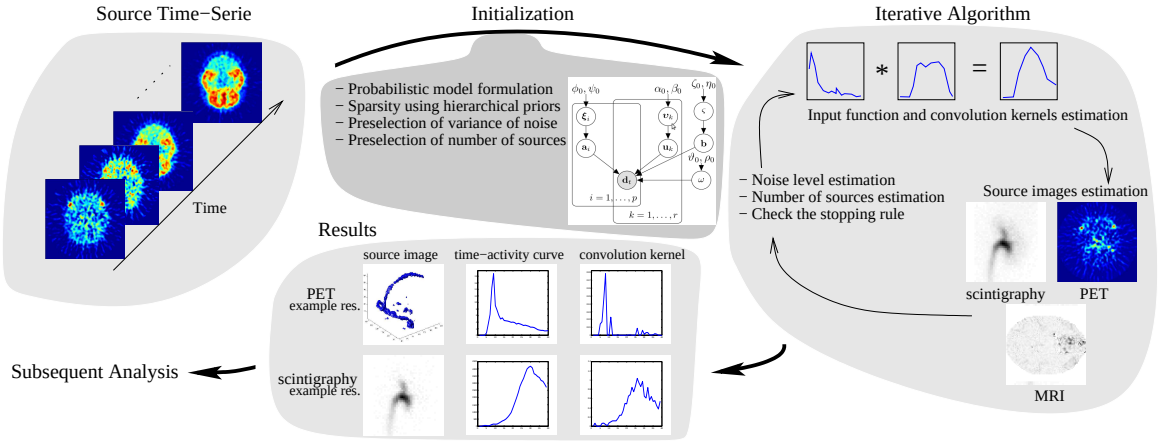
On Sparsity in Bayesian Blind Source Separation for Dynamic Medical Imaging

Ondřej Tichý* ‡

*Katedra matematiky, FJFI, ČVUT,
‡Ústav Teorie Informace a Automatizace, AV ČR, otichy@utia.cas.cz

Abstrakt. A common problem of imaging three-dimensional objects into image plane is superposition of projected structures. In medical imaging, it has been successfully fixed by tomography where it was minimized to partial volume effect in small individual voxels. The problem remains to be solved in dynamic planar imaging to separate overlapping structures and in dynamic tomography to reduce partial volume effect further. In a series of images recording distribution of radiopharmaceuticals and molecular probes with time, an obvious approach is to separate different overlapping structures using their specific dynamics [1]. Since the problem is ill-posed, many additional assumptions were proposed to achieve unique separation [2], [3]. We propose a probabilistic model for blind separation using convolution model [4], assuming each specific tissue dynamics as convolution of input function and specific tissue kernel (organ impulse response or retention function). The key assumptions of separability is that the tissue images and the convolution kernels are most likely sparse. These assumptions are formalized as a Bayesian model with hierarchical prior and solved by the Variational Bayes method. These general assumptions are shown to be relevant in analysis of dynamic image sequences in scintigraphy. We demonstrated that the method outperforms other methods for blind source separation with domain-specific assumptions in selected tasks in dynamic renal scintigraphy and dynamic positron emission tomography. MATLAB implementation of the algorithm is available for download from http://www.utia.cz/S-BSS-vecDC.



The scheme of the S-BSS-vecDC Method.

Poděkování. This work was supported by the Czech Science Foundation, grant No. 13-29225S.

Literatura:

[1] Lawson, R.S., Application of mathematical methods in dynamic nuclear medicine studies, Physics in medicine and biology, vol. 44, pp. 57-98, (1999).

[2] Šmídl, V. and Tichý, O., Automatic Regions of Interest in Factor Analysis for Dynamic Medical Imaging, in 2012 IEEE International Symposium on Biomedical Imaging (ISBI), IEEE (2012).

[3] Chen, L., Choyke, P. L., Chan, T. H., Chi, C. Y., Wang, G., and Wang, Y., Tissue-specific compartmental analysis for dynamic contrast-enhanced mr imaging of complex tumors, Medical Imaging, IEEE Transactions on, 30(12), 2044-2058, (2011).

[4] Tichý, O. and Šmídl, V., Bayesian Blind Separation and Deconvolution of Dynamic Image Sequences Using Sparsity Priors, Medical Imaging, IEEE Transactions on, (2014), (in print, doi:10.1109/TMI.2014.2352791).