Министерство науки и высшего образования РФ

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Факультет Программной инженерии и компьютерных технологий

По дисциплине:

Системы искусственного интеллекта

Лабораторная работа №3.

«Древо решений»

Вариант: Нечетный

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I. Задание

1. Для студентов с четным порядковым номером в группе – датасет с классификацией грибов, а нечетным – датасет с данными про оценки студентов инженерного и педагогического факультетов (для данного датасета нужно ввести метрику: студент успешный/неуспешный на основании грейда).

2. Отобрать случайным образом sqrt(n) признаков.

3. Реализовать без использования сторонних библиотек построение дерева решений (numpy и pandas использовать можно).

4. Провести оценку реализованного алгоритма с использованием Accuracy, precision и recall.

5. Построить AUC-ROC и AUC-PR.

II. Решение

Полный код можно посмотреть по ссылке

1.Реализовать построения дерева решений

Я выбираю порог в 4 балла для оценки результатов обучения студента. То есть, если GRADE меньше или равен 4, он будет оцениваться как «not passed», а более 4 будет оцениваться как «passed».

```
data = pd.read_csv("DATA.csv", index_col=0, sep=';')
data['Decision'] = data['GRADE'].apply(
    lambda x: "not passed" if x <= 4 else "passed")
X = data.iloc[:, :-2]
Y = data.iloc[:, -1]
```

Отобрать случайным образом sqrt(n) признаков.

Используйте библиотеку *train_test_split()*, чтобы разделить набор данных в соотношении 80:20. То есть 80% данных будет тренировочным набором, а остальные 20% — тестовым.

```
X = X.sample(n=6, axis=1)
cols = X.columns.tolist()
cols_new = [dict_num_name.get(str(x)) for x in cols]
X = X.values
Y = Y.values
X_train, X_test, Y_train, Y_test = train_test_split(
    X, Y, test_size=0.2, random_state=3)
```

2.Реализовать построения дерева решений

** Код для построения дерева решений*

```
class TreeNode:
    def __init__(self, feature_names, eps=0.03, depth=10, min_leaf_size=1):
        self.children = {}
        self.decision = None
        self.feature_names = feature_names
        self.split_feature_name = None
        self.split_feature_index = None
        self.eps = eps
        self.depth = depth
        self.min_leaf_size = min_leaf_size

    def get_entropy(self, x):
        entropy = 0
        for x_value in set(x):
            p = x[x == x_value].shape[0] / x.shape[0]
            entropy -= p * np.log2(p)
        return entropy
```

```python
def information_gain(self, x, y):
    entropy = 0
    for x_value in set(x):
        sub_y = y[x == x_value]
        tmp_ent = self.get_entropy(sub_y)
        p = sub_y.shape[0]/y.shape[0]
        entropy += p*tmp_ent
    return self.get_entropy(y) - entropy

def fit(self, X, y):
    self._built_tree(X, y, 0)

def getMajorClass(self, y):
    sum = 0
    result = None
    for x in set(y):
        if np.sum(y == x) > sum:
            sum = np.sum(y == x)
            result = x
    return result
```

```python
def _built_tree(self, X, y, depth):
    if (len(set(y))) == 1:
        self.decision = y[0]
        return
    if len(X[0]) == 0:
        self.decision = self.getMajorClass(y)
        return
    if depth > self.depth:
        self.decision = self.getMajorClass(y)
        return
    if len(y) < self.min_leaf_size:
        self.decision = self.getMajorClass(y)
        return

    self.children = {}
    best_feature_index = 0
    max_gain = 0
    for feature_index in range(len(X[0])):
        gain = self.information_gain(X[:, feature_index], y)
        if max_gain < gain:
            max_gain = gain
            best_feature_index = feature_index
```

```python
        if max_gain < self.eps:
            self.decision = self.getMajorClass(y)
            return

        self.split_feature_name = self.feature_names[best_feature_index]
        self.split_feature_index = cols.index(self.split_feature_name)

        for best_feature in set(X[:, best_feature_index]):
            index = X[:, best_feature_index] == best_feature
            sub_X = X[index]
            sub_X = np.delete(sub_X, best_feature_index, 1)
            sub_col = np.delete(self.feature_names, best_feature_index)
            # print(sub_X.shape)
            if len(X[index]) > 0:
                self.children[best_feature] = TreeNode(feature_names=sub_col)
                self.children[best_feature]._built_tree(
                    sub_X, y[index], depth+1)
            else:
                self.children[best_feature] = TreeNode(
                    feature_names=sub_col, depth=1)
                self.children[best_feature]._built_tree(
                    sub_X, y[index], depth+1)
```

```python
    def predict(self, x):
        if self.decision is not None:
            return self.decision
        else:
            attr_val = x[self.split_feature_index]
            try:
                child = self.children[attr_val]
            except KeyError:
                return '?'
            return child.predict(x)
```

** Пример дерева решения*

```
:When 4 is 1:not passed
:When 4 is 2:When 7 is 1:passed
:When 4 is 2:When 7 is 2:not passed
:When 4 is 3:When 19 is 1:not passed
:When 4 is 3:When 19 is 2:When 17 is 1:When 7 is 1:not passed
:When 4 is 3:When 19 is 2:When 17 is 1:When 7 is 2:When 25 is 1:not passed
:When 4 is 3:When 19 is 2:When 17 is 1:When 7 is 2:When 25 is 2:not passed
:When 4 is 3:When 19 is 2:When 17 is 2:When 10 is 1:When 25 is 1:not passed
:When 4 is 3:When 19 is 2:When 17 is 2:When 10 is 1:When 25 is 2:not passed
:When 4 is 3:When 19 is 2:When 17 is 2:When 10 is 1:When 25 is 3:When 7 is 1:not passed
:When 4 is 3:When 19 is 2:When 17 is 2:When 10 is 1:When 25 is 3:When 7 is 2:not passed
:When 4 is 3:When 19 is 2:When 17 is 2:When 10 is 2:When 7 is 1:When 25 is 2:not passed
:When 4 is 3:When 19 is 2:When 17 is 2:When 10 is 2:When 7 is 1:When 25 is 3:not passed
:When 4 is 3:When 19 is 2:When 17 is 2:When 10 is 2:When 7 is 2:not passed
:When 4 is 3:When 19 is 2:When 17 is 2:When 10 is 3:When 25 is 2:passed
:When 4 is 3:When 19 is 2:When 17 is 2:When 10 is 3:When 25 is 3:not passed
:When 4 is 3:When 19 is 2:When 17 is 3:When 25 is 2:not passed
:When 4 is 3:When 19 is 2:When 17 is 3:When 25 is 3:When 7 is 1:passed
:When 4 is 3:When 19 is 2:When 17 is 3:When 25 is 3:When 7 is 2:When 10 is 1:not passed
:When 4 is 3:When 19 is 2:When 17 is 3:When 25 is 3:When 7 is 2:When 10 is 2:passed
:When 4 is 3:When 19 is 2:When 17 is 4:not passed
:When 4 is 3:When 19 is 3:When 10 is 1:When 17 is 2:When 7 is 1:passed
:When 4 is 3:When 19 is 3:When 10 is 1:When 17 is 2:When 7 is 2:not passed
:When 4 is 3:When 19 is 3:When 10 is 1:When 17 is 3:not passed
:When 4 is 3:When 19 is 3:When 10 is 1:When 17 is 4:not passed
:When 4 is 3:When 19 is 3:When 10 is 1:When 17 is 5:not passed
:When 4 is 3:When 19 is 3:When 10 is 2:not passed
:When 4 is 4:When 17 is 1:When 19 is 2:When 10 is 1:When 7 is 1:passed
:When 4 is 4:When 17 is 1:When 19 is 2:When 10 is 1:When 7 is 2:When 25 is 2:passed
:When 4 is 4:When 17 is 1:When 19 is 2:When 10 is 1:When 7 is 2:When 25 is 3:not passed
:When 4 is 4:When 17 is 1:When 19 is 2:When 10 is 3:not passed
:When 4 is 4:When 17 is 1:When 19 is 3:not passed
```

```
:When 4 is 4:When 17 is 2:When 19 is 1:When 7 is 1:not passed
:When 4 is 4:When 17 is 2:When 19 is 1:When 7 is 2:passed
:When 4 is 4:When 17 is 2:When 19 is 2:When 10 is 1:When 7 is 1:passed
:When 4 is 4:When 17 is 2:When 19 is 2:When 10 is 1:When 7 is 2:not passed
:When 4 is 4:When 17 is 2:When 19 is 2:When 10 is 2:passed
:When 4 is 4:When 17 is 2:When 19 is 2:When 10 is 3:When 25 is 2:passed
:When 4 is 4:When 17 is 2:When 19 is 2:When 10 is 3:When 25 is 3:passed
:When 4 is 4:When 17 is 2:When 19 is 3:When 7 is 1:When 10 is 1:passed
:When 4 is 4:When 17 is 2:When 19 is 3:When 7 is 1:When 10 is 3:not passed
:When 4 is 4:When 17 is 2:When 19 is 3:When 7 is 2:not passed
:When 4 is 4:When 17 is 3:When 10 is 1:not passed
:When 4 is 4:When 17 is 3:When 10 is 2:passed
:When 4 is 4:When 17 is 3:When 10 is 3:When 19 is 1:passed
:When 4 is 4:When 17 is 3:When 10 is 3:When 19 is 3:not passed
:When 4 is 4:When 17 is 4:not passed
:When 4 is 4:When 17 is 5:not passed
:When 4 is 5:When 25 is 2:When 7 is 1:passed
:When 4 is 5:When 25 is 2:When 7 is 2:When 17 is 2:not passed
:When 4 is 5:When 25 is 2:When 7 is 2:When 17 is 3:passed
:When 4 is 5:When 25 is 3:When 10 is 1:not passed
:When 4 is 5:When 25 is 3:When 10 is 2:not passed
:When 4 is 5:When 25 is 3:When 10 is 3:When 7 is 1:passed
:When 4 is 5:When 25 is 3:When 10 is 3:When 7 is 2:not passed
```

* *Пример предсказания результата*

Поскольку мое дерево решений построено на дискретных переменных, будут случаи, когда оно не даст результата. В таких случаях я бы присвоил ему '?'

```
0      not passed
1          passed
2      not passed
3          passed
4               ?
5          passed
6      not passed
7               ?
8      not passed
9      not passed
10     not passed
11              ?
12     not passed
13     not passed
14         passed
15     not passed
16     not passed
17     not passed
18     not passed
19         passed
20              ?
21     not passed
22     not passed
23     not passed
24     not passed
25         passed
26     not passed
27     not passed
28         passed
```

3. Провести оценку реализованного алгоритма сиспользованием Accuracy, precision и recall.

```
def analyze(predict, expect):
    print("accuracy_score:", accuracy_score(expect, predict))
    print("precision_score:", precision_score(
        expect, predict, average="micro"))
    print("recall_score:", recall_score(expect, predict, average="micro"))
```

```
accuracy_score: 0.5862068965517241
precision_score: 0.5862068965517241
recall_score: 0.5862068965517241
```

4.Построить AUC-ROC и AUC-PR.

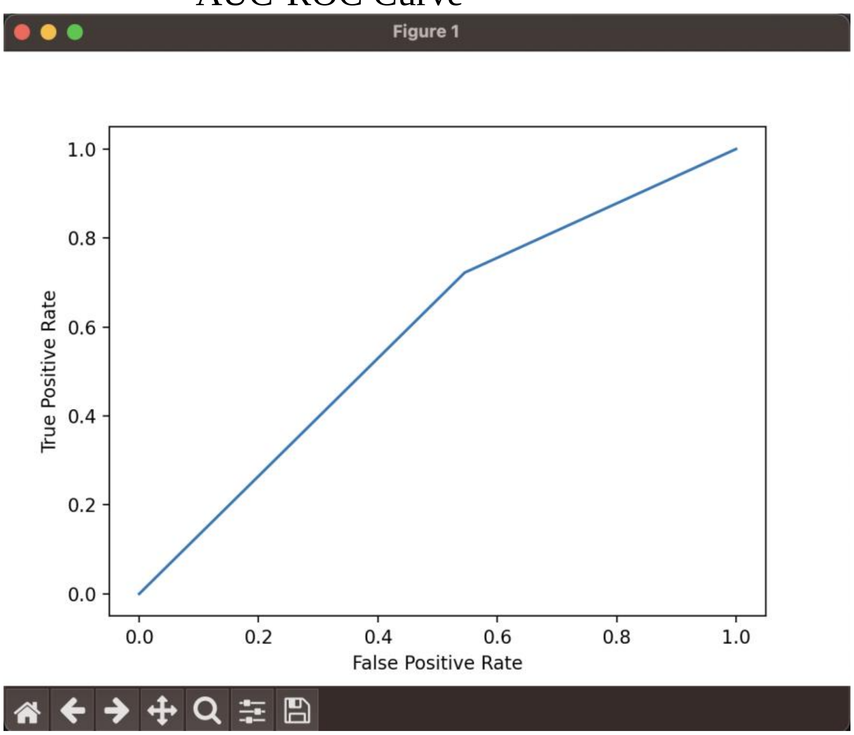
Чтобы визуализировать сравнение качества двух моделей дерева решений, я построил два графика AUC-ROC и AUC-PR.

* *Код для построения AUC-ROC и AUC-PR*

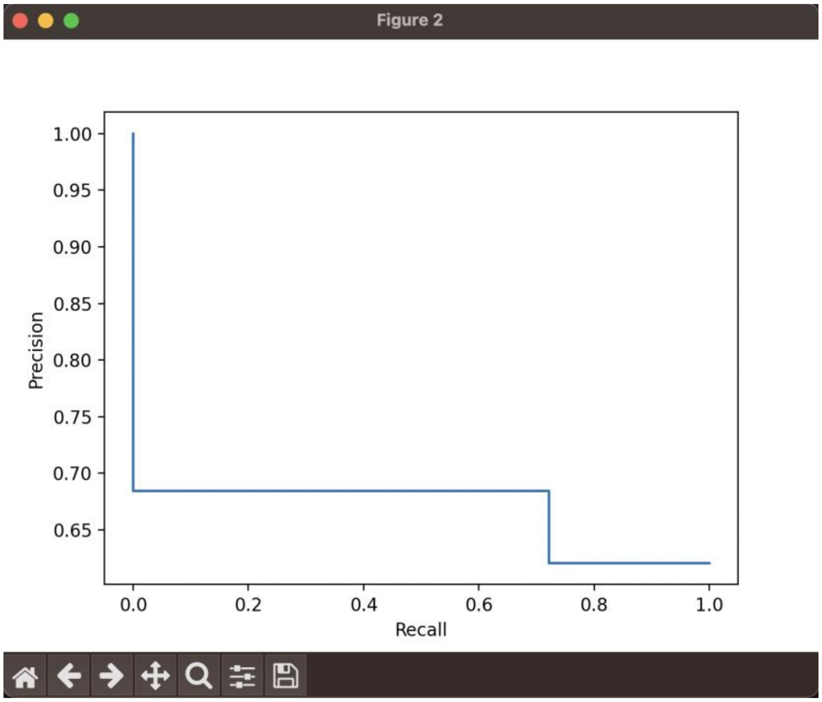
```
def draw_plt(predict_arr, expect_arr):
    y_true = np.array([0 if x == 'passed' else 1 for x in predict_arr])
    y_score = np.array([0 if x == 'passed' else 1 if x ==
                       'not passed' else '-1' for x in expect_arr])

    fpr, tpr, _ = roc_curve(y_true, y_score)
    roc_display = RocCurveDisplay(fpr=fpr, tpr=tpr).plot()
    precision, recall, _ = precision_recall_curve(y_true, y_score)
    pr_display = PrecisionRecallDisplay(
        precision=precision, recall=recall).plot()
    auc_roc = auc(fpr, tpr)
    auc_pr = average_precision_score(y_true, y_score)
    fig, (ax1, ax2) = plt.subplots(1, 2, figsize=(12, 8))
    roc_display.plot(ax=ax1)
    pr_display.plot(ax=ax2)
    plt.show()
```

AUC-ROC Curve



AUC-PR



5.Вывод

Построение модели дерева решений для классификации данныхпо алгоритму C4.5.

Использование характеристических параметров, таких как Accuracy, Precision, Recall для оценки и сравнения качества двухмоделей дерева решений.

Построение графики AUC-ROC и AUC-PR.