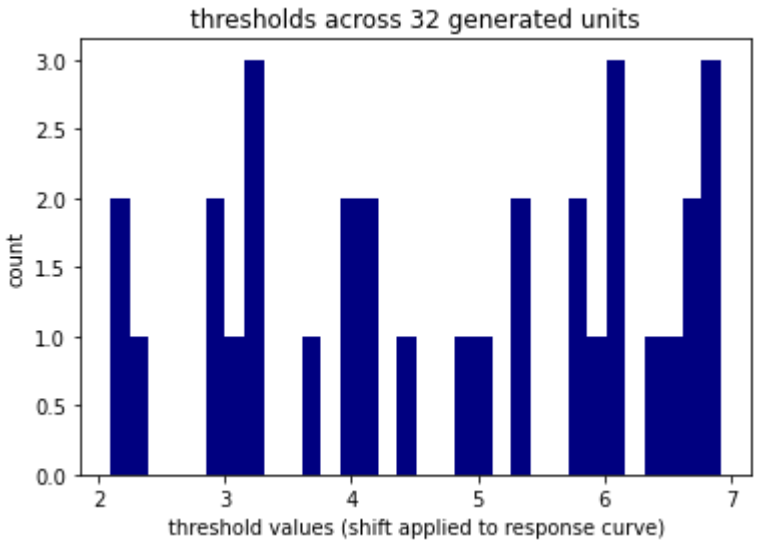
Started 'musim (Python 3.8.12)' kernel
Python 3.8.12 (default, Oct 12 2021, 03:01:40) [MSC v.1916 64 bit (AMD64)]
Type 'copyright', 'credits' or 'license' for more information
IPython 7.29.0 -- An enhanced Interactive Python. Type '?' for help.

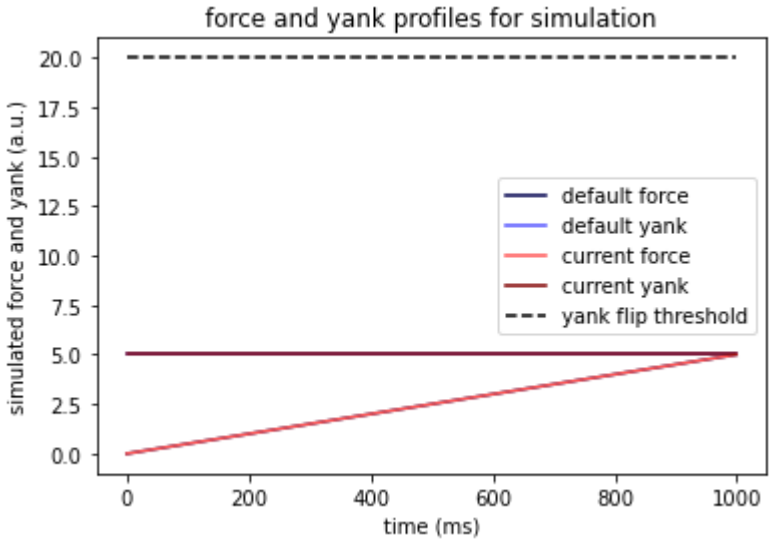
In [ ]:

```
import numpy as np
from MUsim import MUsim
############################################################
############################################################
############################################################
# %%
# # TRADITIONAL MODE (SIZE PRINCIPLE)
# INITIALIZE SIMULATION OBJECT, mu_stat

mu_stat = MUsim()
# GET STATIC MOTOR UNIT THRESHOLDS

mu_stat.num_units = 32
mu_stat.MUthresholds_dist = 'uniform'
static_units = mu_stat.sample_MUs()
# %% PLOT THRESHOLD DISTRIBUTION, FORCE PROFILE, AND INDIVIDUAL UNIT RESPONSES

mu_stat.see('thresholds') # plot binned thresholds across all units
mu_stat.see('force') # plot default applied force
mu_stat.see('curves') # plot unit response curves
# %% SIMULATE MOTOR UNITS SPIKE RESPONSE TO DEFAULT FORCE

spikes = mu_stat.simulate_spikes(noise_level=0)
mu_stat.see('spikes') # plot spike response
# %% CONVOLVE AND PLOT SMOOTHED RESPONSE

smooth = mu_stat.convolve()
mu_stat.see('smooth') # plot smoothed spike response
# %% APPLY NEW FORCE, VIEW RESPONSE

new_force_profile = 3*mu_stat.init_force_profile
mu_stat.apply_new_force(new_force_profile)
spikes2 = mu_stat.simulate_spikes()
mu_stat.see('force') # plot new applied force
mu_stat.see('curves') # plot unit response curves
mu_stat.see('spikes') # plot spike response
# %% CONVOLVE AND PLOT SMOOTHED RESPONSE

smooth = mu_stat.convolve()
mu_stat.see('smooth')
# %% SIMULATE SESSION (MANY TRIALS)

num_trials_to_simulate = 20
mu_stat.num_trials = num_trials_to_simulate
results = mu_stat.simulate_session()
# CONVOLVE ENTIRE SESSION

smooth_results = mu_stat.convolve(target='session')
num_units_to_view = 4
select_units = np.linspace(0,mu_stat.num_units-1,num_units_to_view).astype(int)
mu_stat.see('unit',unit=select_units[0])
mu_stat.see('unit',unit=select_units[1])
```

```
mu_stat.see('unit',unit=select_units[2])
mu_stat.see('unit',unit=select_units[3])
# %% ###################################################

mu_lorenz = MUsim()
# GET LORENZ SIMULATED MOTOR UNITS

mu_lorenz.num_units = 30
mu_lorenz.sample_rate = 1/(0.006) # 166.7 Hz
mu_lorenz.MUthresholds_dist = 'uniform'
lorenz_units = mu_lorenz.sample_MUs(MUmode="lorenz")
# %% SIMULATE MOTOR UNITS SPIKING RULED BY LORENZ DYNAMICS

spikes = mu_lorenz.simulate_spikes(noise_level=0)
mu_lorenz.see('spikes') # plot spike response
# %% CONVOLVE AND PLOT SMOOTHED SPIKES

smooth = mu_lorenz.convolve()
mu_lorenz.see('smooth') # plot smoothed spike response
# %% VIEW LORENZ ATTRACTOR

mu_lorenz.see('lorenz')
############################################################
# %% IMPORT NECESSARY PACKAGES

import numpy as np
import matplotlib.pyplot as plt
from MUsim import MUsim
############################################################
############################################################
############################################################
# %% # DYNAMIC MODE (THRESHOLD REVERSAL)
# INITIALIZE SIMULATION OBJECT, mu_dyn

mu_dyn = MUsim()
# # GET DYNAMIC MOTOR UNIT THRESHOLDS

mu_dyn.num_units = 10
mu_dyn.MUthresholds_dist = 'uniform'
mu_dyn.MUreversal_frac = 1 # set fraction of MU population that will reverse
mu_dyn.MUreversal_static_units = list(range((mu_dyn.num_units-1)))
dyn_units = mu_dyn.sample_MUs(MUmode="dynamic")
# %% PLOT THRESHOLD DISTRIBUTION, FORCE PROFILE, AND INDIVIDUAL UNIT RESPONSES

mu_dyn.see('thresholds') # plot binned thresholds across all units
mu_dyn.see('force') # plot default applied force
mu_dyn.see('curves') # plot unit response curves
# %% SIMULATE MOTOR UNITS SPIKE RESPONSE TO DEFAULT FORCE

spikes1 = mu_dyn.simulate_spikes()
mu_dyn.see('spikes') # plot spike response
# %% CONVOLVE AND PLOT SMOOTHED RESPONSE

smooth1 = mu_dyn.convolve()
mu_dyn.see('smooth') # plot smoothed spike response
# %% APPLY NEW FORCE, VIEW RESPONSE

new_force_profile = 5*(mu_dyn.init_force_profile)
mu_dyn.apply_new_force(new_force_profile)
spikes2 = mu_dyn.simulate_spikes()
```

```
smooth2 = mu_dyn.convolve()
mu_dyn.see('force') # plot new applied force
mu_dyn.see('curves') # plot unit response curves
mu_dyn.see('spikes') # plot spike response
mu_dyn.see('smooth') # plot smoothed spike response
# %% APPLY NON-LINEAR FORCE, VIEW RESPONSE

new_force_profile = -3*np.cos(mu_dyn.init_force_profile)
mu_dyn.apply_new_force(new_force_profile)
spikes3 = mu_dyn.simulate_spikes()
smooth3 = mu_dyn.convolve()
mu_dyn.see('force') # plot new applied force
mu_dyn.see('curves') # plot unit response curves
mu_dyn.see('spikes') # plot spike response
mu_dyn.see('smooth') # plot smoothed spike response
# %% CONVOLVE AND PLOT SMOOTHED RESPONSE

smooth = mu_dyn.convolve()
mu_dyn.see('smooth')
# %% SIMULATE SESSION (MANY TRIALS)

num_trials_to_simulate = 20
mu_dyn.num_trials = num_trials_to_simulate
results = mu_dyn.simulate_session()
# CONVOLVE ENTIRE SESSION

smooth_results = mu_dyn.convolve(target='session')
num_units_to_view = 4
select_units = np.linspace(0,mu_dyn.num_units-1,num_units_to_view).astype(int)
mu_dyn.see('unit',unit=select_units[0])
mu_dyn.see('unit',unit=select_units[1])
mu_dyn.see('unit',unit=select_units[2])
mu_dyn.see('unit',unit=select_units[3])
# %%
```



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could not plot legend with more than 10 MUs.
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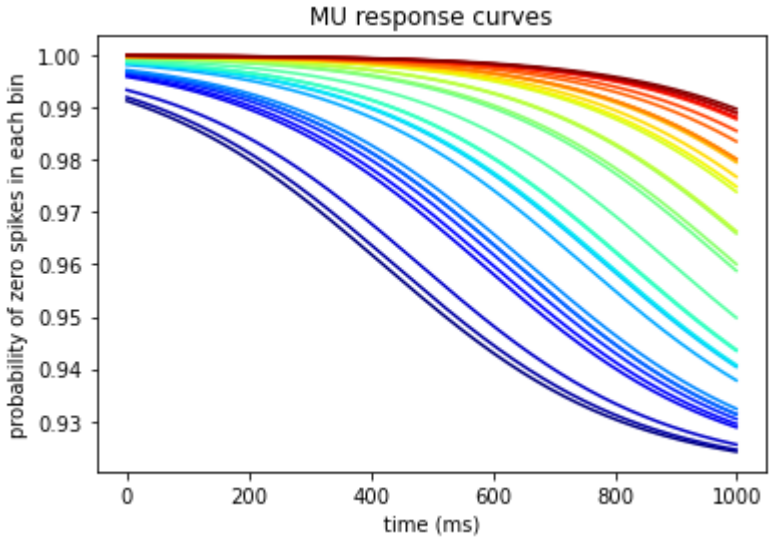


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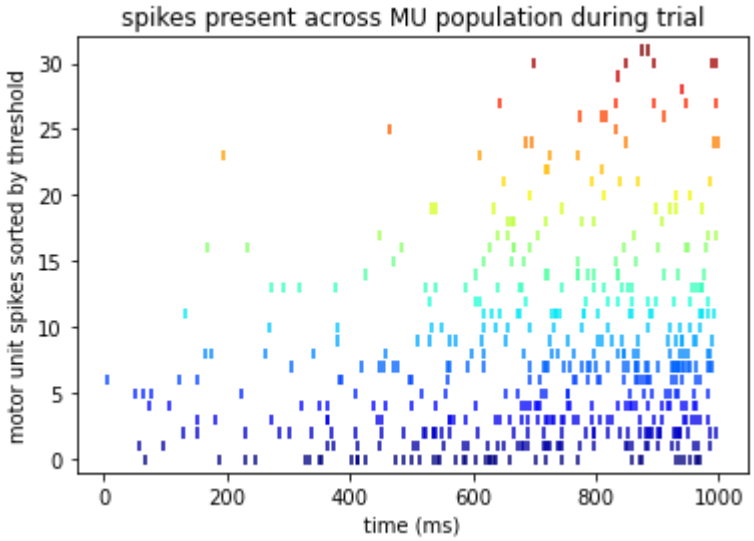

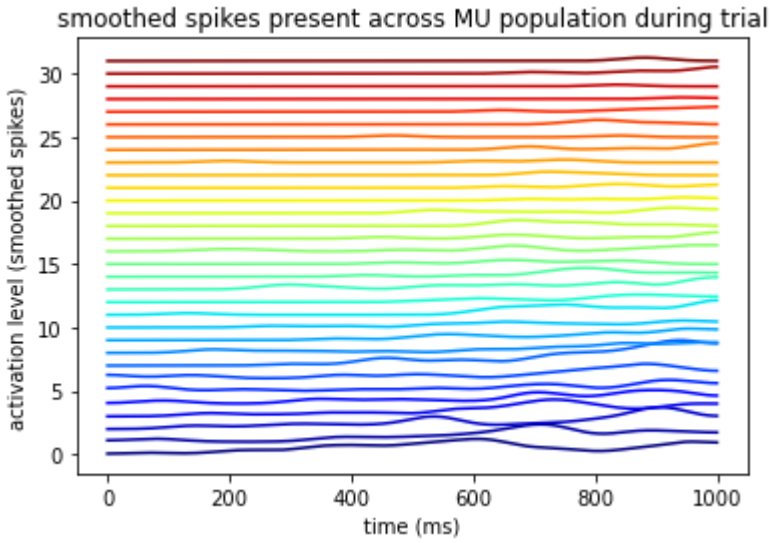

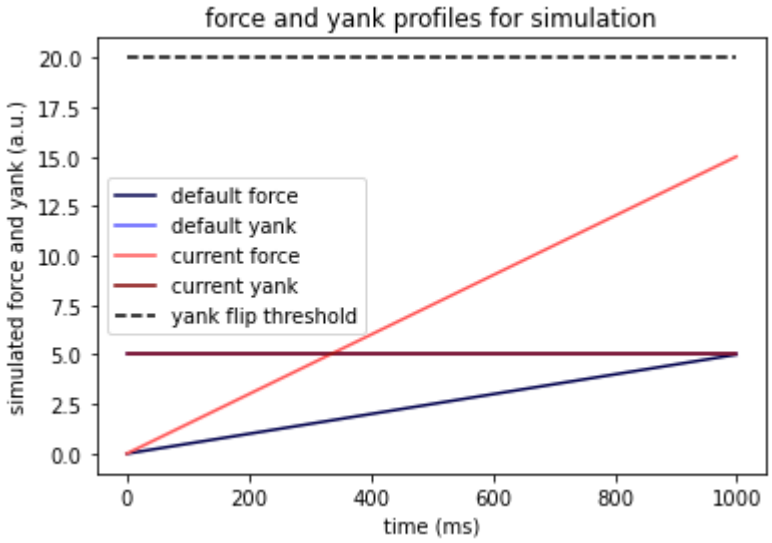


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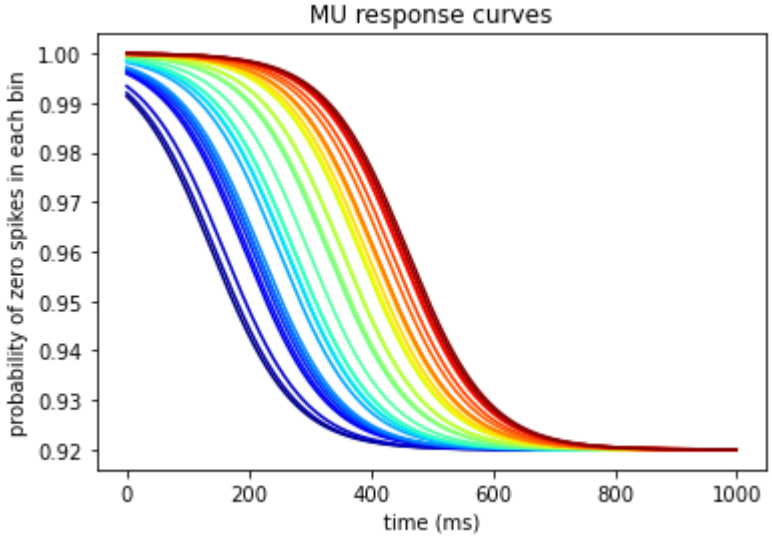


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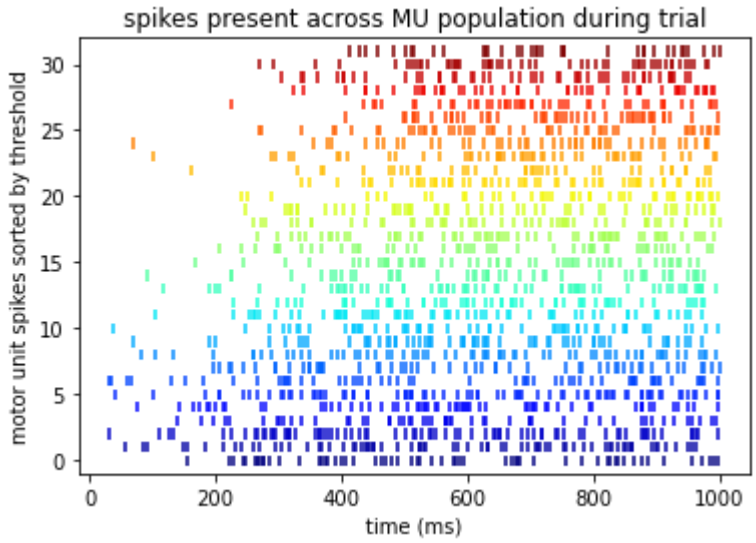
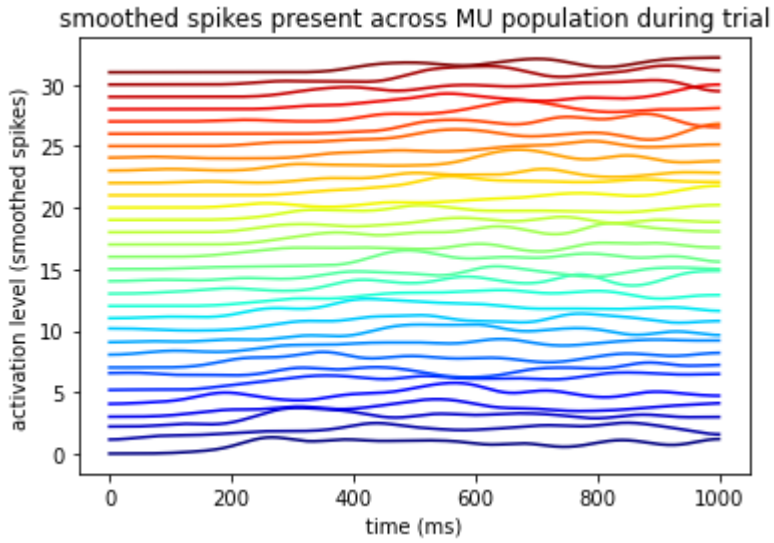
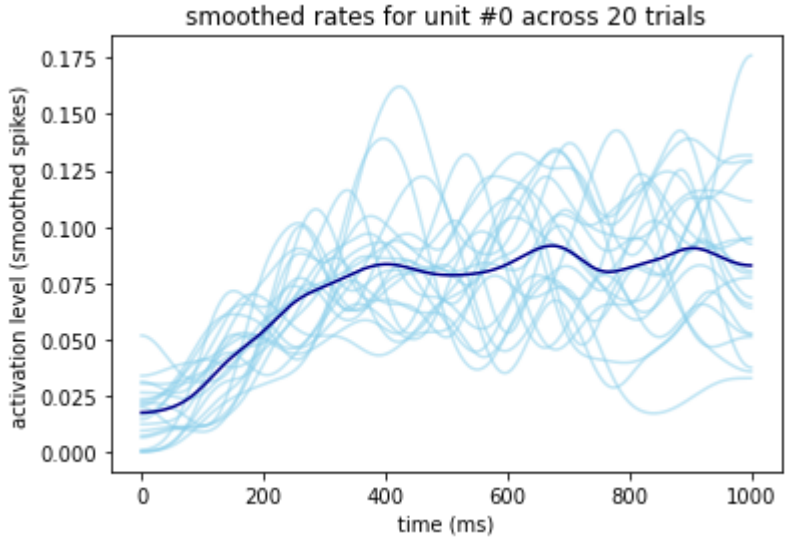
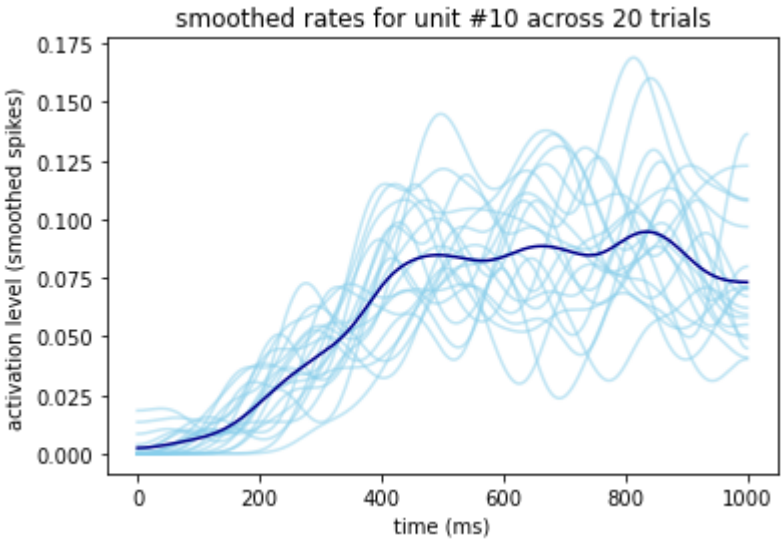
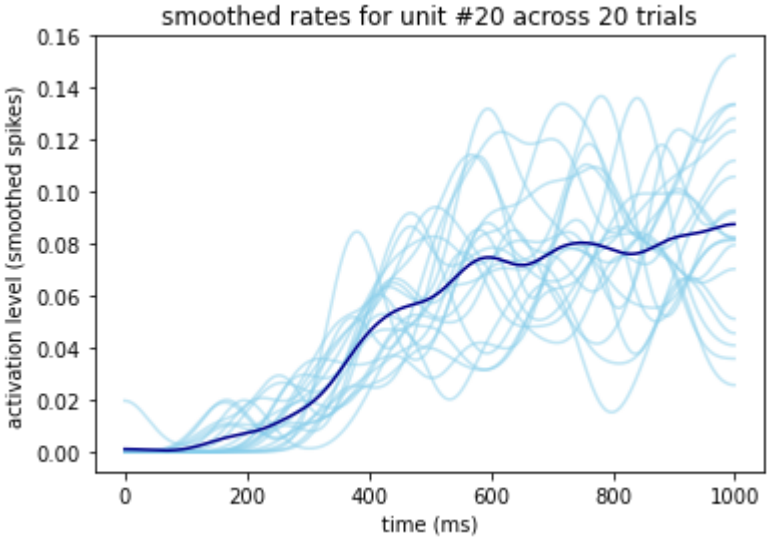
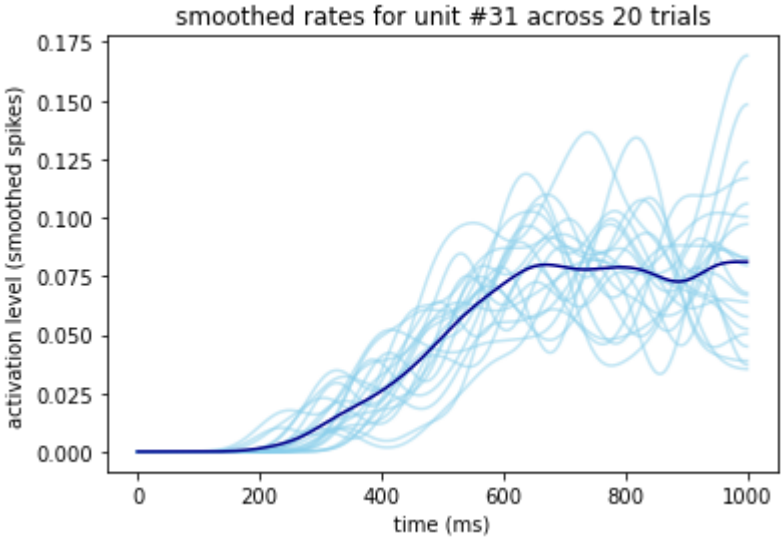

spikes present across MU population during trial
motor unit spikes sorted by threshold
time (ms)


smoothed spikes present across MU population during trial
activation level (smoothed spikes)
time (ms)


smoothed rates for unit #0 across 20 trials
activation level (smoothed spikes)
time (ms)





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could not plot legend with more than 10 MUs.
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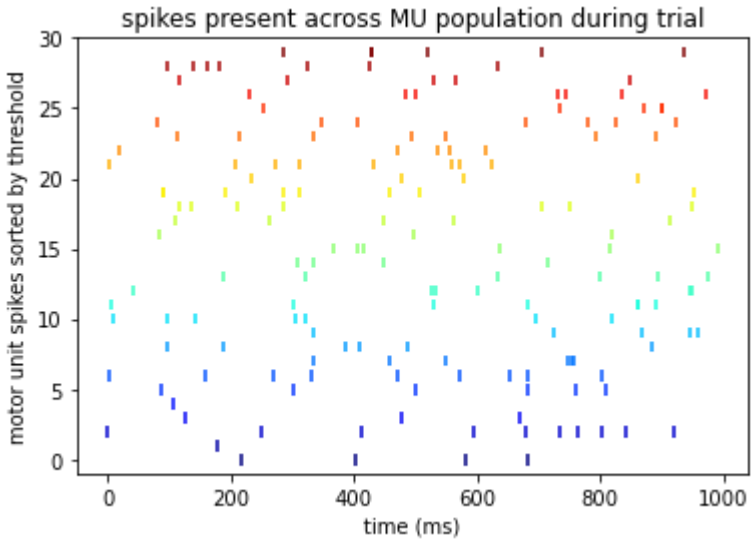
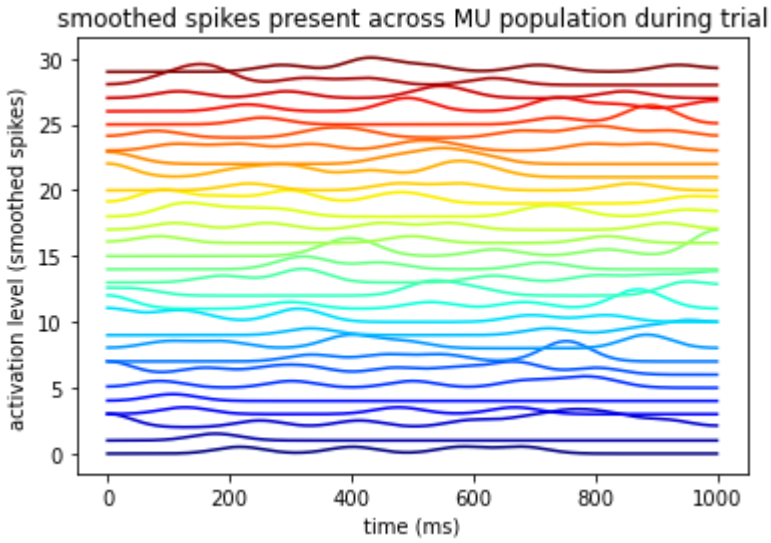
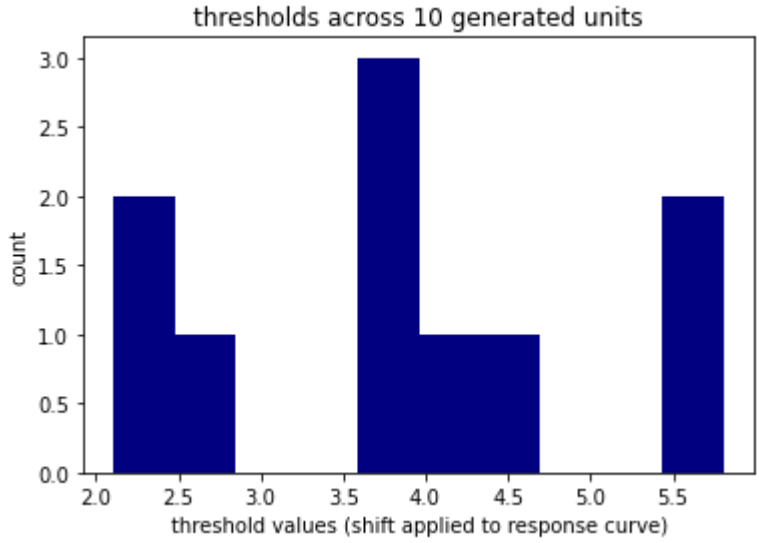
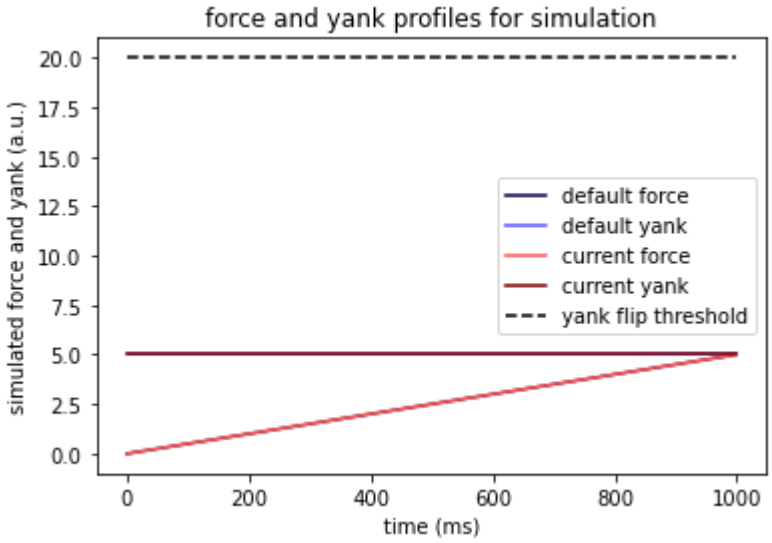
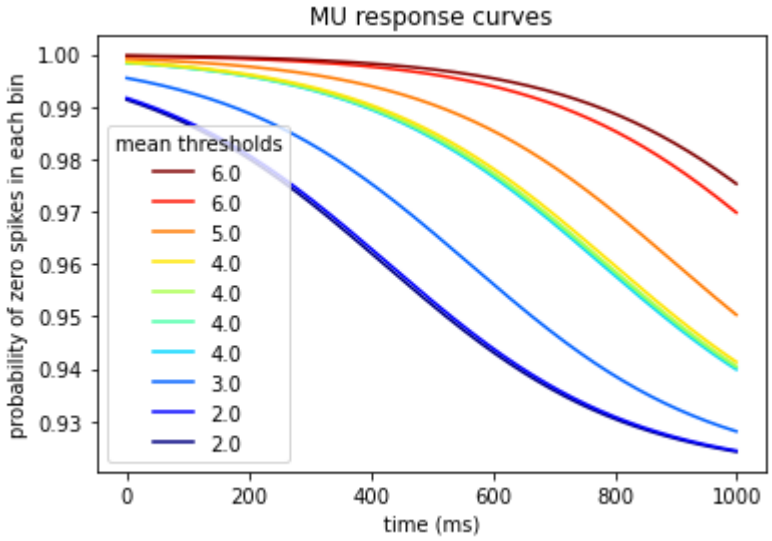
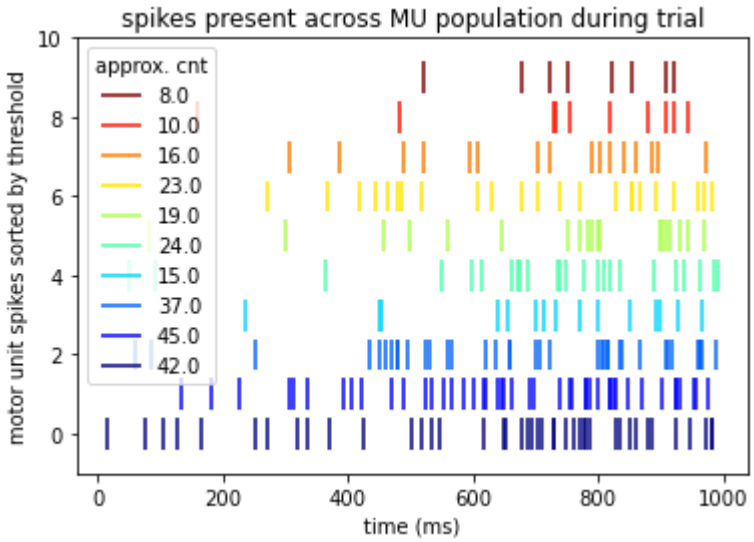

spikes present across MU population during trial
motor unit spikes sorted by threshold
time (ms)

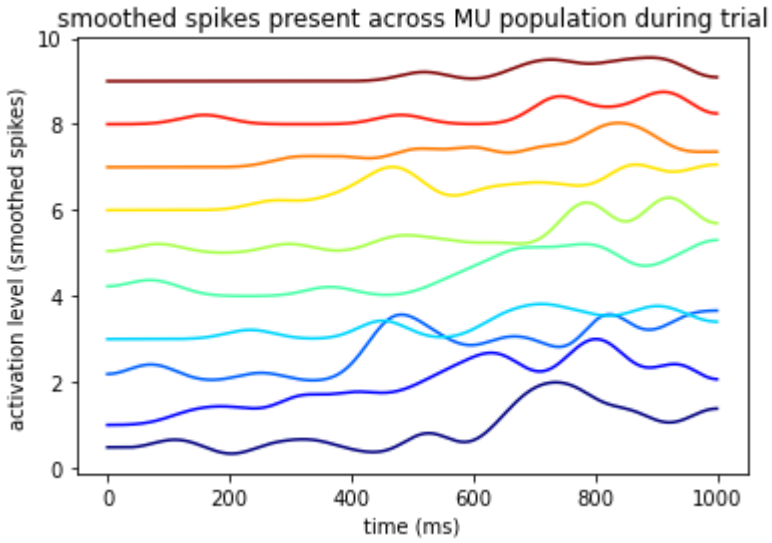

smoothed spikes present across MU population during trial
activation level (smoothed spikes)
time (ms)

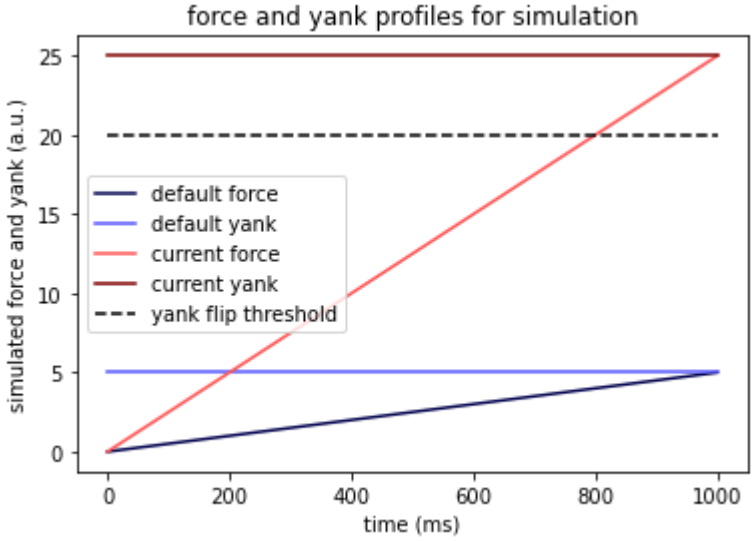

thresholds across 10 generated units
count
threshold values (shift applied to response curve)

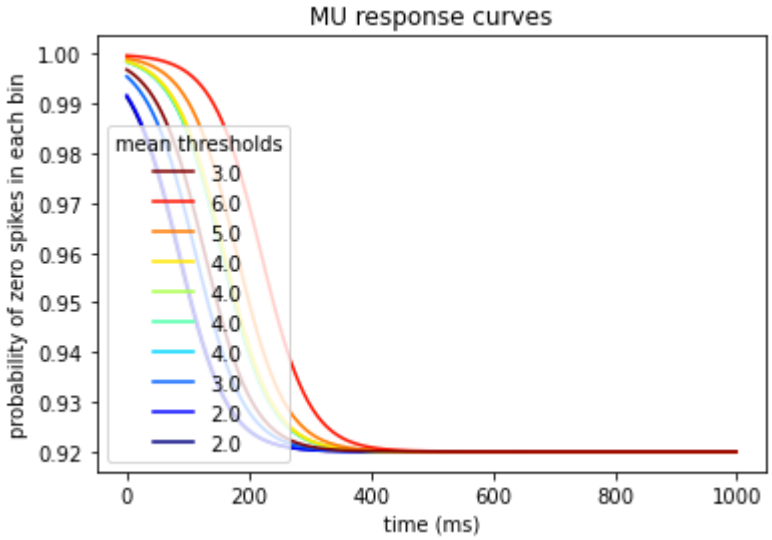

force and yank profiles for simulation
simulated force and yank (a.u.)
time (ms)
default force
default yank
current force
current yank
yank flip threshold

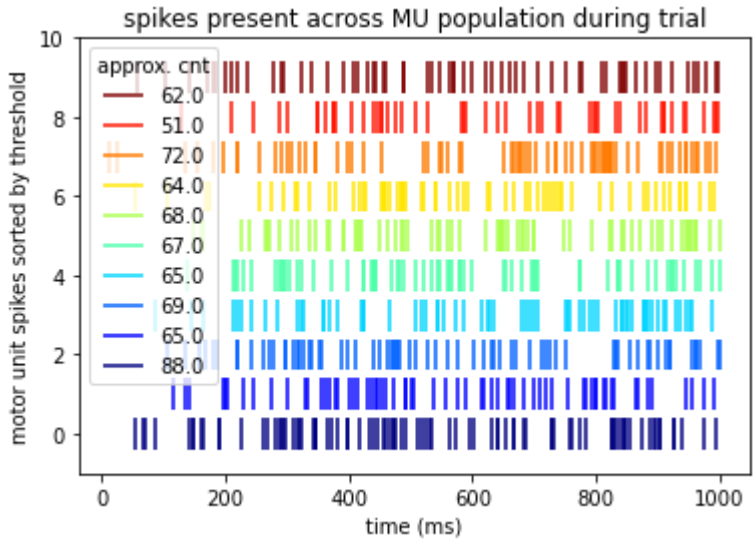

MU response curves
probability of zero spikes in each bin
time (ms)
mean thresholds
6.0
6.0
5.0
4.0
4.0
4.0
4.0
3.0
2.0
2.0

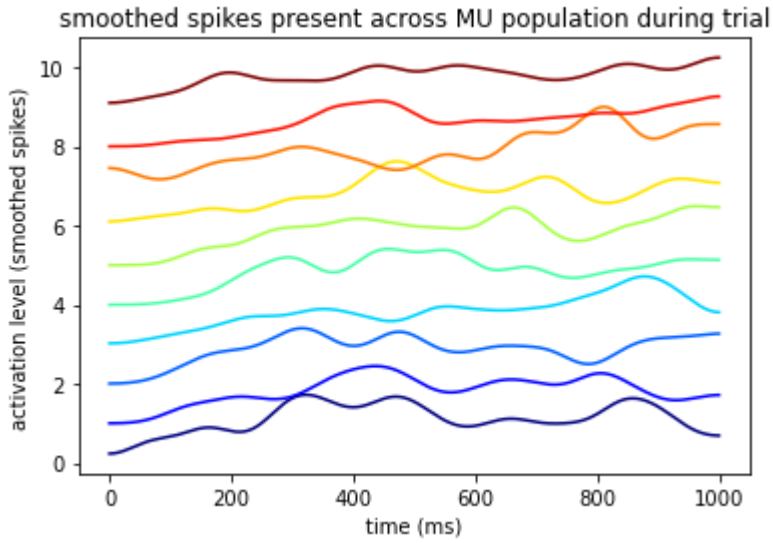

spikes present across MU population during trial
motor unit spikes sorted by threshold
time (ms)
approx. cnt
8.0
10.0
16.0
23.0
19.0
24.0
15.0
37.0
45.0
42.0

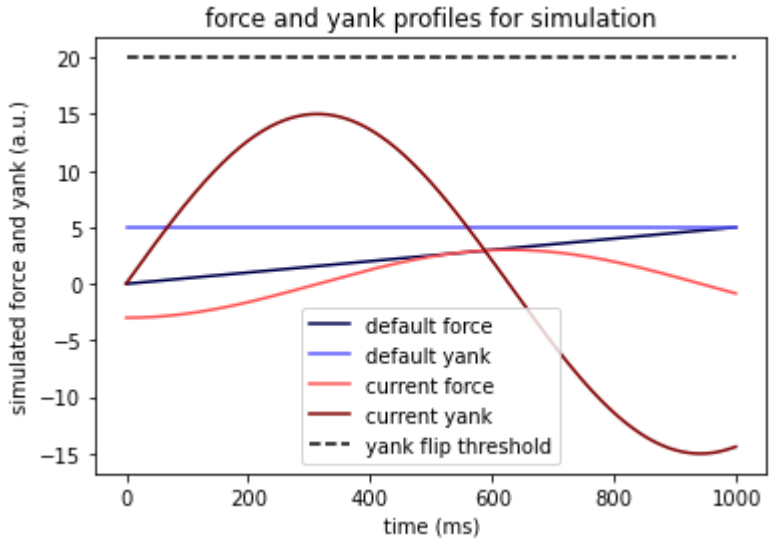

smoothed spikes present across MU population during trial
activation level (smoothed spikes)
time (ms)

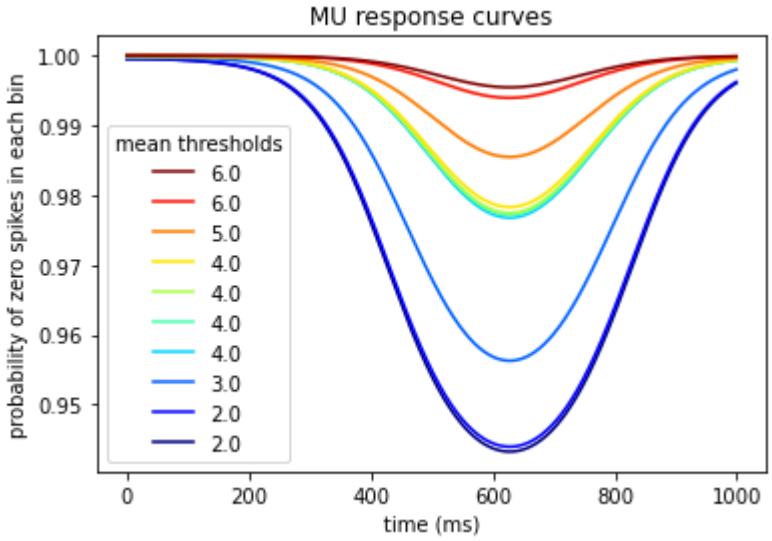

force and yank profiles for simulation
simulated force and yank (a.u.)
time (ms)
default force
default yank
current force
current yank
yank flip threshold

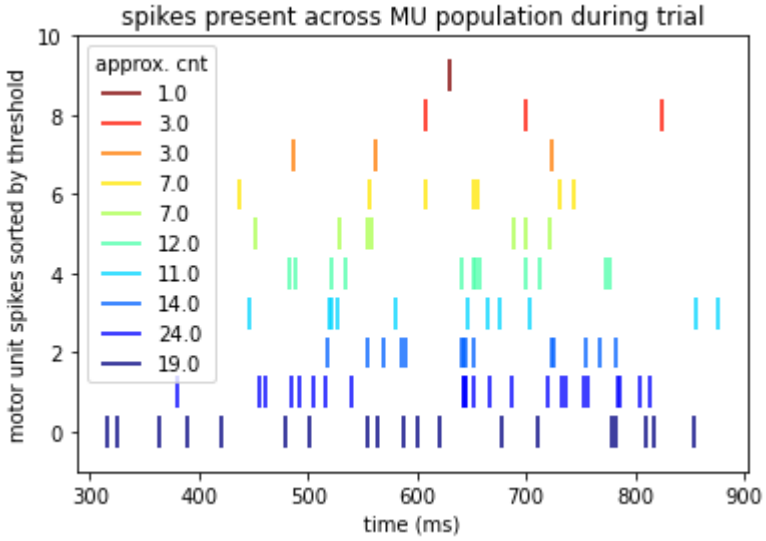

MU response curves
probability of zero spikes in each bin
time (ms)
mean thresholds
3.0
6.0
5.0
4.0
4.0
4.0
4.0
3.0
2.0
2.0

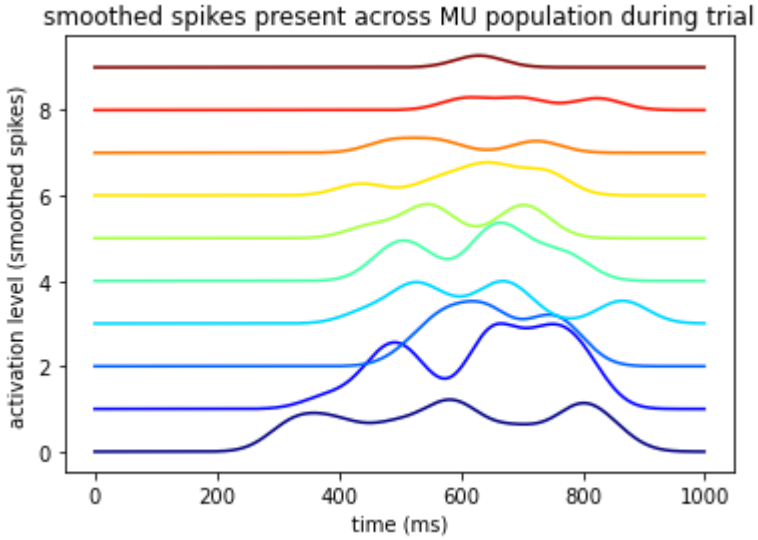

spikes present across MU population during trial
motor unit spikes sorted by threshold
time (ms)
approx. cnt
62.0
51.0
72.0
64.0
68.0
67.0
65.0
69.0
65.0
88.0

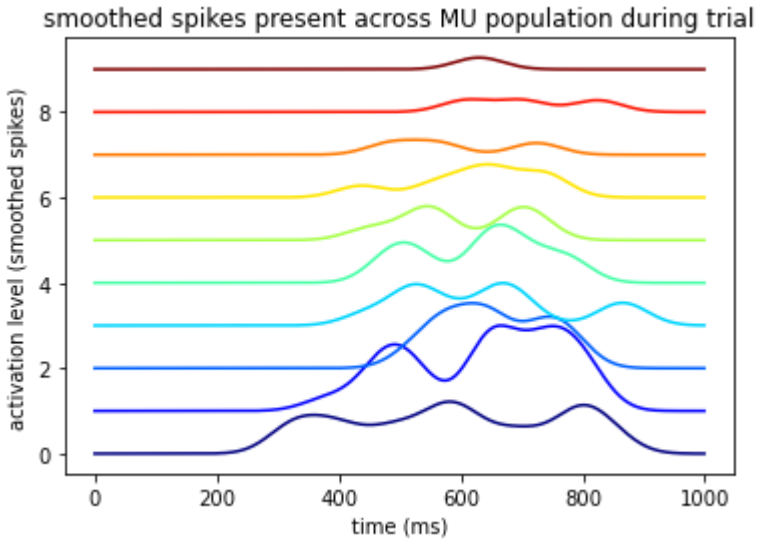

smoothed spikes present across MU population during trial
activation level (smoothed spikes)
time (ms)

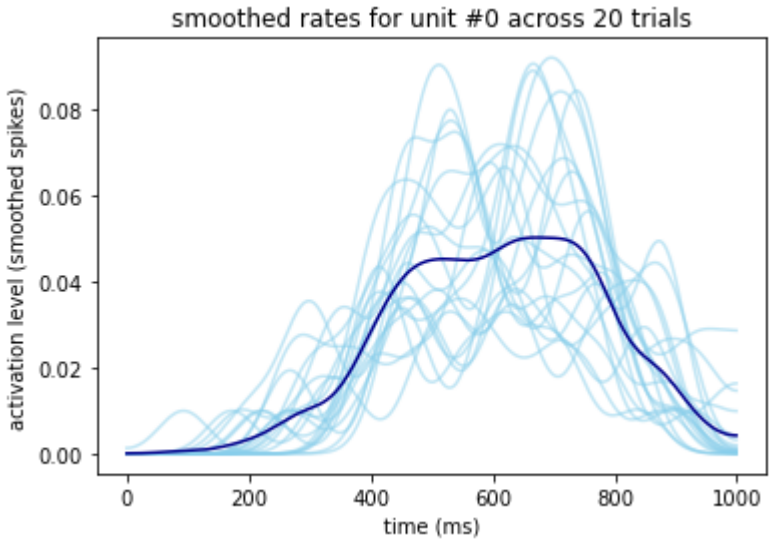

force and yank profiles for simulation
simulated force and yank (a.u.)
time (ms)
default force
default yank
current force
current yank
yank flip threshold

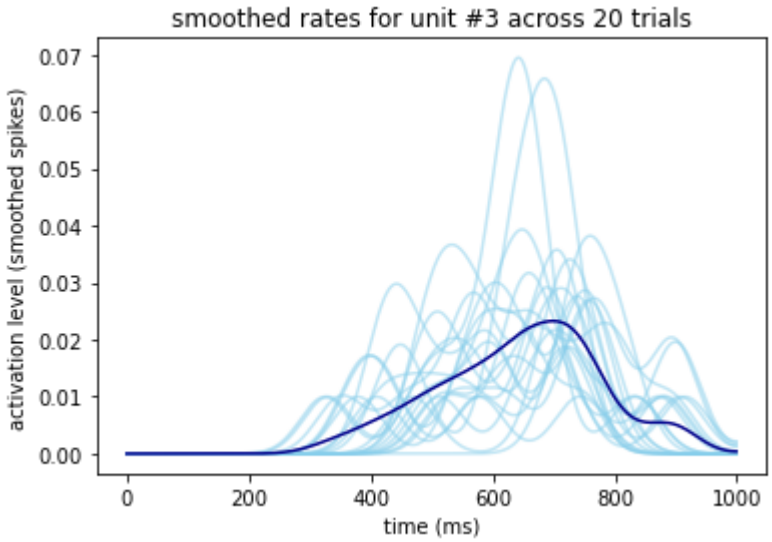

MU response curves
probability of zero spikes in each bin
time (ms)
mean thresholds
6.0
6.0
5.0
4.0
4.0
4.0
4.0
3.0
2.0
2.0

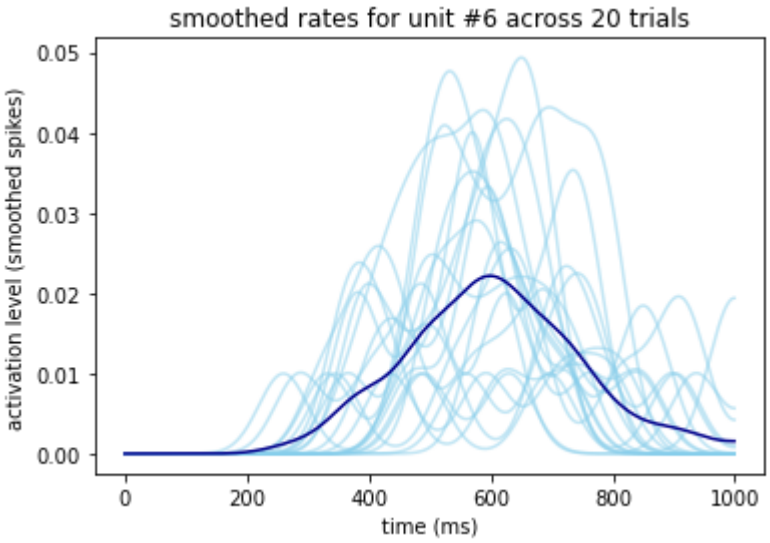

spikes present across MU population during trial
motor unit spikes sorted by threshold
time (ms)
approx. cnt
1.0
3.0
3.0
7.0
7.0
12.0
11.0
14.0
24.0
19.0

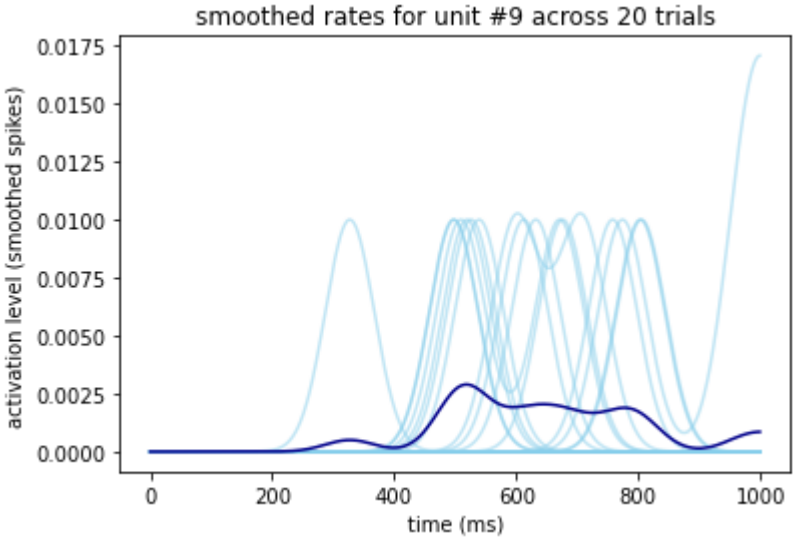

smoothed spikes present across MU population during trial
activation level (smoothed spikes)
time (ms)


smoothed spikes present across MU population during trial
activation level (smoothed spikes)
0
2
4
6
8
0
200
400
600
800
1000
time (ms)


smoothed rates for unit #0 across 20 trials
activation level (smoothed spikes)
0.00
0.02
0.04
0.06
0.08
0
200
400
600
800
1000
time (ms)


smoothed rates for unit #3 across 20 trials
activation level (smoothed spikes)
0.00
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0
200
400
600
800
1000
time (ms)


smoothed rates for unit #6 across 20 trials
activation level (smoothed spikes)
0.05
0.04
0.03
0.02
0.01
0.00
0
200
400
600
800
1000
time (ms)


smoothed rates for unit #9 across 20 trials
activation level (smoothed spikes)
0.0175
0.0150
0.0125
0.0100
0.0075
0.0050
0.0025
0.0000
0
200
400
600
800
1000
time (ms)