Sertifikasi BNSP – Salma Nabilah Rouf

Associate Data Science

22 Desember 2022

Link Google Colab :
https://colab.research.google.com/drive/1sZkIQcTGc0SgqZ7N4zRvYLhHCZofwZcu#scrollTo=LeeOy1epkof4

Link Drive (data clean, collab, dan pdf) :
https://drive.google.com/drive/folders/1Duy1SreMd6XQp5akj1Rz6Qt2FEJfm4AY?usp=sharing

Business Understanding

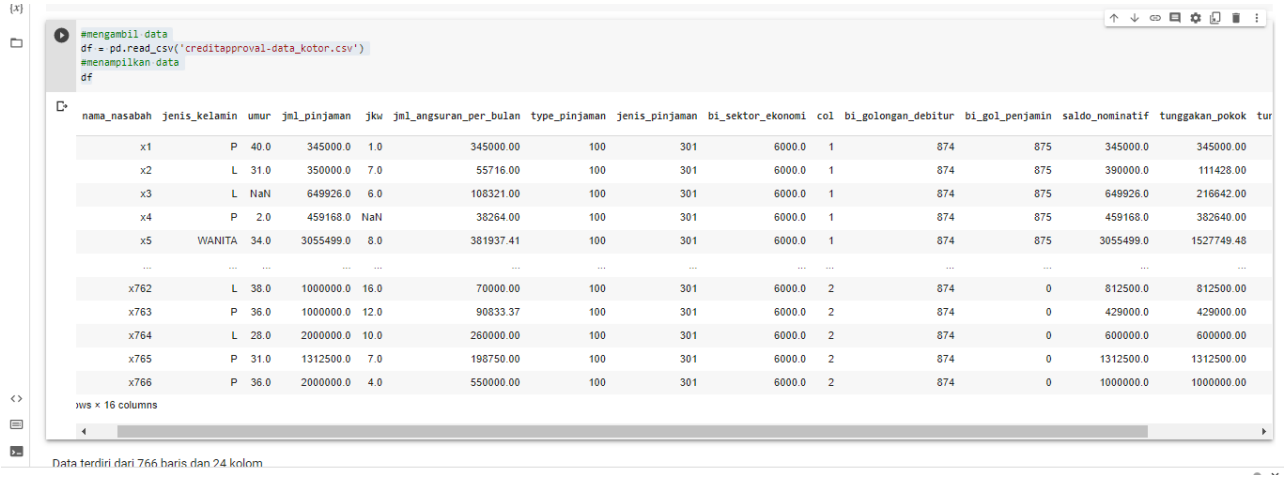
Sumanto seorang kredit analis sebuah Bank ABC sedang memiliki masalah karena banyaknya nasabah yang mengalami kredit macet. Untuk mengantisipasi masalah tersebut, dia mencoba melakukan analisis terhadap data nasabah dan status pembayaran cicilan kreditnya agar dapat memprediksi profile debitur (penghutang) dari aspek lancar atau macet kreditnya.

Tujuan

Untuk memprediksi calon nasabah apakah dapat membayar kredit lancar atau macet berdasarkan data history tahun lalu.(data terlampir)

Data Understanding

```
#import library
import pandas as pd
import numpy as np
```



```
#mengambil data
df = pd.read_csv('creditapproval-data_kotor.csv')
#menampilkan data
df
```

	nama_nasabah	jenis_kelamin	umur	jml_pinjaman	jkw	jml_angsuran_per_bulan	type_pinjaman	jenis_pinjaman	bi_sektor_ekonomi	col	bi_golongan_debitur	bi_gol_penjamin	saldo_nominatif	tunggakan_pokok	tur
	x1	P	40.0	345000.0	1.0	345000.00	100	301	6000.0	1	874	875	345000.0	345000.00	
	x2	L	31.0	350000.0	7.0	55716.00	100	301	6000.0	1	874	875	390000.0	111428.00	
	x3	L	NaN	649926.0	6.0	108321.00	100	301	6000.0	1	874	875	649926.0	216642.00	
	x4	P	2.0	459168.0	NaN	38264.00	100	301	6000.0	1	874	875	459168.0	382640.00	
	x5	WANITA	34.0	3055499.0	8.0	381937.41	100	301	6000.0	1	874	875	3055499.0	1527749.48	
	...	...	...	...	...	...	...	...	...	...	...	...	...	...	
	x762	L	38.0	1000000.0	16.0	70000.00	100	301	6000.0	2	874	0	812500.0	812500.00	
	x763	P	36.0	1000000.0	12.0	90833.37	100	301	6000.0	2	874	0	429000.0	429000.00	
	x764	L	28.0	2000000.0	10.0	260000.00	100	301	6000.0	2	874	0	600000.0	600000.00	
	x765	P	31.0	1312500.0	7.0	198750.00	100	301	6000.0	2	874	0	1312500.0	1312500.00	
	x766	P	36.0	2000000.0	4.0	550000.00	100	301	6000.0	2	874	0	1000000.0	1000000.00	

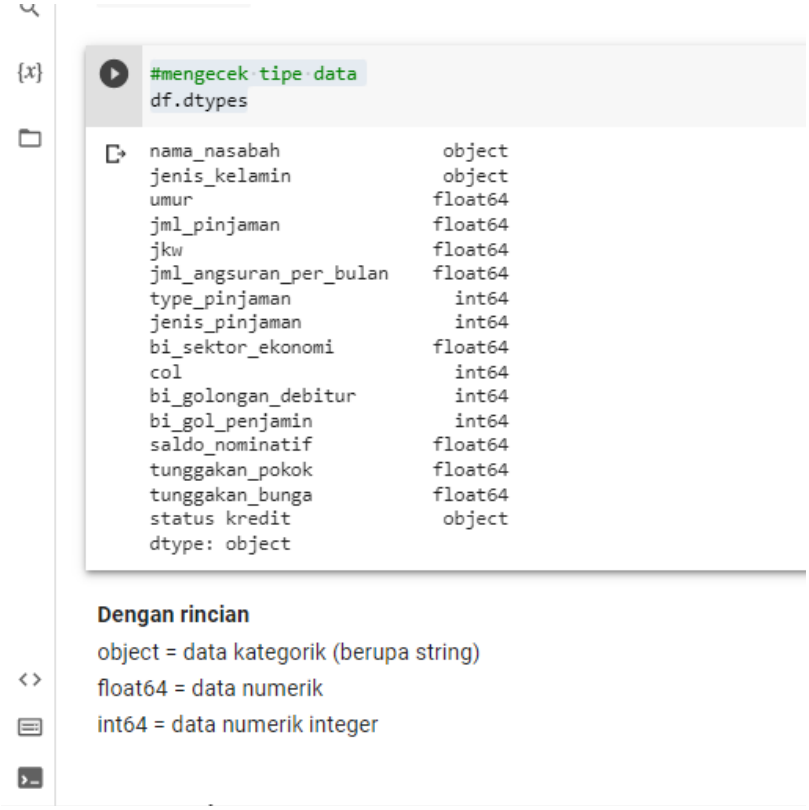
ows × 16 columns

Data terdiri dari 766 baris dan 24 kolom

Data terdiri dari 766 baris dan 24 kolom

Pendefinisian Variabel

`jenis_kelamin` = Jenis kelamin terdiri dari P dan L
`umur` = usia nasabah
`jml_pinjaman` = jumlah pinjaman nasabah
`jkw` = jangka waktu (bulan)
`jml_angsuran_per_bulan` = jumlah angsuran yyng harus dibayar tiap bulan
`type_pinjaman` = tipe pinjaman
`jenis_pinjaman` = jenis pinjaman
`bi_sektor_ekonomi` = Sektor Ekonomi BI
`col`
`bi_golongan_debitur` = golongan debitur
`bi_gol_penjamin` = golongan penjamin
`saldo_nominatif` = saldo nominatif nasabah
`tunggakan_pokok` = tunggakan pokok yang harus dibayar nasabah
`tunggakan_bunga` = tunggakan bunga yang harus dibayar nasabah
`status kredit` = status kredit nasabah



```
#mengecek tipe data
df.dtypes
```

```
nama_nasabah              object
jenis_kelamin             object
umur                     float64
jml_pinjaman             float64
jkw                      float64
jml_angsuran_per_bulan   float64
type_pinjaman              int64
jenis_pinjaman             int64
bi_sektor_ekonomi        float64
col                        int64
bi_golongan_debitur        int64
bi_gol_penjamin            int64
saldo_nominatif          float64
tunggakan_pokok          float64
tunggakan_bunga          float64
status kredit             object
dtype: object
```

Dengan rincian

object = data kategorik (berupa string)
float64 = data numerik
int64 = data numerik integer

Data Cleaning dan Data Preparation

```
df.nunique()
```

```
nama_nasabah              766
jenis_kelamin               6
umur                       58
jml_pinjaman              328
jkw                        51
jml_angsuran_per_bulan    449
type_pinjaman               1
jenis_pinjaman              5
bi_sektor_ekonomi           3
col                         2
bi_golongan_debitur         3
bi_gol_penjamin             5
saldo_nominatif           528
tunggakan_pokok           490
tunggakan_bunga           142
status kredit               2
dtype: int64
```

Dapat dilihat terdapat beberapa kolom memiliki tipe data `object` sedangkan seharusnya adalah `category` agar lebih efektif karena memiliki jumlah nilai unik sedikit. Kolom tersebut adalah `Jenis_Kelamin`, `type_pinjaman`, `jenis_pinjaman`, `bi_sektor_ekonomi`, `col`, `bi_golongan_debitur`, `bi_gol_penjamin`, dan kolom `status kredit`..

```
# Mengumpulkan kolom-kolom yang dingin diubah pada 1 list
kolom_diubah = ['jenis_kelamin', 'type_pinjaman',  'jenis_pinjaman', 'col', 'bi_golongan_debitur', 'bi_gol_penjamin', 'status kredit']

df[kolom_diubah] = df[kolom_diubah].astype('category')
df.dtypes
```

```
nama_nasabah              object
jenis_kelamin           category
umur                     float64
jml_pinjaman             float64
jkw                      float64
jml_angsuran_per_bulan   float64
type_pinjaman           category
jenis_pinjaman          category
bi_sektor_ekonomi        float64
col                     category
bi_golongan_debitur     category
bi_gol_penjamin         category
saldo_nominatif          float64
tunggakan_pokok          float64
tunggakan_bunga          float64
status kredit           category
dtype: object
```

Tipe data sudah sesuai

```
#menelaah data
# menampilkan statistik deskriptif/rincian data
df.describe()
```

	umur	jml_pinjaman	jkw	jml_angsuran_per_bulan	bi_sektor_ekonomi	saldo_nominatif	tunggakan_pokok	tunggakan_bunga
count	757.000000	7.660000e+02	758.000000	7.660000e+02	765.000000	7.660000e+02	7.660000e+02	7.660000e+02
mean	29.073976	2.712483e+06	19.011873	2.333917e+05	6013.045752	2.007386e+06	7.900853e+05	8.771708e+04
std	264.552192	9.995602e+06	32.231431	5.489682e+05	216.196305	8.711282e+06	4.139217e+06	5.682318e+05
min	-7162.000000	8.333333e+04	1.000000	0.000000e+00	6000.000000	-4.000000e+06	0.000000e+00	0.000000e+00
25%	32.000000	8.489286e+05	8.000000	6.750000e+04	6000.000000	5.337500e+05	9.885424e+04	0.000000e+00
50%	38.000000	1.500000e+06	12.000000	1.050000e+05	6000.000000	9.462828e+05	3.391669e+05	0.000000e+00
75%	43.000000	2.000000e+06	20.000000	2.333334e+05	6000.000000	1.639582e+06	7.500000e+05	5.814889e+04
max	1043.000000	2.286550e+08	679.000000	1.035000e+07	9990.000000	2.094041e+08	9.161212e+07	1.100000e+07

```
[ ] # menampilkan info dari data kredit nasabah
    df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 766 entries, 0 to 765
Data columns (total 16 columns):
 #   Column                  Non-Null Count  Dtype
---  ------                  --------------  -----
 0   nama_nasabah            766 non-null    object
 1   jenis_kelamin           766 non-null    category
 2   umur                    757 non-null    float64
 3   jml_pinjaman            766 non-null    float64
 4   jkw                     758 non-null    float64
 5   jml_angsuran_per_bulan  766 non-null    float64
 6   type_pinjaman           766 non-null    category
 7   jenis_pinjaman          766 non-null    category
 8   bi_sektor_ekonomi       765 non-null    float64
 9   col                     766 non-null    category
 10  bi_golongan_debitur     766 non-null    category
 11  bi_gol_penjamin         766 non-null    category
 12  saldo_nominatif         766 non-null    float64
 13  tunggakan_pokok         766 non-null    float64
 14  tunggakan_bunga         766 non-null    float64
 15  status kredit           766 non-null    category
dtypes: category(7), float64(8), object(1)
memory usage: 60.3+ KB
```

```
[ ] #memvalidasi data
    #cek missing value
    df.isnull().sum()
```

```
nama_nasabah              0
jenis_kelamin             0
umur                      9
jml_pinjaman              0
jkw                       8
jml_angsuran_per_bulan    0
type_pinjaman             0
jenis_pinjaman            0
bi_sektor_ekonomi         1
col                       0
bi_golongan_debitur       0
bi_gol_penjamin           0
saldo_nominatif           0
tunggakan_pokok           0
tunggakan_bunga           0
status kredit             0
dtype: int64
```

- terdapat 9 row kolom umur memiliki missing value
- terdapat 8 row kolom jkw memiliki missing value
- terdapat 1 row kolom bi_sektor_ekonomi memiliki missing value

```
[ ] #mengatasi missing value pada kolom umur
    rata_umur = df['umur'].mean()
    df['umur'] = df['umur'].fillna(rata_umur)
```

```
[ ] #menangani missing value di kolom jkw
    rata_jkw = df['jkw'].mean()
    df['jkw'] = df['jkw'].fillna(rata_jkw)
```

```
[ ] #menangani missing value di kolom bi_sektor_ekonomi
    rata_bi_sektor_ekonomi = df['bi_sektor_ekonomi'].mean()
    df['bi_sektor_ekonomi'] = df['bi_sektor_ekonomi'].fillna(rata_bi_sektor_ekonomi)
```

```
[ ] #mengecek kembali jumlah missing value
    df.isnull().sum()
```

```
nama_nasabah              0
jenis_kelamin             0
umur                      0
jml_pinjaman              0
jkw                       0
jml_angsuran_per_bulan    0
type_pinjaman             0
jenis_pinjaman            0
bi_sektor_ekonomi         0
col                       0
bi_golongan_debitur       0
bi_gol_penjamin           0
saldo_nominatif           0
tunggakan_pokok           0
tunggakan_bunga           0
status kredit             0
dtype: int64
```

Data sudah tidak memiliki missing value

```
[ ] #Pengecekan Keunikan data category
    df.nunique()
```

```
nama_nasabah              766
jenis_kelamin               6
umur                       59
jml_pinjaman              328
jkw                        52
jml_angsuran_per_bulan    449
type_pinjaman               1
jenis_pinjaman              5
bi_sektor_ekonomi           4
col                         2
bi_golongan_debitur         3
bi_gol_penjamin             5
saldo_nominatif           528
tunggakan_pokok           490
tunggakan_bunga           142
status kredit               2
dtype: int64
```

```
[ ] df['jenis_kelamin'].unique()
```

```
['P', 'L', 'WANITA', 'LAKI-LAKI', 'PRIA', 'PEREMPUAN']
Categories (6, object): ['L', 'LAKI-LAKI', 'P', 'PEREMPUAN', 'PRIA', 'WANITA']
```

terdapat perbedaan pendefinisian jenis kelamin sehingga perlu disamakan menjadi P dan L saja

```
[ ] df["jenis_kelamin"] = df["jenis_kelamin"].str.replace("WANITA", "P")
    df["jenis_kelamin"] = df["jenis_kelamin"].str.replace("PEREMPUAN", "P")
    df["jenis_kelamin"] = df["jenis_kelamin"].str.replace("LAKI-LAKI", "L")
    df["jenis_kelamin"] = df["jenis_kelamin"].str.replace("PRIA", "L")
```

```
[ ] df["jenis_kelamin"].unique()
```

```
array(['P', 'L'], dtype=object)
```

```
[ ] #mengecek data duplikat
    df.duplicated().sum()
```

```
0
```

Tidak terdapat data duplikat

```
[ ] #membuat file csv data bersih
    df.to_csv('data_clean.csv')
```

Modelling

```
[ ] x = df.loc[:, df.columns != 'status kredit']
    y = df.loc[:, df.columns == 'status kredit']
```

```
[ ] x
```

	nama_nasabah	jenis_kelamin	umur	jml_pinjaman	jkw	jml_angsuran_per_bulan	type_pinjaman
0	x1	P	40.000000	345000.0	1.000000	345000.00	100
1	x2	L	31.000000	350000.0	7.000000	55716.00	100
2	x3	L	29.073976	649926.0	6.000000	108321.00	100
3	x4	P	2.000000	459168.0	19.011873	38264.00	100
4	x5	P	34.000000	3055499.0	8.000000	381937.41	100
...	...	...	...	...	...	...	...
761	x762	L	38.000000	1000000.0	16.000000	70000.00	100
762	x763	P	36.000000	1000000.0	12.000000	90833.37	100
763	x764	L	28.000000	2000000.0	10.000000	260000.00	100
764	x765	P	31.000000	1312500.0	7.000000	198750.00	100
765	x766	P	36.000000	2000000.0	4.000000	550000.00	100

766 rows × 15 columns

```
[ ] y
```

	status kredit
0	MACET
1	MACET
2	MACET
3	MACET
4	MACET

```
[ ] from imblearn.over_sampling import SMOTE
    from sklearn.model_selection import train_test_split
    os = SMOTE(random_state=0)
    x_train, x_test, y_train, y_test = train_test_split(x, y, test_size=0.2, random_state=0)
    columns = x_train.columns
```

```
[ ] clf1 = setup(data = df,
                 target = 'status kredit',
                 numeric_imputation = 'mean',
                 numeric_features= ['umur', 'jml_pinjaman', 'jkw', 'jml_angsuran_per_bulan', 'col', 'sal
                 categorical_features = ['jenis_kelamin','type_pinjaman','jenis_pinjaman', 'bi_sektor_ek
                 ignore_features = ['nama_nasabah'],
                 silent = True
                 )
```

	Description	Value
0	session_id	3348
1	Target	status kredit
2	Target Type	Binary
3	Label Encoded	LANCAR: 0, MACET: 1
4	Original Data	(766, 16)
5	Missing Values	False
6	Numeric Features	8
7	Categorical Features	6
8	Ordinal Features	False
9	High Cardinality Features	False
10	High Cardinality Method	None
11	Transformed Train Set	(536, 27)
12	Transformed Test Set	(230, 27)
13	Shuffle Train-Test	True

+ Code + Text

```
#Pengecekan nilai Accuracy, Precision, F1 Score dengan membandingan menggunakan beragam model
compare_models()
```

	Model	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC	TT (Sec)
lightgbm	Light Gradient Boosting Machine	0.9571	0.9896	0.9765	0.9649	0.9704	0.8927	0.8945	0.128
gbc	Gradient Boosting Classifier	0.9534	0.9876	0.9818	0.9557	0.9682	0.8809	0.8844	0.124
ada	Ada Boost Classifier	0.9515	0.9811	0.9688	0.9644	0.9663	0.8797	0.8811	0.111
rf	Random Forest Classifier	0.9495	0.9890	0.9791	0.9538	0.9656	0.8705	0.8756	0.221
et	Extra Trees Classifier	0.9254	0.9741	0.9687	0.9316	0.9493	0.8086	0.8143	0.182
dt	Decision Tree Classifier	0.9178	0.9012	0.9399	0.9464	0.9427	0.7971	0.7994	0.015
lr	Logistic Regression	0.9105	0.9459	0.9559	0.9252	0.9390	0.7701	0.7785	0.518
knn	K Neighbors Classifier	0.9013	0.9517	0.9324	0.9311	0.9312	0.7557	0.7582	0.023
svm	SVM - Linear Kernel	0.8824	0.0000	0.9765	0.8792	0.9239	0.6661	0.6921	0.012
lda	Linear Discriminant Analysis	0.8619	0.9071	0.9503	0.8694	0.9080	0.6339	0.6443	0.016
ridge	Ridge Classifier	0.8434	0.0000	0.9582	0.8452	0.8979	0.5683	0.5897	0.014
dummy	Dummy Classifier	0.7164	0.5000	1.0000	0.7164	0.8348	0.0000	0.0000	0.014
qda	Quadratic Discriminant Analysis	0.5654	0.8059	0.4406	0.9054	0.5795	0.2384	0.3083	0.015
nb	Naive Bayes	0.5038	0.9061	0.3278	0.9369	0.4810	0.1859	0.2855	0.014

```
INFO:logs:create_model_container: 14
```

Model 1 - Decision Tree

```
[ ] decision_tree_model  = create_model('dt')

    ##https://pycaret.readthedocs.io/en/stable/api/classification.html
```

Fold	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.9630	0.9538	0.9744	0.9744	0.9744	0.9077	0.9077
1	0.9630	0.9538	0.9744	0.9744	0.9744	0.9077	0.9077
2	0.9259	0.9077	0.9487	0.9487	0.9487	0.8154	0.8154
3	0.9259	0.9077	0.9487	0.9487	0.9487	0.8154	0.8154
4	0.8704	0.8174	0.9474	0.8780	0.9114	0.6713	0.6781
5	0.9259	0.9293	0.9211	0.9722	0.9459	0.8286	0.8316
6	0.7925	0.7342	0.8684	0.8462	0.8571	0.4781	0.4786
7	0.9245	0.9272	0.9211	0.9722	0.9459	0.8212	0.8245
8	0.9434	0.9202	0.9737	0.9487	0.9610	0.8577	0.8586
9	0.9434	0.9605	0.9211	1.0000	0.9589	0.8685	0.8761
Mean	0.9178	0.9012	0.9399	0.9464	0.9427	0.7971	0.7994
Std	0.0486	0.0677	0.0315	0.0453	0.0332	0.1237	0.1236

```
INFO:logs:create_model_container: 17
INFO:logs:master_model_container: 17
INFO:logs:display_container: 5
INFO:logs:DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None, criterion='gini',
                       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='deprecated',
                       random_state=3348, splitter='best')
INFO:logs:create_model() succesfully completed.....................................
```

Evaluation

```
[ ] #Melihat plot decision tree
    evaluate_model(decision_tree_model)
```

```
INFO:logs:evaluate_model(estimator=DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None, criterion='g
                       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='deprecated',
                       random_state=3348, splitter='best'), fold=None, fit_kwargs=None, plot_kwargs=None
```

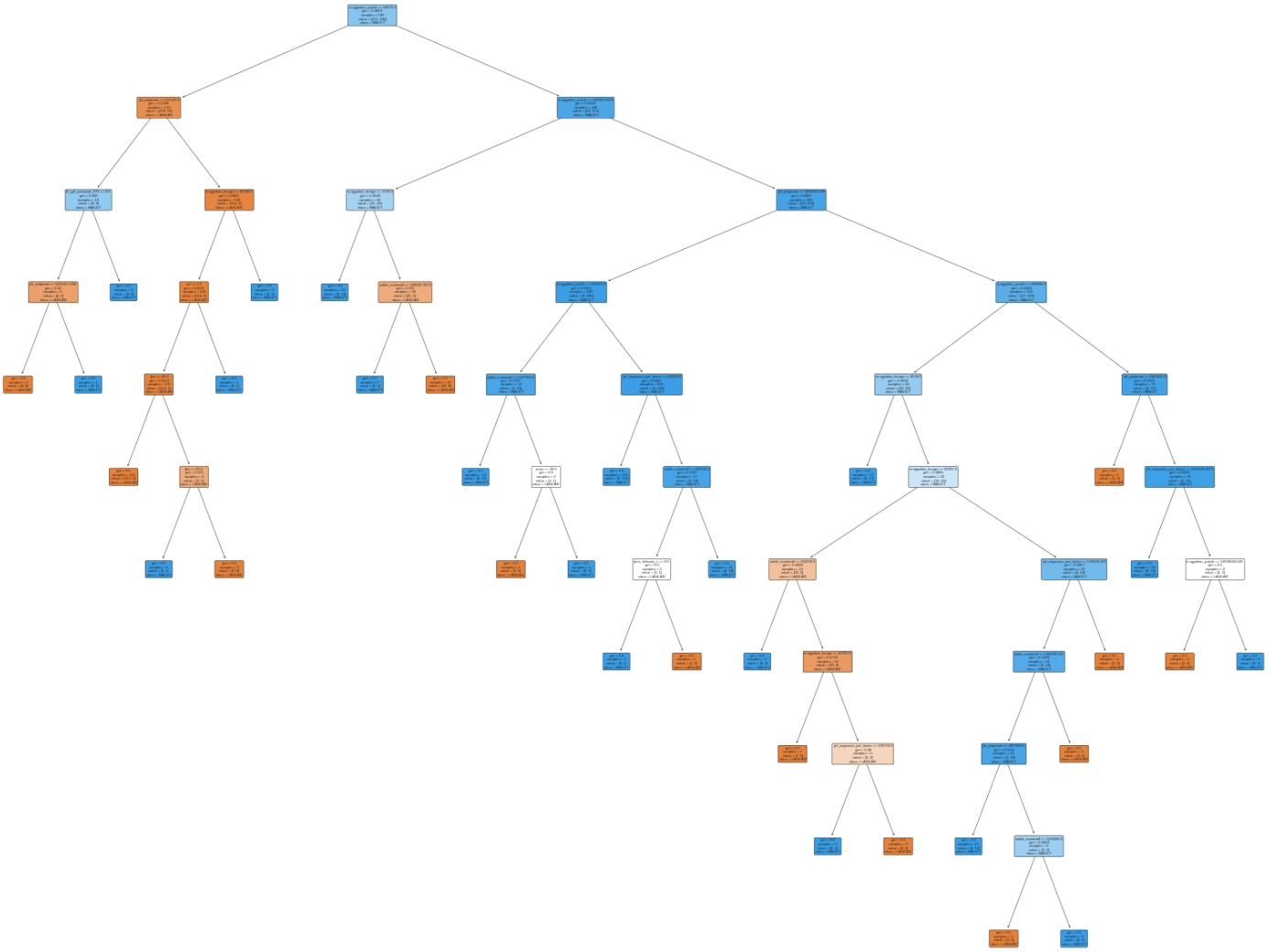
Plot Type:

Hyperparameters	AUC	Confusion Matrix	Threshold	Precision Recall
Prediction Error	Class Report	Feature Selection	Learning Curve	Manifold Learning
Calibration Curve	Validation Curve	Dimensions	Feature Importance	Feature Importanc...
Decision Boundary	Lift Chart	Gain Chart	Decision Tree	KS Statistic Plot

Decision Trees

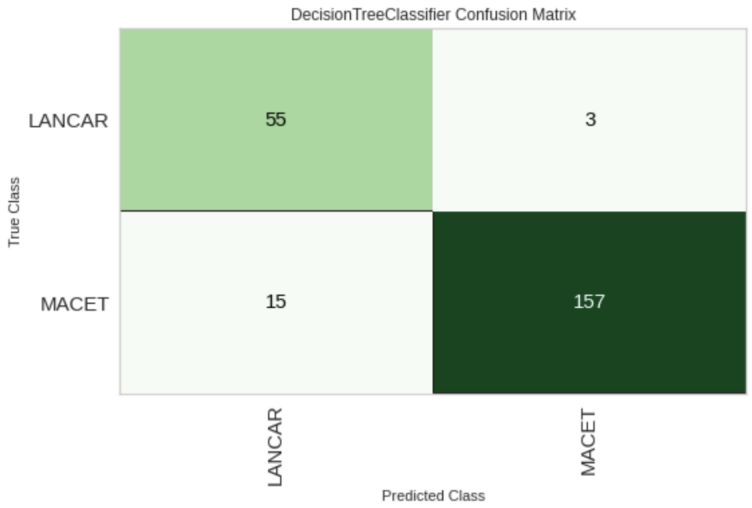
Decision Trees

Tree 0



Confusion Matrix Decision Tree

[ ]




```
INFO:logs:Visual Rendered Successfully
INFO:logs:plot_model() succesfully completed.....................................
```

Interpretasi dari Confusion Matrix Decision Tree

True Positive (55)
Interpretasi: Kredit diprediksi lancar dan memang lancar

True Negative (157):
Interpretasi: Kredit diprediksi macet dan kenyataannya memang macet

False Positive (3): (Kesalahan Tipe 1)
Interpretasi: Kredit diprediksi lancar namun ternyata macet

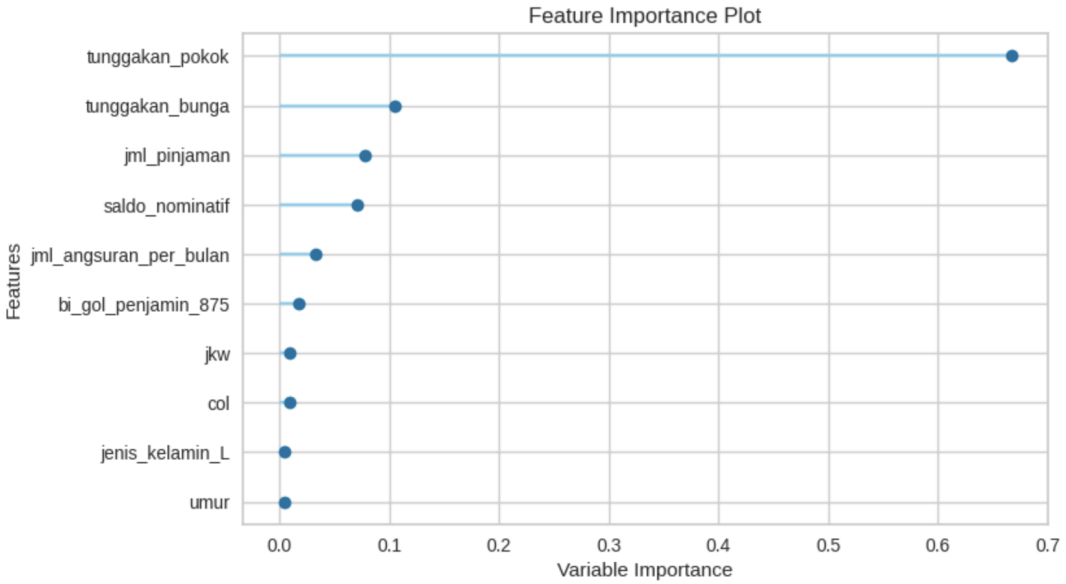
False Negative (15): (Kesalahan Tipe 2, sangat berbahaya)
Interpretasi: Kredit diprediksi macet namun ternyata lancar

```
[ ] #Melihat variabel kepentingan yang paling mempengaruhi variabel target
    evaluate_model(decision_tree_model)
```

```
INFO:logs:Initializing evaluate_model()
INFO:logs:evaluate_model(estimator=DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None, criterion='g
                         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='deprecated',
                         random_state=3348, splitter='best'), fold=None, fit_kwargs=None, plot_kwargs=None
```

Plot Type:

Hyperparameters	AUC	Confusion Matrix	Threshold	Precision Recall
Prediction Error	Class Report	Feature Selection	Learning Curve	Manifold Learning
Calibration Curve	Validation Curve	Dimensions	Feature Importance	Feature Importanc...
Decision Boundary	Lift Chart	Gain Chart	Decision Tree	KS Statistic Plot

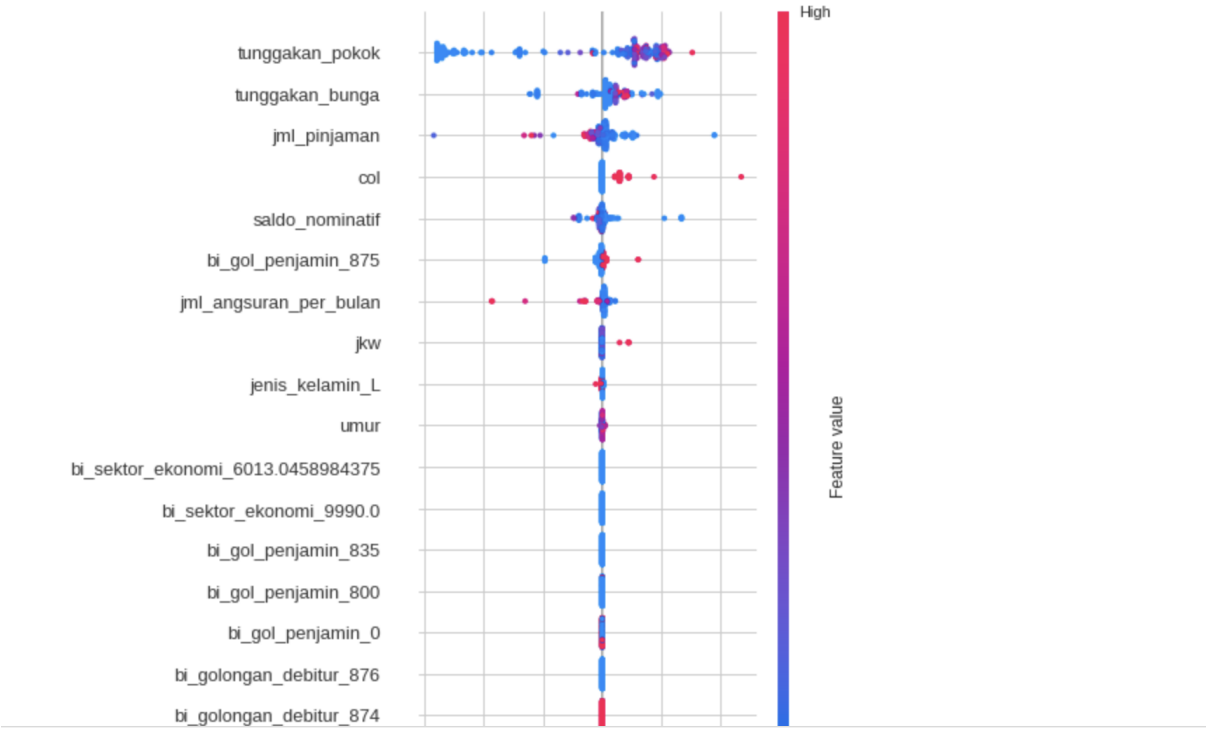


Dari hasil tersebut diketahui bahwa variabel tunggakan_pokok memiliki pengaruh paling besar dalam klasifikasi dengan nilai kepentingan tertinggi. Sedangkan variabel bi_sektor_ekonomi mmenempati nilai kepentingan terendah dibandingkan kolom lainnya**.**

Deployment / Rekomendasi - Decision Tree

```
[ ] #Interpretasi model decision tree
    interpret_model(decision_tree_model)
```

```
INFO:logs:Initializing interpret_model()
INFO:logs:interpret_model(estimator=DecisionTreeClassifier(ccp_alpha=0.0, class_weight=None, crite
                          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='deprecated',
                          random_state=3348, splitter='best'), use_train_data=False, X_new_sample=Non
INFO:logs:Checking exceptions
INFO:logs:plot type: summary
INFO:logs:Creating TreeExplainer
INFO:logs:Compiling shap values
```



Variabel tunggakan pokok memiliki pengaruh paling besar terhadap status kredit, maka dari itu untuk mengantisipasi masalah apakah nantinya nasabah tersebut dapat membayar kredit lancar atau macet perlu ditinjau dan dipertimbangkan kembali khususnya di beberapa feature yang memiliki nilai kepentingan / importance rate yang cukup tinggi.

Model 2 - Random Forest

```
[ ] random_forest_model  = create_model('rf')
```

Fold	Accuracy	AUC	Recall	Prec.	F1	Kappa	MCC
0	0.9630	0.9949	0.9744	0.9744	0.9744	0.9077	0.9077
1	0.9815	1.0000	1.0000	0.9750	0.9873	0.9529	0.9539
2	0.9630	0.9821	0.9744	0.9744	0.9744	0.9077	0.9077
3	0.9815	0.9923	1.0000	0.9750	0.9873	0.9529	0.9539
4	0.8889	0.9564	0.9737	0.8810	0.9250	0.7128	0.7262
5	0.9815	0.9967	1.0000	0.9744	0.9870	0.9548	0.9558
6	0.8679	0.9807	0.9737	0.8605	0.9136	0.6380	0.6605
7	0.9623	0.9895	0.9737	0.9737	0.9737	0.9070	0.9070
8	0.9623	0.9974	1.0000	0.9500	0.9744	0.9031	0.9074
9	0.9434	1.0000	0.9211	1.0000	0.9589	0.8685	0.8761
Mean	0.9495	0.9890	0.9791	0.9538	0.9656	0.8705	0.8756
Std	0.0376	0.0126	0.0229	0.0433	0.0247	0.1024	0.0956

```
INFO:logs:create_model_container: 19
INFO:logs:master_model_container: 19
INFO:logs:display_container: 7
INFO:logs:RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=None,
                       criterion='gini', max_depth=None, max_features='auto',
                       max_leaf_nodes=None, max_samples=None,
                       min_impurity_decrease=0.0, min_impurity_split=None,
                       min_samples_leaf=1, min_samples_split=2,
                       min_weight_fraction_leaf=0.0, n_estimators=100,
                       n_jobs=-1, oob_score=False, random_state=3348, verbose=0,
                       warm_start=False)
INFO:logs:create_model() succesfully completed.....................................
```

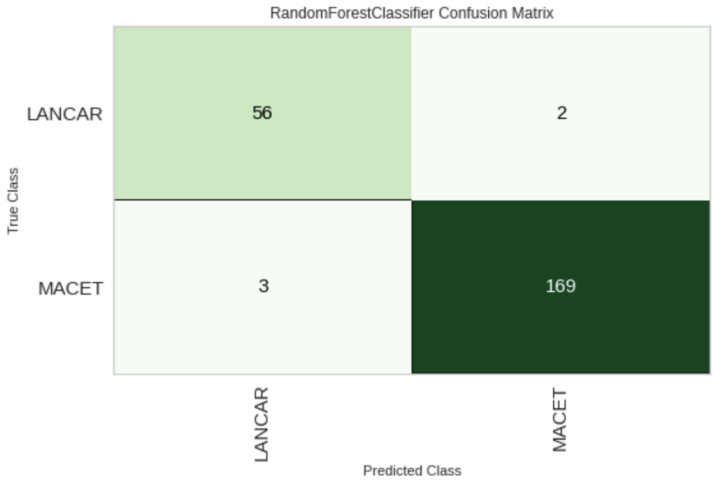
Evaluasi Model Random Forest

```
[ ]  evaluate_model(random_forest_model)
```

```
INFO:logs:Initializing evaluate_model()
INFO:logs:evaluate_model(estimator=RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=No
                         criterion='gini', max_depth=None, max_features='auto',
                         max_leaf_nodes=None, max_samples=None,
                         min_impurity_decrease=0.0, min_impurity_split=None,
                         min_samples_leaf=1, min_samples_split=2,
                         min_weight_fraction_leaf=0.0, n_estimators=100,
                         n_jobs=-1, oob_score=False, random_state=3348, verbose=0,
                         warm_start=False), fold=None, fit_kwargs=None, plot_kwargs=None, feature_name=Non
```

Plot Type:

Hyperparameters	AUC	Confusion Matrix	Threshold	Precision Recall
Prediction Error	Class Report	Feature Selection	Learning Curve	Manifold Learning
Calibration Curve	Validation Curve	Dimensions	Feature Importance	Feature Importanc...
Decision Boundary	Lift Chart	Gain Chart	Decision Tree	KS Statistic Plot




```
INFO:logs:Visual Rendered Successfully
INFO:logs:plot_model() succesfully completed.....................................
```

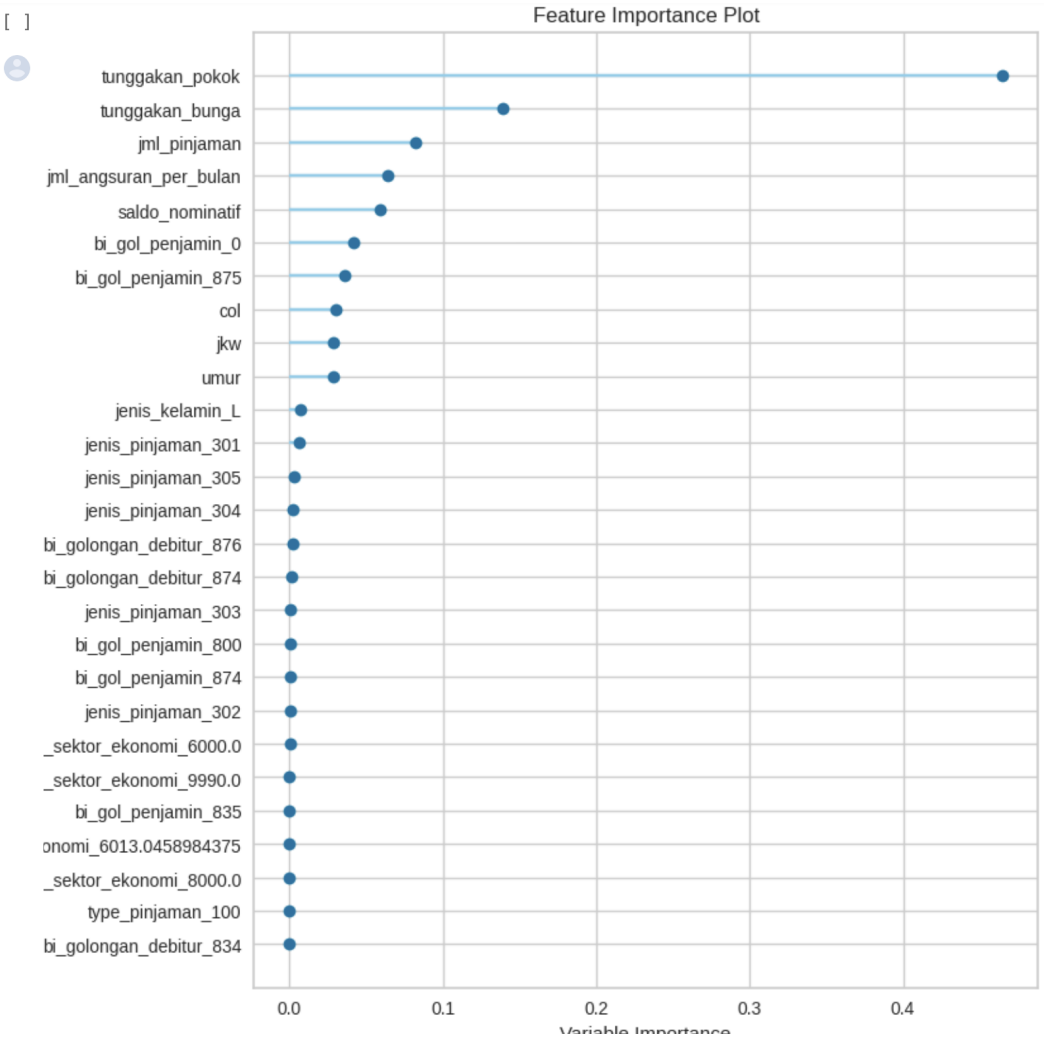
Interpretasi dari Confusion Matrix Random Forest

True Positive (56)
Interpretasi: Kredit diprediksi lancar dan memang lancar

True Negative (169):
Interpretasi: Kredit diprediksi macet dan kenyataannya memang macet

False Positive (2): (Kesalahan Tipe 1)
Interpretasi: Kredit diprediksi lancar namun ternyata macet

False Negative (3): (Kesalahan Tipe 2, sangat berbahaya)
Interpretasi: Kredit diprediksi macet namun ternyata lancar

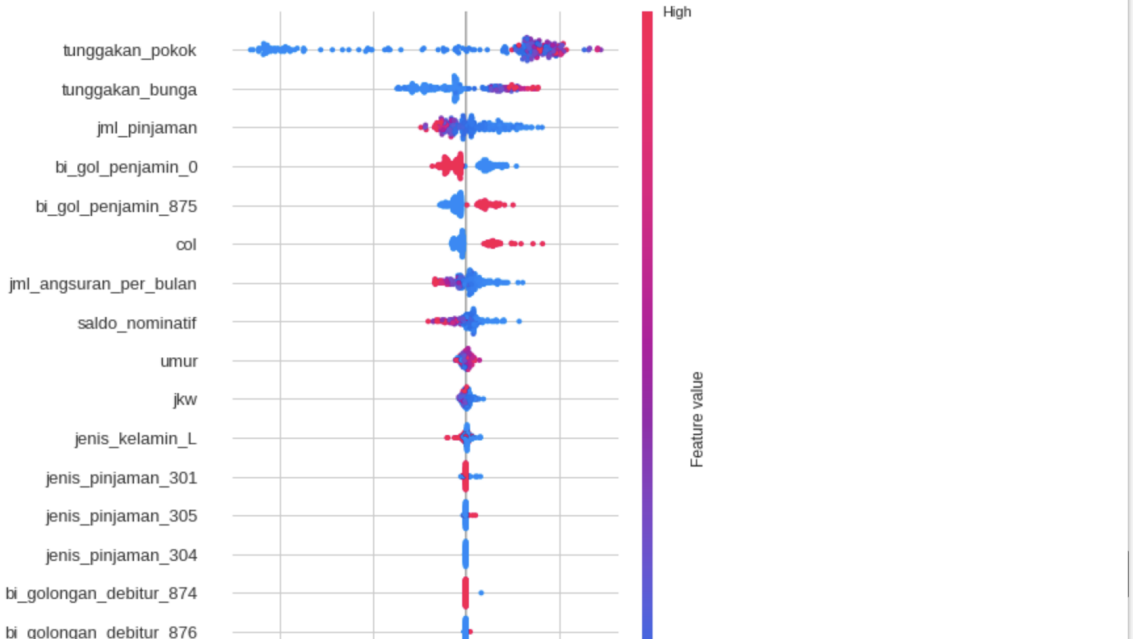


Dari hasil tersebut dihasilkan hasil yg sama dengan model decision tree diketahui bahwa variabel tunggakan_pokok memiliki pengaruh paling besar dalam klasifikasi dengan nilai kepentingan tertinggi. Sedangkan variabel bi_sektor_ekonomi mmenempati nilai kepentingan terendah dibandingkan kolom lainnya.

Deployment/ Rekomendasi Random Forest

```
#Interpretasi model decision tree
interpret_model(random_forest_model)
```

```
INFO:logs:Initializing interpret_model()
INFO:logs:interpret_model(estimator=RandomForestClassifier(bootstrap=True, ccp_alpha=0.0, class_weight=N
                        criterion='gini', max_depth=None, max_features='auto',
                        max_leaf_nodes=None, max_samples=None,
                        min_impurity_decrease=0.0, min_impurity_split=None,
                        min_samples_leaf=1, min_samples_split=2,
                        min_weight_fraction_leaf=0.0, n_estimators=100,
                        n_jobs=-1, oob_score=False, random_state=3348, verbose=0,
                        warm_start=False), use_train_data=False, X_new_sample=None, y_new_sample=None, fe
INFO:logs:Checking exceptions
INFO:logs:plot type: summary
INFO:logs:Creating TreeExplainer
INFO:logs:Compiling shap values
```



Karena hasil random forest tidak jauh berbeda dan menghasilkan variabel pengaruh tertinggi (tunggakan_pokok) dan terendah yang sama dengan metode decision tree maka Rekomendasi/Deployment yang diberikan akanlah sama