

Honours Project Proposal

Project Title: Forecasting Gold Prices Under Uncertainty Using Gaussian Processes

Student(s):

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Supervisor:

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Research Topic Outline:

Gold is a key financial asset with wide-ranging economic significance, often acting as a hedge against inflation and market volatility. However, accurately forecasting gold prices remains challenging due to their complex, non-linear, and highly uncertain nature. Traditional forecasting methods (e.g., ARIMA, linear regression) typically struggle to model the volatility, non-linearity, and structural regime changes observed in commodity markets.

This project proposes to employ Gaussian Processes (GPs) as a probabilistic machine learning framework for forecasting gold prices. GPs are particularly well-suited for this task due to their ability to model complex non-linear relationships, provide full uncertainty quantification, and handle small and noisy datasets efficiently. The project will focus on building and validating GP models that forecast future gold prices while providing a measure of prediction confidence.

Proposed Analysis:

- **Data Sources:**
 - Historical daily gold prices (e.g., from Yahoo Finance or Bloomberg)
 - Macro-economic indicators: USD index, inflation rates, interest rates, stock market volatility (VIX index), crude oil prices
 - Geopolitical risk indices (optional)
- **Methodology:**
 - Conduct a literature review on commodity forecasting and Gaussian Process models.
 - Preprocess datasets: cleaning, normalization, feature selection.
 - Construct baseline predictive models (e.g., ARIMA, Random Forest) for comparative analysis.
 - Develop a Gaussian Process Regression model:
 - Kernel selection and design (e.g., RBF, Matérn, or composite kernels)
 - Hyperparameter tuning via maximum likelihood estimation.
 - Model validation through rolling window forecasts and cross-validation.

- Compare the GP model's predictive performance with baseline models.
- Analyze the impact of uncertainty quantification in risk assessment and investment decision-making.

Timeline & Goals:

Timeline	Task
March – April	Conduct literature review; acquire and preprocess data
April – May	Build and evaluate baseline models
May – June	Implement Gaussian Process model; initial testing
July – August	Full model evaluation; sensitivity and uncertainty analysis
September	Draft dissertation; prepare poster presentation
October	Final edits; viva preparation

Division of Labour:

(If individual project: "Not Applicable.")

Deliverables:

- Proposal Write-up (Deliverable 1)
- Mid-year presentation (Deliverable 2)
- Final dissertation (Deliverable 4)
- Poster presentation (Deliverable 3)

Potential Challenges and Risks:

- Handling potential non-stationarity in gold price series.
- Computational cost for large GP models if dataset size grows substantially.
- Identifying the optimal kernel structure to accurately model complex relationships.

Conclusion:

This project aims to contribute to the financial forecasting literature by demonstrating the advantages of Gaussian Processes in modeling commodity prices, particularly gold, under uncertainty. By offering not only predictions but also measures of confidence, this approach will provide valuable insights for financial analysts, investors, and policymakers.

References (Preliminary):

- Rasmussen, C.E., & Williams, C.K.I. (2006). Gaussian Processes for Machine Learning.
- Bruno Dias et al. (2018). Gaussian Process Regression for Commodity Price Forecasting.

- Andrade & Galeano (2021). Dynamic Gaussian Processes for Financial Time Series.