Publications

- an up-to-date list of publications
- many publications, including their bibtex entries, can be found on dblp
- for citations etc. see the Google scholar profile
- ORCID

Team

Current team:

- Arnab Chatterjee (PhD student)
- Max Hahn-Klimroth (postdoc)
- Lena Krieg (PhD student)
- Maurice Rolvien (PhD student)
- Olga Scheftlowitsch (PhD student)

Alumni:

- Charilaos Efthymiou (University of Warwick)
- Noëla Müller (TU Eindhoven)
- Joon Lee (EPFL)
- Jean Bernoulli Ravelomanana (EPFL)

Projects

Current projects:

- DFG CO 646/3: Message passing algorithms, information-theoretic thresholds and computational barriers.
- DFG CO 646/5: Reconstruction and learning in complex networks.

Completed projects:

- DFG CO 646/4: Random graphs: cores, colourings and contagion. Jointly with TU Graz.
- ERC Project "Phase transitions and computational complexity"

Research area: Probabilistic combinatorics

The systematic study of random combinatorial structures such as random graphs, codes, formulas and matrices commenced with the seminal work of Paul Erdős and Alfréd Rényi in the 1950s/60s. In one of their most important contributions they identified the phase transition for the emergence of the giant component in a random graph, a mean field version of the famous percolation problem. Phase transitions have remained the protagonists of the discipline ever since. Over the years intimate connections between probabilistic combinatorics and statistical physics, particularly the notion of replica symmetry breaking, discovered by physics Nobel laureate Giorgio Parisi, has come to play a pivotal role. This interdisciplinary angle has led to several remarkable discoveries, one of which is the Survey Propagation algorithm for the k-SAT problem, a prominent benchmark in computer science. In addition, the cavity method has led to important predictions on phase transitions. The rigorous verification of these predictions is an ongoing research effort, to which we have been contributing actively.

Selected publications:

Dimitris Achlioptas, Amin Coja-Oghlan: **Algorithmic barriers from phase transitions.** Proc. 49th FOCS, 793-802. **[arxiv]**

Amin Coja-Oghlan, Charilaos Efthymiou, Samuel Hetterich: **On the chromatic number of random regular graphs.** Journal of Combinatorial Theory, Series B **116**:367-439. **[arxiv]**

Peter Ayre, Amin Coja-Oghlan, Pu Gao, Noëla Müller: **The satisfiability threshold for random linear equations.** Combinatorica **40**:179-235. **[arxiv]**

Amin Coja-Oghlan,Tobias Kapetanopoulos, Noëla Müller: **The replica symmetric phase of random constraint satisfaction problems.** Combinatorics, Probability and Computing **29**:346-422. **[arxiv]**

Algorithms for Bayesian inference problems

A great many fundamental computational tasks can best be described as Bayesian inference problems. Graph clustering is a prime example: given a complex network, can we detect and infer a latent community structure? The mathematical study of such inference problems is closely related to fundamental questions in probabilistic combinatorics. Heuristic arguments suggest that depending on the signal-to-noise ratio inference problems typically undergo an *impossible-hard-easy* transition. Specifically, beyond a certain noise level, inference is information-theoretically impossible. On the other hand, at very low noise levels efficient algorithms may be available to solve the inference problem. In the middle ground, inference may be information-theoretically feasible but computationally intractable. In some examples such as the stochastic block model or the Hopfield neural network, statistical physics calculations predict that these three regimes are separated by sharp phase transitions. One of our research objectives is to investigate these predictions rigorously. A further line of work deals with the analysis of inference algorithms, particularly message passing algorithms such as Belief Propagation.

Selected publications:

Amin Coja-Oghlan, Oliver Gebhard, Max Hahn-Klimroth, Philipp Loick: **Optimal group testing.** Proc. COLT 2020. **[arxiv]**

Amin Coja-Oghlan, Florent Krzakala, Will Perkins, Lenka Zdeborová: **Information-theoretic thresholds from the cavity method.** Advances in Mathematics **333**:694-795. **[arxiv]**

Amin Coja-Oghlan: **Belief Propagation fails on random formulas.** Journal of the ACM **63**:#49. **[journal]**