Neural Networks 24 (2011) 693–698

Contents lists available at ScienceDirect

Neural Networks

journal homepage: www.elsevier.com/locate/neunet

# Simulation Platform: A cloud-based online simulation environment

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A R T I C L E I N F O

*Article history:*
Received 29 December 2010
Revised and accepted 14 June 2011

*Keywords:*
Neuroinformatics
Online simulation
Cloud computing
Virtual machine

A B S T R A C T

For multi-scale and multi-modal neural modeling, it is needed to handle multiple neural models described at different levels seamlessly. Database technology will become more important for these studies, specifically for downloading and handling the neural models seamlessly and effortlessly. To date, conventional neuroinformatics databases have solely been designed to archive model files, but the databases should provide a chance for users to validate the models before downloading them. In this paper, we report our on-going project to develop a cloud-based web service for online simulation called "Simulation Platform". Simulation Platform is a cloud of virtual machines running GNU/Linux. On a virtual machine, various software including developer tools such as compilers and libraries, popular neural simulators such as GENESIS, NEURON and NEST, and scientific software such as Gnuplot, R and Octave, are pre-installed. When a user posts a request, a virtual machine is assigned to the user, and the simulation starts on that machine. The user remotely accesses to the machine through a web browser and carries out the simulation, without the need to install any software but a web browser on the user's own computer. Therefore, Simulation Platform is expected to eliminate impediments to handle multiple neural models that require multiple software.



## 1. Introduction

Higher-order brain functions emerge from the hierarchically organized network composed of a massive number of neurons mutually connected, not from individual neurons acting independently. That is, even if each element is a simple computational unit, the connected network can exhibit greater computational capability. The same argument seems valid for neural models, which are developed at various levels from molecule to system, from milliseconds to hours, and from reflex to cognition. Even if each model functions little, the integrated model could demonstrate such higher-order functions. As multi-scale and multi-modal neural modeling, we focus on building an integrated model by combining multiple models together.

To date, a number of neural models at different scales and modalities have been proposed, and many of them are archived and available at neuroscience databases such as ModelDB[1] (Hines, Morse, Migliore, Carnevale, & Shepherd, 2004) and J-Node Platforms[2] (Usui et al., 2008). The latter is composed of eight databases and is organized by Neuroinformatics Japan Center, which is the Japan Node (J-Node) of the International Neuroinformatics Coordinating Facility. J-Node Platforms serve as online databases, and a companion project PLATO (Kannon, Inagaki, Kamiji, Makimura, & Usui, 2011; Usui, 2010) aims to provide the scheme of model integration.

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1 http://senselab.med.yale.edu/modeldb/.
2 http://neuroinf.jp/.

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doi:10.1016/j.neunet.2011.06.010

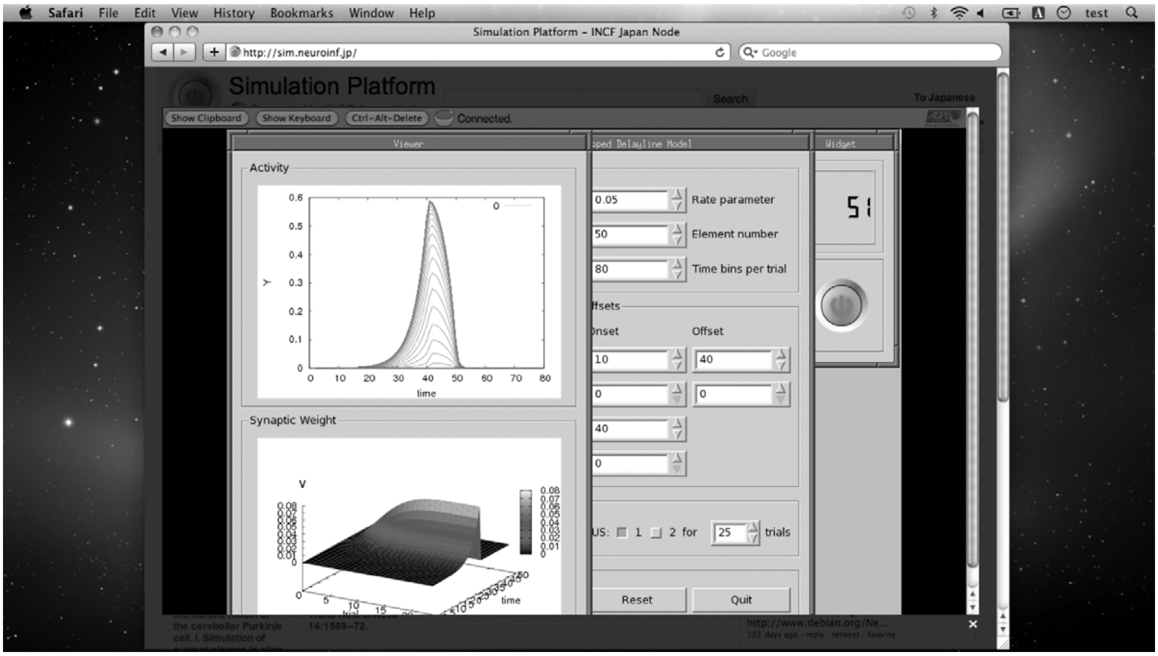


**Fig. 1.** A screenshot of a web browser during a simulation of a tapped delayline model for cerebellar timing mechanisms (Moore et al., 1989). The model script is found at Cerebellar Platform.[3]

For the integration, we have to validate that all component models of an integrated model work properly beforehand. To validate a component model, we have to download it from a database, extract, read instructions, compile if a model is written in a general programming language such as C, install an appropriate neural simulator if a model is written for a simulator such as GENESIS (Bower & Beeman, 1998), NEURON (Carnevale & Hines, 2006) and NEST (Gewaltig & Diesmann, 2007), and finally we are ready to carry out a computer simulation. We have to take these tedious steps for each component model, even for just a simple test. We need a better way to test a model effortlessly. Once we develop such a system that allows us to validate each component model online, we will be able to search, validate, download component models, and build an integrated model by putting them together seamlessly.

Here, we introduce our on-going project on launching a cloud-based web service called "Simulation Platform",[4] as one of the J-Node Platforms (Usui et al., 2010, 2009). Using Simulation Platform, a user can carry out a model simulation and data analysis without the need to install any software on the user's own computer (a screenshot is shown in Fig. 1). The user is simply asked to specify the model script to Simulation Platform using a web browser. Then, the simulation starts on one of virtual machines in the cloud automatically, and the user can control the virtual machine remotely and interactively through the web browser. Hence, Simulation Platform is expected to reduce difficulties in computer simulations.

## 2. System overview of Simulation Platform

Fig. 2 depicts the overall structure of Simulation Platform. Simulation Platform is composed of a set of computational nodes[5] as backends and an administrative node as a frontend. All nodes run CentOS 5.5, a GNU/Linux-based system.[6] The details of these machines are shown in Table 1(A).

**Table 1**
Specification of (A) a computational node and (B) a virtual machine.

| | |
|---|---|
| (A) | |
| Model | HP ProLiant DL360 G5 |
| CPU | Dual Core Xeon Processor 5160 3 GHz |
| RAM | 8 GB (PC2-5300 FB-DIMM) |
| HDD | 146 GB 2.5 inch SAS × 2 (RAID1) |
| Network | NC373i Gigabit Adapter × 2 |
| OS | CentOS 5.5 x86_64 |
| Kernel version | 2.6.18 |
| (B) | |
| Model | Generic x86_64 PC |
| CPU | Generic x86_64 CPU |
| RAM | 1 GB |
| HDD | 4 GB |
| Network | PCnet-FASTIII Gigabit Adapter |
| OS | CentOS 5.5 x86_64 |
| Kernel version | 2.6.18 |

Four virtual machines, also based on CentOS 5.5, run on each computational node.[7] For virtualization, we use a free software (Oracle VirtualBox 3.1.8[8]). The details of a virtual machine are shown in Table 1(B). On each virtual machine, most developer tools such as compilers and libraries, popular neural simulators such as GENESIS, NEURON and NEST, and scientific software such as Gnuplot, R and Octave, are pre-installed. Table 2 lists some of the installed software. A virtual machine can execute a computer simulation upon a user's request. The desktop of the virtual machine appears on the screen of the user's web browser via virtual-network-computing (VNC) protocol, through which the user can interact with the virtual machine remotely.

The administrative node accepts a user's request, assigns a virtual machine to the user, and proxies the connection between

3 http://cerebellum.neuroinf.jp/modules/xoonips/detail.php?item_id=350.
4 http://sim.neuroinf.jp/.
5 As of March 2011, we have four computational nodes.
6 http://www.centos.org/.
7 We have 16 virtual machines as of March 2011.
8 http://www.virtualbox.org/.