Flies, worms and robots: combining perspectives on minibrains and behaviour

November 2014

Sant Feliu de Guíxols (Spain)

Chairs: Matthieu Louis and Barbara Webb

ESF-EMBO

Symposium



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Conference programme overview

SATURDAY 8 NOVEMBER



SUNDAY 9 NOVEMBER

08:45 – 09:00 Conference Opening

SESSION 1 Sensing in living and artificial systems

Questions addressed during the session:

- How much computation already takes place in first order sensory neurons? For example, how much of the adaptability of natural systems is in the early sensory processing layers?
- Are artificial sensory systems still missing some of the tricks we can learn from nature? What types of sensorimotor computations
 that we know worms and flies perform are hard to implement in robots?

Session moderat	tors: Vivek Jayaraman – HHMI – Janelia Farm & Franck Ruffier – CNRS	
09:00 - 09:30	Silke Sachse – Max–Planck Institute for Chemical Ecology, Germany Drosophila Olfaction – Odor coding strategies in a sensory network	
09:30 - 10:00	Aurel Lazar – Columbia University, USA Neurokernel: building an in silico fruit fly brain	
10:00 - 10:30	Miriam Goodman – Stanford School of Medicine, USA Filtering of thermal and mechanical inputs by identified sensory neurons in C. elegans	
10:30 – 11:00	Coffee Break	
11:00 – 11:30	Alex Mauss – Max–Planck Institute of Neurobiology, Germany The neural basis of motion opponency in the fly visual system	
11:30 – 12:00	Shih Chii Liu – University of Zurich, Switzerland Artificial insect-inspired motion systems	





SESSION 2 Sensory-motor integration for simple and complex behaviors

Questions addressed during the session:

- Do we have any examples of a complete sensory-motor control loop understood at a quantitative level? If not, what is needed to complete our understanding?
- How do motor systems, including body morphology and mechanics, shape behaviour, and is this a constraint for transferring ideas from biology to robotics?
- How should we describe behavior? As stimulus-response relationships? As composed of discrete motor primitives/motifs? As feedback systems shaped by proprioception/self-sensation?

Session moderators: Ilona Grunwald Kadow – Max–Planck Institute for Neurobiology & **Silke Sachse** – Max–Planck Institute for Chemical Ecology

12:00 - 12:30	Manuel Zimmer – Research Institute of Molecular Pathology, AT Brain wide spontaneous neuronal dynamics interact with stimulus evoked activity to determine motor state in C. elegans
12:30 – 12:50	Andrew Leifer – Princeton University, USA Optogenetic manipulation and calcium imaging in freely moving C. elegans and its application to the escape response
12:50 – 13:10	Eduardo J. Izquierdo – Indiana University, USA Steering in C. elegans
13:15 – 14:10	Lunch
14:15 – 16:00	Demo-workshop: Experimental techniques to probe neural functions: an introduction for engineers and roboticists
16:00 - 16:30	Adam Stokes – University of Edinburgh, UK Maggots and integrated soft robotic systems
16:30 – 16:50	Marion Silies – European Neuroscience Institute Göttingen, DE Missing links of motion-detecting circuits
16:50 – 17:10	Stephane Viollet – Aix–Marseille University, FR Short range odometry and visual tracking with a vibrating compound eye
17:10 – 17:30	Jan Bartussek – University of Rostock, DE Behavioral evidence for direct visual input to wing steering muscles of Drosophila
17:30 – 17:50	Gwyneth Card – HHMI–Janelia Farm, USA From sensation to action: mechanisms for action selection during Drosophila escape
17:50 – 18:10	Coffee Break
18:10 – 18:30	Floris van Breugel – Complex behavior and perception emerges from iterative feedback-regulated reflexes
18:30 – 19:00	Benjamin de Bivort – Harvard University, USA, A compendium of behavioral motifs in flies, and its shaping by proprioception
19:00 – 19:30	Michael Dickinson – Caltech, USA, Visual motor behaviors in flying Drosophila: Peeking inside the black box
19:30	Dinner
20:30 – 22:00	Poster session





SESSION 2 **continued MONDAY 10 NOVEMBER** Miriam Goodman - Stanford School of Medicine, USA 09:00 - 09:30 Linking sensation to the thermal dependence of behavioral performance Michael Nitabach - Yale University School of Medicine, USA 09:30 - 10:00 Centrifugal control of multisensory decision making in C. elegans Netta Cohen – University of Leeds, UK <u> 10:00 – 10:3</u>0 Complementary and conflicting forms of sensory adaptation regulate salt navigation behavior in C. elegans 10:30 – 11:00 **Coffee Break & Group Photo** Matthieu Louis – Centre for Genomic Regulation, Spain 11:00 – 11:30 Sensorimotor control underlying larval chemotaxis Andrew Gordus - Rockefeller University, USA 11:30 – 11:50 The Influence of Internal States on Perception Gordon J. Berman - Princeton University, USA 11:50 - 12:10 Hierarchy and time scales in spontaneous behavior Greg Stephens - University of Amsterdam, Netherland 12:10 - 12:40 Sampling the movement phenospace: Towards a biophysics of behavior in the wiggling of C. elegans Ingrid Hums – Research Institute of Molecular Pathology, Austria, AU 12:40 - 13:00 Control of head and body coordination in C. elegans during oxygen-induced search behaviors 13:00 Lunch 14:00 - 16:00 Demo-workshop: Illustration of robotics for biologists Pavan Ramdya - University of Lausanne, CH 16:00 - 16:20 Mechanosensory Interactions Drive Collective Behaviour in Drosophila Stanley Heinze – Lund University, SE 16:20 - 16:40 Optic flow processing in the central complex of bees - the neural basis for the bee's odometer? Franck Ruffier – CNRS & Université de la Méditerranée, FR 16:40 – 17:00 Biomimetic robots account for the direct use of optic flow in insect flight control Vivek Jayaraman – HHMI–Janelia Farm, USA 17:00 – 17:30 Sensorimotor integration in the Drosophila central complex 17:30 – 18:00 **Coffee Break** Rob Wood – Harvard University, USA 18:00 - 18:30 Sensing, actuation, and control considerations for robotic insects Anthony Leonardo - HHMI-Janelia Farm, USA 18:30 – 19:00 Internal models direct dragonfly interception steering 19:00 - 19:30 Cecilia Laschi – The Biorobotics Institute, Scuola Superiore Sant'Anna, Italy Soft robotics and the emergence of behaviour: how an octopus can help build soft robots 19:30 Dinner

20:30 – 21:30

Poster Session



TUESDAY 11 NOVEMBER

SESSION 3 Circuit mapping, connectomics, functional inference and modelling

Questions addressed during the session:

- What are the best approaches to get from a connectome to function? Is it more efficient to start from a function and look for its neural substrate? How much connectome detail is "enough"?
- What can we hope to learn from unbiased behavioural screens?
- How can modelling help circuit mapping and functional characterization? What is the value, particularly to robotics but also to neuroscience, of learning precise mechanistic implementations of circuit operations that are already well-described by theoretical models?

Session moderators: Carlos Ribeiro - Champalimaud Foundation & Glenn Turner - CSHL

09:00 - 09:30	Bill Schafer – MRC Laboratory of Molecular Biology, UK Sensory circuits and mechanisms in C. elegans
09:30 - 10:00	Casey Schneider–Mizell – HHMI–Janelia Farm, USA Network architecture underlying multisensory processing in the Drosophila larva
10:00 - 10:30	Aki Nose – The University of Tokyo, Japan Functional dissection of the central circuits that regulate Drosophila larval locomotion
10:30 – 11:00	Coffee Break
11:00 – 11:20	Tomoko Ohyama Multilevel multimodal integration enhances action selection in Drosophila
11:20 - 11:40	Sebastian Hückesfeld – Univeristy of Bonn, DE Feeding motor patterns in Drosophila larvae
11:40 - 12:00	Andrew Seeds – HHMI–Janelia Farm, USA A suppression hierarchy among competing motor programs drives sequential grooming
12:00 – 12:20	Anne C. von Philipsborn – Aarhus University, DK Neuronal circuits for Drosophila courtship song
12:20- 12:40	Kenta Asahina – Caltech, USA Sexually dimorphic neurons control male aggressive arousal in Drosophila through neuropeptide Tachykinin
12:40 - 13:10	Ilona Grunwald Kadow – Max–Planck Institute for Neurobiology, DE A higher brain circuit for immediate integration of conflicting sensory information in Drosophila
13:10	Lunch
AFTERNOON	Half–day excursion
19:00	Dinner
20:30 - 21:00	Forward Look Plenary Discussion: Opportunities, promises and challenges for the coming 10 years
21:00 - 21:30	Rupert Glasgow Robots and selves



WEDNESD	OAY 12 NOVEMBER SESSION 3 continued
09:00 - 09:20	Anthony Leonardo – HHMI–Janelia Farm, USA Anatomical basis for dragonfly interception steering
09:20 - 09:40	Vivek Jayaraman – HHMI–Janelia Farm, USA Mapping functional networks in the Drosophila central complex
09:40 - 10:00	Alice Robie – HHMI–Janelia Farm, USA Creating structure-function brain maps in Drosophila melanogaster
10:00 - 10:20	Elisabetta Chicca – CITEC, Bielefeld University, Germany A neuromorphic minibrain for real-time auditory pattern recognition and behavioral control in crickets
10:20 - 10:50	Barbara Webb – University of Edinburgh, UK Modelling at multiple levels
10:50 – 11:20	Coffee Break

SESSION 4 Plasticity and internal states

Questions addressed during the session:

- What learning capabilities do flies and worms share, and how do they differ? Can we understand these similarities and differences in terms of the neural circuits?
- How do motivational factors control behaviour and interact with learning?

Session moderators: Shannon Olsson - NCBS & Christen Mirth - Gulbenkian Institute

11:20 - 11:50	Bertram Gerber – Leibniz–Institute for Neurobiology, Magdeburg, DE Mechanisms of maggot memory
11:50 - 12:10	Jie–Kai Wu – National Tsing Hua University, Taiwan, ROC Protein-synthesis-dependent representation of long-term memory in sparse efferent neurons of Drosophila mushroom body
12:10 – 12:30	Yoshi Aso – HHMI–Janelia Farm, USA Mushroom body output neurons encode valence and guide memory-based action selection in Drosophila
12:30 - 13:00	Glenn Turner – Cold Spring Harbor, New York, USA Olfactory Signaling in Mushroom Body Output Neurons - Neural coding as a Circuit Converges
13:00 – 13:20	Tim Landgraf – Freie Universiaet Berlin, DE Computational network models of associative learning in the insect brain for neural control of autonomous robots
13:30	Lunch
15:00 - 15:30	Michael Nitabach – Yale University School of Medicine, USA Synaptic topology of homeostatic sleep circuits in the Drosophila brain
15:30 - 16:00	Carlos Ribeiro – Champalimaud Foundation, Portugal The gourmet fly - the behavioral, nutritional, and neuronal basis of nutrient homeostasis



SESSION 5 Circuit and behaviour in ecology and evolution

Questions addressed during the session:

- Are there important natural behaviours in flies and worms that have been experimentally neglected to date? What are the ecologically relevant behaviours? How can we introduce a tractable level of environmental complexity to our experimental design in the lab?
- How much variability is expected in the circuit-function relationships across individuals, strains and species of the same group? Is it best to focus on fully understanding a genetic model species before studying variants?
- Do we need a genetic understanding of behavior, or is a circuit understanding sufficient?
- Should evolution matter to robotics?

Session moderators: Eugenia Chiappe – Champalimaud Foundation & Anthony Leonardo – HHMI–Janelia Farm

50	Margherita Peliti – École Normale Supérieure, FR Biased motion in unbiased environments: is C. elegans navigating?
	Coffee Break
	Dieter Vanderelst – University of Bristol, UK Large brains exploiting minibrain strategies: the case for taxis and template matching in echolocating bats
	Richard Benton – University of Lausanne, CH Evolution of olfactory circuits
	David Stern – HHMI–Janelia Farm, USA The evolution of courtship behavior in Drosophila
	Shannon Olsson – NCBS, IN Built for speed: Flight and the evolution of insect olfactory receptors
	Cat. tagathar & Conference Dinner

THURSDAY 13 NOVEMBER

Breakfast & Departure



ESF-EMBO Symposium











