

Don't reinvent the brain

Using ModelDB and other archives for your research

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16 October 2015

General issues

On reproducibility

“Non-reproducible single occurrences are of no significance to science.”

– Karl Popper in *The logic of scientific discovery*, 1959.

What is needed for a model to be reproducible?

Model

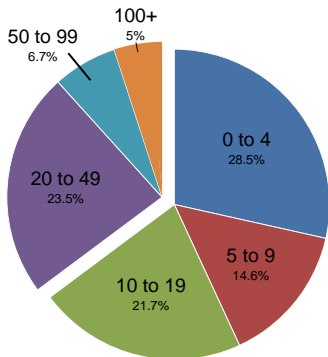
- an approximation of the system of interest
e.g. a model organism or a complete statement of the properties of the model in mathematical or computable form

Experimental protocol

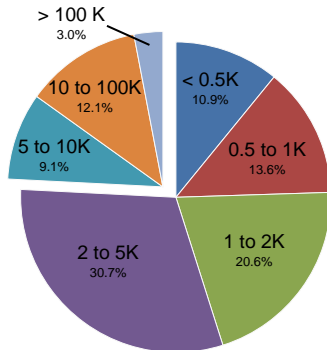
- what was done with the model to produce the data

Science builds upon previous work; in order to do that, the previous work needs to be reproducible.

Models are complicated



Files per Model



File Size

- **38.5%** of ModelDB models have **over 20 files**; **24.2%** of files are **over 5K**.
- It is often hard to fully describe this complexity in a paper.
- Any bugs, typos, errors, or omissions might completely change the dynamics.

Model sharing helps, but only reuse what you understand

The easiest way to replicate someone else's results – a first step toward building on them – is to get their model code from a repository such as ModelDB.

But beware:

- They may be solving a different problem than you (with respect to species, temperature, age, etc).
- Their code may have bugs.

To reduce the risk of problems:

- **Read** the associated paper.
- **Compare** the model and results to other similar models.
- **Examine** the model with ModelView and/or psection.
- **Test** ion channels individually.
- **Collaborate** with an experimentalist.

ModelDB

Part of the SenseLab Project

[Advanced search](#)

ModelDB
[ModelDB Help](#)
User account
[Login](#)
[Register](#)
Find models by
[Model name](#)
[First author](#)
[Each author](#)
[Region\(circuits\)](#)
Find models for
[Cell type](#)
[Current](#)
[Receptor](#)
[Gene](#)
[Transmitters](#)
[Topic](#)
[Simulators](#)
[Methods](#)
Find models of
[Networks](#)
[Neurons](#)
[Electrical synapses \(gap junctions\)](#)
[Chemical synapses](#)
[Ion channels](#)
[Neuromuscular junctions](#)
[Axons](#)
Other resources
[ModelDB related resources](#)
[Models in mercurial repository](#)

ModelDB provides an accessible location for storing and efficiently retrieving computational neuroscience models. ModelDB is tightly coupled with [NeuronDB](#). Models can be coded in any language for any environment. Model code can be viewed before downloading and browsers can be set to auto-launch the models. For further information, see [model sharing in general](#) and [ModelDB in particular](#)

Search

Use the "search" box in the upper left corner to find model entries

- by accession number
- by a particular author
- by keyword (cell type, region, receptor, gene, transmitter, topic, simulator)
- use advanced search for ion currents: because these are short they are problematic to search with free text
- use advanced search for a combined keyword and full text search
- prefix case sensitive words with ^
- use * for completions

Or you may search for publications indexed in [ModelDB](#) or [PubMed](#).

New Model

[Submit a new model entry](#)
[Video tutorial](#)

[@SenseLabProject](#)


[ModelDB Home](#)
[SenseLab Home](#)
[Help](#)
 Questions, comments, problems? Email the [ModelDB Administrator](#)
[How to cite ModelDB](#)
[ModelDB Credits](#)

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What is in ModelDB?

Models for:

- 176 cell types
- 19+ species
- 52 ion channels, pumps, etc
- 129 topics (Alzheimer's, STDP, etc)

1052 published models from 70+ simulators

- 509 NEURON models

Finding models



- **Search box** on the top-left of every page.
- Do **full text** or **attribute** searches.
- Word completions (based on ModelDB entries not English) and attribute results **updated as you type**.
- **Advanced search** and **browsing** are also available.

Anatomy of a ShowModel page

The screenshot shows a web browser displaying a 'ShowModel' page for a model titled 'Amynoid beta (A block) effects on a model CA1 pyramidal cell (Morse et al. 2010)'. The page is annotated with red numbers 1 through 14, corresponding to the list on the right. The annotations point to the following elements:


- (1) Model name and title bar.
- (2) Left sidebar navigation menu.
- (3) Abstract text.
- (4) Citation information (author, year, journal).
- (5) Model information section.
- (6) Metadata table with columns for Name, Value, and Units.
- (7) Download links for the model files.
- (8) Download link for the entire simulation.
- (9) Auto-launch simulation button.
- (10) Simulation platform selection buttons (e.g., NEURON, GENESIS).
- (11) ModelView visualization button.
- (12) 3D printable versions of cells button.
- (13) Directory browser showing a list of files.
- (14) View pane for the currently selected file.

- (1) Search models.
- (2) Browse models.
- (3) Description of model.
- (4) Paper(s) describing or using model.
- (5) Find models and papers cited by this model's paper, or that cite this model.
- (6) Searchable metadata.
- (7) Links to NeuronDB (channel distributions etc within cell types).
- (8) Link to download the entire simulation.
- (9) Auto-launch a NEURON simulation (requires browser configuration).
- (10) Simulation platform (5 minutes of remote desktop access to experiment with the model).
- (11) ModelView: visualize model structure.
- (12) 3D printable versions of cells from the model (in 3DModelDB).
- (13) Directory browser, showing model files.
- (14) View pane for the currently selected file.

ModelView

search

Advanced search



SimTeaDB

ModelDB Help

User account

Login

Register

Find models by

Model name

First author

Each author

Region(s)

Find models for

Cell type

Current

Receptor

Gene

Transmitters

Topic

Simulators

Methods

Find models of

Networks

Neurons

Electrical synapses (gap junctions)

Chemical synapses

Ion channels

Neuromuscular junctions

Axons

Other resources

ModelDB related resources

Models in external repository

Amyloid beta (IA block) effects on a model CA1 pyramidal cell (Morse et al. 2010)

Accession: 87284

The model simulations provide evidence oblique dendrites in CA1 pyramidal neurons are susceptible to hyper-excitability by amyloid beta block of the transient K⁺ channel, IA. See paper for details.

Reference: Morse TM, Carnevale NT, Mutak PG, Migliore M, Shepherd GM (2010) Abnormal excitability of oblique dendrites implicated in early Alzheimer's: a computational study *Front. Neural Circuits* 4:16 [PubMed](#)

Citations: [Citation Browser](#)

Model information (Click on a link to find other models with that property)

Model Type: [Neuron or other electrically excitable cell](#)

Brain Region(s)/Organism:

Cell Type(s): [CA1 pyramidal neuron](#)

Channel(s): [INaF](#) [IL high threshold](#) [IN](#) [LT low threshold](#) [IA](#) [IK](#) [Ih](#)

Gap Junctions:

Receptor(s):

Gene(s):


Transmitter(s):

Simulation Environment: [NEURON](#)

Model Concept(s): [Dendritic Action Potentials](#) [Active Dendrites](#) [Detailed Neuronal Models](#) [Pathophysiology](#) [Aging/Alzheimer's](#)

Implementer(s): [Carnevale, Ted](#) [Ted Carnevale at Yale.edu](#); [Morse, Tom](#) [Tom Morse at Yale.edu](#)

Search NeuronDB for information about: [CA1 pyramidal neuron](#) [INaF](#) [IL high threshold](#) [IN](#) [LT low threshold](#) [IA](#) [IK](#) [Ih](#)

Model files	Download zip file	Simulation Platform	ModelView	Help downloading and running models
<ul style="list-style-type: none"> CA1_8beta translate <li style="background-color: #ffff00;">main.html fig1.jpg fig2.jpg fig3.jpg fig4.jpg 				<p>This is the result of Figure 1, 2 in the paper</p> <p>Figure 3 Migliore M, Shepherd GM (2010) Abnormal excitability of oblique dendrites implicated in early Alzheimer's: a computational study, <i>Neural Circuits</i> 4:16</p> <p>Figure 4</p> <p>Figure 5</p> <p>Figure 6</p> <p>The model code was contributed by Tom Morse. It was created (see paper for details) from earlier models (especially Migliore et al. 2005 and calcium channels from Hemond et al. 2008) with</p>

Morse et al. 2010

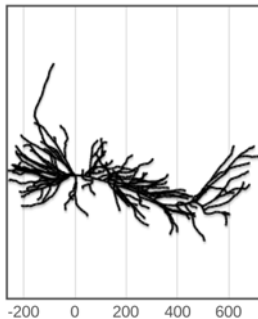
- 194 sections; 974 segments
- ▣ 1 cell with morphology
 - 0 artificial cells
 - 0 NetCon objects
 - 0 LinearMechanism objects
- ▣ Temperature: 35°C
- ▣ Density Mechanisms
- ▣ 1 point processes (0 can receive events) of 1 base classes
- ▣ 7 files shared with other ModelDB models
- ▣ References

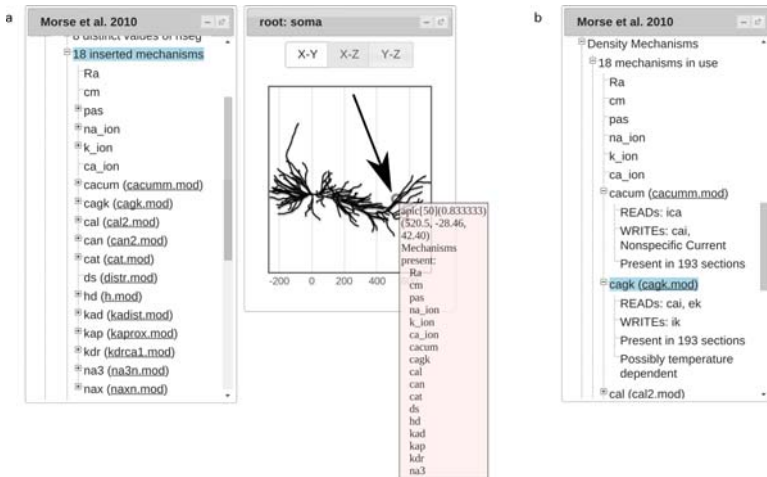
root: soma

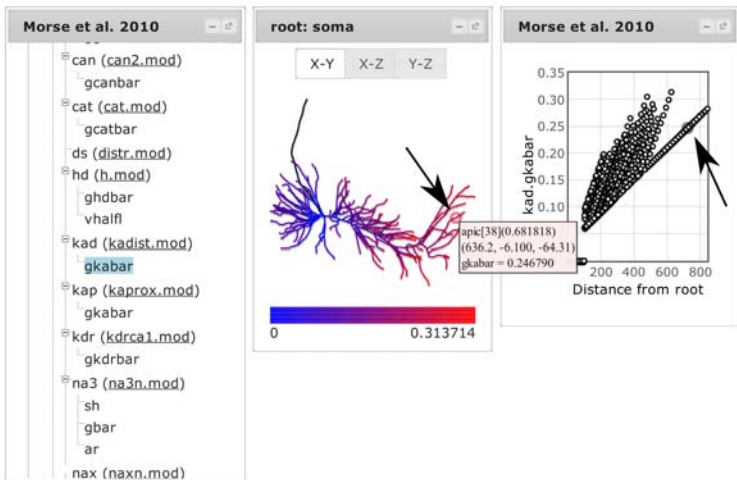
X-Y

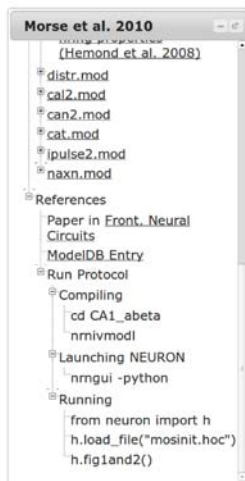
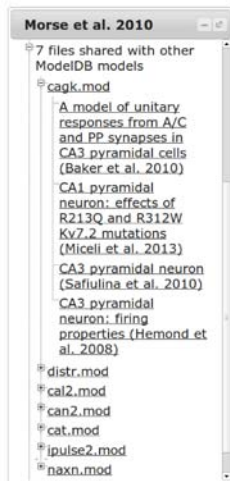
X-Z

Y-Z









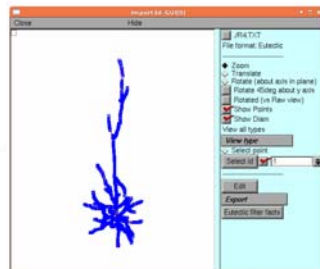
How do people use ModelDB?

- Find a model described in a paper, download it, and experiment to understand the model's predictions.
- Find a model described in a paper. Use ModelView to understand the model's structure.
- Locate models and modeling papers on a given topic.
- Locate model components (e.g. L-type calcium channel) for potential reuse.
- Search for simulator keywords (e.g. `FInitializeHandler`) to find examples of how to use them.

You can help by sharing your model code on ModelDB after publication.

Other resources

NeuroMorpho.Org



Tools ► Miscellaneous ► Import 3D

- **NeuroMorpho.Org** is home to 31,982 reconstructed neurons from 140 cell types and 24 species as of September 24, 2015.
- Warning: not every morphology was reconstructed with the intent of being in a simulation. Before using: rotate to check for z-axis errors, check to make sure the diameters are not all equal.
- Use the Import 3D tool to import morphologies into NEURON. For details, see: neuron.yale.edu/neuron/docs/import3d

Channelpedia (Channelpedia.epfl.ch)

EPFL BLUE BRAIN PROJECT

Nav1.3

Introductions

The tetraethanol-sensitive (TTX-E) channel Nav1.3 is abundantly expressed in neuronal tissues during embryonic and neonatal stages of development and is rare in adult tissues [46].

After general transcription, Nav1.3 is upregulated in dorsal root ganglia (DRG) neurons leading to the evidence that upregulation of Nav1.3 may play a role in underlying experimental DRG neuronal hyperexcitability. This contributing to neuropathic pain [105]. It is thought that the fast activation and inactivation kinetics of Nav1.3, together with its rapid repriming kinetics and persistent current component, contribute to the development of spontaneous synaptic discharges and sustained states of firing characteristic of injured sensory neurons [106].

Genes

Experiments on sodium channels in DRG cells (a dorsal root of rat ganglionic cells) showed that demyelination treatment caused a moderate reduction (approx. 30%) of the mRNA for Nav 1.3 and a marked reduction (approx. 70%) of the mRNA for the Nav 1.5. Treatment with Bay K 8644 produced 80-100% increases of these same mRNAs, in contrast [107].

Nav1.3: sodium channel, voltage-gated, type III, alpha

Gene ID	Chromosome	Position	Species
10023	3	412200-175-454603349	Human
738462	2	18994630-189946377	Human

Transcripts

Acc No	Sequence	Length	Source
AF121138			NCBI
AF121139			NCBI

Models

[1] Nav1.3 (Model ID = 48)

Animal	rat
CellType	Neuron
Age	0 Days
Temperature	33.0°C
Recording	50.0 kHz
Sex	Male
Legend ref	
Reference	Y. A. Cummins et al., J. Neurosci., 2002, Aug 14
Injection	3.0
Integration	0.0, 20.0 * (1.0) - 0.0(1.0) - 0.0(1.0) * (1.0) * (1.0) * (1.0)
Initials	0.0, 20.0 * (1.0) - 0.0(1.0) - 0.0(1.0) * (1.0) - 0.0(1.0) * (1.0) * (1.0)
Injection	3.0
Model	3.0(1.0) + 4.0(1.0) + 4.0(1.0)
Notes	0.00 * (0.00) * (0.00) * (0.00)

References

[1] Cummins Y, et al. Distribution and functional characterization of human Nav1.3 sodium channels. *Proc Natl Acad Sci U S A*. 2002 Jul 23;99(15):9733-8.

[2] ... Tan L, et al. Homing and rat Nav1.3 voltage-gated sodium channels alter its expression properties and sensitivity to the persistent sodium channel blockers.

- Home to information about ion channels.
- Many channels have one or more associated models (e.g. different species or cell types); all are downloadable as MOD files.
- Shows gating variable and channel response to voltage clamp for each model.

Biomodels (www.ebi.ac.uk/biomodels-main)

The screenshot shows the BioModels Database interface. At the top, there is a search bar and navigation links. Below, the model ID 'BIOMD0000000073 - Leloup_JC_Goldbater_A_CircClock_DD' is displayed. A red arrow points to the 'Download SBML' button. Other options include 'Other formats (auto-generated)', 'Actions', and 'Send feedback'. Below the download options, there is a 'Reference Publication' section with details about the model's origin and a 'Model' section with links to the original model and its import instructions.

```
jnml BIOMD0000000073_LEMS.xml -neuron
```

Biomodels model (SBML) \longrightarrow LEMS model \longrightarrow MOD file

```
jnml -sbml-import BIOMD0000000073.xml 1000 5
```

- Biomodels is a systems biology model repository.
- Models are in SBML but can be converted to MOD files via e.g. jNeuroML (github.com/NeuroML/jNeuroML). Test converted models before using in a larger model. Edits will likely be necessary to get them to interoperate with other mechanisms.
- A native SBML importer for NEURON's rxd module is under development.

Open Source Brain (OpenSourceBrain.org)

OPEN SOURCE BRAIN

Purkinje Cell De Schutter and Bower 1994

Download | Download | Download | Download | Purkinje Cell | De Schutter and Bower 1994

Download | Download | Download | Download | Purkinje Cell | De Schutter and Bower 1994

Language: C++ 3.0 Explorer + WebGL Other tools + Model components

Description

Stats

Members

References

Description

An initial implementation in NeuroML of the Purkinje Cell model from De Schutter, E. and Bower, J. M. (1994). Based on Arnd Roth et al's conversion of the original GENESIS code to



neuroConstruct v1.0.0

Project: Settings Tools Help

Generate Problems & Networks

Generate NEURON Mod

Generate GENESIS

Generate PYSN

Link Predefined Simulations

Data Set Manager

Construct

Project Name: Purkinje Cell

Project Description: An initial implementation in NeuroML of the Purkinje Cell model from De Schutter, E. and Bower, J. M. (1994). Based on Arnd Roth et al's conversion of the original GENESIS code to NEURON. Note: conversion not fully complete. Please inquire for details. Also, there are long standing issues about getting GENESIS and NEURON behavior of the Purkinje cell to match. Contact A. Geisen or A. Roth for more details on current status of this model. Changelog: Also need to be updated to post v1.1.3 format (though they will work the with existing file mappings for NEURON & GENESIS)

Cell Types in project: park2 somaOnly somaOnly_all somaOnly_ca somaOnly_caf somaOnly_caf somaOnly_KA somaOnly_kbr

Cell Groups: sampleCellGroup objChannelGroup AllChannel

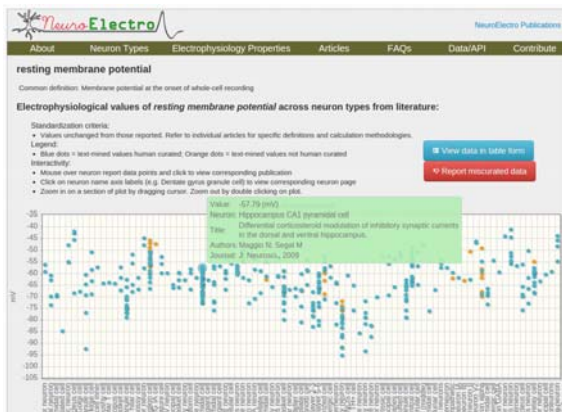
Simulation Configurations: Default Simulation Configuration BioSimulators AllItems AllSimulations Right-click Right-click-download

Project File Version: neuroConstruct v1.0.0

Last modified: 12:22:34, Thursday August 27, 2015

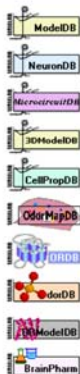
- Open Source Brain promotes collaborative model development via github.
- Models are typically in NeuroML or neuroConstruct format; neuroConstruct (neuroConstruct.org) converts both formats to NEURON.
- The conversion process places different ion channels in different MOD files, which allows extracting model components.

NeuroElectro (NeuroElectro.org)




- NeuroElectro archives experimentally measured electrophysiology values for different cell types; it shows the spread and allows comparing values across different cell types.
- Read the paper associated with a value to understand: species, experimental conditions, etc.

SenseLab (senselab.med.yale.edu)



[Back](#)



User Public

Overview | Data/Search | plus Connectivity | plus Classical References/Notes | Models | BrainPharm

Hippocampus CA1 pyramidal cell

Av: Present Absent

Neuron Type: principal
 Organism: Vertebrates
 ElectroPhysiology: [NeuroElectro.org](#)
 Pharmacology: [iEDSAD](#)
 Reconstructions: [NeuroMorpho.Org](#)
 Genes: [Allen Brain Atlas - Links](#)
 Genes: [Human Brain Transcriptome](#)
 NeuroLex:
 Microcircuit: [Hippocampal Microcircuit](#)
 Connectivity: Live connectivity specified by colored boxes. Dark yellow: distant connectivity. Light yellow: auto connectivity

	Input Receptors	Intrinsic Currents	Output Transmitters
Distal apical dendrite	Hippocampus CA1 oriens alveus interneuron Axon terminal Gaba	Gaba	I _h h3
			I _T low threshold
		AMPA	I _A
		NMDA	I _N
	Perforant pathway entorhinal pyramidal neuron terminals (T)	Glutamate	I _T high threshold
		I _A g	
		I _N	
Middle apical dendrite	Hippocampus CA1 oriens alveus interneuron Axon terminal Gaba	GabaA	I _h h3
	Hippocampus CA1 oriens alveus interneuron Axon terminal Gaba	GabaB	I _T low threshold
	Hippocampus CA1 pyramidal cell Axon terminal Glutamate	NMDA	I _{Potassium}

- SenseLab is a suite of 10 interconnected databases (listed at left).
- ModelDB and NeuronDB (at right) are the most useful for modeling.
- NeuronDB shows what channels are present and the inputs and outputs *by cell region* (e.g. distal apical dendrite vs proximal apical dendrite).

Stay up to date

Twitter

Many repositories announce new developments on Twitter, including:

- SenseLab (including ModelDB): [@SenseLabProject](#)
- Open Source Brain: [@OSBTeam](#)
- NeuroMorpho.Org: [@NeuroMorphoOrg](#)