

CS412 - Machine Learning: Homework 3

Due: December 5, 2025 23:55

Late Accepted Until: December 8 23:55

Colab Notebook Link

Goal

Gain hands-on experience with transfer learning using pretrained deep neural networks.

Task Description

The task in this homework is to perform binary **smiling** classification on a subset of the CelebA dataset using transfer learning.

A pretrained VGG-16 model will be adapted to the task, and its performance will be evaluated under several settings. You will replace the classification head with a binary output layer and train the model for a fixed number of 10 epochs. You are asked to experiment with two fine-tuning strategies: (1) freezing all convolutional layers and training only the classifier head, and (2) freezing all weights, but fine-tuning the last convolutional block along with the classifier head.

After training models with both strategies, determine the best setup based on validation set performance and evaluate the test set while showcasing correct and incorrect classifications. Finally, discuss the contribution of fine-tuning method and basic data augmentation (random horizontal flip and a small amount of color jitter) on model performance.

Dataset

You will use a subset of the CelebA dataset, which contains over 30,000 celebrity face images annotated with 40 attributes CelebA30k.zip, with an accompanying CSV file named CelebA30k.csv. This CSV file contains the image file names and attributes including the whether the subject is smiling under the feature "Smiling". You are expected to split the dataset into 80% training, 10% validation, and 10% test sets. The test set should only be used for final evaluation and must not be involved in model selection or hyperparameter tuning.

Report Guidelines

- Write a report that reads like a project report. Include a cover page with your name, ID number, the course name, HW No., etc.
- Include an introduction section where you state the problem, a method section where you describe evaluated approaches, a results section and a separate discussion section.
- Have an organized report and structured headers so that the flow of the report is similar to the starter notebook.
- Include visualizations, confusion matrices and loss curves under the results section. Present the evaluation metrics and training durations for both models in a well-organized table that compares different settings.
- In the discussion section, comment on the impact of data augmentation, highlight the differences between pure transfer learning and fine-tuning, and discuss overall performance trends as well as typical classification errors observed in your results.

Submission Guideline

- Jupyter Notebook: Include all code cells and outputs. (Outputs must remain in the notebook; it will not be rerun during grading.)
- Notebook Link: Include the shareable link to your notebook at the top of your PDF report.
- Submission Files:
 - CS412-HW3-YourName.ipynb
 - CS412-HW3-YourName.pdf
- Late Submissions: Accepted up to two days late, with a 10-point penalty per day.