

Experiment 7 - CNN Model - Cats & Dogs Classification

Problem Statement:

To create CNN model with dataset containing images of cats and dogs for image classification.

GitHub & Colab Link:

GitHub Link: <https://github.com/piyush-gambhir/ncu-lab-manual-and-end-semester-projects/blob/main/NCU-CSL312%20-%20DL%20-%20Lab%20Manual/Experiment%207/Experiment%207.ipynb>

Google Colab Link:



Dataset

Dataset Link: <https://www.kaggle.com/datasets/tongpython/cat-and-dog>

Installing Dependencies:

```
In [ ]: ! pip install tabulate numpy pandas matplotlib seaborn scikit-learn tensorflow keras
```

```
Requirement already satisfied: tabulate in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (0.9.0)
Requirement already satisfied: numpy in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (1.26.4)
Requirement already satisfied: pandas in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (2.2.2)
Requirement already satisfied: matplotlib in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (3.8.4)
Requirement already satisfied: seaborn in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (0.13.2)
Requirement already satisfied: scikit-learn in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (1.4.2)
Requirement already satisfied: tensorflow in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (2.16.1)
Requirement already satisfied: keras in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (3.2.1)
Requirement already satisfied: python-dateutil<=2.8.2 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from pandas) (2.9.0.post0)
Requirement already satisfied: pytz>=2020.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from pandas) (2024.1)
Requirement already satisfied: tzdata>=2022.7 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from pandas) (2024.1)
Requirement already satisfied: contourpy>=1.0.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from matplotlib) (1.2.1)
Requirement already satisfied: cycler>=0.10 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from matplotlib) (0.12.1)
Requirement already satisfied: fonttools>=4.22.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from matplotlib) (4.51.0)
Requirement already satisfied: kiwisolver>=1.3.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from matplotlib) (1.4.5)
Requirement already satisfied: packaging>=20.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from matplotlib) (24.0)
Requirement already satisfied: pillow>=8 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from matplotlib) (10.3.0)
Requirement already satisfied: pyparsing>=2.3.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from matplotlib) (3.1.2)
Requirement already satisfied: scipy>=1.6.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from scikit-learn) (1.13.0)
Requirement already satisfied: joblib>=1.2.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from scikit-learn) (1.4.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from scikit-learn) (3.4.0)
Requirement already satisfied: tensorflow-intel==2.16.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow) (2.16.1)
Requirement already satisfied: absl-py>=1.0.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (2.1.0)
Requirement already satisfied: astunparse>=1.6.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (1.6.3)
Requirement already satisfied: flatbuffers>=23.5.26 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (24.3.25)
```

Requirement already satisfied: gast!=0.5.0,!0.5.1,!0.5.2,>=0.2.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (0.5.4)

Requirement already satisfied: google-pasta>=0.1.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (0.2.0)

Requirement already satisfied: h5py>=3.10.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (3.11.0)

Requirement already satisfied: libclang>=13.0.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (18.1.1)

Requirement already satisfied: ml-dtypes~0.3.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (0.3.2)

Requirement already satisfied: opt-einsum>=2.3.2 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (3.3.0)

Requirement already satisfied: protobuf!=4.21.0,!4.21.1,!4.21.2,!4.21.3,!4.21.4,!4.21.5,<5.0.0dev,>=3.20.3 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (4.25.3)

Requirement already satisfied: requests<3,>=2.21.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (2.31.0)

Requirement already satisfied: setuptools in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (65.5.0)

Requirement already satisfied: six>=1.12.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (1.16.0)

Requirement already satisfied: termcolor>=1.1.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (2.4.0)

Requirement already satisfied: typing-extensions>=3.6.6 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (4.11.0)

Requirement already satisfied: wrapt>=1.11.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (1.16.0)

Requirement already satisfied: grpcio<2.0,>=1.24.3 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (1.62.2)

Requirement already satisfied: tensorboard<2.17,>=2.16 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (2.16.2)

Requirement already satisfied: tensorflow-io-gcs-filesystem>=0.23.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorflow-intel==2.16.1->tensorflow) (0.31.0)

Requirement already satisfied: rich in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from keras) (13.7.1)

Requirement already satisfied: namex in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from keras) (0.0.8)

Requirement already satisfied: optree in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from keras) (0.11.0)

Requirement already satisfied: markdown-it-py>=2.2.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from rich->keras) (3.0.0)

Requirement already satisfied: pygments<3.0.0,>=2.13.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from rich->keras) (2.17.2)

Requirement already satisfied: wheel<1.0,>=0.23.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from astunparse>=1.6.0->tensorflow-intel==2.16.1->tensorflow) (0.43.0)

Requirement already satisfied: mdurl~0.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from markdown-it-py>=2.2.0->rich->keras) (0.1.2)

Requirement already satisfied: charset-normalizer<4,>=2 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (3.3.2)

Requirement already satisfied: idna<4,>=2.5 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (3.7)

Requirement already satisfied: urllib3<3,>=1.21.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (2.2.1)

Requirement already satisfied: certifi>=2017.4.17 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from requests<3,>=2.21.0->tensorflow-intel==2.16.1->tensorflow) (2024.2.2)

Requirement already satisfied: markdown>=2.6.8 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (3.6)

Requirement already satisfied: tensorboard-data-server<0.8.0,>=0.7.0 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (0.7.2)

Requirement already satisfied: werkzeug>=1.0.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (3.0.2)

Requirement already satisfied: MarkupSafe>=2.1.1 in c:\users\mainp\appdata\local\programs\python\python311\lib\site-packages (from werkzeug>=1.0.1->tensorboard<2.17,>=2.16->tensorflow-intel==2.16.1->tensorflow) (2.1.5)

Code

```
In [ ]: import numpy as np
import matplotlib.pyplot as plt
import seaborn as sns
from sklearn.metrics import confusion_matrix
import tensorflow as tf
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, MaxPooling2D, Flatten, Dense
from tensorflow.keras.preprocessing.image import ImageDataGenerator
```

```
In [ ]: # Model definition
import warnings
model = Sequential([
    Conv2D(32, (3, 3), activation='relu', input_shape=(64, 64, 3)),
    MaxPooling2D(2, 2),
    Conv2D(32, (3, 3), activation='relu'),
    MaxPooling2D(2, 2),
```

```

        Flatten(),
        Dense(128, activation='relu'),
        Dense(1, activation='sigmoid')
    ])

    # Compiler settings
    model.compile(optimizer='adam',
                  loss='binary_crossentropy',
                  metrics=['accuracy'])

    # Suppress warnings
    warnings.filterwarnings('ignore')

```

c:\Users\mainp\AppData\Local\Programs\Python\Python311\Lib\site-packages\keras\src\layers\convolutional\base_conv.py:99: 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__(

```

```

In [ ]: # Image data augmentation and generators
train_datagen = ImageDataGenerator(rescale=1./255,
                                   shear_range=0.1,
                                   zoom_range=0.1,
                                   horizontal_flip=True)

test_datagen = ImageDataGenerator(rescale=1./255)

train_set = train_datagen.flow_from_directory('./dataset/training_set',
                                              target_size=(64, 64),
                                              batch_size=32,
                                              class_mode='binary')

test_set = test_datagen.flow_from_directory('./dataset/test_set',
                                             target_size=(64, 64),
                                             batch_size=32,
                                             class_mode='binary')

```

Found 8005 images belonging to 2 classes.
Found 2023 images belonging to 2 classes.

```

In [ ]: # Model training
history = model.fit(
    train_set,
    steps_per_epoch=100, # Adjust based on your dataset size
    epochs=20,           # Training for 20 epochs
    validation_data=test_set,
    validation_steps=50  # Adjust based on your validation set size
)

```

```

Epoch 1/20
100/100 ————— 99s 937ms/step - accuracy: 0.4903 - loss: 0.7411 - val_accuracy: 0.5000 - val_loss: 0.6932
Epoch 2/20
100/100 ————— 66s 662ms/step - accuracy: 0.5265 - loss: 0.6923 - val_accuracy: 0.5579 - val_loss: 0.6862
Epoch 3/20
100/100 ————— 47s 471ms/step - accuracy: 0.5937 - loss: 0.6724 - val_accuracy: 0.6456 - val_loss: 0.6417
Epoch 4/20
100/100 ————— 95s 920ms/step - accuracy: 0.6341 - loss: 0.6418 - val_accuracy: 0.6194 - val_loss: 0.6352
Epoch 5/20
100/100 ————— 97s 976ms/step - accuracy: 0.6680 - loss: 0.6133 - val_accuracy: 0.6906 - val_loss: 0.6060
Epoch 6/20
100/100 ————— 37s 375ms/step - accuracy: 0.6771 - loss: 0.5966 - val_accuracy: 0.7234 - val_loss: 0.6035
Epoch 7/20
100/100 ————— 118s 1s/step - accuracy: 0.7049 - loss: 0.5831 - val_accuracy: 0.7138 - val_loss: 0.5685
Epoch 8/20
100/100 ————— 79s 795ms/step - accuracy: 0.7114 - loss: 0.5515 - val_accuracy: 0.7069 - val_loss: 0.5857
Epoch 9/20
100/100 ————— 51s 512ms/step - accuracy: 0.7203 - loss: 0.5640 - val_accuracy: 0.7281 - val_loss: 0.5531
Epoch 10/20
100/100 ————— 67s 634ms/step - accuracy: 0.7249 - loss: 0.5424 - val_accuracy: 0.7707 - val_loss: 0.5357
Epoch 11/20
100/100 ————— 193s 2s/step - accuracy: 0.7491 - loss: 0.5145 - val_accuracy: 0.7500 - val_loss: 0.5170
Epoch 12/20
100/100 ————— 93s 938ms/step - accuracy: 0.7325 - loss: 0.5127 - val_accuracy: 0.7163 - val_loss: 0.5456
Epoch 13/20
100/100 ————— 290s 3s/step - accuracy: 0.7429 - loss: 0.5232 - val_accuracy: 0.7231 - val_loss: 0.5598
Epoch 14/20
100/100 ————— 173s 2s/step - accuracy: 0.7521 - loss: 0.5081 - val_accuracy: 0.7423 - val_loss: 0.5143
Epoch 15/20
100/100 ————— 49s 492ms/step - accuracy: 0.7670 - loss: 0.4919 - val_accuracy: 0.7469 - val_loss: 0.5273
Epoch 16/20
100/100 ————— 73s 677ms/step - accuracy: 0.7573 - loss: 0.5033 - val_accuracy: 0.7683 - val_loss: 0.4925
Epoch 17/20
100/100 ————— 79s 794ms/step - accuracy: 0.7846 - loss: 0.4787 - val_accuracy: 0.7500 - val_loss: 0.5215
Epoch 18/20
100/100 ————— 26s 264ms/step - accuracy: 0.7586 - loss: 0.4926 - val_accuracy: 0.7825 - val_loss: 0.4505
Epoch 19/20
100/100 ————— 90s 875ms/step - accuracy: 0.7781 - loss: 0.4705 - val_accuracy: 0.7725 - val_loss: 0.4837
Epoch 20/20
100/100 ————— 72s 730ms/step - accuracy: 0.7754 - loss: 0.4696 - val_accuracy: 0.7707 - val_loss: 0.4765

```

```

In [ ]: # Save the trained model
model.save('cat_dog_classifier_model.h5')

```

WARNING:absl:You are saving your model as an HDF5 file via `model.save()` or `keras.saving.save_model(model)`. This file format is considered legacy. We recommend using instead the native Keras format, e.g. `model.save('my_model.keras')` or `keras.saving.save_model(model, 'my_model.keras')`.

```

In [ ]: # Model evaluation using the new 'evaluate' method
eval_result = model.evaluate(test_set)
print(f"Validation Accuracy: {eval_result[1]*100:.2f}%, Validation Loss: {eval_result[0]:.6f}")

```

```

64/64 ————— 27s 419ms/step - accuracy: 0.7738 - loss: 0.4813
Validation Accuracy: 76.52%, Validation Loss: 0.493094

```

```

In [ ]: # Confusion matrix on the test set
y_pred = model.predict(test_set)
y_pred = (y_pred > 0.5)
y_true = test_set.classes
cm = confusion_matrix(y_true, y_pred)
sns.heatmap(cm, annot=True, fmt='d')
plt.xlabel('Predicted')
plt.ylabel('True')
plt.title('Confusion Matrix')

```

plt.show()

64/64 25s 386ms/step

