Xerxes D. Arsiwalla, Ph.D.

Synthetic Perceptive Emotive & Cognitive Systems Lab,
Institute for Bioengineering of Catalonia, Barcelona, Spain
Email:- x.d.arsiwalla@gmail.com

Education

- Ph.D. (String Theory), University of Amsterdam, Netherlands (2010)
Thesis: *Supersymmetric Black Holes as Probes of Quantum Gravity*; Advisor: Prof. Erik Verlinde
- Diplom Physik (Theoretical Physics), University of Bonn, Germany (2003)
Thesis: *Matrix Models - From Statistical Physics to Gauge Theories*; Advisor: Prof. Rainald Flume
- B.Sc. (Physics), University of Mumbai, India (2000)

Positions Held

- Instructor, Biomedical Engineering & Cognitive Systems, Pompeu Fabra University, Barcelona, Spain (2013 - ...)

Teaching Areas: *Control & Dynamical Systems Theory; Cognitive Science*

- Postdoctoral Fellow, Institute for Bioengineering of Catalonia & Pompeu Fabra University, Spain (2012 - ...)

Research Areas: *Computational Neuroscience; Control Theory; Information Theory; Complex Systems; Consciousness*

- Junior Scientist, Dutch Foundation for Fundamental Research, Amsterdam, Netherlands (2004 - 2009)

Research Areas: *String Theory & Black Holes*

Other Professional Experience

- Visiting Researcher, Barabási Lab, Northeastern University, Boston, USA (2016)

Research Areas: *Controllability of Non-Linear Networks*

- Visiting Scholar, Princeton Neuroscience Institute, Princeton University, Princeton, USA (2012)

Courses: *Biophysics & Computation in Neurons & Networks*

- Thesis Advisor, Master Program in Cognitive Systems, Pompeu Fabra University, Spain (2012 - ...)

- Visiting Scholar, Cold Spring Harbor Asia, Suzhou, China (2011)

Courses: *Cognitive & Computational Neuroscience*

- Research Assistant, Pompeu Fabra University, Spain (2010 - 2011)

Research Areas: *Computational & Systems Neuroscience*

- Teaching Assistant, Physics Dept., University of Amsterdam, Netherlands (2005 - 2008)

Teaching Areas: *Undergraduate Statistical Mechanics, Electrodynamics & Classical Mechanics*

- Visiting Research Fellow, Harish-Chandra Research Institute, Allahabad, India (2004)

Research Areas: *Supersymmetric Gauge Theories & Spin Chains*

- Teaching Assistant, Physics Dept., University of Bonn, Germany (2003)

Teaching Areas: *Undergraduate Quantum Mechanics*

- Research Scholar, Theory Division, CERN - European Organization for Nuclear Research, Geneva, Switzerland (2001)

Research Areas: *Kaon Mixing & CP Violation*

- Research Scholar, Institute for Mathematical Sciences, Chennai, India (2000)

Research Areas: *Quantum Field Theories*

♠ Awards & Fellowships

- Fellowship from Canadian Institute for Advanced Research for Winter School on Neuroscience of Consciousness (2017)
- Best Paper Award at NetSciX (2016)
- Best Paper Finalist at ICANN (2016)
- BrainX^3 Paper Named Frontiers Journals' Top 100 Spotlight Articles of 2015
- Best Paper Award at ACHI (2014)
- Fellowship from Princeton University for Course on Biophysics & Computation in Neurons & Networks (2012)
- Fellowship from Cold Spring Harbor Asia for Summer School on Computational & Cognitive Neuroscience (2011)
- Accepted for UC Berkeley Summer Course on Mining & Modeling of Neuroscience Data (declined) (2011)
- 1st Prize for Project at the Barcelona Cognition, Brain & Technology Summer School (2010)
- Scholarship of the European Union's Convergent Science Network for Biomimetics and Bio-Hybrid Systems (2010)
- 2nd Prize for Breakthrough Idea Challenge at TED^X Amsterdam (2009)
- Fellowship of the Dutch Foundation for Fundamental Research (2004 - 2009)
- Research Fellowship from the Harish-Chandra Research Institute (2004)
- Scholarship of the German Academic Exchange Service (DAAD) & the Heraeus Foundation (2000 - 2003)
- Research Fellowship from CERN, the European Organization for Nuclear Research (2001)
- Research Fellowship from DESY, the German Electron Synchrotron Facility (declined) (2001)
- 1st Prize at the Rotary Club Inter-College Science Trophy (2000)
- Research Fellowship from the Jawaharlal Nehru Center for Advanced Scientific Research (2000)
- Top 1% at the National Graduate Physics Competition (2000)
- Tata Undergraduate Merit Scholarship (1996 - 2000)

♠ Publications

⊙ Journal Articles

- X. D. Arsiwalla, P. Verschure (2018) **Measuring the Complexity of Consciousness**, Frontiers in Neuroscience, **12**, 424.

- X. D. Arsiwalla, C. Moulin-Frier, I. Herreros, M. Sanchez, P. Verschure (2017) **The Morphospace of Consciousness**, (arXiv preprint) arXiv:1705.11190.

- R. Zamora, S. Korff, Q. Mi, D. Barclay, L. Schimunek, R. Zucca, X. D. Arsiwalla, R. L. Simmons, P. Verschure, T. R. Billiar, Y. Vodovotz (2018) **A Computational Analysis of Dynamic, Multi-Organ Inflammation Induced by Endotoxin in Mice**, PLoS Comp Bio (submitted).

- R. Hindriks, J. Schmid, X. D. Arsiwalla, A. Peter, P. Verschure, P. Fries, M. C. Schmid, G. Deco (2017) **Linear Distributed Source Modeling of Local Field Potentials recorded with Intra-cortical Electrode Arrays**, PLoS ONE, **12 (12)**, e0187490.

- X. D. Arsiwalla, P. Mediano, P. Verschure (2017) **Spectral Modes of Network Dynamics Reveal Increased Informational Complexity Near Criticality**, Procedia Computer Science, vol. **108**, pp. 119-128.

- D. Pacheco, R. Zucca, X. D. Arsiwalla, D. Dalmazzo, A. Principe, R. Rocamora, G. Conesa, P. Verschure (2017) **BrainX^3: A Virtual Reality Tool for Neurosurgical Intervention in Epilepsy**, International Journal of Computer Assisted Radiology and Surgery (Int. J. CARS), vol. **12**, Suppl. 1, pp. S113.

• X. D. Arsiwalla, P. Verschure (2016) **The Global Dynamical Complexity of the Human Brain Network**, Applied Network Science, **1**:16.

• R. Hindriks, X. D. Arsiwalla, T. Panagiotaropoulos, M. Besserve, P. Verschure, N. Logothetis, G. Deco (2016) **Discrepancies Between Multi-Electrode LFP and CSD Phase-Patterns: A Forward Modeling Study**, Frontiers in Neural Circuits, **10**, 51.

• X. D. Arsiwalla, D. Dalmazzo, R. Zucca, A. Betella, S. Brandi, E. Martinez, P. Omedas, P. Verschure (2015) **Connectomics to Semantomics: Addressing the Brain's Big Data Challenge**, Procedia Computer Science, vol. **53**, pp. 48-55.

• X. D. Arsiwalla, R. Zucca, A. Betella, E. Martinez, D. Dalmazzo, P. Omedas, G. Deco, P. Verschure (2015) **Network Dynamics with BrainX^3: A Large-Scale Simulation of the Human Brain Network with Real-Time Interaction**, Frontiers in Neuroinformatics **9**, 2.
(Paper Named Frontiers Journals' Top 100 Spotlight Article of 2015)

• A. Betella, R. Zucca, R. Cetnarski, A. Greco, A. Lanata, D. Mazzei, A. Tognetti, X. D. Arsiwalla, P. Omedas, D. Rossi, P. Verschure (2014) **Inference of Human Affective States from Psychophysiological Measurements Extracted Under Ecologically Valid Conditions**, Frontiers in Neuroscience **8**, 286.

• X. D. Arsiwalla, J. de Boer, K. Papadodimas, E. P. Verlinde (2011) **Degenerate Stars and Gravitational Collapse in AdS/CFT**, Journal of High Energy Physics (JHEP) **1101**, 144.

• X. D. Arsiwalla, E. P. Verlinde (2010) **A Black Hole Levitron**, Phys. Rev. D **81**, 084004.

• X. D. Arsiwalla (2009) **Entropy Functions with 5D Chern-Simons terms**, Journal of High Energy Physics (JHEP) **0909**, 059.

• X. D. Arsiwalla (2008) **More Rings to rule them all: Fragmentation, 4D/5D and Split-Spectral Flows**, Journal of High Energy Physics (JHEP) **0802**, 066.

• X. D. Arsiwalla, R. Boels, M. Marino, A. Sinkovics (2006) **Phase Transitions in q-deformed 2d Yang-Mills theory and Topological Strings**, Phys. Rev. D **73**, 026005.

⊙ **Full-Length Conference Papers**

• X. D. Arsiwalla, P. Verschure (2017) **Why the Brain Might Operate Near the Edge of Criticality**, International Conference on Artificial Neural Networks (ICANN 2017), Lecture Notes in Computer Science, vol. **10613**, pp. 326-333.

• X. D. Arsiwalla, I. Herreros, C. Moulin-Frier, P. Verschure (2017) **Consciousness as an Evolutionary Game-Theoretic Strategy**, Conference on Biomimetic and Bio-hybrid Systems (Living Machines 2017), Lecture Notes in Computer Science, vol. **10384**, pp. 509-514.

• C. Moulin-Frier, J. Puigbo, X. D. Arsiwalla, M. Sanchez, P. Verschure (2017) **Embodied Artificial Intelligence through Distributed Adaptive Control: An Integrated Framework**, IEEE International Conference on Development and Learning, IEEE, arXiv:1704.01407.

• I. Herreros, X. D. Arsiwalla, C. Santina, J. Puigbo, A. Bicchi, P. Verschure (2017) **Cerebellar-Inspired Learning Rule for Gain Adaptation of Feedback Controllers**, 25th Mediterranean Conference on Control and Automation, IEEE, pp. 565-570.

• M. Sanchez, C. Moulin-Frier, X. D. Arsiwalla, P. Verschure (2017) **Social Sensorimotor Contingencies: Towards Theory of Mind in Synthetic Agents**, 20th International Conference of the Catalan Association for Artificial Intelligence (CCIA 2017), Frontiers in Artificial Intelligence and Applications, vol. **300**, pp. 251-256.

• X. D. Arsiwalla, P. Verschure (2016) **Computing Information Integration in Brain Networks**, Advances

in Network Science, Lecture Notes in Computer Science, vol. **9564**, pp. 136 - 146.
(Best Paper - NetSciX 2016)

• X. D. Arsiwalla, P. Verschure (2016) **High Integrated Information in Complex Networks Near Criticality**, International Conference on Artificial Neural Networks (ICANN 2016), pp. 184-191.
(Best Paper Finalist - ICANN 2016)

• I. Herreros, X. D. Arsiwalla, P. Verschure (2016) **A Forward Model at Purkinje Cell Synapses Facilitates Cerebellar Anticipatory Control**, Advances in Neural Information Processing Systems, **29**, **(NIPS 2016)**, pp. 3828-3836.

• C. Moulin-Frier, X. D. Arsiwalla, J. Puigbo, M. Sanchez, A. Duff, P. Verschure (2016) **Top-Down and Bottom-Up Interactions between Low-Level Reactive Control and Symbolic Rule Learning in Embodied Agents**, Proceedings of the Cognitive Computation Workshop **(NIPS 2016)**.

• X. D. Arsiwalla, I. Herreros, P. Verschure (2016) **On Three Categories of Conscious Machines**, Conference on Biomimetic and Bio-hybrid Systems (Living Machines 2016), pp. 389-392.

• X. D. Arsiwalla, I. Herreros, C. Moulin-Frier, M. Sanchez, P. Verschure (2016) **Is Consciousness a Control Process?**, 19th International Conference of the Catalan Association for Artificial Intelligence (CCIA 2016), pp. 233-238.

• R. Zucca, X. D. Arsiwalla, H. Le, M. Rubinov, P. Verschure (2016) **Scaling Properties of Human Brain Functional Networks**, International Conference on Artificial Neural Networks (ICANN 2016), pp. 107-114.

• G. Zegarek, X. D. Arsiwalla, D. Dalmazzo, P. Verschure (2016) **Mapping the Language Connectome in Healthy Subjects and Brain Tumor Patients**, International Conference on Artificial Neural Networks (ICANN 2016), pp. 83-90.

• R. Cetnarski, A. Betella, A. Miotto, R. Zucca, X. D. Arsiwalla, P. Omedas, J. Freeman, P. Verschure (2015) **Symbiotic Adaptive Interfaces: A Case Study Using BrainX^3**, Symbiotic Interaction, Springer LNCS, vol. **9359**, pp. 33-44.

• A. Betella, R. Cetnarski, R. Zucca, X. D. Arsiwalla, E. Martinez, P. Omedas, A. Mura, P. Verschure (2014) **BrainX^3: Embodied Exploration of Neural Data**, Proceedings of the 2014 Virtual Reality International Conference, ACM digital library, 37, pp. 1 - 4.

• A. Betella, E. Martinez, W. Kongsantad, R. Zucca, X. D. Arsiwalla, P. Omedas, P. Verschure (2014) **Understanding Large Network Datasets through Embodied Interaction in Virtual Reality**, Proceedings of the 2014 Virtual Reality International Conference, ACM digital library, 23, pp. 1 - 7.

• P. Omedas, A. Betella, R. Zucca, X. D. Arsiwalla, D. Pacheco, J. Wagner, F. Lingenfelser, E. Andre, D. Mazzei, A. Lanat, A. Tognetti, D. Rossi, A. Grau, A. Goldhoorn, E. Guerra, R. Alquezar, A. Sanfeliu, P. Verschure (2014) **XIM-engine: A software framework to support the development of interactive applications that use conscious and unconscious reactions in immersive mixed reality**, Proceedings of the 2014 Virtual Reality International Conference, ACM digital library, 26, pp. 1 - 4.

• A. Betella, D. Pacheco, R. Zucca, X. D. Arsiwalla, P. Omedas, A. Lanata, D. Mazzei, A. Tognetti, A. Greco, N. Carbonaro, J. Wagner, F. Lingenfelser, E. Andre, D. Rossi, P. Verschure (2014) **Interpreting Psychophysiological States Using Unobtrusive Wearable Sensors in Virtual Reality**, International Conference on Advances in Computer-Human Interaction (ACHI 2014), pp. 331-336. **(Best Paper - ACHI 2014)**

• X. D. Arsiwalla, P. Verschure (2013) **Integrated Information for Large Complex Networks**, Proceedings IJCNN 2013 - International Joint Conference on Neural Networks, IEEE digital library, pp. 1 - 7.

• X. D. Arsiwalla, A. Betella, E. Martinez, P. Omedas, R. Zucca, P. Verschure (2013) **The Dynamical Connectome: A Tool for Large-Scale 3D Reconstruction of Brain Activity in Real-Time**, Proceedings

ECMS 2013 - the 27th European Conference on Modeling and Simulation, pp. 865-869.

⊙ **Peer-Reviewed Abstracts**

• P. Verschure, R. Zucca, D. Pacheco, D. Santos-Pata, G. Maffei, J.-Y. Puigbo, X. D. Arsiwalla, A. Principe, G. Conesa, R. Rocamora (2017) **The Neural Code of the Human Brain as Revealed by Analysis of Intracranial Recordings Across a Range of Perceptual and Cognitive Tasks**, Proceedings SfN 2017 - 47th Annual Meeting of the Society for Neuroscience.

• X. D. Arsiwalla, B. Barzel, P. Verschure, A.-L. Barabási (2016) **Controllability Criteria for Discrete-Time Non-Linear Dynamical Networks**, Presented Talk, CCS 2016 - International Conference on Complex Systems.

• X. D. Arsiwalla, P. Verschure (2016) **Formalizing Information Complexity for Dynamical Networks**, Presented Talk, CCS 2016 - International Conference on Complex Systems.

• X. D. Arsiwalla, R. Garcia, P. Verschure (2016) **On the Algebra of Quivers, Networks and Multiplexes**, Presented Talk, CCS 2016 - International Conference on Complex Systems.

• X. D. Arsiwalla, R. Zucca, D. Dalmazzo, P. Omedas, G. Deco, P. Verschure (2016) **Large-Scale Brain Network Dynamics with BrainX^3**, Presented Talk, CCS 2016 - International Conference on Complex Systems.

• X. D. Arsiwalla, R. Zucca, A. Betella, D. Dalmazzo, E. Martinez, P. Omedas, G. Deco, P. Verschure (2016) **Dynamics of the Resting-State Connectome with BrainX^3: From Health to Disease**, Poster, OHBM 2016 - 22nd Annual Meeting of the Organization for Human Brain Mapping.

• X. D. Arsiwalla, R. Zucca, A. Betella, E. Martinez, D. Dalmazzo, P. Omedas, G. Deco, P. Verschure (2015) **Network Dynamics of the Human Brain Connectome with BrainX^3**, Book of Abstracts, ICSLANE 2015 - International Conference on Systems Level Approaches to Neural Engineering.

• X. D. Arsiwalla, P. Verschure (2015) **A Theory of Information Processing for Large-Scale Brain Networks**, Proceedings CogSci 2015 - the 37th Annual Meeting of the Cognitive Science Society, pp. 2844.

• X. D. Arsiwalla, P. Verschure (2015) **Analytic Solutions for Network Information Complexity**, Poster, NetSci 2015 - International Conference of the Network Science Society.

• X. D. Arsiwalla, R. Zucca, A. Betella, E. Martinez, D. Dalmazzo, P. Omedas, G. Deco, P. Verschure (2015) **Network Dynamics of the Human Brain Connectome with BrainX^3**, Poster, NetSci 2015 - International Conference of the Network Science Society.

• X. D. Arsiwalla, R. Zucca, A. Betella, E. Martinez, P. Omedas, P. Verschure (2014) **A Dynamic and Real-Time Interactive Virtual Reality Reconstruction of the Human Brain Connectome**, Poster, OHBM 2014 - 20th Annual Meeting of the Organization for Human Brain Mapping.

• R. Zucca, X. D. Arsiwalla, A. Betella, E. Martinez, P. Omedas, P. Verschure (2014) **Uncovering Causal Pathways in the Cortex through Dynamical Perturbations of the Human Connectome using an Immersive Virtual Reality Environment**, Poster, FENS 2014 - Forum of Neuroscience.

• X. D. Arsiwalla, P. Verschure (2013) **Exploiting Complexity Resonances In Dynamical Networks**, Book of Abstracts, ECCS'13 - the European Conference on Complex Systems.

• H. Le, X. D. Arsiwalla, R. Zucca, P. Verschure (2013) **Topology Of Brain Functional Networks**, Book of Abstracts, ECCS'13 - the European Conference on Complex Systems.

• X. D. Arsiwalla, P. Verschure (2013) **Harnessing Noise and Instability Towards High Values of Integrated Information**, Book of Abstracts, ASSC 2013, 17th Meeting of the Association for the Scientific Study of Consciousness.

• R. Zucca, X. D. Arsiwalla, P. Verschure (2013) **Prefrontal Cortical Modulation of Information Flow in a Model of the Cortico-Thalamic Circuit**, Book of Abstracts, ASSC 2013, 17th Meeting of the Association for the Scientific Study of Consciousness.

• R. Zucca, X. D. Arsiwalla, A. Betella, E. Martinez, P. Omedas, P. Verschure (2013) **Tracing Neural Circuits by Dynamically Simulating Whole-Brain Activity Patterns in the Human Connectome**, Neuroinformatics 2013, Conference Abstracts, Frontiers in Neuroinformatics, 97.

• A. Betella, E. Martnez, R. Zucca, X. D. Arsiwalla, P. Omedas, S. Wierenga et al. (2013) **Advanced Interfaces to Stem the Data Deluge in Mixed Reality: Placing Human (Un)Consciousness in the Loop**, Proceedings SIGGRAPH '13, ACM digital library, 68.

• X. D. Arsiwalla, A. Betella, E. Martinez, P. Omedas, R. Zucca, P. Verschure (2013) **What a Dynamical Connectome Informs us about Large-Scale Neural Circuits and Whole-Brain Activity**, Poster, IJCNN 2013 - International Joint Conference on Neural Networks.

• X. D. Arsiwalla, A. Betella, E. Martinez, P. Omedas, R. Zucca, P. Verschure (2013) **The Dynamic Connectome: Towards Large-Scale 3D Reconstruction of Brain Activity in Real-Time**, CNS 2013 - the 22nd Annual Computational Neuroscience Meeting, In BMC Neuroscience 2013, 14 (Suppl. 1), pp. 407.

♠ Science Outreach Articles

• X. D. Arsiwalla (2015) **Addressing the Human Brain's Big Data Challenge with BrainX^3**, In Phys.Org, March 4 2015, Technology and Computer Sciences Section.

• X. D. Arsiwalla (2009) **Quantum Gravity: A Conflict of Paradigms and Emergent Unification**, In Blind - Magazine for Interdisciplinary Studies, vol. **22**.

♠ Technologies Co-Developed

• **BrainX^3**: A 3D immersive virtual reality system for visualization, simulation and analysis of dynamical networks.

• **Neuro-Semantome**: A text mining engine that mines through a curated database of neuroscience literature and associates knowledge to simulated activity in BrainX^3

♠ European Research Council (ERC) Responsibilities

• **CEEDs Project** (Collective Emotive Empathic Data systems): Work Package Coordination; Deliverables

• **CDAC Project** (Consciousness as a Distributed Adaptive Control theory): Grant Co-Writing; Work Package Coordination; Deliverables

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♠ Peer-Review Responsibilities

• **Network Neuroscience** (MIT Press)

• **Conference on Complex Systems** (CCS)

• **International Conference on Artificial Neural Networks** (ICANN)

• **Living Machines Conference** (LM)

♠ Research Talks

- Invited Speaker, Physics of Cognitive Systems Group, Massachusetts Institute of Technology (MIT), Boston (2017)
Title: *The Networked Brain: Dynamics, Information & Control*

- Invited Speaker, Etkin Lab, Virtual Seminar, School of Medicine, Stanford University (2016)
Title: *A Network Science Approach to Brain Dynamics & Function*

- International Conference on Complex Systems, Amsterdam (2016)
Title: *Controllability Criteria for Discrete-Time Non-Linear Dynamical Networks*

- International Conference on Complex Systems, Amsterdam (2016)
Title: *Formalizing Information Complexity for Dynamical Networks*

- International Conference on Complex Systems, Amsterdam (2016)
Title: *On the Algebra of Quivers, Networks and Multiplexes*

- International Conference on Complex Systems, Amsterdam (2016)
Title: *Large-Scale Brain Network Dynamics with BrainX^3*

- Invited Speaker, Barcelona Cognition Brain & Technology Summer School (2016)
Title: *The Networked Brain: An Approach to Cognition, Disease & Therapy*

- International Conference on Network Science, Wroclaw (2016)
Title: *Computing Information Integration in Brain Networks*

- International Conference on Artificial Neural Networks, Barcelona (2016)
Title: *Mapping the Language Connectome in Healthy Subjects and Brain Tumor Patients*

- International Conference on Artificial Neural Networks, Barcelona (2016)
Title: *High Integrated Information in Complex Networks Near Criticality*

- International Neural Network Society's Big Data Conference, San Francisco (2015)
Title: *Addressing the Brain's Big Data Challenge: Semantics from Connectomics*

- Invited Speaker at Barcelona Cognition Brain and Technology Summer School (2014)
Title: *Quantifying Complexity in Biological Networks*

- European Conference on Complex Systems, Barcelona (2013)
Title: *Quantifying Network Complexity During Dynamic Processes*

- International Joint Conference on Neural Networks, Dallas (2013)
Title: *Integrated Information as a Dynamical Measure of Network Complexity*

- Invited Speaker at Dept. of Engineering & Information Technologies, Pompeu Fabra University, Barcelona (2013)
Title: *The Human Brain Connectome and Information Complexity*

- Barcelona Cognition, Brain & Technology Summer School (2010)
Title: *Probing Hemispheric Lateral Asymmetry in Global & Local Visual Perception*

- Theory Seminar, University of Amsterdam (2008)
Title: *Entropy Functions with 5D Chern-Simons terms*

- School for Theoretical High Energy Physics, Driebergen (2006)
Title: *Black Holes, q-Deformed Yang-Mills and Topological Strings*

- Theory Seminar, University of Amsterdam (2004)
Title: *Matrix Models, Gauge Theories and Spin Chains*

- Theory Seminar, University of Bonn (2003)
Title: *Dijkgraaf-Vafa Conjecture and Matrix Models*

- Physics Institute Seminar, University of Bonn (2001)
Title: *Kaon Mixing and CP Violation*

♠ Teaching Experience

⊙ Course Instructor

Master Program in Cognitive Systems

- Advanced Concepts in Cognitive Science (2018)

Bachelor Degree in Biomedical Engineering

- Control & Dynamical Systems Theory (2017)
- Control & Dynamical Systems Theory (2016)
- Control & Dynamical Systems Theory (2015)
- Control & Dynamical Systems Theory (2014)

⊙ Students Supervised

Master's Theses

- Hoang Le (2012 - 2013) – Currently a PhD student at Caltech, USA.
Thesis title: "Complex Network Analysis - Application to Human Brain Functional Networks"
- Ismael Freire-Gonzalez (co-supervised 2016 - 2017) – Currently a PhD student at Pompeu Fabra University.
Thesis title: "Modeling the Formation of Social Conventions in Multi-Agent Populations"

Undergraduate Projects

- Joana Gelabert (2016 - 2017)
Topic: "Network Analysis of the Human Brain Vasculature"
- Irene Tena (2016 - 2017)
Topic: "Network Analysis of the Human Brain Vasculature"

⊙ Teaching Assistant

- Statistical Physics, University of Amsterdam (Spring 2008)
- Classical Electrodynamics, University of Amsterdam (Fall 2007)
- Classical Mechanics, University of Amsterdam (Fall 2006)
- Classical Mechanics, University of Amsterdam (Fall 2005)
- Advanced Quantum Mechanics, University of Bonn (Fall 2003)

ACT 2019 Application Form: Xerxes D. Arsiwalla

Background in Category Theory/Project Areas: Taken a few courses on category theory (including one by Samson Abramsky & Nikos Tzevelekos) and local algebras. Very interested in the autopoiesis project as my current work involves systems-level theories of cognition and consciousness.

Obtained PhD: In String Theory from the University of Amsterdam in 2010.
     Thesis title: Supersymmetric Black Holes as Probes of Quantum Gravity

Project Preferences: (1st) Toward a mathematical foundation for autopoiesis
                                          (2nd) Simplifying quantum circuits using the ZX-calculus

Commitment to Coming to Oxford: Looking forward to it!

Interest in ACT2019: My current research has focused on the physics and neuroscience of cognitive systems, including computation, control and information processing in brains and bio-inspired architectures. The goal of this research is to discover systems-level computational principles as well as mathematical foundations underlying conscious awareness and biological intelligence. Questions concerning the nature of meaning, reasoning and awareness in cognitive systems address the very foundations of neural computation, biological intelligence and consciousness. Recent developments in categorical foundations of quantum mechanics and quantum computation [1] seem to provide exactly the mathematical objects necessary to formalize the process calculus of cognition and neural computation. Building on these developments in categorical logic, I am interested in the formulation of a category-theoretic process calculus for understanding how meaning, reasoning and awareness are processed and composed in cognitive systems, specifically those based on neural network architectures.

More specifically, in recent work [2], I have been investigating systems-level mechanisms driving intentional goal-oriented behavior in cognitive agents. That led to a functional identification of the components of conscious perception. Namely, to extract meanings or norms concerning the current state of the world and act within that context, an agent has to identify objects or other agents, the actions that those objects / agents are performing, the values of those actions with respect to its own homeostatic drives (self-states regulated by emotions and reactive mechanisms), location and timing information, and based on all that, the agent has to plan an action sequence to optimize its drives (referring to basic survival needs or higher-order goals). The idea is that these components and their compositions can be formally mapped to grammar, respectively semantics underlying action-perception control loops. In this view, conscious reasoning and awareness are processes involving extraction of semantics from representations of composite states of the world, of the self and the integration of the two, required for perception of a unified scene. In other words, I would like to establish

a formal correspondence between a consciously perceived scene (or its representation) and a linguistic sentence, which like a conscious process represents an action sequence. Here is where the machinery of monoidal categories becomes very useful and participation at this school will really help me advance formal aspects of this research.

[1] B. Coecke, M. Sadrzadeh, S. Clark (2010) Mathematical Foundations for a Compositional Distributional Model of Meaning, arXiv preprint arXiv:1003.4394.

[2] X. D. Arsiwalla, R. Sole, C. Moulin-Frier, I. Herreros, M. Sanchez, P. Verschure (2017) The Morphospace of Consciousness, (arXiv preprint) arXiv:1705.11190.

Thank You!

Prof. Dr. Paul F.M.J. Verschure
Director SPECS lab,
Institute for Bioengineering of Catalunya, Barcelona Institute of Science and Technology,
Catalan Institute of Advanced Studies,
SPECS-IBEC, UPC Campus Diagonal - BESÒS (bldg C),
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To Whomsoever It May Concern

Xerxes has been a postdoc in my lab since 2012 and a research assistant before that. He is brilliant, highly driven and extremely hard working. He truly loves research and has a broad spectrum of interests ranging from neuroscience to physics to mathematics. In our recent projects on brain dynamics, theories of consciousness, network theory and complexity measures, Xerxes has made outstanding contributions. His work has led to important insights on resting-state dynamics, neural simulations and computations of information complexity in brain networks and more recently in formalizing a morphospace of consciousness. These works have been published in top-tier journals and conferences and holds great promise for unraveling computational principles of minds and brains.

Xerxes comes from a background in theoretical physics, which explains his computational and principle-based style of problem solving. His approach to research is truly multidisciplinary. His recent work touches upon problems at the foundations of physics, philosophy and computation. He has a genuine passion for learning new things and a penchant for connecting ideas across disciplines. This became apparent as soon as he joined the lab. In order to learn the nuances of neurobiology, he started dropping-into master and graduate courses in neuroscience and enthusiastically talking to biologists, both within the lab and also to those in other labs, including other institutes in Barcelona. Even now, his eagerness to learn, regularly finds him in symposia about computational genomics, molecular biology or courses on algebraic topology.

Xerxes is also an instructor of both biomedical engineering and cognitive science at the university. I hear from colleagues, that he is an able educator and students have rated his lectures very positively. Besides that, Xerxes has been a thesis advisor to Master students. He has been very helpful to colleagues in the lab and his collaborative style of working is the reason why people from other labs in the department also enjoy working with him. I personally have enjoyed the many animated discussions we have had. He always manages to come up with tons of very original ideas. I can say that wherever Xerxes goes, he will make valuable contributions to the team. I wish him the very best in his career and fully support him.

Sincerely,

Prof. Dr. Paul F.M.J. Verschure