

Pure seasonal models

ARIMA MODELS IN R

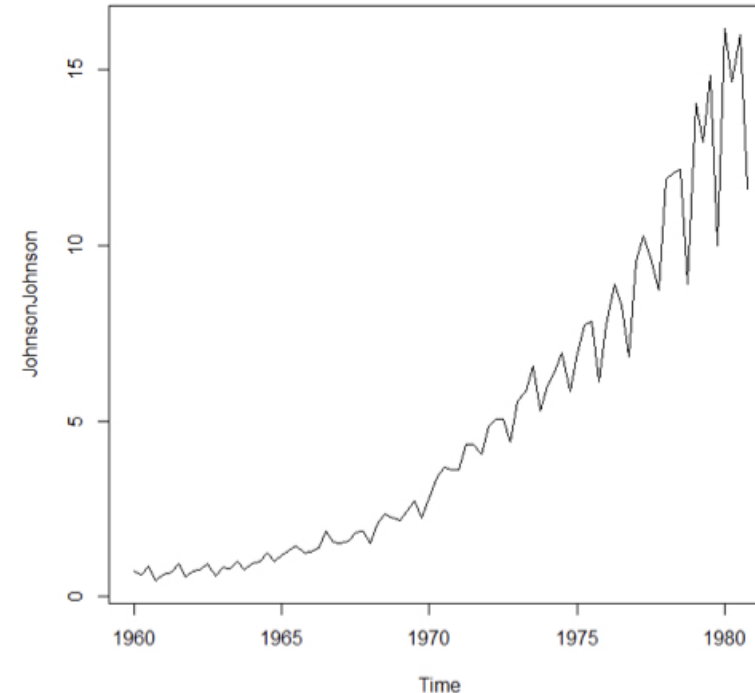
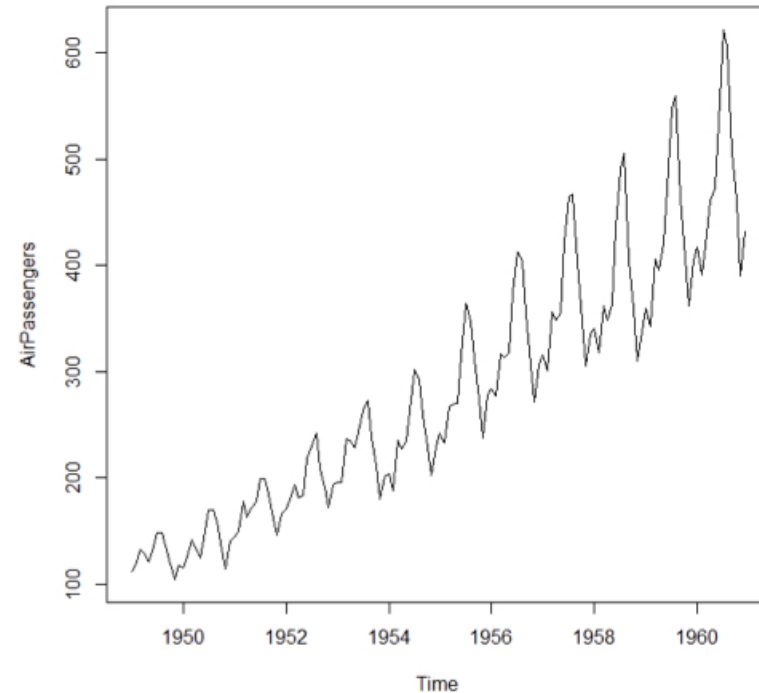


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Pure Seasonal Models

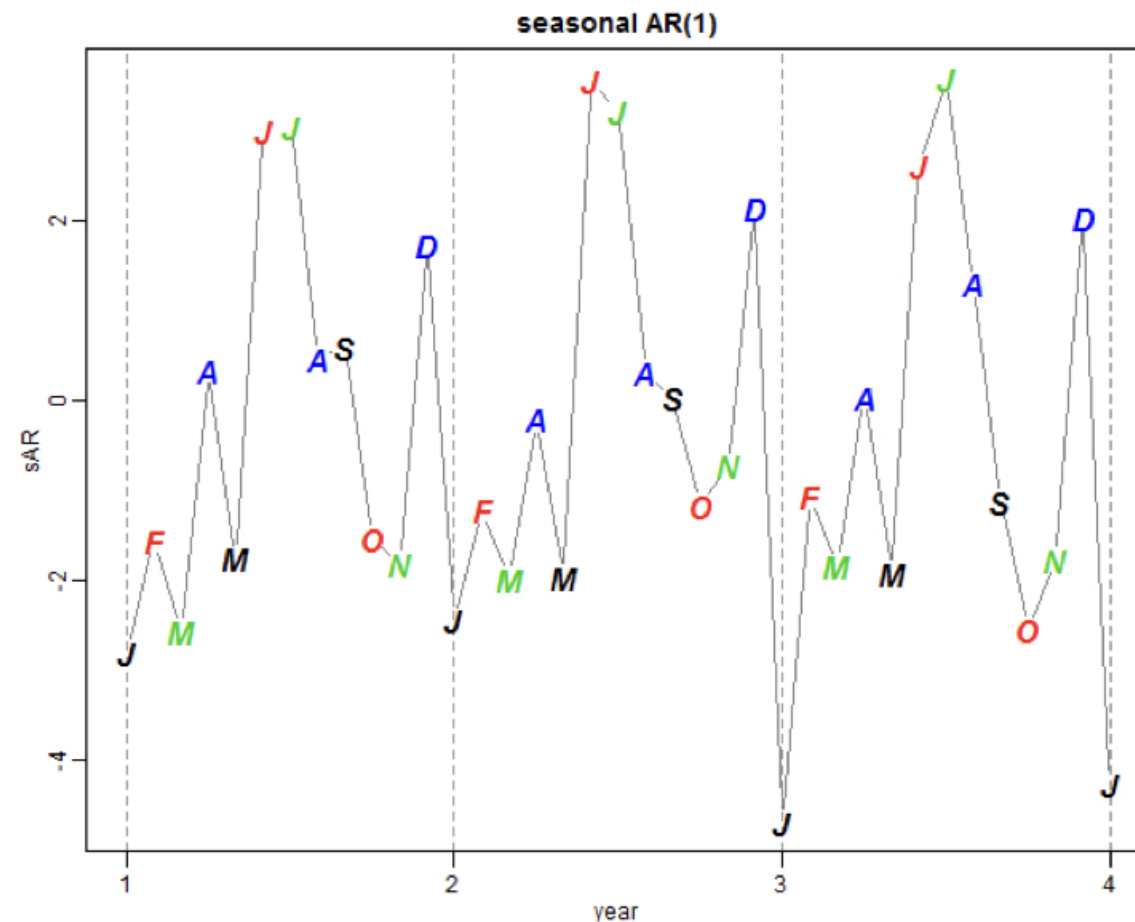
- Often collect data with a known seasonal component
- Air Passengers (1 cycle every $S = 12$ months)
- Johnson & Johnson Earnings (1 cycle every $S = 4$ quarters)



Pure Seasonal Models

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

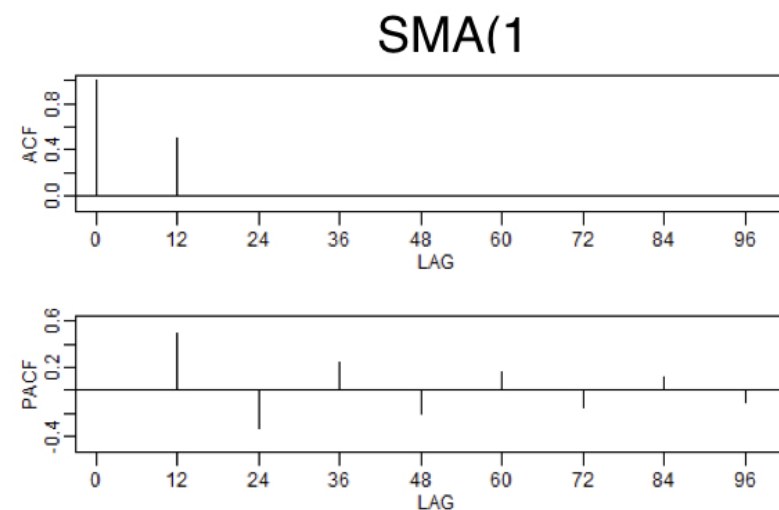
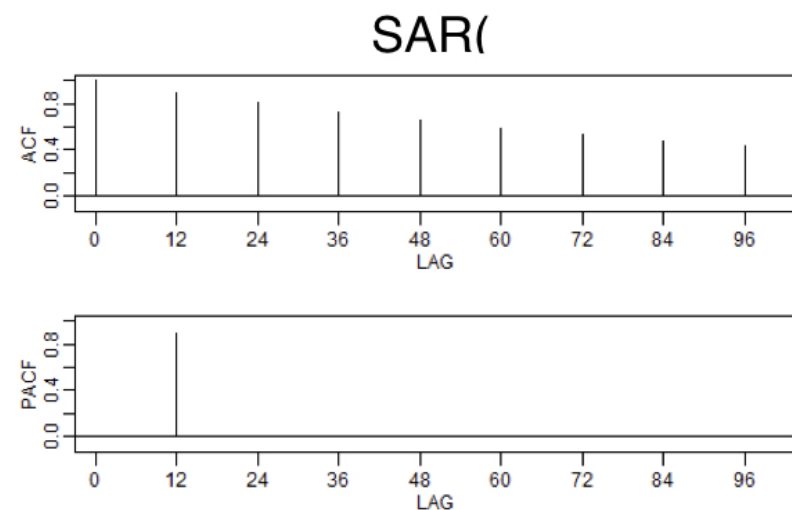
$$X_t = \Phi X_{t-12} + W_t$$



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!
ARIMA MODELS IN R

Mixed seasonal models

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Mixed Seasonal Model

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

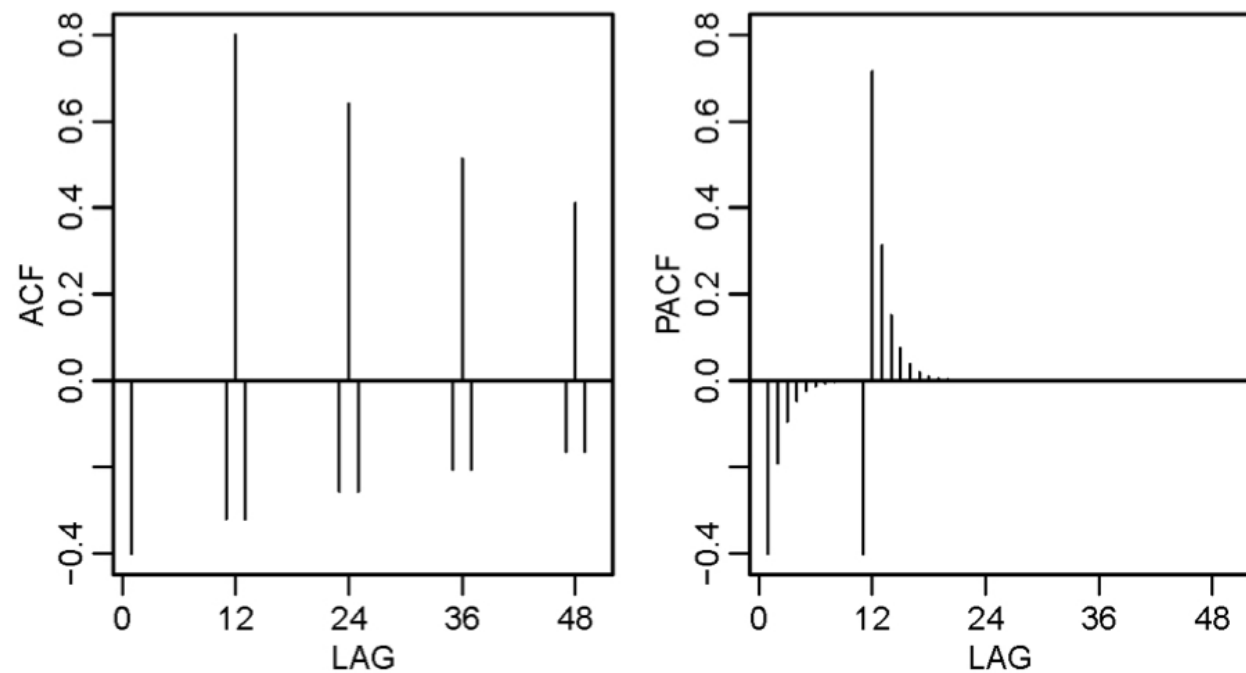
$$X_t = \Phi X_{t-12} + W_t + \theta W_{t-1}$$

- 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:

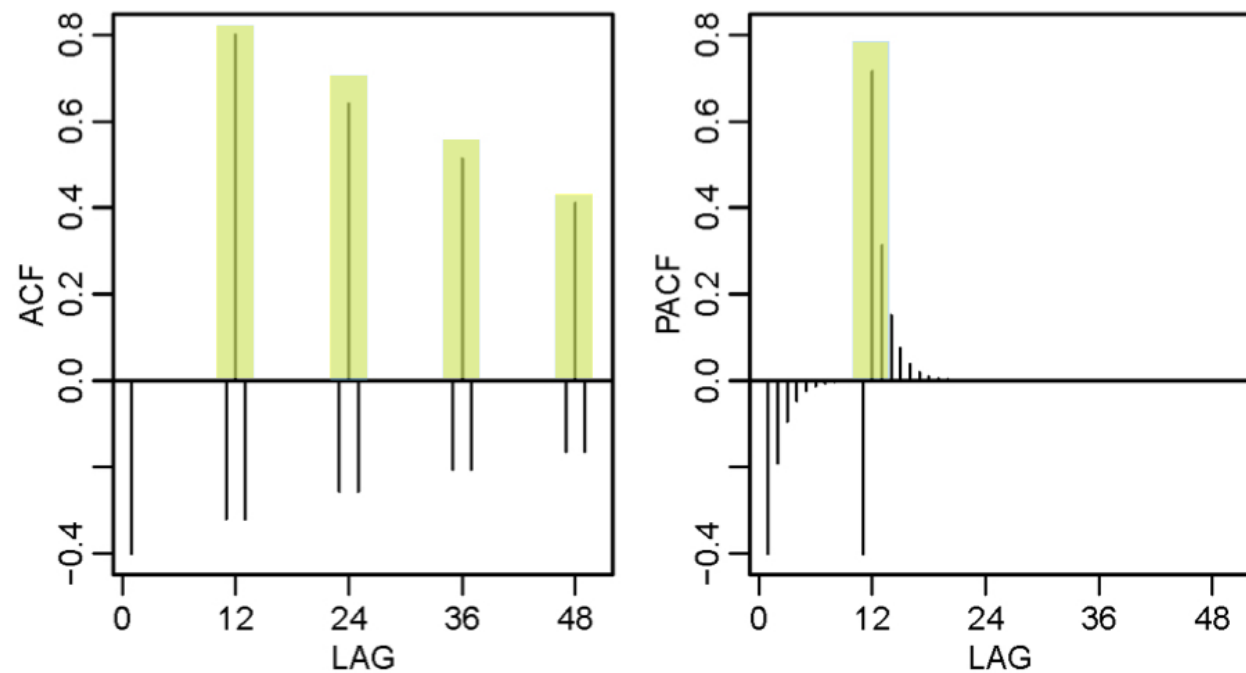
$$X_t = .8X_{t-12} + W_t - .5W_{t-1}$$



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

- The ACF and PACF for this mixed model:

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

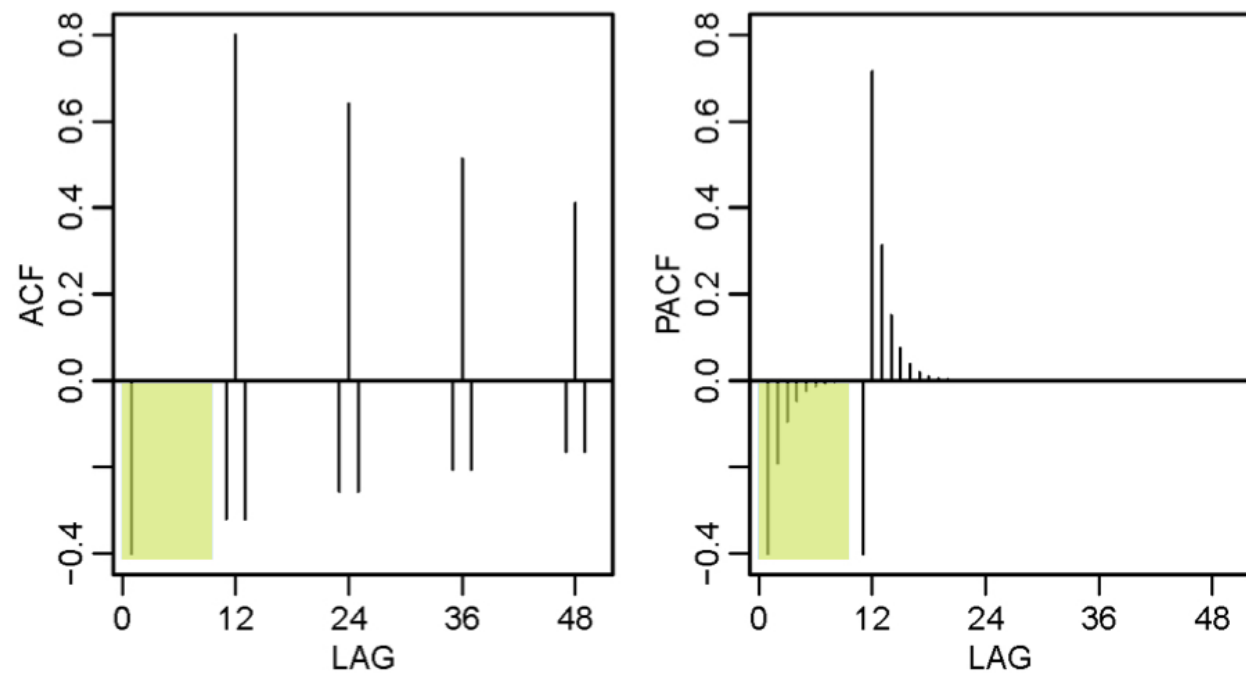


Seasonal

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

- The ACF and PACF for this mixed model:

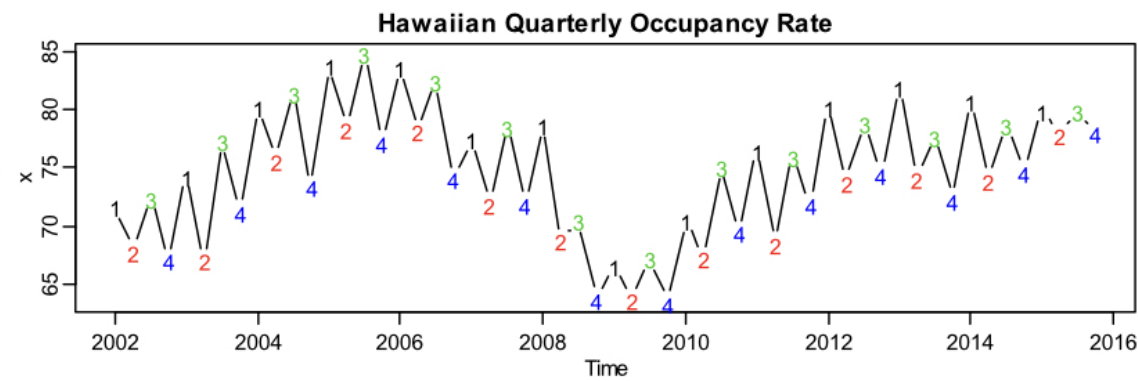
$$X_t = .8X_{t-12} + W_t - .5W_{t-1}$$



Non-seasonal

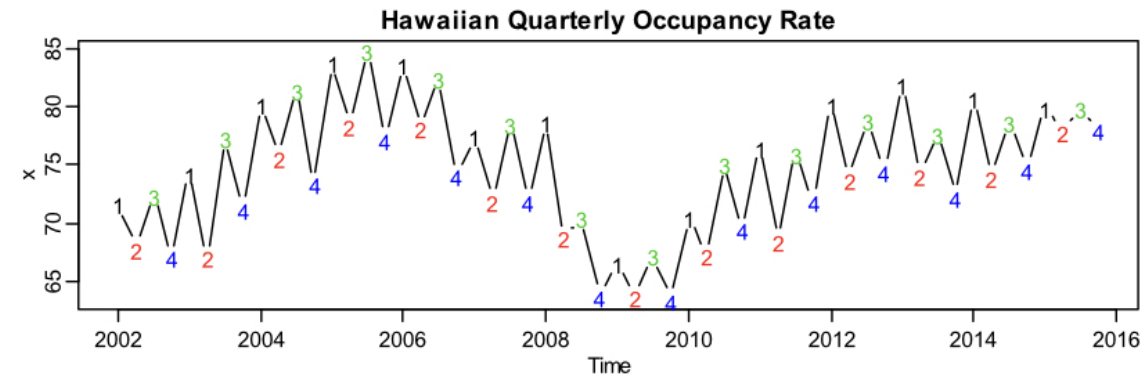
Seasonal Persistence

Quarterly Occupancy Rate:
% rooms filled

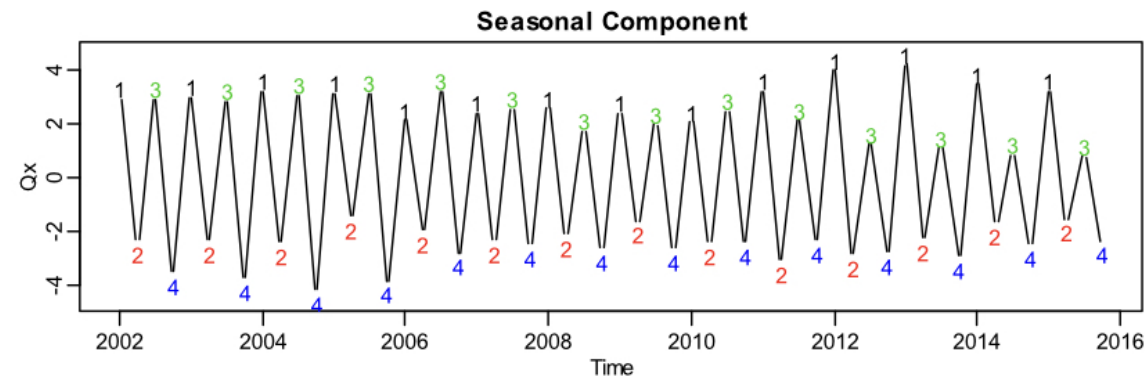


Seasonal Persistence

Quarterly Occupancy Rate:
% rooms filled

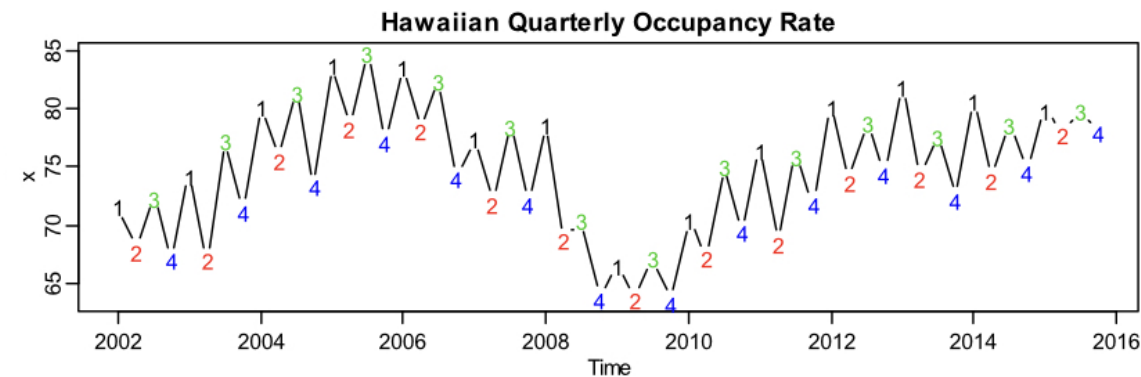


Seasonal Component:
this year vs. last year
 $Q1 \approx Q1$, $Q2 \approx Q2$,
 $Q3 \approx Q3$, $Q4 \approx Q4$

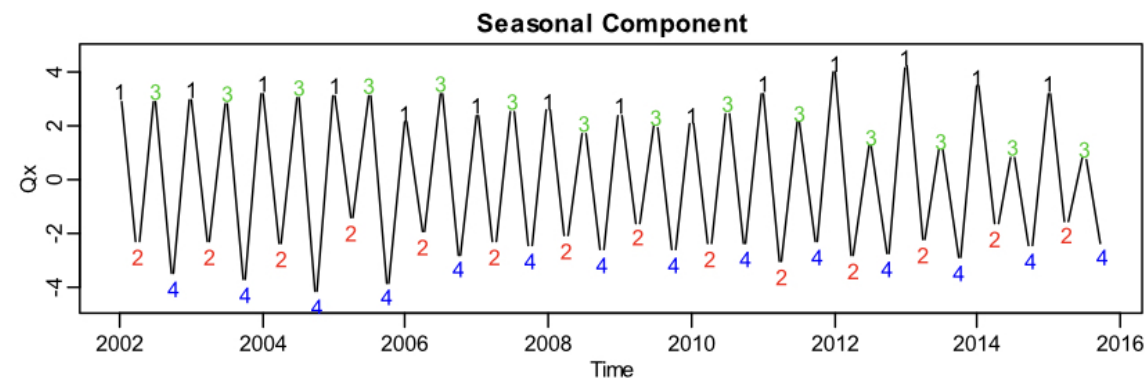


Seasonal Persistence

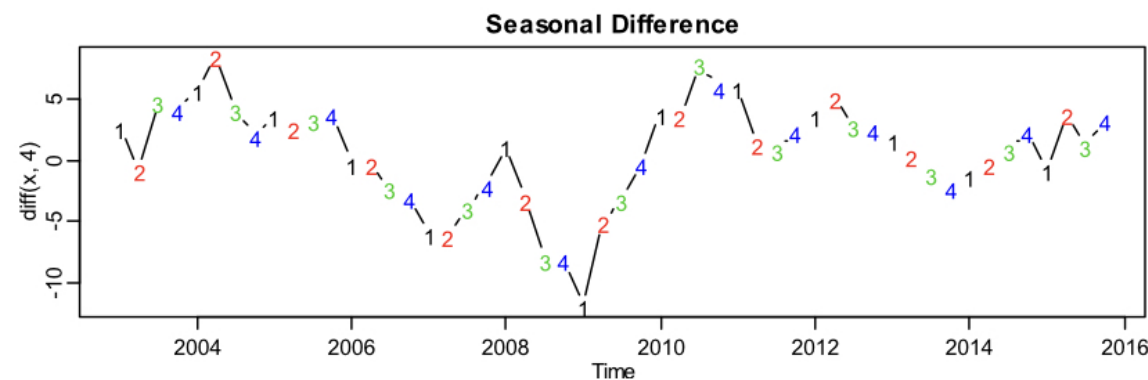
Quarterly Occupancy Rate:
% rooms filled



Seasonal Component:
this year vs. last year
 $Q1 \approx Q1$, $Q2 \approx Q2$,
 $Q3 \approx Q3$, $Q4 \approx Q4$



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



Air Passengers

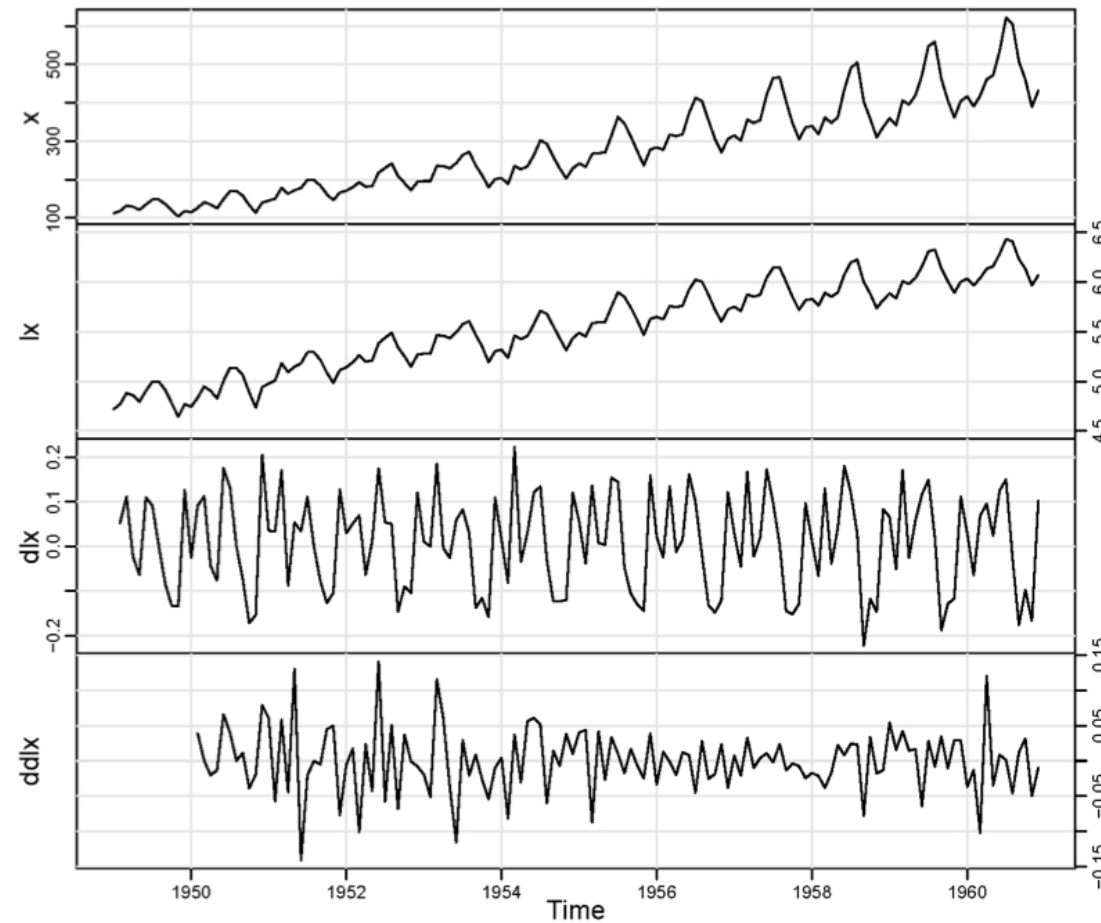
- Monthly totals of international airline passengers, 1949-1960

x: AirPassengers

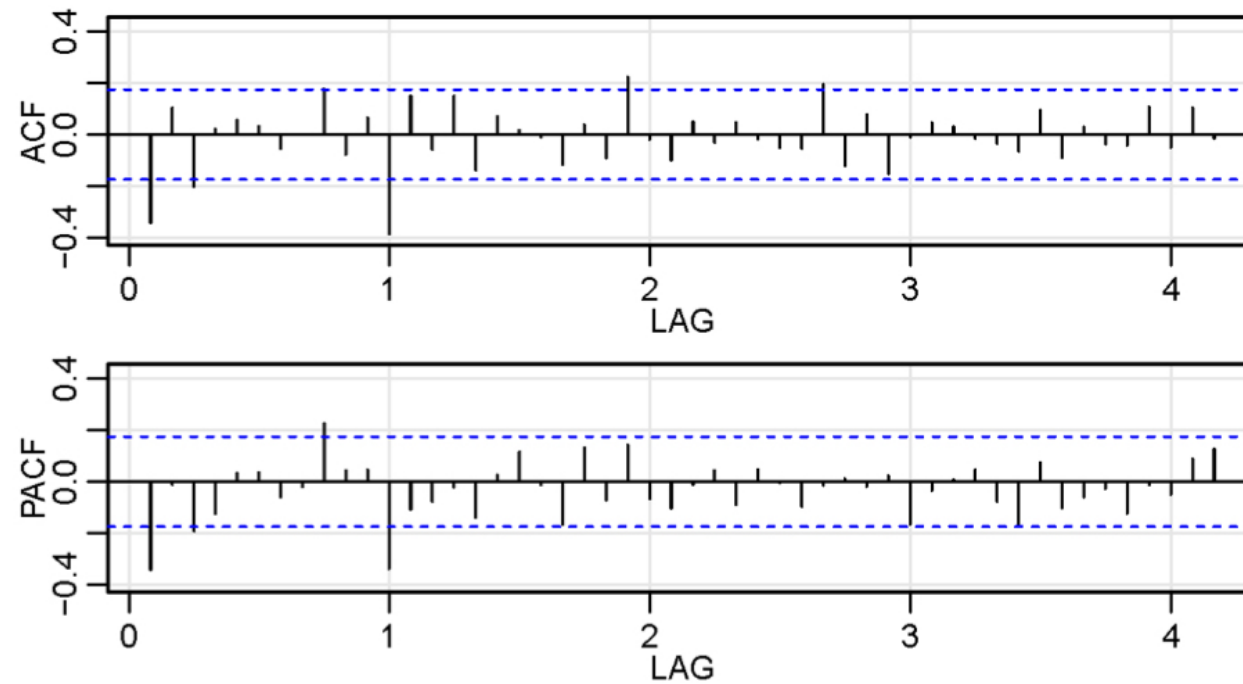
lx: $\log(x)$

dlx: $\text{diff}(lx)$

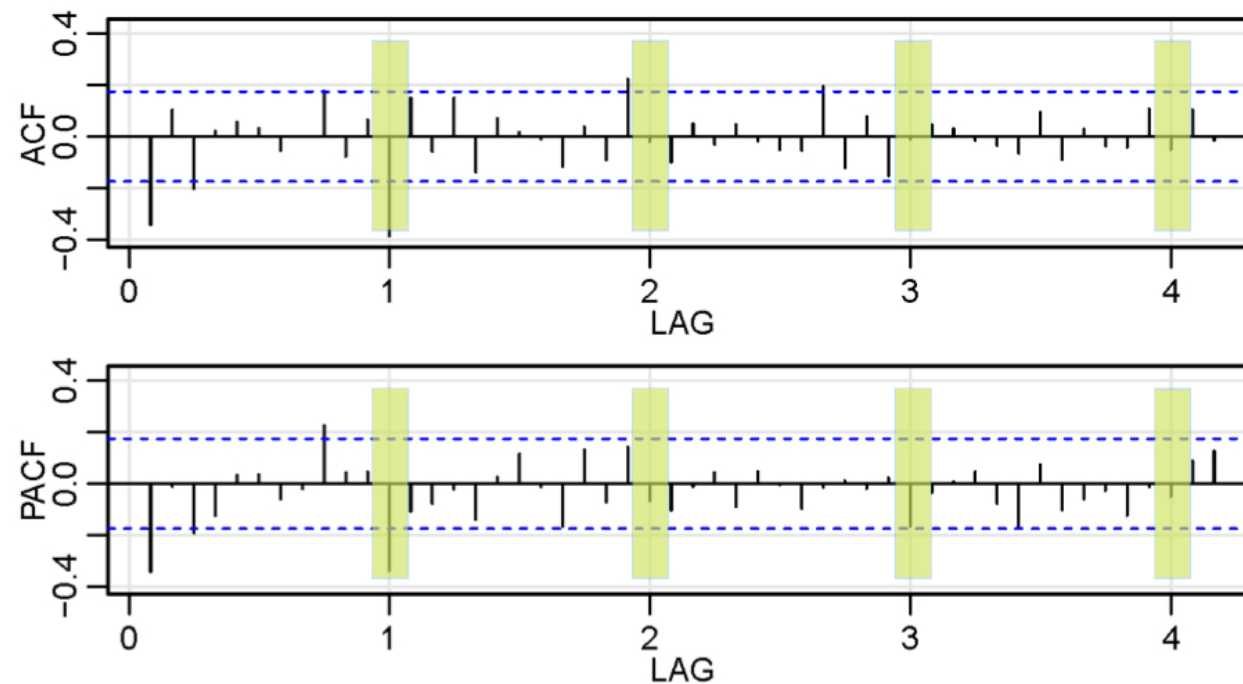
ddlx: $\text{diff}(dlx, 12)$



Air Passengers: ACF and PACF of ddx

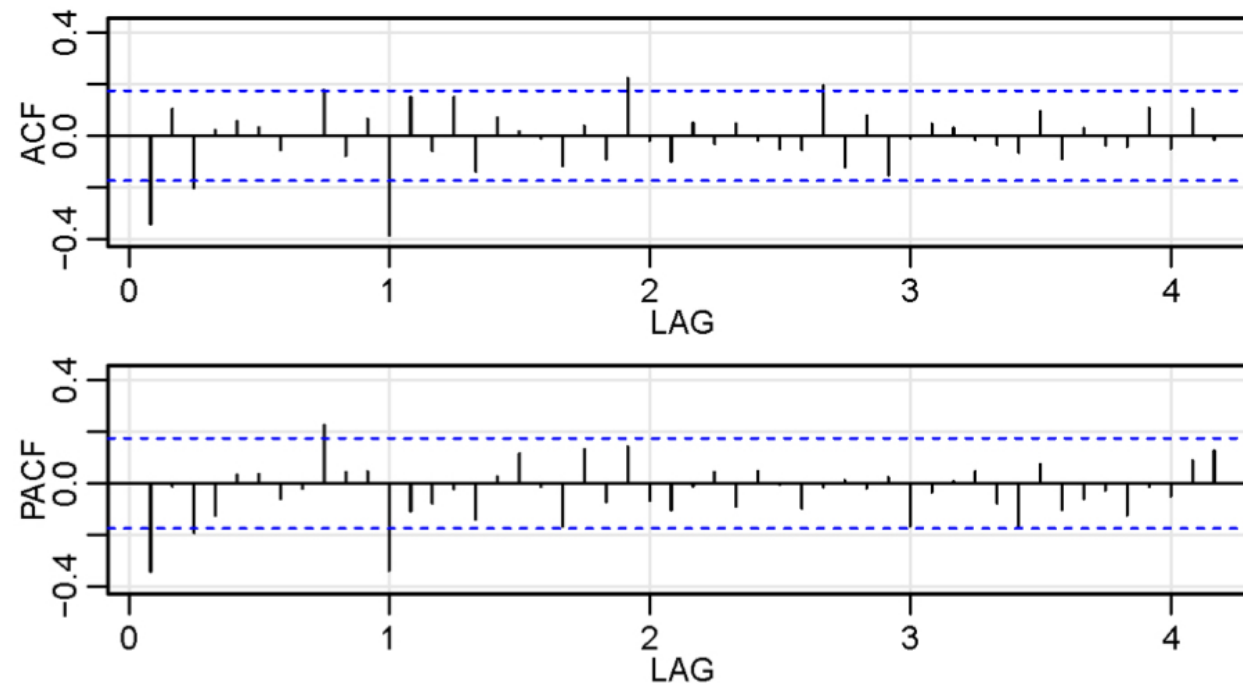


Air Passengers: ACF and PACF of `ddlx`



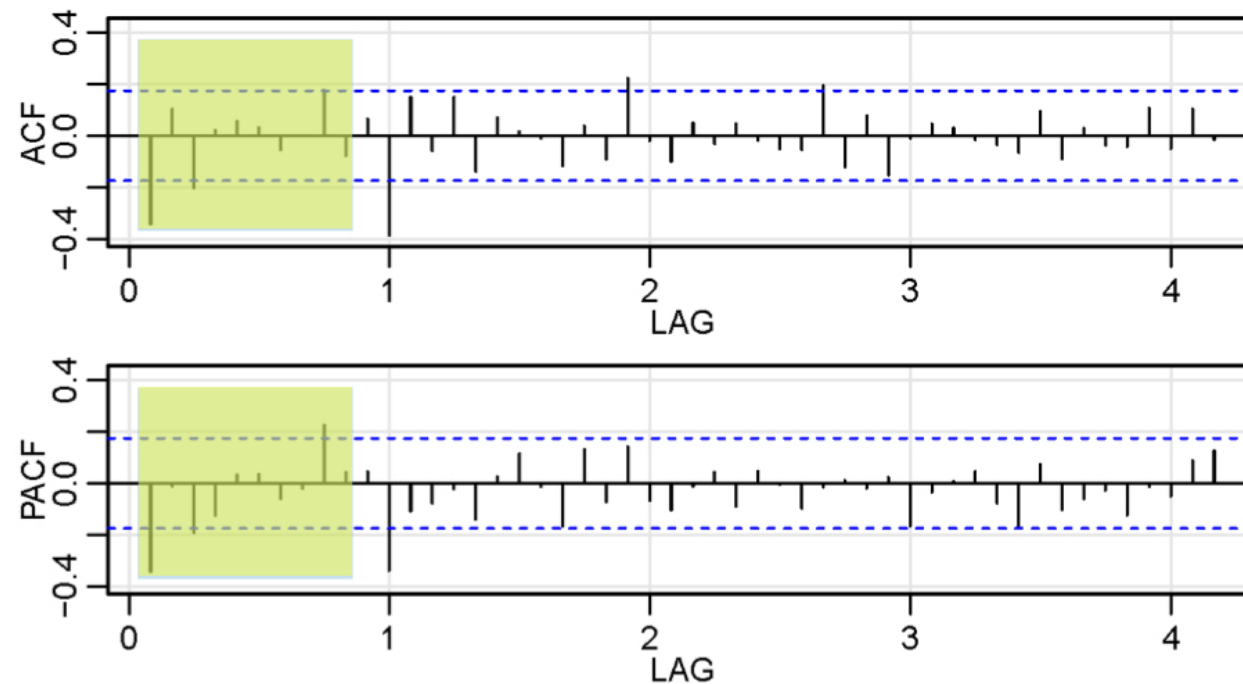
- Seasonal: ACF cutting off at lag 1s ($s = 12$); PACF tailing off at lags 1s, 2s, 3s...

Air Passengers: ACF and PACF of ddx



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

Air Passengers: ACF and PACF of ddx



- 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

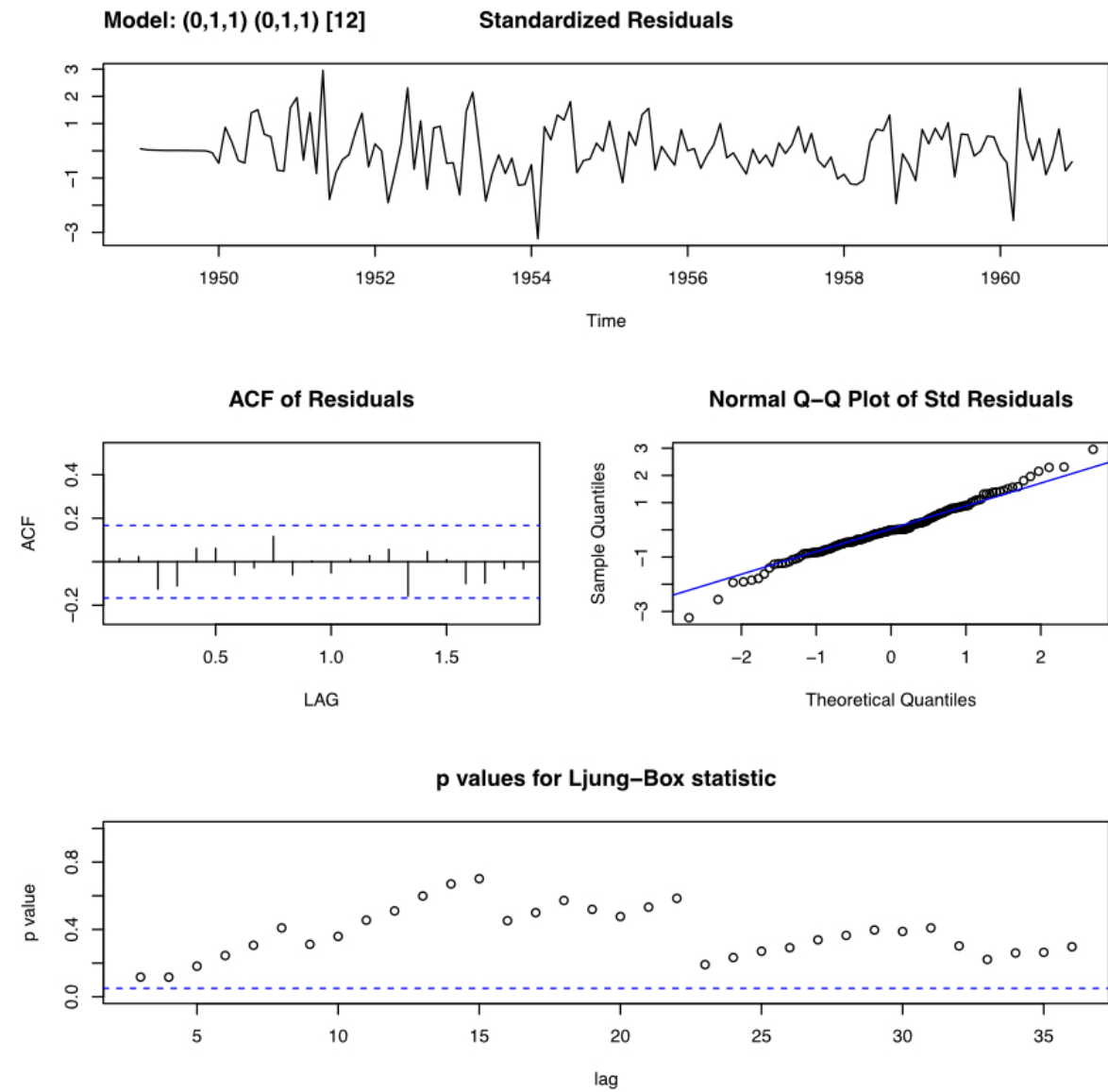
```
airpass_fit1 <- sarima(log(AirPassengers), p = 1,  
                      d = 1, q = 1, P = 0,  
                      D = 1, Q = 1, S = 12)  
  
airpass_fit1$tttable
```

	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$tttable
```

	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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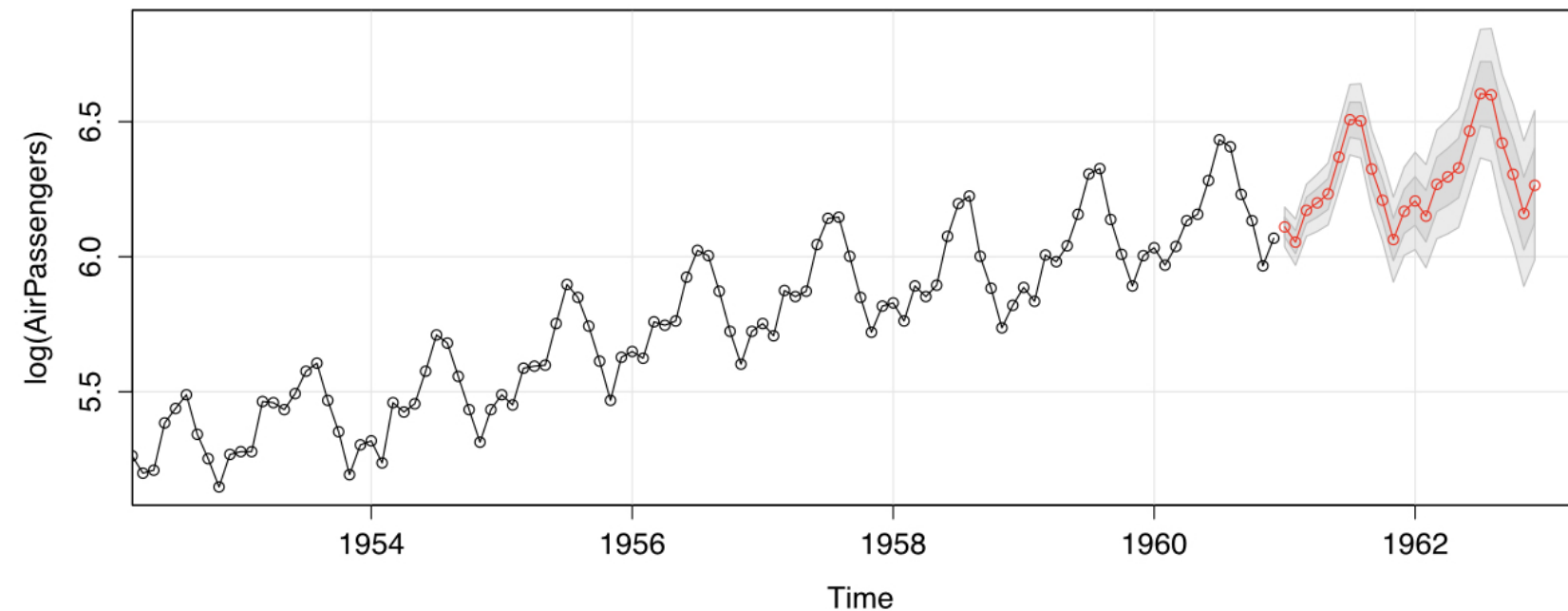
Forecasting ARIMA Processes

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

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



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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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