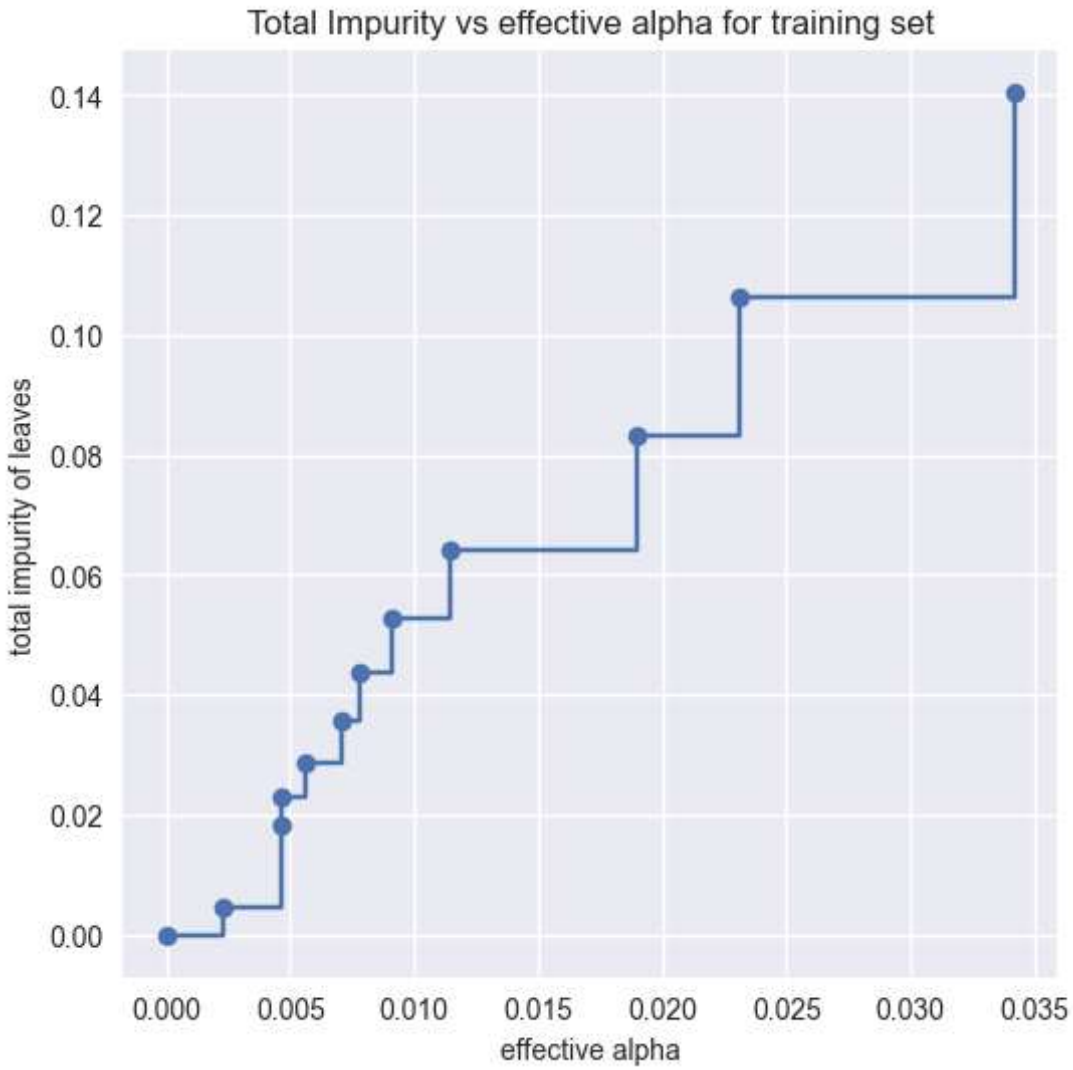
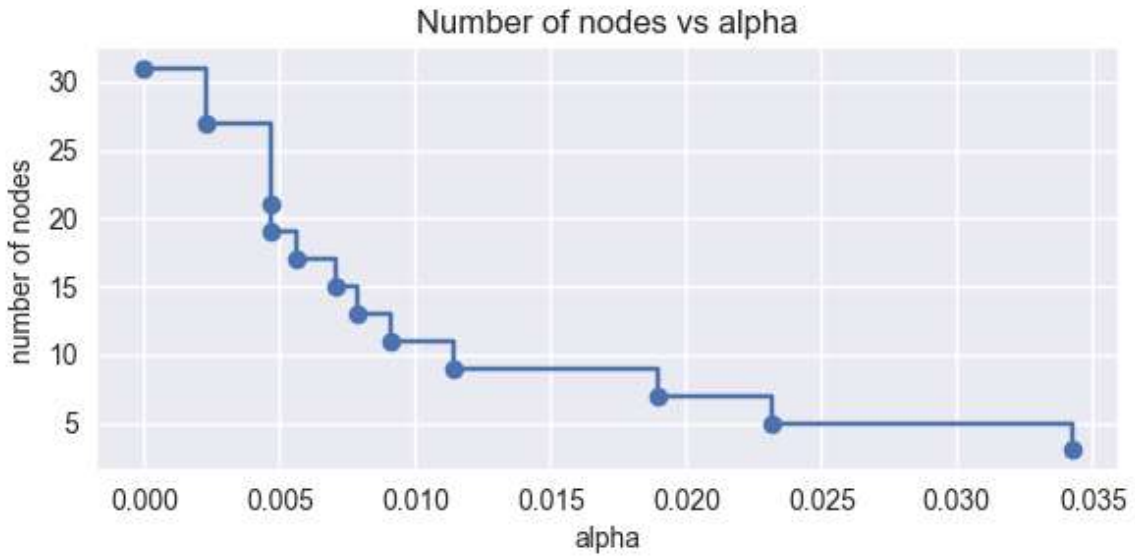
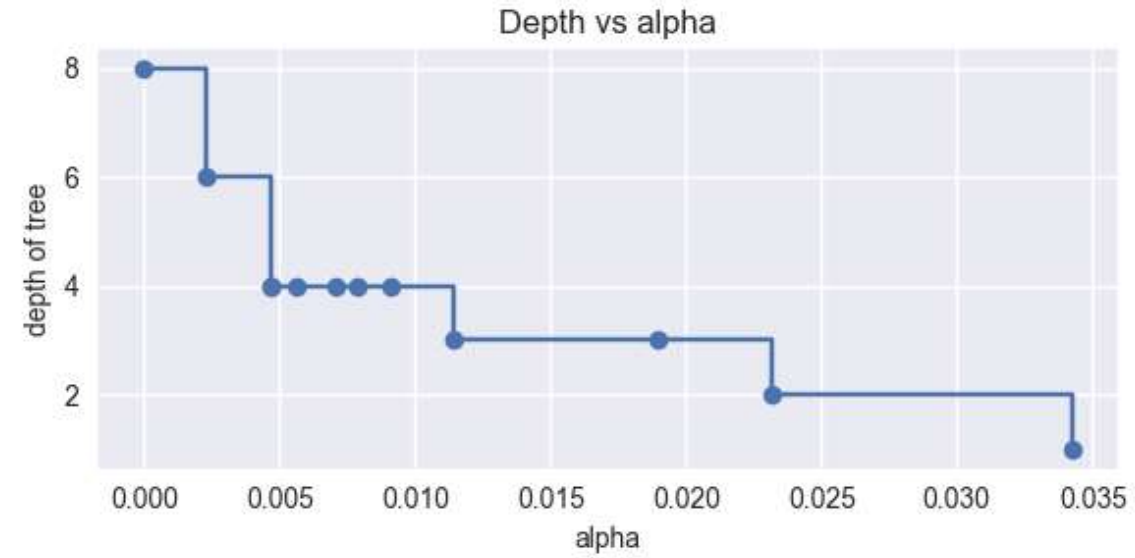
In [2]:
```
# 导入操作系统库
import os
# 更改工作目录
os.chdir(r"D:\softwares\applied statistics\pythoncodelearning\chap5\sourcecode")
# 导入绘图库
import matplotlib.pyplot as plt
# 导入数据集划分工具
from sklearn.model_selection import train_test_split
# 导入数据集工具
from sklearn.datasets import load_breast_cancer
# 导入分类树
from sklearn.tree import DecisionTreeClassifier
# 导入绘图库中的字体管理包
from matplotlib import font_manager
# 实现中文字符正常显示
font = font_manager.FontProperties(fname=r"C:\Windows\Fonts\SimKai.ttf")
# 使用seaborn风格绘图
plt.style.use("seaborn-v0_8")
# 获取数据
X, y = load_breast_cancer(return_X_y=True)
# 数据集划分
X_train, X_test, y_train, y_test = train_test_split(
    X, y, random_state=0
)
# 构建决策树
clf = DecisionTreeClassifier(random_state=0)
# 代价复杂度路径
path = clf.cost_complexity_pruning_path(X_train, y_train)
# cp
ccp_alphas, impurities = path.ccp_alphas, path.impurities
# 绘图
fig, ax = plt.subplots(figsize=(6,6))
ax.plot(ccp_alphas[:-1], impurities[:-1], marker="o", drawstyle="steps-post")
ax.set_xlabel("effective alpha")
ax.set_ylabel("total impurity of leaves")
ax.set_title("Total Impurity vs effective alpha for training set")
plt.show()
fig.savefig("../codeimage/code4.pdf")
# 不同的alpha下构建决策树
clfs = []
for ccp_alpha in ccp_alphas:
    # 构建模型
    clf = DecisionTreeClassifier(
        random_state=0, ccp_alpha=ccp_alpha
    )
    # 模拟拟合
    clf.fit(X_train, y_train)
    # 加入到列表中
    clfs.append(clf)
print(
    "Number of nodes in the last tree is: {} with ccp_alpha: {}".format(
        clfs[-1].tree_.node_count, ccp_alphas[-1]
    )
)
# 去掉最后一个
clfs = clfs[:-1]
ccp_alphas = ccp_alphas[:-1]
# 节点数量
```

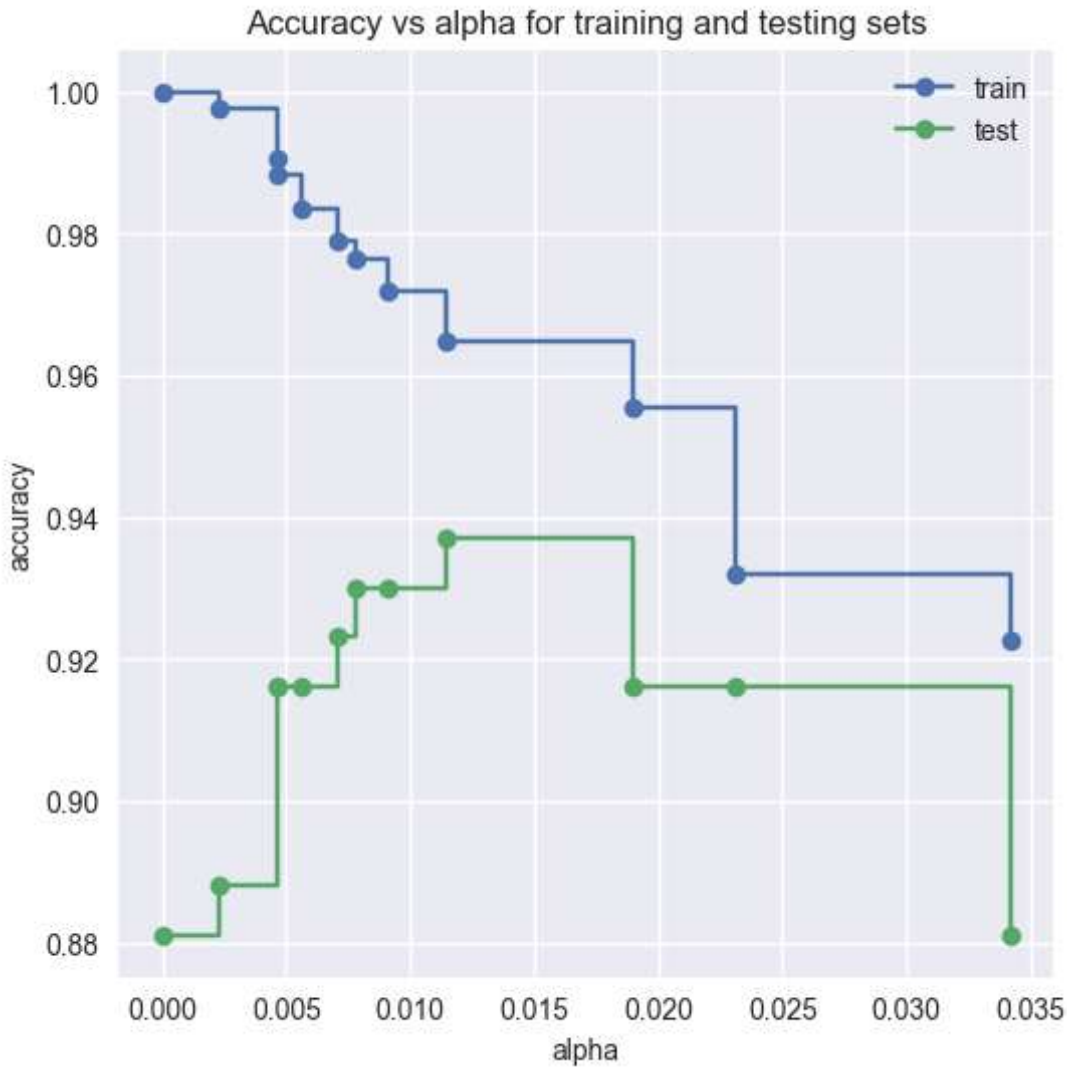
```
node_counts = [clf.tree_.node_count for clf in clfs]
# 深度
depth = [clf.tree_.max_depth for clf in clfs]
fig, ax = plt.subplots(2, 1, figsize=(6,6), tight_layout=True)
ax[0].plot(ccp_alphas, node_counts, marker="o", drawstyle="steps-post")
ax[0].set_xlabel("alpha")
ax[0].set_ylabel("number of nodes")
ax[0].set_title("Number of nodes vs alpha")
ax[1].plot(ccp_alphas, depth, marker="o", drawstyle="steps-post")
ax[1].set_xlabel("alpha")
ax[1].set_ylabel("depth of tree")
ax[1].set_title("Depth vs alpha")
plt.show()
fig.savefig("../codeimage/code5.pdf")
# 预测精度和alpha的关系
# 训练集的准确率
train_scores = [clf.score(X_train, y_train) for clf in clfs]
# 测试集的准确率
test_scores = [clf.score(X_test, y_test) for clf in clfs]
fig, ax = plt.subplots(figsize=(6,6))
ax.set_xlabel("alpha")
ax.set_ylabel("accuracy")
ax.set_title("Accuracy vs alpha for training and testing sets")
ax.plot(ccp_alphas, train_scores, marker="o", label="train", drawstyle="steps-pc
ax.plot(ccp_alphas, test_scores, marker="o", label="test", drawstyle="steps-post
ax.legend()
plt.show()
fig.savefig("../codeimage/code6.pdf")
```




```
Number of nodes in the last tree is: 1 with ccp_alpha: 0.3272984419327777
```


Number of nodes vs alpha
number of nodes
alpha
30
25
20
15
10
5
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035


Depth vs alpha
depth of tree
alpha
8
6
4
2
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035


Accuracy vs alpha for training and testing sets
train
test
accuracy
1.00
0.98
0.96
0.94
0.92
0.90
0.88
0.000
0.005
0.010
0.015
0.020
0.025
0.030
0.035
alpha