Time Series Analysis

Lecture 4

Mixed Autoregressive Moving Average (ARMA) Models

Autoregressive Integrated Moving Average (ARIMA) Models

Seasonal ARIMA (SARIMA) Models

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ARIMA Model: Modeling With the Simulated Data

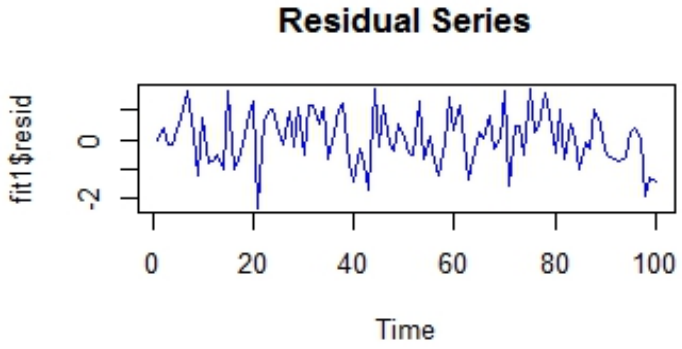
Estimation Using the Simulated Data

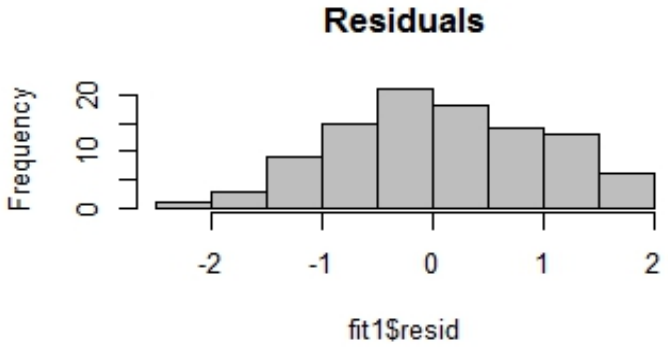
- Note that both of the estimated coefficients are not statistically different from their "true" values.

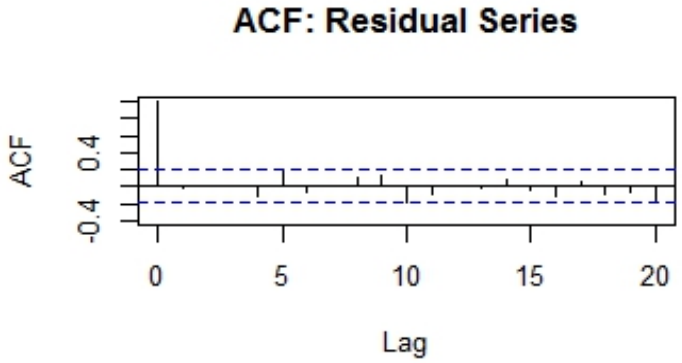
```
> fit1 <- arima(x1, order=c(1,1,1))
> summary(fit1)
Series: x1
ARIMA(1,1,1)

Coefficients:
          ar1   ma1
      0.36  0.32
s.e.  0.18  0.19

sigma^2 estimated as 0.827:  log likelihood=-131
AIC=269   AICc=269   BIC=276

Training set error measures:
                    ME RMSE  MAE MPE MAPE MASE    ACF1
Training set 0.054  0.9 0.75 -23   61 0.82 -0.0028
```

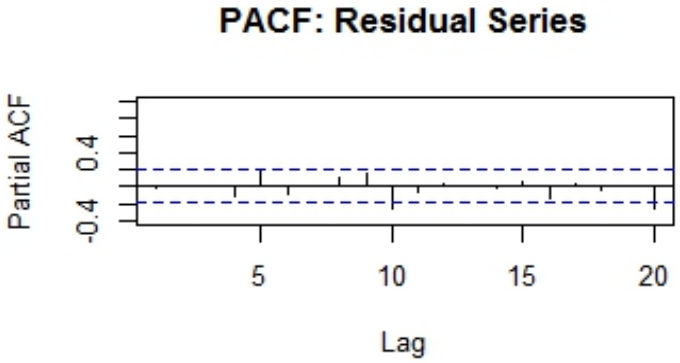
Model Diagnostics Using Residuals

Both the graphical evidence and the Ljung-Box statistic do not reject the residual series as a realization of a white noise process.









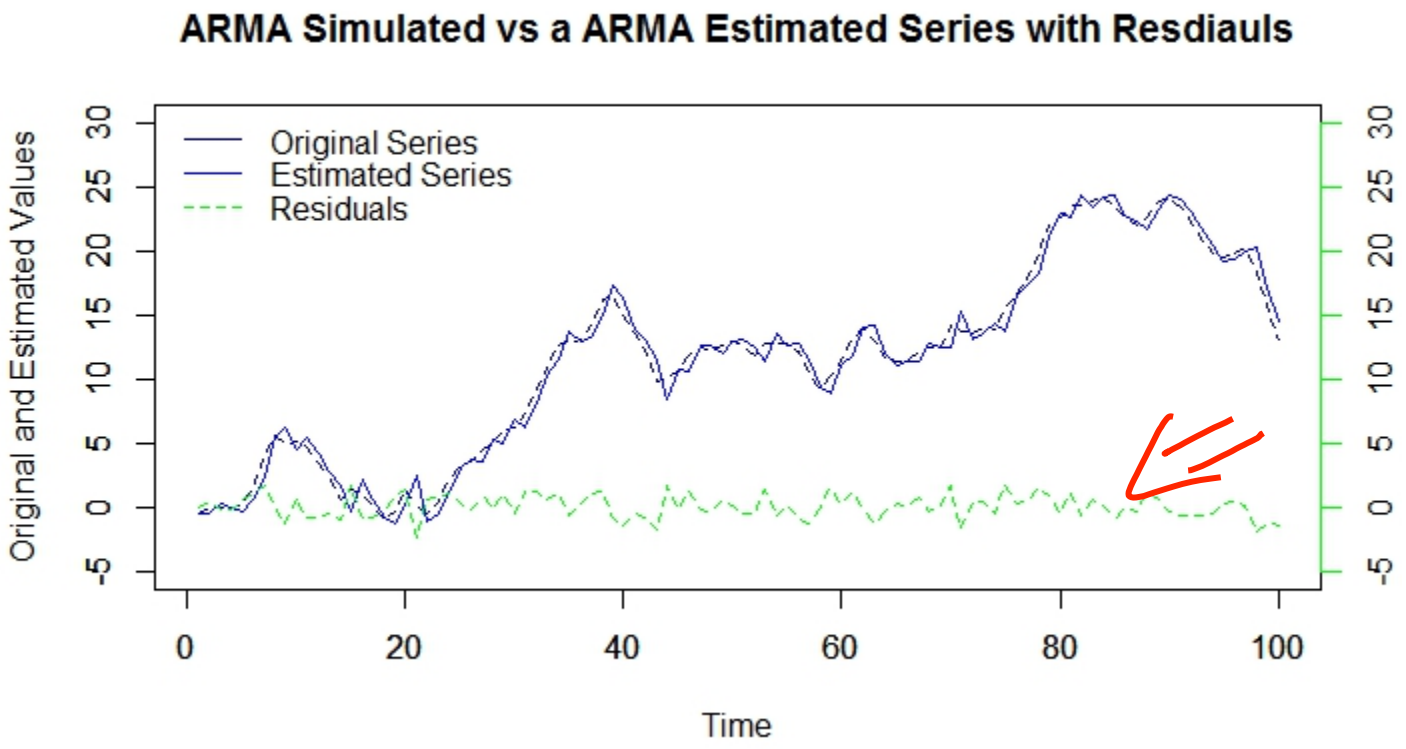

```
 Box-Ljung test

data:  fit1$resid
X-squared = 0.0008, df = 1, p-value = 0.9775
```

Model Performance Evaluation

The model fit is good; it can even capture some of the "turns" in the series.

Descriptive Stat

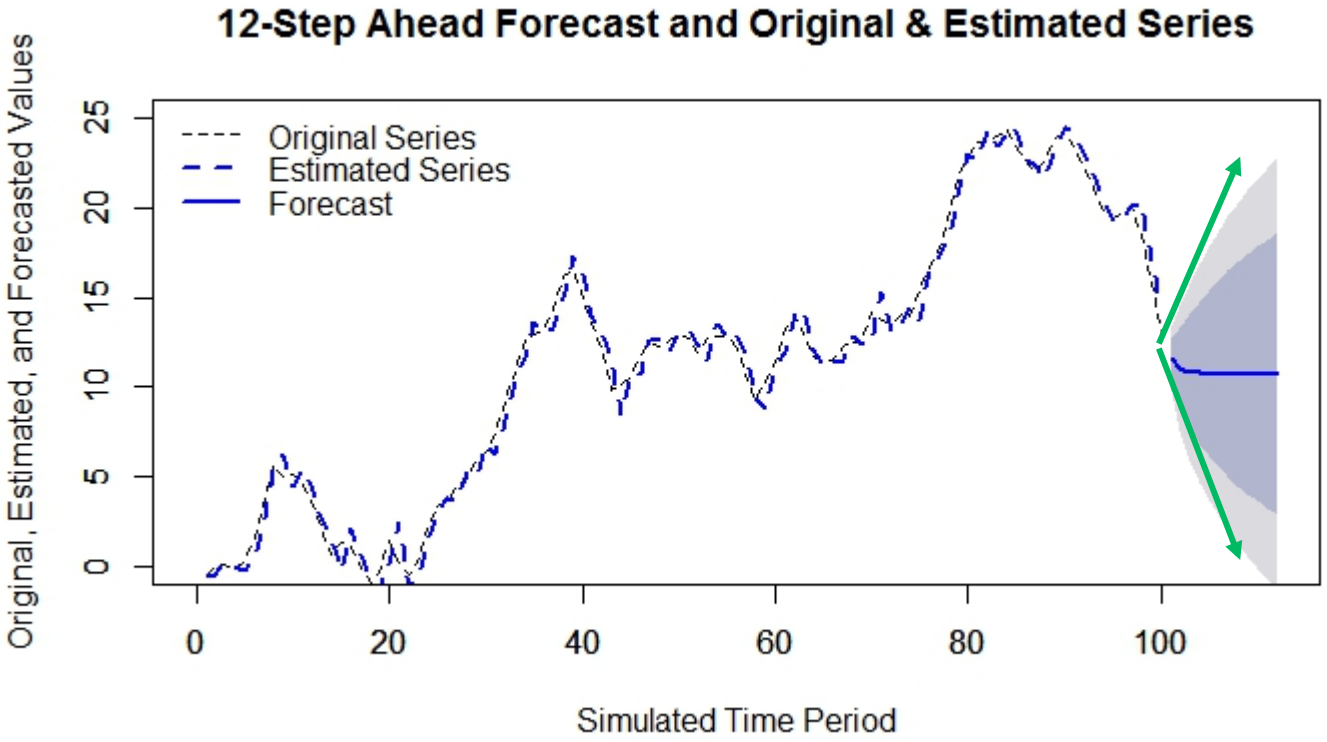
Statistic	N	Mean	St. Dev.	Min	Max
x1	100	12.0	7.4	-0.9	24.0
fitted.fit1.	100	12.0	7.5	-1.3	24.0
fit1.resid	100	0.1	0.9	-2.4	1.7



Forecasting

While the model fit is good, this model produces only a forecast that is a "flat" line.

	Point Forecast	Lo 80	Hi 80	Lo 95	Hi 95
101	12	10.4	13	9.78	13
102	11	8.7	13	7.53	15
103	11	7.6	14	5.93	16
104	11	6.8	15	4.68	17
105	11	6.1	15	3.64	18
106	11	5.5	16	2.73	19
107	11	5.0	16	1.92	20
108	11	4.5	17	1.18	20
109	11	4.0	17	0.49	21
110	11	3.6	18	-0.16	22
111	11	3.2	18	-0.77	22



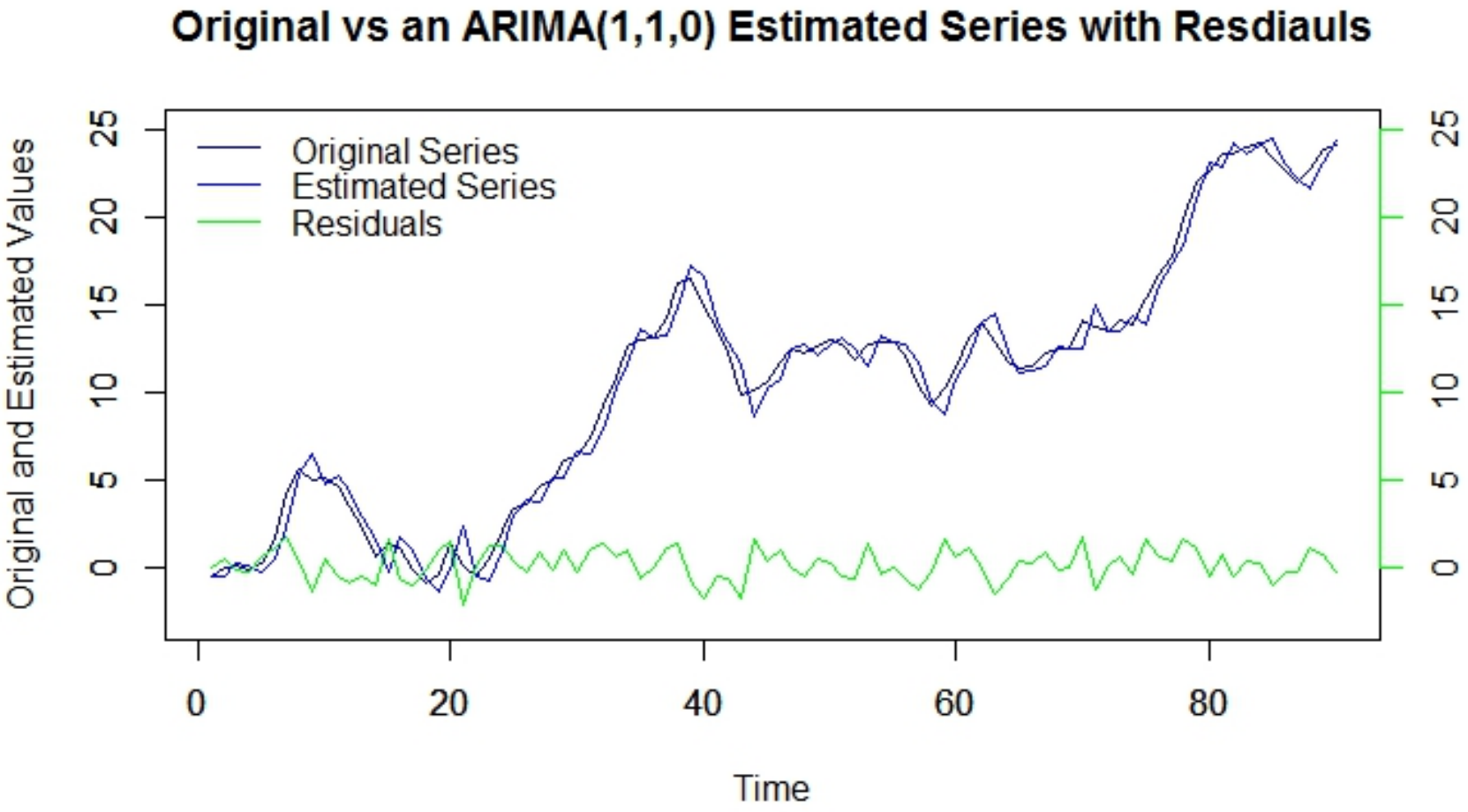
Back-Testing/Out-of-Sample Forecasting

- Re-estimate the model using an ARIMA(1,1,0).
- The AR coefficient is highly significant.

```
Series: x1[1:(length(x1) - 10)]
ARIMA(1,1,0)

Coefficients:
         ar1
      0.52
s.e.  0.09

sigma^2 estimated as 0.83:  log likelihood=-118
AIC=240   AICc=240   BIC=245

Training set error measures:
                    ME RMSE  MAE MPE MAPE MASE  ACF1
Training set 0.13 0.91 0.74 -18   68 0.85 0.053
```

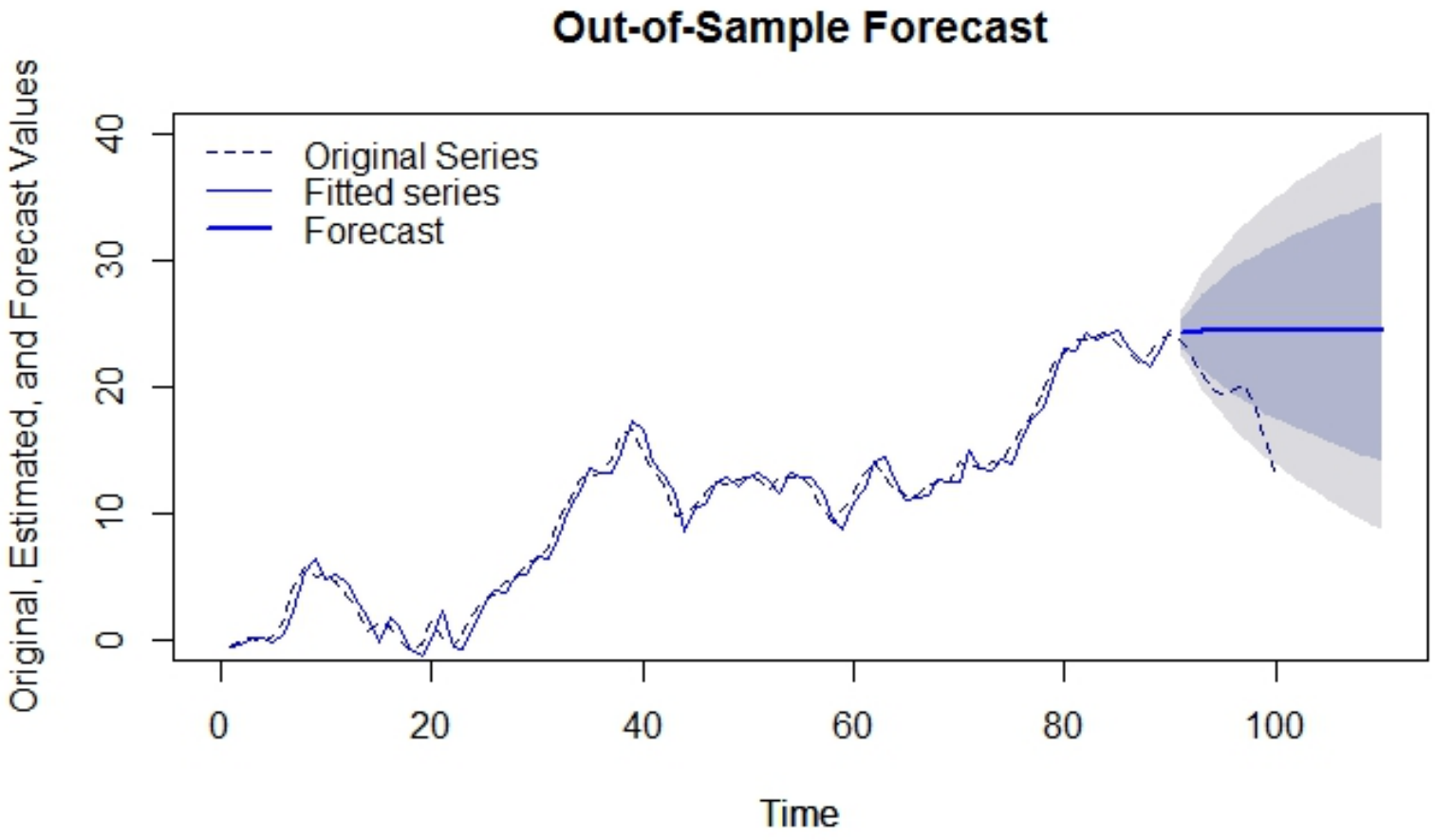
Back-Testing/Out-of-Sample Forecasting

- The model fit is very good.
- The residuals appear to be white noise.



Back-Testing/Out-of-Sample Forecasting

- Although the fit is good, only the 1-step ahead forecast is close for reasons we explained before



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