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Google Colab link :-

https://colab.research.google.com/drive/1ellLhdkU_eLoKOyvkO_beWpoh80MuidZ?usp=sharing

The DynamicLoss function is designed to be a flexible and customizable loss function in TensorFlow/Keras. Let's break down each part of the DynamicLoss class:

Initialization:

```
def __init__(self, learning_rate, curriculum_schedule, **kwargs):
    super(DynamicLoss, self).__init__(**kwargs)
    self.learning_rate = learning_rate
    self.curriculum_schedule = curriculum_schedule
    self.epoch = 0  # To keep track of the current epoch
```

- **learning_rate**: This is a parameter that scales the contribution of the learning progress component in the loss function.
- **curriculum_schedule**: This is a function that takes the current epoch as an argument and returns a curriculum factor. The curriculum factor is used to scale the contribution of the curriculum loss component.
- **epoch**: This variable is used to keep track of the current epoch during training.

Loss Calculation:

```
def call(self, y_true, y_pred):
    # Custom loss components (modify as needed)
    standard_loss = tf.keras.losses.categorical_crossentropy(y_true, y_pred)
    learning_progress_loss = self.learning_rate * self.learning_progress()
    class_balance_loss = self.class_balance_loss(y_true)
    curriculum_loss = self.curriculum_loss(y_pred)
    dynamic_loss = standard_loss + learning_progress_loss + class_balance_loss +
curriculum_loss


    return dynamic_loss
```

* **standard_loss**: This is the standard categorical cross-entropy loss between the true labels (y_true) and the predicted labels (y_pred).

* **learning_progress_loss**: This component represents a custom loss term that increases linearly with epochs. It is scaled by the specified learning rate (self.learning_rate).

* **class_balance_loss**: This component penalizes class imbalance. It calculates the cross-entropy loss between the average class distribution in y_true and a uniform distribution.

* **curriculum_loss**: This component represents a curriculum-based loss term. It is based on the sine of y_pred values and is scaled by a curriculum factor obtained from the curriculum_schedule function.

The final dynamic_loss is the sum of these individual components.

Learning Progress and Class Balance Loss Functions:

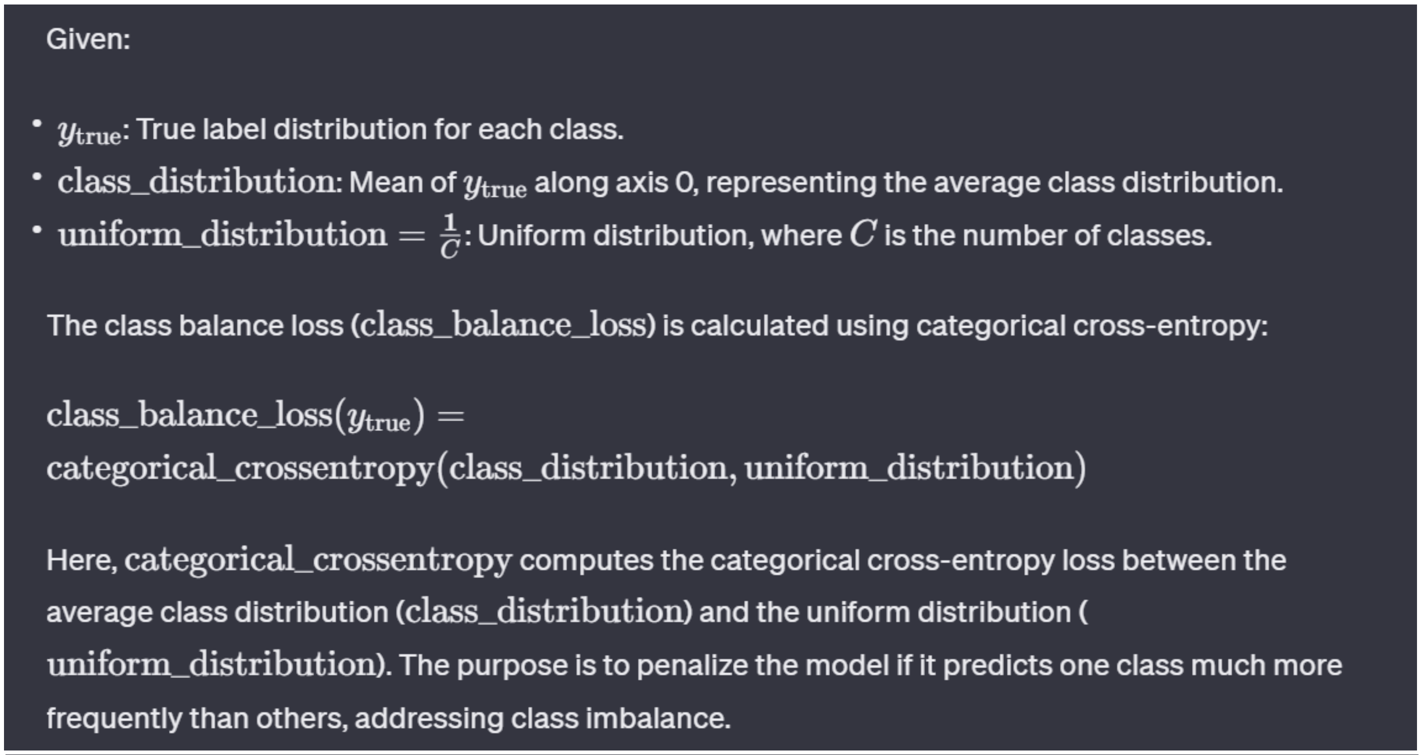
```
def learning_progress(self):
    # Example: Learning progress increases linearly with epochs
    return self.epoch / num_epochs  # Adjust as needed


def class_balance_loss(self, y_true):
    # Example: Penalize class imbalance
    class_distribution = tf.reduce_mean(y_true, axis=0)
    return tf.keras.losses.categorical_crossentropy(class_distribution,
tf.ones_like(class_distribution) / len(class_distribution))
```

- **learning_progress**: This function defines the learning progress, which increases linearly with epochs. It is used in the calculation of the learning progress loss.

$$\alpha/epoch$$

- **class_balance_loss**: This function penalizes class imbalance by calculating the cross-entropy loss between the average class distribution in y_true and a uniform distribution.

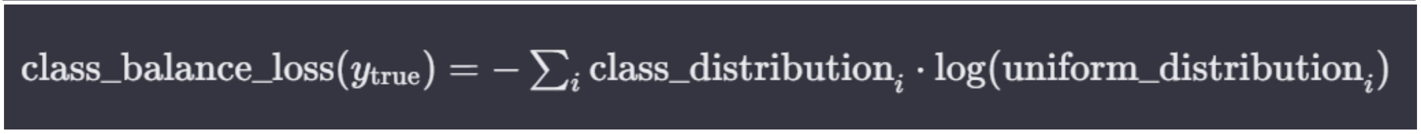

Given:

- y_{true}: True label distribution for each class.
- $\text{class\_distribution}$: Mean of y_{true} along axis 0, representing the average class distribution.
- $\text{uniform\_distribution} = \frac{1}{C}$: Uniform distribution, where C is the number of classes.

The class balance loss ($\text{class\_balance\_loss}$) is calculated using categorical cross-entropy:

$$\text{class\_balance\_loss}(y_{\text{true}}) = \text{categorical\_crossentropy}(\text{class\_distribution}, \text{uniform\_distribution})$$

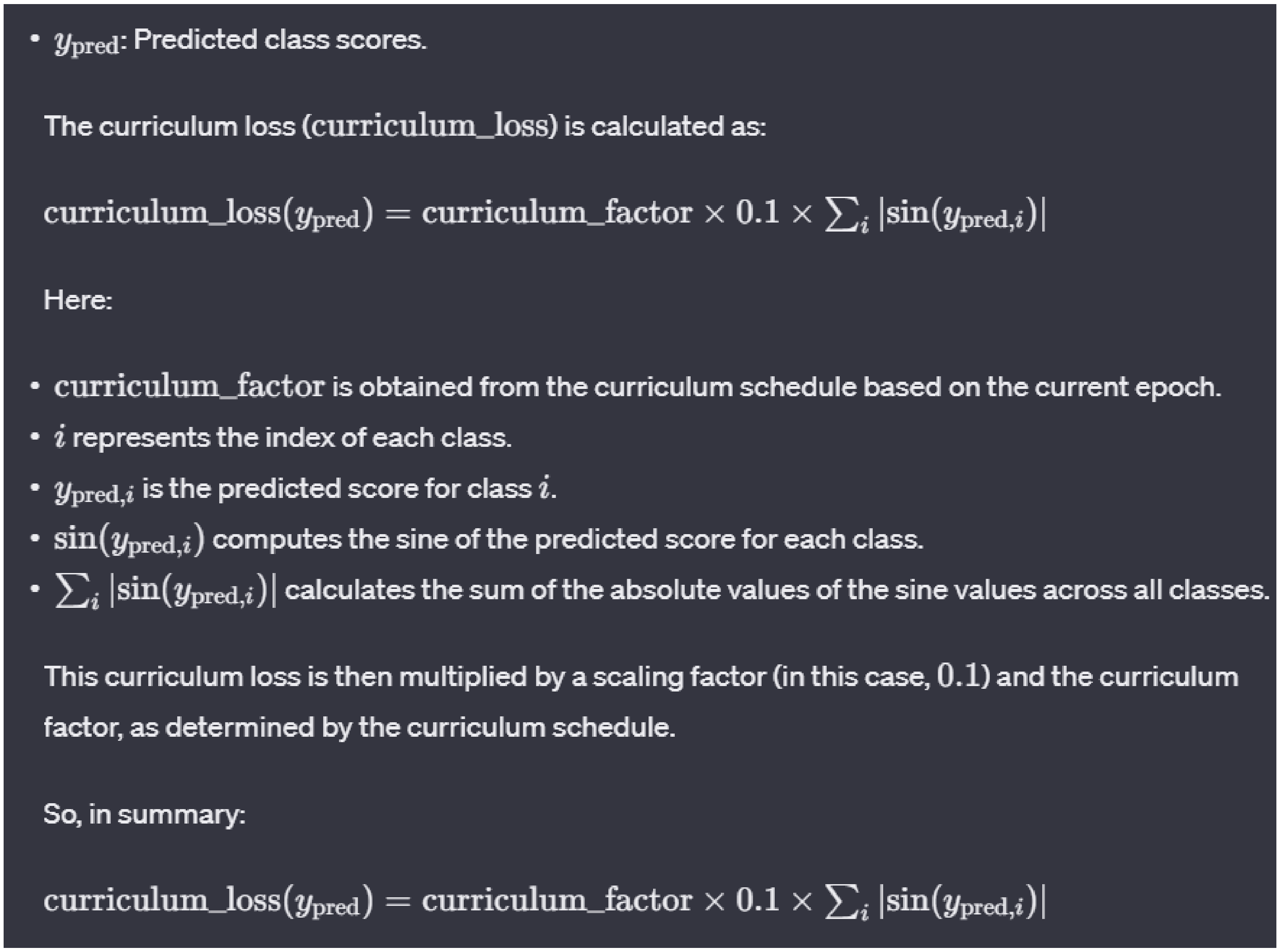
Here, $\text{categorical\_crossentropy}$ computes the categorical cross-entropy loss between the average class distribution ($\text{class\_distribution}$) and the uniform distribution ($\text{uniform\_distribution}$). The purpose is to penalize the model if it predicts one class much more frequently than others, addressing class imbalance.


$$\text{class\_balance\_loss}(y_{\text{true}}) = -\sum_i \text{class\_distribution}_i \cdot \log(\text{uniform\_distribution}_i)$$

Curriculum Loss Function:

```
def curriculum_loss(self, y_pred):
    # Example: Curriculum loss based on the sine of y_pred values
    curriculum_factor = self.curriculum_schedule(self.epoch)
    return curriculum_factor * 0.1 * tf.reduce_sum(tf.abs(tf.math.sin(y_pred)))
```

curriculum_loss : This function calculates a curriculum-based loss term. It is based on the sine of y_pred values and is scaled by a curriculum factor obtained from the curriculum_schedule function.



- y_{pred}: Predicted class scores.

The curriculum loss (curriculum_loss) is calculated as:

$$\text{curriculum\_loss}(y_{\text{pred}}) = \text{curriculum\_factor} \times 0.1 \times \sum_i |\sin(y_{\text{pred},i})|$$

Here:

- curriculum_factor is obtained from the curriculum schedule based on the current epoch.
- i represents the index of each class.
- $y_{\text{pred},i}$ is the predicted score for class i.
- $\sin(y_{\text{pred},i})$ computes the sine of the predicted score for each class.
- $\sum_i |\sin(y_{\text{pred},i})|$ calculates the sum of the absolute values of the sine values across all classes.

This curriculum loss is then multiplied by a scaling factor (in this case, 0.1) and the curriculum factor, as determined by the curriculum schedule.

So, in summary:

$$\text{curriculum\_loss}(y_{\text{pred}}) = \text{curriculum\_factor} \times 0.1 \times \sum_i |\sin(y_{\text{pred},i})|$$

Learning Progress Tracking:

```
def on_epoch_end(self, epoch, logs=None):
    self.epoch = epoch
```

- on_epoch_end: This method updates the self.epoch variable at the end of each epoch, ensuring that the learning progress and curriculum loss functions get the correct epoch information.

In summary, the DynamicLoss function is a versatile custom loss function that allows you to incorporate various components into your neural network training process. It includes standard cross-entropy loss, learning progress loss, class balance loss, and curriculum loss, each of which can be adjusted and customized based on your specific requirements. The learning progress and epoch tracking ensure that the dynamic components evolve over the course of training.