

Specification of channel distribution in NeuroML v2.0

Padraig Gleeson

Lab of Prof. R. Angus Silver

Department of Neuroscience, Physiology and Pharmacology

University College London

Overview

- <biophysics> element of NeuroML v1.x has been updated
- Channel conductance densities are not always uniform across cell
- Models incorporate conductance densities which change as a function of parameters along cell

```
<biophysicalProperties id="bio_cell">
  <membraneProperties>
    <channelPopulation id="naChansDend" ionChannel="NaConductance" segment="2" number="120000" />
    <channelDensity id="pasChans" ionChannel="pas" condDensity="3.0 S_per_cm2" />
    <channelDensity id="naChansSoma" ionChannel="NaConductance" segmentGroup="soma_group"
      condDensity="120.0 mS_per_cm2" />
    <specificCapacitance segmentGroup="soma_group" value="1.0 uF_per_cm2" />
    <specificCapacitance segmentGroup="dendrite_group" value="2.0 uF_per_cm2" />
    <reversalPotential species="na" value="55mV" />
  </membraneProperties>
  <intracellularProperties>
    <species id="ca" concentration="1e-5 mM" />
    <resistivity value="0.1 kohm_cm" />
  </intracellularProperties>
</biophysicalProperties>
```

```
<biophysicalProperties id="bio_cell">
```

```
<membraneProperties>
```

```
<channelPopulation id="naChansDend" ionChannel="NaConductance" segment="2" number="120000"/>
```

```
<channelDensity id="pasChans" ionChannel="pas" condDensity="3.0 S_per_cm2"/>
```

```
<channelDensity id="naChansSoma" ionChannel="NaConductance" segmentGroup="soma_group"
condDensity="120.0 mS_per_cm2"/>
```

```
<specificCapacitance segmentGroup="soma_group" value="1.0 uF_per_cm2"/>
```

```
<specificCapacitance segmentGroup="dendrite_group" value="2.0 uF_per_cm2"/>
```

```
<reversalPotential species="na" value="55mV"/>
```

```
</membraneProperties>
```

```
<intracellularProperties>
```

```
<species id="ca" concentration="1e-5 mM"/>
```

```
<resistivity value="0.1 kohm_cm"/>
```

```
</intracellularProperties>
```

```
</biophysicalProperties>
```

Distinction between properties
of membrane & intracellular
space

```
<biophysicalProperties id="bio_cell">
  <membraneProperties>
    <channelPopulation id="naChansDend" ionChannel="NaConductance" segment="2" number="120000"/>
    <channelDensity id="pasChans" ionChannel="pas" condDensity="3.0 S_per_m2"/>
    <channelDensity id="naChansSoma" ionChannel="NaConductance" segmentGroup="soma_group"
      condDensity="120.0 mS_per_cm2"/>
    <specificCapacitance segmentGroup="soma_group" value="1.0 uF_per_cm2"/>
    <specificCapacitance segmentGroup="dendrite_group" value="2.0 uF_per_cm2"/>
    <reversalPotential species="na" value="55mV"/>
  </membraneProperties>
  <intracellularProperties>
    <species id="ca" concentration="1e-5 mM"/>
    <resistivity value="0.1 kohm_cm"/>
  </intracellularProperties>
</biophysicalProperties>
```

Channel populations allowed

```
<biophysicalProperties id="bio_cell">
  <membraneProperties>
    <channelPopulation id="naChansDend" ionChannel="NaConductance" segment="2" number="120000" />
    <channelDensity id="pasChans" ionChannel="pas" condDensity="3.0 S_per_m2" />
    <channelDensity id="naChansSoma" ionChannel="NaConductance" segmentGroup="soma_group"
      condDensity="120.0 mS_per_cm2" />
    <specificCapacitance segmentGroup="soma_group" value="1.0 uF_per_cm2" />
    <specificCapacitance segmentGroup="dendrite_group" value="2.0 uF_per_cm2" />
    <reversalPotential species="na" value="55mV" />
  </membraneProperties>
  <intracellularProperties>
    <species id="ca" concentration="1e-5 mM" />
    <resistivity value="0.1 kohm_cm" />
  </intracellularProperties>
</biophysicalProperties>
```

Specifying biophysics per segment
or segmentGroup

```
<biophysicalProperties id="bio_cell">
  <membraneProperties>
    <channelPopulation id="naChansDend" ionChannel="NaConductance" segment="2" number="120000"/>
    <channelDensity id="pasChans" ionChannel="pas" condDensity="3.0 S_per_cm2"/>
    <channelDensity id="naChansSoma" ionChannel="NaConductance" segmentGroup="soma_group"
      condDensity="120.0 mS_per_cm2"/>
    <specificCapacitance segmentGroup="soma_group" value="1.0 uF_per_cm2"/>
    <specificCapacitance segmentGroup="dendrite_group" value="2.0 uF_per_cm2"/>
    <reversalPotential species="na" value="55mV"/>
  </membraneProperties>
  <intracellularProperties>
    <species id="ca" concentration="1e-5 mM"/>
    <resistivity value="0.1 kohm_cm"/>
  </intracellularProperties>
</biophysicalProperties>
```

Specifying ion properties by
reversal potential or
concentration

Variable parameters

```
<segmentGroup id="dendrite_group" neuroLexId="saol211023249">
  <member segment="1"/>
  <member segment="2"/>
  <member segment="3"/>

  <!-- A parameter whose value varies from 0 at the start of the group closest to the soma
        to 1 at the most distal point of the segments in the group.-->

  <inhomogeneousParam id="dendrite_group_x1" variable="p1" metric="Path Length from root">
    <proximal translationStart="0"/>
    <distal normalizationEnd="1"/>
  </inhomogeneousParam>

  <!-- A parameter whose value varies from 0 at the start of the group closest to the soma (as it's
        attached to the soma) to 200 at the most distal point of the segments in the group.-->

  <inhomogeneousParam id="dendrite_group_x2" variable="p2" metric="Path Length from root"/>
</segmentGroup>
```



Variable parameters

```
<segmentGroup id="dendrite_group" neuroLexId="saol211023249">
  <member segment="1"/>
  <member segment="2"/>
  <member segment="3"/>
```

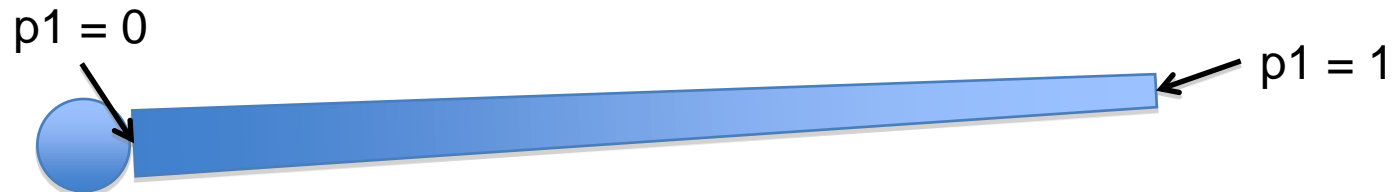
```
<!-- A parameter whose value varies from 0 at the start of the group closest to the soma
to 1 at the most distal point of the segments in the group.-->
```

```
<inhomogeneousParam id="dendrite_group_x1" variable="p1" metric="Path Length from root">
  <proximal translationStart="0"/>
  <distal normalizationEnd="1"/>
</inhomogeneousParam>
```

```
<!-- A parameter whose value varies from 0 at the start of the group closest to the soma (as it's
attached to the soma) to 200 at the most distal point of the segments in the group.-->
```

```
<inhomogeneousParam id="dendrite_group_x2" variable="p2" metric="Path Length from root"/>
```

```
</segmentGroup>
```



Variable parameters

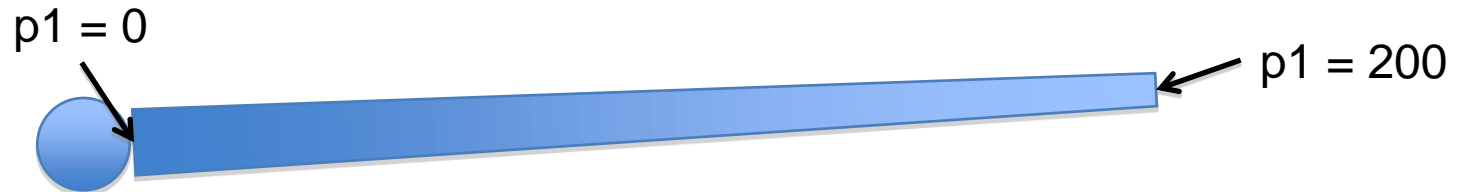
```
<segmentGroup id="dendrite_group" neuroLexId="sa01211023249">
  <member segment="1"/>
  <member segment="2"/>
  <member segment="3"/>

  <!-- A parameter whose value varies from 0 at the start of the group closest to the soma
        to 1 at the most distal point of the segments in the group.-->

  <inhomogeneousParam id="dendrite_group_x1" variable="p1" metric="Path Length from root">
    <proximal translationStart="0"/>
    <distal normalizationEnd="1"/>
  </inhomogeneousParam>

  <!-- A parameter whose value varies from 0 at the start of the group closest to the soma (as it's
        attached to the soma) to 200 at the most distal point of the segments in the group.-->

  <inhomogeneousParam id="dendrite_group_x2" variable="p2" metric="Path Length from root"/>
</segmentGroup>
```



```
<channelDensity id="naChansSoma" ionChannel="NaConductance">  
  <variableParameter parameter="condDensity" segmentGroup="dendrite_group">  
    <!-- Will result in a condDensity of 0.2 at soma end, 0.1 at other end-->  
    <inhomogeneousValue inhomogeneousParam="dendrite_group_x2" value="0.2 - 0.1(p2/200)"/>  
  </variableParameter>  
</channelDensity>
```

