



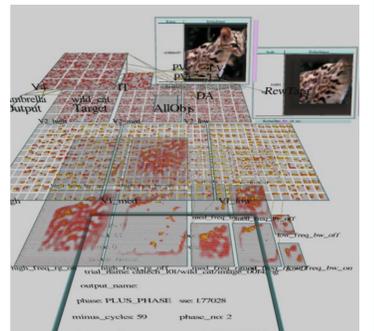
The Emergent Neural Network Modeling System

<http://grey.colorado.edu/emergent>

by Brad Aisa, Brian Mingus, & Randall C. O'Reilly 2007

University of Colorado Boulder

brad.aisa@colorado.edu brian.mingus@colorado.edu randy.oreilly@colorado.edu



Abstract

Emergent --- a major rewrite of PDP++ --- is a comprehensive simulation environment for creating complex, sophisticated models of the brain, cognition, and behavior using neural network models. It includes a rich, new GUI environment for constructing networks and the input/output patterns for the networks to process, along with many powerful analysis tools for understanding what the networks are actually doing. It has a new tabbed-browser style interface (in Qt4), with full 3D graphics (via OpenGL and Open Inventor/Coin3D), and an all new GUI programming system. Emergent supports all the same algorithms as PDP++: Backpropagation (feedforward and recurrent), Self-Organizing (e.g., Hebbian, Kohonen, Competitive Learning), Constraint Satisfaction (e.g., Boltzmann, Hopfield), and the Leabra algorithm that integrates elements of all of the above in one coherent, biologically-plausible framework.

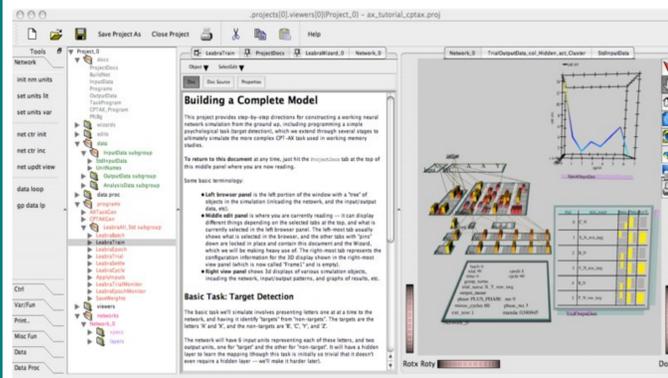
Emergent vs. PDP++

In Emergent, everything has been boiled down to the most basic, general-purpose elements, which can now be combined in more powerful, "emergent" ways.

- * **All New Tabbed-Browser Interface**
- * **GUI-Based Programming**
- * **DataTable-Based Input/Output**
- * **Virtual Environment Simulator**

All New Tabbed-Browser Interface

Emergent's new tabbed-browser interface allows everything to be contained within a single window, with full search, drag-and-drop, cut/copy/paste, etc, for a modern, highly efficient working environment.



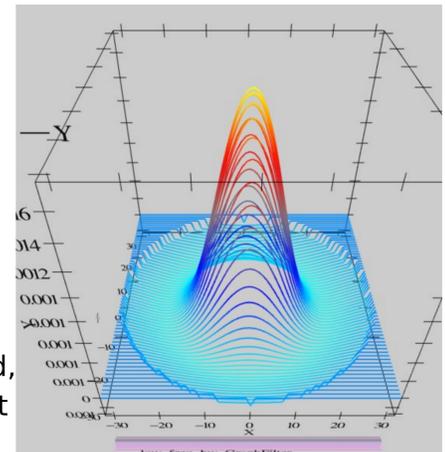
This new interface is especially powerful in a teaching environment, where it is extremely easy to create tutorials such as the AX Tutorial shown above, using a subset of wiki syntax for user documentation, right in the tabbed-browser interface of the simulator.

New GUI-Based Programming

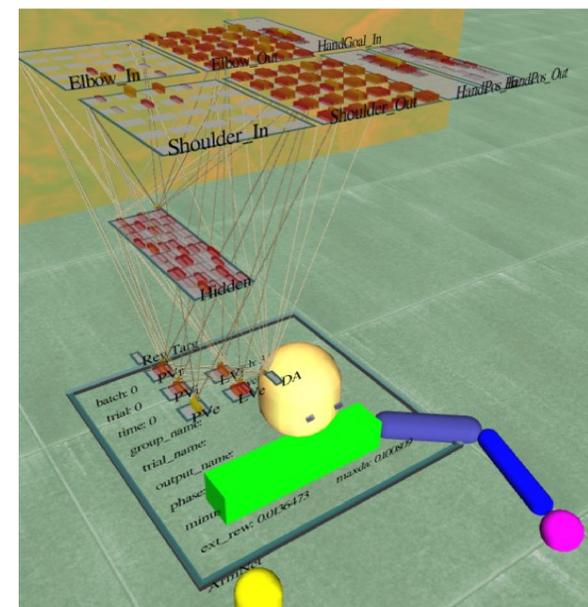
Easier "scripting" of network training --- everything is transparent and user-modifiable. Considerable support is also included for implementing complex psychological tasks via the GUI-based programming environment.

Data Table-Based Input/Output

The rendering of environments and the monitoring of output data --- along with the handling of all other forms of data have been consolidated into a single powerful DataTable object interface that supports many different kinds of operations (e.g., database-style Joins and Sorts, vector and matrix math, 3Dgraphing, statistics, etc). With convenient interfaces to DataTables in the GUI programming environment, flexible and efficient data processing and analysis functions can be readily performed, including advanced 3D plotting capabilities and full support for the GNU Scientific Library



Virtual Environment Simulator



In addition to a greater variety of network visualization tools --- including 3D --- brand new to Emergent is a built-in virtual environment simulator for doing robotics simulations with rigid body physics using the popular Open Dynamics Engine (ODE). As illustrated in the figure above, this allows networks to interact with a realistic simulated environment in order to explore embodied models and robotic functionality.

Available Platforms

Emergent is available with native look and feel on Windows, Mac and Linux, under the standard GPL license.

Installation is easy using either:

- ✓ Easily-installable packages on all major operating systems, including apt & yum on Linux
- ✓./configure build process for advanced users

•And, dynamically-loadable plug-in modules are supported for easy extensibility.

•For download, instructions and installation:

•<http://grey.colorado.edu/emergent>

Why Emergent?

Relative to MATLAB and other general-purpose tools for neural neural network simulation, Emergent offers many important advantages:

- Completely open source, free software.
- Highly optimized for execution speed (e.g., distributed memory computation) while supporting complex biologically-based neural architectures.
- Makes research simulations easily accessible to other users with minimal additional effort:
 - ✓ Built-in documentation system
 - ✓ Pervasive comment fields
 - ✓ Easy-to-use, transparent interface

Most importantly, Emergent is specifically focused upon the critical **systems-level** middle-ground --- between purely abstract, mathematical models on the one hand and single neuron simulations on the other --- precisely the level that is of greatest interest to psychologists, and to cognitive and behavioral neuroscientists. If you're doing large scale, complex neural network models, Emergent offers many advantages.

Thanks to the following for their valuable input and support:

- * Jonathan Cohen & Jay McClelland
- * Members of the Computational Cognitive Neuroscience Lab and the Cognitive Development Center at the University of Colorado Boulder
- * Supported by: NIH R01 MH069597, ONR N00014-07-1-0651, DARPA/ONR N00014-05-1-0880, ONR N00014-03-1-0428 (O'Reilly); NIH IBSC 1 P50 MH 64445 (McClelland)