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The Emergent Platform for Community CCN

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Randall C. O'Reilly · Kai A. Krueger · Brian Mingus · John Rohrlich

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Extends neural simulation into collaborative model development, connecting shared repositories, documentation and high-performance computing.

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The *emergent platform*TM for community CCN

Randall C. O'Reilly (Randy.OReilly@colorado.edu)

Computational Cognitive Neuroscience Lab, Department of Psychology, University of Colorado at Boulder

Kai A. Krueger (Kai.Krueger@colorado.edu)

eCortex Inc, Boulder, Co; Latently, a Public Benefit Corporation, Boulder, Co

Brian Mingus (Brian.Mingus@colorado.edu)

Latently, a Public Benefit Corporation, Boulder, Co

John Rohrlich (John.Rohrlich@colorado.edu)

Computational Cognitive Neuroscience Lab, Department of Psychology, University of Colorado at Boulder

Abstract

The *emergent platform*TM consists of the *emergent*TM simulator (<http://grey.colorado.edu/emergent>) and supporting infrastructure for community CCN model development. It has integrations with open repositories such as wikis and source control as well as with free public supercomputing resources provided through the Neuroscience Gateway on the Comet supercomputer, resulting in a simple, yet full fledged platform for collaboration in brain modeling. The platform supports brain modeling up and down the stack, from computational neuroscience to mean field models to ACT-R and Bayesianism, allowing one to combine the strengths of the different approaches in a single model. *emergent*TM has the best support for visualization of any neural simulator to date, enabling one to use visual regression to develop their intuitions of dynamic brain systems (Wlodzislaw & Dobosz, 2011). The platform has a long history in Connectionism, having descended from PDP (1986) and PDP++ (1995), and comes with a CCN textbook (<http://ccnbook.colorado.edu>) that explores the latest instantiations of the increasingly brain-inspired versions of the PDP models from the early days. While flexible, the platform is also principled and biased towards convergence on a middle-of-the-road approach, with wizards enabling the creation of cognitive architectures linking PFC, hippocampus, midbrain, vision and more.

Keywords: CCN; HPC; cognitive modeling; cognitive architectures; model repository; collaboration

About the *emergent platform*TM

The *emergent platform*TM consists of the *emergent*TM simulator (Aisa, Mingus, & O'Reilly, 2008) for CCN (cognitive computational neuroscience (Kelso & Tognoli, 2009) and computational cognitive neuroscience (O'Reilly, 1998)) and supporting infrastructure for model-lifecycle management and community model development. It has been developed as open source (GPLv2) cross-platform software (Windows, Mac and Linux), with a long history of more than 10 years. Originating in PDP (McClelland, 2015) and PDP++ (O'Reilly, Dawson, & McClelland, 2005), its main strength lies in the cognitive architecture

of Leabra (O'Reilly, 1996; O'Reilly, Hazy, & Herd, 2015), PVLV (O'Reilly, Frank, Hazy, & Watz, 2007; Hazy, Frank, & O'Reilly, 2010) and PBWM (Hazy, Frank, & O'Reilly, 2007), providing a biologically inspired, yet high-level abstract modeling framework of brain area interactions (Jilk, Lebiere, O'Reilly, & Anderson, 2008). This includes PFC - basal ganglia loops and how it enables complex operations and development of representations through learning.

Over the years *emergent*TM has increasingly evolved into a fully fledged collaborative model lifecycle management tool for CCN research, providing direct built-in repositories for sharing models, analysis programs and task environments together with an integrated documentation tool linking up to a reference and bibliography management system to foster scientific discussions on any such shared models or theories. This integrated approach has been used extensively in the free wiki based CCN textbook (O'Reilly, Munakata, Frank, Hazy, & Contributors, 2016). In this paper we now briefly present some of the recent advancements of workflow in this powerful tool and how it can help to collaboratively create increasingly complex and complete cognitive models to encapsulate and codify the current state of scientific knowledge.

Simpler models in *emergent*TM can be run on a single modern desktop or laptop, however, scaling models up to simulate interesting complex cognitive behaviours often requires more computational resources than are available locally. *emergent*TM offers a complete set of tools to launch simulations as well as analyze and manage its data on remote HPC or other scientific computing resources from within the standard UI, making scaling up models and or parallelizing parameter searches a straightforward extension to the standard modeling workflow. The frontend and backend communicate through a shared SVN repository which provides two useful benefits. 1) It is robust to most firewall configurations in standard university HPC facilities, allowing to drive all operations from any internet connected client without needing to log-in to the HPC resource itself 2) It provides a complete version history of all experiments run and their outcome. Thus the HPC interface simultaneously also acts as a built-in shared lab log-book, allowing modellers to keep notes on past efforts and rapidly graphing and comparing any such attempts.

Even though setting up *emergent*TM to use one's own dedi-

cated HPC cluster enables the most flexibility, this option is not always available to all researchers, and compiling *emergent*TM on a university cluster may put an unnecessarily high technical burden on researchers. To minimize this barrier to entry, *emergent*TM has collaborated with the Neuroscience Gateway Portal (Sivagnanam et al., 2013) to provide at least 5,000 free core hours per user on the XSEDE supercomputer. Since version 8.1, *emergent*TM now comes preconfigured with access to the Comet cluster (part of XSEDE), which can be used by anyone, out of the box, subject to an account verification process.

Science has always been a large scale collaborative process and building cognitive models representing the function of numerous parts of the brain is no exception. To foster team-based research *emergent*TM includes numerous collaborative tools. For example *emergent*TM provides the functionality to publish, as well as load projects and utility programs such as common analysis or task environments, straight from its user interface and supports both private team repositories, as well as public repositories hosted by the CCNLab. *emergent*TM also provides built-in support for SVN as well as a patch management system to allow for a straightforward UI-driven distributed development model. We invite the community of CCN researchers to help us develop a more extensive library of common cognitive tasks, as well as all published models written in *emergent*TM.

Summary

*emergent*TM provides an extensive collection of tools for modeling cognitive process in the brain and provides a platform approach to collaborative development of complex brain models. In sum, we are excited to release the emergent platform to a global community of brain-mind researchers all working together to characterize and understand our human nature.

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