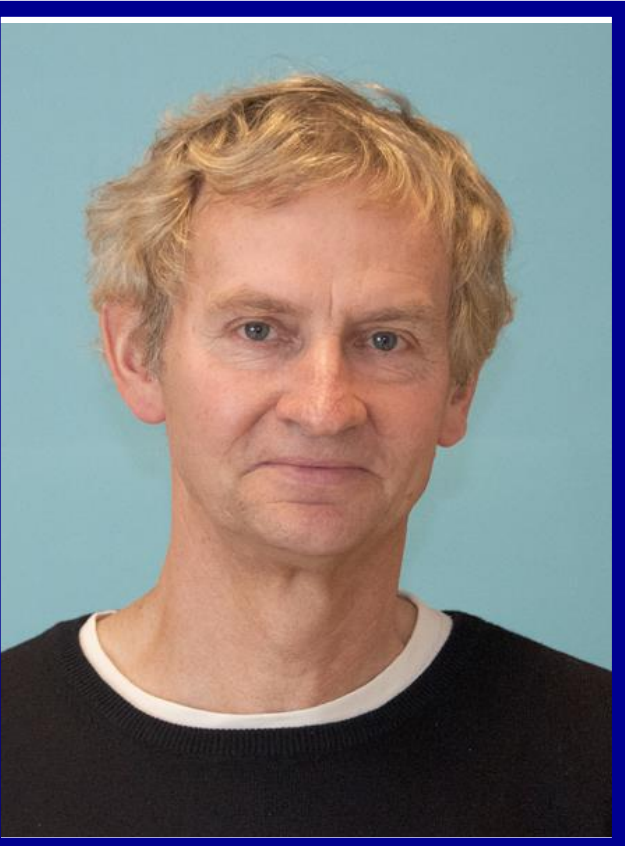


Modeling the Emergence of Informational Content by Adaptive Networks for Temporal Factorisation and Criterial Causation

Jan Treur

Social AI Group, Vrije Universiteit Amsterdam



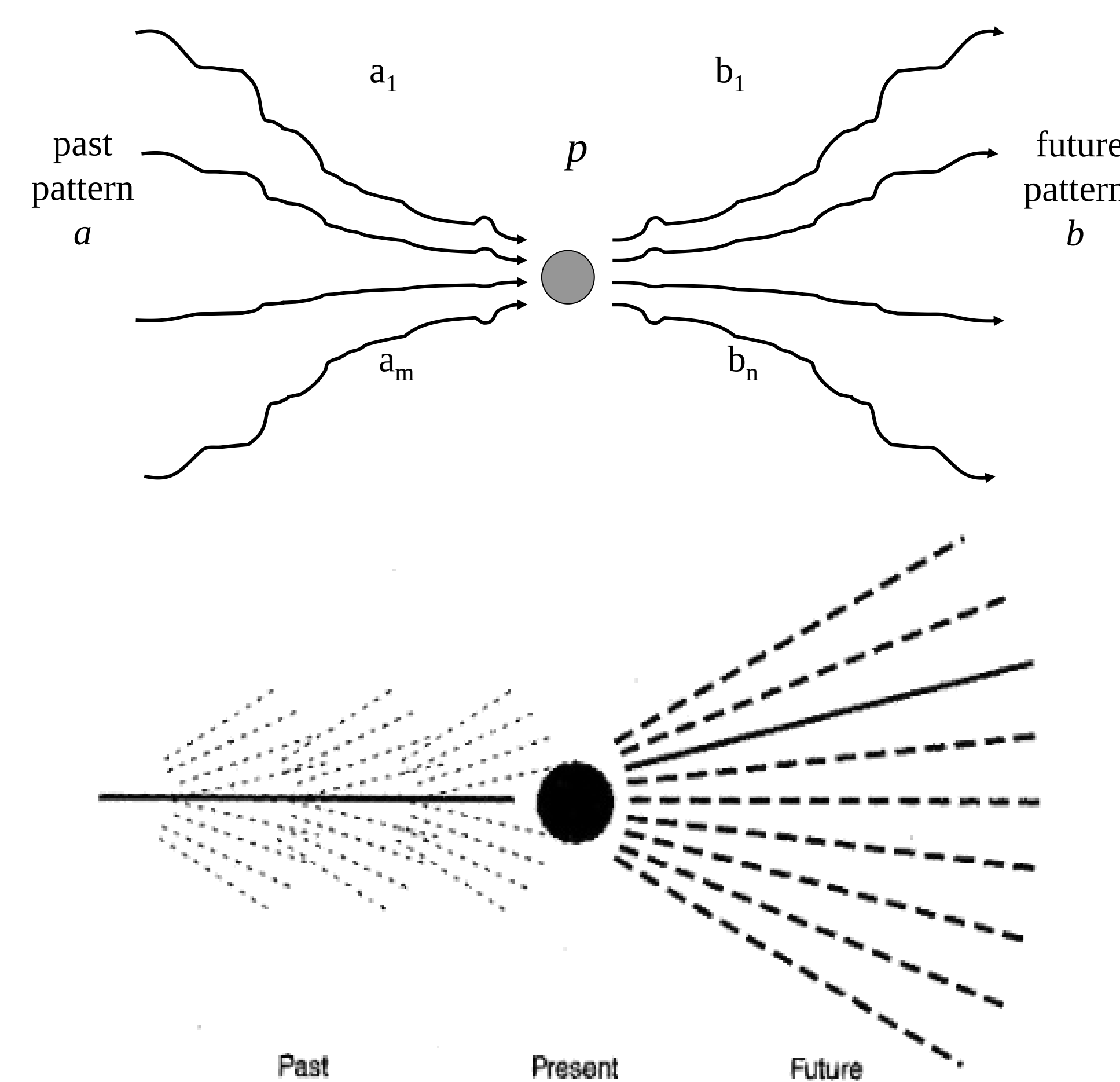
ABSTRACT

Propagated activation of neurons through their network is an important process in the brain, together with adaptation over time of the characteristics of this network such as connection strengths or excitability thresholds. These adaptive network characteristics can be interpreted as informational criteria for activation of a neuron: **emergent informational content**. Activation of neurons is determined by such information via a process termed **criterial causation**. The relationship of criterial causation with the principle of **temporal factorisation** for the dynamics of the world in general is explored and modeled by **adaptive network models**.

INTRODUCTION

Activation of neurons depends on settings of intrinsic characteristics of the network of neurons, such as synaptic connection strengths and excitability thresholds for neurons. These serve as **criteria on the incoming signals** for a neuron to get activated. As part of the plasticity of neural processing, these network characteristics change over time. This is a form of **emerging information formation**, and the firing of neurons is driven by this information. This is called **criterial causation** (Tse, 2013, right picture below). An adaptive network modeling criterial causation was designed; it is also shown how criterial causation relates to the general **temporal factorisation** principle (Treur, 2007ab, left picture below) of past pattern $a \Rightarrow$ future pattern b for world dynamics by a mediating state property p in the present.

TEMPORAL FACTORISATION AND CRITERIAL CAUSATION



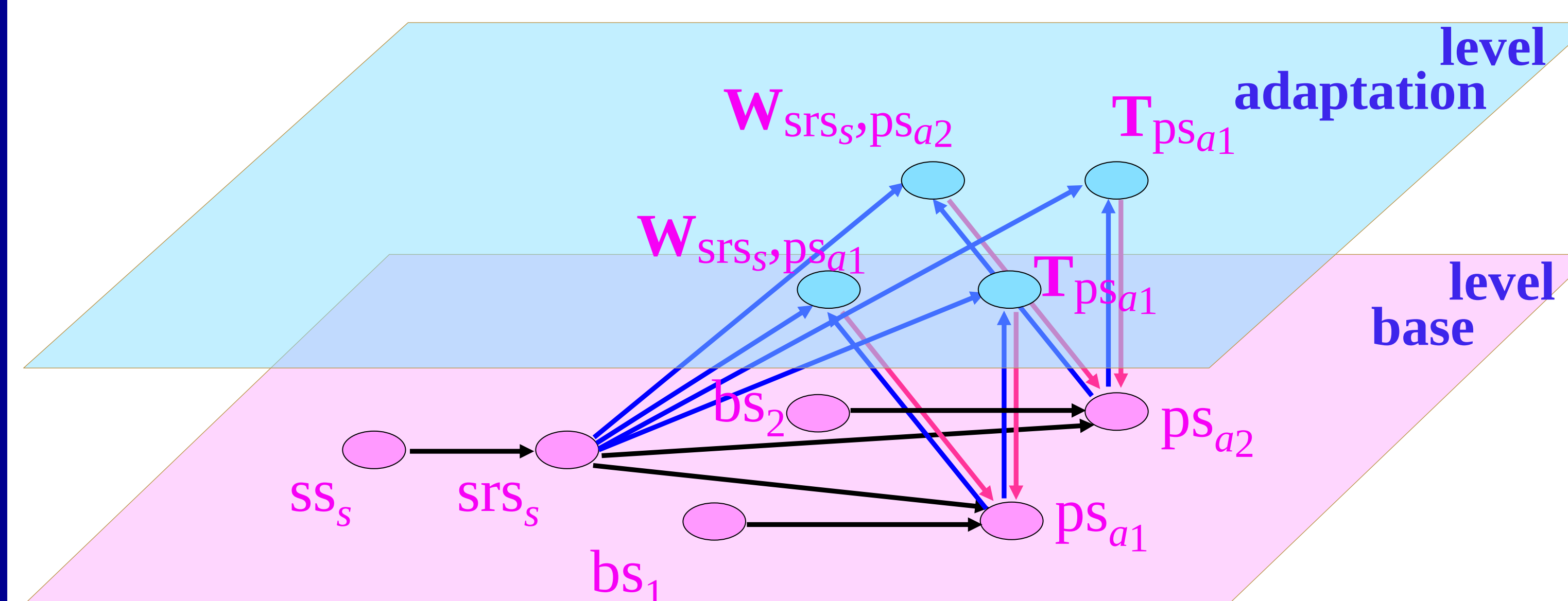
EXAMPLE SCENARIO

A person new in an organisation has to learn to recognize a colleague from seeing his face, modeled by stimulus s .

- There are two options, colleagues a_1 and a_2 . Deciding for one of them is represented by preparation states ps_{a1} and ps_{a2} .
- Belief bs_1 suggests that it is colleague a_1 , and belief bs_2 that it is colleague a_2 .
- These beliefs are indicative, generated from independent circumstantial environmental factors such as location.
- Two types of adaptive network characteristics: the weights of the connections from the sensory state srs_s for s to ps_{a1} and ps_{a2} , and the excitability thresholds for states ps_{a1} and ps_{a2} .
- During the scenario in the past the characteristics are adapted; the settings at the present state define the criteria for criterial causation of the recognition.
- Based on the obtained criteria in the present, in future situations any encounter with s leads to fulfilment of the criteria and as a consequence to recognition.

THE EXAMPLE ADAPTIVE NETWORK MODEL FOR THE EMERGENCE OF INFORMATIONAL CONTENT

Connectivity of the Adaptive Network



nr	state name	explanation
X_1	ss_s	Sensor state for external stimulus s (seeing a face)
X_2	srs_s	Sensory representation state for stimulus s
X_3	bs_1	Belief state 1 (belief that it is Person 1)
X_4	bs_2	Belief state 2 (belief that it is Person 2)
X_5	ps_{a1}	Preparation state for recognition as Person 1
X_6	ps_{a2}	Preparation state for recognition as Person 2
X_7	$W_{srs_s, ps_{a1}}$	State representing the weight of the connection from srs_s to ps_{a1}
X_8	$W_{srs_s, ps_{a2}}$	State representing the weight of the connection from srs_s to ps_{a2}
X_9	$T_{ps_{a1}}$	State representing the excitability threshold of ps_{a1}
X_{10}	$T_{ps_{a2}}$	State representing the excitability threshold of ps_{a2}

Aggregation within the Adaptive Network

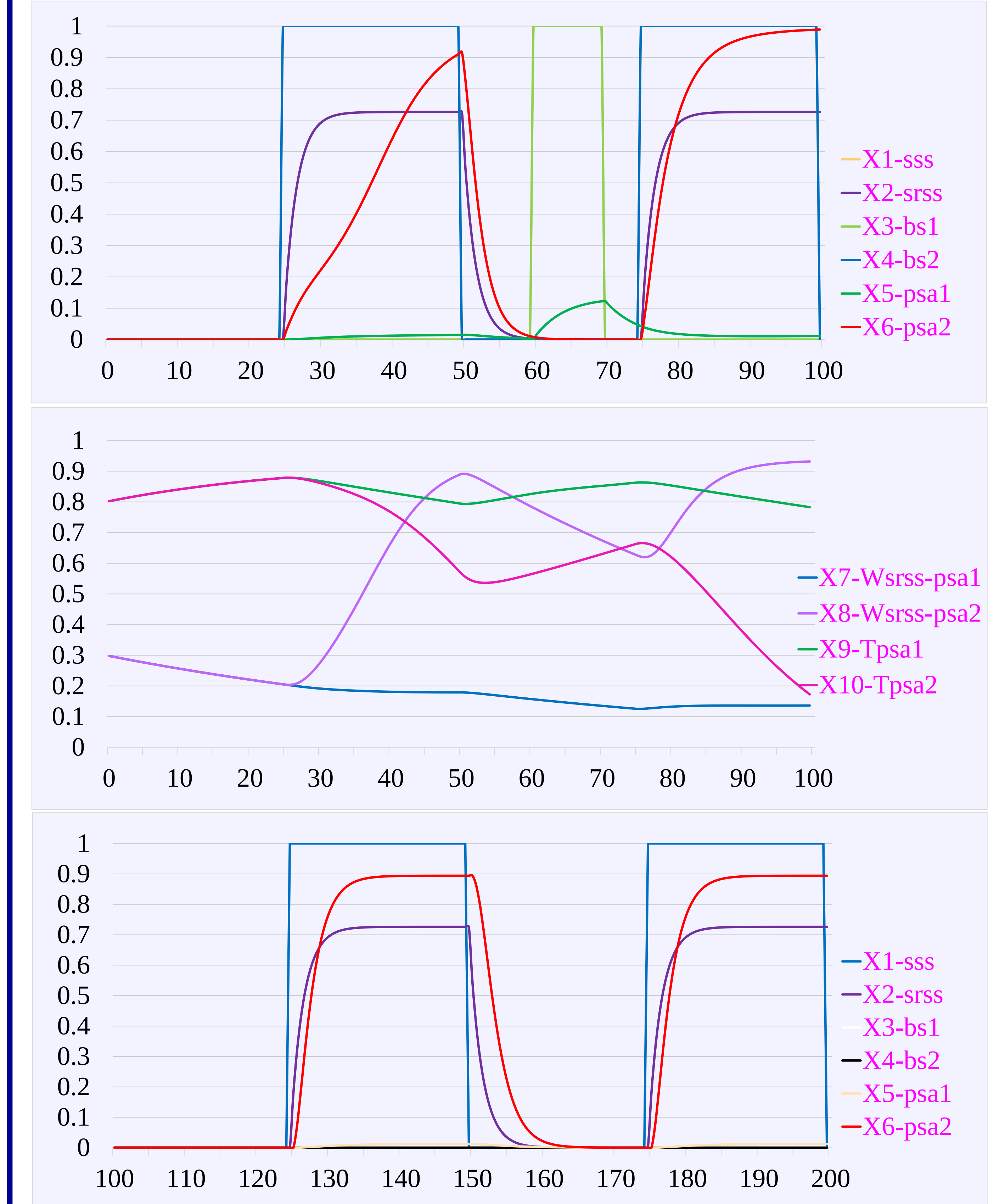
The **W**-states use the **Hebbian learning combination function** $hebb(..)$ defined as

$$hebb(V_1, V_2, W) = V_1 V_2 (1 - W) + \mu W$$

where V_1, V_2 are the two state activation levels and W the value of the reified connection weight, and μ the **persistence factor**.

The other states apply an often used logistic sum function: **alogistic**

EXAMPLE SIMULATIONS



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