

TRC5901/TRC6901 – Project Instructions

Design and optimization of convolutional neural network (CNN) architectures for image classification

This project covers learning outcomes (LO):

LO1 - Construct deep learning frameworks using open-access tools, such as TensorFlow and PyTorch, to solve real-world problems.

LO2 - Design deep learning models for computer vision tasks like image classification and object detection.

LO6 - Communicate deep learning solutions to real-world problems with a wider audience via oral presentations and written reports

CIFAR-10 dataset

Consists of 60000 32x32x3 color images in 10 classes, with 6000 images per class. There are 50000 training images and 10000 test images.

Refer to <https://www.cs.toronto.edu/~kriz/cifar.html> for dataset details.

The tasks include:

1. Randomly split the original 10000 test images into 7000 validation data (700 per class) and 3000 test data (300 per class).
2. Using a ¹flatten, a maximum of ³three dense layers, and an ³output layer as the fully connected layers, Design (a): Add a convolutional layer with a pooling layer. Justify the hyperparameters.
Design (b): Add another convolutional with a pooling layer. Justify the hyperparameters.
Design (c): Add another convolutional with a pooling layer. Justify the hyperparameters.
Design (d): Add another convolutional with a pooling layer. Justify the hyperparameters.
* Note that you will have a total of 4 convolutional layers and 4 pooling layers.
* You can use Keras or PyTorch library.
* Optimize and evaluate the classification performance of each CNN design.
~~✗~~ Do use validation data for each epoch to evaluate overfitting.
* Use a maximum of 20 epochs to train the network for each level of design. Identify if overfitting occurs.
* You must use the same fully connected layers for each design.
3. Based on validation loss or validation accuracy, determine the best CNN architectures [which design? (a), (b), (c) or (d)?]. If overfitting occurs, you can choose the epoch (no max than 20) that returns the highest performance as the final model. As long as you can explain, it is not necessarily 2(d), it can be 2(c) or any other level of design. Evaluate every design with the test data (3000 samples). Does the best design show the highest classification performance when evaluating it with the test data? Explain.

Report Structure (15% of total coursework mark)

1. Title page
2. Table of Contents
3. Introduction
 - Include some literature reviews.
 - Describe computer vision, image classification, and deep learning.
4. Objectives
 - Based on the given tasks, can list out several objectives in bullet points
5. Methods
 - Dataset, design of CNN architectures, evaluation
6. Results and Discussion
 - Show the number of samples for each class in the new validation and test data.
 - Do not include coding here. You can screenshot deep learning model summaries, figures or tables generated from coding to discuss the results.
7. Conclusion
8. References (use EndNote, 5 to 10 references are good enough)
9. Appendix (put coding)
 - Appendix I: Splitting datasets into validation data and test data
 - Appendix II: Design (a)
 - Appendix II: Design (b)
 - Appendix II: Design (c)
 - Appendix II: Design (d)

Report Format

- Times New Roman, 12 Font size, 1.5 lines spacing
- Maximum page limit is 30 pages
- Include page number from **Table of Contents**
- Submit a single PDF file on **Wednesday of Week 10** via Moodle
- Label your file as **Project_StudentID.pdf** [Example: **Project_10001000.pdf**]

Video Format (5% of total coursework mark)

- Record a **presentation** with a **maximum length of 3 minutes**
- Summarize your work in **just a static slide** (do like **3 Minute Thesis Competition**)
- You need to present in a way that even the general audience can understand the contents.
- Submit a single **MP4 file** on **Wednesday of Week 10** via Moodle
- Label your file as **Video_StudentID.mp4** [Example: **Video_10001000.mp4**]

like no background in machine learning?

Report Marking Rubric

	Excellent (80-100)	Good (70-79)	Average (60-69)	Below Average (40-59)	Fail (0)
Introduction (10)	The background and importance of the works are clearly provided and highlighted.	The background and importance of the works are mentioned.	The background and importance of the works are mentioned but lack some content.	The background and importance of the works are poorly highlighted.	Missing
Objectives (5)	Objectives are clearly extracted from the given tasks.	Objectives are obtained from the given tasks.	Objectives are extracted from the given tasks but there are some missing elements.	Objectives are poorly extracted and confusing.	Missing
Methods (20)	The methods are clearly organized and presented based on the given tasks.	The methods include all given tasks.	The methods include the given tasks, but missing some components.	The methods are poorly organized and presented based on the given tasks.	Missing
Results & Discussion (40)	Results are very well presented with figures and tables, along with comprehensive discussions.	Results are presented with figures and tables, along with discussions.	Results are presented with figures and tables but poorly discussed.	Results are poorly presented and poorly discussed.	Missing
Conclusion (5)	The works are clearly summarized and insights are provided.	The works are clearly summarized.	The works are summarized but missing some important elements.	The works are poorly summarized.	Missing
Appendix (10)	All appendices are well organized, provided, and cited in texts.	All appendices are organized, provided, and cited in texts.	All appendices are provided but no proper citation in the texts.	Some appendices are missing.	Missing
Report flow, format, language (10)	The report is very structured and organized with excellent usage of language.	The report is structured and organized with good usage of language.	The report is organized with acceptable language usage.	The report is poorly organized and written.	Missing

Video Marking Rubric

	Excellent (80-100)	Good (70-79)	Average (60-69)	Below Average (40-59)	Fail (0)
Slide design and contents (30)	Very visually attractive and creatively portray the important information of the work.	Visually attractive and portray necessary information of the work.	The overall slide design is acceptable and contains necessary information.	Poor slide design and missing important information.	Missing
Speech contents (30)	Clearly and interactively present the introduction, body, and conclusion of the work.	Present the introduction, body, and conclusion of the work.	Present the introduction, body, and conclusion of the work, but lacks some contents.	Poorly present the introduction, body, and conclusion of the work. Missing important contents.	Missing
Speech clarity (30)	Maintain a reasonable pace with high clarity to the extent that the general audience can easily understand the presentation.	Acceptable pace with good clarity and the general audience can understand the presentation.	Acceptable pace with moderate clarity and the general audience still can roughly understand the presentation.	Unstable pace with low clarity till the general audience finds it is so difficult to understand the presentation.	Missing
Time limit (10)	Maintain between 2 min 40 s and 3 min	Exceed within 10 s or less than 2 min 40 s.	Exceed within 10 s to 20 s	Exceed more than 20 s	Missing