PROGRAM STUDI
TEKNIK INFORMATIKA – S1
FAKULTAS ILMU KOMPUTER
UNIVERSITAS DIAN NUSWANTORO

MATA KULIAH
DATA MINING

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DATA MINING

"Klasifikasi dengan Naïve Bayes"

TIM PENGAMPU DOSEN DATA MINING

2023

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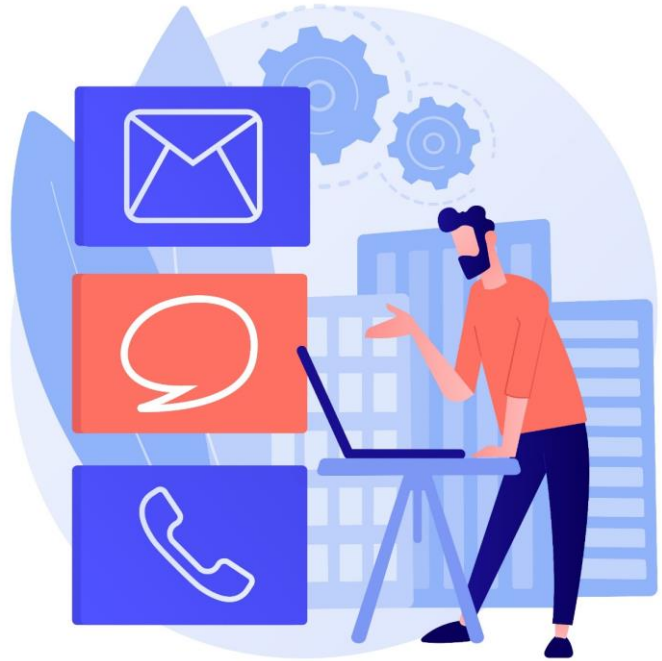
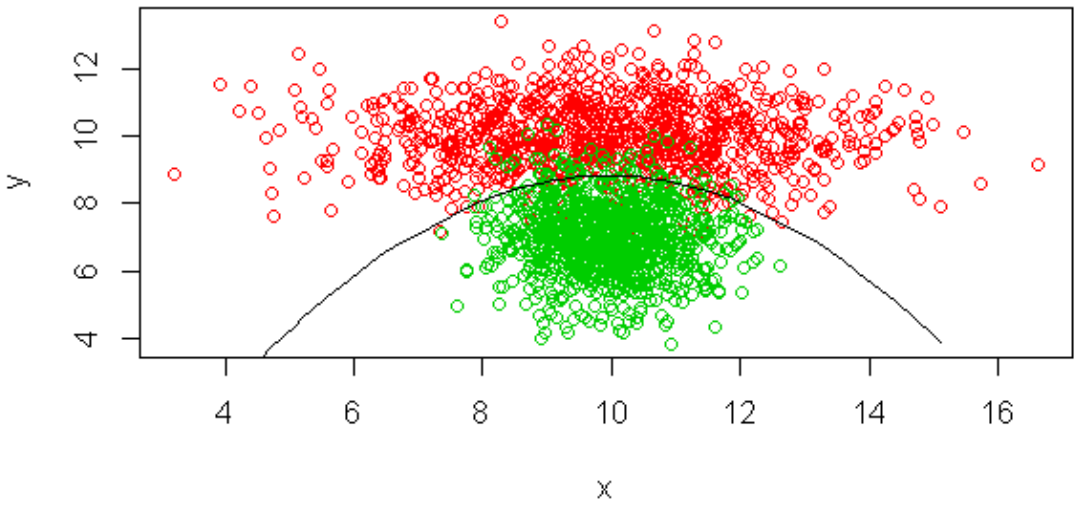


KLASIFIKASI

- Klasifikasi adalah algoritma yang menggunakan data dengan target/class/label berupa nilai kategorikal (nominal).
- Contoh, apabila target/class/label adalah pendapatan, maka bisa digunakan nilai nominal (kategorikal) sbb: pendapatan besar, menengah, kecil.
- Contoh lain adalah rekomendasi contact lens, apakah menggunakan yang jenis soft, hard atau none.
- Algoritma klasifikasi yang biasa digunakan adalah: Naive Bayes, K-Nearest Neighbor, C4.5, ID3, CART, Linear Discriminant Analysis, etc.

BAYESIAN CLASSIFICATION

- Bayesian Classification adalah pengklasifikasian statistik yang dapat digunakan untuk memprediksi *probabilitas* keanggotaan suatu class.
- Bayesian Classification didasarkan pada *teorema Bayes* yang memiliki kemampuan klasifikasi serupa *decision tree* dan *neural network*.
- Bayesian Classification terbukti memiliki *akurasi dan kecepatan* yang tinggi saat diaplikasikan ke dalam database dengan data yang besar.



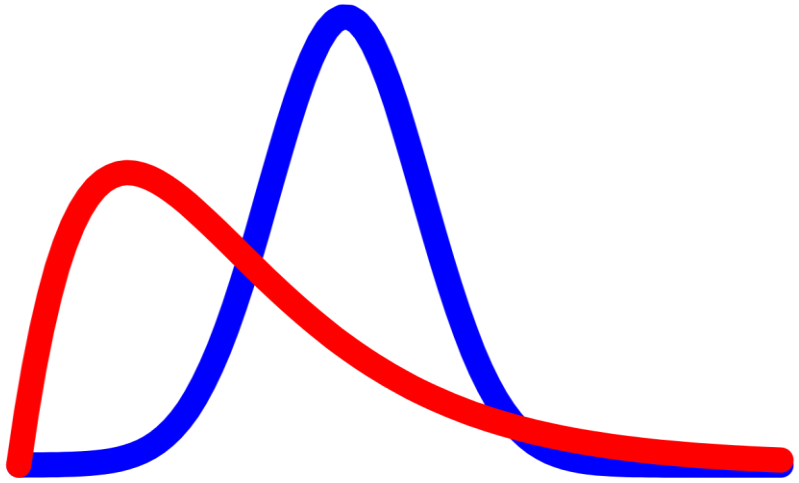
RUMUS TEOREMA BAYES

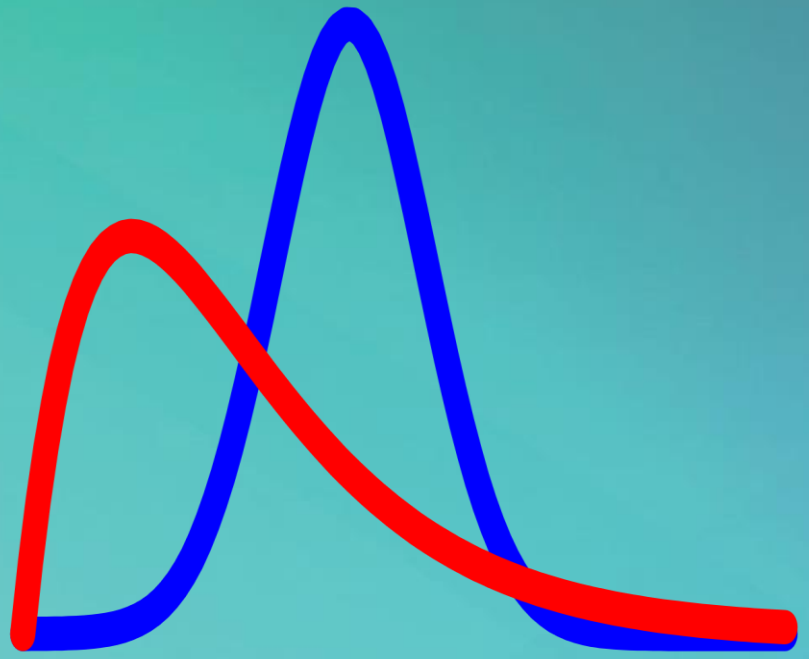
- **Teorema Bayes** memiliki bentuk umum sbb :

$$P(H|X) = \frac{P(X|H)\,P(H)}{P(X)}$$

Keterangan :

X	: data dengan *class* yang belum diketahui
H	: hipotesis data X merupakan suatu *class* spesifik
P(H|X)	: probabilitas hipotesis H berdasar kondisi X (*posteriori probability*)
P(H)	: probabilitas hipotesis H (*prior probability*)
P(X|H)	: probabilitas X berdasar kondisi hipotesis H
P(X)	: probabilitas dari X





Contoh Perhitungan

Klasifikasi menggunakan Naive Bayes

DATA TRAINING

Terdapat dua class dari klasifikasi yang dibentuk yaitu :

C1 => buys_computer = yes
C2 => buys_computer = no

Nilai X yang belum diketahui Label / Kelas :

X =
(
age="<=30",
income="Medium",
student="Yes",
credit_rating="Fair";
)

$$\boldsymbol{P(C_i|X)}=P(C_i)\prod_{k=1}^{N} P(X_k = x_k|C_i)$$

Id	Age	Income	Student	Credit_rating	Class: buys_computer
1	<=30	High	No	Fair	No
2	<=30	High	No	Excellent	No
3	31..40	High	No	Fair	Yes
4	>40	Medium	No	Fair	Yes
5	>40	Low	Yes	Fair	Yes
6	>40	Low	Yes	Excellent	No
7	31..40	Low	Yes	Excellent	Yes
8	<=30	Medium	No	Fair	No
9	<=30	Low	Yes	Fair	Yes
10	>40	Medium	Yes	Fair	Yes
11	<=30	Medium	Yes	Excellent	Yes
12	31..40	Medium	No	Excellent	Yes
13	31..40	High	Yes	Fair	Yes
14	>40	Medium	No	Excellent	No

PENYELESAIAN (1)

Dibutuhkan untuk memaksimalkan P(X|Ci) P(Ci) untuk i=1, 2

- P(Ci) merupakan prior probability untuk setiap class berdasar data contoh
  P(buys_computer="yes") = 9/14 = 0.643
  P(buys_computer="no") = 5/14 = 0.357
- Hitung P(X|Ci) untuk i=1, 2

P(age="<=30"|buys_computer="yes") = 2/9= 0.222
P(age="<=30"|buys_computer="no") = 3/5 = 0.600
P(income="medium"|buys_computer="yes")=4/9=0.444
P(income="medium"|buys_computer="no")=2/5=0.400

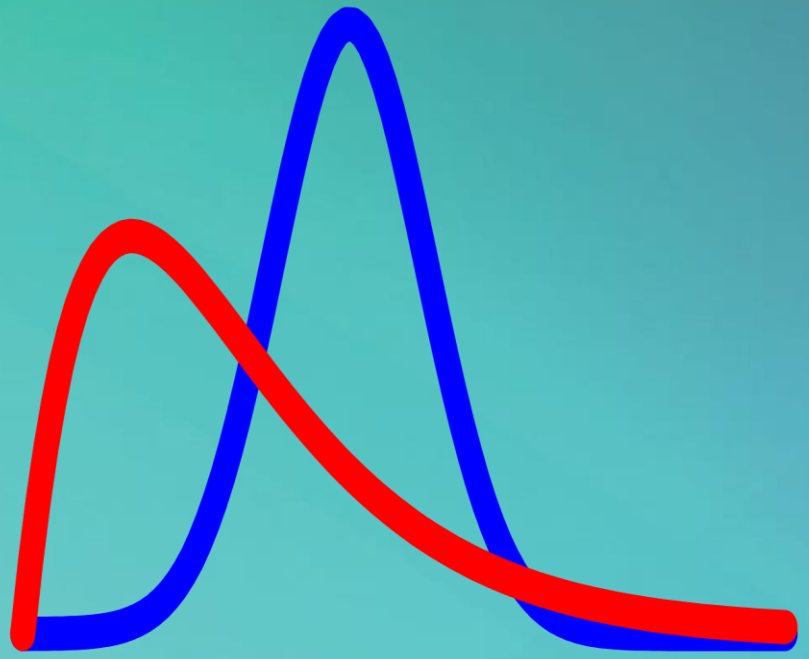
P(student="yes"|buys_computer="yes") = 6/9= 0.667
P(student="yes"|buys_computer="no") = 1/5= 0.200
P(credit_rating="fair"|buys_computer="yes")=6/9= 0.667
P(credit_rating="fair"|buys_computer="no")=2/5= 0.400

PENYELESAIAN (2)

P(X|buys_computer="yes") = 0.222*0.444*0.677*0.677
= 0.044
P(X|buys_computer="no") = 0.600*0.400*0.200*0.400
= 0.019

- P(X|buys_computer="yes") P(buys_computer="yes")
= 0.044 * 0.643 = **0.028**
- P(X|buys_computer="no") P(buys_computer="no")
= 0.019 * 0.357 = 0.007

Kesimpulan: ***buys_computer = "yes"***

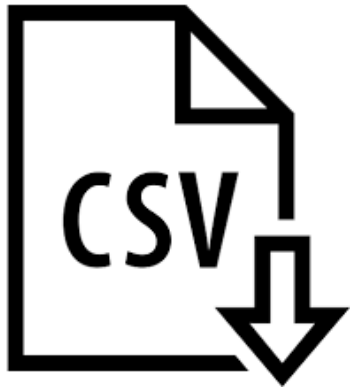


Implementasi Klasifikasi Naive Bayes dengan python

Dataset

dataset - DataFrame

Index	User ID	Gender	Age	EstimatedSalary	Purchased
0	15624510	Male	19	19000	0
1	15810944	Male	35	20000	0
2	15668575	Female	26	43000	0
3	15603246	Female	27	57000	0
4	15804002	Male	19	76000	0
5	15728773	Male	27	58000	0
6	15598044	Female	27	84000	0
7	15694829	Female	32	150000	1
8	15600575	Male	25	33000	0
9	15727311	Female	35	65000	0
10	15570769	Female	26	80000	0
11	15606274	Female	26	52000	0
12	15746139	Male	20	86000	0



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Import library yang digunakan

```
import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
```

Library yang digunakan untuk contoh diatas adalah library **numpy** dan **pandas**.

Import Dataset

```
dataset = pd.read_csv('Social_Network_Ads.csv')
X = dataset.iloc[:, [2, 3]].values
y = dataset.iloc[:, -1].values
```

Splitting the dataset into the Training set and Test set

```
from sklearn.model_selection import train_test_split
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size = 0.25, random_state = 0)
```

Feature Scaling

```
from sklearn.preprocessing import StandardScaler
sc = StandardScaler()
X_train = sc.fit_transform(X_train)
X_test = sc.transform(X_test)
```

Training the Naive Bayes model on the Training set

```
from sklearn.naive_bayes import GaussianNB
classifier = GaussianNB()
classifier.fit(X_train, y_train)
```

Predicting the Test set results

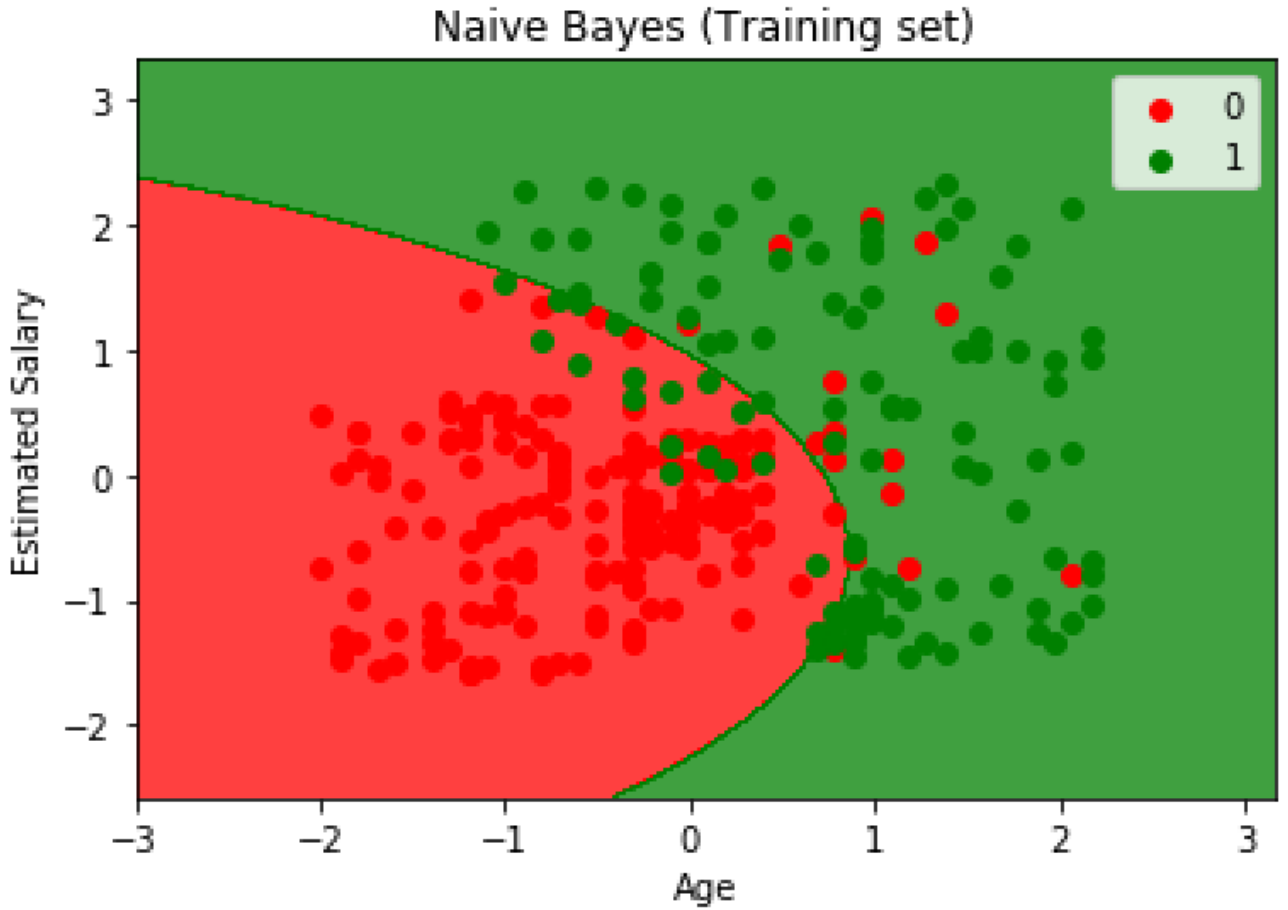
```
y_pred = classifier.predict(X_test)
```

Making the Confusion Matrix

```
from sklearn.metrics import confusion_matrix
cm = confusion_matrix(y_test, y_pred)
print(cm)
```

Visualising the Training set results

```
from matplotlib.colors import ListedColormap
X_set, y_set = X_train, y_train
X1, X2 = np.meshgrid(np.arange(start = X_set[:, 0].min() - 1, stop = X_set[:, 0].max() + 1, step = 0.01),
                     np.arange(start = X_set[:, 1].min() - 1, stop = X_set[:, 1].max() + 1, step = 0.01))
plt.contourf(X1, X2, classifier.predict(np.array([X1.ravel(), X2.ravel()]).T).reshape(X1.shape),
             alpha = 0.75, cmap = ListedColormap(('red', 'green')))
plt.xlim(X1.min(), X1.max())
plt.ylim(X2.min(), X2.max())
for i, j in enumerate(np.unique(y_set)):
    plt.scatter(X_set[y_set == j, 0], X_set[y_set == j, 1],
                c = ListedColormap(('red', 'green'))(i), label = j)
plt.title('Naive Bayes (Training set)')
plt.xlabel('Age')
plt.ylabel('Estimated Salary')
plt.legend()
plt.show()
```


Naive Bayes (Training set)
Estimated Salary
Age
0
1
3
2
1
0
−1
−2
−3
−2
−1
0
1
2
3

Visualising the Test set results

```
from matplotlib.colors import ListedColormap
X_set, y_set = X_test, y_test
X1, X2 = np.meshgrid(np.arange(start = X_set[:, 0].min() - 1, stop = X_set[:, 0].max() + 1, step = 0.01),
                     np.arange(start = X_set[:, 1].min() - 1, stop = X_set[:, 1].max() + 1, step = 0.01))
plt.contourf(X1, X2, classifier.predict(np.array([X1.ravel(), X2.ravel()]).T).reshape(X1.shape),
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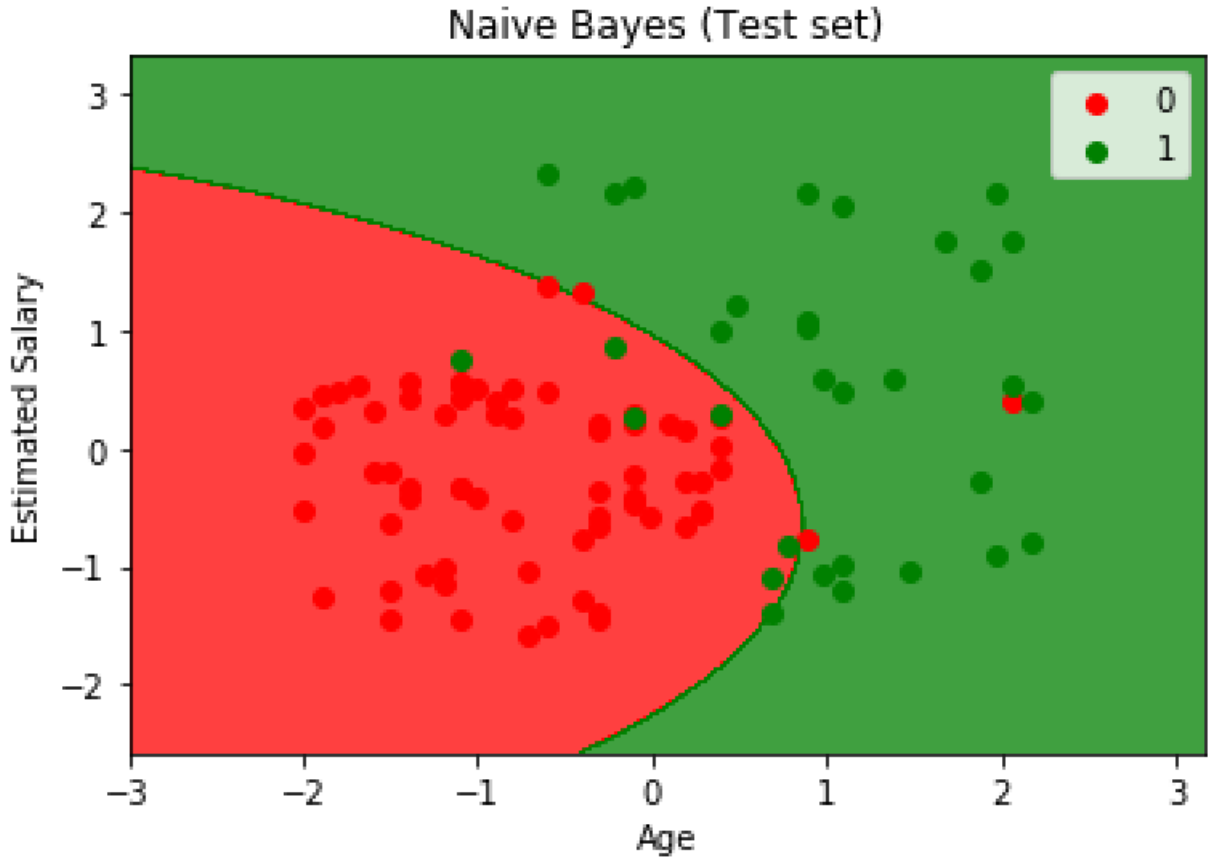
Naive Bayes (Test set)
Estimated Salary
Age
0
1
3
2
1
0
−1
−2
−3
−2
−1
0
1
2
3

Latihan Soal (Kuis)

- Kerjakan Latihan tahapan klasifikasi dengan naïve bayes pada latihan sebelumnya, dataset bisa diganti / dimodifikasi, simpan dalam ***naive_bayes.py*** atau ***naive_bayes.ipynb***, repositorikan file pada **github.com** dan kirimkan URL github melalui Assignment pada kulino (Pada blok Minggu ke-5).

Referensi

1. Jiawei Han, Micheline Kamber, Jian Pei, Data mining : concepts and techniques – 3rd ed, Elsevier, 2012.
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4. Max Bramer, Principles of Data Mining – Undergraduate Topics in Computer Science – 4th ed, Springer, 2020.
5. Sumber gambar: www.freepik.com.

THANKS

ANY QUESTIONS?