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Peramalan Probabilistik Multi-Horizon Saham Indonesia Menggunakan Fine-Tuned Lag-LLaMA dan Implementasi Dashboard Analisis Risiko
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INTISARI

Pasar saham Indonesia memiliki tingkat fluktuasi harga yang tinggi sehingga investor sering kesulitan memperkirakan potensi keuntungan dan kerugian secara akurat. Penelitian ini mengembangkan sistem peramalan harga saham berbasis kecerdasan artifisial yang dirancang untuk membantu investor ritel dan praktisi keuangan dalam mengambil keputusan investasi melalui prediksi rentang harga ke depan dan pengukuran tingkat risiko yang disajikan dengan bahasa sederhana. Model utama yang digunakan adalah Lag-LLaMA, sebuah *foundation model* berbasis *transformer* yang di-*fine-tune* (FT) pada dataset 691 saham Indonesia di Bursa Efek Indonesia (IDX) dengan riwayat minimal lima tahun (sumber Yahoo Finance, total sekitar 870 ribu observasi harian), dilengkapi metode *Retrieval-Augmented Forecasting* (RAF) sebagai augmentasi prediksi, serta diimplementasikan menjadi *dashboard* interaktif berbasis web. Enam model dibandingkan secara komprehensif, yaitu *Autoregressive Moving Average* ARMA(1,1), *Generalized Autoregressive Conditional Heteroskedasticity* (GARCH), Lag-LLaMA (*Base*), Lag-LLaMA (FT-IDX), Lag-LLaMA (FT)+RAF, dan Lag-LLaMA (*Base*)+RAF, menggunakan dua metrik evaluasi probabilistik utama: *Continuous Ranked Probability Score* (CRPS) untuk akurasi distribusi prediksi dan uji Kupiec *Proportion of Failures* (POF) untuk kalibrasi *Value-at-Risk* (VaR), pada 10 saham *blue-chip* IDX selama 252 hari perdagangan (2.520 peramalan per model). Hasil eksperimen menunjukkan Lag-LLaMA (FT-IDX) menempati peringkat pertama dengan nilai CRPS 0,01458 (perbaikan 6,3% dibanding model *base*); *fine-tuning* meningkatkan tingkat lulus uji Kupiec dari 10% menjadi 90%; dan varian RAF mencapai 100% lulus uji Kupiec berkat teknik *mixture distribution* yang mempertahankan lebar distribusi prediktif. *Fine-tuning* terpisah per-horizon (h=1, 5, 10, 21 hari) menghasilkan kualitas distribusi prediktif yang stabil dengan perbedaan CRPS antar-horizon hanya $\sim$1,2%. *Dashboard* yang dikembangkan menyajikan ringkasan prediksi dalam bahasa Indonesia, kalkulator dampak posisi (*position impact calculator*), serta modul Analisis Alokasi Portofolio berbasis *Conditional Value-at-Risk* (CVaR) pada 45 saham indeks *Liquid 45* (LQ45) yang menghasilkan *return* 11,51% dengan *Sharpe ratio* 0,370 (*vs benchmark* 5,83% / *Sharpe* 0,090). Sistem ini diharapkan membantu investor ritel dan praktisi pasar modal mengambil keputusan investasi yang lebih terukur melalui rentang prediksi harga, ukuran risiko terkalibrasi, dan rekomendasi alokasi portofolio.

Kata kunci: Lag-LLaMA, peramalan probabilistik, multi-horizon, saham Indonesia, analisis risiko, fine-tuning, dashboard

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ABSTRACT

The Indonesian stock market exhibits high price fluctuations that make it difficult for investors to estimate potential profits and losses accurately. This study develops an artificial-intelligence-based stock price forecasting system designed to assist retail investors and financial practitioners in making investment decisions through forward price-range predictions and risk measurements presented in plain language. The main model used is Lag-LLaMA, a *transformer*-based *foundation model* fine-tuned (FT) on a dataset of 691 stocks listed on the Indonesia Stock Exchange (IDX) with at least five years of history (sourced from Yahoo Finance, approximately 870 thousand daily observations in total), augmented with *Retrieval-Augmented Forecasting* (RAF), and implemented as an interactive web-based *dashboard*. Six models were comprehensively compared, namely *Autoregressive Moving Average* ARMA(1,1), *Generalized Autoregressive Conditional Heteroskedasticity* (GARCH), Lag-LLaMA (*Base*), Lag-LLaMA (FT-IDX), Lag-LLaMA (FT)+RAF, and Lag-LLaMA (*Base*)+RAF, using two main probabilistic evaluation metrics: the *Continuous Ranked Probability Score* (CRPS) for distribution accuracy and the Kupiec *Proportion of Failures* (POF) test for *Value-at-Risk* (VaR) calibration, on 10 IDX *blue-chip* stocks over 252 trading days (2,520 forecasts per model). The experimental results show that Lag-LLaMA (FT-IDX) ranks first with a CRPS of 0.01458 (a 6.3% improvement over the *base* model); fine-tuning increases the Kupiec pass rate from 10% to 90%; and the RAF variant achieves a perfect 100% Kupiec pass rate via a *mixture distribution* technique that preserves the predictive distribution width. Separate per-horizon fine-tuning (h=1, 5, 10, 21 days) yields stable predictive-distribution quality with cross-horizon CRPS differences of only $\sim$1.2%. The developed *dashboard* provides plain-language prediction summaries in Indonesian, a position impact calculator, and a Portfolio Allocation Analysis module based on *Conditional Value-at-Risk* (CVaR) on 45 *Liquid 45* (LQ45) index constituents, which achieves an 11.51% *return* with a *Sharpe ratio* of 0.370 (*vs* the *benchmark*'s 5.83% / *Sharpe* 0.090). The system is expected to help retail investors and capital market practitioners make more measured investment decisions through price prediction ranges, calibrated risk measures, and portfolio allocation recommendations.

Key words: Lag-LLaMA, probabilistic forecasting, multi-horizon, Indonesian stocks, risk analysis, fine-tuning, dashboard