Assessment Brief Template

| **Academic Year** | **2023 – 2024** |
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| **Semester** | **2** |
| **Module Number** | **CMM536** |
| **Module Title** | **Advanced Data Science** |
| **Assessment Method** | **Individual Coursework** |
| **Deadline (time and date)** | **18th April, 2024, 4 pm.** |
| **Submission** | **Assessment Dropbox in the Module Study Area in CampusMoodle.** |
| **Word Limit**  **(see** [**Assessment Word Limit Statement**](https://campusmoodle.rgu.ac.uk/course/view.php?id=101439)**)** | **1000 words (markdown, excluding code and +/- 10%, according to University guidelines)** |
| **Use of Generative Artificial Intelligence (AI) text** | **IS NOT authorised** |
| **Module Co-ordinator** | **Carlos Moreno-García** |

| What knowledge and/or skills will I develop by undertaking the assessment? |
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| *By undertaking this assessment, the student will understand how to create and develop a data science project which requires complex techniques such as image analysis and advanced machine learning to solve a real-life problem.* |
| **On successful completion of the assessment, students will be able to achieve the following Learning Outcomes:**  1. Critically appraise the challenges posed by the management and processing of complex datasets and data inputs.  2. Discuss, compare and contrast advanced techniques and algorithms for working with complex datasets and data types using data science.  3. Critically evaluate and select state-of-the-art data science techniques and algorithms for selected/given applications involving complex data.  4. Apply advanced techniques and algorithms and critically analyse and evaluate the results. |

| What is expected of me in this assessment? |
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| Task(s) – content The objective of this coursework is for you to use the knowledge acquired (data loading, preprocessing, classification, and machine learning evaluation) to solve a medical imaging problem. A dataset of ultrasound images has been provided as a .zip file in the course Moodle. Alternatively, you can download it from [here](https://www.dropbox.com/scl/fo/m7bybibrpwhpdwvyy6434/h?rlkey=n98gkl69vf8i5m4hdjj60ib7d&dl=0). The dataset consists of the following structure:   * **data**   + **heart**: This contains a sequence of 218 four-chamber heart ultrasound images of a patient’s heart, 128x128 pixel size.   Focused Cardiac Ultrasound for the Nephrologist: The apical window - Renal  Fellow Network  These images were collected from one of the participants of the [Stanford EchoNet challenge](https://aimi.stanford.edu/echonet-dynamic-cardiac-ultrasound), and are split as follows.   * + - **closed**: 80 images where the Mitral valve appears fully closed (thus clearly splitting LV and LA chambers).     - **open**: 138 images where the same valve is open or not fully closed.     - **various**: contains the segmentation masks which were manually annotated by clinicians in our team, and which helped us present new results [in this paper.](https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0293560) In addition, you can see a .gif file with the 218 images in a sequence (showing the heartbeat) and a .tiff with the sequence of images in the order that they appear in the dataset.   + **non-heart**: Contains 925 images of 128x128 pixel abdominal ultrasounds. These images correspond to the training and testing set of the abdominal\_US 🡪 AUS 🡪 images subdirectory of the [US simulation & segmentation challenge](https://www.kaggle.com/datasets/ignaciorlando/ussimandsegm) on Kaggle.     To present your work, you will create a Jupyter Notebook (.ipynb file) where you show the following **three** experiments:   1. The aim of the first experiment is to create a classifier capable of distinguishing between an abdominal ultrasound and a heart ultrasound. Therefore, you only need the images, and you can combine the “closed” and “open” folders to consider all heart images as such. Firstly, Import the images to the notebook (you can use the code seen in **topic 3** and in the **data loading tutorial**) and run a stratified 80/20 train/test classification using two classifiers: a non-neural network one (i.e., SVM, RF, NB, or similar methods discussed in **topics 3 and 6**) and a neural network one (i.e., NN or CNN seen in **topic 7 and 8** respectively). Report the results of both tested models using precision, recall and f1 score (taught in **topic 5**) and in a markdown cell, reflect on which one was the best model and why you think this is the case.    * At this point, it is likely that your classifiers obtain “perfect” results given that the problem may be simple to address by the classifiers, especially if you parametrised them correctly. If that’s the case, run a five-fold cross-validation to verify that your original results are not simply the product of good luck in the splitting. If you didn’t obtain perfect results, then use a class imbalance handling technique (such as [Keras imagedatagenerator](https://www.analyticsvidhya.com/blog/2020/08/image-augmentation-on-the-fly-using-keras-imagedatagenerator/) or [imgaug](https://imgaug.readthedocs.io/en/latest/) as seen in **topic 5**) to try to improve your results.   *NOTE: If you are struggling to implement image augmentation, you could also extract some features from the images (e.g., Harris corners, HOG, SIFT, or SURF, as seen* ***in topic 4****) and apply a data augmentation technique such as SMOTE (seen in* ***topic 5****).*   1. Once you have decided which Machine Learning architecture yields the best results, use only the heart images to re-train that architecture, but now test if the new model can classify “open” or “closed” images correctly. This should be a straightforward 80/20 train/test validation. Report your results in terms of precision, recall, f1-score runtime, ROC and a confusion matrix and reflect on the results obtained so far in a markdown cell. 2. Attempt to improve the results from the previous experiment by means of image/data augmentation or more advanced techniques, such as attention mechanisms (a.k.a. Transformers), Generative AI (GANs) or Transfer Learning (these concepts were seen in **topic 9**). Remember to keep the same test images that you obtained in experiment 2, and only manipulate the images on the training set so that the comparison is fair. Obtain the same metrics as in experiment 2 and report if there’s any change.   *Note: As shown in the paper, the “best” way to do this identification is by segmenting the four chambers and doing a proper identification. If you really want to show your skills, then you can use the annotated masks to train a segmentation algorithm (such as U.NET, YOLO or Mask RCNN) and obtain optimal results.*  The report structure and presentation will also be marked, so make sure that your notebook is presented elegantly and professionally.  Before submitting the .ipynb, **run all cells and DON’T clear the output**, as markers won’t run the code (instead, markers will just read the notebook as a report). Please include any references (data, methods, techniques, concepts) used outside the ones seen during the lectures. |
| Task(s) - format The assessment should be submitted as a single .ipynb file with all output cells available (don’t submit the data). The limit for the markdown cells is 1000 words, including headings and references. |

| How will I be graded? | |
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| A grade will be provided for each criterion on the feedback grid which is specific to the assessment. The overall grade for the assessment will be calculated using the algorithm below. | |
| **A** | At least 4 subgrades of the feedback grid to be at Grade A, at least 6 subgrades of the feedback grid to be at Grade B or better, and 8 subgrades of the feedback grid to be at Grade C or better. |
| **B** | At least 4 subgrades of the feedback grid to be at Grade B or better, at least 6 subgrades of the feedback grid to be at Grade C or better, and normally 8 subgrades of the feedback grid to be at Grade D or better. |
| **C** | At least 4 subgrades of the feedback grid to be at Grade C or better, and at least 6 subgrades of the feedback grid to be at Grade D or better. |
| **D** | At least 4 subgrades of the feedback grid to be at Grade D or better, and at least 6 subgrades of the feedback grid to be at Grade E or better. |
| **E** | At least 4 subgrades of the feedback grid to be at Grade E or better. |
| **F** | Failing to achieve at least 4 subgrades of the feedback grid to be at Grade E or better. |
| **NS** | Non-submission. |

# Feedback grid

| **GRADE** | **A** | **B** | **C** | **D** | **E** | **F** |
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| **DEFINITION / CRITERIA (WEIGHTING)** | **EXCELLENT**  Outstanding  Performance | **COMMENDABLE/VERY GOOD**  Meritorious  Performance | **GOOD**  Highly Competent Performance | **SATISFACTORY**  Competent  Performance | **BORDERLINE FAIL** | **UNSATISFACTORY**  Fail |
| **EXPERIMENT 1**  **2 marks** | Full and correct implementation of the experiment as requested. | Same as A, except for one minor error (e.g., but not limited to, metrics/values explained incorrectly, improvement not adequately explained/justified, reflection slightly unclear). | Same as A, except for one major error (e.g., but not limited to, data loaded incorrectly, issues on the validation splits and/or implementations, metrics calculated incorrectly). | More than one error. | The experiment was implemented incorrectly and/or there is an unclear reflection on the experiments which shows that the student has minimal understanding of the code. | No implementation. |
| **EXPERIMENT 2**  **2 marks** | Full and correct implementation of the experiment as requested. | Same as A, except for one minor error (e.g. but not limited to, metrics/values explained incorrectly or reflection slightly unclear). | Same as A, except for one major error (e.g. but not limited to, data loaded incorrectly, issues on the testing, metrics calculated incorrectly). | More than one error. | The experiment was implemented incorrectly and/or there is an unclear reflection on the experiments which shows that the student has minimal understanding of the code. | No implementation. |
| **EXPERIMENT 3**  **3 marks** | Extremely original and interesting proposal close to scientific and professional standards. State-of-the-art methods are used to present an improvement, with students showing full comprehension of machine learning and computer vision. | The improvement is implemented very well; it has many novel elements, but there are minor errors in the understanding or implementation of the techniques. It is clear to the marker that something could be improved with little to no effort. | The improvement is good and sufficient for the problem, showing that the student knows the basic concepts shown in class and can give an extra step to show a competent answer to the problem. | The solution uses the basic techniques seen in the lecture with an appropriate implementation but doesn’t offer any novelty. | The solution is not original, and the student demonstrates minimal understanding of the code. | No implementation. |
| **Report Structure and Presentation**  **1 mark** | The notebook is presented in a professional manner, with headings, links, and markdown tags. The code is presented neatly. All cells are in the right place and run sequentially with the right numbers in the code cells. All references are appropriately cited. | Same as A, but with a minor issue that the marker can spot. | Same as A, but with a major issue that the marker can spot. | The notebook has a basic appearance, but the layout is simple and doesn’t engage the reader. | The notebook is hard to read and confusing for the marker. | The notebook is corrupted or impossible to read/follow. |

***Coursework received late, without valid reason, will be regarded as a non-submission (NS) and one of your assessment opportunities will be lost.***

| What else is important to my assessment? |
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| What is the Assessment Word Limit Statement? It is important that you adhere to the Word Limit specified above. The Assessment Word Limit Statement can be found in Appendix 2 of the [RGU Assessment Policy](https://www.rgu.ac.uk/about/governance/academic-governance/assessment-policy-procedures). It provides detail on the purpose, setting and implementation of wordage limits; lists what is included and excluded from the word count; and the penalty for exceeding the word count.  **What’s included in the word count?**  The table below lists the constituent parts which are included and excluded from the word limit of a Coursework; more detail can be found in the full Assessment Word Limit Statement. Images will not be allowed as a mechanism to circumvent the word count.   |  |  | | --- | --- | | Excluded | Included | | Cover or Title Page | Main Text e.g. Introduction, Literature Review, Methodology, Results, Discussion, Analysis, Conclusions, and Recommendations | | Executive Summary (Reports) or Abstract | Headings and subheadings | | Contents Page | In-text citations | | List of Abbreviations and/or List of Acronyms | Footnotes (relating to in-text footnote numbers) | | List of Tables and/or List of Figures | Quotes and quotations written within “…” | | Tables – mainly numeric content | Tables – mainly text content | | Figures |  | | Reference List and/or Bibliography |  | | Appendices |  | | Glossary |  |   **What are the penalties?**  The grade for the submission will be reduced to the next lowest grade if:   * The word count of submitted work is above the specified word limit by more than 10%. * The submission contains an excessive use of text within Tables or Footnotes. |
| What is plagiarism? Plagiarism is “the practice of presenting the thoughts, writings or other output of another or others as original, without acknowledgement of their source(s) at the point of their use in the student’s work. All materials including text, data, diagrams or other illustrations used to support a piece of work, whether from a printed publication or from electronic media, should be appropriately identified and referenced and should not normally be copied directly unless as an acknowledged quotation. Text, opinions or ideas translated into the words of the individual student should in all cases acknowledge the original source” ([RGU 2022](https://www.rgu.ac.uk/files/468/2022-23/1810/Regulation-A3-2-Student-Conduct-Procedure-2022-23.pdf)). What is collusion? “Collusion is defined as two or more people working together with the intention of deceiving another. Within the academic environment this can occur when students work with others on an assignment, or part of an assignment, that is intended to be completed separately“ ([RGU 2022](https://campusmoodle.rgu.ac.uk/pluginfile.php/5293639/mod_resource/content/2/content/index.html#/lessons/rBmduIUswGjg5JM_oOPSZRypliSTpT_n)).  For further information please see [Academic Integrity](http://campusmoodle.rgu.ac.uk/course/view.php?id=76611). |
| What if I’m unable to submit?  * The University operates a [Fit to Sit Policy](https://www.rgu.ac.uk/files/309/Student-Forms/1904/Fit-to-Sit-Policy-2022-23.pdf) which means that if you undertake an assessment then you are declaring yourself well enough to do so. * If you require an extension, you should complete and submit a [Coursework Extension Form](https://www.rgu.ac.uk/files/309/Student-Forms/1905/Coursework-Extension-Form-2022-23.docx). This form is available on the RGU [Student and Applicant Forms](https://www.rgu.ac.uk/about/governance/academic-governance/student-and-applicant-forms) page. * Further support is available from your Course Leader. |
| What additional support is available?  * [RGU Study Skills](https://campusmoodle.rgu.ac.uk/course/view.php?id=88648) provide advice and guidance on academic writing, study skills, maths and statistics and basic IT. * [RGU Library guidance on referencing and citing.](https://library.rgu.ac.uk/referencing-and-refworks) * [The Inclusion Centre: Disability & Dyslexia](https://www.rgu.ac.uk/life-at-rgu/support-advice-services/the-inclusion-centre-disability-dyslexia). * Your Module Coordinator, Course Leader and designated Personal Tutor can also provide support. |
| What are the University rules on assessment? The University Regulation ‘[A4: Assessment and Recommendations of Assessment Boards](https://www.rgu.ac.uk/about/governance/academic-governance/academic-regulations)‘ sets out important information about assessment and how it is conducted across the University. |