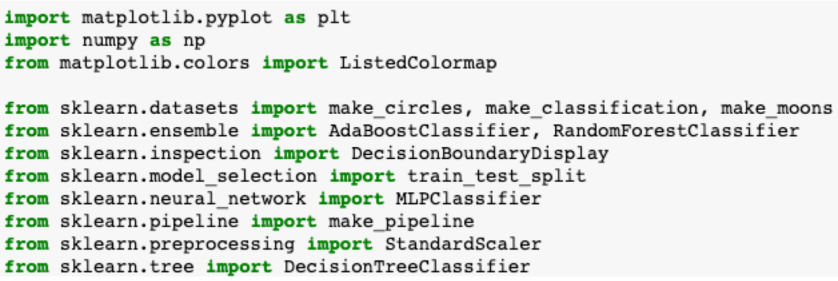
Ensemble methods

TP 6 – Visualizing several algorithms

A comparison of several classifiers in scikit-learn on synthetic datasets. The point of this example is to illustrate the nature of decision boundaries of different classifiers. This should be taken with a grain of salt, as the intuition conveyed by these examples does not necessarily carry over to real datasets.

Particularly in high-dimensional spaces, data can more easily be separated linearly and the simplicity of classifiers The plots show training points in solid colors and testing points semi-transparent. The lower right shows the classification accuracy on the test set.

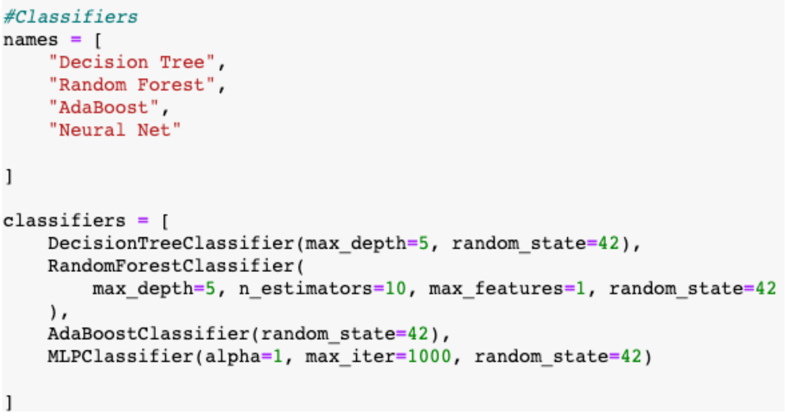
1) Import libraries



```
import matplotlib.pyplot as plt
import numpy as np
from matplotlib.colors import ListedColormap

from sklearn.datasets import make_circles, make_classification, make_moons
from sklearn.ensemble import AdaBoostClassifier, RandomForestClassifier
from sklearn.inspection import DecisionBoundaryDisplay
from sklearn.model_selection import train_test_split
from sklearn.neural_network import MLPClassifier
from sklearn.pipeline import make_pipeline
from sklearn.preprocessing import StandardScaler
from sklearn.tree import DecisionTreeClassifier
```

2) Defining classifiers and hyperparameters



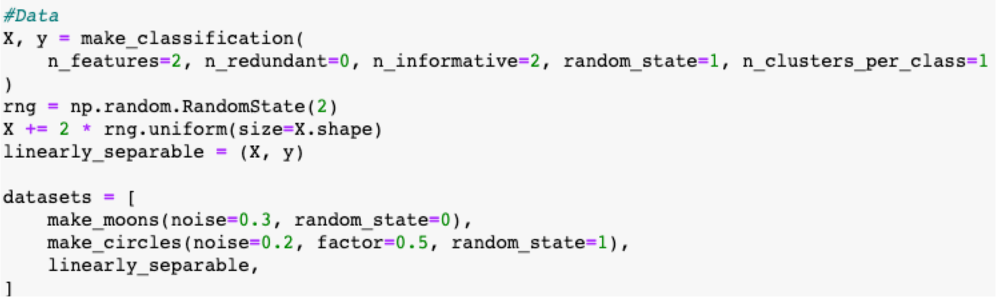
```
#Classifiers
names = [
    "Decision Tree",
    "Random Forest",
    "AdaBoost",
    "Neural Net"

]

classifiers = [
    DecisionTreeClassifier(max_depth=5, random_state=42),
    RandomForestClassifier(
        max_depth=5, n_estimators=10, max_features=1, random_state=42
    ),
    AdaBoostClassifier(random_state=42),
    MLPClassifier(alpha=1, max_iter=1000, random_state=42)

]
```

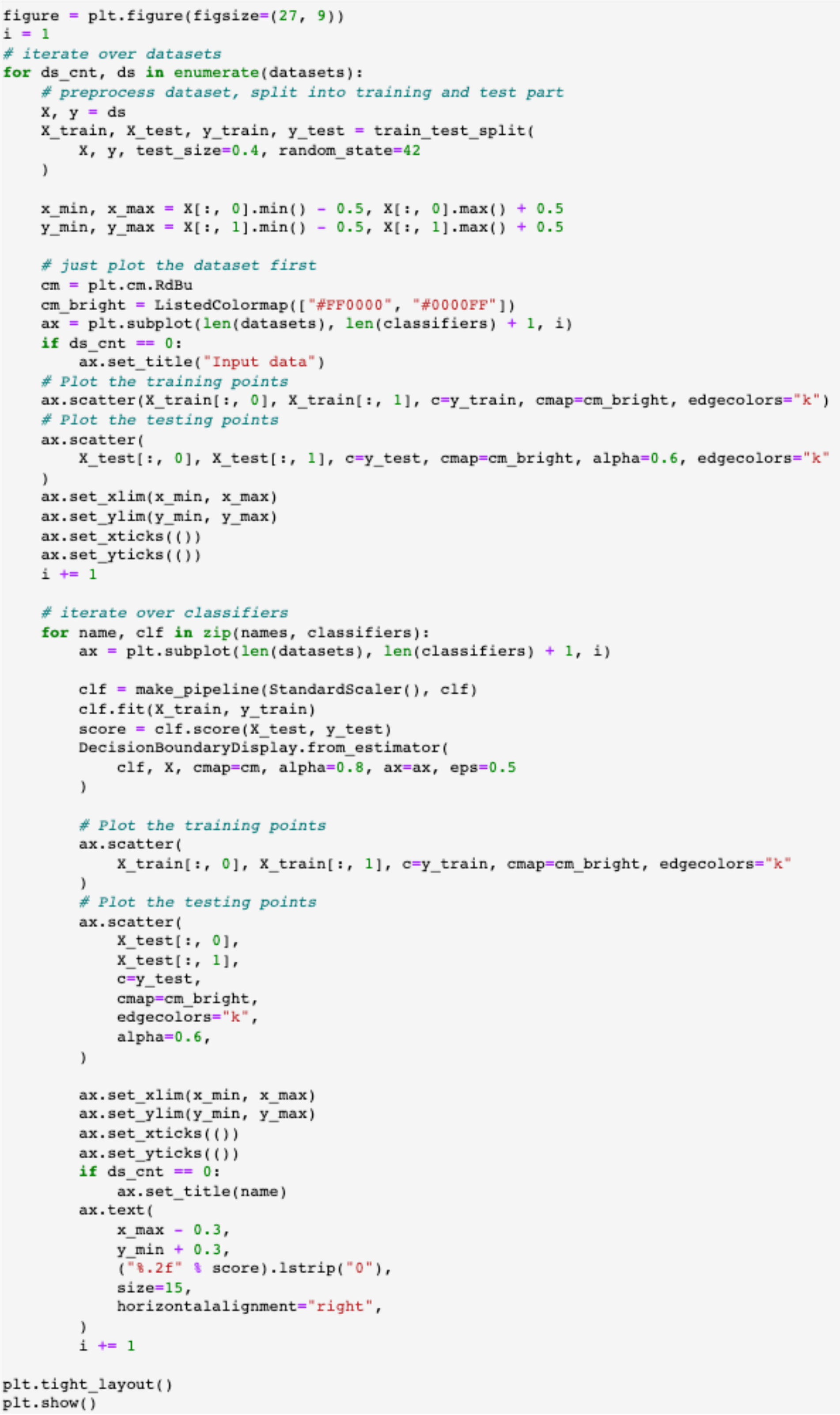
3) Defining data



```
#Data
X, y = make_classification(
    n_features=2, n_redundant=0, n_informative=2, random_state=1, n_clusters_per_class=1
)
rng = np.random.RandomState(2)
X += 2 * rng.uniform(size=X.shape)
linearly_separable = (X, y)

datasets = [
    make_moons(noise=0.3, random_state=0),
    make_circles(noise=0.2, factor=0.5, random_state=1),
    linearly_separable,
]
```

4) Training and ploting



```
figure = plt.figure(figsize=(27, 9))
i = 1
# iterate over datasets
for ds_cnt, ds in enumerate(datasets):
    # preprocess dataset, split into training and test part
    X, y = ds
    X_train, X_test, y_train, y_test = train_test_split(
        X, y, test_size=0.4, random_state=42
    )

    x_min, x_max = X[:, 0].min() - 0.5, X[:, 0].max() + 0.5
    y_min, y_max = X[:, 1].min() - 0.5, X[:, 1].max() + 0.5

    # just plot the dataset first
    cm = plt.cm.RdBu
    cm_bright = ListedColormap(["#FF0000", "#0000FF"])
    ax = plt.subplot(len(datasets), len(classifiers) + 1, i)
    if ds_cnt == 0:
        ax.set_title("Input data")
    # Plot the training points
    ax.scatter(X_train[:, 0], X_train[:, 1], c=y_train, cmap=cm_bright, edgecolors="k")
    # Plot the testing points
    ax.scatter(
        X_test[:, 0], X_test[:, 1], c=y_test, cmap=cm_bright, alpha=0.6, edgecolors="k"
    )
    ax.set_xlim(x_min, x_max)
    ax.set_ylim(y_min, y_max)
    ax.set_xticks(())
    ax.set_yticks(())
    i += 1

    # iterate over classifiers
    for name, clf in zip(names, classifiers):
        ax = plt.subplot(len(datasets), len(classifiers) + 1, i)

        clf = make_pipeline(StandardScaler(), clf)
        clf.fit(X_train, y_train)
        score = clf.score(X_test, y_test)
        DecisionBoundaryDisplay.from_estimator(
            clf, X, cmap=cm, alpha=0.8, ax=ax, eps=0.5
        )

        # Plot the training points
        ax.scatter(
            X_train[:, 0], X_train[:, 1], c=y_train, cmap=cm_bright, edgecolors="k"
        )
        # Plot the testing points
        ax.scatter(
            X_test[:, 0],
            X_test[:, 1],
            c=y_test,
            cmap=cm_bright,
            edgecolors="k",
            alpha=0.6,
        )

        ax.set_xlim(x_min, x_max)
        ax.set_ylim(y_min, y_max)
        ax.set_xticks(())
        ax.set_yticks(())
        if ds_cnt == 0:
            ax.set_title(name)
        ax.text(
            x_max - 0.3,
            y_min + 0.3,
            ("%.2f" % score).lstrip("0"),
            size=15,
            horizontalalignment="right",
        )
        i += 1

plt.tight_layout()
plt.show()
```

- **What is the main difference between the decision trees, adaboost and random forest?**
- **In which cases neural network outperforms ensemble methods in this example and why?**