Understanding AI (771763_A23_T1)

Summative Assignment:
Portfolio of Work

Deadline: Friday 12th January 2024 at 2pm

Summative Assignment (Total Points: 100 marks)

The summative assignment will consist of three exercises, in the areas of supervised and unsupervised learning, image recognition, and the ethics of AI. This portfolio of work will be worth 100% of the total marks for this module.

Please note that all marks shown in canvas are provisional, unratified marks and do not include any late penalties or outcomes of Additional Consideration or Academic Misconduct. Final ratified marks are available via your myHull portal once confirmed and approved by the module board.

Submission Instructions

Please upload the following files as part of your submission:

1. Your written report that addresses **all three exercises**, uploaded as a **single** PDF file.
2. Your code, submitted as a Jupyter Notebook file. Your code for the first two exercises may be submitted as **separate** Jupyter Notebook files.

These files need to be submitted on the Canvas assignment page for the Portfolio of Work assignment, which can be found at the following link:

https://canvas.hull.ac.uk/courses/67474/assignments/217523

Please consider the following when you submit your assignment:

- Plan to submit well before the actual deadline (consider system glitches or any other eventualities that may occur at the last minute).
- Do not upload any report or source code belonging to another person.
- Do not upload any dataset with your submission.

Academic Integrity (Portfolio of Work)

Your Portfolio of Work (the report and the codes) is an independent task and should be treated as such. Please see the following links for further details:

https://libguides.hull.ac.uk/integrity
https://libguides.hull.ac.uk/integrity/writing

Referencing Your Work

It is important that you follow an appropriate referencing style when you cite other people's works. See the following link for more information:

https://libguides.hull.ac.uk/referencing/harvard

Exercise 1: Analysing Second Hand Car Sales Data with Supervised and Unsupervised Learning Models

(Total Points: 40 marks)

In this exercise you will analyse a mock dataset of second hand car sales in the UK. You can download this dataset as a csv file from Canvas at the following link:

https://canvas.hull.ac.uk/files/5020067/download?download_frd=1

You will see that the dataset contains 50,000 rows, with each row corresponding to the sale of a second hand car. For each car sold, the dataset contains the following information:

- **Manufacturer** – the name of the manufacturer that produced the car.
- **Model** – the name of the model of the car.
- **Engine size** – the size of the engine, in litres.
- **Fuel type** – the type of fuel that the engine uses.
- **Year of manufacture** – the year in which the car was made.
- **Mileage** – the total number of miles that the car has been driven.
- **Price** – the price that the car was sold for, in Pound Sterling (GBP).

NOTE: whilst the names of the car manufacturers and models in this dataset may be familiar to you, be aware that this is a *mock* dataset of *imaginary* car sales data that we generated. In particular, the prices given in this dataset are not intended to be a realistic representation of the actual price of a given car. Furthermore, the years of manufacture contained in this dataset do not necessarily reflect the actual years in which a particular model was in production in the real world.

Goal

Your goal for this exercise is to explore how supervised learning models can be used to predict the price of a second hand car, based on the information contained in this dataset. You will also study how unsupervised learning techniques can be used to identify clustering patterns in this dataset.

You will write up the results of your analysis in the style of a scientific report. Your report should address the following questions:

a. Compare regression models that predict the price of a car based on a single numerical input feature. Based on your results, which numerical variable in the dataset is the best predictor for a car's price, and why? For each numerical input feature, is the price better fit by a linear model or by a non-linear (e.g. polynomial) model?
b. Consider regression models that take multiple numerical variables as input features to predict the price of a car. Does the inclusion of multiple input features improve the accuracy of the model's prediction compared to the single-input feature models that you explored in part (a)?

c. In parts (a) and (b) you only considered models that use the numerical variables from the dataset as inputs. However, there are also several *categorical* variables in the dataset that are likely to affect the price of the car. Now train a regression model that uses all relevant input variables (both *categorical* and *numerical*) to predict the price (e.g. a Random Forest Regressor model). Does this improve the accuracy of your results?
d. Develop an Artificial Neural Network (ANN) model to predict the price of a car based on all the available information from the dataset. How does its performance compare to the other supervised learning models that you have considered? Discuss your choices for the architecture of the neural network that you used, and describe how you tuned the hyperparameters in your model to achieve the best performance.
e. Based on the results of your analysis, what is the best model for predicting the price of a car and why? You should use suitable figures and evaluation metrics to support your conclusions.
f. Use the *k*-Means clustering algorithm to identify clusters in the car sales data. Consider different combinations of the numerical variables in the dataset to use as input features for the clustering algorithm. In each case, what is the optimal number of clusters (*k*) to use and why? Which combination of variables produces the best clustering results? Use appropriate evaluation metrics to support your conclusions.
g. Compare the results of the *k*-Means clustering model from part (f) to at least one other clustering algorithm. Which algorithm produces the best clustering? Use suitable evaluation metrics to justify your answer.

Maximum word count: 1500 words.

The grading criteria for this exercise can be found at the end of this document.

Exercise 2: Image Recognition to Identify Species of Flowers

(Total Points: 30 marks)

In this exercise you will develop a Convolutional Neural Network (CNN) model to identify species of flowers from photographs. You will train this model using the tf_flowers dataset from Tensor Flow:

https://www.tensorflow.org/datasets/catalog/tf_flowers

This dataset contains 3670 colour photographs of flowers, consisting of five different species:

- Daisy.
- Dandelion.
- Roses.
- Sunflowers.
- Tulips.

The easiest way to obtain this dataset is to download it directly from the following url:

http://download.tensorflow.org/example_images/flower_photos.tgz

Once you have unzipped the tgz file, you will see that the images are arranged in five sub-directories, corresponding to the five class labels. See the workshop exercises from Week 9 for more information on how to load image data from a directory.

Goal

Your goal for this exercise is to develop a CNN model that will identify the species of a flower from a photograph. You should write up your results in the style of a scientific report. Your report should address the following questions:

a. Describe the architecture of the CNN model that you used (for example, the number and types of layers that you used, the activation functions that you used etc), and discuss your justifications for the choices that you made.
b. Describe the regularisation methods that you used in your CNN model. How do they affect the accuracy of your results?
c. Discuss any other hyperparameter tuning that you undertook to optimise your model. Which hyperparameters have the strongest effect on the performance of your model? Use suitable figures to visualise the accuracy and performance of your final model.
d. Was there any evidence of overfitting in any of your models? Justify your answer with suitable figures.

Maximum word count: 1500 words.

The grading criteria for this exercise can be found at the end of this document.

Exercise 3: A Literature Review on Ethical Applications of AI

(Total Points: 30 marks)

In this exercise you will review **three** journal articles on "the Ethical Applications of AI" that focus on any **one** of the following themes:

- Transparent AI.
- Explainable AI.
- Fairness and Bias in AI applications.
- Trustworthy AI.
- Socially-responsible AI.

Provide a concise report that describes the aims and key conclusions of each article that you reviewed. Your report should highlight **three successes** in how AI can be used in an ethical manner, and **three gaps or challenges** that are faced in the ethics of AI. You should conclude your report by providing **three suggestions** for how to bridge these gaps.

Maximum word count: 1000 words.

The grading criteria for this exercise can be found at the end of this document.

Grading Criteria

Exercise 1: Analysing Second Hand Car Sales Data with Supervised and Unsupervised Learning Models (Max 40 marks)					
Criteria	**1**	**2**	**3**	**4**	**5**
Quality & Structure of the Written Report. (Max 10 marks).	The writing style is unclear, and the report is difficult to follow. Figures are unclear and difficult to interpret, or are missing altogether.	The report is not written in an appropriate scientific style, although the overall contents of the report can still be understood. Figures display some relevent information and results, although major aspects are missing.	The report follows a logical structure, with only minor deficiencies in the clarity of the writing. Figures display the relevant information and results, although some elements may be missing (e.g. if axes are not labelled correctly).	The report is reasonably well-written, and follows a suitable scientific style. Figures are presented clearly, with appropriate axis labels and figure captions.	The report is written to a very high standard that would be suitable for publication in a scientific journal. Figures are of an exceptional quality.
Analysis. (Max 20 marks).	The report only includes one or two modelling approaches. Many of the questions requested in the task remain unanswered. Little or no attempt has been made to compare the results of different models.	Some of the regression models and clustering techniques requested in the task have been attempted, but several are missing. Only superficial comparisons between models have been made. Model comparisons are not supported quantitatively with suitable	The report covers most of the regression models and clustering techniques requested in the task. Some attempt has been made to quantify the results of each model.	The report considers all regression models and clustering techniques requested in the task. All questions in the task have been addressed. The results of all models have been compared quantitatively, with suitable figures and evaluation metrics.	The report conducts an in-depth analysis covering all modelling approaches requested in the task. All questions are answered to an exceptionally high standard.

		evaluation metrics.			
Coding. (Max 10 marks).	No code has been submitted, or any code that has been submitted is only superficial and is not relevant to the task.	The code has been submitted, but is only able to reproduce some of the results from the report. Major parts of the coding are either missing or cannot be run successfully. Little or no attempt has been made to write comments in the code.	The code is able to reproduce most of the results in the report, with only minor omissions. Some attempt has been made to write comments in the code, although the commenting is unclear or incomplete.	The code is well written and can reproduce all of the results presented in the report. The code includes suitable comments to explain what it is doing.	The coding has been written to a professional standard. The coding includes extensive commenting that clearly describes what the code is doing at every step. The code makes use of advanced features such as defining functions and classes to improve the efficiency and clarity of the code.
Exercise 2: Image Recognition to Identify Species of Flowers (Max 30 marks)					
Quality & Structure of the Written Report.(Max 10 marks).	The writing style is unclear, and the report is difficult to follow. Figures are unclear and difficult to interpret, or are missing altogether.	The report is not written in an appropriate scientific style, although the overall contents of the report can still be understood.	The report follows a logical structure, with only minor deficiencies in the clarity of the writing. Figures display the relevant information and results, although some	The report is reasonably well-written, and follows a suitable scientific style. Figures are presented clearly, with appropriate axis labels and figure captions.	The report is written to a very high standard that would be suitable for publication in a scientific journal. Figures are of an exceptional quality.

		Figures display some relevent information and results, although major aspects are missing.	elements may be missing (e.g. if axes are not labelled correctly).		
Analysis. (Max 10 marks).	The modelling approach for classifying the images is incorrect or missing altogether. Many of the questions requested in the task remain unanswered.	Some attempt has been made to develop a CNN model for the image classification problem, although there are some deficiencies in the design of the model that prevent it from achieving a reasonable performance. Little or no attempt has been made to tune the hyper-parameters of the model. The results and performance of the model are not presented quantitatively.	The report utilises appropriate CNN model architectures to tackle the image classification problem. Some attempt has been made to tune the hyper-parameters to find the most accurate solution. Some attempt has been made to quantify the performance of the CNN models.	The report utilises appropriate CNN model architectures to tackle the image classification problem, and explores the effects of tuning many hyper-parameters to determine the optimal solution. Results of different CNN models and hyper-parameter choices are compared quantitatively, using suitable figures and evaluation metrics. All questions in the task are answered well.	The report explores all aspects of the image classification modelling problem in great depth. All questions are answered to an exceptionally high standard.

Coding.(Max 10 marks).	No code has been submitted, or any code that has been submitted is only superficial and is not relevant to the task.	The code has been submitted, but is only able to reproduce some of the results from the report. Major parts of the coding are either missing or cannot be run successfully. Little or no attempt has been made to write comments in the code.	The code is able to reproduce most of the results in the report, with only minor omissions. Some attempt has been made to write comments in the code, although the commenting is unclear or incomplete.	The code is well written and can reproduce all of the results presented in the report. The code includes suitable comments to explain what it is doing.	The coding has been written to a professional standard. The coding includes extensive commenting that clearly describes what the code is doing at every step. The code makes use of advanced features such as defining functions and classes to improve the efficiency and clarity of the code.
Exercise 3: A Literature Review on Ethical Applications of AI (Max 30 marks)					
Quality & Structure of the Written Report (Max 10 marks).	The writing style is unclear, and the report is difficult to follow.	The report is not written in an appropriate style, although the overall contents of the report can still be understood.	The report follows a logical structure, with only minor deficiencies in the clarity of the writing.	The report is reasonably well-written, and follows a suitable style.	The report is written to a very high standard that would be suitable for publication in a scientific journal.
Referencing (Max 10 marks).	Little or no attempt has been made to include references that are relevant to the topic. Citations to the references	Some references have been included, but they are only loosely related to the topic. Citations to the references	The references considered in the report are mostly relevant and on-topic. Some attempt has been made to cite the references in an	The report considers a range of relevant references that cover the topic in depth. The references are cited using an appropriate	The references are highly relevant to the task at hand. All references are cited correctly, following an appropriate referencing style.

	are missing altogether.	are incomplete.	appropriate manner, with only minor errors in the referencing style used.	referencing style.	
Critical Evaluation (Max 10 marks).	Little or no attempt has been made to discuss the successes and gaps in the literature.	The report only discusses a handful of the successes and gaps in the literature. The discussion is only superficial and does not explore these topics in depth.	The report discusses some of the successes and gaps in the literature, and suggestions to fill these gaps, from the reviewed articles. However, it does not include at least three of each of these as requested in the task. The reviewed articles are only considered in isolation, and no attempt has been made to explore the connections between the articles.	The report highlights three successes and three gaps in the literature, and three suggestions to fill these gaps, based on the reviewed articles. Some attempt has been made to consider the connections between the articles, although these are not explored in depth.	The report evaluates the three journal articles in great depth. The report provides a detailed account of three successes, three gaps and three suggestions to fill these gaps, based on the articles that have been reviewed. The connections between the three articles are discussed in detail.