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ScienceDirect

Procedia Computer Science 123 (2018) 295–301

Procedia Computer Science

www.elsevier.com/locate/procedia

8th Annual International Conference on Biologically Inspired Cognitive Architectures, BICA 2017

Modeling emotion and inference as a value calculation system

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Abstract

There have been many studies on the modeling of a relation between emotion and decision making. Though the effect of emotion on inference in making a decision is evident, its computational mechanism, especially for intuitive inference, is not yet clear. Therefore, in this paper, we discuss the possibility of the computational modeling of an intuitive inference guided by emotion in which random-seeming neural excitation plays the role of a probability-based parallel search of values. First, we show a possible architecture of the intuitive inference in which the system of multiple values affects the process of action decision. Then, we focus on an effect of the value-control mechanism for intuitive inference in a path-finding task. In a computer simulation, we aimed to simulate a model of value management in which multiple value components of the brainstem are controlled for an action search. Though the brainstem seems simple, the model includes the essence of the resolution of conflicts between multiple values.

Peer-review under responsibility of the scientific committee of the 8th Annual International Conference on Biologically Inspired Cognitive Architectures

Keywords: Emotion, Decision Making, Value Calculation System, Model, Probabilistic Inference

1 Introduction

Because of the rapid development of AI technology in recent years, soon we can expect to see an AI product that has a more human-like nature. Its typical application is a field involving human interactions. For its instantiation, such an AI will be required to have a set of mental sensing abilities that include those for identifying cognitive states and intentions in order to select an action in answer to an implicit human desire. It is the nature of human behavior that a human's purpose of action is not fixed but dynamically changing, and often multiple desires are in conflict. However, in most traditional cognitive architectures, reinforcement learning is used for action learning, and the reward (or value) for the learning is designed by humans in advance and is fixed.

Given this, how can we design a model of action selection for a human-interacting AI? One way is to develop a very human-like reward/value system. An AI having such a value system would act

Peer-review under responsibility of the scientific committee of the 8th Annual International Conference on Biologically Inspired Cognitive Architectures

10.1016/j.procs.2018.01.046

properly by detecting human desires in real time. Thus, an understanding of the human value system involved in decision making is an indispensable step for realizing advanced interpersonal interaction.

On the other hand, humans make decisions on the basis of emotion as well as value [Schwarz, 1990]. Emotion is sometimes unreasonable, but in many situations in daily life, emotion leads us to a better decision than that from a rational value calculation [Winter, 2014]. Thus, emotion as a decision-making tool appears to have a role similar to that of value calculation. Therefore, in this paper, we hypothesize that emotion is a value calculation system for action selection.

In many cases, decision making involves inference. In traditional AI theory, a typical inference is composed of a tree search with sequential predictions and an evaluation of the predicted state. In humans, this process is explicit. However, the emotive impact on decision making is more implicit and intuitive. Even in an action decision made by an animal, intuitive inference would play a role. In view of this, what is a plausible mechanism of the intuitive inference, and how is the value of emotions involved? In response to this question, this paper attempts to model intuitive reasoning and discusses the control of value as an elemental mechanism that enables an adaptable inference.

In this paper, we review the conventional models of emotion in Section 2 and describe a model of intuitive inference with probabilistic prediction and search using neural excitation in Section 3. In Section 4, we present the results of a computer simulation that includes the control of multiple conflicting values.

2 Conventional model of emotion

2.1 Models of emotion

There are many models for emotion [Ekman and Rosenberg, 1997] [Russell, 1980]. Some have tried to reproduce emotions as phenomena of cognitive architecture [Samsonovich, 2013] [Chernavskaya et al., 2015]. A few do use a computational approach, but these have not yet advanced beyond very simple pilot models [Vallverdú et al., 2016].

For the role of emotion in more complex human cognitive behavior, Toda proposed a qualitative theory for explaining complex human emotion as a process of value assignation through inference toward an action selection [Toda, 1980]. In this theory, a wide variety of human emotions are explained as a process of calculation and inference for assigning a value to a current state using a range of knowledge and basic values. Although the explanation is very attractive and persuasive, the theory remains a conceptual model and does not mention a specific process for its computation. Ortony et al. proposed a precise and comprehensive model that classifies emotions into 22 kinds based on evidence from psychological [Ortony et al., 1988]. In their paper, a set of variables associated with human emotions is provided in their model, and a theory for an engineering implementation is discussed.

For a computational implementation, Adam et al. have modeled the OCC theory using symbol logic [Adam et al., 2009]. Though we can expect a fusion of inference and language by this model, a discussion will be necessary for describing the intuitive phenomenon of emotion that even animals can have. We believe a more brain-like model, such as a neural network model, is suitable as a model of intuitive emotion.

Recently, Koelsch et al. proposed a quartet theory of human emotion that broadly divides factors of emotion into four components—self-maintenance, safety, attachment, and profit—and attempted to assign the components to different brain areas [Koelsch et al., 2015]. In this theory, profit is included as an aspect of emotion, and the orbitofrontal area of the brain is supposed as its domain. Though some people may disagree with its inclusion in emotion, it cannot be denied that economic gain has a large effect on the emotions.