project_1

October 8, 2024

Instituto Tecnológico de Aeronáutica - ITA

Divisão de Engenharia Eletrônica - IEE

ET-287 - Processamento de sinais usando redes neurais

Professora Sarah Negreiros de Carvalho Leite

Aluno Felipe Keller Baltor

1 Projeto 1 - Analisando Vinhos

[18]:
```
%reset
```

```
Once deleted, variables cannot be recovered. Proceed (y/[n])? y
```

[1]:
```
# Importações básicas

import numpy as np # biblioteca de manipulação vetorial e numérica
import matplotlib.pyplot as plt # biblioteca para traçar gráficos
import pandas as pd # biblioteca de manipulação de dados tabulares
from pathlib import Path # biblioteca para manipulação de "paths"
import urllib3 # biblioteca para download do dataset
import zipfile
```

1.0.1 *1. Baixar a base de dados disponível no repositório da UCI machine learning: https://archive.ics.uci.edu/ml/datasets/wine+quality. Gere uma única planilha para os dados de vinho branco e tinto.*

[2]:
```
# Checando se estamos no diretório correto

project_dir = Path('.')

assert project_dir.resolve().name == 'project_1'
```

[6]:
```
# Baixando os dados

data_dir = project_dir / 'data'

if not data_dir.is_dir():
    print("Data folder doesn't exists, checking for zip file")
    data_compressed = project_dir / 'data.zip'
    if not data_compressed.is_file():
        print("Zip file doesn't exists, downloading...")
        data_url = 'https://archive.ics.uci.edu/static/public/186/wine+quality.
 ↪zip'

        http = urllib3.PoolManager()
        r = http.request('GET', data_url, preload_content=False)

        with open(data_compressed, 'wb') as out:
            while True:
                data = r.read(2**16)
                if not data:
                    break
                out.write(data)

        r.release_conn()

    print("Extracting zip to data folder")
    with zipfile.ZipFile(data_compressed, 'r') as zip_ref:
        zip_ref.extractall(data_dir)
    print("Data folder ready!")

else:
    print('Data folder already exists!')
```

```
Data folder doesn't exists, checking for zip file
Zip file doesn't exists, downloading…
Extracting zip to data folder
Data folder ready!
```

[7]:
```
# Printando a descrição dos dados

data_description = data_dir / 'winequality.names'

with open(data_description) as f:
    print(f.read())
```

```
Citation Request:
  This dataset is public available for research. The details are described in
[Cortez et al., 2009].
```

Please include this citation if you plan to use this database:

P. Cortez, A. Cerdeira, F. Almeida, T. Matos and J. Reis.
Modeling wine preferences by data mining from physicochemical properties.
In Decision Support Systems, Elsevier, 47(4):547-553. ISSN: 0167-9236.

Available at: [@Elsevier] http://dx.doi.org/10.1016/j.dss.2009.05.016
[Pre-press (pdf)]
http://www3.dsi.uminho.pt/pcortez/winequality09.pdf
[bib] http://www3.dsi.uminho.pt/pcortez/dss09.bib

1. Title: Wine Quality

2. Sources
Created by: Paulo Cortez (Univ. Minho), Antonio Cerdeira, Fernando Almeida, Telmo Matos and Jose Reis (CVRVV) @ 2009

3. Past Usage:

P. Cortez, A. Cerdeira, F. Almeida, T. Matos and J. Reis.
Modeling wine preferences by data mining from physicochemical properties.
In Decision Support Systems, Elsevier, 47(4):547-553. ISSN: 0167-9236.

In the above reference, two datasets were created, using red and white wine samples.
The inputs include objective tests (e.g. PH values) and the output is based on sensory data
(median of at least 3 evaluations made by wine experts). Each expert graded the wine quality
between 0 (very bad) and 10 (very excellent). Several data mining methods were applied to model
these datasets under a regression approach. The support vector machine model achieved the
best results. Several metrics were computed: MAD, confusion matrix for a fixed error tolerance (T),
etc. Also, we plot the relative importances of the input variables (as measured by a sensitivity
analysis procedure).

4. Relevant Information:

The two datasets are related to red and white variants of the Portuguese "Vinho Verde" wine.
For more details, consult: http://www.vinhoverde.pt/en/ or the reference [Cortez et al., 2009].
Due to privacy and logistic issues, only physicochemical (inputs) and sensory (the output) variables
are available (e.g. there is no data about grape types, wine brand, wine

```
selling price, etc.).

   These datasets can be viewed as classification or regression tasks.
   The classes are ordered and not balanced (e.g. there are munch more normal
wines than
   excellent or poor ones). Outlier detection algorithms could be used to detect
the few excellent
   or poor wines. Also, we are not sure if all input variables are relevant. So
   it could be interesting to test feature selection methods.

5. Number of Instances: red wine - 1599; white wine - 4898.

6. Number of Attributes: 11 + output attribute

   Note: several of the attributes may be correlated, thus it makes sense to
apply some sort of
   feature selection.

7. Attribute information:

   For more information, read [Cortez et al., 2009].

   Input variables (based on physicochemical tests):
   1 - fixed acidity
   2 - volatile acidity
   3 - citric acid
   4 - residual sugar
   5 - chlorides
   6 - free sulfur dioxide
   7 - total sulfur dioxide
   8 - density
   9 - pH
   10 - sulphates
   11 - alcohol
   Output variable (based on sensory data):
   12 - quality (score between 0 and 10)

8. Missing Attribute Values: None
```

[8]:
```
# Lendo os dados e criando a tabela única

red = pd.read_csv(data_dir / 'winequality-red.csv', sep=';')
red['type'] = 1 # red

white = pd.read_csv(data_dir / 'winequality-white.csv', sep=';')
white['type'] = 0 # white
```

```
data = pd.concat([red, white], ignore_index=True)
data
```

[8]:

	fixed acidity	volatile acidity	citric acid	residual sugar	chlorides	\
0	7.4	0.70	0.00	1.9	0.076	
1	7.8	0.88	0.00	2.6	0.098	
2	7.8	0.76	0.04	2.3	0.092	
3	11.2	0.28	0.56	1.9	0.075	
4	7.4	0.70	0.00	1.9	0.076	
…	…	…	…	…	…	
6492	6.2	0.21	0.29	1.6	0.039	
6493	6.6	0.32	0.36	8.0	0.047	
6494	6.5	0.24	0.19	1.2	0.041	
6495	5.5	0.29	0.30	1.1	0.022	
6496	6.0	0.21	0.38	0.8	0.020	

	free sulfur dioxide	total sulfur dioxide	density	pH	sulphates	\
0	11.0	34.0	0.99780	3.51	0.56	
1	25.0	67.0	0.99680	3.20	0.68	
2	15.0	54.0	0.99700	3.26	0.65	
3	17.0	60.0	0.99800	3.16	0.58	
4	11.0	34.0	0.99780	3.51	0.56	
…	…	…	…	…	…	
6492	24.0	92.0	0.99114	3.27	0.50	
6493	57.0	168.0	0.99490	3.15	0.46	
6494	30.0	111.0	0.99254	2.99	0.46	
6495	20.0	110.0	0.98869	3.34	0.38	
6496	22.0	98.0	0.98941	3.26	0.32	

	alcohol	quality	type
0	9.4	5	1
1	9.8	5	1
2	9.8	5	1
3	9.8	6	1
4	9.4	5	1
…	…	…	…
6492	11.2	6	0
6493	9.6	5	0
6494	9.4	6	0
6495	12.8	7	0
6496	11.8	6	0

[6497 rows x 13 columns]

1.0.2 *2. Visualize a dimensão da matriz de dados e do vetor de rótulos.*

[24]:
```
data.shape
```

[24]:
```
(6497, 13)
```

1.0.3 *3. Realize uma análise criteriosa dos dados da base de dados. Pontos que devem ser considerados:*

3.1. A base de dados é consistente?

3.2 Há dados faltantes?

[25]:
```
data.isnull().values.any()
```

[25]:
```
False
```

Como se vê pela expressão acima, não existem valores faltantes na base de dados.

3.3 Há dados não numéricos?

[26]:
```
data.dtypes
```

[26]:
```
fixed acidity           float64
volatile acidity        float64
citric acid             float64
residual sugar          float64
chlorides               float64
free sulfur dioxide     float64
total sulfur dioxide    float64
density                 float64
pH                      float64
sulphates               float64
alcohol                 float64
quality                   int64
type                      int64
dtype: object
```

Na base original não existem dados não numéricos. Esses poderiam ter sido introduzidos com a definição da coluna *type* (que representa o tipo de vinho

3.4 A base de dados é balanceada? Considere as classes vinho tinto e branco. Já da importação dos dados pudemos perceber que os valores dos vinhos tintos e brancos era bastante diferente. Obtendo os números exatos abaixo atestamos que a mesma realmente não é balanceada quanto ao tipo de vinho.

[80]:
```
# https://stackoverflow.com/a/20076611/12427122

data.type.value_counts()[1], data.type.value_counts()[0]
```

[80]:
```
(1599, 4898)
```

1.0.4 *4. Apresente uma análise estatística dos dados que embase quais variáveis de entrada são mais relevantes se quisermos classificar o vinho pelo tipo (tinto vs. branco). Justifique.*

[33]:
```
data[data.type == 1].mean()
```

[33]:
```
fixed acidity            8.319637
volatile acidity         0.527821
citric acid              0.270976
residual sugar           2.538806
chlorides                0.087467
free sulfur dioxide     15.874922
total sulfur dioxide    46.467792
density                  0.996747
pH                       3.311113
sulphates                0.658149
alcohol                 10.422983
quality                  5.636023
type                     1.000000
dtype: float64
```

[53]:
```
100 * data[data.type == 1].std() / data[data.type == 1].mean()
```

[53]:
```
fixed acidity           20.927551
volatile acidity        33.924355
citric acid             71.888809
residual sugar          55.535095
chlorides               53.809492
free sulfur dioxide     65.891077
total sulfur dioxide    70.791666
density                  0.189349
pH                       4.662676
sulphates               25.755113
alcohol                 10.224209
quality                 14.328712
type                     0.000000
dtype: float64
```

[49]:
```
for attr in data.columns:
    if attr == 'type':
        break

    corr = np.corrcoef(data[attr], data.type)[1, 0]
    print(f'correlation of {attr} and type: {corr}')
```

```
correlation of fixed acidity and type: 0.48673983206805316
correlation of volatile acidity and type: 0.6530355891787227
correlation of citric acid and type: -0.1873965007504359
correlation of residual sugar and type: -0.3488210078111932
correlation of chlorides and type: 0.5126782476623964
correlation of free sulfur dioxide and type: -0.47164366490168
correlation of total sulfur dioxide and type: -0.7003571552968026
correlation of density and type: 0.39064531835422284
correlation of pH and type: 0.32912865072599984
correlation of sulphates and type: 0.487217970057309
correlation of alcohol and type: -0.03296955068617277
correlation of quality and type: -0.11932328463611315
```

Dada as correlações acima, calculadas entre cada variável e o tipo de vinho (tinto ou branco), as variáveis que mais indicam os tipos de vinho são a volatilidade da acidez (*volatile acidity*) e o dioxido de enxofre total (*total sulfur dioxide*).

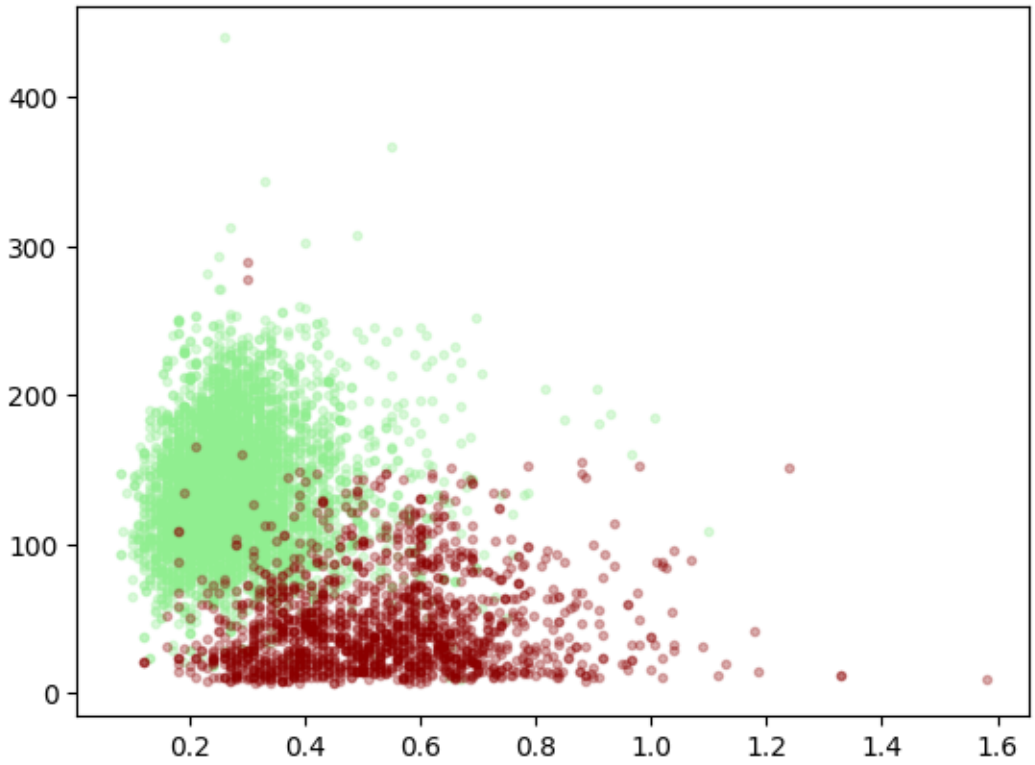
1.0.5 *5. Escolha duas das variáveis de entrada e faça um gráfico de dispersão para visualizar a distribuição dos dados de cada classe de vinho. Justifique sua escolha.*

[71]:
```
red = data[data.type == 1]
white = data[data.type == 0]

attr_1 = 'volatile acidity'
attr_2 = 'total sulfur dioxide'

plt.scatter(white[attr_1], white[attr_2], color='lightgreen', alpha=0.3,␣
 ↪marker='.')
plt.scatter(red[attr_1], red[attr_2], color='darkred', alpha=0.3, marker='.')
```

[71]:
```
<matplotlib.collections.PathCollection at 0x7a7d680d52d0>
```



1.0.6 *6. Considerando agora a variável de qualidade do vinho, avalie como é a prevalência nas duas classes para os vinhos mais bem avaliados (nota > 7) e para os avaliados com nota < 3.*

[111]:
```
high_quality_value = 7

red_good = data[(data.type == 1) & (data.quality > high_quality_value)]
white_good = data[(data.type == 0) & (data.quality > high_quality_value)]

len(red_good), len(white_good)
```

[111]:
```
(18, 180)
```

Considerando vinhos bem avaliados, percebemos que a sua maioria (10 vezes maior) é composta de vinhos brancos.

[106]:
```
len(data[data.quality < 3])
```

[106]:
```
0
```

Como se vê da expressão acima, não existem vinhos com nota menor do que 3. Vamos considerar notas menor do que 4 então.

[110]:
```
low_quality_value = 4
red_bad = data[(data.type == 1) & (data.quality < low_quality_value)]
white_bad = data[(data.type == 0) & (data.quality < low_quality_value)]

len(red_bad), len(white_bad)
```

[110]: (10, 20)

Novamente, há maior prevalência de vinhos brancos entre os piores.