In [87]:

```
# Basic Libraries
import numpy as np
import pandas as pd
import seaborn as sb
import matplotlib.pyplot as plt # we only need pyplot
sb.set() # set the default Seaborn style for graphics
```

In [88]:

```
houseData = pd.read_csv('train.csv')
```

# Problem 1

## a)

In [89]:

```
ca = pd.DataFrame(houseData['CentralAir'])
```

In [90]:

```
ca.describe()
```

Out[90]:

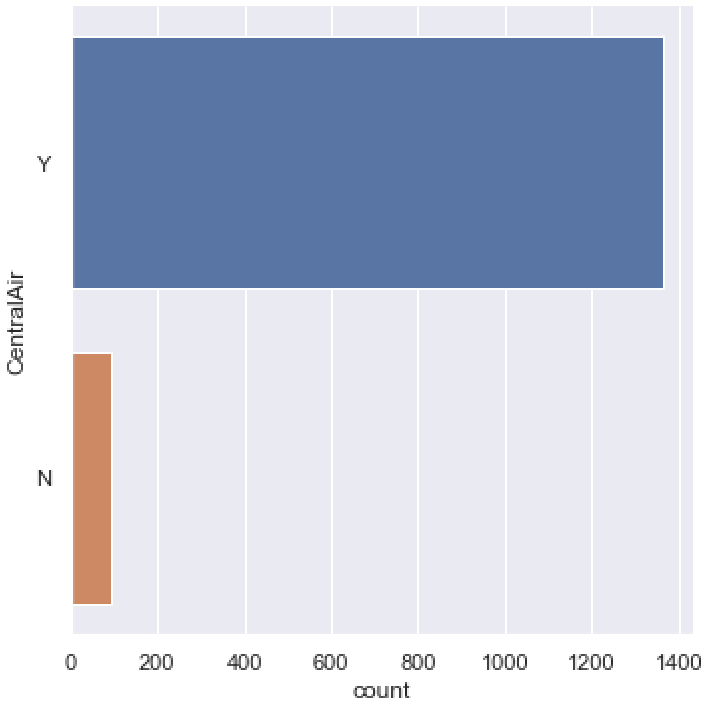
```
        CentralAir
 count        1460
unique           2
   top           Y
  freq        1365
```

In [91]:

```
sb.catplot(y = "CentralAir", data = ca, kind = "count")
```

Out[91]:

```
<seaborn.axisgrid.FacetGrid at 0x7f8901e6aa90>
```



In [92]:

```
houseData["CentralAir"].value_counts()
```

Out[92]:

```
Y    1365
N      95
Name: CentralAir, dtype: int64
```

In [93]:

```
print("Y:N="+str(1365/95))
```

```
Y:N=14.368421052631579
```

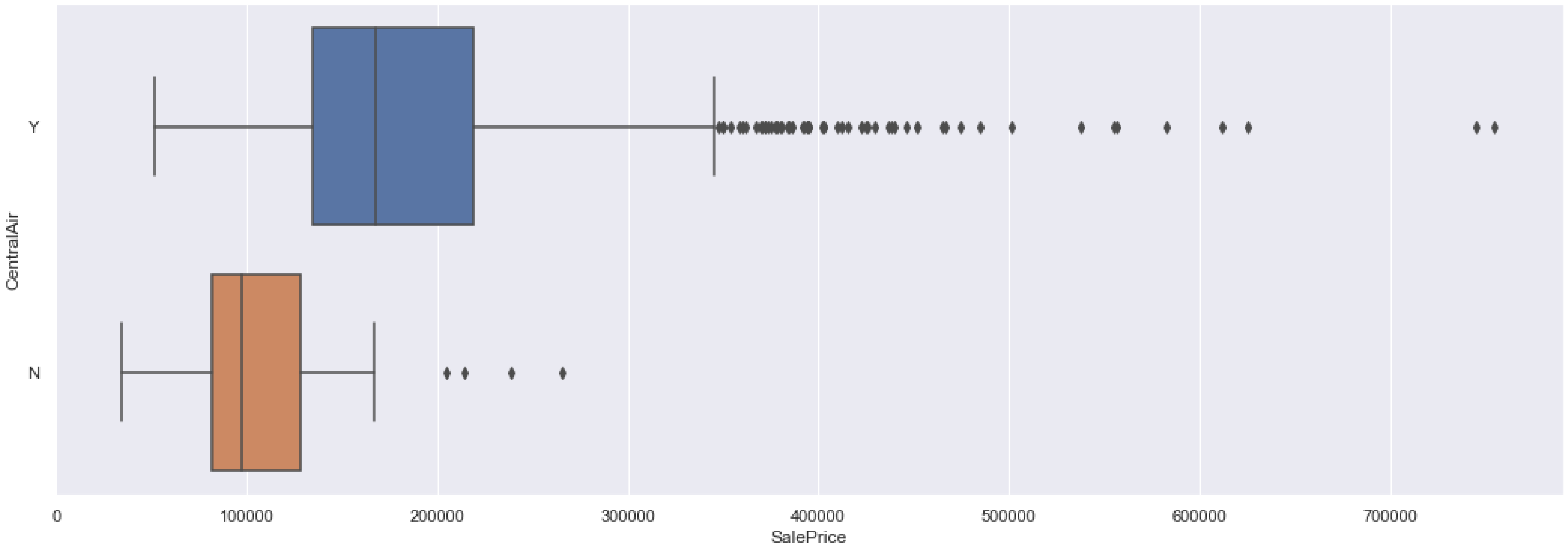
## b)

In [94]:

```
f = plt.figure(figsize=(18, 6))
sb.boxplot(x = "SalePrice", y = "CentralAir", data = houseData, orient = "h")
```

Out[94]:

```
<AxesSubplot:xlabel='SalePrice', ylabel='CentralAir'>
```

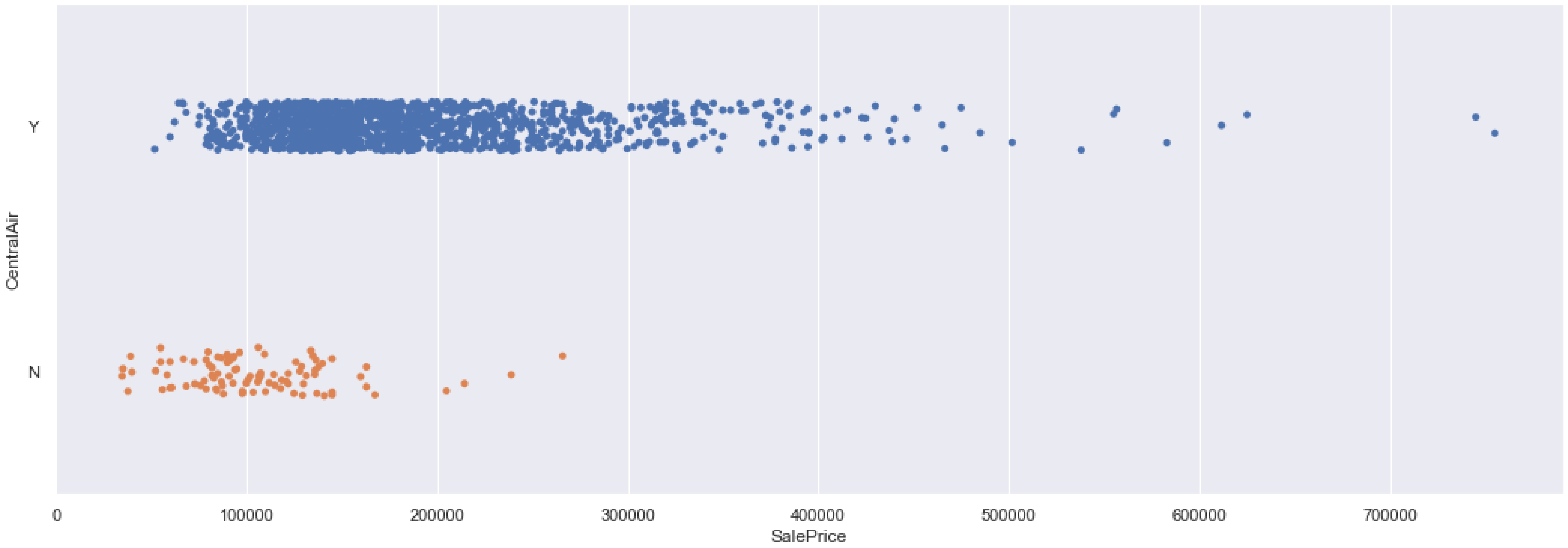


In [95]:

```
f = plt.figure(figsize=(18, 6))
sb.stripplot(x = "SalePrice", y = "CentralAir", data = houseData, orient = "h")
```

Out[95]:

```
<AxesSubplot:xlabel='SalePrice', ylabel='CentralAir'>
```

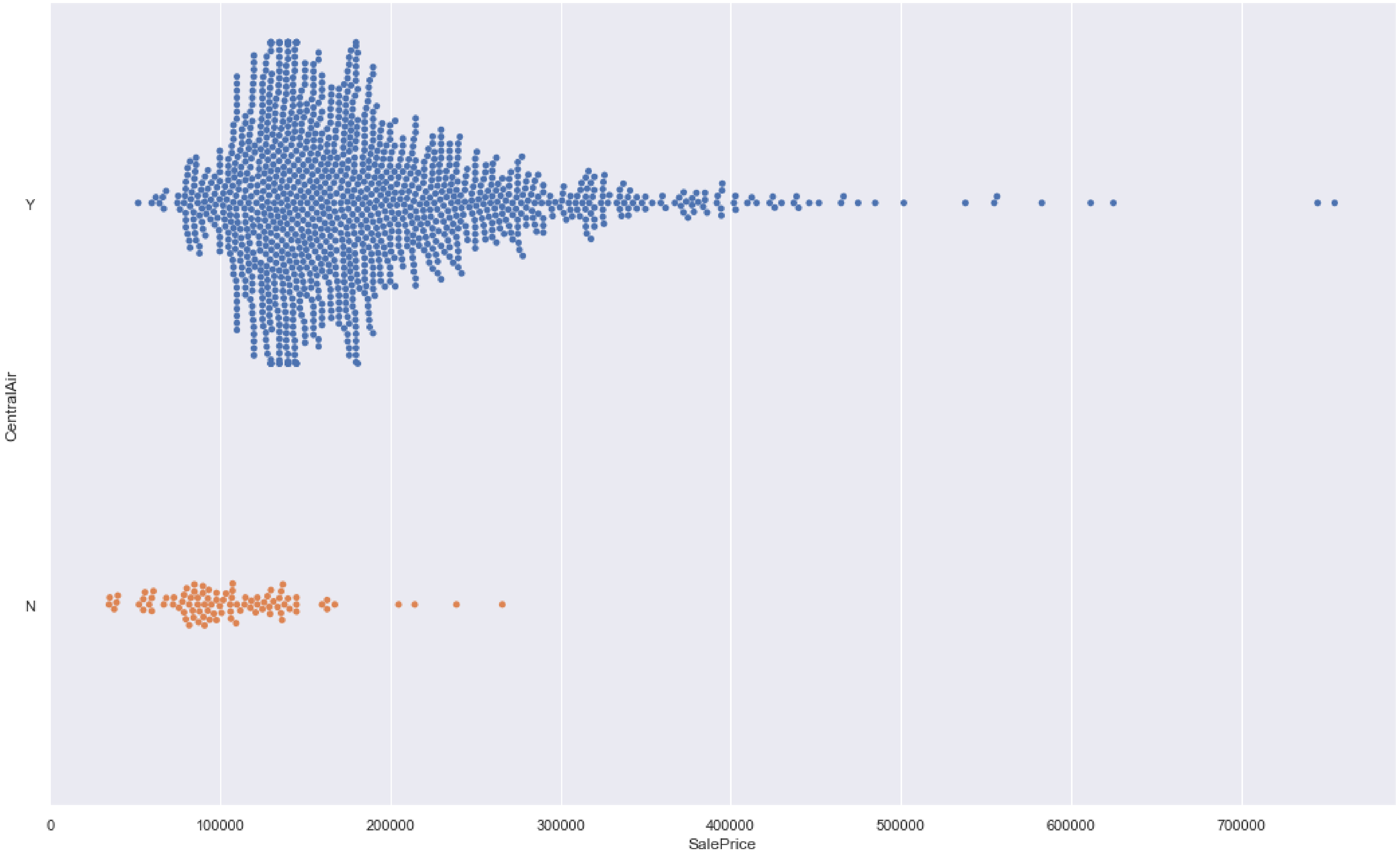


In [96]:

```
f = plt.figure(figsize=(18, 11))
sb.swarmplot(x = "SalePrice", y = "CentralAir", data = houseData, orient = "h")
```

Out[96]:

```
<AxesSubplot:xlabel='SalePrice', ylabel='CentralAir'>
```



c)

In [97]:

```
# Import Decision Tree Classifier model from Scikit-Learn
from sklearn.tree import DecisionTreeClassifier
```

```
# Create a Decision Tree Classifier object
dectree = DecisionTreeClassifier(max_depth = 2)
```

## d)

In [98]:

```
sp = pd.DataFrame(houseData['SalePrice'])

# Train Set : 1100 samples
sp_train = pd.DataFrame(sp[:1100])
ca_train = pd.DataFrame(ca[:1100])

# Test Set : 360 samples
sp_test = pd.DataFrame(sp[-360:])
ca_test = pd.DataFrame(ca[-360:])

# Check the sample sizes
print("Train Set :", ca_train.shape, sp_train.shape)
print("Test Set  :", ca_test.shape, sp_test.shape)
```

```
Train Set : (1100, 1) (1100, 1)
Test Set  : (360, 1) (360, 1)
```

## e)

In [99]:

```
dectree.fit(sp_train, ca_train)
```

Out[99]:

```
DecisionTreeClassifier(max_depth=2)
```

## f)

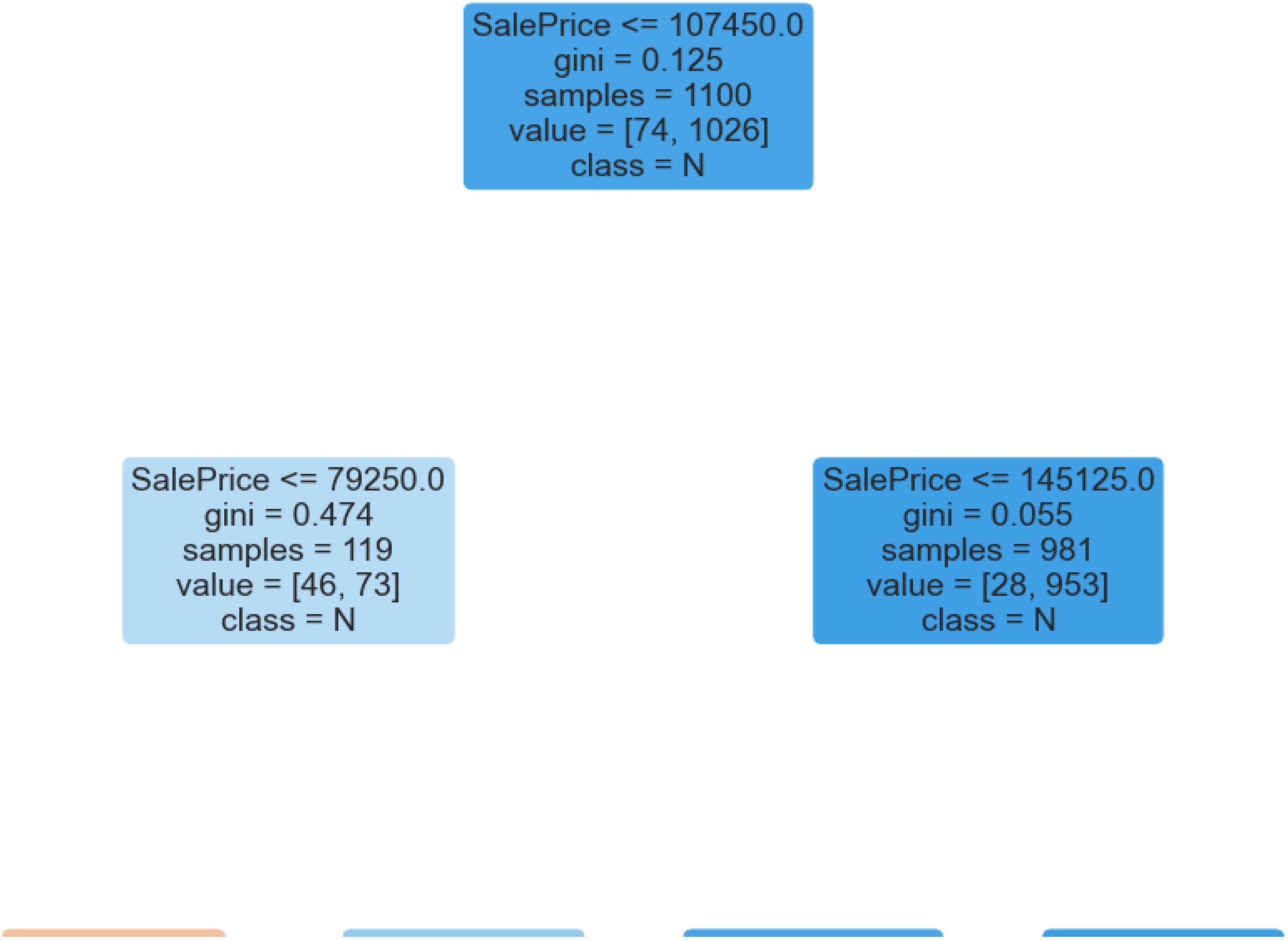
In [100…

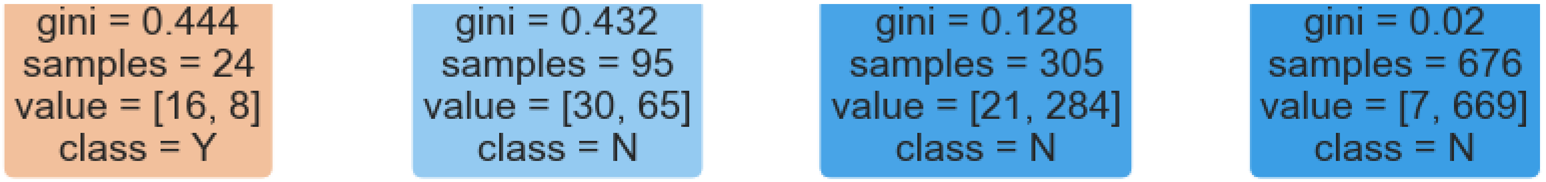
```
from sklearn.tree import plot_tree

f = plt.figure(figsize=(15,15))
plot_tree(dectree, filled=True, rounded=True,
          feature_names=["SalePrice"],
          class_names=["Y","N"])
```

Out[100…

```
[Text(418.5, 679.5, 'SalePrice <= 107450.0\ngini = 0.125\nsamples = 1100\nvalue = [74, 1026]\nclass = N'),
 Text(209.25, 407.69999999999993, 'SalePrice <= 79250.0\ngini = 0.474\nsamples = 119\nvalue = [46, 73]\nclass = N'),
Text(104.625, 135.89999999999998, 'gini = 0.444\nsamples = 24\nvalue = [16, 8]\nclass = Y'),
Text(313.875, 135.89999999999998, 'gini = 0.432\nsamples = 95\nvalue = [30, 65]\nclass = N'),
Text(627.75, 407.69999999999993, 'SalePrice <= 145125.0\ngini = 0.055\nsamples = 981\nvalue = [28, 953]\nclass = N'),
Text(523.125, 135.89999999999998, 'gini = 0.128\nsamples = 305\nvalue = [21, 284]\nclass = N'),
Text(732.375, 135.89999999999998, 'gini = 0.02\nsamples = 676\nvalue = [7, 669]\nclass = N')]
```





## g)

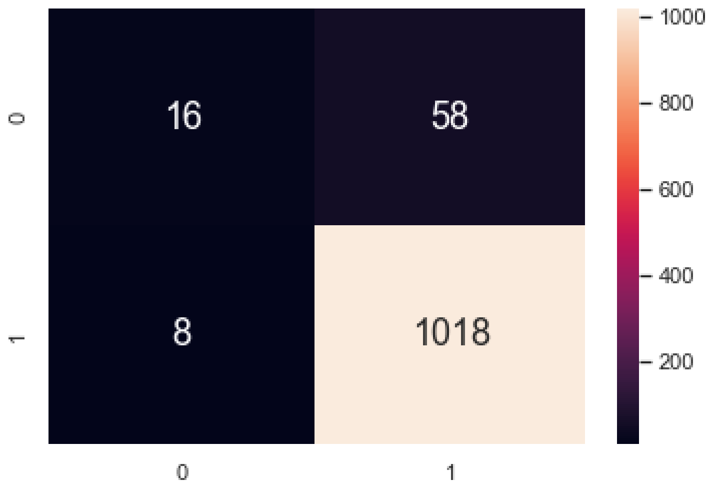
In [101…

```
# Predict CentralAir corresponding to SalePrice (Train Data)
ca_train_pred = dectree.predict(sp_train)

# Plot the two-way Confusion Matrix
from sklearn.metrics import confusion_matrix
sb.heatmap(confusion_matrix(ca_train, ca_train_pred),
           annot = True, fmt=".0f", annot_kws={"size": 18})
```

Out[101…

```
<AxesSubplot:>
```



## h)

In [102…

```
# Print the Classification Accuracy
print("Classification Accuracy \t:", dectree.score(sp_train, ca_train))
```

```
Classification Accuracy 	: 0.94
```

Based on the two-way Confusion Matrix

True Positive Rate: 16

True Negative Rate: 1018

False Positive Rate: 58

False Negative Rate: 8

Classification Accuracy = (TP+TN)/1100

= (1018+16)/1100

= 0.94

### i)

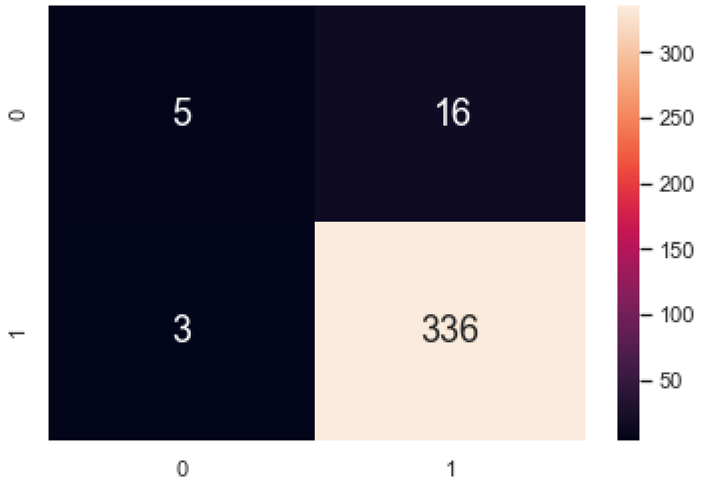
In [103…

```
 # Predict CentralAir corresponding to SalePrice (Test Data)
ca_test_pred = dectree.predict(sp_test)

# Plot the two-way Confusion Matrix
from sklearn.metrics import confusion_matrix
sb.heatmap(confusion_matrix(ca_test, ca_test_pred),
           annot = True, fmt=".0f", annot_kws={"size": 18})
```

Out[103…

```
<AxesSubplot:>
```



## j)

In [104…

```
# Print the Classification Accuracy
print("Classification Accuracy \t:", dectree.score(sp_test, ca_test))
```

```
Classification Accuracy 	: 0.9472222222222222
```

Based on the two-way Confusion Matrix

True Positive Rate: 5

True Negative Rate: 336

False Positive Rate: 16

False Negative Rate: 3

Classification Accuracy = (TP+TN)/360

= (5+336)/360

= 0.9472222222222222

# Problem 2

In [74]:

```
gla = pd.DataFrame(houseData['GrLivArea'])
```

In [62]:

```
from sklearn.model_selection import train_test_split
gla_train, gla_test, ca_train, ca_test = train_test_split(gla, ca, test_size = 0.246)

print("Train Set :", gla_train.shape, ca_train.shape)
print("Test Set  :", gla_test.shape, ca_test.shape)
```

```
Train Set : (1100, 1) (1100, 1)
Test Set  : (360, 1) (360, 1)
```

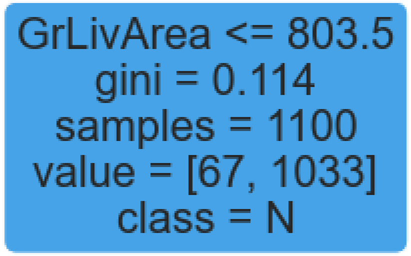
In [63]:

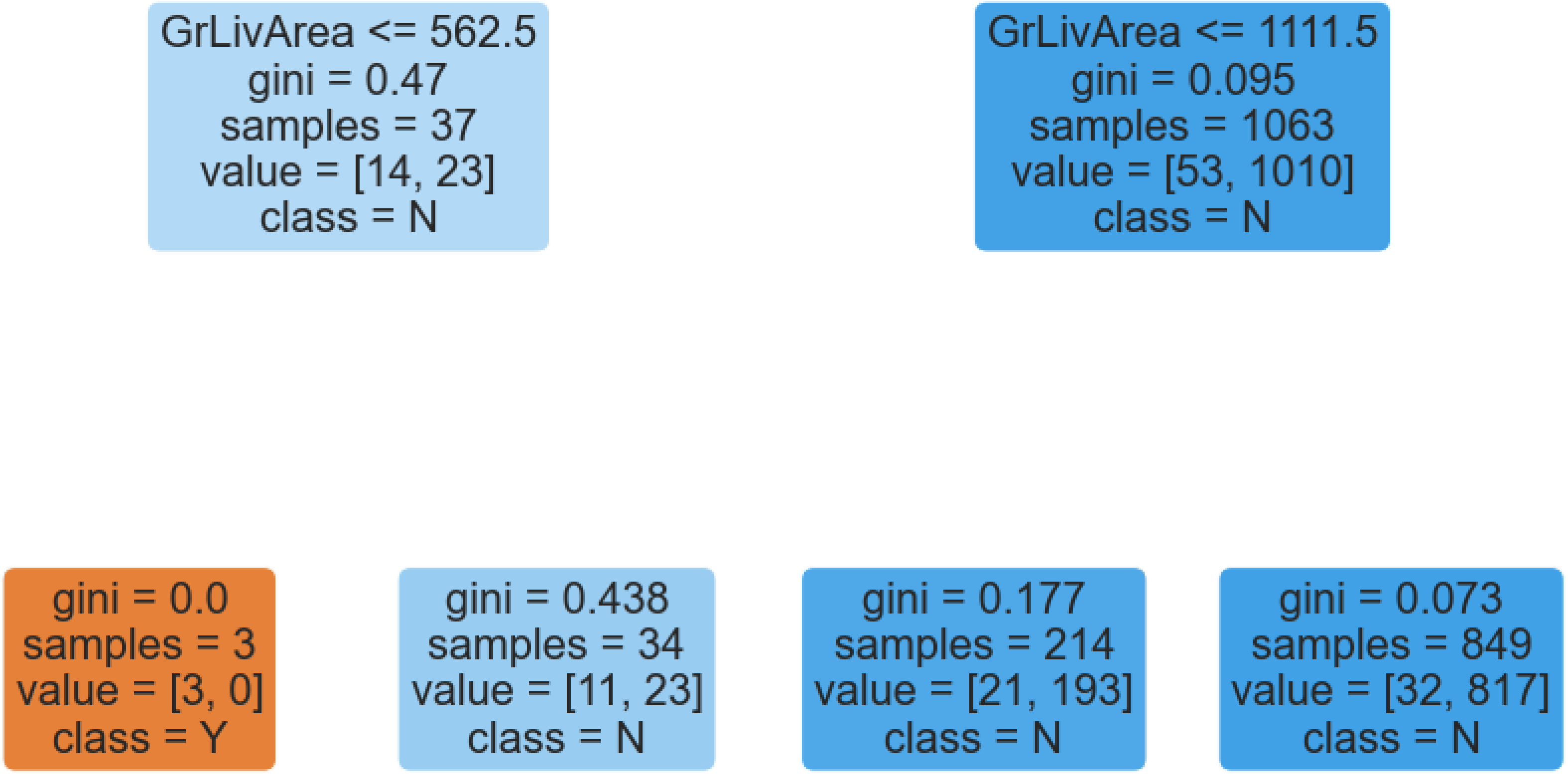
```
dectree.fit(gla_train, ca_train)
from sklearn.tree import plot_tree

f = plt.figure(figsize=(15,15))
plot_tree(dectree, filled=True, rounded=True,
          feature_names=["GrLivArea"],
          class_names=["Y","N"])
```

Out[63]:

```
[Text(418.5, 679.5, 'GrLivArea <= 803.5\ngini = 0.114\nsamples = 1100\nvalue = [67, 1033]\nclass = N'),
 Text(209.25, 407.69999999999993, 'GrLivArea <= 562.5\ngini = 0.47\nsamples = 37\nvalue = [14, 23]\nclass = N'),
 Text(104.625, 135.89999999999998, 'gini = 0.0\nsamples = 3\nvalue = [3, 0]\nclass = Y'),
 Text(313.875, 135.89999999999998, 'gini = 0.438\nsamples = 34\nvalue = [11, 23]\nclass = N'),
 Text(627.75, 407.69999999999993, 'GrLivArea <= 1111.5\ngini = 0.095\nsamples = 1063\nvalue = [53, 1010]\nclass = N'),
 Text(523.125, 135.89999999999998, 'gini = 0.177\nsamples = 214\nvalue = [21, 193]\nclass = N'),
 Text(732.375, 135.89999999999998, 'gini = 0.073\nsamples = 849\nvalue = [32, 817]\nclass = N')]
```





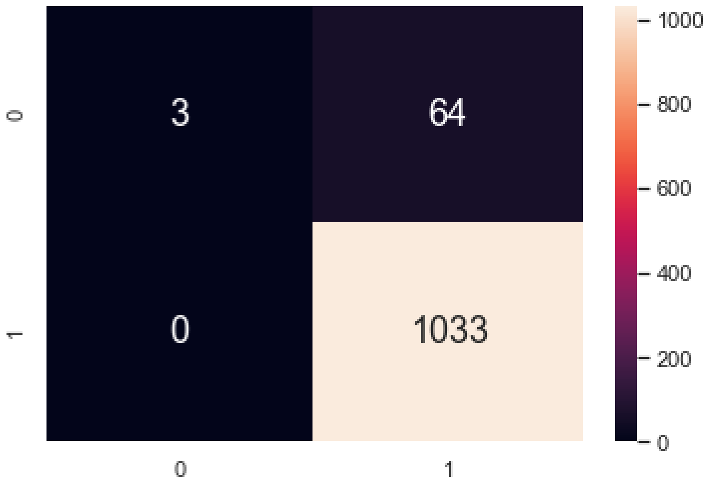
In [70]:

```
# Predict CentralAir corresponding to GrLivArea
ca_train_pred = dectree.predict(gla_train)

# Plot the two-way Confusion Matrix
from sklearn.metrics import confusion_matrix
sb.heatmap(confusion_matrix(ca_train, ca_train_pred),
            annot = True, fmt=".0f", annot_kws={"size": 18})

# Print the Classification Accuracy
print("Classification Accuracy \t:", dectree.score(gla_train, ca_train))
```

```
Classification Accuracy          : 0.9418181818181818
```



Based on the two-way Confusion Matrix

True Positive Rate: 3

True Negative Rate: 1033

False Positive Rate: 64

False Negative Rate: 0

Classification Accuracy = (TP+TN)/1100

= (1033+3)/1100

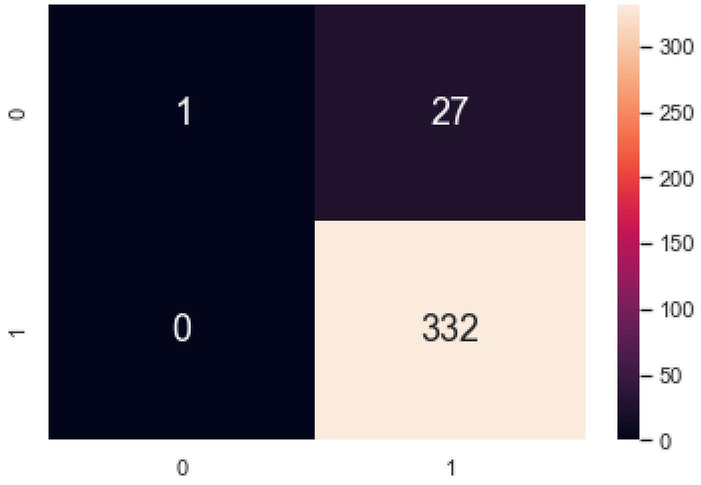
= 0.9418181818181818

In [73]:
```
 # Predict CentralAir corresponding to SalePrice (Test Data)
ca_test_pred = dectree.predict(gla_test)
```

```
# Plot the two-way Confusion Matrix
from sklearn.metrics import confusion_matrix
sb.heatmap(confusion_matrix(ca_test, ca_test_pred),
           annot = True, fmt=".0f", annot_kws={"size": 18})

print("Classification Accuracy \t:", dectree.score(gla_test, ca_test))
```

```
Classification Accuracy          : 0.925
```



Based on the two-way Confusion Matrix

True Positive Rate: 1

True Negative Rate: 332

False Positive Rate: 27

False Negative Rate: 0

Classification Accuracy = (TP+TN)/360

= (1+332)/360

= 0.925

In [75]:

```
oq = pd.DataFrame(houseData['OverallQual'])
```

```
from sklearn.model_selection import train_test_split
oq_train, oq_test, ca_train, ca_test = train_test_split(oq, ca, test_size = 0.246)

print("Train Set :", oq_train.shape, ca_train.shape)
print("Test Set  :", oq_test.shape, ca_test.shape)
```

```
Train Set : (1100, 1) (1100, 1)
Test Set  : (360, 1) (360, 1)
```

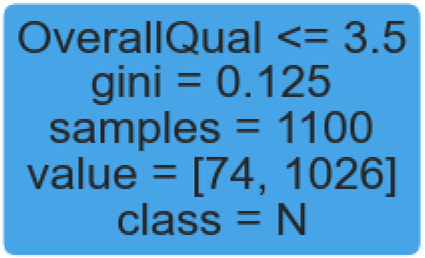
In [76]:

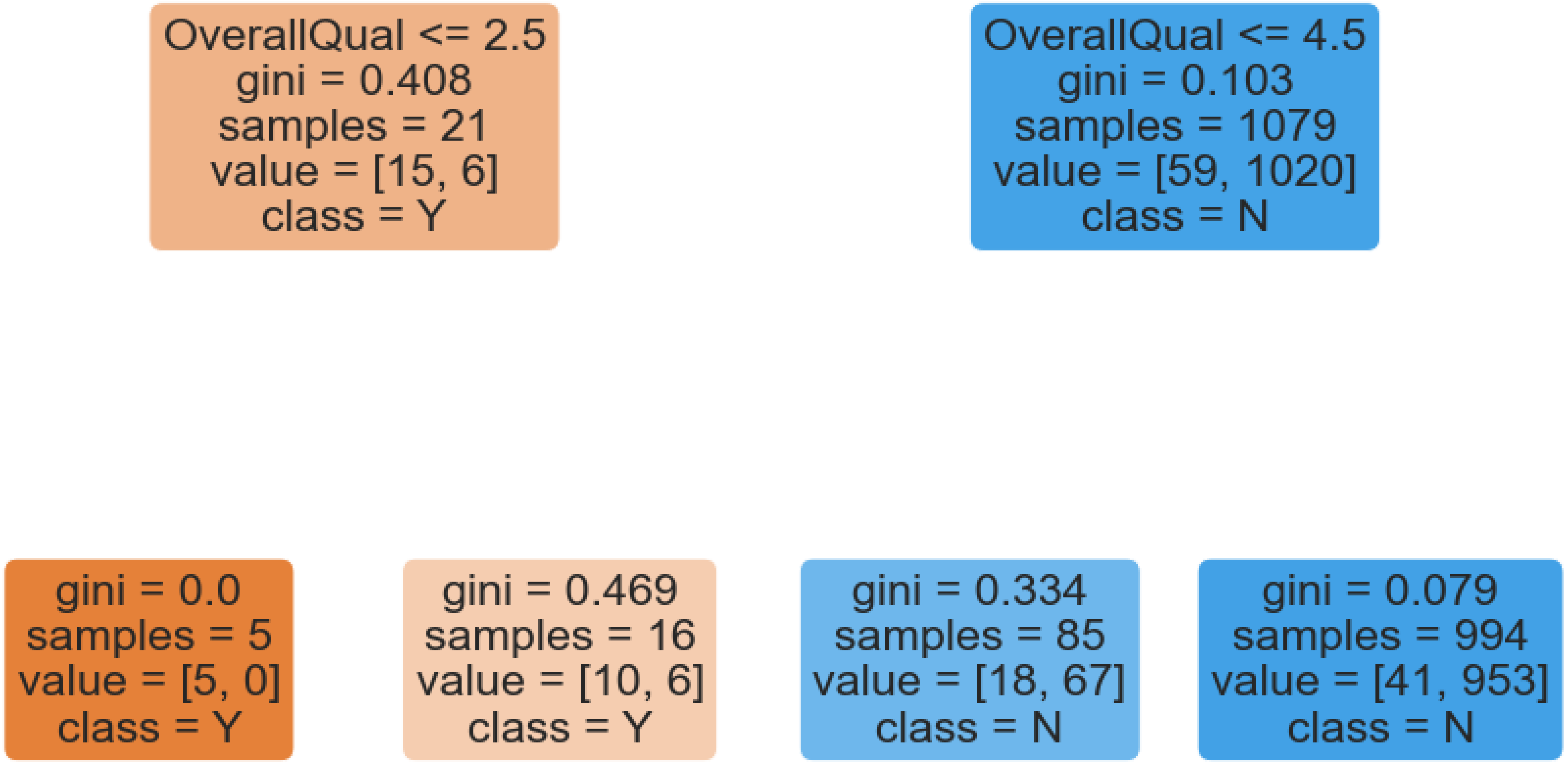
```
dectree.fit(oq_train, ca_train)
from sklearn.tree import plot_tree

f = plt.figure(figsize=(15,15))
plot_tree(dectree, filled=True, rounded=True,
          feature_names=["OverallQual"],
          class_names=["Y","N"])
```

Out[76]:

```
[Text(418.5, 679.5, 'OverallQual <= 3.5\ngini = 0.125\nsamples = 1100\nvalue = [74, 1026]\nclass = N'),
 Text(209.25, 407.69999999999993, 'OverallQual <= 2.5\ngini = 0.408\nsamples = 21\nvalue = [15, 6]\nclass = Y'),
 Text(104.625, 135.89999999999998, 'gini = 0.0\nsamples = 5\nvalue = [5, 0]\nclass = Y'),
 Text(313.875, 135.89999999999998, 'gini = 0.469\nsamples = 16\nvalue = [10, 6]\nclass = Y'),
 Text(627.75, 407.69999999999993, 'OverallQual <= 4.5\ngini = 0.103\nsamples = 1079\nvalue = [59, 1020]\nclass = N'),
 Text(523.125, 135.89999999999998, 'gini = 0.334\nsamples = 85\nvalue = [18, 67]\nclass = N'),
 Text(732.375, 135.89999999999998, 'gini = 0.079\nsamples = 994\nvalue = [41, 953]\nclass = N')]
```





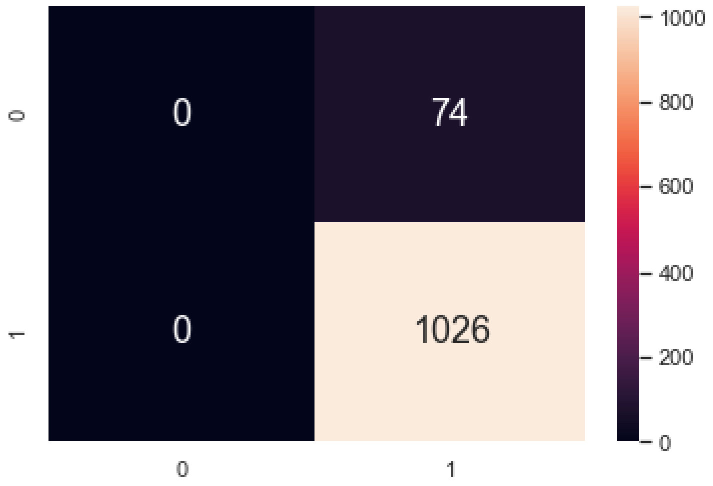
In [77]:

```
# Predict CentralAir corresponding to GrLivArea
ca_train_pred = dectree.predict(gla_train)

# Plot the two-way Confusion Matrix
from sklearn.metrics import confusion_matrix
sb.heatmap(confusion_matrix(ca_train, ca_train_pred),
           annot = True, fmt=".0f", annot_kws={"size": 18})

# Print the Classification Accuracy
print("Classification Accuracy \t:", dectree.score(gla_train, ca_train))
```

```
Classification Accuracy          : 0.9327272727272727
```



Based on the two-way Confusion Matrix

True Positive Rate: 0

True Negative Rate: 1026

False Positive Rate: 74

False Negative Rate: 0

Classification Accuracy = (TP+TN)/1100

= (1026+0)/1100

= 0.9327272727272727

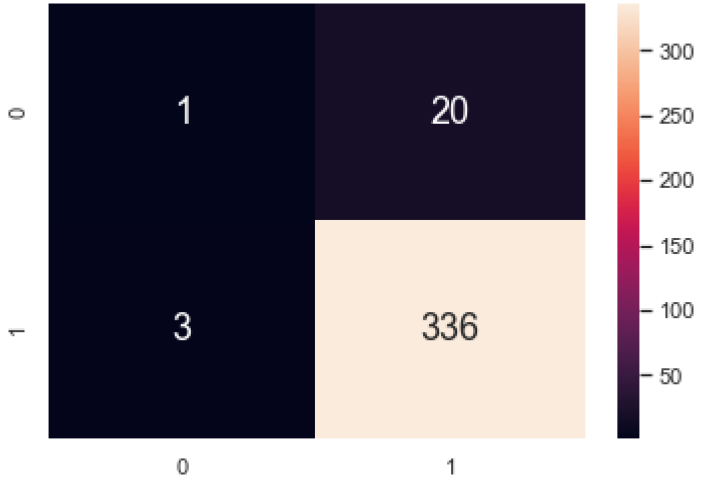
In [78]:

```
 # Predict CentralAir corresponding to SalePrice (Test Data)
ca_test_pred = dectree.predict(oq_test)

# Plot the two-way Confusion Matrix
from sklearn.metrics import confusion_matrix
sb.heatmap(confusion_matrix(ca_test, ca_test_pred),
           annot = True, fmt=".0f", annot_kws={"size": 18})
```

```
print("Classification Accuracy \t:", dectree.score(oq_test, ca_test))
```

```
Classification Accuracy         : 0.9361111111111111
```



Based on the two-way Confusion Matrix

True Positive Rate: 1

True Negative Rate: 336

False Positive Rate: 20

False Negative Rate: 3

Classification Accuracy = (TP+TN)/360

= (336+1)/360

= 0.9361111111111111

In [83]:

```
yb = pd.DataFrame(houseData['YearBuilt'])
from sklearn.model_selection import train_test_split
yb_train, yb_test, ca_train, ca_test = train_test_split(yb, ca, test_size = 0.246)
```

```
print("Train Set :", yb_train.shape, ca_train.shape)
print("Test Set  :", yb_test.shape, ca_test.shape)
```

```
Train Set : (1100, 1) (1100, 1)
Test Set  : (360, 1) (360, 1)
```

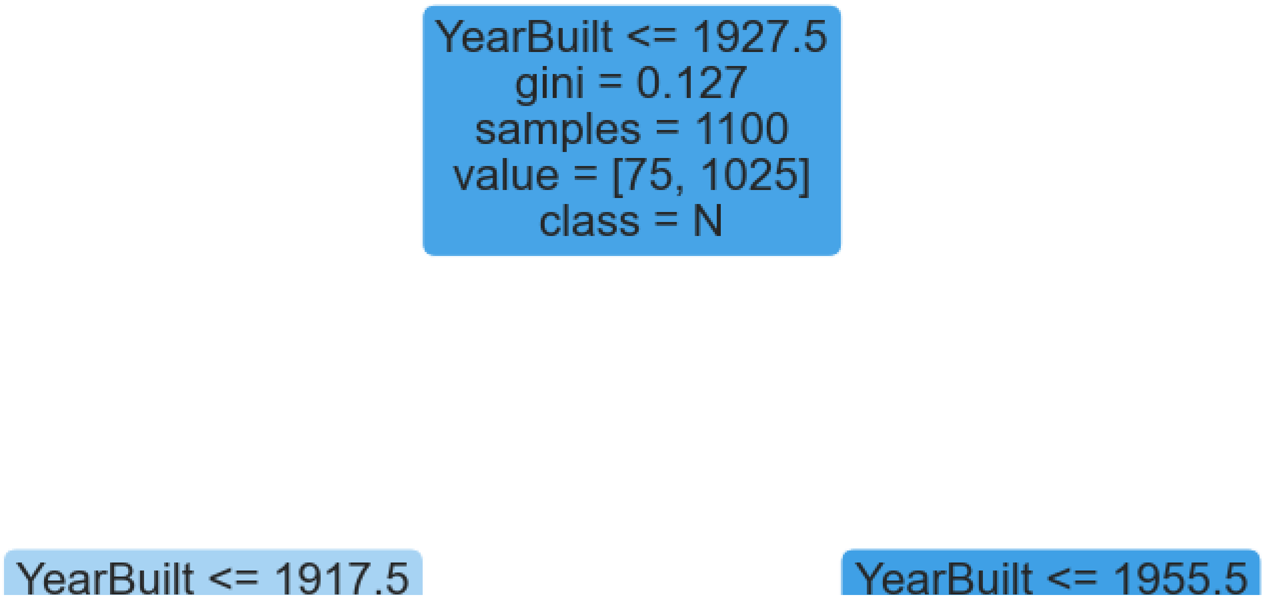
In [84]:

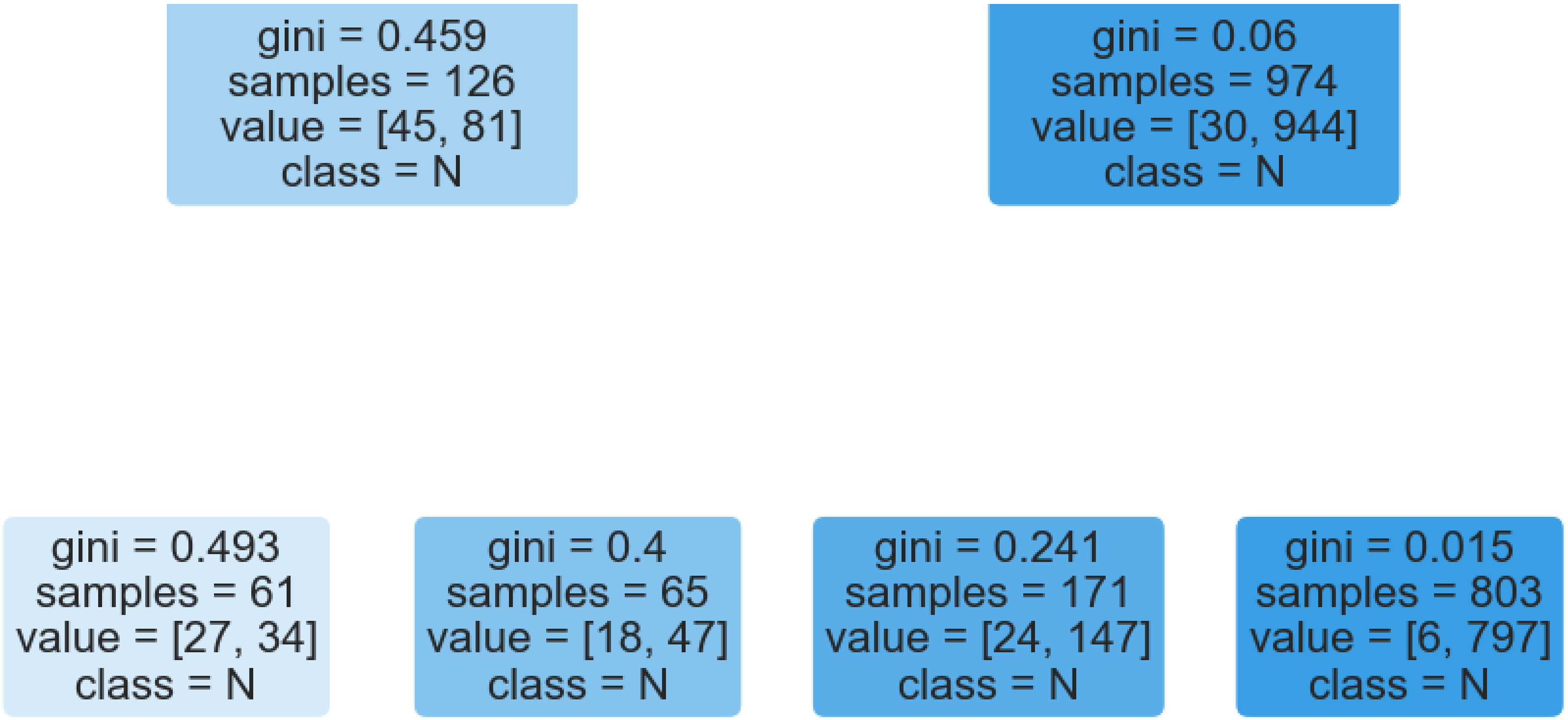
```
dectree.fit(yb_train, ca_train)
from sklearn.tree import plot_tree

f = plt.figure(figsize=(15,15))
plot_tree(dectree, filled=True, rounded=True,
          feature_names=["YearBuilt"],
          class_names=["Y","N"])
```

Out[84]:

```
[Text(418.5, 679.5, 'YearBuilt <= 1927.5\ngini = 0.127\nsamples = 1100\nvalue = [75, 1025]\nclass = N'),
 Text(209.25, 407.69999999999993, 'YearBuilt <= 1917.5\ngini = 0.459\nsamples = 126\nvalue = [45, 81]\nclass = N'),
 Text(104.625, 135.89999999999998, 'gini = 0.493\nsamples = 61\nvalue = [27, 34]\nclass = N'),
 Text(313.875, 135.89999999999998, 'gini = 0.4\nsamples = 65\nvalue = [18, 47]\nclass = N'),
 Text(627.75, 407.69999999999993, 'YearBuilt <= 1955.5\ngini = 0.06\nsamples = 974\nvalue = [30, 944]\nclass = N'),
 Text(523.125, 135.89999999999998, 'gini = 0.241\nsamples = 171\nvalue = [24, 147]\nclass = N'),
 Text(732.375, 135.89999999999998, 'gini = 0.015\nsamples = 803\nvalue = [6, 797]\nclass = N')]
```





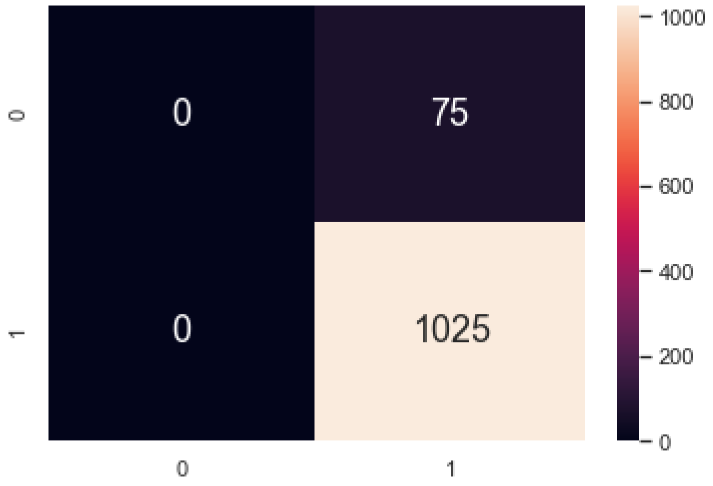
In [85]:

```
# Predict CentralAir corresponding to GrLivArea
ca_train_pred = dectree.predict(yb_train)

# Plot the two-way Confusion Matrix
from sklearn.metrics import confusion_matrix
sb.heatmap(confusion_matrix(ca_train, ca_train_pred),
           annot = True, fmt=".0f", annot_kws={"size": 18})

# Print the Classification Accuracy
print("Classification Accuracy \t:", dectree.score(yb_train, ca_train))
```

```
Classification Accuracy         : 0.9318181818181818
```



Based on the two-way Confusion Matrix

True Positive Rate: 0

True Negative Rate: 1025

False Positive Rate: 75

False Negative Rate: 0

Classification Accuracy = (TP+TN)/1100

= (1025+0)/1100

= 0.9318181818181818

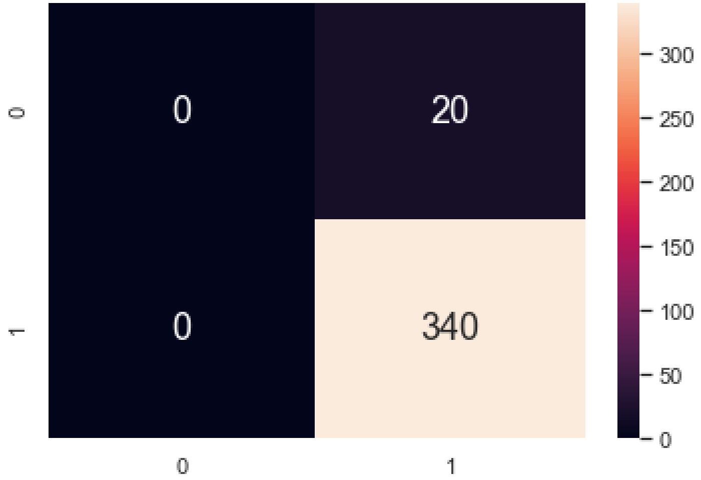
In [86]:

```
 # Predict CentralAir corresponding to SalePrice (Test Data)
ca_test_pred = dectree.predict(yb_test)

# Plot the two-way Confusion Matrix
from sklearn.metrics import confusion_matrix
sb.heatmap(confusion_matrix(ca_test, ca_test_pred),
           annot = True, fmt=".0f", annot_kws={"size": 18})

print("Classification Accuracy \t:", dectree.score(yb_test, ca_test))
```

```
Classification Accuracy          : 0.9444444444444444
```



Based on the two-way Confusion Matrix

True Positive Rate: 0

True Negative Rate: 339

False Positive Rate: 21

False Negative Rate: 0

Classification Accuracy = (TP+TN)/360

= (340+0)/360

= 0.9444444444444444

## Problem 3

Based on the accuracy measures of four of the variables which is SalePrice,GrLivArea, OverallQual, YearBuilt.

Sale Price get the highest classification accuracy which is 0.9472222222222222

Hence, Sale Price is the best to predict “CentralAir”.

In [ ]:

In [ ]: