EE2211 Tutorial 2

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Q0

Program for demonstration of one-hot encoding

```python
from numpy import array
from numpy import argmax
from sklearn.preprocessing import LabelEncoder
from sklearn.preprocessing import OneHotEncoder
```

Importing Libraries

```python
# define example
data = ['cold', 'cold', 'warm', 'cold', 'hot', 'hot', 'warm', 'cold', 'warm', 'hot']
values = array(data)
print(values)
```

Define example data

```python
# integer encode
label_encoder = LabelEncoder()
integer_encoded = label_encoder.fit_transform(values)
print(integer_encoded)
```

Integer encode: convert categorical labels into integer labels:

- 'cold' -> 0
- 'warm' -> 2
- 'hot' -> 1

```python
# binary encode
onehot_encoder = OneHotEncoder(sparse_output=False)
integer_encoded = integer_encoded.reshape(len(integer_encoded), 1)
onehot_encoded = onehot_encoder.fit_transform(integer_encoded)
print(onehot_encoded)
```

OneHotEncoder converts the integer-encoded array into a one-hot encoded matrix. Each category is represented by a binary vector:

0 -> [1, 0, 0] (cold)
1 -> [0, 1, 0] (hot)
2 -> [0, 0, 1] (warm)

```python
# invert first example
inverted = label_encoder.inverse_transform([argmax(onehot_encoded[0, :])])
print(inverted)
```

converted back to the original label

01

Q1

(Data Reading and Visualization, simple data structure)

A Comma Separated Values (CSV) file is a plain text file that contains a list of data. These files are often used for exchanging data between different applications.

- Download the file “government-expenditure-on-education.csv” from https://data.gov.sg/dataset/government-expenditure-on-education .
- Plot the educational expenditure over the years. (Hint: you might need “import pandas as pd” and “import matplotlib.pyplot as plt”.)

Q1

“government-expenditure-on-education.csv”

year	total_expenditure_on_education
1981	942517
1982	1358430
1983	1611647
1984	1769728
1985	1812376
1986	1641893
1987	1654115
1988	1604473
1989	1765250
1990	2056374
1991	2816371
1992	2597894
1993	2902886
1994	3318956
1995	3443857
1996	3771955
1997	4449754
1998	4853120
1999	4857488
2000	5867507
2001	6239575
2002	[illegible]

Q1

```python
import pandas as pd
import matplotlib.pyplot as plt
import os
```

Importing Libraries

```python
df = pd.read_csv("./GovernmentExpenditureonEducation.csv")
```

Reading the CSV File

```python
expenditureList = df['total_expenditure_on_education'].tolist()
yearList = df['year'].tolist()
```

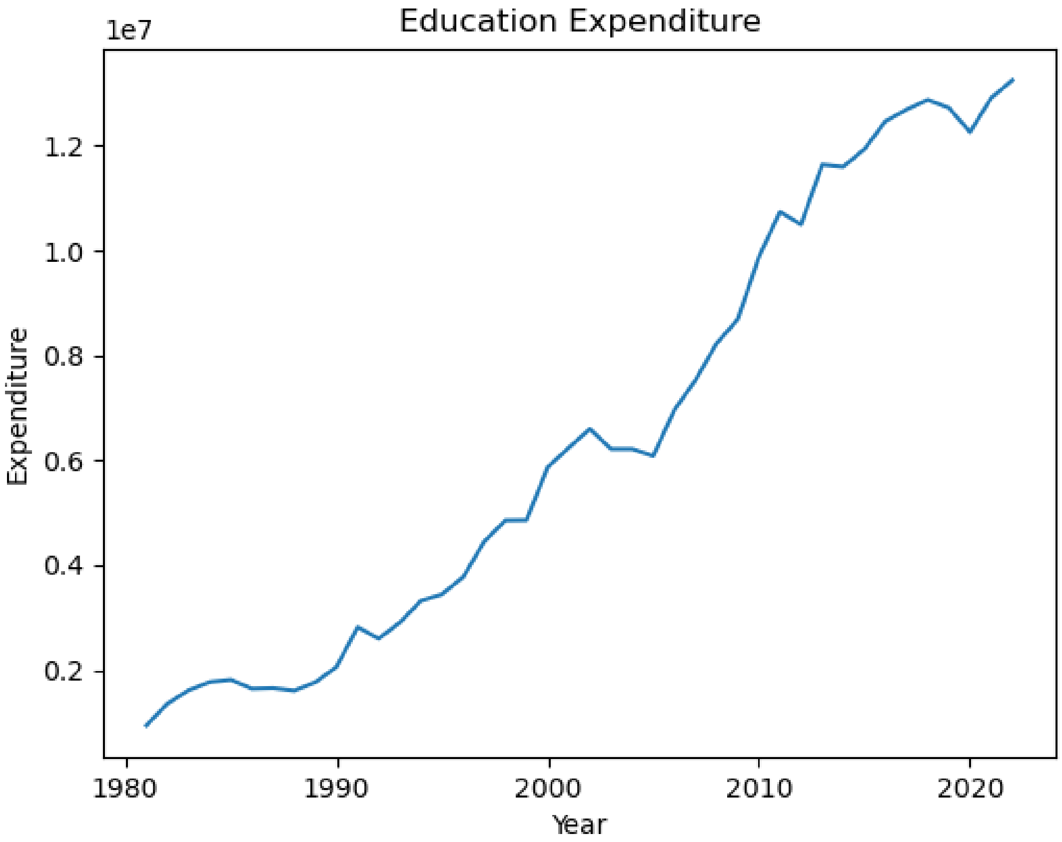
Extract the column from DataFrame and convert it into a list.

```python
plt.plot(yearList, expenditureList, label = 'Expenditure over the years')
plt.xlabel('Year')
plt.ylabel('Expenditure')
plt.title('Education Expenditure')
plt.show()
```

Plotting the Data

01

Q1



Education Expenditure
1e7
1.2
1.0
0.8
0.6
0.4
0.2
Expenditure
1980
1990
2000
2010
2020
Year

02

Q2

(Data Reading and Visualization, slightly more complicated data structure.)

- Download the CSV file from https://data.gov.sg/dataset/annual-motor-vehicle-population-by-vehicle-type.
- Extract and plot the number of Omnibuses, Excursion buses and Private buses over the years as shown below.
- (Hint: you might need “import pandas as pd” and “import matplotlib.pyplot as plt”.)

Q2

	A	B	C	D
1	year	category	type	number
236	2016	Goods and Other Vehic	Very Heavy Good:	16407
237	2016	Buses	Omnibuses	5470
238	2016	Buses	School buses (CB	1840
239	2016	Buses	Private buses	2659
240	2016	Buses	Private hire buses	1598
241	2016	Buses	Excursion buses	6771
242	2016	Tax Exempted Vehicles	Cars and Station-	2506
243	2016	Tax Exempted Vehicles	Motorcycles and :	613
244	2016	Tax Exempted Vehicles	Buses	466
245	2016	Tax Exempted Vehicles	Goods and Other	19311
246	2017	Cars and Station-wagor	Private cars	502187
247	2017	Cars and Station-wagor	Company cars	24196
248	2017	Cars and Station-wagor	Tuition cars	843
249	2017	Cars and Station-wagor	Private Hire (Self-	21180
250	2017	Cars and Station-wagor	Private Hire (Cha	46903
251	2017	Cars and Station-wagor	Off peak cars	16947
252	2017	Taxis	Taxis	23140
253	2017	Motorcycles and Scoot	Motorcycles and :	141304
254	2017	Goods and Other Vehic	Goods-cum-pass	2972
255	2017	Goods and Other Vehic	Light Goods Vehi	94724
256	2017	Goods and Other Vehic	Heavy Goods Veh	28641
257	2017	Goods and Other Vehic	Very Heavy Good:	16520
258	2017	Buses	Omnibuses	5665
259	2017	Buses	School buses (CB	1844
260	2017	Buses	Private buses	2533

```python
import pandas as pd
import matplotlib.pyplot as plt
import os
```

Importing Libraries

```python
df = pd.read_csv("AnnualMotorVehiclePopulationbyVehicleType.csv")
```

Loading the Data

```python
year = df['year'].tolist()
category = df['category'].tolist()
vehtype = df['type'].tolist()
number = df['number'].tolist()
```

Convert the columns from the DataFrame into Python List

```python
val1 = df.loc[df['type']=='Omnibuses'].index
val2 = df.loc[df['type']=='Excursion buses'].index
val3 = df.loc[df['type']=='Private buses'].index
print(val1)
```

Filter the DataFrame based on the condition provided inside the loc method. '.index' returns the indices where the condition is true.

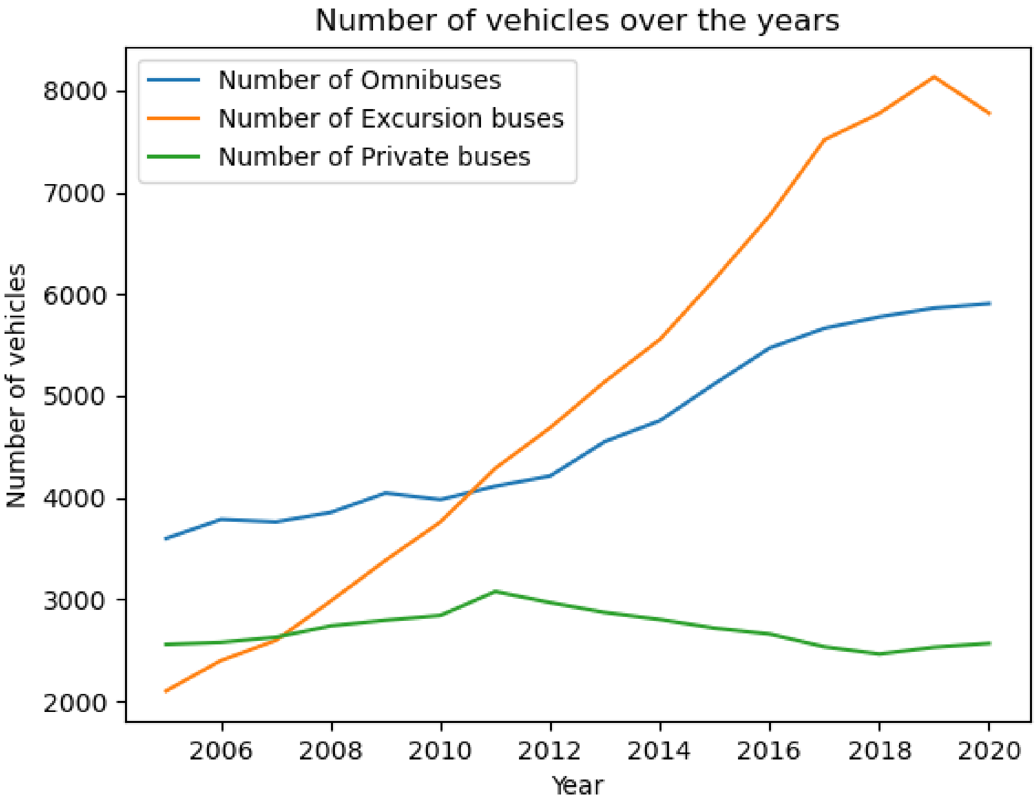
```python
List1 = df.loc[val1]; print(List1)
List2 = df.loc[val2]; print(List2)
List3 = df.loc[val3]; print(List3)
```

Create lists contain only the rows corresponding to 'Omnibuses', 'Excursion buses', and 'Private buses' respectively

```python
plt.plot(List1['year'], List1['number'], label = 'Number of Omnibuses')
plt.plot(List2['year'], List2['number'], label = 'Number of Excursion buses')
plt.plot(List3['year'], List3['number'], label = 'Number of Private buses')
plt.xlabel('Year')
plt.ylabel('Number of vehicles')
plt.title('Number of vehicles over the years')
plt.legend()
plt.show()
```

02

Q2


Number of vehicles over the years
Number of Omnibuses
Number of Excursion buses
Number of Private buses
8000
7000
6000
5000
4000
3000
2000
Number of vehicles
2006
2008
2010
2012
2014
2016
2018
2020
Year

Q2 Method 2

```
import pandas as pd
import colorsys
import matplotlib.pyplot as plt
import seaborn as sns
```

Importing Libraries

```
df = pd.read_csv("AnnualMotorVehiclePopulationbyVehicleType.csv")
```

Load the data

```
sns.set_style("darkgrid")
```

Sets the aesthetic style of the plots to "darkgrid", which includes a dark background with gridlines.

```
df3 = df.loc[df['type'].isin(['Omnibuses', 'Excursion buses', 'Private buses’])]
```

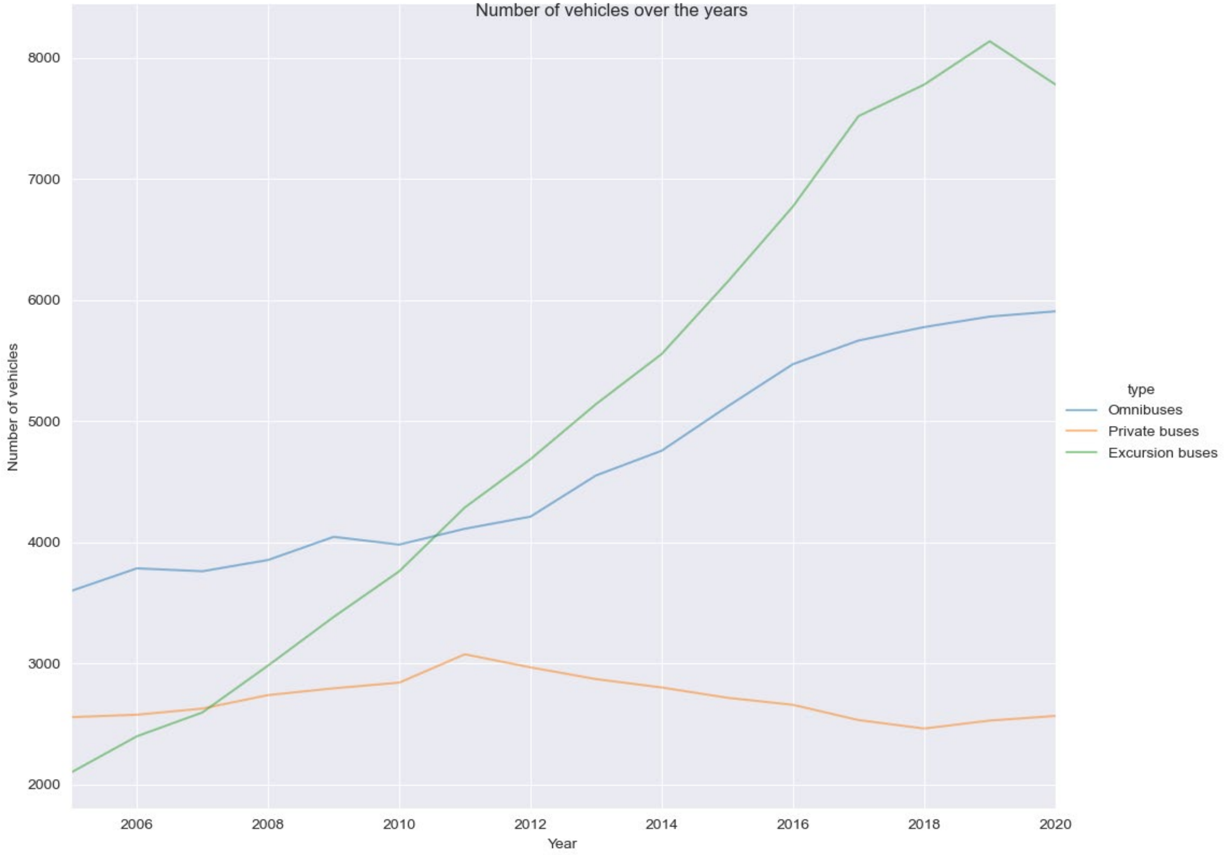
- df.loc[]: This is a label-based indexer for selecting rows and columns from the DataFrame.
- df['type'].isin(): Filters the rows where the specific 'type'

```
g = sns.PairGrid(data=df3, x_vars="year", y_vars="number", hue="type", height=10, aspect=1)
```

A PairGrid object g plots 'year' on the x-axis and 'number' on the y-axis, with different colors for different 'type' values.

```
g = g.map(plt.plot, alpha=0.5)
g = g.set(xlim=(df['year'].min(), df['year'].max()))
g = g.add_legend()
g.fig.suptitle('Number of vehicles over the years')
plt.xlabel('Year')
plt.ylabel('Number of vehicles')
```

Q2 Method 2


Number of vehicles over the years
Number of vehicles
2000
3000
4000
5000
6000
7000
8000
2006
2008
2010
2012
2014
2016
2018
2020
Year
type
Omnibuses
Private buses
Excursion buses

03

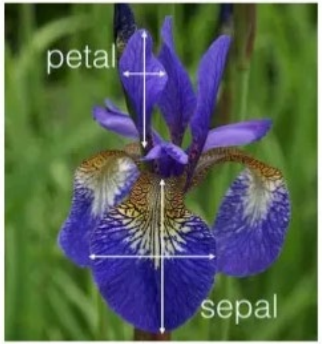
Q3

(Data Reading and Visualization, distribution)

The “iris” flower data set consists of measurements such as the length, width of the petals, and the length, width of the sepals, all measured in centimeters, associated with each iris flower.

- Get the data set “from sklearn.datasets import load_iris” and
- Do a scatter plot as shown below. (Hint: you might need “from pandas.plotting import scatter_matrix”)

Iris Versicolor Iris Setosa Iris Virginica



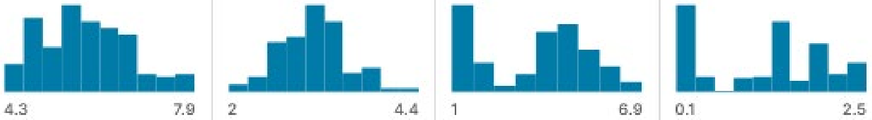
https://analyticsindiamag.com/ai-mysteries/start-building-first-machine-learning-project-famous-dataset/

https://medium.com/analytics-vidhya/exploration-of-iris-dataset-using-scikit-learn-part-1-8ac5604937f8

Q3

About this file

The dataset is a CSV file which contains a set of 150 records under 5 attributes - Petal Length, Petal Width, Sepal Length, Sepal width and Class(Species)



# sepal_length	# sepal_width	# petal_length	# petal_width	species
4.3 – 7.9	2 – 4.4	1 – 6.9	0.1 – 2.5	3 unique values
5.1	3.5	1.4	0.2	Iris-setosa
4.9	3	1.4	0.2	Iris-setosa
4.7	3.2	1.3	0.2	Iris-setosa
4.6	3.1	1.5	0.2	Iris-setosa
5	3.6	1.4	0.2	Iris-setosa
5.4	3.9	1.7	0.4	Iris-setosa
4.6	3.4	1.4	0.3	Iris-setosa
5	3.4	1.5	0.2	Iris-setosa
4.4	2.9	1.4	0.2	Iris-setosa
4.9	3.1	1.5	0.1	Iris-setosa
5.4	3.7	1.5	0.2	Iris-setosa
4.8	3.4	1.6	0.2	Iris-setosa
4.8	3	1.4	0.1	Iris-setosa

https://www.kaggle.com/datasets/arshid/iris-flower-dataset

Q3 Method 1

```
import pandas as pd; print("pandas version: {}".format(pd.__version__))
import matplotlib.pyplot as plt
import sklearn; print("scikit-learn version: {}".format(sklearn.__version__))
```

Importing Libraries and Printing Versions

```
from sklearn.datasets import load_iris
iris_dataset = load_iris()
from sklearn.model_selection import train_test_split
```

Loading the Iris Dataset

```
X_train, X_test, y_train, y_test = train_test_split( iris_dataset['data'], iris_dataset['target'],
random_state=0)
```

Splitting the dataset into training and testing sets

```
# create dataframe from data in X_train
# label the columns using the strings in iris_dataset.feature_names
iris_dataframe = pd.DataFrame(X_train, columns=iris_dataset.feature_names)
```

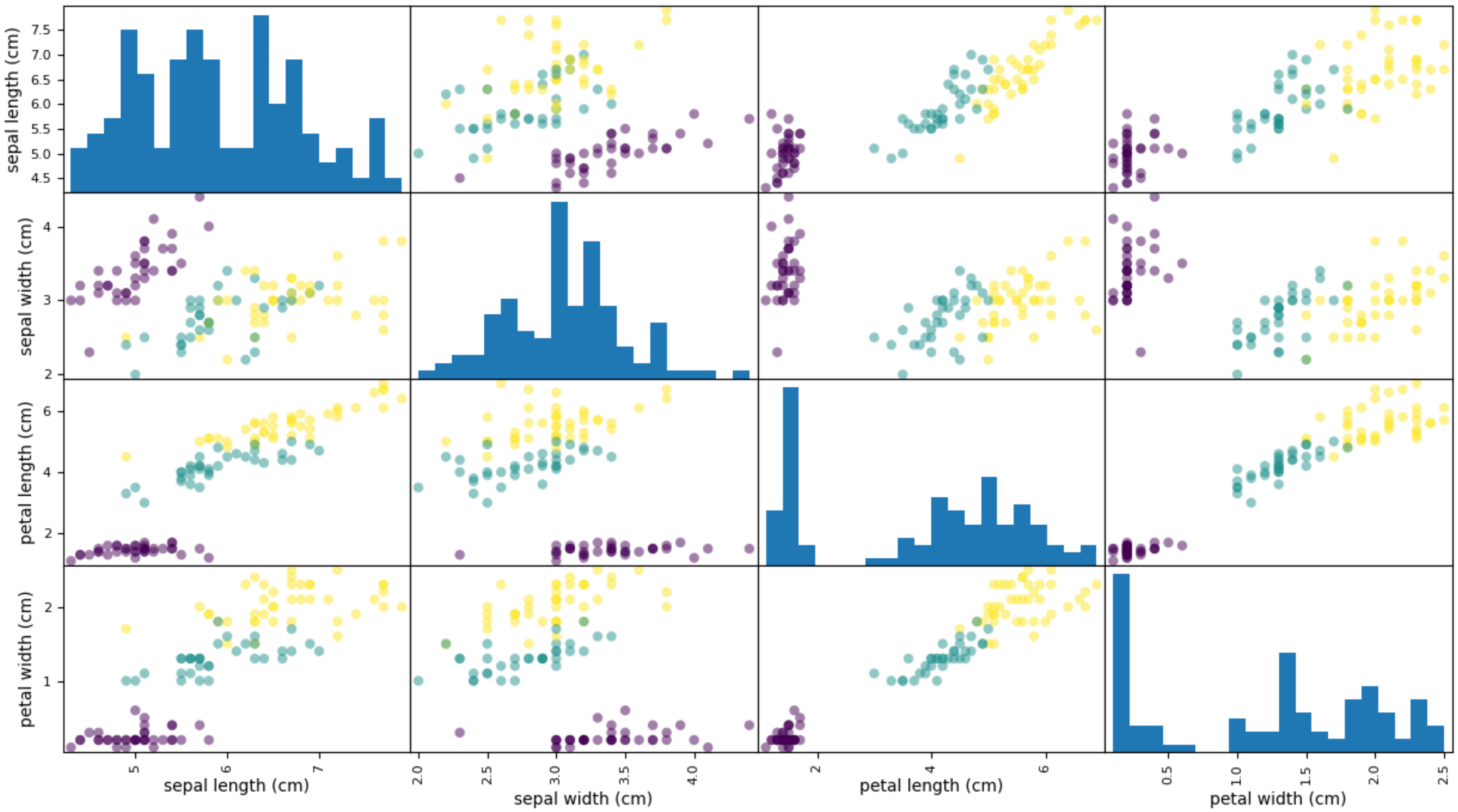
- Create a DataFrame from training data
- Label columns using feature names from iris_dataset (e.g., sepal length, sepal width, petal length, petal width).

```
# create a scatter matrix from the dataframe, color by y_train
from pandas.plotting import scatter_matrix

grr = pd.plotting.scatter_matrix(iris_dataframe, c=y_train, figsize=(15, 15), marker='o',
hist_kwds={'bins': 20})
plt.show()
```

Visualizing data with a scatter matrix

Colors the points according to their class labels



sepal length (cm)
sepal width (cm)
petal length (cm)
petal width (cm)

Q3 Method 2

```python
import pandas as pd
import colorsys
import matplotlib.pyplot as plt
import seaborn as sns
```

Importing Libraries

```python
sns.set()
iris = sns.load_dataset("iris")
```

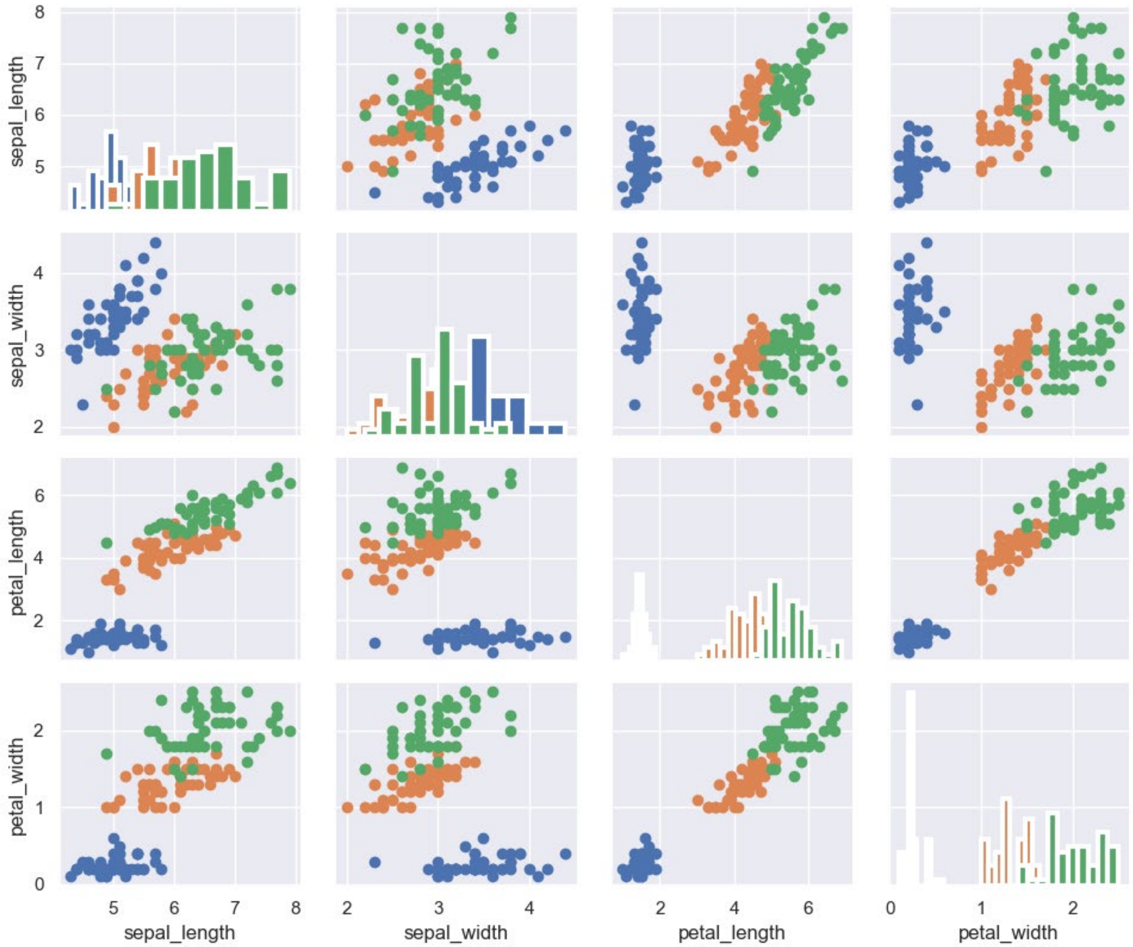
Set Seaborn default style and load the iris dataset

```python
g = sns.PairGrid(iris, hue="species")
```

- A PairGrid to create a matrix of plots to visualize relationships between variables in a dataset
- The hue parameter differentiates the data points by color based on the species of the iris flowers.

```python
g = g.map_diag(plt.hist, linewidth=3)
g = g.map_offdiag(plt.scatter)
plt.show()
```

- Create histograms on diagonal
- Create scatter plots on the off-diagonal


sepal_length
sepal_width
petal_length
petal_width
sepal_length
sepal_width
petal_length
petal_width

04

Q 4

(Data Wrangling/Normalization)

You are given a set of data for supervised learning. A sample block of data looks like this:

“ 1.2234, 0.3302, 123.50, 0.0081, 30033.81, 1
1.3456, 0.3208, 113.24, 0.0067, 29283.18, -1
0.9988, 0.2326, 133.45, 0.0093, 36034.33, 1
1.1858, 0.4301, 128.55, 0.0077, 34037.35, 1
1.1533, 0.3853, 116.70, 0.0066, 22033.58, -1
1.2755, 0.3102, 118.30, 0.0098, 30183.65, 1
1.0045, 0.2901, 123.52, 0.0065, 31093.98, -1
1.1131, 0.3912, 113.15, 0.0088, 29033.23, -1 ”

Each row corresponds to a sample data measurement with 5 input features and 1 response.

(a) What kind of undesired effect can you anticipate if this set of raw data is used for learning?

(b) How can the data be preprocessed to handle this issue?

Q4

Ans:

(a) Those features with very large values may overshadow those with very small values.

(b) We can either use min-max or z-score normalization to resolve the problem.

```python
# Tutorial 2 Problem 4
import pandas as pd
import matplotlib.pyplot as plt
import numpy as np
```

Importing Libraries

```python
data = [ [1.2234, 0.3302, 123.50, 0.0081, 30033.81, 1],
[1.3456, 0.3208, 113.24, 0.0067, 29283.18, -1],
[0.9988, 0.2326, 133.45, 0.0093, 36034.33, 1],
[1.1858, 0.4301, 128.55, 0.0077, 34037.35, 1],
[1.1533, 0.3853, 116.70, 0.0066, 22033.58, -1],
[1.2755, 0.3102, 118.30, 0.0098, 30183.65, 1],
[1.0045, 0.2901, 123.52, 0.0065, 31093.98, -1],
[1.1131, 0.3912, 113.15, 0.0088, 29033.23, -1] ]
```

'data' is a list of lists, where each inner list represents a row of data. Each row contains six values.

```python
df = pd.DataFrame(data)
df.head(7)
```

Converts the list of lists into a pandas DataFrame, which is a table-like data structure with rows and columns.

```python
from sklearn import preprocessing

# Z-score scaling
df_scaled = preprocessing.scale(df)
print(df_scaled.mean(axis=0))
print(df_scaled.std(axis=0))
```

Applies Z-score scaling to the DataFrame df. Z-score scaling standardizes the data such that each column will have a mean of 0 and a standard deviation of 1.

```python
# min-max scaling
mix_max_scale = preprocessing.MinMaxScaler()
df_minax = mix_max_scale.fit_transform(df)
```

Min-Max scaling transforms the data so that all features are within a given range, usually [0, 1]

05 Q5 (Missing Data)

The Pima Indians Diabetes Dataset involves predicting the onset of diabetes within 5 years in Pima Indians given medical details. Download the Pima-Indians-Diabetes data from https://raw.githubusercontent.com/jbrownlee/Datasets/master/pima-indians-diabetes.data.csv.

It is a binary (2-class) classification problem. The number of observations for each class is not balanced. There are 768 observations with 8 input variables and 1 output variable. The variable names are as follows:

0. Number of times pregnant.
1. Plasma glucose concentration a 2 hours in an oral glucose tolerance test.
2. Diastolic blood pressure (mm Hg).
3. Triceps skinfold thickness (mm).
4. 2-Hour serum insulin (mu U/ml).
5. Body mass index (weight in kg/(height in m)^2).
6. Diabetes pedigree function.
7. Age (years).
8. Class variable (0 or 1).

(a) Print the summary statistics of this data set.
(b) Count the number of “0” entries in columns [1,2,3,4,5].
(c) Replace these “0” values by “NaN”.
(Hint: you might need the “.describe()” and “.replace(0, numpy.NaN)” functions “from pandas import read_csv”.)

05

Q5

```
#(a) from pandas import read_csv
import pandas as pd
dataset = pd.read_csv('pima-indians-diabetes.csv', header=None)
print(dataset.describe())
```

Importing the Dataset

```
#(b)
print((dataset[[1,2,3,4,5]] == 0).sum())
```

Counting Zeros in Specific Columns

```
#(c) import numpy
import numpy
# mark zero values as missing or NaN
dataset[[1,2,3,4,5]] = dataset[[1,2,3,4,5]].replace(0, numpy.NaN)
# print the first 20 rows of data
print(dataset.head(20))
print(dataset.isnull().sum())
```

Replacing Zeros with ‘NaN’ and Checking for Missing Values

06

Q6

Disease Outbreak Response System Condition (DORSCON) in Singapore is a colour-coded framework that shows the current disease situation. The framework provides us with general guidelines on what needs to be done to prevent and reduce the impact of infections. There are 4 statuses – Green, Yellow, Orange and Red, depending on the severity and spread of the disease. Which type of data does DORSCON belong to ?

(1) Categorical; (2) Ordinal; (3) Continuous; (4) Interval

07

Q7

A boxplot is a standardized way of displaying the dataset based on a five-number summary: the minimum, the maximum, _BLANK1_, and the first and third quartiles, where the number of data points that fall between the first and third quartiles amounts to _BLANK2_ percent of the total number of data on display.

Ans:

BLANK1: ???

BLANK2: ???

Example of Boxplot

```python
# Tutorial 2: Example of Boxplot
import seaborn as sns
import statistics
import matplotlib.pyplot as plt
import numpy as np
import pandas as pd
```

Importing Libraries

```python
dataPointsWOoutliers=[55,57,57,58,63,66,66,67,68,69,70,70,70,70,72,73,75,76,76,78,79,81.]
dataPointsWoutliers=[35,57,57,58,63,66,66,67,68,69,70,70,70,70,72,73,75,76,76,78,79,99.]]
df_combined = pd.DataFrame()
df_combined['normal'] = dataPointsWOoutliers
df_combined['outliers'] = dataPointsWoutliers
```

Stores both lists of data points in two columns: normal for data without outliers and outliers for data with outliers

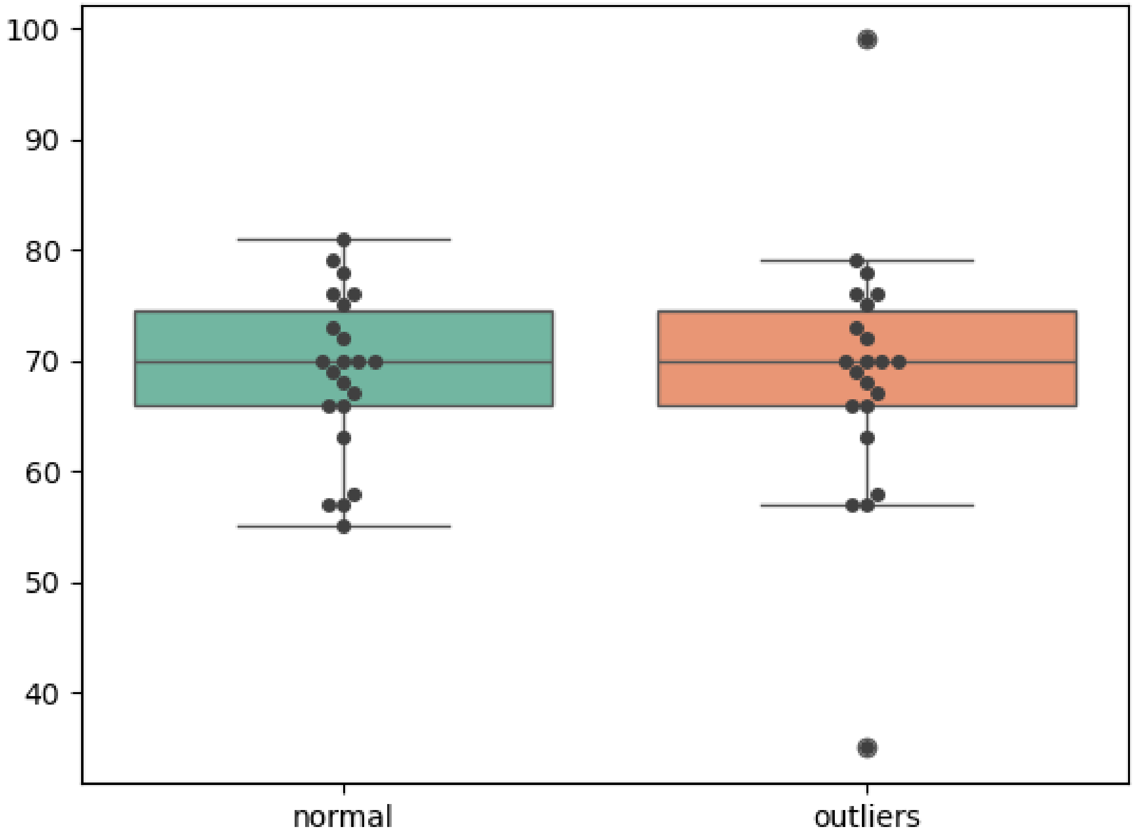
```python
ax1 = sns.boxplot(data=df_combined, orient="v", palette="Set2")
```

A boxplot to show the distribution of the data, highlighting the median, quartiles, and any potential outliers.

```python
ax1 = sns.swarmplot(data=df_combined, orient="v", color=(".25"))
plt.show()
```

Overlays a swarm plot on top of the boxplot

```python
print(statistics.median(dataPointsWOoutliers))
print(statistics.median(dataPointsWoutliers))
```


100
90
80
70
60
50
40
normal
outliers

THANK YOU