

Cell Tracking

April 12, 2013

Abbreviation: cell-tracking
 Number of instances: 1
 Number of variables: 41134
 Number of labels: 2
 Number of factors: 42909
 Order: 9
 Function type: explicit

References

- [1] B. X. Kausler, M. Schiegg, B. Andres, M. Lindner, H. Leitte, L. Hufnagel, U. Koethe, and F. A. Hamprecht. A discrete chain graph model for 3d+t cell tracking with high misdetection robustness. In *ECCV*, 2012.

Description The cell tracking dataset contains one instance of a tracking-by-assignment problem in the context of cell tracking (cf. [1] et al). The model comprises two kinds of binary random variables: detection and assignment. The former distinguish between true cells and misdetections due to noise. The latter describe possible assignments between objects in consecutive timesteps. Consistency is ensured by assigning zero probability to biologically implausible configurations (for instance, a cell dividing into more than two descendants).

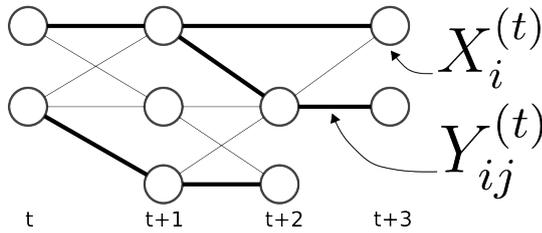


Figure 1: **Tracking-by-assignment.** Assignment variables $Y_{ij}(t)$ model possible assignments between objects in consecutive timesteps. Detection variables $X_{ij}(t)$ label objects either as false positive or as true positive detections.

Objective / Learning The model is implemented as a chain graph. Conditional random fields describe the assignments between consecutive timesteps and are depending on prior potentials that model the true positive vs. false positive probabilities of detections (see Fig. 1). The objective is to find the minimum energy configuration (that is the most likely tracking):

$$E(\mathcal{X}, \mathcal{Y}) = \sum_{t=1}^T \sum_{X_i^{(t)} \in \mathcal{X}^{(t)}} E_{\text{det}}(X_i^{(t)}) + \sum_{t=1}^{T-1} \left(\sum_i E_{\text{out}}(X_i^{(t)}, \mathcal{Y}_{i \rightarrow}^{(t)}) + \sum_j E_{\text{in}}(\mathcal{Y}_{\rightarrow j}^{(t)}, X_j^{(t+1)}) \right)$$

The energy domain was chosen to allow linear programming-based inference methods. Inconsistent configurations are assigned a very high energy to approximate zero probability. Parameters were learned by exhaustive search on a manually labeled dataset.