Spring 2024: CS5720

Neural Networks & Deep Learning - ICP-8

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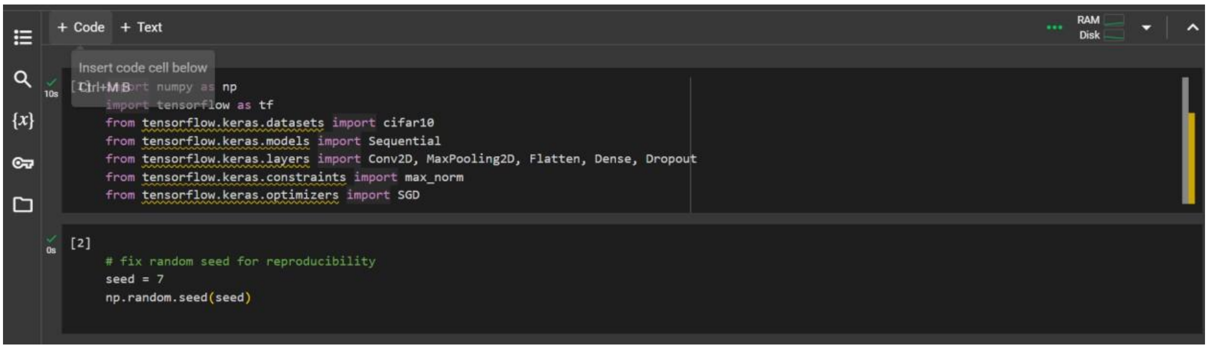
GitHub Link:

https://github.com/vishnutejaayyangar/ICP-8

Video Link:
https://drive.google.com/drive/u/3/folders/16aBivXonHIsMIdwVCPYxS6oywy_lS21X

Use Case Description:
LeNet5, AlexNet, Vgg16, Vgg19
1. Training the model
2. Evaluating the model



```
[3]
# load data
(X_train, y_train), (X_test, y_test) = cifar10.load_data()

# normalize inputs from 0-255 to 0.0-1.0
X_train = X_train.astype('float32')
X_test = X_test.astype('float32')
X_train = X_train / 255.0
X_test = X_test / 255.0
```

```
Downloading data from https://www.cs.toronto.edu/~kriz/cifar-10-python.tar.gz
170498071/170498071 [==============================] - 2s 0us/step
```

```
[4]
# one-hot encode outputs
#num_classes = 10  # Since CIFAR-10 has 10 classes
y_train = tf.keras.utils.to_categorical(y_train, num_classes = 10)
y_test = tf.keras.utils.to_categorical(y_test, num_classes = 10)
#num_classes = y_test.shape[1]
```

```
# Create the model
model = Sequential()
model.add(Conv2D(32, (3, 3), input_shape=(32, 32, 3), activation='relu', padding='same', kernel_constraint=max_norm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(32, (3, 3), activation='relu', padding='same', kernel_constraint=max_norm(3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(64, (3, 3), activation='relu', padding='same', kernel_constraint=max_norm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(64, (3, 3), activation='relu', padding='same', kernel_constraint=max_norm(3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=max_norm(3)))
model.add(Dropout(0.2))
model.add(Conv2D(128, (3, 3), activation='relu', padding='same', kernel_constraint=max_norm(3)))
model.add(MaxPooling2D(pool_size=(2, 2)))
model.add(Flatten())
model.add(Dropout(0.2))
model.add(Dense(1024, activation='relu', kernel_constraint=max_norm(3)))
model.add(Dropout(0.2))
model.add(Dense(512, activation='relu', kernel_constraint=max_norm(3)))
model.add(Dropout(0.2))
model.add(Dense(10, activation='softmax'))
```

```
[6]
# Compile model
epochs = 5
lrate = 0.01
sgd = SGD(lr=lrate, momentum=0.9, nesterov=False)  # Remove decay parameter
model.compile(loss='categorical_crossentropy', optimizer=sgd, metrics=['accuracy'])
print(model.summary())
```

```
WARNING:absl:`lr` is deprecated in Keras optimizer, please use `learning_rate` or use the legacy optimizer, e.g.,tf.keras.optimizers.legacy.SGD.
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 conv2d (Conv2D)             (None, 32, 32, 32)        896

 dropout (Dropout)           (None, 32, 32, 32)        0

 conv2d_1 (Conv2D)           (None, 32, 32, 32)        9248

 max_pooling2d (MaxPooling2  (None, 16, 16, 32)        0
 D)

 conv2d_2 (Conv2D)           (None, 16, 16, 64)        18496

 dropout_1 (Dropout)         (None, 16, 16, 64)        0

 conv2d_3 (Conv2D)           (None, 16, 16, 64)        36928

 max_pooling2d_1 (MaxPoolin  (None, 8, 8, 64)          0
 g2D)
```

```
conv2d_4 (Conv2D)           (None, 8, 8, 128)         73856

dropout_2 (Dropout)         (None, 8, 8, 128)         0

conv2d_5 (Conv2D)           (None, 8, 8, 128)         147584

max_pooling2d_2 (MaxPoolin  (None, 4, 4, 128)         0
g2D)

flatten (Flatten)           (None, 2048)              0

dropout_3 (Dropout)         (None, 2048)              0

dense (Dense)               (None, 1024)              2098176

dropout_4 (Dropout)         (None, 1024)              0

dense_1 (Dense)             (None, 512)               524800

dropout_5 (Dropout)         (None, 512)               0

dense_2 (Dense)             (None, 10)                5130

=================================================================
Total params: 2915114 (11.12 MB)
Trainable params: 2915114 (11.12 MB)
Non-trainable params: 0 (0.00 Byte)
_________________________________________________________________
None
```

```
[7] # Fit the model
    history = model.fit(X_train, y_train, validation_data=(X_test, y_test), epochs=epochs, batch_size=32)

    # Final evaluation of the model
    scores = model.evaluate(X_test, y_test, verbose=0)
    print("Accuracy: %.2f%%" % (scores[1] * 100))
```

```
Epoch 1/5
1563/1563 [==============================] - 507s 323ms/step - loss: 1.8599 - accuracy: 0.3126 - val_loss: 1.4817 - val_accuracy: 0.4530
Epoch 2/5
1563/1563 [==============================] - 522s 334ms/step - loss: 1.4269 - accuracy: 0.4810 - val_loss: 1.3270 - val_accuracy: 0.5192
Epoch 3/5
1563/1563 [==============================] - 515s 329ms/step - loss: 1.2139 - accuracy: 0.5643 - val_loss: 1.0599 - val_accuracy: 0.6218
Epoch 4/5
1563/1563 [==============================] - 520s 332ms/step - loss: 1.0560 - accuracy: 0.6258 - val_loss: 1.0832 - val_accuracy: 0.6197
Epoch 5/5
1563/1563 [==============================] - 457s 293ms/step - loss: 0.9435 - accuracy: 0.6672 - val_loss: 0.8670 - val_accuracy: 0.6934
Accuracy: 69.34%
```

```
[8] # Predict the first 4 test samples
    num_samples_to_predict = 4
    predictions = model.predict(X_test[:num_samples_to_predict])

    # Convert predictions to class labels (assuming one-hot encoding)
    predicted_labels = np.argmax(predictions, axis=1)

    # Convert actual labels to class labels (assuming one-hot encoding)
    actual_labels = np.argmax(y_test[:num_samples_to_predict], axis=1)

    # Print the predicted and actual labels
    print("Predicted Labels:", predicted_labels)
    print("Actual Labels:", actual_labels)
```

```
1/1 [==============================] - 0s 156ms/step
Predicted Labels: [3 1 0 0]
Actual Labels: [3 8 8 0]
```

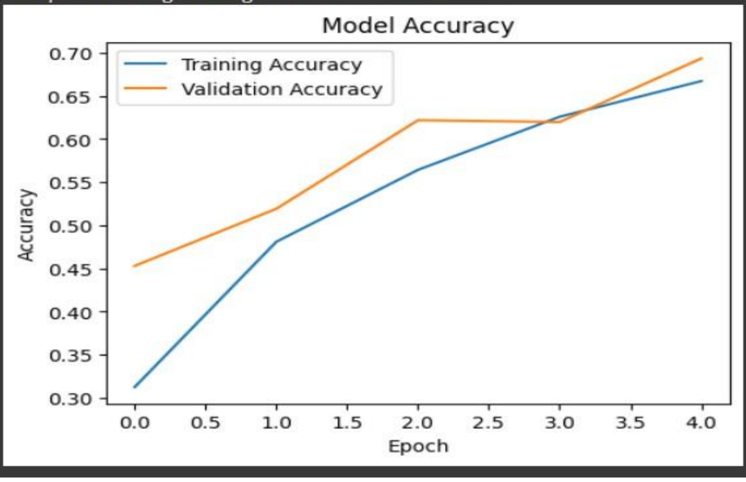
```
[9] # Compare and print the results
    for i in range(num_samples_to_predict):
        if predicted_labels[i] == actual_labels[i]:
            print(f"Image {i+1}: Predicted Correctly  (Class {predicted_labels[i]})")
        else:
            print(f"Image {i+1}: Predicted Incorrectly  (Predicted Class {predicted_labels[i]}, Actual Class {actual_labels[i]})")
```

```
Image 1: Predicted Correctly  (Class 3)
Image 2: Predicted Incorrectly  (Predicted Class 1, Actual Class 8)
Image 3: Predicted Incorrectly  (Predicted Class 0, Actual Class 8)
Image 4: Predicted Correctly  (Class 0)
```

```python
import matplotlib.pyplot as plt

# Plot training & validation accuracy values
plt.figure(figsize=(12, 4))
plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.title('Model Accuracy')
plt.xlabel('Epoch')
plt.ylabel('Accuracy')
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7b6018e5de40>
```




```python
# Plot training & validation loss values
plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.title('Model Loss')
plt.xlabel('Epoch')
plt.ylabel('Loss')
plt.legend()

plt.show()
```