

Oral Presentation

Formal mean field theories for graph rewriting

Vincent Danos

University of Edinburgh

`vdanos@inf.ed.ac.uk`

In this paper, we conjoin ideas from two scientific traditions not seen together often: 1) graph transformation systems (GTS) stemming off of concurrency and formal language theories, and 2) mean field approximations (MFA), a group of techniques used to great effect in statistical physics to obtain simplified descriptions of complex dynamics. We find that by using existing tools from algebraic graph rewriting, we can build a powerful framework which encompasses a large class of MFAs. Specifically, as soon as the dynamics of interest is underpinned by a graph transformation system (GTS), we show how to build the associated mean field machinery. Besides providing a clean language-theoretic foundation for MFAs, our construction has a number of interesting features. First, it separates clearly the algebraic aspects of MFAs from the difficult analytic questions pertaining to their soundness (not addressed in this paper). Second, it completely encapsulates the combinatorics involved in the generation of MFAs. Third, it can be automated so that the order of the approximation is no longer limited to the humanly computable. Last, arguments are couched in terms of axiomatic graph rewriting. And thus, even though we nominally treat only the case of typed directed multigraphs, the scope of our construction includes a wide range of dynamics on graph-like structures such as hypergraph rewriting.