PREDIKSI CUACA PER JAM UNTUK REKOMENDASI KENYAMANAN OLAHRAGA MENGGUNAKAN METODE BILSTM BERBASIS MOBILE

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ABSTRAK

Cuaca tropis Indonesia yang sangat variabel berdampak signifikan pada sektor transportasi, pertanian, industri, serta aktivitas luar ruangan seperti olahraga. Prediksi cuaca per jam yang akurat untuk suhu, kelembapan, dan curah hujan menjadi krusial guna mendukung kenyamanan termal manusia (terukur via Temperature Humidity Index/THI) dan produktivitas. Penelitian ini mengembangkan model prediksi cuaca per jam menggunakan arsitektur Bidirectional Long Short-Term Memory (BiLSTM) dua lapis dan transformasi Yeo–Johnson untuk mengatasi zero-inflation data curah hujan. Data historis per jam wilayah Jakarta (1 Januari 2021–31 Desember 2023) dari Open-Meteo API diproses melalui pembersihan, interpolasi, dan normalisasi (Yeo–Johnson + Min-Max Scaling). Deret waktu dengan lookback 24 jam dan horizon prediksi 1 jam dibagi menjadi training (80%), validasi (10%), dan uji (10%). Model BiLSTM (64→128 neuron, dropout 0,1–0,2, regularisasi L2≈1e−4) dikompilasi dengan optimizer Adam dan Huber loss, lalu dioptimasi via random search dan early stopping. Hasil menunjukkan transformasi Yeo–Johnson menurunkan skewness curah hujan dari 12,56 ke 1,17. Model mencapai RMSE terdenormalisasi 0,8787 °C (NSE 0,892) untuk suhu, 4,8653% (NSE 0,875) untuk kelembapan, dan 0,7463 mm (NSE 0,368) untuk curah hujan. Implementasi API real-time berbasis Android berhasil menyajikan prediksi per jam untuk rekomendasi kenyamanan olahraga. Temuan membuktikan efektivitas kombinasi BiLSTM dan Yeo–Johnson dalam prediksi cuaca tropis, dengan rekomendasi pengayaan variabel dan periode data untuk penelitian lanjutan.

Kata kunci: BiLSTM; prediksi cuaca per jam; transformasi Yeo–Johnson; time series; iklim tropis.

HOURLY WEATHER PREDICTION FOR RECOMMENDATIONS ON SPORTS COMFORT USING MOBILE-BASED BILSTM METHOD

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ABSTRACT

Indonesia's highly variable tropical climate has a significant impact on the transportation, agriculture, and industrial sectors, as well as outdoor activities such as sports. Accurate hourly weather forecasts for temperature, humidity, and rainfall are crucial to support human thermal comfort (measured via the Temperature Humidity Index/THI) and productivity. This study develops an hourly weather prediction model using a two-layer Bidirectional Long Short-Term Memory (BiLSTM) architecture and Yeo–Johnson transformation to address zero-inflation in rainfall data. Hourly historical data for Jakarta (January 1, 2021–December 31, 2023) from the Open-Meteo API was processed through cleaning, interpolation, and normalization (Yeo–Johnson + Min-Max Scaling). The time series with a 24-hour lookback and a 1-hour prediction horizon was divided into training (80%), validation (10%), and testing (10%) sets. The BiLSTM model (64→128 neurons, dropout 0.1–0.2, L2 regularization ≈1e−4) was compiled with the Adam optimizer and Huber loss, then optimized via random search and early stopping. The results show that the Yeo–Johnson transformation reduces rainfall skewness from 12.56 to 1.17. The model achieved a denormalized RMSE of 0.8787 °C (NSE 0.892) for temperature, 4.8653% (NSE 0.875) for humidity, and 0.7463 mm (NSE 0.368) for rainfall. The real-time Android-based API implementation successfully provided hourly predictions for sports comfort recommendations. The findings demonstrate the effectiveness of the BiLSTM and Yeo–Johnson combination in tropical weather prediction, with recommendations for variable enrichment and data periods for further research.

Keywords*: BiLSTM; hourly weather prediction; Yeo–Johnson transformation; time series; tropical climate*