Variational inference for the hidden cellular Potts model

Oleg Lukashenko*, Ekaterina Potapova†

Markov random fields are widely used in the analysis of data with some spatial configuration. The spatial structure is modeled as an undirected graph, whose vertices correspond to the hidden variables, while its edges describe the dependence structure. Such models are used in various fields, such as image processing, simulation of the malignant tumors growing, etc.

In this research, we consider the application of the hidden Potts model for the estimation of the tissue lesion by the malignant cells. For this reason, a Bayesian framework has been applied with the cellular Potts model as a prior representing interactions between different types of cells and the likelihood being the distribution of registered type (lymphocyte, stromal, and tumor) of the observed cell.

The posterior distribution of the hidden Potts model has a rather complicated form, thus the exact Bayesian inference is not always possible, therefore, one has to rely on approximate methods such as variational inference. We applied the so-called meanfield approximation to solve the problem described above. A few experiments on the synthetic data have been conducted to demonstrate the performance of the proposed approach in terms of accuracy, i.e. the fraction of the correctly identified cell types. Also, the influence of the model parameters has been investigated.

*Institute of Applied Mathematical Research, KarRC RAS, lukashenko@krc.karelia.ru. The study was supported by the RSCF, project 21-71-10135

†Petrozavodsk State University, katya.potapova88@gmail.com