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Time Series Data Recognition by Support Vector Machine

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1 Introduction

Support Vector Machine(SVM) proposed by Vapnik is new pattern recognition method. SVM for classification and Regression is studied in pattern recognition field. SVM for classification is called Support Vector Classifier (SVC). SVC shows high recognition ability in recognition for fixed length data such as character and picture. SVC has following three key ideas.

- The formulation of learning is performed optimum as regards both empirical risk and generalization performance based on structural risk minimization(SRM).
- SVC can find a global optimum because it uses convex quadratic problem to form optimum problem in formulation.
- Input pattern mapped nonlinearly to higher dimensional feature space and a linear discrimination boundary is constructed in the higher dimensional feature space. A linear discrimination boundary in higher dimensional corresponds to a nonlinear discrimination boundary in original input space.

However SVC can not deal with time series data because SVC is formed on the premise that the dimension number of data which SVC can recognize is fixed. But if I developed SVCmodel which deal with time series data and if this model could relate high recognition ability in recognition for fixed length data with recognition for time series data, recognition

ability of this model is upper than that of conventional discrimination machine. Therefore, I find that frame data of time series data is fixed length data and a recognition ability of the model which consist of SVC which deal with frame data and recognize time series data is upper than that of conventional discrimination machine. Therefore, in this study, I extend SVC and develop the new discrimination machine which recognize time series data.

2 Proposed Methods

In this study, I proposed SVC chain model(Chain SVC:CSVC) that consists of number of SVC and that is similar to HMM which is widely used for the speech recognition and so on. The most difference between CSVC and HMM is that CSVC used class-belonging function which represents credibility of occurring signal from an object class on each SVC in contrast with HMM which used a probability density function on each state. The class-belonging possibility is defined by distance between separation hyperplane and input data. The advantage of using CSVC to time series data recognition are that no modification is required for the original formulation of SVC which deals with fixed length data and may be possible to use algorithm for HMM.

The formulation of learning of CSVC is defined as an optimization problem of minimizing the sum of objective function in optimum problem of SVC. This is the problem which is determining divide of training data. I proposed the repetition learning as the solution of the optimum problem in formulation which is done by algorithm like Viterbi algorithm which is used in HMM. The recognition algorithm is defined as a search problem of the transition series which maximizes score calculated from the product of state transition weights and class-belonging possibility. This problem is solved by algorithm like Viterbi algorithm.

3 Experimental Results

I made an experiment on the handwriting digits recognition to evaluate efficiency of the proposed CSVC. I compared the result of the experiment with that HMM in the case of 2 dimensions feature quantity of speed vector and 4 dimension feature quantity of speed vector and relative position vector.

In case of 2 dimension, I used training data 200 letter (three sets), and the test data 100 letter (five sets). The result of accuracy rate of HMM and CSVC is 91% and 68% respectively. It seems the reason why the accuracy rate of CSVC is lower-than that of HMM is that overlap in feature quantity space is too large compare to that 2 dimension of feature quantity is low.

In case of 4 dimensions, I used training data 400 letter (three sets), and the test data 100 letter (five sets). The result of accuracy rate of HMM and CSVC is 92.6% and 91.6% respectively. It seems the reason why the accuracy rate of CSVC is improved is that the number of the feature quantity dimensions increased. CSVC showed the recognition

ability which is equal to HMM but there are few amounts of data to have used for the experiment, therefor it can not comparison of both in a strict sense.

4 Consideration

The result show that the objective function of minimum problem for learning formulation became big by repetition learning.

It suggests that there is some problems of relationship between the definition of the class-belonging possibility and the algorithm of repetition learning. In this experiment, I defined class-belonging possibility by distance from the optimal separation hyperplane of SVC. However, to make Viterbi algorithm alike repetition learning possible I must be define the class-belonging which contain information about the distribution of the data.