Introduction to Time Series Analysis
(Assignment for IITP –BSE Course)

1. Make separate python file (.ipynb) for each dataset and read the datasets in each file using pandas and store in dataframe, print first 5 rows of data including the header row.

Monthly Car Sales

	Month	Sales
0	1960-01	6550
1	1960-02	8728
2	1960-03	12026
3	1960-04	14395
4	1960-05	14587

Monthly sunspots

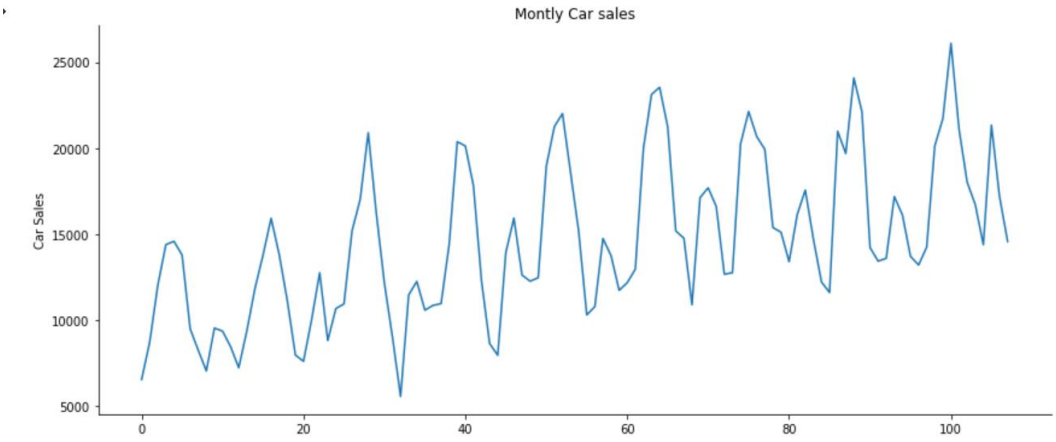
	Month	Sunspots
0	1749-01	58.0
1	1749-02	62.6
2	1749-03	70.0
3	1749-04	55.7
4	1749-05	85.0

Daily Female births

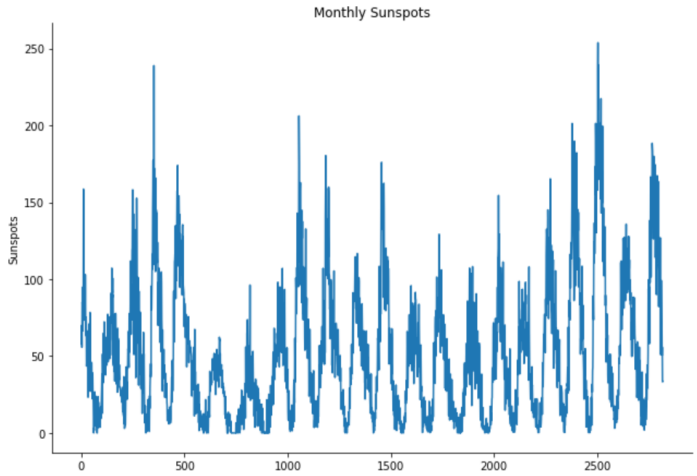
Date		Births
0	1959-01-01	35
1	1959-01-02	32
2	1959-01-03	30
3	1959-01-04	31
4	1959-01-05	44

2. Plot all three dataset to analyse the series.

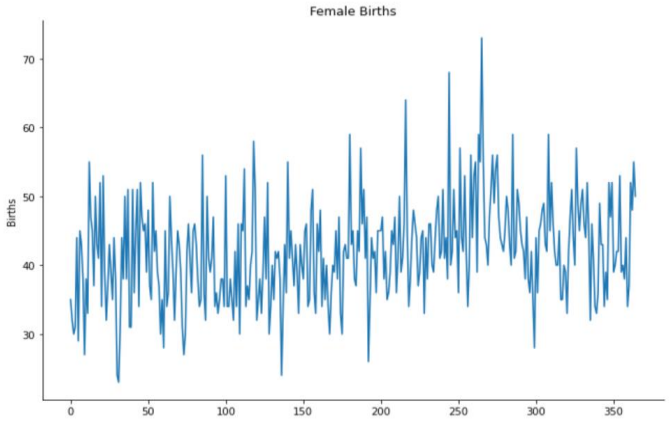
Monthly Car Sales



Monthly sunspots



Daily Female births



3. Set “Date” column of the dataset as index. Please take the correct name of the column.

Monthly Car Sales

```
DatetimeIndex(['1960-01-01', '1960-02-01', '1960-03-01', '1960-04-01',
               '1960-05-01', '1960-06-01', '1960-07-01', '1960-08-01',
               '1960-09-01', '1960-10-01',
               ...
               '1968-03-01', '1968-04-01', '1968-05-01', '1968-06-01',
               '1968-07-01', '1968-08-01', '1968-09-01', '1968-10-01',
               '1968-11-01', '1968-12-01'],
              dtype='datetime64[ns]', name='Month', length=108, freq=None)
```

Monthly sunspots

```
DatetimeIndex(['1749-01-01', '1749-02-01', '1749-03-01', '1749-04-01',
               '1749-05-01', '1749-06-01', '1749-07-01', '1749-08-01',
               '1749-09-01', '1749-10-01',
               ...
               '1983-03-01', '1983-04-01', '1983-05-01', '1983-06-01',
               '1983-07-01', '1983-08-01', '1983-09-01', '1983-10-01',
               '1983-11-01', '1983-12-01'],
              dtype='datetime64[ns]', name='Month', length=2820,
freq=None)
```

Daily Female births

```
DatetimeIndex(['1959-01-01', '1959-01-02', '1959-01-03', '1959-01-04',
               '1959-01-05', '1959-01-06', '1959-01-07', '1959-01-08',
               '1959-01-09', '1959-01-10',
               ...
               '1959-12-22', '1959-12-23', '1959-12-24', '1959-12-25',
               '1959-12-26', '1959-12-27', '1959-12-28', '1959-12-29',
               '1959-12-30', '1959-12-31'],
              dtype='datetime64[ns]', name='Date', length=365, freq=None)
```

4. Try fetching the data using index i.e. for a specific date, specific month and specific year.

Monthly Car Sales

```
Sales    7049
Name: 1960-09-01 00:00:00, dtype: int64
```

Monthly sunspots

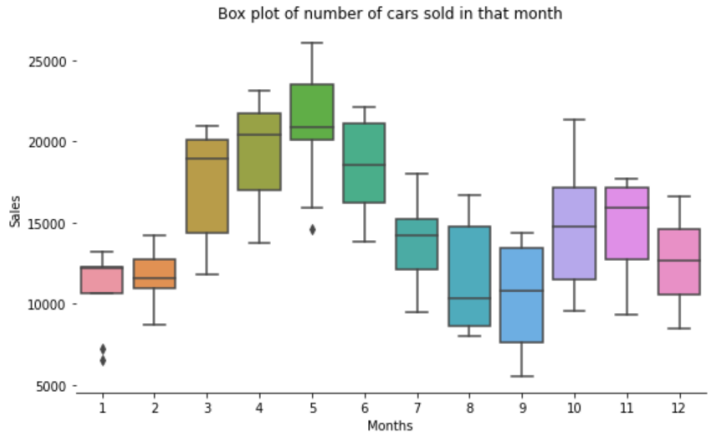
```
Sunspots    66.3
Name: 1749-08-01 00:00:00, dtype: float64
```

Daily Female births

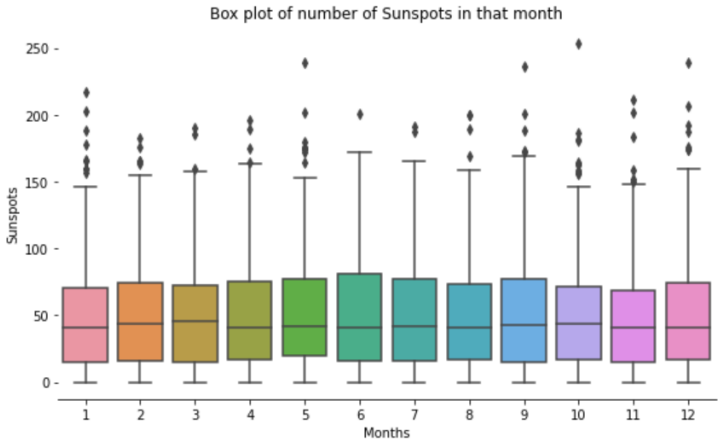
```
Births    35
Name: 1959-01-01 00:00:00, dtype: int64
```

5. Plot the boxplot using daily data for daily-total-female-births dataset and monthly data for monthly-car-sales.csv, monthly-sunspots.csv, daily-total-female-births datasets.

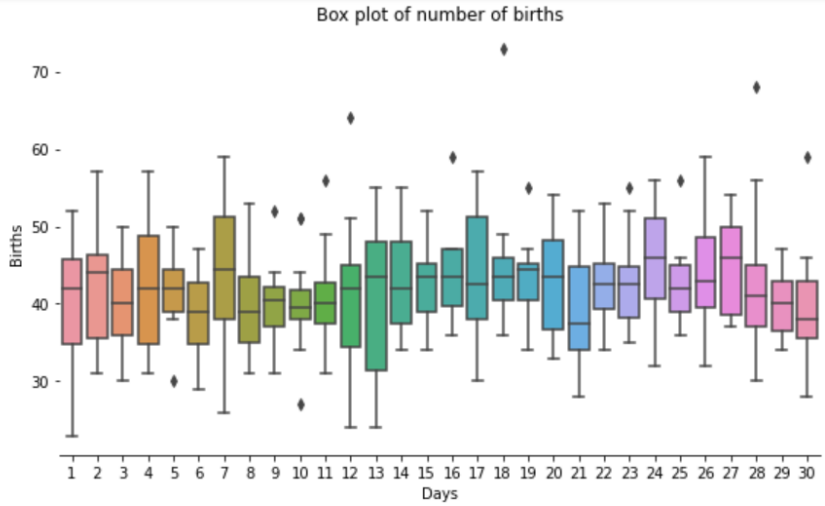
Monthly Car Sales



Monthly sunspots

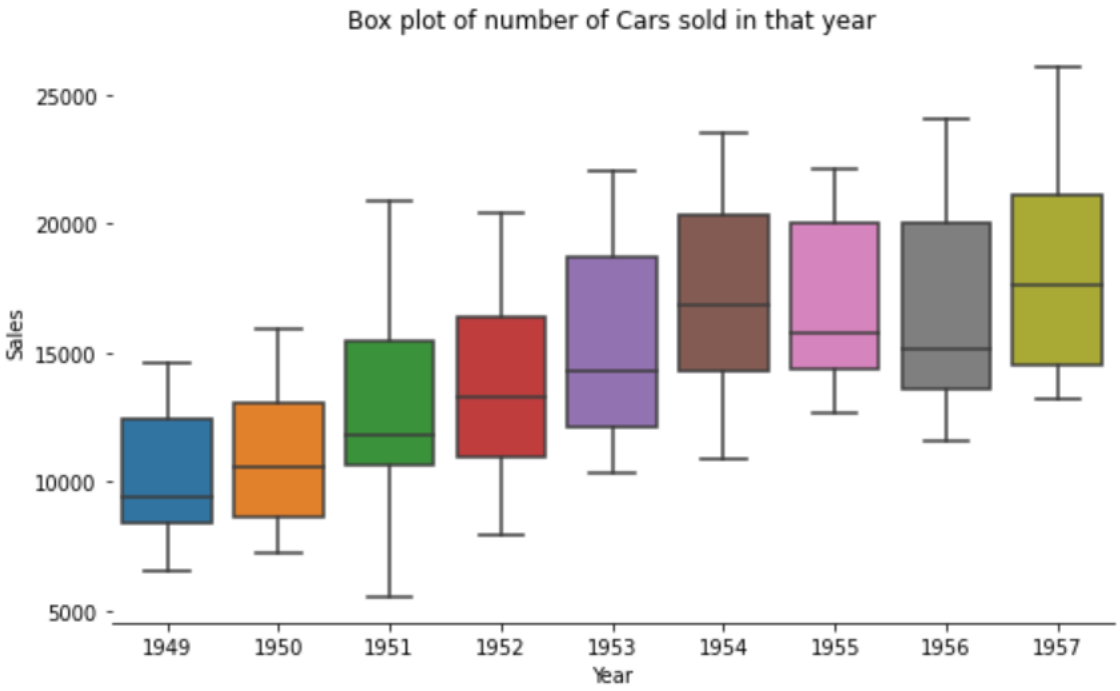


Daily Female births

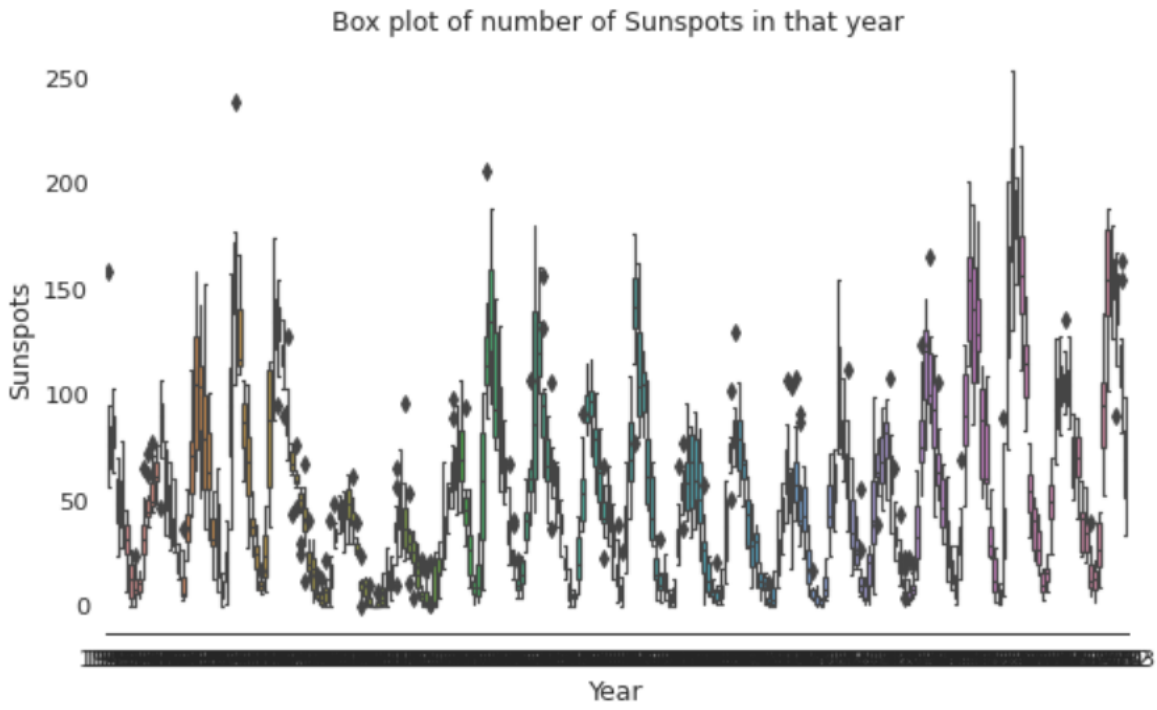


6. Plot the boxplot using yearly data for (i) and (ii).

Monthly Car Sales

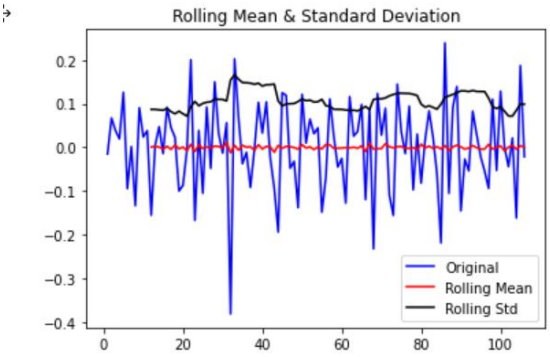


Monthly sunspots



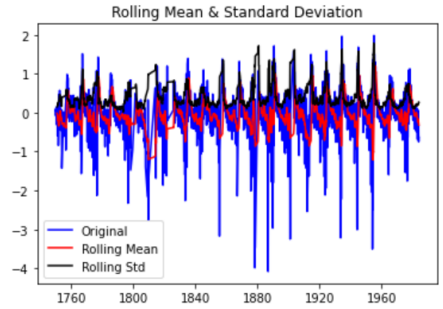
7. Calculate moving average of the data and test stationarity (rolling mean, standrad deviation)

Monthly Car Sales



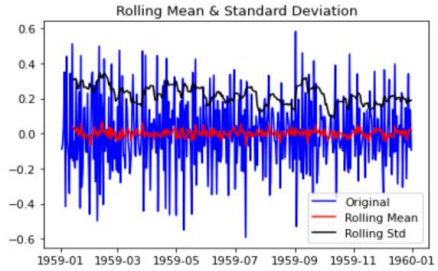

```
Results of Dickey-Fuller Test:
Test Statistic                -8.314600e+00
p-value                        3.709908e-13
#Lags Used                     1.300000e+01
Number of Observations Used    9.200000e+01
Critical Value (1%)           -3.503515e+00
Critical Value (5%)           -2.893508e+00
Critical Value (10%)          -2.583824e+00
dtype: float64
```

Monthly sunspots




```
Results of Dickey-Fuller Test:
Test Statistic                -1.012900e+01
p-value                        9.021717e-18
#Lags Used                     1.700000e+01
Number of Observations Used    2.507000e+03
Critical Value (1%)           -3.432961e+00
Critical Value (5%)           -2.862694e+00
Critical Value (10%)          -2.567384e+00
dtype: float64
```

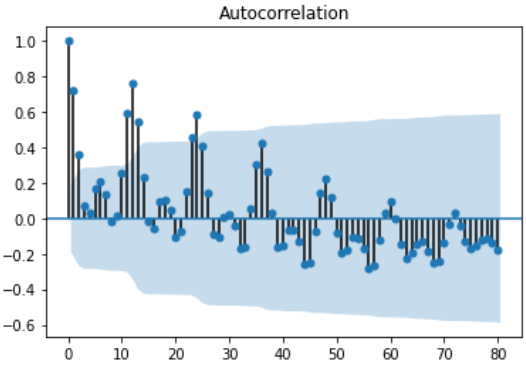
Daily Female births

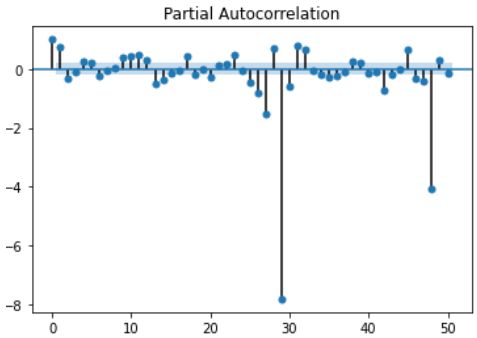



```
Results of Dickey-Fuller Test:
Test Statistic                -1.296334e+01
p-value                        3.191205e-24
#Lags Used                     6.000000e+00
Number of Observations Used    3.570000e+02
Critical Value (1%)           -3.448801e+00
Critical Value (5%)           -2.869670e+00
Critical Value (10%)          -2.571101e+00
dtype: float64
```

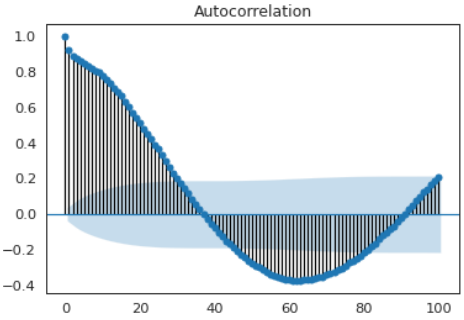
8. Plot autocorrelation and partial autocorrelation and interpret the results of ACF and PACF plots to find the order of AR, MA, ARMA, ARIMA models

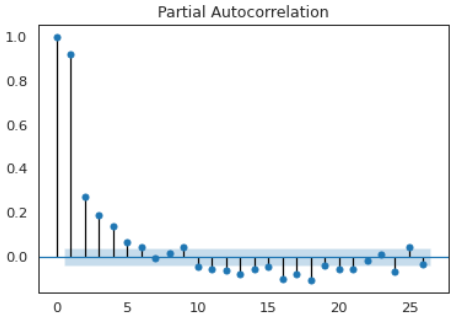
Monthly Car Sales



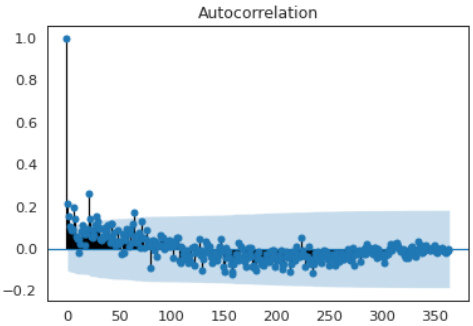


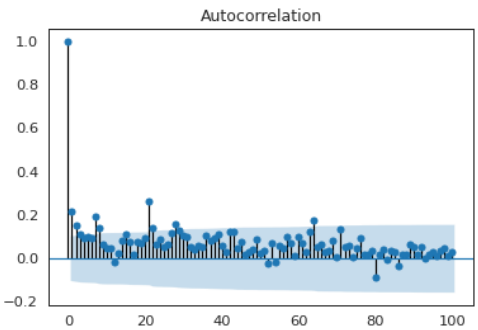
Monthly sunspots





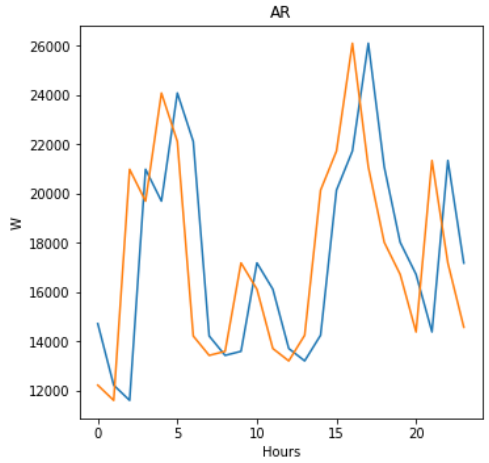
Daily Female births

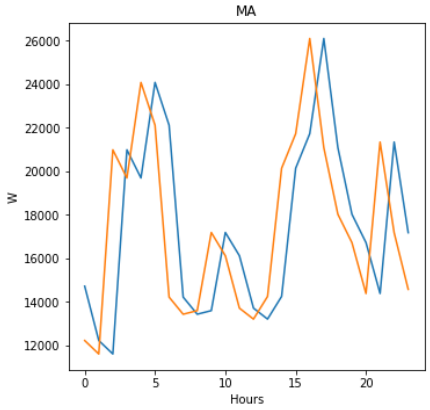


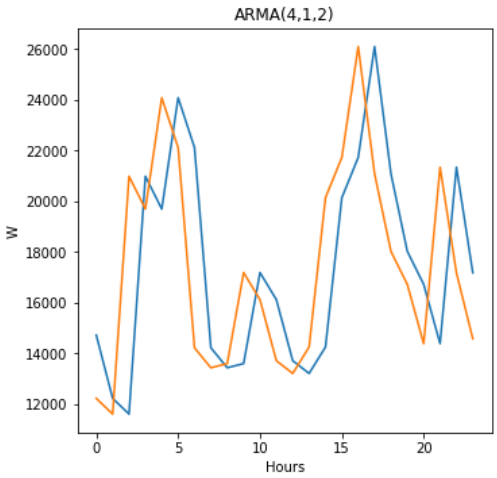


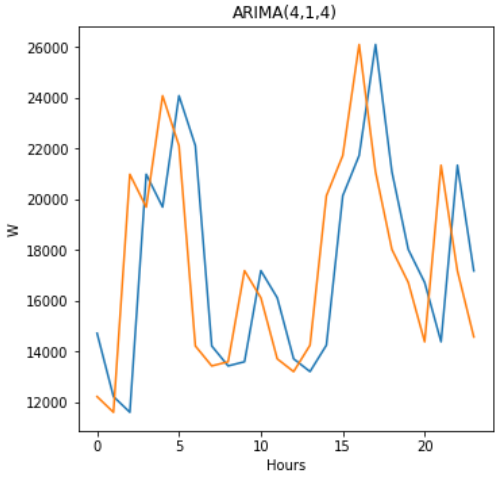
11. Plot the original versus predicted graph for each of the model prediction.

Monthly Car Sales

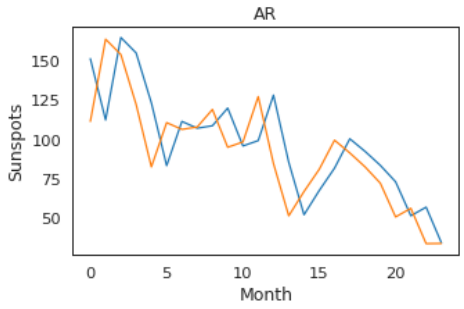


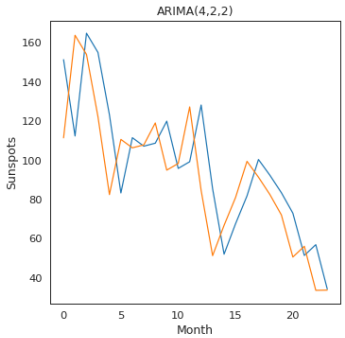




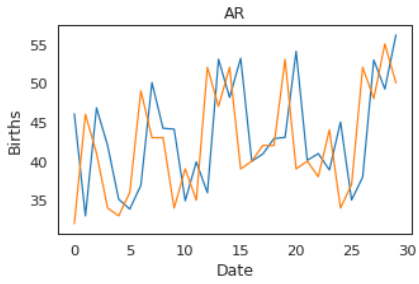


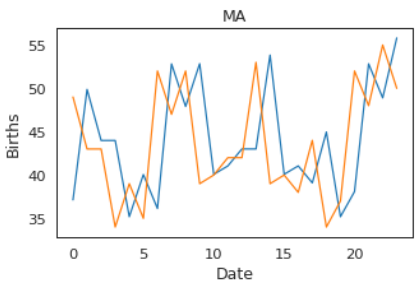
Monthly sunspots

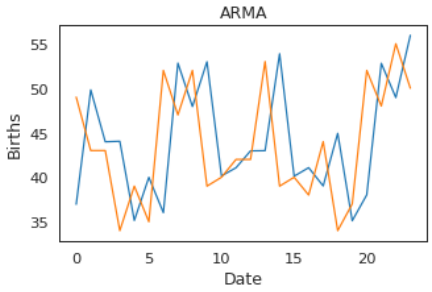


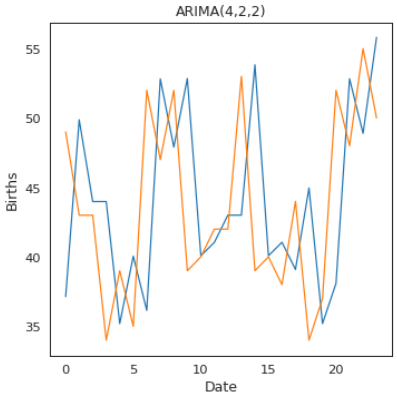


Daily Female births



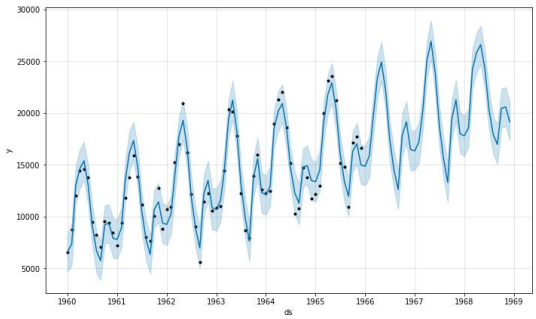


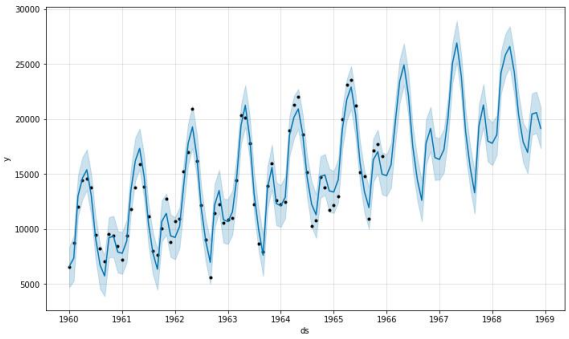




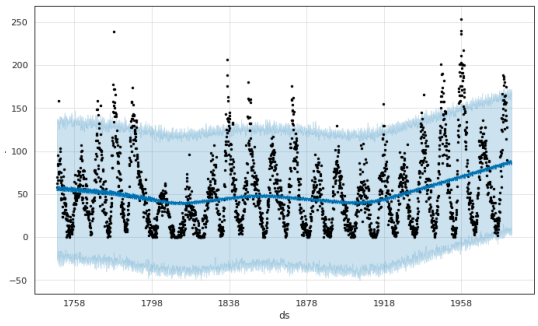
12. Apply Prophet model, calculate the error matrices & plot the original versus predicted.

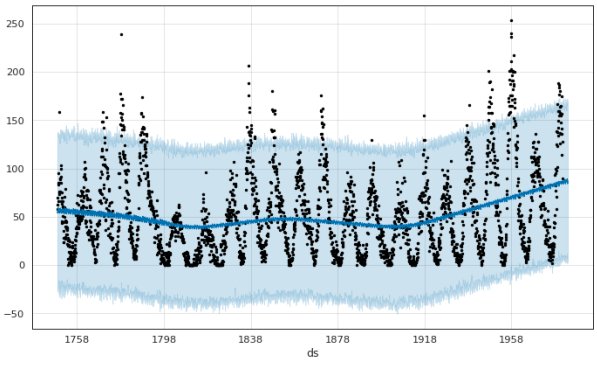
Monthly Car Sales



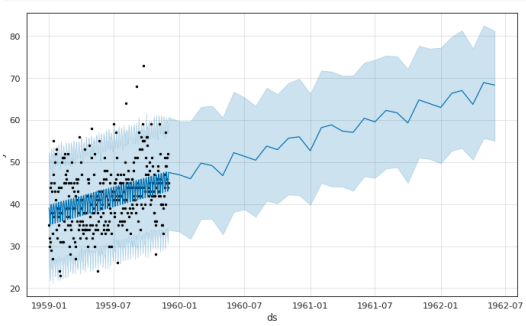


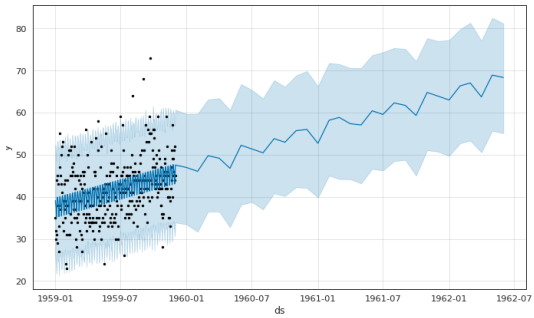
Monthly sunspots





Daily Female births





14. Calculate RMSE & MAPE matrices on the prediction of each model and compare all the results in tabular format.

	Monthly Car Sales		Monthly Sunspots		Daily Female births	
	RSME	**MAPE**	**RSME**	**MAPE**	**RSME**	**MAPE**
AR	3947.22	17.32	24.64	24.1	8.372	16.24
MA	3947.22	17.32	24.63	24.1	8.372	16.24
ARMA	3947.2	17.32	24.63	24.1	8.177	16.24
ARIMA	3947.14	17.32	24.64	24.1	8.137	16.24
ARIMA (min AIC)	3647.57	17.32	24.63	24.11	7.685	16.24
PROPHET	3108.93		42.61		16.813	
LSTM(Vanila)	4193.01	21.5	26.78		9.185	17.52
LSTM(Stack)	4279.78	22.6	27.28		8.094	15.69
LSTM(Bi directional)	4310.82	23.9	25.68		9.555	18.75