Modelling the Influence of Affect on Cognitive Processing using Chrest and Nengo

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Abstract

It has long been understood that there is an interplay between affect and cognition((Kort & Reilly, 2003), but this interaction, based on the recent chess studies((Guntz, Crowley, Vaufreydaz, Balzarini, & Dessus, 2018), is much more intertwined than what the established theories postulate. To understand the underlying mechanisms in greater detail we propose an integrated model using Chrest and Nengo. We analyze the results based on simulations with data from previous empirical studies.

Keywords: Affect, Cognition , Chess, Nengo , Chrest

Introduction

The outline of our Paper is as follows: We start with Motivation for study followed by: Rational for using chess, Problem description, Research Objectives, Insights from previous research, State the Hypothesis, give a detailed view of proposed Architecture and finally implications for further research.

Motivation:

1. How do Chess players leverage emotions/Affect to deal with information overload and complexity?
2. How can interplay between emotions and cognition (information processing) be modelled?
3. How can interplay between emotions and information processing be modelled in two player chess game, where the behavioral signals from opponent serve as valuable cue? and behavioral cues from the player can serve as valuable information regarding the game play and therefore regulating these emotions (to suppress the display of behavior) have adverse effect on cognitive performance? (How can this scenario be quantified?)
4. How do chess players leverage emotions to Improve game play, complement the information processing capability and gain information about the situation based on the emotions of the opponent.?
5. What are the underlying mechanisms of this Cognitive Affective process and how can the components be modelled using available cognitive Frameworks/models?

Why Chess:

Researchers in computer science have famously referred to chess as the 'drosophila' of artificial intelligence (AI)(Lane & Gobet, 2012). What they seem to mean by this is that chess, like the common fruit fly, is an accessible, familiar, and relatively simple experimental technology that nonetheless can be used productively to produce valid knowledge about other, more complex system ((Ensmenger, 2012).

Chess is a very complex game. (Shannon showed a calculation for the lower bound of the game-tree complexity of chess, resulting in about 10120 possible games, to demonstrate the impracticality of solving chess by brute force, in his 1950 paper "Programming a Computer for Playing Chess". As a comparison, the number of atoms in the observable universe, to which it is often compared, is roughly estimated to be 1080 - Which is orders of magnitude lower) (Claude Shannon , 1950)

Problem Description:

Despite the enormous complexity, Chess players perform very well, in addition to making accurate moves under time constraints (Gobet, 2005)

Insights from Previous Research:

Even though, Chunking and template theory explain underlying mechanisms about how human mind can overcome the limitations imposed by working memory. Chunking and template theory is implemented in Chrest Framework. This framework has been used to validate the results of various chess observations. Similarly, modules for attention are also part of this framework.(Gobet, Lane, & Lloyd-Kelly, 2015)

Recent studies have highlighted the influence of emotions in dealing with this complexity(Guntz et al., 2018). The studies indicate that emotions are more tightly coupled with the information processing capability. Chess players associate previous game situations to specific emotions and use the emotions in narrowing down the potential candidate moves which are subsequently evaluated. But These studies were conducted in lab, and so far, there is no theoretical model to explain this observation.

Research Objective:

We propose to model the influence of emotions on chess playing skill using Chrest and Nengo.

We Leverage the modules already implemented in Chrest (Gobet & Jansen, 2004) for chess capabilities and leverage nengo for modulating the emotion based on the game situation. (Chrest and Nengo(Bekolay et al., 2014) work in tandem simulating a real-player scenario)

Hypothesis:

H1a: Emotions, rather than just cognitive abilities, will influence cognitive processing in chess task

H2a: Emotions, complement and assist cognitive abilities, in chess task (They are integral to Cognitive abilities)

Proposed Architecture

We have built on the existing NTIM Framework ((Degroot & Broekens, 2003). The current Architecture is limited to manipulating behavior but does not integrate emotion to complement the cognitive task. We use CHREST Framework to model the attention, heuristic search and pattern recognition, and the input from Nengo which is based on the situational parameters given (Personality Model) is used to manipulate the emotion Valance and Arousal.

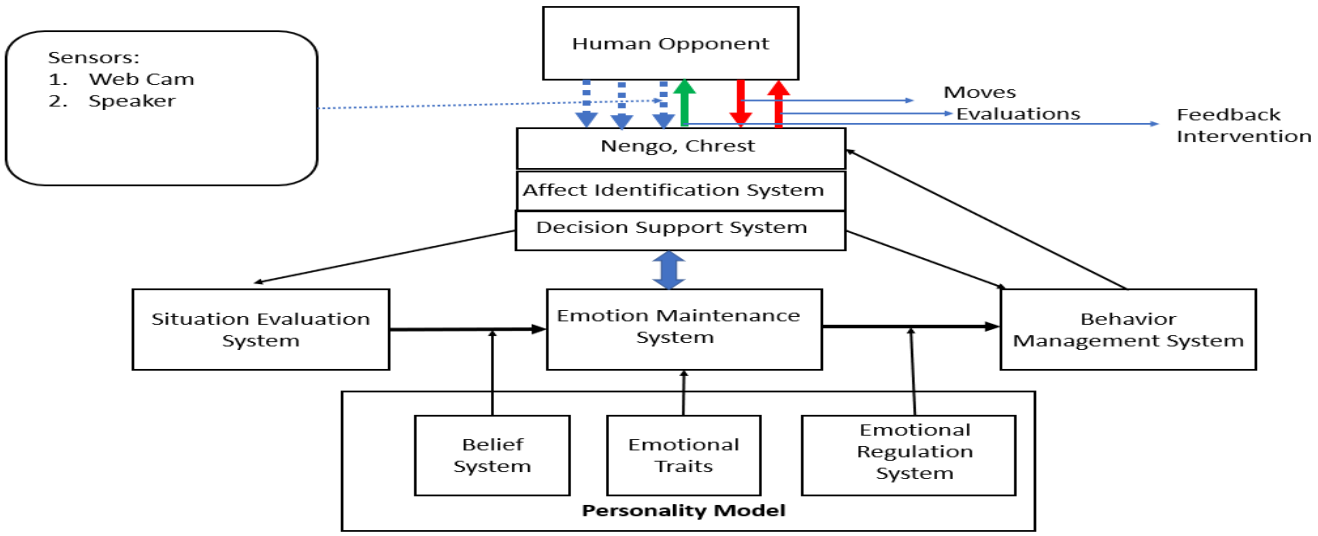

Figure 1 Proposed Architecture to integrate Affect and Cognition

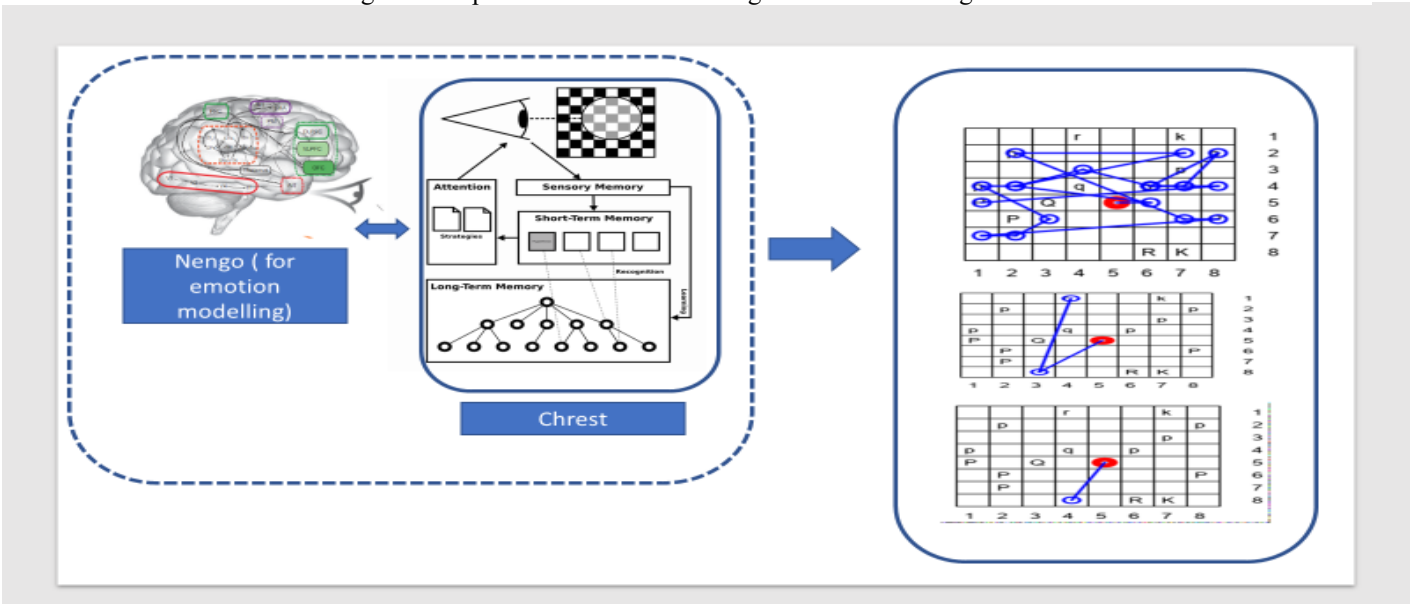

Figure 2 Integration of Nengo and Chrest and output Results (Gaze patterns)

Results

S.NO	User Profile	Chess-Score (ELO) - DV	Fixation Time, Gaze time, Fixation Duration (Seconds)
1	Cognitive (Analytical)	1900	16.1,12,5.4
2	Cognitive - Affective	2100	18.1,12,5.3.5
3	Affective (Intuition)	1700	7.3,5,6

Future Directions

The Framework can be used to model the users profile based on the affective and cognitive observations and has practical implications in developing cognitive affective learning agents.

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