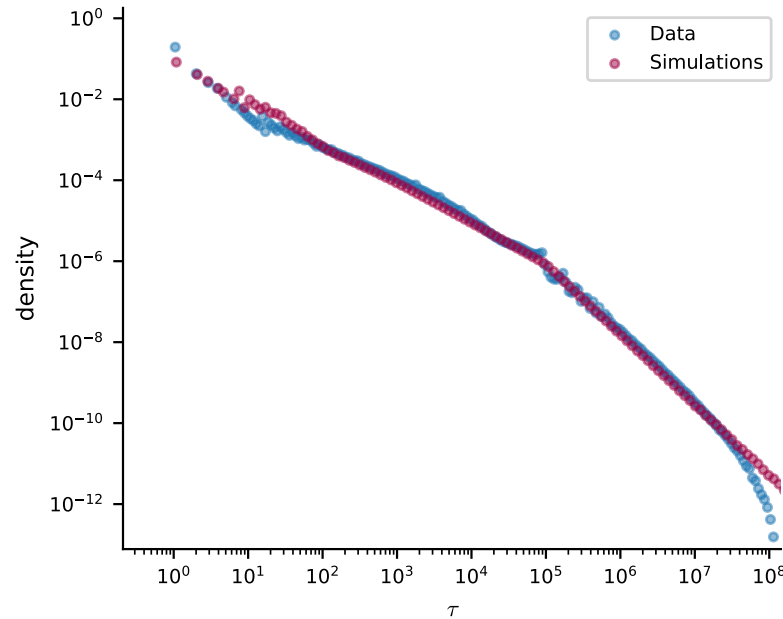
↪ *It fits* (+ it runs fast: $\sim 10s$) ($\pi \approx 0.20, \mu_{A_1} \approx 0.019, \mu_{A_2} \approx 0.74, \mu_B \approx 4.8, k = 81$)

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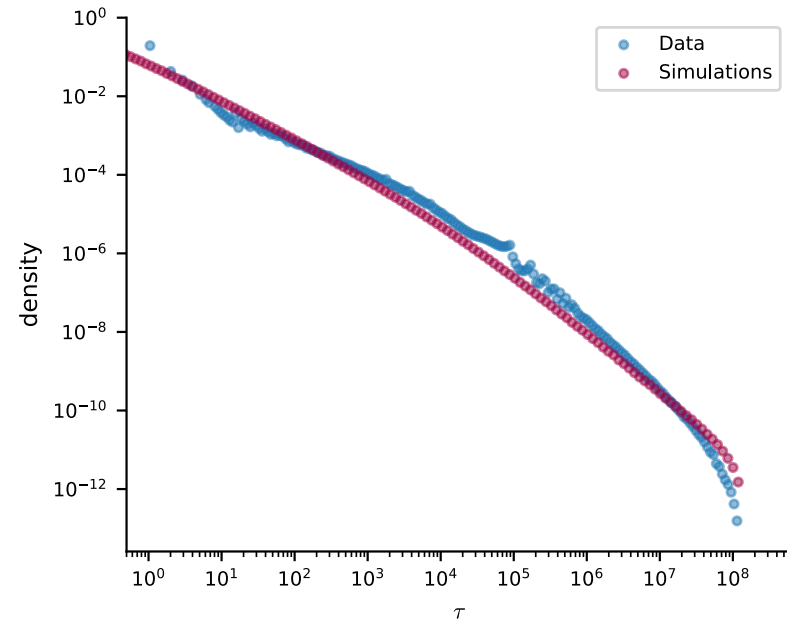
Issue: no guarantee average event rate for nodes is conserved.

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→ What if we just contract/dilate time to fit event rates?
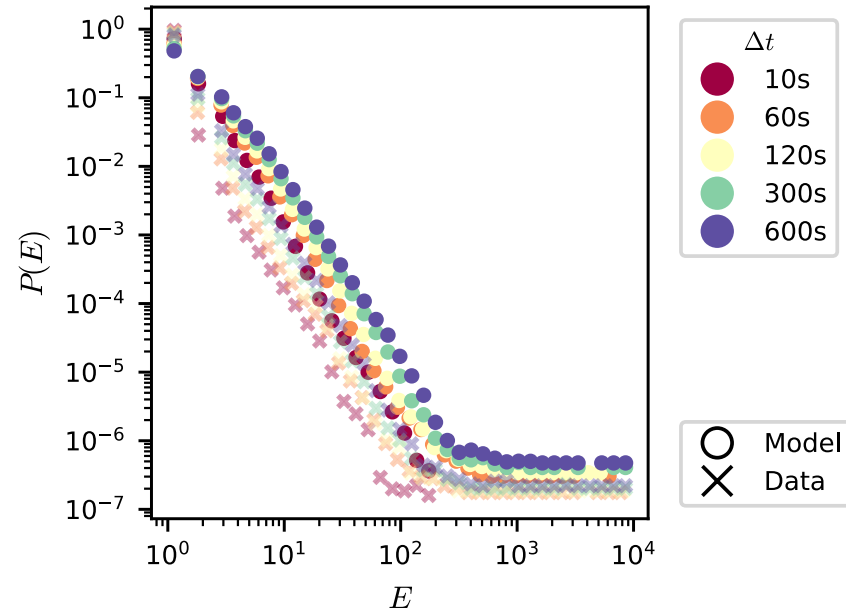
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↪ very similar β in $p(E) \sim E^{-\beta}$

What we've shown...

- Network of Telegram channels is very social-network-like
- Main mechanisms behind its emergence: tie reinforcement, clustering, language assortativity + memory process

...and what this leads to

- Model information propagation and effect of interventions
- Very global view of temporal process: what about local coordination?

and much more!

Thanks for your attention 🤗

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