In [ ]:
```python
import sys
import numpy as np
import pandas as pd
import os
import seaborn as sns
import matplotlib.pyplot as plt
import statsmodels.formula.api as sm
from sklearn import linear_model
from sklearn.neighbors import KNeighborsClassifier
from sklearn.metrics import classification_report
from sklearn.model_selection import train_test_split
from sklearn.feature_selection import SelectKBest
from sklearn.feature_selection import chi2
from sklearn.feature_selection import f_classif
from sklearn.feature_selection import (
    SelectKBest,
    f_classif,
    mutual_info_classif as MIC,
)
from sklearn.pipeline import make_pipeline
from sklearn.svm import LinearSVC
from sklearn.metrics import classification_report
import matplotlib.pyplot as plt
from sklearn.tree import DecisionTreeClassifier as DTC
from sklearn.ensemble import RandomForestClassifier as RF
from sklearn.datasets import make_classification
from sklearn.model_selection import cross_val_score
from sklearn.model_selection import RepeatedStratifiedKFold
from numpy import mean
from numpy import std
from sklearn.naive_bayes import GaussianNB
```

In [ ]:
```python
data = pd.read_csv("../../data/rice_msc_dataset.csv")
data.head()
```

Out[ ]:

	AREA	PERIMETER	MAJOR_AXIS	MINOR_AXIS	ECCENTRICITY	EQDIASQ	SOLIDITY	CONVEX_AREA	EXTENT	ASPECT_RATIO	...	ALLdaub4L	ALLdaub4a
0	7805	437.915	209.8215	48.0221	0.9735	99.6877	0.9775	7985	0.3547	4.3693	...	113.9924	65.0610
1	7503	340.757	138.3361	69.8417	0.8632	97.7400	0.9660	7767	0.6637	1.9807	...	105.7055	64.3685
2	5124	314.617	141.9803	46.5784	0.9447	80.7718	0.9721	5271	0.4760	3.0482	...	109.7155	62.6423
3	7990	437.085	201.4386	51.2245	0.9671	100.8622	0.9659	8272	0.6274	3.9325	...	116.5405	64.9069
4	7433	342.893	140.3350	68.3927	0.8732	97.2830	0.9831	7561	0.6006	2.0519	...	107.7502	64.7071

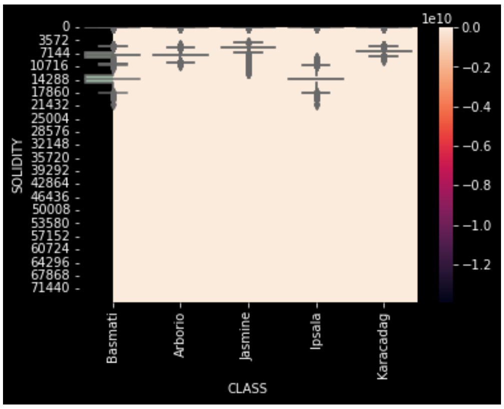
5 rows × 107 columns

CZĘŚĆ 1: Podstawowa eksploracja danych

In [ ]:
```python
# Sprawdzamy czy są jakieś missing values
data.isnull().values.any()  # Są
ile_brakuje = data.isnull().sum()

print(ile_brakuje)

ile_brakuje[
    ile_brakuje > 0
]  # Zmienne dla których są jakies brakujące wartosci

# Usunę wiersze z brakującymi wartosciami.

data2 = data.dropna()  # Nowe dane
len(data.index) - len(
    data2.index
)  # Czyli było 8 wierszy z brakującymi zmiennymi

data2 = data2.reset_index()

# Tworzymy roboczy zbiór danych bez ostatniej kolumny

data3 = data2.drop(["CLASS"], axis=1)

data3 = data3.drop(["index"], axis=1)

data4 = data2[["CLASS"]]

# Macierz korelacji
# Zbadamy skorelowanie poszczególnych zmiennych (docelowo objasniających),
# żeby zdecydować których nie ma sensu wspólnie używać przy przewidywaniu rodzaju ryżu.

sns.heatmap(data3)  # nie widać tutaj zbyt wiele

M = data3.corr()

# Wypisujemy "Mocno" dla elementów macierzy, w których korelacja > 0.9
M[abs(M) > 0.9] = "Mocno"

# Rysujemy boxploty dotyczące AREA dla różnych rodzajów ryżu

data_powierzchnia = data2[["AREA", "CLASS"]]

box_area = sns.boxplot(
    x="CLASS", y="AREA", data=data_powierzchnia, color="#99c2a2"
)

Ipsala = data_powierzchnia.loc[data_powierzchnia["CLASS"] == "Ipsala"]
Ipsala = Ipsala.reset_index()
```

```python
Ipsala[(Ipsala["AREA"] > 12500) & (Ipsala["AREA"] < 15000)].shape[
    0
]  # ponad połowa wartosci w srodku boxplota: 8827

Ipsala[Ipsala["AREA"] > 17000].shape[0]  # 260
Ipsala[Ipsala["AREA"] > 20000].shape[0]  # 1 mocny outlier

Ipsala[Ipsala["AREA"] < 10000].shape[0]  # 111

Ipsala["AREA"].mean()
Ipsala["AREA"].median()

ax2 = sns.boxplot(x="CLASS", y="AREA", data=Ipsala, color="#99c2a2")

ax = sns.boxplot(x="CLASS", y="AREA", data=data_powierzchnia, color="#99c2a2")
# Boxplot stworzony dla wszystkich typów ryżu wskazuje na to, że są istotne różnice w powierzchni jeżeli chodzi o Ipsala, Karacad
# natomiast zbadanie powierzchni nie odróżni nam od siebie Basmati i Arborio.

# Weźmiemy jeszcze trwałość, żeby może odróżnić dwa pozostałe rodzaje ryżu

data_trwalosc = data2[["SOLIDITY", "CLASS"]]

box_trwalosc = sns.boxplot(
    x="CLASS", y="SOLIDITY", data=data_trwalosc, color="#99c2a2"
)
# Powinno nam odróżnić basmati od arborio
# KNN
X, Y = data[["AREA", "SOLIDITY"]], data["CLASS"]
X_train, X_test, Y_train, Y_test = train_test_split(X, Y, test_size=0.1)

knn = KNeighborsClassifier()
knn.fit(X_train, Y_train)
przewidziane = knn.predict(X_test)

print(classification_report(Y_test, przewidziane))
```

```
AREA            0
PERIMETER       0
MAJOR_AXIS      0
MINOR_AXIS      0
ECCENTRICITY    0
               ..
ALLdaub4Cr      0
ALLdaub4XX      0
ALLdaub4YY      0
ALLdaub4ZZ      0
CLASS           0
Length: 107, dtype: int64
              precision    recall  f1-score   support

     Arborio       0.48      0.50      0.49      1510
     Basmati       0.50      0.49      0.50      1475
      Ipsala       0.97      0.97      0.97      1464
     Jasmine       0.82      0.84      0.83      1540
   Karacadag       0.73      0.69      0.71      1511

    accuracy                           0.70      7500
   macro avg       0.70      0.70      0.70      7500
weighted avg       0.70      0.70      0.70      7500
```



CZĘŚĆ 2: Feature selection - DRZEWA DECYZYJNE

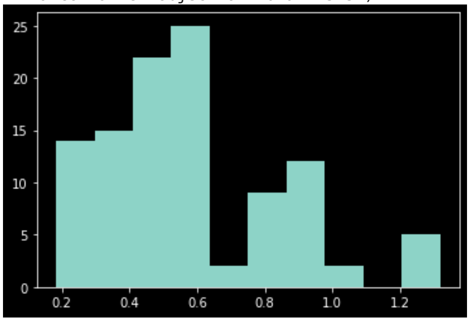
In [ ]:
```python
X_train, X_test, Y_train, Y_test = train_test_split(
    data3, data4, test_size=0.1
)
```

In [ ]:
```python
mi_score = MIC(X_train, Y_train.values.ravel())
print(mi_score)
```

```
[0.9222672  0.95153369 0.94509252 0.97918273 1.28682013 0.92148427
 0.22582828 0.92330146 0.49420704 1.28719163 1.31883341 1.29603698
 0.98487244 0.92334715 1.29489125 0.20517238 0.54769565 0.52174951
 0.28416738 0.61987908 0.62350495 0.61390085 0.37434653 0.40892057
 0.32990184 0.5375414  0.56390541 0.48112958 0.80729879 0.86108037
 0.83441858 0.58267955 0.61355614 0.35087569 0.32771852 0.57116246
 0.6672937  0.31161098 0.43460577 0.40423717 0.19915763 0.30147511
 0.56667159 0.54636941 0.52920061 0.31627468 0.52084322 0.77290635
 0.88141344 0.6407397  0.52851842 0.57367353 0.38941369 0.44327624
 0.44272523 0.55089628 0.18301439 0.28174977 0.87020658 0.83865321
 0.9007467  0.50827953 0.87409289 0.47941098 0.62996041 0.57716041
 0.38755722 0.36235985 0.43288547 0.2207219  0.54397606 0.23191625
 0.18368543 0.86428063 0.82758197 0.85430274 0.48958836 0.50694028
 0.28628026 0.48382792 0.46961871 0.53518613 0.26683194 0.31938761
 0.23617321 0.56235554 0.5787765  0.49038165 0.62529991 0.41061347
 0.33609114 0.54587198 0.51998425 0.2883656  0.58038965 0.6124857
 0.35245676 0.52190982 0.77440481 0.87908921 0.51016186 0.87238678
 0.47799938 0.48566796 0.50924268 0.28745391]
```

In [ ]:
```python
np.histogram(mi_score)
plt.hist(
    mi_score
)  # widzimy, że najwięcej zmiennych wpada w przedział [0.4,0.6]
```

Out[ ]:
```
(array([14., 15., 22., 25.,  2.,  9., 12.,  2.,  0.,  5.]),
 array([0.18301439, 0.29659629, 0.41017819, 0.5237601 , 0.637342  ,
        0.7509239 , 0.8645058 , 0.9780877 , 1.09166961, 1.20525151,
        1.31883341]),
 <BarContainer object of 10 artists>)
```



In [ ]:
```python
mi_score_selected_index = np.where(mi_score > 0.5)[0]
# wybiorę zmienne, które mają mi_score > 0.5
```

In [ ]:
```python
X_2 = data3[data3.columns[mi_score_selected_index - 1]]
# wybieram zmienne z odpowiednio dużym mi_score
```

In [ ]:
```python
X_train_2, X_test_2, Y_train2, Y_test2 = train_test_split(
    X_2, data4, test_size=0.1
)
```

In [ ]:
```python
model_1 = DTC().fit(X_train, Y_train)
model_2 = DTC().fit(X_train_2, Y_train2)

score_1 = model_1.score(X_test, Y_test)
score_2 = model_2.score(X_test_2, Y_test2)

print(f"score_1:{score_1}\n score_2:{score_2}\n")
```

```
score_1:0.996
 score_2:0.9958666666666667
```

In [ ]:
```python
data3.columns[mi_score_selected_index - 1]
```

Out[ ]:
```
Index(['ALLdaub4ZZ', 'AREA', 'PERIMETER', 'MAJOR_AXIS', 'MINOR_AXIS',
       'ECCENTRICITY', 'SOLIDITY', 'EXTENT', 'ASPECT_RATIO', 'ROUNDNESS',
       'COMPACTNESS', 'SHAPEFACTOR_1', 'SHAPEFACTOR_2', 'SHAPEFACTOR_4',
       'meanRR', 'meanRB', 'StdDevRR', 'StdDevRG', 'skewRB', 'kurtosisRR',
       'kurtosisRB', 'entropyRR', 'entropyRG', 'entropyRB', 'meanH', 'StdDevH',
       'StdDevS', 'kurtosisS', 'kurtosisV', 'entropyH', 'entropyV', 'meanL',
       'meanA', 'meanB', 'StdDevL', 'StdDevA', 'skewB', 'kurtosisB',
       'entropyL', 'entropyA', 'entropyB', 'meanY', 'meanCr', 'StdDevY',
       'skewCr', 'kurtosisCr', 'entropyY', 'entropyCb', 'meanXX', 'StdDevYY',
       'skewZZ', 'kurtosisXX', 'kurtosisZZ', 'entropyZZ', 'ALLdaub4RR',
       'ALLdaub4RB', 'ALLdaub4H', 'ALLdaub4V', 'ALLdaub4L', 'ALLdaub4a',
       'ALLdaub4b', 'ALLdaub4Y', 'ALLdaub4XX'],
      dtype='object')
```

In [ ]:
```python
# liczba zmiennych objasniajacych które zostały:

len(data3.columns[mi_score_selected_index - 1])
# Czyli widzimy, że pomimo usunięcia 63 zmiennych, model praktycznie nie stracił na jakosci
```

Out[ ]:
```
63
```

In [ ]:
```python
################################################
# Spróbujmy pójść dalej.
################################################

mi_score_selected_index2 = np.where(mi_score > 0.8)[
    0
]  # wybiorę zmienne, które mają mi_score > 0.5

X_3 = data3[
    data3.columns[mi_score_selected_index2 - 1]
```

```
]  # wybieram zmienne z odpowiednio dużym mi_score


X_train_3, X_test_3, Y_train3, Y_test3 = train_test_split(
    X_3, data4, test_size=0.1
)

model_3 = DTC().fit(X_train_3, Y_train3)
score_3 = model_3.score(X_test_3, Y_test3)

print(f"score_1:{score_1}\n score_3:{score_3}\n")
```

```
score_1:0.996
 score_3:0.9901333333333333
```

In [ ]:

```
# pozostałe kolumny w feature selection:

data3.columns[mi_score_selected_index2 - 1]
```

Out[ ]:

```
Index(['ALLdaub4ZZ', 'AREA', 'PERIMETER', 'MAJOR_AXIS', 'MINOR_AXIS',
       'ECCENTRICITY', 'SOLIDITY', 'EXTENT', 'ASPECT_RATIO', 'ROUNDNESS',
       'COMPACTNESS', 'SHAPEFACTOR_1', 'SHAPEFACTOR_2', 'kurtosisRB',
       'entropyRR', 'entropyRG', 'meanA', 'kurtosisB', 'entropyL', 'entropyA',
       'meanY', 'kurtosisCr', 'entropyY', 'entropyCb', 'ALLdaub4a',
       'ALLdaub4Y'],
      dtype='object')
```

In [ ]:

```
# liczba zmiennych objasniajacych które zostały:

len(data3.columns[mi_score_selected_index2 - 1])  # 26

################################################
# Wciąż jest bardzo dobrze, idziemy dalej.
################################################
```

Out[ ]:

```
26
```

In [ ]:

```
mi_score_selected_index3 = np.where(mi_score > 0.95)[
    0
]  # wybiorę zmienne, które mają mi_score > 0.5

X_4 = data3[
    data3.columns[mi_score_selected_index2 - 1]
]  # wybieram zmienne z odpowiednio dużym mi_score


X_train_4, X_test_4, Y_train4, Y_test4 = train_test_split(
    X_4, data4, test_size=0.1
)

model_4 = DTC().fit(X_train_4, Y_train4)
score_4 = model_4.score(X_test_4, Y_test4)

print(f"score_1:{score_1}\n score_4:{score_4}\n")
```

```
score_1:0.996
 score_4:0.994
```

In [ ]:

```
data3.columns[mi_score_selected_index3 - 1]
```

Out[ ]:

```
Index(['AREA', 'MAJOR_AXIS', 'MINOR_AXIS', 'EXTENT', 'ASPECT_RATIO',
       'ROUNDNESS', 'COMPACTNESS', 'SHAPEFACTOR_2'],
      dtype='object')
```

In [ ]:

```
len(data3.columns[mi_score_selected_index3 - 1])  # 8
```

Out[ ]:

```
8
```

CZĘŚĆ 3: LASY LOSOWE

In [ ]:

```
model = RF()
cv = RepeatedStratifiedKFold(n_splits=10, n_repeats=3, random_state=1)
n_scores = cross_val_score(
    model,
    X_train_4,
    Y_train4,
    scoring="accuracy",
    cv=cv,
    n_jobs=-1,
    error_score="raise",
)

print("Accuracy: %.3f (%.3f)" % (mean(n_scores), std(n_scores)))
# Accuracy 0.995 - jestesmy bardzo zadowoleni
```

```
/home/mchraba/anaconda3/envs/rice_classification/lib/python3.9/site-packages/sklearn/model_selection/_validation.py:680: DataConv
ersionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for examp
le using ravel().
  estimator.fit(X_train, y_train, **fit_params)
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  estimator.fit(X_train, y_train, **fit_params)
/home/mchraba/anaconda3/envs/rice_classification/lib/python3.9/site-packages/sklearn/model_selection/_validation.py:680: DataConv
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/home/mchraba/anaconda3/envs/rice_classification/lib/python3.9/site-packages/sklearn/model_selection/_validation.py:680: DataConv
```

```
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ersionWarning: A column-vector y was passed when a 1d array was expected. Please change the shape of y to (n_samples,), for examp
le using ravel().
  estimator.fit(X_train, y_train, **fit_params)
Accuracy: 0.995 (0.001)
```

CZĘŚĆ 4: NAIWNY BAYES

In [ ]:

```
gnb = GaussianNB()
Y_pred = gnb.fit(X_train_4, Y_train4.values.ravel()).predict(X_test_4)

print(classification_report(Y_test4, Y_pred))
```

```
              precision    recall  f1-score   support

     Arborio       0.51      0.34      0.41      1524
     Basmati       0.53      0.61      0.57      1488
      Ipsala       0.98      0.99      0.99      1513
     Jasmine       0.90      0.71      0.79      1480
   Karacadag       0.61      0.85      0.71      1495

    accuracy                           0.70      7500
   macro avg       0.71      0.70      0.69      7500
weighted avg       0.71      0.70      0.69      7500
```

In [ ]:

```
# Sprawdzmy jeszcze dla wiekszej liczby zmiennych

Y_pred_wiecej = gnb.fit(X_train_3, Y_train3.values.ravel()).predict(X_test_3)

print(classification_report(Y_test3, Y_pred_wiecej))
```

```
              precision    recall  f1-score   support

     Arborio       0.51      0.34      0.41      1542
     Basmati       0.53      0.62      0.57      1485
      Ipsala       0.98      0.99      0.98      1452
     Jasmine       0.90      0.68      0.77      1485
   Karacadag       0.61      0.85      0.71      1536

    accuracy                           0.69      7500
   macro avg       0.70      0.70      0.69      7500
weighted avg       0.70      0.69      0.69      7500
```