

MODEL PREDIKSI CUACA DI YOGYAKARTA MENGGUNAKAN MACHINE LEARNING BERDASARKAN DATA HISTORIS DARI BMKG

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INTISARI

Latar Belakang: Cuaca berdampak besar pada kehidupan, terutama saat terjadi perubahan ekstrem di Yogyakarta. BMKG menggunakan metode *Numerical Weather Prediction (NWP)*, namun akurasinya terbatas untuk jangka panjang dan cuaca ekstrem. Sebagai alternatif, *Machine Learning (ML)* menawarkan prediksi yang lebih adaptif dan akurat dengan menganalisis pola dari data historis.

Tujuan: Penelitian ini bertujuan mengembangkan dan mengevaluasi model prediksi cuaca berbasis *Machine Learning* menggunakan data historis BMKG Yogyakarta, serta membandingkan akurasinya dengan data aktual BMKG, khususnya untuk cuaca ekstrem.

Metode Penelitian: Data historis cuaca Yogyakarta (2020-2024) dari BMKG dikumpulkan, diproses (preprocessing), dan dibagi untuk pelatihan (2020-2023) serta pengujian (2024). Empat algoritma ML (*Random Forest*, *XGBoost*, LSTM, ARIMA) diuji dan dievaluasi menggunakan metrik RMSE, MAPE, dan R^2 Score. Model terbaik kemudian diuji kemampuannya mendeteksi cuaca ekstrem berdasarkan kuartil ketiga (Q3).

Hasil: Model *XGBoost default* menunjukkan performa terbaik (RMSE 0.0832, MAPE 57.81%, R^2 0.8097) dan mampu mendeteksi cuaca ekstrem dengan akurasi 83.33%. Versi tuning-nya menghasilkan MAPE lebih rendah (24.57%) namun R^2 sedikit turun (0.7586). Sistem prediksi telah diterapkan dalam dashboard web *Streamlit* dengan dukungan prediksi harian, 3-harian, dan bulanan.

Kesimpulan: Sistem prediksi curah hujan berbasis *Machine Learning* dengan algoritma *XGBoost* berhasil dikembangkan dan diimplementasikan untuk Yogyakarta. Model *XGBoost* terbukti paling akurat dalam memprediksi curah hujan dan mendeteksi cuaca ekstrem. Fleksibilitas resolusi waktu dan antarmuka interaktif menjadikan sistem ini alat potensial untuk perencanaan strategis dan mitigasi bencana.

Kata-kunci: Prediksi Cuaca, Curah Hujan, *Machine Learning*, *XGBoost*, *Time Series*, Yogyakarta, BMKG.

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WEATHER PREDICTION MODEL IN YOGYAKARTA USING MACHINE LEARNING BASED ON HISTORICAL DATA FROM BMKG

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ABSTRACT

Background: Weather significantly impacts daily life, especially during extreme changes in Yogyakarta. The Meteorology, Climatology, and Geophysics Agency (BMKG) uses Numerical Weather Prediction (NWP), but its accuracy is limited for long-term forecasts and extreme weather events. As an alternative, Machine Learning (ML) offers more adaptive and accurate predictions by analyzing patterns from historical data.

Objective: This study aims to develop and evaluate a weather prediction model based on Machine Learning using historical data from BMKG Yogyakarta, and to compare its accuracy with actual BMKG data, particularly in predicting extreme weather events.

Method: Historical weather data from Yogyakarta (2020–2024) obtained from BMKG was collected, preprocessed, and split into training (2020–2023) and testing (2024) datasets. Four ML algorithms (Random Forest, XGBoost, LSTM, ARIMA) were tested and evaluated using RMSE, MAPE, and R^2 Score metrics. The best-performing model was then tested for its ability to detect extreme weather using the third quartile (Q3) threshold.

Result: The default XGBoost model performed best (RMSE 0.0832, MAPE 57.81%, R^2 0.8097) and detected extreme weather with 83.33% accuracy. The tuned version yielded a lower MAPE (24.57%) but a slightly lower R^2 (0.7586). The prediction system has been implemented in the Streamlit web dashboard, supporting daily, 3-day, and monthly predictions.

Conclusion: A Machine Learning-based rainfall prediction system using the XGBoost algorithm was successfully developed and implemented in Yogyakarta. The XGBoost model proved to be the most accurate in predicting rainfall and detecting extreme weather. Its flexible time resolution and interactive interface make this system a potential tool for strategic planning and disaster mitigation.

Keywords: Weather Prediction, Rainfall, Machine Learning, XGBoost, Time Series, Yogyakarta, BMKG.

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