

Table of Contents

An Overview of Hybrid Neural Systems	1
<i>Stefan Wermter and Ron Sun</i>	

Structured Connectionism and Rule Representation

Layered Hybrid Connectionist Models for Cognitive Science	14
<i>Jerome Feldman and David Bailey</i>	
Types and Quantifiers in SHRUTI: A Connectionist Model of Rapid Reasoning and Relational Processing	28
<i>Lokendra Shastri</i>	
A Recursive Neural Network for Reflexive Reasoning	46
<i>Steffen Hölldobler, Yvonne Kalinke and Jörg Wunderlich</i>	
A Novel Modular Neural Architecture for Rule-Based and Similarity-Based Reasoning	63
<i>Rafal Bogacz and Christophe Giraud-Carrier</i>	
Addressing Knowledge-Representation Issues in Connectionist Symbolic Rule Encoding for General Inference	78
<i>Nam Seog Park</i>	
Towards a Hybrid Model of First-Order Theory Refinement	92
<i>Nelson A. Hallack, Gerson Zaverucha, and Valmir C. Barbosa</i>	

Distributed Neural Architectures and Language Processing

Dynamical Recurrent Networks for Sequential Data Processing	107
<i>Stefan C. Kremer and John F. Kolen</i>	
Fuzzy Knowledge and Recurrent Neural Networks: A Dynamical Systems Perspective	123
<i>Christian W. Omlin, Lee Giles, and Karvel K. Thornber</i>	
Combining Maps and Distributed Representations for Shift-Reduce Parsing	144
<i>Marshall R. Mayberry and Risto Miikkulainen</i>	
Towards Hybrid Neural Learning Internet Agents	158
<i>Stefan Wermter, Garen Arevian, and Christo Panchev</i>	

A Connectionist Simulation of the Empirical Acquisition of Grammatical Relations 175
William C. Morris, Garrison W. Cottrell, and Jeffrey Elman

Large Patterns Make Great Symbols: An Example of Learning from Example 194
Pentti Kanerva

Context Vectors: A Step Toward a “Grand Unified Representation” 204
Stephen I. Gallant

Integration of Graphical Rules with Adaptive Learning of Structured Information 211
Paolo Frasconi, Marco Gori, and Alessandro Sperduti

Transformation and Explanation

Lessons from Past, Current Issues, and Future Research Directions in Extracting the Knowledge Embedded in Artificial Neural Networks 226
Alan B. Tickle, Frederic Maire, Guido Bologna, Robert Andrews, and Joachim Diederich

Symbolic Rule Extraction from the DIMLP Neural Network 240
Guido Bologna

Understanding State Space Organization in Recurrent Neural Networks with Iterative Function Systems Dynamics 255
Peter Tiño, Georg Dorffner, and Christian Schittenkopf

Direct Explanations and Knowledge Extraction from a Multilayer Perceptron Network that Performs Low Back Pain Classification 270
Marilyn L. Vaughn, Steven J. Cavill, Stewart J. Taylor, Michael A. Foy, and Anthony J.B. Fogg

High Order Eigentensors as Symbolic Rules in Competitive Learning 286
Hod Lipson and Hava T. Siegelmann

Holistic Symbol Processing and the Sequential RAAM: An Evaluation 298
James A. Hammerton and Barry L. Kalman

Robotics, Vision and Cognitive Approaches

Life, Mind, and Robots: The Ins and Outs of Embodied Cognition 313
Noel Sharkey and Tom Ziemke

Supplementing Neural Reinforcement Learning with Symbolic Methods . . . 333
Ron Sun

Self-Organizing Maps in Symbol Processing	348
<i>Timo Honkela</i>	
Evolution of Symbolization: Signposts to a Bridge Between Connectionist and Symbolic Systems	363
<i>Ronan G. Reilly</i>	
A Cellular Neural Associative Array for Symbolic Vision	372
<i>Christos Orovos and James Austin</i>	
Application of Neurosymbolic Integration for Environment Modelling in Mobile Robots	387
<i>Gerhard Kraetzschmar, Stefan Sablatnög, Stefan Enderle, and Günther Palm</i>	
Author Index	403