Assignment 4 A Second-Order Adaptive Reified Network Model Showing Plasticity and Metaplasticity

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1 author:

Jan Treur
Vrije Universiteit Amsterdam
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Assignment 4

A Second-Order Adaptive Reified Network Model

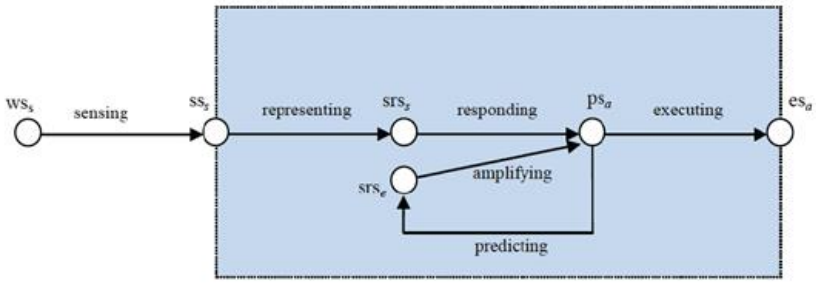
Showing Plasticity and Metaplasticity

Assignment Outcomes

After doing this assignment it is expected that you will understand the following terms:

- Multi-order adaptive reified temporal-causal networks
- Conceptual representation of a reified network model in two forms: a 3D graphical connectivity picture, and a specification of role matrices.
- Simulation of multi-order adaptive networks

In this assignment, you are asked to model a multi-level, second-order adaptive extension of the example temporal-causal network model described in Book 1, Chapter 2 (which was also used in Assignment 3). The following figure shows a graphical conceptual representation of this base network model. For more information about this example model, read Book 1, Chapter 2, Section 2.4.2.



References

Book 1, Chapter 2, Section 2.4, and Book 2, Chapter 3, Section 3.6.1, and Chapter 4. The Word file of the latter chapter is available so that you can copy pictures and tables from it to serve as starting points; see in Files Treur-Chap04v2acc.docx.

Main scenario

Upon observing stimulus *s* a person is learning to decide whether or not to perform action *a*. There are two connections that are learned by a Hebbian learning adaptation principle (*plasticity*), described by combination function **hebb$_\mu$(..)**: the responding connection and the predicting connection. However, the learning speed for these connections is also adaptive (*metaplasticity*); the learning accelerates with exposure to the stimulus as represented by srs_s.

Use the concepts and formats introduced in the above references to analyse and model this scenario by a second-order reified temporal-causal network by the following steps.

Q1. Make a conceptual representation in 3D graphical format

Make a 3D picture similar to Fig 4.3 in Book 2, Chapter 4.

- Use the above model as the base network model, depicted in the horizontal base plane (pink)
- For the first reification level (the second plane, light blue), introduce two connection weight reification states for the two chosen connections, similar to the states

  $\mathbf{W}_{X_i,Y}$

  in Fig. 3.4 in Book 2, Chapter 3.
- For the second reification level (third plane, light purple), introduce two learning speed reification states for the two chosen connection weights, similar to the second-order reification state

  $\mathbf{H}_{\mathbf{W}_{\mathrm{srs}_s,\mathrm{ps}_a}}$

  in Fig. 4.3 in Book 2, Chapter 4.
- Make a legend in the form of a table with all states and their explanation similar to Table 4.2 in Book 2, Chapter 4.

Q2. Make a conceptual representation in role matrix format

Specify the role matrices for the different network characteristics similar to what is shown in Box 4.1 in Book 2, Chapter 4:

- **Connectivity**
  - role matrix **mb** for base connectivity of all states
  - role matrix **mcw** for all connection weights
- **Aggregation**
  - role matrix **mcfw** for the combination function weights
  - role matrix **mcfp** for the combination function parameters
- **Timing**
  - role matrix **ms** for speed factors of all states

Q3. Describe what behaviour you expect from the above network model

Which states are constant and nonzero from the beginning? Which states start at 0? In which order will the states have high and low values? How fast will they increase? In particular, discuss the difference between (1) first-order adaptation with constant learning speed, and (2) second-order adaptation using adaptive learning speed.

Q4. Choose appropriate initial values and generate simulations

Use the Matlab template NOMEadaptive. In particular, run two specific scenarios and compare them: (1) first-order adaptive with constant learning speed, and (2) second-order adaptive with adaptive learning speed. Discuss whether the results are in accordance with 3.