cppcourse-brunel

introduction

This program simulates a spiking neural network of 12500 neurons described in Nicolas Brunel's paper "Dynamics of Sparsely Connected Networks of Excitatory and Inhibitory Spiking Neurons".

The main objective is to be able to reproduce figure 8 found on page of the abovementioned paper. To do so, I've implemented a C++ program that outputs a data file containing the spiking times of 50 randomly chosen neurons.

implementation documentation

All information concerning the C++ program can be found in the attributed Doxygen file. `cppcourse-brunel/html/index.html` Additional information about the simulation can be found in the paper.

running the program

The program is automatically set to case C of figure 8. In order to reproduce all cases, constants G and ETA are to be changed in the `constants.h` file. Running the simulation will print out the number of average spikes per second as well as the total running time for a 1 second simulation.

plot reproduction

In order to plot the data, I used a jupyter notebook file creating two plots : a scatterplot and a histogram.

- The scatterplot shows the neuron ID (y-axis) depending on the spiking time (x-axis). In fact, every dot corresponds to one spike.
- The histogram shows the number of spikes for a given time interval (bins of 1 ms).

The results in this file are from my own jupyter notebook, but equivalent results could be obtained from either Prof. Gewaltig's jupyter notebook or Antoine Albertelli's web application https://cs116-plot.antoinealb.net/.

jupyter notebook

here is the specific jupyter notebook I used. The ipynb file can be found at `cppcourse-brunel/results/rasterplot.ipynb`

rasterplot

```
import matplotlib.pyplot as plt
import numpy as np
```

```
x, y = np.loadtxt('rasterdata.gdf', delimiter = '\t', unpack = True)
```

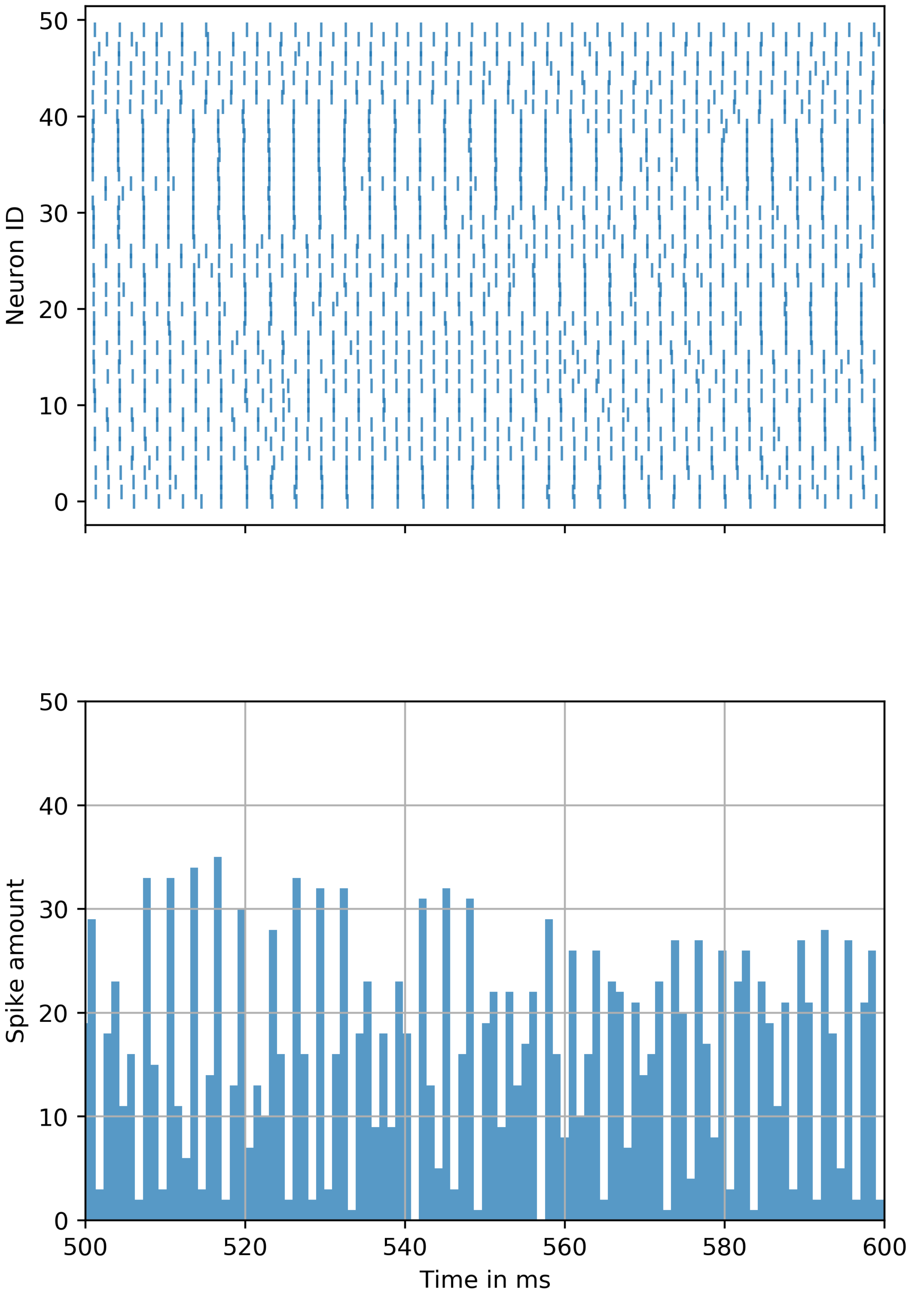
```
fig,ax = plt.subplots(1)
ax.plot(x,y, "|", alpha=.8)
plt.xlim([500, 600])
plt.ylabel('Neuron ID')
ax.set_xticklabels([])
plt.savefig('fig.png', dpi = 400)
plt.show()


plt.hist(x, 1000, rwidth=1, alpha=.75)
plt.xlim([500, 600])
plt.ylim([0,50])
plt.xlabel('Time in ms')
plt.ylabel('Spike amount')
plt.grid(True)
plt.savefig('hist.png', dpi = 400)
plt.show()
```

results

note : only 100 ms of total simulation are shown

- case A

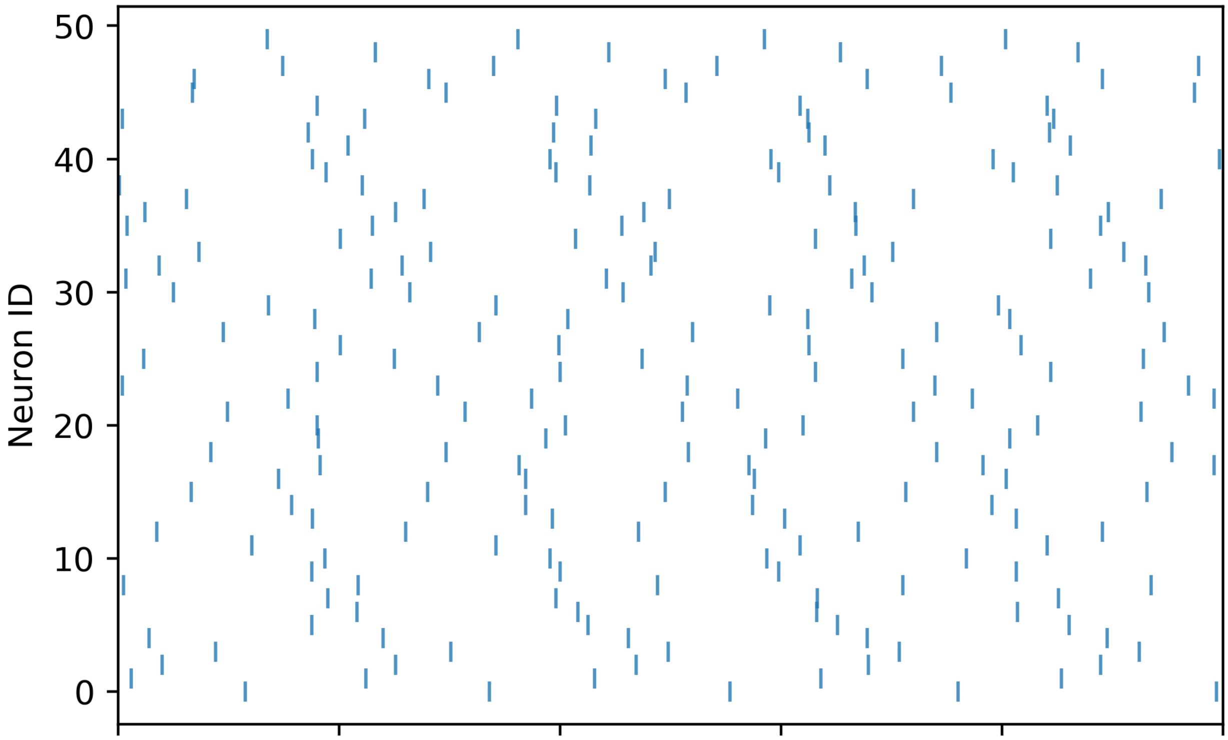


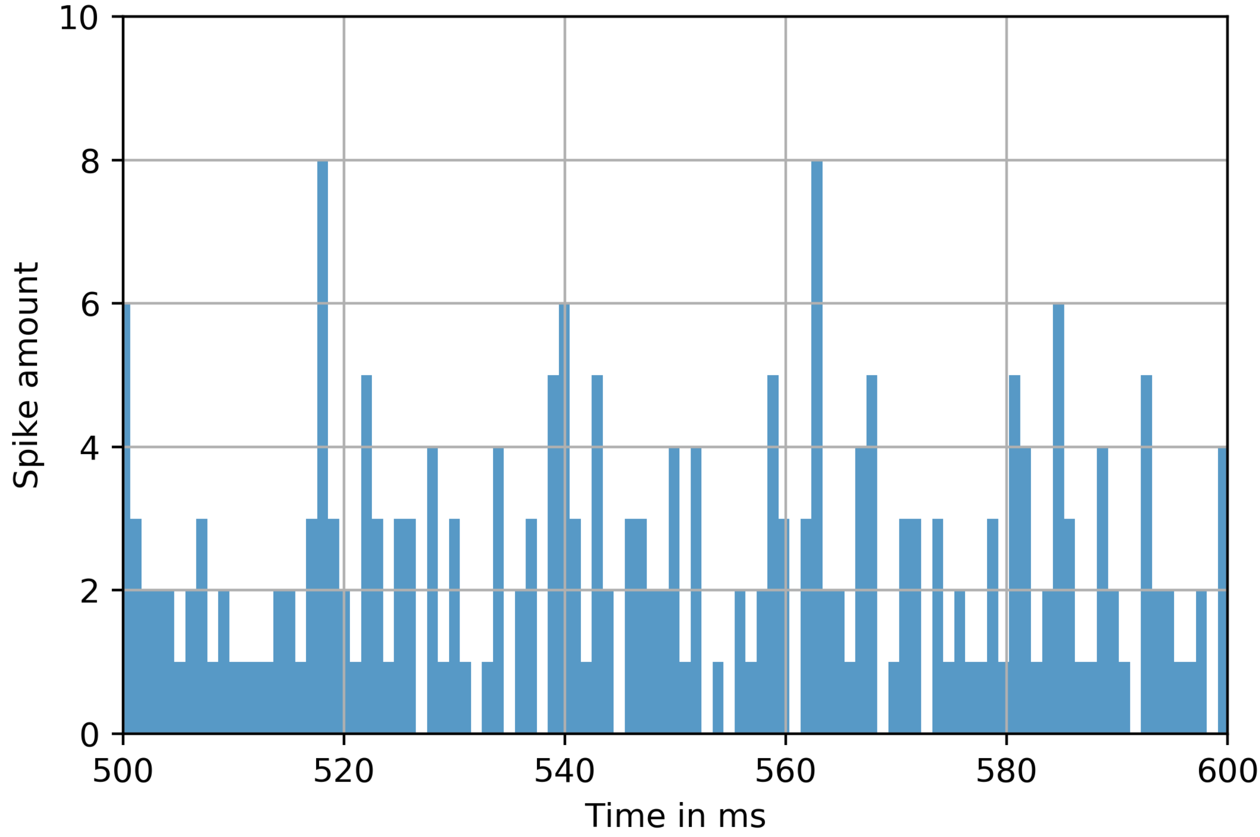
Neuron ID
50
40
30
20
10
0
Spike amount
50
40
30
20
10
0
500
520
540
560
580
600
Time in ms

Average spike number : 318.039 per second

Total runtime : 84.127 seconds for 1 simulation second

- case B

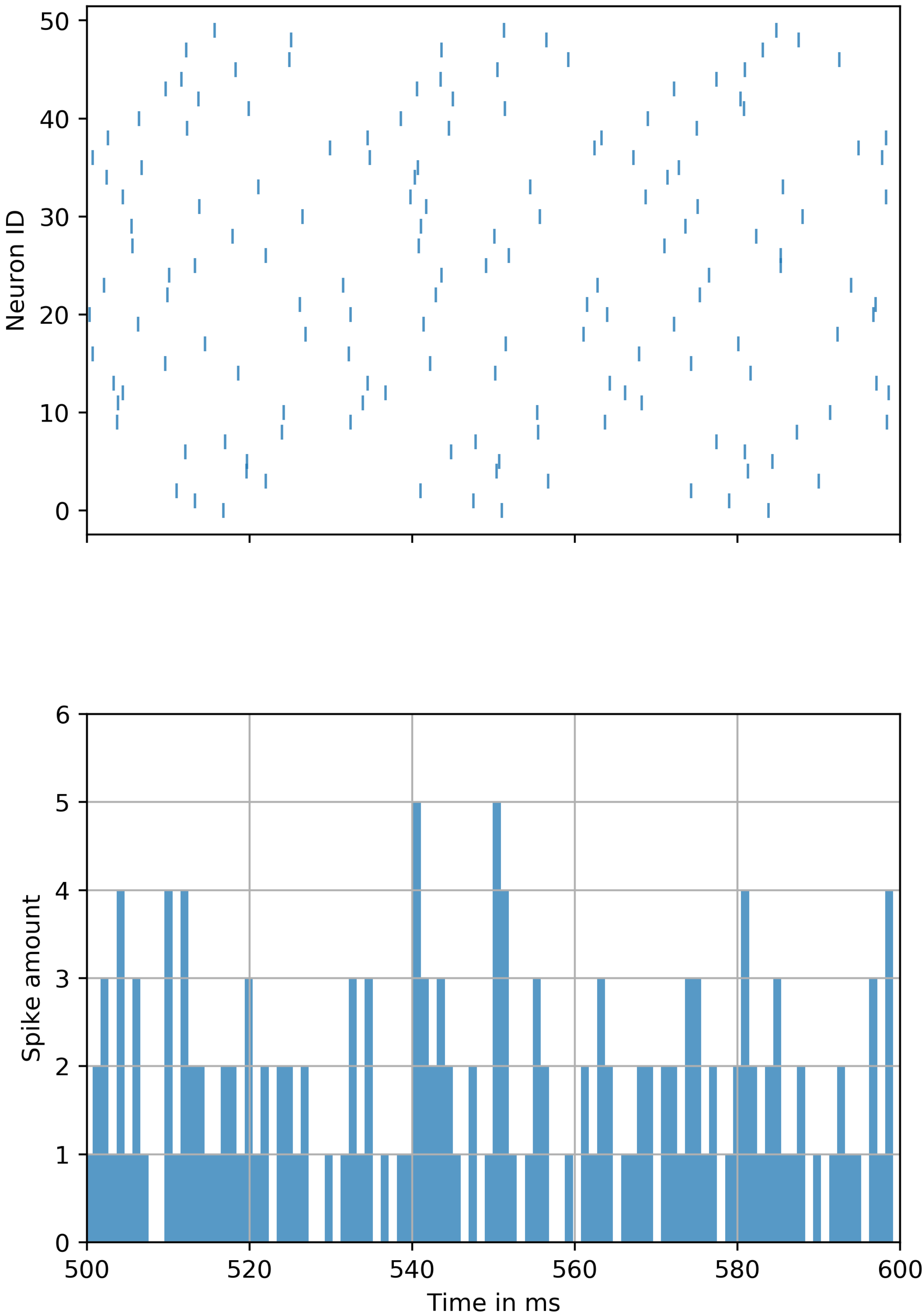




Average spike number : 47.075 per second

Total runtime : 101.813 seconds for 1 simulation second

- case C

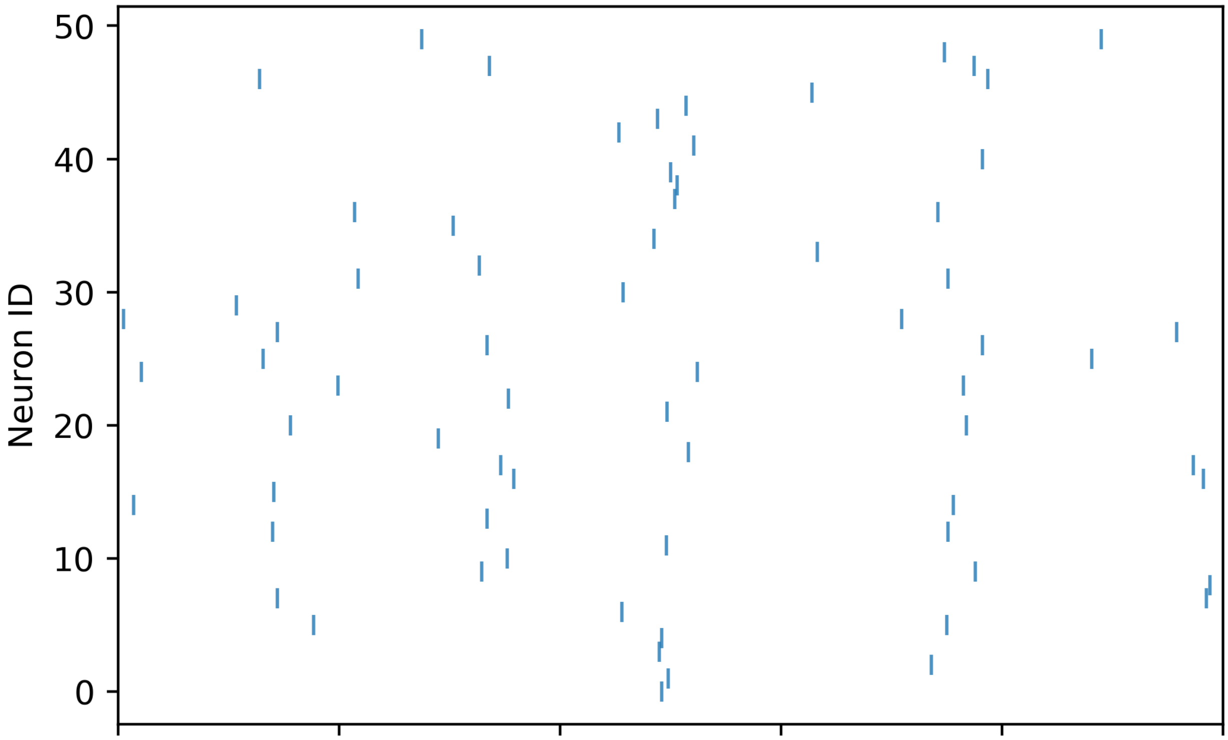


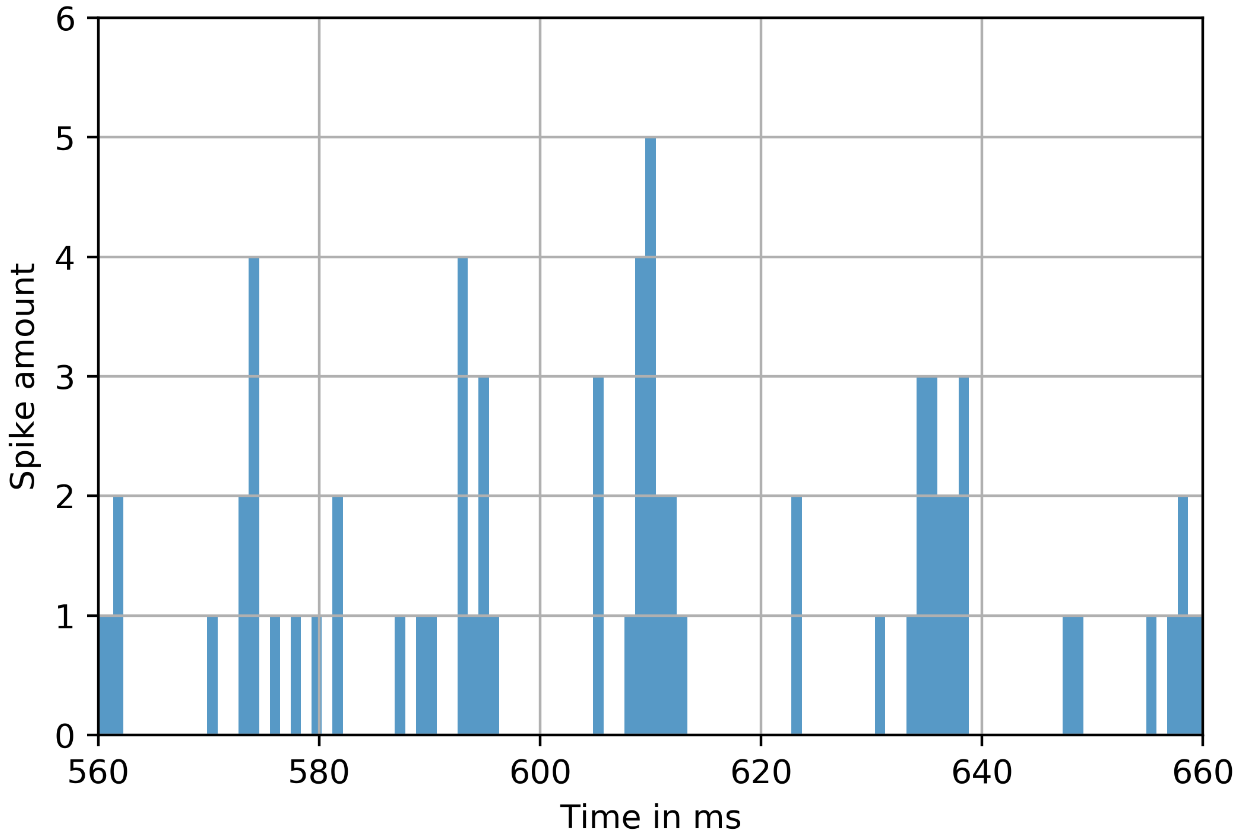
Neuron ID
0
10
20
30
40
50
Spike amount
0
1
2
3
4
5
6
500
520
540
560
580
600
Time in ms

Average spike number : 31.2985 per second

Total runtime : 92.1516 seconds for 1 simulation second

- case D





Average spike number : 14.3681 per second

Total runtime : 75.854 seconds for 1 simulation second