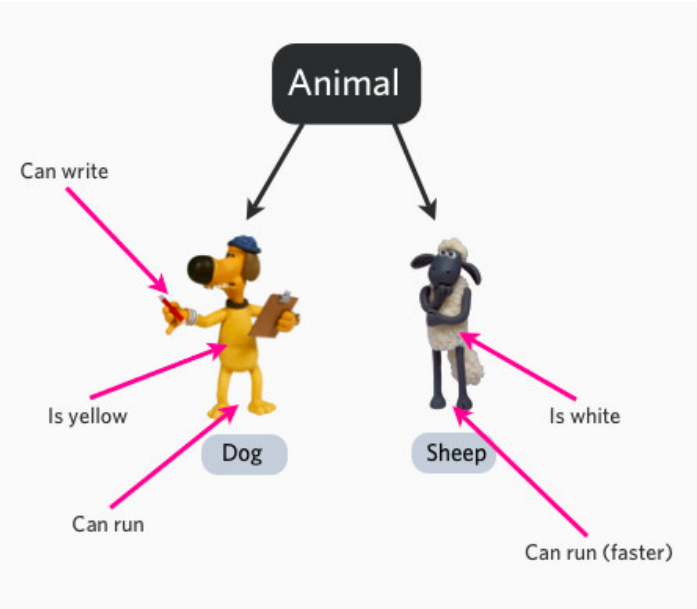
LASCON 2018

Tutorial on Classes and Objects



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Cell Class

- Classes are useful to encapsulate variables and functions:
  - Class variables = attributes
  - Class functions = methods
- Objects are instances of a class

Class Animal

Attributes:
size, sound

Methods:
talk()

Object Dog(Animal)

Attributes:
size = ‘small’
sound = ‘woof’

Methods:
talk()

Object Cat(Animal)

Attributes:
size = ‘small’
sound = ‘meow’

Methods:
talk()

Object Cow(Animal)

Attributes:
size = ‘big’
sound = ‘mooo’

Methods:
talk()

Cell Class

```
class Animal():
      def __init__(self, size, sound):
            self.size = size
            self.sound = sound

      def talk(self, length):
            print self.sound * length
```

- Constructor method __init__() initializes object attributes
- Methods must must have explicit object reference (`self`) as the first parameter

```
cat = Animal(size='small', sound='meow')
dog = Animal(size='small', sound='woof')
cow = Animal(size='big',   sound='mooo')

cat.size
'small'

cow.size
'big'

dog.talk(3)
'woofwoofwoof'

cat.talk(10)
'meowmeowmeowmeowmeowmeowmeowmeowmeowmeow'
```

- Attribute names are common to all objects but have different values for each one
- Method is shared by all objects, but produces different outputs
- Method can have arguments

Cell Class

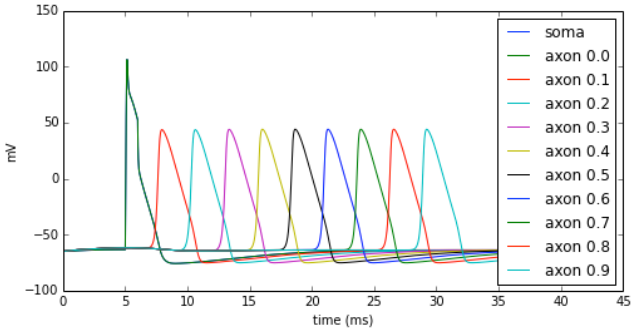
```
class Contact(object):
    """A given person for my database of friends."""

    def __init__(self, first_name=None, last_name=None, email=None, phone=None):
        self.first_name = first_name
        self.last_name = last_name
        self.email = email
        self.phone = phone

    def print_info(self):
        """Print all of the information of this contact."""
        my_str = "Contact info:"
        if self.first_name:
            my_str += " " + self.first_name
        if self.last_name:
            my_str += " " + self.last_name
        if self.email:
            my_str += " " + self.email
        if self.phone:
            my_str += " " + self.phone
        print my_str
```

```
bob = Contact('Bob','Smith')
joe = Contact(email='someone@somewhere.com')
```

Cell Class (with real stuff!)

- Encapsulate properties (eg. diam) and methods (eg. recording) of a neuron so we can create many of them easily

```python
from neuron import h, gui
from matplotlib import pyplot

soma = h.Section(name='soma')
dend = h.Section(name='dend')
dend.connect(soma(1))
h.topology()

# Surface area of cylinder is 2*pi*r*h (sealed ends are implicit).
soma.L = soma.diam = 12.6157 # Makes a soma of 500 microns squared.
dend.L = 400 # microns
dend.diam = 1 # microns

for sec in h.allsec():
    sec.Ra = 100   # Axial resistance in Ohm * cm
    sec.cm = 1     # Membrane capacitance in micro Farads / cm^2

# Insert active Hodgkin-Huxley current in the soma
soma.insert('hh')
soma.gnabar_hh = 0.12  # Sodium conductance in S/cm2
soma.gkbar_hh = 0.036  # Potassium conductance in S/cm2
soma.gl_hh = 0.0003    # Leak conductance in S/cm2
soma.el_hh = -54.3     # Reversal potential in mV

# Insert passive current in the dendrite
dend.insert('pas')
dend.g_pas = 0.001  # Passive conductance in S/cm2
dend.e_pas = -65    # Leak reversal potential mV
dend.nseg = 10

# Change the maximum sodium conductance of the middle segment of the soma to 0.13
soma(0.5).hh.gnabar = 0.13

# Change the equilibrium potential of the passive mechanism in the middle segment of the dend to -65
dend(0.5).pas.e = -65
```



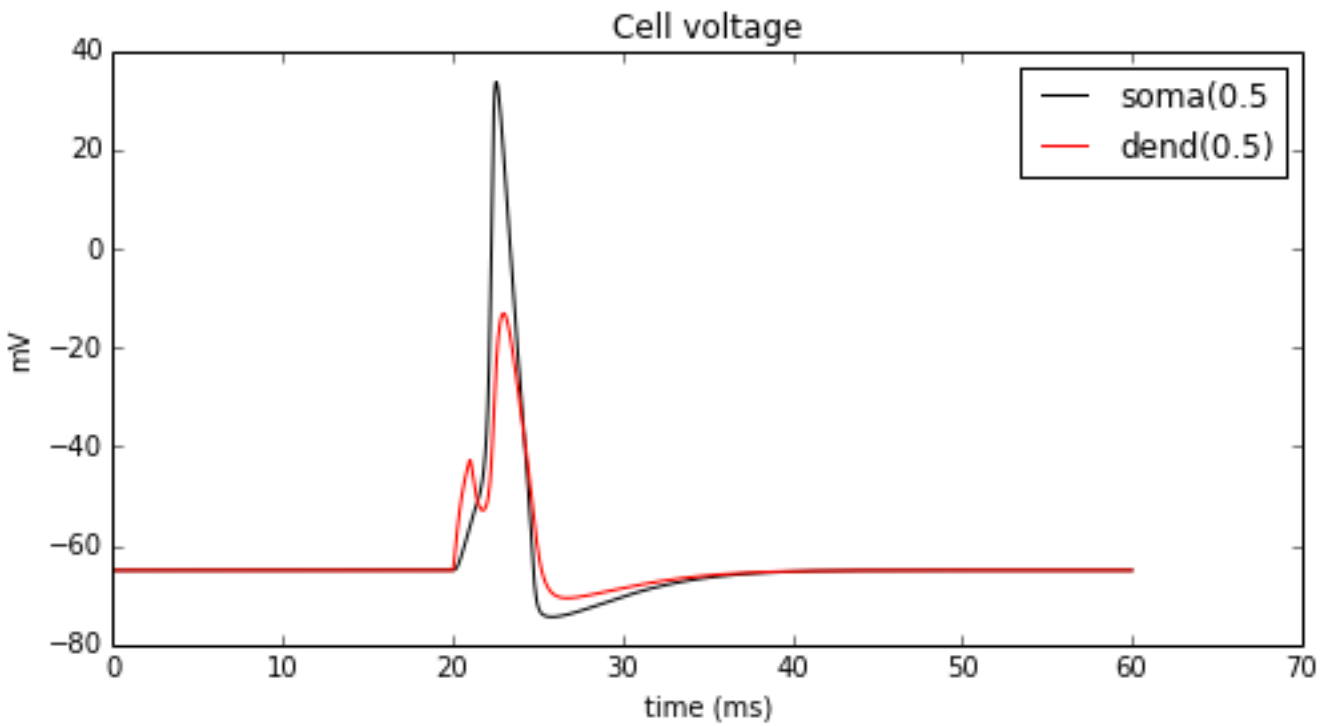
Creating an HH cell class

The aim is to put inside a *cell class* (check code for lab2) all the operations required to create, define and stimulate a cell (check code for lab3 and lab4). Follow these steps

1) Create a class called *HHCell* with an empty constructor (for now).
2) Add a method *create_sections* that creates the *soma* and *dend* sections. Make sure these sections are an attribute of the class (use *self !)*
3) Add a method *build_topology* that connects the dendrite to the soma (at location 1)
4) Add a method *define_biophysics* that sets the biophysic of the soma and dendrite: axial resistance and membrane capacitance; adds active HH channels to the soma, and passive channels to the dendrite (use same params as in lab 3).
5) Add a method *add_current_stim* to apply a current clamp stimulation to the dendrite (location 1.0), with amplitude 0.3 nA, duration of 1 ms, and delay of 20 ms. Make sure the current clamp object is an attribute of the class.
6) Add a method *record_voltage* to record the voltage from the *soma* and *dend (*at location 0.5).
7) Add a method *plot_voltage* to plot the voltage at the soma and dendrite (location 0.5), in black and red color.
8) Call the *create_sections*, *build_topology, define_geometry,* and *define_biophysics* methods from the class constructor.

Creating an HH cell class

1) Create a cell object called *cell1* of class *HHCell.*
2) Add current clamp stimulation to the *cell1* object.
3) Set up the voltage recording of the *cell1* object.
4) Set the simulation duration to 60 mV, and run the simulation.
5) Plot the voltages of the *cell1* object.



Cell Class

HHCell

Attributes:

- soma
- dend
- stim
- soma_v_vec
- dend_v_vec
- t_vec

Methods:

- __init__()
- create_sections()
- build_topology()
- define_geometry()
- define_biophysics()
- add_current_stim()
- set_recording()
- plot_voltage()