39 hours logged, up to 70-80 h actually spent

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| --- | --- |
| Log:   1. Dates 2. Tasks 3. Time it took (min) 4. Complete/Partially/Not 5. Notes   Notes: What I did, why, Improvements, next steps, questions  If we have more time:   1. Plug in more realistic data 2. Make interactive (with sliders?) 3. Improvements:    1. 3D – cells not overlapping 4. **GPT math questions** 5. **Finish tests:**    1. **Why it breaks in expanded view?** | Next to dos:   1. **Write discussion** 2. **~~Polish math – explanation~~** 3. **~~Write function documentation~~** 4. **~~Add noise (only discussion)~~** 5. **Self assessment** 6. **Read through the file.** 7. **~~References list~~** 8. How gradient descent works 9. Add random noise 10. Test model     1. Consider making some signals defective to see what happens   Thesis eg. RGC axons grow towards the optic disc even in mouse models with defective growth into the optic fiber layer (e. g. Slit1/2 or Robo mutants, see Thompson *et al.*, 2006)   * 1. See what percentage of axons move up and then towards the optic disc |
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| Date | Tasks | Time spent | C/P/N | Notes |
| 21.04 | Write a short into  Play around with current model |  | N  P | Model works now. Need more specific tasks in order to do better. |
| 28.04 | Locate Uni thesis | 15 | C | **What? -** Hristina.t.stefanova drive (Not the final version but should be ok)  Downloaded into project folder  **Why?** – use optic pathway info and references |
|  | Write a short intro | 45 | P | **What? -** Explained what neurons are and the optic pathway as the inspiration of the project.  **To do: Transform first step paragraph from thesis into model:**  **Include chemoattractors and repelents, noise (what type? Maybe we can explore several?)** |
| 02.05 | Transform first step into a model plan | 120 | P | 1. Find an image to demonstrate location of RGC and where the axons need to go 2. Found out new information – **repulsive signalling seems to be the main one that I can use**. Chemmoattractant NCAMs are secreted by RGC themselves to make a tract. 3. Next steps? – check gpt info??? 4. Repulsion is a bit shit because I only have attraction starting code. |
| 03.05 | Look at chemoattraction code from GPT try to figure out how it works and take it from there. | 120 |  | Understand how the code works.  I managed to:   1. Reverse from attraction to repulsion (change + to -) 2. Numpy functions:    1. np.meshgrid – creates a coordinate mesh? Somehow?? 3. Find some things about plotting a gradient (see knowledge)    1. Assume exponential decrease of concentration    2. Distance from a point in any point is      1. Start on making an image of what you want to put in the model:   A diagram of cell layers  AI-generated content may be incorrect. |
| 06.05 | 1. Plot a field with the layers  2. Put multiple amacrine cells to secrete repulsive gradient  3. Place some neurons |  |  | 1. Found out about laminin and muller glia repulsion 2. Made a model |
| 07.05 | To do:   1. Model optic disc with netrin attraction |  | P |  |
| 17.05 | Add optic disc attraction | 150  15 | C  C | Added optic disc attractants – works ok, not perfect  Changed sigma for attraction – wider attraction field  **Edited** code for readability – separate attractor fields, name stuff properly |
| 18.05 | Start on an introduction | 30  60 | P | Create the final ipynb file – start piecing together  Generate 2 variants of random noise – see what happens  What to do now – Explain how the code works with math |
| 20.05 | Review guidelines | 10 | P | NB – must show **analytical skills** – how the model is constructed, testing the model somehow |
|  | Understand and edit the math explanation – the **most important** thing |  | N |  |
|  | Edit grid size – make rectangular | 85 | C | Grid size now – 160 x 80 – more rectangular to reflect actual retina  NB coordinates are still normalised which makes it a bit more weird – uses % of the x and y to place sources and neurons |
| 21.05 | 1. Tweak model  2. Test model  3. Writing  **4. GPT questions about the model** | 45  65 |  | Learned about np.gradient() – calculating partial derivatives; GPT generated model that uses all 8 neighbours  Comparison between random white noise and correlated perlin noise |
| 22.05 | 1. GPT questions cont. | 110 |  | Method:   1. Go though each question: 2. Spend 10 mins trying to respond – when time is up finish your answer and get feedback 3. Ask about things you don’t understand   Questions:  **5. Numerical Method**  *You implemented a discrete Euler-style gradient descent. What are the potential numerical drawbacks of this approach, and could other integration methods (e.g., Runge-Kutta) be better suited?*  **6. Field Superposition**  *The total field is a linear sum of all cues. Can you think of biological or mathematical reasons to consider non-linear interactions (e.g. saturation or inhibitory dominance)?*  **7. Biological Interpretation**  *If a simulated axon failed to reach the optic disc, what conclusions could you draw about the field configuration or step size? Could this mirror any known developmental pathologies?*  **8. Limitations and Next Steps**  *What are two limitations of your current model that could be addressed with modest effort in future iterations?*  Prompt:  Lets go though the next defence question. Please give me feedback on my answers and then improve on them or generate a better answer. Here’s the question:  Very helpful to gain more insight into the project |
| 24.05 | Write up | 100  50 |  | Edit and add introduction images. Edit introduction.  Edit code – tried moving attractors down but the code needs more tweaking to work. Abandon this for now and concentrate on the working model.  Use model without noise for now |
| 26.05 | Wrap model in functions  Math explainer | 200  80 |  |  |
| 27.05 | Compare funcions in own solution and chat GPT  Test  Write-up | 60 |  |  |
| 28.05 | Run tests | 60  90 |  | Attempt to plot start x over highest\_y – start\_y – didn’t work  Made main return axon trajectories  Plot start\_x over highest\_y – start\_y |
| 29.05 | Polish math explanations  Do more tests/Refine model |  |  | 1. Field generation – include the strength parameters, field is weighted sum 2. Include assumptions for the field and axon movements 3. Ploted axons on target – not great many 0 |
| 30.05 | ?Refine model to factor cell sizes  Order tests  Write discussion | 30 | P | What? – Found an image |
| 01.06 | Refine fields coordinates (y axis) | 30 | P | Looked at some histology slides. Ratio appears to be:   * Amacrine layer (but it contains other cells too) – 10 * RGC layer – 5 * Optic fiber layer – 5 * Muller endfeet layer – 1   However this is not super accurate, and has many problems – RGC includes whole cell bodies which are quite big themselves  Muller layer is not easy to see  Amacrine layer is very thick but includes other cells as well  Attempted to change field ratios but it makes other problems come up ☹ |
| 02.06 | Write testing section. | 120 | P | Müller glia have limited effect.  Test model in expanded view – **breaks why**?  Spillover effect of amacrine repulsion in the attractor field? **How to fix it?** |
| 03.06 | Write testing section. | 180 |  | Plotted final axonal positions for several trials. Why? – assess model success |
| 04.06 | Recover logs and todos  Finish test section (80min)  Write discussion | 20  160  90 | C  P  P | 1. Do axons grow upward? – not great 2. Identified problem with wide field – fixed by modifying coordinates 3. Still not working as expected – sigma |
| 05.06 | Finish discussion  Write function documentation  Mathematical explainer | 90  40  72 (mins) | P  C | Write the math discussion\  Thank you chat GPT |