Bournemouth University

Submission Coursework Brief

School of Computing and Engineering

Unit: Deep Learning and Applications (COMP6071)		
Unit Contact: Hari Pandey	**Credits:** 20	**Level:** 6

Assessment Title: Deep Learning Kaggle Competition: Footprint Image Classification	
Assessment Number: 1 of 1	
Assessment Type: Individual	**Weighting (%):** 100%
Deadline: 20/01/2026 12:00 PM	**Submission Method**: Brightspace assignment (Large/multiple file) / Brightspace assignment (Panopto video)

Quality Assessor (QA): Hongchuan Yu	**Other Marker(s):** N/A

Can I use Generative AI tools?

Basic spelling and grammar correction tools are permitted.

Generative AI assisted idea generation and structuring

Generative AI can be used for summarising, creating structures and generating ideas for content. No generative AI content is allowed in the final submission.

Tasks:

This is an individual assignment which addresses all four Intended Learning Outcomes (ILOs) for this unit.

Your task is to design, implement, and evaluate a deep learning-based classifier to solve an image classification problem within a competitive Kaggle environment. You will be required to build a model from scratch to establish a baseline, systematically experiment with a range of techniques to improve performance, and leverage state-of-the-art pre-trained models. The entire project, including all code, analysis, and a comprehensive report, must be submitted as a single, self-contained Jupyter Notebook, accompanied by a short video presentation.

BACKGROUND

You have been contracted as a Deep Learning Engineer to develop a proof-of-concept system for forensic analysis. The goal is to automatically predict an individual's sex based on images of their footprint. Such a tool could help investigators narrow down the field of potential suspects in a criminal investigation. Your task is to build the most accurate predictive model using modern deep learning techniques.

DATASET AND KAGGLE COMPETITION

The image dataset for this assignment will be provided via a private Kaggle competition. The training set contains 1,573 footprint images, each labelled with the corresponding sex (0/1). A separate test set of 1,055 images is provided without labels, which you will use to generate predictions for submission.

To join the Kaggle competition:

1. Go to https://www.kaggle.com and create an account.
2. Sign up for the competition at: https://www.kaggle.com/t/d9310f0a07e0982afae3e4e669559331
3. You can use http://www.kaggle.com/competitions/budl25 to access the competition again at any time.

You will be required to upload a .csv file with your predictions for the test set. A sample submission file will be provided on Kaggle to demonstrate the required format.

You can make a maximum of 5 submissions per day. There are two leaderboards: a public leaderboard based on a portion of the test data, and a private leaderboard based on the remaining data. You can track your progress on the public leaderboard. Your final mark will be based on a combination of your position on the private leaderboard and effort demonstrated via the number, frequency and diversity of your submissions.

The Kaggle competition closes 5 days before the submission deadline to allow you to finalise your writeup.

ASSIGNMENT REQUIREMENTS

Technical Constraints:

1. **Framework:** All models must be implemented using PyTorch ecosystem. The use of Keras, TensorFlow, or other deep learning frameworks is not permitted. If in doubt, please ask the unit leader.
2. **Environment:** Your notebook must be fully reproducible in a standard Google Colab environment. Any external libraries not included in Colab by default must be installable via a pip install command in an early code cell.

Submission Structure:

Your submission must be a single Jupyter Notebook containing all code, narrative, and outputs. It should be structured with the following sections:

1. **Introduction:** Define the project's objective and the business case (e.g., forensic analysis). Justify why deep learning is a suitable approach for this image classification problem compared to traditional machine learning methods.
2. **Exploratory Data Analysis (EDA) and Preprocessing:**
    - Load and analyse the image dataset. Investigate image dimensions, colour channels, class distribution, and identify any potential issues.
    - Investigate the dataset for any potential imbalances or characteristics that could introduce ethical bias into your model and document your findings.
    - Visualise sample images from each class.

- Define, implement, and justify your data preprocessing and augmentation pipeline (e.g., resizing, normalization, rotations, flips).

3. **Baseline Model (From Scratch):**
    - Design, implement, and train a simple baseline classifier architecture **built entirely from scratch** in PyTorch. This model must not use any pre-trained weights.
    - Evaluate its performance on a validation set and document the initial benchmark score. This model serves as the starting point for all subsequent improvements.
4. **State-of-the-Art Model Analysis:**
    - Before experimenting with pre-trained models, conduct an exploratory analysis of at least three relevant vision architectures (e.g., ResNet, EfficientNet, ViT) available in libraries like torchvision.models or TIMM.
    - Compare their features, complexity (parameters, FLOPs), and suitability for this specific problem. This section serves as the "literature review" part of your report.
5. **Systematic Experimentation for Model Improvement:**
    - This is the core of the assignment. You must document **at least 10 distinct, well-justified experiments** aimed at improving upon the baseline model's performance.
    - Each experiment must be presented as a sub-section with a clear hypothesis, implementation details, results (tables/graphs), and a concise analysis of the outcome.
6. **Final Model Evaluation and Explainability (XAI):**
    - Select your single best-performing model based on the experimental results.
    - Provide a comprehensive performance evaluation on your validation set, including a confusion matrix, accuracy, precision, recall, and F1-score.
    - Apply and interpret an XAI method (e.g., Grad-CAM) on several validation images for which your model incurs the highest loss.
    - Beyond accuracy, critically evaluate your model's reliability. In the context of a legal investigation, what are the risks and limitations of using your model's predictions as evidence?
7. **Conclusion and Reflection:**
    - Summarise the project's key findings.
    - Based on your analysis, would you recommend this model for deployment? What safeguards or further testing would you demand before it could be used responsibly in the real world?

Intended Learning Outcomes (ILOs)

1. Demonstrate an understanding of Machine Learning tasks where Deep Learning solutions are applied.

2. Demonstrate an understanding of common Deep Learning methods and models and their suitable applications.

3. Identify, select and apply Machine Learning and Deep Learning methods to solve complex real-world problems using state-of-the-art software tools and libraries.

4. Analyse and optimise the performance of Deep Learning solutions professionally in appreciation of their ethical, legal and social impacts.

Submission Format:

You must submit two items via Brightspace. If any of these items is missing, you will be awarded 0 marks for the whole assignment:

1. A single **Jupyter Notebook** (.ipynb) file. This notebook must be self-contained and reproducible. At the top of the notebook, you must clearly state:
    a. Your Kaggle Username
    b. Your final score on the Kaggle private leaderboard
    c. The total number of submissions you made to Kaggle
2. A **10-minute video presentation** (a compact .mp4 file) in which you walk through your Jupyter notebook, explaining your methodology, key experiments, final results, and critical reflections.

How will this be assessed?

Element	Criterion	Mark	ILO(s)
Video presentation	**Clarity of Explanation & Walkthrough:** The quality of the walkthrough of the code, key results, and the ability to articulate project's narrative and findings.	15%	2,3,4
Kaggle Performance & Code	**Kaggle Performance & Effort:** A combination of the final accuracy on the private leaderboard and the number, frequency and diversity of submissions.	10%	3,4
	Code & Notebook Quality: Complexity, correctness, and reproducibility of the PyTorch implementation.	10%	3
Analysis and Experimentation	**Problem & Baseline Analysis:** Justification for using deep learning and a well-reasoned baseline model.	10%	1,3
	State-of-the-Art Architecture Analysis: Quality of research and comparison of pre-trained models.	10%	1,2
	Depth and Rigour of Experiments: Quality of the 10+ experiments, including narrative, analysis, and results.	20%	4
Evaluation and Reporting	**Final Model Evaluation:** Critical evaluation of the best model's performance and insightful discussion of ethical, legal, and social impacts.	10%	2,4
	Application and Interpretation of XAI: Correct application and insightful interpretation of explainability methods.	10%	2
	Report Professionalism & Conclusion: Overall structure, clarity, and quality of the final conclusions.	5%	4

Questions about this assessment:

You are encouraged to ask questions about the brief as early as possible during timetabled sessions, office hours and electronically via email and Teams chat.

Academic Integrity

The work you submit must be your own. Any attempt to gain an unfair advantage in your assessment by **cheating**, deception or fraud is considered an academic offence. The 'Assessment help and support' section of the unit (found under 'Assessment' in the content area) provides more guidance on avoiding academic

offences, including **any guidance on what will or will not be considered an academic offence in this specific assessment**.

Help and support

The 'Assessment help and support' section of the unit (found under 'Assessment' in the content area) provides information and guidance, including specific information on support for this assessment. It provides help with our policies on deadline extensions and information on support available in the university, including academic skills support and additional learning support for students with disabilities.

Disclaimer: The information provided in this assignment brief is correct at time of publication. In the unlikely event that any changes are deemed necessary, they will be communicated clearly via e-mail and via the VLE and a new version of this coursework brief will be circulated.

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