Ontology-assisted keyword search for NeuroML models

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Arizona State University
Airplanes to Brains
Boeing 787

2.3 million parts
Reusing Models Is Difficult

• Written in a variety of computer languages
  – Translation
  – Extraction

• Duplication of effort
  – Above incentivize re-creation of models
  – Loss to funders and taxpayers
• International collaborative to create modular XML language to describe computational neuroscience models

• Allows description of:
  – Individual neurons + morphology + dynamics
  – Their components
  – Networks composed of neurons
NeuroML facilitates component re-use
Automated NeuroML Translation
Challenges of Finding Components

• Searching procedural code is difficult:
  – Lack of knowledge of the language
  – Lack of knowledge of the code structure & conventions
  – Lack of knowledge of model implementation
NeuroML-DB facilitates component search

NeuroML-DB.org

= Multi-Scale SQL Search of NeuroML

+ SPARQL Graph Search of NeuroLex Ontology
Multi-Scale SQL Search

- **Network**
  - Granule Cell Net
  - Purkinje Cell Net

- **Cellular**
  - Golgi
  - Purkinje
  - CA3 Pyramidal

- **Membrane**
  - GABA
  - Glutamate
  - Na
  - Ca
  - K

*Parent* and *children* relationships are indicated on the diagram.
SPARQL Graph Search

Graph:
- Purkinje Cell
- Cerebellum
- Cerebellar Cortex
- GABA
- Golgi Cell
- Granule Layer

Relationships:
- Located_in: Purkinje Cell to Cerebellum
- located_in: Golgi Cell to Granule Layer
- ls_part_of: Cerebellum to Cerebellar Cortex
- ls_part_of: GABA to Golgi Cell
Demo

neuroml-db.org
Search NeuroML Models

Keyword Search Results

- **MultiDecaySyn Synapse** (NMLSY000100)
- **ApicalSyn Synapse** (NMLSY000099)
- **GapJuncCML Synapse** (NMLSY000084)
- **NMDA Synapse** (NMLSY000083)
- **MF_AMPA Synapse** (NMLSY000082)
- **GABAA Synapse** (NMLSY000081)
- **AMPA_GranGol Synapse** (NMLSY000080)
- **Golgi Cell Network - Vervaeke** (NMLNT000070)
- **Cerebellar Granule Layer Network** (NMLNT000001)
- **Golgi_Cell** (NMLCL000085)

Ontology Based Recommendations

- **Cerebellar Granule Layer Network** (NMLNT000001)
  Includes Cerebellum Golgi cell
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<td>An active membrane model of the cerebellar Purkinje cell. 1. Simulation of current clamps in slice</td>
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Search NeuroML Models

Keyword Search Results

- **NMDA Synapse** (NMLSY000083)
- **MF_AMPA Synapse** (NMLSY000082)
- **GABAA Synapse** (NMLSY000081)
- **AMPA_GranGol Synapse** (NMLSY000080)
- **Cerebellar Granule Layer Network** (NMLNT000001)

Ontology Based Recommendations

- **Golgi Cell** (NMLCL000004)
  - Releases GABA
- **Golgi Cell Network - Vervaeke** (NMLNT000070)
  - Releases GABA
- **Purkinje Cell** (NMLCL000005)
  - Releases GABA
Search for cerebellum models:

**Keyword Search Results**
- MultiDecaySyn Synapse (NMLSY000100)
- ApicalSyn Synapse (NMLSY000099)
- GapJuncCML Synapse (NMLSY000084)
- NMDA Synapse (NMLSY000083)
- MF_AMPA Synapse (NMLSY000082)
- GABAA Synapse (NMLSY000081)
- AMPA_GranGol Synapse (NMLSY000080)
- Golgi Cell Network - Vervaeke (NMLNT000070)
- Cerebellar Granule Layer Network (NMLNT000001)
- Golgi Cell (NMLCL000085)

**Ontology Based Recommendations**
- Granule Cell (NMLCL000002) located in Granular layer of cerebellar cortex
- Golgi Cell (NMLCL000004) located in Granular layer of cerebellar cortex
- Golgi Cell Network - Vervaeke (NMLNT000070) located in Granular layer of cerebellar cortex
- Purkinje Cell (NMLCL000005) located in Cerebellum
Search NeuroML Models

cerebellum gaba

Keyword Search Results

NMDA Synapse (NMLSY000083)
MF_AMPA Synapse (NMLSY000082)
GABAA Synapse (NMLSY000081)
AMPA_GranGol Synapse (NMLSY000080)
Cerebellar Granule Layer Network (NMLNT000001)
Golgi Cell (NMLCL000004)
Granule Input Mossy Fiber Cell (NMLCL000003)
Granule Cell (NMLCL000002)

Ontology Based Recommendations

Golgi Cell (NMLCL000004)
Locate in Granular layer of cerebellar cortex
Releases GABA

Golgi Cell Network - Vervaeke (NMLNT000070)
Located in Granular layer of cerebellar cortex
Releases GABA

Purkinje Cell (NMLCL000005)
Located in Cerebellum
Releases GABA

Granule Cell (NMLCL000002)
Located in Granular layer of cerebellar cortex
Implementation Evaluation

Keyword Search

Ontology Search
Imagine... one day anyone being able to effortlessly assemble cognitive models from pre-made components and networks.

What will they create? What will you create?
Acknowledgements

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