BE9-MMMB – Mathematical Methods for Bioengineers

Coursework Three
Deadline: 5pm, Fri 10th Jan, 2020.

Each coursework consists of a set of “real” data analysis or mathematical modelling tasks, which you should be able to carry out with the aid of what you have learned from the lectures and problem classes.

Your coursework should be created as a Jupyter Notebook. To submit this through Blackboard, first convert it to html. To do this, from the notebook itself run the following command:

```
! jupyter nbconvert --to html your_notebook_name.ipynb
```

Your coursework submission should include markup text describing your answers to the questions, and explanations, your code, and inline figures. Your figures should be of publication quality – label all axes, provide legends where appropriate, etc. Each answer should include a brief discussion of you’re the meaning of your quantitative results, markup text.

You may collaborate, but you must write up your report **completely independently** (this will be checked), and <u>reference all sources</u> beyond the material on Blackboard.

<u>Coursework Three</u>

1. Load the full imaging dataset (see previous coursework) in the file cw1_data2.mat. You may have noticed that the calcium fluorescence time series for each cell in this dataset comprises brief “calcium transient” events interspersed amongst the baseline fluorescence. Write a function to convert each time series into an event train, in which an (instantaneous) event corresponds to the beginning of a detected calcium transient. For three selected cells, plot the continuous fluorescence time series as a function of time, with the times of detected events marked by a tick overlaid on the same plot.

[30 marks]

2. As described in previous coursework exercises (particularly Coursework One), the data is collected from a mouse running in repeated loops around a circular track. Write a function which returns the data for a cell in the form response[trial,position], where trial indicates which loop around the track the mouse is on, position indicates the binned spatial angle of the mouse’s location, and response is 0 or 1 as above. Plot this as a `rastergram’ (ticks indicating events on axes showing trials (y axis) vs angular location (x axis)) for three example cells showing high, medium and low selectivity of the firing of the cell to the mouse’s location on the circular track.

[20 marks]

3. For these 3 cells, calculate the mutual information between the binary response variable and spatial angle, theta. Use 20 bins for spatial angle. Does this correspond to what you expect based on the previous plots?

[20 marks]

4. How much information does the “best” cell convey about spatial location, compared to the uncertainty (entropy) of the spatial location variable?

[10 marks]

5. Plot the distribution of spatial information values (in bits) for all cells, and briefly discuss your results.

[20 marks]

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6 December 2019