A Graph-Based, In-Memory Workflow Library for Brain/MINDS 2.0 – The Japan Digital Brain Project

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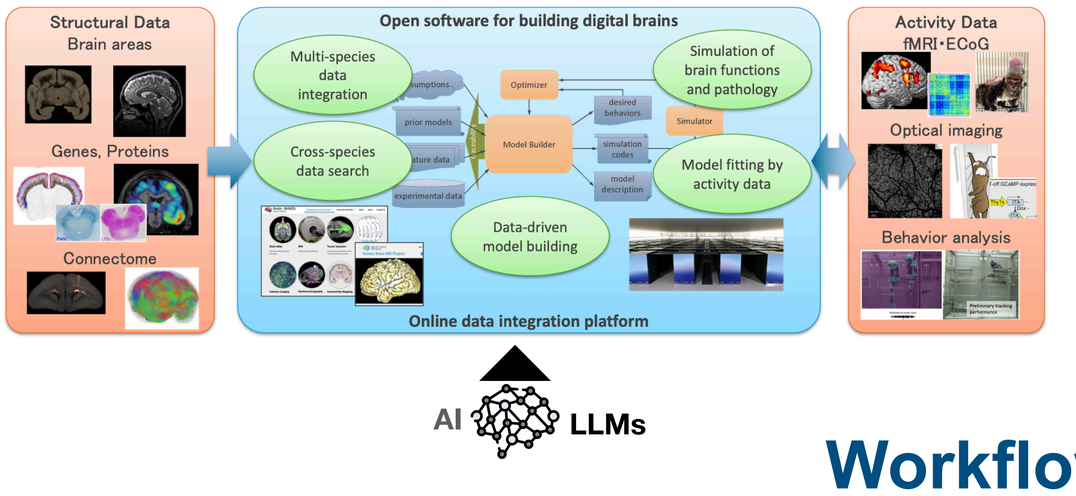
Brain/MINDS 2.0 - The Digital Brain Project

Goals: open software for building digital brains
-online platform for data integration, model building and simulations-



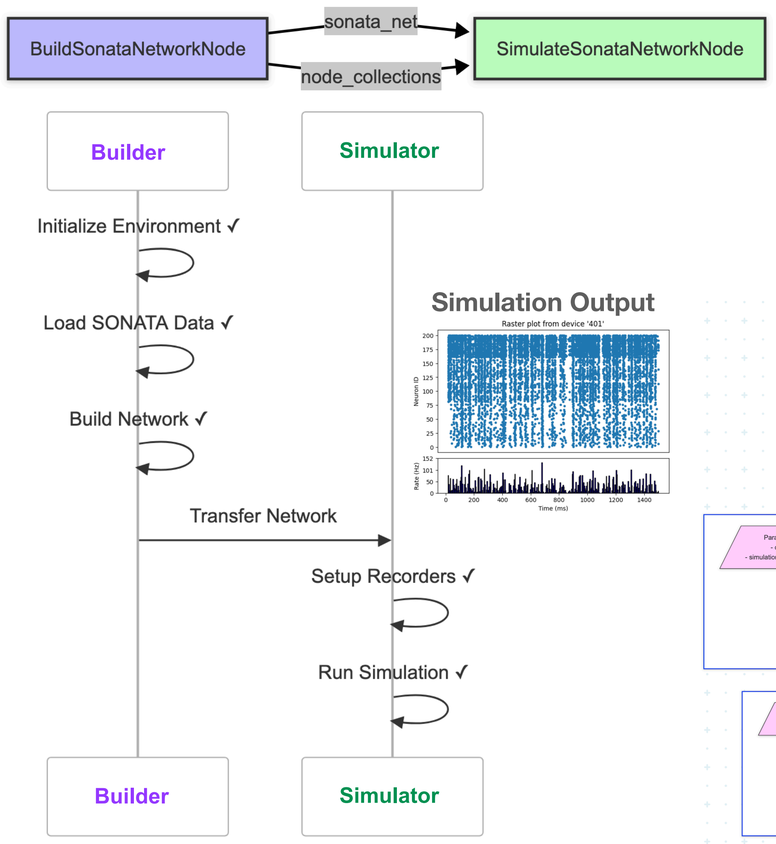
The Digital Brain as a graph-based framework

- The Brain/MINDS 2.0 Digital Brain aims to create a framework that supports **interoperability with open data and popular neuroscience tools** such as TVB, NEST, NEURON, and others, leveraging their Python interfaces.
- We present a python-based graph framework that **transforms complex scientific workflows into modular, interpretable, reusable components through a node-edge** architecture.
- The node is the fundamental building block of our library. It defines **inputs, outputs, parameters, and processing steps** (methods).
  A node is defined as a **python class** that follows a schema.

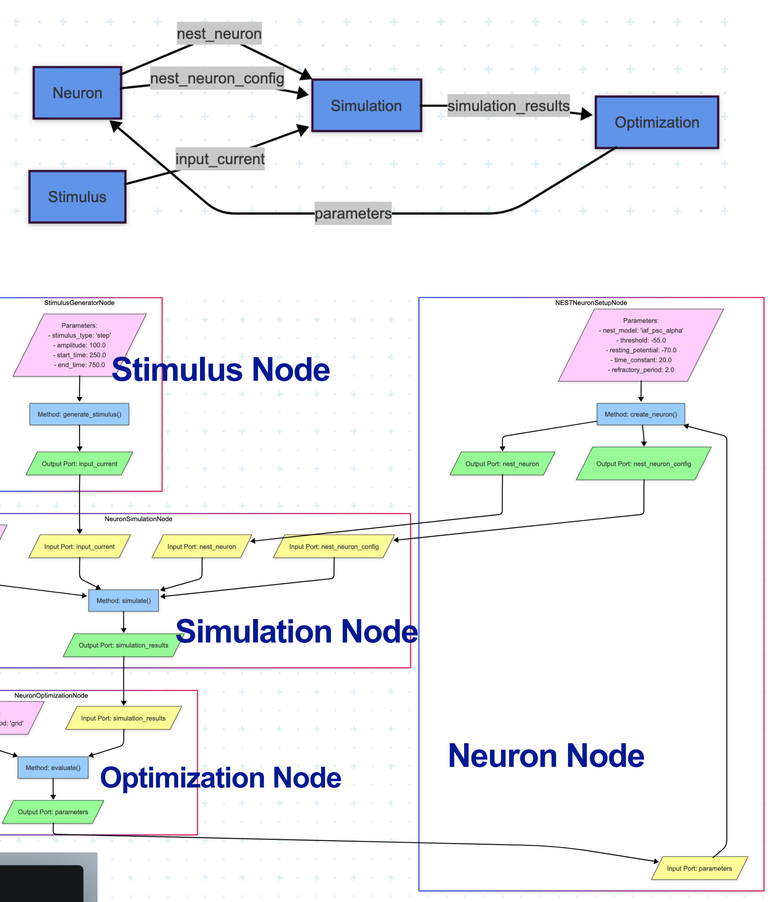
Parameters
Input port
Output port
Methods

Workflow examples

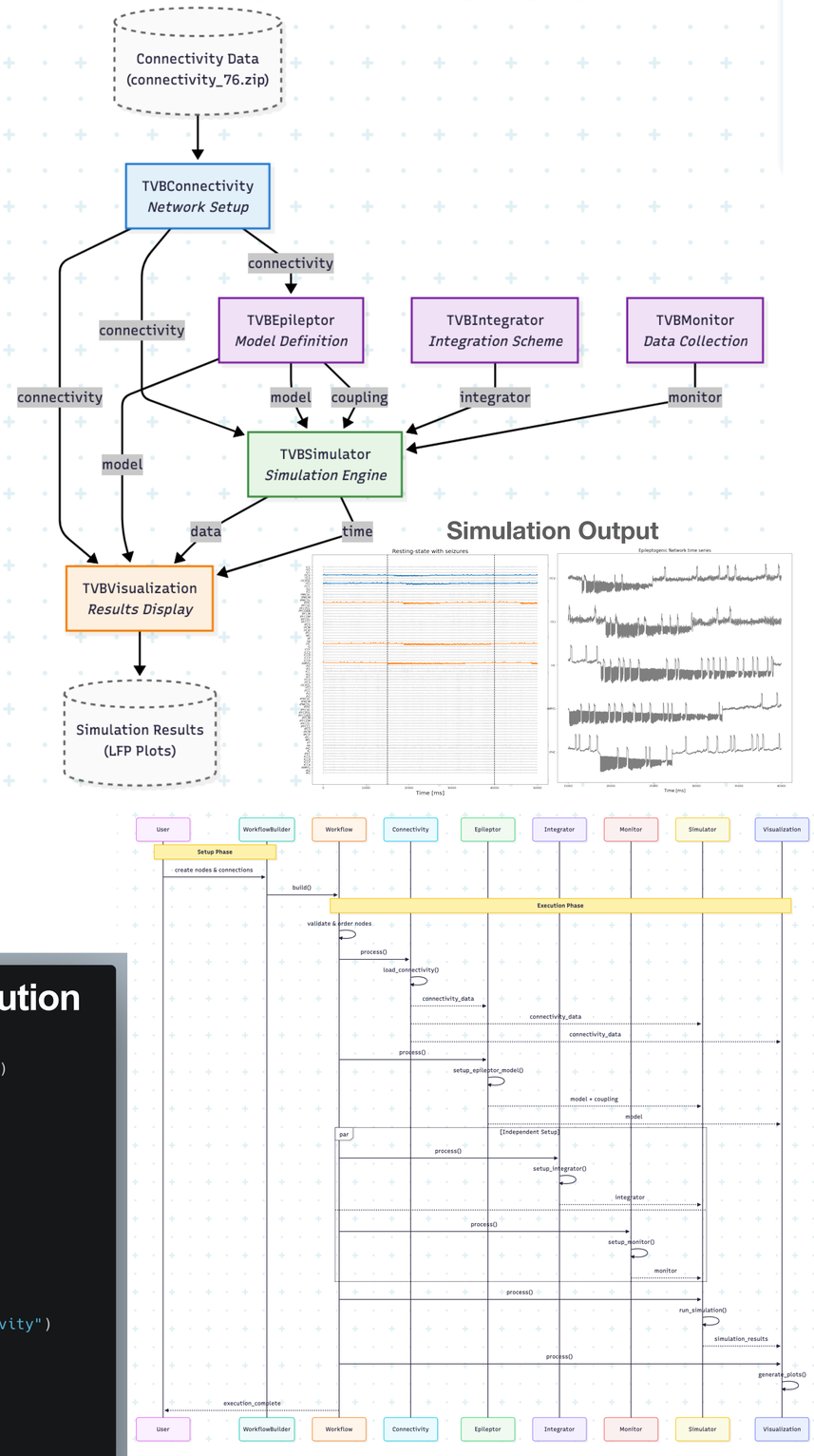
1.**SONATA-NEST** workflow implementation



2.**NEST neuron** optimization workflow



3.**TVB Resting-State in Epilepsy** workflow



Node definition

```python
from neuroworkflow.core.node import Node
from neuroworkflow.core.schema import NodeDefinitionSchema, PortDefinition, ParameterDefinition,
MethodDefinition
from neuroworkflow.core.port import PortType

class MyNode(Node):
    """Brief description of node functionality."""

    NODE_DEFINITION = NodeDefinitionSchema(
        type='node_category',
        description='What this node does',

        parameters={
            'param1': ParameterDefinition(
                default_value=1.0,
                description='Parameter description',
                optimizable=True,
                optimization_range=[0.1, 10.0]
            ),
        },

        inputs={
            'input_data': PortDefinition(
                type=PortType.OBJECT,
                description='Input description'
            ),
        },

        outputs={
            'output_data': PortDefinition(
                type=PortType.OBJECT,
                description='Output description'
            ),
        },

        methods={
            'process_method': MethodDefinition(
                description='Main processing method',
                inputs=['input_data'],
                outputs=['output_data']
            ),
        }
    )

    def __init__(self, name: str):
        super().__init__(name)
        self._define_process_steps()

    def _define_process_steps(self):
        self.add_process_step(
            "process_method",
            self.process_method,
            method_key="process_method"
        )

    def process_method(self, input_data):
        """Main processing logic."""
        # Access parameters: self._parameters['param1']
        # Your processing logic here
        result = input_data  # Replace with actual processing

        return {'output_data': result}
```

Parameters
Input port
Output port
Methods
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Workflow building & execution

```python
# 1. Create & Configure Nodes
load_sc =
TVBConnectivitySetUpNode("TVBConnectivity").configure(connectivity_file='connectivity_76.zip')
model = TVBEpileptorNode("TVBEpileptor").configure()
integrator = TVBIntegratorNode("TVBIntegrator").configure()
monitor = TVBMonitorNode("TVBMonitor").configure()
simulation = TVBSimulatorNode("TVBSimulator").configure()
plots = TVBVisualizationNode("TVBVisualization").configure()

# 2. Build Workflow
workflow_builder = WorkflowBuilder("Resting-State in Epilepsy")
workflow_builder.add_node(load_sc).add_node(model).add_node(integrator)
                .add_node(monitor).add_node(simulation).add_node(plots)

# 3. Connect Nodes (Data Flow)
workflow_builder.connect("TVBConnectivity", "tvb_connectivity", "TVBEpileptor", "tvb_connectivity")
                .connect("TVBEpileptor", "tvb_model", "TVBSimulator", "tvb_model")
                .connect("TVBIntegrator", "tvb_integrator", "TVBSimulator", "tvb_integrator")
                .connect("TVBSimulator", "tvb_simdata", "TVBVisualization", "data_series")

# 4. Execute
workflow = workflow_builder.build()
success = workflow.execute()
```


Community-based approach for building digital brains

- The model builder aims to be **composed by several custom nodes built by collaboration**.
- Several **easy-to-understand complex brain models** and workflows may be built and **deployed easily**.

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