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Classification of First-Episode Schizophrenia Using Wavelet Imaging Features

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Abstract. This work explores the design and implementation of an algorithm for the classification of magnetic resonance imaging data for computer-aided diagnosis of schizophrenia. Features for classification were first extracted using two morphometric methods: voxel-based morphometry (VBM) and deformation-based morphometry (DBM). These features were then transformed into a wavelet domain using the discrete wavelet transform with various numbers of decomposition levels. The number of features was then reduced by thresholding and subsequent selection by: Fisher's Discrimination Ratio (FDR), Bhattacharyya Distance, and Variances (Var.). A Support Vector Machine with a linear kernel was used for classification. The evaluation strategy was based on leave-one-out cross-validation.

Keywords. Machine learning, neuroimaging, schizophrenia, support vector machines

1. Introduction and methods

Machine learning offers promising methods for computer-aided diagnosis of neuropsychiatric disorders. The use of these computing methods is highly desirable, as they have the potential to create an objective process of early diagnosis and prognosis. This research explores the design of the classification algorithm and the application of wavelet transformation to image data. Our proposed algorithm follows the ideas in [1]. Compared to the original algorithm, the main advantage of our version lies in the ability to carry out more experiments with different decomposition levels by wavelet transform.

The algorithm consists of five main steps: (i) Two types of preprocessing were used to extract features: VBM (gray matter densities) and DBM (local volume changes), (ii) images were decomposed by wavelet transformation into another domain. It was necessary to specify two parameters: decomposition levels and mother wavelet (sym5) [2], [3], (iii) the number of features was reduced by the experimentally determined thresholding of absolute values smaller than 0.05, (iv) the number of features was reduced by selection. Three different metrics were used for this: FDR, Bhattacharyya distance, and Var., (v) the classification into two groups (FES/NC) was carried out. The algorithm was tested on a dataset provided by The University Hospital Brno (104 T1-weighted MR images of subjects, of which 52 subjects were patients with first episode

of schizophrenia (FES) and 52 were healthy volunteers (HC)). Classification performance was evaluated using leave-one-out cross-validation. The best results of experiments with differently selected parameters are shown in Table 1.

Table 1. Classification accuracy for distinguishing between FES and HC.

Morphometric method	Metrics	Decomposition level	Number of features	Accuracy [%]	Sensitivity [%]	Specificity [%]
DBM	FDR	4	1000	56.73	55.77	57.69
			5000	69.23	67.31	71.15
		5	1000	58.65	57.69	59.62
			5000	**72.12**	**67.31**	**76.92**
	Var	4	1000	57.69	55.77	59.62
			5000	69.23	67.31	71.15
		5	1000	59.62	57.69	61.54
			5000	**71.15**	**67.31**	**75.00**
VBM	FDR	4	1000	**73.08**	**71.15**	**75.00**
			5000	67.31	65.38	69.23
		5	1000	71.15	69.23	73.08
			5000	67.31	63.46	71.15
	Var	4	1000	**73.08**	**71.15**	**75.00**
			5000	69.23	67.31	71.15
		5	1000	71.15	69.23	73.08
			5000	68.27	65.38	71.15

2. Discussion and conclusion

The strongest results were obtained using DBM, where the classifier achieved the best performance for five decomposition levels selected using FDR and Var for 5000 features. The first case achieved 72.12% accuracy, 67.31% sensitivity and 76.92% specificity, and the second case attained 71.15% accuracy, 67.31% sensitivity and 75.00% specificity. Using VBM with four decomposition levels for 1000 features and Var. and FDR metrics, 73.08% accuracy, 71.15% sensitivity, and 75.00% specificity were achieved.

The results from this analysis are comparable to those of similar works [4], [5], [6]. Despite the classification of FES and HC, the resulting accuracy is still too low to propose the algorithm be used in clinical practice as an objective method for the diagnosis of this devastating neuropsychiatric disorder. This work was supported by the project No. AZV 17-33136A (Ministry of Health, CZ).

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