Anticipating food price crises by reservoir computing and quantum reservoir computing

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Anticipating price crises in the market of agri-commodities is critical to guarantee both the sustainability of the food system and to ensure food security. However, this is not an easy task, since the problem implies analyzing small and very volatile time series, which are highly influenced by external factors.

In this work, we show that suitable reservoir computing (RC) algorithms can be developed that outperform both econometric models and complex neural networks approaches, by reducing the Mean Absolute Error and, more importantly, increasing the Market Direction Accuracy. For this purpose, the applicability of five variants of RC to forecast this market is explored, and their performance evaluated by comparing the results with those obtained with the standard LSTM and SARIMA benchmarks. We conclude that decomposing the time series and modeling each component with a separate RC is essential to successfully anticipate price trends, and that this method works even in the complex changing temporal scenario of the Covid-19 pandemic, when part of the data were collected.

Next, we develop a quantum reservoir computing approach to forecast the market. Quantum reservoir computing has proven highly efficient in the near-intermediate scale quantum era. In a previous paper [Phys. Rev. E **106**, 106, L043301 (2022)], an optimal criterion to design quantum reservoirs for 'static' tasks with time-independent data, was developed. In this work, we extend that analysis to 'temporal' tasks, forecasting the price time series of agri-commodities. Our results show that the design of the quantum reservoirs is crucial for the performance of the algorithm, specially when external regressor variables are not available, and that the resulting criterion provides optimal designs in terms of both performance and suitability of implementation in current quantum devices.

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