CS 292F.300 Final project proposal

Jonny Luntzel

TOTAL POINTS

1 / 1

QUESTION 1

1 Proposal submitted 1 / 1

✓ **- 0 pts** **Correct**

This sounds great. I look forward to seeing the results.

292 Project Proposal

Outline

- An analysis of a pathway found in the drosophila brain, the anterior visual pathway
- Retrieve specific neuron types as object files, make assumptions in order to model them as RC circuits
- Discretize
- If time permits (it won't), take into account branching axons instead of simplifying as 1 input / output per neuron type

The drosophila brain maintains a neural bump of activity in an ellipsoidal substructure called the ellipsoid body (EB), and visual inputs help to maintain an internal compass-like representation of the animal's position. Specifically, there is a pathway called the anterior visual pathway (AVP) in drosophila (see figures below) which I aim to analyze using some of the techniques learned in our class. The AVP moves from the medulla (ME) to the AOTU by means of MeTu neurons, from the AOTU to the BU by means of TuBu neurons, and from the BU to the EB.

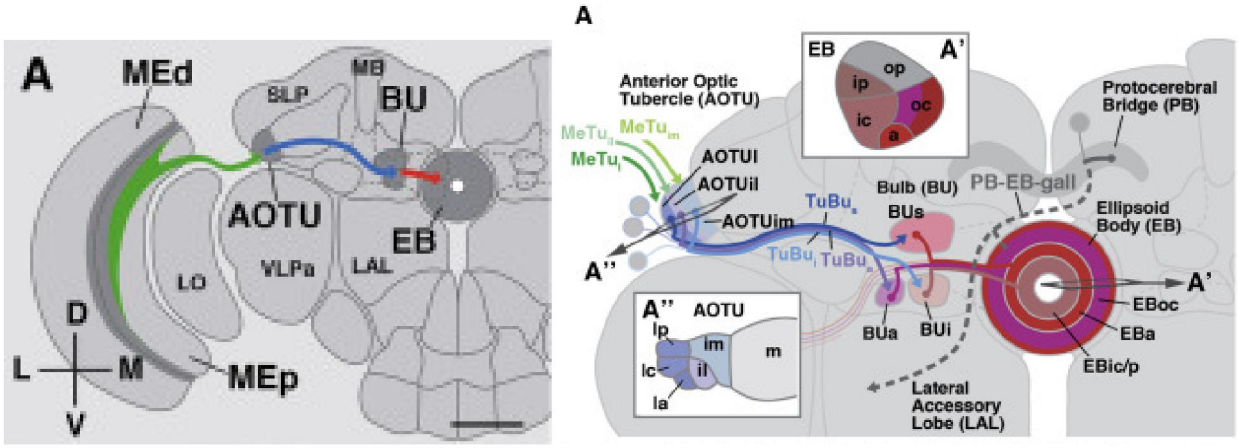

Fig 1: First leg (green) is from ME to AOTU. Second leg (blue) is from the AOTU to BU. Final leg (red) is from BU to EB of the central complex [1].

The medulla is a couple layers below the surface of the eye and is involved in sending visual information to deeper regions for the processing of form, colour, and direction of motion, while the AOTU is one of those regions. The pathway at hand has peculiar properties, such as TuBu neuron output signals corresponding to a retinotopy (the visual field is tiled by neural responses, and retinotopy describes this arrangement) that covers the ipsilateral visual field for the bulb to send to the ellipsoid body. This suggests that the AVP plays a role in maintaining the internal bump within drosophila, and its mechanics are not clear.

Looking at the electrical properties of neurons, the cell membrane insulates and both the inside and outside of the cell can conduct ([2], [3]). Therefore, the membrane can be treated as a capacitor and the possibility arises for differing charges inside and outside the cell. I plan to use an EM reconstruction database called Flywire, and retrieve object files of three or more neurons in the left posterior lateral pathway, which is one of many pathways comprising the AVP. With the specific neuron types I will make simplifying assumptions found in cable theory such as assuming voltage only differs along the longitudinal axis of the neuron, and create or use a model which allows me to find the voltage, current, etc. along various regions of each neuron given some external current applied to the outermost of three neurons. In summary I will implement a model that can report predicted signal propagation times and other potentially interesting measures. The computational modeling will likely be done in Mathematica and I may use external software for retrieving radius, length, and other morphological measurements of neurons that will be documented.

By treating small discrete compartments within neurons as vertices, and connections between them as edges, I can follow the notation of May 3rd lecture and write the system in matrix format. The resulting graph will look like path graphs stitched together, where most vertices have a degree of 2 and some have a degree of 3 or more if any neurons innervate a handful of other neurons. Then I can perform analyses of which I am not currently still considering. To answer what kinds of analyses I can perform, I aim to review chapter 11 and lectures on resistive networks to gather ideas. The distance between neurons is minute and they are basically touching each other, so for the sake of time and simplicity I may treat the entire pathway effectively as a single neuron. Furthermore I will likely treat branching axons as just 1 output.

I may also treat an entire neuron as a vertex whose voltage is whatever it ends up at its outgoing axonal arbors, and am open to revisions and suggestions.

Works Cited

https://www.sciencedirect.com/science/article/pii/S0960982217302658 [1]
http://www.scholarpedia.org/article/Electrical_properties_of_cell_membranes [2]
http://www.scholarpedia.org/article/Neuronal_cable_theory [3]

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