**Deep Learning Small Project Report**

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1. **What we did:**
   1. **Model:** We used pretrained ResNet18 to perform transfer learning. To comply with the dataset, we changed the last fully-connected layer to 20 neurons. Since we are dealing with multi-class and multi-label problem, we add a sigmoid activation function to the end of the fully-connected layer.
   2. **Loss function:** We used binary cross entropy loss. Since the labels are independent from each other, we need this loss function to calculate loss of each neuron of the output independently.
   3. **Learning rate:** To save computational power, we set the learning rate to 0.02.
   4. **Training procedures:** We have in total 3 training phases.
      1. In phase 1, we resize the data to 224 and perform a center crop. By training the pretrained ResNet18 with these data for 15 epochs, we now entered phase 2.
      2. In phase 2, we performed data augmentation by randomly rotating the image between -10 and 10. And then we trained the model again for 15 epochs.
      3. In phase 3, we performed another method of augmentation by setting both jitter saturation and jitter hue to 0.05, as well as randomly horizontal flipping. And finally, we trained the model again for 15 epochs.
   5. **Other hyperparameters:**
      1. **Threshold:** threshold of deciding whether it has such label, which will affect the precision.
2. **How to reproduce:**
   1. **How to train the model:**

The file directory should look like this:



Ensure that the above three files are in the same folder. Then run the python file “train\_model.py”

* 1. **How to run the GUI:**
     1. After the model is trained, state of best model and data of top 50 ranked images for each label will be stored.



1. **Result and evaluation:**
   1. The graph below shows the training and validation loss through 45 epochs in total:

A screenshot of a cell phone

Description automatically generated

As we can see in the graph, both training and validation loss are decreasing through the training. However, at the first 10 epochs, validation loss decreased much faster than the training loss.

* 1. The graph below shows a plot of prevision averaged over all 20 classes for 20 values from 0 to 1 with interval 0.05.

A screenshot of a map

Description automatically generated

As we can see in the graph, the precision reaches the highest when threshold is 0.4. And the highest precision is 0.8565135759676487.