knn

November 25, 2024

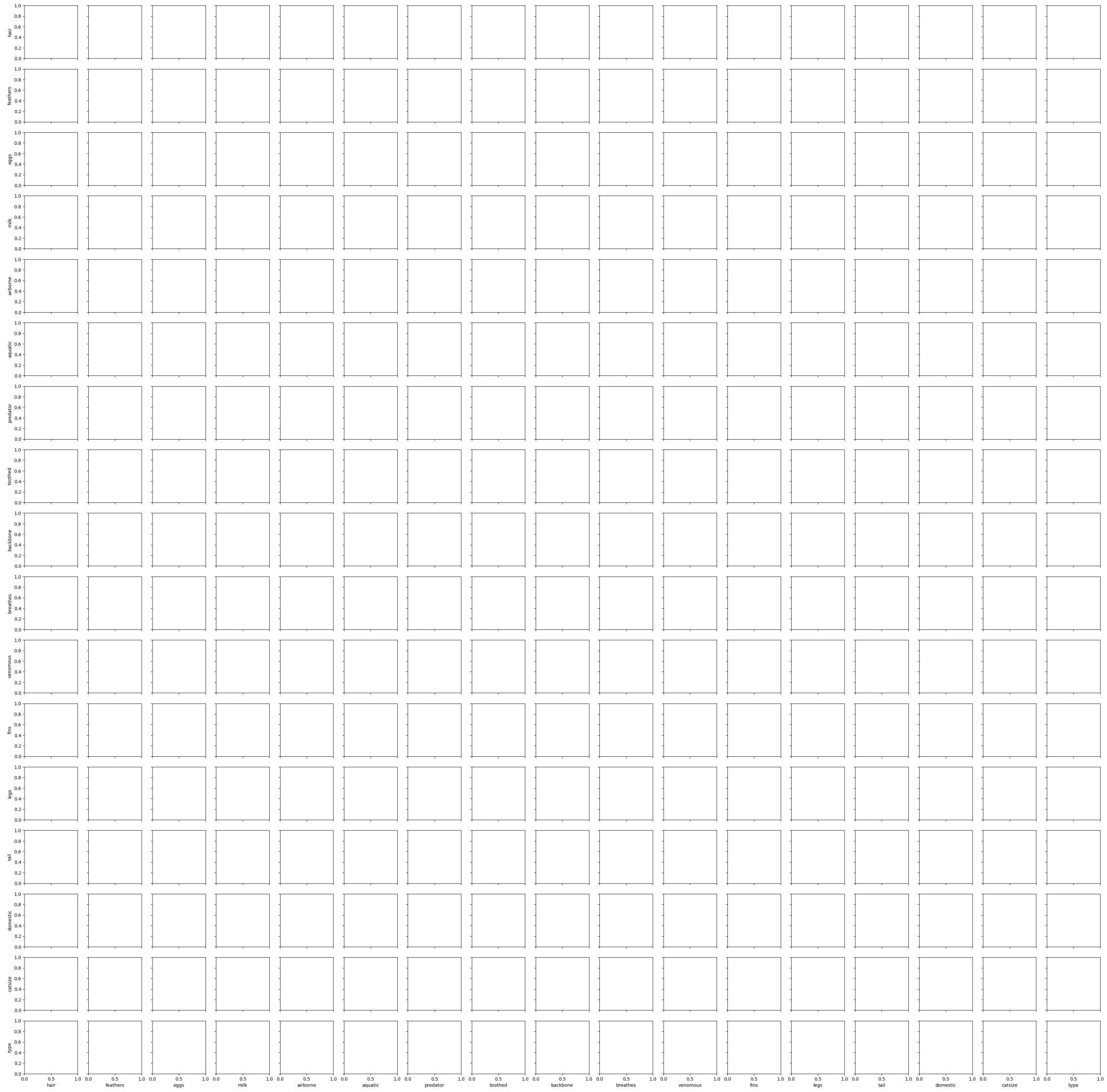
[7]:

```python
import pandas as pd
import seaborn as sns
import matplotlib.pyplot as plt

# Load the dataset
df = pd.read_csv('/content/Zoo.csv')  # Replace with the actual file path

# Basic exploration
print("First 5 rows of the dataset:")
print(df.head())           # View first few rows
print("\nDataset Information:")
print(df.info())           # Check for data types and null values
print("\nSummary Statistics:")
print(df.describe())       # Summary statistics for numeric columns

# Pair plot (for numeric features)
try:
    sns.pairplot(df, hue='class')  # Replace 'class' with the target column name
    plt.title('Pairwise Feature Relationships')
    plt.show()
except Exception as e:
    print(f"Pair plot error: {e}")

# Class distribution (for categorical target)
try:
    sns.countplot(x='class', data=df)  # Replace 'class' with the target column name
    plt.title('Class Distribution')
    plt.show()
except Exception as e:
    print(f"Class distribution plot error: {e}")
```

```
First 5 rows of the dataset:
  animal name  hair  feathers  eggs  milk  airborne  aquatic  predator  \
0    aardvark     1         0     0     1         0        0         1
1    antelope     1         0     0     1         0        0         0
2        bass     0         0     1     0         0        1         1
3        bear     1         0     0     1         0        0         1
```

```
4        boar     1         0     0     1         0        0         1

   toothed  backbone  breathes  venomous  fins  legs  tail  domestic  catsize  \
0        1         1         1         0     0     4     0         0        1
1        1         1         1         0     0     4     1         0        1
2        1         1         0         0     1     0     1         0        0
3        1         1         1         0     0     4     0         0        1
4        1         1         1         0     0     4     1         0        1

   type
0     1
1     1
2     4
3     1
4     1

Dataset Information:
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 101 entries, 0 to 100
Data columns (total 18 columns):
 #   Column       Non-Null Count  Dtype 
---  ------       --------------  ----- 
 0   animal name  101 non-null    object
 1   hair         101 non-null    int64 
 2   feathers     101 non-null    int64 
 3   eggs         101 non-null    int64 
 4   milk         101 non-null    int64 
 5   airborne     101 non-null    int64 
 6   aquatic      101 non-null    int64 
 7   predator     101 non-null    int64 
 8   toothed      101 non-null    int64 
 9   backbone     101 non-null    int64 
 10  breathes     101 non-null    int64 
 11  venomous     101 non-null    int64 
 12  fins         101 non-null    int64 
 13  legs         101 non-null    int64 
 14  tail         101 non-null    int64 
 15  domestic     101 non-null    int64 
 16  catsize      101 non-null    int64 
 17  type         101 non-null    int64 
dtypes: int64(17), object(1)
memory usage: 14.3+ KB
None

Summary Statistics:
             hair    feathers        eggs        milk    airborne     aquatic  \
count  101.000000  101.000000  101.000000  101.000000  101.000000  101.000000   
mean     0.425743    0.198020    0.584158    0.405941    0.237624    0.356436   
```

```
std      0.496921    0.400495    0.495325    0.493522    0.427750    0.481335
min      0.000000    0.000000    0.000000    0.000000    0.000000    0.000000
25%      0.000000    0.000000    0.000000    0.000000    0.000000    0.000000
50%      0.000000    0.000000    1.000000    0.000000    0.000000    0.000000
75%      1.000000    0.000000    1.000000    1.000000    0.000000    1.000000
max      1.000000    1.000000    1.000000    1.000000    1.000000    1.000000

         predator     toothed    backbone    breathes    venomous        fins  \
count  101.000000  101.000000  101.000000  101.000000  101.000000  101.000000
mean     0.554455    0.603960    0.821782    0.792079    0.079208    0.168317
std      0.499505    0.491512    0.384605    0.407844    0.271410    0.376013
min      0.000000    0.000000    0.000000    0.000000    0.000000    0.000000
25%      0.000000    0.000000    1.000000    1.000000    0.000000    0.000000
50%      1.000000    1.000000    1.000000    1.000000    0.000000    0.000000
75%      1.000000    1.000000    1.000000    1.000000    0.000000    0.000000
max      1.000000    1.000000    1.000000    1.000000    1.000000    1.000000

             legs        tail    domestic     catsize        type
count  101.000000  101.000000  101.000000  101.000000  101.000000
mean     2.841584    0.742574    0.128713    0.435644    2.831683
std      2.033385    0.439397    0.336552    0.498314    2.102709
min      0.000000    0.000000    0.000000    0.000000    1.000000
25%      2.000000    0.000000    0.000000    0.000000    1.000000
50%      4.000000    1.000000    0.000000    0.000000    2.000000
75%      4.000000    1.000000    0.000000    1.000000    4.000000
max      8.000000    1.000000    1.000000    1.000000    7.000000
Pair plot error: 'class'
Class distribution plot error: Could not interpret value `class` for `x`. An
entry with this name does not appear in `data`.
```



[9]:
```
# Handle missing values
numeric_cols = df.select_dtypes(include=['number']).columns  # Get numeric␣
 ↪columns
df[numeric_cols] = df[numeric_cols].fillna(df[numeric_cols].mean())  # Mean␣
 ↪imputation for numeric cols only
# If you have a specific categorical column you want to handle:
# df['categorical_col'].fillna(df['categorical_col'].mode()[0], inplace=True) ␣
 ↪# Mode imputation for a specific column

# Handle outliers (using IQR)
Q1 = df[numeric_cols].quantile(0.25)
Q3 = df[numeric_cols].quantile(0.75)
IQR = Q3 - Q1
```

```
df = df[~((df[numeric_cols] < (Q1 - 1.5 * IQR)) | (df[numeric_cols] > (Q3 + 1.5␣
 ↪* IQR))).any(axis=1)]  # Remove outliers

print(df.isnull().sum())  # Confirm no missing values remain
```

```
animal name    0
hair           0
feathers       0
eggs           0
milk           0
airborne       0
aquatic        0
predator       0
toothed        0
backbone       0
breathes       0
venomous       0
fins           0
legs           0
tail           0
domestic       0
catsize        0
type           0
dtype: int64
```

[11]:

```
# Separate features and target
X = df.drop(columns='animal name')  # Assuming 'animal name' is the target␣
 ↪column name
y = df['animal name']

# Split into training and testing sets
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.2,␣
 ↪random_state=42)

print(f"Training set size: {X_train.shape}")
print(f"Testing set size: {X_test.shape}")
```

```
Training set size: (26, 17)
Testing set size: (7, 17)
```

[12]:

```
from sklearn.neighbors import KNeighborsClassifier

# Instantiate the model
k = 5  # Example value for K, can be optimized later
knn = KNeighborsClassifier(n_neighbors=k, metric='euclidean')  # Using␣
 ↪Euclidean distance
```

```
# Fit the model
knn.fit(X_train, y_train)
```

[12]:

```
KNeighborsClassifier(metric='euclidean')
```

[13]:

```
from sklearn.metrics import accuracy_score, precision_score, recall_score,␣
 ↪f1_score, classification_report

# Predict on test set
y_pred = knn.predict(X_test)

# Evaluate performance
accuracy = accuracy_score(y_test, y_pred)
precision = precision_score(y_test, y_pred, average='weighted')  # Weighted for␣
 ↪multi-class
recall = recall_score(y_test, y_pred, average='weighted')
f1 = f1_score(y_test, y_pred, average='weighted')

print("Accuracy:", accuracy)
print("Precision:", precision)
print("Recall:", recall)
print("F1 Score:", f1)
print("\nClassification Report:\n", classification_report(y_test, y_pred))
```

```
Accuracy: 0.0
Precision: 0.0
Recall: 0.0
F1 Score: 0.0

Classification Report:
               precision    recall  f1-score   support

    antelope       0.00      0.00      0.00       0.0
        bear       0.00      0.00      0.00       0.0
        boar       0.00      0.00      0.00       0.0
     cheetah       0.00      0.00      0.00       0.0
        frog       0.00      0.00      0.00       1.0
     giraffe       0.00      0.00      0.00       1.0
        lion       0.00      0.00      0.00       0.0
        mink       0.00      0.00      0.00       1.0
    mongoose       0.00      0.00      0.00       1.0
     opossum       0.00      0.00      0.00       1.0
    squirrel       0.00      0.00      0.00       1.0
     wallaby       0.00      0.00      0.00       1.0

    accuracy                           0.00       7.0
   macro avg       0.00      0.00      0.00       7.0
```

```
weighted avg       0.00      0.00      0.00       7.0

/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531:
UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels
with no predicted samples. Use `zero_division` parameter to control this
behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531:
UndefinedMetricWarning: Recall is ill-defined and being set to 0.0 in labels
with no true samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531:
UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels
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with no true samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
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UndefinedMetricWarning: Precision is ill-defined and being set to 0.0 in labels
with no predicted samples. Use `zero_division` parameter to control this
behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
/usr/local/lib/python3.10/dist-packages/sklearn/metrics/_classification.py:1531:
UndefinedMetricWarning: Recall is ill-defined and being set to 0.0 in labels
with no true samples. Use `zero_division` parameter to control this behavior.
  _warn_prf(average, modifier, f"{metric.capitalize()} is", len(result))
```
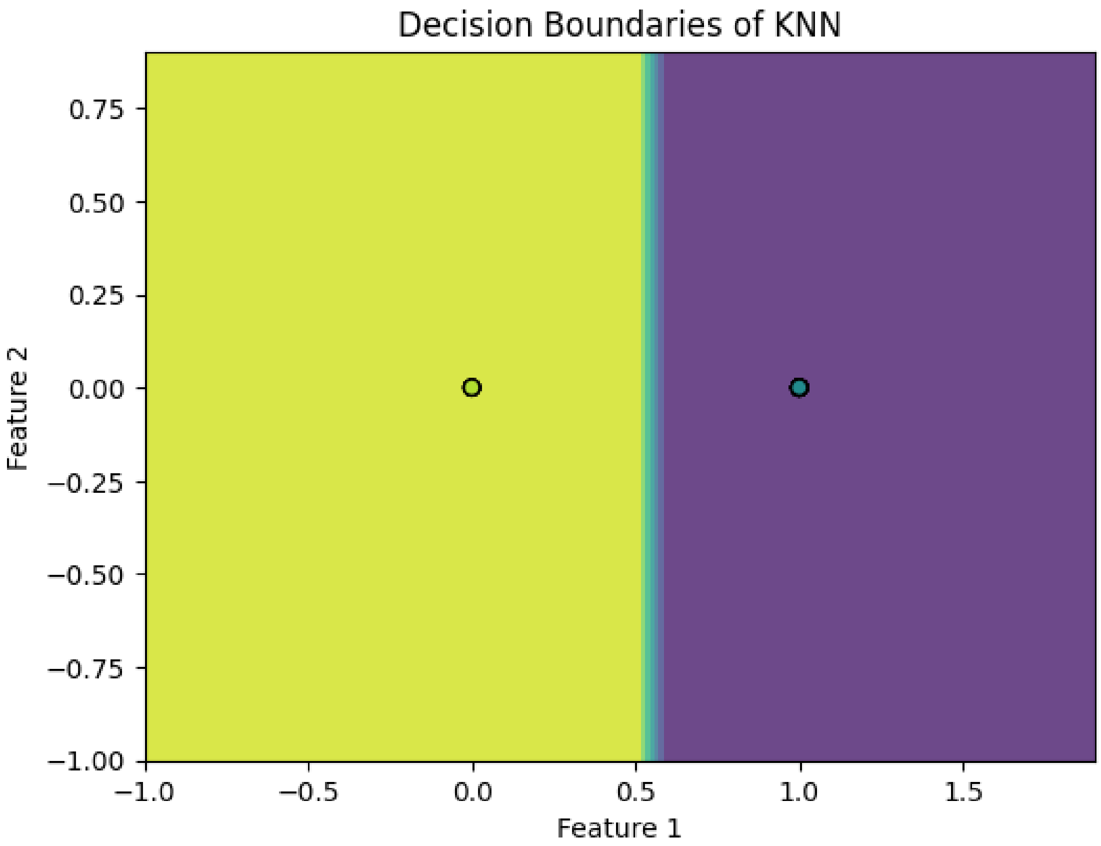

[19]:

```python
import numpy as np
import matplotlib.pyplot as plt
from sklearn.preprocessing import LabelEncoder

# ... (previous code) ...

# Reduce to 2 features for visualization (if needed)
X_train_vis = X_train.iloc[:, :2]
```

```
X_test_vis = X_test.iloc[:, :2]

# Create a LabelEncoder to convert class labels to numerical values
le = LabelEncoder()
y_train_encoded = le.fit_transform(y_train)

# Train KNN on the reduced dataset using encoded labels
knn.fit(X_train_vis, y_train_encoded)

# Create a meshgrid for decision boundaries
x_min, x_max = X_train_vis.iloc[:, 0].min() - 1, X_train_vis.iloc[:, 0].max() + 1
y_min, y_max = X_train_vis.iloc[:, 1].min() - 1, X_train_vis.iloc[:, 1].max() + 1
xx, yy = np.meshgrid(np.arange(x_min, x_max, 0.1), np.arange(y_min, y_max, 0.1))

# Predict on meshgrid
Z = knn.predict(np.c_[xx.ravel(), yy.ravel()])
Z = Z.reshape(xx.shape)

# Plot decision boundaries
plt.contourf(xx, yy, Z, alpha=0.8)
plt.scatter(X_train_vis.iloc[:, 0], X_train_vis.iloc[:, 1], c=y_train_encoded, edgecolor='k', marker='o')  # Use encoded labels for plotting
plt.title('Decision Boundaries of KNN')
plt.xlabel('Feature 1')
plt.ylabel('Feature 2')
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:493: UserWarning: X does
not have valid feature names, but KNeighborsClassifier was fitted with feature
names
  warnings.warn(
```



[24]:

```python
import numpy as np
import matplotlib.pyplot as plt
from sklearn.neighbors import KNeighborsClassifier

# Ensure the dataset has at least 2 features
if X_train.shape[1] < 2 or X_test.shape[1] < 2:
    raise ValueError("The dataset must have at least two features for␣
 ↪visualization.")

# Select two features for visualization (first two features)
X_train_vis = X_train.iloc[:, :2]
X_test_vis = X_test.iloc[:, :2]

# Train a KNN classifier
try:
    knn_vis = KNeighborsClassifier(n_neighbors=5, metric='euclidean')
    knn_vis.fit(X_train_vis, y_train)
except Exception as e:
    print(f"Error training KNN: {e}")
    raise
```

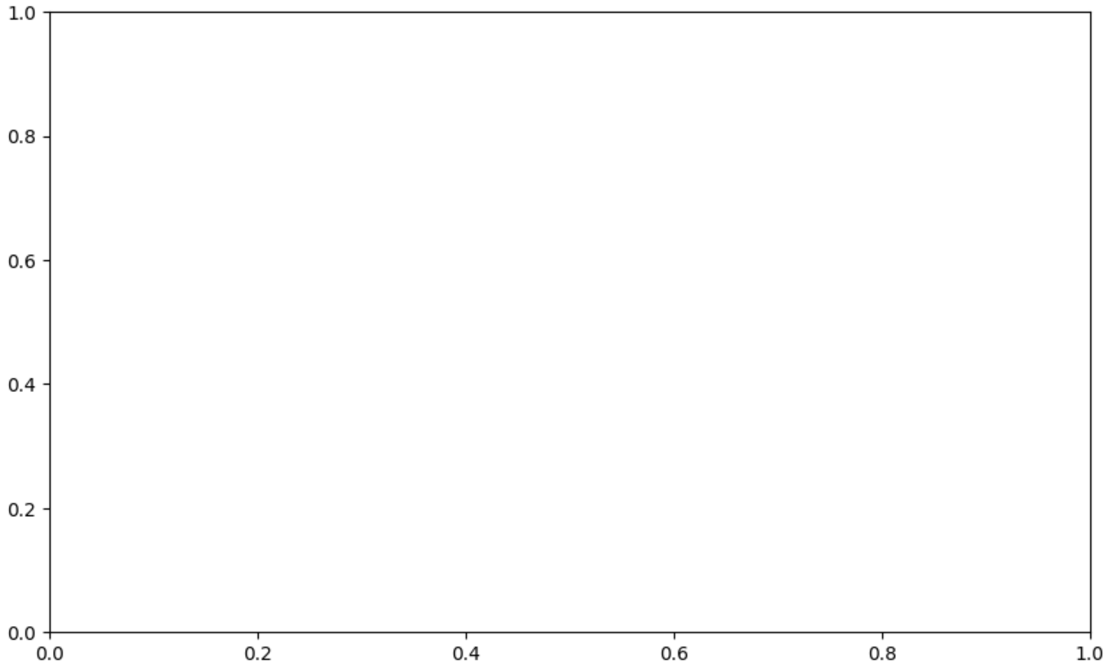
```python
# Create a meshgrid for visualization
x_min, x_max = X_train_vis.iloc[:, 0].min() - 1, X_train_vis.iloc[:, 0].max() + 1
y_min, y_max = X_train_vis.iloc[:, 1].min() - 1, X_train_vis.iloc[:, 1].max() + 1
xx, yy = np.meshgrid(np.arange(x_min, x_max, 0.1), np.arange(y_min, y_max, 0.1))

# Predict grid points
try:
    Z = knn_vis.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)
except Exception as e:
    print(f"Error predicting meshgrid points: {e}")
    raise

# Plot decision boundaries
plt.figure(figsize=(10, 6))
plt.contourf(xx, yy, Z, alpha=0.8, cmap='coolwarm')

# Plot training points
plt.scatter(X_train_vis.iloc[:, 0], X_train_vis.iloc[:, 1], c=y_train, edgecolor='k', marker='o', cmap='coolwarm', label='Training data')

# Plot testing points
plt.scatter(X_test_vis.iloc[:, 0], X_test_vis.iloc[:, 1], c=y_test, edgecolor='k', marker='x', cmap='coolwarm', label='Testing data')

plt.title("Decision Boundaries of KNN Classifier")
plt.xlabel("Feature 1")
plt.ylabel("Feature 2")
plt.legend()
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:493: UserWarning: X does
not have valid feature names, but KNeighborsClassifier was fitted with feature
names
  warnings.warn(
```

```
---------------------------------------------------------------------------
TypeError                                 Traceback (most recent call last)
<ipython-input-24-e1e6a8b45154> in <cell line: 36>()
     34 # Plot decision boundaries
     35 plt.figure(figsize=(10, 6))
---> 36 plt.contourf(xx, yy, Z, alpha=0.8, cmap='coolwarm')
     37 
     38 # Plot training points
```

```
/usr/local/lib/python3.10/dist-packages/matplotlib/pyplot.py in contourf(data,␣
 ↪*args, **kwargs)
   2936 @_copy_docstring_and_deprecators(Axes.contourf)
   2937 def contourf(*args, data=None, **kwargs) -> QuadContourSet:
-> 2938     __ret = gca().contourf(
   2939         *args, **({"data": data} if data is not None else {}), **kwargs
   2940     )

/usr/local/lib/python3.10/dist-packages/matplotlib/__init__.py in inner(ax,␣
 ↪data, *args, **kwargs)
   1463     def inner(ax, *args, data=None, **kwargs):
   1464         if data is None:
-> 1465             return func(ax, *map(sanitize_sequence, args), **kwargs)
   1466 
   1467         bound = new_sig.bind(ax, *args, **kwargs)

/usr/local/lib/python3.10/dist-packages/matplotlib/axes/_axes.py in␣
 ↪contourf(self, *args, **kwargs)
   6526         """
   6527         kwargs['filled'] = True
-> 6528         contours = mcontour.QuadContourSet(self, *args, **kwargs)
   6529         self._request_autoscale_view()
   6530         return contours

/usr/local/lib/python3.10/dist-packages/matplotlib/contour.py in __init__(self,␣
 ↪ax, levels, filled, linewidths, linestyles, hatches, alpha, origin, extent,␣
 ↪cmap, colors, norm, vmin, vmax, extend, antialiased, nchunk, locator,␣
 ↪transform, negative_linestyles, clip_path, *args, **kwargs)
    845                 mpl.rcParams['contour.negative_linestyle']
    846 
--> 847         kwargs = self._process_args(*args, **kwargs)
    848         self._process_levels()
    849 

/usr/local/lib/python3.10/dist-packages/matplotlib/contour.py in␣
 ↪_process_args(self, corner_mask, algorithm, *args, **kwargs)
   1531             self._corner_mask = corner_mask
   1532 
-> 1533             x, y, z = self._contour_args(args, kwargs)
   1534 
   1535             contour_generator = contourpy.contour_generator(

/usr/local/lib/python3.10/dist-packages/matplotlib/contour.py in␣
 ↪_contour_args(self, args, kwargs)
   1575         else:
   1576             raise _api.nargs_error(fn, takes="from 1 to 4", given=nargs
-> 1577         z = ma.masked_invalid(z, copy=False)
```

```
   1578         self.zmax = z.max().astype(float)
   1579         self.zmin = z.min().astype(float)

/usr/local/lib/python3.10/dist-packages/numpy/ma/core.py in masked_invalid(a,␣
 ↪copy)
   2358     """
   2359     a = np.array(a, copy=False, subok=True)
-> 2360     res = masked_where(~(np.isfinite(a)), a, copy=copy)
   2361     # masked_invalid previously never returned nomask as a mask and␣
 ↪doing so
   2362     # threw off matplotlib (gh-22842).  So use shrink=False:

TypeError: ufunc 'isfinite' not supported for the input types, and the inputs␣
 ↪could not be safely coerced to any supported types according to the casting␣
 ↪rule ''safe''
```



[25]:
```python
print(X_train.dtypes)  # Check data types of features
print(y_train.dtype)   # Check data type of target
```

```
hair        int64
feathers    int64
eggs        int64
milk        int64
airborne    int64
aquatic     int64
```

```
predator     int64
toothed      int64
backbone     int64
breathes     int64
venomous     int64
fins         int64
legs         int64
tail         int64
domestic     int64
catsize      int64
type         int64
dtype: object
object
```

[29]:

```
X_train = X_train.apply(pd.to_numeric, errors='coerce')
X_test = X_test.apply(pd.to_numeric, errors='coerce')
```

[30]:

```
import numpy as np
import matplotlib.pyplot as plt
from sklearn.neighbors import KNeighborsClassifier

# Select the first two features
X_train_vis = X_train.iloc[:, :2]
X_test_vis = X_test.iloc[:, :2]

# Train KNN classifier
knn_vis = KNeighborsClassifier(n_neighbors=5, metric='euclidean')
knn_vis.fit(X_train_vis, y_train)

# Create meshgrid
x_min, x_max = X_train_vis.iloc[:, 0].min() - 1, X_train_vis.iloc[:, 0].max() +␣
  ↪1
y_min, y_max = X_train_vis.iloc[:, 1].min() - 1, X_train_vis.iloc[:, 1].max() +␣
  ↪1
xx, yy = np.meshgrid(np.arange(x_min, x_max, 0.1), np.arange(y_min, y_max, 0.1))

# Predict on meshgrid
Z = knn_vis.predict(np.c_[xx.ravel(), yy.ravel()])
Z = Z.reshape(xx.shape)

# Plot decision boundaries
plt.figure(figsize=(10, 6))
plt.contourf(xx, yy, Z, alpha=0.8, cmap='coolwarm')

# Plot training points
plt.scatter(X_train_vis.iloc[:, 0], X_train_vis.iloc[:, 1], c=y_train,␣
  ↪edgecolor='k', marker='o', cmap='coolwarm', label='Training data')
```

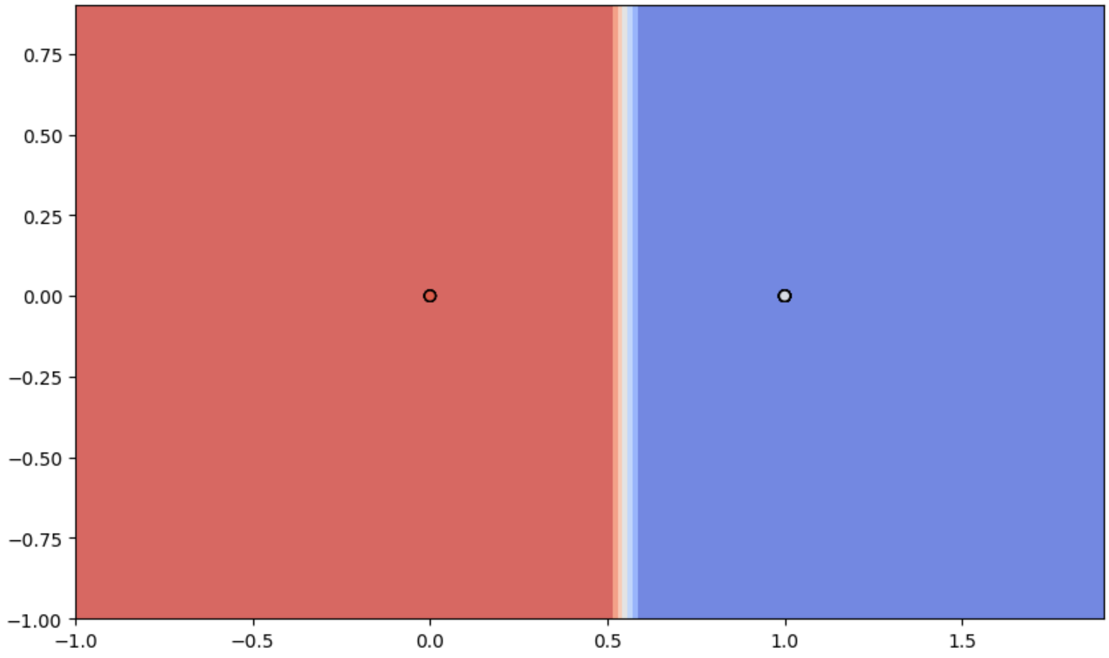
```python
# Plot testing points
plt.scatter(X_test_vis.iloc[:, 0], X_test_vis.iloc[:, 1], c=y_test,␣
 ↪edgecolor='k', marker='x', cmap='coolwarm', label='Testing data')

plt.title("Decision Boundaries of KNN Classifier")
plt.xlabel("Feature 1")
plt.ylabel("Feature 2")
plt.legend()
plt.show()
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:493: UserWarning: X does
not have valid feature names, but KNeighborsClassifier was fitted with feature
names
  warnings.warn(
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
/usr/local/lib/python3.10/dist-packages/matplotlib/axes/_axes.py in␣
 ↪_parse_scatter_color_args(c, edgecolors, kwargs, xsize, get_next_color_func)
   4482             try:  # Is 'c' acceptable as PathCollection facecolors?
-> 4483                 colors = mcolors.to_rgba_array(c)
   4484             except (TypeError, ValueError) as err:

/usr/local/lib/python3.10/dist-packages/matplotlib/colors.py in to_rgba_array(c␣
 ↪alpha)
    504     else:
--> 505         rgba = np.array([to_rgba(cc) for cc in c])
    506

/usr/local/lib/python3.10/dist-packages/matplotlib/colors.py in <listcomp>(.0)
    504     else:
--> 505         rgba = np.array([to_rgba(cc) for cc in c])
    506

/usr/local/lib/python3.10/dist-packages/matplotlib/colors.py in to_rgba(c, alpha)
    301     if rgba is None:  # Suppress exception chaining of cache lookup␣
 ↪failure.
--> 302         rgba = _to_rgba_no_colorcycle(c, alpha)
    303         try:

/usr/local/lib/python3.10/dist-packages/matplotlib/colors.py in␣
 ↪_to_rgba_no_colorcycle(c, alpha)
    383             return c, c, c, alpha if alpha is not None else 1.
--> 384         raise ValueError(f"Invalid RGBA argument: {orig_c!r}")
    385     # turn 2-D array into 1-D array
```

```
ValueError: Invalid RGBA argument: 'wallaby'

The above exception was the direct cause of the following exception:

ValueError                                Traceback (most recent call last)
<ipython-input-30-a494d8a7aa1b> in <cell line: 30>()
     28
     29 # Plot testing points
---> 30 plt.scatter(X_test_vis.iloc[:, 0], X_test_vis.iloc[:, 1], c=y_test,␣
 ↪edgecolor='k', marker='x', cmap='coolwarm', label='Testing data')
     31
     32 plt.title("Decision Boundaries of KNN Classifier")

/usr/local/lib/python3.10/dist-packages/matplotlib/pyplot.py in scatter(x, y, s ␣
 ↪c, marker, cmap, norm, vmin, vmax, alpha, linewidths, edgecolors,␣
 ↪plotnonfinite, data, **kwargs)
   3685     **kwargs,
   3686 ) -> PathCollection:
-> 3687     __ret = gca().scatter(

   3688         x,
   3689         y,

/usr/local/lib/python3.10/dist-packages/matplotlib/__init__.py in inner(ax,␣
 ↪data, *args, **kwargs)
   1463     def inner(ax, *args, data=None, **kwargs):
   1464         if data is None:
-> 1465             return func(ax, *map(sanitize_sequence, args), **kwargs)
   1466
   1467         bound = new_sig.bind(ax, *args, **kwargs)

/usr/local/lib/python3.10/dist-packages/matplotlib/axes/_axes.py in␣
 ↪scatter(self, x, y, s, c, marker, cmap, norm, vmin, vmax, alpha, linewidths,␣
 ↪edgecolors, plotnonfinite, **kwargs)
   4668             orig_edgecolor = kwargs.get('edgecolor', None)
   4669         c, colors, edgecolors = \
-> 4670             self._parse_scatter_color_args(

   4671                 c, edgecolors, kwargs, x.size,
   4672                 get_next_color_func=self._get_patches_for_fill.
 ↪get_next_color)

/usr/local/lib/python3.10/dist-packages/matplotlib/axes/_axes.py in␣
 ↪_parse_scatter_color_args(c, edgecolors, kwargs, xsize, get_next_color_func)
   4490                     # Both the mapping *and* the RGBA conversion failed ␣
 ↪pretty
   4491                     # severe failure => one may appreciate a verbose␣
 ↪feedback.
```

```
-> 4492                         raise ValueError(
   4493                             f"'c' argument must be a color, a sequence of␣
 ↪colors, "
   4494                             f"or a sequence of numbers, not {c!r}") from er

ValueError: 'c' argument must be a color, a sequence of colors, or a sequence o ␣
 ↪numbers, not 96     wallaby
48         mink
84     squirrel
50     mongoose
25         frog
28      giraffe
54      opossum
Name: animal name, dtype: object
```



[31]:

```python
from sklearn.preprocessing import LabelEncoder

le = LabelEncoder()
y_train = le.fit_transform(y_train)  # Encode training labels
y_test = le.transform(y_test)        # Encode testing labels
```

```
---------------------------------------------------------------------------
ValueError                                Traceback (most recent call last)
<ipython-input-31-8af8943cd32f> in <cell line: 5>()
      3 le = LabelEncoder()
      4 y_train = le.fit_transform(y_train)  # Encode training labels
----> 5 y_test = le.transform(y_test)        # Encode testing labels

/usr/local/lib/python3.10/dist-packages/sklearn/preprocessing/_label.py in␣
 ↪transform(self, y)
    130         """
    131         check_is_fitted(self)
--> 132         y = column_or_1d(y, dtype=self.classes_.dtype, warn=True)
    133         # transform of empty array is empty array
    134         if _num_samples(y) == 0:

/usr/local/lib/python3.10/dist-packages/sklearn/utils/validation.py in␣
 ↪column_or_1d(y, dtype, warn)
   1379     """
   1380     xp, _ = get_namespace(y)
-> 1381     y = check_array(

   1382         y,
   1383         ensure_2d=False,

/usr/local/lib/python3.10/dist-packages/sklearn/utils/validation.py in␣
 ↪check_array(array, accept_sparse, accept_large_sparse, dtype, order, copy,␣
 ↪force_writeable, force_all_finite, ensure_2d, allow_nd, ensure_min_samples,␣
 ↪ensure_min_features, estimator, input_name)
   1008                             input_name=input_name,
   1009                         )
-> 1010                     array = xp.astype(array, dtype, copy=False)
   1011                 else:
   1012                     array = _asarray_with_order(array, order=order,␣
 ↪dtype=dtype, xp=xp)

/usr/local/lib/python3.10/dist-packages/sklearn/utils/_array_api.py in␣
 ↪astype(self, x, dtype, copy, casting)
    388     def astype(self, x, dtype, *, copy=True, casting="unsafe"):
    389         # astype is not defined in the top level NumPy namespace
--> 390         return x.astype(dtype, copy=copy, casting=casting)
    391
    392     def asarray(self, x, *, dtype=None, device=None, copy=None):  # noq

ValueError: invalid literal for int() with base 10: 'wallaby'
```

```
[32]: print("y_train type:", type(y_train))
      print("Unique values in y_train:", y_train.unique() if hasattr(y_train,␣
       ↪"unique") else np.unique(y_train))
```

```
y_train type: <class 'numpy.ndarray'>
Unique values in y_train: [ 0  1  2  3  4  5  6  7  8  9 10 11 12 13 14 15 16 17
18 19 20 21 22 23
```

```
 24 25]
```

[33]:

```python
y_train = y_train.astype(str)
y_test = y_test.astype(str)
```

[37]:

```python
import pandas as pd
from sklearn.preprocessing import LabelEncoder

# Ensure y_train and y_test are strings, which is common for categorical labels
y_train = y_train.astype(str)
y_test = y_test.astype(str)

# Combine y_train and y_test into one Series
combined_labels = pd.concat([y_train, y_test], axis=0)

# Initialize and fit the LabelEncoder on combined labels
le = LabelEncoder()
le.fit(combined_labels)

# Transform y_train and y_test using the learned encoder
y_train = le.transform(y_train)
y_test = le.transform(y_test)

# Print mapping for reference
print("Label mapping:", dict(zip(le.classes_, le.transform(le.classes_))))
```

```
Label mapping: {'0': 0, '1': 1, '10': 2, '11': 3, '12': 4, '13': 5, '14': 6,
'15': 7, '16': 8, '17': 9, '18': 10, '19': 11, '2': 12, '20': 13, '21': 14,
'22': 15, '23': 16, '24': 17, '25': 18, '3': 19, '4': 20, '5': 21, '6': 22, '7':
23, '8': 24, '9': 25, 'frog': 26, 'giraffe': 27, 'mink': 28, 'mongoose': 29,
'opossum': 30, 'squirrel': 31, 'wallaby': 32}
```

[38]:

```python
print("Data types after conversion:", y_train.dtype, y_test.dtype)
print("Encoded y_train:", y_train)
print("Encoded y_test:", y_test)
```

```
Data types after conversion: int64 int64
Encoded y_train: [24 12  0 13 21 14 19 18  3  1  4  8 11  6  2  9 25 22  5 15 23
10 16 17
 20  7]
Encoded y_test: [32 28 31 29 26 27 30]
```

[40]:

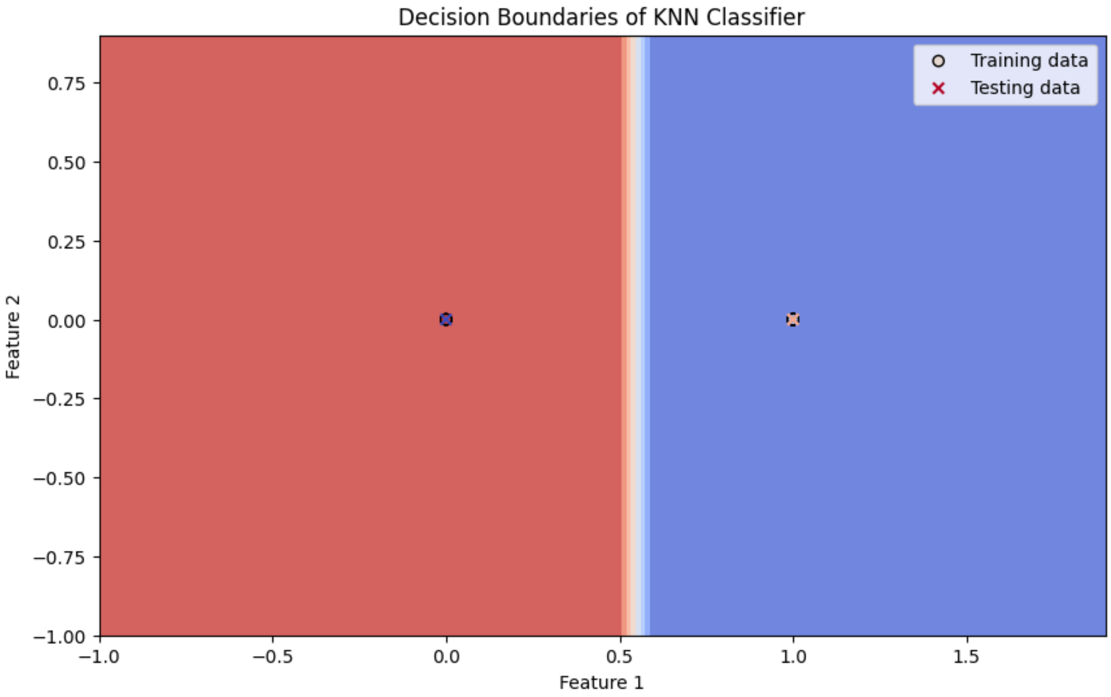
```python
import numpy as np
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.neighbors import KNeighborsClassifier
from sklearn.preprocessing import LabelEncoder
import matplotlib.pyplot as plt
```

```
# Assuming you have your dataset loaded into X and y
# Example: Replace this with your actual dataset
# X = your_features_dataframe
# y = your_target_series

# Ensure y_train and y_test are pandas Series
y_train = pd.Series(y_train)
y_test = pd.Series(y_test)

# Combine y_train and y_test into one Series for fitting LabelEncoder
combined_labels = pd.concat([y_train, y_test], axis=0)

# Initialize LabelEncoder and fit it on the combined labels
le = LabelEncoder()
le.fit(combined_labels)

# Transform y_train and y_test using the learned encoder
y_train = le.transform(y_train)
y_test = le.transform(y_test)

# Print the label mapping for reference
print("Label mapping:", dict(zip(le.classes_, le.transform(le.classes_))))

# Select the first two features for visualization (ensure your dataset has at least 2 features)
X_train_vis = X_train.iloc[:, :2]
X_test_vis = X_test.iloc[:, :2]

# Train the KNN classifier (with k=5 and Euclidean distance)
knn_vis = KNeighborsClassifier(n_neighbors=5, metric='euclidean')
knn_vis.fit(X_train_vis, y_train)

# Create a meshgrid for plotting the decision boundaries
x_min, x_max = X_train_vis.iloc[:, 0].min() - 1, X_train_vis.iloc[:, 0].max() + 1
y_min, y_max = X_train_vis.iloc[:, 1].min() - 1, X_train_vis.iloc[:, 1].max() + 1
xx, yy = np.meshgrid(np.arange(x_min, x_max, 0.1), np.arange(y_min, y_max, 0.1))

# Predict on the meshgrid to plot decision boundaries
Z = knn_vis.predict(np.c_[xx.ravel(), yy.ravel()])
Z = Z.reshape(xx.shape)

# Plot the decision boundaries
plt.figure(figsize=(10, 6))
plt.contourf(xx, yy, Z, alpha=0.8, cmap='coolwarm')
```

```python
# Plot the training points
plt.scatter(X_train_vis.iloc[:, 0], X_train_vis.iloc[:, 1], c=y_train, edgecolor='k', marker='o', cmap='coolwarm', label='Training data')

# Plot the testing points
plt.scatter(X_test_vis.iloc[:, 0], X_test_vis.iloc[:, 1], c=y_test, edgecolor='k', marker='x', cmap='coolwarm', label='Testing data')

plt.title("Decision Boundaries of KNN Classifier")
plt.xlabel("Feature 1")
plt.ylabel("Feature 2")
plt.legend()
plt.show()
```

```
Label mapping: {'0': 0, '1': 1, '10': 2, '11': 3, '12': 4, '13': 5, '14': 6,
'15': 7, '16': 8, '17': 9, '18': 10, '19': 11, '2': 12, '20': 13, '21': 14,
'22': 15, '23': 16, '24': 17, '25': 18, '26': 19, '27': 20, '28': 21, '29': 22,
'3': 23, '30': 24, '31': 25, '32': 26, '4': 27, '5': 28, '6': 29, '7': 30, '8':
31, '9': 32}
```

```
/usr/local/lib/python3.10/dist-packages/sklearn/base.py:493: UserWarning: X does
not have valid feature names, but KNeighborsClassifier was fitted with feature
names
  warnings.warn(
<ipython-input-40-fffef41ec01f>:56: UserWarning: You passed a
edgecolor/edgecolors ('k') for an unfilled marker ('x').  Matplotlib is ignoring
the edgecolor in favor of the facecolor.  This behavior may change in the
future.
  plt.scatter(X_test_vis.iloc[:, 0], X_test_vis.iloc[:, 1], c=y_test,
edgecolor='k', marker='x', cmap='coolwarm', label='Testing data')
```


Decision Boundaries of KNN Classifier
Training data
Testing data
Feature 1
Feature 2
−1.0
−0.5
0.0
0.5
1.0
1.5
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75
−1.00

```
[ ]:
```