```python
# Task 3: Time Series Analysis - Air Passengers Dataset

# 1. Import Libraries
import pandas as pd
import numpy as np
import matplotlib.pyplot as plt
from statsmodels.tsa.seasonal import seasonal_decompose
from statsmodels.tsa.arima.model import ARIMA
from sklearn.metrics import mean_squared_error

# 2. Load Dataset (directly from GitHub raw link)
url = "https://raw.githubusercontent.com/jbrownlee/Datasets/master/airline-passengers.csv"
df = pd.read_csv(url, parse_dates=['Month'], index_col='Month')
df.rename(columns={'Passengers': 'Passengers'}, inplace=True)

print("Data Head:\n", df.head())

# 3. Resample to Quarterly (optional example)
quarterly = df.resample('Q').mean()
print("\nQuarterly Data Head:\n", quarterly.head())

# 4. Trend/Seasonality Decomposition
decomposition = seasonal_decompose(df['Passengers'], model='multiplicative') # Decompose only the 'Passengers' column
fig = decomposition.plot()
fig.set_size_inches(12, 8)
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plt.show()


# 5. Moving Averages
df['MA_6'] = df['Passengers'].rolling(window=6).mean()
df['MA_12'] = df['Passengers'].rolling(window=12).mean()


plt.figure(figsize=(12, 6))
plt.plot(df['Passengers'], label='Actual')
plt.plot(df['MA_6'], label='6-Month MA', linestyle='--')
plt.plot(df['MA_12'], label='12-Month MA', color='red')
plt.legend()
plt.title('Moving Averages Smoothing')
plt.show()


# 6. ARIMA Forecasting
# Split dataset
train = df.iloc[:-12]
test = df.iloc[-12:]


# Fit SARIMA model
model = ARIMA(train['Passengers'], order=(2,1,1), seasonal_order=(1,1,1,12)) # Fit ARIMA on 'Passengers' column
result = model.fit()


# Forecast
forecast = result.forecast(steps=12)
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rmse = np.sqrt(mean_squared_error(test['Passengers'], forecast)) # Calculate RMSE using
'Passengers' column of test set

print(f"RMSE: {rmse:.1f} passengers")


# Plot forecast vs actual

plt.figure(figsize=(12,6))

plt.plot(train.index, train['Passengers'], label='Training Data')

plt.plot(test.index, test['Passengers'], label='Actual', color='blue')

plt.plot(test.index, forecast, label='Forecast', color='red', linestyle='--')

plt.fill_between(test.index, forecast*0.8, forecast*1.2, alpha=0.2, color='gray')

plt.title(f"ARIMA Forecast (RMSE={rmse:.1f})")

plt.legend()

plt.show()
```

Output:

```
Data Head:
           Passengers
Month
1949-01-01        112
1949-02-01        118
1949-03-01        132
1949-04-01        129
1949-05-01        121

Quarterly Data Head:
           Passengers
Month
1949-03-31  120.666667
1949-06-30  128.333333
1949-09-30  144.000000
1949-12-31  113.666667
1950-03-31  127.333333
/tmp/ipython-input-1356391056.py:19: FutureWarning: 'Q' is deprecated and will be removed in a future version, please use 'QE' instead.
  quarterly = df.resample('Q').mean()
```
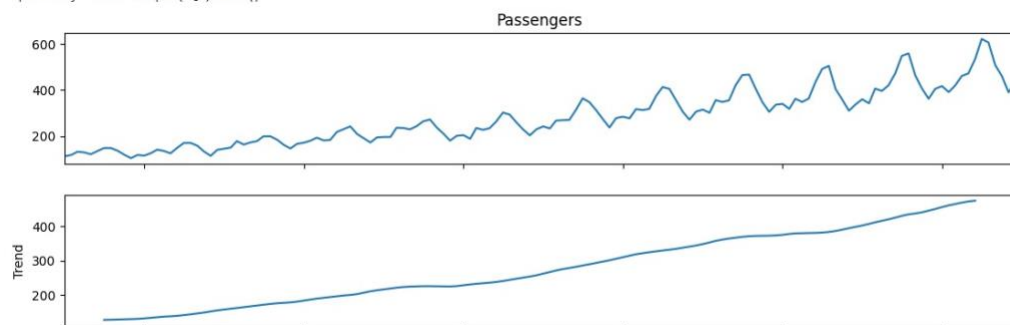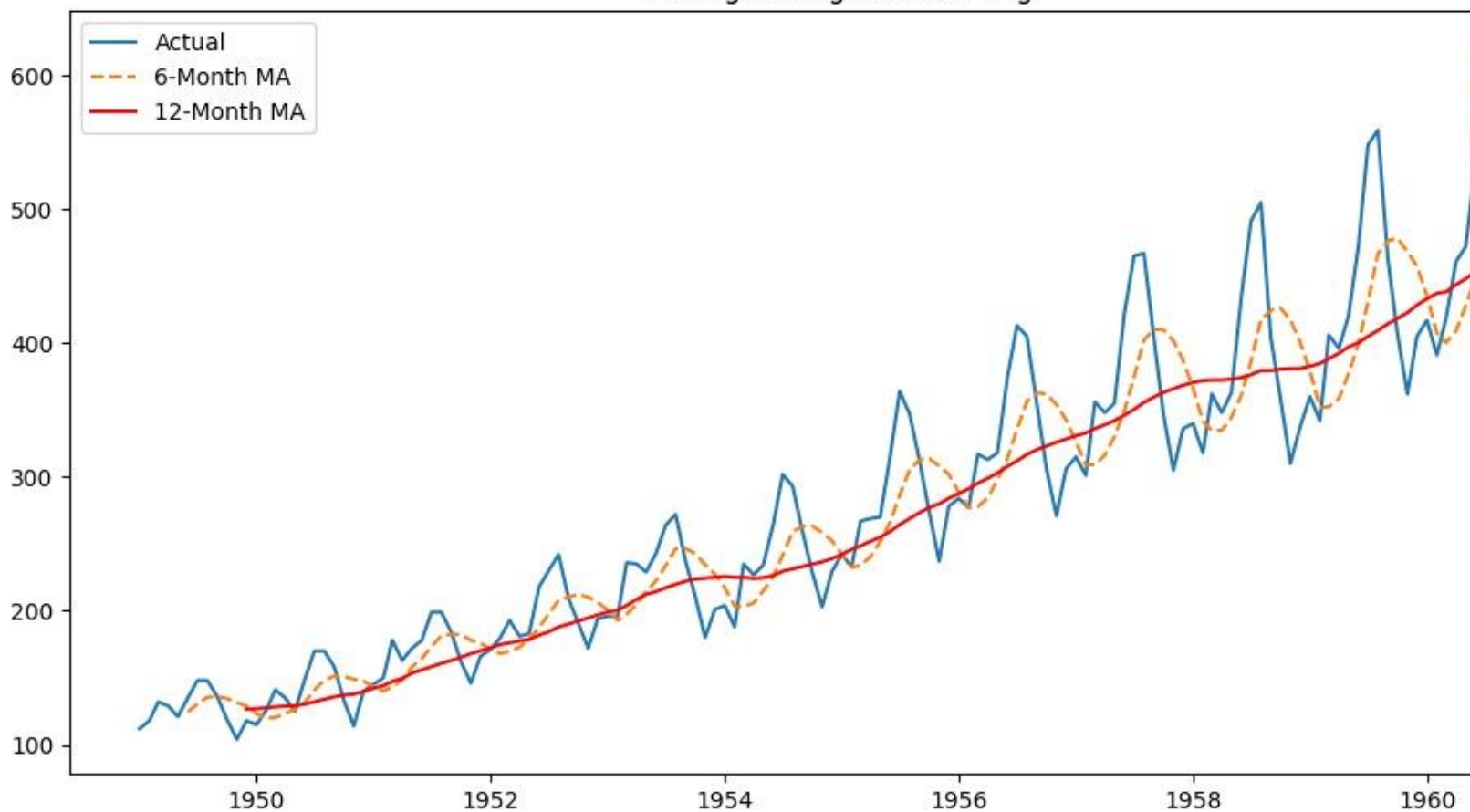

Passengers / Trend

Moving Averages Smoothing

ARIMA Forecast (RMSE=21.2)