Optimasi Model Prediksi Temperatur T-iSO1 dalam Time Series Forecasting Menggunakan Random Forest dan Decision Tree

Import Library

```
import pandas as pd
import numpy as np
import joblib
import seaborn as sns
import matplotlib.pyplot as plt
from sklearn.ensemble import RandomForestRegressor
from sklearn.tree import DecisionTreeRegressor
from sklearn.metrics import mean_absolute_error, mean_squared_error, r2_score
from sklearn.preprocessing import MinMaxScaler
from xgboost import XGBRegressor
from IPython.display import display
```

Load Dataset

```
dataset_path = r"D:\HildasCollegeStuffs\PROPOSAL\Model\dataset.txt"
df = pd.read_csv(dataset_path, delimiter='\t')
```

Exploratory Data Analysis (EDA)

```
df.head()
```

	t (s)	TH-IN	T-HT	TH-OUT	T-HOT LEG	TA	TC-IN	T-CTB OUT	T-CT	T- CTB IN	TC-OUT	T-COLD LEG	TB	T-AIR	T-iSO1	T-iSO2
0	0	23.93	27.54	24.90	24.981538	25.344993	25.93	16.494643	15.9	16.085691	22.89	22.961715	24.123676	27.277591	28.286037	27.928758
1	1	23.93	27.54	24.90	24.981538	25.344993	25.93	16.494643	15.9	16.085691	22.89	22.961715	24.123676	27.277591	28.286037	27.928758
2	2	23.94	27.55	24.91	24.997826	25.361506	25.93	16.499692	15.9	16.103291	22.92	22.964195	24.131001	27.295456	28.284092	27.941781
3	3	23.94	27.55	24.91	24.997826	25.361506	25.93	16.499692	15.9	16.103291	22.92	22.964195	24.131001	27.295456	28.284092	27.941781
4	4	23.94	27.55	24.90	24.983867	25.357697	25.93	16.508891	15.9	16.100641	22.91	22.994142	24.096513	27.281296	28.284503	27.934991

```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 11001 entries, 0 to 11000
Data columns (total 16 columns):
 #   Column      Non-Null Count  Dtype
---  ------      --------------  -----
 0   t (s)       11001 non-null  int64
 1   TH-IN       11001 non-null  float64
 2   T-HT        11001 non-null  float64
 3   TH-OUT      11001 non-null  float64
 4   T-HOT LEG   11001 non-null  float64
 5   TA          11001 non-null  float64
 6   TC-IN       11001 non-null  float64
 7   T-CTB OUT   11001 non-null  float64
 8   T-CT        11001 non-null  float64
 9   T- CTB IN   11001 non-null  float64
 10  TC-OUT      11001 non-null  float64
 11  T-COLD LEG  11001 non-null  float64
 12  TB          11001 non-null  float64
 13  T-AIR       11001 non-null  float64
 14  T-iSO1      11001 non-null  float64
 15  T-iSO2      11001 non-null  float64
dtypes: float64(15), int64(1)
memory usage: 1.3 MB
```

```
import pandas as pd
from tabulate import tabulate

# Misal data kamu sudah ada di df
summary = df.describe().transpose()

# Tampilkan dalam bentuk tabel
print(tabulate(summary, headers='keys', tablefmt='pretty'))
```

```
+------------+---------+--------------------+--------------------+-----------+-----------+-----------+-----------+-----------+
|            |  count  |        mean        |        std         |    min    |    25%    |    50%    |    75%    |    max    |
+------------+---------+--------------------+--------------------+-----------+-----------+-----------+-----------+-----------+
|   t (s)    | 11001.0 |       5500.0       | 3175.859489964882  |    0.0    |  2750.0   |  5500.0   |  8250.0   |  11000.0  |
|   TH-IN    | 11001.0 | 38.12166348513772  | 7.846051896325843  |   23.05   |   32.24   |   41.09   |   44.74   |   46.27   |
|    T-HT    | 11001.0 | 75.27722207072084  | 16.965042313551393 |   27.52   |   66.79   |   82.48   |   88.3    |   90.84   |
|   TH-OUT   | 11001.0 | 43.55457685664939  | 8.483529467338824  |   24.73   |   37.59   |   46.85   |   50.56   |   52.51   |
| T-HOT LEG  | 11001.0 | 42.47149290600855  | 8.506501266742267  | 24.656151 | 36.566724 | 45.901248 | 49.47147  | 51.230692 |
|     TA     | 11001.0 | 42.07305941350786  | 8.422583624287963  | 24.847489 | 36.155722 | 45.458903 | 48.985524 | 50.685542 |
|   TC-IN    | 11001.0 | 41.57753840559949  |  8.19814473324757  |   25.09   |   35.65   |   44.97   |   48.29   |   50.02   |
```

```
| T-CTB OUT  | 11001.0 | 16.113292873375148 | 0.3312090657569372 | 15.440084 | 15.841095 | 16.107254 | 16.396562 | 16.821803 |
|    T-CT    | 11001.0 |  15.284395054995   | 0.3448043449276694 |   14.58   |   14.99   |   15.27   |   15.57   |   15.95   |
| T- CTB IN  | 11001.0 | 15.479726663303335 | 0.3438428138662611 | 14.767714 | 15.190937 | 15.468006 | 15.767611 | 16.219379 |
|   TC-OUT   | 11001.0 | 39.43358785564949  | 7.932373581993186  |   22.73   |   33.83   |   42.64   |   45.92   |   47.65   |
| T-COLD LEG | 11001.0 | 38.74984932769748  |  7.83857142467911  | 22.607678 | 33.125741 | 41.759639 | 45.24475  | 46.859493 |
|     TB     | 11001.0 | 38.63618575484047  |  7.71896864831884  | 23.18963  | 33.090512 | 41.700429 | 44.936244 | 46.622453 |
|   T-AIR    | 11001.0 | 26.61469622252522  | 0.3182735593199206 | 25.680082 | 26.444293 | 26.585118 | 26.780457 | 27.519559 |
|   T-iSO1   | 11001.0 | 45.91789240414508  | 7.723529928645326  | 27.986769 | 41.397621 | 48.895056 | 52.07175  |  53.3984  |
|   T-iSO2   | 11001.0 | 60.32791755522226  | 12.619855135147018 | 27.812506 | 53.454573 | 65.620008 | 70.029475 | 72.104312 |
+------------+---------+--------------------+--------------------+-----------+-----------+-----------+-----------+-----------+
```

Data Preprocessing

```
#Penanganan Missing Value
display(df.isnull().sum())
df.dropna(inplace=True)
```

```
t (s)         0
TH-IN         0
T-HT          0
TH-OUT        0
T-HOT LEG     0
TA            0
TC-IN         0
T-CTB OUT     0
T-CT          0
T- CTB IN     0
TC-OUT        0
T-COLD LEG    0
TB            0
T-AIR         0
T-iSO1        0
T-iSO2        0
```

```
display(df.isnull().sum())
```

```
t (s)         0
TH-IN         0
T-HT          0
TH-OUT        0
T-HOT LEG     0
TA            0
TC-IN         0
T-CTB OUT     0
T-CT          0
T- CTB IN     0
TC-OUT        0
T-COLD LEG    0
TB            0
T-AIR         0
T-iSO1        0
T-iSO2        0
```

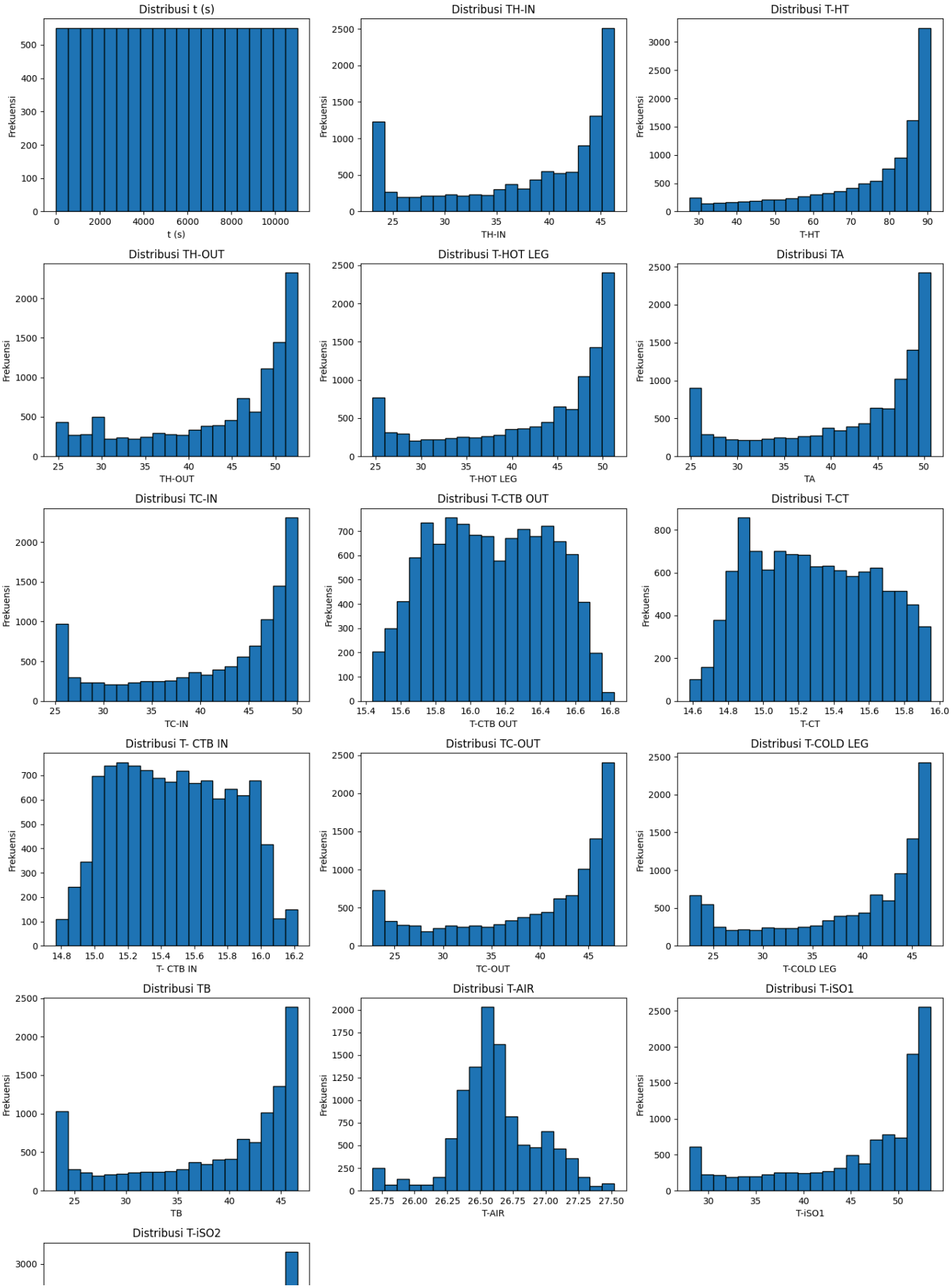
```
# Konversi tipe dari ke numerik
def convert_numeric(df):
    df = df.apply(pd.to_numeric, errors='coerce')
    return df

cleaned_df = convert_numeric(df)
cleaned_df.to_csv("cleaned_dataset.csv", index=False)
```

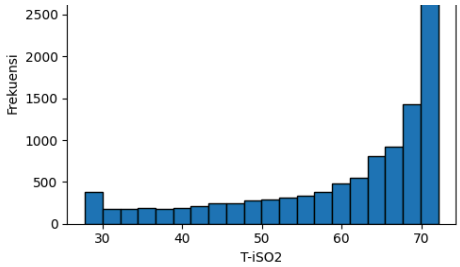
Feature Selection

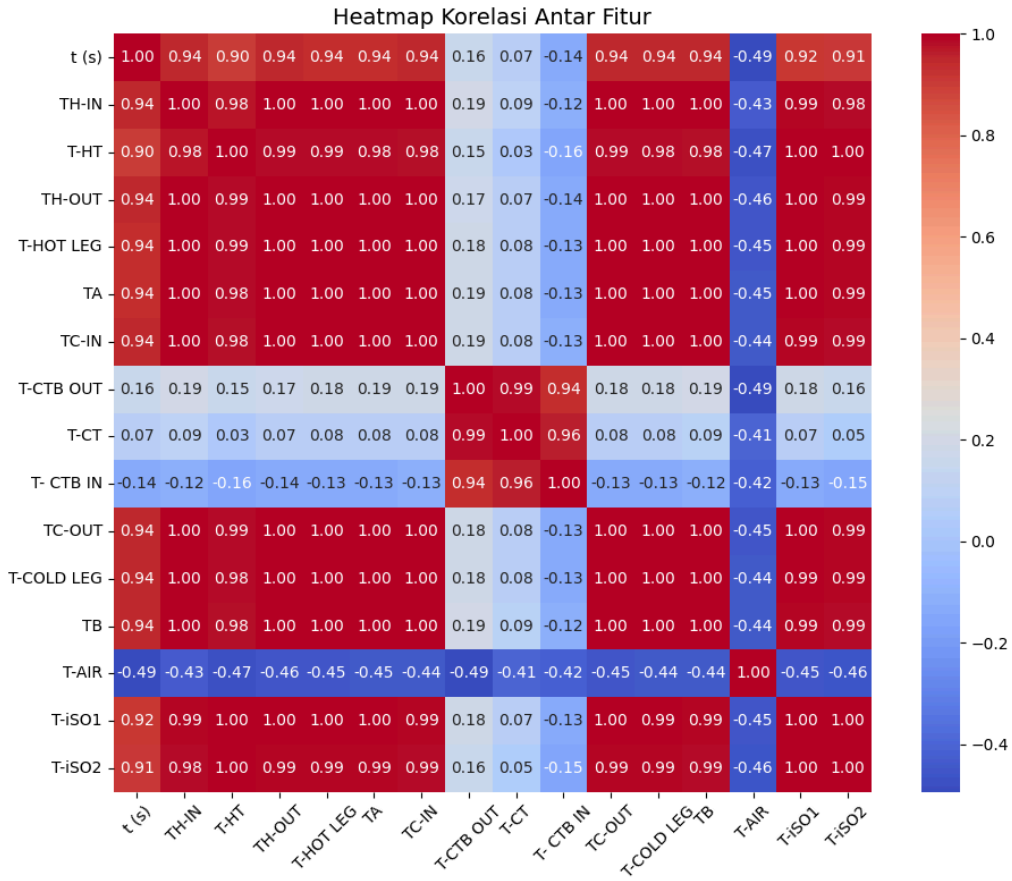
```
# --- HISTOGRAM ---
num_cols = 3  # jumlah kolom per baris
num_features = len(cleaned_df.columns)
num_rows = (num_features + num_cols - 1) // num_cols

fig, axes = plt.subplots(num_rows, num_cols, figsize=(15, 4 * num_rows))
axes = axes.flatten()

for i, col in enumerate(cleaned_df.columns):
    axes[i].hist(cleaned_df[col], bins=20, edgecolor='black')
    axes[i].set_title(f'Distribusi {col}')
    axes[i].set_xlabel(col)
    axes[i].set_ylabel('Frekuensi')

# Hapus subplot kosong (jika jumlah fitur < subplot)
for j in range(i + 1, len(axes)):
    fig.delaxes(axes[j])

fig.suptitle("Distribusi Fitur Dataset", fontsize=16)
plt.tight_layout(rect=[0, 0, 1, 0.97])
plt.show()

# --- HEATMAP KORELASI ---
plt.figure(figsize=(10, 8))
sns.heatmap(cleaned_df.corr(), annot=True, cmap="coolwarm", fmt=".2f", square=True)
```

```
sns.heatmap(cleaned_df.corr(), annot=True, cmap='coolwarm', fmt='.2f', square=True)
plt.title("Heatmap Korelasi Antar Fitur", fontsize=14)
plt.xticks(rotation=45)
plt.yticks(rotation=0)
plt.tight_layout()
plt.show()
```

Distribusi Fitur Dataset




Frekuensi
2500
2000
1500
1000
500
0
30
40
50
60
70
T-iSO2

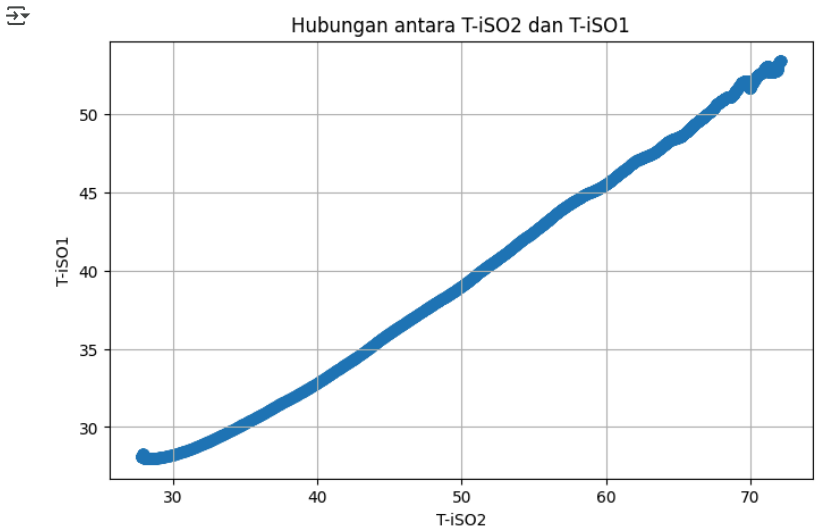

Heatmap Korelasi Antar Fitur
t (s) 1.00 0.94 0.90 0.94 0.94 0.94 0.94 0.16 0.07 -0.14 0.94 0.94 0.94 -0.49 0.92 0.91
TH-IN 0.94 1.00 0.98 1.00 1.00 1.00 1.00 0.19 0.09 -0.12 1.00 1.00 1.00 -0.43 0.99 0.98
T-HT 0.90 0.98 1.00 0.99 0.99 0.98 0.98 0.15 0.03 -0.16 0.99 0.98 0.98 -0.47 1.00 1.00
TH-OUT 0.94 1.00 0.99 1.00 1.00 1.00 1.00 0.17 0.07 -0.14 1.00 1.00 1.00 -0.46 1.00 0.99
T-HOT LEG 0.94 1.00 0.99 1.00 1.00 1.00 1.00 0.18 0.08 -0.13 1.00 1.00 1.00 -0.45 1.00 0.99
TA 0.94 1.00 0.98 1.00 1.00 1.00 1.00 0.19 0.08 -0.13 1.00 1.00 1.00 -0.45 1.00 0.99
TC-IN 0.94 1.00 0.98 1.00 1.00 1.00 1.00 0.19 0.08 -0.13 1.00 1.00 1.00 -0.44 0.99 0.99
T-CTB OUT 0.16 0.19 0.15 0.17 0.18 0.19 0.19 1.00 0.99 0.94 0.18 0.18 0.19 -0.49 0.18 0.16
T-CT 0.07 0.09 0.03 0.07 0.08 0.08 0.08 0.99 1.00 0.96 0.08 0.08 0.09 -0.41 0.07 0.05
T- CTB IN -0.14 -0.12 -0.16 -0.14 -0.13 -0.13 -0.13 0.94 0.96 1.00 -0.13 -0.13 -0.12 -0.42 -0.13 -0.15
TC-OUT 0.94 1.00 0.99 1.00 1.00 1.00 1.00 0.18 0.08 -0.13 1.00 1.00 1.00 -0.45 1.00 0.99
T-COLD LEG 0.94 1.00 0.98 1.00 1.00 1.00 1.00 0.18 0.08 -0.13 1.00 1.00 1.00 -0.44 0.99 0.99
TB 0.94 1.00 0.98 1.00 1.00 1.00 1.00 0.19 0.09 -0.12 1.00 1.00 1.00 -0.44 0.99 0.99
T-AIR -0.49 -0.43 -0.47 -0.46 -0.45 -0.45 -0.44 -0.49 -0.41 -0.42 -0.45 -0.44 -0.44 1.00 -0.45 -0.46
T-iSO1 0.92 0.99 1.00 1.00 1.00 1.00 0.99 0.18 0.07 -0.13 1.00 0.99 0.99 -0.45 1.00 1.00
T-iSO2 0.91 0.98 1.00 0.99 0.99 0.99 0.99 0.16 0.05 -0.15 0.99 0.99 0.99 -0.46 1.00 1.00
t (s)
TH-IN
T-HT
TH-OUT
T-HOT LEG
TA
TC-IN
T-CTB OUT
T-CT
T- CTB IN
TC-OUT
T-COLD LEG
TB
T-AIR
T-iSO1
T-iSO2
1.0
0.8
0.6
0.4
0.2
0.0
−0.2
−0.4

Memilih Target & Fitur

```
def select_features(df):
    # Menentukan fitur (X) dan target (Y) tanpa seleksi fitur berbasis model
    X = df[['t (s)', 'T-iSO2']]  # Menggunakan semua fitur kecuali target
    y = df['T-iSO1']  # Target yang ingin diprediksi

    return X, y

# Menentukan X dan Y tanpa regressor
X, y = select_features(cleaned_df)

print("Fitur yang digunakan:", X.columns.tolist())
print("Target:", y.name)
```

```
Fitur yang digunakan: ['t (s)', 'T-iSO2']
Target: T-iSO1
```

```
# Scatter plot antara input dan output
plt.figure(figsize=(8, 5))
plt.scatter(cleaned_df['T-iSO2'], cleaned_df['T-iSO1'], alpha=0.5)
plt.xlabel('T-iSO2')
plt.ylabel('T-iSO1')
plt.title('Hubungan antara T-iSO2 dan T-iSO1')
plt.grid()
plt.show()
```



Splitting Data (Train 80% - Test 20%)

```
def train_test_split(data, test_size=0.2):
    split_idx = int(len(data) * (1 - test_size))
    return data[:split_idx, :], data[split_idx:, :]
```

```
def series_to_supervised(df):
    supervised_df = df[['t (s)', 'T-iSO2', 'T-iSO1']].copy()
    return supervised_df

supervised_df = series_to_supervised(cleaned_df)
time_index = df['t (s)'].iloc[len(df) - len(supervised_df):].values.astype(float)
data = supervised_df.values
```

Pengembangan Model

```
def random_forest_forecast(train, testX):
    train = np.array(train)
    trainX, trainy = train[:, :-1], train[:, -1]

    model = RandomForestRegressor(n_estimators=50, max_depth=10, min_samples_split=10, max_features='sqrt', random_state=42)
    model.fit(trainX, trainy)

    yhat = model.predict([testX])
    return yhat[0], model
```

```
def decision_tree_forecast(train, testX):
    train = np.array(train)
```

```
    trainX, trainy = train[:, :-1], train[:, -1]

    model = DecisionTreeRegressor(max_depth=10, random_state=42)
    model.fit(trainX, trainy)

    yhat = model.predict([testX])
    return yhat[0], model
```

Walk-forward Validation (Training & Testing)

```
def walk_forward_validation(data, test_size=0.2, use_decision_tree=False):
    predictions = []
    train, test = train_test_split(data, test_size)
    history = [x for x in train]

    model = None
    for i in range(len(test)):
        if i % 10 == 0:
            print(f"Processing test data index {i}/{len(test)}...")
        testX, testy = test[i, :-1], test[i, -1]

        if use_decision_tree:
            yhat, model = decision_tree_forecast(history, testX)
        else:
            yhat, model = random_forest_forecast(history, testX)

        predictions.append(yhat)
        history.append(test[i])

    mae = mean_absolute_error(test[:, -1], predictions)
    mse = mean_squared_error(test[:, -1], predictions)
    rmse = np.sqrt(mse)
    r2 = r2_score(test[:, -1], predictions)
    return mae, mse, rmse, r2, test[:, -1], predictions, model, time_index[-len(test):]
```

Matrix Evaluation

```
mae_rf, mse_rf, rmse_rf, r2_rf, y_rf, yhat_rf, trained_model_rf, test_time_rf = walk_forward_validation(data, test_size=0.2, use_decision_tree=False)
```

```
Processing test data index 0/2201...
Processing test data index 10/2201...
Processing test data index 20/2201...
Processing test data index 30/2201...
Processing test data index 40/2201...
Processing test data index 50/2201...
Processing test data index 60/2201...
Processing test data index 70/2201...
Processing test data index 80/2201...
Processing test data index 90/2201...
Processing test data index 100/2201...
Processing test data index 110/2201...
Processing test data index 120/2201...
Processing test data index 130/2201...
Processing test data index 140/2201...
Processing test data index 150/2201...
Processing test data index 160/2201...
Processing test data index 170/2201...
Processing test data index 180/2201...
Processing test data index 190/2201...
Processing test data index 200/2201...
Processing test data index 210/2201...
Processing test data index 220/2201...
Processing test data index 230/2201...
Processing test data index 240/2201...
Processing test data index 250/2201...
Processing test data index 260/2201...
Processing test data index 270/2201...
Processing test data index 280/2201...
Processing test data index 290/2201...
Processing test data index 300/2201...
Processing test data index 310/2201...
Processing test data index 320/2201...
Processing test data index 330/2201...
Processing test data index 340/2201...
Processing test data index 350/2201...
Processing test data index 360/2201...
Processing test data index 370/2201...
Processing test data index 380/2201...
Processing test data index 390/2201...
Processing test data index 400/2201...
Processing test data index 410/2201...
Processing test data index 420/2201...
Processing test data index 430/2201...
Processing test data index 440/2201...
Processing test data index 450/2201...
Processing test data index 460/2201...
Processing test data index 470/2201...
Processing test data index 480/2201...
Processing test data index 490/2201...
Processing test data index 500/2201...
```

```
Processing test data index 510/2201...
Processing test data index 520/2201...
Processing test data index 530/2201...
Processing test data index 540/2201...
Processing test data index 550/2201...
Processing test data index 560/2201...
Processing test data index 570/2201...
```

```
mae_dt, mse_dt, rmse_dt, r2_dt, y_dt, yhat_dt, trained_model_dt, test_time_dt = walk_forward_validation(data, test_size=0.2, use_decision_tree=True)
```

```
Processing test data index 0/2201...
Processing test data index 10/2201...
Processing test data index 20/2201...
Processing test data index 30/2201...
Processing test data index 40/2201...
Processing test data index 50/2201...
Processing test data index 60/2201...
Processing test data index 70/2201...
Processing test data index 80/2201...
Processing test data index 90/2201...
Processing test data index 100/2201...
Processing test data index 110/2201...
Processing test data index 120/2201...
Processing test data index 130/2201...
Processing test data index 140/2201...
Processing test data index 150/2201...
Processing test data index 160/2201...
Processing test data index 170/2201...
Processing test data index 180/2201...
Processing test data index 190/2201...
Processing test data index 200/2201...
Processing test data index 210/2201...
Processing test data index 220/2201...
Processing test data index 230/2201...
Processing test data index 240/2201...
Processing test data index 250/2201...
Processing test data index 260/2201...
Processing test data index 270/2201...
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Processing test data index 310/2201...
Processing test data index 320/2201...
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Processing test data index 380/2201...
Processing test data index 390/2201...
Processing test data index 400/2201...
Processing test data index 410/2201...
Processing test data index 420/2201...
Processing test data index 430/2201...
Processing test data index 440/2201...
Processing test data index 450/2201...
Processing test data index 460/2201...
Processing test data index 470/2201...
Processing test data index 480/2201...
Processing test data index 490/2201...
Processing test data index 500/2201...
Processing test data index 510/2201...
Processing test data index 520/2201...
Processing test data index 530/2201...
Processing test data index 540/2201...
Processing test data index 550/2201...
Processing test data index 560/2201...
Processing test data index 570/2201...
```

```
rf_model_filename = "random_forest_model.pkl"
dt_model_filename = "decision_tree_model.pkl"
joblib.dump(trained_model_rf, rf_model_filename)
joblib.dump(trained_model_dt, dt_model_filename)

print(f"Random Forest Model saved as {rf_model_filename}")
print(f"Decision Tree Model saved as {dt_model_filename}")
```

```
Random Forest Model saved as random_forest_model.pkl
Decision Tree Model saved as decision_tree_model.pkl
```

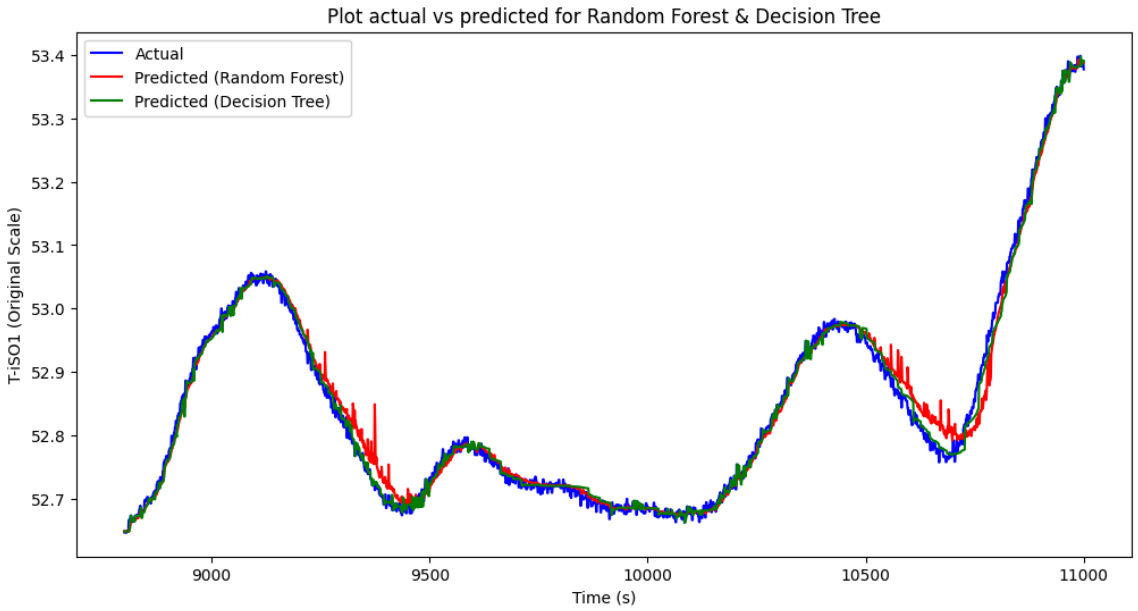
```
results_df = pd.DataFrame({
    "Model": ["Random Forest", "Decision Tree"],
    "MAE": [mae_rf, mae_dt],
    "MSE": [mse_rf, mse_dt],
    "RMSE": [rmse_rf, rmse_dt],
    "R²": [r2_rf, r2_dt]
})

display(results_df)
results_df.to_csv("model_results_trimmed.csv", index=False)
```

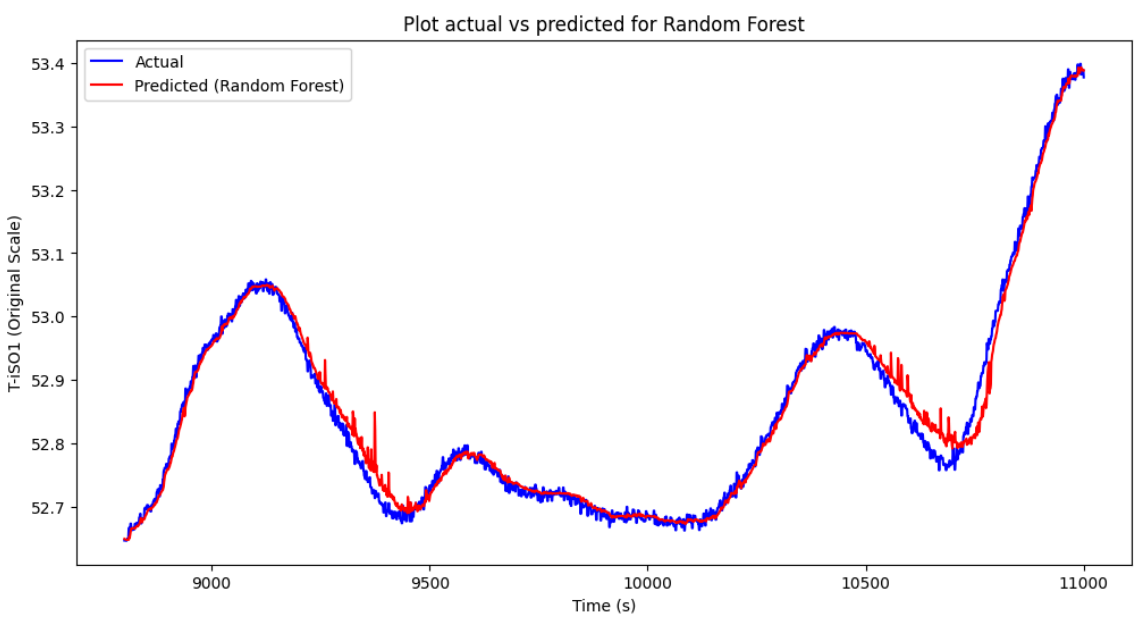
	Model	MAE	MSE	RMSE	R^2
0	Random Forest	0.013640	0.000373	0.019312	0.986877
1	Decision Tree	0.009225	0.000148	0.012160	0.994797

Visualization

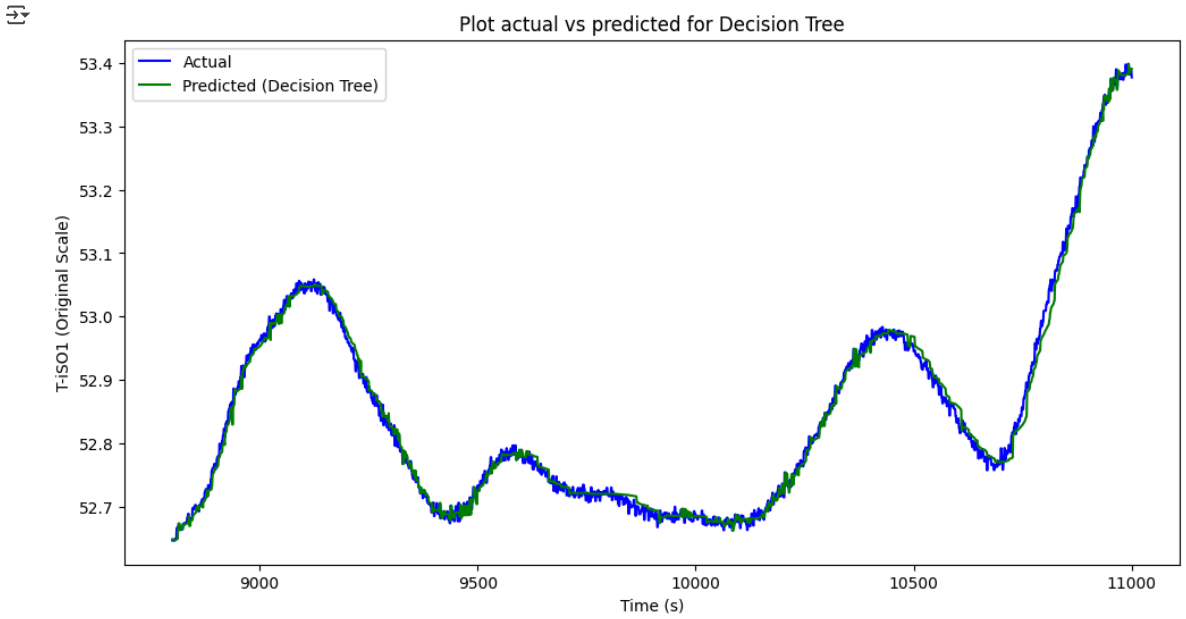
```
plt.figure(figsize=(12, 6))
plt.plot(test_time_rf, y_rf, label='Actual', color='blue')
plt.plot(test_time_rf, yhat_rf, label='Predicted (Random Forest)', color='red')
plt.plot(test_time_dt, yhat_dt, label='Predicted (Decision Tree)', color='green')
plt.title('Plot actual vs predicted for Random Forest & Decision Tree')
plt.xlabel('Time (s)')
plt.ylabel('T-iSO1 (Original Scale)')
plt.legend()
plt.show()
```




```
plt.figure(figsize=(12, 6))
plt.plot(test_time_rf, y_rf, label='Actual', color='blue')
plt.plot(test_time_rf, yhat_rf, label='Predicted (Random Forest)', color='red')
plt.title('Plot actual vs predicted for Random Forest')
plt.xlabel('Time (s)')
plt.ylabel('T-iSO1 (Original Scale)')
plt.legend()
plt.show()
```



```
plt.figure(figsize=(12, 6))
plt.plot(test_time_dt, y_dt, label='Actual', color='blue')
plt.plot(test_time_dt, yhat_dt, label='Predicted (Decision Tree)', color='green')
plt.title('Plot actual vs predicted for Decision Tree')
plt.xlabel('Time (s)')
plt.ylabel('T-iSO1 (Original Scale)')
plt.legend()
plt.show()
```




```
# Membuat DataFrame hasil prediksi
predictions_df = pd.DataFrame({
    'index': np.arange(len(test_time_rf)),
    't (s)': test_time_rf,
    'Actual_T-iSO1': y_rf,
    'Predicted_T-iSO1_RF': yhat_rf,
    'Predicted_T-iSO1_DT': yhat_dt
})

# Menampilkan sekilas
display(predictions_df.head())

# Simpan ke CSV
predictions_df.to_csv('predictions_rf_dt.csv', index=False)

print("Predictions saved as predictions_rf_dt.csv")
```

	index	t (s)	Actual_T-iSO1	Predicted_T-iSO1_RF	Predicted_T-iSO1_DT
0	0	8800.0	52.647219	52.649705	52.649167
1	1	8801.0	52.647219	52.649286	52.649037
2	2	8802.0	52.647677	52.648897	52.648923
3	3	8803.0	52.647677	52.648529	52.648850
4	4	8804.0	52.646890	52.648465	52.648785

```
Predictions saved as predictions_rf_dt.csv
```

Implementasi Dashboard Berbasis Streamlit

```
!streamlit run dashboard.py
```

```
^C
```

```
from sklearn.tree import plot_tree

# Visualisasi pohon keputusan untuk Decision Tree
plt.figure(figsize=(20,10))
plot_tree(trained_model_dt, filled=True, feature_names=X.columns, rounded=True, fontsize=12)
plt.title("Decision Tree Structure")
plt.show()

from sklearn.tree import export_text

# Tampilkan aturan dari Decision Tree dalam bentuk teks
tree_rules = export_text(trained_model_dt, feature_names=list(X.columns))
```