Брагин Алексей. КЭ - 402

In [ ]:
```
import graphviz
import numpy as np
import pandas as pd
from sklearn import tree
import matplotlib.pyplot as plt
from sklearn.metrics import classification_report
from yellowbrick.classifier import ClassificationReport
from sklearn.model_selection import train_test_split, GridSearchCV
from sklearn.ensemble import RandomForestClassifier, GradientBoostingClassifier
```

In [3]:
```
train_data = pd.read_csv('adult.data', names=['age',
                                              'workclass',
                                              'fnlwgt',
                                              'education',
                                              'education-num',
                                              'marital-status',
                                              'occupation',
                                              'relationship',
                                              'race',
                                              'sex',
                                              'capital-gain',
                                              'capital-loss',
                                              'hours-per-week',
                                              'native-country',
                                              'salary'])
```

In [4]:
```
train_data.sample(5)
```

Out[4]:

	age	workclass	fnlwgt	education	education-num	marital-status	occupation	relationship	race	s
15088	53	Private	218311	HS-grad	9	Divorced	Sales	Not-in-family	White	Fem
24365	31	Local-gov	209103	Some-college	10	Married-civ-spouse	Protective-serv	Husband	White	M
14851	17	Self-emp-inc	413557	9th	5	Never-married	Sales	Own-child	White	Fem
23208	24	Private	464103	HS-grad	9	Never-married	Adm-clerical	Not-in-family	White	M
26033	67	Self-emp-not-inc	217892	Doctorate	16	Married-civ-spouse	Prof-specialty	Husband	White	M

In [5]:
```
train_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
```

```
RangeIndex: 32561 entries, 0 to 32560
Data columns (total 15 columns):
 #   Column          Non-Null Count  Dtype
---  ------          --------------  -----
 0   age             32561 non-null  int64
 1   workclass       32561 non-null  object
 2   fnlwgt          32561 non-null  int64
 3   education       32561 non-null  object
 4   education-num   32561 non-null  int64
 5   marital-status  32561 non-null  object
 6   occupation      32561 non-null  object
 7   relationship    32561 non-null  object
 8   race            32561 non-null  object
 9   sex             32561 non-null  object
 10  capital-gain    32561 non-null  int64
 11  capital-loss    32561 non-null  int64
 12  hours-per-week  32561 non-null  int64
 13  native-country  32561 non-null  object
 14  salary          32561 non-null  object
dtypes: int64(6), object(9)
memory usage: 3.7+ MB
```

В данных присутствуют пропуски. Удалим строки содержащие пустые значения

In [6]:
```
train_data.where(train_data == ' ?').count()
```

Out[6]:
```
age                 0
workclass        1836
fnlwgt              0
education           0
education-num       0
marital-status      0
occupation       1843
relationship        0
race                0
sex                 0
capital-gain        0
capital-loss        0
hours-per-week      0
native-country    583
salary              0
dtype: int64
```

In [7]:
```
train_data = train_data[train_data != ' ?'].dropna()
```

In [8]:
```
train_data.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 30162 entries, 0 to 32560
Data columns (total 15 columns):
 #   Column          Non-Null Count  Dtype
```

```
---  ------          --------------  -----
 0   age             30162 non-null  int64
 1   workclass       30162 non-null  object
 2   fnlwgt          30162 non-null  int64
 3   education       30162 non-null  object
 4   education-num   30162 non-null  int64
 5   marital-status  30162 non-null  object
 6   occupation      30162 non-null  object
 7   relationship    30162 non-null  object
 8   race            30162 non-null  object
 9   sex             30162 non-null  object
 10  capital-gain    30162 non-null  int64
 11  capital-loss    30162 non-null  int64
 12  hours-per-week  30162 non-null  int64
 13  native-country  30162 non-null  object
 14  salary          30162 non-null  object
dtypes: int64(6), object(9)
memory usage: 3.7+ MB
```

In [9]:

```
X = train_data[['age',
                'workclass',
                'fnlwgt',
                'education',
                'education-num',
                'marital-status',
                'occupation',
                'relationship',
                'race',
                'sex',
                'capital-gain',
                'capital-loss',
                'hours-per-week',
                'native-country']]

y = train_data['salary']
```

Кодируем категориальные признаки

In [10]:

```
X = pd.get_dummies(X, prefix_sep='_', drop_first=True)

# 0: <=50k, 1: >50k
y = y.apply(lambda x: 0 if x == ' <=50K' else 1)
class_names = ['<=50k', '>50k']
```

Разбиваем данные на обучающую и тестовую выборки в соотношении 70 на 30

In [11]:

```
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size=0.3, random_
print(y_train.shape, y_test.shape)
```

```
(21113,) (9049,)
```

In [87]:

```
def build_tree(X_train, X_test, y_train, y_test):
    param_grid = [{
```

```
            'criterion':['gini', 'entropy'],
            'max_depth':[1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 15],
            'min_samples_leaf':[1, 2, 3, 4, 5, 6, 7, 8, 9, 10],
           }]

    tree_clf = tree.DecisionTreeClassifier(random_state=1)

    gs_clf = GridSearchCV(tree_clf, param_grid, cv=2, n_jobs=12)
    gs_clf.fit(X_train, y_train)

    print(gs_clf.best_params_)

    y_pred = gs_clf.predict(X_test)

    return (classification_report(y_test, y_pred, target_names=class_names, outp
            classification_report(y_test, y_pred, target_names=class_names))
```

Обучаем дерево решений

Дополнительно при обучении используем перебор параметров модели для достижения наилучших результатов. Обученная модель показала 85% accuracy на тестовых данных

In [88]:

```
%%time
report_dct, report_txt = build_tree(X_train, X_test, y_train, y_test)
print(report_txt)
```

```
{'criterion': 'gini', 'max_depth': 9, 'min_samples_leaf': 6}
              precision    recall  f1-score   support

       <=50k       0.87      0.94      0.90      6742
        >50k       0.78      0.58      0.66      2307

    accuracy                           0.85      9049
   macro avg       0.82      0.76      0.78      9049
weighted avg       0.84      0.85      0.84      9049

CPU times: user 1.35 s, sys: 217 ms, total: 1.56 s
Wall time: 4.74 s
```

In [ ]:

```
def best_random_forest():
    param_grid = [{
            'n_estimators':[50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150],
            'max_depth':[10, 15, 20, 25, 30, 35, 40],
            'min_samples_leaf':[1, 2, 3, 4, 5],
           }]

    clf = GridSearchCV(RandomForestClassifier(random_state=1), param_grid, scori
    clf.fit(X_train, y_train)

    print(clf.best_params_)

    y_pred = clf.predict(X_test)
    print(classification_report(y_test, y_pred, target_names=class_names))
```

Обучаем случайный лес

При обучении также используем перебор параметров модели. Обученная модель показала 86% accuracy на тестовых данных

In [111…

```
%%time
best_random_forest()
```

```
Fitting 5 folds for each of 385 candidates, totalling 1925 fits
{'max_depth': 35, 'min_samples_leaf': 2, 'n_estimators': 110}
              precision    recall  f1-score   support

       <=50k       0.88      0.94      0.91      6742
        >50k       0.79      0.61      0.69      2307

    accuracy                           0.86      9049
   macro avg       0.83      0.78      0.80      9049
weighted avg       0.85      0.86      0.85      9049

CPU times: user 9.92 s, sys: 1.36 s, total: 11.3 s
Wall time: 7min 43s
```

In [115…

```
def best_gradient_boosting():
    param_grid = [{
              'n_estimators':[50, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150],
              'learning_rate':[0.1, 0.5, 1.0],
              'max_depth':[10, 15, 20, 25, 30, 35, 40],
              'min_samples_leaf':[1, 2, 3, 4, 5],
             }]

    clf = GridSearchCV(GradientBoostingClassifier(random_state=1), param_grid, s
    clf.fit(X_train, y_train)

    print(clf.best_params_)

    y_pred = clf.predict(X_test)
    print(classification_report(y_test, y_pred, target_names=class_names))
```

Градиентный бустинг

При обучении также используем перебор параметров модели. Обученная модель показала 86% accuracy на тестовых данных

In [116…

```
%%time
best_gradient_boosting()
```

```
Fitting 5 folds for each of 1155 candidates, totalling 5775 fits
{'learning_rate': 0.1, 'max_depth': 10, 'min_samples_leaf': 2, 'n_estimators': 7
0}
              precision    recall  f1-score   support

       <=50k       0.89      0.94      0.91      6742
        >50k       0.78      0.65      0.71      2307

    accuracy                           0.86      9049
   macro avg       0.83      0.79      0.81      9049
```

```
weighted avg       0.86      0.86      0.86      9049

CPU times: user 27.7 s, sys: 4.09 s, total: 31.8 s
Wall time: 5h 30min 49s
```

In [29]:

```
def build_random_forest(n_estimators):
    clf = RandomForestClassifier(n_estimators=n_estimators,
                                 max_depth=35,
                                 min_samples_leaf=2,
                                 random_state=1)
    clf = ClassificationReport(clf, classes=class_names)

    clf.fit(X_train, y_train)
    acc = clf.score(X_test, y_test)
    print(f'Accuracy {round(acc, 5)} with n_estimators = {n_estimators}')
    clf.show()
    print('-----------------------------------------------------------------')
```

In [31]:

```
def build_gradient_boosting(n_estimators):
    clf = GradientBoostingClassifier(n_estimators=n_estimators,
                                 max_depth=10,
                                 min_samples_leaf=2,
                                 learning_rate=0.1,
                                 random_state=1)
    clf = ClassificationReport(clf, classes=class_names)

    clf.fit(X_train, y_train)
    acc = clf.score(X_test, y_test)
    print(f'Accuracy {round(acc, 5)} with n_estimators = {n_estimators}')
    clf.show()
    print('-----------------------------------------------------------------')
```

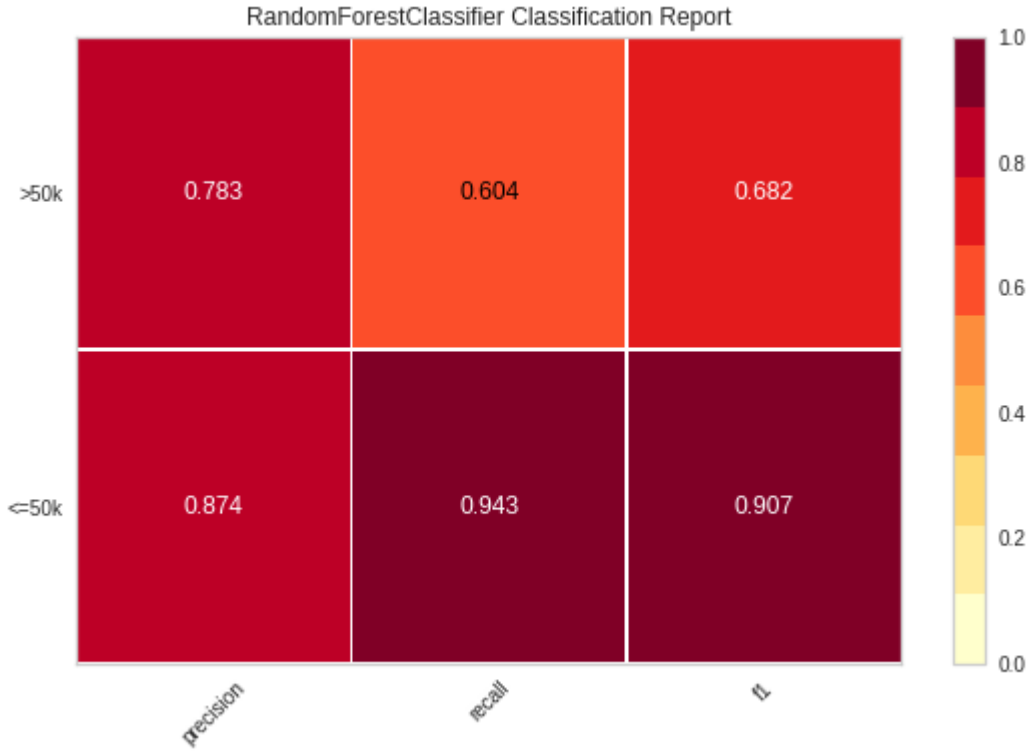
Случайный лес с различными значениями кол-ва участников ансамбля

Результаты отличаются незначительно. Наилучший результат - accuracy 0.85711 с 90 участниками ансамбля

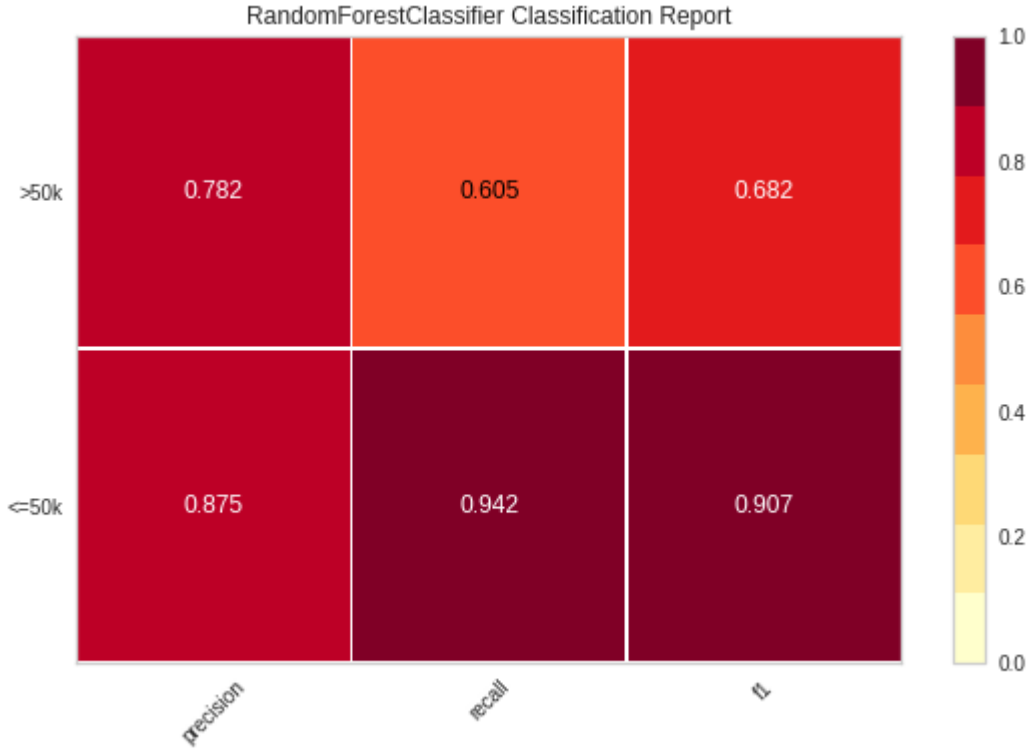
In [30]:

```
for i in range(50, 110, 10):
    build_random_forest(i)
```

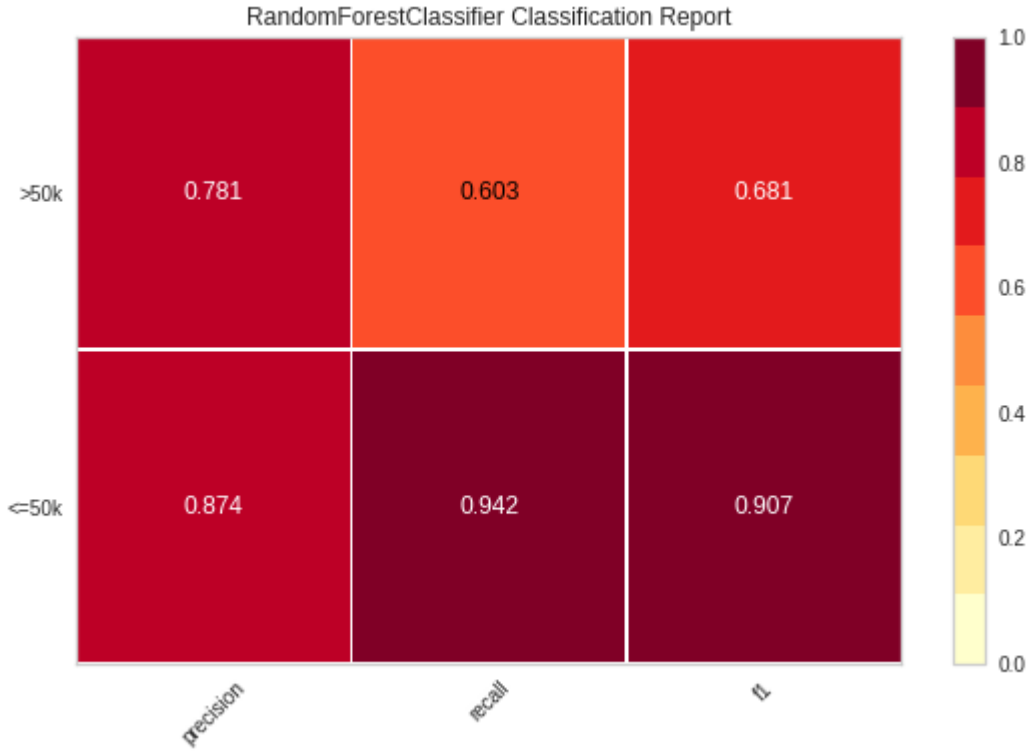
```
Accuracy 0.85634 with n_estimators = 50
```



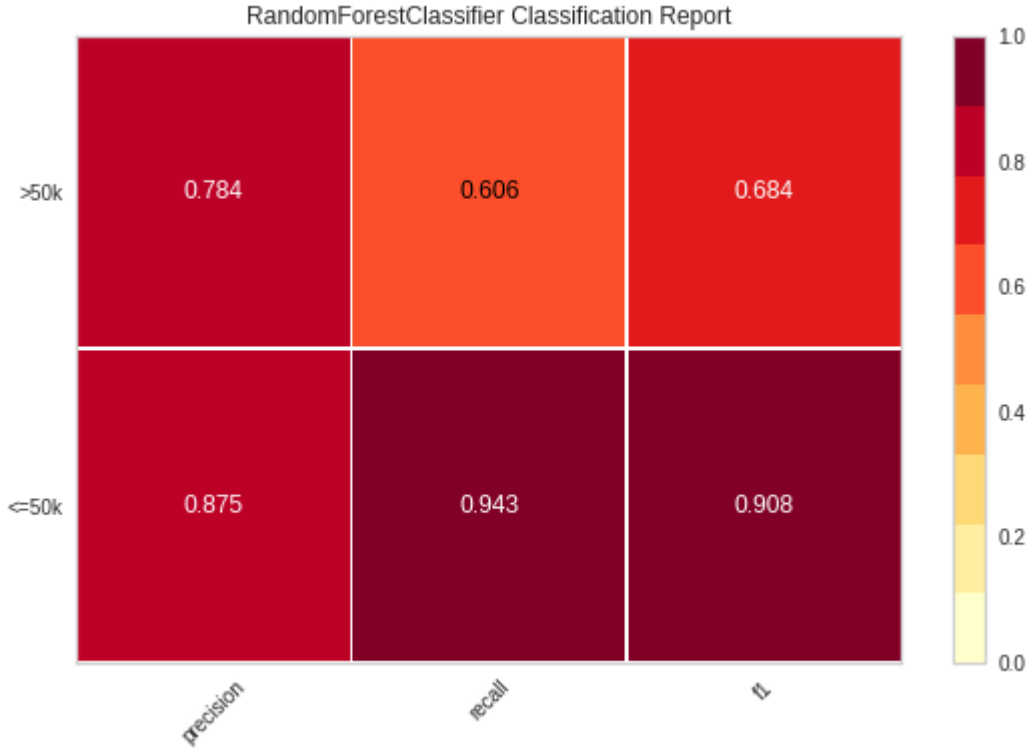
Accuracy 0.85634 with n_estimators = 60



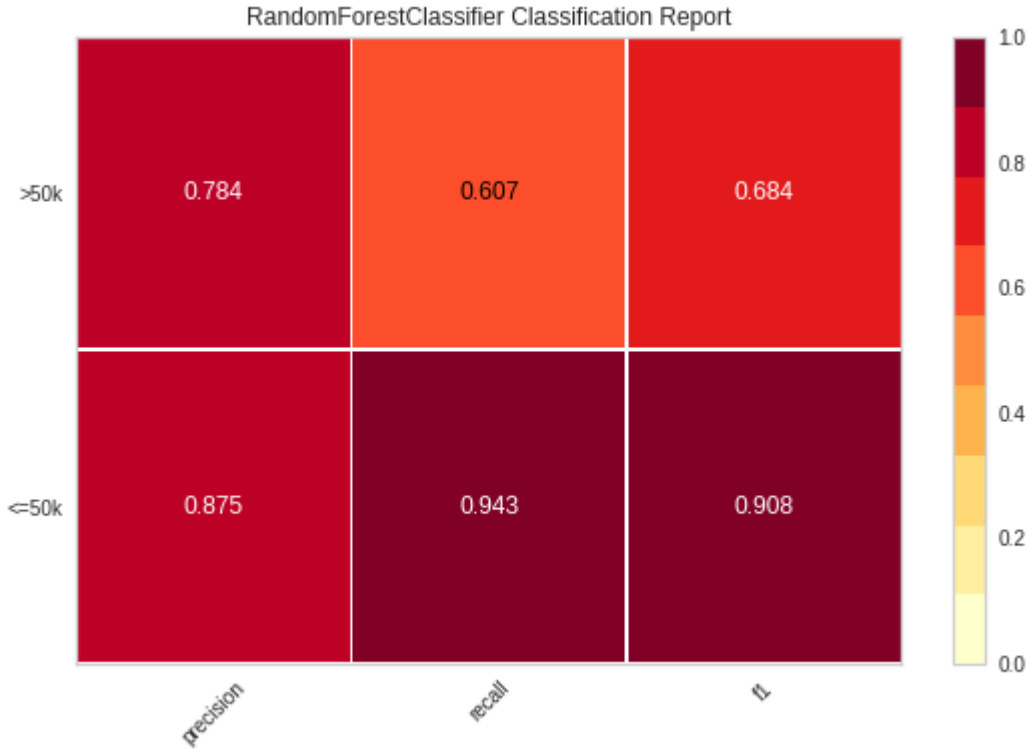
Accuracy 0.85567 with n_estimators = 70



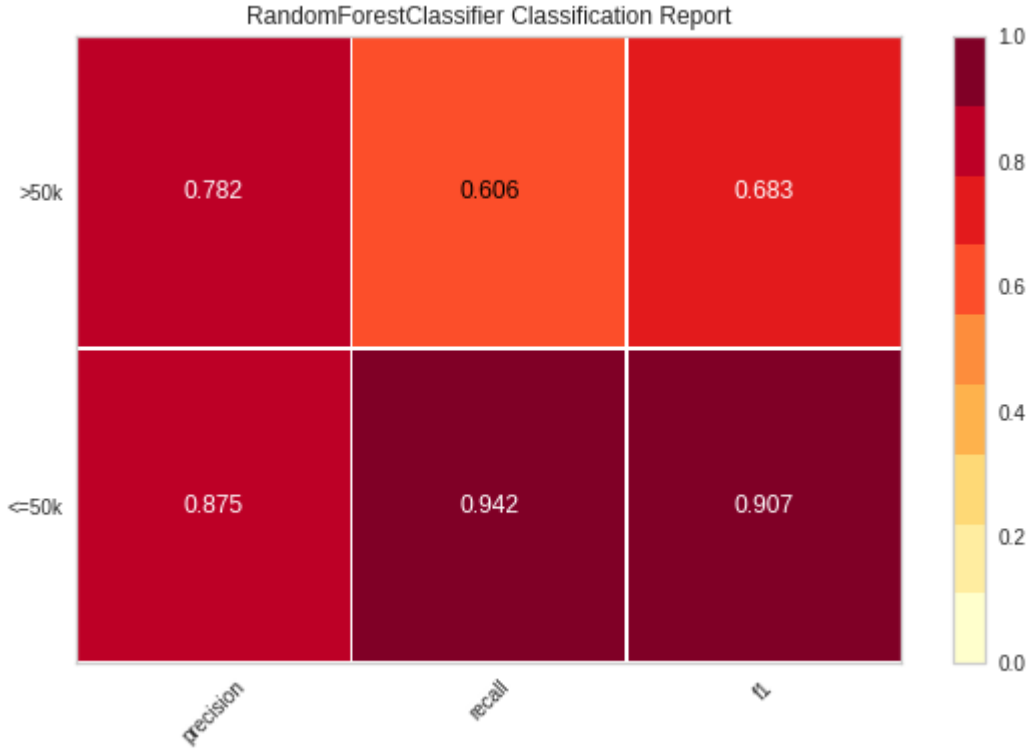
Accuracy 0.857 with n_estimators = 80



Accuracy 0.85711 with n_estimators = 90



```
Accuracy 0.85645 with n_estimators = 100
```

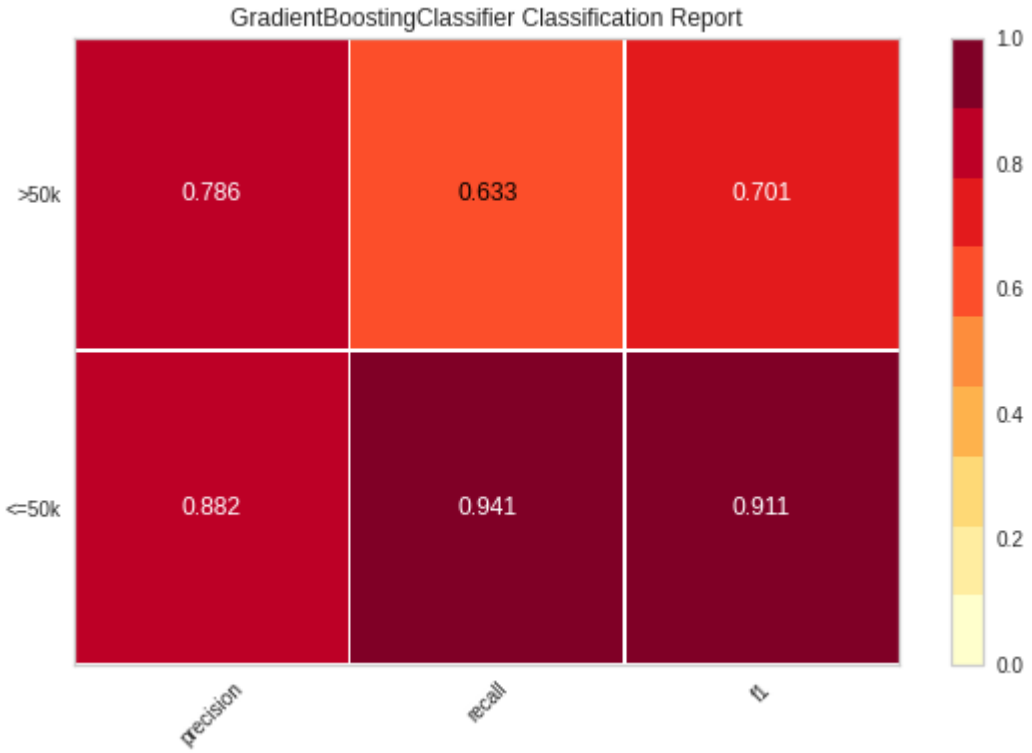


Градиентный бустинг с различными значениями кол-ва участников ансамбля

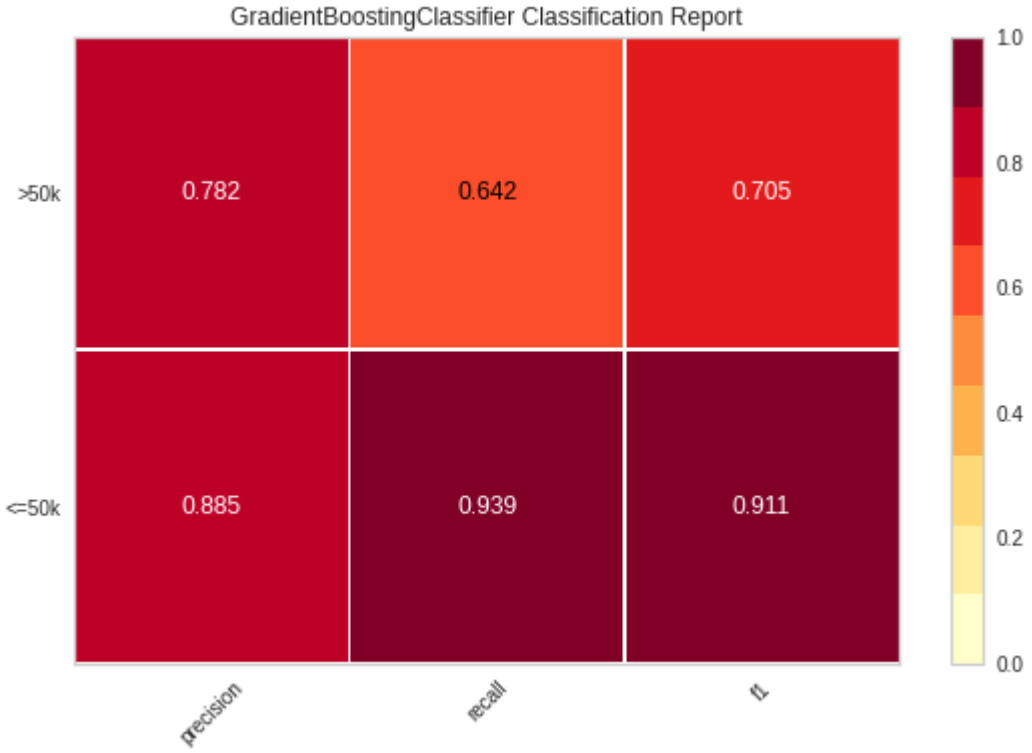
Результаты отличаются незначительно. Наилучший результат - accuracy 0.86452 с 80 участниками ансамбля. В среднем для достжения лучших результатов градиентному бустингу необходимо меньшее кол-во участников ансабля нежели случайному лесу

In [32]:
```
for i in range(50, 110, 10):
    build_gradient_boosting(i)
```

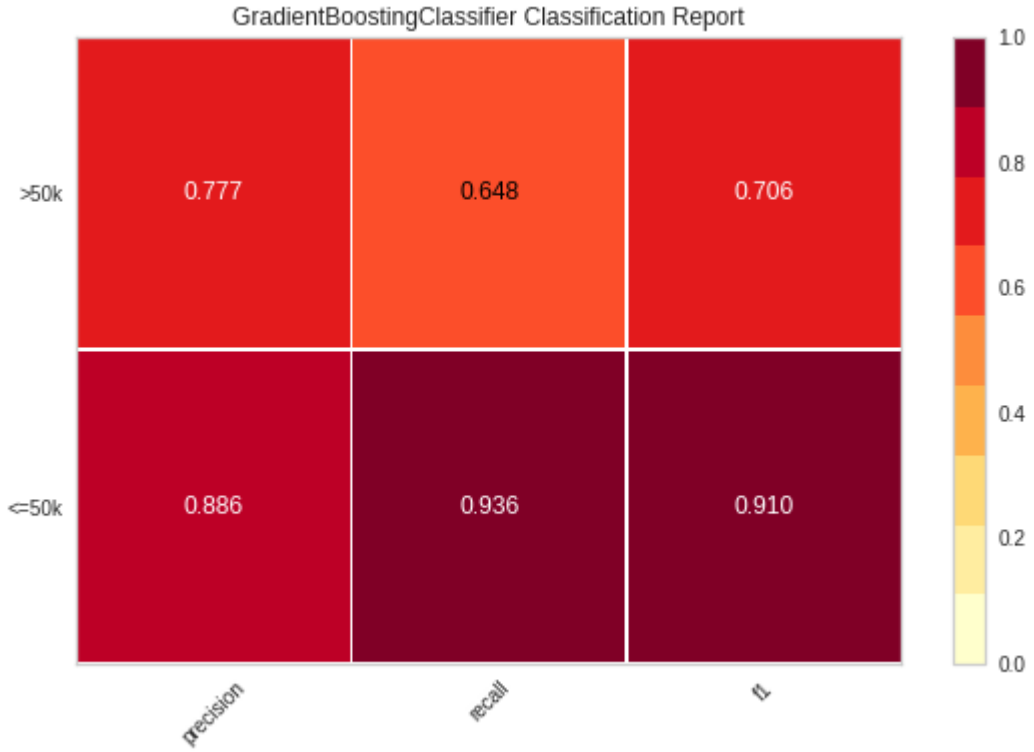
```
Accuracy 0.86242 with n_estimators = 50
```



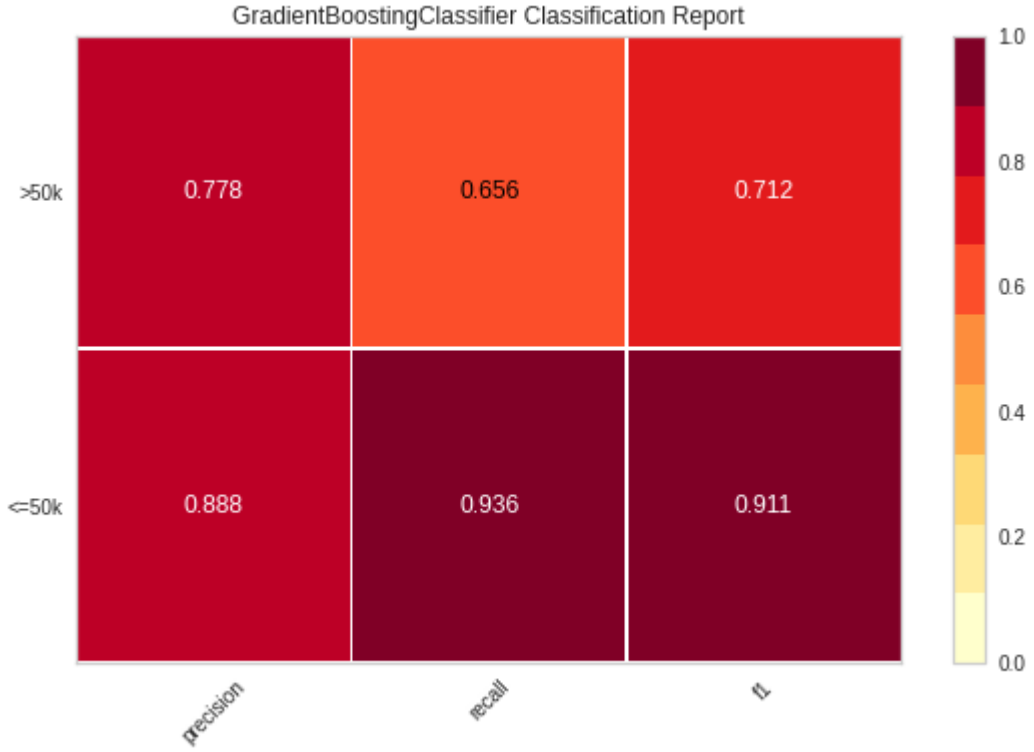

```
----------------------------------------------------------------
Accuracy 0.86308 with n_estimators = 60
```



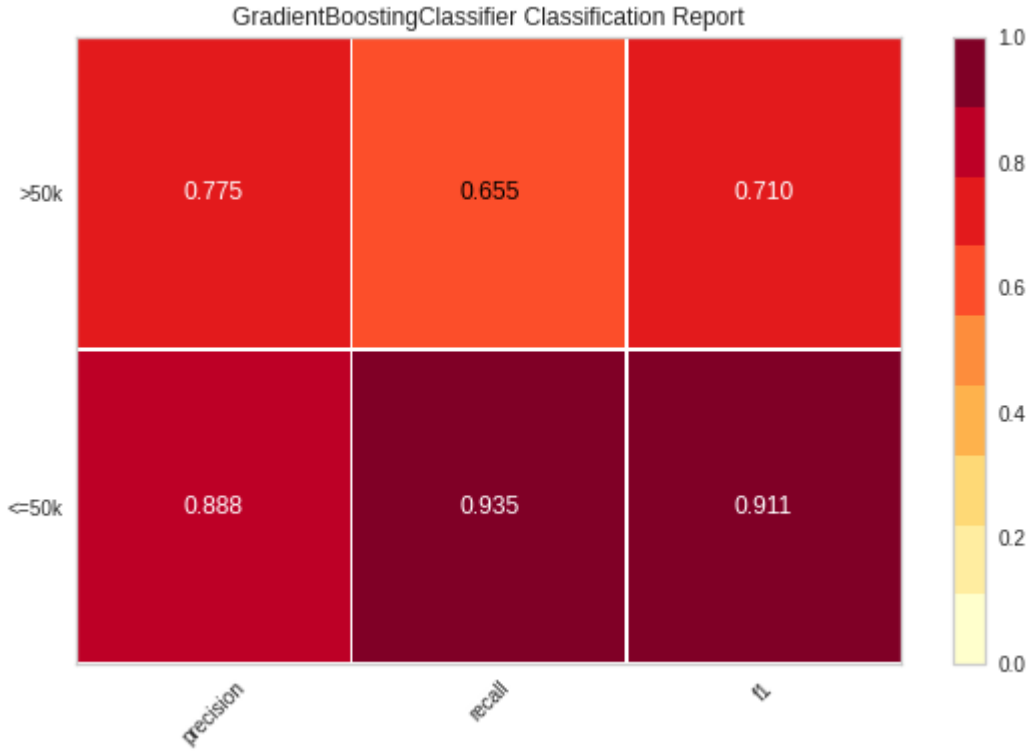

```
----------------------------------------------------------------
Accuracy 0.86275 with n_estimators = 70
```



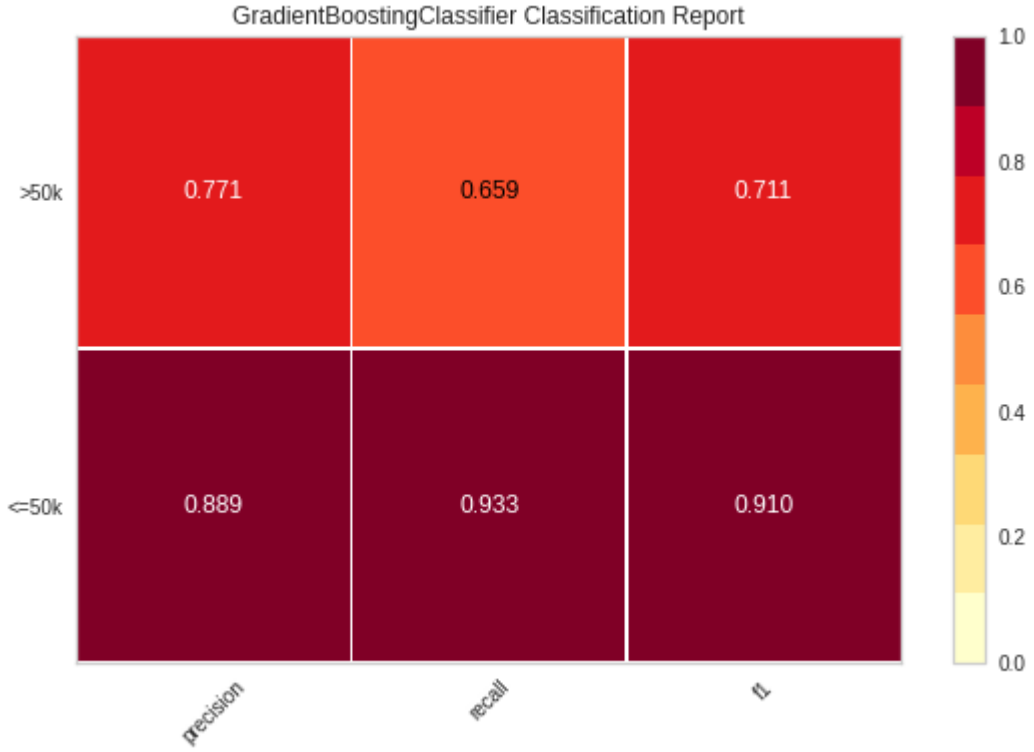
Accuracy 0.86452 with n_estimators = 80



Accuracy 0.86363 with n_estimators = 90




```
----------------------------------------------------------------
Accuracy 0.86319 with n_estimators = 100
```




```
----------------------------------------------------------------
```

In [ ]: