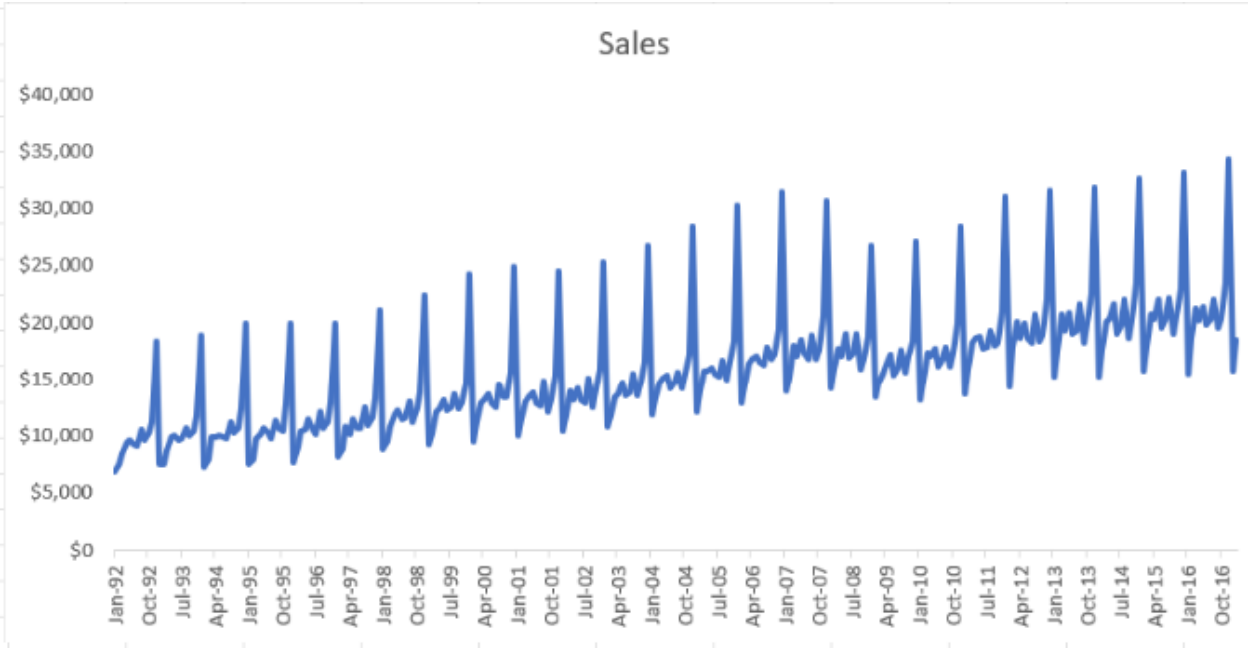
5.6 Time Series Analysis and Forecasting
By Mary Kane

Answers 5.6.

2. Observe the pattern of the line in your time series and answer the following questions:



o What characteristics does the pattern display (e.g., seasonality, stationarity)? Write a short paragraph to explain your answer.

The time series displays a clear upward trend, indicating that the sales have increased over time. The series also shows strong seasonality, with regularly repeating spikes that occur at consistent intervals, likely corresponding to peak retail periods such as holidays or the end-of-year sales.

The data are non-stationary because both the mean and the variance change over time.

o What advice might you give your client based on this time series. Why?

a. Plan inventory and staff around predictable seasonal spikes.

b. Use the low season period to train staff, system upgrades, review and negotiate suppliers' contracts, and run promotions to lift baseline sales.

c. There is a long-term business growth trend, budget and plan increasing capacity overtime (warehouse space, supplier volumes, technology)

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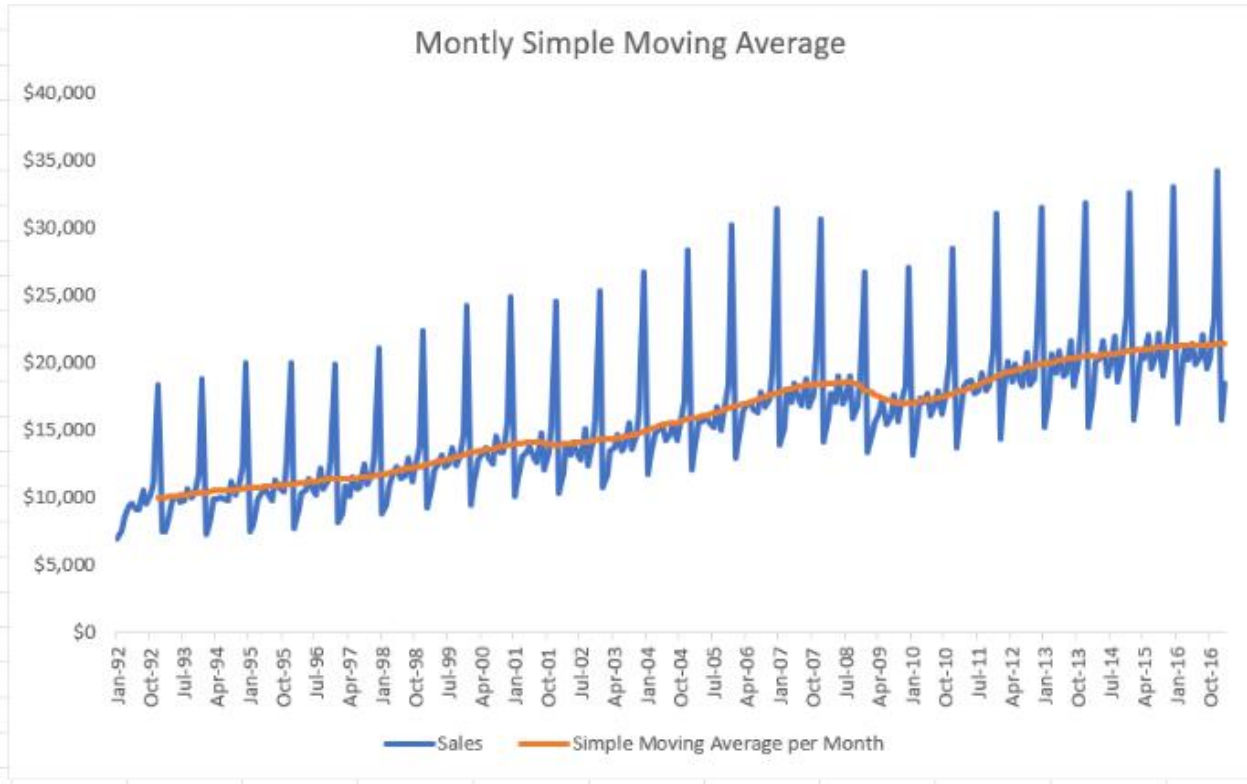
3. Create a simple moving average using the instructions in the Exercise.



A 12-period simple moving average was applied to the sales time series to smooth short-term seasonal fluctuations. The moving average reveals a clear upward trend in sales over time while reducing the impact of recurring seasonal spikes. This confirms that sales growth is sustained rather than driven solely by temporary seasonal effects.

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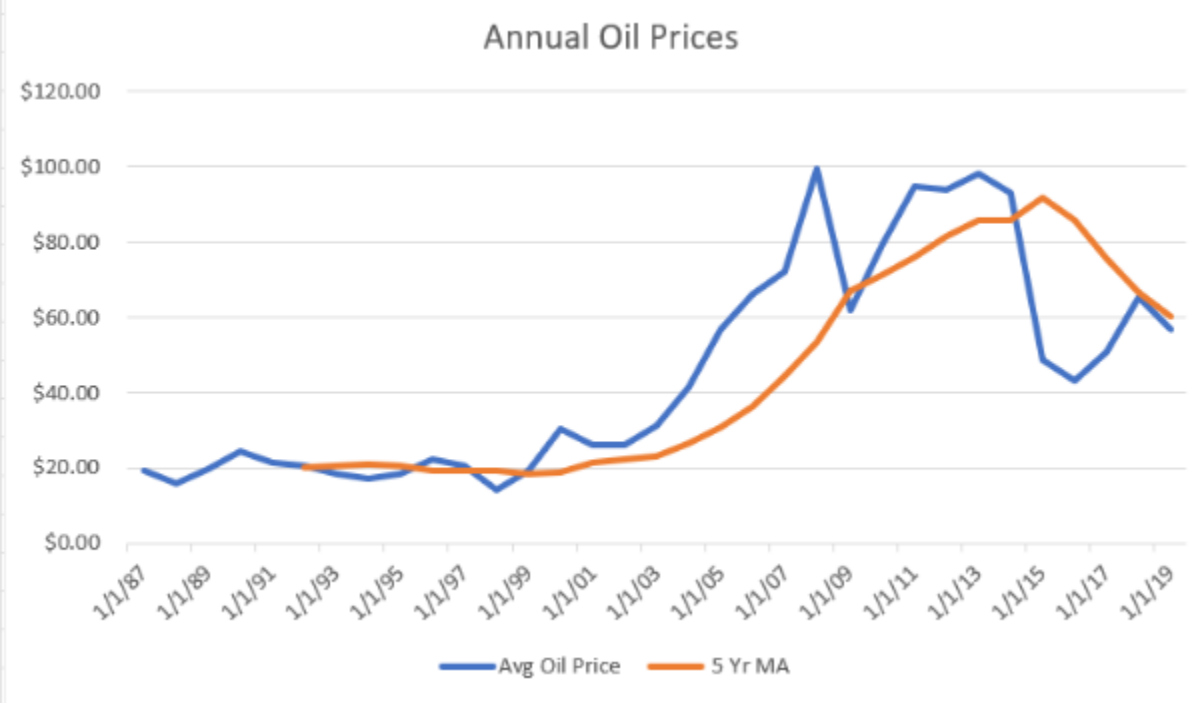
4. Observe the pattern/trend of the oil price line in relation to the five-year moving average line and answer the following questions:



o Is there a certain characteristic to the pattern and trend? Make sure to provide a short explanation for your answer.

The pattern and trend relative to five-year moving average shows high volatility. Periods where oil prices remain consistently above the moving average indicated sustained growth phases (mid 2000) and extended periods below the moving average signal prolonged downturns (decline 2014).

o Explain how the moving average affects oil price volatility and how it makes forecasting easier.

The five-year moving average reduces volatility by averaging prices over multiple years, smoothing the impact of sudden spikes and crashes in oil prices, resulting in a more stable trend line. It reveals a Long Term direction.

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5.a. This Exercise mainly looked at non-stationary time series. Briefly explain why you might convert a non-stationary time series into a stationary time series before applying a forecasting model. (If you need help answering this question, check out the Resources above.)

Converting a time series to stationarity ensures that the patterns a model learns in the past remain valid for the future, improving forecast reliability.

We convert a non-stationary time series into a stationary one because most forecasting models assume stationarity to produce reliable, stable predictions.

In a non-stationary series, key properties such as the mean, variance, and autocorrelation change over time, often due to trends or seasonality. When these properties are unstable, model parameters can shift, leading to biased estimates and poor forecasts. By transforming the series (for example, through differencing, detrending, or seasonal adjustment), you remove systematic patterns and make the underlying process more consistent over time.

A stationary time series allows forecasting models to:

- Learn stable relationships in the data
- Produce more accurate and interpretable predictions
- Better capture the true signal rather than trend-driven noise

5.b. There are lots of other forecasting models, such as the Autoregressive Integrated Moving Average (ARIMA) model, which you'll have an opportunity to explore using Python in Achievement 6.

o Do some research on the ARIMA model and one other model not covered in this Exercise; Facebook Prophet is one example that's become popular in recent years.

ARIMA Model (Autoregressive Integrated Moving Average) is a popular forecasting method used for time series that exhibit patterns like trend or autocorrelation but may not be strictly seasonal. ARIMA stands for Autoregressive Integrated Moving Average, which basically means it looks at past values of the series (autoregressive), differences between values (integrated), and past forecast errors (moving average) to make future predictions. While the internal calculations can be complex, the intuition is simple: ARIMA tries to use the structure in the historical data to estimate what comes next. It works especially well if the time series can be made stationary by differencing out trends or seasonality.

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ARIMA is widely used in economics and finance because it can handle a variety of real-world patterns in data.

👉 Learn more: https://otexts.com/fpp3/arima.html

Facebook Prophet

Facebook Prophet is a forecasting model developed by the data science team at Meta (Facebook) to make time series forecasting more user-friendly and better suited to messy real-world data. Prophet works by decomposing a series into interpretable components — trend, seasonality, and holidays/events — and is built to be robust to missing data and outliers. Unlike traditional models that need the data to be stationary or strictly structured, Prophet can automatically adjust for multiple seasonal cycles (e.g., weekly and yearly) and special events that might affect the series. It's especially useful when stakeholders want a model that's easy to tune, explain, and visualize, and when the focus is on long-term forecasting with trends and recurring patterns.

👉 Learn more: https://facebook.github.io/prophet/docs/quick_start.html

O Imagine you have to explain these models to a colleague who's unfamiliar with them. Write two short paragraphs (1 for each model) without going into the technical details. Include links to the resources you found during research.

Why These Are Useful Without Technical Jargon

- **ARIMA** forecasts are based on learning from the series' own history, making it ideal when the data is regular and relationships over time are consistent.
- **Prophet** makes forecasting accessible and interpretable, especially when the series