A Computational Model of Cortical Functioning at Cellular Level

- A Thesis Submitted for the Degree of Master in AI -

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Abstract

When looking at the cortex at cellular level we see a wild proliferation of seemingly random connections. Links between almost every type of cell are commonplace, making the attempt to understand the cortex' structure and function using an empirical approach an arduous business.

Yet, although the empirical approach has so far been unable to solve the cortical puzzle, it has identified many important pieces. In this thesis an attempt is made to put these pieces together using an information-theoretic perspective. If we were to re-design the cortex from scratch, what functions would it have to fulfill? How would we build it using merely the type of information-processing neurons are capable of? Is there neuro-biological evidence suggesting this is indeed how the cortex operates?

To gain more insight, a biologically plausible neural network is proposed simulating the six layers of the cortex at cellular level. Besides reproducing a number of biological phenomena, this model also leads to new hypotheses that neuroscientists may find useful when directing their future research.

This thesis was submitted for the degree of Master in Artificial Intelligence from the Department of Cognitive Artificial Intelligence (CKI) of the Utrecht University, the Netherlands. It focusses on a key topic of CKI, namely the interaction between neuroscience and self-learning systems.