

ROBOTICS AND MACHINE INTELLIGENCE

MECH3465

COURSEWORK ASSIGNMENT 1

Assignment Brief

Task Description

Aircraft recognition in remote sensing images can provide valuable data on aircraft performance under real-world operating conditions, such as evaluating wing aerodynamics during flight or ground movements. Engineers can use this data to optimise maintenance schedules, allocate resources efficiently and improve fuel usage.

Using the Aircraft Recognition dataset (available for download at <https://bit.ly/AircraftDataset>), design and implement artificial neural networks to classify aircraft based on their manufacturer and variations. The trained classifier should be able to distinguish at least five types of manufacturers and variation. The combination of variation and manufacturers are flexible. The proposed approach must involve custom architecture designed specifically for this task using pyTorch (<https://pytorch.org/>). Additionally, the performance of the initial model should be systematically compared to that of an optimised version, with weighted F1-score serving as the primary metric for evaluation. The work should provide a detailed analysis of both models, highlighting improvements achieved through optimisation.

Your tasks are below:

1. Design a convolutional neural network (CNN). Justify your choice of model by explaining why it's suitable for your specific application.
2. Document the process of tuning hyperparameters and impact analysis. Provide detailed evidence of the impact these parameters have on model performance.
3. Optimise your CNN model's performance through pre-processing techniques or alternative neural network structures, using weighted F1-score as the primary evaluation metric to compare performance outcomes.
4. Write a comprehensive evaluation section that includes:
 - A detailed rationale for the choice of your model and optimisation processes of fine tuning your model (max 200 words).
 - A section comparing your model to your optimised model, accompanied by evaluation metrics in the form of tables or graphs and draw conclusions (max 200 words).
 - A critical evaluation and reflection on the results, discussing potential improvements and acknowledging any limitations of your approach (max 200 words).
 - A statement on ethical and societal implications of the booming usage of artificial neural networks in engineering (max 200 words).

The goal of this coursework is not to produce a state-of-the-art model. If your model performs poorly with respect to the model you have designed, do not worry—this is not what we are testing. It should however be appropriately motivated and evaluated (you will be tested on those aspects).

- You **must** use Python and its libraries to tackle this task. You are strongly encouraged to make use of existing libraries for model building, cross-evaluation and using unseen data for verification.

- Don't be afraid to explore techniques that were not (fully) covered during the lectures and practical, such as (but not limited to) cross validation, early stopping criterion and grid search.

Your report can include images, such as your test and validation performance plots.

You will submit:

1. The complete code of your solution as a Jupyter notebook.
If you do any pre-processing to the data, please list all those steps in your notebook.
Please also include outputs (e.g. do not clear the outputs after processing)
2. Export Jupiter notebook as pdf file
3. Combine your code and the pdf file into a single ZIP archive file named as Group_ID_NAME.zip and submit the zip file through the "coursework machine learning" under the Assessment and Feedback section on the Minerva.

Marking:

Methodology [45%]: 15% Method/Model; 30% Evaluation

For the report [55%]: 15% Structure; 10% presentation; 30% Criticality/Discussion.

See Appendix A for marking scheme.

Appendix A: Marking Scheme

Grade Range	100%-90%	89%-80%	79%-70%	69%-60%	59%-40%	39%-30%	29%-0	Grade Awarded
Descriptor	Excellent	Very Good	Good	Satisfactory	Average	Weak	Very Poor	
Model (Weighting = 15%)	Code without bugs and algorithm /model described and justified in high level of detail; Comparison with multiple optimised models presented	Code without bugs algorithm/model described and justified in detail with a few exceptions; Detailed comparison with optimised model(s)	Code with a limited bugs and algorithm /model described or justified with in detailed information; Some comparison with a optimised model presented	Code with a minor bugs and algorithm/model described or justified with limited information on optimised model	Code with few bugs and algorithm/model not well described and justified on optimized model	Code with few bugs and algorithm/model described or not justified with optimized model	Code is not running successfully	
Evaluation Quality of Analysis (Weighting = 30%)	Well informed and authoritative discussion and a comprehensive analysis of a significantly complex technical problem with detailed evaluation.	Clear and reasoned arguments backed up with a significant analysis indicating a very good grasp of a difficult technical problem with evidenced evaluation	Arguments presented are of a reasonable technical level, supported by a good quality analysis, and have been well considered and clearly stated.	The arguments presented are of reasonable technical depth, supported by some analysis and show a satisfactory understanding.	Only limited critical discussion of the technical problem studied. Little analysis or a low level of analysis. Suggests limited understanding of problem.	Very little evidence of critical discussion of technical work or results. Superficial understanding of problems. Minimal analysis included.	The lack of quality of the technical argument suggests that the student has very little understanding of the problem. No analysis.	
Report Writing with critical discussion. (Weighting = 30%)	Exceptionally clear, precise and concise English. Excellent spelling & grammar, few typos. Model choice and motivation provided in detail and well explained.	Clear and well written, easy to understand, and mostly free of errors. Model choice and motivation provided in detail.	Most of the text is clear and easily understood. There are some issues with grammar and spelling. Detailed model choice provided.	The text can be understood, but some elements are not entirely clear. A sizeable volume of errors is noticeable. Marginally information provided for model choice.	Hard to understand much of the text. Significant spelling errors and grammatical flaws. Some of model choice but no motivation mentioned.	The volume and nature of the grammatical errors, combined with poor writing makes this report difficult to read. Superficial way of explanation of model choice.	Unintelligible. Impossible to read due to exceptionally poor use of English. Not explanation of choice of model	
Report Presentation & Figures (Weighting = 15%)	Professional standard of presentation. All illustrations are well formatted and presented.	A clear and consistent presentation style making it easy to read. Most of the figures are clear and well presented.	There are some minor flaws in the presentation and the clarity of the figures.	A number of basic errors present – inconsistent use of styles, margins etc. Figures are satisfactory.	Significant flaws in the presentation detracting from the overall impression of the report. Flawed figures, e.g. badly drawn and untidy.	Unacceptable presentation: untidy and inconsistent use of styles. Figures are messy and unclear.	No evidence of any effective effort on the quality of the presentation. Report is hard to follow due to unclear figures.	
Report Organisation & Structure (Weighting = 10%)	Structure is entirely correct with all sections correctly placed. Reading contents gives clear overview.	A well organised report with all sections logically placed enhancing understanding of work.	A report which is sufficiently well organised, making the reading easy.	There may be some issues with the structure, but these do not detract from overall quality.	There are flaws in the way the report is structured which damages the overall quality of the report.	Serious flaws in structure which makes it difficult to read and understand the report.	No discernable structure. Illogical placement of sections. Impossible to follow argument.	

Comments:	
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