Chapter 16
Important Attributes Selection Based on Rough Set for Speech Emotion Recognition

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ABSTRACT
Speech emotion recognition is becoming more and more important in such computer application fields as health care, children education, etc. In order to improve the prediction performance or providing faster and more cost-effective recognition system, an attribute selection is often carried out beforehand to select the important attributes from the input attribute sets. However, it is time-consuming for traditional feature selection method used in speech emotion recognition to determine an optimum or suboptimum feature subset. Rough set theory offers an alternative, formal and methodology that can be employed to reduce the dimensionality of data. The purpose of this study is to investigate the effectiveness of Rough Set Theory in identifying important features in speech emotion recognition system. The experiments on CLDC emotion speech database clearly show this approach can reduce the calculation cost while retaining a suitable high recognition rate.

INTRODUCTION
As one of the main cognitive processes at the perception layer of the Layered Reference Model of the Brain (LRMB), emotion is a personal feeling derived from one’s current internal status, mood, circumstances, historical context and external stimuli (Wang, 2005; Wang, 2007; Griffith & Greitzer, 2007). It is one of the most important challenges in speech technologies to recognize the speaker’s emotional states and give a suitable feedback. The objective of speech emotion...
recognition is to determine the emotional state of the speaker out of the speech samples (Cowie, Douglas-Cowie, Tsapatsoulis, Votsis, Kollias, Fellenz, et al., 2001). Speech emotion recognition is becoming more and more important in such computer application fields as health care, children education, etc.

Undoubtedly, the classifier is very important for emotion recognition, however, the performance (runtime cost or classification accuracy) can also be significantly improved via removing irrelevant and redundant features (Jain & Chandrasekaran, 1983; Hall, 1999). There are many algorithms have been proposed to select good feature subset for speech emotion recognition system in the last years (Ververidis, Kotropou & Pitas, 2004; Razak & Komiyama, 2005; Dellaert, Polzin & Waibel, 1996; Oudeyer, 2003; Kwon & Chan, 2003; Wang & Guan, 2005), however, it is time-consuming for these traditional feature selection method used in speech emotion recognition to determine an optimum or suboptimum feature subset.

Rough Set Theory (RST) proposed by Pawlak in 1980s offers an alternative, formal and methodology that can be employed to reduce the irrelevant and redundant features of dataset (Pawlak, 1984; Orlowska, 1997; Peter & Skowron, 2000; Yao, 2006). Attribute reduction algorithms of RST can select the most information rich attributes in a dataset without transforming the data while attempting to minimize information loss during the selection process. Unlike statistical correlation-reducing approaches, it requires no prior assumption and retains the semantics of the original data. Relying on simple set operations makes it suitable as a preprocessor for techniques that are much more complex.

In this paper, a feature selection method based on rough set theory is proposed for speech emotion recognition. Figure 1 illustrates the block diagram of the process flow in an emotion recognition system based on the proposed attribute selection method. A comparison of recognition attribute accuracy with and without the feature selection process step is done on CLDC emotion speech database. An accuracy of 74.75% with only 13 features is got. The experiments clearly show this approach can keep high recognition rate and reduce the calculation cost.

BASIC CONCEPTS OF ROUGH SET THEORY

In rough set theory, data is stored in a table, which may be called decision table. Rows of the decision table stand for objects, and columns show attributes which are divided into two disjoint groups called condition and decision attributes respectively. Each row of a decision table induces a decision rule. Decision rules are closely connected with approximations. Roughly speaking, certain decision rules describe lower approximation of decisions in terms of conditions, whereas uncertain decision rules refer to the boundary region of decisions. For the convenience of discussion, some basic concepts of rough set are introduced as follows.

Definition 1. An information system is defined as a quadruple tuple such that \( S = (U, R, V, f) \), where \( U \) is a finite set of objects and \( R = C \cup D \) is a finite set of attributes, \( C \) is the condition attribute set and \( D = \{d\} \) is the decision attribute set. With every attribute \( a \in R \), set of its values \( V_a \) is associated. Each attribute \( a \) determines function \( f_a : U \rightarrow V_a \).

Definition 2. For a subset of attributes \( B \subseteq A \), the indiscernibility relation is defined by \( \text{Ind}(B) = \{(x, y) \in U \times U : a(x) = a(y), \forall a \in B\} \).

Definition 3. The lower approximation \( B^-(X) \) and the upper approximation \( B^+(X) \) of a set of objects \( X \subseteq U \) with reference to a set of attributes \( B \subseteq A \) may be defined in terms of the classes in the equivalence relation, as follows:

\[
B^-(X) = \bigcup \{E \in U / Ind(B) | E \subseteq X\}
\]
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