ASSIGNMENT-04

NAME: P.PRASANNA SREE

REG.NO:192324309

Assignment: Time Series Visualization and Interpretation

1. Visualizing Time Series on Linear vs Log Axes

Given:
Monthly sales data

- Month 1 = 50 units
- Month 6 = 500 units
- Month 12 = 50,000 units

a) Linear y-axis plot and misrepresentation

When the data is plotted on a linear y-axis, the large value at Month 12 (50,000) dominates the chart. Early growth from 50 to 500 appears almost flat and insignificant, even though it represents a 10× increase. This visually understates early exponential growth and misleads interpretation.
Issue:

- Early changes are compressed
- Later values visually overpower the plot

b) Logarithmic y-axis with proportional ink

Using a logarithmic y-axis, equal vertical distances represent equal multiplicative changes.

- Growth from 50 → 500 → 50,000 appears proportional
- Exponential growth becomes visually linear
- Ink usage reflects true growth rates rather than absolute magnitudes

Benefit:
Log scaling preserves relative change and avoids visual distortion.

c) Moving average smoothing (window = 3)

A 3-point moving average smooths short-term fluctuations by averaging adjacent values.
Overlaying the smoothed line:

- Reduces noise
- Highlights the underlying growth trend
- Introduces slight phase lag, delaying visible changes

d) Sketch comparison and interpretation

Linear scale (misleading): | | | | |* +-------

----------------- Log scale (accurate): | | |

*

*

*

*

*

| *

|*

+------------------------

Conclusion:
The logarithmic plot is better for interpreting exponential growth, while the linear plot exaggerates late-stage values and hides early growth.

2. Multiple Time Series and Overplotting

Given:

Daily temperature readings for 15 cities over one year

a) Single plot and overplotting issues

Plotting all 15 time series on one chart causes:

- Heavy line overlap
- Color confusion
- Difficulty identifying individual city trends

This results in visual clutter and poor interpretability.

b) Reducing clutter using transparency and grouping

Applying:

- Alpha transparency (lighter lines)
- Color grouping (by region or climate zone)

helps reveal overlapping patterns and reduces dominance of any single series, but some clutter still remains.

c) Small multiples (faceting) redesign

Each city is plotted in a separate panel with a common scale.

- Eliminates overplotting
- Makes seasonal patterns clearly visible
- Enables easy city-to-city comparison

d) Comparison and justification

Design Strength

Single plot Compact but cluttered

Faceted plot Clear seasonal variation

Conclusion:
Small multiples communicate seasonal variation more effectively and are cognitively easier to interpret.

3. Trend, Seasonality, and Detrending

Given:
Monthly electricity consumption data for 10 years

a) STL decomposition

STL (Seasonal and Trend decomposition using Loess) separates the time series into:

- Trend: long-term movement
- Seasonality: repeating annual patterns
- Residual: random noise

b) Component interpretation

- Trend: Shows gradual increase due to population growth or industrialization
- Seasonality: Peaks during summer (cooling demand) and winter (heating demand)
- Residuals: Capture anomalies and irregular fluctuations

c) Detrending and visualization

Detrending removes the trend component, leaving:

Detrended Series = Original − Trend

The resulting plot oscillates around zero, emphasizing seasonal and irregular patterns.

d) Importance of detrending

Detrending:

- Reveals hidden cycles
- Improves stationarity
- Enhances pattern detection and forecasting accuracy

4. Visualizing Uncertainty in Trends

Given:
Weekly average heart-rate values with 95% confidence intervals

a) Mean trend with confidence bands

The visualization includes:

- A central line for mean heart rate
- Upper and lower bounds representing 95% confidence intervals

This clearly communicates estimation uncertainty.

b) Misleading design example

A misleading plot:

- Uses overly thick confidence bands
- Truncated y-axis exaggerates uncertainty
- Makes estimates appear unreliable

c) Improved design with transparent ribbons

Redesign using:

● Semi-transparent confidence ribbons ● Proportional ink ● Full y-axis scale

This maintains accuracy without visual exaggeration.

d) Impact on decision-making

Proper uncertainty visualization:

- Builds trust in data
- Prevents overreaction
- Supports informed medical decisions

Misleading uncertainty can cause unnecessary alarm or false confidence.

Overall Conclusion

Effective time series visualization requires:

- Appropriate axis scaling
- Managing overplotting
- Decomposition for clarity
- Honest representation of uncertainty

Good design improves insight, while poor design misleads interpretation.