Support Vector Regression prediction of graded fMRI activity

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INTRODUCTION Pattern classification techniques offer a novel way of looking at imaging data. Support vector classification is a machine learning technique that has been used to perform classification of fMRI data [1]. Brain state classification may not always be a binary classification problem, as the level of BOLD activation may be a graded response [2]. This study explores support vector regression (SVR) as a tool to investigate graded activation in the visual as well as motor cortices.

METHODS ***Acquisition:*** Data were acquired on a 3T GE scanner. T2*-weighted data was acquired using a custom spiral-in sequence (TR/TE/FA/FOV=2s/30ms/90/22cm, 64x64matrix, 40 axial slices of 3mm thk) ***FMRI paradigms:*** Two separate paradigms were used. 1) A graded visual task in which subject was presented with varying levels of contrast of a flashing checkerboard image, interspersed with a static fixation image for the same duration. 1, 10, 40 and 100 percent contrast levels of the image were used (10s, 4levels, 4cycles, 320s total time). 2) A graded motor task which involved presenting the subject with a paradigm with alternating blocks of fixation and finger tapping (at different frequencies 1, 2, 3 and 4 Hz) (20s, 4levels, 2cycles, 320s total time). Two runs were acquired using each paradigm.

Analysis: SVR training and testing were done using libSVM [3]. The model trained on run 1 was used to test run 2, and vice versa. Gross anatomical feature selection was used to define the ROI. SVR analysis was done on voxels belonging to the ROI in each case.

RESULTS Fig. 1 (a) and 2 (a) show plots of the SVR output for visual and motor cortices respectively. To compare them to the actual fMRI activity, the time courses of top nine maximally correlated voxels were averaged and the respective average time course plots are shown in Fig. 1 (b) and 2 (b). The graded activation predicted by the SVR matches well with the actual time course activity.

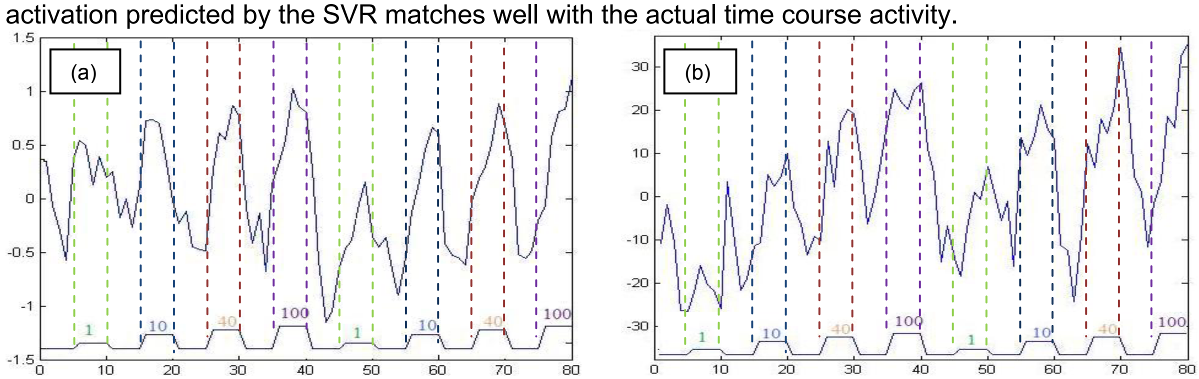

Figure 1. (a) SVR output and (b) average time course of significant voxels in the visual cortex. Only the first half of the time plots have been displayed in this case to aid inspection.

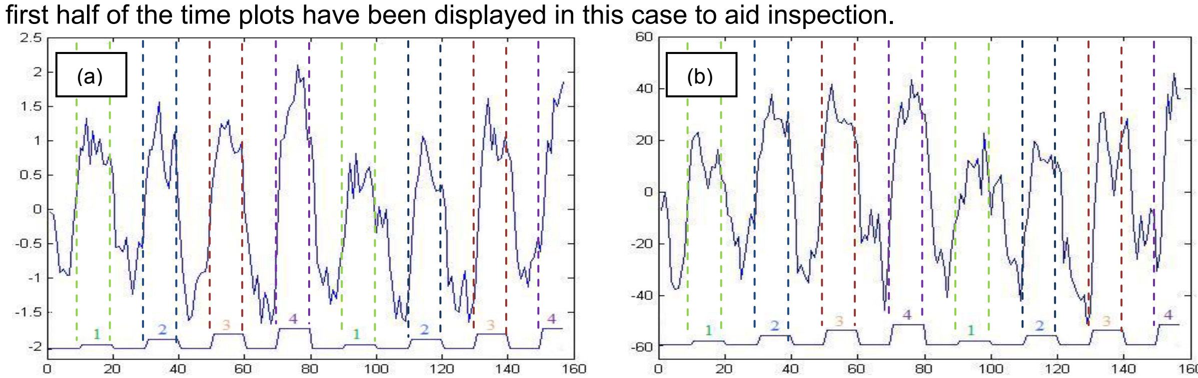

Figure 2. (a) SVR output and (b) average time course of significant voxels in the motor cortex.

DISCUSSION AND CONCLUSION In the present study, SVR analysis is able to detect graded activation in both the visual and motor cortices. Thus, support vector regression can be used to evaluate activation levels in multiple neural systems in the human brain. SVR being a machine learning technique, learns the mapping from the training set and creates a model, which facilitates prediction of classes for all subsequent testing sets almost instantly. These findings establish the feasibility of using SVR as a tool to evaluate graded activation and providing the subject with real-time biofeedback.

REFERENCES [1] LaConte, S. et al (2005) NeuroImage, 26:317-329.
[2] Hoge, RD. et al (1999) PNAS, 9403-9408.
[3] Chih-Chung Chang and Chih-Jen Lin, LIBSVM: a library for support vector machines, 2001. Software available at http://www.csie.ntu.edu.tw/~cjlin/libsvm