

# Stationarity and Time Series Visualizations best practices

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## 1. Stationarity

### 1.1 Why Stationarity Matters

- Most classical models (AR, ARMA, ARIMA, SARIMA) assume stationarity.
- A non-stationary series can produce spurious correlations and unstable coefficients.
- Stationarity ensures that past patterns are predictive of future patterns.

### 1.2 How Practitioners test for Stationarity

- Visual check: Plot the series, rolling mean, and rolling standard deviation.
- Statistical tests:
  1. Augmented Dickey–Fuller (ADF)
  2. KPSS test (null = stationary)
  3. Phillips–Perron
- ACF/PACF plots to check for decay in autocorrelations.

### 1.3 How They fix Non-Stationarity

- Differencing (first, seasonal, or higher order).
- Log / sqrt transformations to stabilize variance.
- Detrending or removing seasonality.
- Using models that handle non-stationarity directly (Prophet, state-space models, machine learning).

### 1.4 Real-World Examples (with sources)

Sector	Visual Type	Why it Works better
Finance	Hyndman & Athanasopoulos (2018), <i>Forecasting: Principles and Practice</i>	Non-stationary stock price data was differenced before ARIMA modeling.
Energy demand forecasting	“Short-Term Electricity Load Forecasting” (IEEE 2017)	Seasonal differencing applied to make load stationary before SARIMA.
Climate	NOAA time series analysis blog	Used KPSS + differencing to remove seasonal trend before fitting AR models.

## 2. Visualization Best Practices

### 2.1 Why Plain Line Plots Fall Short

- They can hide seasonality, volatility, or missing data.
- They can be hard to interpret if the dataset is large or multi-variate.

### 2.2 Best Practices Found in Real Examples

Sector	Visual Type	Why it Works better
Finance (Bloomberg dashboards)	Candlestick charts + volume bars	Show open/high/low/close plus trading volume in one view, revealing volatility trends.
Healthcare (CDC COVID dashboard)	Rolling averages + shaded confidence bands	Reduces noise and shows uncertainty intervals, improving decision-making.

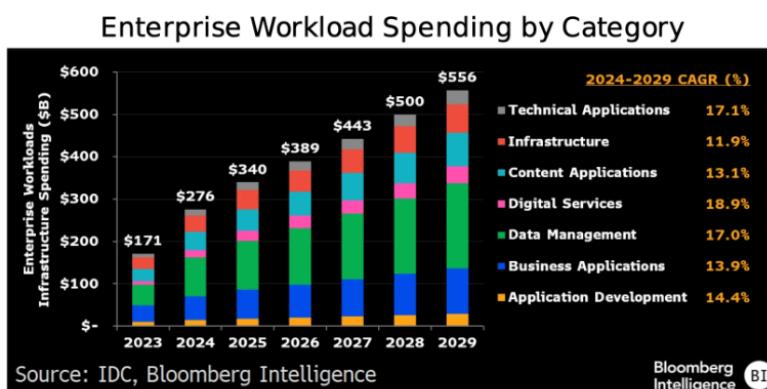
Climate (NASA GISS temperature anomalies)	Anomaly plots + trend lines + smoothing	Highlights deviations from baseline and long-term warming trends clearly.
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## 2.2 Examples of Useful Insights (with citations):

- <https://finance.yahoo.com/>



- <https://www.bloomberg.com/>



### Annual CO<sub>2</sub> emissions by world region

Emissions from fossil fuels and industry are included, but not land-use change emissions. International aviation and shipping are included as separate entities, as they are not included in any country's emissions.

Our World in Data

