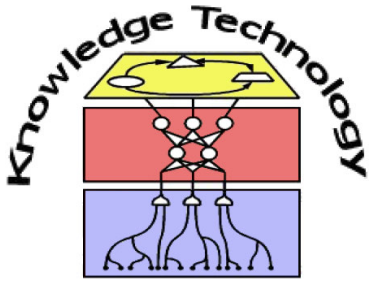
Bio-Inspired Artificial Intelligence

Organisation and Introduction

Prof. Dr. Stefan Wermter



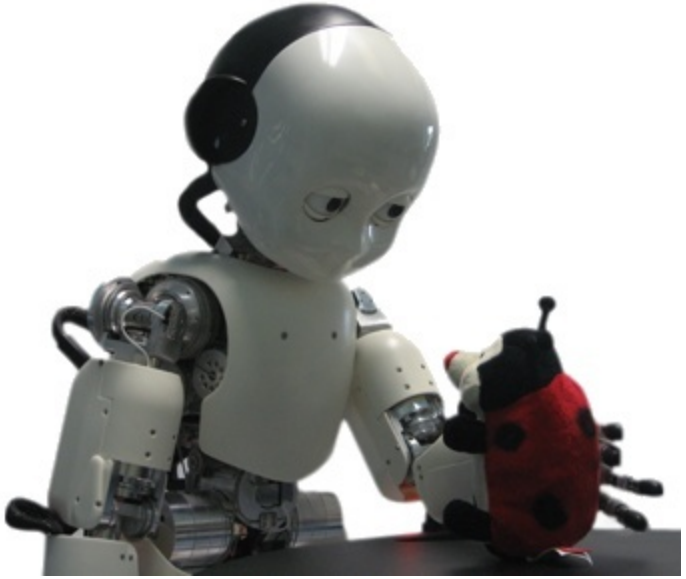
http://www.informatik.uni-hamburg.de/WTM/

A bit about us…

- Joint the University of Hamburg in 2010
- Head of Knowledge Technology Group
- Main research interest in Neural and Hybrid (Neural Symbolic) Knowledge Technology
- Prior to University of Hamburg worked at
  - University of Sunderland, United Kingdom (12 years)
  - ICSI / University of California, Berkeley, USA (1 y)
  - University of Dortmund (2 y)
  - University of Massachusetts, USA (2 y)

What is Bio-Inspired Artificial Intelligence?

- Intelligent behaviour of a bio-inspired artificial agent ?
  - Plan actions
  - Make decisions and do reasoning
  - React to something unexpected
  - Learn and use knowledge
  - Communicate and cooperate
  - Interpret images and scenes



- Central requirement
  - Learn, represent and process knowledge
  - Consider findings about intelligent behaviour in nature
  - From cells to reasoning

Motivation for this module

- To provide introductions to biological plausible neural networks, evolutionary computing, and their combination
- To present methods for problem solving, action planning and reasoning which are based on biological principles
- To discuss bio-inspired approaches to human capabilities like language processing and vision
- To provide insight to novel and exciting bio-inspired intelligent systems from swarms of small and simple robots to sophisticate humanoid robots
- To give examples for human-robot interaction, which integrates higher cognitive functions based on biological principles

Remarks about slides

- These slides/notes are meant to facilitate access
- They are “pointers” to the learning
- Slides are not meant to replace text books or journals
- Slides are not self-contained but are part of the lecture

Spoken language choice?

- International education gets more and more important for research, industry, business...
- ...from international schools to colleges and universities
- We want to help students to prepare for a career in industry or academia with an international English language element
- Most relevant computer science literature in English
- Slides will be in English and we deliver this module in English

Logistics

- **Lecture**
  Thursday 10:15, D-220
- **Seminar**
  as block in February
- Examinations: verbal in English or German,
  Feb. 2014, April 2014
- You can take this as a
  - Single module (**Wahlbereich *Master Informatik***,
    Core lecture *Master Intelligent Adaptive Systems*) ...
  - or as part of the **Integriertes Anwendungsfach Neuroinformatik**

Integrated Subject “Neuroinformatics”

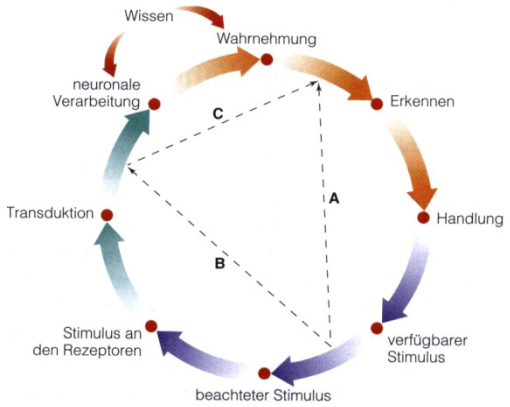
- http://www.informatik.uni-hamburg.de/WTM/teaching/IAFNeuroInformatics.shtml

Neuroinformatik I				
Lecture	Allgemeine Psychologie	Franz	WS, Tue 16-18, Thu 12-14	Audimax 2, ESA A
Lecture	Bio-inspired Artificial Intelligence	Wermter	WS, Thu 10-12	D-220
Integrated Seminar	Bio-inspired Artificial Intelligence	Magg, Wermter	WS, As a block	F-235

Neuroinformatik II				
Lecture	Biopsychologie	Hötting	**WS**, Wed 10-12 Mon 14-16	Audimax 2, Erzwiss H
Lecture	Knowledge Processing with Neural Networks	Wermter	Summer Semester 2014	
Integrated Seminar	Knowledge Processing with Neural Networks	Weber, Wermter	Summer Semester 2014	

IAF “Neuroinformatics” 1: Allgemeine Psychologie 1

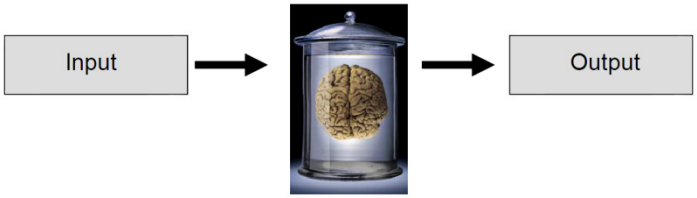
- **Lecture**
  Tuesday 16:15, Audimax 2
- **Supplementary Lecture**
  Every second Thursday 12:15, ESA B



- Topics:
  - Perception
  - Language
  - Attention
  - Consciousness
  - Motor functions
  - Thinking and problem solving

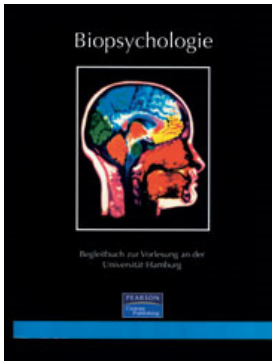
IAF “Neuroinformatics” 2: Biopsychology

- **Lecture**
  Wednesday 10:15, Audimax 2
- **Supplementary Lecture**
  Every second Monday 14:15, Erzwiss H



Already starts this semester!

- Topics:
  - Neurons, action potential, synapses, anatomy
  - Qualitative and quantitative methods
  - Visual and auditory systems
  - Vestibular gustatory and olfactory systems
  - Somatosensory and sensorimotor systems
  - Plasticity and lateralisation
  - Sleep, emotions, and stress

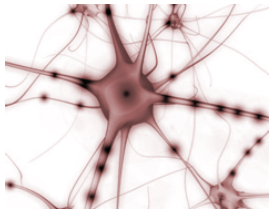


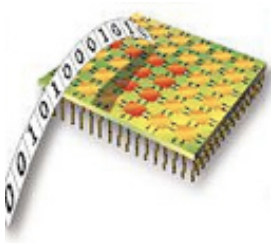
Benefits of attending the lectures

- Regular and effective learning of main concepts
- Discussions about provided methods and approaches as well as about emerging questions
- Access to video demonstrations and live demos in our lab
- Links to staff members and related research in our group
- The early bird catches the worm

Topics of the lecture (1)

- Cellular Systems
- Spiking Neural Networks
- Bio-Inspired Language Processing
- Bio-Inspired Vision
- Evolutionary Computing





Topics of the lecture (2)

- Behaviour-based Robotics

- Evolutionary Neural Robotics

- Swarm Intelligence

Topics of the lecture (3)

- Communication based Cooperation
- Bioinspired Robot Sound Localization
- Spiking Neural Architectures for Multimodal Processing
- Human-Robot Interaction

Motivating questions… or how to make a coffee

- How is it possible to bridge the large gap between neural network processing in the brain and intelligent performance of humans?

- How is it possible to build more effective systems which integrate neural techniques into intelligent systems?

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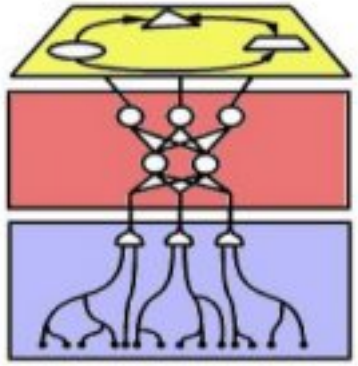
Approach: hybrid processing for learning cognitive agents

- Symbolic knowledge and planning
- Fast encoding and manipulation
- Interpretable knowledge and rules

- Reactive behavior
- Neural connectionist learning
- Robustness



- Embodied bioinspired computation
- Neuroscience and plasticity
- Spatiotemporal integration

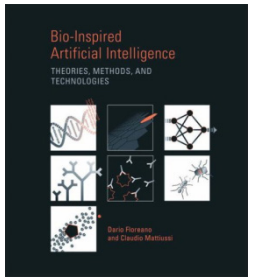
Some initial robotic answers… or how to make a coffee

- How is it possible to bridge the large gap between neural network processing in the brain and intelligent performance of humans?

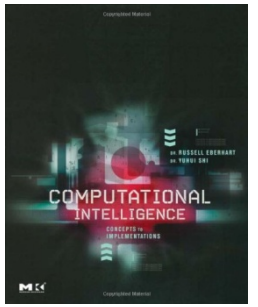
- How is it possible to build more effective systems which integrate neural techniques into intelligent systems?

General literature background

- Floreano, D., Mattiussi, C. *Bio-inspired Artificial Intelligence: Theories, Methods, and Technologies*. MIT Press, 2008.



- Eberhart, R.C., Shi, Y. *Computational Intelligence: Concepts to Implementations*. Elsevier/Morgan Kaufmann, 2007.

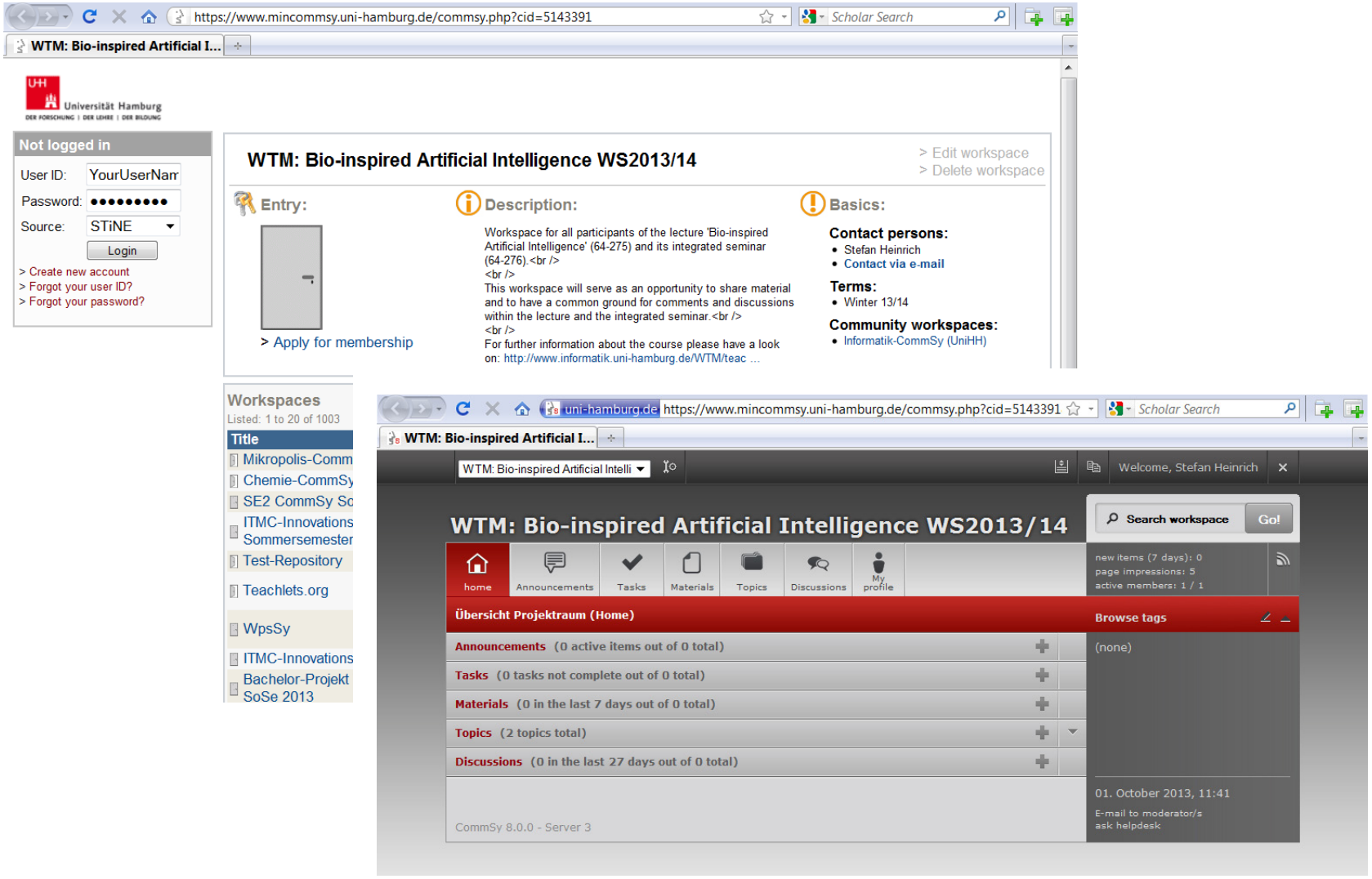


additional material will be provided in the lectures

Links to the lecture material

- http://www.informatik.uni-hamburg.de/WTM/teaching/WiSe13_BioInspiredAI_V.shtml

...hit the link to the Min-CommSy page and apply for membership.



End of Introduction

- Questions?