Kernel SIME: simultaneous estimation of blood input function using a kernel method and its evaluation with total-body PET

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Introduction: Dynamic PET allows quantification of physiological parameters through kinetic modeling. The accuracy of estimated parameters is influenced by the quality of extracted blood input function. Image-derived (ID) input function (IF) suffers from partial volume effect when it is extracted from small blood vessels such as the case in dynamic brain imaging. Alternatively, optimization-derived input function (OD-IF) from simultaneous estimation (SIME) of input function and kinetic parameters is not stable due to the ill-posedness of the optimization problem. In this work, we developed a new method that exploits ID-IF as a priori information to stabilize SIME through a kernel framework.

Methods: The standard SIME approach estimates an IF and kinetic parameters simultaneously by fitting multiple tissue time activity curves (TACs) of different regions of interest. The approach commonly parameterizes IF using a highly nonlinear model which is difficult to estimate in practice. The proposed kernel SIME method exploits ID-IF as a *priori* information of IF using a kernel representation. The unknown parameters are linear in the model and thus much easier to estimate. The OD-IF by this kernel SIME method was evaluated and compared with ID-IF and OD-IF from conventional SIME using datasets collected from uEXPLORER total-body PET/CT.

Results: The estimated OD-IF by kernel SIME show a good match with the reference input functions. Compared to ID-IF and OD-IF with conventional SIME, estimated kinetic parameters with proposed kernel OD-IF have lower percentage mean absolute error (MAE). Parametric images with proposed kernel OD-IF show similar patterns and close values as those with the reference IF.

Conclusion: We proposed and investigated a kernel SIME method to obtain OD-IF. The method could be potentially applied when major blood pool is not covered in the field of view, such as dynamic brain imaging with a conventional short PET scanner.

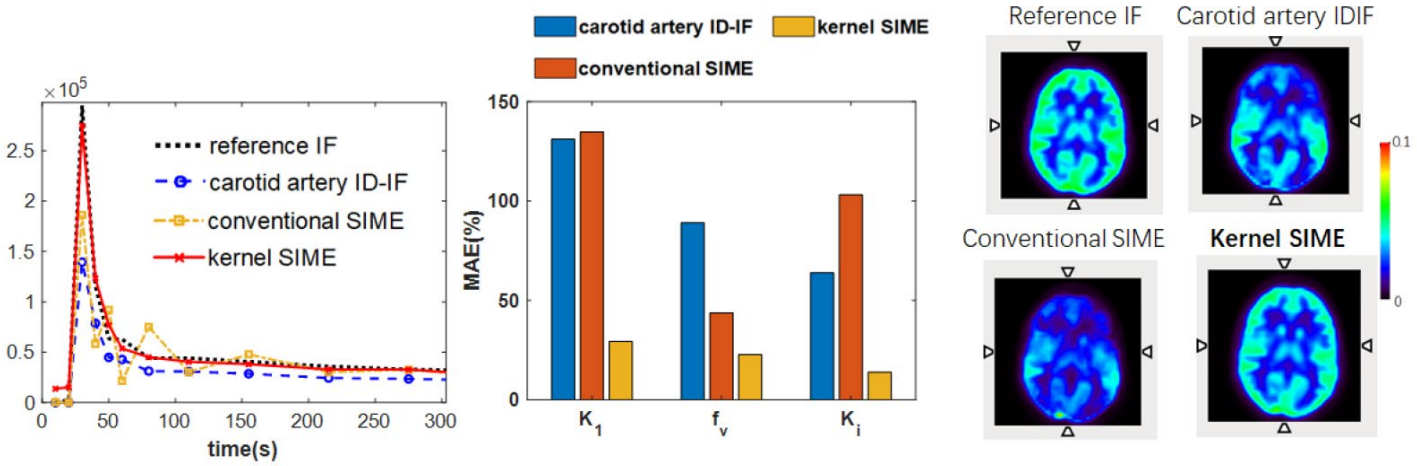

Figure 1. Results for estimated input function (left), mean absolute error for kinetic parameters (middle), and estimated Ki image (right) from different methods.