**EIE4122 Deep Learning and Deep Neural Networks**

**Lab 3: Gradient Vanishing Problem and ResNet**

**A. Objectives and Outcomes**

After finishing this lab, you should be able to perform the following:

* Understand the gradient vanishing problem.
* Understand the architecture of ResNets.
* Use Google Colab to develop a ResNet to overcome the gradient vanishing problem.

**B. Google Colab**

Google Colab is a free cloud service with GPU support. You may use Colab to develop deep learning applications based on popular libraries such as Keras, TensorFlow, PyTorch, and OpenCV.

**C. Submission**

Write a report and submit it to Blackboard before the deadline. Your report may contain the following:

1. Discussions on your observations, e.g., the maximum number of layers that a feedforward network or a residue network could have without suffering from gradient vanishing.
2. The screen capture of the histograms of the weights at the bottom and the upper layers.
3. The structure of the ResNet (you may infer this from the code or use *resnet.summary()*.
4. Explanation of why the ResNet can be very deep but still does not suffer from the gradient vanishing problem.
5. Explain why ReLU can help mitigating the gradient vanishing problem.

**D. Procedures**

***D.1 Prepare Colab Environment***

1. Colab runs on browsers. You need a Google account to use Colab. If you do not have one, visit https://support.google.com/mail/answer/56256?hl=en.
2. Display the Google Drive (https://drive.google.com/drive/) page in your browser. Create the following directory structure in your Google Drive:

My Drive/Learning/EIE4122/lab3/

After creating the folders, you should see something like this:

图形用户界面, 应用程序

描述已自动生成

Later, you may mount your folders in Google Drive to the working environment of Colab.

1. Download the Colab file from <https://github.com/enmwmak/EIE4122/blob/main/Gradient_vanishing.ipynb>. Save the file as “Gradient\_vanishing.ipynb” on your Desktop. Upload the file to your Google Drive under “My Drive/Learning/EIE4122/lab3”.
2. Right click “Gradient\_vanishing.ipynb” and open it with Colab lab, configure the Colab to use GPU by clicking Edit 🡪 Notebook settings.
3. Check the version of TensorFlow and Keras. (You may click “+Code” to create a new command edit box at the top of the file.)

图形用户界面, 文本, 应用程序

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If the version is not as the same as the above, reinstall the Tensorflow and Keras as following:

文本

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1. Follow the procedures in the Colab file. Remember capturing the outputs and findings to your reports.

**Hints:**

* 1. You can find the histograms of the weights in TensorBoard as shown in the following figure. In the figure, “Distributions” shows the information in 2-D while “Histograms” shows the same information in 3-D.

图形用户界面, 网站, 日程表

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* 1. A model using the ReLU activation function may suffer from the “dying ReLU problem”, which means that the ReLU neurons only output values of 0. This could be avoid by adding a batch normalization layer before each convolutional layer. Search the Internet “Keras Batch Normalization” for the documentation and examples of how to use BN in Keras.

**References:**

[1] <https://machinelearningmastery.com/how-to-fix-vanishing-gradients-using-the-rectified-linear-activation-function/>

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