Communities to Communications
My Research Blurb

B R Vinay Kumar

Introductory talk, NETWORKS Day
January 22, 2024
Allard Pierson Museum
Amsterdam, The Netherlands

Brief Bio

- PhD: Dept. of ECE, Indian Institute of Science, Bengaluru.
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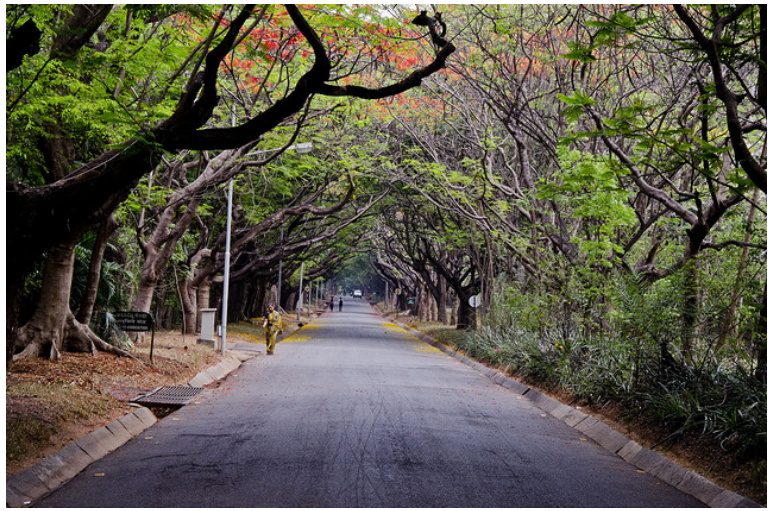

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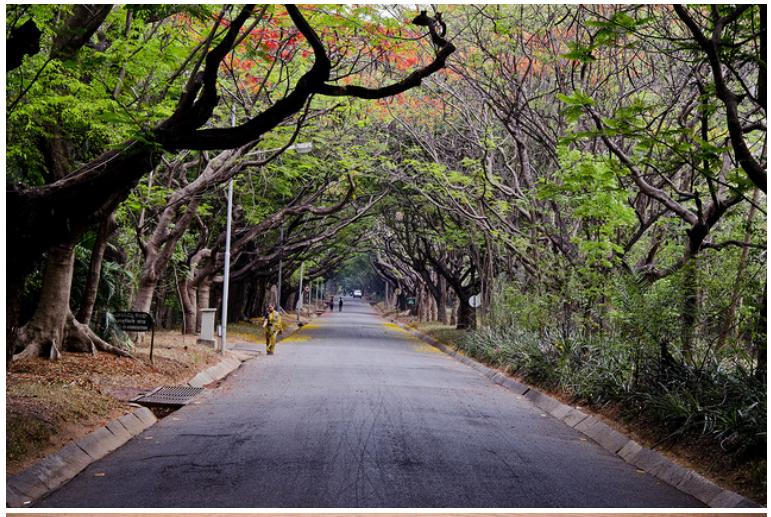

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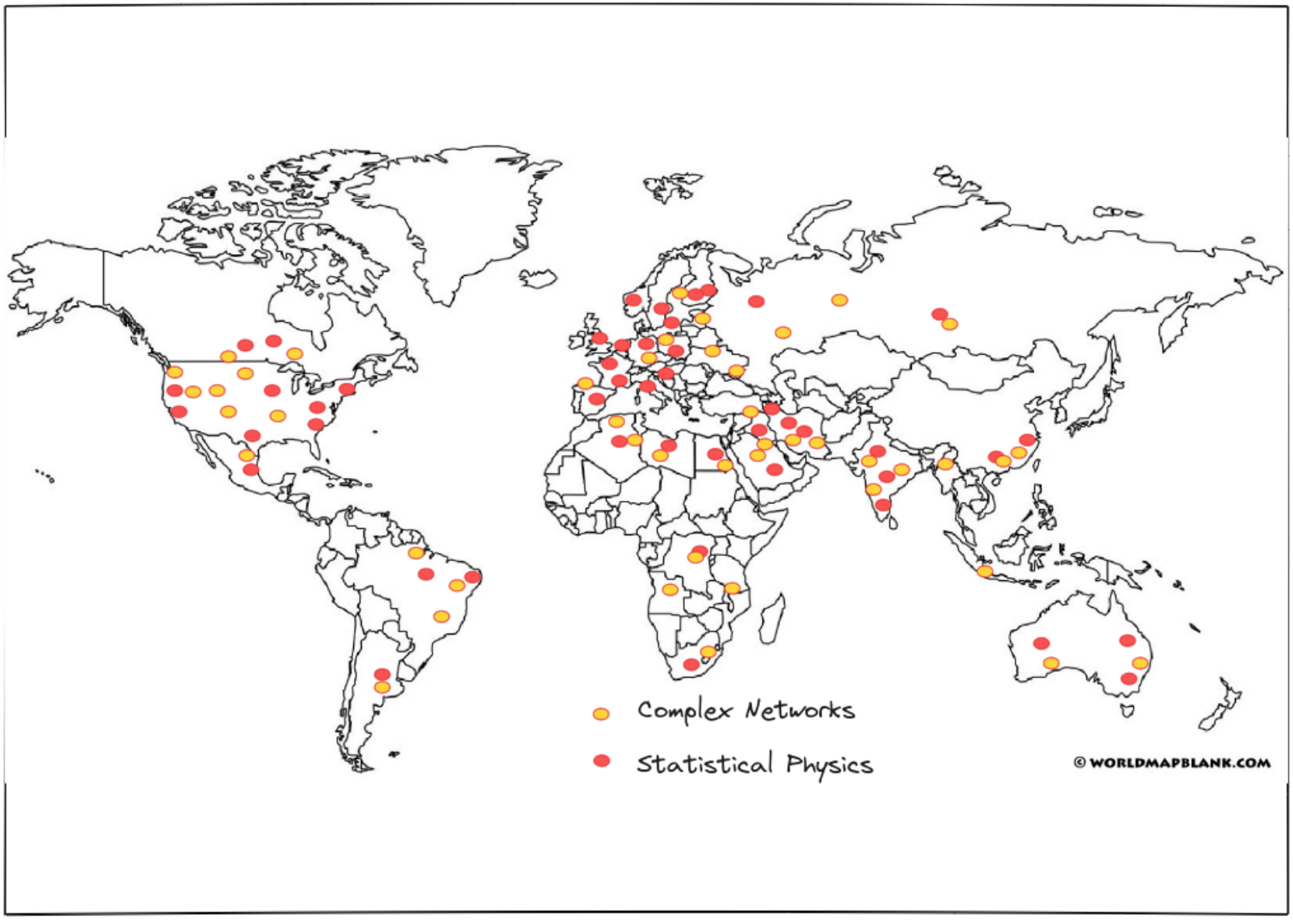
Research interests

- random graphs/geometric graphs
- inference on graphs / community detection
- percolation/spreading process

Goal: Propose and analyze robust mathematical models that can capture observed physical phenomena

Community detection: co-authorship network



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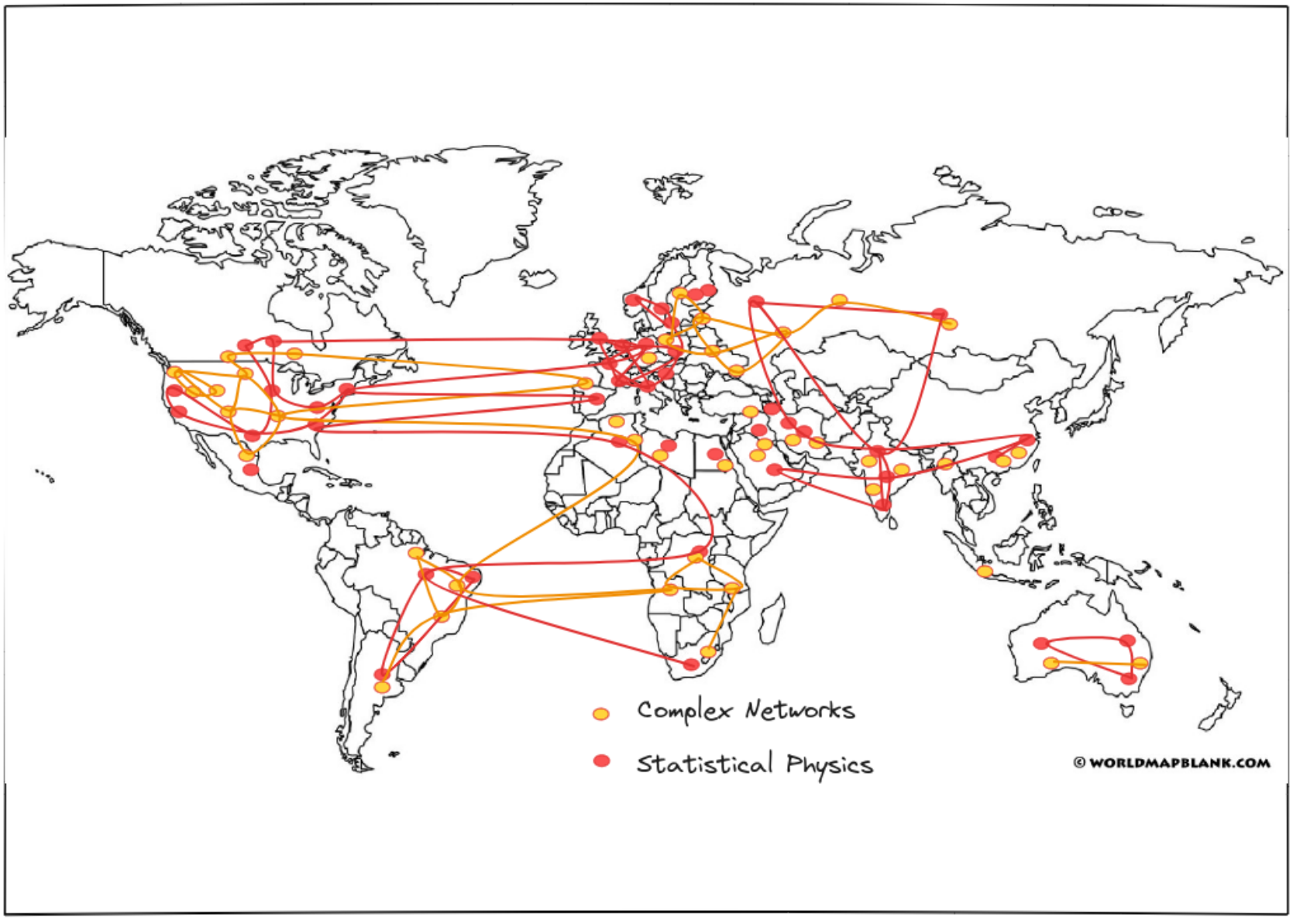

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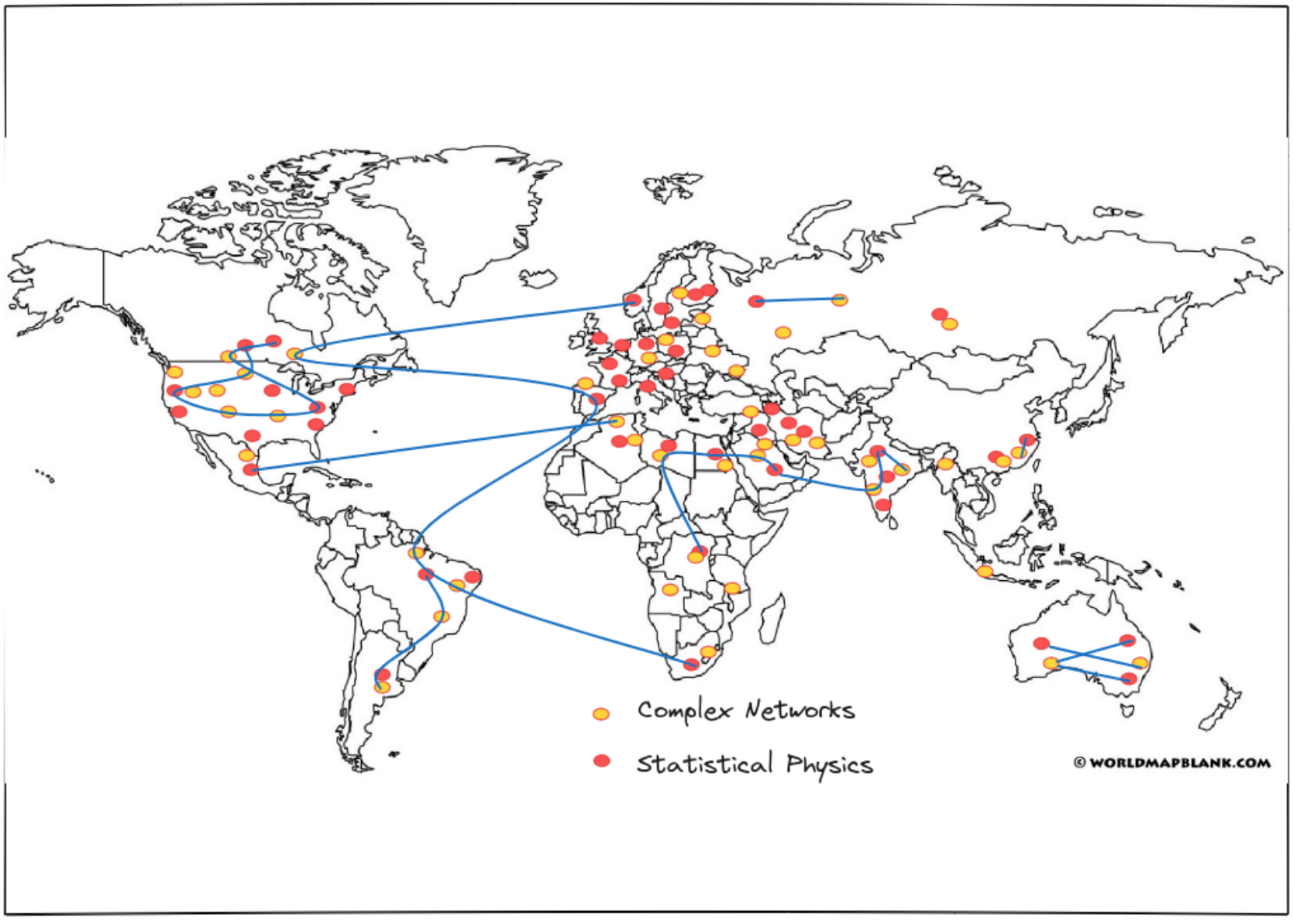
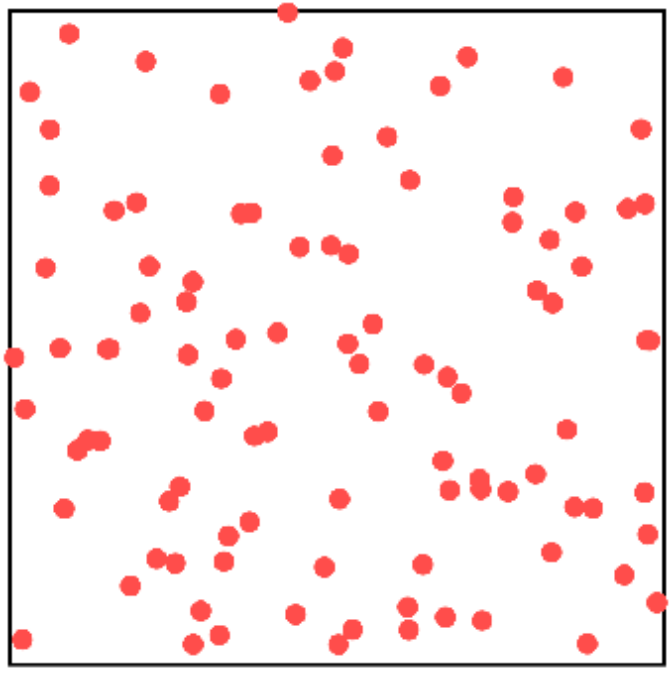


Euclidean Random Graphs

- Locations: $\mathbf{X} \sim$ PPP(λn) on $\mathbf{S} = \left[-\frac{1}{2}, \frac{1}{2}\right]^d$



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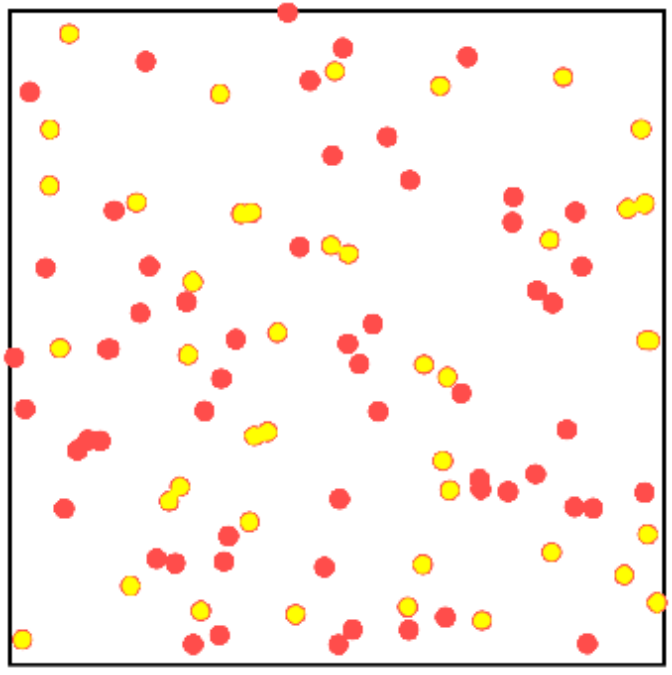

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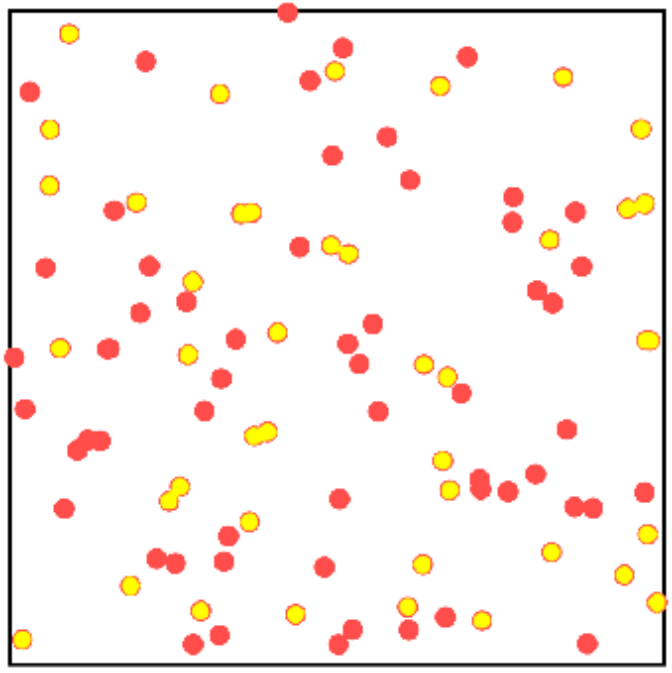
- Geometric kernel: $\phi \colon \mathbf{S} \times \mathbf{S} \to [0, 1]$



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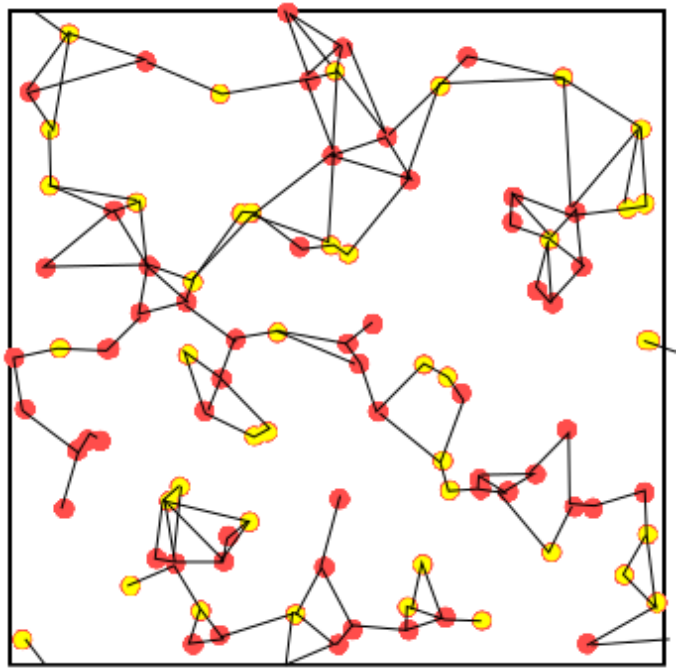

Given locations $\mathbf{X}$ and communities $\boldsymbol{\sigma}$

$$A_{uv} = 1 \begin{cases} \text{with prob. } p\ \phi(||X_u - X_v||) & \text{if } \sigma(u) = \sigma(v) \\ \text{with prob. } q\ \phi(||X_u - X_v||) & \text{if } \sigma(u) \neq \sigma(v) \end{cases}$$

$$\mathbf{A} = (A_{uv})_{u,v=1}^{N} \sim GKBM(\lambda n, p, q, \phi)$$

Abbe, E., Baccelli, F., and Sankararaman, A. (2021). Community detection on Euclidean random graphs. Information and Inference: A Journal of the IMA, 10(1), 109-160.

Problem Setting and Results

$$\mathbf{A} \sim GKBM(\lambda n, p, q, \phi)$$

Problem: Given the locations $\mathbf{X}$ and the adjacency matrix $\mathbf{A}$, recover $\boldsymbol{\sigma}$ exactly.

- An estimate $\hat{\boldsymbol{\sigma}}_n$ of $\boldsymbol{\sigma}_n$ recovers the communities exactly if

$$\lim_{n\to\infty} \mathbb{P}\left(\hat{\boldsymbol{\sigma}}_n \in \{\pm\boldsymbol{\sigma}_n\}\right) = 1$$

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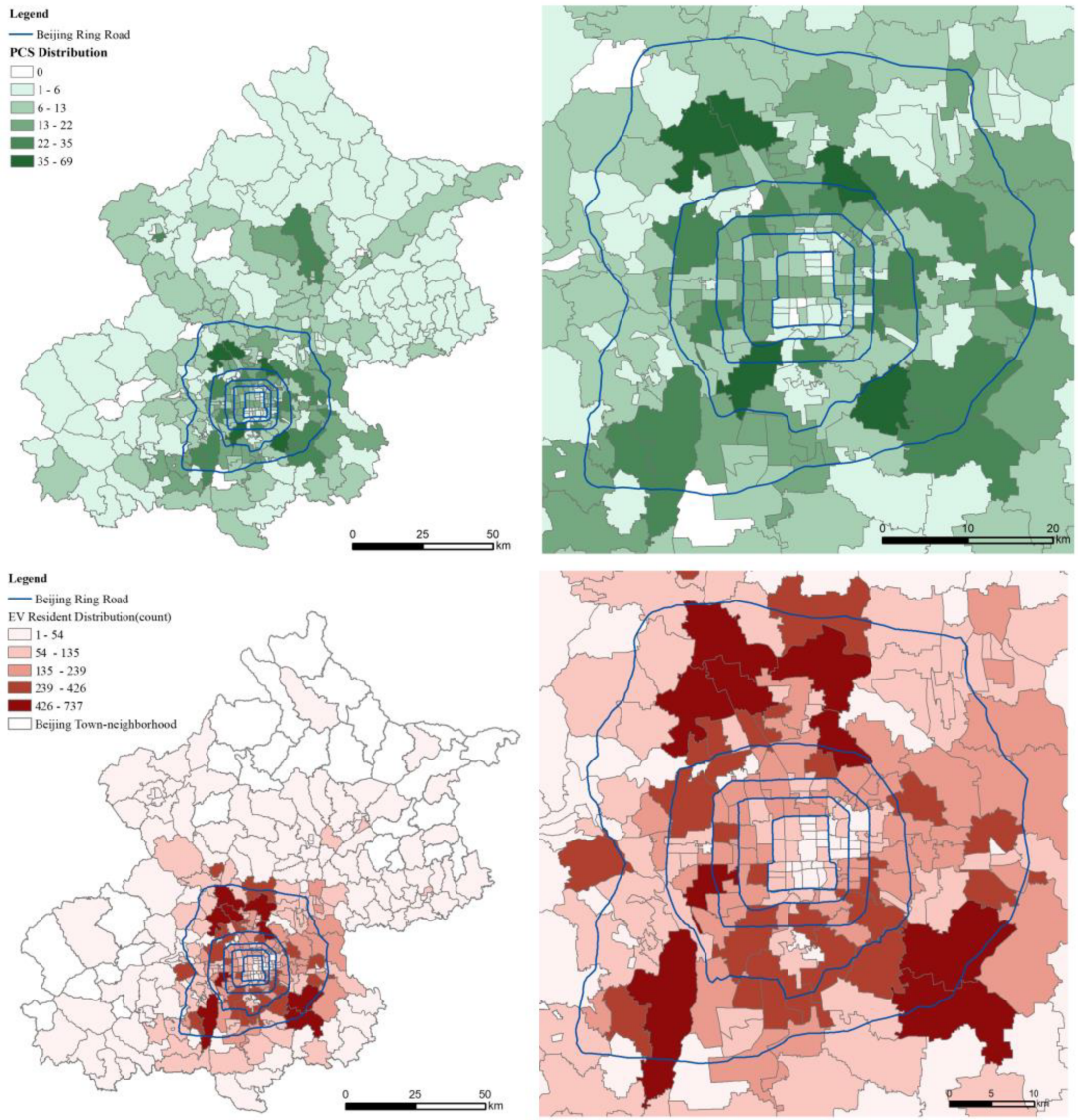
Main Results

- Impossibility: If $I_\phi(p, q) < 1$, no algorithm can recover the communities exactly.

- Achievability: There exists a polynomial time algorithm achieving exact-recovery whenever $I_\phi(p, q) > 1$

Electric vehicles



Kang, J., Kan, C. and Lin, Z., 2021. Are electric vehicles reshaping the city? An investigation of the clustering of electric vehicle owners' dwellings and their interaction with urban spaces. ISPRS International Journal

EV Problem formulation

Evaluate load imbalance on EV charging framework induced due to user mobility patterns.

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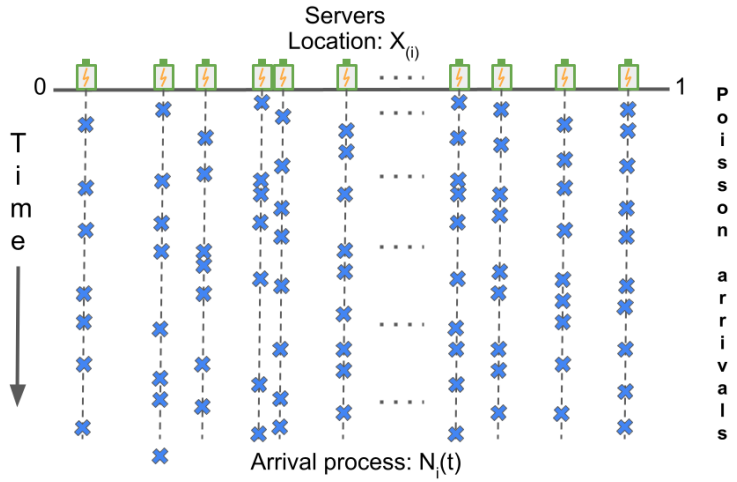
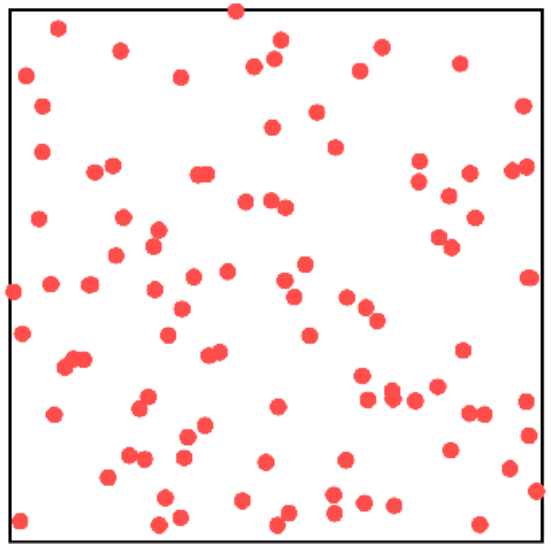
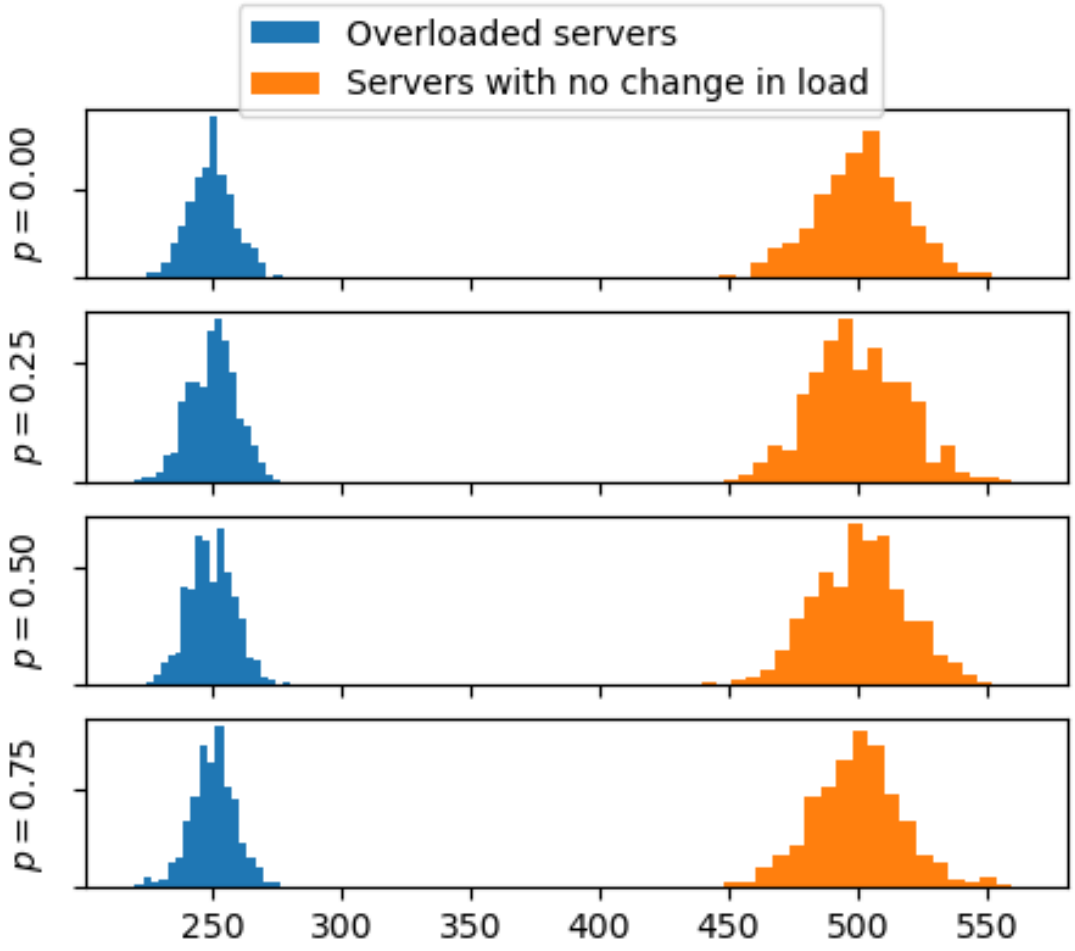
- n charging stations distributed uniformly in $[0, 1]^d$
- Arrival queues of rate λ each
- Arrivals stay in queue with probability p or jump to nearest neighbour with probability $1 - p$ independently
- Problem: Characterize the charging stations that see an arrival rate $> \lambda$.





EVCS distribution

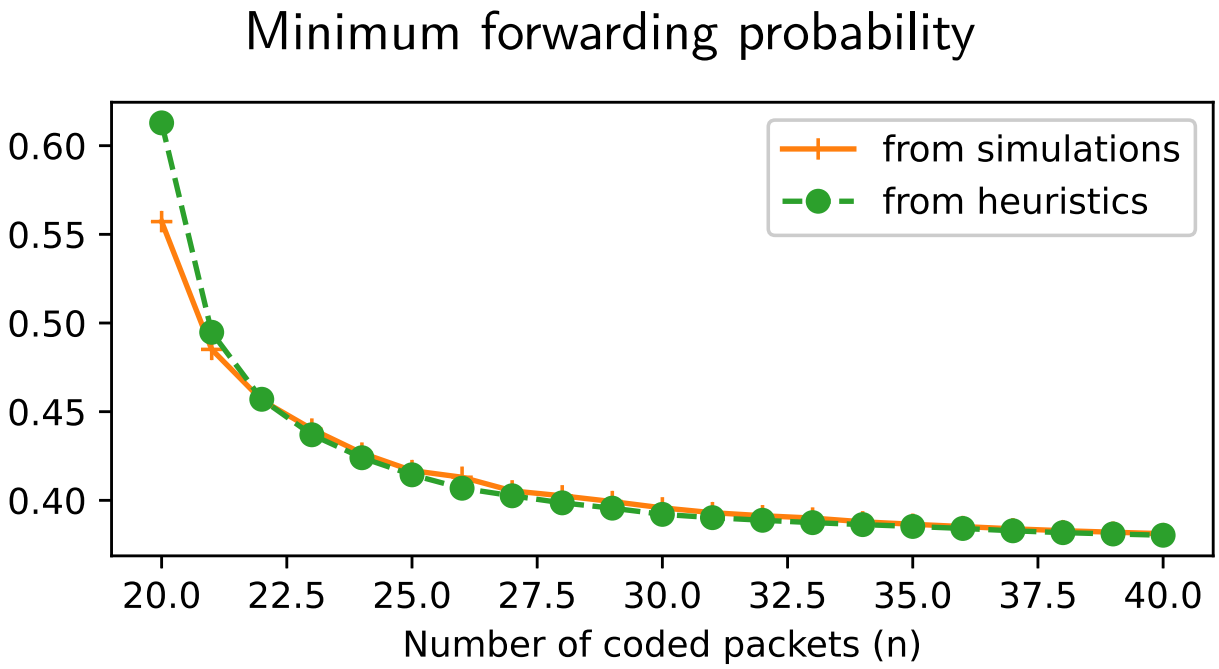
Histogram of the overloaded EVCS for $n = 1000$ in 1d



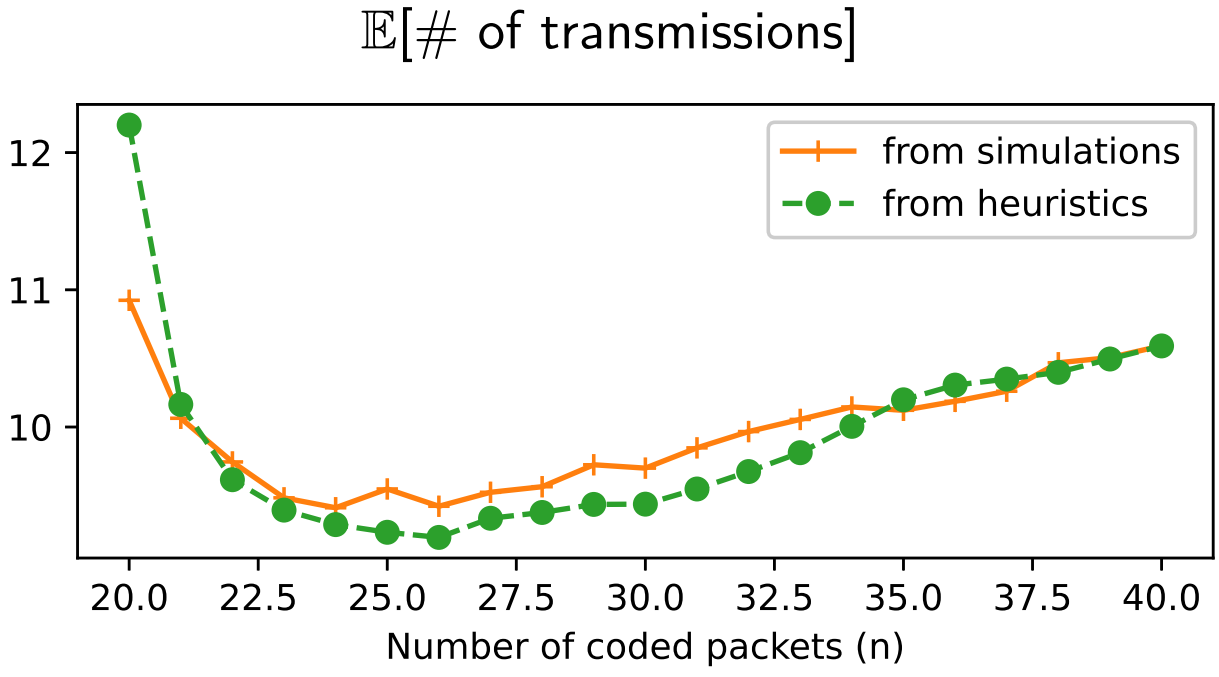
Some videos now !!

Probabilistic forwarding results

$p_{k,n,\delta}$



$\tau_{k,n,\delta}$



Some other works

- Community recovery on hypergraphs
- COVID-19 infection rate estimation

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Get in touch !!

https://vinkumbr.github.io/