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Final Project Journal

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For: 3301 Numerical Methods of Simulation

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| December 2, 2022: Created the structure of the Project Journal and started thinking about the tasks and time that will be required to accomplish the project. |
| December 3, 2022: Started a Gannt Chart so we can get and stay organized.   * Create outline and structure of report (1 week) * Write Backward Euler Method for a constant h (1 week) * Write Newton Method (1 week) * Join the two methods (1 week) * Create introduction and literature review of report (2 weeks) * Meet to discuss code (1 day) * Write code for adjusting h based on second derivative (3 weeks) * Write code for adjusting h based on the Mean Square Error (3 weeks) * Write code for various convergence tests to show the algorithm still converges with the variable h’s (1 week) * Create the methodology section of the report (2 weeks) * Put all finished code into a single appendix file (1 week) * Compare methods (statistically) (2 weeks) * Write the results section of report (2 weeks) * Write discussion section of report (2 weeks) * Write conclusion section of report (2 weeks) * Create presentation (1 week) * Submit Report (1 day) * Present Project (1 day) |
| December 5, 2022: Finished the Gannt Chart and sent it to Sophia. She approves overall and we are off and running. We will spend this next week reviewing, reading, and collecting our thoughts and ideas. |
| December 8, 2022: I spent the day refining code from the exercises for the implicit solver using Newton’s Method. Mostly just MATLAB practice since I am rusty.  Calculate a derivative  <https://de.mathworks.com/matlabcentral/answers/30313-how-to-calculate-a-derivative>  Symbolic Math Toolbox  <https://de.mathworks.com/matlabcentral/answers/445457-how-to-install-and-enable-symbolic-math-toolbox>  Installing the add-on  <https://de.mathworks.com/matlabcentral/answers/101885-how-do-i-install-additional-toolboxes-into-an-existing-installation-of-matlab>  Reinstall Matlab with the add-on  <https://de.mathworks.com/matlabcentral/answers/98886-how-do-i-install-matlab-or-other-mathworks-products> |
| December 9, 2022: Started writing the Step Size section of the Introduction chapter of the report.  \*\*<https://mmsallaboutmetallurgy.com/wp-content/uploads/2019/01/numerical-methods.pdf>  \*\*<https://people.sc.fsu.edu/~jpeterson/nde_book4.pdf>  \*\*<https://personal.math.ubc.ca/~CLP/CLP2/clp_2_ic/ap_variable.html> |
| December 11, 2022: Finished the Step Size section of the Introduction chapter of the report.  \*\*<https://mmsallaboutmetallurgy.com/wp-content/uploads/2019/01/numerical-methods.pdf>  \*\*<https://people.sc.fsu.edu/~jpeterson/nde_book4.pdf>  \*\*<https://personal.math.ubc.ca/~CLP/CLP2/clp_2_ic/ap_variable.html> |
| December 12, 2022: Professor Struck wants us to compare our methods to some other adaptive step size methods, so I spent the day researching. This is a huge topic and I only understand things at the surface level so I started with the textbooks today. Hopefully I will find a few options before meeting with Sophia on Wednesday.  \*\*<https://mmsallaboutmetallurgy.com/wp-content/uploads/2019/01/numerical-methods.pdf>  \*\*<https://people.sc.fsu.edu/~jpeterson/nde_book4.pdf>  \*\*<https://personal.math.ubc.ca/~CLP/CLP2/clp_2_ic/ap_variable.html> |
| December 13, 2022: I decided on the adaptive step size control method and the predictor-corrector method. Both are commonly used and I already understand the basics of one of them so that’s a plus. Today I just made some notes about how they work so I can talk to Sophia about them tomorrow. |
| December 14, 2022: Met with Sophia to discuss the project so far. For the early stages, we will essentially split the labor between the report and the coding. I will start doing the literature review and she will start programming. We were initially going to use Struck’s solution for the base algorithm with a constant step size, but she thinks it would be better if we made our own, and it will make coding the other two algorithms easier, which are good points. So, she is going to write all three algorithms from scratch. |
| December 17, 2022: Wrote intro section about adaptive step size control method.  <https://en.wikipedia.org/wiki/Adaptive_step_size>  \*\*<https://people.sc.fsu.edu/~jpeterson/nde_book4.pdf>  \*\*<https://personal.math.ubc.ca/~feldman/math/vble.pdf> |
| December 18, 2022: Wrote intro section about predictor corrector method.  <https://en.wikipedia.org/wiki/Adaptive_step_size>  \*\*<https://people.sc.fsu.edu/~jpeterson/nde_book4.pdf>  \*\*<https://personal.math.ubc.ca/~feldman/math/vble.pdf> |
| December 21, 2022: Sophia wants to do the report in Latex. I don’t prefer it because I’m not great at it, so this is a good opportunity to improve my skills. I went through dozens of templates looking for something decent and I eventually found one to use:  <https://www.overleaf.com/latex/templates/politecnico-di-milano-deib-phd-thesis-template/ydsvtyzwxfdk>  Some of the places I looked:  <https://www.overleaf.com/gallery/tagged/report>  <https://www.latextemplates.com/cat/academic-journals>  <https://en.wikibooks.org/wiki/LaTeX/Scientific_Reports>  <https://scientificallysound.org/2019/02/19/1396/> |
| December 22, 2022: Started transferring work so far into Latex  <https://tex.stackexchange.com/questions/52276/inline-equation-in-latex-with-text>  <https://tex.stackexchange.com/questions/111580/removing-an-unwanted-page-between-two-chapters> |
| December 23, 2022 - December 26, 2022: Christmas |
| December 27, 2022: Still converting the stuff I already did from Word to Latex. Latex is a little annoying (tedious), but at least Overleaf is pretty user-friendly.  <https://tex.stackexchange.com/questions/111580/removing-an-unwanted-page-between-two-chapters>  <https://tex.stackexchange.com/questions/39988/space-before-chapters-and-contents>  <https://epsviewer.org/onlineviewer.aspx>  <https://www.overleaf.com/learn/latex/Bibtex_bibliography_styles> |
| December 28, 2022 - January 1, 2023: New Years |
| January 2, 2023: I finally got all my previous work into Latex. I also made the whole structure of the document including the abstract, chapters, and appendix. Now we should just be able to drop content into it as we generate it. The only thing I have left to add is the bibliography. |
| January 6, 2023: Wrote bibliography in Overleaf. That was more complicated than I expected. Thank goodness for nice people on StackExchange!  <https://www.overleaf.com/learn/latex/Bibtex_bibliography_styles>  <https://tex.stackexchange.com/questions/17445/how-can-i-change-the-references-to-reference-in-the-thebibliography-environm>  <https://tex.stackexchange.com/questions/36396/how-to-properly-write-multiple-authors-in-bibtex-file>  <https://tex.stackexchange.com/questions/12597/renaming-the-bibliography-page-using-bibtex> |
| January 7, 2023: Started methodology section today: chose test IVPs for testing and wrote MATLAB code for visualizing their analytical solutions.  <https://tex.stackexchange.com/questions/198432/using-the-tab-command>  <https://tex.stackexchange.com/questions/254785/e-vs-exp-in-display-mode>  <https://www.symbolab.com/solver/ordinary-differential-equation-calculator/y%E2%80%B2%5Cleft(t%5Cright)%2B4y%5Cleft(t%5Cright)%3D8t%2C%20y%5Cleft(0%5Cright)%3D1?or=input>  <https://garsia.math.yorku.ca/MPWP/LATEXmath/node9.html>  <https://oeis.org/wiki/List_of_LaTeX_mathematical_symbols>  <https://www.overleaf.com/learn/latex/Subscripts_and_superscripts>  <https://tex.stackexchange.com/questions/20538/what-is-the-right-order-when-using-frontmatter-tableofcontents-mainmatter> |
| January 8, 2023: Wrote the intro to the Methodology chapter today. Also uploaded the MATLAB code from yesterday to Appendix A after figuring out how to format code using the mcode package  <https://www.overleaf.com/latex/templates/highlighting-matlab-code-in-latex-with-mcode/nhtksndnsmmx>  <https://tex.stackexchange.com/questions/343723/where-put-mcode-sty>  <https://github.com/TeXworks/texworks/issues/828> |
| January 9, 2023: Wrote the Second Derivative section of the Methodology chapter.  <https://de.mathworks.com/matlabcentral/fileexchange/8015-m-code-latex-package>  <https://courses-archive.maths.ox.ac.uk/node/view_material/49161#:~:text=To%20include%20your%20Matlab%20file,m%7D>. |
| January 11, 2023: Wrote the Mean Square Error section of the Methodology chapter.  <https://de.mathworks.com/matlabcentral/fileexchange/8015-m-code-latex-package>  <https://courses-archive.maths.ox.ac.uk/node/view_material/49161#:~:text=To%20include%20your%20Matlab%20file,m%7D>.  <https://www.google.com/search?q=how+to+add+a+.sty+into+the+same+folder+as+your+latex+document&sxsrf=AJOqlzUkdWfoD-b9Hw1DH6YFPawDUeNJmQ:1673174702397&source=lnms&tbm=vid&sa=X&ved=2ahUKEwjn8KG-5bf8AhXLzqQKHW6kDrUQ_AUoAXoECAEQAw&biw=1536&bih=664&dpr=1.25#fpstate=ive&vld=cid:98f67153,vid:R5uFpUdnMA0> |
| January 13, 2023: I wrote some code today for the adaptive step size control method and the predictor corrector method, but it’s a pretty hacky (my style lol) and I’m not sure if it’s actually working correctly. I guess we probably won’t include it in the project, but I spent my day doing it so I figured I would mention it. |
| January 14, 2023 - February 6, 2023: Studying for and taking exams for other classes. |
| February 7, 2023: We are getting pretty behind where we wanted to be in the Gannt Chart. Studying for exams just took more than we expected, but those are over now, so it’s time to kick things into overdrive. I talked to Sophia today; she said she is basically done with the code, but still has a few bugs to work out to make the programs easier to use. She said she should have them ready for testing by the end of the week. |
| February 9, 2023: I went back over the Introduction chapter making it look nicer and fixing some of the equations I messed up before. I spent the rest of the day getting the Results chapter of the report structured and ready for some tables and diagrams. |
| February 12, 2023: Got the code for all three algorithms from Sophia. Took a couple hours to understand everything she did and then started writing up the descriptions of the algorithms in the Results chapter of the report. |
| February 15, 2023: As written, the algorithms are solving y’=2x right now. Started trying to modify it to solve our test IVPs. It’s so hard to work on somebody else’s code!  I spent most of the day sifting through programming textbooks and old lecture notes as well as Reddit, StackExchange, Quora and Mathworks.com…no luck yet. |
| February 16, 2023: The code is working for the linear IVP, but we are still stuck on the other two. The code is written to solve a first order ODE, but IVP 2 and 3 are second order. It seems like it should be so trivial to modify the algorithms to work for a linear system, but I suck at coding and I am struggling. The only thing that makes me feel better is the fact that Sophia can’t figure it out either and she is *good* at coding…although that shouldn’t make me feel better since we still don’t have working code lol. |
| February 17, 2023: Sophia is trying to modify the base script and I am working on the 2nd derivative algorithm since it’s a little less complicated than the MSE one. When either of us is successful, we will do the same for the other two algorithms so that each algorithm solves all three test IVPs. A friend told me about a tool called chat GPT which can apparently write code for you, so now I am trying to figure out how to use that to get some help. No success yet, but from what I have seen so far, it’s actually a pretty amazing tool.  <https://chat.openai.com/chat> |
| February 18, 2023: I feel so close to getting this stupid thing to work I could cry. I have made and unmade so many changes, large and small, that it’s getting difficult to keep track of what I have tried already. Every time I figure out how to deal with one error, three more show up that I have never heard of. I had high hopes for chat GPT at first, and it *is* an amazing tool for some things, but it’s useless when it comes to writing code, at least MATLAB code for these purposes. Giving up on that pathway and going back to StackExchange and Mathworks now. |
| February 19, 2023: Another full day spent trying to modify the 2nd derivative code. Starting to get discouraged. |
| February 20, 2023: Met with Sophia again today. We decided we would try for one more day to modify the scripts to solve the test IVPs…if we are unsuccessful, we will meet again tomorrow and choose two more first order IVPs to test instead. I tried for three more hours with no success. Giving up. I guess we only have a first order ODE solver. |
| February 21, 2023: Talked to Sophia and we just decided to cut our losses and come up with some easier test IVPs. We are going to stick with linear, non-linear and variable coefficients so I spent the afternoon looking for some suitable ones that are first order. Once I chose a couple, I remade the Analytical Solutions section of the Methodology chapter of the report. I also adapted the MATLAB code to generate solutions of the new IVPs and added those to the report as well.  <https://mathdf.com/dif/#>  <https://www.wolframalpha.com/>  <https://www.symbolab.com/solver/ordinary-differential-equation-calculator> |
| February 22, 2023: Sophia got the algorithms working for IVP 3, but the one I chose for IVP 2 isn’t working. So, we just decided to change it once more. I found another non-linear ODE and I think this one is even better since it includes a periodic trig function, which we did not have before. Once selected, I remade the analytical solution and the code for the graph and got them in the report.  <https://mathdf.com/dif/#>  <https://www.wolframalpha.com/>  <https://www.symbolab.com/solver/ordinary-differential-equation-calculator> |
| February 23, 2023: Woot! We finally have some results to write about! Today I started getting stuff into the Results chapter of the report. I also added the basic structure of the Discussion chapter. |
| February 24, 2023: Sophia added a bunch more stuff to the Results and Discussion chapters and the report is looking good. Today I started working on the Conclusion a bit, but I think she was working on it at the same time so, to avoid confusion in Overleaf, I decided to write the Abstract. This project is complete; it was time. :) |
| February 25, 2023: Spent today going back through the entire report, editing and polishing. English isn’t Sophia’s first language so grammar and flow come down to me. She is still working to get some of the diagrams and stuff into the report. I also fixed one of the images that annoyingly wouldn’t show up. It’s minor, but I spent over an hour trying to figure it out.  <https://tex.stackexchange.com/questions/214532/how-to-end-wrapfigure-environment> |
| February 26, 2023: The report is basically done so today I made the presentation slide show. I hope the professor doesn’t just want a PDF because I spent a lot of time organizing and detailing the presentation notes as well. I think Sophia may want to add a couple slides of her awesome flow diagrams for the code, but we are basically now ready to present.  <https://www.freecodecamp.org/news/eulers-method-explained-with-examples/>  <https://wethestudy.com/mathematics/newton-raphson-method-how-calculators-work/>  <https://rosettacode.org/wiki/Euler_method> |
| February 27, 2023: Today was all about finishing touches for my part. I spent some time formatting this document so it would be presentable, and I spent the rest going through the minor details (e.g. making sure variables are italicized and dimensions aren’t, or cleaning up titles and axis labels etc.). Sophia has a bit more to add to the report tonight and I will do a final check tomorrow to make sure we are submission-ready. |
| February 28, 2023: Did a final proof read through the entire document. Now compiling everything for submission. |
| Final Note: I realize as I read back through this project log, that numerous times I made statements such as “I wrote the … chapter of the report,” but I want to stress that those statements should only imply that I got to them first. Sophia added a lot of really valuable input and content for the report, so I want to be clear that I am in no way taking the full credit. I hope I can honestly say that I also made some valuable contributions to the programming side of the project as well. Although Sophia technically wrote all three algorithms, I contributed in getting them to work for our IVPs and at least shared in the misery of defeat and in the triumph of success. That’s gotta be worth something, right? :) |