

Educational Simulations For the Neural and Cognitive Sciences

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Brain Function and Simulation

To understand the functioning of brains we must bridge many levels of analysis from molecules, cells and synapses to perception and behavior. Although experimental analysis is a precondition for understanding information processing by nervous systems, it is in no way sufficient. Rather, computer simulations help to tackle problems resulting from dynamics and complexity of nervous systems. It has become common scientific practice in the neural and cognitive sciences to investigate brain function by both experiments as well as model simulations.

Simulation In Higher Education

In the higher education of the neural and cognitive sciences, however, simulations are still only applied sporadically – even though educational materials (e.g. internet applets for well-known models such as Hodgkin-Huxley, Reichardt-detector, LTP etc.) and simulation tools (e.g. MatLab™) are readily available. Application suffers from various uncertainties of how to use simulations in higher education: *Do simulations effectively complement the well established methods of "chalk and talk", laboratory practicals or paper discussions? How long will it take to prepare application? Exactly which cases have a reasonable cost-gain ratio? Should I make demonstrations or let the students make it by their own in a practical course? How can I assess success or failure of use...* In sum, 'recipes' for applying simulations in education are widely missing.

The 'monist'-System

The monist-project has committed itself to the task of developing such recipes for simulations in higher education. The basis of the monist-project is a software package (monist-console) designed for providing compact, ready to use educational simulations. Simulations become educational as they are complemented by topical texts, instructional design, concrete tasks and an editor for individual notes and solutions. These 'format' is integrated in the monist-console. The software supports self-learning but particularly aids tutors to integrate simulations in their

courses. Online file-management and communication tools (via monist-server) help to organize personalized courses: learners can upload their solutions of tasks and protocols, educators can support learning or administrate via chat, mail, news etc.

Sharing Educational Content

Educators having existing simulations (applets, programs etc.) can embed them in the monist-system. The authoring mode provides means for designing or modifying educational material. An integrated simulation construction kit is under development. Authored educational simulations can be submitted to a central server for publication. We plan to offer two publication modes: *open content* for directly making content available for registered users and *closed content* undergoing reviewing organized by the monist editorial board – aiming at high-quality, approved educational simulations. An update mechanism offers simulations newly published on the server for download to the local monist-console.

Table 1: Subjects and methods as reflected by the members of the 'monist'-Group.

Subjects (in monist)	Method (in monist)	Group	University
Biophysics	Data Analysis Statistics	Aertsen	Freiburg
Cognitive Neuroscience	Psychophysics Biol. Robotics	Mallot	Tübingen
Learning & Behavior	Experimental Neuroethology	Menzel	Berlin
Motor Systems	Systems Theory	Cruse	Bielefeld
Neural Networks, Appl.	Neural Engineering	Gross	Ilmenau
Neural Networks, Theor.	Neuro-informatics	Ritter	Bielefeld
Psychology	Experimental Psychology	Dörner	Bamberg
Sensory Systems	Experimental Neurobiology	Egelhaaf	Bielefeld

The 'monist'-Group

The monist-project is organized in ten groups throughout Germany. One group develops the technical platform and content (Educational Simulations Workgroup, Bielefeld) and one group carries out evaluation (Seel, Freiburg). Each of the eight other groups has a specific thematic focus and develops content or specific simulation tools necessary for educating students in the thematic field (see table 1). A critical mass of educational simulations and the technical platform will be provided by the monist-group. However, the organization is open for any good contribution helping to integrate simulation into education for neural and cognitive sciences.

Offers and Requests

The monist-project offers applicable tools and content (work in progress). It aims at teachers wishing to use and

evaluate the monist-console (betatest@monist.de), authors seeking to contribute concepts or integrate their existing simulations (publish@monist.de) and developers ready to participate (support@monist.de). But beyond software and content development, the monist-project works on several practical fields for fostering the concrete application of simulations in higher education, e.g. evaluation for best practice scenarios, studies on learning and memory and organizational networking.

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Further Information: <http://www.monist.de>

The screenshot shows the Monist Client software interface. The window title is "Monist Client". The top menu bar includes "Navigator", "Search", "Edit", "View", "Options", "Style", "Page", "Language", and "Help". A breadcrumb trail shows the navigation path: "History: Monist -> Neuron -> Networks -> The Goldman equation describes the resting potential -> Coding describes how an input signal is represented in an output signal". On the left is a "Navigator" tree with categories like "Monist", "Courses", "Units", "Glossary", etc. The main content area displays a lesson titled "Characteristics: the basic relation between input and output signal". It contains text explaining photoreceptor responses and an educational simulation. The simulation includes a control panel with sliders for "Eingangssignal Stufe" (min, Amplitude, max) and "Aktivierungsfunktion Logistisch" (Steigung, max). A graph shows "Antwort f(t)" with a sigmoidal curve. Below the graph is an oscilloscope showing a step function and its corresponding sigmoidal response. The interface is in German.

Figures 1: Screenshot of the monist console. The navigator-tree (left) with the content browser (right) including an educational simulation. The navigator tree. represents the organization of courses, units, monist users, etc. Note: monist is multilingual: Standard language is English but other languages are possible (as shown in the simulation in German language).