Week 2 initial meeting

Albert

August 15, 2025

Attendees: Albert, Kyle, Calvin, Oscar, Tim
Location: Carslaw 356 Time: 1400-1600

1 Admin

- Agreed to meeting every Wednesday in Fisher / libraries, at 1600-1700
- Formed a WhatsApp group to coordinate team
- Created a Github repo for all members
  - Repo is owned by Albert, on their personal github account
  - Personal accounts were created for Calvin, Kyle and Tim

2 Roles

Decided to just let roles settle, as opposed to creating a hierarchy (group leader, programmers, calculators etc.)
Albert is only second year, all others are third year. Good spread of MATH20/922, MATH20/921, MATH20/923, and various 3rd year units like non-linear odes, financial derivatives, metric spaces etc. Oscar and Kyle both have a second major in Physics, Oscar has minimal programming experience, Kyle has programmed in Swift. Calvin is CompSci major, and so is comfortable with programming. Tim has done Python and R previously, Albert has also done Python R, and has also done SAGE before.

Week 3 Minutes

Kyle George

August 23, 2025

Attendees: Kyle, Albert
Date: 20th of August 2025 from 1600 to 1620 Location: Fisher Library 2nd floor, common area.

1 Project Direction

- Kyle noted that the time to select the project's direction was approaching, and put forth Chapter 10 of the textbook as a potential direction.
- Albert suggested Chapter 4 as it may be easier from a mathematical and programming point of view.
- Kyle agreed with this, but added that an easier project may be less entertaining or interesting.
- Kyle and Albert then looked over the relevant textbook chapters, and concluded that it was best to make a final decision when the whole group was present.

The meeting concluded early as there was nothing further to discuss.

Secondary meeting.

Attendees: Kyle, Albert, Calvin
Date: 22th of August 2025 from 1200-1205 Location: Outside Carslaw 175

- Brief discussion of project with no conclusion reached. Kyle pushed for Ch10 again, whilst Albert again pushed for both neuro projects.
- Calvin had no strong opinions on any of the topics
- Conclusion reached was that our options for three topics should include Ch10 and one of the neuro topics.

Week 4 Minutes

Albert Stark

August 27, 2025

Attendees:Albert, Kyle, Calvin
Date: 27th of August 2025 from 1600 to 1625 Location: Fisher Library 2nd floor, common area.

1 Project selection

- Confirmed choice for selection of Chapters 5, 7, 10 as 1st, 2nd, 3rd preferences for project area respectivley.
- Discussed difficulty in producing the project proposal, which will likely have to be done at the Wednesday Week 5 meeting.
  - Albert will book a meeting room in Fisher Library for this purpose
- Confirmed that Oscar needs to be added to the WhatsApp group as it was realised that he had not been added in error at the initial meeting in the Week 2 Lab
- Confirmed that Calvin would send the E-Mail to Prof. Wechselberger with the preferences.

Meeting conclueded with the attendees agreeing that we should wait to recieve the confirmation of project specifics before further discussion on that front continued.

Week 4 Minutes

Albert Stark

September 3, 2025

Attendees:Albert, Kyle, Calvin, Kim
Date: 3rd of September 2025 from 1600 to approx. 1745 Location: Susan Wakil Health building: room 116, Calvins apartment

Presentation planning / writing

- All members assembled in room 116 and finished writing their slides.
- Difficulty was had with github diff management, but this was overcome with a bit of forced commits.
- The room was only able to be booked for 1 hour so a significant time pressure was felt. This was alleviated when Calvin offered us to walk 5 mins to his apartment to actually record the presentation
- Presentation was recorded in Calvins apartment, on the topic of a modified FitzHugh-Nagumo system of equations.
  - Each member of the group was recorded separately presenting their slides, to be edited later by Calvin
  - Calvin agreed to upload the final product + slides as the assignment submission

Meeting concluded with the attendees finishing recording the presentation and going their separate ways.

Week 6 Minutes

Calvin

September 14, 2025

Attendees:Albert, Kyle, Calvin, Tim
Date: 10th of September 2025 from to Location: Fisher Library floor 2

Deciding new project

- Kyle noted that Martin mentioned on Ed discussion that projects should involve **more than two ODEs**, so we are reconsidering our project design.
- Our previous project direction included a **PDE component**, which is out of scope for this pitch, so we must pivot.
- The most recent idea we explored also drifts into PDE territory, meaning we will need to conduct further research before committing.
- We discussed drafting an **email to Martin** to clarify the requirements — specifically, to confirm:
  1. Whether the **Hodgkin–Huxley model** is acceptable as a project basis.
  2. Whether having **more than two ODEs** is strictly required.
  3. Whether alternative models like the **Izhikevich model** would be considered valid.
- Albert worked on the submodels and comparative analysis
- Kyle worked on the hodkin huxley and hindmarsh rose models
- Calvin worked on finding research papers

Week 7 Minutes

Calvin

September 21, 2025

Attendees:Albert, Kyle, Calvin, Tim
Date: 17th of September 2025 from to Location: Fisher Library floor 2

Deciding new project

- Kyle will perform phase–plane analysis, acknowledging that some parameters may currently be inaccurate.
- Kyle has implemented a prototype version of the Connor–Stevens model and submitted it to the GitHub repository.
- Kyle will continue development and refinement of his prototype model.
- Albert will investigate the parameterization of the model by conducting background research and attempting to reconcile the values with published sources.
- Calvin and Tim will continue to focus on identifying experimental datasets relevant to the Connor–Stevens model.
- We plan to perform phase–plane analysis across nontrivial and scientifically interesting parameter combinations. This will include 2D analyses (e.g., membrane voltage versus gating variables) as well as higher–dimensional explorations such as five 3D phase planes.
- Tim has located a giant squid axon dataset but cannot yet confirm whether it is based on direct experimental recordings or on simulation data. Further investigation is ongoing.

Weekly Minutes Week 8 Math3888

Calvin Ming En Kok

September 2025

Attendees:Albert, Kyle, Calvin, Tim
Date: 24th of September 2025 from to Location: Fisher Library floor 2

Bifurcation Analysis and Experimental Data

Kyle generated bifurcation analysis diagrams using the Connor–Stevens model, examining 3D plots of real and imaginary parts under varying parameters. Since different initial conditions yield different trajectories, the steady state is the common feature that we focus on.

Albert, Calvin, and Tim were unable to find a publicly available dataset for the giant squid axon (the original Hodgkin–Huxley experiments). As a next step, they plan to contact the journal website that published the data to request access.

We also discussed the homework assignment, compared our bifurcation diagrams created with Python and XPPAUT, and considered possible reasons why discrepancies might arise.

Weekly Minutes – Week 9 (MATH3888)

Calvin Ming En Kok

October 2025

Attendees: Albert, Kyle, Calvin, Tim
Date: 8th September 2025
Location: Fisher Library, Level 2

Discussion Summary

- The group reviewed the existing bifurcation analysis results and compared them with theoretical expectations.
- Some discrepancies were observed between simulated outcomes and preliminary experimental data, especially in the transition region.
- The team agreed that improving simulation runtime is a priority to allow more parameter sweeps and detailed analysis.
- Data interpretation is still in progress; more biological context may be needed to validate the observed bifurcation points.
- Plans were made to prepare preliminary figures for inclusion in the project report and Week 10 presentation.

Bifurcation Analysis and Experimental Data

- **Kyle** will work on improving the runtime of the model by implementing **multi-threading** in Python.
- **Albert** will continue refining the **bifurcation model**.
- **Tim** will analyse and interpret the **experimental data** found so far to identify emerging patterns.
- **Calvin** will:
  - Write XPP (.ode) files for the three time scales.
  - Plot the bifurcation analysis model in XPP.

Weekly Minutes – Week 10 (MATH3888)

Calvin Ming En Kok

October 2025

Attendees: Albert, Kyle, Calvin, Tim
Date: 15th October 2025
Location: Fisher Library, Level 2

Discussion Summary

- Kyle has identified a potential codimension-2 pitchfork bifurcation and will proceed with simulations to ve
- Calvin will revisit the parameter settings to locate the Hopf bifurcation, testing alternative parameter combinations in XPPAUT.
- Albert will migrate the current private GitHub repository to a dedicated GitHub organization for improved collaboration and access control.Albert will move our github private repositary to a github organisation

Weekly Minutes – Week 10 (MATH3888)

Calvin Ming En Kok

October 2025

Attendees: Albert, Kyle, Calvin, Tim
Date: 22nd October 2025
Location: Fisher Library, Level 2

Discussion Summary

- Calvin managed to find a hopf bifurcation for the full system with V vs Iapp after changing one of the parameter values v3 from -45 to 45.
- kyle and albert also verified this hopf bifurcation using time series code in python
- the group will start working on the presentation and report, the group also has allocated sections for the report
- albert and calvin will extract the experimental data we found in binary and run it in our model and compare the results

Weekly Minutes – Week 12 (MATH3888)

Calvin Ming En Kok

October 2025

Attendees: Albert, Kyle, Calvin, Tim
Date: 29nd October 2025
Location: Fisher Library, Level 2

Discussion Summary

- Our group worked collaboratively to develop the presentation.
- Kyle coordinated the structure by assigning slide responsibilities and speaking times to each member.
- The slide distribution is as follows:
  - Slide 1: Time
  - Slides 2–3: Albert
  - Slide 4: Kyle
  - Slide 5: Calvin
- The total presentation duration is approximately 7 minutes and 50 seconds.
- We also discussed and agreed on the key points to include for clarity and coherence.

Weekly Minutes – Week 13 (MATH3888)

Calvin Ming En Kok

November 2025

Attendees: Albert, Kyle, Calvin, Tim
Date: 5th November 2025
Location: Fisher Library, Level 2

Discussion Summary

- Our group worked collaboratively to finalise the report.
- We organised and formatted the images and written content to ensure the report fit within the page limit.
- Kyle focused on producing the tables for the experimental data.
- Albert took the lead in structuring and organising the overall report layout.
- Calvin completed the analysis of the timescales in the *Mathematical Results* section.