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EVALUATION OF MACHINE LEARNING TECHNIQUES FOR FORECASTING MALAYSIA'S CONSUMER PRICE INDEX: A COMPARATIVE STUDY

(Penilaian Kaedah Pembelajaran Mesin untuk Meramalkan Indeks Harga Pengguna Malaysia: Satu Kajian Perbandingan)

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ABSTRACT

Ensuring price stability through accurate measurement and management of the Consumer Price Index (CPI) fosters a stable economic environment conducive to sustainable growth, investment, and employment. As a key economic indicator, the CPI provides a comprehensive assessment of inflation, purchasing power, and the cost of living, serving as an essential tool for policymakers, businesses, and consumers. In Malaysia, the CPI has steadily increased, reflecting a stable inflation rate. Recognizing the need for low and stable inflation, governments prioritize this goal to enhance economic prosperity and societal well-being. Accurate CPI forecasting is crucial for economic stability and informed financial decisions. Machine learning (ML) models have demonstrated significant potential for improving CPI forecasting accuracy over traditional methods. However, research specifically targeting CPI and inflation rate forecasting in Malaysia remains limited. This study evaluates the performance of five ML techniques: Autoregressive Integrated Moving Average (ARIMA), Geometric Brownian Motion (GBM), Gated Recurrent Unit (GRU), Long Short-Term Memory (LSTM), and Adaptive Neuro-Fuzzy Inference System (ANFIS), in predicting Malaysia's CPI. The models are assessed by comparing their prediction to actual CPI data from October 2022 to September 2023. Results indicate that GRU model performs best, exhibiting the lowest RMSE, MSE, and MAPE scores, thereby highlighting a consistent upward trend in inflation. This study encourages further exploration of Malaysia's inflation using advanced ML models or hybrid approaches to enhance forecasting accuracy.

Keywords: consumer price index forecasting; machine learning models; Malaysia inflation; economic prediction; GRU accuracy

ABSTRAK

Memastikan kestabilan harga melalui pengukuran dan pengurusan yang tepat terhadap Indeks Harga Pengguna (IHP) memupuk persekitaran ekonomi yang stabil dan sesuai untuk pertumbuhan, pelaburan, dan pekerjaan yang mampan. Sebagai penunjuk ekonomi utama, IHP memberikan penilaian menyeluruh mengenai inflasi, kuasa beli, dan kos sara hidup, menjadikannya alat penting untuk penggubal dasar, perniagaan, dan pengguna. Di Malaysia, IHP telah meningkat secara berterusan, mencerminkan kadar inflasi yang stabil. Menyedari keperluan untuk inflasi yang rendah dan stabil, kerajaan mengutamakan matlamat ini bagi meningkatkan kemakmuran ekonomi dan kesejahteraan masyarakat. Ramalan IHP yang tepat adalah penting untuk kestabilan ekonomi dan keputusan kewangan termaklum. Model pembelajaran mesin telah menunjukkan potensi yang ketara untuk meningkatkan ketepatan ramalan IHP berbanding kaedah tradisional. Namun, penyelidikan yang menumpukan khusus kepada ramalan IHP dan kadar inflasi di Malaysia masih terhad. Kajian ini menilai prestasi lima kaedah pembelajaran mesin: Purata Pergerakan Bersepadu Autoregresif (ARIMA), Pergerakan Brownian Geometri (GBM), Unit Berulang Berpagar (GRU), Memori Jangka Pendek Panjang (LSTM), dan Sistem Inferens Neuro-Kabur Adaptif (ANFIS), dalam meramalkan IHP di Malaysia. Model-model ini dinilai dengan membandingkan ramalan mereka dengan data IHP sebenar dari Oktober 2022 hingga September 2023. Hasil kajian menunjukkan bahawa Model

GRU menunjukkan prestasi terbaik, mempamerkan nilai RMSE, MSE, dan MAPE terendah, sekali gus menonjolkan trend menaik yang konsisten dalam inflasi. Kajian ini menggalakkan penerokaan selanjutnya terhadap inflasi Malaysia menggunakan model pembelajaran mesin lanjutan atau pendekatan hibrid untuk meningkatkan ketepatan ramalan.

Kata kunci: ramalan indeks harga pengguna; model pembelajaran mesin; inflasi Malaysia; ramalan ekonomi; ketepatan GRU

References

Almosova A. & Andresen N. 2023. Nonlinear inflation forecasting with recurrent neural networks. *Journal of Forecasting* **42**(2): 240-259.

Bernama. 2024. Malaysia's headline inflation to moderate to 2.5 pct in 2024 – World Bank. https://www.bernama.com/en/news.php?id=2284571 (16 May 2024).

Barkan O., Benchimol J., Caspi I., Cohen E., Hammer A. & Koenigstein N. 2023. Forecasting CPI inflation components with Hierarchical Recurrent Neural Networks. *International Journal of Forecasting* **39**(3): 1145-1162.

Castañeda J.C. & Chang R. 2023. Evaluating core inflation measures: A statistical inference approach. *Latin American Journal of Central Banking* **4**(4): 100099.

Del Rosario D. & Koh W.C. 2024. Malaysia's inflation is cooling, but beware of five potential disruptors. ASEAN+3 Macroeconomic Research Office. https://amro-asia.org/malaysias-inflation-is-cooling-but-beware-of-five-potential-disruptors (14 May 2024).

Department of Statistics Malaysia. 2024. Consumer Price Index. Ministry of Economy Department of Statistics Malaysia. https://www.dosm.gov.my/portal-main/release-content/consumer-price-index-march-2024 (14 May 2024).

Dergunov I., Meinerding C. & Schlag C. 2023. Extreme inflation and time-varying expected consumption growth. *Management Science* **69**(5): 2972-3002.

Graf B. 2020. Consumer Price Index Manual, 2020: Concepts and Methods. In *Consumer Price Index Manual, 2020*. International Monetary Fund.

Ibrahim S.N.I., Misiran M. & Laham M.F. 2021. Geometric fractional Brownian motion model for commodity market simulation. *Alexandria Engineering Journal* **60**(1): 955-962.

Islam R., Ghani A.B.A., Mahyudin E. & Manickam N. 2017. Determinants of factors that affecting inflation in Malaysia. *International Journal of Economics and Financial Issues* **7**(2): 355-364.

Ismail Z. 2022. Ukraine invasion and the impact on Malaysian economy. SinarDaily. https://www.sinardaily.my/article/172047/focus/money/ukraine-invasion-and-the-impact-on-malaysian-economy (15 May 2024).

Ivașcu C. 2023. Can machine learning models predict inflation? *Proceedings of the International Conference on Business Excellence* **17**(1): 1748-1756.

Jang J.S. 1993. ANFIS: adaptive-network-based fuzzy inference system. *IEEE transactions on systems, man, and cybernetics* **23**(3): 665-685.

Konarasinghe K.M.U.B. 2022. Modeling consumer price index of Malaysia: Application of exponential smoothers. *Journal of New Frontiers in Education and Social Sciences* **2**(1): 16–33.

Kumar A., Jamadar I., Goel R., Petluri R.C. & Feng W. 2024. Mathematically forecasting stock prices with Geometric Brownian Motion. *The North Carolina Journal of Mathematics and Statistics* **10**(1): 1-14.

Kuzu Y.E. & Alp S. 2022. Estimating the macroeconomic indicators using ARIMA and ANFIS methods. *Recent Advances in Science and Engineering* **2**(1): 6-17.

Medeiros M.C., Vasconcelos G.F.R., Veiga Á. & Zilberman E. 2019. Forecasting inflation in a data-rich environment: The benefits of machine learning methods. *Journal of Business & Economic Statistics* **39**(1): 98–119.

Ming O.K. 2022. MP SPEAKS | How Russian invasion of Ukraine will affect Malaysians. Malaysiakini. https://malaysiakini.com/columns/612520 (15 May 2024).

Moshiri S. & Cameron N. 2000. Neural network versus econometric models in forecasting inflation. *Journal of Forecasting* **19**(3): 201-217.

Neath A.A. & Cavanaugh J.E. 2012. The Bayesian information criterion: background, derivation, and applications. *WIREs Computational Statistics* **4**(2): 199-203.

Reddy K. & Clinton V. 2016. Simulating stock prices using Geometric Brownian Motion: Evidence from Australian companies. *Australasian Accounting, Business and Finance Journal* **10**(3): 23-47.

Samsudin H.B., Rozali N.A.M. & Mohamad D.N. 2016. Predicting the inflation rate in Malaysia using Sukuk term structure. *Journal of Quality Measurement and Analysis* **12**(1-2): 27-36.

Sari N.R., Wibawa A.P. & Mahmudy W.F. 2017. Comparison of ANFIS and NFS on inflation rate forecasting. In *5th International Conference on Electrical, Electronics and Information Engineering (ICEEIE)*, pp. 123-130.

Singh A., Shukla B. & Jos J. 2023. Comparative analysis of CPI prediction for India using statistical methods and neural networks. In *2nd International Conference for Innovation in Technology (INOCON)*, pp. 1-6.

Sitanggang E., Aulia J., Matondang K.A. & Indriani R. 2022. The effect of inflation on the rate of economic growth. *Asian Journal of Applied Business and Management* **1**(1): 1–10.

Srivastava A.K., Gupta H., Shyam H.S. & Gupta M. 2023. The linkage between inflation and economic growth: Evidence from India. *Journal of Information & Optimization Sciences* **44**(1): 25-40.

Sujatna Y., Karno A.S.B., Hastomo W., Yuningsih N., Arif D., Handayani S.S., Kardian A.R., Wardhani I.R. & Rere, L.M.R. 2023. Stacked LSTM-GRU long-term forecasting model for Indonesian Islamic Banks. *Knowledge Engineering and Data Science* **6**(2): 215-230.

Theoharidis A.F., Guillén D.A. & Lopes H. 2023. Deep learning models for inflation forecasting. *Applied Stochastic Models in Business and Industry* **39**(3): 447-470.

Vesović M.V. & Jovanović R.Ž. 2022. Adaptive neuro fuzzy inference systems in identification, modeling and control: The state-of-the-art. *Tehnika* **77**(4): 439-446.

Yang C. & Guo S. 2021. Inflation prediction method based on deep learning. *Computational Intelligence and Neuroscience* **2021**(1): 1071145.

Zahara S., Sugianto & Ilmiddaviq M.B. 2020. Consumer price index prediction using Long Short Term Memory (LSTM) based cloud computing. *Journal of Physics: Conference Series* **1456**(1): 012022.

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