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Lecture 1: Introduction to Graphical Models

In medical imaging, Bio Imaging, computer vision, and other areas there are various tools which are very useful, such as Deep learning and Graphical Models. In some sense, deep learning is good when it comes to learning the right features for the task at hand. In contrast, Graphical Models are good to explicitly model prior knowledge, e.g. cell division. Especially in medical and bio-imaging where often the amount of labelled training data is small and prior knowledge is plenty, graphical models are a good tool. In this lecture I will give an introduction to undirected graphical models, also known as Markov Random Fields. I will explain various modelling concepts and then focus on the optimization of undirected graphical models, which is in general an NP-hard problem. I will also show various application scenarios in computer vision.

Lecture 2: Graphical Models in BioImaging

Using the language of graphical models, and also random forests, I will present five works where this has been used to build advanced systems: (i) I will introduce an approach to segment multiple convex-shape objects in an image using an advanced multi-cut technique. (ii) I will present the Decision (and Regression) Tree Field work where Random Forest and

Graphical Models are combined and trained jointly. (iii) I will explain how to match two deformable objects, e.g. C-elegans, using graph matching. (iv) I will present a method to derive not only one solution of a graphical model but multiple, diverse solutions, which can then, in turn, be used in a bigger framework e.g. for cell tracking. (v) Finally I will present a system for cell tracking called tracking-by-assignment using higher-order Graphical Models, solved via integer linear programming (ILP).