https://www.w3schools.com/python/python_ml_decision_tree.a

Machine Learning Lab3: Created by Jibrael Jos,PhD

Topic: Decision Tree Explorations

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Roll No:23122023

Date:21 March

Submission : 21 March 2024

Python Notebook as PDF (File Name MLSVMLab23.pdf)

and Observations in MLLab2_23.xlsx

Where 21 can be replaced with your roll number

Questions:

1. Run SVM2 for cancer.csv

In [ ]:
```
#importing necessery libraries
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt

# reading csv file.
x = pd.read_csv("cancer.csv")
a = np.array(x)

y = a[:,2]
x = np.column_stack((x.col1,x.col2))

print(x.shape)
print (x),(y)
```

```
(569, 2)
[[ 122.8  1001.  ]
 [ 132.9  1326.  ]
 [ 130.   1203.  ]
 ...
 [ 108.3   858.1 ]
 [ 140.1  1265.  ]
 [  47.92  181.  ]]
```

Out[ ]:
```
(None,
 array([1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1.,
1.,
        1., 1., 0., 0., 0., 1., 1., 1., 1., 1., 1., 1., 1., 1., 1.,
1.,
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0.,
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1.,
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0.,
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0.,
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0.,
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0.,
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1.,
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1.,
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0.,
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0.,
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0.,
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0.,
        0., 1., 1., 0., 0., 0., 0., 0., 0., 1., 0., 0., 0., 0., 0., 0.,
0.,
        0., 0., 0., 1., 0., 0., 0., 0., 0., 0., 0., 1., 0., 1., 0., 0.,
1.,
        0., 0., 0., 0., 0., 1., 1., 0., 1., 0., 1., 0., 0., 0., 0., 0.,
```

```
1.,
       0., 0., 1., 0., 1., 0., 1., 1., 0., 0., 0., 1., 0., 0., 0., 0.,
0.,
       0., 0., 0., 0., 0., 0., 1., 0., 1., 1., 0., 0., 0., 0., 0., 0.,
0.,
       0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0., 0.,
0.,
       0., 1., 1., 1., 1., 1., 1., 0.]))
```

In [ ]:
```
# import support vector classifier
from sklearn.svm import SVC
clf = SVC(kernel='linear')

# fitting
clf.fit(x, y)
```

Out[ ]:
```
SVC(kernel='linear')
```

In [ ]:
```
#predicting
clf.predict([[120, 990]])
```

Out[ ]:
```
array([1.])
```

2. Run Linear and Poly

In [ ]:
```
import numpy as np

def make_meshgrid(x, y, h=0.2):#0.02
    x_min, x_max = x.min() - 1, x.max() + 1
    y_min, y_max = y.min() - 1, y.max() + 1
    xx, yy = np.meshgrid(np.arange(x_min, x_max, h), np.arange(y_min, y_m
    return xx, yy

def plot_contours(ax, clf, xx, yy, **params):
    Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)
    out = ax.contourf(xx, yy, Z, **params)
    return out
```

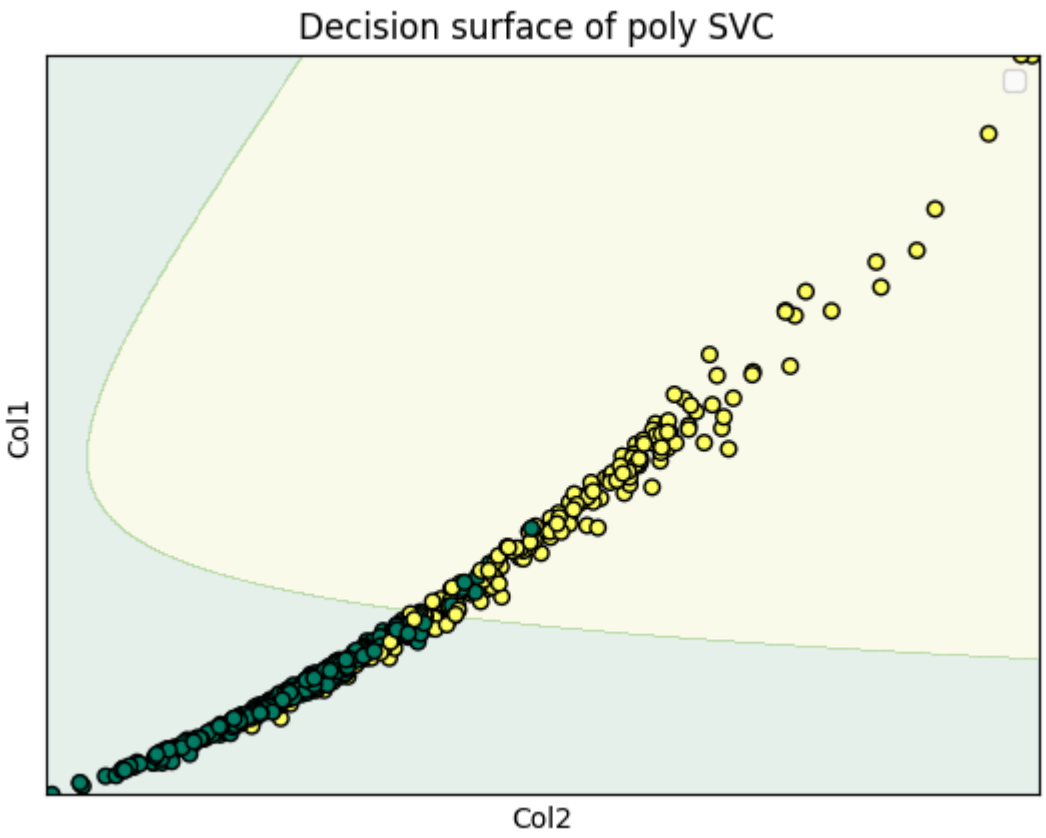
In [ ]:
```
X=x
model = SVC(kernel='poly',degree=5)
clf = model.fit(X, y)
print(clf)
fig, ax = plt.subplots()

title = ('Decision surface of poly SVC ')

X0, X1 = X[:, 0], X[:, 1]
print(X0,X1)

xx, yy = make_meshgrid(X0, X1)

plot_contours(ax, clf, xx, yy, cmap=plt.cm.summer, alpha=0.1)
ax.scatter(X0, X1, c=y, cmap=plt.cm.summer, s=30, edgecolors='k')
ax.set_ylabel('Col1')
ax.set_xlabel('Col2')
```

```
ax.set_xticks(())
ax.set_yticks(())
ax.set_title(title)
ax.legend()
plt.show()
```

```
SVC(degree=5, kernel='poly')
[122.8  132.9  130.    77.58 135.1   82.57 119.6   90.2   87.5   83.97
 102.7  103.6  132.4  103.7   93.6   96.73  94.74 108.1  130.    87.46
  85.63  60.34 102.5  137.2  110.   116.    97.41 122.1  102.4  115.
 124.8   77.93 112.8  127.9  107.   110.1   93.63  82.61  95.54  88.4
  86.18  71.9  128.3   87.32  85.42 123.7   51.71  85.98  78.04  86.91
  74.72  87.21  75.71 120.3   97.26  73.34 125.5   95.55  82.61  54.34
  64.55  54.66  96.42  59.2   82.69  97.4   60.11  71.8   58.79  81.37
 123.6   58.79 114.2   90.43  79.19 104.1   87.91 120.2  143.7   83.19
  73.81  86.49 171.5  129.1   76.95 121.1   94.25 122.    79.78  95.77
  94.57 100.2   84.74  86.6  100.3  132.4   77.79  62.11  74.34  94.48
  88.05  43.79  77.22  63.95  67.41  87.21  75.17  79.01 152.8   72.48
  62.5   82.15  97.83  68.64  55.84  76.53  58.74  98.64 105.7  114.2
  73.34 121.4  166.2   94.28  86.1   88.44  87.76 123.4   99.58 130.4
  79.08 101.7  106.2  102.   120.2   81.72  74.72  73.06  96.85  73.
  61.24 105.1   73.66  83.74  68.26  78.11  78.99  97.84  93.97  88.12
  83.51  53.27  63.78  70.87  85.31  78.27 117.4  108.4   76.84  68.69
  76.1  126.3  130.7   79.85 152.1   95.5   68.77 109.3  116.1   96.22
  78.85  85.84 102.5   70.21  67.49  54.42  64.6  109.3   82.01  81.29
 182.1  142.7  101.2   73.53  98.92  63.76 118.6   74.68  75.27  78.83
  94.37  82.02  60.73  81.15 100.4   82.53  90.63 117.4  127.5   94.49
  78.54 115.1  158.9   91.56  81.09  98.78  62.92 109.7   87.02  98.17
 134.7   75.51 188.5  114.5   92.87  90.96  77.32  65.05 129.7  128.
  87.88  88.59  65.12 102.6   84.55  92.51  66.62  97.45  81.35  85.26
 113.4   71.76  70.79 134.4   60.21  89.79 153.5  132.5   92.55 113.4
  87.38  78.61  73.93  88.54 129.1   66.72  84.13  84.95  68.01  73.87
 138.9   73.28 130.7  113.   126.5   91.43 133.6  103.2  110.2  103.7
 132.9  111.   114.4  100.   111.6  135.7   69.28  87.16  82.38  69.5
  90.3   72.23 147.3   61.5  115.2   76.2   71.79 120.9   86.24  88.99
 126.2   74.24 127.2  108.8   84.08  79.83  77.87  81.89  73.72  72.17
  96.03  97.03  83.14  75.54  81.78  88.06  69.14  75.    91.22  66.85
 129.5   80.43 134.7   66.86  73.59  74.23  84.07  56.36  85.69  82.71
  74.33  92.68  82.29  73.73  54.09  79.19  77.25 118.7   60.07  78.6
  66.52 131.1   82.82 135.9   78.01  81.25  90.03  76.09 106.9  107.5
 105.8   84.52  71.94  71.38  77.88 111.8   84.08 122.9   64.41 155.1
  94.15  61.64  71.49 129.9   75.03  66.2   76.66  94.87  73.02  77.23
  73.7  107.1  174.2   98.    71.24  81.92  85.09  88.52  56.74  59.82
  79.42  85.24  81.87 106.6   85.48 133.8  133.7   78.31 140.9  147.2
 109.    97.65 141.3  134.8   87.84 106.3   70.15  85.89  88.27  73.3
  73.16  70.67  78.75  80.64  85.79  93.97  78.78  88.37  73.38 128.9
  65.75  55.27 102.4  144.4   78.07  89.75  88.1   83.05  70.31  75.26
 124.4   76.14  84.18  83.18  78.29  70.39 104.3   82.63 117.8   78.41
  72.49  70.92  59.75  97.53  96.71  76.39  59.6  102.9   80.88  70.95
  74.2   98.22  75.46  89.46  61.93  63.19  67.49  68.79  70.47  80.98
 102.1   81.47 133.8  123.7   94.89  91.12  82.67  89.78  88.68  89.59
  71.73 112.4   88.37  66.82 117.5   77.61 117.3   95.88  94.25 138.1
  76.83 127.7   76.77  93.86  80.62  86.34  74.87  84.1   82.61  61.68
 111.2  186.9   92.25  73.88  84.28  86.87  85.98  61.06 119.    76.38
  61.49  76.85  96.45  77.42  70.41  82.89  92.41  88.97  73.99 109.8
  78.29  88.73  87.32  87.76 102.8   82.85  94.21 128.1   75.49 107.1
  78.18 114.6  118.4   78.83  84.06  96.12  82.69  80.45 121.3  137.8
  98.73  92.33  81.25 152.1   61.49  64.12  79.47  71.25 104.7  103.8
  76.31  94.66  88.64  94.29  97.26  72.76 120.8  130.5   84.45  82.51
  59.96 165.5   71.3   88.73  63.    54.53  87.44  78.94  90.31  77.83
  75.89  75.21  87.76 134.7   70.79 137.8   93.77  76.37  47.98  48.34
  74.65  95.81  94.7   84.88  89.77  87.19  65.31  65.85  61.05  68.89
  68.51  71.49  81.35  59.01  82.5   65.67  64.73  59.26  96.39  74.52
  91.38  70.67 103.4  143.   142.   131.2  108.3  140.1   47.92] [1001.  1
326.  1203.   386.1 1297.   477.1 1040.   577.9  519.8  475.9
  797.8  781.  1123.   782.7  578.3  658.8  684.5  798.8 1260.   566.3
```

```
 520.   273.9  704.4 1404.   904.6  912.7  644.8 1094.   732.4  955.1
1088.   440.6  899.3 1162.   807.2  869.5  633.   523.8  698.8  559.2
 563.   371.1 1104.   545.2  531.5 1076.   201.9  534.6  449.3  561.
 427.9  571.8  437.6 1033.   712.8  409.  1152.   656.9  527.2  224.5
 311.9  221.8  645.7  260.9  499.   668.3  269.4  394.1  250.5  502.5
1130.   244.   929.4  584.1  470.9  817.7  559.2 1006.  1245.   506.3
 401.5  520.  1878.  1132.   443.3 1075.   648.2 1076.   466.1  651.9
 662.7  728.2  551.7  555.1  705.6 1264.   451.1  294.5  412.6  642.5
 582.7  143.5  458.7  298.3  336.1  530.2  412.5  466.7 1509.   396.5
 290.2  480.4  629.9  334.2  230.9  438.6  245.2  682.5  782.6  982.
 403.3 1077.  1761.   640.7  553.5  588.7  572.6 1138.   674.5 1192.
 455.8  748.9  809.8  761.7 1075.   506.3  423.6  399.8  678.1  384.8
 288.5  813.   398.   512.2  355.3  432.8  432.   689.5  640.1  585.
 519.4  203.9  300.2  381.9  538.9  460.3  963.7  880.2  448.6  366.8
 419.8 1157.  1214.   464.5 1686.   690.2  357.6  886.3  984.6  685.9
 464.1  565.4  736.9  372.7  349.6  227.2  302.4  832.9  526.4  508.8
2250.  1311.   766.6  402.   710.6  317.5 1041.   420.3  428.9  463.7
 609.9  507.4  288.1  477.4  671.4  516.4  588.9 1024.  1148.   642.7
 461.   951.6 1685.   597.8  481.9  716.6  295.4  904.3  529.4  725.5
1290.   428.  2499.   948.   610.7  578.9  432.2  321.2 1230.  1223.
 568.9  561.3  313.1  761.3  546.4  641.2  329.6  684.5  496.4  503.2
 895.   395.7  386.8 1319.   279.6  603.4 1670.  1306.   623.9  920.6
 575.3  476.5  389.4  590.  1155.   337.7  541.6  512.2  347.   406.3
1364.   407.4 1206.   928.2 1169.   602.4 1207.   713.3  773.5  744.9
1288.   933.1  947.8  758.6  928.3 1419.   346.4  561.   512.2  344.9
 632.6  388.  1491.   289.9  998.9  435.6  396.6 1102.   572.3  587.4
1138.   427.3 1145.   805.1  516.6  489.   441.   515.9  394.1  396.
 651.   687.3  513.7  432.7  492.1  582.7  363.7  431.1  633.1  334.2
1217.   471.3 1247.   334.3  403.1  417.2  537.3  246.3  566.2  530.6
 418.7  664.9  504.1  409.1  221.2  481.6  461.4 1027.   244.5  477.3
 324.2 1274.   504.8 1264.   457.9  489.9  616.5  446.   813.7  826.8
 793.2  514.   387.3  390.   464.4  918.6  514.3 1092.   310.8 1747.
 641.2  280.5  373.9 1194.   420.3  321.6  445.3  668.7  402.7  426.7
 421.   758.6 2010.   716.6  384.6  485.8  512.   593.7  241.   278.6
 491.9  546.1  496.6  838.1  552.4 1293.  1234.   458.4 1546.  1482.
 840.4  711.8 1386.  1335.   579.1  788.5  338.3  562.1  580.6  361.6
 386.3  372.7  447.8  462.9  541.8  664.7  462.   596.6  392.  1174.
 321.6  234.3  744.7 1407.   446.2  609.1  558.1  508.3  378.2  431.9
 994.   442.7  525.2  507.6  469.1  370.   800.   514.5  991.7  466.1
 399.8  373.2  268.8  693.7  719.5  433.8  271.2  803.1  495.   380.3
 409.7  656.1  408.2  575.3  289.7  307.3  333.6  359.9  381.1  501.3
 685.   467.8 1250.  1110.   673.7  599.5  509.2  611.2  592.6  606.5
 371.5  928.8  585.9  340.9  990.   441.3  981.6  674.8  659.7 1384.
 432.  1191.   442.5  644.2  492.9  557.2  415.1  537.9  520.2  290.9
 930.9 2501.   646.1  412.7  537.3  542.9  536.9  286.3  980.5  408.8
 289.1  449.9  686.9  465.4  358.9  506.9  618.4  599.4  404.9  815.8
 455.3  602.9  546.3  571.1  747.2  476.7  666.  1167.   420.5  857.6
 466.5  992.1 1007.   477.3  538.7  680.9  485.6  480.1 1068.  1320.
 689.4  595.9  476.3 1682.   248.7  272.5  453.1  366.5  819.8  731.3
 426.   680.7  556.7  658.8  701.9  391.2 1052.  1214.   493.1  493.8
 257.8 1841.   388.1  571.   293.2  221.3  551.1  468.5  594.2  445.2
 422.9  416.2  575.5 1299.   365.6 1308.   629.8  406.4  178.8  170.4
 402.9  656.4  668.6  538.4  584.8  573.2  324.9  320.8  285.7  361.6
 360.5  378.4  507.9  264.   514.3  321.4  311.7  271.3  657.1  403.5
 600.4  386.   716.9 1347.  1479.  1261.   858.1 1265.   181. ]
```

```
No artists with labels found to put in legend.  Note that artists whose la
bel start with an underscore are ignored when legend() is called with no a
rgument.
```

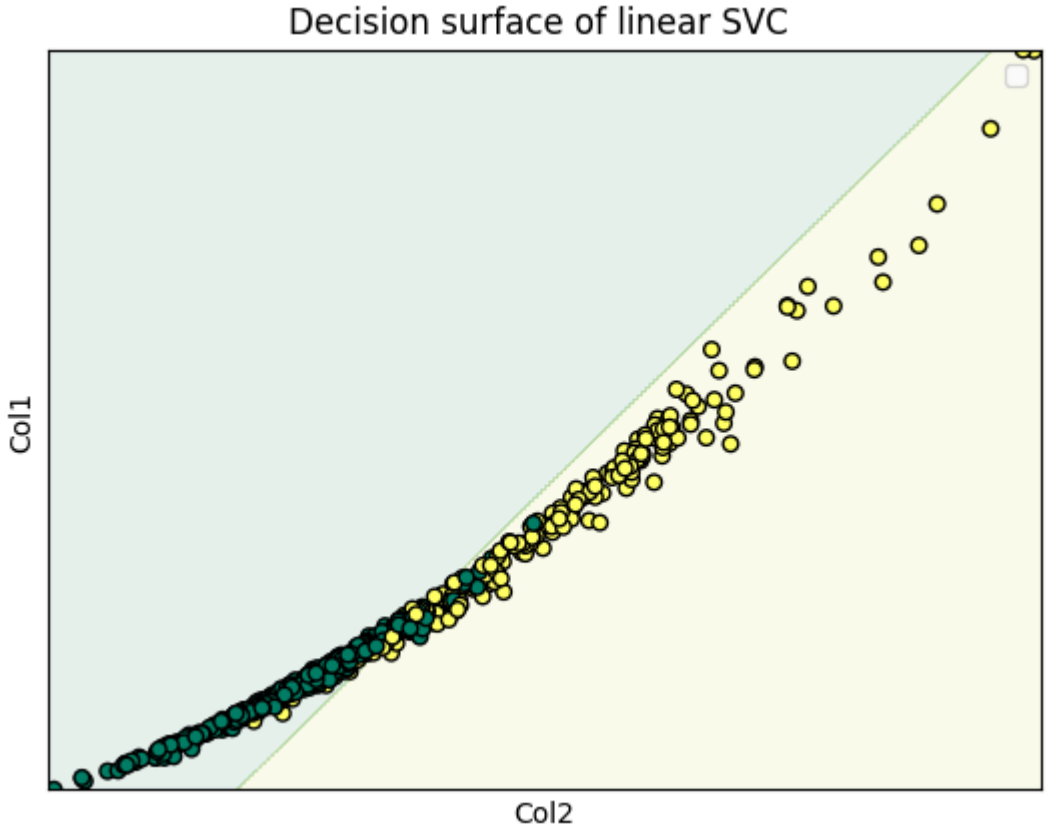


In [ ]:
```
X=x
model = SVC(kernel='linear')
clf = model.fit(X, y)
print(clf)
fig, ax = plt.subplots()

title = ('Decision surface of linear SVC ')

X0, X1 = X[:, 0], X[:, 1]
print(X0,X1)

xx, yy = make_meshgrid(X0, X1)

plot_contours(ax, clf, xx, yy, cmap=plt.cm.summer, alpha=0.1)
ax.scatter(X0, X1, c=y, cmap=plt.cm.summer, s=30, edgecolors='k')
ax.set_ylabel('Col1')
ax.set_xlabel('Col2')
ax.set_xticks(())
ax.set_yticks(())
ax.set_title(title)
ax.legend()
plt.show()
```

```
SVC(kernel='linear')
[122.8  132.9  130.    77.58 135.1   82.57 119.6   90.2   87.5   83.97
 102.7  103.6  132.4  103.7   93.6   96.73  94.74 108.1  130.    87.46
  85.63  60.34 102.5  137.2  110.   116.    97.41 122.1  102.4  115.
 124.8   77.93 112.8  127.9  107.   110.1   93.63  82.61  95.54  88.4
  86.18  71.9  128.3   87.32  85.42 123.7   51.71  85.98  78.04  86.91
  74.72  87.21  75.71 120.3   97.26  73.34 125.5   95.55  82.61  54.34
  64.55  54.66  96.42  59.2   82.69  97.4   60.11  71.8   58.79  81.37
 123.6   58.79 114.2   90.43  79.19 104.1   87.91 120.2  143.7   83.19
  73.81  86.49 171.5  129.1   76.95 121.1   94.25 122.    79.78  95.77
  94.57 100.2   84.74  86.6  100.3  132.4   77.79  62.11  74.34  94.48
  88.05  43.79  77.22  63.95  67.41  87.21  75.17  79.01 152.8   72.48
  62.5   82.15  97.83  68.64  55.84  76.53  58.74  98.64 105.7  114.2
  73.34 121.4  166.2   94.28  86.1   88.44  87.76 123.4   99.58 130.4
  79.08 101.7  106.2  102.   120.2   81.72  74.72  73.06  96.85  73.
  61.24 105.1   73.66  83.74  68.26  78.11  78.99  97.84  93.97  88.12
  83.51  53.27  63.78  70.87  85.31  78.27 117.4  108.4   76.84  68.69
  76.1  126.3  130.7   79.85 152.1   95.5   68.77 109.3  116.1   96.22
  78.85  85.84 102.5   70.21  67.49  54.42  64.6  109.3   82.01  81.29
 182.1  142.7  101.2   73.53  98.92  63.76 118.6   74.68  75.27  78.83
  94.37  82.02  60.73  81.15 100.4   82.53  90.63 117.4  127.5   94.49
  78.54 115.1  158.9   91.56  81.09  98.78  62.92 109.7   87.02  98.17
 134.7   75.51 188.5  114.5   92.87  90.96  77.32  65.05 129.7  128.
  87.88  88.59  65.12 102.6   84.55  92.51  66.62  97.45  81.35  85.26
 113.4   71.76  70.79 134.4   60.21  89.79 153.5  132.5   92.55 113.4
  87.38  78.61  73.93  88.54 129.1   66.72  84.13  84.95  68.01  73.87
 138.9   73.28 130.7  113.   126.5   91.43 133.6  103.2  110.2  103.7
 132.9  111.   114.4  100.   111.6  135.7   69.28  87.16  82.38  69.5
  90.3   72.23 147.3   61.5  115.2   76.2   71.79 120.9   86.24  88.99
 126.2   74.24 127.2  108.8   84.08  79.83  77.87  81.89  73.72  72.17
  96.03  97.03  83.14  75.54  81.78  88.06  69.14  75.    91.22  66.85
 129.5   80.43 134.7   66.86  73.59  74.23  84.07  56.36  85.69  82.71
  74.33  92.68  82.29  73.73  54.09  79.19  77.25 118.7   60.07  78.6
  66.52 131.1   82.82 135.9   78.01  81.25  90.03  76.09 106.9  107.5
 105.8   84.52  71.94  71.38  77.88 111.8   84.08 122.9   64.41 155.1
  94.15  61.64  71.49 129.9   75.03  66.2   76.66  94.87  73.02  77.23
  73.7  107.1  174.2   98.    71.24  81.92  85.09  88.52  56.74  59.82
  79.42  85.24  81.87 106.6   85.48 133.8  133.7   78.31 140.9  147.2
 109.    97.65 141.3  134.8   87.84 106.3   70.15  85.89  88.27  73.3
  73.16  70.67  78.75  80.64  85.79  93.97  78.78  88.37  73.38 128.9
  65.75  55.27 102.4  144.4   78.07  89.75  88.1   83.05  70.31  75.26
 124.4   76.14  84.18  83.18  78.29  70.39 104.3   82.63 117.8   78.41
  72.49  70.92  59.75  97.53  96.71  76.39  59.6  102.9   80.88  70.95
  74.2   98.22  75.46  89.46  61.93  63.19  67.49  68.79  70.47  80.98
 102.1   81.47 133.8  123.7   94.89  91.12  82.67  89.78  88.68  89.59
  71.73 112.4   88.37  66.82 117.5   77.61 117.3   95.88  94.25 138.1
  76.83 127.7   76.77  93.86  80.62  86.34  74.87  84.1   82.61  61.68
 111.2  186.9   92.25  73.88  84.28  86.87  85.98  61.06 119.    76.38
  61.49  76.85  96.45  77.42  70.41  82.89  92.41  88.97  73.99 109.8
  78.29  88.73  87.32  87.76 102.8   82.85  94.21 128.1   75.49 107.1
  78.18 114.6  118.4   78.83  84.06  96.12  82.69  80.45 121.3  137.8
  98.73  92.33  81.25 152.1   61.49  64.12  79.47  71.25 104.7  103.8
  76.31  94.66  88.64  94.29  97.26  72.76 120.8  130.5   84.45  82.51
  59.96 165.5   71.3   88.73  63.    54.53  87.44  78.94  90.31  77.83
  75.89  75.21  87.76 134.7   70.79 137.8   93.77  76.37  47.98  48.34
  74.65  95.81  94.7   84.88  89.77  87.19  65.31  65.85  61.05  68.89
  68.51  71.49  81.35  59.01  82.5   65.67  64.73  59.26  96.39  74.52
  91.38  70.67 103.4  143.   142.   131.2  108.3  140.1   47.92] [1001.  1
326.  1203.   386.1 1297.   477.1 1040.   577.9  519.8  475.9
  797.8  781.  1123.   782.7  578.3  658.8  684.5  798.8 1260.   566.3
```

```
 520.   273.9  704.4 1404.   904.6  912.7  644.8 1094.   732.4  955.1
1088.   440.6  899.3 1162.   807.2  869.5  633.   523.8  698.8  559.2
 563.   371.1 1104.   545.2  531.5 1076.   201.9  534.6  449.3  561.
 427.9  571.8  437.6 1033.   712.8  409.  1152.   656.9  527.2  224.5
 311.9  221.8  645.7  260.9  499.   668.3  269.4  394.1  250.5  502.5
1130.   244.   929.4  584.1  470.9  817.7  559.2 1006.  1245.   506.3
 401.5  520.  1878.  1132.   443.3 1075.   648.2 1076.   466.1  651.9
 662.7  728.2  551.7  555.1  705.6 1264.   451.1  294.5  412.6  642.5
 582.7  143.5  458.7  298.3  336.1  530.2  412.5  466.7 1509.   396.5
 290.2  480.4  629.9  334.2  230.9  438.6  245.2  682.5  782.6  982.
 403.3 1077.  1761.   640.7  553.5  588.7  572.6 1138.   674.5 1192.
 455.8  748.9  809.8  761.7 1075.   506.3  423.6  399.8  678.1  384.8
 288.5  813.   398.   512.2  355.3  432.8  432.   689.5  640.1  585.
 519.4  203.9  300.2  381.9  538.9  460.3  963.7  880.2  448.6  366.8
 419.8 1157.  1214.   464.5 1686.   690.2  357.6  886.3  984.6  685.9
 464.1  565.4  736.9  372.7  349.6  227.2  302.4  832.9  526.4  508.8
2250.  1311.   766.6  402.   710.6  317.5 1041.   420.3  428.9  463.7
 609.9  507.4  288.1  477.4  671.4  516.4  588.9 1024.  1148.   642.7
 461.   951.6 1685.   597.8  481.9  716.6  295.4  904.3  529.4  725.5
1290.   428.  2499.   948.   610.7  578.9  432.2  321.2 1230.  1223.
 568.9  561.3  313.1  761.3  546.4  641.2  329.6  684.5  496.4  503.2
 895.   395.7  386.8 1319.   279.6  603.4 1670.  1306.   623.9  920.6
 575.3  476.5  389.4  590.  1155.   337.7  541.6  512.2  347.   406.3
1364.   407.4 1206.   928.2 1169.   602.4 1207.   713.3  773.5  744.9
1288.   933.1  947.8  758.6  928.3 1419.   346.4  561.   512.2  344.9
 632.6  388.  1491.   289.9  998.9  435.6  396.6 1102.   572.3  587.4
1138.   427.3 1145.   805.1  516.6  489.   441.   515.9  394.1  396.
 651.   687.3  513.7  432.7  492.1  582.7  363.7  431.1  633.1  334.2
1217.   471.3 1247.   334.3  403.1  417.2  537.3  246.3  566.2  530.6
 418.7  664.9  504.1  409.1  221.2  481.6  461.4 1027.   244.5  477.3
 324.2 1274.   504.8 1264.   457.9  489.9  616.5  446.   813.7  826.8
 793.2  514.   387.3  390.   464.4  918.6  514.3 1092.   310.8 1747.
 641.2  280.5  373.9 1194.   420.3  321.6  445.3  668.7  402.7  426.7
 421.   758.6 2010.   716.6  384.6  485.8  512.   593.7  241.   278.6
 491.9  546.1  496.6  838.1  552.4 1293.  1234.   458.4 1546.  1482.
 840.4  711.8 1386.  1335.   579.1  788.5  338.3  562.1  580.6  361.6
 386.3  372.7  447.8  462.9  541.8  664.7  462.   596.6  392.  1174.
 321.6  234.3  744.7 1407.   446.2  609.1  558.1  508.3  378.2  431.9
 994.   442.7  525.2  507.6  469.1  370.   800.   514.5  991.7  466.1
 399.8  373.2  268.8  693.7  719.5  433.8  271.2  803.1  495.   380.3
 409.7  656.1  408.2  575.3  289.7  307.3  333.6  359.9  381.1  501.3
 685.   467.8 1250.  1110.   673.7  599.5  509.2  611.2  592.6  606.5
 371.5  928.8  585.9  340.9  990.   441.3  981.6  674.8  659.7 1384.
 432.  1191.   442.5  644.2  492.9  557.2  415.1  537.9  520.2  290.9
 930.9 2501.   646.1  412.7  537.3  542.9  536.9  286.3  980.5  408.8
 289.1  449.9  686.9  465.4  358.9  506.9  618.4  599.4  404.9  815.8
 455.3  602.9  546.3  571.1  747.2  476.7  666.  1167.   420.5  857.6
 466.5  992.1 1007.   477.3  538.7  680.9  485.6  480.1 1068.  1320.
 689.4  595.9  476.3 1682.   248.7  272.5  453.1  366.5  819.8  731.3
 426.   680.7  556.7  658.8  701.9  391.2 1052.  1214.   493.1  493.8
 257.8 1841.   388.1  571.   293.2  221.3  551.1  468.5  594.2  445.2
 422.9  416.2  575.5 1299.   365.6 1308.   629.8  406.4  178.8  170.4
 402.9  656.4  668.6  538.4  584.8  573.2  324.9  320.8  285.7  361.6
 360.5  378.4  507.9  264.   514.3  321.4  311.7  271.3  657.1  403.5
 600.4  386.   716.9 1347.  1479.  1261.   858.1 1265.   181. ]
```

```
No artists with labels found to put in legend.  Note that artists whose la
bel start with an underscore are ignored when legend() is called with no a
rgument.
```

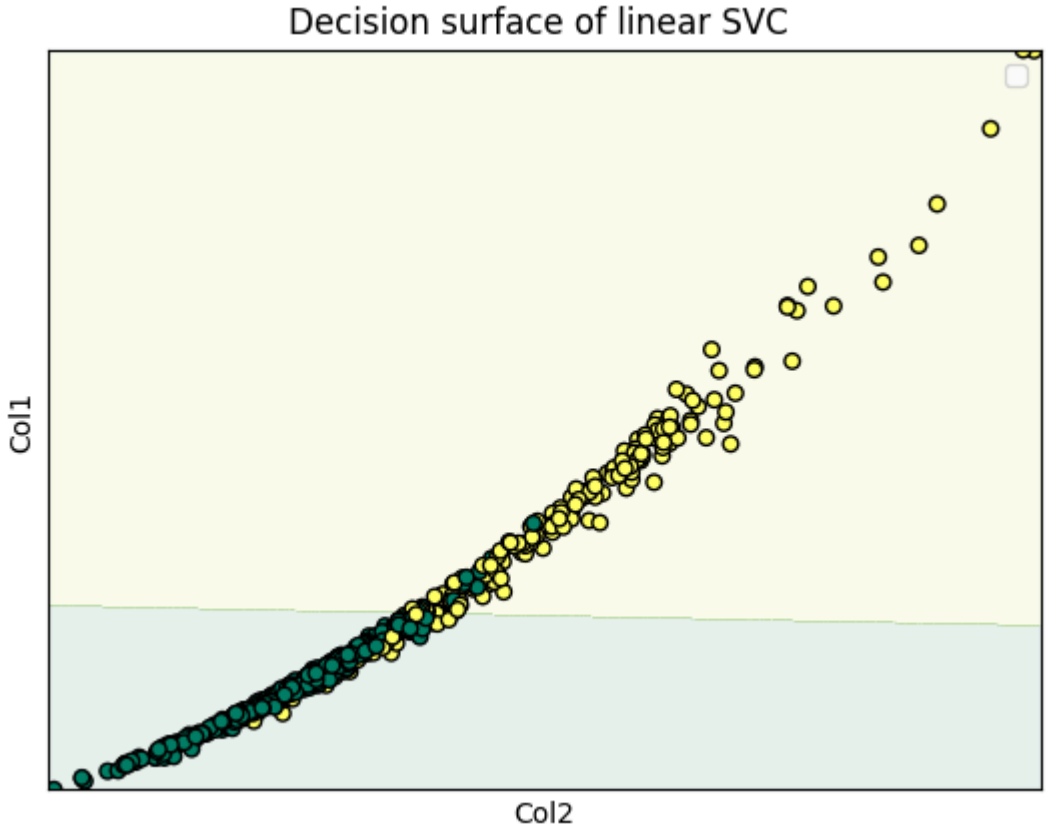


In [ ]:
```
X=x
model = SVC(kernel='poly',gamma='scale')
clf = model.fit(X, y)
print(clf)
fig, ax = plt.subplots()

title = ('Decision surface of linear SVC ')

X0, X1 = X[:, 0], X[:, 1]
print(X0,X1)
xx, yy = make_meshgrid(X0, X1)

plot_contours(ax, clf, xx, yy, cmap=plt.cm.summer, alpha=0.1)
ax.scatter(X0, X1, c=y, cmap=plt.cm.summer, s=30, edgecolors='k')
ax.set_ylabel('Col1')
ax.set_xlabel('Col2')
ax.set_xticks(())
ax.set_yticks(())
ax.set_title(title)
ax.legend()
plt.show()
```

```
SVC(kernel='poly')
[122.8  132.9  130.    77.58 135.1   82.57 119.6   90.2   87.5   83.97
 102.7  103.6  132.4  103.7   93.6   96.73  94.74 108.1  130.    87.46
  85.63  60.34 102.5  137.2  110.   116.    97.41 122.1  102.4  115.
 124.8   77.93 112.8  127.9  107.   110.1   93.63  82.61  95.54  88.4
  86.18  71.9  128.3   87.32  85.42 123.7   51.71  85.98  78.04  86.91
  74.72  87.21  75.71 120.3   97.26  73.34 125.5   95.55  82.61  54.34
  64.55  54.66  96.42  59.2   82.69  97.4   60.11  71.8   58.79  81.37
 123.6   58.79 114.2   90.43  79.19 104.1   87.91 120.2  143.7   83.19
  73.81  86.49 171.5  129.1   76.95 121.1   94.25 122.    79.78  95.77
  94.57 100.2   84.74  86.6  100.3  132.4   77.79  62.11  74.34  94.48
  88.05  43.79  77.22  63.95  67.41  87.21  75.17  79.01 152.8   72.48
  62.5   82.15  97.83  68.64  55.84  76.53  58.74  98.64 105.7  114.2
  73.34 121.4  166.2   94.28  86.1   88.44  87.76 123.4   99.58 130.4
  79.08 101.7  106.2  102.   120.2   81.72  74.72  73.06  96.85  73.
  61.24 105.1   73.66  83.74  68.26  78.11  78.99  97.84  93.97  88.12
  83.51  53.27  63.78  70.87  85.31  78.27 117.4  108.4   76.84  68.69
  76.1  126.3  130.7   79.85 152.1   95.5   68.77 109.3  116.1   96.22
  78.85  85.84 102.5   70.21  67.49  54.42  64.6  109.3   82.01  81.29
 182.1  142.7  101.2   73.53  98.92  63.76 118.6   74.68  75.27  78.83
  94.37  82.02  60.73  81.15 100.4   82.53  90.63 117.4  127.5   94.49
  78.54 115.1  158.9   91.56  81.09  98.78  62.92 109.7   87.02  98.17
 134.7   75.51 188.5  114.5   92.87  90.96  77.32  65.05 129.7  128.
  87.88  88.59  65.12 102.6   84.55  92.51  66.62  97.45  81.35  85.26
 113.4   71.76  70.79 134.4   60.21  89.79 153.5  132.5   92.55 113.4
  87.38  78.61  73.93  88.54 129.1   66.72  84.13  84.95  68.01  73.87
 138.9   73.28 130.7  113.   126.5   91.43 133.6  103.2  110.2  103.7
 132.9  111.   114.4  100.   111.6  135.7   69.28  87.16  82.38  69.5
  90.3   72.23 147.3   61.5  115.2   76.2   71.79 120.9   86.24  88.99
 126.2   74.24 127.2  108.8   84.08  79.83  77.87  81.89  73.72  72.17
  96.03  97.03  83.14  75.54  81.78  88.06  69.14  75.    91.22  66.85
 129.5   80.43 134.7   66.86  73.59  74.23  84.07  56.36  85.69  82.71
  74.33  92.68  82.29  73.73  54.09  79.19  77.25 118.7   60.07  78.6
  66.52 131.1   82.82 135.9   78.01  81.25  90.03  76.09 106.9  107.5
 105.8   84.52  71.94  71.38  77.88 111.8   84.08 122.9   64.41 155.1
  94.15  61.64  71.49 129.9   75.03  66.2   76.66  94.87  73.02  77.23
  73.7  107.1  174.2   98.    71.24  81.92  85.09  88.52  56.74  59.82
  79.42  85.24  81.87 106.6   85.48 133.8  133.7   78.31 140.9  147.2
 109.    97.65 141.3  134.8   87.84 106.3   70.15  85.89  88.27  73.3
  73.16  70.67  78.75  80.64  85.79  93.97  78.78  88.37  73.38 128.9
  65.75  55.27 102.4  144.4   78.07  89.75  88.1   83.05  70.31  75.26
 124.4   76.14  84.18  83.18  78.29  70.39 104.3   82.63 117.8   78.41
  72.49  70.92  59.75  97.53  96.71  76.39  59.6  102.9   80.88  70.95
  74.2   98.22  75.46  89.46  61.93  63.19  67.49  68.79  70.47  80.98
 102.1   81.47 133.8  123.7   94.89  91.12  82.67  89.78  88.68  89.59
  71.73 112.4   88.37  66.82 117.5   77.61 117.3   95.88  94.25 138.1
  76.83 127.7   76.77  93.86  80.62  86.34  74.87  84.1   82.61  61.68
 111.2  186.9   92.25  73.88  84.28  86.87  85.98  61.06 119.    76.38
  61.49  76.85  96.45  77.42  70.41  82.89  92.41  88.97  73.99 109.8
  78.29  88.73  87.32  87.76 102.8   82.85  94.21 128.1   75.49 107.1
  78.18 114.6  118.4   78.83  84.06  96.12  82.69  80.45 121.3  137.8
  98.73  92.33  81.25 152.1   61.49  64.12  79.47  71.25 104.7  103.8
  76.31  94.66  88.64  94.29  97.26  72.76 120.8  130.5   84.45  82.51
  59.96 165.5   71.3   88.73  63.    54.53  87.44  78.94  90.31  77.83
  75.89  75.21  87.76 134.7   70.79 137.8   93.77  76.37  47.98  48.34
  74.65  95.81  94.7   84.88  89.77  87.19  65.31  65.85  61.05  68.89
  68.51  71.49  81.35  59.01  82.5   65.67  64.73  59.26  96.39  74.52
  91.38  70.67 103.4  143.   142.   131.2  108.3  140.1   47.92] [1001.  1
326.  1203.   386.1 1297.   477.1 1040.   577.9  519.8  475.9
  797.8  781.  1123.   782.7  578.3  658.8  684.5  798.8 1260.   566.3
```

```
 520.   273.9  704.4 1404.   904.6  912.7  644.8 1094.   732.4  955.1
1088.   440.6  899.3 1162.   807.2  869.5  633.   523.8  698.8  559.2
 563.   371.1 1104.   545.2  531.5 1076.   201.9  534.6  449.3  561.
 427.9  571.8  437.6 1033.   712.8  409.  1152.   656.9  527.2  224.5
 311.9  221.8  645.7  260.9  499.   668.3  269.4  394.1  250.5  502.5
1130.   244.   929.4  584.1  470.9  817.7  559.2 1006.  1245.   506.3
 401.5  520.  1878.  1132.   443.3 1075.   648.2 1076.   466.1  651.9
 662.7  728.2  551.7  555.1  705.6 1264.   451.1  294.5  412.6  642.5
 582.7  143.5  458.7  298.3  336.1  530.2  412.5  466.7 1509.   396.5
 290.2  480.4  629.9  334.2  230.9  438.6  245.2  682.5  782.6  982.
 403.3 1077.  1761.   640.7  553.5  588.7  572.6 1138.   674.5 1192.
 455.8  748.9  809.8  761.7 1075.   506.3  423.6  399.8  678.1  384.8
 288.5  813.   398.   512.2  355.3  432.8  432.   689.5  640.1  585.
 519.4  203.9  300.2  381.9  538.9  460.3  963.7  880.2  448.6  366.8
 419.8 1157.  1214.   464.5 1686.   690.2  357.6  886.3  984.6  685.9
 464.1  565.4  736.9  372.7  349.6  227.2  302.4  832.9  526.4  508.8
2250.  1311.   766.6  402.   710.6  317.5 1041.   420.3  428.9  463.7
 609.9  507.4  288.1  477.4  671.4  516.4  588.9 1024.  1148.   642.7
 461.   951.6 1685.   597.8  481.9  716.6  295.4  904.3  529.4  725.5
1290.   428.  2499.   948.   610.7  578.9  432.2  321.2 1230.  1223.
 568.9  561.3  313.1  761.3  546.4  641.2  329.6  684.5  496.4  503.2
 895.   395.7  386.8 1319.   279.6  603.4 1670.  1306.   623.9  920.6
 575.3  476.5  389.4  590.  1155.   337.7  541.6  512.2  347.   406.3
1364.   407.4 1206.   928.2 1169.   602.4 1207.   713.3  773.5  744.9
1288.   933.1  947.8  758.6  928.3 1419.   346.4  561.   512.2  344.9
 632.6  388.  1491.   289.9  998.9  435.6  396.6 1102.   572.3  587.4
1138.   427.3 1145.   805.1  516.6  489.   441.   515.9  394.1  396.
 651.   687.3  513.7  432.7  492.1  582.7  363.7  431.1  633.1  334.2
1217.   471.3 1247.   334.3  403.1  417.2  537.3  246.3  566.2  530.6
 418.7  664.9  504.1  409.1  221.2  481.6  461.4 1027.   244.5  477.3
 324.2 1274.   504.8 1264.   457.9  489.9  616.5  446.   813.7  826.8
 793.2  514.   387.3  390.   464.4  918.6  514.3 1092.   310.8 1747.
 641.2  280.5  373.9 1194.   420.3  321.6  445.3  668.7  402.7  426.7
 421.   758.6 2010.   716.6  384.6  485.8  512.   593.7  241.   278.6
 491.9  546.1  496.6  838.1  552.4 1293.  1234.   458.4 1546.  1482.
 840.4  711.8 1386.  1335.   579.1  788.5  338.3  562.1  580.6  361.6
 386.3  372.7  447.8  462.9  541.8  664.7  462.   596.6  392.  1174.
 321.6  234.3  744.7 1407.   446.2  609.1  558.1  508.3  378.2  431.9
 994.   442.7  525.2  507.6  469.1  370.   800.   514.5  991.7  466.1
 399.8  373.2  268.8  693.7  719.5  433.8  271.2  803.1  495.   380.3
 409.7  656.1  408.2  575.3  289.7  307.3  333.6  359.9  381.1  501.3
 685.   467.8 1250.  1110.   673.7  599.5  509.2  611.2  592.6  606.5
 371.5  928.8  585.9  340.9  990.   441.3  981.6  674.8  659.7 1384.
 432.  1191.   442.5  644.2  492.9  557.2  415.1  537.9  520.2  290.9
 930.9 2501.   646.1  412.7  537.3  542.9  536.9  286.3  980.5  408.8
 289.1  449.9  686.9  465.4  358.9  506.9  618.4  599.4  404.9  815.8
 455.3  602.9  546.3  571.1  747.2  476.7  666.  1167.   420.5  857.6
 466.5  992.1 1007.   477.3  538.7  680.9  485.6  480.1 1068.  1320.
 689.4  595.9  476.3 1682.   248.7  272.5  453.1  366.5  819.8  731.3
 426.   680.7  556.7  658.8  701.9  391.2 1052.  1214.   493.1  493.8
 257.8 1841.   388.1  571.   293.2  221.3  551.1  468.5  594.2  445.2
 422.9  416.2  575.5 1299.   365.6 1308.   629.8  406.4  178.8  170.4
 402.9  656.4  668.6  538.4  584.8  573.2  324.9  320.8  285.7  361.6
 360.5  378.4  507.9  264.   514.3  321.4  311.7  271.3  657.1  403.5
 600.4  386.   716.9 1347.  1479.  1261.   858.1 1265.   181. ]
```

```
No artists with labels found to put in legend.  Note that artists whose la
bel start with an underscore are ignored when legend() is called with no a
rgument.
```

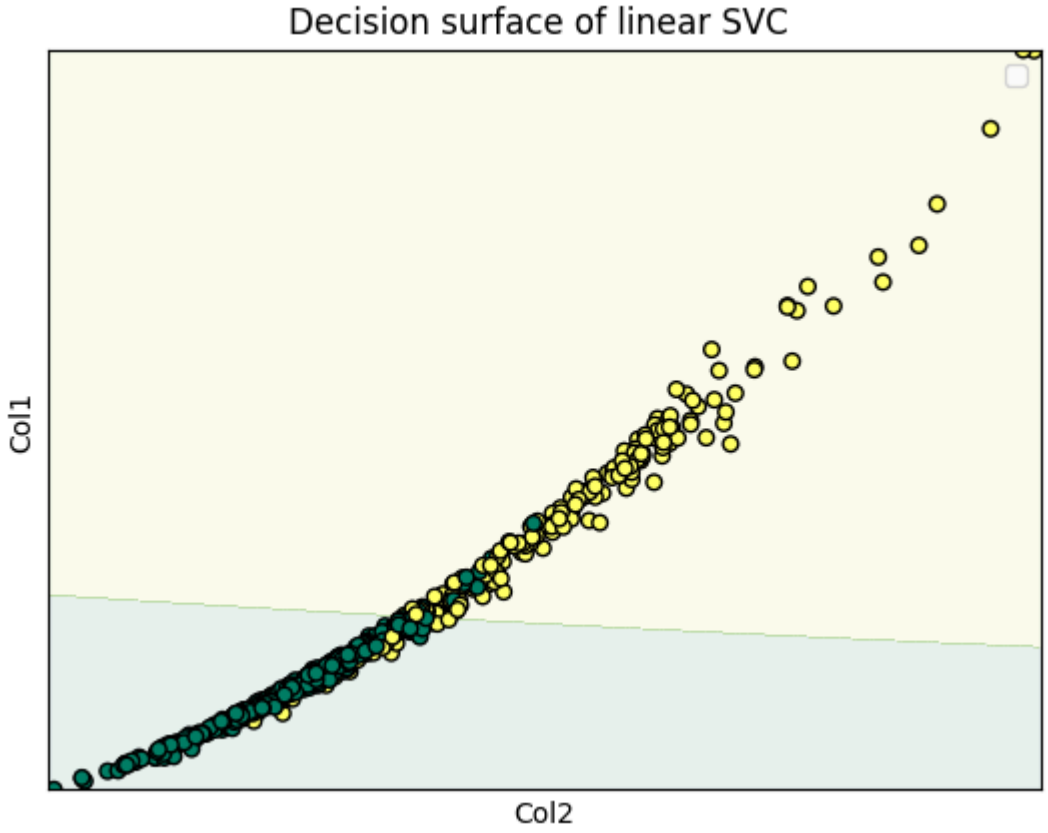


In [ ]:
```
X=x
model = SVC(kernel='poly',tol=1,shrinking=True,probability=True)
clf = model.fit(X, y)
print(clf)
fig, ax = plt.subplots()

title = ('Decision surface of linear SVC ')

X0, X1 = X[:, 0], X[:, 1]
print(X0,X1)
xx, yy = make_meshgrid(X0, X1)

plot_contours(ax, clf, xx, yy, cmap=plt.cm.summer, alpha=0.1)
ax.scatter(X0, X1, c=y, cmap=plt.cm.summer, s=30, edgecolors='k')
ax.set_ylabel('Col1')
ax.set_xlabel('Col2')
ax.set_xticks(())
ax.set_yticks(())
ax.set_title(title)
ax.legend()
plt.show()
```

```
SVC(kernel='poly', probability=True, tol=1)
[122.8  132.9  130.    77.58 135.1   82.57 119.6   90.2   87.5   83.97
 102.7  103.6  132.4  103.7   93.6   96.73  94.74 108.1  130.    87.46
  85.63  60.34 102.5  137.2  110.   116.    97.41 122.1  102.4  115.
 124.8   77.93 112.8  127.9  107.   110.1   93.63  82.61  95.54  88.4
  86.18  71.9  128.3   87.32  85.42 123.7   51.71  85.98  78.04  86.91
  74.72  87.21  75.71 120.3   97.26  73.34 125.5   95.55  82.61  54.34
  64.55  54.66  96.42  59.2   82.69  97.4   60.11  71.8   58.79  81.37
 123.6   58.79 114.2   90.43  79.19 104.1   87.91 120.2  143.7   83.19
  73.81  86.49 171.5  129.1   76.95 121.1   94.25 122.    79.78  95.77
  94.57 100.2   84.74  86.6  100.3  132.4   77.79  62.11  74.34  94.48
  88.05  43.79  77.22  63.95  67.41  87.21  75.17  79.01 152.8   72.48
  62.5   82.15  97.83  68.64  55.84  76.53  58.74  98.64 105.7  114.2
  73.34 121.4  166.2   94.28  86.1   88.44  87.76 123.4   99.58 130.4
  79.08 101.7  106.2  102.   120.2   81.72  74.72  73.06  96.85  73.
  61.24 105.1   73.66  83.74  68.26  78.11  78.99  97.84  93.97  88.12
  83.51  53.27  63.78  70.87  85.31  78.27 117.4  108.4   76.84  68.69
  76.1  126.3  130.7   79.85 152.1   95.5   68.77 109.3  116.1   96.22
  78.85  85.84 102.5   70.21  67.49  54.42  64.6  109.3   82.01  81.29
 182.1  142.7  101.2   73.53  98.92  63.76 118.6   74.68  75.27  78.83
  94.37  82.02  60.73  81.15 100.4   82.53  90.63 117.4  127.5   94.49
  78.54 115.1  158.9   91.56  81.09  98.78  62.92 109.7   87.02  98.17
 134.7   75.51 188.5  114.5   92.87  90.96  77.32  65.05 129.7  128.
  87.88  88.59  65.12 102.6   84.55  92.51  66.62  97.45  81.35  85.26
 113.4   71.76  70.79 134.4   60.21  89.79 153.5  132.5   92.55 113.4
  87.38  78.61  73.93  88.54 129.1   66.72  84.13  84.95  68.01  73.87
 138.9   73.28 130.7  113.   126.5   91.43 133.6  103.2  110.2  103.7
 132.9  111.   114.4  100.   111.6  135.7   69.28  87.16  82.38  69.5
  90.3   72.23 147.3   61.5  115.2   76.2   71.79 120.9   86.24  88.99
 126.2   74.24 127.2  108.8   84.08  79.83  77.87  81.89  73.72  72.17
  96.03  97.03  83.14  75.54  81.78  88.06  69.14  75.    91.22  66.85
 129.5   80.43 134.7   66.86  73.59  74.23  84.07  56.36  85.69  82.71
  74.33  92.68  82.29  73.73  54.09  79.19  77.25 118.7   60.07  78.6
  66.52 131.1   82.82 135.9   78.01  81.25  90.03  76.09 106.9  107.5
 105.8   84.52  71.94  71.38  77.88 111.8   84.08 122.9   64.41 155.1
  94.15  61.64  71.49 129.9   75.03  66.2   76.66  94.87  73.02  77.23
  73.7  107.1  174.2   98.    71.24  81.92  85.09  88.52  56.74  59.82
  79.42  85.24  81.87 106.6   85.48 133.8  133.7   78.31 140.9  147.2
 109.    97.65 141.3  134.8   87.84 106.3   70.15  85.89  88.27  73.3
  73.16  70.67  78.75  80.64  85.79  93.97  78.78  88.37  73.38 128.9
  65.75  55.27 102.4  144.4   78.07  89.75  88.1   83.05  70.31  75.26
 124.4   76.14  84.18  83.18  78.29  70.39 104.3   82.63 117.8   78.41
  72.49  70.92  59.75  97.53  96.71  76.39  59.6  102.9   80.88  70.95
  74.2   98.22  75.46  89.46  61.93  63.19  67.49  68.79  70.47  80.98
 102.1   81.47 133.8  123.7   94.89  91.12  82.67  89.78  88.68  89.59
  71.73 112.4   88.37  66.82 117.5   77.61 117.3   95.88  94.25 138.1
  76.83 127.7   76.77  93.86  80.62  86.34  74.87  84.1   82.61  61.68
 111.2  186.9   92.25  73.88  84.28  86.87  85.98  61.06 119.    76.38
  61.49  76.85  96.45  77.42  70.41  82.89  92.41  88.97  73.99 109.8
  78.29  88.73  87.32  87.76 102.8   82.85  94.21 128.1   75.49 107.1
  78.18 114.6  118.4   78.83  84.06  96.12  82.69  80.45 121.3  137.8
  98.73  92.33  81.25 152.1   61.49  64.12  79.47  71.25 104.7  103.8
  76.31  94.66  88.64  94.29  97.26  72.76 120.8  130.5   84.45  82.51
  59.96 165.5   71.3   88.73  63.    54.53  87.44  78.94  90.31  77.83
  75.89  75.21  87.76 134.7   70.79 137.8   93.77  76.37  47.98  48.34
  74.65  95.81  94.7   84.88  89.77  87.19  65.31  65.85  61.05  68.89
  68.51  71.49  81.35  59.01  82.5   65.67  64.73  59.26  96.39  74.52
  91.38  70.67 103.4  143.   142.   131.2  108.3  140.1   47.92] [1001.  1
326.  1203.   386.1 1297.   477.1 1040.   577.9  519.8  475.9
  797.8  781.  1123.   782.7  578.3  658.8  684.5  798.8 1260.   566.3
```

```
 520.   273.9  704.4 1404.   904.6  912.7  644.8 1094.   732.4  955.1
1088.   440.6  899.3 1162.   807.2  869.5  633.   523.8  698.8  559.2
 563.   371.1 1104.   545.2  531.5 1076.   201.9  534.6  449.3  561.
 427.9  571.8  437.6 1033.   712.8  409.  1152.   656.9  527.2  224.5
 311.9  221.8  645.7  260.9  499.   668.3  269.4  394.1  250.5  502.5
1130.   244.   929.4  584.1  470.9  817.7  559.2 1006.  1245.   506.3
 401.5  520.  1878.  1132.   443.3 1075.   648.2 1076.   466.1  651.9
 662.7  728.2  551.7  555.1  705.6 1264.   451.1  294.5  412.6  642.5
 582.7  143.5  458.7  298.3  336.1  530.2  412.5  466.7 1509.   396.5
 290.2  480.4  629.9  334.2  230.9  438.6  245.2  682.5  782.6  982.
 403.3 1077.  1761.   640.7  553.5  588.7  572.6 1138.   674.5 1192.
 455.8  748.9  809.8  761.7 1075.   506.3  423.6  399.8  678.1  384.8
 288.5  813.   398.   512.2  355.3  432.8  432.   689.5  640.1  585.
 519.4  203.9  300.2  381.9  538.9  460.3  963.7  880.2  448.6  366.8
 419.8 1157.  1214.   464.5 1686.   690.2  357.6  886.3  984.6  685.9
 464.1  565.4  736.9  372.7  349.6  227.2  302.4  832.9  526.4  508.8
2250.  1311.   766.6  402.   710.6  317.5 1041.   420.3  428.9  463.7
 609.9  507.4  288.1  477.4  671.4  516.4  588.9 1024.  1148.   642.7
 461.   951.6 1685.   597.8  481.9  716.6  295.4  904.3  529.4  725.5
1290.   428.  2499.   948.   610.7  578.9  432.2  321.2 1230.  1223.
 568.9  561.3  313.1  761.3  546.4  641.2  329.6  684.5  496.4  503.2
 895.   395.7  386.8 1319.   279.6  603.4 1670.  1306.   623.9  920.6
 575.3  476.5  389.4  590.  1155.   337.7  541.6  512.2  347.   406.3
1364.   407.4 1206.   928.2 1169.   602.4 1207.   713.3  773.5  744.9
1288.   933.1  947.8  758.6  928.3 1419.   346.4  561.   512.2  344.9
 632.6  388.  1491.   289.9  998.9  435.6  396.6 1102.   572.3  587.4
1138.   427.3 1145.   805.1  516.6  489.   441.   515.9  394.1  396.
 651.   687.3  513.7  432.7  492.1  582.7  363.7  431.1  633.1  334.2
1217.   471.3 1247.   334.3  403.1  417.2  537.3  246.3  566.2  530.6
 418.7  664.9  504.1  409.1  221.2  481.6  461.4 1027.   244.5  477.3
 324.2 1274.   504.8 1264.   457.9  489.9  616.5  446.   813.7  826.8
 793.2  514.   387.3  390.   464.4  918.6  514.3 1092.   310.8 1747.
 641.2  280.5  373.9 1194.   420.3  321.6  445.3  668.7  402.7  426.7
 421.   758.6 2010.   716.6  384.6  485.8  512.   593.7  241.   278.6
 491.9  546.1  496.6  838.1  552.4 1293.  1234.   458.4 1546.  1482.
 840.4  711.8 1386.  1335.   579.1  788.5  338.3  562.1  580.6  361.6
 386.3  372.7  447.8  462.9  541.8  664.7  462.   596.6  392.  1174.
 321.6  234.3  744.7 1407.   446.2  609.1  558.1  508.3  378.2  431.9
 994.   442.7  525.2  507.6  469.1  370.   800.   514.5  991.7  466.1
 399.8  373.2  268.8  693.7  719.5  433.8  271.2  803.1  495.   380.3
 409.7  656.1  408.2  575.3  289.7  307.3  333.6  359.9  381.1  501.3
 685.   467.8 1250.  1110.   673.7  599.5  509.2  611.2  592.6  606.5
 371.5  928.8  585.9  340.9  990.   441.3  981.6  674.8  659.7 1384.
 432.  1191.   442.5  644.2  492.9  557.2  415.1  537.9  520.2  290.9
 930.9 2501.   646.1  412.7  537.3  542.9  536.9  286.3  980.5  408.8
 289.1  449.9  686.9  465.4  358.9  506.9  618.4  599.4  404.9  815.8
 455.3  602.9  546.3  571.1  747.2  476.7  666.  1167.   420.5  857.6
 466.5  992.1 1007.   477.3  538.7  680.9  485.6  480.1 1068.  1320.
 689.4  595.9  476.3 1682.   248.7  272.5  453.1  366.5  819.8  731.3
 426.   680.7  556.7  658.8  701.9  391.2 1052.  1214.   493.1  493.8
 257.8 1841.   388.1  571.   293.2  221.3  551.1  468.5  594.2  445.2
 422.9  416.2  575.5 1299.   365.6 1308.   629.8  406.4  178.8  170.4
 402.9  656.4  668.6  538.4  584.8  573.2  324.9  320.8  285.7  361.6
 360.5  378.4  507.9  264.   514.3  321.4  311.7  271.3  657.1  403.5
 600.4  386.   716.9 1347.  1479.  1261.   858.1 1265.   181. ]
```

```
No artists with labels found to put in legend.  Note that artists whose la
bel start with an underscore are ignored when legend() is called with no a
rgument.
```



3. Check accuracy in terms of percentage

if possible try train test split to get training accuracy and testing accuracy

In [ ]:
```
import pandas as pd
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
df = pd.read_csv('cancer.csv')
x = df.drop('diagnosis', axis=1)
y = df['diagnosis']
X_train, X_test, y_train, y_test = train_test_split(x, y, test_size=0.2,
clf = SVC(kernel='linear')
clf.fit(X_train, y_train)



y_train_pred = clf.predict(X_train)
y_test_pred = clf.predict(X_test)


train_accuracy = accuracy_score(y_train, y_train_pred) * 100
test_accuracy = accuracy_score(y_test, y_test_pred) * 100

print("Accuracy for training data : ", train_accuracy)
print("Accuracy for testing data : ", test_accuracy)
```

```
Accuracy for training data :  89.23076923076924
Accuracy for testing data :  88.59649122807018
```

5. Check SVM with Data we used in Decision Tree

In [ ]:
```
import matplotlib.pyplot as plt

df = pd.read_csv("dataTree1.csv")

d = {'UK': 0, 'USA': 1, 'N': 2}
df['Nationality'] = df['Nationality'].map(d)
d = {'YES': 1, 'NO': 0}
df['Go'] = df['Go'].map(d)

features = ['Age', 'Experience', 'Rank','Nationality']

features = ['Experience', 'Rank']
print(features)
X1a = df[features]
y = df['Go']

model = SVC()
clf = model.fit(X1a, y)

features = ['Experience', 'Rank']
print(features)
X = df[features]
```

```
['Experience', 'Rank']
['Experience', 'Rank']
```

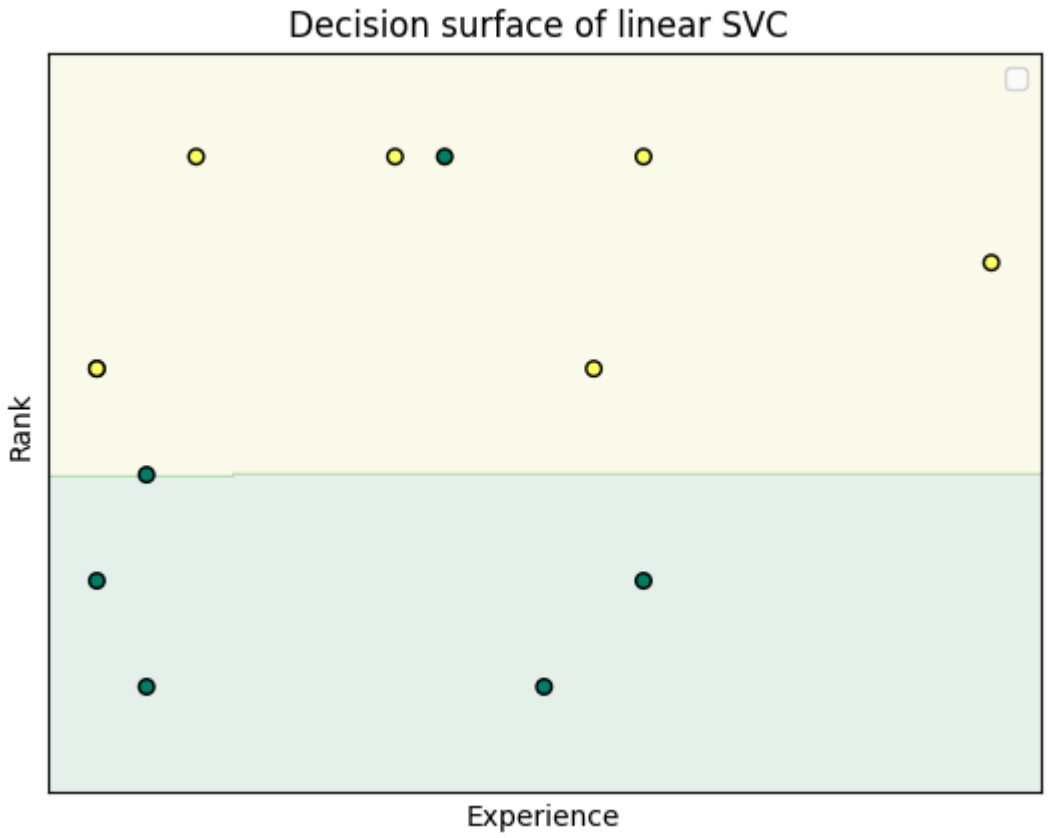
5. Check SVM with Data we used in Decision Tree

In [ ]:
```
import pandas as pd
import numpy as np
df = pd.read_csv('dataTree1.csv')
go = {'NO': 0, 'YES': 1}
df['Go'] = df['Go'].map(go)
nationality = {'UK': 0, 'USA': 1, 'N': 2}
df['Nationality'] = df['Nationality'].map(nationality)
month = {'Jan': 0, 'April': 1, 'May': 2, 'June': 3, 'July': 4, 'Sep': 5,
df['Month'] = df['Month'].map(month)
arr = np.array(df)
y = arr[:, 4]
x = np.column_stack((df.Age, df.Experience, df.Rank, df.Nationality))
```

In [ ]:
```
import numpy as np

def make_meshgrid(x, y, h=.02):
    x_min, x_max = x.min() - 1, x.max() + 1
    y_min, y_max = y.min() - 1, y.max() + 1
    xx, yy = np.meshgrid(np.arange(x_min, x_max, h), np.arange(y_min, y_m
    return xx, yy

def plot_contours(ax, clf, xx, yy, **params):
    Z = clf.predict(np.c_[xx.ravel(), yy.ravel()])
    Z = Z.reshape(xx.shape)
    out = ax.contourf(xx, yy, Z, **params)
    return out
model = SVC(kernel='linear')
clf = model.fit(X1a, y)
print(clf)
fig, ax = plt.subplots()
```

```
title = ('Decision surface of linear SVC ')

X0, X1 = X.iloc[:, 0], X.iloc[:, 1]
xx, yy = make_meshgrid(X0, X1)

plot_contours(ax, clf, xx, yy, cmap=plt.cm.summer, alpha=0.1)
ax.scatter(X0, X1, c=y, cmap=plt.cm.summer, s=30, edgecolors='k')
ax.set_ylabel('Rank')
ax.set_xlabel('Experience')
ax.set_xticks(())
ax.set_yticks(())
ax.set_title(title)
ax.legend()
plt.show()
```

```
/Library/Frameworks/Python.framework/Versions/3.11/lib/python3.11/site-pac
kages/sklearn/base.py:465: UserWarning: X does not have valid feature name
s, but SVC was fitted with feature names
  warnings.warn(
No artists with labels found to put in legend.  Note that artists whose la
bel start with an underscore are ignored when legend() is called with no a
rgument.
SVC(kernel='linear')
```



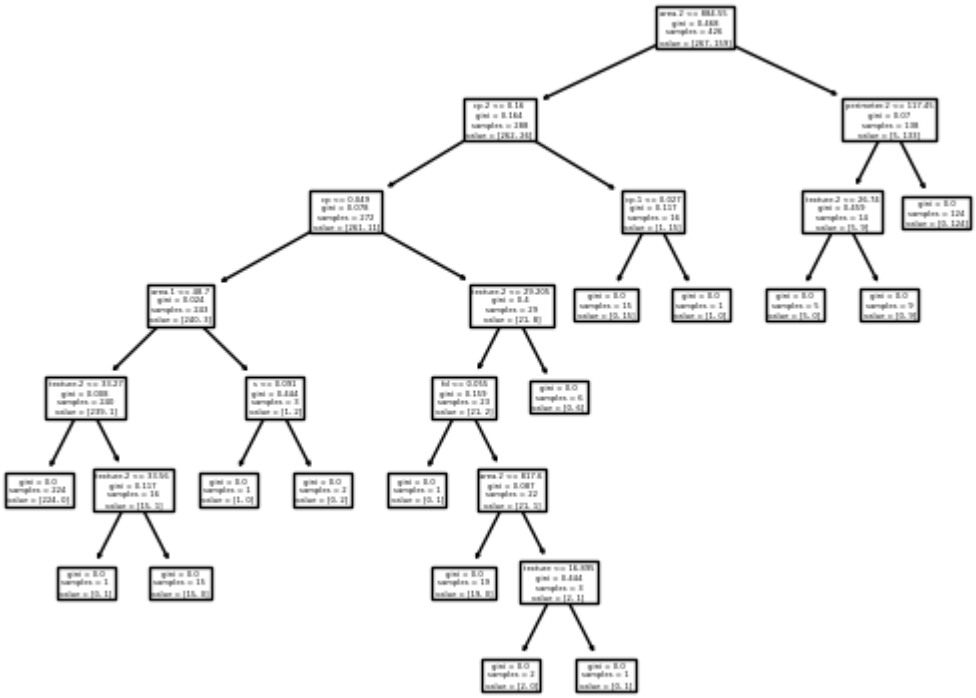
6. Run the Decision Tree for Cancer ALL data with 30 columns for X and Diagnosis column for y.(Please remove ID column)

In [ ]:
```
df = pd.read_excel("cancerAll.xlsx")
df = df.drop("ID",axis=1)
x=['radius', 'texture', 'perimeter', 'area', 's', 'c',
       'concavity', 'cp', 'sym', 'fd', 'radius.1', 'texture.1', 'perimete
       'area.1', 's.1', 'c.1', 'concavity.1', 'cp.1', 'sym.1', 'fd.1',
       'radius.2', 'texture.2', 'perimeter.2', 'area.2', 's.2', 'c.2',
       'concavity.2', 'cp.2', 'sym.2', 'fd.2']
```

```
X = df[x]
Y = df["diagnosis"]

from sklearn.tree import DecisionTreeClassifier
from sklearn import  tree
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
import matplotlib.pyplot as plt
from sklearn.tree import export_graphviz
from graphviz import Source
x_train,x_test,y_train,y_test = train_test_split(X,Y,random_state=3)
model = DecisionTreeClassifier(criterion="gini",splitter="best")
model = model.fit(x_train,y_train)
y_pred  = model.predict(x_test)
accuracy = accuracy_score(y_test,y_pred)*100
print(accuracy)
tree.plot_tree(model, feature_names=x)
```

```
93.7062937062937
```

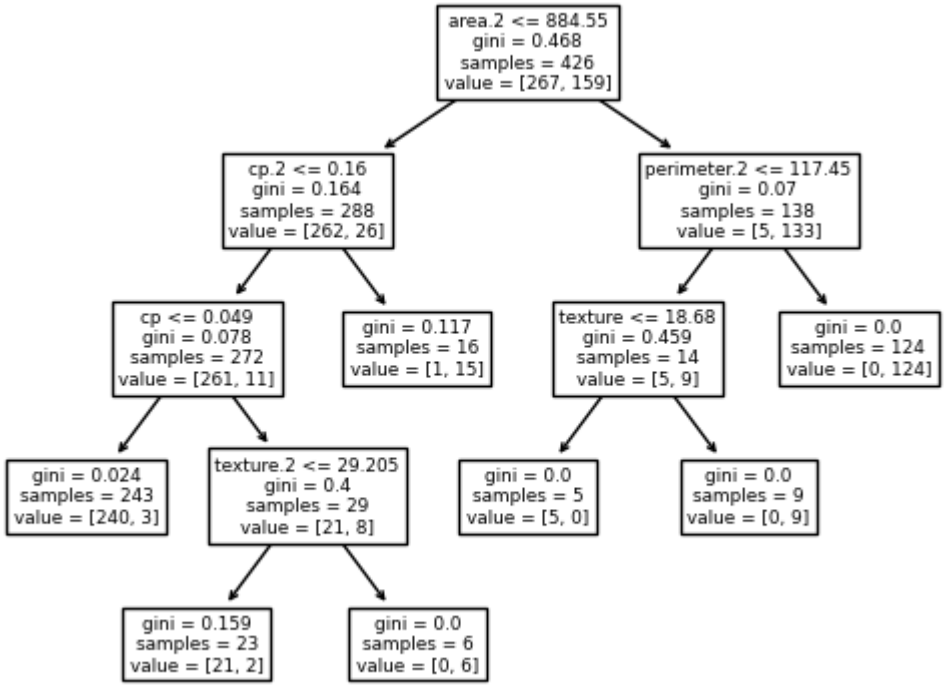
Out[ ]:
```
[Text(0.7083333333333334, 0.9375, 'area.2 <= 884.55\ngini = 0.468\nsampl
es = 426\nvalue = [267, 159]'),
 Text(0.5119047619047619, 0.8125, 'cp.2 <= 0.16\ngini = 0.164\nsamples =
288\nvalue = [262, 26]'),
 Text(0.35714285714285715, 0.6875, 'cp <= 0.049\ngini = 0.078\nsamples =
272\nvalue = [261, 11]'),
 Text(0.19047619047619047, 0.5625, 'area.1 <= 48.7\ngini = 0.024\nsample
s = 243\nvalue = [240, 3]'),
 Text(0.09523809523809523, 0.4375, 'texture.2 <= 33.27\ngini = 0.008\nsa
mples = 240\nvalue = [239, 1]'),
 Text(0.047619047619047616, 0.3125, 'gini = 0.0\nsamples = 224\nvalue =
[224, 0]'),
 Text(0.14285714285714285, 0.3125, 'texture.2 <= 33.56\ngini = 0.117\nsa
mples = 16\nvalue = [15, 1]'),
 Text(0.09523809523809523, 0.1875, 'gini = 0.0\nsamples = 1\nvalue = [0,
1]'),
 Text(0.19047619047619047, 0.1875, 'gini = 0.0\nsamples = 15\nvalue = [1
5, 0]'),
 Text(0.2857142857142857, 0.4375, 's <= 0.091\ngini = 0.444\nsamples = 3
\nvalue = [1, 2]'),
 Text(0.23809523809523808, 0.3125, 'gini = 0.0\nsamples = 1\nvalue = [1,
0]'),
 Text(0.3333333333333333, 0.3125, 'gini = 0.0\nsamples = 2\nvalue = [0,
2]'),
 Text(0.5238095238095238, 0.5625, 'texture.2 <= 29.205\ngini = 0.4\nsamp
les = 29\nvalue = [21, 8]'),
 Text(0.47619047619047616, 0.4375, 'fd <= 0.055\ngini = 0.159\nsamples =
23\nvalue = [21, 2]'),
 Text(0.42857142857142855, 0.3125, 'gini = 0.0\nsamples = 1\nvalue = [0,
1]'),
 Text(0.5238095238095238, 0.3125, 'area.2 <= 817.6\ngini = 0.087\nsample
s = 22\nvalue = [21, 1]'),
 Text(0.47619047619047616, 0.1875, 'gini = 0.0\nsamples = 19\nvalue = [1
9, 0]'),
 Text(0.5714285714285714, 0.1875, 'texture <= 16.895\ngini = 0.444\nsamp
les = 3\nvalue = [2, 1]'),
 Text(0.5238095238095238, 0.0625, 'gini = 0.0\nsamples = 2\nvalue = [2,
0]'),
 Text(0.6190476190476191, 0.0625, 'gini = 0.0\nsamples = 1\nvalue = [0,
1]'),
 Text(0.5714285714285714, 0.4375, 'gini = 0.0\nsamples = 6\nvalue = [0,
6]'),
 Text(0.6666666666666666, 0.6875, 'cp.1 <= 0.027\ngini = 0.117\nsamples
= 16\nvalue = [1, 15]'),
 Text(0.6190476190476191, 0.5625, 'gini = 0.0\nsamples = 15\nvalue = [0,
15]'),
 Text(0.7142857142857143, 0.5625, 'gini = 0.0\nsamples = 1\nvalue = [1,
0]'),
 Text(0.9047619047619048, 0.8125, 'perimeter.2 <= 117.45\ngini = 0.07\ns
amples = 138\nvalue = [5, 133]'),
 Text(0.8571428571428571, 0.6875, 'texture.2 <= 26.74\ngini = 0.459\nsam
ples = 14\nvalue = [5, 9]'),
 Text(0.8095238095238095, 0.5625, 'gini = 0.0\nsamples = 5\nvalue = [5,
0]'),
 Text(0.9047619047619048, 0.5625, 'gini = 0.0\nsamples = 9\nvalue = [0,
9]'),
 Text(0.9523809523809523, 0.6875, 'gini = 0.0\nsamples = 124\nvalue =
[0, 124]')]
```



In [ ]:
```
from sklearn.tree import DecisionTreeClassifier
from sklearn import  tree
from sklearn.model_selection import train_test_split
from sklearn.metrics import accuracy_score
import matplotlib.pyplot as plt
from sklearn.tree import export_graphviz
from graphviz import Source
x_train,x_test,y_train,y_test = train_test_split(X,Y,random_state=3)
model = DecisionTreeClassifier(criterion="gini",splitter="best",max_leaf_
model = model.fit(x_train,y_train)
y_pred  = model.predict(x_test)
accuracy = accuracy_score(y_test,y_pred)*100
print(accuracy)
tree.plot_tree(model, feature_names=x)
```

```
94.4055944055944
```

Out[ ]:
```
[Text(0.5555555555555556, 0.9, 'area.2 <= 884.55\ngini = 0.468\nsamples
= 426\nvalue = [267, 159]'),
 Text(0.3333333333333333, 0.7, 'cp.2 <= 0.16\ngini = 0.164\nsamples = 28
8\nvalue = [262, 26]'),
 Text(0.2222222222222222, 0.5, 'cp <= 0.049\ngini = 0.078\nsamples = 272
\nvalue = [261, 11]'),
 Text(0.1111111111111111, 0.3, 'gini = 0.024\nsamples = 243\nvalue = [24
0, 3]'),
 Text(0.3333333333333333, 0.3, 'texture.2 <= 29.205\ngini = 0.4\nsamples
= 29\nvalue = [21, 8]'),
 Text(0.2222222222222222, 0.1, 'gini = 0.159\nsamples = 23\nvalue = [21,
2]'),
 Text(0.4444444444444444, 0.1, 'gini = 0.0\nsamples = 6\nvalue = [0,
6]'),
 Text(0.4444444444444444, 0.5, 'gini = 0.117\nsamples = 16\nvalue = [1,
15]'),
 Text(0.7777777777777778, 0.7, 'perimeter.2 <= 117.45\ngini = 0.07\nsamp
les = 138\nvalue = [5, 133]'),
 Text(0.6666666666666666, 0.5, 'texture <= 18.68\ngini = 0.459\nsamples
= 14\nvalue = [5, 9]'),
 Text(0.5555555555555556, 0.3, 'gini = 0.0\nsamples = 5\nvalue = [5,
0]'),
 Text(0.7777777777777778, 0.3, 'gini = 0.0\nsamples = 9\nvalue = [0,
9]'),
 Text(0.8888888888888888, 0.5, 'gini = 0.0\nsamples = 124\nvalue = [0, 1
24]')]
```



In [ ]:
```
from sklearn.svm import SVC
x = ['area.2','cp.2','cp','texture.2','perimeter.2','texture']
X = df[x]
model = SVC(kernel='linear')
clf = model.fit(X, Y)
print(clf)
y_pred = clf.predict(X)
accuracy = accuracy_score(Y,y_pred)*100
print("Accuraccy of the model: ",accuracy)
```

```
SVC(kernel='linear')
Accuraccy of the model:  94.5518453427065
```

In [ ]: