Pure seasonal models

ARIMA MODELS IN R

David Stoffer
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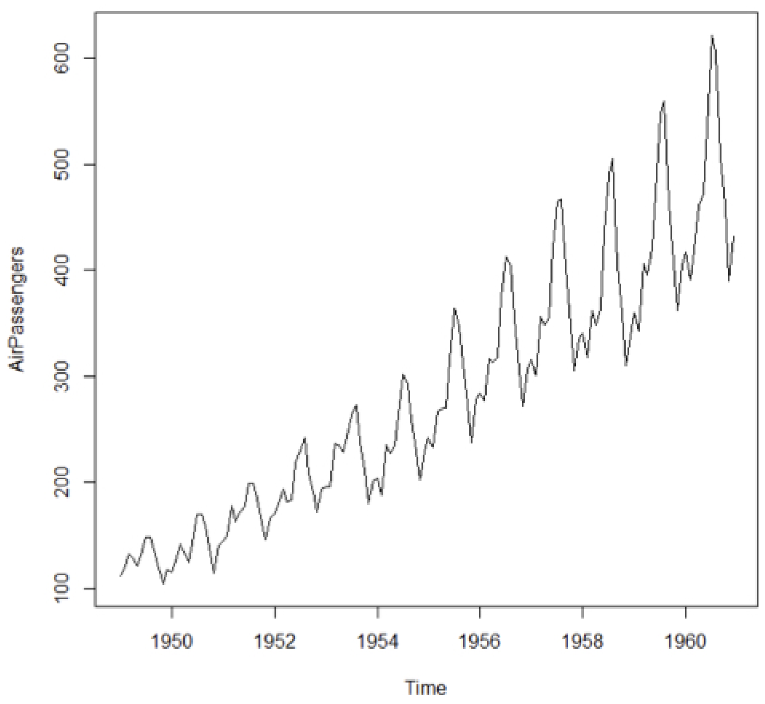
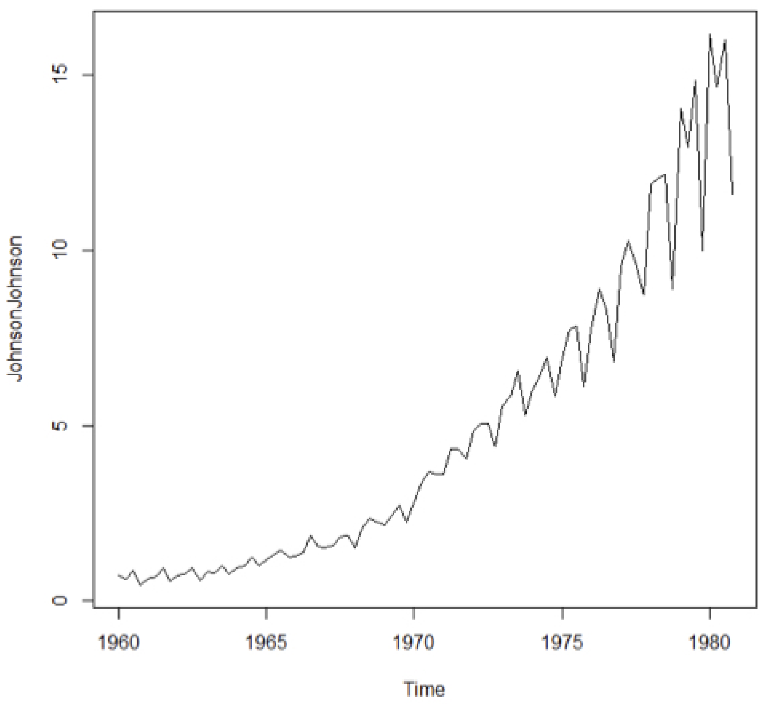
Pure Seasonal Models

- Often collect data with a known seasonal component
- Air Passengers (1 cycle every S = 12 months)
- Johnson & Johnson Earnings (1 cycle every S = 4 quarters)

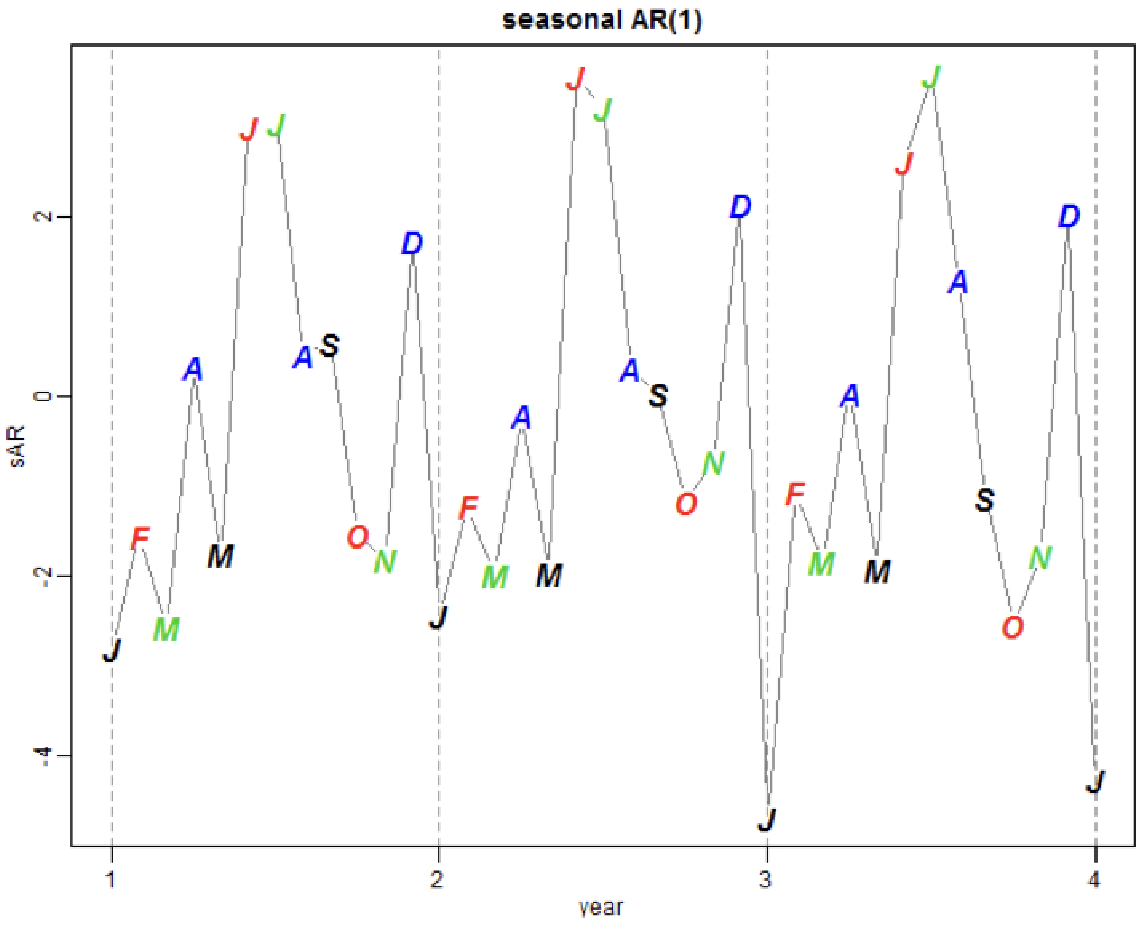




Pure Seasonal Models

Consider pure seasonal models such as an SAR$(P = 1)_{s=12}$

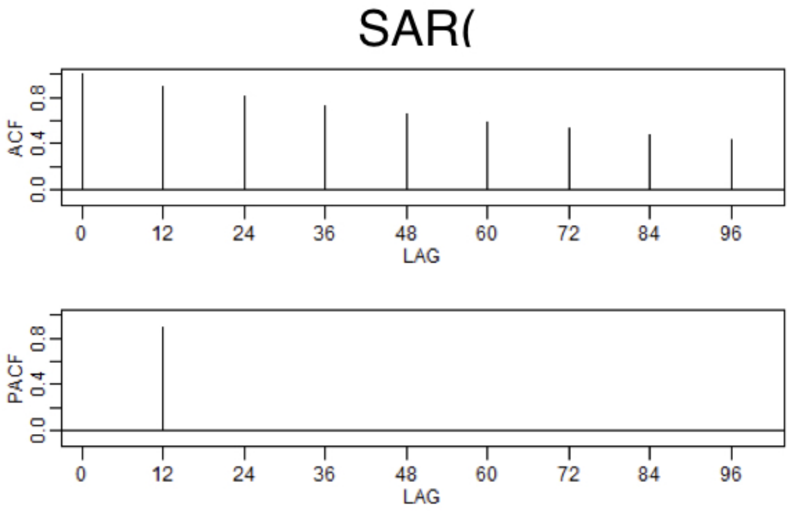
$$X_t = \Phi X_{t-12} + W_t$$

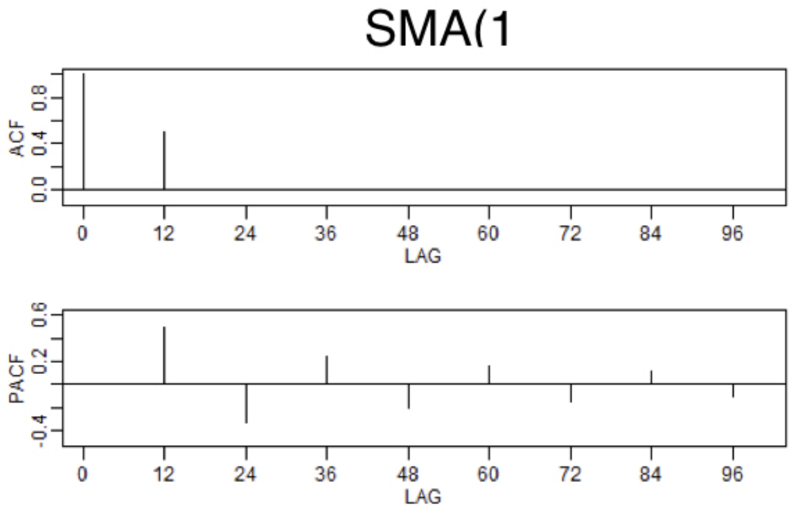


ACF and PACF of Pure Seasonal Models

	$SAR(P)_S$	$SMA(Q)_S$	$SARMA(P, Q)_S$
ACF*	Tails off	Cuts off lag QS	Tails off
PACF*	Cuts off lag PS	Tails off	Tails off

* The values at the nonseasonal lags are zero





Let's practice!

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Mixed seasonal models

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Mixed Seasonal Model

- Mixed model: SARIMA$(p, d, q) \times (P, D, Q)_s$ model
- Consider a SARIMA$(0, 0, 1) \times (1, 0, 0)_{12}$ model

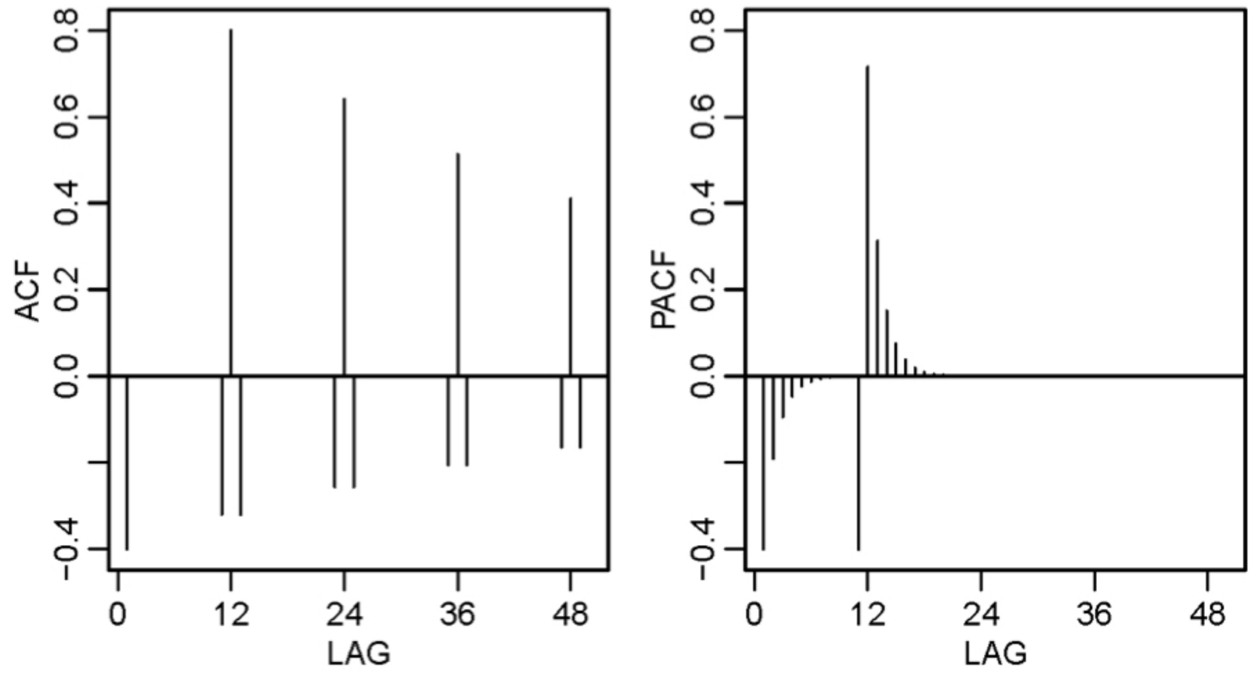
$$X_t = \Phi X_{t-12} + W_t + \theta W_{t-1}$$

- SAR(1): Value this month is related to last year's value X_{t-12}
- MA(1): This month's value related to last month's shock W_{t-1}

ACF and PACF of SARIMA(0,0,1) x (1,0,0) s=12

- The ACF and PACF for this mixed model:

$$X_t = .8X_{t-12} + W_t - .5W_{t-1}$$



ACF and PACF of SARIMA(0,0,1) x (1,0,0) s=12

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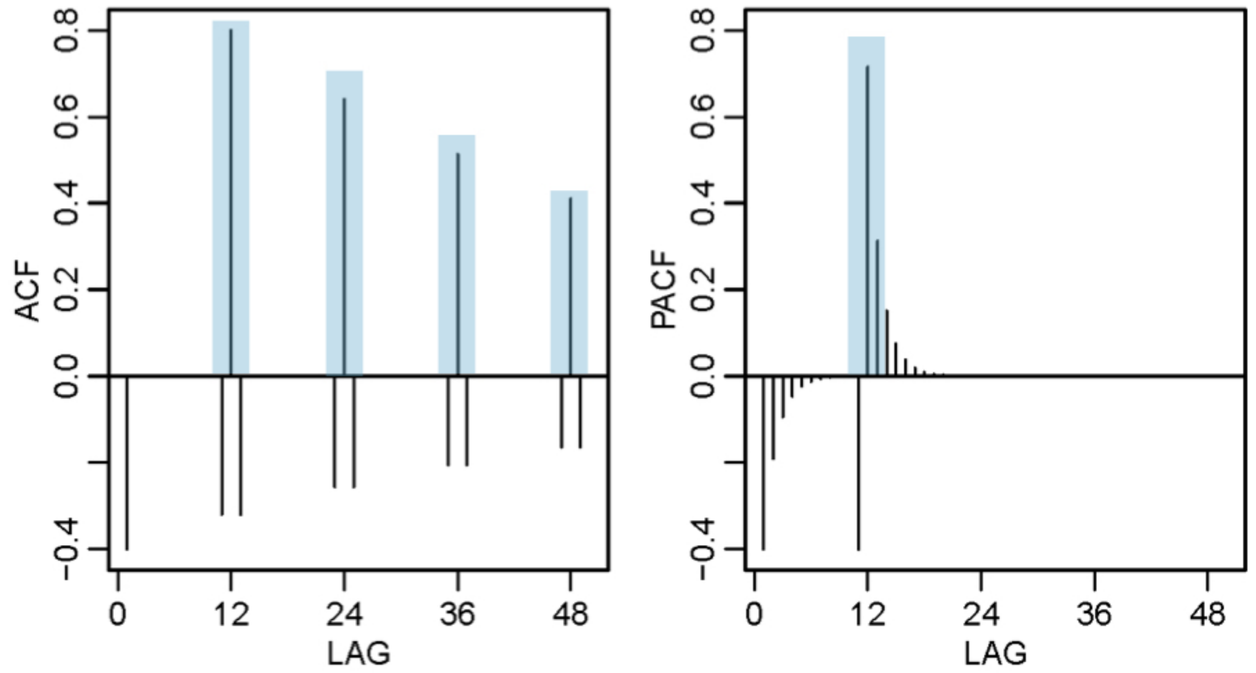
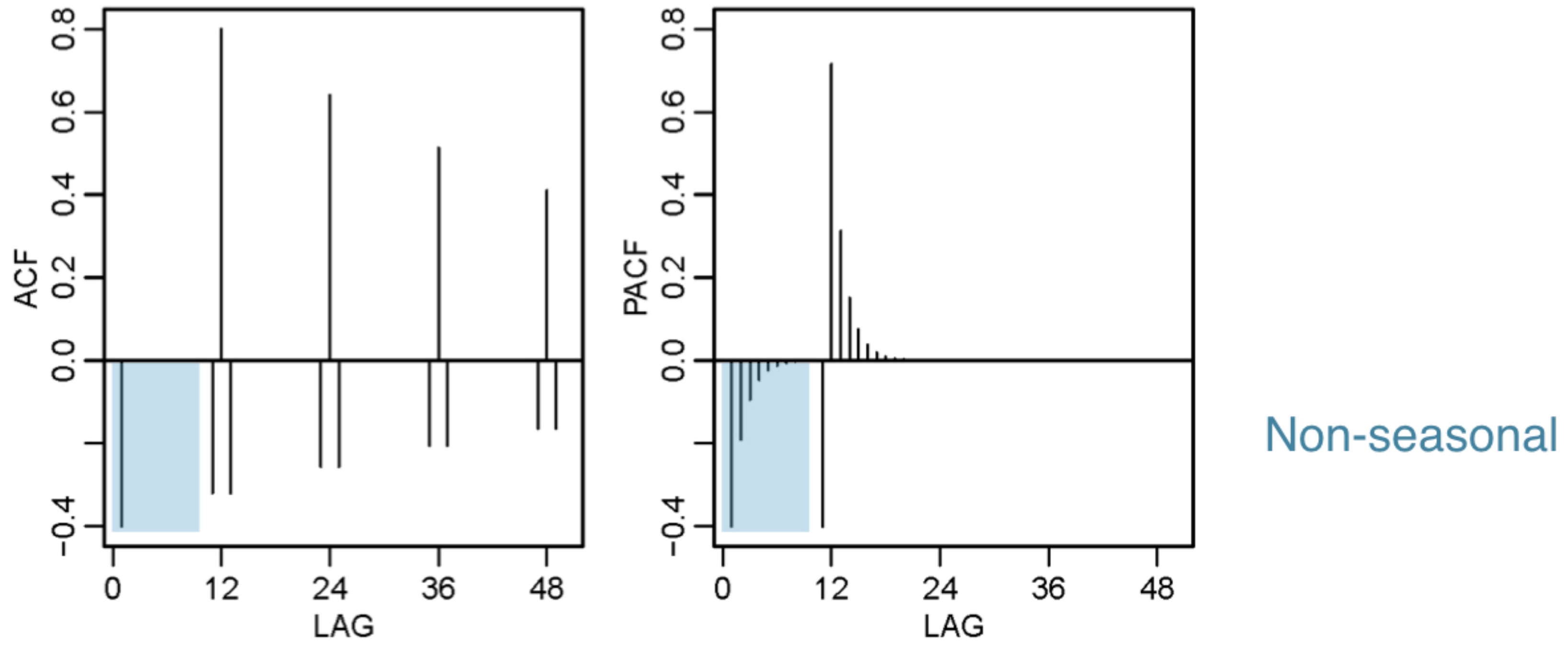


Seasonal

ACF and PACF of SARIMA(0,0,1) x (1,0,0) s=12

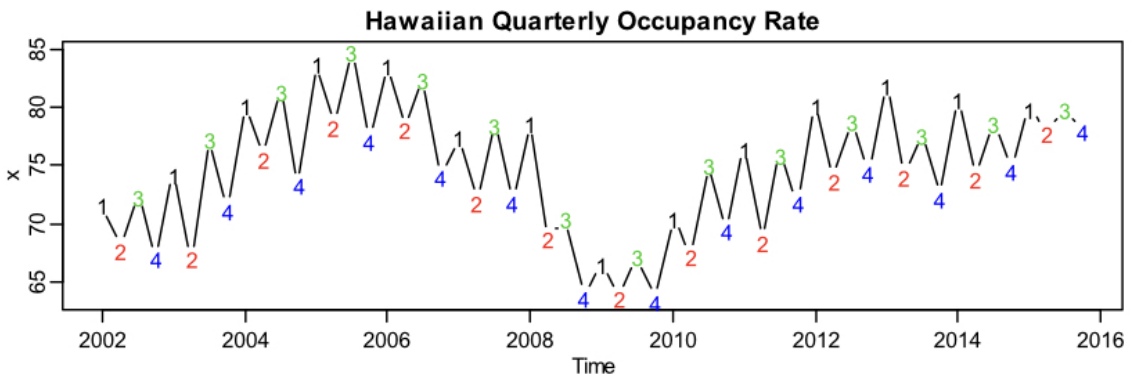
- The ACF and PACF for this mixed model:

$$X_t = .8X_{t-12} + W_t - .5W_{t-1}$$



Seasonal Persistence

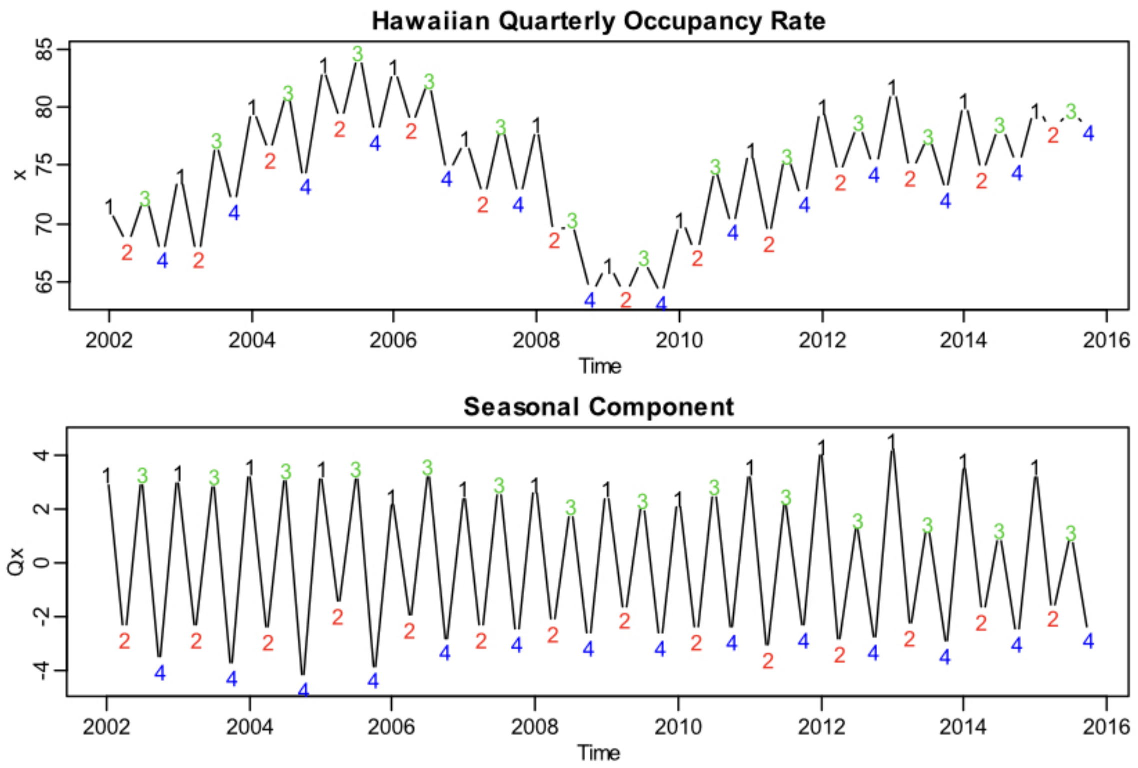
Quarterly Occupancy Rate:
% rooms filled



Seasonal Persistence

Quarterly Occupancy Rate:
% rooms filled

Seasonal Component:
this year vs. last year
Q1 ≈ Q1, Q2 ≈ Q2,
Q3 ≈ Q3, Q4 ≈ Q4

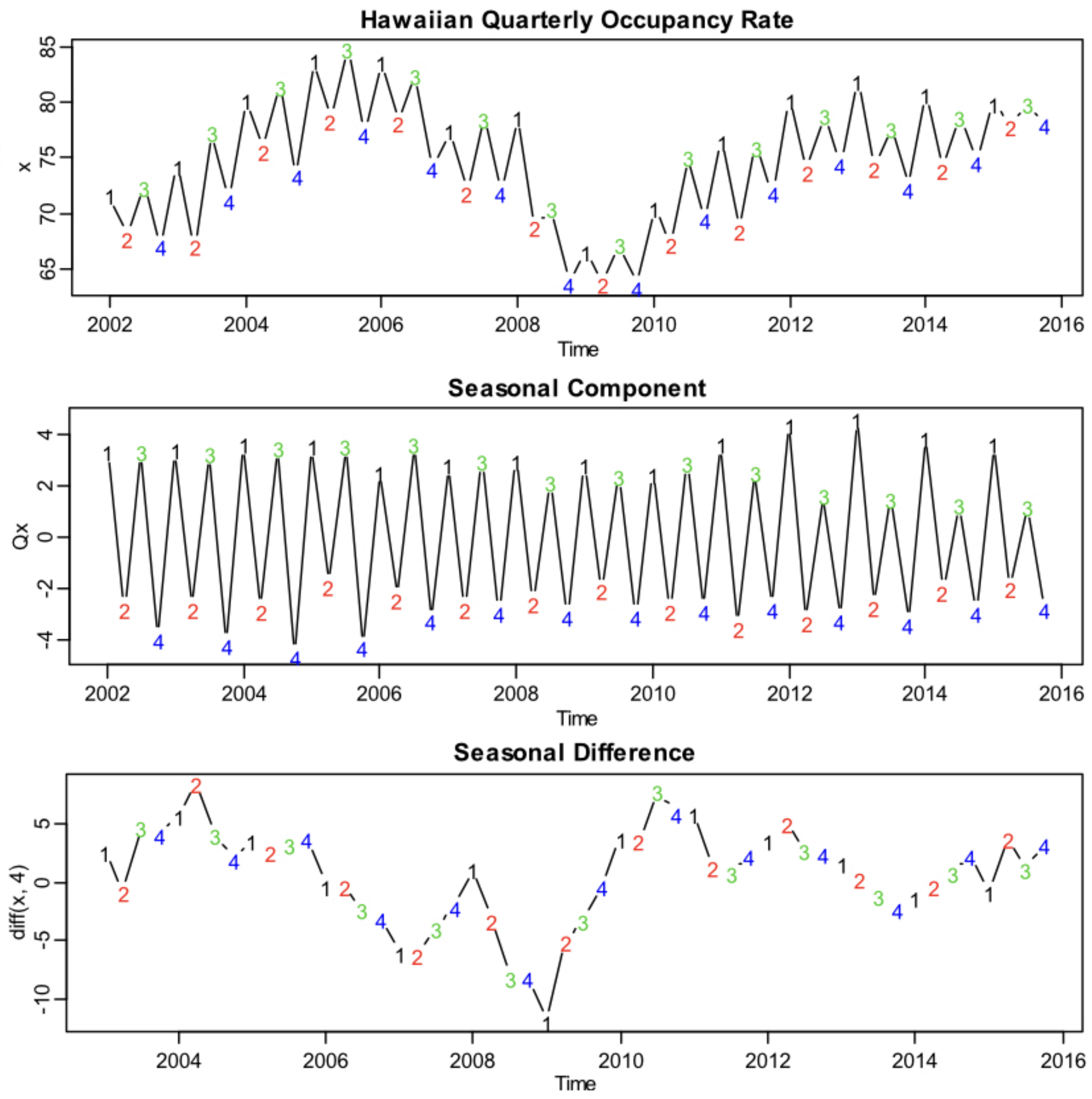


Seasonal Persistence

Quarterly Occupancy Rate: % rooms filled

Seasonal Component: this year vs. last year
Q1 ≈ Q1, Q2 ≈ Q2,
Q3 ≈ Q3, Q4 ≈ Q4

Remove seasonal persistence by a seasonal difference:
$X_t - X_{t-4}$ or D = 1, S = 4 for quarterly data



Air Passengers

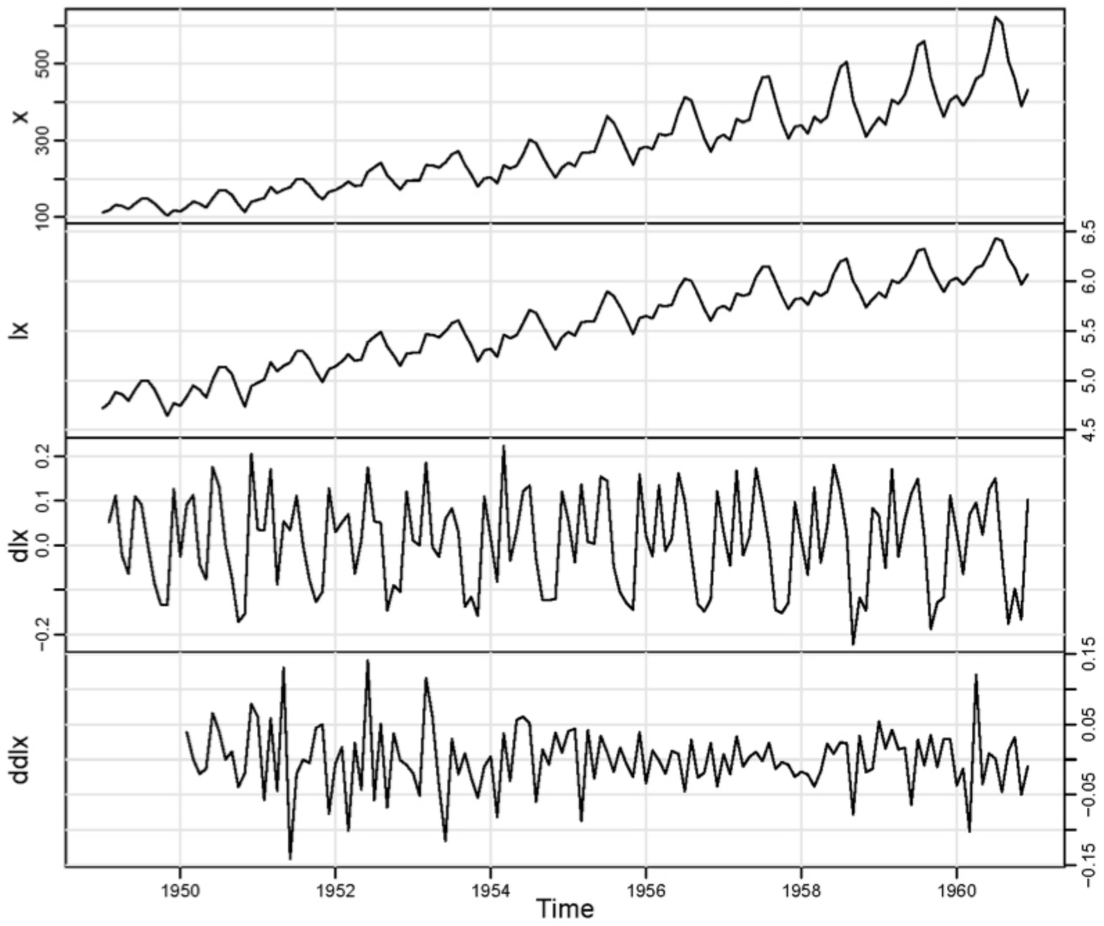
- Monthly totals of international airline passengers, 1949-1960

x: AirPassengers

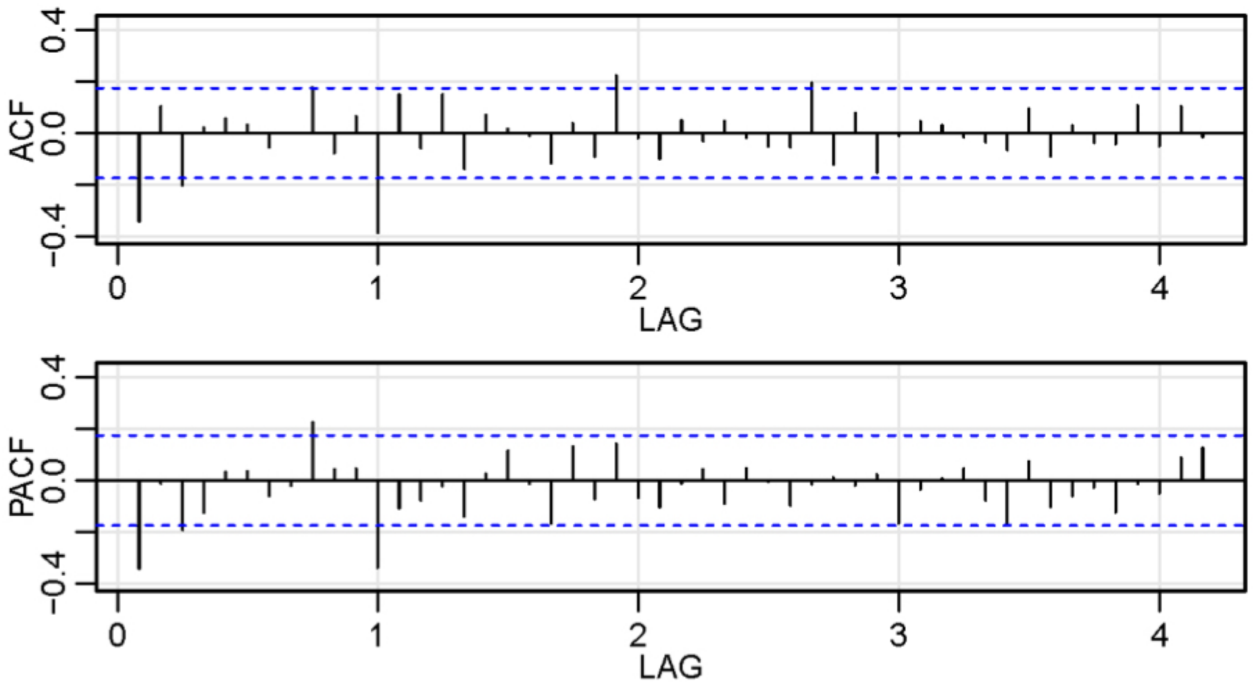
lx: log(x)

dlx: diff(lx)

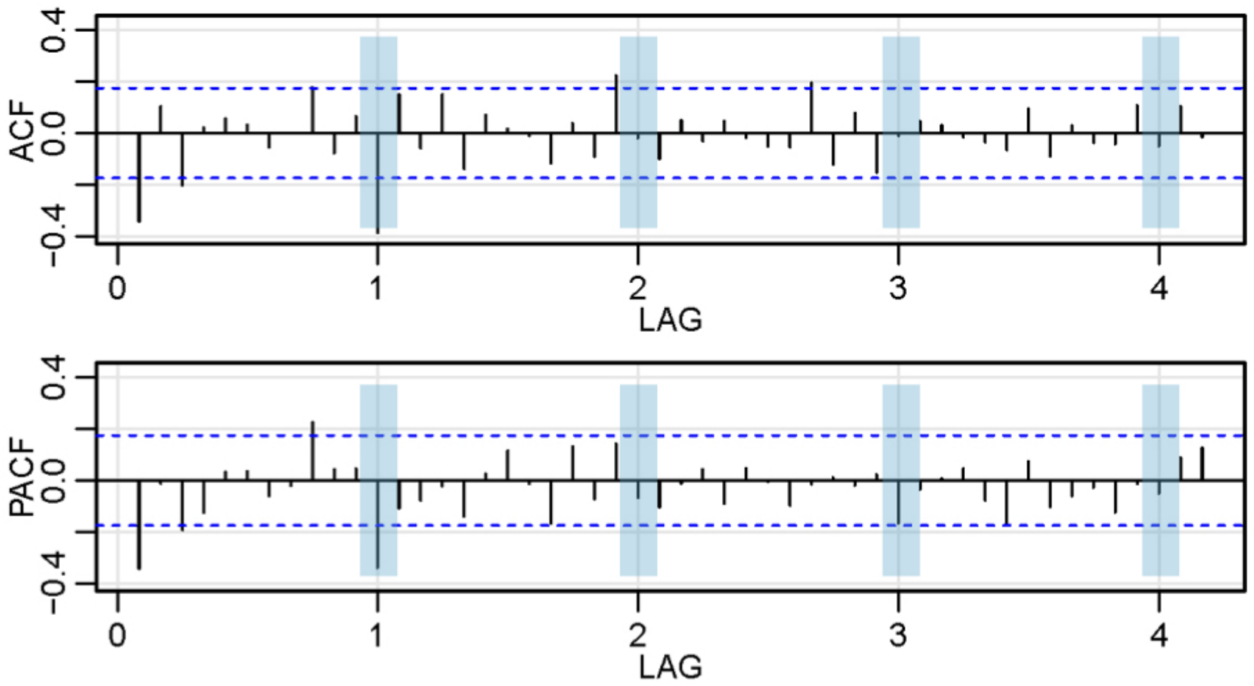
ddlx: diff(dlx, 12)



Air Passengers: ACF and PACF of ddlx

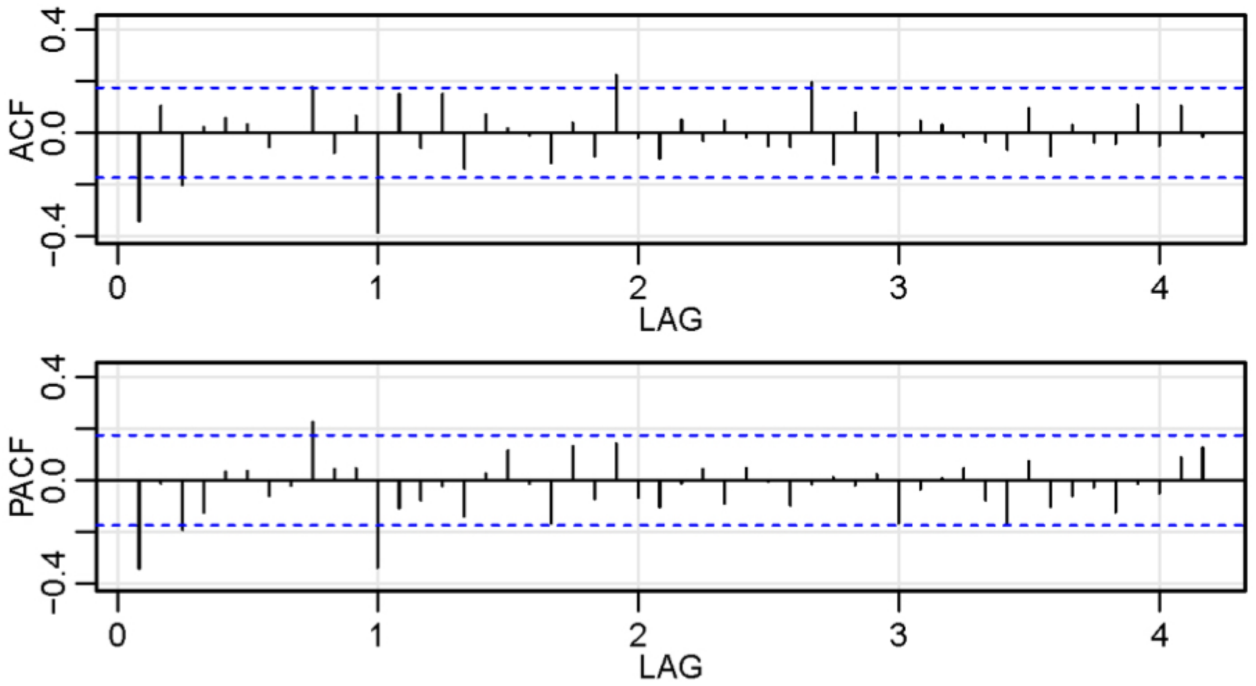


Air Passengers: ACF and PACF of ddlx



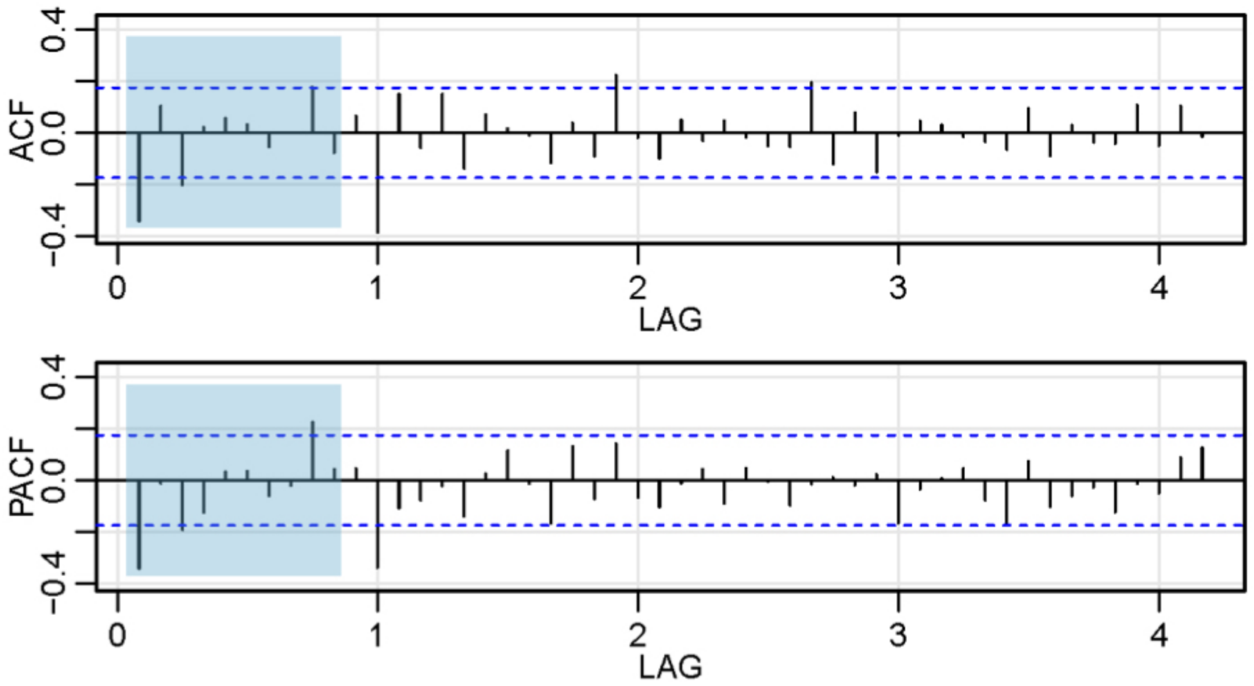
- Seasonal: ACF cutting off at lag 1s (s = 12); PACF tailing off at lags 1s, 2s, 3s...

Air Passengers: ACF and PACF of ddlx



- Seasonal: ACF cutting off at lag 1s (s = 12); PACF tailing off at lags 1s, 2s, 3s...

Air Passengers: ACF and PACF of ddlx



- Seasonal: ACF cutting off at lag 1s (s = 12); PACF tailing off at lags 1s, 2s, 3s...
- Non-Seasonal: ACF and PACF both tailing off

Air Passengers

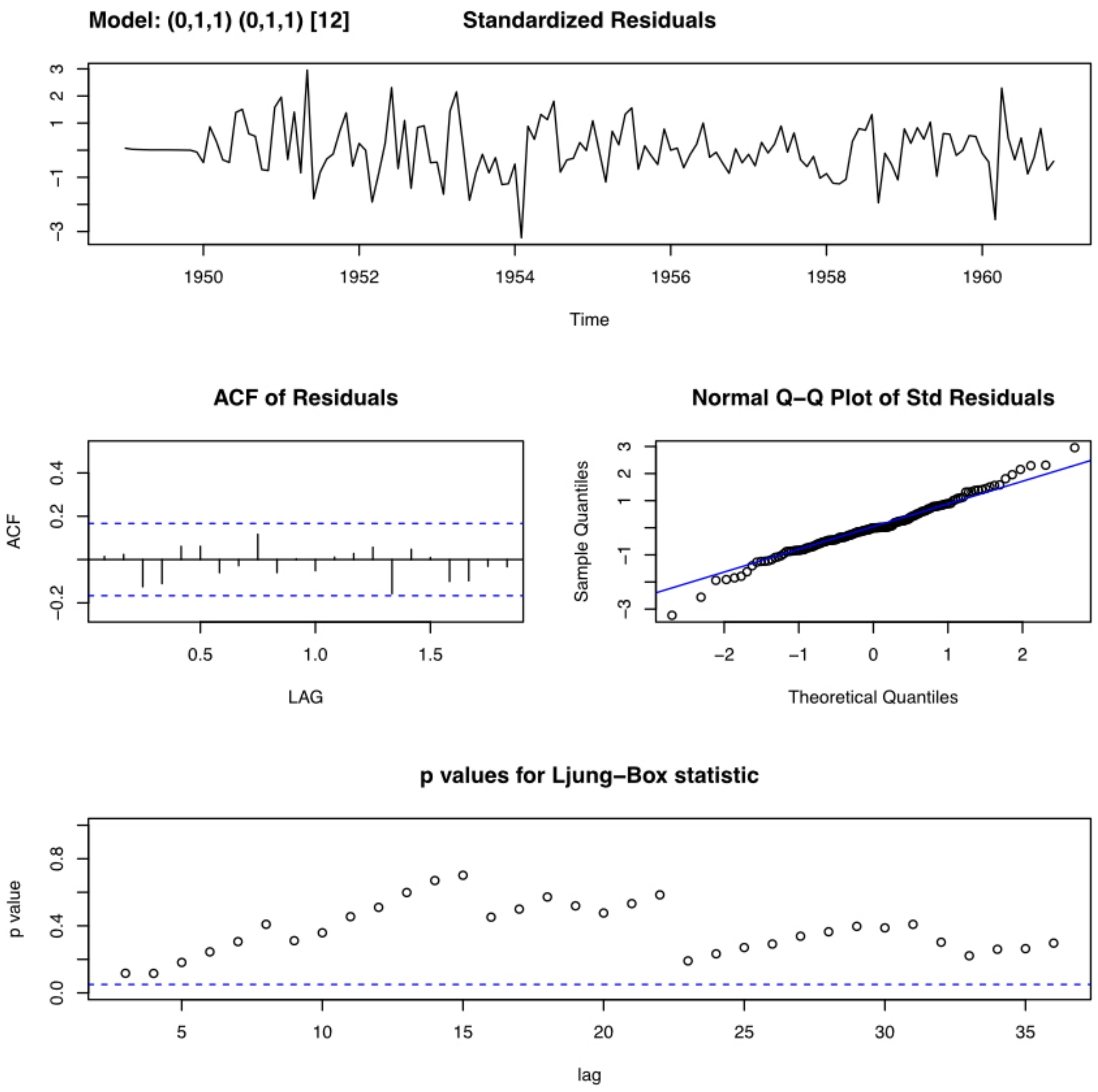
```
airpass_fit1 <- sarima(log(AirPassengers), p = 1,
                                           d = 1, q = 1, P = 0,
                                           D = 1, Q = 1, S = 12)
airpass_fit1$ttable
```

```
     Estimate     SE t.value p.value
ar1    0.1960 0.2475  0.7921  0.4296
ma1   -0.5784 0.2132 -2.7127  0.0075
sma1  -0.5643 0.0747 -7.5544  0.0000
```

```
airpass_fit2 <- sarima(log(AirPassengers), 0, 1, 1, 0, 1, 1, 12)
airpass_fit2$ttable
```

```
     Estimate     SE t.value p.value
ma1   -0.4018 0.0896 -4.4825       0
sma1  -0.5569 0.0731 -7.6190       0
```

Air Passengers



Let's practice!

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Forecasting seasonal ARIMA

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Forecasting ARIMA Processes

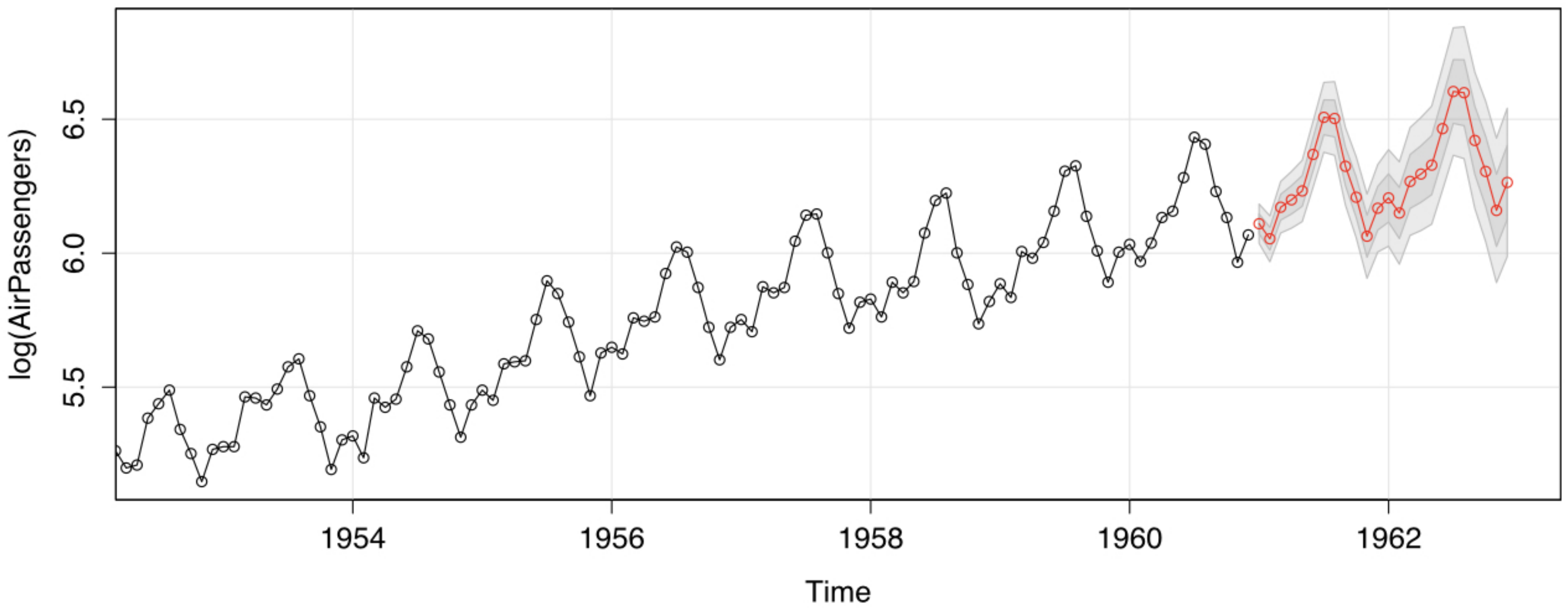
- Once model is chosen, forecasting is easy because the model describes how the dynamics of the time series behave over time
- Simply continue the model dynamics into the future
- In the `astsa` package, use `sarima.for()` for forecasting

Forecasting Air Passengers

- In the previous video, we decided that a

SARIMA$(0, 1, 1) \times (0, 1, 1)_{12}$ model was appropriate

```
sarima.for(log(AirPassengers), n.ahead = 24,
           0, 1, 1, 0, 1, 1, 12)
```



Let's practice!

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Congratulations!

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What you've learned

- How to identify an ARMA model from data looking at ACF and PACF
- How to use integrated ARMA (ARIMA) models for nonstationary time series
- How to cope with seasonality

Don't stop here!

- `astsa` package
- Other DataCamp courses in Time Series Analysis

Thank you!

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