Forecasting 301 – Homework #5

Topic: ARIMA Forecasting (Python Coding)

Due Date: April 30, 2025

Overview

In this assignment you will build, diagnose, and evaluate ARIMA/SARIMA models on a real-world time-series dataset.

• **Deliverable:** One Jupyter notebook (.ipynb) containing Markdown explanations, Python code, charts, and answers.
• **Dataset:** *Monthly Airline Passengers 1949-1960* ("AirPassengers" — available via `statsmodels.api`).
• **Grading:** See the detailed rubric on the following pages (100 pts total).

Assignment Questions

1 Explore & Visualize

- a. Load the dataset into a pandas Series indexed by `PeriodIndex`.
- b. Plot the series; comment on trend, seasonality, and variance.
- c. Plot ACF & PACF of the original and first-differenced series.

2 Decompose & Difference

- a. Apply STL or classical seasonal decomposition.
- b. Based on plots, decide on non-seasonal differencing **d** and seasonal differencing **D**.
- c. Justify each choice with visuals/statistics (ADF, KPSS, etc.).

3 Model Selection

- a. Hold out the last 24 months as a test set.
- b. Use `pmdarima.auto_arima` *or* manual grid search to select the best SARIMA model by AIC.
- c. Perform residual diagnostics (Ljung-Box, QQ plot) and interpret the results.

4 Forecast & Evaluate

- a. Produce a 12-step-ahead forecast with 80 % & 95 % prediction intervals.
- b. Plot forecasts vs actuals.
- c. Report RMSE and MAPE on the hold-out set.
- d. Briefly discuss at least one way to improve the model.

Detailed Grading Rubric (100 pts)

Problem 1: Explore & Visualize — 25 pts

- 5 pts — Load dataset with proper PeriodIndex
- 5 pts — Clear time-series plot with labeled axes
- 8 pts — Accurate discussion of trend & seasonality
- 4 pts — Discussion of variance/stationarity
- 3 pts — ACF & PACF plots and correct initial interpretation

Problem 2: Decompose & Difference — 20 pts

- 5 pts — STL or classical decomposition executed
- 5 pts — Justified choice of non-seasonal differencing d
- 5 pts — Justified choice of seasonal differencing D
- 5 pts — Evidence (plots/stats) supporting choices

Problem 3: Model Selection — 25 pts

- 5 pts — Hold-out split: last 24 months
- 5 pts — Model search (auto_arima or manual) documented
- 5 pts — Model chosen using information criteria (AIC/BIC)
- 5 pts — Residual diagnostics performed (Ljung-Box, QQ)
- 5 pts — Interpretation of coefficients & diagnostics

Problem 4: Forecast & Evaluate — 30 pts

- 6 pts — 12-step forecast with 80 % & 95 % intervals
- 6 pts — Plot forecasts vs actuals, clearly labeled
- 6 pts — Compute RMSE and MAPE on hold-out set
- 6 pts — Baseline comparison (e.g., seasonal naïve) discussed
- 6 pts — Thoughtful discussion of limitations & improvements

Scoring Guidance

• 90-100 pts: Exemplary execution, insightful narrative, professional presentation.

• 80-89 pts: Solid analysis with minor issues or omissions.

• 70-79 pts: Meets basic requirements; notable gaps in analysis or discussion.

• < 70 pts: Missing core analyses or significant conceptual errors.