Statistical physics of tailored random graphs: entropies, processes, and generation

ACC Coolen, King's College London

These lectures are devoted to the statistical mechanical analysis of various problems related to large but sparse complex graphs and networks, and stochastic processes that take place on such systems. Although we will solve models in the asymptotic regime, they are `locally small' in the sense that (in contrast to simple mean field models) each component in a sparse graph feels only a finite (small) environment. The analytical tools to be used tend to be built on various flavours of the replica method and on path integrals, but they will be explained as we go along for those who are not familiar with them. The envisaged structure is roughly as follows (but I am happy to adapt plans and content to the needs of the audience):

Lecture 1:
Ensembles of sparse random graphs. Loops, clustering, tree-like versus loopy graphs. Ensemble entropies. Numerical generation of tailored random graphs.

Lecture 2:
The replica method. Replica analysis of processes on tailored sparse random graphs with discrete variables. Order parameters, replica symmetry, and phase transitions.

Lecture 3:
Replica analysis of processes on tailored sparse random graphs with continuous variables. Order parameters, replica symmetry, and Guzai expansion.

Lecture 4:
Advanced topics. Replica analysis of loopy complex graphs.