Project specification

MEi:CogSci 1st year semestral project

by Anton Kovac

TOPIC OF SPECIALISATION

Reimplementation of a part of existing model of Working Memory / Long Term Memory (WM/LTM) and addition to it an affective component. This implementation would cause that highly affective parts of memory would be better retrieved from Long Term Memory.

PHENOMENON and (PERSONAL) GOALS

My goal is to examine the Working Memory and Long Term Memory with respect to connectionist paradigm. I will work with existing model of WM/LTM. Further, I am going to revise a part of the current model and add a new architecture.

The main reason I picked this topic is my personal interest in the working memory phenomena which was in other form (empirical experiment) the topic of my bachelor thesis.

The interdisciplinary character of such work is an accomplishing combination of both, the psychological phenomena (working and long term memory) with computational modeling approach (connectionist paradigm).

References:

TAKAC, Martin – KNOTT, Alistair. *Working memory encoding of event sand their participant: a neural network model with applications in sensorimotor processing and sentence generation.*

TAKAC, Martin – KNOTT, Alistair. *Mechanisms for storing and accessing event representations in episodic memory, and their expression in language: a neural network model*

LEARNING OUTCOMES

Because of my professional background in psychology I have not yet gained appropriate skills in computer science therefore I expect to achieve this experience from such work. I would learn to create artificial neural network model and implement it into existing model of psychological phenomena. Furthermore, I expect to learn how to use existing libraries (i.e. Numpy in Python, etc.) in particular programing languages (Python, Matlab, JAVA) and improve my skills in programming per se. Moreover, this project gives me an opportunity get to know the work of computer scientist in deeper way and earn new skills resulting from cooperation with people from computer science environment.

Methodological

Ability to formulate research hypothesis with respect to connectionist paradigm. Further, to earn experience of testing computational model and find appropriate parameters of artificial neural network and model as a whole.

Systemic

- Interdisciplinary work/thinking
  - *I expect to earn a new and deep insight into work of computer scientist.*

- Project-oriented work and organisational skill
  - *Work in cooperation with scientist in computational field.*

PROJECT

Project title:

The Simulation of Affective Retrieval using the Self-Organizing Map with Temporal Context

Short Project Description (300-500 characters)

This project focuses on creating the Merge Self-Organizing Map (MSOM) and experiment with this artificial neural network with respect to simulate function of working memory in human coming out from existing model of working memory based on connectionist paradigm. The outcome of this project would be the MSOM architecture ready to implement to this particular model.

Project Plan

Project steps**:**

I. Literature research

7.3.2016 – 10.4.2016 (40 working hours)

Baddeley, A. "*The episodic buffer: a new component of working memory?*" Trends in cognitive sciences, vol. 4, no. 11, pp. 417-423, 2000

Baddeley, A. *"Working memory: looking back and looking forward."* Nature reviews neuroscience, vol. 4, no. 10, pp. 829-839, 2003

Baddeley, A. *"Working memory: theories, models, and controversies."* Annual review of psychology, vol. 63, pp. 1-29, 2012

M. Strickert and B. Hammer *"Neural Gas for Sequences"*, In T. Yamakawa, editor, Proceedings of the Workshop on Self-Organizing Networks (WSOM), pp. 53–58, Kyushu Institute of Technology, 2003

M. Strickert and B. Hammer, "*Merge SOM for temporal data,"* Neurocomputing, vol. 64, pp. 39-71, 2005

M. Takac and A. Knott, *"A Neural Network Model of Episode Representations in Working Memory,"* Cogn Comput, vol. 7, no. 5, pp.509-525, 2015

M. Takac and A. Knott, *"A simulationist model of episode representations in working memory: Technical appendix,"* 2015

II. Planning of experiment

11.4.2016 – 17.4.2016 (10 working hours)

Choosing appropriate computational approach and finding possible ways to realize the experiment. For this project we decided to create architecture of affective component separately from existing model of working memory. That would provide more time and space for experiments of behavior of such network. We set several goals:

- *Create artificial network system (Merge Self- Organizing Map - MSOM) to represent affective component in such way to future implement to existing model of working memory*
- *Examine behavior of this network on basic tasks*
- *Examine parameters of network with respect to goal of the project*
- *Explore behavior of the network on test input episodes*

III. Realization of the experiment

18.4.2016 – 16.5.2016 (40 working hours)

Firstly, we will create MSOM architecture and test it on basic task to the network that presents words by one letter at the time. The MSOM characteristics would remember the context of previously presented letters and on the topographical map would be seen that the neurons with their neighbors react to similar inputs (letters/words).
Secondly, such network will be ready for experiments for our purposes. The main goal is to examine the changes of network learning with adding the affective component which is composed of two dimensional vector of uniformly distributed values between 0 and 1. Secondary goal is to explore how the inputs (episodes) will be represented on the network topology.
Tertiary objective is to examine the activation of the network topology by top-down spreading of test data.

IV. Data analysis and interpretation of data

17.5.2016 – 22.5.2016 (10 working hours)

The analysis of the results and discussion concerning the graphical output. The first discussion about the abstract and poster for MEi:CogSci conference.

V. Documentation of project

23.5.2016 – 1.6.2016 (6 working hours)

Preparation and uploading of the final version of abstract for MEi:CogSci conference (including the consideration of the reviews).

2.6.2016 – 20.6.2016 (20 working hours)

Working on the final version of poster for MEi:CogSci conference.

ABSTRACT

Introduction

Current work aims to implement additional component to existing connectionist model of semantic working memory [1]. The main assumption of this model is that the events are experienced through structured sensorimotor routines, which allows to propose them as events with their participant composed of agent, patient and action. However, such settings may lack some properties of current episode like affective component. Therefore we decided to implement additional architecture to capture such component.
Presented model of semantic working memory has in the Current situation component recurrent architecture: it takes as an input the current episode and its own internal representation of past episodes [2]. It is implemented as Merge Self- *Organizing* Map (MSOM) [3]. Its properties offer to reconstruct the situation by top-down propagation from the weights back to the WM episode medium.

Experiment

Our main goal of this project was to create and test architecture of current episode enriched by affective component in a manner: agent / patient / action / + affect. This affective component is represented as two dimensional vector: <positive valence; negative valence>. The positive and negative affect is represented as randomly assigned number from uniform distribution from interval <0,1>. Therefore larger value can express more positive or more negative affect of current situation (i.e. similar values represent ambivalent emotion). The initialization of the input episodes should be biased with some sort of affect. E.g. some actions may be threatened as more positive or more negative, i.e. I|eat|cream is probably more emotionally positive than Dog|bites|me. Furthermore, when we train our network in such conditions the future presentation of similar episodes will evolve similar emotion like in the past. In addition, when we present to the trained MSOM architecture episode with hidden affective component, the network can abstract affective component from the learned connections with past episodes.

Results and Conclusions

We trained MSOM network successfully. Furthermore, we are able to approximate affective component of the testing episodes without explicit presentation of emotional part. Such property can be used in retrieval from long term storage, i.e. episodes with higher emotional valence can be retrieved easier. We are currently aiming to perform more experiments before we try to add up into the presented model [1], [2].

Acknowledgement

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References

[1] M. Takac and A. Knott, "A Neural Network Model of Episode Representations in Working Memory," Cogn Comput, vol. 7, no. 5, pp.509-525, 2015
[2] M. Takac and A. Knott, "A simulationist model of episode representations in working memory: Technical appendix," 2015
[3] M. Strickert and B. Hammer, "Merge SOM for temporal data," Neurocomputing, vol. 64, pp. 39-71, 2005