Logic and the Power of Recurrent Graph Neural Networks – Abstract

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Graph neural networks (GNNs) are deep learning models for graph data that play a key role in machine learning on graphs. A GNN describes a distributed algorithm carrying out local computations at the vertices of the input graph. Typically, the parameters governing this algorithm are acquired through a data-driven learning process.

After reviewing GNNs and their basic theory, in this talk, I will focus on the expressiveness of recurrent GNNs. We show that recurrent GNNs can emulate all graph algorithms that respect the natural message-passing invariance induced by the colour refinement (or Weisfeiler–Leman) algorithm. Furthermore, we show that by incorporating random initialisation, recurrent GNNs can emulate all graph algorithms. This emulation introduces only a polynomial overhead in both time and space. In particular, any polynomial-time graph algorithm can be simulated by a recurrent GNN with random initialisation running in polynomial time.

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