Assignment 1

Instruction

Q-1) Consider the following function with two parameters:

$$f(x,y) = x^2 + y^2 + x(y+2) + \cos(3x)$$

a) Take the derivative of the function with respect to x
b) Take the derivative of the function with respect to y
c) Implement and use gradient descent and find the minimum of this function. You can use Python.
d) Plot the gradient descent results.

Note that, include all your solutions in your report. Implementation should be submitted separately.

Q-2) You are required to design and implement your own custom deep learning architecture and apply it to solve an image classification problem. Additionally, you will implement and evaluate four well-known deep learning models: ResNet-50, VGG-19, DenseNet-121 and EfficientNet (e.g., EfficientNetB0 or B1) deep learning architectures, on the same image classification task. Use CIFAR-100 dataset (from https://www.cs.toronto.edu/~kriz/cifar.html). You are free to use any deep learning framework such as Keras, TensorFlow, or PyTorch.

You should begin by designing a custom convolutional neural network (CNN) of reasonable complexity. A network with approximately four to eight convolutional layers is recommended.

In your report:

1) Include your own designed deep learning architecture.
2) Explain your architecture in detail in the report, including the number and type of layers used, activation functions, pooling layers, optimizer, loss function, and any regularization methods applied, such as dropout or batch normalization. You should also describe the hyperparameters chosen (e.g., learning rate, batch size, number of epochs) and justify why you selected them.

3) Explain the preprocessing steps applied to the dataset. This should include any resizing, normalization, conversion to grayscale if applicable, and any data augmentation techniques.
4) During training, you must track and plot both the training and validation loss for each epoch, as well as the training and validation accuracy. These plots must be included in your report, and you should provide a discussion of the results. Specifically, comment on whether the model shows signs of overfitting or underfitting, and if any techniques such as early stopping were used to address these issues.
5) Analyze how the weights are updated during training. Pick one or two convolutional filters from the first layer (from your model) and visualize them before and after training. Comment on the changes.
6) Test the images over the trained algorithms. Obtain the accuracy results, false positives, false negatives, true positives, and true negatives as well as F1-score. Include as a table.
7) Compare the performance of your algorithm with the ResNet-50, VGG-19, DenseNet-121 and EfficientNet deep learning architectures and discuss the results.

Submission:

Submit a single .zip file containing your report and all implementation files via the Canvas course page. Do not include the dataset in your submission. Name your zip file using your first and last name in the following format:

firstname_lastname.zip

For example: john_doe.zip

Submission Deadline:

Submission deadline is 15th May 2025 until 23:59.

Evaluation

The assignment is graded with U or G. To pass, you must complete the both questions in full. It is important to note that this is an individual assignment. This means that everything that you submit for grading must be created by you. Plagiarism is not allowed in any form.