Affect classification using genetic-optimized ensembles of fuzzy ARTMAPs

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A B S T R A C T

Training neural networks in distinguishing different emotions from physiological signals frequently involves fuzzy definitions of each affective state. In addition, manual design of classification tasks often uses sub-optimum classifier parameter settings, leading to average classification performance. In this study, an attempt to create a framework for multi-layered optimization of an ensemble of classifiers to maximize the system's ability to learn and classify affect, and to minimize human involvement in setting optimum parameters for the classification system is proposed. Using fuzzy adaptive resonance theory mapping (ARTMAP) as the classifier template, genetic algorithms (GAs) were employed to perform exhaustive search for the best combination of parameter settings for individual classifier performance. Speciation was implemented using subset selection of classification data attributes, as well as using an island model genetic algorithms method. Subsequently, the generated population of optimum classifier configurations was used as candidates to form an ensemble of classifiers. Another set of GAs were used to search for the combination of classifiers that would result in the best classification ensemble accuracy. The proposed methodology was tested using two affective data sets and was able to produce relatively small ensembles of fuzzy ARTMAPs with excellent affect recognition accuracy.

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1. Introduction

Affective states indicate the general psychological state of a person in response to external or internal stimulus, or social and environmental factors. While psychological states can be difficult to measure, there have been several attempts to create consistent models to cover the entire emotion spectrum. Russell's Arousal-Valence scale [1] used two measures to describe most emotional states. The Arousal axis denotes the intensity of the experienced emotion, ranging from high excitability to lethargy. The Valence axis represents a more abstract concept of the polarity or pleasure derived from the emotion. Positive valence encompasses feel-good emotions such as joy and content, whereas negative valence includes psychologically disruptive emotions such as anger, fear, and sadness, with each emotion can be represented as a range of values.

The Positive and Negative Affect Schedule (PANAS) [2] utilizes a similar concept with two-dimensional measures of Positive Affect (PA) and Negative Affect (NA) for describing several distinct emotion states. The two measures are independent domains, with PA having correlations to social activity and diurnal variations, and NA related to self-perceived stress and no circadian patterns. Robert Plutchik [3] proposed an alternate emotion model utilizing a small number of basic emotions: joy, trust, fear, surprise, sadness, disgust, anger, and anticipation. Plutchik's model conveyed the complexity of the human emotion spectrum as combinations of any two basic emotions. In practice, however, humans are capable of a variety of complex, nuanced emotions that are difficult to represent using two-dimensional representation. Most experiments involving human affect thus incorporate some form of self-assessment for users to describe their own emotions. For the sake of simplicity, the self-assessment tests rely on a smallest number of affect dimensions, such as the Arousal-Valence space, to describe the most number of emotions.

Affective machines are devices designed to recognize, interpret, and in some cases, simulate human emotions. Ambulatory monitoring systems may be designed to monitor physiological and behavioural cues from human subjects and respond accordingly. For example, in a hospice environment, a system may be implemented for 24-h monitoring and trigger alerts for medical intervention if any behavioural or physiological assessment showed signs of distress. Another application involves two-way