Time Series Fundamentals

A Guided-Discovery Adventure

Date: _____ **Name:** _____ **Roll No:** _____

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1. The First Mystery: When Does a Time Series Behave?

Look at this plot (Mystery Plot #1):

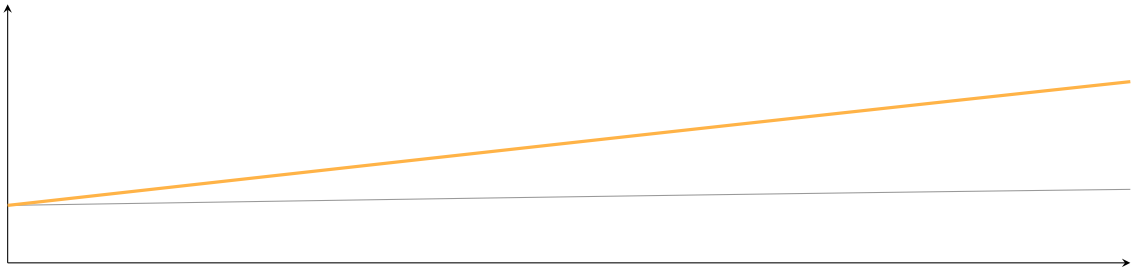

Figure 1: Something is changing... but what?

Q1. Stare at the graph. Where does the "average height" of the series seem to drift? Why might this drift make forecasting tricky?

A model expects the data's "personality" (mean, variance) to stay stable. When it shifts over time, the model keeps chasing a moving target. This stability is called **stationarity**.

2. The Difference Trick: Calming the Chaos

Here's the same series... and its first difference (Mystery Plot #2):

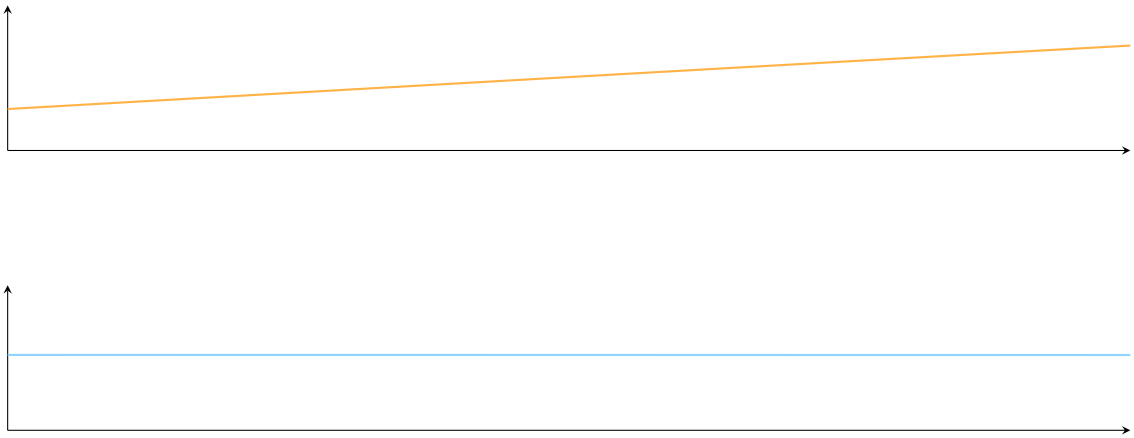

Figure 2: Top: drifting series. Bottom: its daily changes — surprisingly stable!

Q2. Why does the bottom plot "calm down"? What part of the original series disappeared after differencing?

Differencing removes slow movement (trend), leaving behind a stable, wigglier-but-predictable structure.

3. Why Logs Matter: When Big Numbers Swing Too Hard

Mystery Plot #3: A growing series and its log-transform

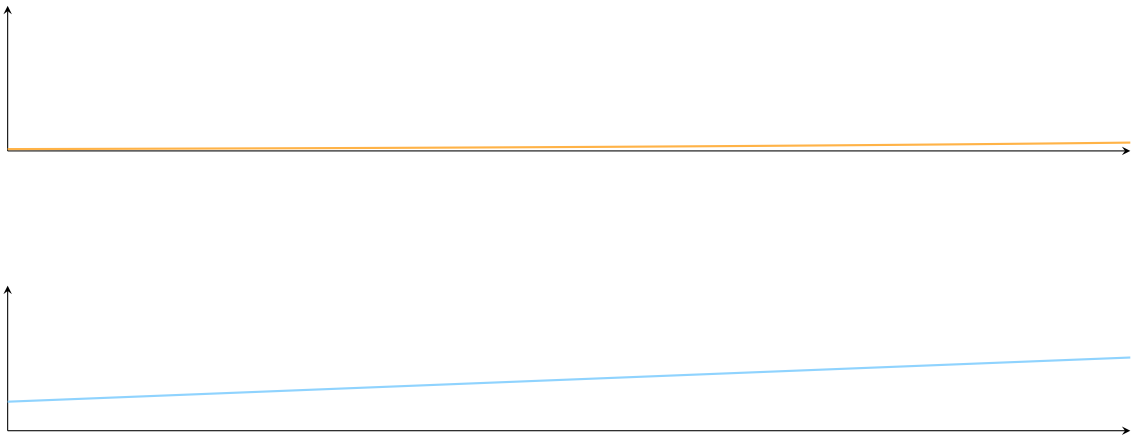

Figure 3: Log-transform "shrinks" big swings into manageable ones.

Q3. Why might taking logs help stabilize the "wildness" of the upper plot?

Logs compress large numbers more than small ones → variance becomes steadier.

4. ACF: How Far Back Does Memory Go?

Mystery Plot #4: The ACF bars

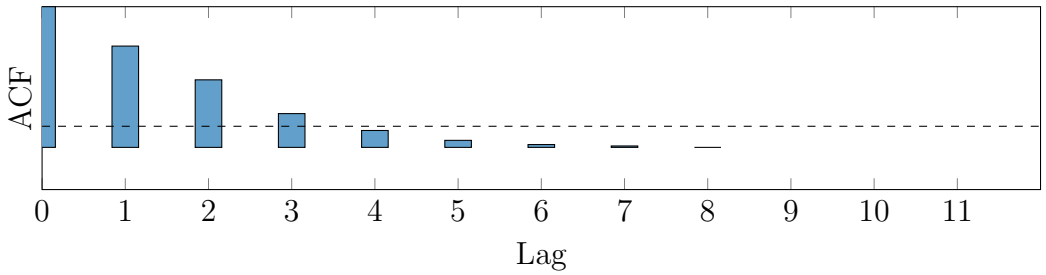

Figure 4: Bars show similarity with the past. How long does memory last here?

Q4. Which lag seems most important? Does memory fade quickly or slowly?

ACF shows *total* correlation with past values, including indirect influence.

5. PACF: Direct Influence or Indirect Echo?

Mystery Plot #5: The PACF

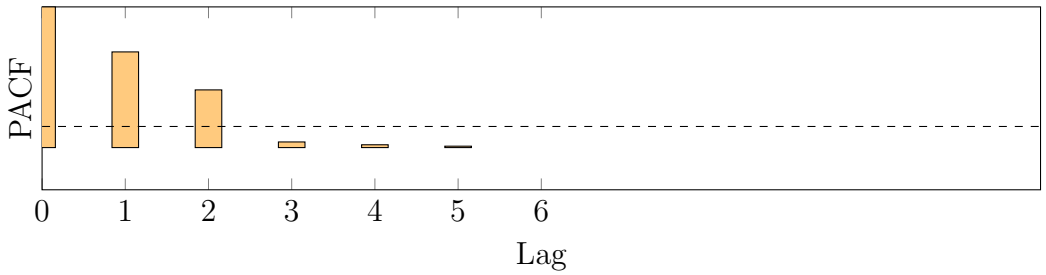

Figure 5: Which lags directly influence the present?

Q5. If lag 2 still matters *after removing* lag 1's effect, what does that say about the series structure?

PACF reveals *direct* effects, helping identify AR order.

6. AR or MA? Your Time Series Detective Rulebook

Observation	**Likely Model**
ACF cuts off after lag q	MA(q)
PACF cuts off after lag p	AR(p)
Both decay slowly	Non-stationary (difference!)

Q6. If ACF spikes at lags 1–3 then vanishes, which model whispers its name?

Q7. If PACF yells only at lag 1 then goes silent, what model might fit?

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7. Mini Puzzles: Solve the Mystery!

Puzzle A. The series looks like a person climbing stairs while wobbling. Which transformation fixes it?

Puzzle B. ACF shows a perfect spike at lag 3. What is it trying to tell you?

Puzzle C. PACF spikes at lag 2 only. Predict the AR order.

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8. Mini Case Study: Food Delivery Orders

A city's daily food orders over 18 months show an upward trend, strong weekly patterns, and high dependence on the previous day.

Q1. Stationarity check

What problem is present in the data? Name one simple transformation to fix it.

Q2. Memory in data

If correlation with past days fades gradually, what does this say about how far back the model should look?

Q3. Seasonality link

At which time gaps would you expect repeated correlation peaks, and and what part of the data causes them?
