School of Computing
FACULTY OF ENGINEERING AND
PHYSICAL SCIENCES

Final Report

Creating learning resources for teaching Finite Element Analysis

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Submitted in accordance with the requirements for the degree of
Computer Science with Mathematics

2022/23

COMP3931 Individual Project

The candidate confirms that the following have been submitted.

Items	Format	Recipient(s) and Date
Final Report	PDF file	Uploaded to Minerva (DD/MM/YY)
<Example> Scanned participant consent forms	PDF file / file archive	Uploaded to Minerva (DD/MM/YY)
<Example> Link to online code repository	URL	Sent to supervisor and assessor (DD/MM/YY)
<Example> User manuals	PDF file	Sent to client and supervisor (DD/MM/YY)

The candidate confirms that the work submitted is their own and the appropriate credit has been given where reference has been made to the work of others.

I understand that failure to attribute material which is obtained from another source may be considered as plagiarism.

(Signature of Student) _____

Summary

<Concise statement of the problem you intended to solve and main achievements (no more than one A4 page)>

Acknowledgements

<The page should contain any acknowledgements to those who have assisted with your work. Where you have worked as part of a team, you should, where appropriate, reference to any contribution made by other to the project.>

Note that it is not acceptable to solicit assistance on 'proof reading' which is defined as the "the systematic checking and identification of errors in spelling, punctuation, grammar and sentence construction, formatting and layout in the test"; see
`https://www.leeds.ac.uk/secretariat/documents/proof_reading_policy.pdf`

Contents

Chapter 1

Introduction and Background Research

1.1 Introduction

** Start by explaining the problem. This includes a brief description of PDEs, the need for numerical solutions to such equations and general motivaiton for the subject. Then go on to talk about the need for education, future aims for the project (such as being turned into a module or maybe a free online resource), and the importance of user feedback. Here is a citation [1]. **

1.2 Overview of literature regarding mathematical education

** Discuss different taxonomies, best practices, and approaches. Reference empirical studies if possible. **

1.3 Analysis of available learning resources on FEA

** Review a few online tutorials, discuss what is good and bad about each with respect to the previous subsection. Do the same for books. Also a good point to review some of the materials I want to base the notebooks off of and explain why I chose them. **

Chapter 2

Methods

2.1 Justification of software choices

** Discuss Jupyter Notebook as a learning tool and why it makes for a good solution with respect to the background research performed. Talk about: why Python is good for numerical computation and good for people with a mathematical background; why DOLFINx is a great package for implementing the Finite Element Method and what dependencies come with that; how version control is used and the benefits of good version control management **

2.2 Justification of design choices

** Talk about content plan, why I structured it the way I did and why I chose the content I did, always referring back to relevant research. Motivate the need for a mathematical understanding of the problem and it's solution instead of simply solving using packages you don't understand. This section should talk more about the education and mathematics, and should also touch upon the background of my target audience.**

2.3 Agile project management description

** Introduce Agile development as a concept and then discuss the details how how it was used. Benefits and drawbacks, as well as the importance of user feedback. Could talk about how user feedback was collected here but could also save that for the results and discussion section. Might be good to have it here though. **

Chapter 3

Results

3.1 Agile development

**Here I should discuss the success of the agile methodology in allowing me to perform rapid changes and meet user requirements better. How easy was it to make changes? How many changes were requested and what was the scale of those changes? Did users agree or disagree and how did I reconcile that? **

3.2 Evaluation of user feedback

3.2.1 User data

** Present data collected from users. Briefly discuss my impressions of how users found the course from their responses to the final questionnaire. **

3.2.2 Analysis

** Compare their responses with some resource I can find online. Maybe an empirical study has done something similar, and I can formulate my questions in such a way where direct comparison is possible. As always, provide plenty of references. As a result of the comparison, evaluate what was successful and what was unsuccessful about the project. Could compare against more advanced online educational services (codecademy, brilliant etc). **

Chapter 4

Discussion

4.1 Conclusions

** Did I meet the project goals set out at the start? Do I fully know if it was a success or a failure and why? What would I do differently if I were to do it again? **

4.2 Ideas for future work

** Possibility for using more sophisticated means of teaching. Deeper exploration of Finite Element Analysis, maybe room for a part 2 to the course? **

References

[1] D. Parikh, N. Ahmed, and S. Stearns. An adaptive lattice algorithm for recursive filters. *Acoustics, Speech and Signal Processing, IEEE Transactions on*, 28(1):110–111, 1980.

Appendix A

Self-appraisal

<This appendix should contain everything covered by the 'self-appraisal' criterion in the mark scheme. Although there is no length limit for this section, 2—4 pages will normally be sufficient. The format of this section is not prescribed, but you may like to organise your discussion into the following sections and subsections.>

A.1 Critical self-evaluation

A.2 Personal reflection and lessons learned

A.3 Legal, social, ethical and professional issues

<Refer to each of these issues in turn. If one or more is not relevant to your project, you should still explain *why* you think it was not relevant.>

A.3.1 Legal issues

A.3.2 Social issues

A.3.3 Ethical issues

A.3.4 Professional issues

Appendix B

External Material

<This appendix should provide a brief record of materials used in the solution that are not the student's own work. Such materials might be pieces of codes made available from a research group/company or from the internet, datasets prepared by external users or any preliminary materials/drafts/notes provided by a supervisor. It should be clear what was used as ready-made components and what was developed as part of the project. This appendix should be included even if no external materials were used, in which case a statement to that effect is all that is required.>