РОССИЙСКИЙ УНИВЕРСИТЕТ ДРУЖБЫ НАРОДОВ

Факультет физико-математических и естественных наук

Кафедра математического моделирования и искусственного интеллекта

ОТЧЕТ ПО ЛАБОРАТОРНОЙ РАБОТЕ № 6

Дисциплина: Интеллектуальный анализ данных

Студент: Генералов Даниил

Группа: НПИбд-01-21

Москва 2024

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1. Считайте заданный набор данных из репозитария UCI, включая указанный в индивидуальном задании столбец с метками классов..

2. Если среди меток класса имеются пропущенные значения, то удалите записи с пропущенными метками класса. Преобразуйте категориальные признаки в числовые при помощи кодирования меток (label encoding). Если в признаках имеются пропущенные значения, то замените пропущенные значения, используя метод, указанный в индивидуальном задании. Если в признаках пропущенных значений нет, то удалите из набора данных записи, идентифицированные как выбросы при помощи метода кластеризации DBSCAN.

3. Используя метод снижения размерности данных, указанный в индивидуальном задании, определите и оставьте в наборе данных не более четырех признаков.

4. Нормализуйте оставшиеся признаки набора данных методом, указанным в индивидуальном задании.

5. Визуализируйте набор данных в виде точек в трехмерном пространстве, отображая точки разных классов разными цветами. При визуализации набора данных используйте три признака с наиболее высокой оценкой важности. В качестве подписей осей используйте названия признаков. В подписи рисунка укажите название набора данных. Создайте легенду набора данных.

6. Разбейте набор данных на обучающую и тестовую выборки. Создайте и обучите классификатор на основе деревьев решений с глубиной дерева не более 4, определите долю верных ответов на тестовой выборке и визуализируйте границу принятия решений и построенное дерево решений. При визуализации границы принятия решений используйте два признака с наиболее высокой оценкой важности.

7.
8.
9.

Вариант 10

Automobile Data Set

Название файла: imports-85.data

Ссылка: http://archive.ics.uci.edu/ml/datasets/Automobile

Класс: num-of-doors (столбец No 6)

Метод обработки пропущенных значений – медиана признака

Метод нормализации признаков – нормировка по норме max

Алгоритм снижения размерности данных – рекурсивное исключение признаков (RFE)

Дополнительные базовые классификаторы:

- наивный байесовский классификатор

- классификатор ближайших соседей (к-во соседей = 3)

Комбинированный классификатор: VotingClassifier

Ансамблевые классификаторы: BaggingClassifier, GradientBoostingClassifier

Показатель качества модели – коэффициент Жаккара (jaccard)

1. открыть базу данных и прочитать значения

In [1]:
```
from ucimlrepo import fetch_ucirepo
```

```python
# fetch dataset
automobile= fetch_ucirepo(id=10)
```

In [2]:
```python
automobile['data'].keys()
```

Out[2]: dict_keys(['ids', 'features', 'targets', 'original', 'headers'])

In [3]:
```python
automobile['data']['features']
```

Out[3]:

	price	highway-mpg	city-mpg	peak-rpm	horsepower	compression-ratio	stroke	bore
0	13495.0	27	21	5000.0	111.0	9.0	2.68	3.47
1	16500.0	27	21	5000.0	111.0	9.0	2.68	3.47
2	16500.0	26	19	5000.0	154.0	9.0	3.47	2.68
3	13950.0	30	24	5500.0	102.0	10.0	3.40	3.19
4	17450.0	22	18	5500.0	115.0	8.0	3.40	3.19
...	...	...	...	...	...	...	...	...
200	16845.0	28	23	5400.0	114.0	9.5	3.15	3.78
201	19045.0	25	19	5300.0	160.0	8.7	3.15	3.78
202	21485.0	23	18	5500.0	134.0	8.8	2.87	3.58
203	22470.0	27	26	4800.0	106.0	23.0	3.40	3.01
204	22625.0	25	19	5400.0	114.0	9.5	3.15	3.78

205 rows × 25 columns

In [4]:
```python
automobile['data']['features']['num-of-doors'].unique()
```

Out[4]: array([2., 4., nan])

In [5]:
```python
data = automobile['data']['features']
```

2. предобработка данных

In [6]:
```python
KLASS = 'num-of-doors'

data = data.dropna(subset=[KLASS])
data
```

Out[6]:

	price	highway-mpg	city-mpg	peak-rpm	horsepower	compression-ratio	stroke	bore
0	13495.0	27	21	5000.0	111.0	9.0	2.68	3.47
1	16500.0	27	21	5000.0	111.0	9.0	2.68	3.47
2	16500.0	26	19	5000.0	154.0	9.0	3.47	2.68
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...	...	...	...	...	...	...	...	...
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204	22625.0	25	19	5400.0	114.0	9.5	3.15	3.78

203 rows × 25 columns

In [7]:

```
from sklearn.preprocessing import LabelEncoder
KATEGORICAL = ['fuel-system', 'engine-location', 'drive-wheels', 'engine-typ
ENCODERS = []
for k in KATEGORICAL:
    encoder = LabelEncoder()
    data[k] = encoder.fit_transform(data[k])
    ENCODERS.append(encoder)

data
```

```
/tmp/ipykernel_53338/2462000071.py:6: SettingWithCopyWarning:
A value is trying to be set on a copy of a slice from a DataFrame.
Try using .loc[row_indexer,col_indexer] = value instead

See the caveats in the documentation: https://pandas.pydata.org/pandas-docs/
stable/user_guide/indexing.html#returning-a-view-versus-a-copy
  data[k] = encoder.fit_transform(data[k])
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204	22625.0	25	19	5400.0	114.0	9.5	3.15	3.78

203 rows × 25 columns

In [8]:

```
for col in data.columns:
    data[col] = data[col].fillna(data[col].median())

data
```

```
/tmp/ipykernel_53338/3630728420.py:2: SettingWithCopyWarning:
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204	22625.0	25	19	5400.0	114.0	9.5	3.15	3.78

203 rows × 25 columns

3. снижение размерности

In [9]:

```
from sklearn.feature_selection import RFE
from sklearn.linear_model import SGDClassifier

est = SGDClassifier()
rfe = RFE(estimator=est, n_features_to_select=4)

X = data.drop(KLASS, axis=1)

rfe.fit(X, data[KLASS])

print(rfe.support_)
```

```
[False False False False  True False False False False  True False False
  True False False False False False False False False False False  True]
```

In [10]:

```
Xreduced = X[X.columns[rfe.support_]]

Xreduced
```

Out[10]:

	horsepower	engine-size	curb-weight	normalized-losses
0	111.0	130	2548	115.0
1	111.0	130	2548	115.0
2	154.0	152	2823	115.0
3	102.0	109	2337	164.0
4	115.0	136	2824	164.0
...	...	...	...	...
200	114.0	141	2952	95.0
201	160.0	141	3049	95.0
202	134.0	173	3012	95.0
203	106.0	145	3217	95.0
204	114.0	141	3062	95.0

203 rows × 4 columns

4. нормализация данных

In [11]:

```
Xreduced = (Xreduced - Xreduced.max()) / (Xreduced.max())

Xreduced
```

Out[11]:

	horsepower	engine-size	curb-weight	normalized-losses
0	-0.614583	-0.601227	-0.373340	-0.550781
1	-0.614583	-0.601227	-0.373340	-0.550781
2	-0.465278	-0.533742	-0.305706	-0.550781
3	-0.645833	-0.665644	-0.425234	-0.359375
4	-0.600694	-0.582822	-0.305460	-0.359375
...	...	...	...	...
200	-0.604167	-0.567485	-0.273979	-0.628906
201	-0.444444	-0.567485	-0.250123	-0.628906
202	-0.534722	-0.469325	-0.259223	-0.628906
203	-0.631944	-0.555215	-0.208805	-0.628906
204	-0.604167	-0.567485	-0.246926	-0.628906

203 rows × 4 columns

5. визуализация

In [12]:
```
rfe_more = RFE(estimator=SGDClassifier(), n_features_to_select=3)
rfe_more.fit(Xreduced, data[KLASS])


rfe_most = RFE(estimator=SGDClassifier(), n_features_to_select=2)
rfe_most.fit(Xreduced, data[KLASS])

Xreduced_more = Xreduced[Xreduced.columns[rfe_more.support_]]
Xreduced_most = Xreduced[Xreduced.columns[rfe_most.support_]]

Xreduced_more
```

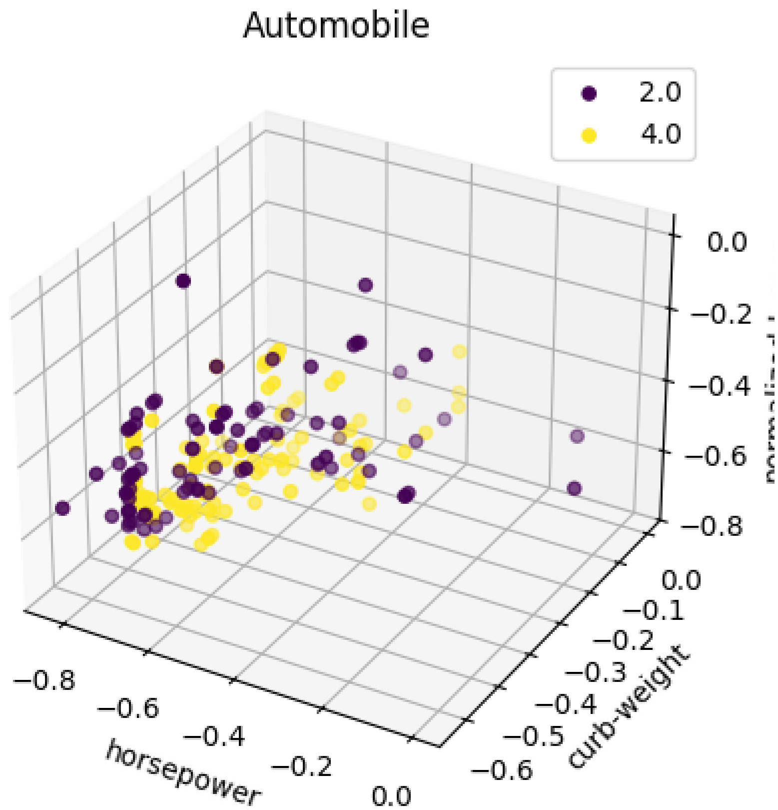
Out[12]:

	horsepower	curb-weight	normalized-losses
0	-0.614583	-0.373340	-0.550781
1	-0.614583	-0.373340	-0.550781
2	-0.465278	-0.305706	-0.550781
3	-0.645833	-0.425234	-0.359375
4	-0.600694	-0.305460	-0.359375
...	...	...	...
200	-0.604167	-0.273979	-0.628906
201	-0.444444	-0.250123	-0.628906
202	-0.534722	-0.259223	-0.628906
203	-0.631944	-0.208805	-0.628906
204	-0.604167	-0.246926	-0.628906

203 rows × 3 columns

In [13]:
```
import matplotlib.pyplot as plt

fig = plt.figure()
ax = fig.add_subplot(111, projection='3d')

cols = Xreduced_more.columns

for k in set(data[KLASS]):
    Xreduced_more_subset = Xreduced_more[data[KLASS] == k]
    ax.scatter(Xreduced_more_subset[cols[0]], Xreduced_more_subset[cols[1]],

ax.set_xlabel(cols[0])
ax.set_ylabel(cols[1])
ax.set_zlabel(cols[2])
ax.legend()
```

```
plt.title('Automobile')
plt.show()
```



6. классификация

In [14]:
```
from sklearn.model_selection import train_test_split

X_train, X_test, y_train, y_test = train_test_split(Xreduced_more, data[KLAS
```

In [15]:
```
from sklearn.tree import DecisionTreeClassifier

clf = DecisionTreeClassifier(max_depth=4)
clf.fit(X_train, y_train)
```

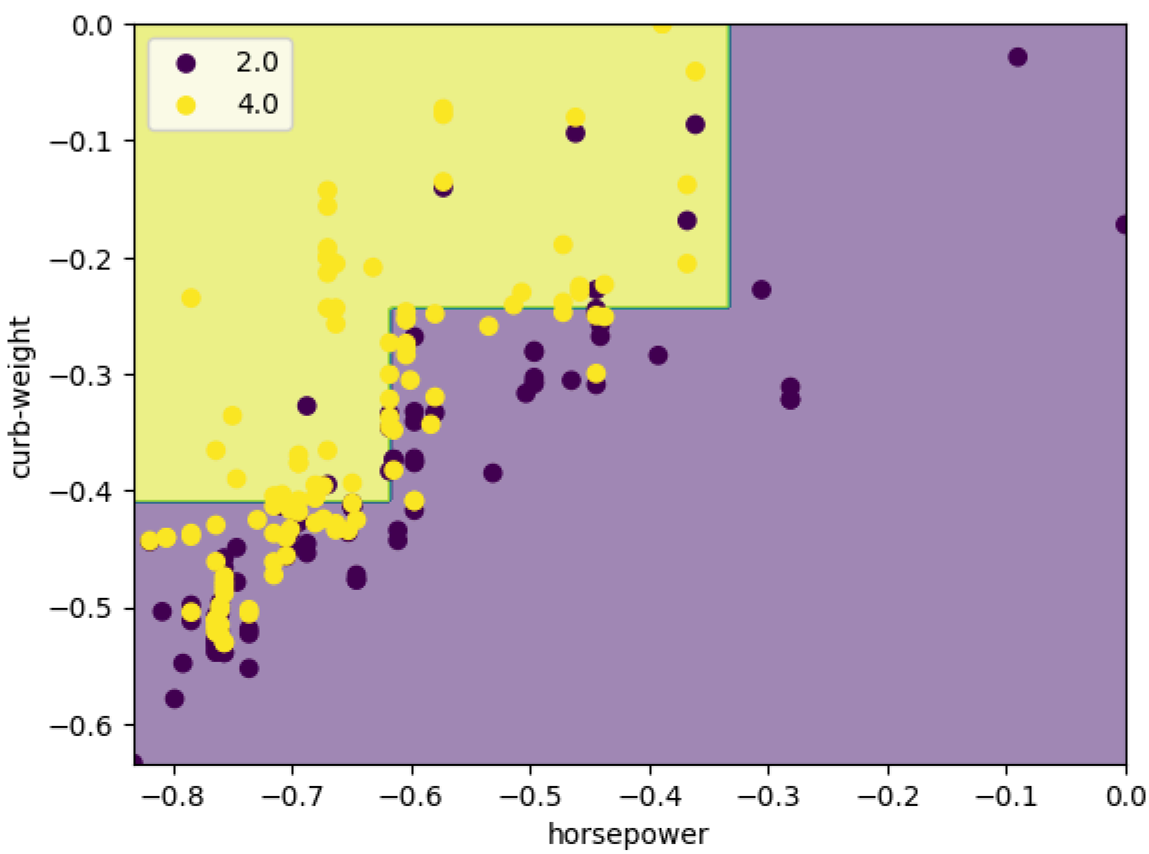
Out[15]:
```
DecisionTreeClassifier
DecisionTreeClassifier(max_depth=4)
```

In [16]:
```
train_ok = (clf.predict(X_train) == y_train).sum()
test_ok = (clf.predict(X_test) == y_test).sum()
print("Train OK:", train_ok, "/", len(y_train), "=", train_ok/len(y_train))
print("Test  OK:", test_ok, "/", len(y_test), "=", test_ok/len(y_test))
```

```
Train OK: 139 / 162 = 0.8580246913580247
Test  OK: 26 / 41 = 0.6341463414634146
```

In [17]:
```
import pandas as pd
import numpy as np
from sklearn.inspection import DecisionBoundaryDisplay

fig = plt.figure()
ax = fig.add_subplot()

cols = Xreduced_most.columns

xx0, xx1 = np.meshgrid(np.linspace(min(Xreduced_most[cols[0]]), max(Xreducec

least_important_col = list(set(Xreduced_more.columns) - set(cols))[0]
least_important_col_avg = Xreduced_more[least_important_col].mean()

Xmeshgrid = pd.DataFrame(np.array([xx0.ravel(), xx1.ravel(), [least_importar

response = clf.predict(Xmeshgrid)
response = response.reshape(xx0.shape)

DecisionBoundaryDisplay(xx0=xx0, xx1=xx1, response=response, xlabel=cols[0],

for k in set(data[KLASS]):
    Xreduced_most_subset = Xreduced_most[data[KLASS] == k]
    ax.scatter(Xreduced_most_subset[cols[0]], Xreduced_most_subset[cols[1]],
ax.legend()
```

Out[17]: <matplotlib.legend.Legend at 0x7f09d5c70750>



7. комбинирование классификаторов

In [18]:
```
from sklearn.naive_bayes import GaussianNB

clf2 = GaussianNB()
clf2.fit(X_train, y_train)

train_ok = (clf2.predict(X_train) == y_train).sum()
test_ok = (clf2.predict(X_test) == y_test).sum()
print("Train OK:", train_ok, "/", len(y_train), "=", train_ok/len(y_train))
print("Test  OK:", test_ok, "/", len(y_test), "=", test_ok/len(y_test))
```

```
Train OK: 107 / 162 = 0.6604938271604939
Test  OK: 21 / 41 = 0.5121951219512195
```

In [19]:
```
# k nearest neighbors (k=3)
from sklearn.neighbors import KNeighborsClassifier

clf3 = KNeighborsClassifier(n_neighbors=3)
clf3.fit(X_train, y_train)

train_ok = (clf3.predict(X_train) == y_train).sum()
test_ok = (clf3.predict(X_test) == y_test).sum()
print("Train OK:", train_ok, "/", len(y_train), "=", train_ok/len(y_train))
print("Test  OK:", test_ok, "/", len(y_test), "=", test_ok/len(y_test))
```

```
Train OK: 146 / 162 = 0.9012345679012346
Test  OK: 31 / 41 = 0.7560975609756098
```

In [20]:
```
from sklearn.ensemble import VotingClassifier

clf4 = VotingClassifier([
    ('decision-tree', clf),
    ('naive-bayes', clf2),
    ('knn', clf3)
])

clf4.fit(X_train, y_train)

train_ok = (clf4.predict(X_train) == y_train).sum()
test_ok = (clf4.predict(X_test) == y_test).sum()
print("Train OK:", train_ok, "/", len(y_train), "=", train_ok/len(y_train))
print("Test  OK:", test_ok, "/", len(y_test), "=", test_ok/len(y_test))
```

```
Train OK: 141 / 162 = 0.8703703703703703
Test  OK: 26 / 41 = 0.6341463414634146
```

In [21]:
```
from sklearn.metrics import jaccard_score

print("jaccard_score:")
print("Decision tree:", jaccard_score(y_test, clf.predict(X_test), average='
print("Naive Bayes  :", jaccard_score(y_test, clf2.predict(X_test), average=
```

```
print("KNN          :", jaccard_score(y_test, clf3.predict(X_test), average=
print("Voting       :", jaccard_score(y_test, clf4.predict(X_test), average=
```

```
jaccard_score:
Decision tree: 0.46593776282590416
Naive Bayes  : 0.3448110951697752
KNN          : 0.6086303939962476
Voting       : 0.4662288930581613
```

8. ансамблевый классификатор

In [22]:
```
from sklearn.ensemble import BaggingClassifier

clf5 = BaggingClassifier(n_estimators=1000)
clf5.fit(X_train, y_train)

train_ok = (clf5.predict(X_train) == y_train).sum()
test_ok = (clf5.predict(X_test) == y_test).sum()
print("Train OK:", train_ok, "/", len(y_train), "=", train_ok/len(y_train))
print("Test  OK:", test_ok, "/", len(y_test), "=", test_ok/len(y_test))
```

```
Train OK: 162 / 162 = 1.0
Test  OK: 33 / 41 = 0.8048780487804879
```

In [23]:
```
# gradient boosting
from sklearn.ensemble import GradientBoostingClassifier

clf6 = GradientBoostingClassifier(n_estimators=1000)
clf6.fit(X_train, y_train)

train_ok = (clf6.predict(X_train) == y_train).sum()
test_ok = (clf6.predict(X_test) == y_test).sum()
print("Train OK:", train_ok, "/", len(y_train), "=", train_ok/len(y_train))
print("Test  OK:", test_ok, "/", len(y_test), "=", test_ok/len(y_test))
```

```
Train OK: 162 / 162 = 1.0
Test  OK: 29 / 41 = 0.7073170731707317
```

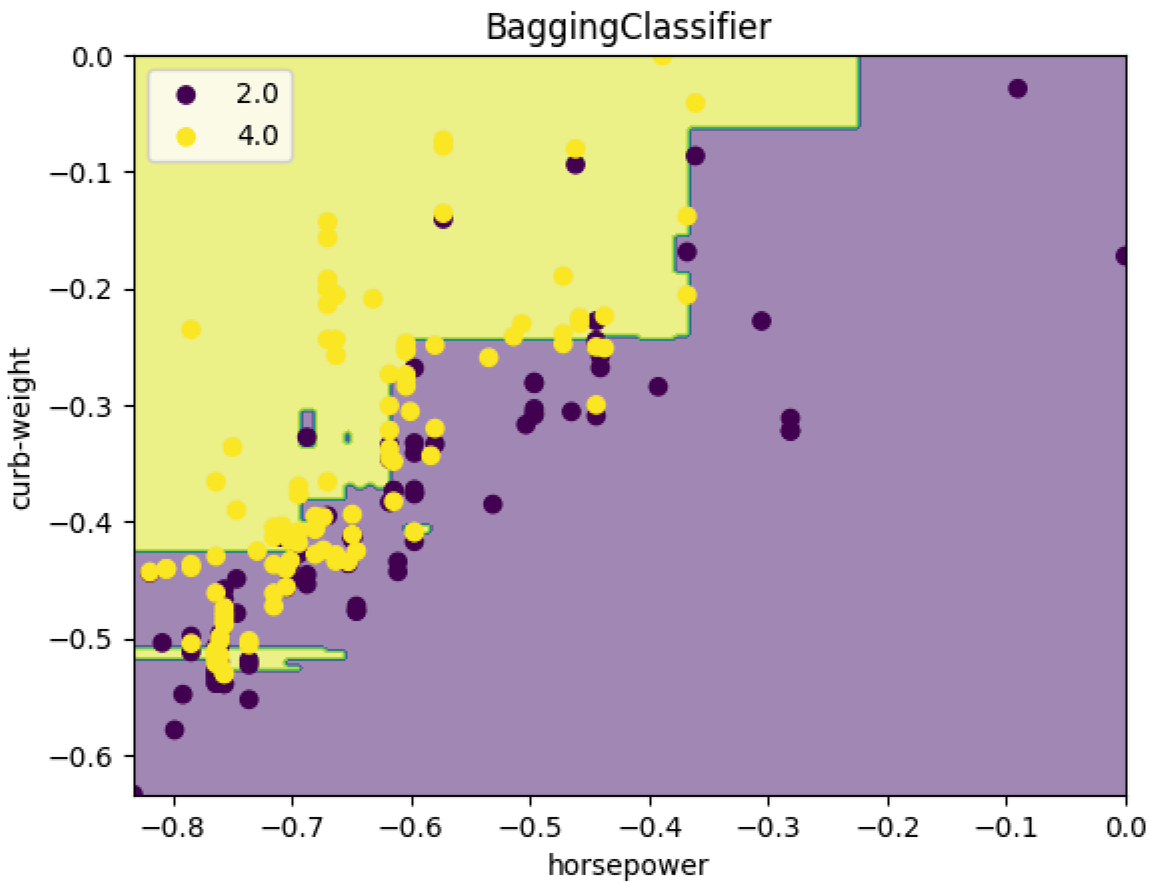
In [24]:
```
print("jaccard_score:")
print("Decision tree:", jaccard_score(y_test, clf.predict(X_test), average='
print("Naive Bayes  :", jaccard_score(y_test, clf2.predict(X_test), average=
print("KNN          :", jaccard_score(y_test, clf3.predict(X_test), average=
print("Voting       :", jaccard_score(y_test, clf4.predict(X_test), average=
print("Bagging      :", jaccard_score(y_test, clf5.predict(X_test), average=
print("Gradient     :", jaccard_score(y_test, clf6.predict(X_test), average=
```

```
jaccard_score:
Decision tree: 0.46593776282590416
Naive Bayes  : 0.3448110951697752
KNN          : 0.6086303939962476
Voting       : 0.4662288930581613
Bagging      : 0.6741463414634147
Gradient     : 0.5488501742160279
```

9. границы ансамблевых классификаторов

In [25]:
```
fig = plt.figure()
ax = fig.add_subplot()

cols = Xreduced_most.columns

xx0, xx1 = np.meshgrid(np.linspace(min(Xreduced_most[cols[0]]), max(Xreducec

least_important_col = list(set(Xreduced_more.columns) - set(cols))[0]
least_important_col_avg = Xreduced_more[least_important_col].mean()

Xmeshgrid = pd.DataFrame(np.array([xx0.ravel(), xx1.ravel(), [least_importar

response = clf5.predict(Xmeshgrid)
response = response.reshape(xx0.shape)

DecisionBoundaryDisplay(xx0=xx0, xx1=xx1, response=response, xlabel=cols[0],

for k in set(data[KLASS]):
    Xreduced_most_subset = Xreduced_most[data[KLASS] == k]
    ax.scatter(Xreduced_most_subset[cols[0]], Xreduced_most_subset[cols[1]],
ax.legend()
plt.title("BaggingClassifier")
```

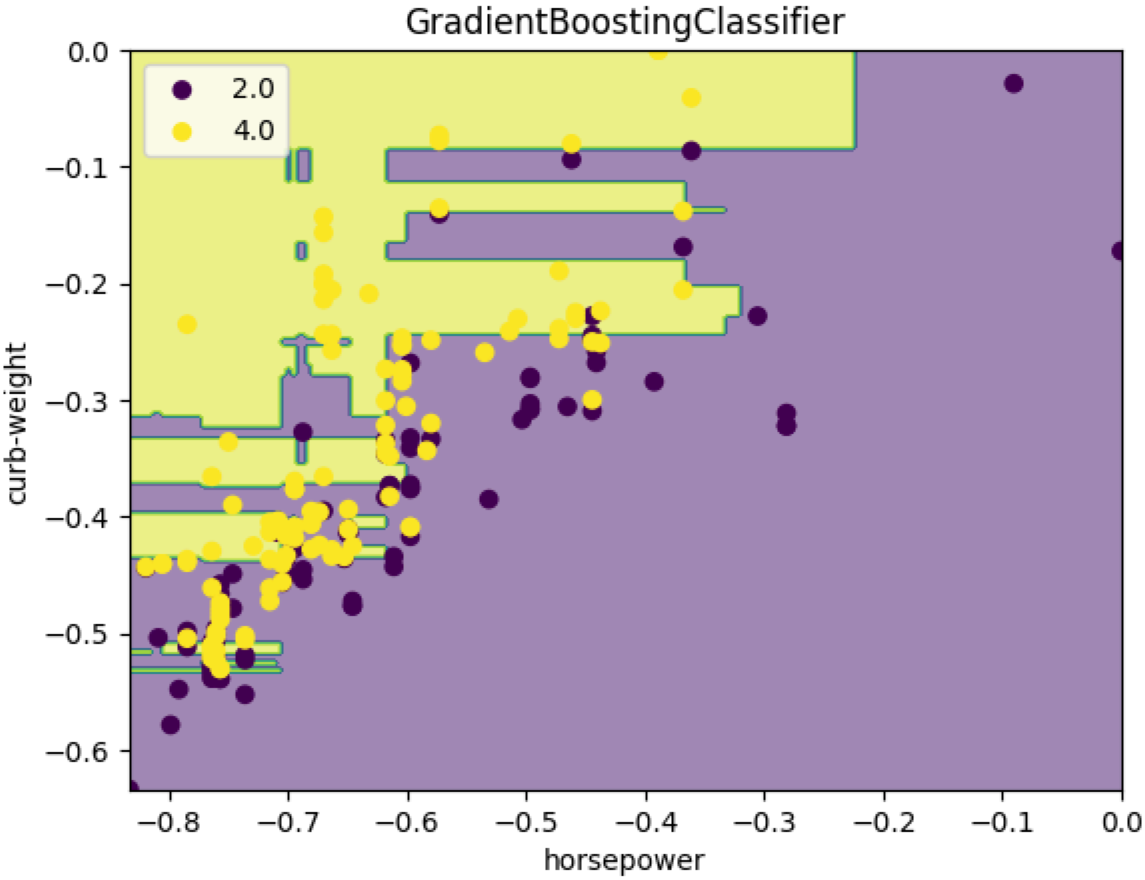
Out[25]:
```
Text(0.5, 1.0, 'BaggingClassifier')
```



In [26]:

```
fig = plt.figure()
ax = fig.add_subplot()

cols = Xreduced_most.columns

xx0, xx1 = np.meshgrid(np.linspace(min(Xreduced_most[cols[0]]), max(Xreduced

least_important_col = list(set(Xreduced_more.columns) - set(cols))[0]
least_important_col_avg = Xreduced_more[least_important_col].mean()

Xmeshgrid = pd.DataFrame(np.array([xx0.ravel(), xx1.ravel(), [least_importar

response = clf6.predict(Xmeshgrid)
response = response.reshape(xx0.shape)

DecisionBoundaryDisplay(xx0=xx0, xx1=xx1, response=response, xlabel=cols[0],

for k in set(data[KLASS]):
    Xreduced_most_subset = Xreduced_most[data[KLASS] == k]
    ax.scatter(Xreduced_most_subset[cols[0]], Xreduced_most_subset[cols[1]],
ax.legend()
plt.title("GradientBoostingClassifier")
```

Out[26]: Text(0.5, 1.0, 'GradientBoostingClassifier')



GradientBoostingClassifier
2.0
4.0
curb-weight
horsepower
0.0
−0.1
−0.2
−0.3
−0.4
−0.5
−0.6
−0.8
−0.7
−0.6
−0.5
−0.4
−0.3
−0.2
−0.1
0.0