

```
In [1]: pip install tensorflow numpy scikit-learn matplotlib

Requirement already satisfied: tensorflow in c:\users\user\anaconda3\lib\site-packages (2.10.0)
Requirement already satisfied: numpy in c:\users\user\anaconda3\lib\site-packages (1.24.3)
Requirement already satisfied: scikit-learn in c:\users\user\anaconda3\lib\site-packages (1.2.1)
Requirement already satisfied: matplotlib in c:\users\user\anaconda3\lib\site-packages (3.7.0)
Requirement already satisfied: opt-einsum=>2.3.2 in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (3.3.0)
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Requirement already satisfied: packaging in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (22.0)
Requirement already satisfied: termcolor=>1.1.0 in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (2.3.0)
Requirement already satisfied: gast<=>0.4.0,>=0.2.1 in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (0.4.0)
Collecting protobuf<3.20,>=3.9.2
  Using cached protobuf-3.19.6-cp310-cp310-win_amd64.whl (895 kB)
Requirement already satisfied: six>=1.12.0 in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (1.16.0)
Requirement already satisfied: tensorboard<2.11,>=2.10 in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (2.10.0)
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Requirement already satisfied: google-pasta=>0.1.1 in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (0.2.0)
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Requirement already satisfied: tensorflow-estimator<2.11,>=2.10.0 in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (2.10.0)
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Requirement already satisfied: typing-extensions=>3.6.6 in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (4.4.0)
Requirement already satisfied: keras-preprocessing=>1.1.1 in c:\users\user\anaconda3\lib\site-packages (from tensorflow) (1.1.2)
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Requirement already satisfied: kiwisolver=>1.0.1 in c:\users\user\anaconda3\lib\site-packages (from matplotlib) (1.4.4)
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Requirement already satisfied: pillow=>6.2.0 in c:\users\user\anaconda3\lib\site-packages (from matplotlib) (9.4.0)
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Requirement already satisfied: requests<3,>=2.21.0 in c:\users\user\anaconda3\lib\site-packages (from tensorboard<2.11,>=2.10->tensorflow) (2.28.1)
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Requirement already satisfied: urllib3<2.0 in c:\users\user\anaconda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow) (1.26.14)
Requirement already satisfied: pyasn1-modules=>0.2.1 in c:\users\user\anaconda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow) (0.2.8)
Requirement already satisfied: cachetools=>6.0,>=2.0.0 in c:\users\user\anaconda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow) (5.3.0)
Requirement already satisfied: rsa<5,>=3.1.4 in c:\users\user\anaconda3\lib\site-packages (from google-auth<3,>=1.6.3->tensorboard<2.11,>=2.10->tensorflow) (4.9)
Requirement already satisfied: requests-oauthlib=>0.7.0 in c:\users\user\anaconda3\lib\site-packages (from google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.11,>=2.10->tensorflow) (1.3.1)
Requirement already satisfied: certifi=>2017.4.17 in c:\users\user\anaconda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow) (2023.5.7)
Requirement already satisfied: idna<4,>=2.5 in c:\users\user\anaconda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow) (3.4)
Requirement already satisfied: charset-normalizer<3,>=2 in c:\users\user\anaconda3\lib\site-packages (from requests<3,>=2.21.0->tensorboard<2.11,>=2.10->tensorflow) (2.0.4)
Requirement already satisfied: MarkupSafe=>2.1.1 in c:\users\user\anaconda3\lib\site-packages (from werkzeug=>1.0.1->tensorboard<2.11,>=2.10->tensorflow) (2.1.1)
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Requirement already satisfied: oauthlib=>3.0.0 in c:\users\user\anaconda3\lib\site-packages (from requests-oauthlib=>0.7.0->google-auth-oauthlib<0.5,>=0.4.1->tensorboard<2.11,>=2.10->tensorflow) (3.2.2)
Installing collected packages: protobuf
  Attempting uninstall: protobuf
    Found existing installation: protobuf 3.20.3
    Uninstalling protobuf-3.20.3:
      Successfully uninstalled protobuf-3.20.3
Successfully installed protobuf-3.19.6
Note: you may need to restart the kernel to use updated packages.
```

```
In [2]: import os
import numpy as np
import matplotlib.pyplot as plt
from tensorflow.keras.preprocessing.image import ImageDataGenerator
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Flatten, Dense
from sklearn.neighbors import KNeighborsClassifier
from sklearn.tree import DecisionTreeClassifier, plot_tree
from sklearn.metrics import accuracy_score, precision_score, recall_score, f1_score, confusion_matrix
```

```
In [3]: train_dir = r'C:\Users\USER\Desktop\Spring 2024\Machine Learning intelligence\Assignment\PandaOrBear\PandasBears\Train'
```

```
In [4]: test_dir = r'C:\Users\USER\Desktop\Spring 2024\Machine Learning intelligence\Assignment\PandaOrBear\PandasBears\Test'
```

```
In [5]: # Image Data Generator for loading images
train_datagen = ImageDataGenerator(rescale=1.0/255.0)
test_datagen = ImageDataGenerator(rescale=1.0/255.0)
```

```
In [6]: train_generator = train_datagen.flow_from_directory(
    train_dir,
    target_size=(256, 256),
    batch_size=32,
    class_mode='binary',
    color_mode='grayscale'
)

Found 500 images belonging to 2 classes.
```

```
In [7]: test_generator = test_datagen.flow_from_directory(
    test_dir,
    target_size=(256, 256),
    batch_size=32,
    class_mode='binary',
    color_mode='grayscale'
)

Found 100 images belonging to 2 classes.
```

```
In [8]: # Build a simple neural network model
model = Sequential([
    Flatten(input_shape=(256, 256, 1)),
    Dense(128, activation='relu'),
    Dense(1, activation='sigmoid')
])
```

```
In [9]: model.compile(optimizer='adam', loss='binary_crossentropy', metrics=['accuracy'])
```

```
In [10]: # Train the model
model.fit(train_generator, epochs=10, validation_data=test_generator)

Epoch 1/10
16/16 [=====] - 3s 147ms/step - loss: 5.4389 - accuracy: 0.7440 - val_loss: 0.8519 - val_accuracy: 0.9500
Epoch 2/10
16/16 [=====] - 2s 120ms/step - loss: 0.5649 - accuracy: 0.9500 - val_loss: 0.5393 - val_accuracy: 0.9700
Epoch 3/10
16/16 [=====] - 2s 123ms/step - loss: 0.5664 - accuracy: 0.9660 - val_loss: 0.2570 - val_accuracy: 0.9800
Epoch 4/10
16/16 [=====] - 2s 126ms/step - loss: 0.2092 - accuracy: 0.9800 - val_loss: 0.1185 - val_accuracy: 0.9700
Epoch 5/10
16/16 [=====] - 2s 123ms/step - loss: 0.0369 - accuracy: 0.9900 - val_loss: 0.0160 - val_accuracy: 0.9900
Epoch 6/10
16/16 [=====] - 2s 131ms/step - loss: 0.0085 - accuracy: 0.9960 - val_loss: 0.0151 - val_accuracy: 0.9900
Epoch 7/10
16/16 [=====] - 2s 132ms/step - loss: 0.0050 - accuracy: 0.9960 - val_loss: 0.0048 - val_accuracy: 1.0000
Epoch 8/10
16/16 [=====] - 2s 124ms/step - loss: 5.9209e-04 - accuracy: 1.0000 - val_loss: 0.0011 - val_accuracy: 1.0000
Epoch 9/10
16/16 [=====] - 2s 127ms/step - loss: 9.2486e-05 - accuracy: 1.0000 - val_loss: 0.0035 - val_accuracy: 1.0000
Epoch 10/10
16/16 [=====] - 2s 124ms/step - loss: 7.8623e-05 - accuracy: 1.0000 - val_loss: 0.0027 - val_accuracy: 1.0000
Out[10]: <keras.callbacks.History at 0x1eb4d63100>
```

```
In [11]: # Evaluate the model on test data
test_loss, test_acc = model.evaluate(test_generator)
print(f"Neural Network - Accuracy: {test_acc}")

4/4 [=====] - 0s 64ms/step - loss: 0.0027 - accuracy: 1.0000
Neural Network - Accuracy: 1.0
```

```
In [12]: # Extract features from the trained model for KNN and Decision Tree
feature_extractor = Sequential(model.layers[:-1])
train_features = feature_extractor.predict(train_generator)
test_features = feature_extractor.predict(test_generator)

16/16 [=====] - 1s 75ms/step
4/4 [=====] - 0s 59ms/step
```

```
In [13]: # Get Labels
train_labels = train_generator.classes
test_labels = test_generator.classes
```

```
In [14]: # Train the Decision Tree model
dt_classifier = DecisionTreeClassifier(random_state=42)
dt_classifier.fit(train_features, train_labels)
```

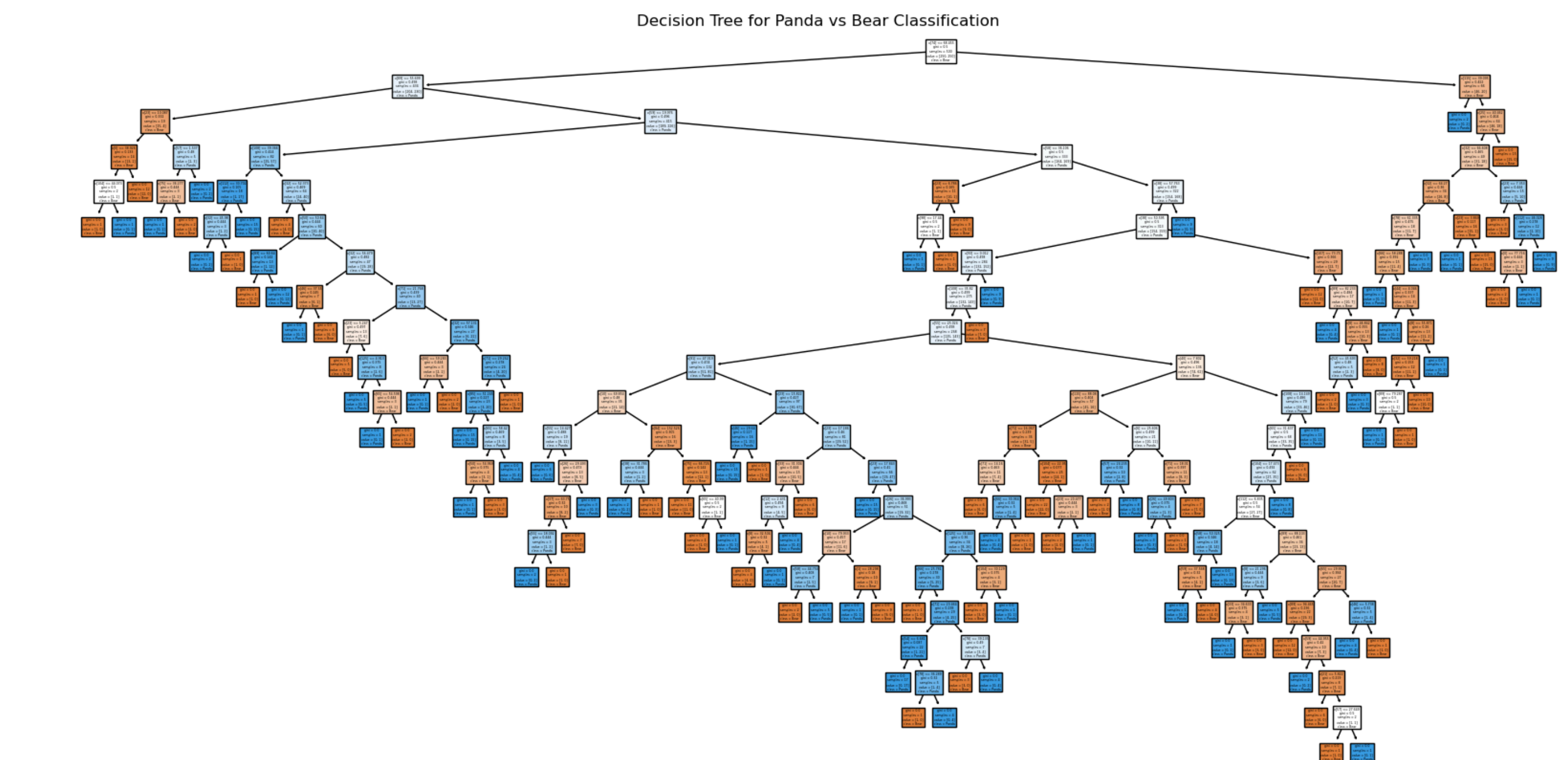
```
Out[14]: DecisionTreeClassifier
DecisionTreeClassifier(random_state=42)
```

```
In [15]: # Evaluate the Decision Tree model
y_pred_dt = dt_classifier.predict(test_features)
accuracy_dt = accuracy_score(test_labels, y_pred_dt)
precision_dt = precision_score(test_labels, y_pred_dt)
recall_dt = recall_score(test_labels, y_pred_dt)
f1_dt = f1_score(test_labels, y_pred_dt)
```

```
In [16]: print(f"Decision Tree - Accuracy: {accuracy_dt}")
print(f"Decision Tree - Precision: {precision_dt}")
print(f"Decision Tree - Recall: {recall_dt}")
print(f"Decision Tree - F1 Score: {f1_dt}")
print(confusion_matrix(test_labels, y_pred_dt))

Decision Tree - Accuracy: 0.44
Decision Tree - Precision: 0.4444444444444444
Decision Tree - Recall: 0.48
Decision Tree - F1 Score: 0.4615384615384615
[[20 30]
 [26 24]]
```

```
In [17]: # Plot the decision tree
plt.figure(figsize=(20,10)) # Adjust the size to fit the entire tree
plot_tree(dt_classifier, filled=True, feature_names=None, class_names=['Bear', 'Panda'])
plt.title("Decision Tree for Panda vs Bear Classification")
plt.show()
```



```
In [18]: # Train the KNN model
knn_classifier = KNeighborsClassifier(n_neighbors=5)
knn_classifier.fit(train_features, train_labels)
```

```
Out[18]: KNeighborsClassifier
KNeighborsClassifier()
```

```
In [19]: # Evaluate the KNN model
y_pred_knn = knn_classifier.predict(test_features)
accuracy_knn = accuracy_score(test_labels, y_pred_knn)
precision_knn = precision_score(test_labels, y_pred_knn)
recall_knn = recall_score(test_labels, y_pred_knn)
f1_knn = f1_score(test_labels, y_pred_knn)
```

```
In [20]: print(f"KNN - Accuracy: {accuracy_knn}")
print(f"KNN - Precision: {precision_knn}")
print(f"KNN - Recall: {recall_knn}")
print(f"KNN - F1 Score: {f1_knn}")
print(confusion_matrix(test_labels, y_pred_knn))

KNN - Accuracy: 0.41
KNN - Precision: 0.4
KNN - Recall: 0.36
KNN - F1 Score: 0.3789473684210526
[[22 27]
 [32 18]]
```

```
In [21]: # Compare Models
print("Neural Network vs Decision Tree vs KNN")
print(f"Neural Network - Accuracy: {test_acc}")
print(f"Decision Tree - Accuracy: {accuracy_dt}, Precision: {precision_dt}, Recall: {recall_dt}, F1 Score: {f1_dt}")
print(f"KNN - Accuracy: {accuracy_knn}, Precision: {precision_knn}, Recall: {recall_knn}, F1 Score: {f1_knn}")

Neural Network vs Decision Tree vs KNN
Neural Network - Accuracy: 1.0
Decision Tree - Accuracy: 0.44, Precision: 0.4444444444444444, Recall: 0.48, F1 Score: 0.4615384615384615
KNN - Accuracy: 0.41, Precision: 0.4, Recall: 0.36, F1 Score: 0.3789473684210526
```

```
In [ ]:
```