Using Markov Random Fields to model tree-like structures in 3D microscopy images.

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A quick, flexible, accurate and automatic image processing software package will enable biomedical researchers to analyse orders of magnitude more data. In particular this could have a huge impact on the advancement of the field of neuroscience and our understanding of the brain.

Neural reconstruction is such a common problem faced by many neuroscientists that the Allen Institute for Brain Sciences and the Howard Hughes Medical Institute launched the DIADEM (Digital Reconstruction of Axonal and Dendritic Morphology) competition in order to encourage the development of automatic tracing algorithms. The competition organisers have provided 5 datasets including gold standard (manual) reconstructions and a specific metric of success, thus the problem of tracing in microscopy images is hard but well-defined. More information about the competition can be found at http://www.diademchallenge.org/.

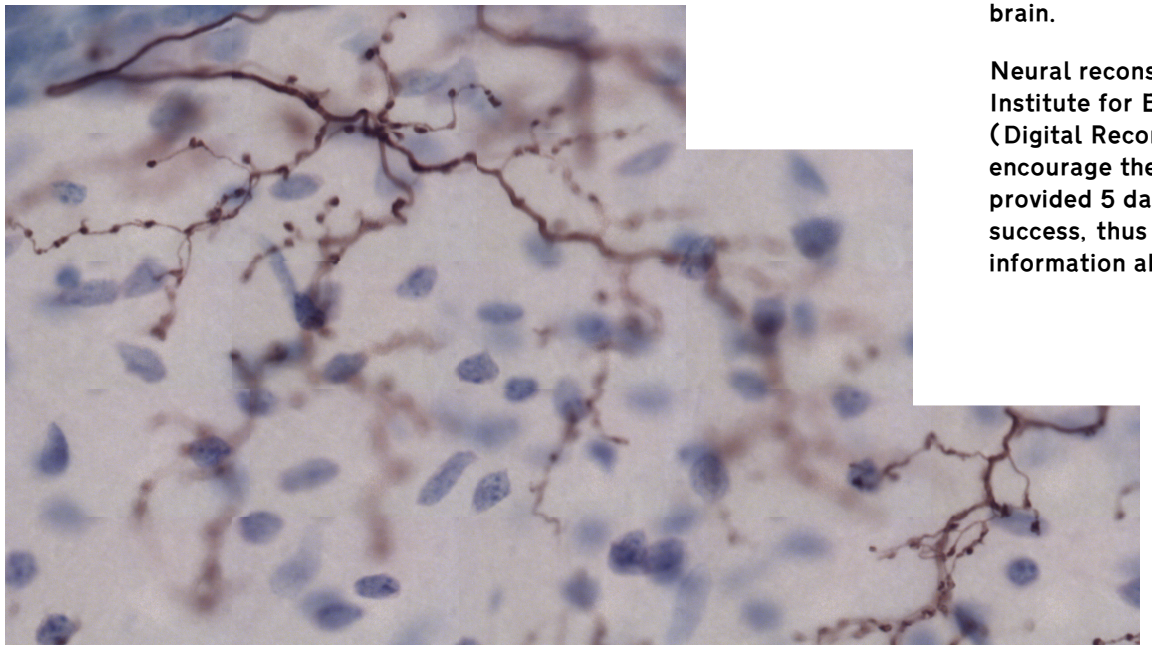

Figure 1. Microscopy image of cerebellar climbing fibres.

We will develop a library of probabilistic models such as Markov Random Fields (MRFs) to deal with images of neurones. This is a graphical model where nodes have a hidden cause, and observable variables which are influenced by the hidden cause and the neighbours. This would be used to extend 2D existing texture models (1) to 3D. This would be useful for tracing out and quantifying the shape and structure of neurones. The model would be tested on images of neurones from a variety of different imaging techniques: confocal imaging of GFP/YFP, light microscopy, and two-photon microscopy. Developing a method to understand how microscopy images are generated from hidden sources like this would allow for the automatic tracing and segmentation of a wide range of microscopy images and could be applied to a number of different research areas, e.g. the tracing of blood vessels or automating the identification of pathologies from microscopy images.

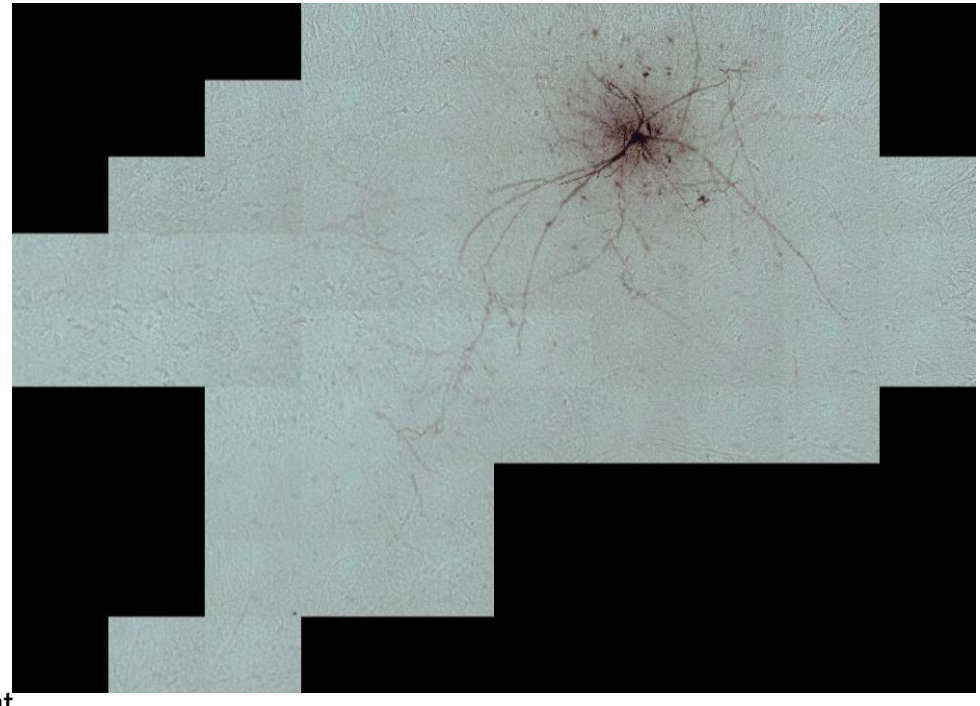

Figure 2. Microscopy image of hippocampal CA3 interneurones

[1] Efros and Leung. *Texture synthesis by non-parametric sampling.* International Conference on Computer Vision (1999)

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