

COM3025 Deep Learning and Advanced AI Coursework

Academic Year 2022/23, Semester 2

February 24, 2023

Overview

The overall Units of Assessment (UoA) for the module are as below:

- **Lab Practice 20%** Between week 1 and 7, there are lab exercises/tasks each week related to the subject area of the week. Upon the completion of the lab tasks, there are two lab challenges hosted through kaggle competition platform. The results should be submitted to corresponding kaggle website for an automatic evaluation. On reflecting the returned performance score, re-submission with revised work is encouraged. Mark awarding schemes are published on the kaggle challenge websites. Solutions to lab exercises will be provided about two weeks after initial assignments. Regular engagement with the lab tasks will enable good digestion of the module content and prepare yourself for lab challenges and the coursework project.

- **Coursework 80%** This is comprised of two parts:

Theory Test (15%): This will take place in week 9, during the lab hours, through SurreyLearn online test platform. The test will be on the content covered in lab notes/tasks and lecture notes.

Coursework Project (65%): Students will choose one of the projects proposed in this guideline. Students will form project groups with 3-5 members to undertake the project selected by the group. Throughout the course, students are required to read a list of state of art literature, and understand the key techniques and concepts in these readings. A poster and the developed program code should be submitted to **Surreylearn** in week 12, 15th May 2023, Monday, at 4pm. Each project group will present their work with demonstration of the developed system, followed by a viva. This will take place after the project submission. Feedback will be given within 15 working days.

Important dates:

- Week 4: Project groups will form and start to choose coursework topic. Coursework project will formally start.
- Week 8, Tuesday, 28th March, at 4pm, Lab challenges due. Evaluation results on testing data should be submitted to kaggle website for scoring. All code from both challenges should be submitted to SurreyLearn. Final marks on the Lab Practice 20% UoA will be recorded here.

- Week 9, Tuesday, 25th April, 14:00-16:00: Theory test. The marks should be returned automatically upon completion of the test.
- Week 12, Monday, 15th May at 4pm: Coursework due, to be submitted to SurreyLearn.
- Week 12 - 13: vivas.

Coursework Project Assessment

Coursework poster, code and any supplementary materials should be submitted to SurreyLearn.

There are many useful guidelines on how to design an academic poster.¹

The poster can be structured based on the following marking criteria. The poster, developed source code, data (if not available online) should be submitted together with any supplementary materials that demonstrate the quality of the project, which could include further analysis, study, experiments, results etc.

Viva

Students will present their posters and the developed systems during the viva which involves questions and discussions. Questions on all subject areas covered in the module as well as the readings from the literature could be asked.

Marking criteria for the poster and viva

- The introduction to the project: providing appropriate and clear background information, detailing the objectives of the project. Literature review should be carried out. Students are expected to find and use sources of information, but must show their origins by referencing all sources used. If the reference list becomes long and cannot fit within the poster, put a few key reference in the main poster and leave the rest in the appendix. (20/100)
- In depth analysis of the problems; critical discussion of research and technical issues/challenges; Clear description of the approach developed with justification. Effective graphic illustration will be great to support the overall presentation. (20/100)
- Implementation and evaluation of the methods. Detailed discussion of the system results, thoughtful presentation on the data used, e.g. data distribution across different categories, how many of them for training, testing and evaluation; and what is the recognition accuracy etc. Figures and tables can be useful to present such information, especially when multiple approaches are developed and comparison of various approaches/choices are conducted. (30/100)
- Discussions and findings of the investigation/study . (10/100)
- Clarity in presentation and ability to deal with questions in the viva. (20/100)

¹<https://www.makesigns.com/tutorials/>

Proposed coursework ideas

The followings are suggested ideas for a coursework project:

1 Skin Cancer Detection and Interpretation

The aim of this project is an opportunity for you to apply what you have learned in class to a real world problem, which is yet to be solved. Much effort in this area have been carried out as seen in publications including data and software. Up to now, there are still live challenges for this particular problem.

There are multiple elements in the research and development that you can consider in this project:

- a. Collect data and conduct data analysis: See the references given below as a starting point. There is a need to clean and organise the data appropriately, partly due to the fact that there are many duplications from multiple data sources; also, it is important to perform data analysis and prepare the data for a holistic AI algorithm development. Apart from the data in the given references, you can also collect further data, so that the overall collection is sufficiently large enough with appropriate distribution of various skin conditions alongside normal ones, for training, validation and testing.
- b. Design and implement one or more deep learning systems, experiment with various algorithms to maximise the learning capability. Evaluate the performance and report the findings.
- c. Cost functions should be carefully thought through and justified.
- d. Image segmentation or object detection can be carried out to extract the pathological regions for refined detection and analysis.
- e. Various visualisation techniques can be developed to allow explainability of the software as well as illustrating in-depth clinical information for a better user experience (e.g. aiding doctors/nurses/clinicians in the clinical pathway for more precise diagnosis and better patient's outcome.)
- f. Dive deeper in this problem, to see if AI algorithms can understand similar patterns as what human experts have discovered. Check out here².

The following are some references on skin cancer datasets as well as some overview of AI algorithms in primary care setting. These could be a starting point to embark your own research and development. Broader literature review could be carried out.

- a. Characteristics of publicly available skin cancer image datasets: a systematic review ^{3, 4, 5}
- b. Artificial intelligence and machine learning algorithms for early detection of skin cancer in

²https://www.dermoscopy.ch/Main_Page

³<https://pubmed.ncbi.nlm.nih.gov/34772649/>

⁴[https://www.thelancet.com/journals/landig/article/PIIS2589-7500\(21\)00252-1/fulltext](https://www.thelancet.com/journals/landig/article/PIIS2589-7500(21)00252-1/fulltext)

⁵<https://www.thelancet.com/action/showPdf?pii=S2589-7500%2821%2900252-1>

community and primary care settings: a systematic review^{6,7}

You may find many other resources, data, code, developed by the research community as well as those through various skin condition detection challenges/competitions.

Any project developed on top of existing work, should carefully cite the source of prior work, and specify your own and additional contribution in the project.

2 Medical Conversational AI

The aim of this project is an opportunity for you to apply what you have learned in class to a real-world problem that is yet to be solved. Much effort in this area has been carried out and published, including data, and software.

2.1 Task Background

The Medical Dialogue Task involves developing a dialogue system that can effectively communicate with patients or medical professionals in natural language. This task is important for improving patient care, reducing medical errors, and enhancing the overall efficiency of the healthcare system. In this coursework, we will use the MedDialog dataset⁸, which is a large-scale collection of medical conversations between patients and healthcare professionals.

2.2 Task Requirements

The task requires you to develop a dialogue system that can accurately understand and respond to patient queries or statements. Specifically, the requirements for this task are:

- a. Carry out extensive literature review and conduct experiments on the state-of-art methods, exploring further datasets other than MedDialog if exist.
- b. Develop a novel machine learning model that can predict the next utterance in a medical conversation. The method must differ from the baseline method provided in the relevant material section.
- c. Evaluate the performance of your model on the MedDialog dataset.
- d. Conduct an analysis of the errors made by your model and propose improvements.
- e. Develop a user-friendly interface that allows patients or medical professionals to interact with the dialogue system in a natural way.

2.3 Marking Criteria

Your assignment will be evaluated based on the following criteria:

- a. Accuracy of your machine learning model

⁶[https://www.thelancet.com/journals/landig/article/PIIS2589-7500\(22\)00023-1/fulltext#supplementaryMaterial](https://www.thelancet.com/journals/landig/article/PIIS2589-7500(22)00023-1/fulltext#supplementaryMaterial)

⁷<https://www.thelancet.com/action/showPdf?pii=S2589-7500%2822%2900023-1>

⁸<https://www.kaggle.com/datasets/dsxavier/diagnoise->

- b. Quality of your error analysis and proposed improvements
- c. Clarity and organization of your report

2.4 Relevant Materials

You are expected to read and cite relevant materials in your report. Some suggested readings include:

1. This paper ⁹ describes the MedDialog dataset and provides baseline results for the Medical Dialogue Task.
2. Diagnose me ¹⁰ The dataset kaggle webpage.
3. NLP Med Dialogue – Analysis and Engineering ¹¹ The python notebook for data analysis and processing.
4. GPT-Neo Fine-tuning ¹² The python notebook for Language Model fine-tuning on this dataset.

⁹<https://arxiv.org/abs/2004.03329>

¹⁰<https://www.kaggle.com/datasets/dsxavier/diagnose-me>

¹¹<https://www.kaggle.com/code/dsxavier/nlp-med-dialogue-analysis-engineering#2.-Data-Analysis->

¹²<https://www.kaggle.com/code/damianpanek/diagnose-me-fine-tuning-gptneo-125m>