Chapter 9
A Novel Emotion Recognition Method Based on Ensemble Learning and Rough Set Theory

Yong Yang
Chonggqing University of Posts and Telecommunications, China

Guoyin Wang
Chonggqing University of Posts and Telecommunications, China

ABSTRACT

Emotion recognition is a very hot topic, which is related with computer science, psychology, artificial intelligence, etc. It is always performed on facial or audio information with classical method such as ANN, fuzzy set, SVM, HMM, etc. Ensemble learning theory is a novelty in machine learning and ensemble method is proved an effective pattern recognition method. In this paper, a novel ensemble learning method is proposed, which is based on selective ensemble feature selection and rough set theory. This method can meet the tradeoff between accuracy and diversity of base classifiers. Moreover, the proposed method is taken as an emotion recognition method and proved to be effective according to the simulation experiments.

INTRODUCTION

In recent years, cognitive informatics (CI) emerges as a profound interdisciplinary research area that consists of modern informatics, computation, software engineering, artificial intelligence (AI), neural psychology and cognitive science. It studies the internal information processing mechanisms and natural intelligence of the brain (Wang, 2009, 2007a; Wang & Kinsner, 2006).

Affective computing is also an interdisciplinary research area, which related with computer science, psychology, artificial intelligence, etc. It is proposed by Picard, which handles with recognition, expressing, modeling, communicating and responding to emotion (Ahn & Picard, 2006; Picard, 2003). As for the relationship of emotion and cognition, at first, most cognitive psychologists ignore the issue of the effects of emotion on cognition by trying to ensure that all their participants are in a relatively neutral emotional state. Nowadays, it is widely accepted that affective information would selectively influences cognitive procedure, such as attention, learning, and memory. On the other hand, there are numer-

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ous studies showing that emotional experience is influenced by cognitive appraisal. Although the relationship between cognitive appraisals and specific emotional experience may sometimes be weak because any given emotion can be produced by various combinations of appraisals, the relationship is widely accepted and is researched by different researchers (Wang, 2007b; Picard, 2003). In a sense, the research on emotion and cognition will be helpful for each other.

In the research works on affective computing, emotion recognition is one of the most fundamental and important modules. Usually, emotion recognition is studied by the methods of artificial neural network (ANN), fuzzy set (FS), support vector machine (SVM), hidden Markov model (HMM), rough set (RS), and the recognition rate often arrives at 64% to 98% (Picard, 1997, 2003; Picard, Vyzas, & Healey, 2001).

Until now, research on emotion recognition is mainly according to the basic type of emotion, such as happiness, sadness, surprise, anger, disgust, fear and neutral. Some applications focus on the particular emotion states, for example, sleepy is focused in a driver monitor system. Research on complicated and mixed emotion recognition, such as bittersweet, and slight emotion are very difficult, since they can't be taken as a simple classification problems, and they are hardly solved based on traditional classification methods. As for the complicated and mixed emotion, we prefer to model how it can be mixed by basic emotion states and how it can be changed over time, but it is beyond the scope of this paper.

It is a long way to achieve a computer act as a human in emotion recognition since there are many problems unsolved in psychology and cognitive theories, for example, how does emotion come into being, what is the essence of emotion, and what is the feature of emotion. Among these problems, it is an open question that which features are important and essential for emotion, and which features are crucial for emotion recognition. Since it is hardly to get the inner features without any interfere on human, and at the same time, guarantee human be in a natural states. Research on emotion recognition is always taken based on facial or speech features. In this paper, emotion recognition is researched based on facial features according to seven classical types, i.e., happiness, sadness, surprise, anger, disgust, fear and neutral.

Ensemble learning has been a hot research topic in machine learning since 1990s' (Ditterrich, 1997). Ensemble methods are based on learning algorithms that construct a set of base classifiers and then classify new objects by integrating the prediction of the base classifiers. An ensemble system is often much more accurate than each base classifiers. Ditterrich proved the effectiveness of ensemble methods from viewpoint of statistic, computation and representation (Ditterrich, 2001). As a popular machine learning method, ensemble methods are often used in pattern recognition, network security, medical diagnosis, etc. (Freund, 1995; Breiman, 1996; Tsymbal, Pechenizkiy, & Cunningham, 2005).

A necessary and sufficient condition for an ensemble system to be more accurate than any of its base classifiers is that the base classifiers are accurate and diverse. An accurate classifier is one that has an error rate less than random guessing on new instance. Two classifiers are diversity if they make different errors on unseen objects (Ditterrich, 2001). Besides accuracy and diversity, another important issue for creating an effective ensemble system is the choice of the function for combining the predictions of the base classifiers. There are many techniques for the integration of an ensemble system, such as majority voting, weighted voting, reliability-based weighted voting, etc (Tsymbal, Pechenizkiy, & Cunningham, 2005).

There are so many methods proposed for ensemble. The most popular way for ensemble is to get different subset of the original dataset by resampling the training data set many times. Bagging (Breiman, 1996), boosting (Freund,