

The Swedish INCF Node

Focus is on computational neuroscience, simulation tools, brain imaging, neurorobotics and PhD Neuroinformatics training

The organization of the Node

The INCF National Node of Sweden is located at the Royal Institute of Technology (KTH) in Stockholm. The node functions as a network of research groups, covering primarily computational neuroscience including large scale computing and software tools for modeling and simulations. Also databases for brain imaging as well as neurorobotics are represented. The node is furthermore coordinating an Erasmus Mundus PhD programme in Neuroinformatics.

Training in neuroinformatics coordinated by the Node

EuroSPIN – European Study Program In Neuroinformatics (within the Erasmus Mundus II programme)

www.kth.se/eurospin

The objective of this doctoral training programme is to provide top quality training for PhD students within the neuroinformatics area

Four partners participate (all countries INCF members):

- Royal Institute of Technology (KTH), Sweden
- University of Edinburgh, UK
- National Centre for Biological Science, India
- Albert-Ludwigs-Universität Freiburg, Germany

Pairwise joint PhD training between the partners
→ Leading to a joint PhD degree after 4 years

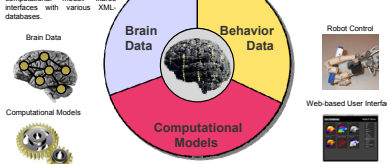
Neuro- and Cognitive Robotics - example

Main research groups:

Prof Christian Balkenius, Lund University
Prof Tom Ziemke, Univ of Skövde



Anatomical and physiological data allows automatic validation of the structure of a computational model. Ikaros interfaces with various XML-databases.



Ikaros contains a large number of modules that implement models of different parts of the brain. An XML-based language is used to build systems of such modules.

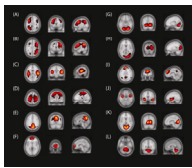
www.ikaros-project.org

Balkenius et al (2010) Ikaros: Building cognitive models for robots, *Advanced Engineering Informatics* 24:40-48

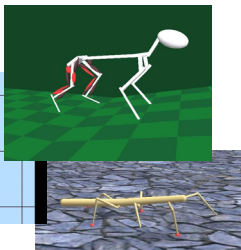
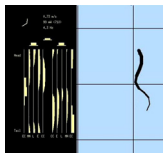
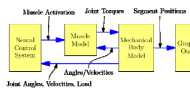
Imaging of the nervous system

Main research groups:

Prof Martin Ingvar, KI
PhD Patrik Krieger, KI
Prof Per Roland, KI
Assoc Prof Fredrik Ullén, KI
Prof Erwin Laure, PDC, KTH
Project leader Gert Svensson, PDC, KTH
Prof Tony Lindeberg, Computer Vision, KTH



Neuromechanical models



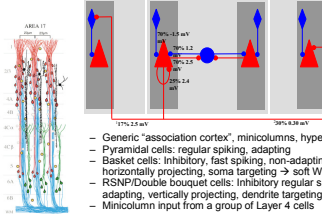
Harischandra and Ekeberg (2008) System identification of muscle-joint interactions of the cat hind limb during locomotion, *Biol Cybern* 99: 125-138
Ekeberg and Pearson (2005) Computer simulation of stepping in the hind legs of the cat: an examination of mechanisms regulating the stance-to-swing transition, *J. Neurophysiol* 94: 4256-4268

Computational Neuroscience - examples

Main research groups:

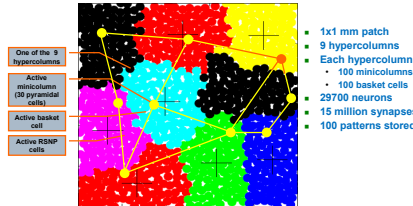
Prof Sten Grillner, Karolinska Institute
Prof Anders Lansner, KTH and Stockholm University
Prof Jeanette Hellgren Kotaleski, KTH and INCF
Assoc Prof Erik Fransén, KTH
PhD Mikael Djurfeldt, KTH and INCF
Assoc Prof Örjan Ekeberg, KTH
Prof Sverker Sikström, Växjö University and KTH
Prof Jesper Tegnér, Karolinska Institute
Assoc Prof Dan Lundh, Univ Skövde
Prof Lennart Gustafsson, Univ of Luleå
Prof Hans Liljenström, SLU, Uppsala

A cortical layer 2/3 model.



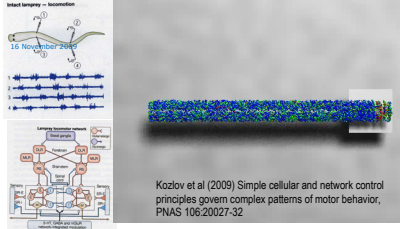
- Generic "association cortex", minicolumns, hypercolumns
- Pyramidal cells: regular spiking, adapting
- Basket cells: Inhibitory, fast spiking, non-adapting, horizontally projecting, soma targeting → soft WTA
- RSNP/Double bouquet cells: Inhibitory regular spiking, adapting, vertically projecting, dendrite targeting
- Minicolumn input from a group of Layer 4 cells

...and simulated network layout

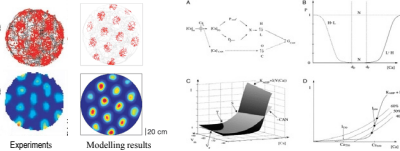


Lundqvist et al (2006): Attractor dynamics in a modular network model of the neocortex, *Network: Computation in Neural Systems* 17(3):253-76.

A full scale model of the lamprey locomotor network

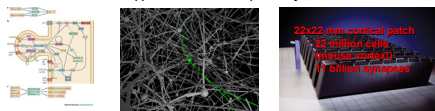


Dendritic integration: Grid cells and working memory in entorhinal cortex, and epileptogenesis in hippocampus



Giocomo et al (2007) Temporal frequency of subthreshold oscillations scales with entorhinal grid cell spatial frequency, *Science* 315: 1719-1722
Fransén et al (2006) Mechanism of graded persistent cellular activity of entorhinal cortex layer V neurons, *Neuron* 49: 735-746
Fransén and Tigerholm (2010) Role of A-type potassium currents in excitability, network synchrony, and epilepsy, *Hippocampus* (in press)

Multi Scale approaches and interoperability



Hellgren Kotaleski and Blackwell (2010) Modeling the molecular mechanisms of synaptic plasticity using systems biology approaches, *Nat Rev Neurosci* 11:239-51
Djurfeldt et al (2008) Brain-scale simulation of the neocortex on the Blue Gene/L supercomputer, *IBM J Res Dev* 52: 31-42
Djurfeldt et al (2010) Run-Time Interoperability Between Neuronal Network Simulators Based on the MUSIC Framework, *Neuroinformatics* 8:43-60

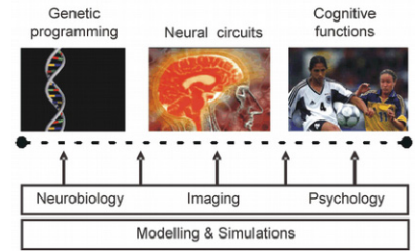
Node closely linked with:

STOCKHOLM BRAIN INSTITUTE

- integrating brain research from genes to behaviour

A consortium for Cognitive and Computational Neuroscience with the aim to enhance the understanding of higher brain functions. Aims in focus:

- Study specific cognitive functions: Action-Perception, Emotions, Learning and Memory from three perspectives
- By studying the normal functioning of the brain, cognitive dysfunctions can be better understood: Autism and ADHD in childhood, Schizophrenia in young adults, and Alzheimer's and Parkinson's diseases in the elderly

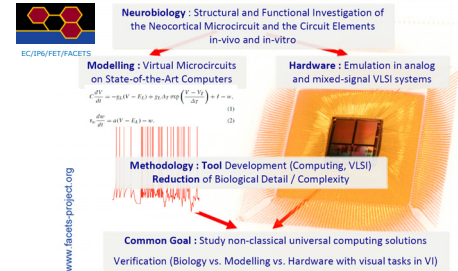


Stockholm Brain Institute partners:
KI Neuroscience groups
SU Psychology
KTH/CB (leads computational platform)
KTH/PDC (provides HPC, brain imaging platform)
Companies (IBM, AstraZeneca)

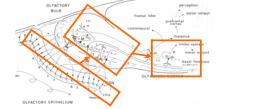


EU collaborations – FACETS, Neurochem, SelAct

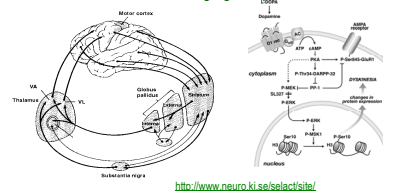
FACETS: Basic idea, methodological approach and goals



NEUROChem



SELACT: to understand basal ganglia, in particular striatum



<http://www.neuro.ki.se/select/site/>