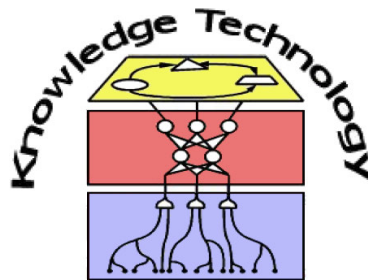


# Bio-Inspired Artificial Intelligence

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 sophisticated 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	<u>Allgemeine Psychologie</u>	Franz	WS, Tue 16-18, Thu 12-14	Audimax 2, ESA A
Lecture	<u>Bio-inspired Artificial Intelligence</u>	Wermter	WS, Thu 10-12	D-220
Integrated Seminar	<u>Bio-inspired Artificial Intelligence</u>	Magg, Wermter	WS, As a block	F-235
Neuroinformatik II				
Lecture	<u>Biopsychologie</u>	Hötting	<b>WS</b> , Wed 10-12 Mon 14-16	Audimax 2, Erzwiss H
Lecture	<u>Knowledge Processing with Neural Networks</u>	Wermter	Summer Semester 2014	
Integrated Seminar	<u>Knowledge Processing with Neural Networks</u>	Weber, Wermter	Summer Semester 2014	



# IAF “Neuroinformatics” 1: Allgemeine Psychologie 1

## ■ Lecture

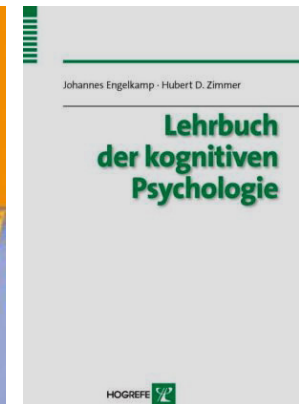
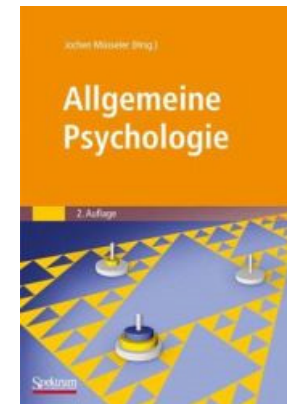
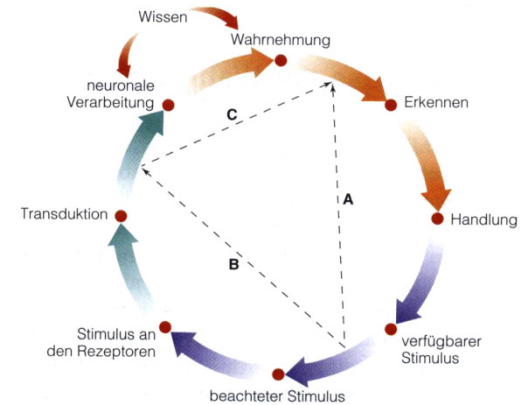
Tuesday 16:15, Audimax 2

## ■ 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

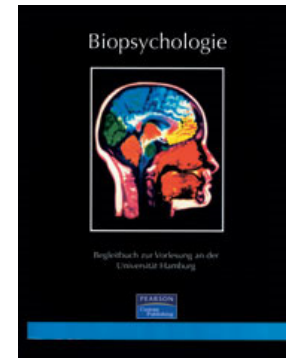
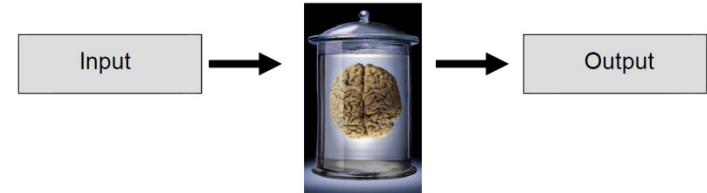
## ■ Supplementary Lecture

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

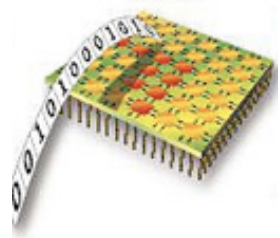
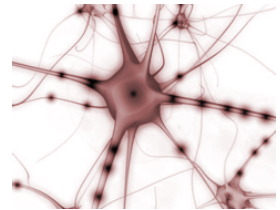


# Benefits of attending the lectures

- 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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# Motivating questions... or how to make a coffee

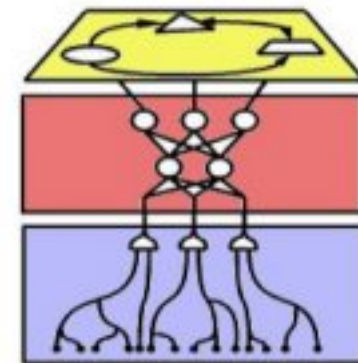
- How is it possible to bridge the large gap between neural network processing in the brain and intelligent performance of humans?



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

# 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

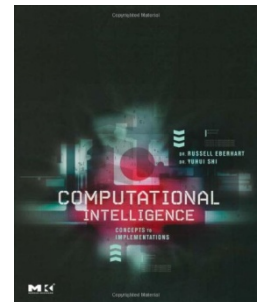
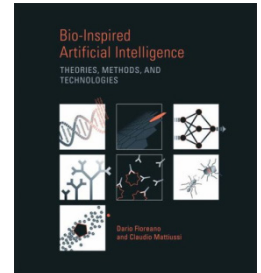
- How is it possible to bridge the large gap between neural network processing in the brain and intelligent performance of humans?



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

The screenshot shows a web browser window displaying the lecture page for 'Bio-Inspired Artificial Intelligence' at the University of Hamburg. The browser's address bar shows the URL: [http://www.informatik.uni-hamburg.de/WTM/teaching/WiSe13\\_BioInspiredAI\\_V.shtml](http://www.informatik.uni-hamburg.de/WTM/teaching/WiSe13_BioInspiredAI_V.shtml). The page header includes the University of Hamburg logo and the text 'MIN Faculty Department of Informatics Knowledge Technology'. The main content area is titled 'Teaching' and features a 'Lecture: Bio-Inspired Artificial Intelligence / Bioinspirierte Künstliche Intelligenz' for the 'Winter Semester 2013/2014'. A 'News/Aktuelles' section lists registration periods and the use of the 'MIN-CommSy' system. A 'General Information/Allgemeine Informationen' section provides details about the lecture number (64-275), lecturer (Prof. Stefan Wermter), period (Thu/Do 10-12), room (D-220), credit hours (2 SWS), language (English/German), and module (IAF-NI1, Wahlbereich, freier Wahlbereich). A left sidebar contains a navigation menu with links to Home, Overview, Staff, Teaching, International MSc IAS, Thesis Offers, Research Projects, Neurobotics, Publications, Books, News and Media, Videos, YouTube Channel, Selected Links, Location, Open Positions, Contact, and Internal: Wiki.

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MIN Faculty  
Department of Informatics  
Knowledge Technology

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## Teaching

**Lecture: Bio-Inspired Artificial Intelligence / Bioinspirierte Künstliche Intelligenz**

Winter Semester 2013/2014

### News/Aktuelles

- First registration period/*Erste Anmeldephase* (StINE): 02.09.2013 - 12.09.2013 (13:00h), and for first semester students: 07.10.2013 - 10.10.2013 (13:00h)
- For this course we use the [MIN-CommSy](#) - all participants will be affirmed after the first lecture.

### General Information/Allgemeine Informationen

LV-Nummer: 64-275  
Lecturer: [Prof. Stefan Wermter](#)  
Period: Thu/Do 10-12  
Room: D-220  
Credit Hours: 2 SWS  
Language: English/Deutsch with English Material  
Module: IAF-NI1, Wahlbereich, freier Wahlbereich

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

The screenshot shows a web browser window with the URL <https://www.mincommsy.uni-hamburg.de/commsy.php?cid=5143391>. The page header includes the University of Hamburg logo and the text "Universität Hamburg DER FORSCHUNG | DER LEHRE | DER BILDUNG". On the left, there is a "Not logged in" section with a login form containing fields for "User ID:" (with placeholder "YourUserNam"), "Password:" (masked with dots), and "Source:" (a dropdown menu with "STINE" selected). A "Login" button is below the form. Links for "Create new account", "Forgot your user ID?", and "Forgot your password?" are also present. The main content area is titled "WTM: Bio-inspired Artificial Intelligence WS2013/14" and includes links for "Edit workspace" and "Delete workspace". It is divided into three columns: "Entry:" with a placeholder image and a link to "Apply for membership"; "Description:" with text about the workspace for participants of the lecture 'Bio-inspired Artificial Intelligence' (64-275) and its integrated seminar (64-276), and a link to the course page; and "Basics:" with sections for "Contact persons:" (Stefan Heinrich, contact via e-mail), "Terms:" (Winter 13/14), and "Community workspaces:" (Informatik-CommSy (UniHH)).

The screenshot shows a sidebar titled "Workspaces" with the text "Listed: 1 to 20 of 1003". It contains a list of workspace titles: Mikropolis-Comm, Chemie-CommSy, SE2 CommSy Sc, ITMC-Innovations Sommersemester, Test-Repository, Teachlets.org, WpsSy, ITMC-Innovations, Bachelor-Projekt SoSe 2013.

The screenshot shows the workspace interface for "WTM: Bio-inspired Artificial Intelligence WS2013/14". The top navigation bar includes a search bar, a "Go!" button, and a "Welcome, Stefan Heinrich" message. Below the navigation bar is a dashboard with a grid of icons for "home", "Announcements", "Tasks", "Materials", "Topics", "Discussions", and "My profile". The main content area is titled "Übersicht Projektraum (Home)" and features a table with the following data:

Category	Status	Actions
Announcements	(0 active items out of 0 total)	+
Tasks	(0 tasks not complete out of 0 total)	+
Materials	(0 in the last 7 days out of 0 total)	+
Topics	(2 topics total)	+
Discussions	(0 in the last 27 days out of 0 total)	+

On the right side of the dashboard, there is a "Browse tags" section with a "(none)" tag. At the bottom right, there is a timestamp "01. October 2013, 11:41" and a link to "E-mail to moderator/s ask helpdesk". The footer of the page reads "CommSy 8.0.0 - Server 3".

# End of Introduction

- Questions?