Deep Learning

Subtitle: Assignment

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Information categorisation:
Open

Department: SATM

Date: 15, November, 2024

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AAI MSc

Deep Learning 2024/25

Background

This assignment deals with the implementation from scratch of relatively simple deep learning models and techniques for transfer learning of object detection models for computer vision applications. You should be able to complete the whole assignment without access to large computation cluster and relying only on your laptops or online training tools (e.g. Google Colab). If you have issues, you can setup a remote access to one of our Cranfield machines in the PC labs – contact SASAAI about this.

Brief

CIFAR-10

Task 1 – Image classification on the ~~MNIST~~ handwritten digits recognition dataset

The CIFAR-10 classification dataset was mentioned and discussed during the lectures several times.

Task 1a. You are asked to train 2 different models for CIFAR-10 image recognition:

1. Model A) With only the fully connected (i.e. dense) layers.
2. Model B) A self-designed convolutional neural network.

Appropriately discuss the architectures, model size and parameters, and the hyperparameters chosen.

Task 1b. Please demonstrate that you monitored the training of the neural network by monitoring appropriately the loss-function, the accuracy, and confusion matrix. Demonstrate the performance of the models relying on appropriate graphs and discuss the differences between FC and CNN classifier.

Task 1c.

1) Apply a pre-trained network (Alexnet, VGG, ResNet, etc.) to the CIFAR-10 dataset and visualize learned filters and feature maps (any layer you want).

2) Fine-tuning the pre-trained network you have selected above and explain your fine-tuning strategies, then 1) test performance after fine-tuning vs. no fine-tuning, 2) visualize the feature maps again and discuss your findings.

Task 2 – UAV Object Detection using transfer learning

You are provided a small dataset with images of UAV. The labels of the dataset contain the parameters for a bounding box regression of the dataset. You can download the full dataset from CANVAS. As you will notice, this is a relatively small dataset. This means that you are not going to be able to train an object detector from scratch on such a small dataset.

Task 2a.

Start by selecting 12 samples for both training and testing data and plot in 3x4 subplot format indicating:

1. Plot the labels and verify the label format: [x y width height].
2. Pre-process the data set and split the data set in training/validation/testing set, explain your data processing and split strategy.

Task 2b. Your aim is to train an object detector which achieves a good performance on the dataset and detects the position of UAVs in the picture.

1) You need to apply and compare two different object detection networks, and one of it should be YOLO networks (no requirement to the specific version).
2) Evaluate the efficiency of your transfer learning strategies.

You don't have constrains about computational time (for inference) so you can opt also for two-stage detectors.

Students are supposed to understand how to fine-tune a pre-trained deep neural network to detect UAVs. Solve the issues in the transfer progress, such as pre-process the data set and adjust the layer architecture. The choice of model is up to the student (there isn't necessarily a single correct answer).

Assignment Guidance

- The assignment provides you with an opportunity to investigate one of the major areas discussed within the module in more detail.
- Please use the standard Cranfield report template as attached to the assignment description – alternatively, if you prefer latex, you can use a standard single column report document class.
- The language or framework used is NOT part of the assessment. Use whatever you feel more confident in using.
- Please list your name and student number on the top of the report.
- Please provide a cover with your name, student number, assignment title.
- Please provide a table of contents.
- A report including the reasoning and justification (strict word count limit: 3000 words), excluding diagrams, figures, and tables.
- Please provide an additional section listing all references cited in your work (bibliography does not count for the word count limit).
- Any diagram or material 'cut and paste' from the web, or copied from any source, should be clearly referenced at the point where it occurs in the report.
- You can submit your codes as appendix.
- Please check the submission deadline carefully, try your best to avoid last minute submission.
- Violation of these rules is regarded as plagiarism and is treated severely by the University.

Extensions
Please note that extension requests will normally require third party evidence to support such request. Further information can be found in Section C of the Senate Handbook on Assessment Rules. Extension should be request to SAS before the submission deadline.

Late Submission & Penalty
- Standard penalties will be applied according to the Senate Handbook.

Submission
The Assignment should be submitted through CANVAS - please contact your SAS lead for any queries on submission practicalities.
- This is an individual assignment and, whilst it is allowed for each student to talk to other students (it is actually encouraged), you must ultimately do your own research and write a unique assignment report.
- Hence, you may discuss your ideas and problems in a general way with other students, but you must not copy or share text, data files, specific scenarios, etc.
- Each assignment is going to be checked for plagiarism (against other assignments and other online resources).

Marking Rubric
The assignment will be assessed according to the following marking rubric.

	Fail (0-49%)	Pass (50-59%)	Good Pass (60-69%)	Excellent (70-100%)
Task 1a (10%)	Absence of, or seriously flawed model architecture	Demonstrate understanding of DL model architecture	Demonstrate good understanding model architecture	Model architecture and discussion demonstrates further research done
Task 1b (15%)	Absence of, or seriously flawed monitoring of the model training and performance	Demonstrate understanding of strategies for monitoring of the model training and performance	Demonstrate good understanding of strategies for monitoring of the model training and performance	Demonstrate excellent understanding of strategies for monitoring of the model training and performance with further research done and beyond the tasks required
Task 1c (25%)	Absence of, or seriously flawed model architecture	Demonstrate understanding of DL model	Demonstrate good understanding model architecture	Model architecture and discussion demonstrates

		architecture and tuning operations	and tuning operations	further research done
Task 2a (10%)	Absence of, or seriously flawed data processing and organisation	Demonstrate understanding of how dataset and pre-processing is carried out	Demonstrate good understanding of dataset organisation	Fully correct implementation and data pre-processing
Task 2b (30%)	Absence of, or seriously flawed model architecture	Demonstrate understanding of DL model architecture, model comparison & evaluation, and fine-tuning operations	Demonstrate good understanding model architecture, model comparison & evaluation, and fine-tuning operations	Model architecture and discussion demonstrates further research done
Presentation (10%)	A large number of spelling or grammar errors; references incorrectly cited. Poor or no use of titles, subtitles, figures or tables; Lack of legends and labelling.	Most spelling and grammar is correct; other presentational aspects generally correctly applied	Minor errors	No mistakes in spelling or grammar; references correctly and consistently cited; appropriate use of titles and subtitles; creative use of figures and tables to complement the text and are correctly labelled and referred to.

You will be marked on the correctness and comprehensiveness of your answers, and quality of your presentation. The language used must be of a sufficient standard to permit assessment of the above criteria.