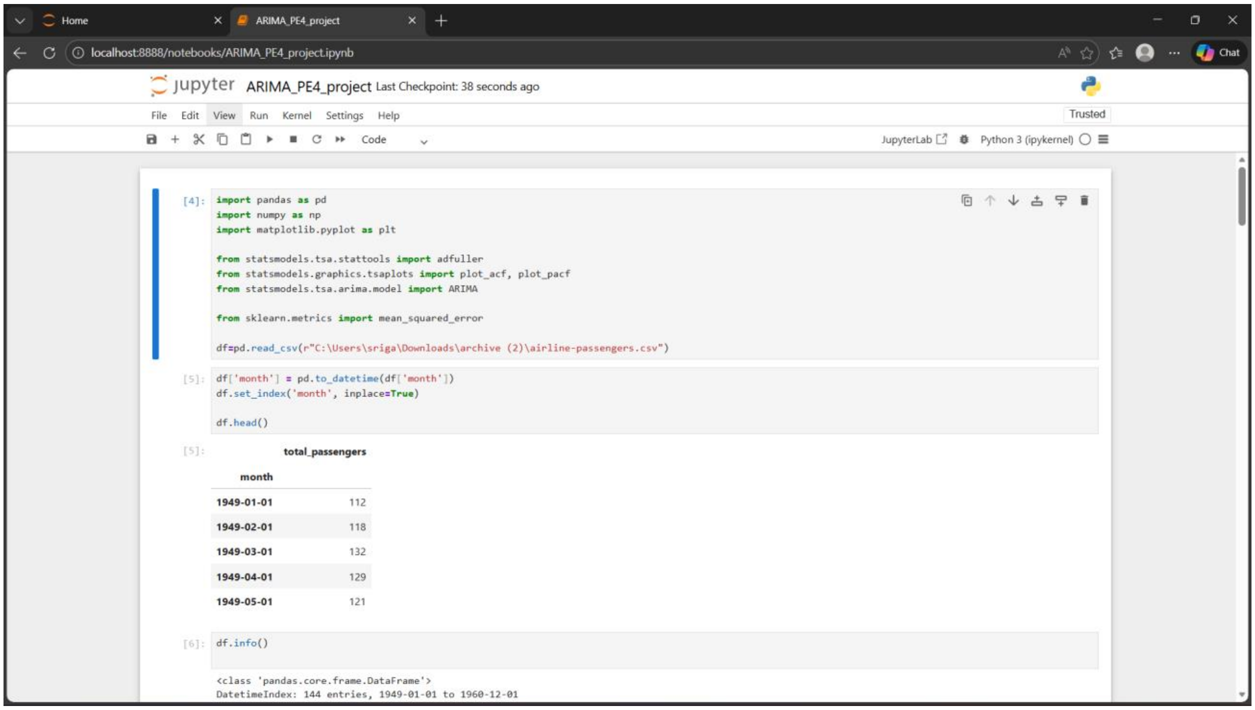

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```
[4]: import pandas as pd
     import numpy as np
     import matplotlib.pyplot as plt

     from statsmodels.tsa.stattools import adfuller
     from statsmodels.graphics.tsaplots import plot_acf, plot_pacf
     from statsmodels.tsa.arima.model import ARIMA

     from sklearn.metrics import mean_squared_error

     df=pd.read_csv(r"C:\Users\sriga\Downloads\archive (2)\airline-passengers.csv")
```

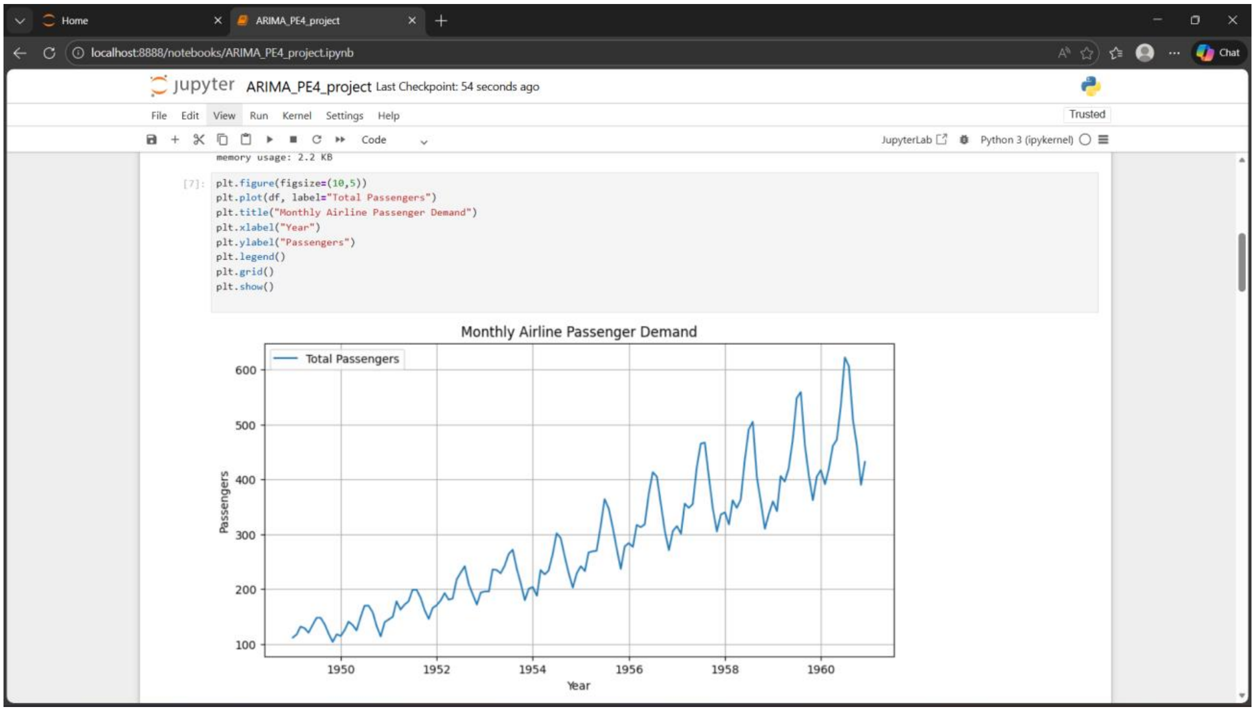
```
[5]: df['month'] = pd.to_datetime(df['month'])
     df.set_index('month', inplace=True)

     df.head()
```

[5]:

	total_passengers
month	
1949-01-01	112
1949-02-01	118
1949-03-01	132
1949-04-01	129
1949-05-01	121

```
[6]: df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
DatetimeIndex: 144 entries, 1949-01-01 to 1960-12-01
```



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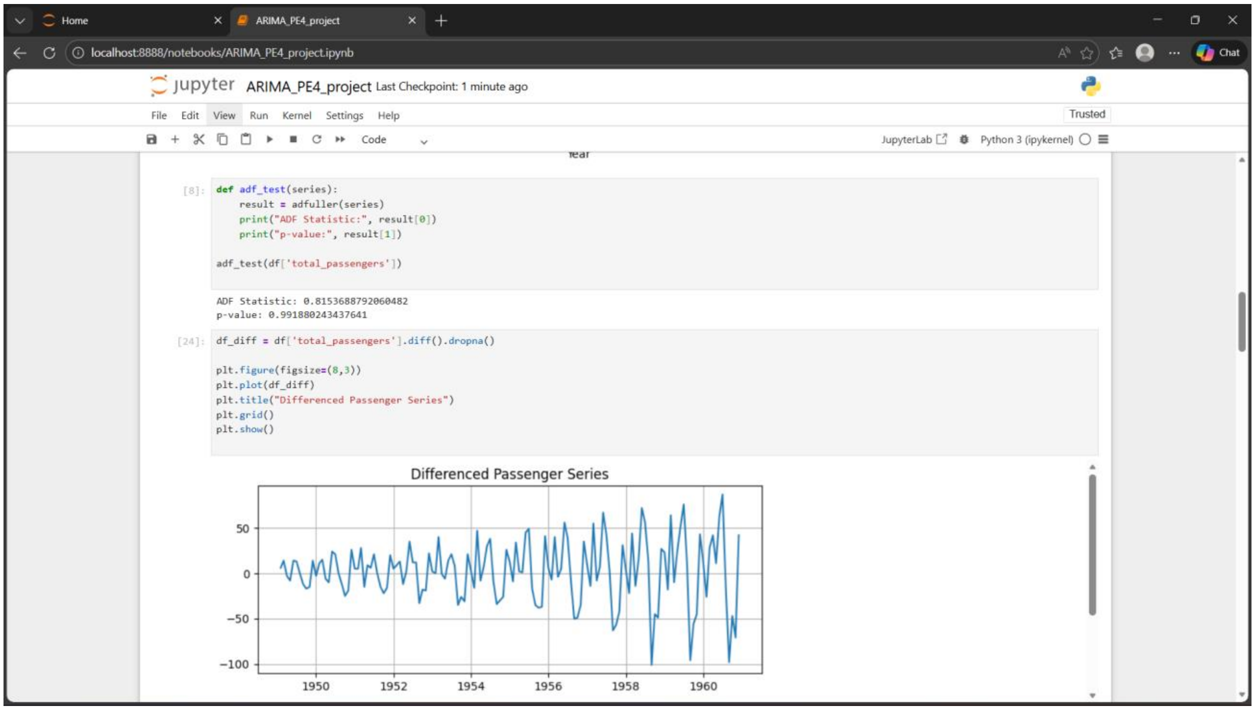
```
memory usage: 2.2 KB
```

```
[7]: plt.figure(figsize=(10,5))
     plt.plot(df, label="Total Passengers")
     plt.title("Monthly Airline Passenger Demand")
     plt.xlabel("Year")
     plt.ylabel("Passengers")
     plt.legend()
     plt.grid()
     plt.show()
```

Monthly Airline Passenger Demand
Total Passengers
600
500
400
300
200
100
Passengers
1950
1952
1954
1956
1958
1960
Year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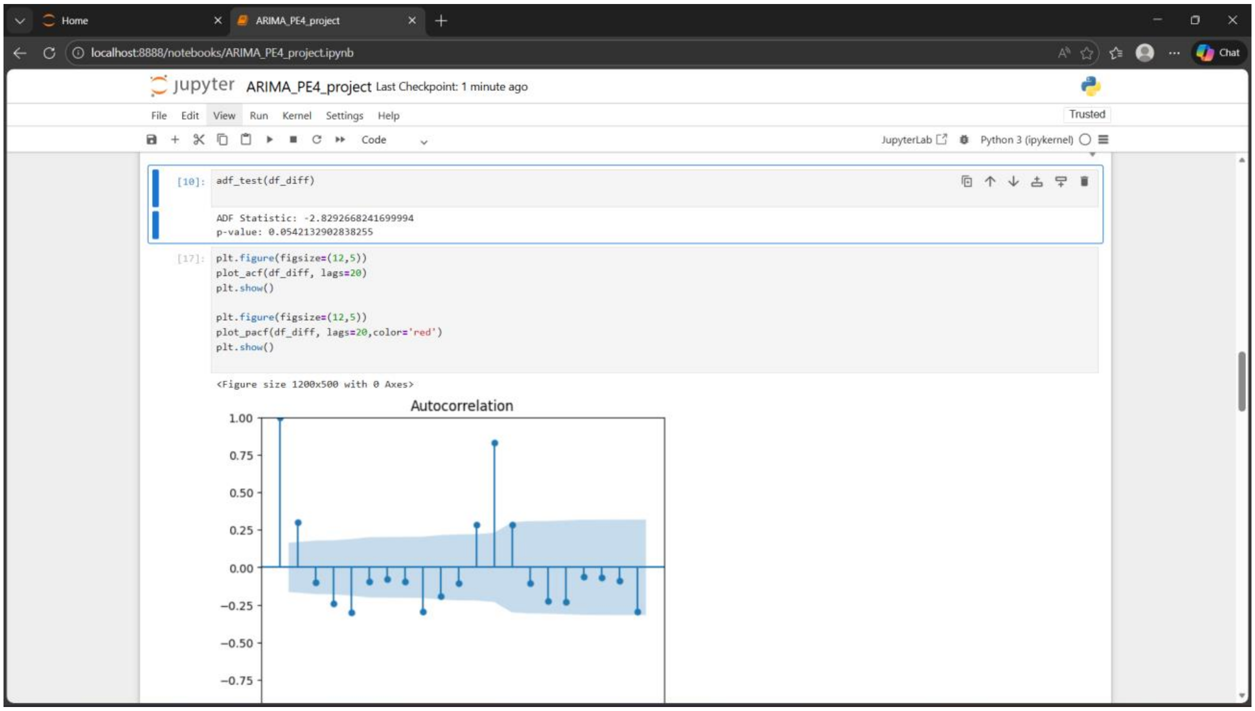
Python 3 (ipykernel)
Year

```
[8]: def adf_test(series):
         result = adfuller(series)
         print("ADF Statistic:", result[0])
         print("p-value:", result[1])

     adf_test(df['total_passengers'])
```

```
ADF Statistic: 0.8153688792060482
p-value: 0.991880243437641
```

```
[24]: df_diff = df['total_passengers'].diff().dropna()

      plt.figure(figsize=(8,3))
      plt.plot(df_diff)
      plt.title("Differenced Passenger Series")
      plt.grid()
      plt.show()
```

Differenced Passenger Series
50
0
−50
−100
1950
1952
1954
1956
1958
1960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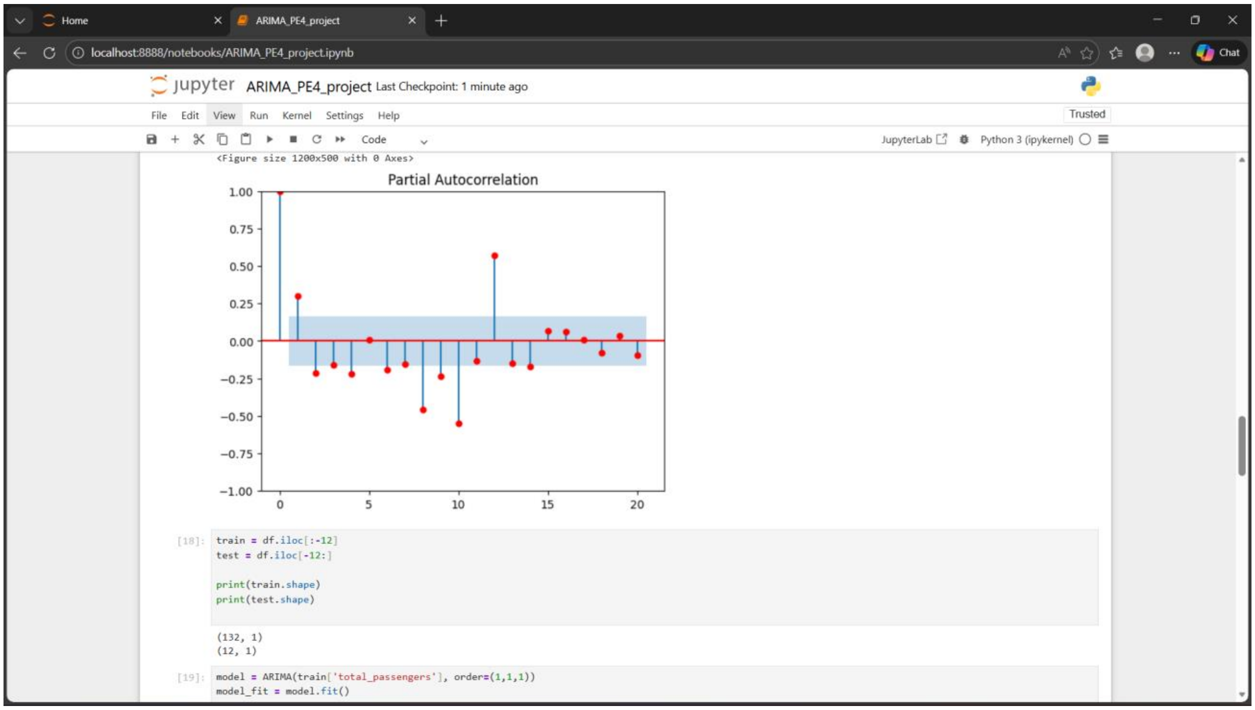
```
[10]: adf_test(df_diff)
```

```
ADF Statistic: -2.8292668241699994
p-value: 0.0542132902838255
```

```
[17]: plt.figure(figsize=(12,5))
      plot_acf(df_diff, lags=20)
      plt.show()

      plt.figure(figsize=(12,5))
      plot_pacf(df_diff, lags=20,color='red')
      plt.show()
```

```
<Figure size 1200x500 with 0 Axes>
```

Autocorrelation
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75

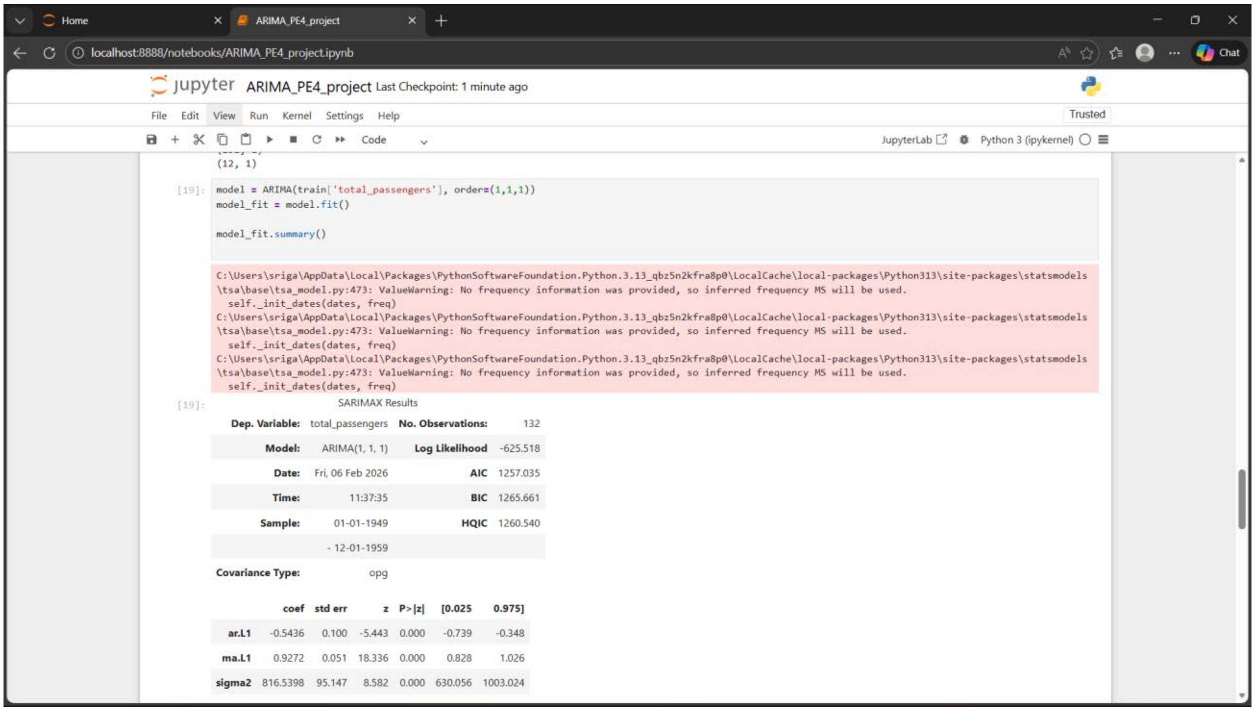


```
<Figure size 1200x500 with 0 Axes>
```

```
[18]: train = df.iloc[:-12]
      test = df.iloc[-12:]

      print(train.shape)
      print(test.shape)
```

```
(132, 1)
(12, 1)
```

```
[19]: model = ARIMA(train['total_passengers'], order=(1,1,1))
      model_fit = model.fit()
```



```
(12, 1)
```

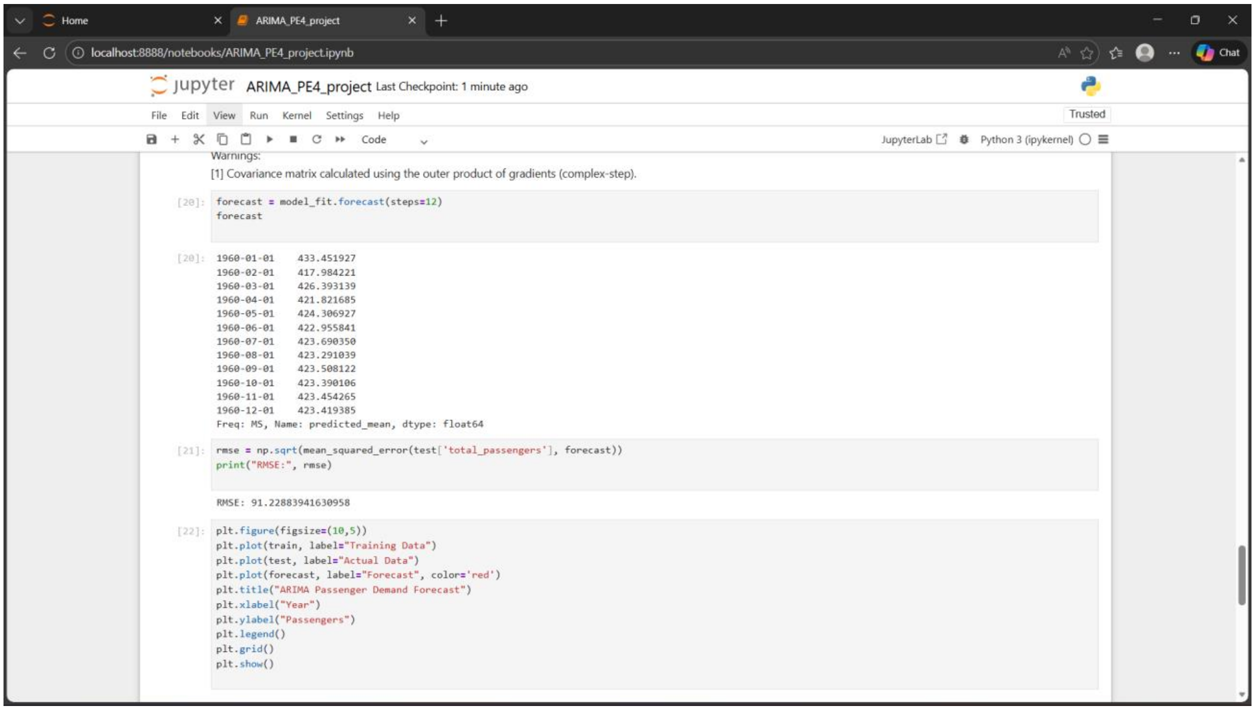
```
[19]: model = ARIMA(train['total_passengers'], order=(1,1,1))
      model_fit = model.fit()

      model_fit.summary()
```

```
C:\Users\sriga\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.13_qbz5n2kfra8p0\LocalCache\local-packages\Python313\site-packages\statsmodels
\tsa\base\tsa_model.py:473: ValueWarning: No frequency information was provided, so inferred frequency MS will be used.
  self._init_dates(dates, freq)
C:\Users\sriga\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.13_qbz5n2kfra8p0\LocalCache\local-packages\Python313\site-packages\statsmodels
\tsa\base\tsa_model.py:473: ValueWarning: No frequency information was provided, so inferred frequency MS will be used.
  self._init_dates(dates, freq)
C:\Users\sriga\AppData\Local\Packages\PythonSoftwareFoundation.Python.3.13_qbz5n2kfra8p0\LocalCache\local-packages\Python313\site-packages\statsmodels
\tsa\base\tsa_model.py:473: ValueWarning: No frequency information was provided, so inferred frequency MS will be used.
  self._init_dates(dates, freq)
```

[19]: SARIMAX Results

Dep. Variable:	total_passengers	**No. Observations:**	132
Model:	ARIMA(1, 1, 1)	**Log Likelihood**	-625.518
Date:	Fri, 06 Feb 2026	**AIC**	1257.035
Time:	11:37:35	**BIC**	1265.661
Sample:	01-01-1949	**HQIC**	1260.540
	- 12-01-1959		
Covariance Type:	opg		

	coef	std err	z	P>|z|	[0.025	0.975]
ar.L1	-0.5436	0.100	-5.443	0.000	-0.739	-0.348
ma.L1	0.9272	0.051	18.336	0.000	0.828	1.026
sigma2	816.5398	95.147	8.582	0.000	630.056	1003.024



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Warnings:
[1] Covariance matrix calculated using the outer product of gradients (complex-step).

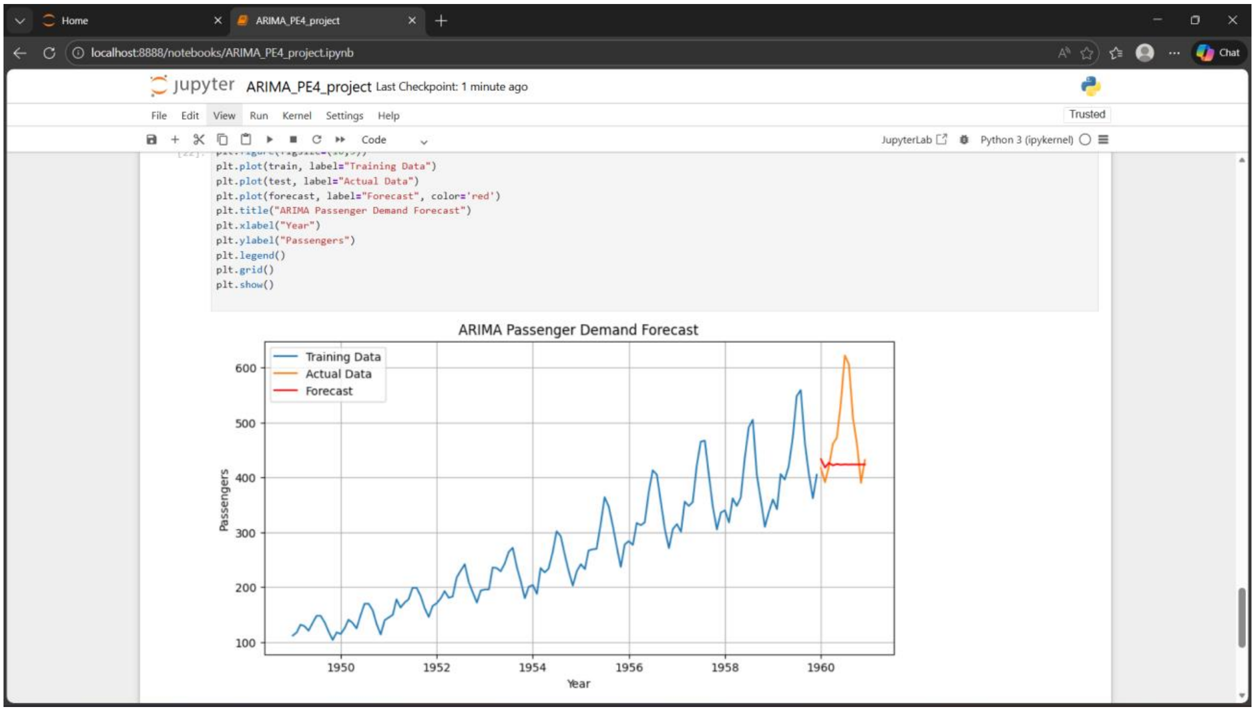
```
[20]: forecast = model_fit.forecast(steps=12)
      forecast
```

```
[20]: 1960-01-01    433.451927
      1960-02-01    417.984221
      1960-03-01    426.393139
      1960-04-01    421.821685
      1960-05-01    424.306927
      1960-06-01    422.955841
      1960-07-01    423.690350
      1960-08-01    423.291039
      1960-09-01    423.508122
      1960-10-01    423.390106
      1960-11-01    423.454265
      1960-12-01    423.419385
      Freq: MS, Name: predicted_mean, dtype: float64
```

```
[21]: rmse = np.sqrt(mean_squared_error(test['total_passengers'], forecast))
      print("RMSE:", rmse)
```

```
RMSE: 91.22883941630958
```

```
[22]: plt.figure(figsize=(10,5))
      plt.plot(train, label="Training Data")
      plt.plot(test, label="Actual Data")
      plt.plot(forecast, label="Forecast", color='red')
      plt.title("ARIMA Passenger Demand Forecast")
      plt.xlabel("Year")
      plt.ylabel("Passengers")
      plt.legend()
      plt.grid()
      plt.show()
```



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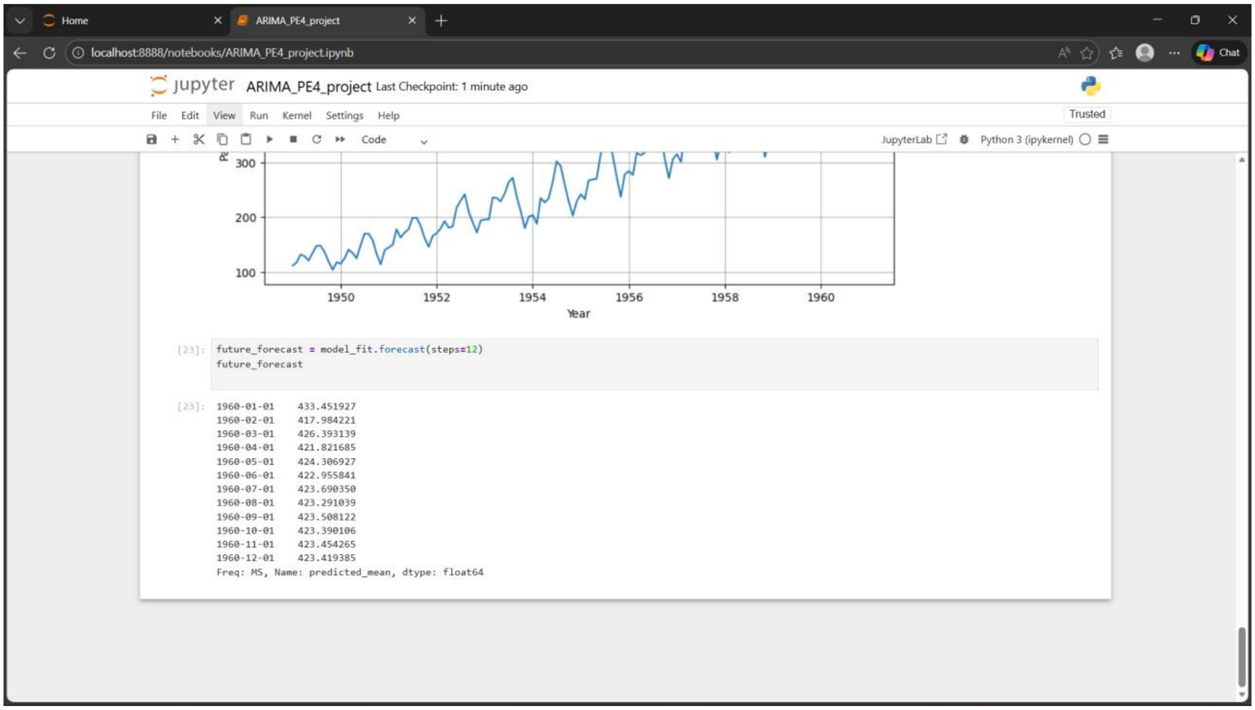
```
plt.plot(train, label="Training Data")
plt.plot(test, label="Actual Data")
plt.plot(forecast, label="Forecast", color='red')
plt.title("ARIMA Passenger Demand Forecast")
plt.xlabel("Year")
plt.ylabel("Passengers")
plt.legend()
plt.grid()
plt.show()
```

ARIMA Passenger Demand Forecast
Training Data
Actual Data
Forecast
600
500
400
300
200
100
Passengers
1950
1952
1954
1956
1958
1960
Year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Code
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Python 3 (ipykernel)
300
200
100
1950
1952
1954
1956
1958
1960
Year

```
[23]: future_forecast = model_fit.forecast(steps=12)
      future_forecast
```

```
[23]: 1960-01-01    433.451927
      1960-02-01    417.984221
      1960-03-01    426.393139
      1960-04-01    421.821685
      1960-05-01    424.306927
      1960-06-01    422.955841
      1960-07-01    423.690350
      1960-08-01    423.291039
      1960-09-01    423.508122
      1960-10-01    423.390106
      1960-11-01    423.454265
      1960-12-01    423.419385
      Freq: MS, Name: predicted_mean, dtype: float64
```