Pedestrian Dynamics

In different scenarios

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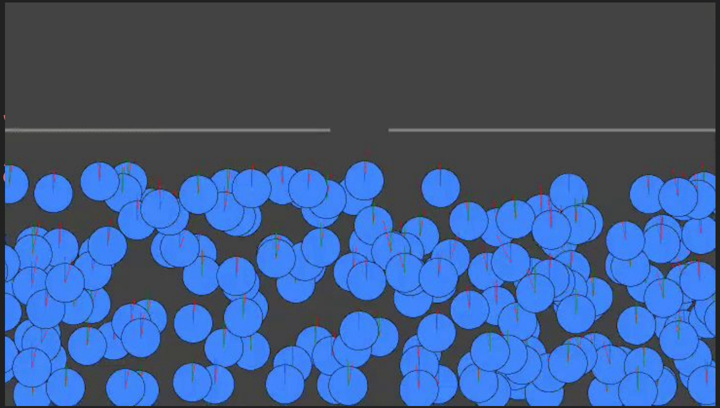
Motivation

- Busy train station
- Risk of clogging (faster-is-slower)
- Analysis of behavior can help with prevention

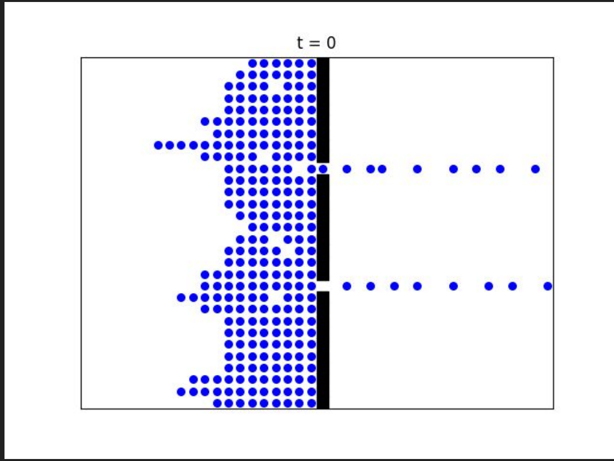


More about pedestrian dynamics

Avoid collisions while maintaining their desired speed.

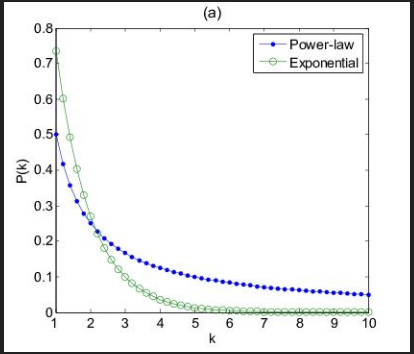
Attraction towards destination

Repulsion from others or obstacles



Problem definition and hypotheses

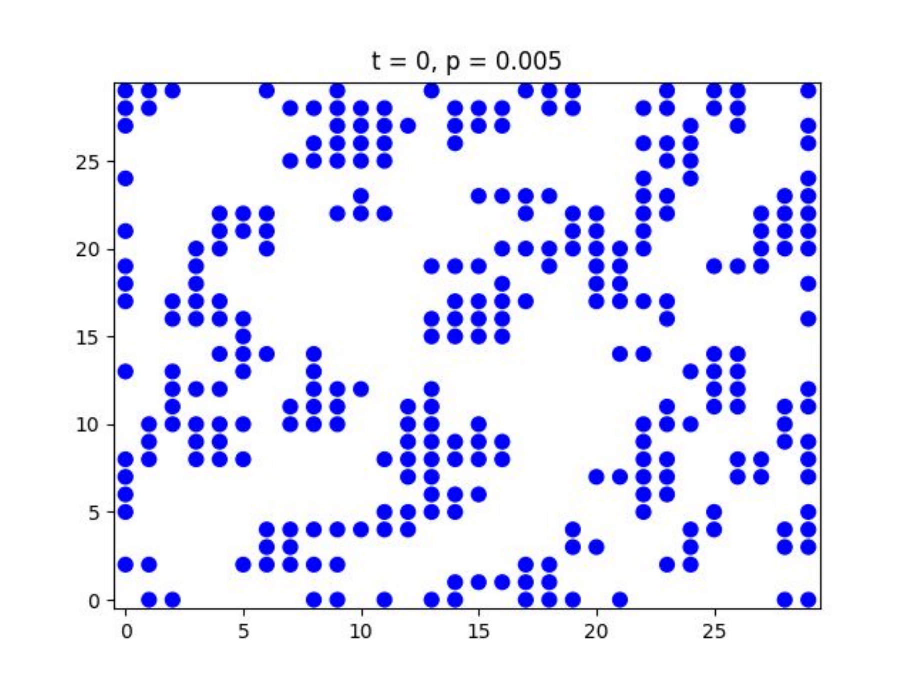
- Can we find emergent behavior in our system?
    - Clusters/jams and lane formation
- How does density affect cluster/jam distributions
    - Higher density -> more clusters and jams
- Is there a power law somewhere?
    - Cluster/jam size distribution



Simple model - cluster forming

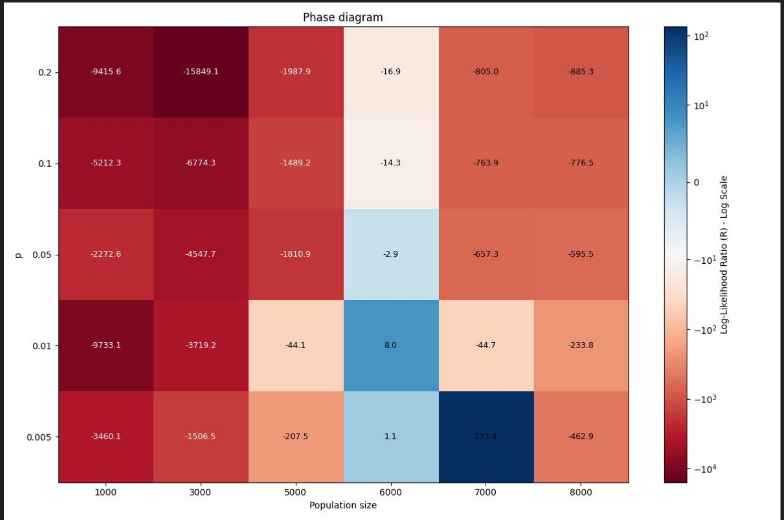
- Random chosen direction
- Probability p to change direction at each move
- Only attempts to move when possible
- Move is blocked? Stay in place.

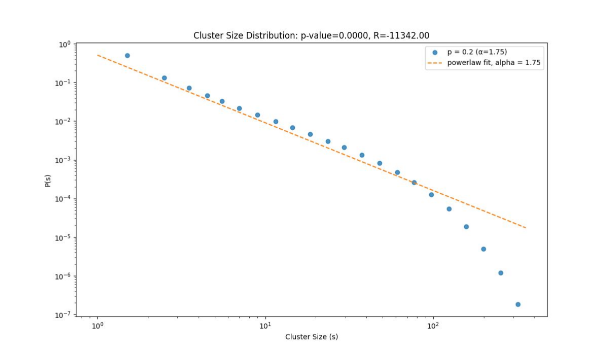
- Not very realistic: discrete grid & random movement

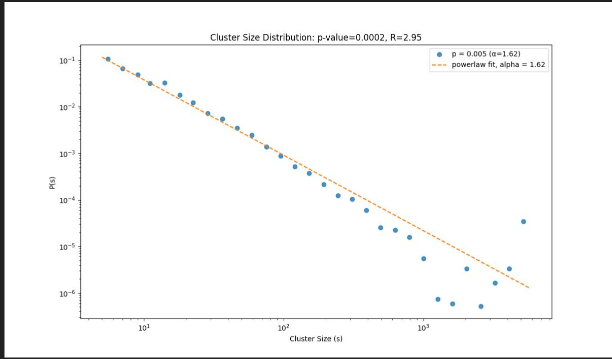


Phase diagram

- Grid size 100*100
- Cluster size probability
- Power law for small p and high density?
- Exponential cut off
- Finite size effect

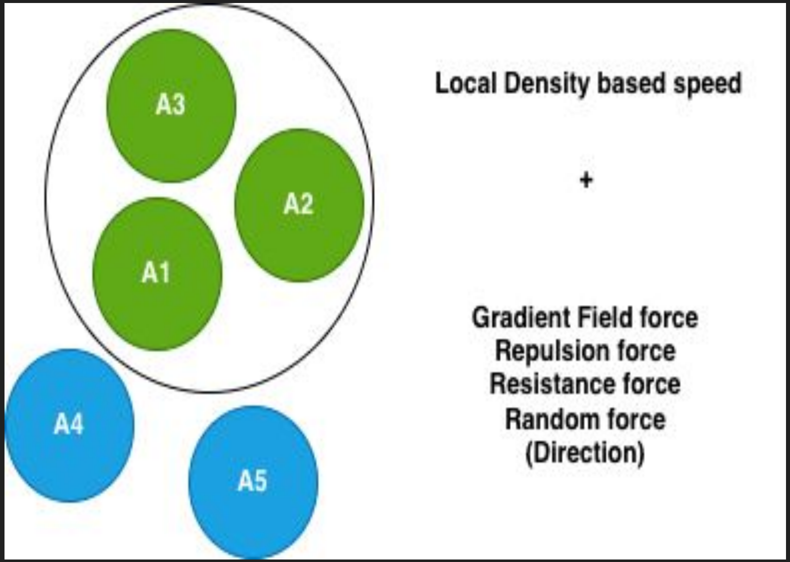


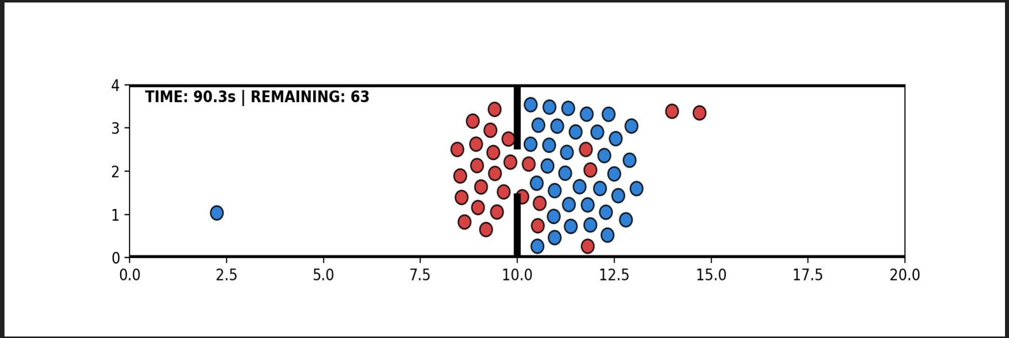




Continuous AB Models

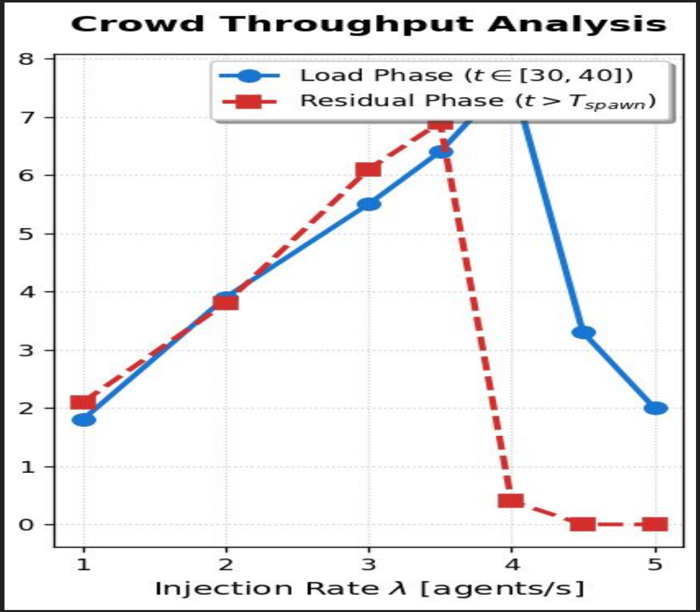
- AB Models are continuous space + physics based.
- Agents have psychological and body forces for drive.
- Exhibits emergent lane formation and congestion.





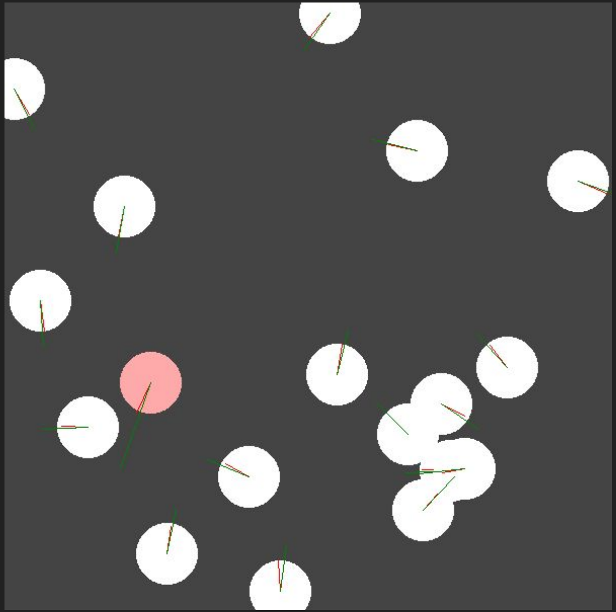
Formalizing Complexity Measurement

- Easy to observe complex behaviour ; Challenging to quantify them.
- Which model parameters cause such phase transitions?



Time-to-collision Dynamics

- Power law connects E-tau
  (tau: time-to-collision, ttc)
- Energy gradient is the moving force
- People ignores obstacles far away: large time-to-collision is supposed to cut-off energy



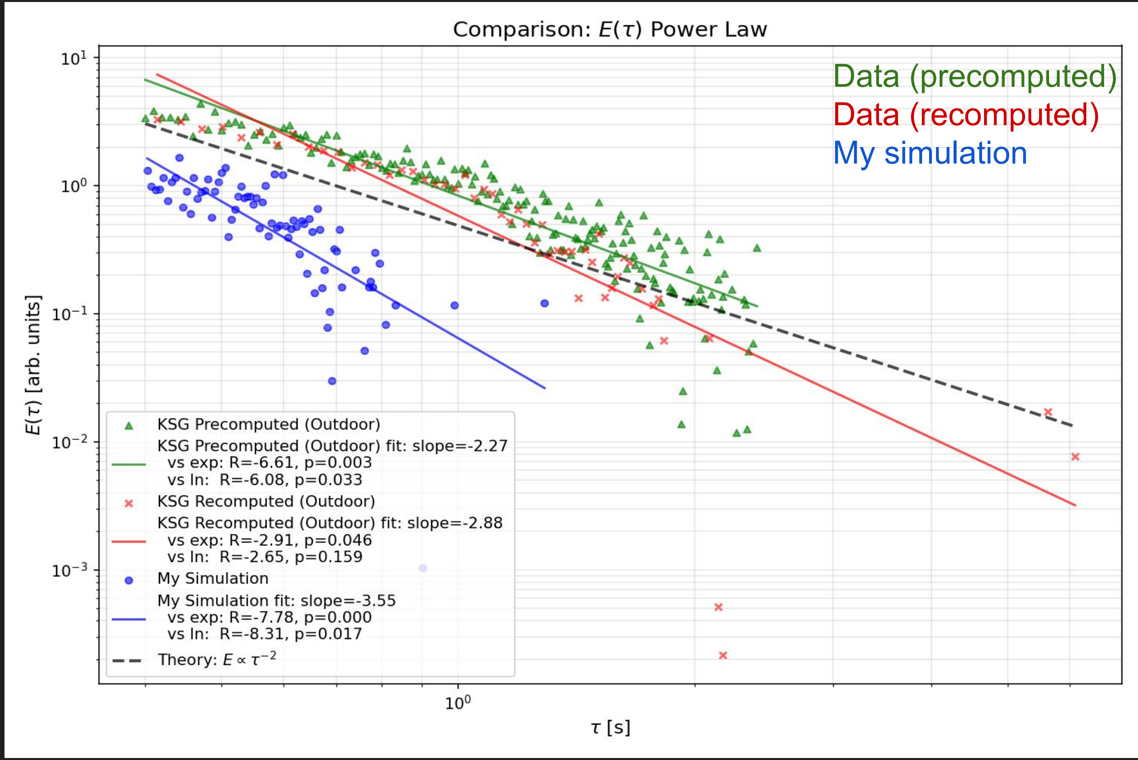
$$E(\tau) = \frac{k}{\tau^2} e^{-\tau/\tau_0}.$$

$$\mathbf{F} = -\nabla_{\mathbf{r}} \left(\frac{k}{\tau^2} e^{-\tau/\tau_0} \right),$$

"Universal Power Law Governing Pedestrian Interactions", PRL 113, 238701 (2014)

Ioannis Karamouzas,Brian Skinner, and Stephen J. Guy

Universal Power Law



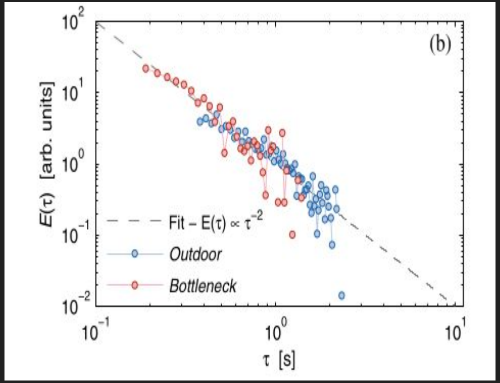
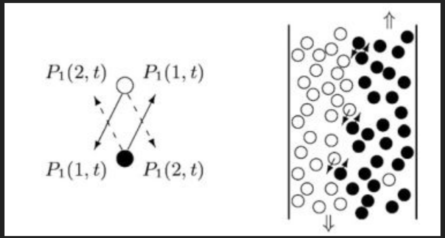


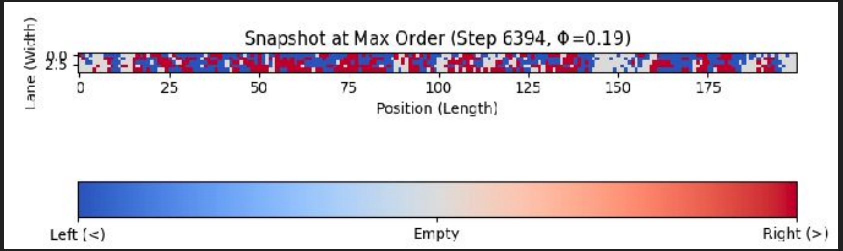
Fig. from K-S-G 2014

Emergence / Self-organized Lanes



Lanes

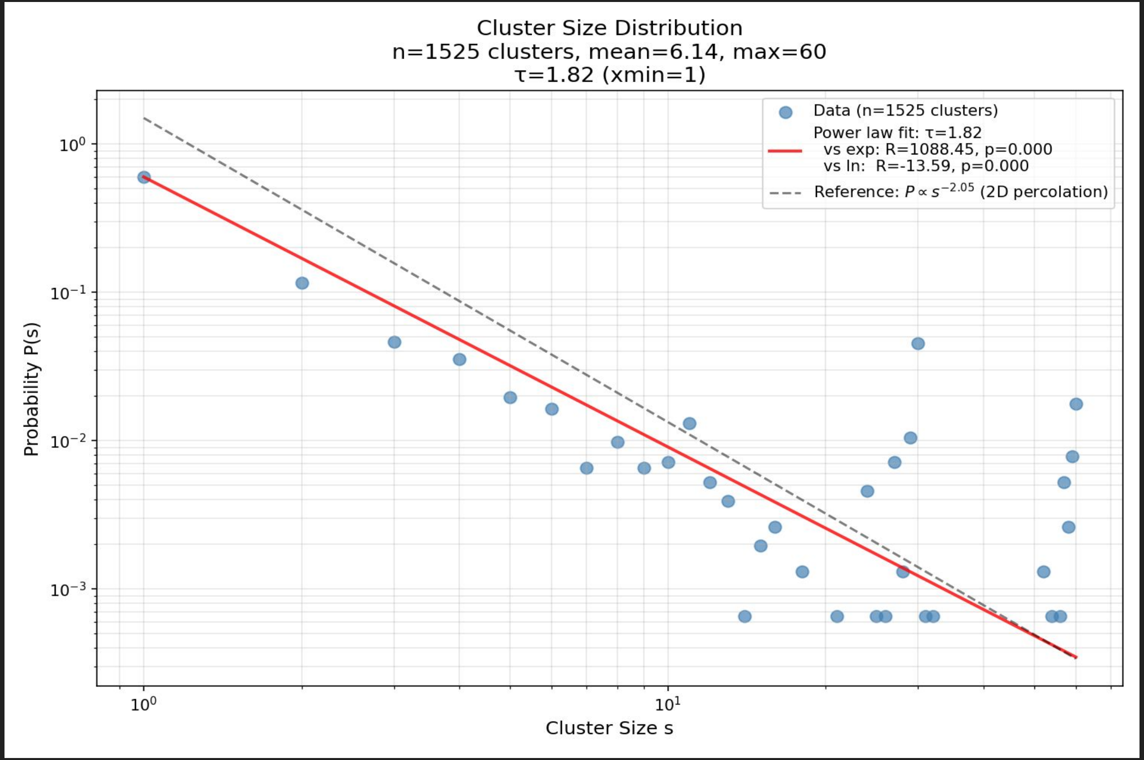
Are Hard to define

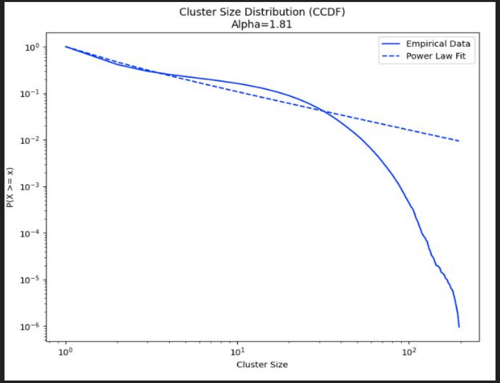


“Quantitative Sociodynamics”, 2nd Edition, Dirk Helbing

CA-based reference

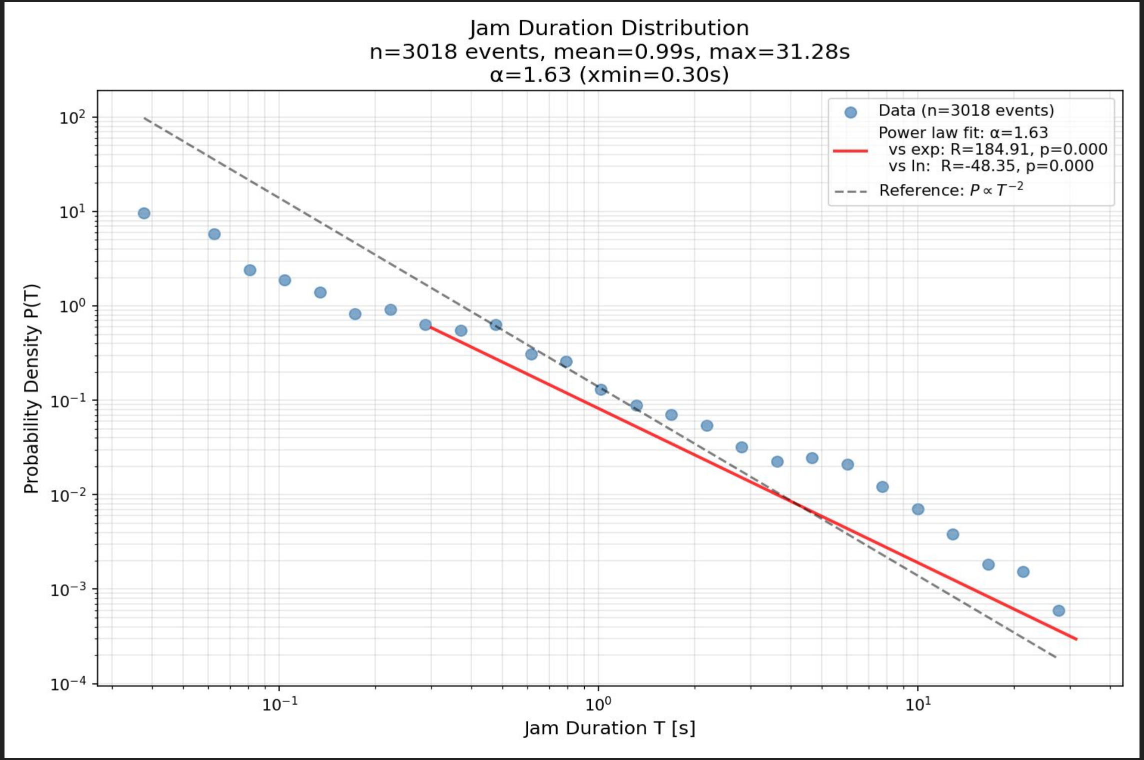
Cluster Size Distribution (Power Law?)

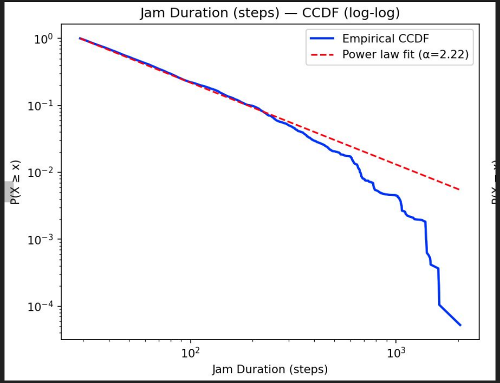




CA-based reference

Jam Duration Distribution (Power Law?)





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Future work