Tugas Proyek Akhir Microcredential Data Science

Analisis Prediksi Tingkat Curah Hujan Berdasarkan Data-data Sebelumnya

Kondisi cuaca merupakan hal penting yang perlu dipelajari karena cuaca di suatu daerah menentukan rangkaian aktifitas manusia. Sebagai contoh, informasi iklim dan klasifikasinya banyak menjadi acuan untuk bidang pertanian, transportasi, dan pariwisata seperti: pelayaran, penerbangan, dan masa pola tanam. Maka dari itu pengamatan terhadap kondisi cuaca, khususnya kondisi curah hujan sangat penting dilakukan.

Besarnya curah hujan yang terjadi tidak dapat ditentukan secara pasti, namun dapat diprediksi atau diperkirakan. Dengan menggunakan data historis besarnya curah hujan beberapa waktu yang lampau, maka dapat diprediksi berapa besarnya curah hujan yang terjadi pada masa yang akan datang. Banyak cara yang dapat dilakukan untuk memprediksi besarnya curah hujan di suatu tempat, salah satunya adalah menggunakan teknik regresi.

Dengan menggunakan data-data historis dari curah hujan yang lalu dan beberapa parameter data seperti tahun, tekanan udara, penyinaran matahari, kecepatan angin, kelembapan dan suhu maka prediksi curah hujan dapat dilakukan.

Data diambil dari website resmi Badan Pusat Statistik mengenai iklim Indonesia yang berupa :

- Jumlah Curah Hujan dan Jumlah Hari Hujan di Stasiun Pengamatan BMKG, 2011-2015 (https://www.bps.go.id/statictable/2017/02/08/1959/jumlah-curahhujan-dan-jumlah-hari-hujan-di-stasiun-pengamatan-bmkg-2011-2015.html)
- Tekanan Udara dan Penyinaran Matahari di Stasiun Pengamatan BMKG, 2011-2015 (https://www.bps.go.id/statictable/2017/02/09/1962/tekanan-udaradan-penyinaran-matahari-di-stasiun-pengamatan-bmkg-2011-2015.html)
- Kecepatan Angin dan Kelembaban di Stasiun Pengamatan BMKG, 2011-2015 (https://www.bps.go.id/statictable/2017/02/08/1960/kecepatanangin-dan-kelembaban-di-stasiun-pengamatan-bmkg-2011-2015.html)
- Suhu Minimum, Rata-Rata, dan Maksimum di Stasiun Pengamatan BMKG (oC), 2011-2015 (https://www.bps.go.id/statictable/2017/02/09/1961/suhu-minimumrata-rata-dan-maksimum-di-stasiun-pengamatan-bmkg-oc-2011-2015.html)

Berikut proses prediksi yang dilakukan

Import Library

```
# basic computing
import pandas as pd
import numpy as np

# visualizing
import seaborn as sns
import matplotlib.pyplot as plt

# preprocessing
from scipy.stats.mstats import winsorize
from sklearn.preprocessing import StandardScaler
from sklearn.model_selection import train_test_split
from sklearn.decomposition import PCA

# modelling
from sklearn.pipeline import make_pipeline
from sklearn.preprocessing import PolynomialFeatures
from sklearn.linear_model import LinearRegression
from sklearn.svm import SVR
from sklearn.ensemble import RandomForestRegressor,
GradientBoostingRegressor
from sklearn.model_selection import GridSearchCV

# evaluating
import sklearn.metrics as metrics
```

Load dan Explorasi data

karena data yang diambil dari beberapa sumber file yang berbeda dan memiliki strukturnya tersendiri maka dibutuhkan fungsi khusus yang akan memproses pengambilan data tersebut sekaligus merapikan datanya

```
def create_df(da, year=[]):
  data = da.copy()
  nd = pd.DataFrame()
  data.drop(["Provinsi","Stasiun BMKG"], axis=1, inplace=True)
  length = int(data.shape[1]/5)
  col_names = data.columns[0:length]
  for i in range(0,5):
    val  = data.iloc[:,0:length]
    d = dict(zip(val.columns[0::1],  col_names))
    val = val.rename(columns=d)
    if(len(year)>0):
      val["year"] = year[i]
    nd = nd.append(val, ignore_index=True)
    data.drop(data.columns[0:length], axis=1, inplace=True)
  return nd

da1 = create_df(pd.read_excel("data/Indo_151_15887472.xls"))
da2 = create_df(pd.read_excel("data/Indo_151_17952722.xls"))
da3 = create_df(pd.read_excel("data/Indo_151_18467275.xls"))
```

```
da4 = create_df(pd.read_excel("data/Indo_151_21445257.xls"),  year =
[2011,2012,2013,2014,2015])

da_list = [da1,da2,da3,da4]
data_cuaca = pd.concat(da_list, axis=1, join="inner")
col = ['tekanan_udara', 'penyinaran_matahari', 'suhu_minimum',
'suhu_rata_rata', 'suhu_maksimum', 'curah_hujan', 'hari_hujan',
'kecepatan_angin', 'kelembaban', 'tahun']
data_cuaca.columns = col

data_cuaca = data_cuaca[['tahun', 'tekanan_udara',
'penyinaran_matahari', 'suhu_minimum', 'suhu_rata_rata',
'suhu_maksimum', 'kecepatan_angin', 'kelembaban', 'hari_hujan',
'curah_hujan']]
data_cuaca
```

```
     tahun  tekanan_udara  penyinaran_matahari  suhu_minimum
suhu_rata_rata  \
0     2011         1009.4                52.20          22.4
27.1
1     2011            NaN                44.40          21.7
27.2
2     2011          990.8                32.80          15.6
NaN
3     2011         1008.7                42.30          19.9
27.0
4     2011         1010.2                54.10          21.0
26.9
..     ...            ...                  ...           ...
...
165   2015         1012.5                78.00          20.4
27.9
166   2015         1012.4                66.52          20.1
26.5
167   2015         1013.0                84.07          21.6
27.3
168   2015         1011.5                61.63          21.8
27.4
169   2015         1011.1                64.47          20.9
27.8

     suhu_maksimum  kecepatan_angin  kelembaban  hari_hujan
curah_hujan
0             34.4             4.90        79.4       150.0
1268.0
1             36.0             1.80        79.0       225.0
2042.0
2             34.2             0.50        54.2         NaN
NaN
3             35.8             5.40        74.5       211.0
2405.0
```

```
4              34.8              5.50        82.5       209.0
2295.0
..              ...               ...         ...         ...          .
..
165            35.6              1.93        77.2        93.0
1167.9
166            35.3              2.35        83.6       167.0
1987.2
167            34.2              2.60        78.3       127.0
913.4
168            33.8              1.54        83.6       218.0
2844.6
169            35.6              2.60        75.5       168.0
1265.9

[170 rows x 10 columns]
```

```
data_cuaca.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 170 entries, 0 to 169
Data columns (total 10 columns):
 #   Column               Non-Null Count  Dtype  
---  ------               --------------  -----  
 0   tahun                170 non-null    int64  
 1   tekanan_udara        158 non-null    float64
 2   penyinaran_matahari  159 non-null    float64
 3   suhu_minimum         163 non-null    float64
 4   suhu_rata_rata       158 non-null    float64
 5   suhu_maksimum        162 non-null    float64
 6   kecepatan_angin      159 non-null    float64
 7   kelembaban           162 non-null    float64
 8   hari_hujan           155 non-null    float64
 9   curah_hujan          162 non-null    float64
dtypes: float64(9), int64(1)
memory usage: 13.4 KB
```

```
print("Ukuran data yang diperoleh :", data_cuaca.shape)
```

```
Ukuran data yang diperoleh : (170, 10)
```

Menghapus duplicated data

```
col_duplicated =
['tekanan_udara','penyinaran_matahari','suhu_minimum','suhu_rata_rata'
,'suhu_maksimum','kecepatan_angin','kelembaban','hari_hujan','curah_hu
jan']
data_cuaca[data_cuaca.duplicated(subset=col_duplicated,keep=False)]
```

```
    tahun  tekanan_udara  penyinaran_matahari  suhu_minimum
suhu_rata_rata  \
6    2011                NaN                  NaN           NaN
NaN
23   2011                NaN                  NaN           NaN
NaN
57   2012                NaN                  NaN           NaN
NaN
61   2012                NaN                  NaN           NaN
NaN
65   2012                NaN                  NaN           NaN
NaN
98   2013                NaN                  NaN           NaN
NaN

    suhu_maksimum  kecepatan_angin  kelembaban  hari_hujan
curah_hujan
6             NaN              NaN         NaN         NaN
NaN
23            NaN              NaN         NaN         NaN
NaN
57            NaN              NaN         NaN         NaN
NaN
61            NaN              NaN         NaN         NaN
NaN
65            NaN              NaN         NaN         NaN
NaN
98            NaN              NaN         NaN         NaN
NaN
```

```
data_drop_duplicated =
data_cuaca.drop_duplicates(subset=col_duplicated,keep=False)
print("Ukuran data yang setelah duplicate data dihapus :",
data_drop_duplicated.shape)
```

```
Ukuran data yang setelah duplicate data dihapus : (164, 10)
```

Handling Missing Value

```
data_drop_duplicated.isna().sum()
```

```
tahun                  0
tekanan_udara          6
penyinaran_matahari    5
suhu_minimum           1
suhu_rata_rata         6
suhu_maksimum          2
kecepatan_angin        5
kelembaban             2
hari_hujan             9
curah_hujan            2
dtype: int64
```

```
data_drop_duplicated[data_drop_duplicated.isna().any(axis=1)]
```

```
     tahun  tekanan_udara  penyinaran_matahari  suhu_minimum  
suhu_rata_rata  \
1     2011            NaN                44.40          21.7   
27.20   
2     2011         990.80                32.80          15.6   
NaN   
10    2011        1009.50                60.90          23.4   
28.50   
14    2011        1010.10                69.10          20.0   
NaN   
17    2011        1009.70                68.00          20.7   
NaN   
20    2011            NaN                  NaN           NaN   
NaN   
21    2011         968.00                  NaN          20.4   
27.10   
25    2011        1009.90                54.40          22.8   
27.60   
27    2011            NaN                  NaN          22.0   
NaN   
35    2012            NaN                48.00          21.0   
27.30   
48    2012        1010.00                75.00          20.6   
28.00   
59    2012        1010.30                62.80          23.1   
27.70   
69    2013            NaN                45.66          21.6   
28.77   
70    2013         996.57                43.30          22.7   
25.13   
71    2013        1008.96                  NaN          21.2   
26.00   
85    2013        1010.30                68.00          20.8   
28.25   
87    2013        1010.27                61.83          21.6   
26.90   
93    2013        1010.18                57.42          20.6   
26.70   
103   2014            NaN                38.00          20.0   
27.90   
119   2014        1010.60                73.00          20.5   
NaN   
129   2014        1010.10                  NaN          20.7   
26.80   

     suhu_maksimum  kecepatan_angin  kelembaban  hari_hujan  
curah_hujan  
1             36.0             1.80       79.00       225.0   
```

```
2042.0
2              34.2               0.50       54.20          NaN
NaN
10             35.4               2.40       74.30          NaN
1274.0
14             34.8               7.20       71.50          NaN
1790.0
17             32.5               7.00       80.10          NaN
NaN
20              NaN                NaN         NaN        218.0
3434.6
21             36.0               5.30       81.80        195.0
2751.0
25             34.1               1.80       76.10          NaN
667.0
27             33.0               2.00       84.00        121.0
1511.0
35             36.9               0.60       76.00        227.0
3175.0
48             35.4              13.30         NaN          NaN
1389.0
59             35.0               3.80       76.00          NaN
760.0
69             36.4               1.99       78.67        218.0
2627.0
70              NaN               1.06       86.91        232.0
4627.4
71             36.2                NaN       76.00        214.0
2628.7
85             35.2                NaN       80.00        160.0
2098.9
87             36.4              12.12       85.17          NaN
3382.0
93             36.8               3.58       76.50          NaN
905.7
103            35.2                NaN       79.00        200.0
2148.0
119            33.3               3.00       82.80        106.0
1563.9
129            33.1                NaN       74.70        172.0
2263.6
```

menghapus nilai NaN pada kolom curah_hujan (target)

```
data_drop_null = data_drop_duplicated.dropna(subset=['curah_hujan'])
```

```
data_drop_null.isna().sum()
```

```
tahun                   0
tekanan_udara           6
penyinaran_matahari     5
```

```
suhu_minimum           1
suhu_rata_rata         4
suhu_maksimum          2
kecepatan_angin        5
kelembaban             2
hari_hujan             7
curah_hujan            0
dtype: int64
```

```
data_drop_null[data_drop_null.isna().any(axis=1)]
```

```
     tahun  tekanan_udara  penyinaran_matahari  suhu_minimum  
suhu_rata_rata  \
1     2011            NaN                44.40          21.7   
27.20   
10    2011        1009.50                60.90          23.4   
28.50   
14    2011        1010.10                69.10          20.0   
NaN   
20    2011            NaN                  NaN           NaN   
NaN   
21    2011         968.00                  NaN          20.4   
27.10   
25    2011        1009.90                54.40          22.8   
27.60   
27    2011            NaN                  NaN          22.0   
NaN   
35    2012            NaN                48.00          21.0   
27.30   
48    2012        1010.00                75.00          20.6   
28.00   
59    2012        1010.30                62.80          23.1   
27.70   
69    2013            NaN                45.66          21.6   
28.77   
70    2013         996.57                43.30          22.7   
25.13   
71    2013        1008.96                  NaN          21.2   
26.00   
85    2013        1010.30                68.00          20.8   
28.25   
87    2013        1010.27                61.83          21.6   
26.90   
93    2013        1010.18                57.42          20.6   
26.70   
103   2014            NaN                38.00          20.0   
27.90   
119   2014        1010.60                73.00          20.5   
NaN   
129   2014        1010.10                  NaN          20.7   
26.80   
```

```
     suhu_maksimum  kecepatan_angin  kelembaban  hari_hujan
curah_hujan
1             36.0             1.80       79.00       225.0
2042.0
10            35.4             2.40       74.30         NaN
1274.0
14            34.8             7.20       71.50         NaN
1790.0
20             NaN              NaN         NaN       218.0
3434.6
21            36.0             5.30       81.80       195.0
2751.0
25            34.1             1.80       76.10         NaN
667.0
27            33.0             2.00       84.00       121.0
1511.0
35            36.9             0.60       76.00       227.0
3175.0
48            35.4            13.30         NaN         NaN
1389.0
59            35.0             3.80       76.00         NaN
760.0
69            36.4             1.99       78.67       218.0
2627.0
70             NaN             1.06       86.91       232.0
4627.4
71            36.2              NaN       76.00       214.0
2628.7
85            35.2              NaN       80.00       160.0
2098.9
87            36.4            12.12       85.17         NaN
3382.0
93            36.8             3.58       76.50         NaN
905.7
103           35.2              NaN       79.00       200.0
2148.0
119           33.3             3.00       82.80       106.0
1563.9
129           33.1              NaN       74.70       172.0
2263.6
```

Melakukan imputasi data pada missing value di kolom prediktor

```
missing_columns = data_drop_null.drop(["tahun","curah_hujan"],
axis=1).columns
clean = data_drop_null.loc[:,["tahun","curah_hujan"]]

def random_imputation(df, feature):
    number_missing = df[feature].isnull().sum()
    observed_values = df.loc[df[feature].notnull(), feature]
    df.loc[df[feature].isnull(), feature + '_imp'] =
np.random.choice(observed_values, number_missing, replace = True)

    return df

for feature in missing_columns:
    data_drop_null[feature + '_imp'] = data_drop_null[feature]
    data_drop_null = random_imputation(data_drop_null, feature)

deter_data = pd.DataFrame(columns = [name for name in
missing_columns])

for feature in missing_columns:

    deter_data[feature] = data_drop_null[feature + "_imp"]
    parameters = list(set(data_drop_null.columns) -
set(missing_columns) - {feature + '_imp'})

    model = LinearRegression()
    model.fit(X = data_drop_null[parameters], y =
data_drop_null[feature + '_imp'])

    deter_data.loc[data_drop_null[feature].isnull(), feature] =
model.predict(data_drop_null[parameters])
[data_drop_null[feature].isnull()]

deter_data
```

```
     tekanan_udara  penyinaran_matahari  suhu_minimum  suhu_rata_rata
\
0      1009.400000                52.20          22.4            27.1

1      1006.645665                44.40          21.7            27.2

3      1008.700000                42.30          19.9            27.0

4      1010.200000                54.10          21.0            26.9

5      1009.600000                54.00          23.4            27.3

..             ...                  ...           ...             ...

165    1012.500000                78.00          20.4            27.9

166    1012.400000                66.52          20.1            26.5

167    1013.000000                84.07          21.6            27.3

168    1011.500000                61.63          21.8            27.4
```

```
169    1011.100000                64.47          20.9            27.8


     suhu_maksimum  kecepatan_angin  kelembaban  hari_hujan
0             34.4             4.90        79.4       150.0
1             36.0             1.80        79.0       225.0
3             35.8             5.40        74.5       211.0
4             34.8             5.50        82.5       209.0
5             34.6             2.70        84.8       217.0
..             ...              ...         ...         ...
165           35.6             1.93        77.2        93.0
166           35.3             2.35        83.6       167.0
167           34.2             2.60        78.3       127.0
168           33.8             1.54        83.6       218.0
169           35.6             2.60        75.5       168.0

[162 rows x 8 columns]
```

```
data_drop_null = pd.concat([clean, deter_data], axis=1)
data_drop_null
```

```
     tahun  curah_hujan  tekanan_udara  penyinaran_matahari  
suhu_minimum  \
0     2011       1268.0    1009.400000                52.20  
22.4
1     2011       2042.0    1006.645665                44.40  
21.7
3     2011       2405.0    1008.700000                42.30  
19.9
4     2011       2295.0    1010.200000                54.10  
21.0
5     2011       2593.0    1009.600000                54.00  
23.4
..     ...          ...            ...                  ...  
...
165   2015       1167.9    1012.500000                78.00  
20.4
166   2015       1987.2    1012.400000                66.52  
20.1
167   2015        913.4    1013.000000                84.07  
21.6
168   2015       2844.6    1011.500000                61.63  
21.8
169   2015       1265.9    1011.100000                64.47  
20.9

     suhu_rata_rata  suhu_maksimum  kecepatan_angin  kelembaban  
hari_hujan
0              27.1           34.4             4.90        79.4  
150.0
```

```
1              27.2          36.0             1.80         79.0
225.0
3              27.0          35.8             5.40         74.5
211.0
4              26.9          34.8             5.50         82.5
209.0
5              27.3          34.6             2.70         84.8
217.0
..              ...           ...              ...          ...
...
165            27.9          35.6             1.93         77.2
93.0
166            26.5          35.3             2.35         83.6
167.0
167            27.3          34.2             2.60         78.3
127.0
168            27.4          33.8             1.54         83.6
218.0
169            27.8          35.6             2.60         75.5
168.0

[162 rows x 10 columns]
```

Handling Outlier

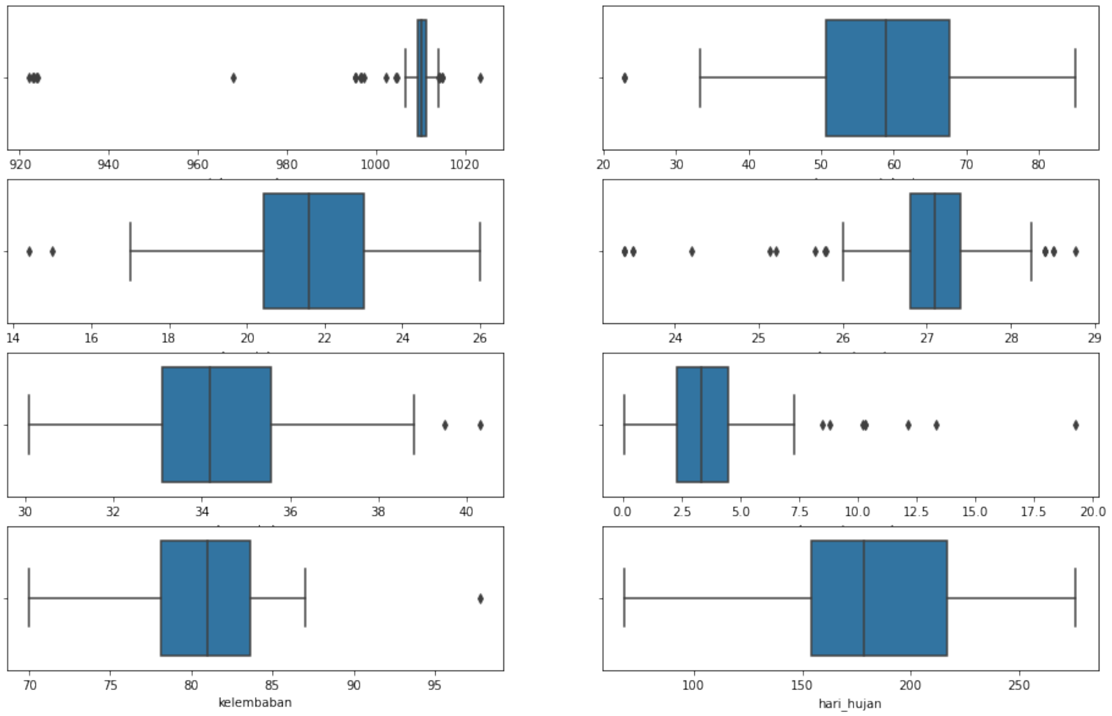
permasalahan outlier diselesaikan dengan menggunakan metode winsorize yaitu menggeser nilai yang oulier ke dalam quartile data

```
data_drop_null.describe()
```

```
             tahun  curah_hujan  tekanan_udara  penyinaran_matahari  \
count   162.000000   162.000000     162.000000           162.000000   
mean   2013.067901  2298.672840    1006.954416            59.137645   
std       1.410372   835.757699      15.711808            11.970379   
min    2011.000000   460.900000     922.100000            22.900000   
25%    2012.000000  1682.275000    1009.300000            50.625000   
50%    2013.000000  2267.200000    1010.127027            58.915000   
75%    2014.000000  2832.400000    1011.200000            67.620000   
max    2015.000000  5041.000000    1023.326206            85.050000   

       suhu_minimum  suhu_rata_rata  suhu_maksimum  kecepatan_angin  \
count    162.000000      162.000000     162.000000       162.000000   
mean      21.442099       27.008484      34.340573         3.814047   
std        2.020229        0.911201       1.758389         2.455706   
min       14.400000       23.400000      30.100000         0.070000   
25%       20.425000       26.800000      33.100000         2.305000   
50%       21.600000       27.100000      34.200000         3.325000   
75%       23.000000       27.400000      35.575000         4.500000   
max       26.000000       28.770000      40.300000        19.250000   
```

```
       kelembaban  hari_hujan
count  162.000000  162.000000
mean    80.576513  182.458811
std      3.907215   42.680784
min     70.000000   68.000000
25%     78.100000  154.250000
50%     81.000000  178.500000
75%     83.595000  217.000000
max     97.800000  276.000000
```

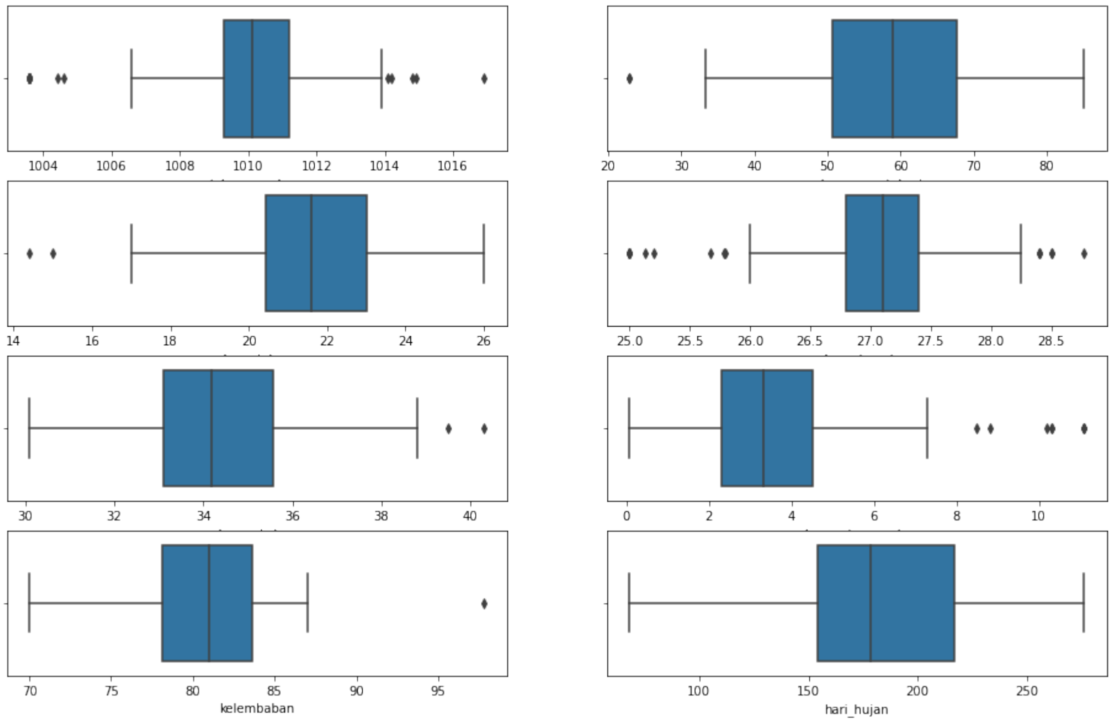
```
# show boxplot
def boxplot_feature(data):
    fig, ax = plt.subplots(4, 2, figsize=(16,10))

    sns.boxplot(data=data, x='tekanan_udara', ax=ax[0][0])
    sns.boxplot(data=data, x='penyinaran_matahari', ax=ax[0][1])

    sns.boxplot(data=data, x='suhu_minimum', ax=ax[1][0])
    sns.boxplot(data=data, x='suhu_rata_rata', ax=ax[1][1])

    sns.boxplot(data=data, x='suhu_maksimum', ax=ax[2][0])
    sns.boxplot(data=data, x='kecepatan_angin', ax=ax[2][1])

    sns.boxplot(data=data, x='kelembaban', ax=ax[3][0])
    sns.boxplot(data=data, x='hari_hujan', ax=ax[3][1])

# defining outlier boundaries
def find_outlier(df, variable_name):
    q1 = df[variable_name].quantile(0.25)
    q3 = df[variable_name].quantile(0.75)
    iqr = q3-q1
    outer_fence = 3*iqr
    outer_fence_le = q1-outer_fence
    outer_fence_ue = q3+outer_fence
    return outer_fence_le, outer_fence_ue

boxplot_feature(data_drop_null)
```



```
data_outlier = data_drop_null.copy()
col_outlier = data_outlier.drop(['tahun', 'curah_hujan'],
axis=1).columns
col_outlier
```

```
Index(['tekanan_udara', 'penyinaran_matahari', 'suhu_minimum',
       'suhu_rata_rata', 'suhu_maksimum', 'kecepatan_angin',
'kelembaban',
       'hari_hujan'],
      dtype='object')
```

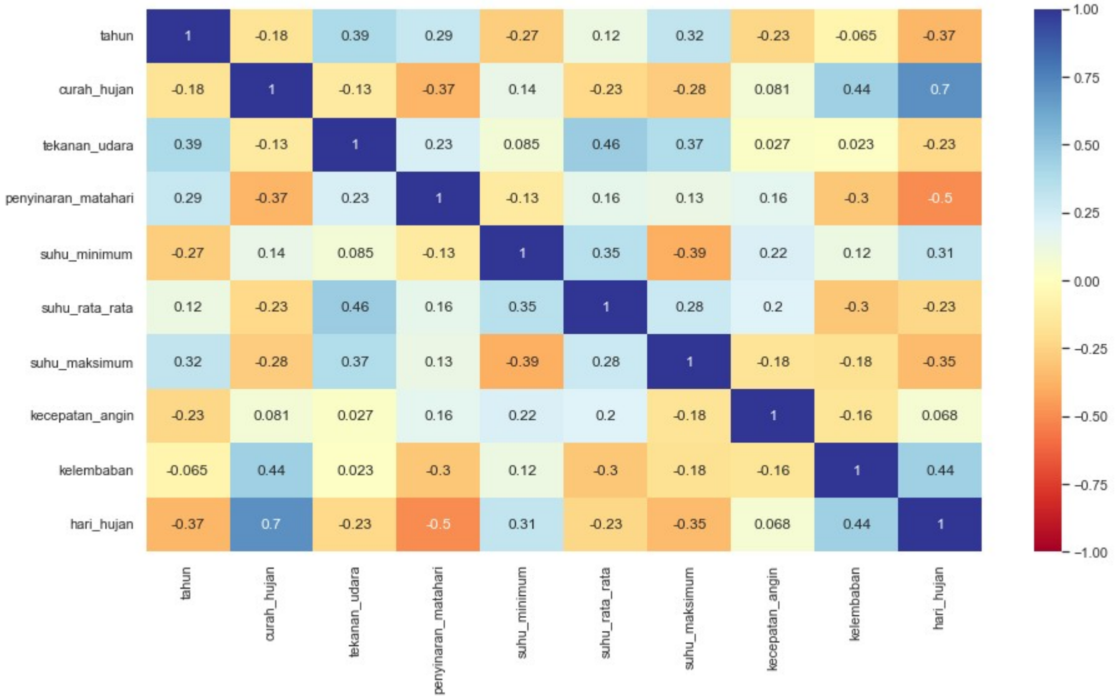
```
for col in col_outlier:
    outer_fence_le, outer_fence_ue = find_outlier(data_outlier, col)
#     dt_wn_win = winsorize(data_outlier[col], limits=(0.025, 0.025))
#     data_outlier[col] = dt_wn_win
    data_outlier[col] = np.where(data_outlier[col] < outer_fence_le,
outer_fence_le,
                                 np.where(data_outlier[col] >
outer_fence_ue, outer_fence_ue, data_outlier[col]))

boxplot_feature(data_outlier)
```



Seleksi Fitur

```
sns.set(rc = {'figure.figsize':(15,8)})
sns.heatmap(data_outlier.corr(), vmin=-1, vmax=1, annot=True,
cmap='RdYlBu')
```

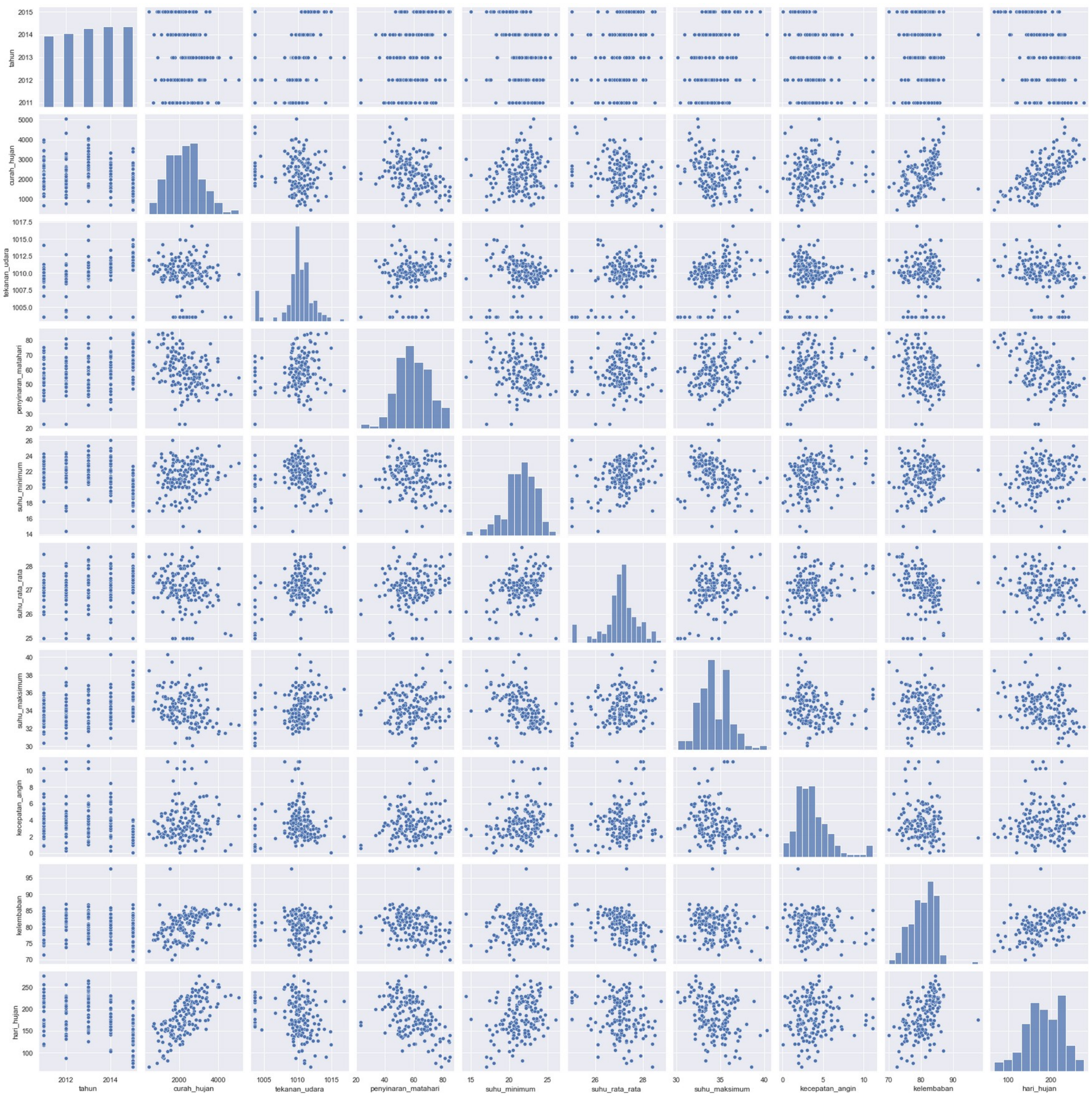
```
<AxesSubplot:>
```



	tahun	curah_hujan	tekanan_udara	penyinaran_matahari	suhu_minimum	suhu_rata_rata	suhu_maksimum	kecepatan_angin	kelembaban	hari_hujan
tahun	1	-0.18	0.39	0.29	-0.27	0.12	0.32	-0.23	-0.065	-0.37
curah_hujan	-0.18	1	-0.13	-0.37	0.14	-0.23	-0.28	0.081	0.44	0.7
tekanan_udara	0.39	-0.13	1	0.23	0.085	0.46	0.37	0.027	0.023	-0.23
penyinaran_matahari	0.29	-0.37	0.23	1	-0.13	0.16	0.13	0.16	-0.3	-0.5
suhu_minimum	-0.27	0.14	0.085	-0.13	1	0.35	-0.39	0.22	0.12	0.31
suhu_rata_rata	0.12	-0.23	0.46	0.16	0.35	1	0.28	0.2	-0.3	-0.23
suhu_maksimum	0.32	-0.28	0.37	0.13	-0.39	0.28	1	-0.18	-0.18	-0.35
kecepatan_angin	-0.23	0.081	0.027	0.16	0.22	0.2	-0.18	1	-0.16	0.068
kelembaban	-0.065	0.44	0.023	-0.3	0.12	-0.3	-0.18	-0.16	1	0.44
hari_hujan	-0.37	0.7	-0.23	-0.5	0.31	-0.23	-0.35	0.068	0.44	1

```
plt.figure(figsize=(16,8))
sns.pairplot(data=data_outlier)
```

```
<seaborn.axisgrid.PairGrid at 0x21de741d400>

<Figure size 1152x576 with 0 Axes>
```



variabel fitur diambil dari nilai korelasi yang tinggi terhadap data target

```
data_selection = data_outlier.copy()
data_selection = data_selection[["penyinaran_matahari",
"suhu_rata_rata", "kelembaban", "hari_hujan", "curah_hujan"]]
data_selection.head()
```

```
   penyinaran_matahari  suhu_rata_rata  kelembaban  hari_hujan
curah_hujan
0                 52.2            27.1        79.4       150.0
1268.0
1                 44.4            27.2        79.0       225.0
2042.0
3                 42.3            27.0        74.5       211.0
2405.0
4                 54.1            26.9        82.5       209.0
2295.0
```

```
5                  54.0             27.3         84.8        217.0
2593.0
```

Preprocessing

proses persiapan data dilakukan dengan standarisasi data dan splitting data sebelum masuk dalam training model

```
scaler = StandardScaler()
data_scaled = scaler.fit_transform(data_selection)
```

```
data_scaled[:5]
```

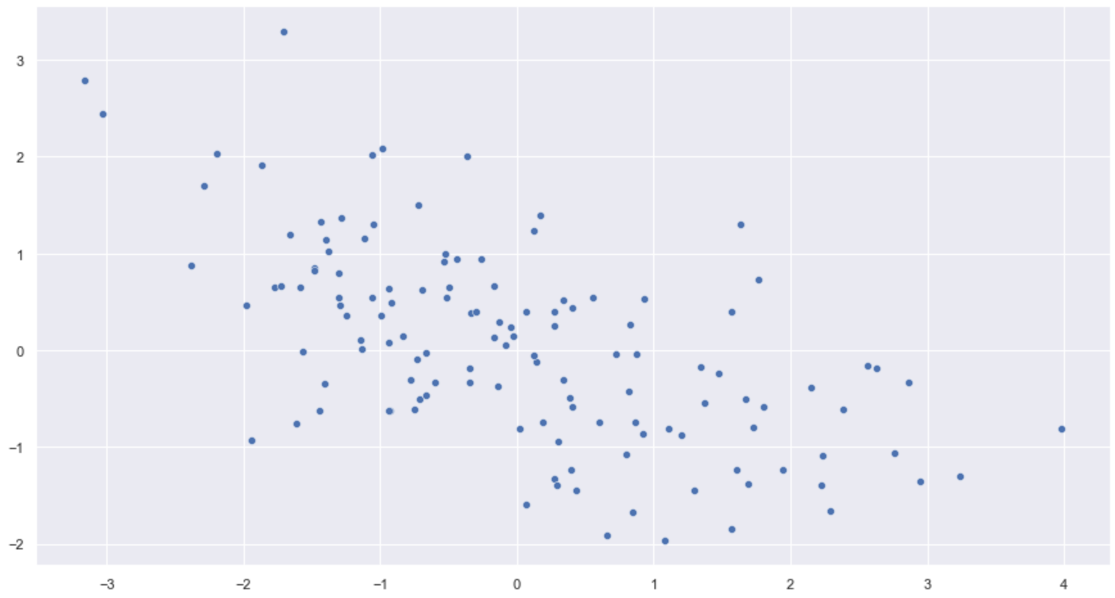
```
array([[-0.58136482,  0.05278938, -0.30204675, -0.7628599 , -
1.23704362],
       [-1.23499379,  0.19015481, -0.4047389 ,  0.99981997, -
0.30806623],
       [-1.41097081, -0.08457605, -1.56002563,  0.6707864 ,
0.12761696],
       [-0.42214751, -0.22194149,  0.49381744,  0.6237816 , -
0.00440825],
       [-0.43052737,  0.32752024,  1.08429732,  0.81180079,
0.35326005]])
```

```
X = data_scaled[:, :-1]
y = data_scaled[:, -1]
X_train, X_test, y_train, y_test = train_test_split(X, y, test_size =
0.2, random_state=3)
```

visualisasi data dengan mereduksi fitur menjadi 1 fitur komponen

```
model_pca = PCA(n_components=1)
X_train_reduction = model_pca.fit_transform(X_train)
sns.scatterplot(x=X_train_reduction.T[0], y=y_train)
```

```
<AxesSubplot:>
```



Tune Parameter with Multiple Models

beberapa percobaan model yang akan digunakan yaitu :

- Linear Regression
- Polynomial Regression
- Support Vector Machine
- Random Forest
- Gradient Boosting

Linear Regression

```
lin_reg = LinearRegression().fit(X_train, y_train)

lin_reg_pred = lin_reg.predict(X_test)

lin_reg_mae = metrics.mean_absolute_error(y_test, lin_reg_pred)
lin_reg_mse = metrics.mean_squared_error(y_test, lin_reg_pred)
lin_reg_rmse = np.sqrt(lin_reg_mse)
lin_reg_r2 = metrics.r2_score(y_test, lin_reg_pred)

print("Results of linear regression")
print("MAE:",lin_reg_mae)
print("MSE:", lin_reg_mse)
print("RMSE:", lin_reg_rmse)
print("R-Squared:", lin_reg_r2)
```

```
Results of linear regression
MAE: 0.4154313842060864
MSE: 0.2648324426169261
```

```
RMSE: 0.514618735198133
R-Squared: 0.6586902708376591
```

Polynomial Regression

```
pol_reg = make_pipeline(PolynomialFeatures(),
LinearRegression()).fit(X_train, y_train)

pol_reg_pred = pol_reg.predict(X_test)

pol_reg_mae = metrics.mean_absolute_error(y_test, pol_reg_pred)
pol_reg_mse = metrics.mean_squared_error(y_test, pol_reg_pred)
pol_reg_rmse = np.sqrt(pol_reg_mse)
pol_reg_r2 = metrics.r2_score(y_test, pol_reg_pred)

print("Results of polynomial regression")
print("MAE:",pol_reg_mae)
print("MSE:", pol_reg_mse)
print("RMSE:", pol_reg_rmse)
print("R-Squared:", pol_reg_r2)
```

```
Results of polynomial regression
MAE: 0.4702594045227867
MSE: 0.32671395942288883
RMSE: 0.5715889776954143
R-Squared: 0.5789388494011674
```

Support Vector Machine

```
svr_params = {'kernel': ['poly', 'rbf', 'linear'],
              'C': [0.06, 0.1, 0.3, 0.6, 1, 3, 6, 10],
              'gamma': [0.01, 0.03, 0.06, 0.1, 0.3, 0.6, 1],
              'degree': [1, 2, 3]}
svr = GridSearchCV(estimator=SVR(), param_grid=svr_params, cv=4)
svr.fit(X_train, y_train)
```

```
GridSearchCV(cv=4, estimator=SVR(),
             param_grid={'C': [0.06, 0.1, 0.3, 0.6, 1, 3, 6, 10],
                         'degree': [1, 2, 3],
                         'gamma': [0.01, 0.03, 0.06, 0.1, 0.3, 0.6,
1],
                         'kernel': ['poly', 'rbf', 'linear']})
```

```
print("parameter terbaik dari model support vector machine :",
svr.best_estimator_)
print("score validation terbaik dari model support vector machine :",
svr.best_score_)
```

```
parameter terbaik dari model support vector machine : SVR(C=3,
degree=1, gamma=0.06)
score validation terbaik dari model support vector machine :
0.43270048804099515
```

```
svr_pred = svr.predict(X_test)

svr_mae = metrics.mean_absolute_error(y_test, svr_pred)
svr_mse = metrics.mean_squared_error(y_test, svr_pred)
svr_rmse = np.sqrt(svr_mse)
svr_r2 = metrics.r2_score(y_test, svr_pred)

print("Results of support vector machine")
print("MAE:",svr_mae)
print("MSE:", svr_mse)
print("RMSE:", svr_rmse)
print("R-Squared:", svr_r2)
```

```
Results of support vector machine
MAE: 0.48213889428313816
MSE: 0.3362690944479732
RMSE: 0.5798871394055685
R-Squared: 0.5666244195099683
```

Random Forest

```
rf_params = {'bootstrap': [False, True], 'max_depth': [1, 2, 5, 10,
20, 30, 50, 70, 100, 150, None],
             'max_features': ['auto', 'log2', 'sqrt'],
             'n_estimators': [5, 10, 20, 50, 100, 150, 200, 300, 500]}
rf = GridSearchCV(estimator=RandomForestRegressor(),
param_grid=rf_params, cv=4)
rf.fit(X_train, y_train)
```

```
GridSearchCV(cv=4, estimator=RandomForestRegressor(),
             param_grid={'bootstrap': [False, True],
                         'max_depth': [1, 2, 5, 10, 20, 30, 50, 70,
100, 150,
                                       None],
                         'max_features': ['auto', 'log2', 'sqrt'],
                         'n_estimators': [5, 10, 20, 50, 100, 150,
200, 300,
                                          500]})
```

```
print("estimator terbaik dari model random forest :",
rf.best_estimator_)
print("score validation terbaik dari model random forest :",
rf.best_score_)
```

```
estimator terbaik dari model random forest :
RandomForestRegressor(max_depth=150, max_features='log2',
n_estimators=10)
score validation terbaik dari model random forest : 0.5042314081553801
```

```
rf_pred = rf.predict(X_test)

rf_mae = metrics.mean_absolute_error(y_test, rf_pred)
```

```
rf_mse = metrics.mean_squared_error(y_test, rf_pred)
rf_rmse = np.sqrt(rf_mse)
rf_r2 = metrics.r2_score(y_test, rf_pred)

print("Results of random forest")
print("MAE:",rf_mae)
print("MSE:", rf_mse)
print("RMSE:", rf_rmse)
print("R-Squared:", rf_r2)
```

```
Results of random forest
MAE: 0.547195760418061
MSE: 0.4502746032349228
RMSE: 0.6710250392011633
R-Squared: 0.4196968416702216
```

Gradient Boosting

```
gbm_params = {'learning_rate': [0.01, 0.03, 0.06, 0.1, 0.15, 0.3,
0.6],
              'subsample'    : [1, 0.6, 0.3, 0.1],
              'n_estimators' : [10, 20, 50, 100, 300, 600],
              'max_depth'    : [1, 2, 3, 4]}
gbm = GridSearchCV(estimator=GradientBoostingRegressor(),
param_grid=gbm_params, cv=4)
gbm.fit(X_train, y_train)
```

```
GridSearchCV(cv=4, estimator=GradientBoostingRegressor(),
             param_grid={'learning_rate': [0.01, 0.03, 0.06, 0.1,
0.15, 0.3,
                                           0.6],
                         'max_depth': [1, 2, 3, 4],
                         'n_estimators': [10, 20, 50, 100, 300, 600],
                         'subsample': [1, 0.6, 0.3, 0.1]})
```

```
print("estimator terbaik dari model gradient boosting :",
gbm.best_estimator_)
print("score validation terbaik dari model gradient boosting :",
gbm.best_score_)
```

```
estimator terbaik dari model gradient boosting :
GradientBoostingRegressor(learning_rate=0.06, max_depth=2,
n_estimators=50,
                          subsample=0.3)
score validation terbaik dari model gradient boosting :
0.49452220160364285
```

```
gbm_pred = gbm.predict(X_test)

gbm_mae = metrics.mean_absolute_error(y_test, gbm_pred)
gbm_mse = metrics.mean_squared_error(y_test, gbm_pred)
gbm_rmse = np.sqrt(gbm_mse)
```

```
gbm_r2 = metrics.r2_score(y_test, gbm_pred)

print("Results of gradient boosting")
print("MAE:", gbm_mae)
print("MSE:", gbm_mse)
print("RMSE:", gbm_rmse)
print("R-Squared:", gbm_r2)
```

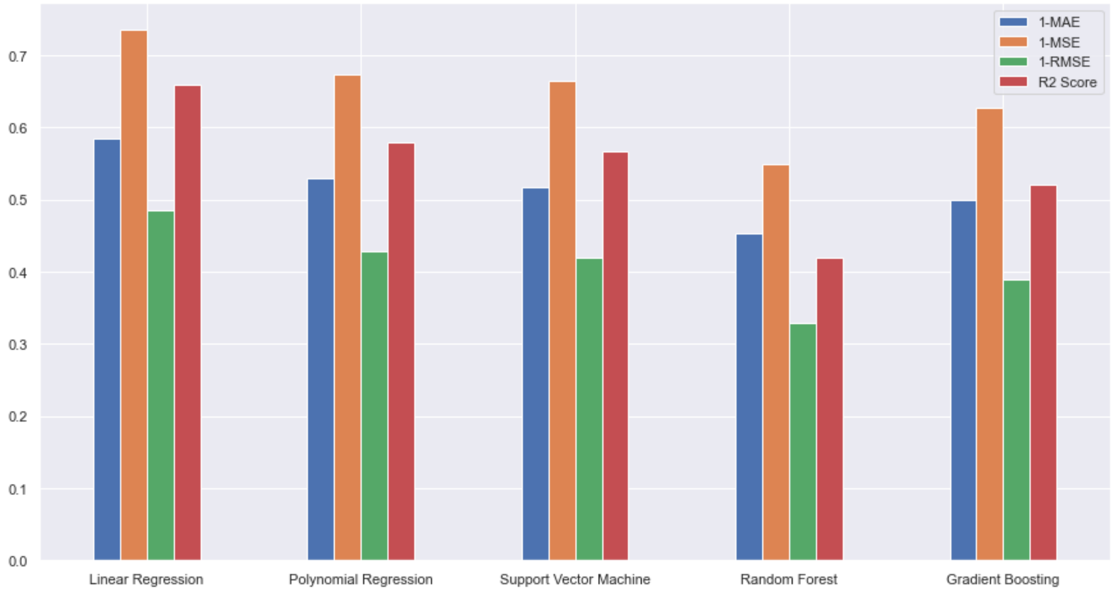
```
Results of gradient boosting
MAE: 0.4998806457315422
MSE: 0.3720945941598548
RMSE: 0.609995568967394
R-Squared: 0.5204533708161542
```

Select Model

```
data_score = pd.DataFrame({"1-MAE": [1-lin_reg_mae, 1-pol_reg_mae, 1-
svr_mae, 1-rf_mae, 1-gbm_mae],
                          "1-MSE": [1-lin_reg_mse, 1-pol_reg_mse, 1-
svr_mse, 1-rf_mse, 1-gbm_mse],
                          "1-RMSE": [1-lin_reg_rmse, 1-pol_reg_rmse,
1-svr_rmse, 1-rf_rmse, 1-gbm_rmse],
                          "R2 Score": [lin_reg_r2, pol_reg_r2, svr_r2,
rf_r2, gbm_r2]},
                          index=['Linear Regression', 'Polynomial
Regression', 'Support Vector Machine', 'Random Forest', 'Gradient
Boosting'])
data_score
```

```
                           1-MAE     1-MSE    1-RMSE  R2 Score
Linear Regression       0.584569  0.735168  0.485381  0.658690
Polynomial Regression   0.529741  0.673286  0.428411  0.578939
Support Vector Machine  0.517861  0.663731  0.420113  0.566624
Random Forest           0.452804  0.549725  0.328975  0.419697
Gradient Boosting       0.500119  0.627905  0.390004  0.520453
```

```
data_score.plot.bar()
plt.xticks(rotation=0)
plt.show()
```



kesimpulan dari proses training model yang telah dibangun, Linear Regression memiliki nilai metrik evaluasi terbaik dengan nilai R-Square sebesar 65.8%, dilanjutkan dengan Polynomial Regression 57.8%, Support Vector Machine 56.6%, Gradient Boosting 52.0%, dan Random Forest 41.9%