



Analysis and quantitative comparison of neural network dynamics on a neuron-wise and population level

Robin Gutzen

Information

Band / Volume 102

ISBN 978-3-95806-738-7

Forschungszentrum Jülich GmbH
Institut für Neurowissenschaften und Medizin (INM)
Computational and Systems Neuroscience (INM-6)

Analysis and quantitative comparison of neural network dynamics on a neuron-wise and population level

Robin Gutzen

Schriften des Forschungszentrums Jülich
Reihe Information / Information

Band / Volume 102

ISSN 1866-1777

ISBN 978-3-95806-738-7

CONTENTS

I Introduction

- 1 Background 3
 - 1.1 Scales of neural organization 3
 - 1.2 A network view onto neural organization 6
 - 1.3 Quantitative description of neural data in measures and models 9
 - 1.4 Comparability of measured and modeled neural activity data 13
 - 1.5 Relationships between connectivity, activity, and function of neural networks 16
- 2 Thesis statement 23
 - 2.1 Principles of how connectivity provokes activity provokes function 23
 - 2.2 Systematic quantitative comparisons of neural systems 24
 - 2.3 Characterization of neural systems on a meaningful level of abstraction 25
 - 2.4 Thematic threads 26
- 3 Thematic Outline 27

II Results

- 4 Network level validation & reproducible simulations 33
 - 4.1 Introduction 34
 - 4.2 Methods 35
 - 4.3 Results 50
 - 4.4 Conclusion 57
- 5 Network activity and connectivity comparisons via eigenvector angles 61
 - 5.1 Introduction 61
 - 5.2 Methods 65
 - 5.3 Results 74
 - 5.4 Conclusion 83
- 6 Activity-driven calibration of network connectivity 87
 - 6.1 Introduction 88
 - 6.2 Methods 91
 - 6.3 Results 100
 - 6.4 Conclusion 107
- 7 Slow wave analysis across heterogenous datasets 111
 - 7.1 Introduction 112
 - 7.2 Methods 116
 - 7.3 Results 127
 - 7.4 Conclusion 143

8	Cortical wave dynamics in behaving monkeys	147
8.1	Introduction	147
8.2	Methods	148
8.3	Results	152
8.4	Conclusion	158
III Conclusion		
9	Conclusion	165
9.1	Characterization of neural data	165
9.2	Modalities of comparison	167
9.3	Interplay of connectivity, activity, function:	169
10	Discussion & Outlook	173
10.1	Open and collaborative science practices	173
10.2	Continuous validation testing	174
10.3	Reusability of the Collaborative Brain Wave Analysis Pipeline	176
10.4	Inferring connectivity and predicting activity	178
10.5	Relation between spike patterns and LFP waves	180
10.6	Functional roles of cortical waves	182
10.7	Personal perspective on the future of (computational) neuroscience	187
IV Appendix		
A	Visualizing cortical waves	191
B	The Kintsugi brain	193
	Bibliography	195

Information

Band / Volume 102

ISBN 978-3-95806-738-7

Mitglied der Helmholtz-Gemeinschaft

