# ABSTRAK

## DETEKSI ANOMALI DATA IKLIM MIKRO PERKEBUNAN KELAPA SAWIT DENGAN MENGGUNAKAN ALGORITMA *ISOLATION FOREST*.

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Perubahan iklim mikro di kebun kelapa sawit dapat berdampak pada produktivitas dan kesehatan tanaman, sehingga pemantauan serta deteksi awal terhadap anomali cuaca sangatlah penting. Penelitian ini bertujuan untuk mendeteksi anomali pada data iklim mikro dengan menggunakan algoritma *Isolation Forest*. Data yang diperoleh dari sensor cuaca selama periode tujuh bulan (1 Juni–31 Desember 2024) mencakup suhu, kelembapan, curah hujan, kecepatan angin, arah angin, serta intensitas radiasi matahari. Proses pra-pemrosesan mencakup interpolasi linier untuk menangani nilai yang hilang serta pengambilan sampel data dari interval 1 menit ke 30 menit. Model *Isolation Forest* dinilai menggunakan *Mean Absolute Error (MAE), Root Mean Square Error (RMSE),* dan *Mean Absolute Percentage Error (MAPE)* yang berbasis *moving average*. Hasil menunjukkan kinerja yang sangat baik pada suhu (MAE=1,77; RMSE=2,41; MAPE=5,53%), cukup baik pada kelembaban (MAE=6,81; RMSE=9,02; MAPE=11,24%) dan curah hujan (MAE=0,003; RMSE=9,02; MAPE=10,68%), serta kurang akurat pada data yang berfluktuasi seperti arah angin (MAE=38,7; RMSE=61,94; MAPE=50,22%), kecepatan angin (MAE=0,101; RMSE=0,188; MAPE=24,88%), dan intensitas radiasi matahari (MAE=225,205; RMSE=264,06; MAPE=37,45%). Ketidakkonsistenan dalam evaluasi pada fitur tertentu mungkin disebabkan oleh: (1) ketidakcocokan *moving average* sebagai *baseline*; (2) ketidakcocokan RMSE untuk model *Isolation Forest*; (3) ketidakcocokan model dengan tipe data tersebut; atau (4) kualitas data yang buruk karena *noise* atau kesalahan sensor. Oleh karena itu, diperlukan penelitian lebih lanjut dengan model deteksi berbeda, pendekatan tambahan atau pra-proses lanjutan untuk meningkatkan kualitas data sebelum proses deteksi anomali dilakukan.

**Kata kunci**: *Deteksi Anomali, Evaluasi Model, Iklim Mikro, Isolation Forest, Perkebunan Kelapa Sawit***.**

# ABSTRACT

## ANOMALY DETECTION IN OIL PALM PLANTATION MICROCLIMATE DATA USING THE ISOLATION FOREST ALGORITHM

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Microclimate changes in oil palm plantations can affect to productivity and plant health, making weather anomaly monitoring and early detection crucial. This study aims to detect anomalies in microclimate data using the Isolation Forest algorithm. The data, collected from weather sensors over a seven-month period (June 1–December 31, 2024), includes temperature, humidity, rainfall, wind speed, wind direction, and solar radiation intensity. The preprocessing stage involved linear interpolation to handle missing values and resampling the data from 1-minute to 30-minute intervals. The Isolation Forest model was evaluated using three metrics: Mean Absolute Error (MAE), Root Mean Square Error (RMSE), and Mean Absolute Percentage Error (MAPE), with a moving average used as the baseline. The results demonstrated excellent performance for temperature (MAE = 1.77; RMSE = 2.41; MAPE = 5.53%), good performance for humidity (MAE = 6.81; RMSE = 9.02; MAPE = 11.24%) and rainfall (MAE = 0.003; RMSE = 9.02; MAPE = 10.68%), but lower accuracy for more fluctuating features such as wind direction (MAE = 38.7; RMSE = 61.94; MAPE = 50.22%), wind speed (MAE = 0.101; RMSE = 0.188; MAPE = 24.88%), and pyrano (MAE = 225.205; RMSE = 264.06; MAPE = 37.45%). The inconsistency in evaluation results for certain features may be due to: (1) the moving average basis used is not compatible with the type of wind speed and solar intensity data; (2) the evaluation method used is not suitable with the Isolation Forest model; (3) the Isolation Forest model for anomaly detection is not proper with the type of data for these two parameters; (4) the quality of wind speed and solar intensity data is not well mannered due to noise or sensor reading errors. Therefore, further research is neded with different detection models, additional approaches, or further preprocessing are needed to improve data quality prior to anomaly detection.

**Keywords**: *Anomaly Detection, Isolation Forest, Model Evaluation, Microclimate, Oil Palm Plantation*.