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Modeling of Correlated Objects with Application to Detection of Metastatic Cancer using Functional CT Imaging

Perfusion computed tomography (CTp) is an emerging functional imaging modality that uses physiological models to quantify characteristics pertaining to the passage of fluid through blood vessels. Perfusion characteristics provide physiological correlates for neovascularization induced by tumor angiogenesis. Thus CTp offers promise as a non-invasive quantitative functional imaging tool for cancer detection, prognostication, and treatment monitoring. We developed a Bayesian probabilistic framework for simultaneous supervised classification of multivariate correlated regions. We demonstrate that simultaneous Bayesian classification yields dramatic improvements in performance in the presence of strong correlation, yet remains competitive with classical methods in the presence of weak or no correlation. A semi-parametric model is further implemented for estimation and prediction of sparse spatiotemporally correlated CTp characteristics derived from multiple intra-patient metastatic sites. We considered weighted kernel smoothing for group mean curve and joint prediction of curves arising from multiple ROIs within the same patient to improve characterizations of contrast absorption over time. The methodology builds a foundation for probabilistic segmentation of regions of liver that exhibit perfusion characteristic indicative of metastatic sites using CTp maps acquired over the entire liver.