Data Standardization

July 10, 2024

The process of standardizing the data to a common format and common range

[4]:
```
import numpy as np
import pandas as pd
import sklearn.datasets
from sklearn.preprocessing import StandardScaler #function that will be use to␣
 ↪standardize our data set
from sklearn.model_selection import train_test_split #it helsp to split the␣
 ↪data into train and test dataset
```

[22]:
```
#loading the dataset

data = pd.read_csv('breast_cancer_data.csv')
data.head()
```

[22]:
```
         id diagnosis  radius_mean  texture_mean  perimeter_mean  area_mean  \
0    842302         M        17.99         10.38          122.80     1001.0
1    842517         M        20.57         17.77          132.90     1326.0
2  84300903         M        19.69         21.25          130.00     1203.0
3  84348301         M        11.42         20.38           77.58      386.1
4  84358402         M        20.29         14.34          135.10     1297.0

   smoothness_mean  compactness_mean  concavity_mean  concave points_mean  \
0          0.11840           0.27760          0.3001              0.14710
1          0.08474           0.07864          0.0869              0.07017
2          0.10960           0.15990          0.1974              0.12790
3          0.14250           0.28390          0.2414              0.10520
4          0.10030           0.13280          0.1980              0.10430

   …  texture_worst  perimeter_worst  area_worst  smoothness_worst  \
0  …          17.33           184.60      2019.0            0.1622
1  …          23.41           158.80      1956.0            0.1238
2  …          25.53           152.50      1709.0            0.1444
3  …          26.50            98.87       567.7            0.2098
4  …          16.67           152.20      1575.0            0.1374

   compactness_worst  concavity_worst  concave points_worst  symmetry_worst  \
0             0.6656           0.7119                0.2654          0.4601
```

```
1              0.1866           0.2416                0.1860          0.2750
2              0.4245           0.4504                0.2430          0.3613
3              0.8663           0.6869                0.2575          0.6638
4              0.2050           0.4000                0.1625          0.2364

   fractal_dimension_worst  Unnamed: 32
0                  0.11890          NaN
1                  0.08902          NaN
2                  0.08758          NaN
3                  0.17300          NaN
4                  0.07678          NaN

[5 rows x 33 columns]
```

[14]:
```
dataset = sklearn.datasets.load_breast_cancer()
```

[15]:
```
print(dataset)
```

```
{'data': array([[1.799e+01, 1.038e+01, 1.228e+02, …, 2.654e-01, 4.601e-01,
        1.189e-01],
       [2.057e+01, 1.777e+01, 1.329e+02, …, 1.860e-01, 2.750e-01,
        8.902e-02],
       [1.969e+01, 2.125e+01, 1.300e+02, …, 2.430e-01, 3.613e-01,
        8.758e-02],
       …,
       [1.660e+01, 2.808e+01, 1.083e+02, …, 1.418e-01, 2.218e-01,
        7.820e-02],
       [2.060e+01, 2.933e+01, 1.401e+02, …, 2.650e-01, 4.087e-01,
        1.240e-01],
       [7.760e+00, 2.454e+01, 4.792e+01, …, 0.000e+00, 2.871e-01,
        7.039e-02]]), 'target': array([0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
0, 0, 0, 0, 0, 1, 1, 1,
       0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 1, 0, 0, 0, 0, 0, 0,
       0, 0, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 0, 1, 1, 1, 1, 0, 1, 0, 0,
       1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 0, 0,
       1, 1, 1, 0, 1, 1, 0, 0, 1, 1, 1, 0, 0, 1, 1, 1, 1, 0, 1, 1, 0, 1,
       1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 1, 0, 0, 1, 1, 1, 0, 0, 1, 0, 1, 0,
       0, 1, 0, 0, 1, 1, 0, 1, 1, 0, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 0, 1, 1, 1, 1, 0, 0, 1, 0, 1, 1, 0, 0, 1, 1, 0, 0, 1, 1, 1,
       1, 0, 1, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 0, 0,
       0, 0, 1, 0, 0, 0, 1, 0, 1, 0, 1, 1, 0, 1, 0, 0, 0, 0, 1, 1, 0, 0,
       1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 1, 0, 1, 1, 0, 0, 1, 0, 1, 1,
       1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0, 0,
       0, 0, 1, 1, 1, 1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 0, 1, 0, 0, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 0, 1, 1, 1, 1, 0, 0,
       0, 1, 1, 1, 1, 0, 1, 0, 1, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0,
       0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 1, 0, 0, 0, 1, 0, 0,
       1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 1, 0, 1, 1, 0, 0, 1, 1,
       1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 0, 1, 1, 0,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 0, 1, 1, 1, 1,
       1, 0, 1, 1, 0, 1, 0, 1, 1, 0, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0,
       1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 1, 1, 1, 1,
       1, 1, 1, 0, 1, 0, 1, 1, 0, 1, 1, 1, 1, 1, 0, 0, 1, 0, 1, 0, 1, 1,
       1, 1, 1, 0, 1, 1, 0, 1, 0, 1, 0, 0, 1, 1, 1, 0, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 0, 1, 0, 0, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1,
       1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 1, 0, 0, 0, 0, 0, 0, 1]), 'frame': None,
'target_names': array(['malignant', 'benign'], dtype='<U9'), 'DESCR': '..
_breast_cancer_dataset:\n\nBreast cancer wisconsin (diagnostic)
dataset\n--------------------------------------------\n\n**Data Set
Characteristics:**\n\n    :Number of Instances: 569\n\n    :Number of
Attributes: 30 numeric, predictive attributes and the class\n\n    :Attribute
Information:\n        - radius (mean of distances from center to points on the
perimeter)\n        - texture (standard deviation of gray-scale values)\n
- perimeter\n        - area\n        - smoothness (local variation in radius
lengths)\n        - compactness (perimeter^2 / area - 1.0)\n        - concavity
(severity of concave portions of the contour)\n        - concave points (number
of concave portions of the contour)\n        - symmetry\n        - fractal
dimension ("coastline approximation" - 1)\n\n        The mean, standard error,
and "worst" or largest (mean of the three\n        worst/largest values) of
these features were computed for each image,\n        resulting in 30 features.
For instance, field 0 is Mean Radius, field\n        10 is Radius SE, field 20
is Worst Radius.\n\n        - class:\n                - WDBC-Malignant\n
- WDBC-Benign\n\n    :Summary Statistics:\n\n
===================================== ====== ======\n
Min    Max\n    ===================================== ====== ======\n    radius
(mean):                        6.981  28.11\n    texture (mean):
9.71   39.28\n    perimeter (mean):                     43.79  188.5\n    area
(mean):                          143.5  2501.0\n    smoothness (mean):
0.053  0.163\n    compactness (mean):                   0.019  0.345\n
concavity (mean):                     0.0    0.427\n    concave points (mean):
0.0    0.201\n    symmetry (mean):                      0.106  0.304\n
fractal dimension (mean):             0.05   0.097\n    radius (standard error):
0.112  2.873\n    texture (standard error):             0.36   4.885\n
perimeter (standard error):           0.757  21.98\n    area (standard error):
6.802  542.2\n    smoothness (standard error):          0.002  0.031\n
compactness (standard error):         0.002  0.135\n    concavity (standard
error):            0.0    0.396\n    concave points (standard error):     0.0
0.053\n    symmetry (standard error):            0.008  0.079\n    fractal
dimension (standard error):   0.001  0.03\n    radius (worst):
7.93   36.04\n    texture (worst):                      12.02  49.54\n
perimeter (worst):                    50.41  251.2\n    area (worst):
185.2  4254.0\n    smoothness (worst):                   0.071  0.223\n
compactness (worst):                  0.027  1.058\n    concavity (worst):
0.0    1.252\n    concave points (worst):               0.0    0.291\n
symmetry (worst):                     0.156  0.664\n    fractal dimension
```

```
(worst):            0.055  0.208\n    =====================================
====== ======\n\n    :Missing Attribute Values: None\n\n    :Class Distribution:
212 - Malignant, 357 - Benign\n\n    :Creator:  Dr. William H. Wolberg, W. Nick
Street, Olvi L. Mangasarian\n\n    :Donor: Nick Street\n\n    :Date: November,
1995\n\nThis is a copy of UCI ML Breast Cancer Wisconsin (Diagnostic)
datasets.\nhttps://goo.gl/U2Uwz2\n\nFeatures are computed from a digitized image
of a fine needle\naspirate (FNA) of a breast mass.  They
describe\ncharacteristics of the cell nuclei present in the image.\n\nSeparating
plane described above was obtained using\nMultisurface Method-Tree (MSM-T) [K.
P. Bennett, "Decision Tree\nConstruction Via Linear Programming." Proceedings of
the 4th\nMidwest Artificial Intelligence and Cognitive Science Society,\npp.
97-101, 1992], a classification method which uses linear\nprogramming to
construct a decision tree.  Relevant features\nwere selected using an exhaustive
search in the space of 1-4\nfeatures and 1-3 separating planes.\n\nThe actual
linear program used to obtain the separating plane\nin the 3-dimensional space
is that described in:\n[K. P. Bennett and O. L. Mangasarian: "Robust
Linear\nProgramming Discrimination of Two Linearly Inseparable
Sets",\nOptimization Methods and Software 1, 1992, 23-34].\n\nThis database is
also available through the UW CS ftp server:\n\nftp ftp.cs.wisc.edu\ncd math-
prog/cpo-dataset/machine-learn/WDBC/\n\n.. topic:: References\n\n   - W.N.
Street, W.H. Wolberg and O.L. Mangasarian. Nuclear feature extraction \n     for
breast tumor diagnosis. IS&T/SPIE 1993 International Symposium on \n
Electronic Imaging: Science and Technology, volume 1905, pages 861-870,\n
San Jose, CA, 1993.\n   - O.L. Mangasarian, W.N. Street and W.H. Wolberg. Breast
cancer diagnosis and \n     prognosis via linear programming. Operations
Research, 43(4), pages 570-577, \n     July-August 1995.\n   - W.H. Wolberg,
W.N. Street, and O.L. Mangasarian. Machine learning techniques\n     to diagnose
breast cancer from fine-needle aspirates. Cancer Letters 77 (1994) \n
163-171.', 'feature_names': array(['mean radius', 'mean texture', 'mean
perimeter', 'mean area',
       'mean smoothness', 'mean compactness', 'mean concavity',
       'mean concave points', 'mean symmetry', 'mean fractal dimension',
       'radius error', 'texture error', 'perimeter error', 'area error',
       'smoothness error', 'compactness error', 'concavity error',
       'concave points error', 'symmetry error',
       'fractal dimension error', 'worst radius', 'worst texture',
       'worst perimeter', 'worst area', 'worst smoothness',
       'worst compactness', 'worst concavity', 'worst concave points',
       'worst symmetry', 'worst fractal dimension'], dtype='<U23'), 'filename':
'breast_cancer.csv', 'data_module': 'sklearn.datasets.data'}
```

Loading the dataset to our pandas dataframe

[17]:
```
df = pd.DataFrame(dataset.data, columns=dataset.feature_names)
```

[18]:
```
df.head()
```

```
[18]:    mean radius  mean texture  mean perimeter  mean area  mean smoothness  \
      0        17.99         10.38          122.80     1001.0          0.11840
      1        20.57         17.77          132.90     1326.0          0.08474
      2        19.69         21.25          130.00     1203.0          0.10960
      3        11.42         20.38           77.58      386.1          0.14250
      4        20.29         14.34          135.10     1297.0          0.10030

         mean compactness  mean concavity  mean concave points  mean symmetry  \
      0           0.27760          0.3001              0.14710         0.2419
      1           0.07864          0.0869              0.07017         0.1812
      2           0.15990          0.1974              0.12790         0.2069
      3           0.28390          0.2414              0.10520         0.2597
      4           0.13280          0.1980              0.10430         0.1809

         mean fractal dimension  …  worst radius  worst texture  worst perimeter  \
      0                 0.07871  …         25.38          17.33           184.60
      1                 0.05667  …         24.99          23.41           158.80
      2                 0.05999  …         23.57          25.53           152.50
      3                 0.09744  …         14.91          26.50            98.87
      4                 0.05883  …         22.54          16.67           152.20

         worst area  worst smoothness  worst compactness  worst concavity  \
      0      2019.0            0.1622             0.6656           0.7119
      1      1956.0            0.1238             0.1866           0.2416
      2      1709.0            0.1444             0.4245           0.4504
      3       567.7            0.2098             0.8663           0.6869
      4      1575.0            0.1374             0.2050           0.4000

         worst concave points  worst symmetry  worst fractal dimension
      0                0.2654          0.4601                  0.11890
      1                0.1860          0.2750                  0.08902
      2                0.2430          0.3613                  0.08758
      3                0.2575          0.6638                  0.17300
      4                0.1625          0.2364                  0.07678

      [5 rows x 30 columns]
```

```
[19]: df.shape
```

```
[19]: (569, 30)
```

x= features which are the dataset values and analyzing the featureswe get the target. y = the target

```
[27]: x = df
      y =dataset.target
```

```
[25]: print(x)
```

```
     mean radius  mean texture  mean perimeter  mean area  mean smoothness  \
0          17.99         10.38          122.80     1001.0          0.11840
1          20.57         17.77          132.90     1326.0          0.08474
2          19.69         21.25          130.00     1203.0          0.10960
3          11.42         20.38           77.58      386.1          0.14250
4          20.29         14.34          135.10     1297.0          0.10030
..           …             …              …          …              …
564        21.56         22.39          142.00     1479.0          0.11100
565        20.13         28.25          131.20     1261.0          0.09780
566        16.60         28.08          108.30      858.1          0.08455
567        20.60         29.33          140.10     1265.0          0.11780
568         7.76         24.54           47.92      181.0          0.05263

     mean compactness  mean concavity  mean concave points  mean symmetry  \
0             0.27760         0.30010              0.14710         0.2419
1             0.07864         0.08690              0.07017         0.1812
2             0.15990         0.19740              0.12790         0.2069
3             0.28390         0.24140              0.10520         0.2597
4             0.13280         0.19800              0.10430         0.1809
..                …              …                    …             …
564           0.11590         0.24390              0.13890         0.1726
565           0.10340         0.14400              0.09791         0.1752
566           0.10230         0.09251              0.05302         0.1590
567           0.27700         0.35140              0.15200         0.2397
568           0.04362         0.00000              0.00000         0.1587

     mean fractal dimension  …  worst radius  worst texture  \
0                   0.07871  …        25.380          17.33
1                   0.05667  …        24.990          23.41
2                   0.05999  …        23.570          25.53
3                   0.09744  …        14.910          26.50
4                   0.05883  …        22.540          16.67
..                      …  …           …             …
564                 0.05623  …        25.450          26.40
565                 0.05533  …        23.690          38.25
566                 0.05648  …        18.980          34.12
567                 0.07016  …        25.740          39.42
568                 0.05884  …         9.456          30.37

     worst perimeter  worst area  worst smoothness  worst compactness  \
0             184.60      2019.0           0.16220            0.66560
1             158.80      1956.0           0.12380            0.18660
2             152.50      1709.0           0.14440            0.42450
3              98.87       567.7           0.20980            0.86630
4             152.20      1575.0           0.13740            0.20500
..               …           …                …                 …
564           166.10      2027.0           0.14100            0.21130
565           155.00      1731.0           0.11660            0.19220
```

```
566           126.70      1124.0           0.11390            0.30940
567           184.60      1821.0           0.16500            0.86810
568            59.16       268.6           0.08996            0.06444

     worst concavity  worst concave points  worst symmetry  \
0             0.7119                0.2654          0.4601
1             0.2416                0.1860          0.2750
2             0.4504                0.2430          0.3613
3             0.6869                0.2575          0.6638
4             0.4000                0.1625          0.2364
..               …                   …             …
564           0.4107                0.2216          0.2060
565           0.3215                0.1628          0.2572
566           0.3403                0.1418          0.2218
567           0.9387                0.2650          0.4087
568           0.0000                0.0000          0.2871

     worst fractal dimension
0                    0.11890
1                    0.08902
2                    0.08758
3                    0.17300
4                    0.07678
..                       …
564                  0.07115
565                  0.06637
566                  0.07820
567                  0.12400
568                  0.07039

[569 rows x 30 columns]
```

[28]:

```python
print(y)
```

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

Splitting the data into traing data and testing data before standardizing. And train test split function was imported already and the function is used below. test_size is how much data we want in our test size, usually 10-20% for test data random state is to reproduce the code = 3 depending on what you want. Is an identity for spliting the data in a specific way.

In most cases it is better to standardize the data before splitting it.

[32]:
```python
x_train, x_test, y_train, y_test = train_test_split(x, y, test_size =0.2,␣
 ↪random_state=3)
```

[33]:
```python
print(x.shape, x_train.shape, x_test.shape)
```

```
(569, 30) (455, 30) (114, 30)
```

Data Standardization; to do this I print the standard deviation of the whole dataset by calling the data 'dataset' because it contains all the data. The data I will call is from 'dataset = sklearn.datasets.load_breast_cancer()'

And find the standard deviation.

If our data contains all all the value in the same range the standard deviation should be 1.

And my dataset below is 228.29 so the dataset are not in the same range and they varies alot

[35]:
```python
print(dataset.data.std())
```

```
228.29740508276657
```

Using StandardScaler since it was imported already

[37]:
```python
scaler = StandardScaler()
```

[38]:
```python
scaler.fit(x_train)
```

[38]:
```
StandardScaler()
```

[39]:
```python
x_train_standardized = scaler.transform(x_train)
```

[40]:
```python
print(x_train_standardized)
```

```
[[ 1.40381088  1.79283426  1.37960065 …  1.044121    0.52295995
   0.64990763]
 [ 1.16565505 -0.14461158  1.07121375 …  0.5940779   0.44153782
  -0.85281516]
 [-0.0307278  -0.77271123 -0.09822185 … -0.64047556 -0.31161687
  -0.69292805]
 …
 [ 1.06478904  0.20084323  0.89267396 …  0.01694621  3.06583565
  -1.29952679]
 [ 1.51308238  2.3170559   1.67987211 …  1.14728703 -0.16599653
```

```
   0.82816016]
 [-0.73678981 -1.02636686 -0.74380549 … -0.31826862 -0.40713129
  -0.38233653]]
```

For x test

[41]:
```
x_test_standardized = scaler.transform(x_test)
```

Now looking at the standard deviation of our x_train data it shows that our std is 1 And for x test is is 0.87 and it is close to 1 This means that the data are in similar range

[42]:
```
print(x_train_standardized.std())
```

```
1.0
```

[43]:
```
print(x_test_standardized.std())
```

```
0.8654541077212674
```

[ ]:

[ ]:

[ ]:

[ ]:

[ ]: