

Construction and Use of Models

Construction of cell models

- Specify topology: create and connect sections

- Specify geometry: stylized (L & diam)
or 3D (x,y,z,diam)

- Specify biophysics: insert density mechanisms,
attach "biological" point processes (synapses)

Construction of network models

- Define cell classes

- Create cells (instances of cell classes)

- Connect cells

Example: using the GUI to build and exercise a stylized model

1. How to use the CellBuilder to create and manage a model cell.
2. How to use NEURON's graphical tools to make an interface for running simulations.

Step 0: Conceptualize the task

Shape

stick figure / anatomically detailed

Channel distribution

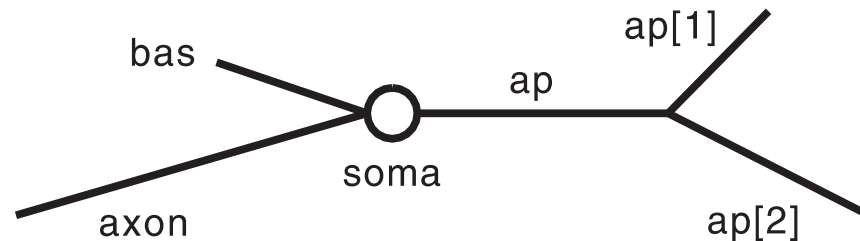
uniform / nonuniform

whole cell / region / individual neurite

Creation

single cell / use in a network

Step 1: using the CellBuilder to make a stylized model



Section	L	diam	Biophysics
soma	20 μm	20 μm	hh
ap[0]	400	2	reduced hh *
ap[1]	300	1	reduced hh *
ap[2]	500	1	reduced hh *
bas	200	3	pas §
axon	800	1	hh

* gnabar_hh and gkbar_hh reduced to 10%, $\text{el_hh} = -64 \text{ mV}$

§ $\text{e_pas} = -65 \text{ mV}$

Throughout the cell $\text{Ra} = 160 \Omega \text{ cm}$, $\text{cm} = 1 \mu\text{f} / \text{cm}^2$

Launch NEURON with its GUI library

`nrngui`

or

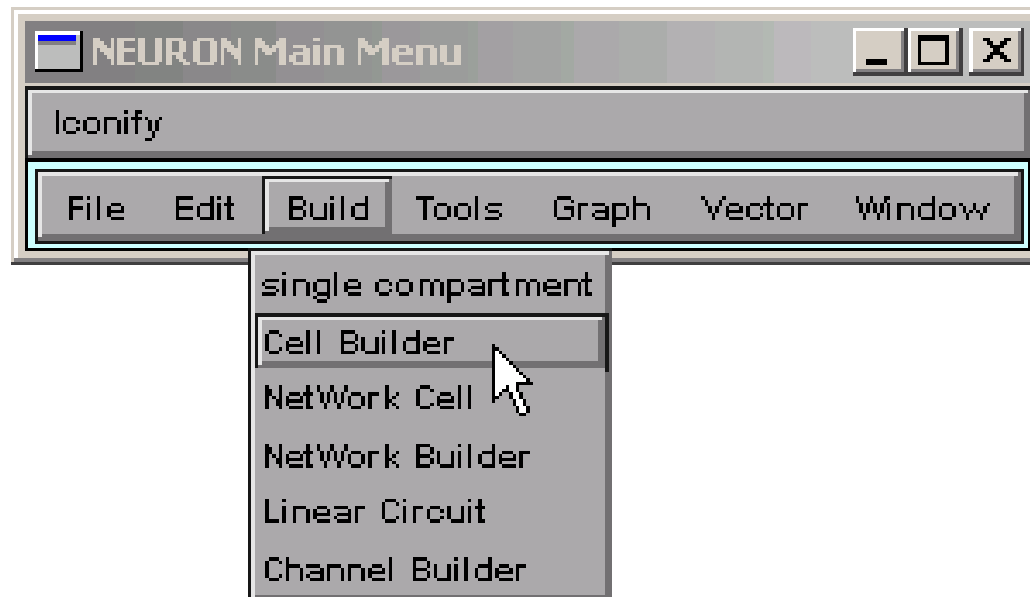
`python`

`from neuron import h, gui`

or

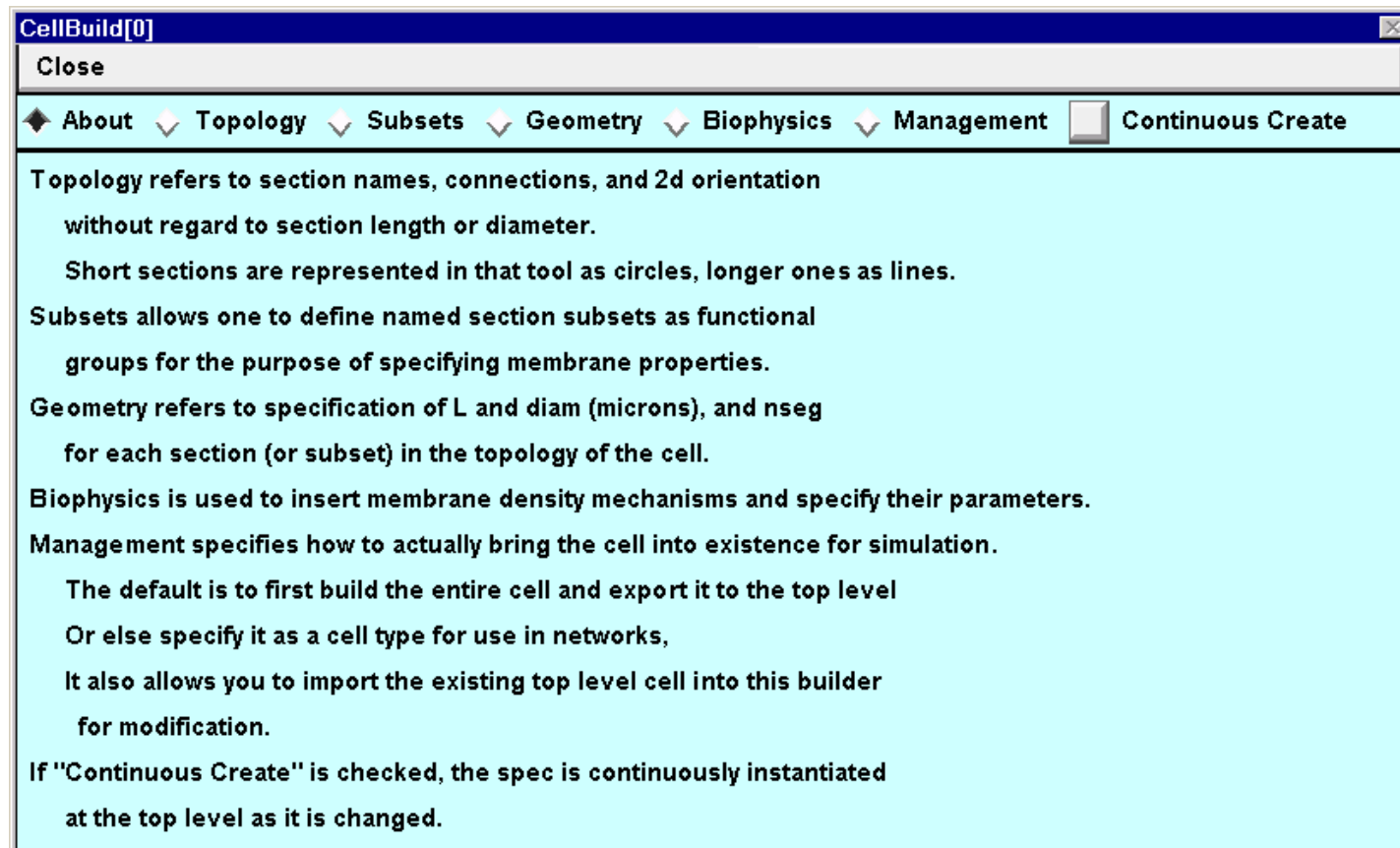
click on nrngui icon (MSWin, MacOS)

Bring up a CellBuilder



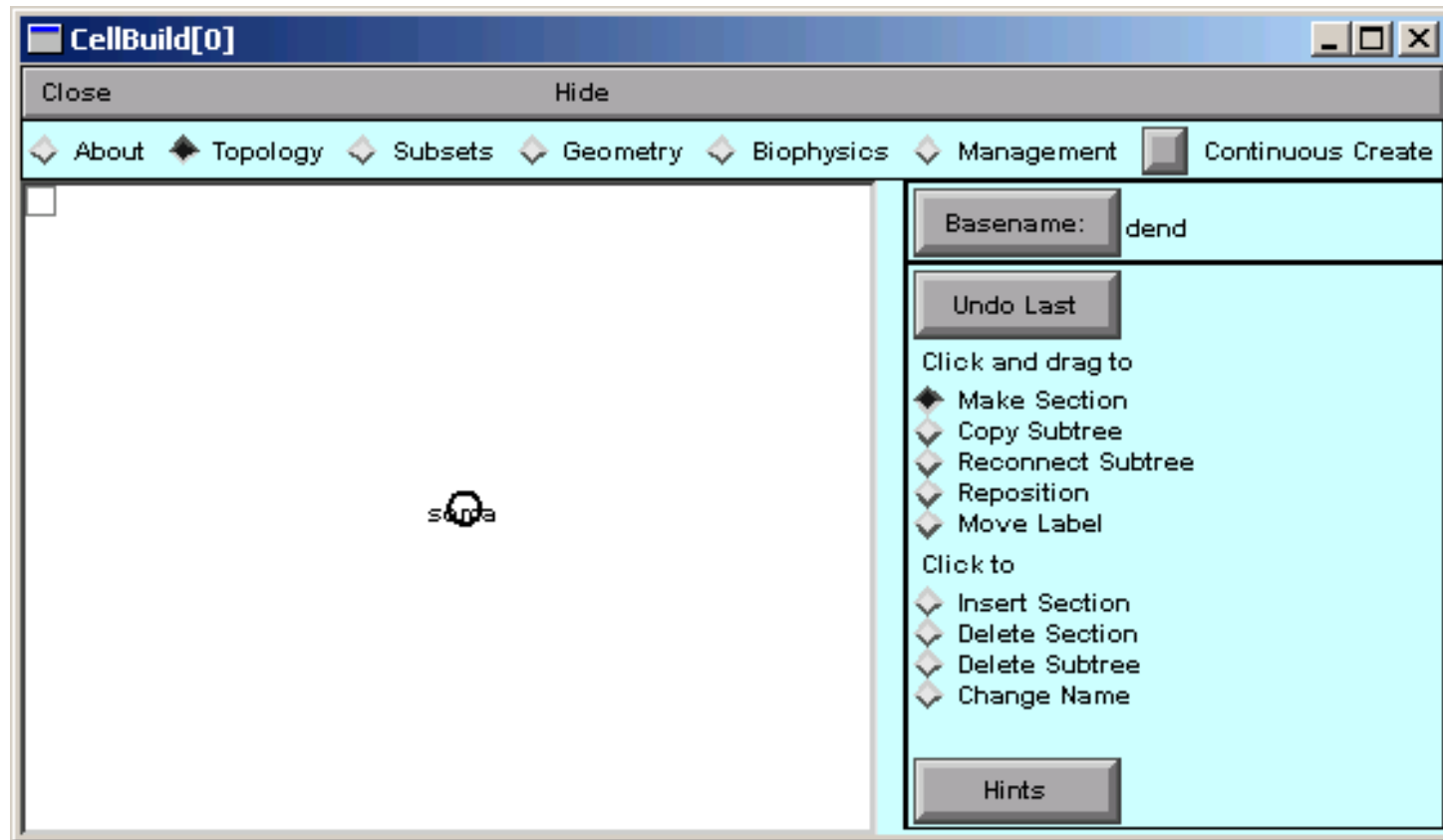
NEURON Main Menu / Build / Cell Builder

The CellBuilder



Use buttons from left to right.

Topology



CB starts with a "soma" section.
We want to create new sections.

Specifying the "Basename"

Basename: dend



Making a new section

Place cursor near end
of existing section



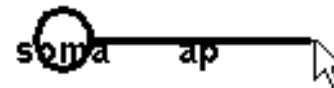
Click to start new section



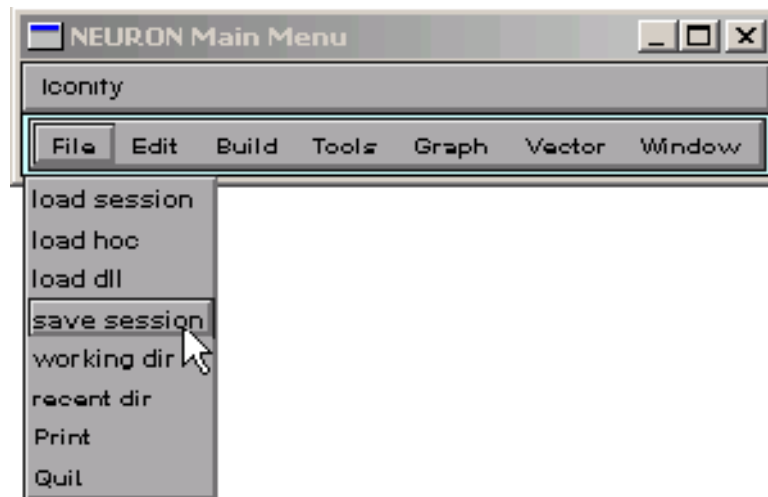
Drag to desired length



Release mouse button

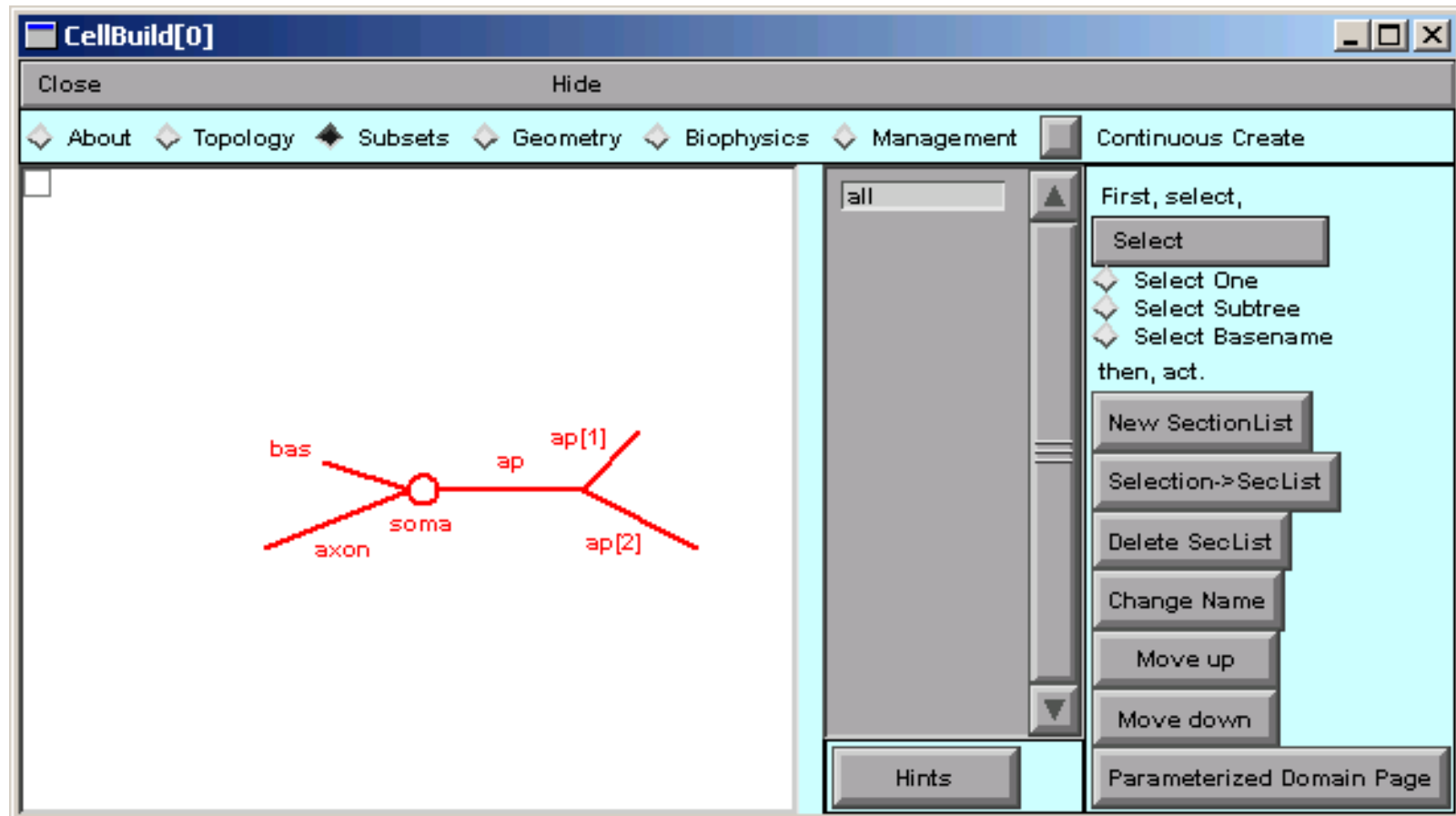


Save your work as you make progress!



NEURON Main Menu / File / save session

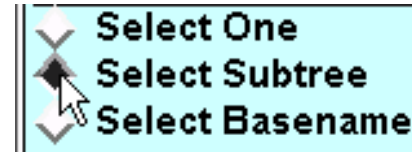
Subsets



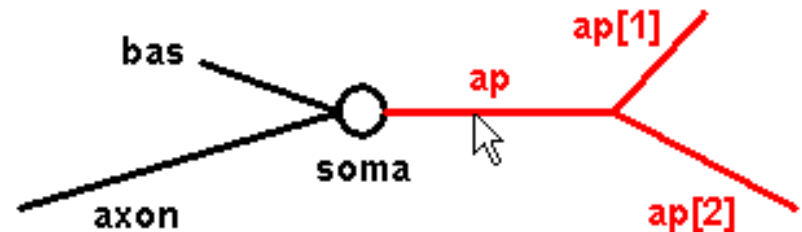
Group sections that have shared properties.
We want to make an "apicals" subset.

Making a new subset

Click "Select Subtree"



Click root of apical tree . . .



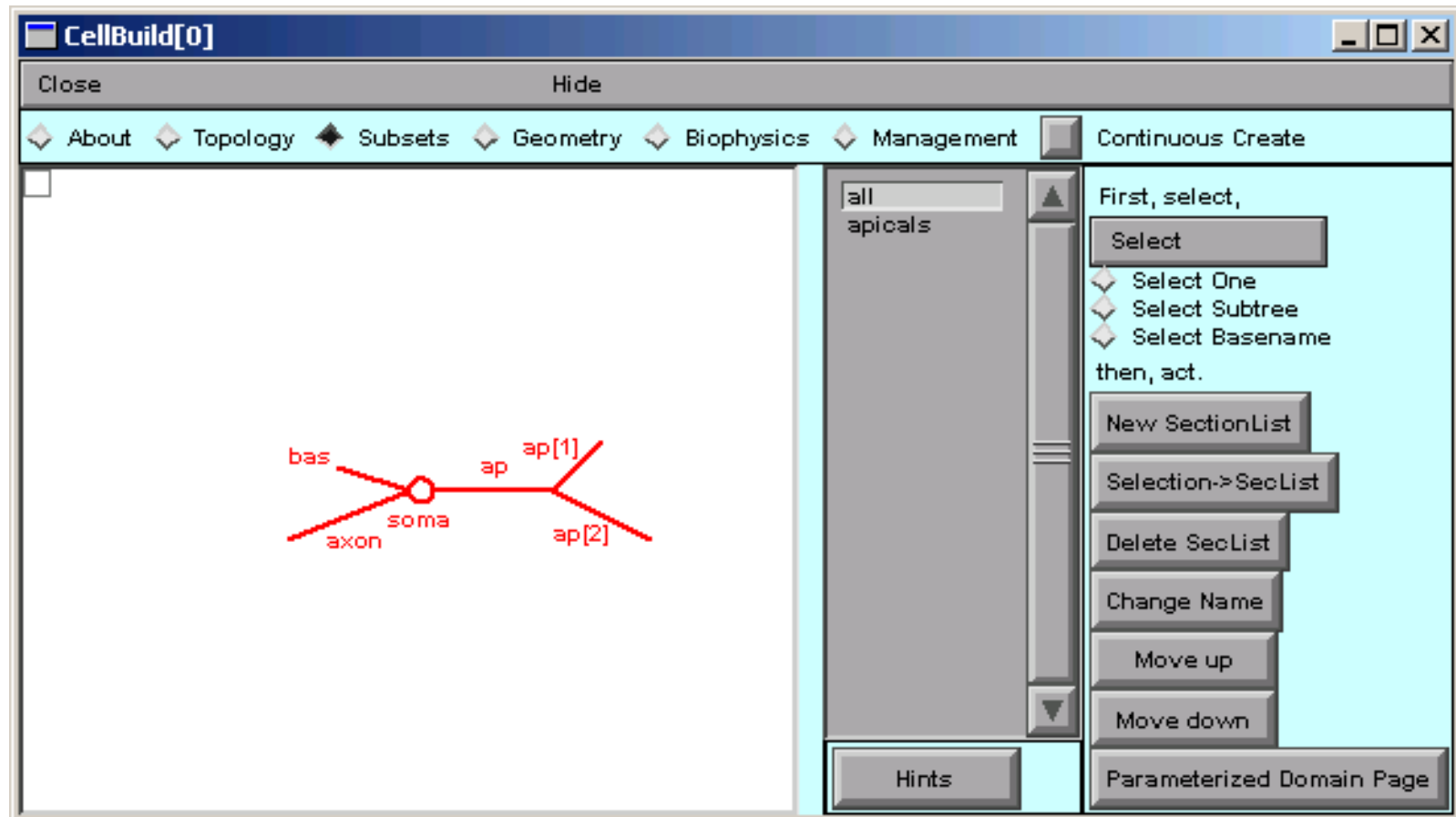
. . . then "New SectionList"



Making a new subset *continued*



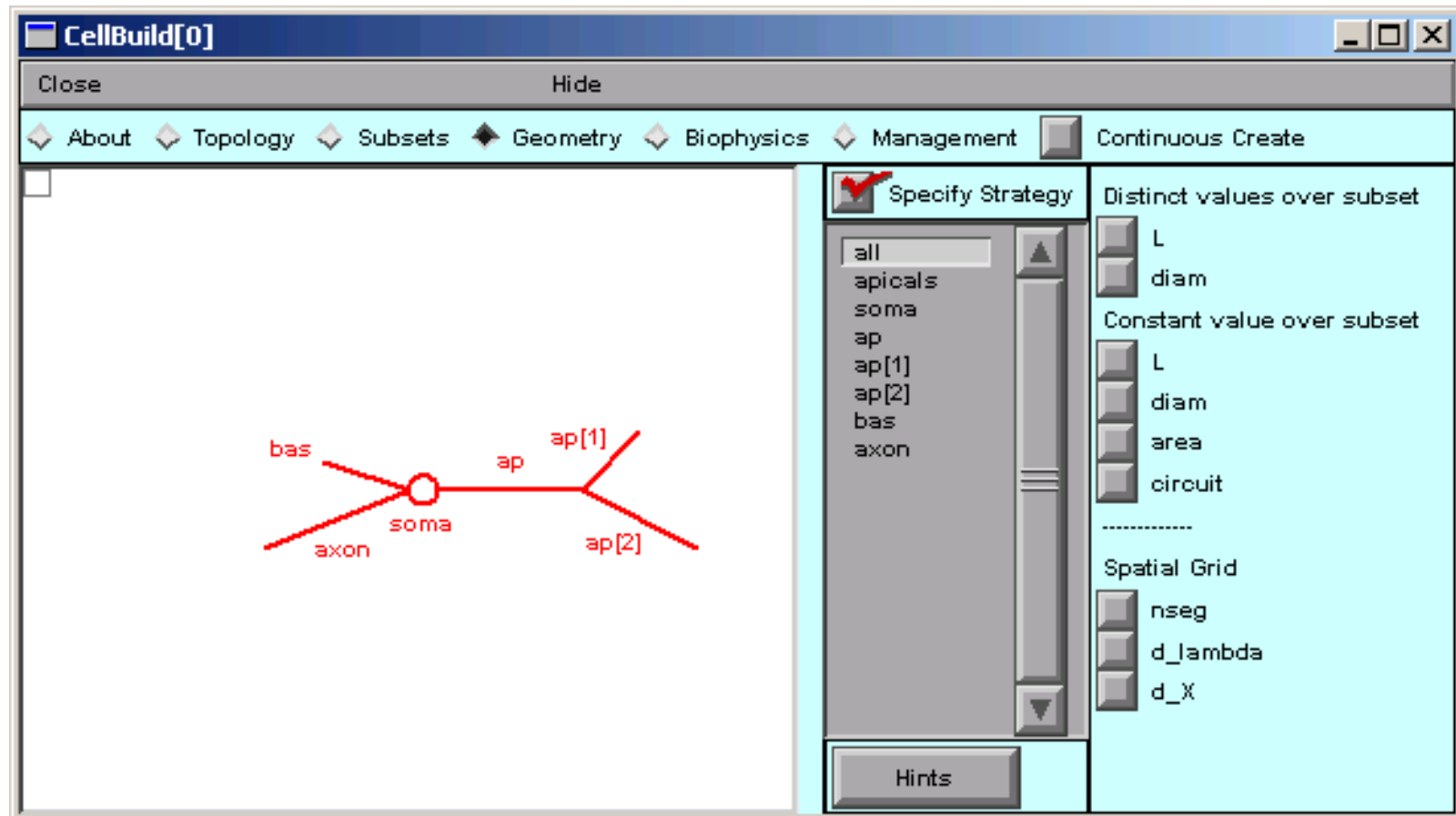
Subsets finished



Note "apicals".

Time to save a new session file.

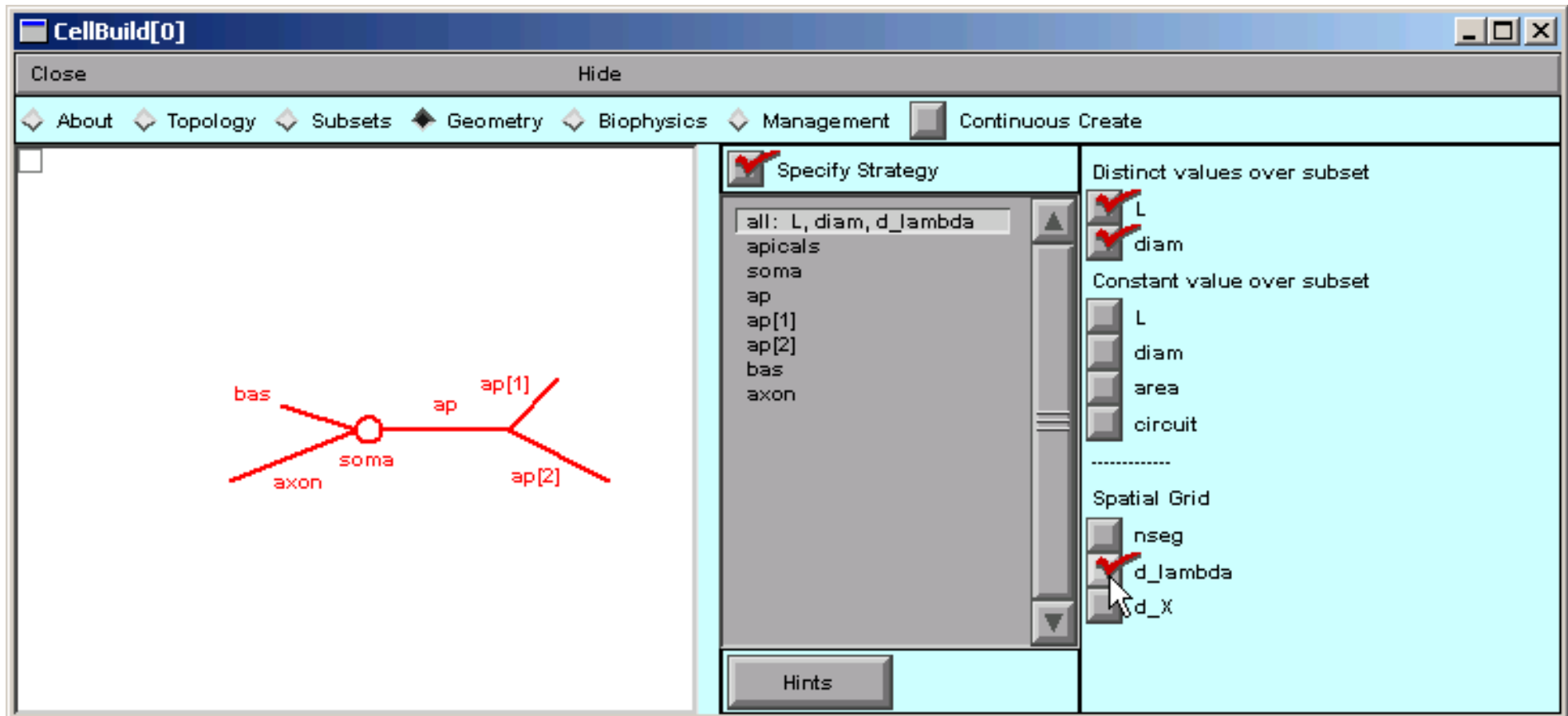
Geometry



"Specify Strategy" is ON.

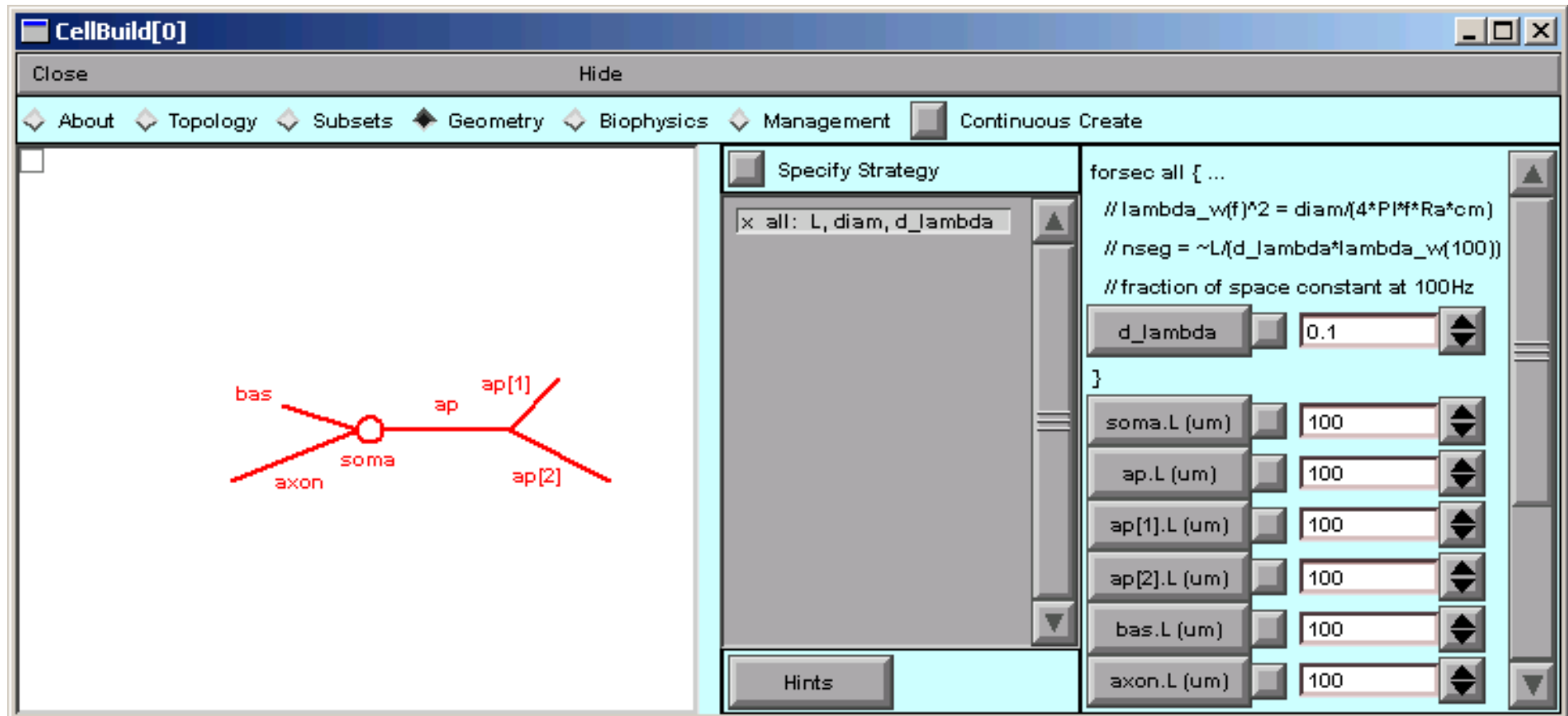
A good strategy is a concise strategy.

Geometry strategy



Each section has a different L and diam.
Compartmentalize according to $\lambda_{100 \text{ Hz}}$ (d_lambda rule).

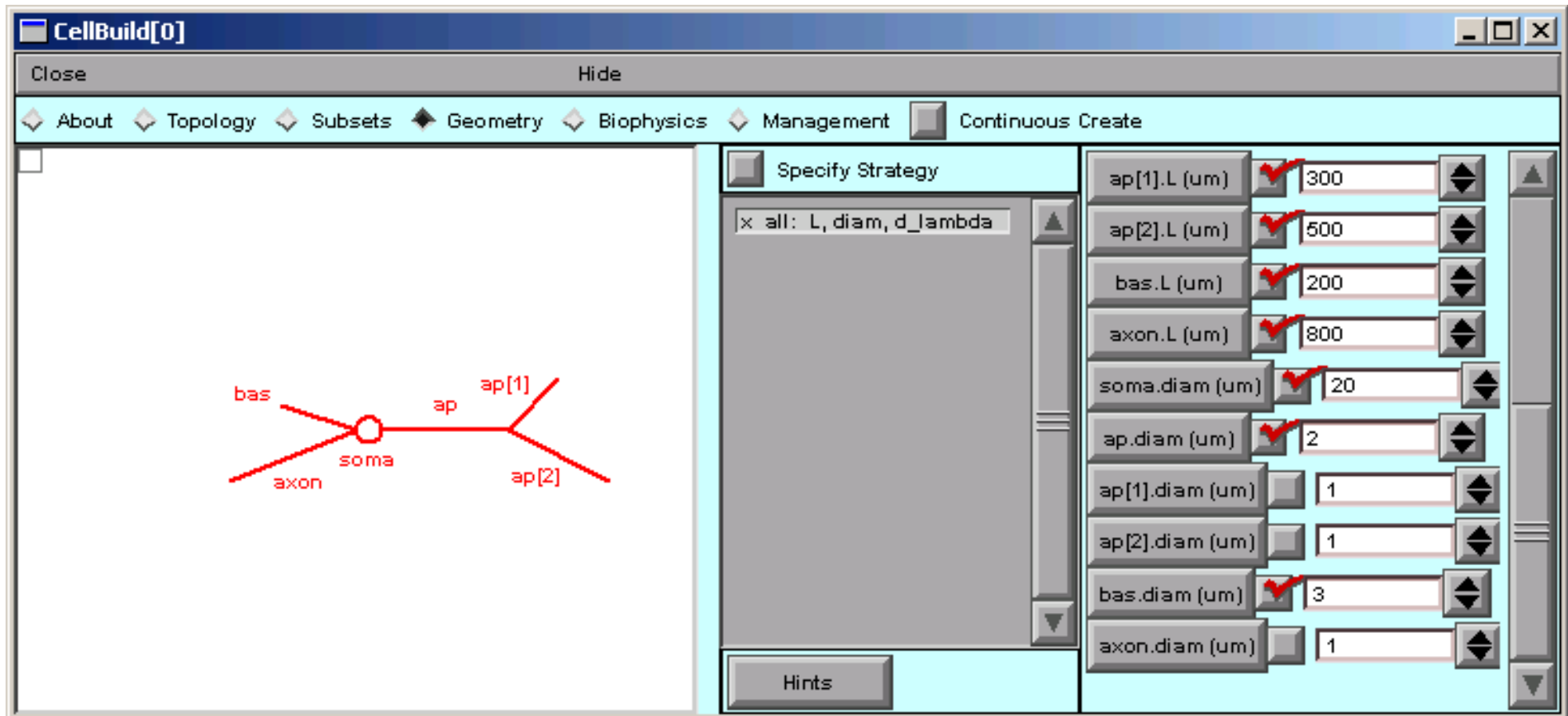
Implementing geometry strategy



When strategy is complete, turn "Specify Strategy" OFF and start assigning values to parameters.

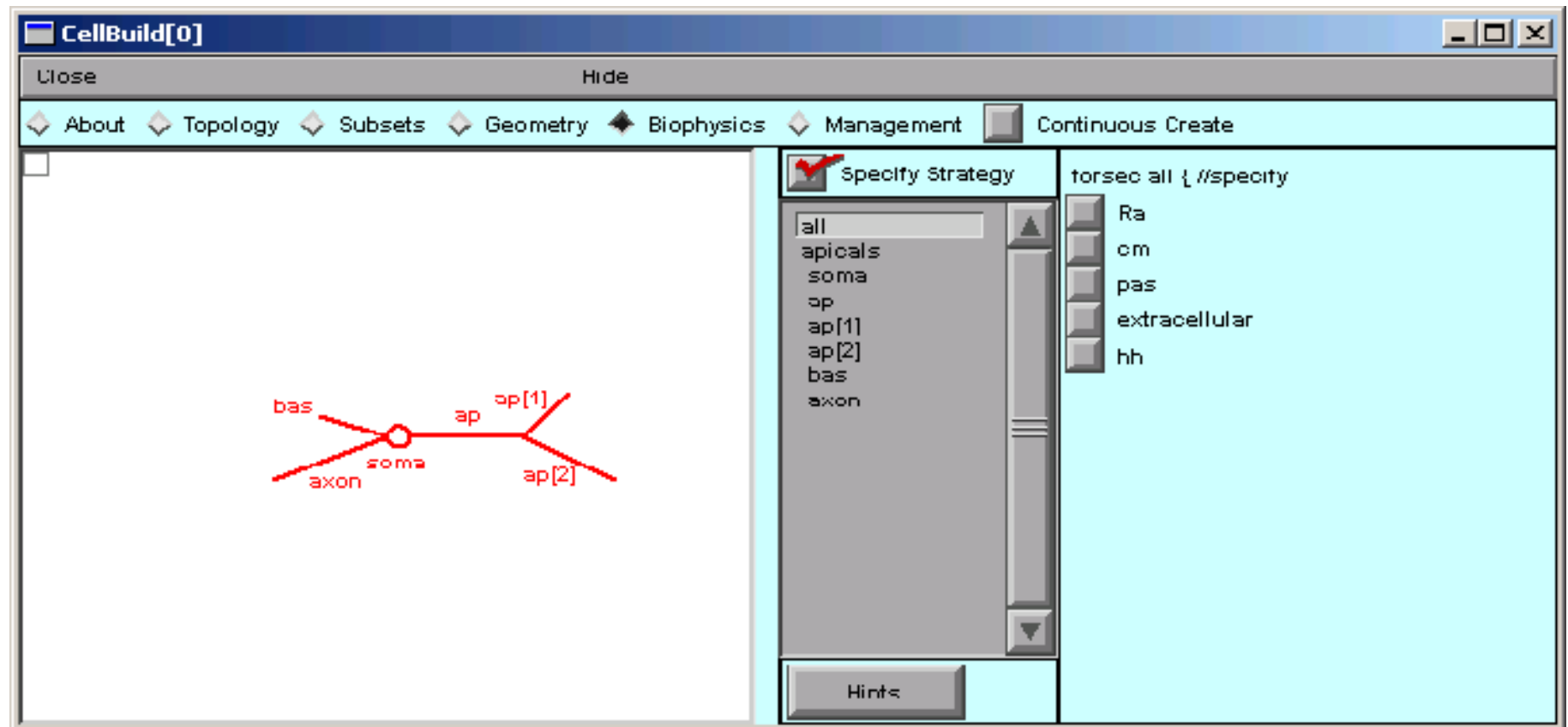
$d_lambda = 0.1$ at 100 Hz usually gives good spatial accuracy.

Implementing geometry *continued*



Set L and diam for all sections.
Time to save to a session file!

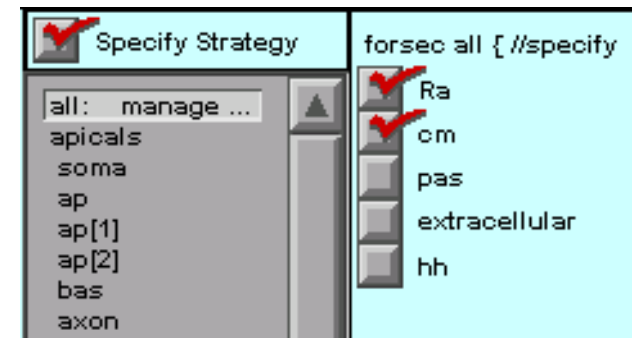
Biophysics



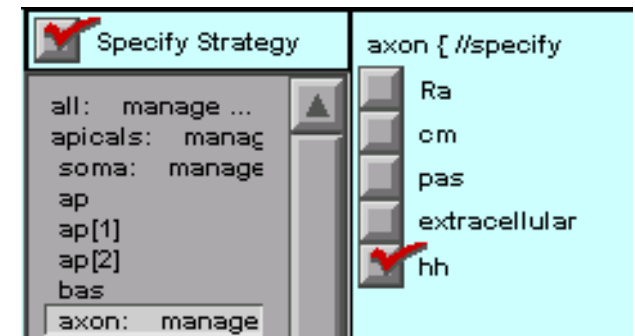
"Specify Strategy" is ON.
Base the plan on shared properties.

Biophysics strategy

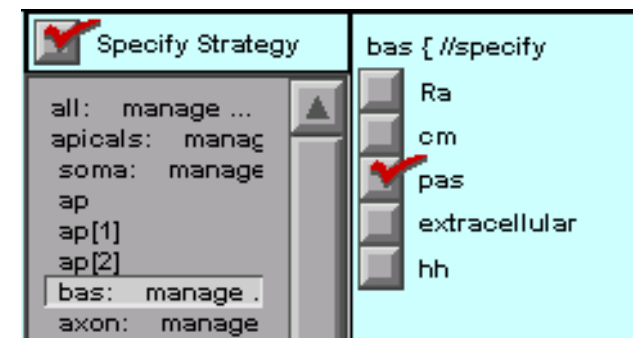
Ra and cm are homogeneous



apicals, soma and axon have hh



bas has pas



Implementing biophysics strategy

Double Ra

Specify Strategy

all

Ra

cm

apicals

hh

soma

hh

bas

pas

axon

hh

forsec all { // specify Ra

Ra (ohm-cm) 80*2

Fix apicals hh params

Specify Strategy

all

x Ra

cm

apicals

x hh

soma

hh

bas

pas

axon

hh

forsec apicals { insert hh

gnabar_hh (S/cm2) ✓ 0.012

gkbar_hh (S/cm2) ✓ 0.0036

gl_hh (S/cm2) 0.0003

el_hh (mV) ✓ -64

Shift e_pas in bas

Specify Strategy

all

x Ra

cm

apicals

x hh

soma

hh

bas

x pas

axon

hh

bas { insert pas

g_pas (S/cm2) 0.001

e_pas (mV) ✓ -65

Save another session file!!

Management

Option 1: save as a Cell Type
for use in a network

The screenshot shows a 'Management' dialog box with a light blue background. At the top, there is a tab labeled 'Management' with a diamond icon, and a checkbox labeled 'Continuous Create'. Below the tabs, there is a section with a 'Cell Type' tab (selected with a mouse cursor), 'Export', and 'Import' buttons, along with a 'Hints' button. The main text area contains the following instructions: 'This is necessary only if the cell is used in a network', 'This creates a file that declares a cell type with the current specification', and 'Such a cell class is usable in networks and can be employed by the network builder tool.' Below this text is a 'Classname' input field containing the text 'Cell'. Further down is a 'Select Output' section with a dropdown menu showing 'soma.v{1}'. At the bottom of the dialog is a 'Save hoc code in file' button.

Management Continuous Create

Cell Type Export Import Hints

This is necessary only if the cell is used in a network

This creates a file that declares a cell type
with the current specification

Such a cell class is usable in networks and
can be employed by the network builder tool.

Classname

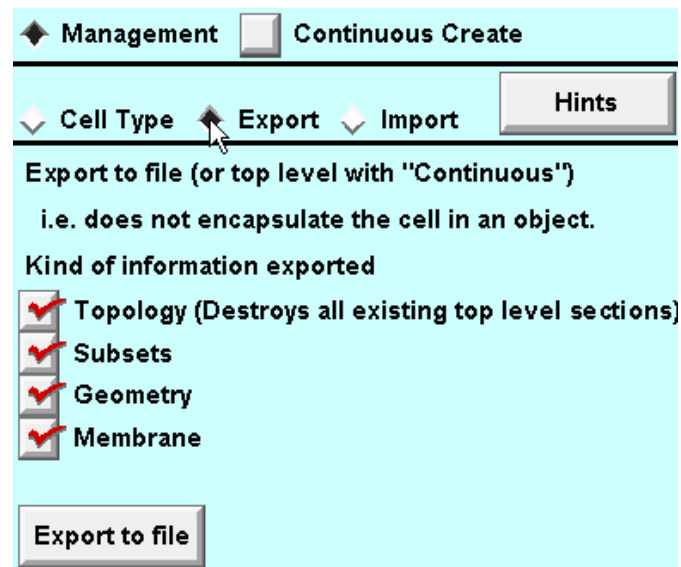
Cell

Select Output
soma.v{1}

Save hoc code in file

Management *continued*

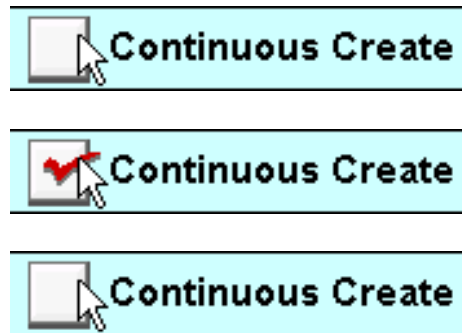
Option 2: save as hoc file



Management *continued*

Option 3: export to interpreter

Toggle Continuous Create ON and OFF



or just leave it ON all the time.