Fuzzy Logic Usage in Emotion Communication of Human Machine Interaction

Zhe Xu
Bournemouth University, UK

David John
Bournemouth University, UK

Anthony C. Boucouvalas
Bournemouth University, UK

INTRODUCTION

As the popularity of the Internet has expanded, an increasing number of people spend time online. More than ever, individuals spend time online reading news, searching for new technologies, and chatting with others. Although the Internet was designed as a tool for computational calculations, it has now become a social environment with computer-mediated communication (CMC).

Picard and Healey (1997) demonstrated the potential and importance of emotion in human-computer interaction, and Bates (1992) illustrated the roles that emotion plays in user interactions with synthetic agents.

Is emotion communication important for human-computer interaction?

Scott and Nass (2002) demonstrated that humans extrapolate their interpersonal interaction patterns onto computers. Humans talk to computers, are angry with them, and even make friends with them. In our previous research, we demonstrated that social norms applied in our daily life are still valid for human-computer interaction. Furthermore, we proved that providing emotion visualisation in the human-computer interface could significantly influence the perceived performances and feelings of humans. For example, in an online quiz environment, human participants answered questions and then a software agent judged the answers and presented either a positive (happy) or negative (sad) expression. Even if two participants performed identically and achieved the same number of correct answers, the perceived performance for the one in the positive-expression environment is significantly higher than the one in the negative-expression environment (Xu, 2005).

Although human emotional processes are much more complex than in the above example and it is difficult to build a complete computational model, various models and applications have been developed and applied in human-agent interaction environments such as the OZ project (Bates, 1992), the Cathexis model (Velasquez, 1997), and Elliot's (1992) affective reasoner.

We are interested in investigating the influences of emotions not only for human-agent communication, but also for online human-human communications. The first question is, can we detect a human's emotional state automatically and intelligently?

Previous works have concluded that emotions can be detected in various ways—in speech, in facial expressions, and in text—for example, investigations that focus on the synthesis of facial expressions and acoustic expression including Kaiser and Wehrle (2000), Wehrle, Kaiser, Schmidt, and Scherer (2000), and Zentner and Scherer (1998). As text is still dominating online communications, we believe that emotion detection in textual messages is particularly important.

BACKGROUND

Approaches for extracting emotion information from textual messages can be classified into the catego-

ries of keyword tagging, lexical affinity, statistical methods, or real-world models (Liu, Lieberman, & Selker, 2003).

We have developed a textual emotion-extraction engine that can analyze text sentences typed by users. The emotion extraction engine has been presented by Xu and Boucouvalas (2002).

The emotion-extraction engine can analyze sentences, detect emotional content, and display appropriate expressions. The intensity and duration of the expressions are also calculated and displayed in real time automatically. The first version of our engine searched for the first person, *I*, and the current tense, therefore the ability of the engine was very limited. In our latest version, the engine applies not only grammatical knowledge, but also takes real-word information and cyberspace knowledge into account. It intends to satisfy the demands of complicated sentence analysis.

The user's mood is defined as the feelings perceived from a user's series are input in the emotion-extraction engine. The current emotion of a user is based totally on the information assessed within a single sentence.

A user's mood may not be consistent with the current emotion of the user. For example, a user may present a sad feeling in one sentence, but previously the user was talking about happy and interesting things. The sad feeling presented may not be a significant emotion and overall the user's mood may be still happy.

To calculate the mood of a user, previous emotions and current emotions need to be analyzed together. We assume that emotions are additive and cumulative. One way of calculating the mood is to average the historic emotions and then find out what category the averaged emotion is in. This approach is described by Xu (2005). Here, an alternative fuzzy-logic approach is presented.

Fuzzy Logic

Fuzzy logic was developed to deal with concepts that do not have well-defined, sharp boundaries (Bezdek, 1989), which theoretically is ideal for emotion as no well-defined boundaries are defined for emotion categories (e.g., happiness, sadness, surprise, fear, disgust, and anger).

The transition from one physiological state to another is a gradual one. These states cannot be treated as classical sets, which either wholly include a given affect or exclude it. Even within the physiological response variables, one set merges into another and cannot be clearly distinguished from another. For instance, consider two affective states: a relaxed state and an anxious state. If classical sets are used, a person is either relaxed or anxious at a given instance, but not both. The transition from one set to another is rather abrupt and such transitions do not occur in real life.

EMOTION EXTRACTION ENGINE

The emotion extraction engine is a generic prototype based on keyword tagging and real-world knowledge. Figure 1 depicts an overview of the architecture of the emotion-extraction engine.

The sentence analysis component includes three components: input analysis, the tagging system, and the parser. The input-analysis function splits textual messages into arrays of words and carries out initial analysis to remove possible errors in the input. The tagging system converts the array of words into an array of tags. The parser uses rewrite rules and AI (artificial intelligence) knowledge to carry out information extraction. The engine classifies emotions into the following categories: happiness, sadness, surprise, fear, disgust, and anger. For further details, please refer to Xu and Boucouvalas (2002) and Xu (2005). This article only discusses the fuzzy-logic components, which can be seen as an extension to the parser. With fuzzy logic methods, the emotion-extraction engine can be used to analyze complex situations.

Conflicting Emotion Detection

The inputs of the conflicting-emotion detection component are the emotion parameters that are passed from the sentence analysis component. As mixed emotions are a common phenomenon in daily life, it is not unusual for a user to type in a sentence, such as, "I am happy that I got a promotion, but it is sad that my salary is cut," that contains mixed emotions in an online chatting environment.