Análisis de Datos y Aprendizaje Máquina con Tensorflow 2.0: Clasificación

2019/09/30

1 Árboles de decision ID3

- Objetivo: Conocer los arboles ID3 para clasificación y como visualizarlos
- Documentación: https://scikit-learn.org/stable/modules/tree.html#tree-algorithms-id3-c4-5-c5-0-and-cart

Los árboles de decisión son un método de aprendizaje supervisado relacionado con la entropía, se utiliza para la clasificación y la regresión. El algoritmo hace particiones en las características de los datos de forma que los va clasificando

Los árboles de decisión son muy interpretables, lo que puede ser muy útil con algunos conjuntos de datos, pues indican que variable difiere de otra en cuanto a la cantidad de datos que se particionan

```
In [1]: import sklearn
        import pandas as pd
        import seaborn as sns
        import matplotlib.pyplot as plt
```

1.1 Análisis exploratorio

1.1.1 Etiquetas de clase a valor numérico

- Diagnosis (M = malignant, B = benign)

```
In [2]: %matplotlib inline

        df = pd.read_csv("data-breast.csv",index_col=0)

        df.head(10)
```

```
Out[2]:           diagnosis  radius_mean  texture_mean  perimeter_mean  area_mean  \
        id
        842302            M        17.99         10.38          122.80     1001.0
        842517            M        20.57         17.77          132.90     1326.0
        84300903          M        19.69         21.25          130.00     1203.0
        84348301          M        11.42         20.38           77.58      386.1
        84358402          M        20.29         14.34          135.10     1297.0
```

```
843786          M        12.45          15.70            82.57      477.1
844359          M        18.25          19.98           119.60     1040.0
84458202        M        13.71          20.83            90.20      577.9
844981          M        13.00          21.82            87.50      519.8
84501001        M        12.46          24.04            83.97      475.9

          smoothness_mean  compactness_mean  concavity_mean  \
id
842302            0.11840           0.27760         0.30010
842517            0.08474           0.07864         0.08690
84300903          0.10960           0.15990         0.19740
84348301          0.14250           0.28390         0.24140
84358402          0.10030           0.13280         0.19800
843786            0.12780           0.17000         0.15780
844359            0.09463           0.10900         0.11270
84458202          0.11890           0.16450         0.09366
844981            0.12730           0.19320         0.18590
84501001          0.11860           0.23960         0.22730

          concave points_mean  symmetry_mean  ...  texture_worst  \
id                                            ...
842302                0.14710         0.2419  ...          17.33
842517                0.07017         0.1812  ...          23.41
84300903              0.12790         0.2069  ...          25.53
84348301              0.10520         0.2597  ...          26.50
84358402              0.10430         0.1809  ...          16.67
843786                0.08089         0.2087  ...          23.75
844359                0.07400         0.1794  ...          27.66
84458202              0.05985         0.2196  ...          28.14
844981                0.09353         0.2350  ...          30.73
84501001              0.08543         0.2030  ...          40.68

          perimeter_worst  area_worst  smoothness_worst  compactness_worst  \
id
842302             184.60      2019.0            0.1622             0.6656
842517             158.80      1956.0            0.1238             0.1866
84300903           152.50      1709.0            0.1444             0.4245
84348301            98.87       567.7            0.2098             0.8663
84358402           152.20      1575.0            0.1374             0.2050
843786             103.40       741.6            0.1791             0.5249
844359             153.20      1606.0            0.1442             0.2576
84458202           110.60       897.0            0.1654             0.3682
844981             106.20       739.3            0.1703             0.5401
84501001            97.65       711.4            0.1853             1.0580

          concavity_worst  concave points_worst  symmetry_worst  \
id
842302             0.7119                0.2654          0.4601
842517             0.2416                0.1860          0.2750
```

```
84300903            0.4504            0.2430          0.3613
84348301            0.6869            0.2575          0.6638
84358402            0.4000            0.1625          0.2364
843786              0.5355            0.1741          0.3985
844359              0.3784            0.1932          0.3063
84458202            0.2678            0.1556          0.3196
844981              0.5390            0.2060          0.4378
84501001            1.1050            0.2210          0.4366

          fractal_dimension_worst  Unnamed: 32
id
842302                    0.11890          NaN
842517                    0.08902          NaN
84300903                  0.08758          NaN
84348301                  0.17300          NaN
84358402                  0.07678          NaN
843786                    0.12440          NaN
844359                    0.08368          NaN
84458202                  0.11510          NaN
844981                    0.10720          NaN
84501001                  0.20750          NaN

[10 rows x 32 columns]
```

```
In [3]: df.iloc[:,1:].describe()
```

```
Out[3]:        radius_mean  texture_mean  perimeter_mean    area_mean  \
count   569.000000    569.000000      569.000000   569.000000
mean     14.127292     19.289649       91.969033   654.889104
std       3.524049      4.301036       24.298981   351.914129
min       6.981000      9.710000       43.790000   143.500000
25%      11.700000     16.170000       75.170000   420.300000
50%      13.370000     18.840000       86.240000   551.100000
75%      15.780000     21.800000      104.100000   782.700000
max      28.110000     39.280000      188.500000  2501.000000

       smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
count       569.000000        569.000000      569.000000           569.000000
mean          0.096360          0.104341        0.088799             0.048919
std           0.014064          0.052813        0.079720             0.038803
min           0.052630          0.019380        0.000000             0.000000
25%           0.086370          0.064920        0.029560             0.020310
50%           0.095870          0.092630        0.061540             0.033500
75%           0.105300          0.130400        0.130700             0.074000
max           0.163400          0.345400        0.426800             0.201200

       symmetry_mean  fractal_dimension_mean  ...  texture_worst  \
count     569.000000              569.000000  ...     569.000000
mean        0.181162                0.062798  ...      25.677223
std         0.027414                0.007060  ...       6.146258
```

```
min        0.106000                 0.049960  ...      12.020000
25%        0.161900                 0.057700  ...      21.080000
50%        0.179200                 0.061540  ...      25.410000
75%        0.195700                 0.066120  ...      29.720000
max        0.304000                 0.097440  ...      49.540000

       perimeter_worst   area_worst  smoothness_worst  compactness_worst  \
count       569.000000   569.000000        569.000000         569.000000
mean        107.261213   880.583128          0.132369           0.254265
std          33.602542   569.356993          0.022832           0.157336
min          50.410000   185.200000          0.071170           0.027290
25%          84.110000   515.300000          0.116600           0.147200
50%          97.660000   686.500000          0.131300           0.211900
75%         125.400000  1084.000000          0.146000           0.339100
max         251.200000  4254.000000          0.222600           1.058000

       concavity_worst  concave points_worst  symmetry_worst  \
count       569.000000            569.000000      569.000000
mean          0.272188              0.114606        0.290076
std           0.208624              0.065732        0.061867
min           0.000000              0.000000        0.156500
25%           0.114500              0.064930        0.250400
50%           0.226700              0.099930        0.282200
75%           0.382900              0.161400        0.317900
max           1.252000              0.291000        0.663800

       fractal_dimension_worst  Unnamed: 32
count               569.000000          0.0
mean                  0.083946          NaN
std                   0.018061          NaN
min                   0.055040          NaN
25%                   0.071460          NaN
50%                   0.080040          NaN
75%                   0.092080          NaN
max                   0.207500          NaN

[8 rows x 31 columns]
```

```
In [4]: df = df.replace({'B':0, 'M':1})
        df
```

```
Out[4]:           diagnosis  radius_mean  texture_mean  perimeter_mean  area_mean  \
        id
        842302            1        17.99         10.38          122.80     1001.0
        842517            1        20.57         17.77          132.90     1326.0
        84300903          1        19.69         21.25          130.00     1203.0
        84348301          1        11.42         20.38           77.58      386.1
        84358402          1        20.29         14.34          135.10     1297.0
        ...             ...          ...           ...             ...        ...
        926424            1        21.56         22.39          142.00     1479.0
```

```
926682          1        20.13         28.25          131.20     1261.0
926954          1        16.60         28.08          108.30      858.1
927241          1        20.60         29.33          140.10     1265.0
92751           0         7.76         24.54           47.92      181.0

          smoothness_mean  compactness_mean  concavity_mean  \
id
842302            0.11840           0.27760         0.30010
842517            0.08474           0.07864         0.08690
84300903          0.10960           0.15990         0.19740
84348301          0.14250           0.28390         0.24140
84358402          0.10030           0.13280         0.19800
...                   ...               ...             ...
926424            0.11100           0.11590         0.24390
926682            0.09780           0.10340         0.14400
926954            0.08455           0.10230         0.09251
927241            0.11780           0.27700         0.35140
92751             0.05263           0.04362         0.00000

          concave points_mean  symmetry_mean  ...  texture_worst  \
id                                            ...
842302                0.14710         0.2419  ...          17.33
842517                0.07017         0.1812  ...          23.41
84300903              0.12790         0.2069  ...          25.53
84348301              0.10520         0.2597  ...          26.50
84358402              0.10430         0.1809  ...          16.67
...                       ...            ...  ...            ...
926424                0.13890         0.1726  ...          26.40
926682                0.09791         0.1752  ...          38.25
926954                0.05302         0.1590  ...          34.12
927241                0.15200         0.2397  ...          39.42
92751                 0.00000         0.1587  ...          30.37

          perimeter_worst  area_worst  smoothness_worst  compactness_worst  \
id
842302             184.60      2019.0           0.16220            0.66560
842517             158.80      1956.0           0.12380            0.18660
84300903           152.50      1709.0           0.14440            0.42450
84348301            98.87       567.7           0.20980            0.86630
84358402           152.20      1575.0           0.13740            0.20500
...                   ...         ...               ...                ...
926424             166.10      2027.0           0.14100            0.21130
926682             155.00      1731.0           0.11660            0.19220
926954             126.70      1124.0           0.11390            0.30940
927241             184.60      1821.0           0.16500            0.86810
92751               59.16       268.6           0.08996            0.06444

          concavity_worst  concave points_worst  symmetry_worst  \
id
```

```
842302              0.7119               0.2654           0.4601
842517              0.2416               0.1860           0.2750
84300903            0.4504               0.2430           0.3613
84348301            0.6869               0.2575           0.6638
84358402            0.4000               0.1625           0.2364
...                    ...                  ...              ...
926424              0.4107               0.2216           0.2060
926682              0.3215               0.1628           0.2572
926954              0.3403               0.1418           0.2218
927241              0.9387               0.2650           0.4087
92751               0.0000               0.0000           0.2871

          fractal_dimension_worst  Unnamed: 32
id
842302                    0.11890          NaN
842517                    0.08902          NaN
84300903                  0.08758          NaN
84348301                  0.17300          NaN
84358402                  0.07678          NaN
...                           ...          ...
926424                    0.07115          NaN
926682                    0.06637          NaN
926954                    0.07820          NaN
927241                    0.12400          NaN
92751                     0.07039          NaN

[569 rows x 32 columns]
```

1.2 Preparar datos para entrenamiento

```
In [5]: from sklearn.model_selection import train_test_split

        X = df.drop('diagnosis',axis=1)
        X = X.drop('Unnamed: 32',axis=1)
        y = df['diagnosis']
        # dividir datos
        train, test, train_labels, test_labels = train_test_split(X, y,
                                                test_size = 0.33, random_state = 42)
```

```
In [6]: train.head()
```

```
Out[6]:         radius_mean  texture_mean  perimeter_mean  area_mean  smoothness_mean  \
        id
        87164         15.46         11.89          102.50      736.9          0.12570
        905190        12.85         21.37           82.63      514.5          0.07551
        857637        19.21         18.57          125.50     1152.0          0.10530
        914580        12.47         17.31           80.45      480.1          0.08928
        892604        12.46         19.89           80.43      471.3          0.08451

                compactness_mean  concavity_mean  concave points_mean  symmetry_mean  \
        id
        87164        0.15550      0.20320          0.10970      0.1966
        905190       0.08316      0.06126          0.01867      0.1580
        857637       0.12670      0.13230          0.08994      0.1917
        914580       0.07630      0.03609          0.02369      0.1526
        892604       0.10140      0.06830          0.03099      0.1781

                fractal_dimension_mean  ...  radius_worst  texture_worst  \
        id                              ...
        87164                  0.07069  ...         18.79          17.04
        905190                 0.06114  ...         14.40          27.01
        857637                 0.05961  ...         26.14          28.14
        914580                 0.06046  ...         14.06          24.34
        892604                 0.06249  ...         13.46          23.07

                perimeter_worst  area_worst  smoothness_worst  compactness_worst  \
        id
        87164            125.00      1102.0           0.15310             0.3583
        905190            91.63       645.8           0.09402             0.1936
        857637           170.10      2145.0           0.16240             0.3511
        914580            92.82       607.3           0.12760             0.2506
        892604            88.13       551.3           0.10500             0.2158

                concavity_worst  concave points_worst  symmetry_worst  \
        id
        87164            0.5830               0.18270          0.3216
        905190           0.1838               0.05601          0.2488
        857637           0.3879               0.20910          0.3537
        914580           0.2028               0.10530          0.3035
        892604           0.1904               0.07625          0.2685

                fractal_dimension_worst
        id
        87164                   0.10100
        905190                  0.08151
        857637                  0.08294
        914580                  0.07661
        892604                  0.07764

        [5 rows x 30 columns]
```

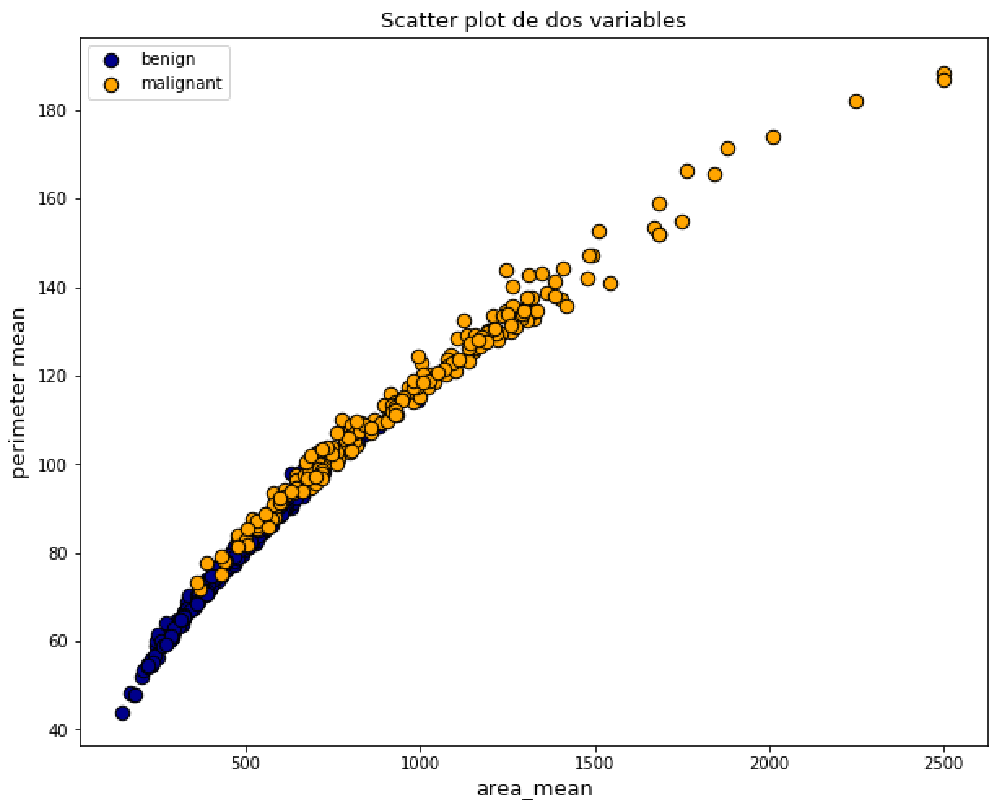
1.3 Visualizar características con matplotlib

- Obtener etiquetas

```
In [7]: import numpy as np

        target_ids = np.unique(df.values[:,0])
```

```
In [8]: df['area_mean'].values.shape, df['perimeter_mean'].values.shape
```

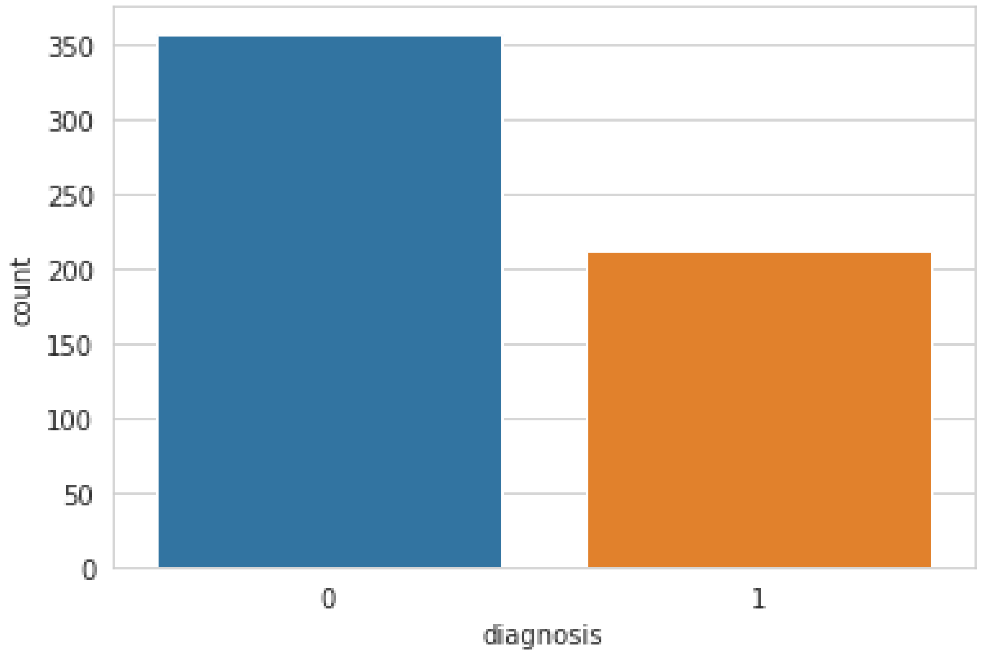
```
Out[8]: ((569,), (569,))

In [9]: X_plot = np.concatenate(([df['area_mean'].values], [df['perimeter_mean'].values]), axis=0

In [10]: y = df['diagnosis'].values

In [11]: X_plot.shape

Out[11]: (2, 569)

In [12]: plt.figure(figsize=(10,8))
         colors = ['darkblue','orange']
         target_names = ['benign','malignant']


         for i, c, label in zip(target_ids, colors, target_names):
             plt.scatter(X_plot[0,i == y], X_plot[1,i == y], c = c,  edgecolors='black', s=285,la
         plt.legend()
         plt.title("Scatter plot de dos variables",fontsize=13)
         plt.xlabel("area_mean",fontsize=13)
         plt.ylabel("perimeter mean",fontsize=13)
         plt.show()
```



- Equilibrio de etiquetas

```
In [13]: sns.set_style('whitegrid')
         sns.countplot(x='diagnosis',data=df)
```

```
Out[13]: <matplotlib.axes._subplots.AxesSubplot at 0x7fd56895dd50>
```



1.4 Evaluación del modelo

- Se obtienen las predicciones, informe de clasificación y matriz de confusión.

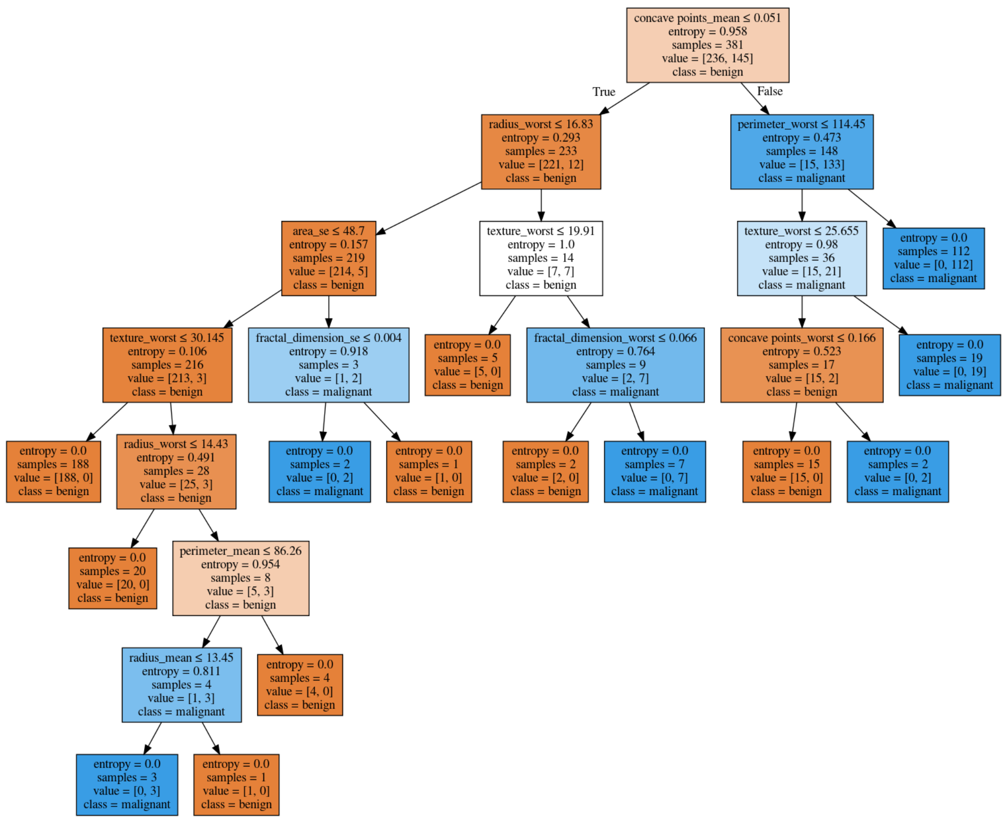
```
In [14]: from sklearn.tree import DecisionTreeClassifier
```

1.5 Se usa ‘entropía’

```
In [15]: dtc = DecisionTreeClassifier(criterion="entropy")
         dtc.fit(train, train_labels)
```

```
Out[15]: DecisionTreeClassifier(class_weight=None, criterion='entropy', max_depth=None,
                                max_features=None, max_leaf_nodes=None,
                                min_impurity_decrease=0.0, min_impurity_split=None,
                                min_samples_leaf=1, min_samples_split=2,
                                min_weight_fraction_leaf=0.0, presort=False,
                                random_state=None, splitter='best')
```

```
In [16]: import warnings
         warnings.filterwarnings("ignore")

In [17]: from sklearn.externals.six import StringIO
         from IPython.display import Image
         from sklearn.tree import export_graphviz
         import pydotplus



         dot_data = StringIO()
         export_graphviz(dtc, out_file=dot_data,
                         filled=True, rounded=False,
                         special_characters=True,
                         feature_names =  X.columns, class_names=target_names)
         graph = pydotplus.graph_from_dot_data(dot_data.getvalue())
         Image(graph.create_png())

Out[17]:
```


concave points_mean ≤ 0.051 entropy = 0.958 samples = 381 value = [236, 145] class = benign
True
False
radius_worst ≤ 16.83 entropy = 0.293 samples = 233 value = [221, 12] class = benign
perimeter_worst ≤ 114.45 entropy = 0.473 samples = 148 value = [15, 133] class = malignant
area_se ≤ 48.7 entropy = 0.157 samples = 219 value = [214, 5] class = benign
texture_worst ≤ 19.91 entropy = 1.0 samples = 14 value = [7, 7] class = benign
texture_worst ≤ 25.655 entropy = 0.98 samples = 36 value = [15, 21] class = malignant
entropy = 0.0 samples = 112 value = [0, 112] class = malignant
texture_worst ≤ 30.145 entropy = 0.106 samples = 216 value = [213, 3] class = benign
fractal_dimension_se ≤ 0.004 entropy = 0.918 samples = 3 value = [1, 2] class = malignant
entropy = 0.0 samples = 5 value = [5, 0] class = benign
fractal_dimension_worst ≤ 0.066 entropy = 0.764 samples = 9 value = [2, 7] class = malignant
concave points_worst ≤ 0.166 entropy = 0.523 samples = 17 value = [15, 2] class = benign
entropy = 0.0 samples = 19 value = [0, 19] class = malignant
entropy = 0.0 samples = 188 value = [188, 0] class = benign
radius_worst ≤ 14.43 entropy = 0.491 samples = 28 value = [25, 3] class = benign
entropy = 0.0 samples = 2 value = [0, 2] class = malignant
entropy = 0.0 samples = 1 value = [1, 0] class = benign
entropy = 0.0 samples = 2 value = [2, 0] class = benign
entropy = 0.0 samples = 7 value = [0, 7] class = malignant
entropy = 0.0 samples = 15 value = [15, 0] class = benign
entropy = 0.0 samples = 2 value = [0, 2] class = malignant
entropy = 0.0 samples = 20 value = [20, 0] class = benign
perimeter_mean ≤ 86.26 entropy = 0.954 samples = 8 value = [5, 3] class = benign
radius_mean ≤ 13.45 entropy = 0.811 samples = 4 value = [1, 3] class = malignant
entropy = 0.0 samples = 4 value = [4, 0] class = benign
entropy = 0.0 samples = 3 value = [0, 3] class = malignant
entropy = 0.0 samples = 1 value = [1, 0] class = benign

- Guardar árbol en .png

```
In [18]: graph.write_png('cancer.png')

Out[18]: True

In [19]: dtc.score(test, test_labels)

Out[19]: 0.9574468085106383

In [20]: predictions = dtc.predict(test)

In [21]: from sklearn.metrics import classification_report,confusion_matrix

         print("Predicciones:\n")
         print(predictions)
         print("\nReporte de clasificación:\n")
         print(classification_report(predictions,test_labels))
```

```
Predicciones:

[0 1 1 0 0 1 1 1 1 0 0 1 0 0 0 1 0 0 0 1 0 0 1 0 0 0 0 0 0 1 0 0 0 0 0 0 1
 0 1 0 0 1 0 0 0 0 0 0 0 0 1 1 0 0 0 0 0 1 1 0 0 1 1 0 0 0 1 1 0 0 1 1 0 1
 0 0 0 0 0 0 1 0 0 1 1 1 1 1 0 0 0 0 0 0 0 0 1 1 0 1 1 0 1 1 0 0 0 1 0 0 1
 0 0 1 0 1 0 0 0 1 0 0 0 1 0 1 1 0 0 1 1 1 0 0 0 1 1 0 0 1 0 1 0 0 1 0 1 1
 1 0 1 0 0 0 0 1 1 0 0 0 0 0 0 0 0 0 0 0 0 1 0 0 0 0 0 0 0 0 0 0 0 0 0 1 1
 1 0 0]

Reporte de clasificación:

              precision    recall  f1-score   support

           0       0.98      0.95      0.97       125
           1       0.91      0.97      0.94        63

    accuracy                           0.96       188
   macro avg       0.95      0.96      0.95       188
weighted avg       0.96      0.96      0.96       188
```

```
In [22]: print("Confusion matrix")
         conf_mat=confusion_matrix(predictions,test_labels)
         print(conf_mat)
```

```
Confusion matrix
[[119   6]
 [  2  61]]
```

- Probar ID3 con otro dataset