17장. 결정 트리 (Decision Tree)

1. 패키지 설치

1.1 머신 러닝 패키지 scikit-learn

In [1]:
```
!pip install sklearn
```

```
Requirement already satisfied: sklearn in c:₩users₩ghkrg₩anaconda3₩envs₩data_mining₩lib₩site-packages (0.0)
Requirement already satisfied: scikit-learn in c:₩users₩ghkrg₩anaconda3₩envs₩data_mining₩lib₩site-packages (from sklearn) (0.24.2)
Requirement already satisfied: scipy>=0.19.1 in c:₩users₩ghkrg₩anaconda3₩envs₩data_mining₩lib₩site-packages (from scikit-learn->sklearn)
(1.6.3)
Requirement already satisfied: threadpoolctl>=2.0.0 in c:₩users₩ghkrg₩anaconda3₩envs₩data_mining₩lib₩site-packages (from scikit-learn->skle
arn) (2.1.0)
Requirement already satisfied: joblib>=0.11 in c:₩users₩ghkrg₩anaconda3₩envs₩data_mining₩lib₩site-packages (from scikit-learn->sklearn) (1.
0.1)
Requirement already satisfied: numpy>=1.13.3 in c:₩users₩ghkrg₩anaconda3₩envs₩data_mining₩lib₩site-packages (from scikit-learn->sklearn)
(1.20.1)
```

1.2 시각화 패키지 graphviz

- 바이너리 설치 : https://graphviz.org/download/ (https://graphviz.org/download/)
- 패키지 설치

In [2]:
```
!pip install graphviz
```

```
Requirement already satisfied: graphviz in c:₩users₩ghkrg₩anaconda3₩envs₩data_mining₩lib₩site-packages (0.16)
```

2. 데이터셋

In [3]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import itertools
from sklearn.metrics import confusion_matrix
from sklearn.model_selection import learning_curve, train_test_split
from sklearn.ensemble import RandomForestClassifier
from sklearn.tree import DecisionTreeClassifier
from sklearn import tree
import graphviz
%matplotlib inline
```

2.2 데이터셋 로딩

In [4]:
```
import requests
import os

dataset_path = os.path.join('data', 'wdbc.data')
if os.path.exists(dataset_path) is False:
    data = requests.get("https://archive.ics.uci.edu/ml/machine-learning-databases/breast-cancer-wisconsin/wdbc.data")
    with open(dataset_path, "w") as f:
      f.write(data.text)
```

In [5]:
```
import pandas as pd

column_names = [
    "diagnosis","radius_mean", "texture_mean", "perimeter_mean", "area_mean", "smoothness_mean",
    "compactness_mean", "concavity_mean", "points_mean", "symmetry_mean", "dimension_mean",
    "radius_se", "texture_se", "perimeter_se", "area_se", "smoothness_se",
    "compactness_se", "concavity_se", "points_se", "symmetry_se", "dimension_se",
    "radius_worst", "texture_worst", "perimeter_worst", "area_worst", "smoothness_worst",
    "compactness_worst", "concavity_worst", "points_worst", "symmetry_worst", "dimension_worst"
    ]
class_names = ['M', 'B']
dataset = pd.read_csv(dataset_path, names=column_names)
dataset.sample(5)
```

Out[5]:

	diagnosis	radius_mean	texture_mean	perimeter_mean	area_mean	smoothness_mean	compactness_mean	concavity_mean	points_mean	symmetry
864292	B	10.51	20.19	68.64	334.2	0.11220	0.13030	0.06476	0.03068	
8611555	M	25.22	24.91	171.50	1878.0	0.10630	0.26650	0.33390	0.18450	
87106	B	11.15	13.08	70.87	381.9	0.09754	0.05113	0.01982	0.01786	
886226	M	19.45	19.33	126.50	1169.0	0.10350	0.11880	0.13790	0.08591	
915691	M	13.40	20.52	88.64	556.7	0.11060	0.14690	0.14450	0.08172	

5 rows × 31 columns

In [6]:
```
X = dataset[dataset.columns[1:]]
X_mean = dataset[dataset.columns[2:12]]
dataset['target'] = (dataset['diagnosis']=='M')*0 + ₩
                    (dataset['diagnosis']=='B')*1
y = dataset['target']
```

2.3 데이터 분할

In [7]:
```
X_train, X_test, Y_train, Y_test = train_test_split(X, y, test_size=0.2)
```

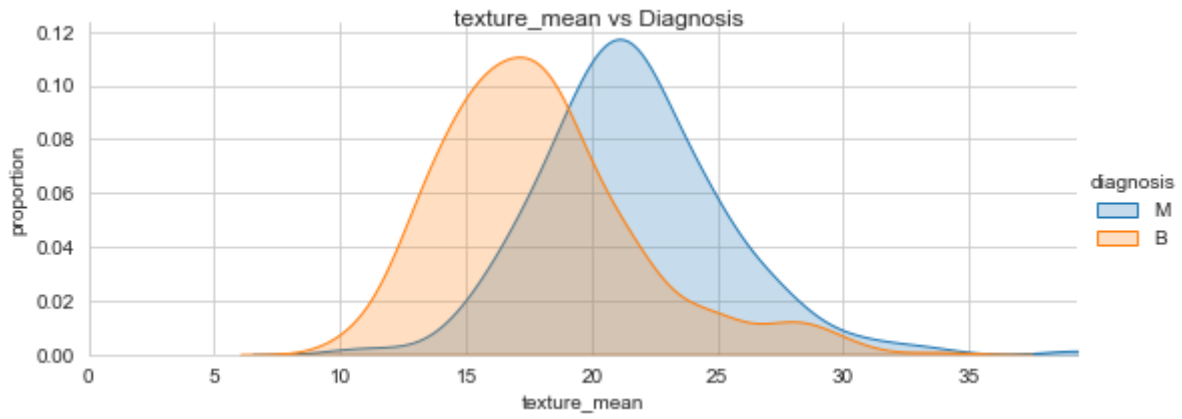
3. 데이터 탐색

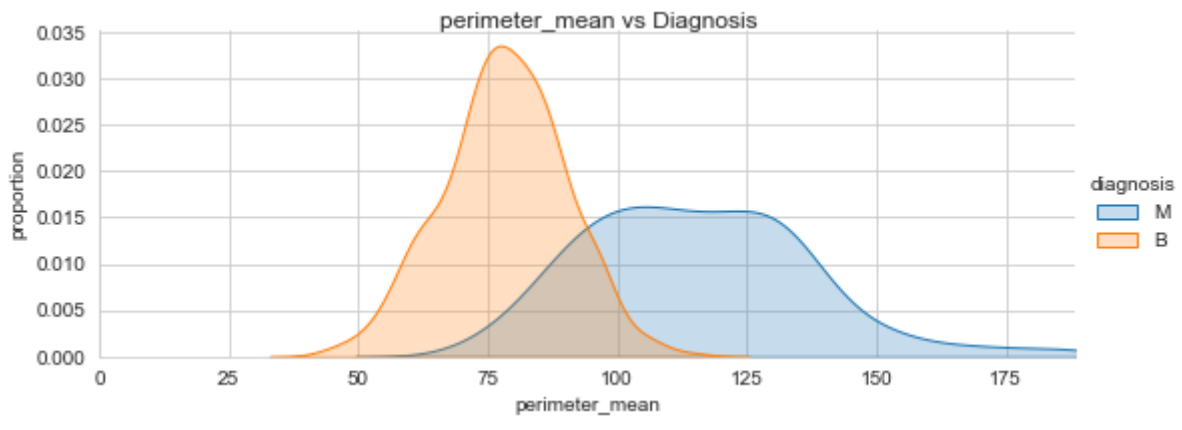
3.1 레이블 별 특징 분포 그래프

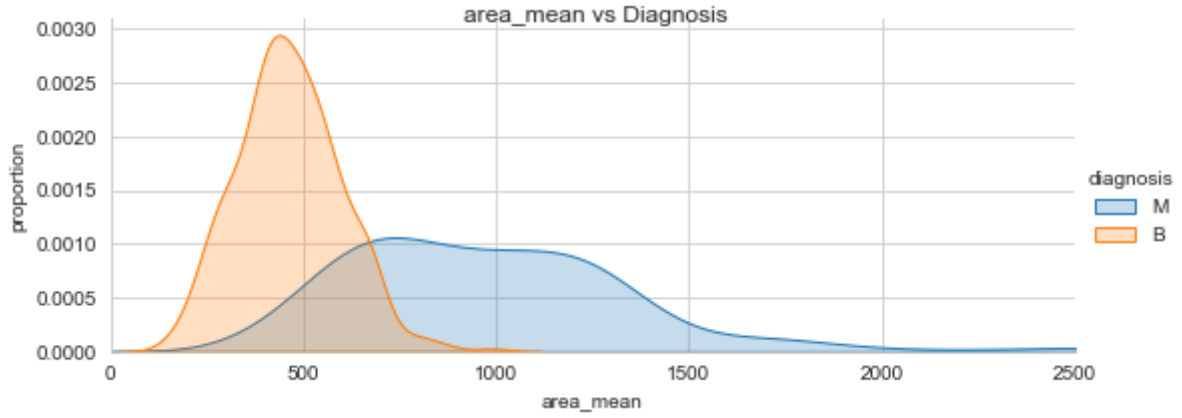
In [8]:
```
def plot_feature_by_label(dataframe, feature_name, label_name, title):
    sns.set_style("whitegrid")
    ax = sns.FacetGrid(dataframe, hue=label_name,aspect=2.5)
    ax.map(sns.kdeplot,feature_name,shade=True)
    ax.set(xlim=(0, dataframe[feature_name].max()))
    ax.add_legend()
    ax.set_axis_labels(feature_name, 'proportion')
    ax.fig.suptitle(title)
    plt.show()
```

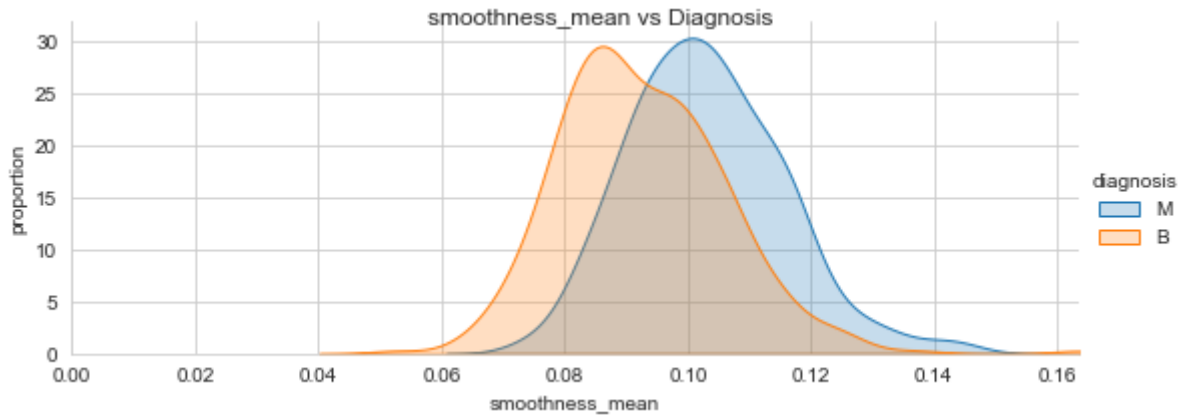
3.2 특징 별 분포

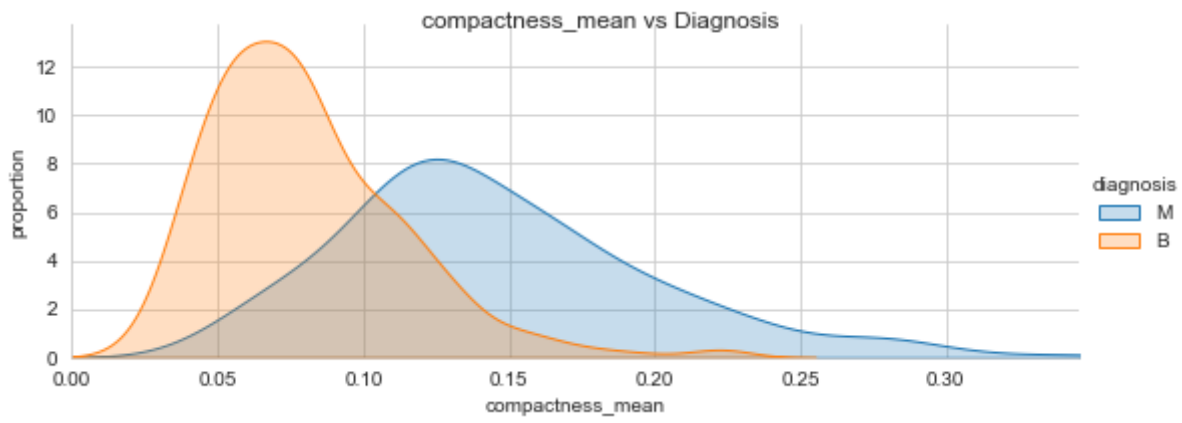
In [9]:
```
for feature_name in X_mean.keys():
    plot_feature_by_label(dataset, feature_name, 'diagnosis', feature_name + ' vs Diagnosis')
```

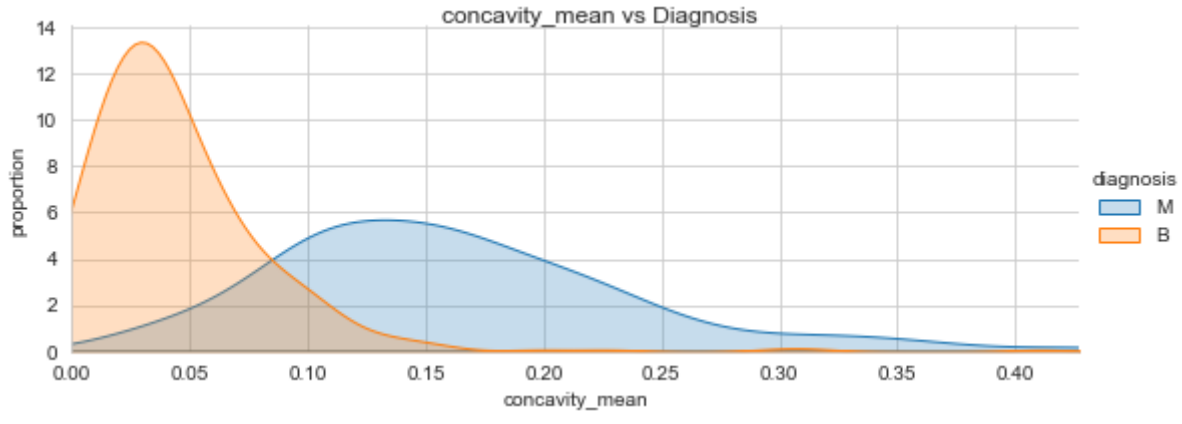


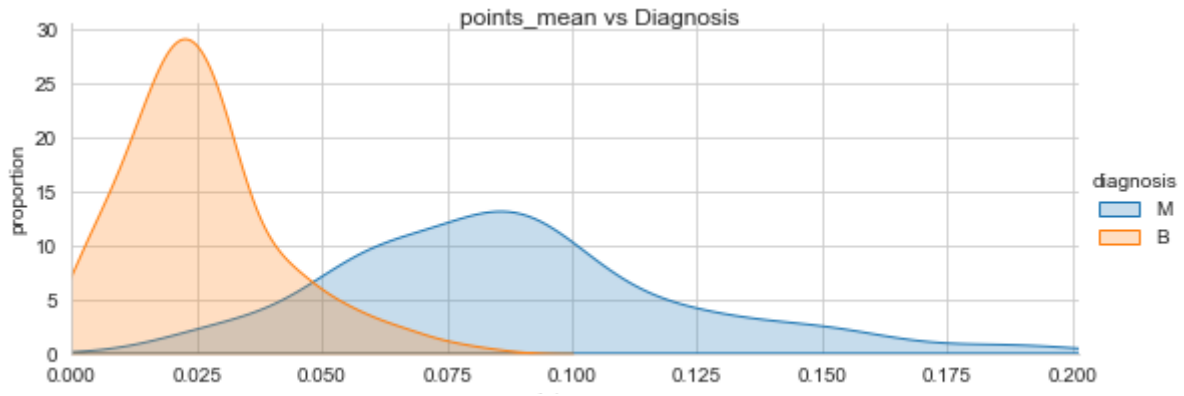


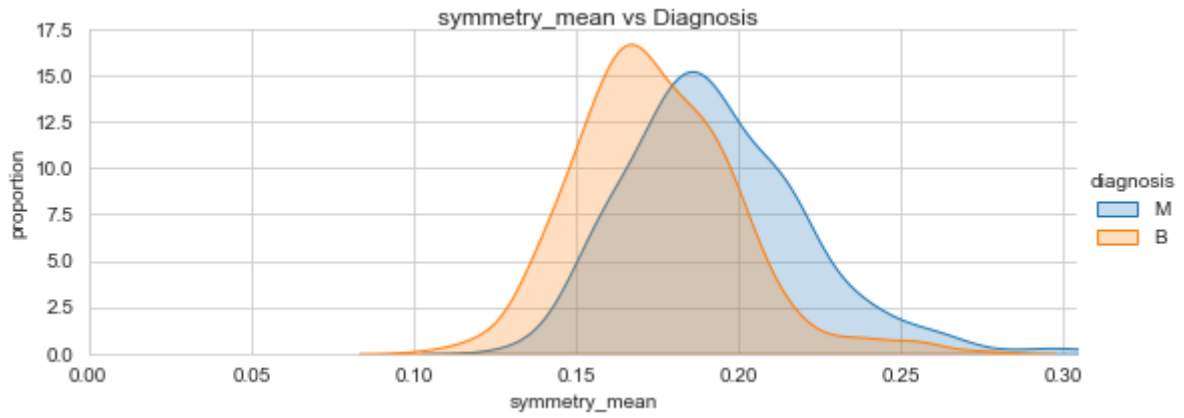


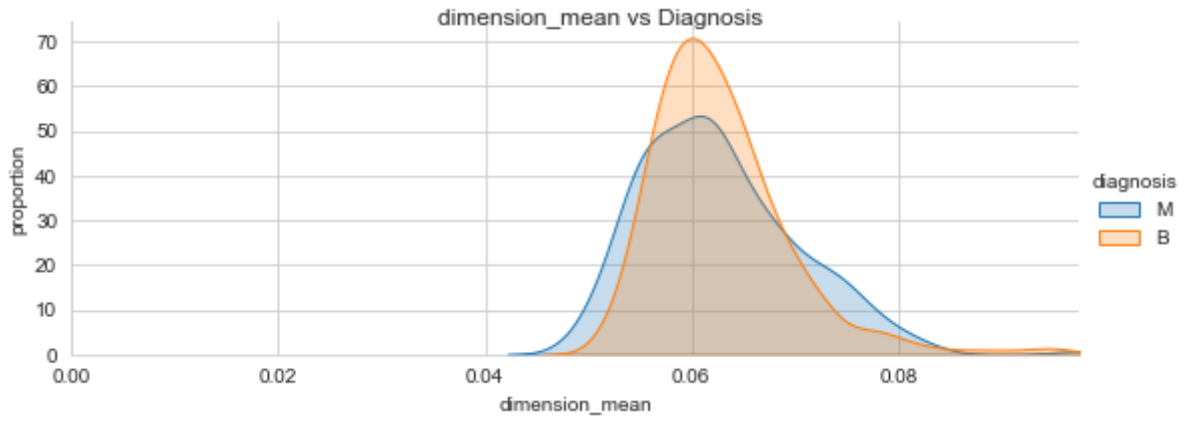


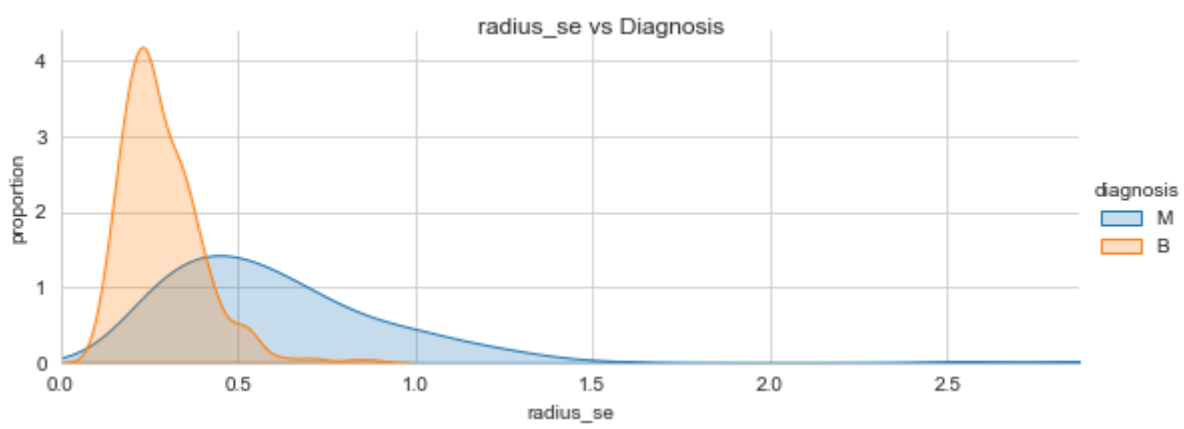












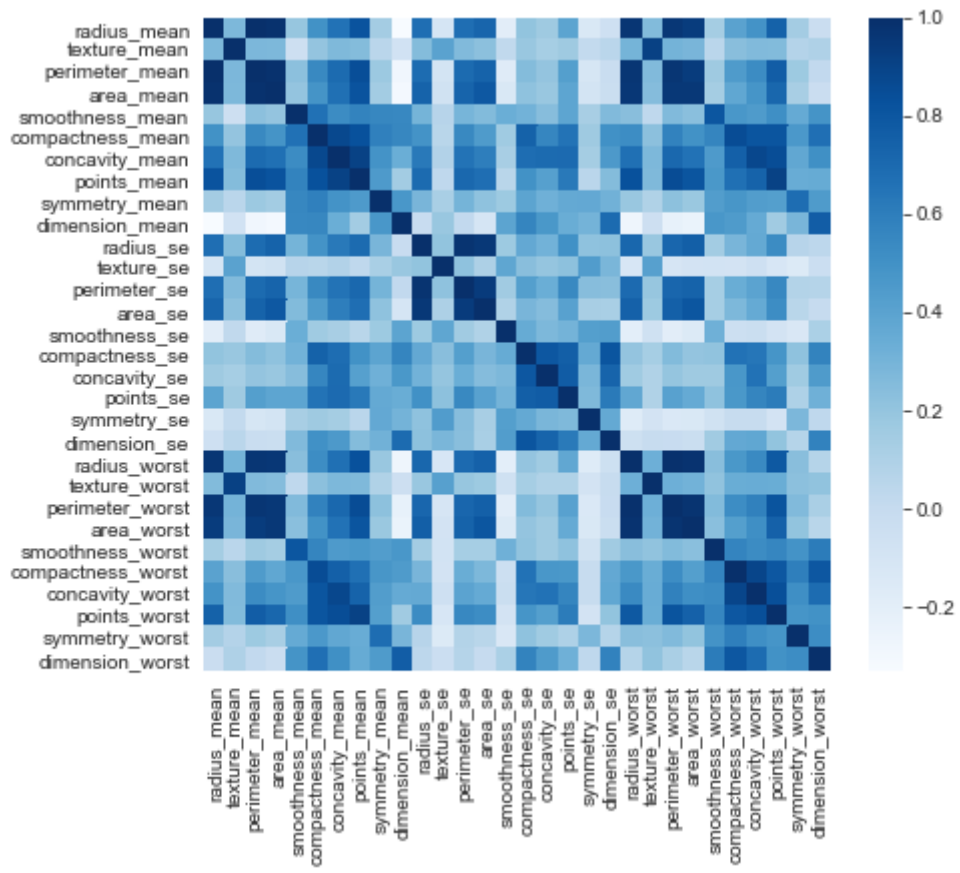
4. 특징 선택 (Feature Selection)

4.1 원래의 특징

4.1.1 히트맵으로 상관관계 확인

In [10]:
```
fig, ax = plt.subplots(figsize=(7, 6))
sns.heatmap(X_train.corr(), annot=False, fmt=".2f", cmap='Blues')
```

Out[10]: <AxesSubplot:>

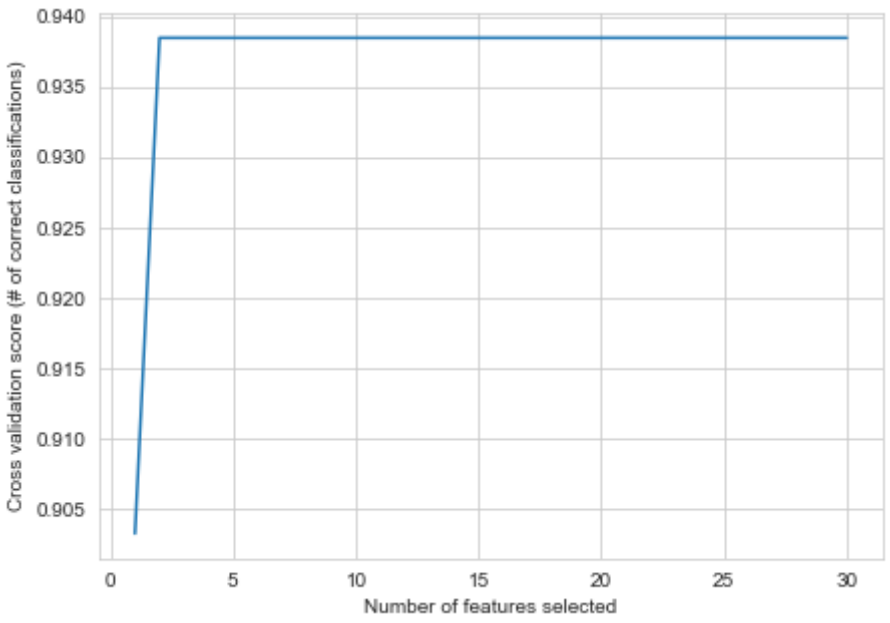


4.2 특징 선택 (Feature Selection)

In [11]:
```
from sklearn.feature_selection import RFECV

min_features_to_select = 1
clf = DecisionTreeClassifier(max_depth=2, min_samples_leaf=12, random_state=12)
rfe = RFECV(estimator=clf,
            step=1,
            cv=5,
            scoring='accuracy',
            min_features_to_select=min_features_to_select
            )
rfe = rfe.fit(X_train, Y_train)
```

In [12]:
```
plt.figure(figsize=(7,5))
plt.xlabel("Number of features selected")
plt.ylabel("Cross validation score (# of correct classifications)")
plt.plot(range(min_features_to_select, len(rfe.grid_scores_)+min_features_to_select), rfe.grid_scores_)
plt.show()
```



In [13]:
```
best_features = X_train.columns.values[rfe.support_]
drop_features = [ column_name for column_name in column_names[1:] if column_name not in best_features ]
print('Optimal number of features :', rfe.n_features_)
print('Best features :', best_features)
print('Drop features :', drop_features)
```

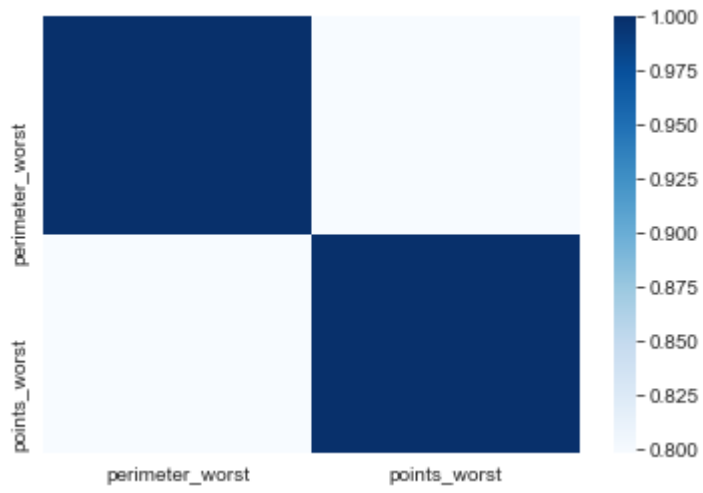
```
Optimal number of features : 2
Best features : ['perimeter_worst' 'points_worst']
Drop features : ['radius_mean', 'texture_mean', 'perimeter_mean', 'area_mean', 'smoothness_mean', 'compactness_mean', 'concavity_mean', 'po
ints_mean', 'symmetry_mean', 'dimension_mean', 'radius_se', 'texture_se', 'perimeter_se', 'area_se', 'smoothness_se', 'compactness_se', 'co
ncavity_se', 'points_se', 'symmetry_se', 'dimension_se', 'radius_worst', 'texture_worst', 'area_worst', 'smoothness_worst', 'compactness_wo
rst', 'concavity_worst', 'symmetry_worst', 'dimension_worst']
```

In [14]:
```
dataset2 = dataset.drop(drop_features, axis=1)
```

4.2.2 히트맵으로 상관성 재확인

In [15]:
```
X2 = dataset2[dataset2.columns[1:-1]]
y2 = dataset2.target
X_train2, X_test2, Y_train2, Y_test2 = train_test_split(X2, y2, test_size=0.2)
sns.heatmap(X_train2.corr(), annot=False, fmt=".2f", cmap='Blues')
```

Out[15]: <AxesSubplot:>



4.3 특징 추출 (Feature Extraction)

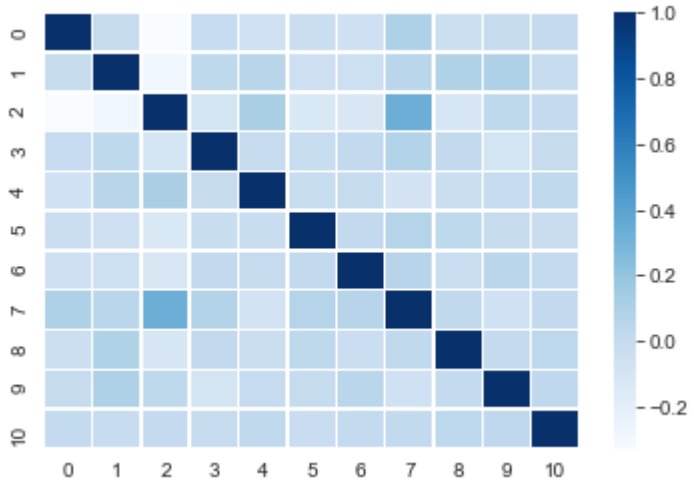
4.3.1 PCA 차원 축소

In [16]:
```
from sklearn.decomposition import PCA
X3,y3 = X,y
variance_pct = 11
pca = PCA(n_components=variance_pct) # Create PCA object
X_transformed = pca.fit_transform(X3,y3) # Transform the initial features
```

4.3.2 히트맵으로 상관성 재확인

In [17]:
```
X3pca = pd.DataFrame(X_transformed) # Create a data frame from the PCA'd data
X_train3, X_test3, Y_train3, Y_test3 = train_test_split(X3pca, y3, test_size=0.2)
sns.heatmap(X_train3.corr(), linewidths=.5, annot=False, fmt=".2f", cmap='Blues')
```

Out[17]: <AxesSubplot:>



5. 모델 훈련 및 성능 비교

5.1 세 모델 훈련

In [18]:
```
clf1 = tree.DecisionTreeClassifier(max_depth=3,min_samples_leaf=12)
clf1.fit(X_train, Y_train)
clf2 = tree.DecisionTreeClassifier(max_depth=3,min_samples_leaf=12)
clf2.fit(X_train2, Y_train2)
clf3 = tree.DecisionTreeClassifier(max_depth=3,min_samples_leaf=12)
clf3.fit(X_train3, Y_train3)
```

Out[18]: DecisionTreeClassifier(max_depth=3, min_samples_leaf=12)

5.2 세 모델의 성능

In [19]:
```
print('Accuracy of Decision Tree classifier on original training set: {:.2f}'.format(clf1.score(X_train, Y_train)))
print('Accuracy of Decision Tree classifier on original test set: {:.2f}'.format(clf1.score(X_test, Y_test)))
print('Accuracy of Decision Tree classifier on reduced training set: {:.2f}'.format(clf2.score(X_train2, Y_train2)))
print('Accuracy of Decision Tree classifier on reduced test set: {:.2f}'.format(clf2.score(X_test2, Y_test2)))
print('Accuracy of Decision Tree classifier on PCA-transformed training set: {:.2f}'.format(clf3.score(X_train3, Y_train3)))
print('Accuracy of Decision Tree classifier on PCA-transformed test set: {:.2f}'.format(clf3.score(X_test3, Y_test3)))
```

```
Accuracy of Decision Tree classifier on original training set: 0.96
Accuracy of Decision Tree classifier on original test set: 0.93
Accuracy of Decision Tree classifier on reduced training set: 0.95
Accuracy of Decision Tree classifier on reduced test set: 0.93
Accuracy of Decision Tree classifier on PCA-transformed training set: 0.95
Accuracy of Decision Tree classifier on PCA-transformed test set: 0.94
```

6. 의사 결정 트리 및 주요 특징 시각화

6.1 세 모델의 특징 이름

In [20]:
```
feature_names1 = X.columns.values
feature_names2 = X2.columns.values
feature_names3 = X3pca.columns.values # [0 1 2 3 4]
```

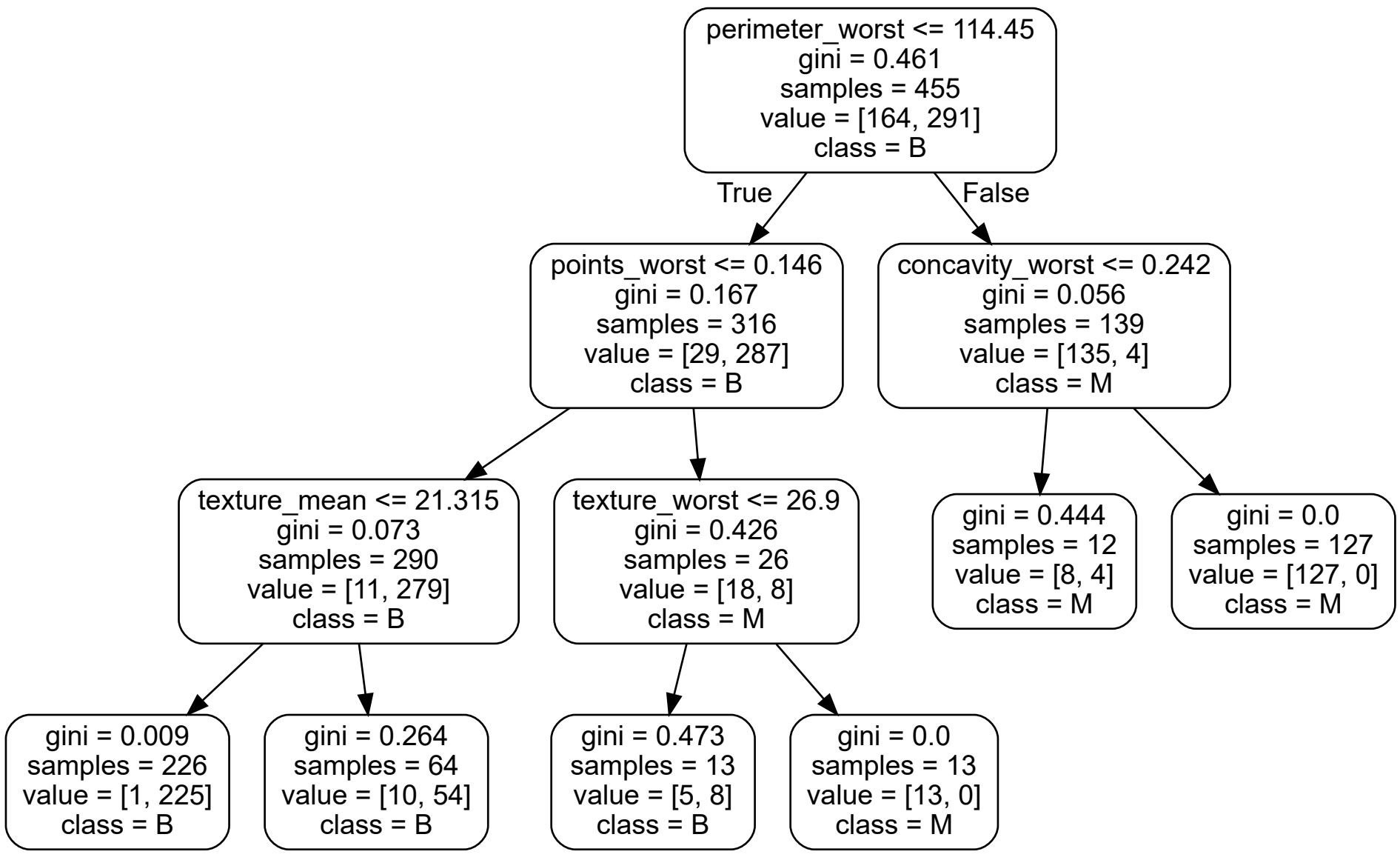
6.2 원래의 특징

6.2.1 의사 결정 트리

In [21]:
```
def plot_decision_tree(tree_clf, feature_names, target_names):
    dot_data = tree.export_graphviz(
                            tree_clf,
                            out_file=None,
                            feature_names=feature_names,
                            class_names=target_names,
                            filled=False,
                            rounded=True,
                            special_characters=False)
    graph = graphviz.Source(dot_data)
    return graph
```

In [22]:
```
plot_decision_tree(clf1,feature_names1, class_names)
```

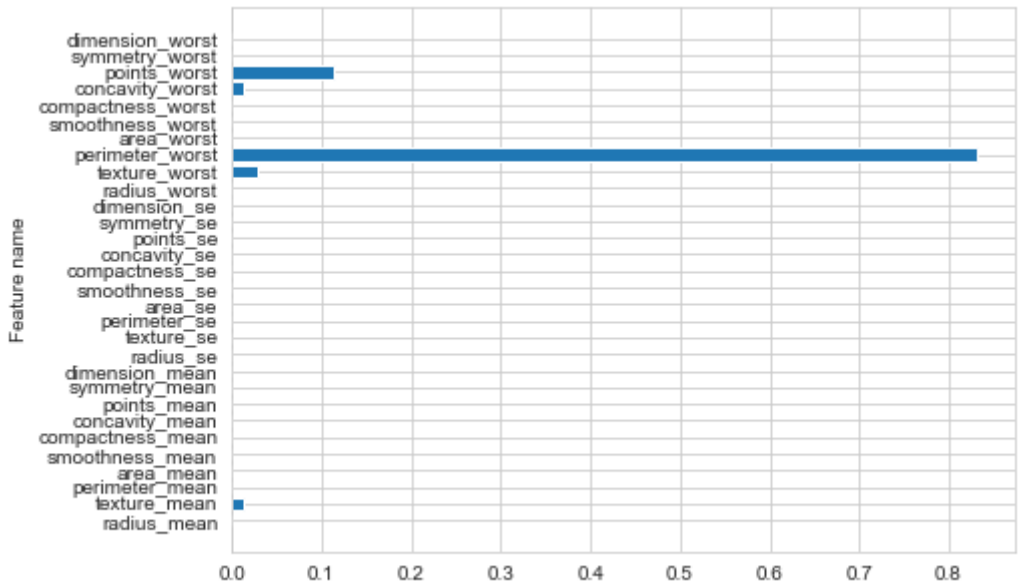
Out[22]:



5.1.2 주요 특징 확인

In [23]:
```
def plot_feature_importances(clf, feature_names):
    c_features = len(feature_names)
    plt.barh(range(c_features), clf.feature_importances_)
    plt.xlabel("Feature importance")
    plt.ylabel("Feature name")
    plt.yticks(np.arange(c_features), feature_names)
    plt.show()
```

In [24]:
```
fig, ax = plt.subplots(figsize=(7, 5))
plot_feature_importances(clf1, feature_names1)
```

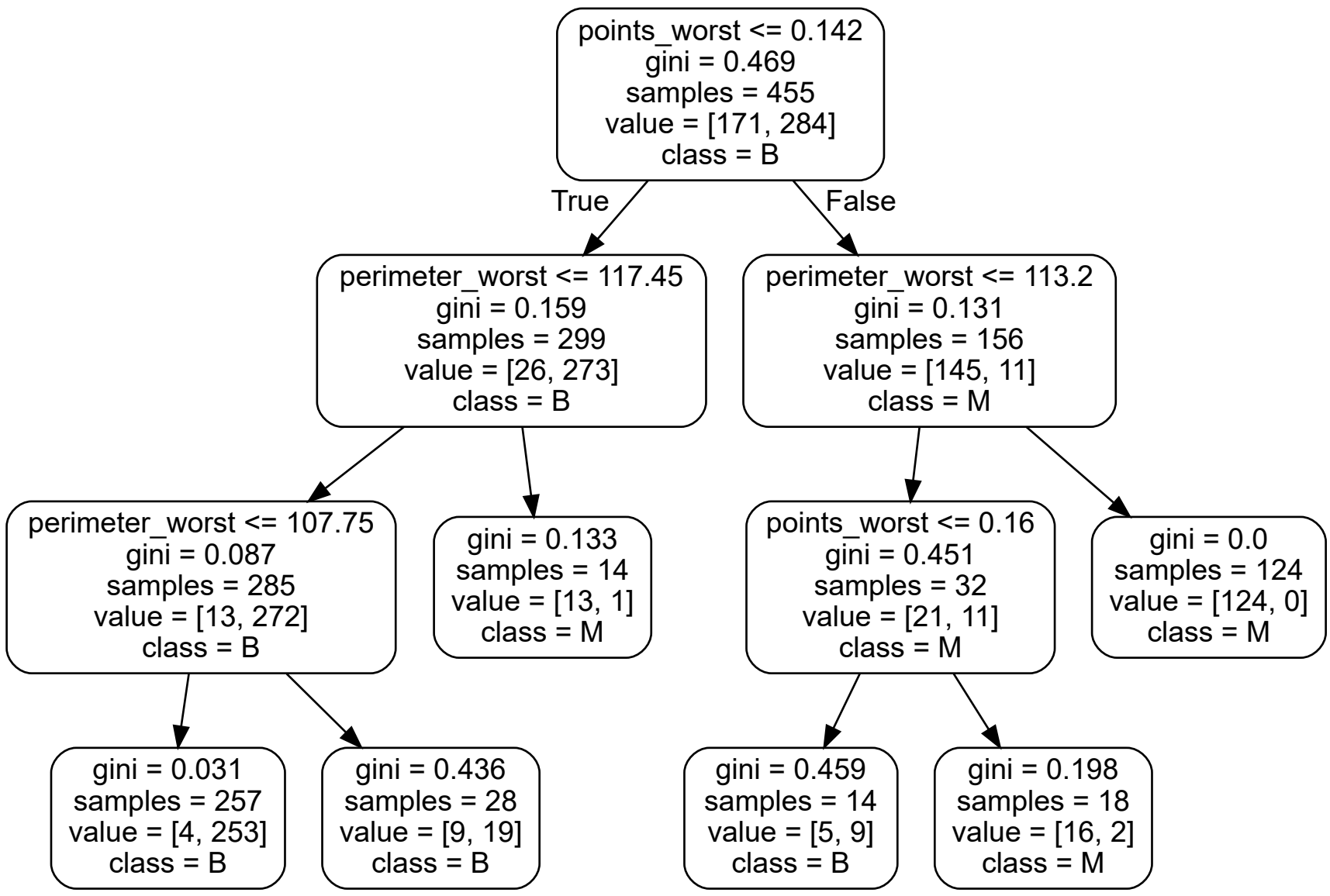


6.3 특징 선택 (Feature Selection)

6.3.1 의사 결정 트리

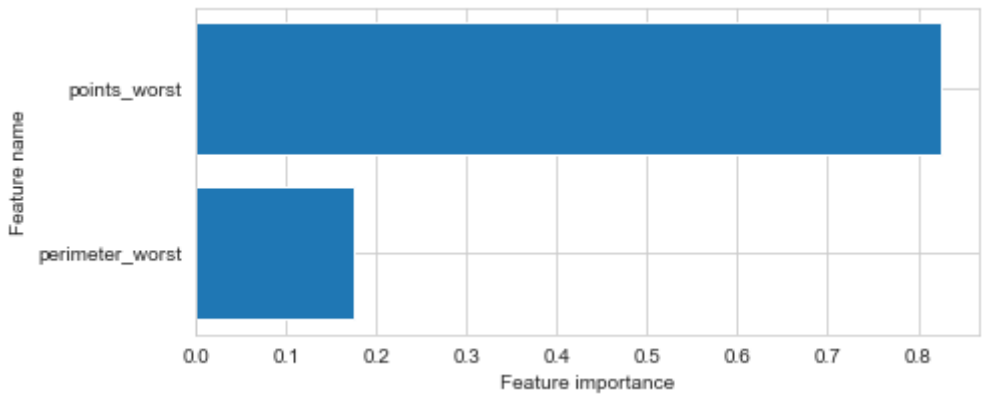
In [25]:
```
plot_decision_tree(clf2,feature_names2, class_names)
```

Out[25]:



6.3.2 주요 특징

In [26]:
```
fig, ax = plt.subplots(figsize=(7, 3))
plot_feature_importances(clf2, feature_names2)
```

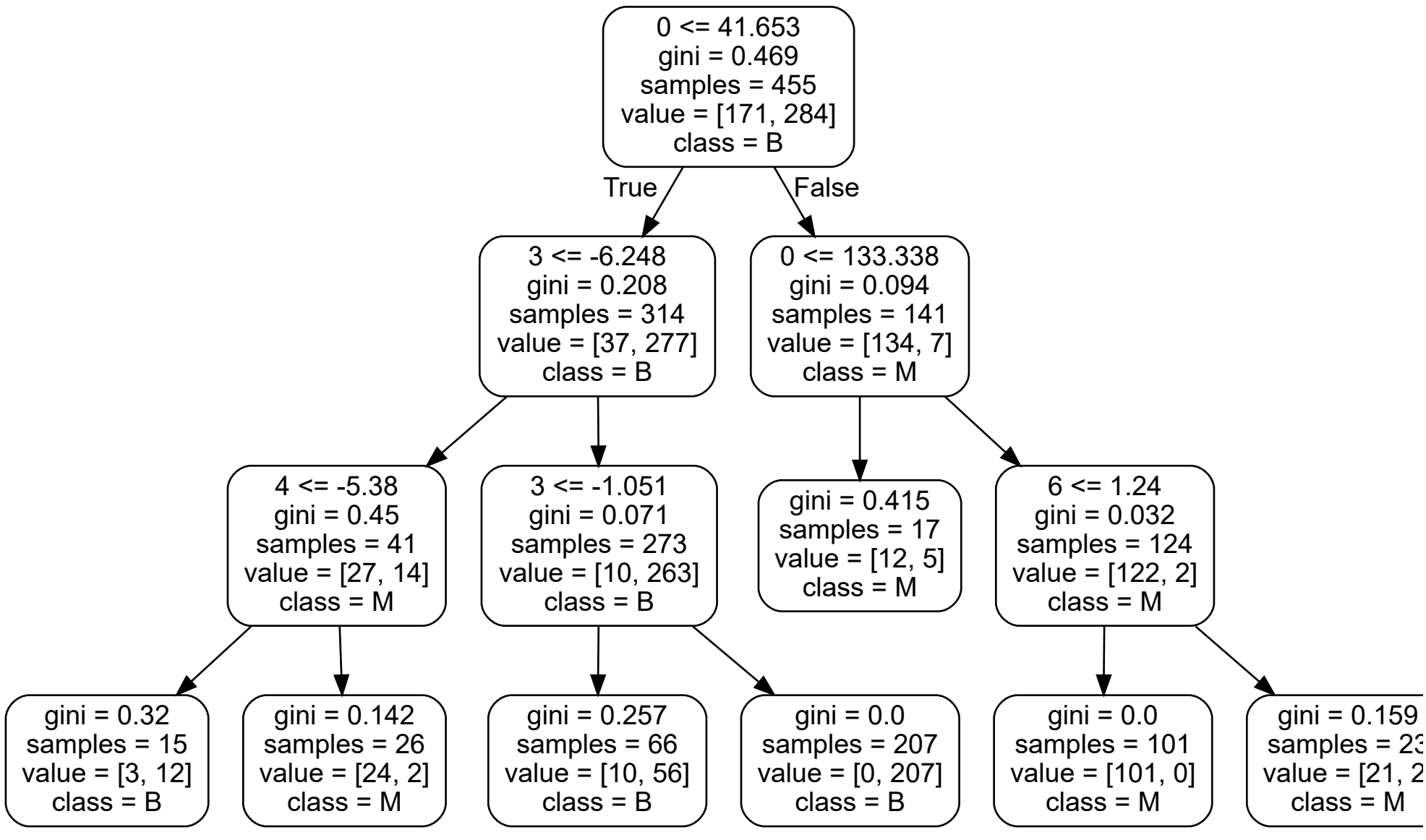


6.4 특징 추출 (Feature Extraction)

6.3.1 의사 결정 트리

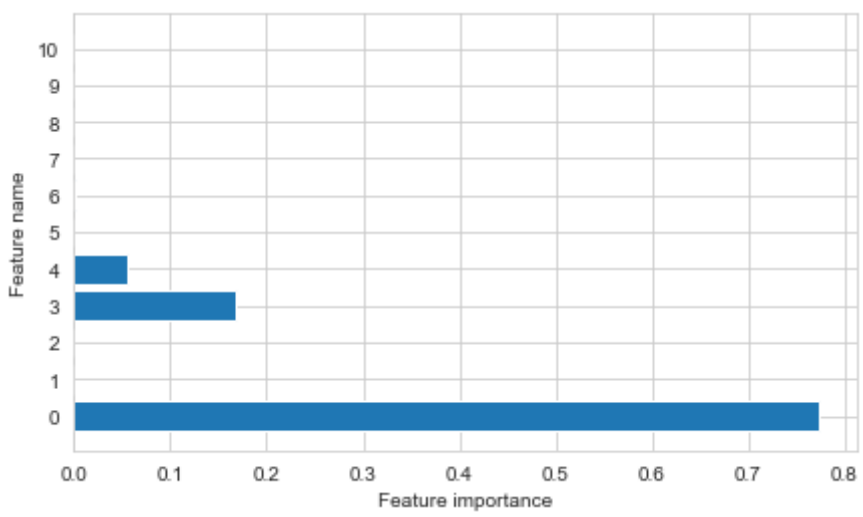
In [27]:
```
plot_decision_tree(clf3,feature_names3, class_names)
```

Out[27]:



6.4.2 주요 특징

In [28]:
```
fig, ax = plt.subplots(figsize=(7, 4))
plot_feature_importances(clf3, feature_names3)
```



7. 랜덤 포레스트

7.1 학습 곡선 그래프

In [29]:
```
def plot_learning_curve(estimator, title, X, y, ylim=None, cv=None,
                        n_jobs=1, train_sizes=np.linspace(.1, 1.0, 5)):
    """
    Plots a learning curve. http://scikit-learn.org/stable/modules/learning_curve.html
    """
    plt.figure()
    plt.title(title)
    if ylim is not None:
        plt.ylim(*ylim)
    plt.xlabel("Training examples")
    plt.ylabel("Score")
    train_sizes, train_scores, test_scores = learning_curve(
        estimator, X, y, cv=cv, n_jobs=n_jobs, train_sizes=train_sizes)
    train_scores_mean = np.mean(train_scores, axis=1)
    train_scores_std = np.std(train_scores, axis=1)
    test_scores_mean = np.mean(test_scores, axis=1)
    test_scores_std = np.std(test_scores, axis=1)
    plt.grid()
    plt.fill_between(train_sizes, train_scores_mean - train_scores_std,
                     train_scores_mean + train_scores_std, alpha=0.1,
                     color="r")
    plt.fill_between(train_sizes, test_scores_mean - test_scores_std,
                     test_scores_mean + test_scores_std, alpha=0.1, color="g")
    plt.plot(train_sizes, train_scores_mean, 'o-', color="r",
             label="Training score")
    plt.plot(train_sizes, test_scores_mean, 'o-', color="g",
             label="Cross-validation score")
    plt.legend(loc="best")
    return plt
```

7.2 혼동 행렬 그래프

In [30]:
```
def plot_confusion_matrix(cm, classes,
                          normalize=False,
                          title='Confusion matrix',
                          cmap=plt.cm.Blues):
    """
    http://scikit-learn.org/stable/auto_examples/model_selection/plot_confusion_matrix.html
    """
    plt.imshow(cm, interpolation='nearest', cmap=cmap)
    plt.title(title)
    plt.colorbar()
    tick_marks = np.arange(len(classes))
    plt.xticks(tick_marks, classes, rotation=45)
    plt.yticks(tick_marks, classes)
    fmt = '.2f' if normalize else 'd'
    thresh = cm.max() / 2.
    for i, j in itertools.product(range(cm.shape[0]), range(cm.shape[1])):
        plt.text(j, i, format(cm[i, j], fmt),
                 horizontalalignment="center",
                 color="white" if cm[i, j] > thresh else "black")
    plt.tight_layout()
    plt.ylabel('True label')
    plt.xlabel('Predicted label')
```

In [31]:
```
dict_characters = {0: 'M', 1: 'B'}
```

7.3. 모델 훈련

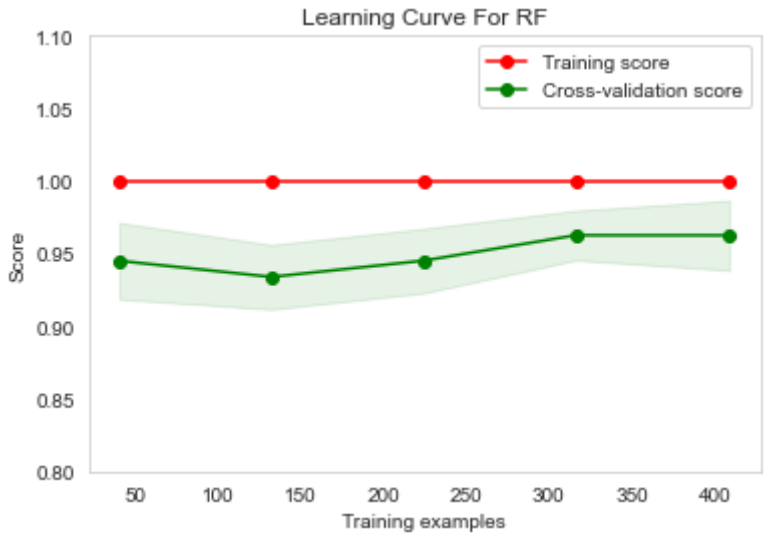
In [32]:
```
(X1, y1) = (X, y)
X_train1,X_test1,Y_train1,Y_test1=train_test_split(X1,y1,random_state=0)
clf = RandomForestClassifier(max_features=4,random_state=0)
clf.fit(X_train1,Y_train1)
print('Accuracy of Random Forest Classifier on training data: {:.2f}'.format(clf.score(X_train1,Y_train1)))
print('Accuracy of Random Forest Classifier on testing data: {:.2f}'.format(clf.score(X_test1,Y_test1)))
```

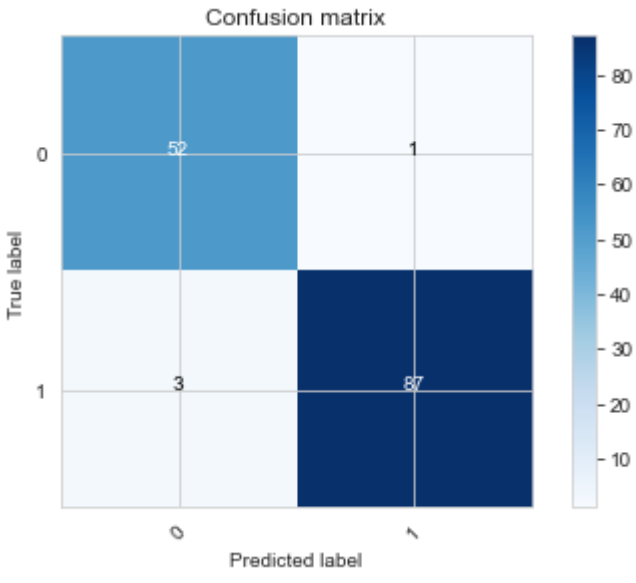
```
Accuracy of Random Forest Classifier on training data: 1.00
Accuracy of Random Forest Classifier on testing data: 0.97
```

7.4. 모델 평가 (정확도 97%)

In [33]:
```
model = clf
prediction = model.predict(X_test1)
cnf_matrix = confusion_matrix(Y_test1, prediction)
```

In [34]:
```
plot_learning_curve(model, 'Learning Curve For RF', X_train, Y_train, (0.80,1.1), 10)
plt.show()
plot_confusion_matrix(cnf_matrix, classes=dict_characters, title='Confusion matrix')
plt.show()
```





/