# Coursework Objective

In this coursework, you will design, implement, and evaluate a custom computer vision model for image classification using a range of classical deep learning techniques. The task emphasizes the implementation of the attention mechanism to enhance the model's focus on relevant image features during classification and the integration of Explainable AI (XAI) methods to interpret and explain the model's decisions. You are required to construct the model from scratch without relying on pre-trained models. Your work will involve documenting all stages, including data preprocessing, model design, training, evaluation, and XAI integration. The aim is to assess your ability to apply theoretical concepts in practice, critically analyze your model's performance, and effectively communicate your findings.

# Instructions

* Read the entire coursework specification sheet thoroughly.
* All sources **MUST** be referenced correctly using IEEE referencing style. You can find a guide from the following links: [IEEE Referencing](https://pitt.libguides.com/citationhelp/ieee#:~:text=IEEE%20citation%20style%20includes%20in,the%20IEEE%20Editorial%20Style%20Manual.)
* This coursework is an **individual** piece of work. University rules concerning plagiarism, collusion, syndication, and cheating apply.
* Students are **ONLY ALLOWED** to use TensorFlow or Keras deep learning framework for the implementation of this coursework. This is to prevent students from buying source code or employing the services of third parties. Students **MUST** only stick to the concepts discussed and tools used in class.

# Coursework Title:

Design and Implementation of a Custom Computer Vision Model Using Classical Deep Learning Techniques with Attention Network and Explainable AI for Image Classification

# Instruction for Coursework Writing Structure:

Follow the provided article template with the following structure:

# Abstract:

Write a concise and informative abstract that summarizes the key aspects of your report. Include the problem statement, the proposed custom model design, the dataset used, main findings, and key evaluation metrics. The abstract should provide readers with a clear understanding of your report at a glance.

# 1.0 Introduction:

# Introduce the problem of image classification, the importance of XAI in developing trustworthy AI models, and attention mechanisms. State the objectives and significant contribution of your report.

# 2.0 Literature Review:

# Review relevant literature on image classification, ensemble models, and attention mechanisms. Discuss previous works and highlight their contributions and limitations.

# 3.0 Methodology:

# Detail the dataset used, data preprocessing steps, model architecture, attention mechanism, and the integration of XAI techniques. Provide diagrams illustrating your model architecture and design pipeline.

# 3.1 Data Preprocessing:

# Obtain the image dataset for the image classification task. Ensure the dataset is consistent and contains diverse images from different categories.

# Perform data preprocessing steps, including resizing, normalization, and augmentation, to prepare the data for model training and testing.

# 3.2 Data Split:

# Split the dataset into three subsets: training, validation, and testing sets. Use a split ratio appropriate for the dataset size.

# 3.3 Model Construction:

# Design the Model: Create a custom image classification model incorporating classical deep learning techniques taught during the lectures. You are required to build this model from scratch. The model design should reflect a thoughtful selection of layers, activation functions, and optimization strategies. You cannot use pre-trained models.

# Attention Mechanism: Implement the attention mechanism from scratch to enhance the model's focus on relevant image features during classification. You cannot use existing attention mechanisms such as Squeeze-and-Excitation and CBAM.

# Integrate Explainable AI: Integrate XAI techniques, such as Grad-CAM, LIME, and SHAP, into your model to provide interpretability and explainability for its decisions.

# 3.4 Model Training:

# Train the Model: Use the training dataset to train your model. Optimize hyperparameters, such as learning rate, batch size, epochs, and others, to improve model performance.

# Monitor Progress: Track and record training metrics, including loss, accuracy, and training time.

# Results and Discussion:

Present your experimental results with tables, figures, and plots. Interpret the results, discuss model performance, and analyze how XAI contributed to understanding model decisions.

# 4.1 Model Testing and Evaluation:

# Evaluate the Model: Test the model using the testing dataset. Evaluate the performance using metrics such as loss, accuracy, recall, precision, sensitivity, specificity, confusion matrix, F1-score, and ROC-AUC curve, precision-recall curve.

# Apply XAI Methods: Use the XAI techniques integrated into your model to interpret the classification results. Analyze which features were most influential in making predictions and how the model's decisions can be explained.

# Conclusion, Limitation and Future Work:

# Summarize your findings, discuss any limitations encountered, and propose directions for future research or model improvements.

# References:

# Cite all the sources used in your report writing. The minimum number of references is 10 and should not exceed 15.

There are two styles of citation in Computer Science: IEEE or ACM. We recommend using IEEE style. IEEE citation style is used primarily for electronics, engineering, telecommunications, software engineering, computer science, and information technology reports. The three main parts of a reference are as follows:

1. Author’s name listed as first initial of first name, then full last.
2. Title of article, patent, conference paper, etc., in quotation marks.
3. Title of journal or book in italics

Each reference number should be enclosed in square brackets on the same line as the text, before any punctuation, with a space before the bracket.

Examples of in-text citation:

“. . .end of the line for my report [1].”

“The theory was first put forward in 1987 [2].”

“Scholtz [3] has argued. . . .” “For example, see [4].”

“Several recent studies [3, 4, 15, 22] have suggested that. . . .”

Reference

# [1] S. Bhanndahar. ECE 4321. Class Lecture, Topic: “Bluetooth can’t help you.” School of Electrical and Computer Engineering, Georgia Institute of Technology, Atlanta, GA, Jan. 9, 2008.

# Dataset:

This coursework is designed for you to work independently and to ensure the uniqueness of your report in order to avoid collusion. No two students should have the same or similar CNN model. The dataset will be randomly allocated to every student, and you will have to download the dataset from the link provided to you. You must use and stick to the dataset assigned to you. Any violation of this instruction will result in a reduction of **20 points** because the aim is to encourage students to work individually and to avoid collusion and cheating.

# Submission:

Submit your report following the single-column report template provided by the tutor. Include step-by-step descriptions of the tasks you performed, and the results obtained during the experiment. Ensure that your report is well-organized, clearly written, and includes all the necessary evaluation metrics and graphs as specified in the coursework requirements. The length of the report should not be less than 2000 words and **MUST** not exceed 5000 words for the coursework to contribute towards the development of writing skills; therefore, it is required to complete your coursework following these instructions.The submission deadline is **week 12, December, 2024, by 15:30**. Late submissions may incur penalties of up to **20 marks reduction**, so make sure to plan your work accordingly. Failure to submit your coursework will result in a **Zero Mark**. In the case of exceptional circumstances, contact the **Award Administrator** in advance.

# Submission Format:

The coursework assignment submitted should be compressed into a .zip or .rar file, the following files should be contained in the compressed file：

* A *report article* as a *Microsoft Word* document.

File name format: *202118010xxx\_CHC6781MV\_Coursework\_Report.docx*

* A .*zip file* containing the report experiments: all the program’s sources, including the code, graphs, model architecture, results, and diagrams from the experiments. All plots\figures generated should be **600dpi** in resolution and the labels (text in the figure) should have **font-size between 20-25pt** for clarity.
* File name format: *202118010xxx\_CHC6781MV\_Coursework\_Files.zip*

# Grading Criteria and Rubric:

The total weight for this coursework is 50%, and you will be assessed based on the following criteria:

# 1. Abstract (3%)

**Assessment**: Clarity and conciseness in summarizing the problem, custom model design, dataset, main findings, and key evaluation metrics. The abstract should give a clear snapshot of the report.

# 2. Introduction (3%)

**Assessment:** Introduction of the image classification problem, importance of Explainable AI (XAI), attention mechanisms, and clear articulation of the report’s objectives and contributions.

# 3. Literature Review (4%)

**Assessment:** Depth of literature review on image classification, ensemble models, and attention mechanisms. Evaluation of how well the review contextualizes your approach, highlighting contributions and limitations of existing works.

# 4. Methodology (15%)

**Data Preprocessing (2%):** Correct implementation and thorough documentation of data preprocessing steps, including dataset acquisition, consistency checks, resizing, normalization, and augmentation.

**Data Split (2%):** Appropriateness of the dataset split into training, validation, and testing subsets, and justification of the chosen split ratio.

**Model Construction (8%):** Creative and sound design of the model architecture, implementing the attention mechanism, and integrating XAI techniques (e.g., Grad-CAM, LIME, SHAP).

**Model Training (3%):** Effective training of the model with appropriate hyperparameter optimization. Accurately report the training metrics including loss, accuracy, and training time.

# 5. Results and Discussion (10%)

**Model Testing and Evaluation (6%):** Accurate and thorough evaluation of the model using metrics like loss, accuracy, recall, precision, sensitivity, specificity, confusion matrix, F1-score, ROC-AUC curve, and precision-recall curve. Correct application of XAI methods to interpret and analyze the model’s decisions.

**Discussion (4%):** Critical analysis and interpretation of the results, particularly focusing on how XAI techniques help in understanding the model’s decision-making process.

# 6. Conclusion, Limitation, and Future Work (3%)

**Assessment:** Clear and concise summary of the findings, thoughtful discussion of encountered limitations, and realistic propositions for future research or model improvements.

# 7. References (3%)

**Assessment:** Correct and consistent use of IEEE referencing style with appropriate and relevant citation sources, ensuring that the minimum number of references is met.

# 8. Presentation and Formatting (4%)

**Assessment:** Adherence to the provided report template, clarity and coherence in writing, and proper formatting of figures, tables, and diagrams. The quality of plots (600dpi) and readability of labels (font size 20-25pt) will also be evaluated.

# 9. Overall Report Quality (5%)

**Assessment:** Overall coherence, clarity, and professionalism in the report’s writing and structure. Effectively communicates ideas and demonstrates critical thinking; showing a solid grasp of the subject matter.

# Note:

Make sure to start the coursework early, as it involves several tasks that require time and effort. Seek help from the tutor if you encounter any difficulties during the process. Good luck with your image classification experiment and report article writing!

**Module Name:** Machine Vision

**Module Code: CHC6781**

Assessment Title: (Insert the assessment title)

**Student Number: (Insert you student number – make sure it is correct)**

**Word Count: (insert your total word counted excluding cover page, contents pages, reference list and appendices)**

***AI Declaration:***

**Delete as appropriate.**

***I have utilised / have not utilised the use of AI tool(s) in this assessment.***

***I have used the following AI tool(s): please provide the name of the AI tool(s) you have used and provide the exact prompt(s) you provided in***

|  |
| --- |
| *For example:*  *AI Tool: CHAT GPT – Prompt: Find information on what are the impacts of utilising AI Tools for academic Purposes and career prospects?*  *Baidu translator: I have written the abstract, section 1, section 2, section 3, section 4, and section 5 in Chinese language and used Baidu Translate to covert these tasks to English.* |

***The box below:***

If the declaration has not been made, and your tutors suspect use of AI, you will be called into do a **viva voce** and it will be considered academic misconduct if you fail the viva voce. This will be the same for the use of translation software which will also requires you to declare the use of.

**Full disclosure will not result in an academic penalty or a lower score, so please be honest and fill in the declaration when submitting your assignment(s)**.