



# ***Brain Scaffold Builder***

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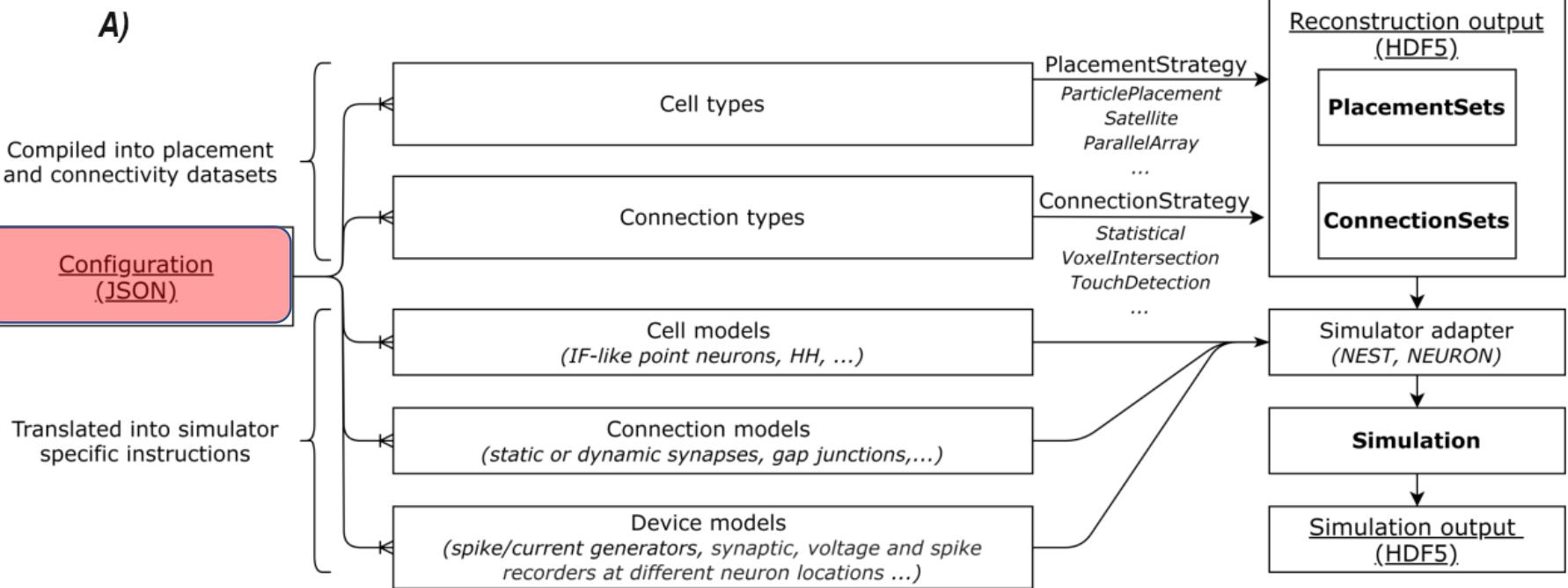
...

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***Internal Workshop RisingNet  
11th Dec 2020***

# BSB diagram

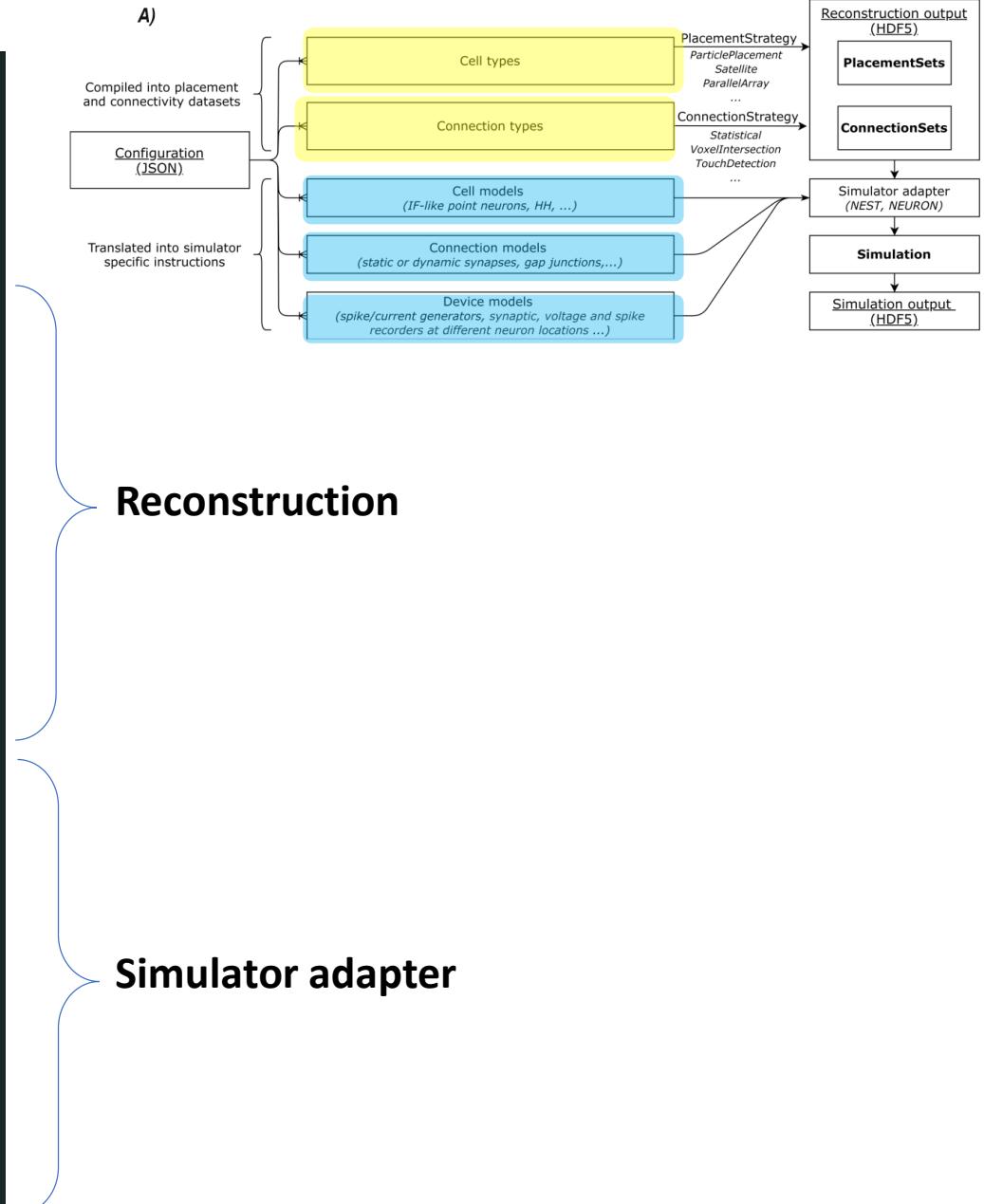
A)

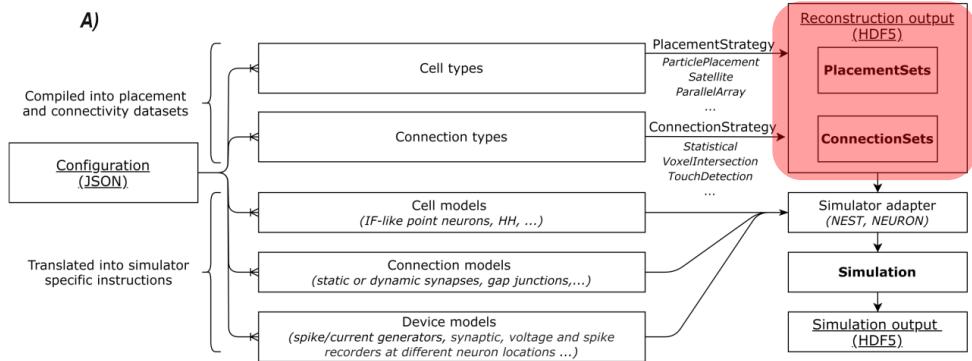


```

1  {
2    "name": "DBBS NEURON simulator configuration",
3    "output": {
4      "format": "bsb.output.HDF5Formatter",
5      "morphology_repository": "morphologies.hdf5",
6      "file": "300x_200z.hdf5"
7    },
8    "network_architecture": {
9      "simulation_volume_x": 300.0,
10     "simulation_volume_z": 200.0,
11     "store_kd_trees": true,
12     "store_compound_kd_tree": true,
13     "store_pf_kd_trees": true
14   },
15   "layers": {=},
16   "cell_types": {=},
17   "after_placement": {
18     "microzones": {=}
19   },
20   "connection_types": {=},
21   "after_connectivity": {=},
22
23   "simulations": {
24     "stim_on_MFs": {
25       "simulator": "neuron",
26       "resolution": 0.1,
27       "duration": 1200,
28       "temperature": 32,
29       "cell_models": {=},
30       "connection_models": {=},
31       "devices": {=}
32     }
33   }
34 }

```





## Reconstruction

Note: no parallel computing!

```
bsb -v=3 -c=mouse_cerebellum_cortex.json compile
```

```
bsb -v=3 -c=mouse_cerebellum_cortex.json compile -x 300 -z 200
```

...

Reconstruction output: 300x\_200z.hdf5

```
{  
  "name": "DBBS NEURON simulator configuration",  
  "output": {  
    "format": "bsb.output.HDF5Formatter",  
    "morphology_repository": "morphologies.hdf5",  
    "file": "300x_200z.hdf5"  
  },  
  "network_architecture": {  
    "simulation_volume_x": 300.0,  
    "simulation_volume_z": 200.0,  
    "store_kd_trees": true,  
    "store_compound_kd_tree": true,  
    "store_pf_kd_trees": true  
  },  
  "layers": {  
    "cell_types": {},  
    "after_placement": {},  
    "microzones": {}  
  },  
  "connection_types": {},  
  "after_connectivity": {},  
  
  "simulations": {  
    "stim_on_MFs": {  
      "simulator": "neuron",  
      "resolution": 0.1,  
      "duration": 1200,  
      "temperature": 32,  
      "cell_models": {},  
      "connection_models": {},  
      "devices": {}  
    }  
  }  
}
```

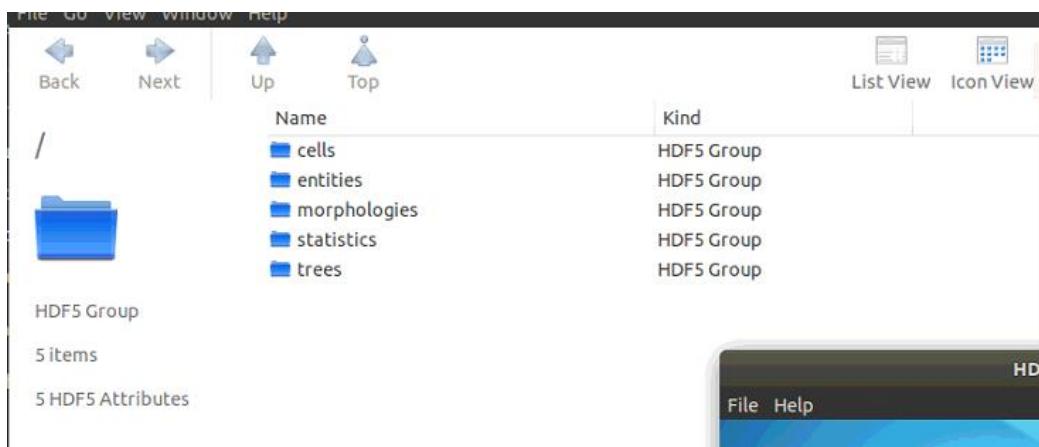


```
"cell_types": {  
  "granule_cell": {  
    "placement": {  
      "class": "bsb.placement.ParticlePlacement",  
      "layer": "granular_layer",  
      "soma_radius": 2.5,  
      "density": 3.9e-3  
    },  
    "morphology": {  
      "class": "bsb.morphologies.NoGeometry",  
      "dendrite_length": 40,  
      "detailed_morphologies": {  
        "names": ["GranuleCell"]  
      }  
    },  
    "plotting": {  
      "display_name": "granule cell",  
      "color": "#E62214",  
      "opacity": 0.3  
    }  
  },  
  "glomerulus": {  
    "relay": true,  
    "placement": {  
      "class": "bsb.placement.ParticlePlacement",  
      "layer": "granular_layer",  
      "soma_radius": 1.5,  
      "density": 3e-4  
    },  
    "morphology": {  
      "class": "bsb.morphologies.NoGeometry"  
    },  
    "plotting": {  
      "display_name": "glomerulus",  
      "color": "#0E1030"  
    }  
  },  
  "golgi_cell": {  
    "placement": {
```

```
{  
    "name": "DBBS NEURON simulator configuration",  
    "output": {  
        "format": "bsb.output.HDF5Formatter",  
        "morphology_repository": "morphologies.hdf5",  
        "file": "300x_200z.hdf5"  
    },  
    "network_architecture": {  
        "simulation_volume_x": 300.0,  
        "simulation_volume_z": 200.0,  
        "store_kd_trees": true,  
        "store_compound_kd_tree": true,  
        "store_pf_kd_trees": true  
    },  
    "layers": {},  
    "cell_types": {},  
    "after_placement": {  
        "microzones": {}  
    },  
    "connection_types": {},  
    "after_connectivity": {}  
}  
  
"simulations": {  
    "stim_on_MFs": {  
        "simulator": "neuron",  
        "resolution": 0.1,  
        "duration": 1200,  
        "temperature": 32,  
        "cell_models": {},  
        "connection_models": {},  
        "devices": {}  
    }  
}
```



```
"connection_types": {  
    "glomerulus_to_granule": {  
        "class": "bsb.connectivity.ConnectomeGlomerulusGranule",  
        "from_cell_types": [{"type": "glomerulus", "compartments": ["soma"]}],  
        "to_cell_types": [{"type": "granule_cell", "compartments": ["dendrites"]}],  
        "after": ["mossy_to_glomerulus"],  
        "convergence": 4,  
        "detailed": true  
    },  
    "golgi_to_granule": {  
        "class": "bsb.connectivity.ConnectomeGolgiGranule",  
        "from_cell_types": [{"type": "golgi_cell", "compartments": ["axon"]}],  
        "to_cell_types": [{"type": "granule_cell", "compartments": ["dendrites"]}],  
        "after": ["golgi_to_glomerulus", "glomerulus_to_granule"],  
        "detailed": true  
    },  
    "golgi_to_golgi": {  
        "class": "bsb.connectivity.VoxelIntersection",  
        "from_cell_types": [{"type": "golgi_cell", "compartments": ["axon"]}],  
        "to_cell_types": [{"type": "golgi_cell", "compartments": ["basal_dendrites"]}],  
        "affinity": 0.2  
    },  
    "parallel_fiber_to_golgi": {  
        "class": "bsb.connectivity.FiberIntersection",  
        "from_cell_types": [{"type": "granule_cell", "compartments": ["parallel_fiber"]}],  
        "to_cell_types": [{"type": "golgi_cell", "compartments": ["apical_dendrites"]}],  
        "resolution": 20.0,  
        "affinity": 0.2  
    },  
    "ascending_axon_to_purkinje": {  
        "class": "bsb.connectivity.TouchDetector",  
        "from_cell_types": [{"type": "granule_cell", "compartments": ["ascending_axon"]}],  
        "to_cell_types": [{"type": "purkinje_cell", "compartments": ["aa_targets"]}],  
        "compartment_intersection_radius": 3.0,  
        "synapses": {  
            "type": "norm",  
            "loc": 4,  
            "scale": 0.4  
        }  
    },  
    "basket_to_purkinje": {  
        "class": "bsb.connectivity.VoxelIntersection",  
        "from_cell_types": [{"type": "basket_cell", "compartments": ["axon"]}],  
        "to_cell_types": [{"type": "purkinje_cell", "compartments": ["soma"]}],  
        "voxels_post": 1  
    }  
}
```



## *Exploration of network .hdf5*

### *updatingConnectionsToAnExistingStructure.py*

To regenerate and overwrite only specific connection types by a different .json on the same network structure .hdf5

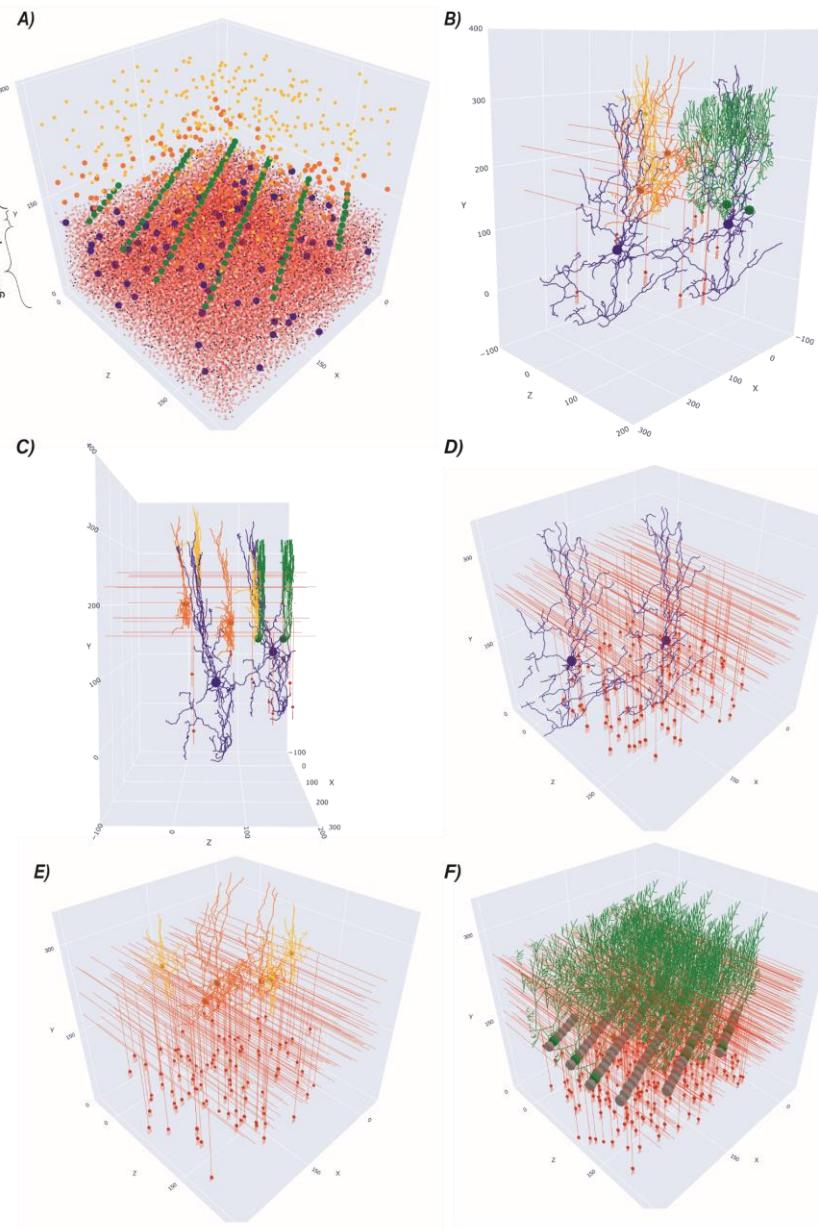
# Placement

[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/figure\\_Html&al/reconstruction\\_structure/network\\_somas.html](file:///D:/Dropbox/Scaffold_NEURON_paper/figure_Html&al/reconstruction_structure/network_somas.html)

[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/figure\\_Html&al/reconstruction\\_structure/network\\_scene.html](file:///D:/Dropbox/Scaffold_NEURON_paper/figure_Html&al/reconstruction_structure/network_scene.html)

[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/figure\\_Html&al/reconstruction\\_structure/granular\\_scene.html](file:///D:/Dropbox/Scaffold_NEURON_paper/figure_Html&al/reconstruction_structure/granular_scene.html)

— Granule cell — Golgi cell — Glomeruli — Purkinje cell — Basket cell — Stellate cell

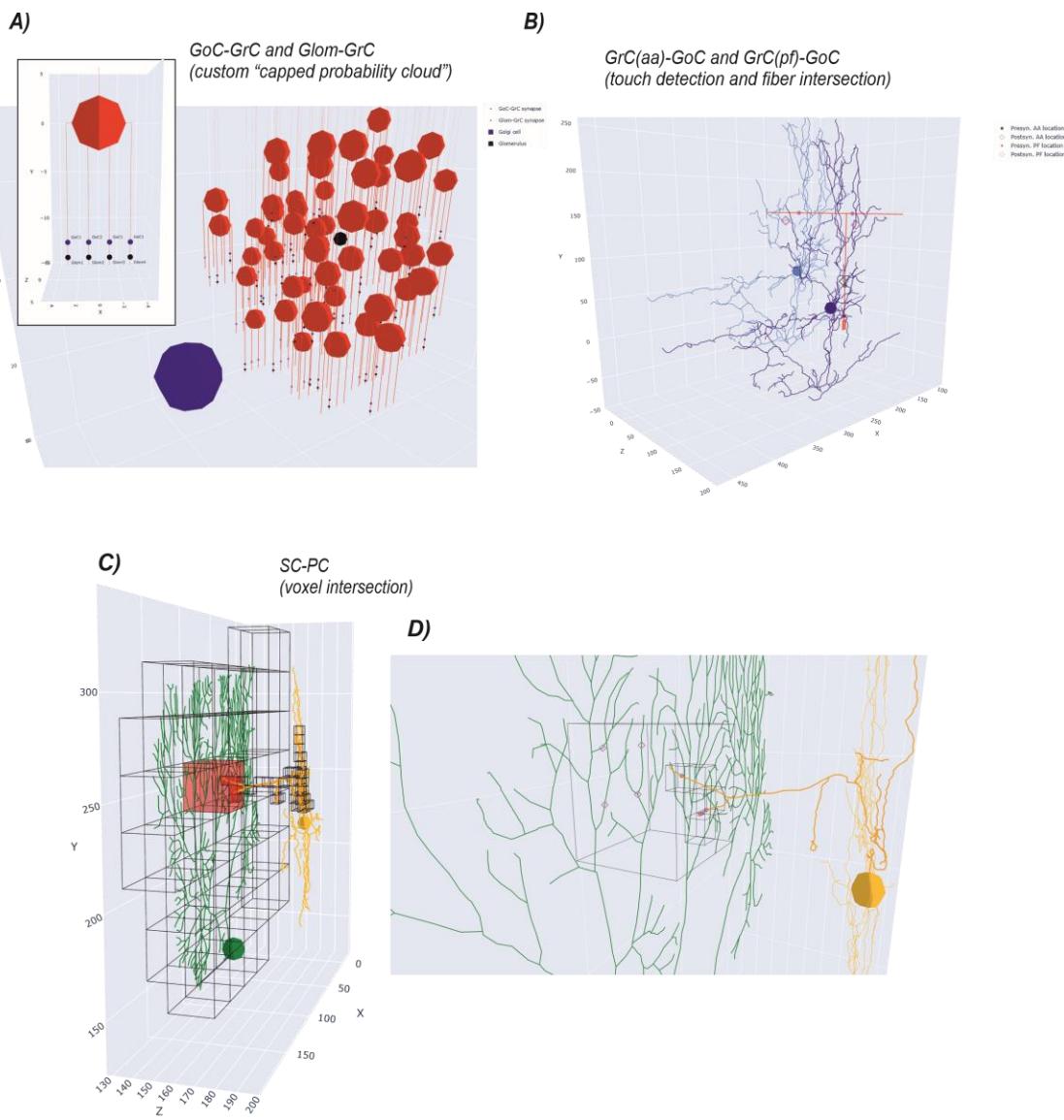


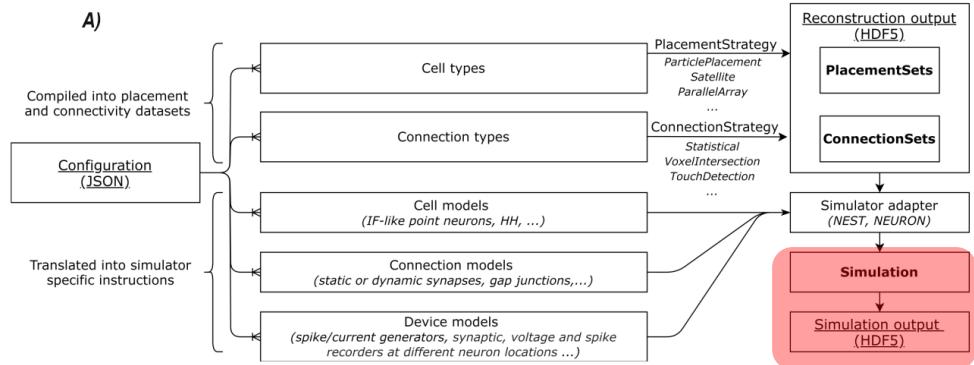
# Connectivity

[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/figure\\_Html&al/reconstruction\\_structure/grc\\_golgi\\_touch\\_v2.html](file:///D:/Dropbox/Scaffold_NEURON_paper/figure_Html&al/reconstruction_structure/grc_golgi_touch_v2.html)

[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/figure\\_Html&al/reconstruction\\_structure/stellate\\_purkinje\\_voxel\\_intersection.html](file:///D:/Dropbox/Scaffold_NEURON_paper/figure_Html&al/reconstruction_structure/stellate_purkinje_voxel_intersection.html)

[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/figure\\_Html&al/reconstruction\\_structure/vi\\_intersections\\_v2.html](file:///D:/Dropbox/Scaffold_NEURON_paper/figure_Html&al/reconstruction_structure/vi_intersections_v2.html)





## Simulation

parallel computing!

```
mpiexec -n 4 bsb -v 3 simulate stim_on_MFs --hdf5="300x_200z.hdf5"
```

On HPC (e.g. PizDaint CSCS):

```
srun -C mc -n 48 -p debug bsb -v 3 simulate stim_on_MFs --hdf5="300x_200z.hdf5"
```

Or by job.slurm

If necessary:

```
bsb reconfigure 300x_200z.hdf5 mouse_cerebellum_cortex.json
```

Simulation output: results\_stim\_on\_MFs\_10HzAllMfs.hdf5

```

{
  "name": "DBBS NEURON simulator configuration",
  "output": {
    "format": "bsb.output.HDF5Formatter",
    "morphology_repository": "morphologies.hdf5",
    "file": "300x_200z.hdf5"
  },
  "network_architecture": {
    "simulation_volume_x": 300.0,
    "simulation_volume_z": 200.0,
    "store_kd_trees": true,
    "store_compound_kd_tree": true,
    "store_pf_kd_trees": true
  },
  "layers": {},
  "cell_types": {},
  "after_placement": {
    "microzones": {}
  },
  "connection_types": {},
  "after_connectivity": {}

  "simulations": {
    "stim_on_MFs": {
      "simulator": "neuron",
      "resolution": 0.1,
      "duration": 900,
      "temperature": 32,
      "cell_models": {},
      "connection_models": {},
      "devices": {}
    }
  }
}

```

*B)*

*NEURON*

```

"simulations": {
  "stim_on_MFs": {
    "simulator": "neuron",
    "resolution": 0.1,
    "duration": 900,
    "temperature": 32,
    "cell_models": {},
    "connection_models": {},
    "devices": {}
  }
}

```

*C)*

*NEST*

```

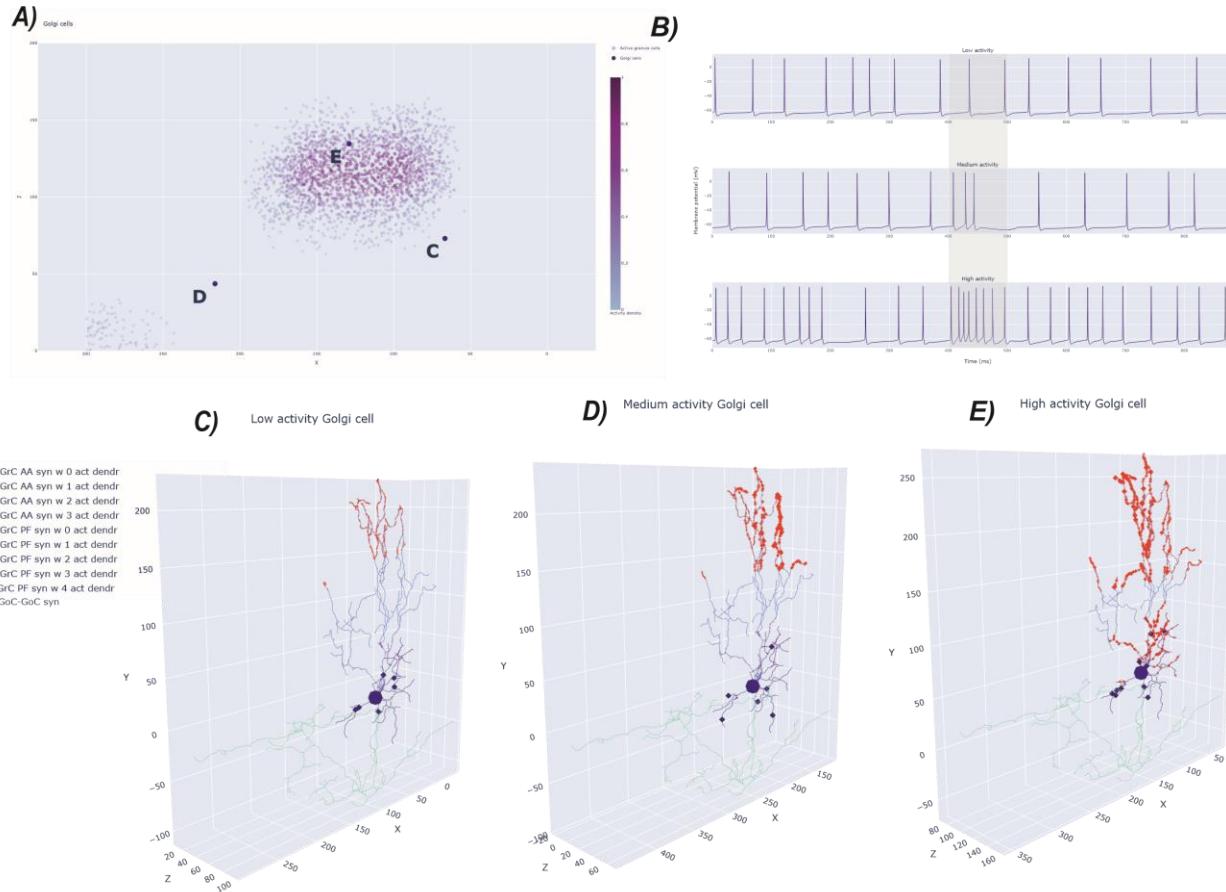
"simulations": {
  "stim_on_MFs": {
    "simulator": "nest",
    "resolution": 0.1,
    "duration": 900,
    "modules": ["cerebmodule"],
    "default_neuron_model": "eglf_cond_alpha_multisyn",
    "default_synapse_model": "static_synapse",
    "cell_models": {},
    "connection_models": {},
    "devices": {}
  }
}

```

*Exploration .json for NEURON and NEST Simulator Adapters...*

- *cell\_models*
- *connection\_models* (static or plastic for NEST)
- *devices*

# *Exploration of simulation results hdf5 for NEURON...*



[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/LastFigs/GoC\\_HighAct.html](file:///D:/Dropbox/Scaffold_NEURON_paper/LastFigs/GoC_HighAct.html)

[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/LastFigs/GoC\\_NOAct.html](file:///D:/Dropbox/Scaffold_NEURON_paper/LastFigs/GoC_NOAct.html)

*Example of synaptic current recording (device):*

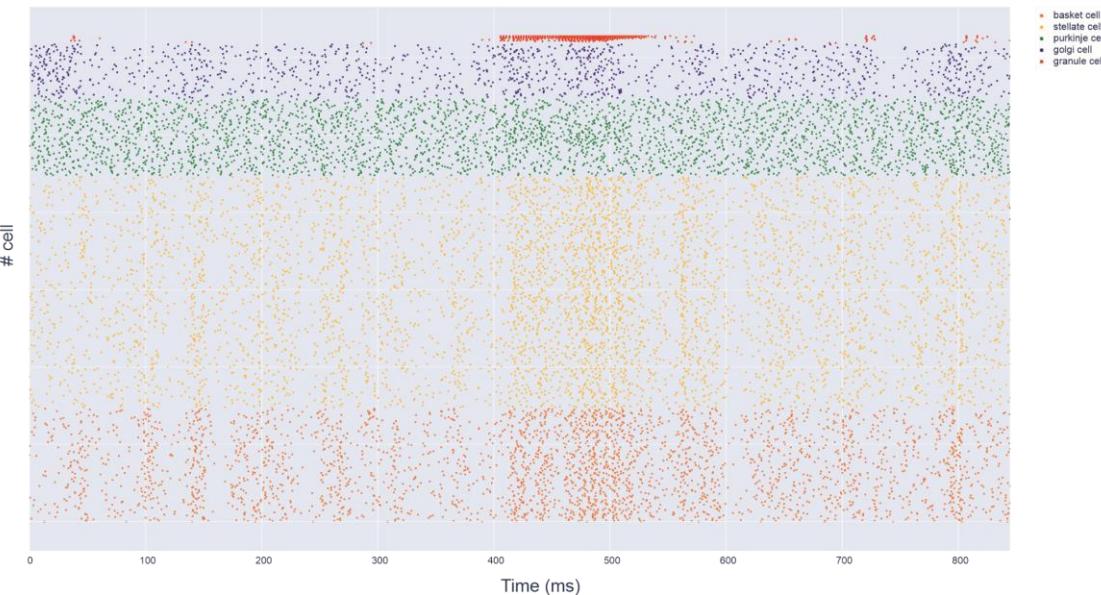
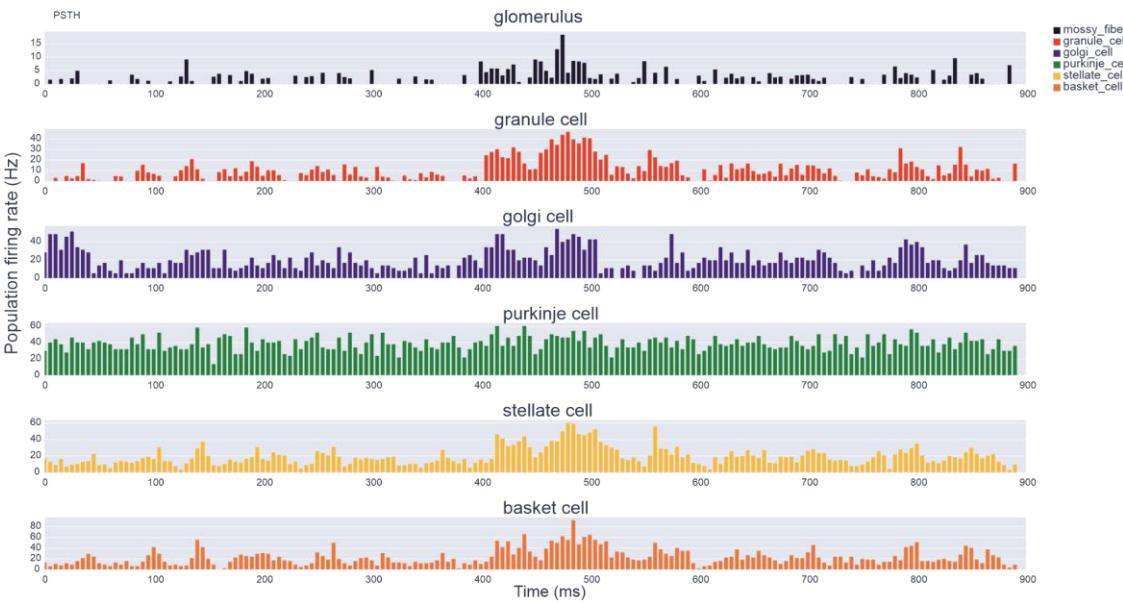
[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/LastFigs/PC126\\_currents\\_AMPAvsGABA.html](file:///D:/Dropbox/Scaffold_NEURON_paper/LastFigs/PC126_currents_AMPAvsGABA.html)



*Example of a phenomenon at granular layer – center-surround:*

[file:///D:/Dropbox/Scaffold\\_NEURON\\_paper/LastFigs/center\\_surround\\_balance.html](file:///D:/Dropbox/Scaffold_NEURON_paper/LastFigs/center_surround_balance.html)

# Exploration of simulation results hdf5 for NEST...



## *Video blender-python*



- Installation, compatibility, dependencies, versions...
- NEURON mod/hoc/swc/... files: morphologies, electrical properties, synapses...
- Ad-hoc Python libraries
- Code separation..

Ongoing steps:

- Arbor simulator
- SONATA, standard formats,..
- ...