

AN INTEGRATED APPROACH OF COMPUTATIONAL TECHNIQUES IN DATA ANALYSIS

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ABSTRACT:

Computational Technique is an inter related set of skills and practices for solving complex problems. Specially for Educators integrating computational thinking in Data Analysis, is a problem-solving approach and is a cognitive process designing accessible instructions. Collecting Digital promise, Raw data using statistical methods and tools transforming complex data into actionable knowledge in the form of Algorithm that computes value of Mathematical Function for every value of its argument. Focus of this paper is mainly on ensuring data is accurate, complete and consistent and preventing unauthorized changes, corruption or loss. Making it trust worthy for decision making, thorough checks for error implemented in this work can have a positive impact and gives highest quality in all areas. To investigate fluctuations pattern as well as predict short and long term changes some key developments are suggested as a part of this work. Applying Time series a statistical technique is used to analyze data points recorded at regular time intervals to monitor model and predict system behavior which improves forecasting accuracy.

Also established temporal relationships among its variables strengthens both Business and Research. This alignment contribution of Stochastic process based on previously observed values to predict future values, when the indexing data points are collected in the form of continuous data is an important research step.

In Forecasting data Moving Average Model Auto Regressive seasonal (SARIMA) application is addressed. This study proposes a novel approach to enhance numerous aspects of seasonal variates. Hence knowledge on seasonal variation discussed in this paper can immune data points available in business sectors.

Key words:

Time Series, Data Points, Computational Techniques, Forecasting, Evaluation Metrics, Statistical Methods, SARIMA Model.

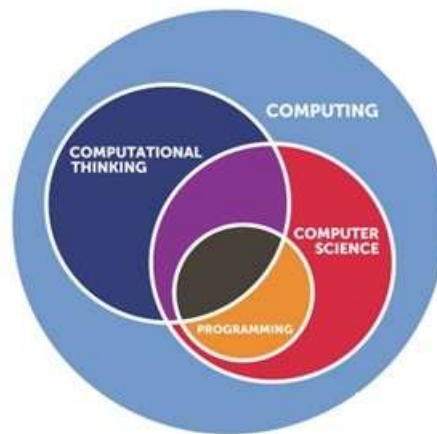
INTRODUCTION:

In field of statistics time series analysis has become more in use of various domains such as business, finance, energy, trend analysis wherever data collected as seasonal pattern study of seasonal variation help to make short term planning and impact greatly on every outcome of its activity. Even though many independent computational techniques have been acknowledged to perform better, our aim is to provide a reliable prediction formula applicable to current case study on gold prices in the market. Dealing with intricate characteristics of time series data such as seasonal patterns, Trends volatility at over all levels enables informed decision making. To delve deeper into the subject to study on time series data.

- a) Time series data refers to raw sequence of observations indexed in time order
 - b) Time series forecast uses data to make future projection employing models like SARIMA
 - c) Time series analysis includes seasonality, trends, and cycles meets, a requirement for sufficiently large sample size, and it is unique in its capacity to highlight cause effect relationship that involve time series data generally has 4 components acts as elements of data sets to establish and best relations fitted approach of model enquiries
- 1) **Trends:** Long- term increases, decreases, or stationary movement
 - 2) **Seasonality:** Predictable patterns at fixed intervals
 - 3) **Cycles:** Fluctuations without a constant Consistent period
 - 4) **Noise:** Residual unexplained Variability

ROLE OF DATA IN TIME SERIES ANALYSIS;

Every computations involves a Mathematical Equation which designs accessible instruction after gathering suitable data that fits in frame work.



A frame work for computational thinking integration

Core importance of collecting data is to organize into why, what how to solve useable formats and proceed to find hidden patterns, correlate into under standable visualization in the form of charts, graphs plotted with data points involves

- i.Health care-** identifying out breaks, personalizing treatment
- ii.Finance** – defecting fraud arriving risk
- iii.Marketing** – understand customer behavior, optimizing companies
- iv.Retail** – predicting trends, improve customer experiences
- v.Business intelligence** – focus on presenting current data for report and monitor.
- vi.Forecast** – predicting future out comes.

In recent months there have been many ups and downs in the international markets regarding gold price valuations which has shown Trend Analysis Pattern. Public anxiety also increase to notice and preserve it as a future investment. Even though many discomforts are felt in the form of threats, every investor maximum trades to purchase it. As a first choice gold investing in India is popular for hedging against inflation and port folio diversification with 5-10% also recommended. Top secure options include RBI – issued sovereign gold bonds offering good interest rate. Traditional physical gold remain popular but in curs storage and purity issues. Similarly gold ETFs for liquidity and digital gold for Convenience allows to buy gold gold acts as a safe heaven during market volatility and inflation.

Since gold has historically provided stable returns, with substantial gains in 2025-26 making it a reliable long term investment our work is inclined towards A series of data points indexed as a sequence taken at successive equally spaced points in discrete time data. Time series models will often make use of natural one way ordering of time so that values for a given period will be expressed as deriving in some way from past observed values.

SIGNIFICANCE OF EVALUATION METRICS:

A Case study on fluctuations of Gold Prices , sales data has been collected from a reputed Jewelry Market

Year	Spring	Summer	Monsoon	Winter
First	1890	1820	1830	1770
Second	1950	1980	2020	1970
Third	2320	2480	2580	2660
Fourth	2860	3000	3200	3350

a).Method of Moving Average

This method is superior than simple average method. It is based on the additive model of time series. It involves the following steps:

1. First of all, moving averages are computed from the original data. If data are given on monthly basis, then 12-monthly moving-averages and if quarterly data are given, then 4-quarterly moving averages are computer. These moving averages gives us trend values(T).
2. After this, using additive model from each original figure, corresponding trend value is deducted to arrive at short-term fluctuations. That is, $O - T = S + C + I$.
3. By making a separate table, short-term fluctuations for different months or quarterly periods are summed up and the sum is divided by the number of years and arithmetic averages are computed for different months or quarters.
4. General average is computed by summing up all the averages relating to the quarters or months. Hereafter, seasonal indices are computed by using the following formula:

$$Seasonal\ Variations = Quarterly\ Average - General\ Average$$

Table 1 of observations

Year	Values	4-Quarterly Totals	2-period Totals Centralized Totals	Quarterly Moving Average Trend (T)	Short-term Fluctuations(O-T)	Seasonal Variations (S)
2022	1890					-55.92
	1820					+68.07
	1830	→	14680	1835	-5	+44.08
		→	7370			

2023	1970	14900	1863	-93	-56.25
	7530				
	1950	15250	1906	44	-55.92
	7720				
2024	1980	15640	1955	25	+68.07
	7920				
	2020	16210	2026	-6	+44.08
	8290				
2025	1970	17080	2135	-165	-56.25
	8790				
	2320	18140	2688	-358	-55.92
	9350				
2025	2480	19390	2424	56	+68.07
	10040				
	2580	20620	2576	4	+44.08
	10580				
2025	2660	21680	2710	-50	+56.25
	11100				
	2860	22820	2853	7	-55.92
	11720				
2025	3000	24130	3016	-16	+68.07
	12410				
	3200	-	-	-	+44.08
	3350				-56.25

Calculation of Seasonal Variations

Table 2 of observations

Year	1 st Quater	2 nd Quater	3 rd Quater	4 th Quater
2022	-	-	-15	-93
2023	44	25	-6	-165
2024	-358	56	4	-50
2025	7	-16	-	-
Total	-307	265	-7	-308
Average	-102.33	21.66	-2.33	-102.66
Seasonal indices	-55.92	68.07	44.08	-56.25

General average: $(-102.33+21.66+(-2.33) +(-102.66)) / 4 = -46.415$

b. Ratio to Trend Method:

This is the most popular method of measuring seasonal variations. It is based on the multiplicative model of time series. The following steps are taken up under this method:

1. Obtain the trend values by the moving averages method. If given data are quarterly, then 4- quarterly moving averages are found out. As against it, if given data are monthly, then 12-monthly moving averages are computed.

2. After this, using multiplicative model each figure relating to the time-periods of original data is divided by the corresponding trend value and the quotient is multiplied by 100 to get ratio-to-moving average:

$$\text{Ratio to Moving Trend} = \frac{O}{T} \times 100 \quad \text{where, O = Original Value}$$

$$T = \text{Moving Average}$$

3. Next, arithmetic averages are computed after arranging the ratio-to-moving averages related to different periods in a separate table.

4. All averages relating to ratio-to-moving averages are summed up and treated to get a general average.

5. Finally, making the general average as base, the seasonal indices for quarters are found by the following formula:

$$\text{Seasonal Index} = \frac{\text{Quarterly Average}}{\text{General Average}} \times 100$$

Table 3 of observations

Year	Spring(Q1)	Summer(Q2)	Monsoon(Q3)	Winter(Q4)
2022	1890	1820	1830	1770
2023	1950	1980	2020	1970
2024	2320	2480	2580	2660
2025	2860	3000	3200	3350

Calculation of Quarterly Trend Values:

Consider 2022 trend value for the middle quarter i.e., half of the second and half of the third is 762.5. Quarterly increment is 199 so the trend value of second quarter is 762.5-99.5 i.e., 663 and for third quarter is 762.5+99.5 i.e., 862. Trend value of first quarter is 663-199=464, fourth quarter is 862+199=1061.

Quarterly Trend values

Table 4 of observations

Year	1 st Quater	2 nd Quater	3 rd Quater	4 th Quater
2022	464	663	862	1061
2023	1260.25	1459.25	1658.25	1857.25
2024	2056.5	2255.5	2454.5	2653.5
2025	2852.75	3051.75	3250.75	3449.75

The given values are to be expressed as the percentages of the corresponding trend values

Quarterly values as % of trend values

Table 5 of observations

year	1st	2nd	3rd	4 th
2022	407.32	274.50	212.29	166.82
2023	154.73	135.68	121.81	106.07
2024	112.81	109.95	105.11	100.99
2025	100.25	98.32	98.43	97.10
Total	775.11	618.45	537.64	470.98
Average	193.77	154.61	134.41	117.74
Seasonal indices	129.06	102.98	89.52	78.42

General average: $(193.77+154.61+134.41+117.74) / 4 = 150.13$

To estimate future values of gold prices seasonal indices by ratio to trend method are fitted in the form of trend setter straight line for SARIMA function with Auto regression programming model has been introduced

Now the Equation of Straight Line Trend $Y=a+bX$

Noticed $a = \sum Y/N, b = \sum XY/X^2$

$a = 9420/4 = 2355$

$b = 4777.5/6 = 796.25$

$Y = 2355 + 796.25X$

Yearly increment 796.25

Quarterly increment = $796.25/4 = 199$

Graphical Representation on

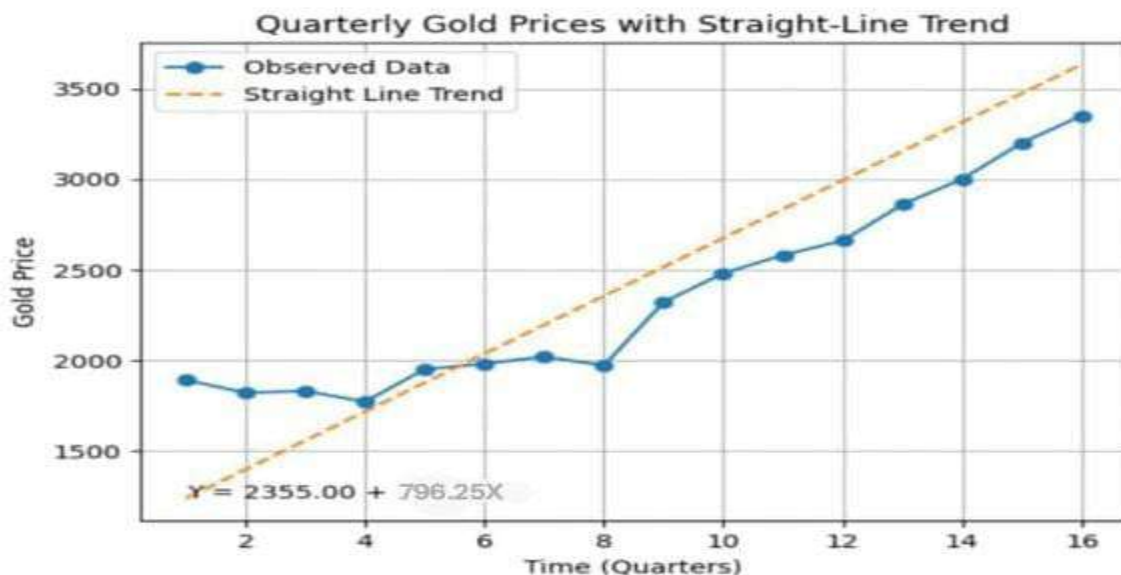


Table 6 of observations

Year	Yearly Total	Quarterly Total(Y)	Deviation from 2024(X)	XY	X ²	Trend Values Y _c
2022	7310	1827.5	-2	3655	4	762.5
2023	7920	1980	-1	-1980	1	1558.75
2024	10040	2510	0	0	0	2355
2025	12410	3102.5	1	3102.5	1	3151.25
SUM		9420	-2	4777.5	6	

Challenges on Time Series Analysis

While time series analysis has a lot to offer, it also comes with its own set of limitations and challenges, such as:

1. **Limited Scope:** Time series analysis is restricted to time-dependent data. It's not suitable for cross-sectional or purely categorical data.
2. **Noise Introduction:** Techniques like differencing can introduce additional noise into the data, which may obscure fundamental patterns or trends.
3. **Interpretation Challenges:** Some transformed or differenced values may need more intuitive meaning, making it easier to understand the real-world implications of the results.
4. **Generalization Issues:** Results may only sometimes be generalizable, primarily when the analysis is based on a single, isolated dataset or period.
5. **Model Complexity:** The choice of model can greatly influence the results, and selecting an inappropriate model can lead to unreliable or misleading conclusions.
6. **Non-Independence of Data:** Unlike other types of statistical analysis, time series data points are not always independent, which can introduce bias or error in the analysis.
7. **Data Availability:** Time series analysis often requires many data points for reliable results, and such data may not always be easily accessible or available

FUTURE EXPECTATIONS:

Experts’ opinion due to large scale profit booked by investors is considered one of the main reasons for the change in gold prices in international markets. In addition, the continuous change in US dollar exchange rate is a key trigger. Moreover, traders expect significant contributions and report that these are temporary variations only.

The banking sector noted that the long-term investment theme in gold remains strong. Continuous its trend, the current flow in gold prices is merely a small enhancement and is driven only for temporary circumstances. It also mention that investors have not lost confidence in gold.

On the other hand, there is some uncertainty among buyers of physical gold jewellery about whether gold prices will fall or raise in the future. However, those who purchase physical gold jewellery can ease the impact of rising prices by buying in small quantities even digitally. This is because, especially in Indian households, purchasing gold jewellery for weddings and other auspicious occasions is considered essential. Therefore, buying physical gold jewellery can help protect against future price increases.

From an investment perspective, experts say that for those who wish to invest in gold for the long term, investing through ETF funds is an easier method. By investing this way, there is potential to earn good long-term returns.

Meanwhile, although gold prices are following hike trend worldwide, experts believe that after this correction, investors may once again show interest in gold and silver. In particular, international banks such as Barclays have indicated this view. In a report, Barclays stated that as long as geopolitical tensions continue, investor interest in gold and silver investments is unlikely to diminish.

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