Time-Series Forecasting of Nigeria's GDP Using ARIMA Model: An Analysis of Economic Growth Trends from 1990 to 2023

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# Introduction

This project aims to forecast the future Gross Domestic Product (GDP) of Nigeria using the ARIMA (AutoRegressive Integrated Moving Average) model. The analysis will focus on Nigeria's GDP data from 1990 to 2023 to identify trends, seasonal patterns, and the underlying structure of Nigeria's economic growth. The goal is to predict future GDP values over the next decade (2024-2030) and provide insights into the country's economic trajectory.

# Key Objectives

1. Collect and Clean GDP Data:  
- Obtain historical GDP data for Nigeria (both Nominal GDP and Real GDP) from credible sources like the World Bank, IMF, or Nigeria’s National Bureau of Statistics.  
- Perform data preprocessing to handle missing values, remove outliers, and convert the data into a format suitable for time-series analysis.  
  
2. Explore Time-Series Data:  
- Perform Exploratory Data Analysis (EDA) to visualize the data, identify any trends, seasonality, or cyclic behavior in Nigeria’s economic growth.  
- Use plots like line charts, histograms, and ACF/PACF plots to understand the characteristics of the GDP data.  
  
3. Stationarity Testing and Differencing:  
- Use the Augmented Dickey-Fuller (ADF) test to check if the data is stationary. If the data is non-stationary, apply differencing (i.e., subtracting previous values from the current values) to achieve stationarity.  
  
4. ARIMA Model Development:  
- Identify the best-fit ARIMA model using the ACF (Autocorrelation Function) and PACF (Partial Autocorrelation Function) plots to determine suitable values for the AR (p), I (d), and MA (q) parameters.  
- Fit the ARIMA model to the data and train it on historical GDP data from 1990 to 2023.  
  
5. Model Evaluation and Diagnostics:  
- Evaluate the model using performance metrics such as Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and Mean Absolute Percentage Error (MAPE).  
- Perform diagnostic checks by analyzing the residuals (errors) of the ARIMA model to ensure they resemble white noise (no autocorrelation).  
  
6. Forecasting:  
- Use the trained ARIMA model to forecast Nigeria’s GDP for the next 5-10 years (2024-2030).  
- Compare the predicted GDP values with actual historical data (if available) for validation.  
  
7. Visualization and Reporting:  
- Create visualizations to display the historical and forecasted GDP values.  
- Prepare a comprehensive report explaining the findings, including insights on Nigeria’s economic growth trends and potential future economic scenarios.

# Methodologies

1. ARIMA Model:  
- AR (AutoRegressive): Models the relationship between an observation and a number of lagged observations.  
- I (Integrated): Ensures the data is stationary by differencing it.  
- MA (Moving Average): Models the relationship between an observation and the residual errors from a moving average model applied to lagged observations.  
  
2. Data Preprocessing:  
- Ensure data is cleaned and correctly formatted (date and numeric columns).  
- Apply necessary transformations (e.g., log transformations) if the data exhibits exponential growth.  
  
3. Modeling Process:  
- Step 1: Plot the data and check for trends, seasonality, and stationarity.  
- Step 2: Perform the ADF test to determine stationarity and difference the data if needed.  
- Step 3: Use ACF and PACF plots to determine the best values for the AR (p), I (d), and MA (q) parameters.  
- Step 4: Fit the ARIMA model and check model diagnostics to ensure residuals are white noise.  
- Step 5: Forecast future GDP values and visualize them.

# Expected Outcomes

1. Forecasting Future GDP:  
- The ARIMA model will predict the GDP of Nigeria for the next decade (2024-2030), allowing policymakers and analysts to anticipate future economic performance.  
  
2. Insight into Economic Trends:  
- By modeling and analyzing the data, you will uncover long-term trends in Nigeria's economic growth, which may be influenced by factors such as oil prices, inflation, and government policies.  
  
3. Model Evaluation:  
- You will compare the accuracy of the ARIMA model's forecasts with actual GDP data (if available) to assess the reliability of the model for economic forecasting.  
  
4. Actionable Insights:  
- The project will provide insights on whether Nigeria’s GDP growth is expected to increase or slow down in the future, which could help guide economic policy and investment decisions.

# Tools and Technologies

1. Programming Language: Python  
2. Libraries:  
- ARIMA: statsmodels  
- Data Handling: pandas, numpy  
- Visualization: matplotlib, seaborn  
- Modeling and Evaluation: statsmodels, scikit-learn  
- Time Series Analysis: statsmodels.tsa for ARIMA and diagnostic checks  
3. Data Sources:  
- World Bank: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD  
- IMF: https://www.imf.org/en/Data  
- National Bureau of Statistics (Nigeria): https://nigerianstat.gov.ng/

# Possible Extensions

1. Model Comparison:  
- Compare the performance of ARIMA with other models like SARIMA (Seasonal ARIMA) or machine learning models (e.g., LSTM or XGBoost) to see which model better captures Nigeria’s economic trends.  
  
2. Incorporate Exogenous Variables:  
- Include additional factors (e.g., inflation rate, oil price fluctuations, foreign direct investment) to improve the forecast accuracy.  
  
3. Real-Time Forecasting:  
- Create an interactive dashboard that updates GDP forecasts in real-time as new data becomes available.

# Conclusion

This project provides a structured approach to forecasting Nigeria's GDP using the ARIMA model. By analyzing historical data, fitting an ARIMA model, and making predictions for the future, you will not only gain insight into Nigeria’s economic trends but also understand how ARIMA can be applied to real-world time-series forecasting problems.