Time Series Analysis
Lecture 3

Autoregressive Models and Moving Average Models

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Moving Average Models

Modeling (i.e., Estimation, Model Diagnosis, Model Performance Evaluation, and Forecasting) Using Simulated Data

Estimation Results of a MA(2) Model

- Using the simulated data from the MA2 models with parameters (0.5, -0.4), estimate a MA(2) model.
- Both of the estimated MA parameters are not statistically different from 0.5 and -0.4.
- The estimated intercept is not statistically significant.

```
Series: ma2c2
ARIMA(0,0,2) with non-zero mean

Coefficients:
        ma1      ma2  intercept
      0.475  -0.525      0.034
s.e.  0.088   0.084      0.085

sigma^2 estimated as 0.796:  log likelihood=-133
AIC=273   AICc=274   BIC=284
```

MA(2) Model: Original, Fitted, and Residual Values

- It is always a good idea to examine the descriptive statistics and list a few values of the original series, the estimated values, and the residual values.

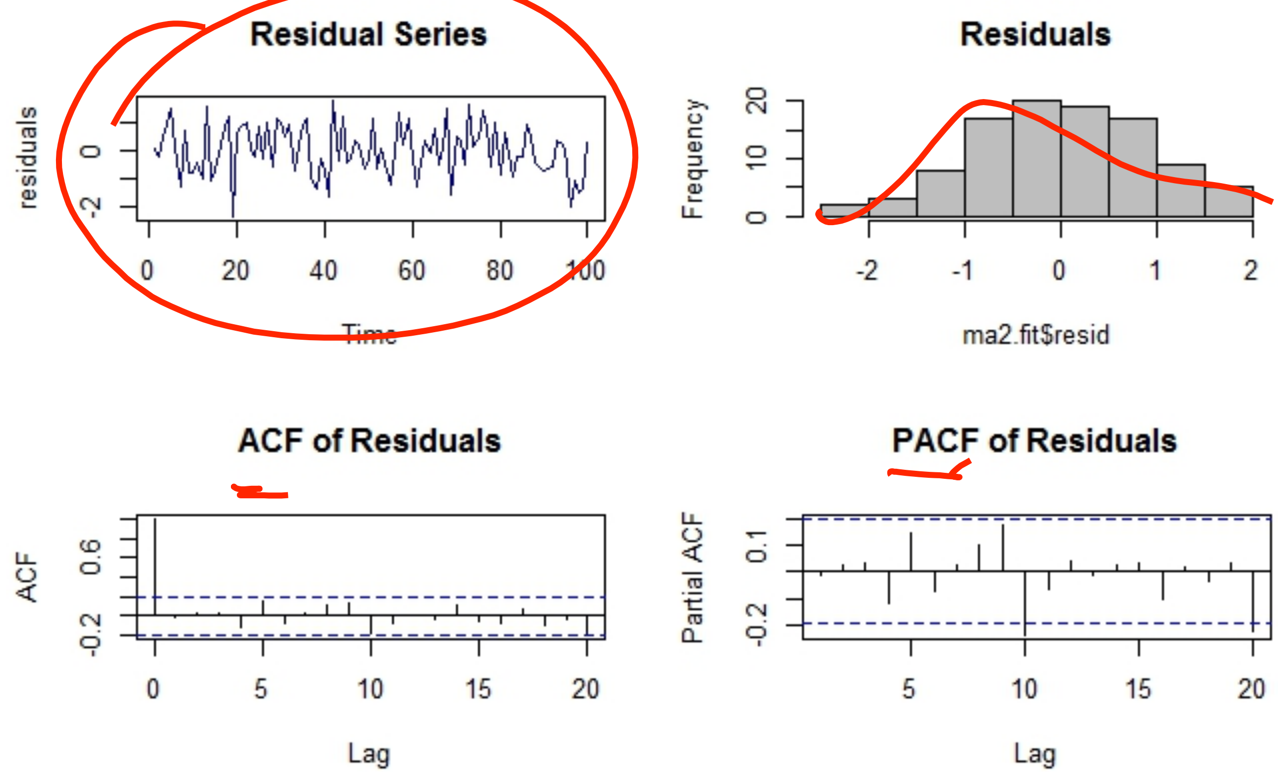
```
> df<-data.frame(cbind(ma2c2, fitted(ma2.fit), ma2.fit$resid))
> stargazer(df, type="text")

==================================================
Statistic         N   Mean  St. Dev.  Min    Max
--------------------------------------------------
ma2c2            100 0.027  1.100    -2.400 2.400
fitted.ma2.fit.  100 0.027  0.610    -1.600 1.700
ma2.fit.resid    100 0.001  0.900    -2.400 1.800
--------------------------------------------------
```

```
> head(cbind(ma2c2, fitted(ma2.fit), ma2.fit$resid),10)
       ma2c2 fitted(ma2.fit) ma2.fit$resid
 [1,]  0.075          0.0413         0.033
 [2,] -0.242         -0.0093        -0.233
 [3,]  0.529          0.0219         0.507
 [4,]  1.319          0.3856         0.933
 [5,]  1.745          0.2299         1.515
 [6,]  0.293          0.1371         0.156
 [7,] -2.018         -0.7243        -1.294
 [8,]  0.174         -0.4995         0.673
 [9,]  0.133          0.8989        -0.766
[10,] -1.435         -0.6438        -0.791
```

MA(2) Model: Examining the Residual Values

- All of the graphical evidence point to the residuals mimicking white noise
- The Ljung-Box test of residual dynamics cannot reject the null hypothesis that the independence of the residual series.



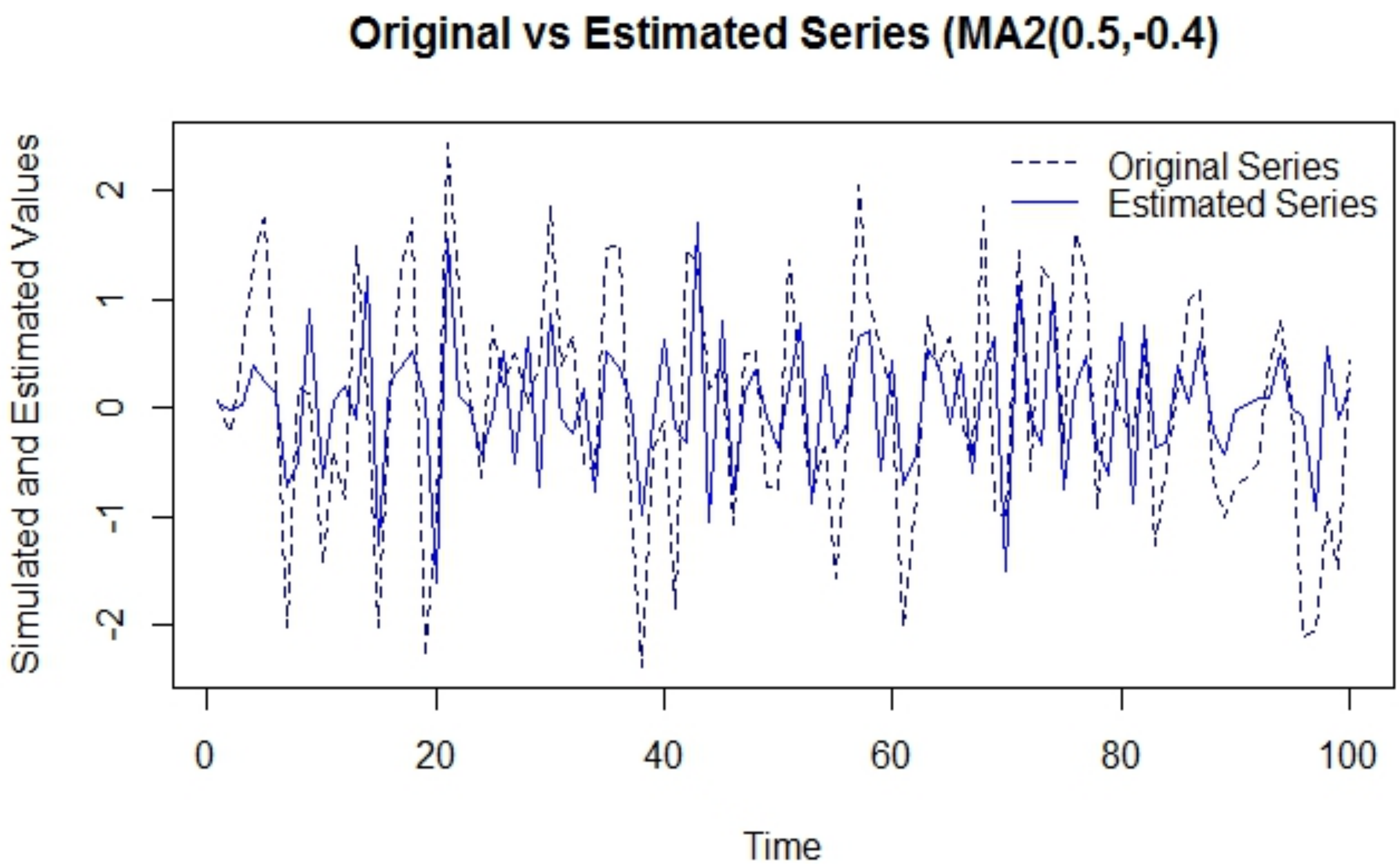

```
> Box.test(ma2.fit$resid, type="Ljung-Box")

 Box-Ljung test

data:  ma2.fit$resid
X-squared = 0.03, df = 1, p-value = 0.8623
```

Model Performance Evaluation: In-Sample Fit

- The pointwise fit is not perfect.
- However, remember that these are point estimates.



Forecasting

- Note that the forecast after the third step ahead is a constant; this is the feature of MA(2) models.
- This holds true for the high and low forecasts.

```
Model Information:
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Error measures:
                  ME RMSE  MAE MPE MAPE MASE   ACF1
Training set 0.00071 0.89 0.74  56  151 0.65 -0.017

Forecasts:
    Point Forecast Lo 80 Hi 80 Lo 95 Hi 95
101          0.880 -0.27   2.0 -0.88   2.6
102         -0.102 -1.37   1.2 -2.04   1.8
103          0.034 -1.37   1.4 -2.11   2.2
104          0.034 -1.37   1.4 -2.11   2.2
105          0.034 -1.37   1.4 -2.11   2.2
106          0.034 -1.37   1.4 -2.11   2.2
107          0.034 -1.37   1.4 -2.11   2.2
108          0.034 -1.37   1.4 -2.11   2.2
109          0.034 -1.37   1.4 -2.11   2.2
110          0.034 -1.37   1.4 -2.11   2.2
```
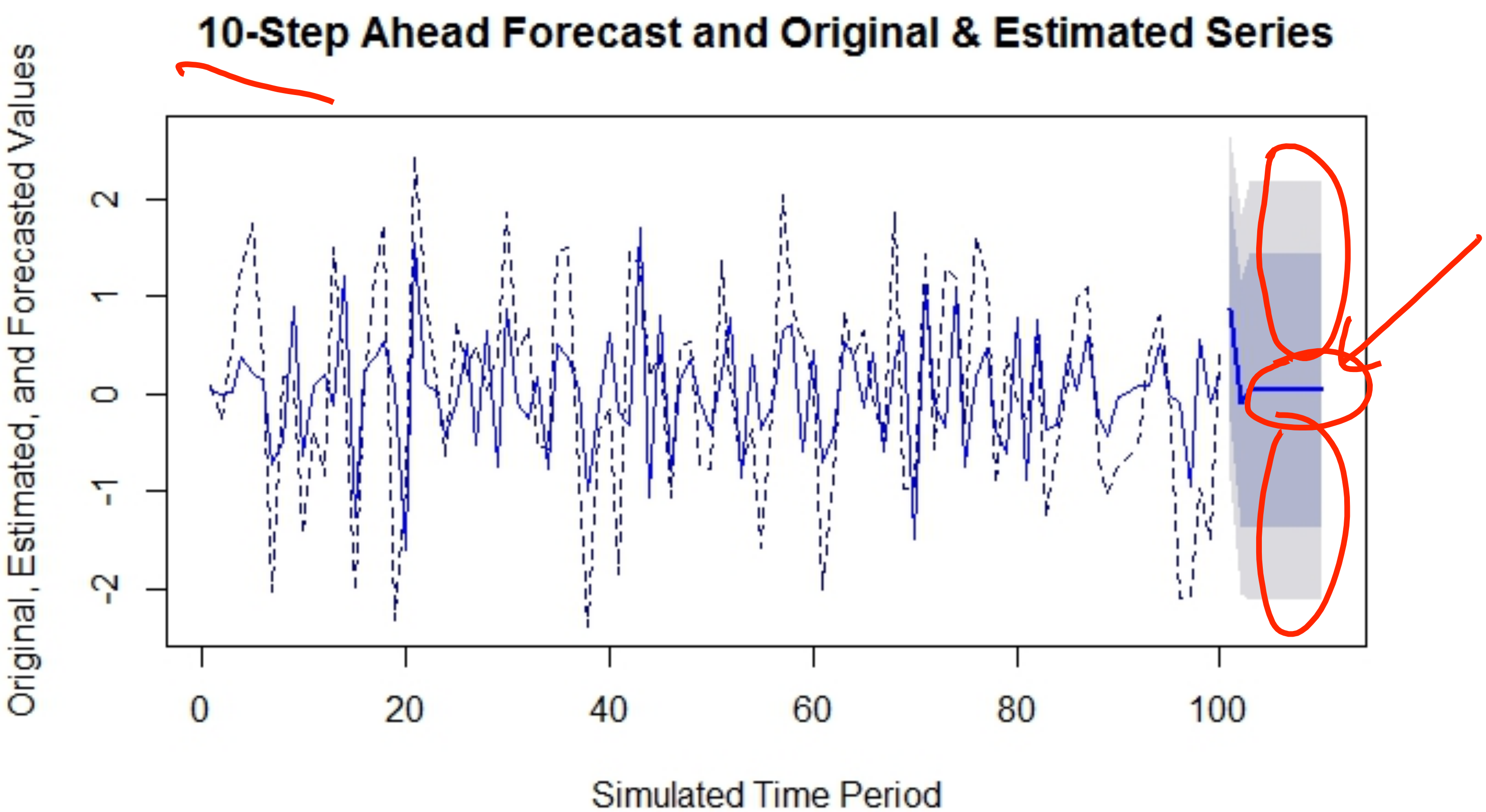

Forecasting (2)

- The following graph plots the original series, overlaid with the estimated series, a 10-step-ahead forecast series, and the confidence interval of the forecast.



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