alexnet-1

March 13, 2025

[1]:

```
import tensorflow as tf
from tensorflow.keras import layers, models
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.datasets import cifar10
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.utils import to_categorical
```

[2]:

```
# Load CIFAR-10 dataset
(x_train, y_train), (x_test, y_test) = cifar10.load_data()
```

[3]:

```
print(x_train.shape)
print(y_train.shape)
print(x_test.shape)
print(y_test.shape)
```

```
(50000, 32, 32, 3)
(50000, 1)
(10000, 32, 32, 3)
(10000, 1)
```

[4]:

```
# Normalize the images to the range [0, 1]
x_train = x_train / 255.0
x_test = x_test / 255.0
```

[5]:

```
# Convert class vectors to binary class matrices (one-hot encoding)
y_train = to_categorical(y_train, 10)
y_test = to_categorical(y_test, 10)
```

[6]:

```
# Define AlexNet model in Keras
input_shape=(32, 32, 3)
num_classes=10
alexnet_model = models.Sequential()

# Layer 1: Conv Layer
alexnet_model.add(Conv2D(96, (11, 11), strides=4, padding='same',␣
 ↪input_shape=input_shape))
```

```
alexnet_model.add(layers.BatchNormalization())
alexnet_model.add(layers.Activation('relu'))
alexnet_model.add(MaxPooling2D(pool_size=(2, 2), strides=(1, 1)))

# Layer 2: Conv Layer
alexnet_model.add(Conv2D(256, (5, 5), padding='same'))
alexnet_model.add(layers.BatchNormalization())
alexnet_model.add(layers.Activation('relu'))
alexnet_model.add(MaxPooling2D(pool_size=(2, 2), strides=(1, 1)))

# Layer 3: Conv Layer
alexnet_model.add(Conv2D(384, (3, 3), padding='same'))

# Layer 4: Conv Layer
alexnet_model.add(Conv2D(384, (3, 3), padding='same'))


# Layer 5: Conv Layer
alexnet_model.add(Conv2D(256, (3, 3), padding='same'))
alexnet_model.add(layers.Activation('relu'))
alexnet_model.add(MaxPooling2D(pool_size=(2, 2), strides=(1, 1)))

# Flatten the data for Fully Connected Layers
alexnet_model.add(Flatten())

# Layer 6: Fully Connected Layer
alexnet_model.add(Dense(4096))
alexnet_model.add(layers.Activation('relu'))
alexnet_model.add(layers.Dropout(0.5))

# Layer 7: Fully Connected Layer
alexnet_model.add(Dense(4096))
alexnet_model.add(layers.Activation('relu'))
alexnet_model.add(layers.Dropout(0.5))

# Layer 8: Output Layer
alexnet_model.add(Dense(num_classes))
alexnet_model.add(layers.Activation('softmax'))
```

```
C:\Users\KH.EN.P2MCA24006\AppData\Local\Packages\PythonSoftwareFoundation.Python
.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-
packages\keras\src\layers\convolutional\base_conv.py:107: UserWarning: Do not
pass an `input_shape`/`input_dim` argument to a layer. When using Sequential
models, prefer using an `Input(shape)` object as the first layer in the model
instead.
  super().__init__(activity_regularizer=activity_regularizer, **kwargs)
```

[7]:

```
'''#Do not run this code
#Generalized definition of AlexNet
# Define AlexNet model in Keras
def AlexNet(input_shape=(32, 32, 3), num_classes=10):
    model = models.Sequential()

    # Layer 1: Conv Layer
    model.add(layers.Conv2D(96, (11, 11), strides=4, padding='same',␣
 ↪input_shape=input_shape))
    model.add(layers.BatchNormalization())
    model.add(layers.Activation('relu'))
    model.add(layers.MaxPooling2D(pool_size=(3, 3), strides=(2, 2)))

    # Layer 2: Conv Layer
    model.add(layers.Conv2D(256, (5, 5), padding='same'))
    model.add(layers.BatchNormalization())
    model.add(layers.Activation('relu'))
    model.add(layers.MaxPooling2D(pool_size=(3, 3), strides=(2, 2)))

    # Layer 3: Conv Layer
    model.add(layers.Conv2D(384, (3, 3), padding='same'))
    model.add(layers.Activation('relu'))

    # Layer 4: Conv Layer
    model.add(layers.Conv2D(384, (3, 3), padding='same'))
    model.add(layers.Activation('relu'))

    # Layer 5: Conv Layer
    model.add(layers.Conv2D(256, (3, 3), padding='same'))
    model.add(layers.Activation('relu'))
    model.add(layers.MaxPooling2D(pool_size=(3, 3), strides=(2, 2)))

    # Flatten the data for Fully Connected Layers
    model.add(layers.Flatten())

    # Layer 6: Fully Connected Layer
    model.add(layers.Dense(4096))
    model.add(layers.Activation('relu'))
    model.add(layers.Dropout(0.5))

    # Layer 7: Fully Connected Layer
    model.add(layers.Dense(4096))
    model.add(layers.Activation('relu'))
    model.add(layers.Dropout(0.5))

    # Layer 8: Output Layer
    model.add(layers.Dense(num_classes))
    model.add(layers.Activation('softmax'))

    return model

# Define the model
alexnet_model = AlexNet(input_shape=(32, 32, 3), num_classes=10)'''
```

[7]:
```
"#Do not run this code\n#Generalized definition of AlexNet\n# Define AlexNet
model in Keras\ndef AlexNet(input_shape=(32, 32, 3), num_classes=10):\n    model
= models.Sequential()\n\n    # Layer 1: Conv Layer\n
model.add(layers.Conv2D(96, (11, 11), strides=4, padding='same',
input_shape=input_shape))\n    model.add(layers.BatchNormalization())\n
model.add(layers.Activation('relu'))\n
model.add(layers.MaxPooling2D(pool_size=(3, 3), strides=(2, 2)))\n\n    # Layer
2: Conv Layer\n    model.add(layers.Conv2D(256, (5, 5), padding='same'))\n
model.add(layers.BatchNormalization())\n
model.add(layers.Activation('relu'))\n
model.add(layers.MaxPooling2D(pool_size=(3, 3), strides=(2, 2)))\n\n    # Layer
3: Conv Layer\n    model.add(layers.Conv2D(384, (3, 3), padding='same'))\n
model.add(layers.Activation('relu'))\n\n    # Layer 4: Conv Layer\n
model.add(layers.Conv2D(384, (3, 3), padding='same'))\n
model.add(layers.Activation('relu'))\n\n    # Layer 5: Conv Layer\n
model.add(layers.Conv2D(256, (3, 3), padding='same'))\n
model.add(layers.Activation('relu'))\n
model.add(layers.MaxPooling2D(pool_size=(3, 3), strides=(2, 2)))\n\n    #
Flatten the data for Fully Connected Layers\n    model.add(layers.Flatten())\n\n
# Layer 6: Fully Connected Layer\n    model.add(layers.Dense(4096))\n
model.add(layers.Activation('relu'))\n    model.add(layers.Dropout(0.5))\n\n
# Layer 7: Fully Connected Layer\n    model.add(layers.Dense(4096))\n
model.add(layers.Activation('relu'))\n    model.add(layers.Dropout(0.5))\n\n
# Layer 8: Output Layer\n    model.add(layers.Dense(num_classes))\n
model.add(layers.Activation('softmax'))\n\n    return model\n\n# Define the
model\nalexnet_model = AlexNet(input_shape=(32, 32, 3), num_classes=10)"
```

[8]:
```
# Compile the model
#alexnet_model.
 ↪compile(optimizer='adam',loss='categorical_crossentropy',metrics=['accuracy'])
alexnet_model.compile(optimizer=Adam(learning_rate=0.01),
                      loss='categorical_crossentropy',
                      metrics=['accuracy'])
```

[9]:
```
alexnet_model.summary()
```

```
Model: "sequential"


 Layer (type)                      Output Shape                 Param #
```

```
conv2d (Conv2D)                   (None, 8, 8, 96)                34,944

batch_normalization               (None, 8, 8, 96)                   384
(BatchNormalization)

activation (Activation)           (None, 8, 8, 96)                     0

max_pooling2d (MaxPooling2D)      (None, 7, 7, 96)                     0

conv2d_1 (Conv2D)                 (None, 7, 7, 256)              614,656

batch_normalization_1             (None, 7, 7, 256)                1,024
(BatchNormalization)

activation_1 (Activation)         (None, 7, 7, 256)                    0

max_pooling2d_1 (MaxPooling2D)    (None, 6, 6, 256)                    0

conv2d_2 (Conv2D)                 (None, 6, 6, 384)              885,120

conv2d_3 (Conv2D)                 (None, 6, 6, 384)            1,327,488

conv2d_4 (Conv2D)                 (None, 6, 6, 256)              884,992

activation_2 (Activation)         (None, 6, 6, 256)                    0

max_pooling2d_2 (MaxPooling2D)    (None, 5, 5, 256)                    0

flatten (Flatten)                 (None, 6400)                         0

dense (Dense)                     (None, 4096)                26,218,496

activation_3 (Activation)         (None, 4096)                         0

dropout (Dropout)                 (None, 4096)                         0

dense_1 (Dense)                   (None, 4096)                16,781,312

activation_4 (Activation)         (None, 4096)                         0

dropout_1 (Dropout)               (None, 4096)                         0

dense_2 (Dense)                   (None, 10)                      40,970

activation_5 (Activation)         (None, 10)                           0
```

```
Total params: 46,789,386 (178.49 MB)

Trainable params: 46,788,682 (178.48 MB)

Non-trainable params: 704 (2.75 KB)
```

[10]:
```python
###---model architecture---
tf.keras.utils.
 ↪plot_model(alexnet_model,show_layer_names=True,show_shapes=True,show_dtype=False)
```

```
You must install pydot (`pip install pydot`) for `plot_model` to work.
```

[11]:
```python
# Create data augmentation generator
datagen = ImageDataGenerator(
    width_shift_range=0.1,  # randomly shift images horizontally
    height_shift_range=0.1,  # randomly shift images vertically
    horizontal_flip=True     # randomly flip images horizontally
)
```

[12]:
```python
datagen.fit(x_train)  #optional step
```

[ ]:
```python
# Train the model
history = alexnet_model.fit(datagen.flow(x_train, y_train, batch_size=256),
                            epochs=2,
                            validation_data=(x_test, y_test),
                            verbose=1)
```

```
C:\Users\KH.EN.P2MCA24006\AppData\Local\Packages\PythonSoftwareFoundation.Python
.3.11_qbz5n2kfra8p0\LocalCache\local-packages\Python311\site-
packages\keras\src\trainers\data_adapters\py_dataset_adapter.py:121:
UserWarning: Your `PyDataset` class should call `super().__init__(**kwargs)` in
its constructor. `**kwargs` can include `workers`, `use_multiprocessing`,
`max_queue_size`. Do not pass these arguments to `fit()`, as they will be
ignored.
  self._warn_if_super_not_called()

Epoch 1/2
196/196            409s 2s/step -
accuracy: 0.0978 - loss: 461801.1875 - val_accuracy: 0.0995 - val_loss: 10.7883
Epoch 2/2
196/196            412s 2s/step -
accuracy: 0.0984 - loss: 4.1614 - val_accuracy: 0.1000 - val_loss: 2.3026
```

[14]:
```python
# Evaluate the model
test_loss, test_acc = alexnet_model.evaluate(x_test, y_test, verbose=2)
print(f'Test accuracy: {test_acc:.4f}')
```

```
313/313 - 22s - 72ms/step - accuracy: 0.1000 - loss: 2.3026
Test accuracy: 0.1000
```

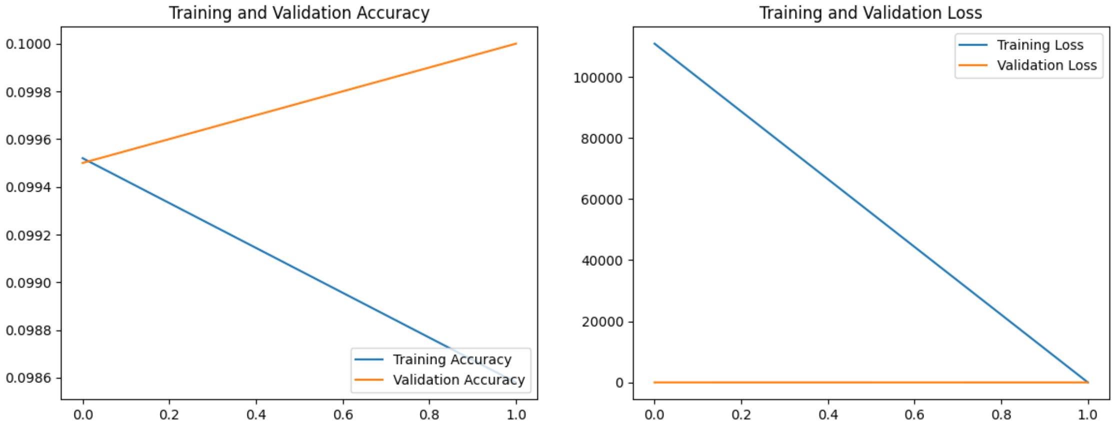
[15]:

```
# Plot training and validation accuracy and loss
import matplotlib.pyplot as plt
plt.figure(figsize=(14, 5))

plt.subplot(1, 2, 1)
plt.plot(history.history['accuracy'], label='Training Accuracy')
plt.plot(history.history['val_accuracy'], label='Validation Accuracy')
plt.legend(loc='lower right')
plt.title('Training and Validation Accuracy')

plt.subplot(1, 2, 2)
plt.plot(history.history['loss'], label='Training Loss')
plt.plot(history.history['val_loss'], label='Validation Loss')
plt.legend(loc='upper right')
plt.title('Training and Validation Loss')

plt.savefig('./foo.png')
plt.show()
```



[ ]: