

Online Quiz

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1 Monthly Catfish Sales Time Series Analysis

(a) ACF and PACF Analysis

The ACF and PACF plots for the monthly catfish sales series (2000–2010) show:

- ACF slowly decays, indicating nonstationarity.
- PACF has several significant lags, especially around lag 4.
- Seasonal lag 12 spike may exist due to monthly seasonality.

These patterns support the need for differencing and an ARIMA structure.

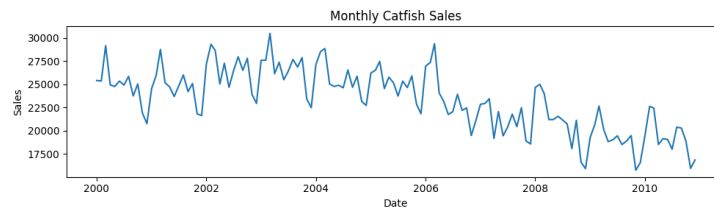


Figure 1: Catfish sales.

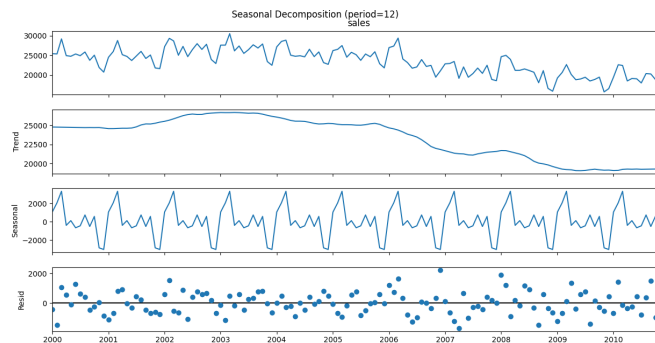


Figure 2: ACF and PACF of catfish sales.

(b) Training and Testing Split

- Training: Jan 2000 – Dec 2009
- Testing: Jan 2010 – Dec 2010

(c) ARIMA Model Identification and Diagnostics

The best model fitted to the training set was:

$$\text{ARIMA}(4, 1, 4)$$

Residual analysis:

- Residual ACF shows no significant correlations.
- Ljung–Box (lag 10): $p = 0.756 > 0.05 \rightarrow$ residuals are white noise.
- Residuals fluctuate randomly around zero.

Conclusion: The ARIMA(4,1,4) model is adequate.

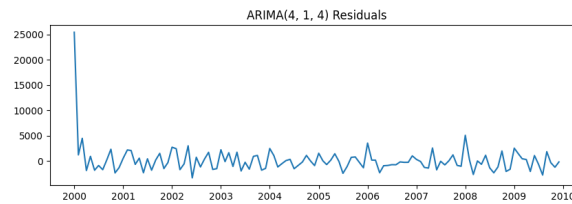


Figure 3: ARIMA residual plot.

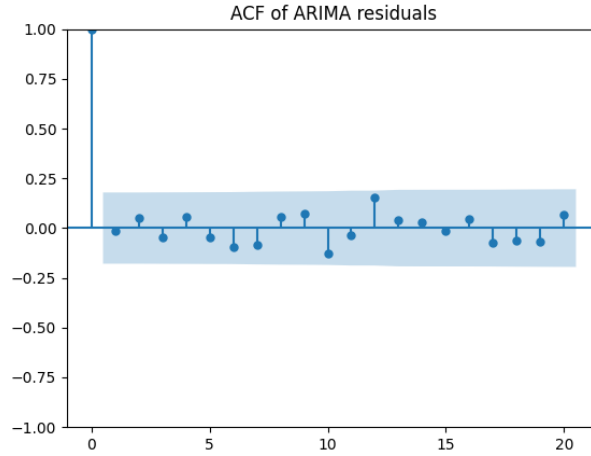


Figure 4: ACF of ARIMA residuals.

(d) Alternative ARMA Model

The best ARMA-only model was:

$$\text{ARMA}(4, 0, 4)$$

Diagnostics:

- Ljung–Box p-value: $0.012 < 0.05 \rightarrow$ remaining autocorrelation.

Conclusion: ARMA is inadequate compared to ARIMA.

(e) Forecast Accuracy (Testing Phase)

$$\text{RMSE}_{\text{ARIMA}} = 1683.12, \quad \text{RMSE}_{\text{ARMA}} = 1909.90.$$

ARIMA(4,1,4) performed better.

Forecast accuracy must be evaluated on the testing set because it measures true out-of-sample performance.

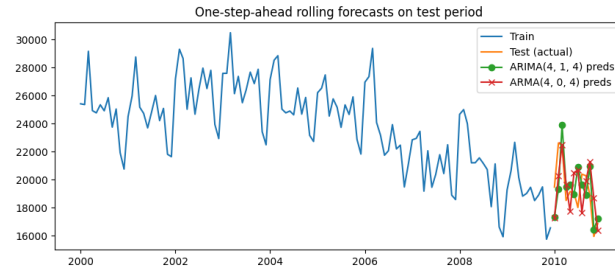


Figure 5: One-step-ahead forecasts for the 2010 testing set.

(f) Final Forecasting

The $\text{ARIMA}(4,1,4)$ model was re-fitted on the full dataset (2000–2010) and used to forecast 12 months ahead (2011).

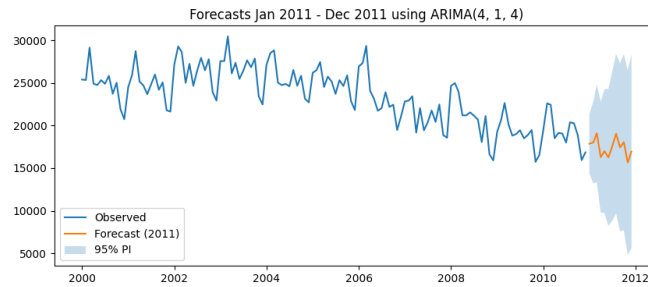


Figure 6: Final 12-month forecast with 95% prediction intervals.

2 Monthly Electric Consumption Time Series

(a) SARIMA Model Fitting

The model fitted to the training period (1986–2016) was:

$$\text{SARIMA}(1, 1, 0)(1, 1, 0)_{12}$$

Key findings:

- $\text{AR}(1) = -0.1854$ (significant)
- Seasonal $\text{AR}(12) = -0.3803$ (significant)
- Residual tests indicate remaining autocorrelation:

$$p_{12} = 0.000021, \quad p_{24} = 0.000246$$

- Residuals are not perfectly normal ($\text{JB} = 9.26, p = 0.01$)

Conclusion: Model captures trend and seasonality but has residual issues.

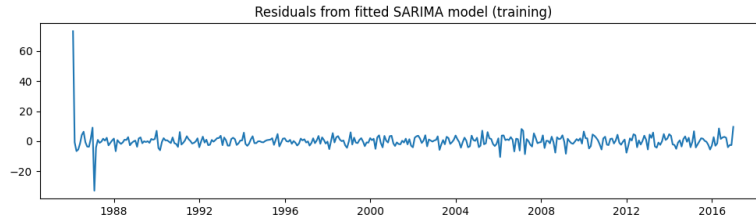


Figure 7: Residual from fitted SARIMA.

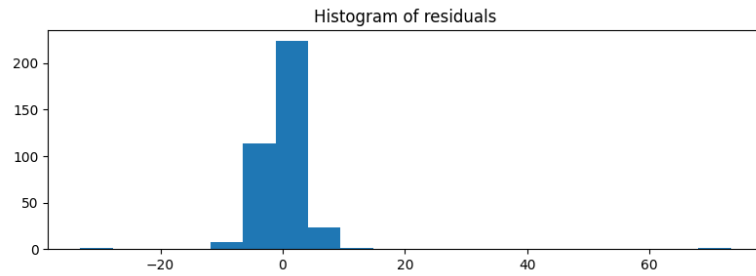


Figure 8: Histogram of residuals.

(b) Rolling One-Step-Ahead Forecasting (2017)

Rolling forecasts were produced for each month of 2017 by:

1. Re-fitting the SARIMA model with all available data up to that month.
2. Forecasting the next month.
3. Adding the true value and repeating.

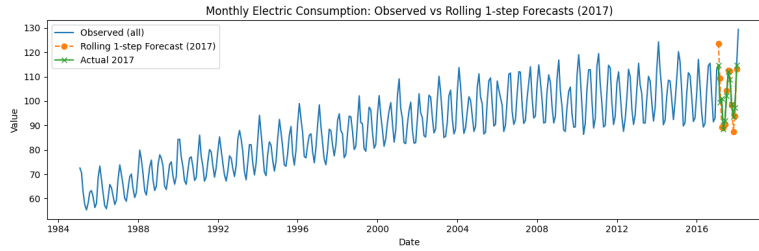


Figure 9: Rolling one-step-ahead forecast for 2017.

(c) Forecast Accuracy

Results:

$$\text{MAPE} = 4.0892\%, \quad \text{RMSE} = 5.6519$$

Interpretation:

- MAPE indicates excellent relative accuracy.
- RMSE measures absolute error in the original units.
- MAPE is more interpretable; RMSE penalizes large errors more strongly.

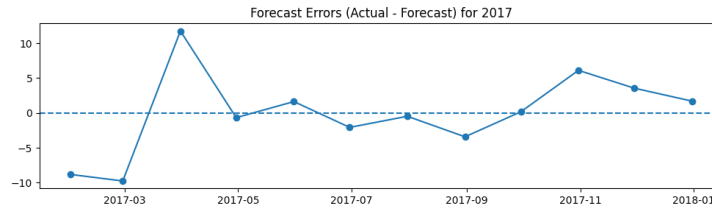


Figure 10: Actual vs forecast electric consumption in 2017.