MuscleHillExample

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This notebook presents a simulation of 5000 ms of 400 descending commands and 800 motoneurons from soleus. The force is prduced by a Hill-type muscle model.

Input #1

```
import sys
sys.path.insert(0, '..')
import time
import matplotlib.pyplot as plt
%matplotlib inline
import numpy as np

from Configuration import Configuration
from MotorUnitPool import MotorUnitPool
from NeuralTract import NeuralTract
from SynapsesFactory import SynapsesFactory
from jointAnkleForceTask import jointAnkleForceTask
```

Input #2

```
conf = Configuration('confMuscleHillExample.rmto')
conf.simDuration_ms = 5000 # Here I change simulation duration without changing the Configu
```

Input #3

```
pools = dict()
pools[0] = MotorUnitPool(conf, 'SOL')
pools[1] = NeuralTract(conf, 'CMExt')
ankle = jointAnkleForceTask(conf, pools)
Syn = SynapsesFactory(conf, pools)
del Syn
```

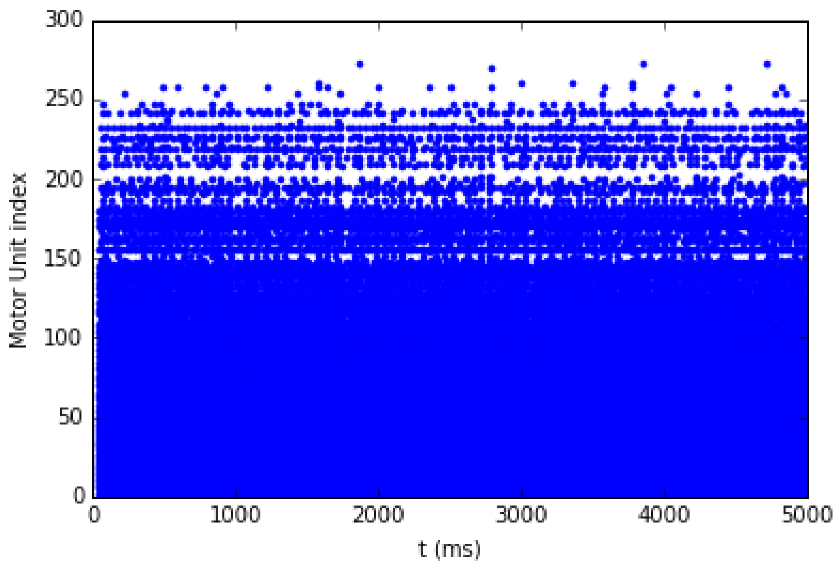
Output #3

```
3586.0
Motor Unit Pool SOL built
Descending Command CMExt built
All the 95753 synapses were built
```

Input #4

```
t = np.arange(0.0, conf.simDuration_ms, conf.timeStep_ms)
conf.simDuration_ms = 5000 # Here I change simulation duration without changing the Configu
```

Input #5



Spike times of all motoneurons along the 5000 ms of simulation.

```
tic = time.clock()
for i in xrange(0,len(t)-1):
    ankle.atualizeAnkle(t[i], np.sin(2*np.pi*t[i]/1000.0))
    pools[1].atualizePool(t[i])
    pools[0].atualizeMotorUnitPool(t[i])
toc = time.clock()
print str(toc - tic) + ' seconds'
```

Output #5

```
10393.867636 seconds
```

Input #6

```
pools[0].listSpikes()
pools[1].listSpikes()
```

The spike times of the MNs along the 5000 ms of simulation are shown in Fig. **??**.

Input #7

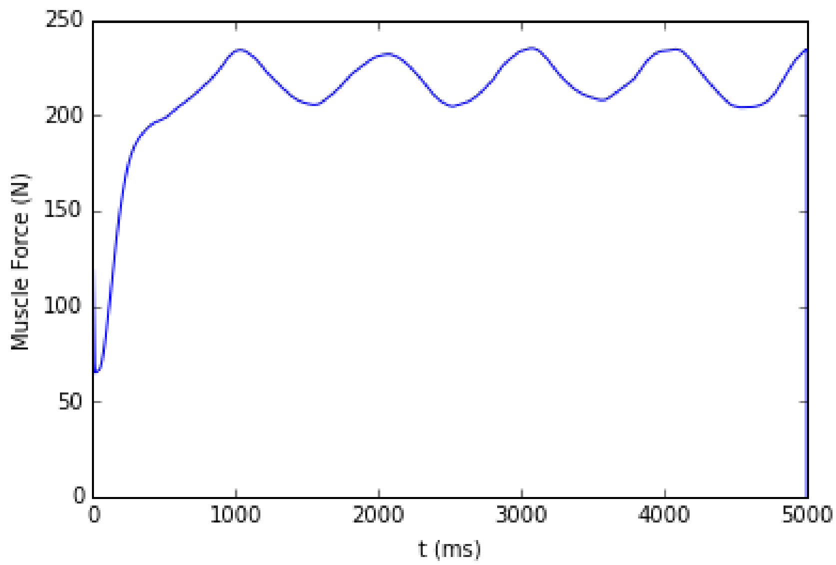
```
plt.figure()
plt.plot(pools[0].poolTerminalSpikes[:, 0],
    pools[0].poolTerminalSpikes[:, 1]+1, '.')
plt.xlabel('t (ms)')
plt.ylabel('Motor Unit index')
```

Output #7

```
Out[7]: <matplotlib.text.Text at 0x7f46bee56350>
```

The muscle force produced by the Hill-type model is shown in Fig.**??**.

Input #8



Muscle force during the simulation.

```
plt.figure()
plt.plot(t, pools[0].Muscle.force, '-')
plt.xlabel('t (ms)')
plt.ylabel('Muscle Force (N)')
```

Output #8

```
Out[8]: <matplotlib.text.Text at 0x7f46bf0da490>
```

The muscle length computed with the Hill-type model is shown in Fig.**??**.
Input #9

```
plt.figure()
plt.plot(t, pools[0].Muscle.length_m, '-')
plt.xlabel('t (ms)')
plt.ylabel('Muscle Length (m)')
```

Output #9

```
Out[9]: <matplotlib.text.Text at 0x7f46befd9f50>
```

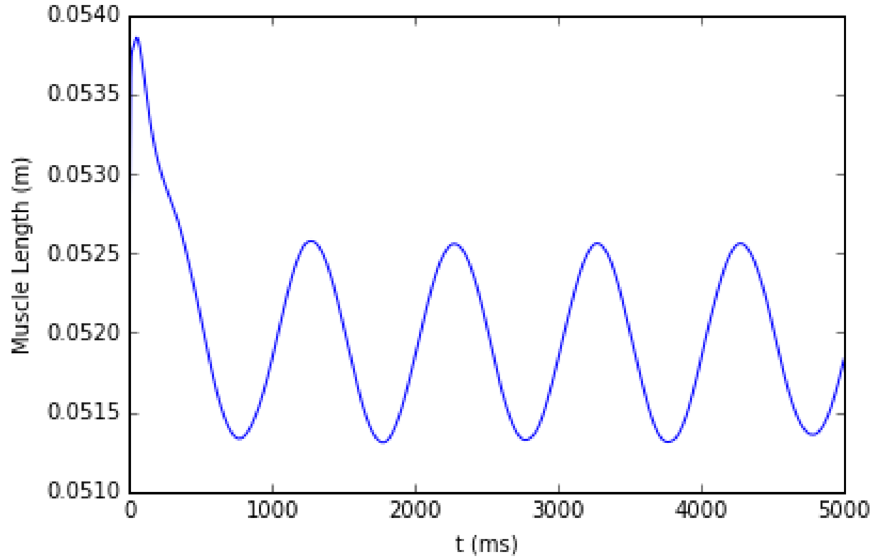
The muscle velocity, computed by the Hill-type muscle model, is in Fig.**??**.
Input #10

```
plt.figure()
plt.plot(t, pools[0].Muscle.velocity_m_ms, '-')
plt.xlabel('t (ms)')
plt.ylabel('Muscle Velocity (m/ms)')
```

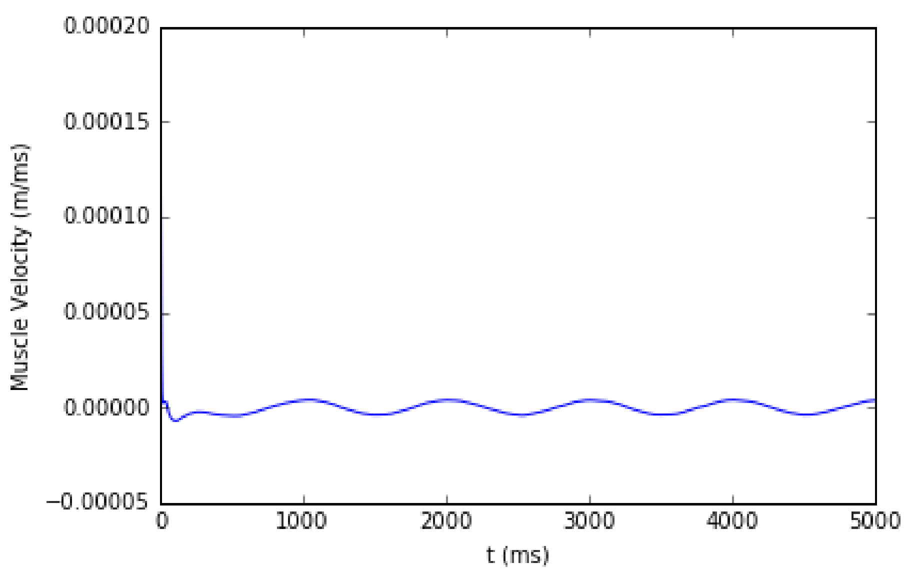
Output #10

```
Out[10]: <matplotlib.text.Text at 0x7f46bedae3d0>
```

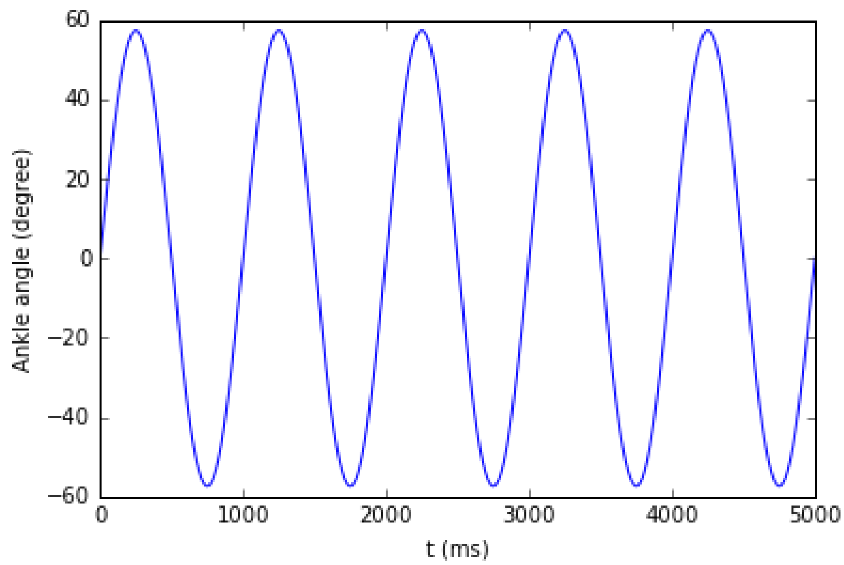
The ankle joint angle is shown in Fig. **??**.
Input #11



Muscle length along the 5000 ms of simulation.



Velocity os muscle length variation during the simulation.



Ankle angle during the 5000 ms of simulation.

```
plt.figure()
plt.plot(t, ankle.ankleAngle_rad*180.0/np.pi, '-')
plt.xlabel('t (ms)')
plt.ylabel('Ankle angle (degree)')
```

Output #11

```
Out[11]: <matplotlib.text.Text at 0x7f46bce32210>
```

Input #None