Quantum Reservoir Computing for Market Forecasting: An Application to Fight Food-Price Crises

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Our inspiration for this project comes from the *Pasqal Regenerative Quantum Challenge*, where the winning team used Quantum Reservoir Computing (QRC) to forecast renewable energy production. Their success reflects a broader trend in quantum machine learning: enhancing classical models by integrating quantum components to leverage properties like superposition and entanglement, which can reveal hidden patterns that traditional algorithms might miss.

Building on this idea, QRC emerges as a particularly promising technique. As a quantum-inspired extension of classical reservoir computing, it combines the rich dynamics of quantum systems with the simplicity of linear readouts to learn temporal patterns, making it a strong candidate for problems involving complex, high-dimensional, or dynamically evolving data, such as time series forecasting tasks.

In our project, we apply QRC to the domain of food price prediction, a problem with critical implications for sustainability. Specifically, we explore how QRC can be used to forecast tomato prices using real-world datasets. Accurate prediction of staple food prices is more than a technical challenge: it plays a central role in supporting food security, informing policy, and responding to the socioeconomic risks associated with market volatility. As highlighted by recent events in Nigeria, where over 35 percent food inflation led to deadly riots and food warehouse lootings, the inability to anticipate price shocks can have severe consequences for vulnerable populations. Forecasting thus becomes an essential tool to support the UN Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty), SDG 2 (Zero Hunger), SDG 12 (Responsible Consumption and Production), and SDG 13 (Climate Action).

The technical core of our project involves encoding a normalized time series input into quantum states and feeding them through a fixed, randomly initialized quantum circuit that acts as a reservoir. After quantum evolution, we extract features via measurement and use these as inputs to a simple Ridge regression model. This hybrid setup allows us to capture complex temporal dependencies without the need for backpropagation or deep learning. We benchmark our QRC implementation on a simple sinusoidal signal and later test it on a real tomato price dataset. We also compare its performance to that of classical methods.

What makes QRC particularly appealing is its ability to simulate memory and non-linear dynamics in a resource-efficient way. Entanglement enables the encoding of past input dependencies, while superposition allows high-dimensional feature mapping, both of which are difficult to achieve in classical reservoir computing without large computational costs.

In this presentation, we begin by introducing the sustainability motivation behind food price forecasting. We then explain the inner workings of quantum reservoir computing in an accessible, step-by-step way. Finally, we show the results of the model we implemented, share visualizations, and discuss both the potential and current limitations of QRC in this field.

By the end of our presentation, we hope to have not only shown the relevance of Quantum Reservoir Computing for sustainability-focused forecasting, but also sparked some intuition for when and how this approach might be useful; so that, if one day you encounter a fitting scenario, you'll have both the conceptual tools and inspiration to explore it further.

References

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