RMIT UNIVERSITY

Deep Learning
COSC 2779
Assignment 1

Assessment Type	Individual assignment. Submit online via Canvas → Assignments → Assignment 1. Marks awarded for meeting requirements as closely as possible. Clarifications/updates may be made via announcements/relevant discussion forums.
Due Date	Week 7, Monday 7th September 2020, 05:00pm
Marks	30%

1 Overview

In this assignment you will explore a real dataset to practice the typical deep learning process. The assignment is designed to help you become more confident in applying deep learning approaches. In this assignment you will:

- Develop a deep learning system to solve a real-world problem.
- Analyse the output of the algorithm(s).
- Research how to extend the DL techniques that are taught in class.
- Provide an ultimate judgement of the final trained model that you would use in a real-world setting.

To complete this assignment, you will require skills and knowledge from lecture and lab material for Weeks 1 to 5 (inclusive). You may find that you will be unable to complete some of the activities until you have completed the relevant lab work. However, you will be able to commence work on some sections. Thus, do the work you can initially, and continue to build in new features as you learn the relevant skills. *A deep learning model cannot be developed within a day or two. Therefore, start early.*

2 Learning Outcomes

This assessment relates to all of the learning outcomes of the course which are:

- Discuss and critically analyse a variety of neural network architectures; Evaluate and Compare approaches and algorithms on the basis of the nature of the problem/task being addressed.
- Synthesise suitable solutions to address particular machine learning problems based on analysis of the problem and characteristics of the data involved.

- Communicate effectively with a variety of audiences through a range of modes and media, in particular to: interpret abstract theoretical propositions, choose methodologies, justify conclusions and defend professional decisions to both IT and non-IT personnel via technical reports of professional standard and technical presentations.
- Develop skills for further self-directed learning in the general context of neural networks and machine learning; Research, Discuss, and Use new and novel algorithms for solving problems; Adapt experience and knowledge to and from other computer sciences contexts such as artificial intelligence, machine learning, and software design.

3 Assessment details

3.1 Task

Head pose estimation has many applications such as driver monitoring, attention recognition and multi-view facial analysis. For example, the head pose of a driver can be used to identify if the driver is distracted (e.g. looking at the phone or falling asleep at the wheel). An example commercial system that uses such technology is: FOVIO Driver Monitoring (FDM) processor by Seeing Machines.

In this assignment, you will develop a deep convolutional neural network (CNN) to identify the head pose given an image of a person. The head pose is quantified by two values: Tilt - Vertical angle of the head , Pan - Horizontal angle of the head. (The center point of the head in the image, gaze direction etc. are also important parameters for a complete system, but we will ignore this for now).

The machine learning task we are interested in is to "Predict the head pose of a person given an input image captured from a camera placed directly in front of the person". Note that we are interested in predicting head pose for people that might not be included in the training set.

- You need to come up with a deep learning system, where each key element of the system is *justified* using data analysis, performance analysis and/or knowledge from relevant literature.
- Setup an evaluation framework, including selecting appropriate performance measures, and determining how to split the data into training and validation.
- Finally you need to analyse the results from your model using appropriate techniques and establish how adequate your model is to perform the task in real world and discuss limitation if there are any (**ultimate judgement**).
- Predict the result for the test set.

3.2 Dataset

The data set for this assignment is available on Canvas. There are the following files:

- "`README.md`": Description of dataset.
- "`modified_data.zip`": Contain all the images (test and train set).
- "`train_data.csv`": Contain files names of the train set, person id, sequence id for each person, ground truth tilt and pan angles. This data is to be used in developing the models. Use this for your own exploration and evaluation of which approach you think is "best" for this prediction task.
- "`test_data.csv`": Contain files names of the test set, person id, sequence id for each person. You need to predict the tilt/pan for this data and submit the prediction via canvas. The teaching team will use this data to evaluate the performance of the model you have developed.
- "`s1234567_predictions.csv`": Shows the expected format for your predictions on the unseen test data. You should organize your predictions in this format. Any deviation from this format will result in zero marks for the "Performance on test set" rubric category. Change the number to your student ID.

The original data is from Head Pose Image Database published with *N. Gourier, D. Hall, J. L. Crowley, "Estimating Face Orientation from Robust Detection of Salient Facial Features", Proceedings of ICPR International Workshop on Visual Observation of Deictic Gestures 2004.*

Licence agreement: The dataset can only be used for the purpose of this assignment. Sharing or distributing this data or using this data for any other commercial or non-commercial purposes is prohibited.

4 Submission

You have to submit all the relevant material as listed below via Canvas.

1. **A report** (of no more than 3 pages , plus up to 2 pages for appendices) critically analysing your approach and ultimate judgement. Should be in PDF format.
2. A **set of predictions** from your ultimate judgement. Should be in CSV format.
3. Your **code** (Jupyter notebooks) used to perform your analysis. Should be a ZIP file containing all the support files.

The submission portal on canvas consists of two sub-pages. page one for report submission and the second page for code and other file submission. More information is provided on canvas. Include only source code in a zip file containing your student ID. We strongly recommend you to attach a README file with instructions on how to run your application. Make sure that your assignment can run only with the code included in your zip file! Include a PDF version of your report.

After the due date, you will have 5 business days to submit your assignment as a late submission. Late submissions will incur a penalty of 10% per day. After these five days,

Canvas will be closed and you will lose ALL the assignment marks.

Assessment declaration:
When you submit work electronically, you agree to the assessment declaration - `https://www.rmit.edu.au/students/student-essentials/assessment-and-exams/assessment/assessment-declaration`

5 Teams

Not relevant. This is an individual assignment.

6 Academic integrity and plagiarism (standard warning)

Academic integrity is about honest presentation of your academic work. It means acknowledging the work of others while developing your own insights, knowledge and ideas. You should take extreme care that you have:

- Acknowledged words, data, diagrams, models, frameworks and/or ideas of others you have quoted (i.e. directly copied), summarised, paraphrased, discussed or mentioned in your assessment through the appropriate referencing methods
- Provided a reference list of the publication details so your reader can locate the source if necessary. This includes material taken from Internet sites. If you do not acknowledge the sources of your material, you may be accused of plagiarism because you have passed off the work and ideas of another person without appropriate referencing, as if they were your own.

RMIT University treats plagiarism as a very serious offence constituting misconduct. Plagiarism covers a variety of inappropriate behaviours, including:

- Failure to properly document a source
- Copyright material from the internet or databases
- Collusion between students

For further information on our policies and procedures, please refer to the following: `https://www.rmit.edu.au/students/student-essentials/rights-and-responsibilities/academic-integrity`.

7 Marking guidelines

A detailed rubric is attached on canvas. In summary:

- Approach 40%;
- Ultimate Judgment & Analysis 20%;
- Performance on test set (Unseen data) 20%;
- Implementation 10%;
- Report Presentation 10%;

Approach: You are required to use a suitable approach to find a predictive model. You may use any form of ML paradigm, including: Regression or Classification. Each key element of the approach need to be *justified* using data analysis, performance analysis and/or published work in literature. *This assignment isn't just about your code or model, but the thought process behind your work.* The elements of your approach may include:

- Setting up the evaluation framework
- Selecting CNN architecture, loss function and optimization procedure.
- Hyper-parameter setting and tuning
- Identify problem specific issues/properties and solutions

Ultimate Judgement: You must make an *ultimate judgement* of the "best" model that you would use and recommend in a real-world setting for this problem. It is up to you to determine the criteria by which you evaluate your model and determine what is means to be "the best model". You need to provide evidence to support your ultimate judgement and discuss limitation of your approach/ultimate model if there are any.

Performance on test set (Unseen data): You must use the model chosen in your ultimate judgement to predict the `Tilt and Pan` on unseen testing data (provided in `test_data.csv`). Your ultimate prediction will be evaluated, and the performance of all of the ultimate judgements will be published.

Critical Analysis & Report

Finally, you must compile a report describing and analysing the approach that you have taken to find a suitable model and make your ultimate judgement. Your report ***must*** be no longer that 3 pages , plus an additional 2 pages for appendices. The appendices must only contain references, figure, diagram, or data tables that provide evidence to support the conclusions and statements in your report.

Any over length content, or content outside of these requirements will not be marked. For example, if you report is too long, ONLY the first 3 pages pages of text will be read and marked.

In this report you should describe elements such as:

- Your final selected approach
- Why you selected this approach

- Parameter settings and other approaches you have tried.
- Limitation and improvements that are required for real-world implantation.

This will allow us to understand your rationale. We encourage you to explore this problem and not just focus on maximising a single performance metric. By the end of your report, we should be convinced that of your ultimate judgement and that you have considered all reasonable aspects in investigating this problem.

Remember that good analysis provides *factual statements, evidence and justifications for conclusions* that you draw. A statements such as:

> *"I did xyz because I felt that it was good"*

is not analysis. This is an unjustified opinion. Instead, you should aim for statements such as:

> *"I did xyz because it is more efficient. It is more efficient because …"*