Predicting clinical outcome from image derived morphological change

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In this presentation we will outline a series of results on supervised and unsupervised learning of clinical outcome from medical images. We will be concerned with relating dynamic shape compensated measurements, shape, and spatial deformations to clinical parameters. The main challenge addressed is the fact that image measurement are of a dimensionality many times higher than the number of observations. In general, this problem is solved by input variable selection, subspace methods and/or regularization. The methods that we apply operated seamlessly between these solutions and is based on seminal work by Brad Efron, Trevor Hastie, and Robert Tibshirani, Stanford University (1; 2; 3).

Myocardial infarction may by quantified by analysis of myocardial perfusion magnetic resonance images (MRI). The images are formed by MRI of a contrast agent bolus passage through the myocardium. Attenuated and delayed response identifies regions affected by the infarction. Following image co-registration perfusion dependent intensity variation in single voxel elements are recorded over time (4). In order to identify anomalous behavior from healthy tissue we apply the support vector domain descriptor (SVDD) (5). The SVDD classifier is a hyper-sphere in a transformed input space. An efficient algorithm for computing the solution for all values of a regularization parameter was proposed in (6). The infarction region is found as outliers in an SVDD procedure integrating information across all values of the regularization parameter (7).

In two studies brain MRI is related to clinical parameters such as memory scores, walking speed, and verbal fluency. Following mid-sagittal surface extraction (8) and segmentation of the corpus callosum in the mid-sagittal plane (9) the clinical parameters are regressed on localized shape components of variance identified using sparse principal components analysis (10). In a second study full brain deformation fields across populations are related to memory loss using a ridge regression procedure with permutation testing taking into account voxel dependencies.

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