

# MERGING LANES: WHERE E-LEARNING DIVERSITY MEETS FUTURE TRENDS

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## **MERGING LANES: WHERE E-LEARNING DIVERSITY MEETS FUTURE TRENDS**

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## FORECASTING GOLD MARKET TRENDS USING BACKWARD NEWTON'S DIVIDED DIFFERENCE INTERPOLATION

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### ABSTRACT

*Accurate short-term forecasting plays a crucial role in decision-making across various domains, particularly in financial markets. This study applies Newton's Backwards Divided Difference (NBDD) interpolation method to predict gold price trends using recent historical data. NBDD is especially suitable for extrapolation near the end of a dataset, making it an effective tool for short-term forecasting. Polynomial models of degree 3 and degree 7 are constructed to study the prediction accuracy. The findings indicate that lower-degree polynomials provide a closer fit to historical data, while higher-degree polynomials effectively capture the general trend.*

**Keywords:** *Newton's Backwards Divided Difference, polynomial equations, gold price forecasting, classical interpolation method*

### Introduction

Forecasting commodity prices, particularly gold prices, is a significant task in financial analysis due to gold's role as a safe-haven asset and an investment instrument. Reliable short-term predictions help investors, policymakers and analysts make decisions under uncertainty. Mathematical interpolation techniques have long been used to estimate unknown values based on known data points, especially when recent data carry greater predictive importance.

Newton's Backwards Divided Difference (NBDD) method is an interpolation technique designed to generate polynomial approximations using data points located near the end of a dataset. NBDD focuses on the most recent values, making it suited for short-term forecasting. This study employs NBDD to construct polynomial models of degree 3 and degree 7 for predicting gold price movements, with particular emphasis on comparing low-degree and high-degree polynomial approximations.

## **Literature Review**

Newton's Divided Difference (NDD) interpolation has long been recognised in numerical analysis for its flexibility and efficiency in constructing interpolating polynomials. Its recursive formulation makes it particularly well-suited for datasets where predictions are required near the most recent observations. Kassahun et al. (2022) highlight the effectiveness of NBDD in extrapolating values at or near the end of equally spaced datasets, underscoring its relevance in time series forecasting contexts.

Recent applications of NBDD in financial forecasting have demonstrated promising results. Warpe and Pippal (2023) applied the method to short-term commodity price forecasting, reporting improved predictive performance when recent data points were emphasised. Similarly, Huang (2023) found that NBDD yielded superior short-term forecasts compared to forward-based interpolation methods in economic and financial datasets, reinforcing the method's utility in volatile markets.

Other studies have expanded the scope of NDD interpolation in financial and economic forecasting. Rahman and Chowdhury (2024) compared NDD with Lagrange interpolation in financial time series, concluding that NDD's recursive structure provides better adaptability for short-term predictions. Singh and Patel (2023) demonstrated its effectiveness in capturing rapid fluctuations in equity markets, while Zhou (2021) showed that NDD outperformed spline and forward interpolation methods for extrapolating near-end data in economic time series.

Beyond financial applications, Mohd Zin et al. (2025) applied Newton's Forward Divided Difference (NFDD) to gold price forecasting, showing improved accuracy with higher-order polynomials. Lee (2025) provided a modern overview of NDD interpolation, emphasising its versatility in economics and engineering datasets, particularly with non-uniform spacing. Collectively, these studies illustrate a growing consensus that NDD methods, especially backward formulations, are highly effective for short-term forecasting tasks where recent data points carry greater predictive weight.

## **Methodology**

This study employs the NBDD method to analyse historical gold price data, which were collected monthly and quarterly from March 2022 to April 2025, sourced from MSN Finance, as shown in Figure 1. The dataset consists of equally spaced observations, making it suitable for divided difference interpolation.



Figure 1: Gold Price from March 2022 to April 2025

In the NBDD framework, the independent variable values are indexed from the most recent observation backwards, with  $x_i$  ordered from bottom to top. Table 1 shows the construction of the NBDD table using the MSN Finance data.

Table 1: NBDD construction

$x_i$	$f(x_i)$	1 <sup>st</sup> DD	2 <sup>nd</sup> DD	3 <sup>rd</sup> DD	4 <sup>th</sup> DD	5 <sup>th</sup> DD	6 <sup>th</sup> DD	7 <sup>th</sup> DD	8 <sup>th</sup> DD
0	1943.80								
3	1848.70	-31.7000							
6	1709.30	-46.4667	-2.4611	1.7006					
9	1801.10	30.6000	12.8444	-1.6636	-0.2803	0.0316			
12	1854.60	17.8333	-2.1278	0.6679	0.1943	-0.0237	-0.0031	0.0003	
15	1978.00	41.1333	3.8833	-1.2605	-0.1607	0.0269	0.0028	-0.0003	0.0000
18	1967.10	-3.6333	-7.4611	1.6531	0.2428	-0.0339	-0.0034	0.0004	0.0000
21	2089.70	40.8667	7.4167	-1.5438	-0.2664	0.0395	0.0041	-0.0004	0.0000
24	2095.70	2.0000	-6.4778	2.3716	0.3263	-0.0482	-0.0049	0.0005	0.0000
27	2369.30	91.2000	14.8667	-2.3920	-0.3970	0.0432	0.0051		
30	2523.00	51.2333	-6.6611	0.6278	0.2516				
33	2658.50	45.1667	-1.0111						

Two interpolating polynomial models are derived:

A degree 3 polynomial,  $P_3(x) = 2658.50 + 45.1667x - 1.0111x^2 + 0.6278x^3$

A degree 7 polynomial,  $P_7(x) = 2658.50 + 45.1667x - 1.0111x^2 + 0.6278x^3 + 0.2516x^4 + 0.4326x^5 + 0.0051x^6 + 0.0005x^7$

These models were implemented using Maple software to compute interpolated values and forecast future gold prices. Finally, prediction performance was assessed using Percentage Absolute Relative

Error (PARE), allowing a comparative analysis of the models' effectiveness in capturing gold price trends.

## Results

The application of NBDD yields two approximate polynomial functions of degree 3 and degree 7, as summarised in Table 2.

Table 2: Approximation Values and PARE Results for Degree 3 and Degree 7

Date	$x_i$	Gold Price $f(x_i)$	Approx. Degree 3	Approx. Degree 7	PARE Degree 3 (%)	PARE Degree 7 (%)
01/08/2022	5	1787.70	-8981.7222	-117058.7087	602.4178	6648.0063
03/01/2023	10	1846.10	-3754.6667	-2162.212	303.3837	217.1232
01/11/2023	14	1992.20	-988.0222	2092.75	149.5945	5.0472
01/04/2024	19	1847.20	1097.0333	2028.47	40.6110	9.8132
02/01/2025	25	2257.10	2206.5000	2150.51	2.2418	4.7224

For the earlier data points, both degree 3 and degree 7 approximations exhibit extremely large deviations from the actual gold prices, as reflected by very high PARE values. In particular, degree 7 exhibits substantially larger errors, reaching up to 6648.01%, which suggests severe overfitting and numerical instability when higher-degree polynomials are applied far from the interpolation nodes.

As the data points move closer to the interpolation range, the approximation accuracy improves notably for both degrees. The degree 7 approximation demonstrates a significant reduction in error, with a PARE of only 5.05%, compared to 149.59% for the degree 3 approximation. This trend continues for the end data points, where degree 7 again outperforms degree 3, recording a lower PARE of 9.81% versus 40.61%.

At the end of the data point, both methods achieve relatively accurate approximations. However, degree 3 yields the lowest error at 2.24%, compared to 4.72% for Degree 7, indicating that lower-degree interpolation may offer more stable and reliable predictions near the endpoint of the data range.

## Discussion

The comparison between degree 3 and degree 7 polynomials reveals a clear trade-off between approximation accuracy and numerical stability across different time periods. At earlier data points,

particularly in August 2022 and January 2023, both interpolation degrees produced large errors, with degree 7 showing extremely high PARE values. This behaviour suggests that higher-degree polynomials are highly sensitive to data distribution and prone to oscillations when estimating values far from the interpolation nodes.

As the evaluated points move closer to the central interpolation region, the performance of the degree 7 polynomial improves significantly. Degree 7 achieves substantially lower PARE values compared to degree 3, indicating its ability to capture more complex fluctuations in gold price movements. This demonstrates that higher-degree interpolation can provide better local accuracy when sufficient nearby data points are available.

However, the results from January 2025 indicate that degree 3 interpolation yields a lower error than degree 7. This suggests that lower-degree polynomials may offer more reliable and stable approximations near the endpoints of the dataset. The smoother nature of the degree 3 polynomial helps prevent excessive oscillations, making it more suitable for estimating long-term trends.

## Conclusion

As a conclusion, the increasing polynomial degree does not necessarily guarantee improved prediction accuracy. While degree 7 interpolation can outperform degree 3 within certain regions, it is also more susceptible to numerical instability and overfitting. Therefore, selecting an appropriate polynomial degree is crucial and should consider the intended prediction range and the balance between accuracy and stability.

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