# **Assignment 3 (10%)**

**Real-Time Image Classification with CNNs Using Transfer Learning**

DUE DATE: Tuesday, December 5th, 2023, 11:59 PM ET

**Objective:**

* To implement a real-time image classification system.
* To understand and apply the principles of transfer learning using pre-trained ResNets.
* To gain experience with preprocessing live streaming data for CNNs.
* To evaluate the performance of the system in a real-world scenario.

**Assignment Guidelines:**

* All students in this course must read and meet the expectations described in the [Student Academic Integrity](https://intranet.laurentian.ca/policies/2017.09.19%20-%20Policy%20and%20Procedures%20on%20Academic%20Integrity%20-%20EN.pdf).
* Assignments must follow the programming standards document published on the course website in the D2L. Marks will be taken off if standards are not followed.
* **Submit just .py file(s) AND the associate report in PDF per group**. Name the file based on your group “ID” and the assignment number, exactly as in this example for **assignment 3 and** **group 1**: **COSC\_4117EL\_A3\_G1.py**. Same naming convention applies to the PDF, **COSC\_4117EL\_A3\_G1.pdf**.
* **Do NOT zip the files** that you submit.
* You may submit the assignment multiple times, but only the most recent version will be marked.
* After the due date and time, a late penalty of 2% per hour, or a portion of an hour, will be applied. After 49 hours, the penalty is 100% and submissions will no longer be accepted. The date and time of the last file submitted control the mark for the entire assignment.
* These assignments are your chance to learn the material for the exams. **Code your assignments independently (or solely within your group)**. We use software to compare all submitted assignments with one another, and pursue academic dishonesty vigorously. **You must complete the Honesty Declaration in the D2L before you will be able to submit your assignment.**

**Introduction:**

In this assignment, you will explore the potent combination of Convolutional Neural Networks (CNNs) and transfer learning to address a real-world problem with real-time image classification from a live webcam feed. Utilizing pre-trained [ResNet models](https://pytorch.org/vision/main/models/resnet.html), your task is to design and develop a system that accurately classifies live images. **You will document your process and results in a detailed report and demonstrate the functionality of your model through a video presentation. Please upload the video to YouTube and provide the link(s) to your video in the report.**

**PART 1: Proposal and Justification (in your report) [10 marks]**

1. Identify a Problem::
   1. Suggest a creative real-time classification problem that can be addressed using a webcam. This could involve recognizing gestures, emotions, certain types of objects, or specific activities.
   2. Justify why your chosen problem is significant and detailing the relevance and potential impact of your solution in real-world scenarios.
2. Dataset Description:
   1. Describe the type of dataset you would require for training your model. Include details on the classes, the diversity of the dataset, and how you would gather or access this data.
   2. Discuss any data augmentation techniques you would employ to enhance the robustness of your model.

P**ART 2: Implementation Guide (in your report) [20 marks]**

1. Transfer Learning Approach:
   1. Explain how you would use a pre-trained ResNet model for your task. Include details on which version of ResNet you would choose and why.
   2. Describe the modifications you would make to the network to suit your specific classification problem.
2. Real-Time Processing:
   1. Outline the steps you would take to process images from a webcam in real time for classification by CNN.
   2. Describe the custom alterations necessary for the ResNet model to fit your classification requirements.

*Utilizing Libraries and Tools:*

*You are encouraged to make use of existing libraries and tools to facilitate the development of your project such as PyTorch for CNN and ResNet, and OpenCV for image processing tasks.*

*Feel free to use the sample code provided as a foundation for your implementation. This code should be tailored and extended to fulfill your project's specific requirements.*

P**ART 3: Performance Evaluation and Testing [10 marks]**

1. Evaluation Metrics:
   1. Define the metrics you would use to evaluate the performance of your model (accuracy, precision, recall, F1 score, etc.).
   2. Explain why these metrics are suitable for your problem.

2. Testing Protocol:

1. Outline the steps you would take to process images from a webcam in real time for classification by CNN.
2. Discuss any challenges you anticipate in real-time processing and how you would address them.

**Video Demonstration:**

Record a video demonstrating the testing of your CNN model. In this video, articulate the features of your model, the real-time classification process, and the results.

Upload the video to YouTube and provide the link in your report. This video will serve as a visual and practical complement to your written documentation.

**Submission:**

1. Submit the code with your implementations as .py files.
2. You may submit more than one .py file if needed. Make sure you rename the filename accordingly.
3. Submit your report as a PDF file, include a detailed report explaining your approach, any challenges faced, and the decisions made. Include YouTube video’s link(s), visualizations, tables, or charts that support your findings.
4. Your assignment should be self-contained, meaning a person should be able to understand your process and results just by reading your report and going through your code.

**Note on Group Contributions and Grading:**

If any group member believes that another member of their group deserves a lower grade due to their contribution level, they are encouraged to address this concern. To formalize this, the group can include an additional section in their report detailing the situation and the proposed grade adjustment, with the consent of all group members. It's essential that all group members agree and provide their consent for any proposed grade changes.

It's always best to communicate openly within your group and seek collaborative solutions. However, if discrepancies in contributions are significant and consensus is achieved, this mechanism ensures fairness in grading.

**Best of luck! Remember, the process and learning are as important as the final results.**