ARIMA model

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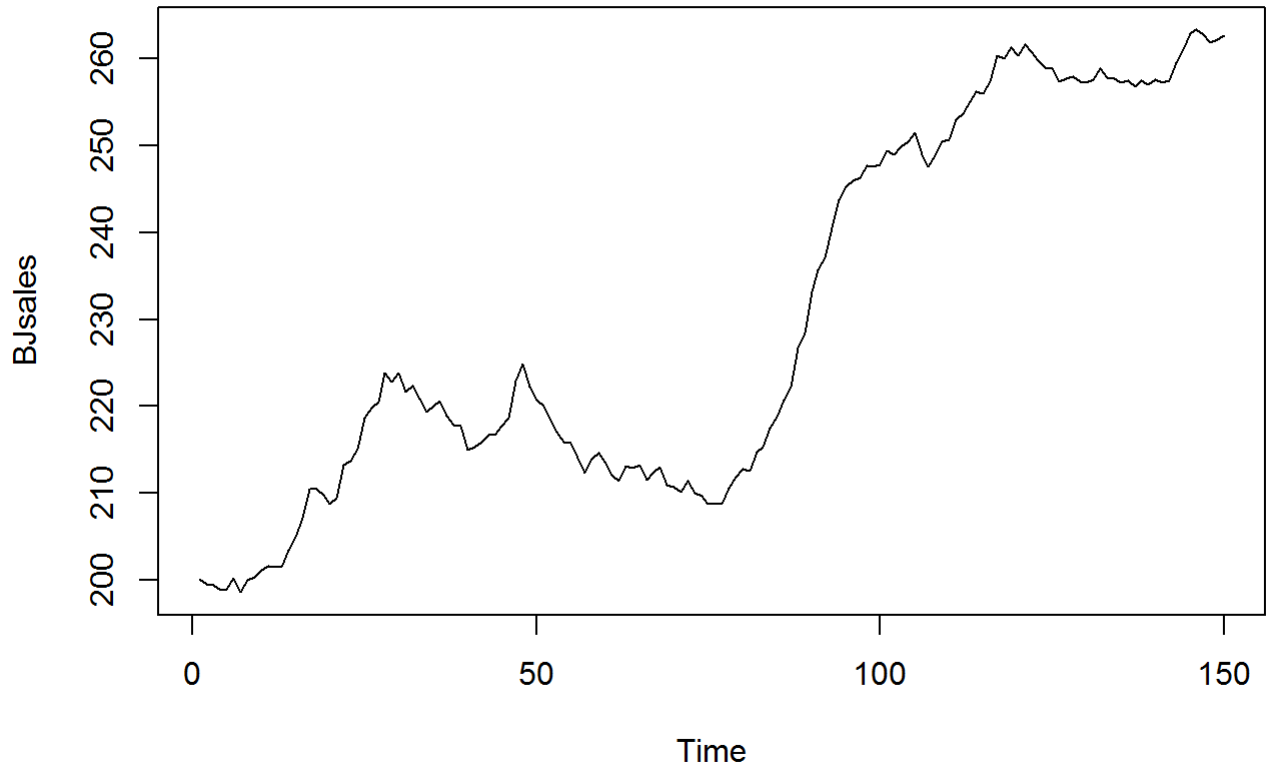
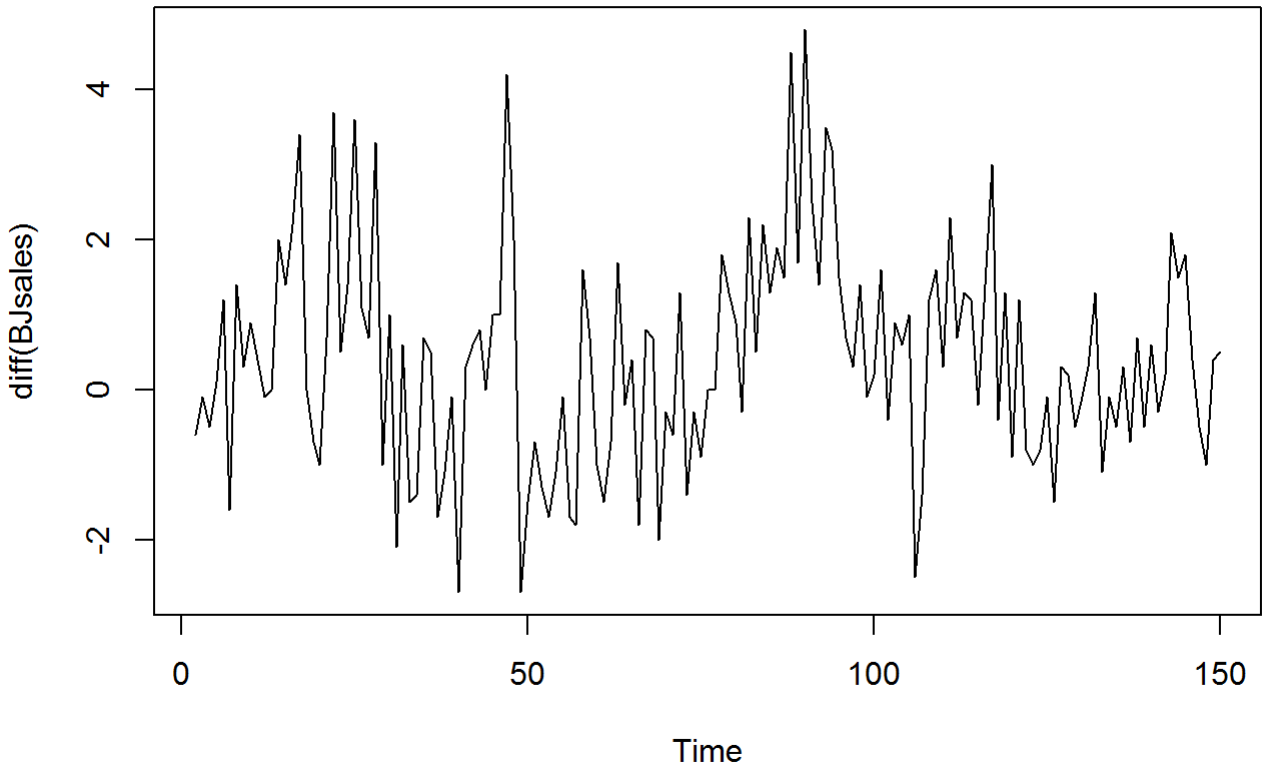
We will try to fit ARIMA model to BJsales dataset from 'dataset' package in R. Here is the plot of it.

```
library(datasets)
plot(BJsales)
```



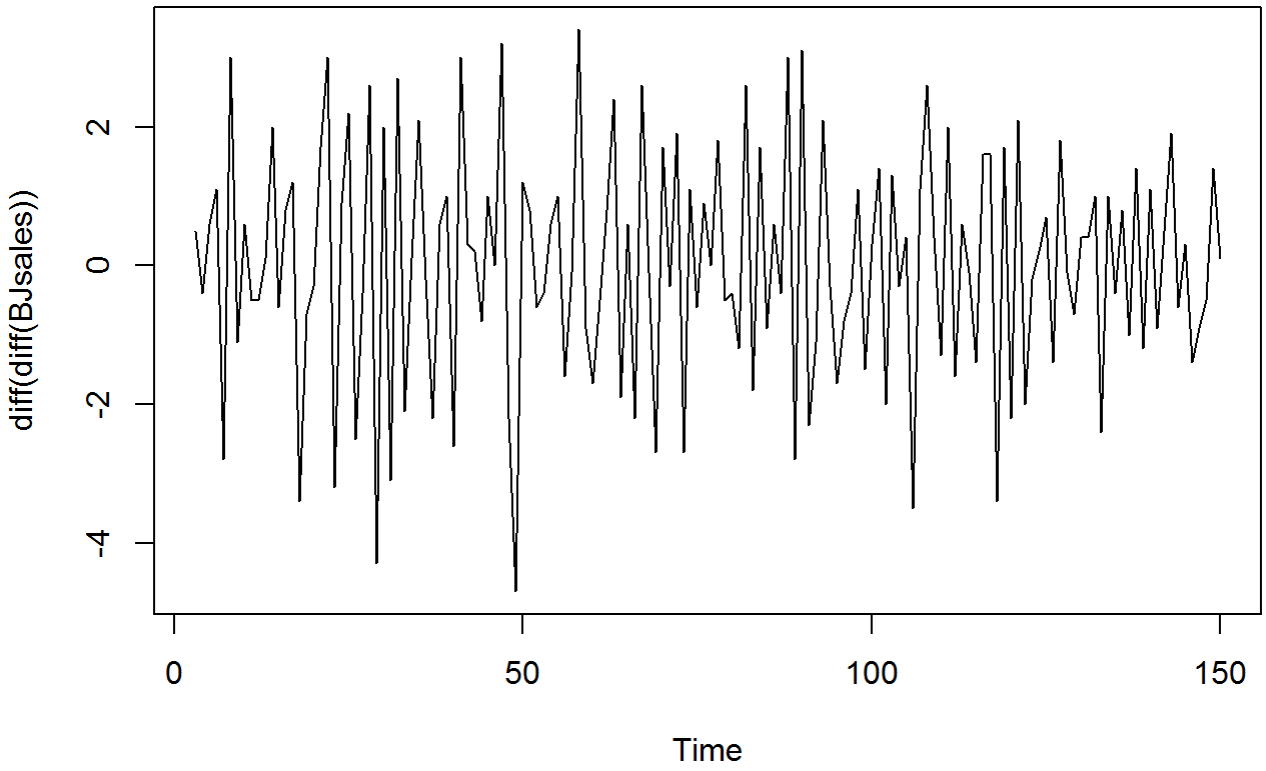
Mean in changing over time and seems time series is not statioary. Let's take the difference.

```
plot(diff(BJsales))
```



Seems It is still not staionary, let's take one more diff.

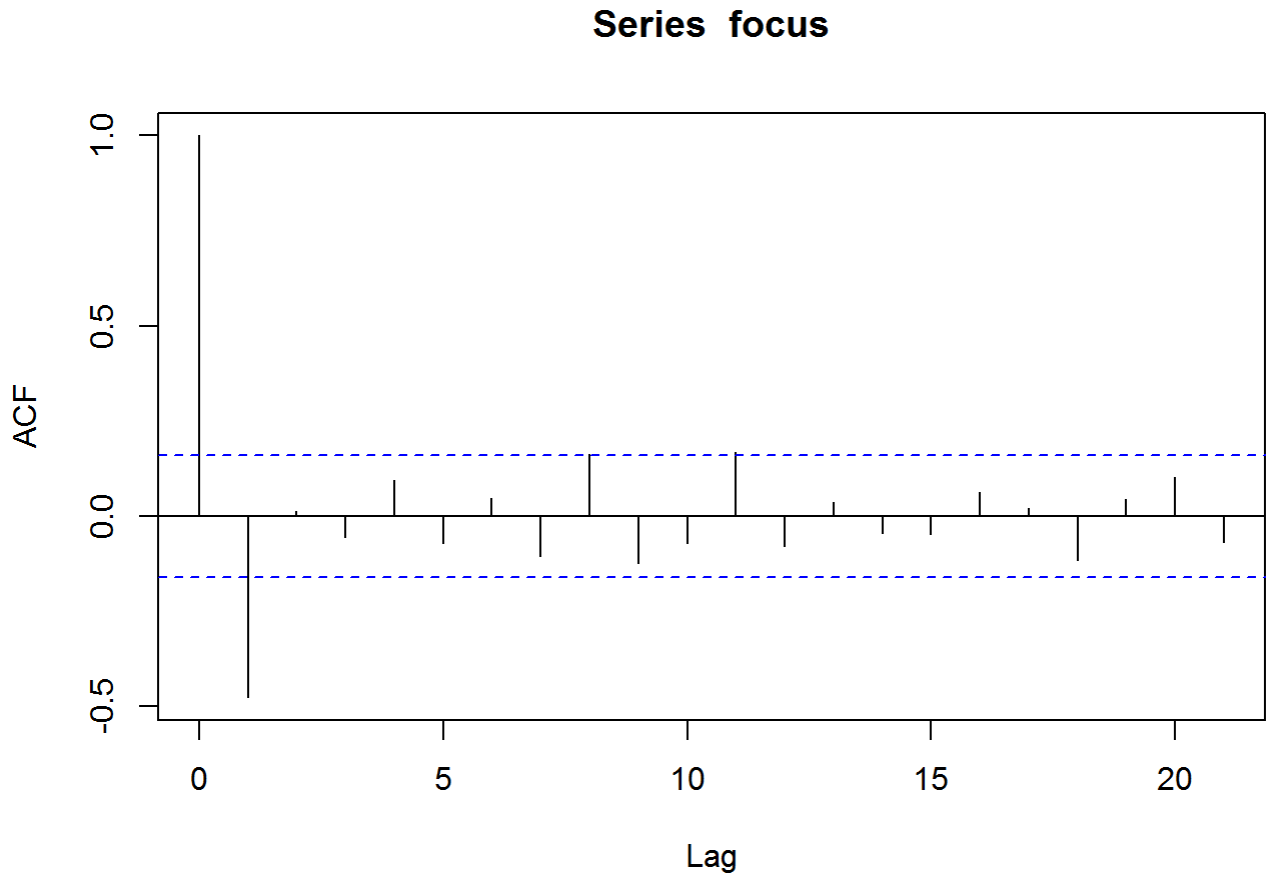
```
plot(diff(diff(BJsales)))
```



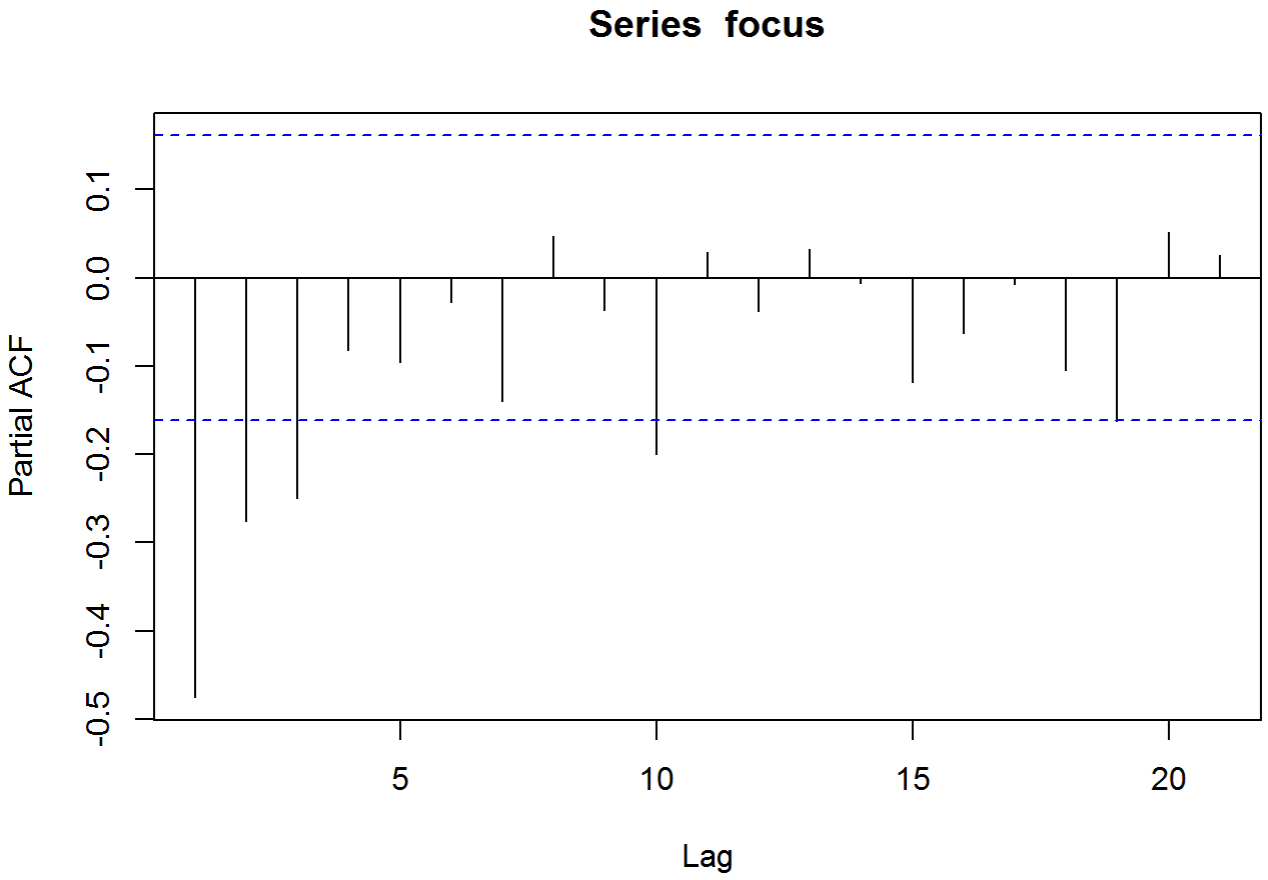
Now it seems stationary. Let's plot acf

and pacf of this doubly differenced series.

```
focus<- diff(diff(BJsales))
acf(focus)
```




```
pacf(focus)
```



From ACF lag 1, 8 and 11 seems significant, while from PACF seems lag 1, 2, 3, 10 and 19 seems significant.

Keeping parsimonious principle in mind we shall consider order of 0 and 1 for MA terms and oreder of (0, 1, 2, 3) for AR terms.

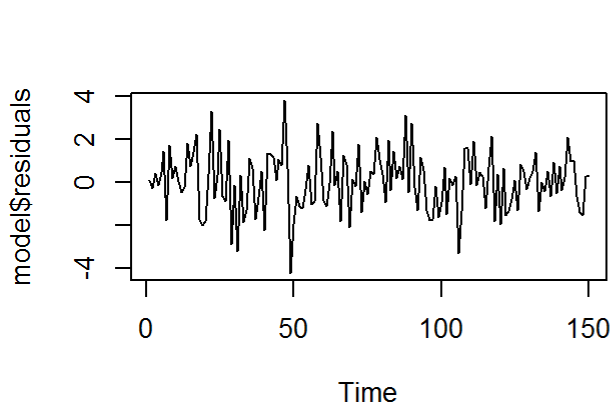
Now let's try differenct models and check their AIC.

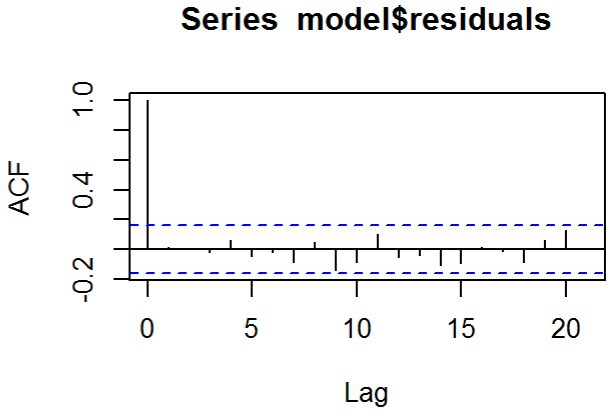
```
d <- 2
for (p in 0:3){
  for (q in 0:1){
    if(p+d+q<6){ # Ensures simple model
      mm<- arima(x = BJsales, order = c(p, d, q))
      pval <- Box.test(mm$residuals, lag = log(length(mm$residuals)))
      sse <- sum(mm$residuals^2)
      aic <- mm$aic
      cat(p, d, q, "AIC = ", aic, "SSE = ", sse, "P-value = ", pval$p.value, "\n")
    }
  }
}
```

```
## 0 2 0 AIC =  577.6777 SSE =  423.7908 P-value =  7.610494e-07
## 0 2 1 AIC =  517.1371 SSE =  276.2293 P-value =  0.9632467
## 1 2 0 AIC =  541.9646 SSE =  327.92 P-value =  0.003606979
## 1 2 1 AIC =  518.9734 SSE =  275.8554 P-value =  0.941776
## 2 2 0 AIC =  532.2986 SSE =  302.7467 P-value =  0.05824473
## 2 2 1 AIC =  520.2684 SSE =  274.0474 P-value =  0.795544
## 3 2 0 AIC =  524.7648 SSE =  283.4941 P-value =  0.7035291
```

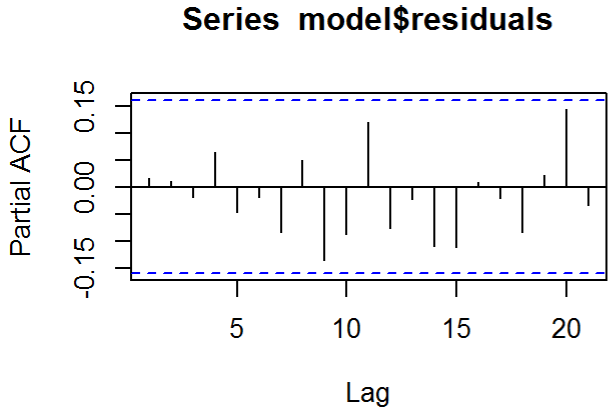
Seems like (0, 2, 1) has smallest AIC but does not have significant p-value. Let's leave it for this post and plots residual.

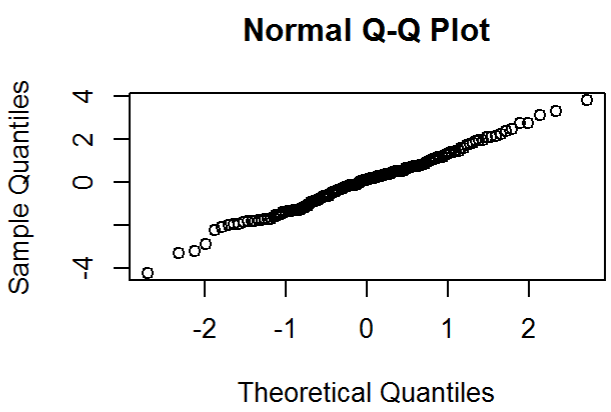
```
model <- arima(x = BJsales, order = c(0, 2, 1))
par(mfrow = c(2, 2))
plot(model$residuals)
acf(model$residuals)
pacf(model$residuals)
qqnorm(model$residuals)
```





There seems no significant



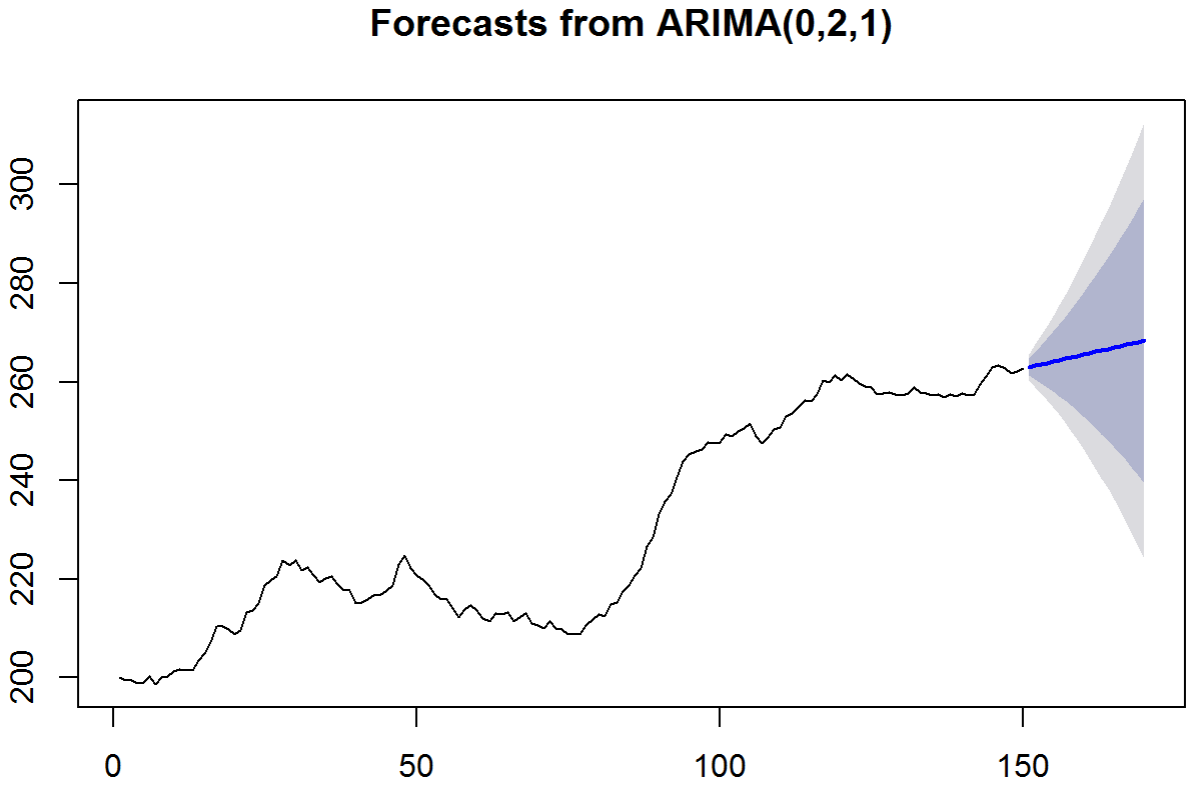


correlation as well as QQ-plot also looks okay. Now let's plot the forecast.

```
library(forecast)
```

```
## Warning: package 'forecast' was built under R version 3.3.3
```

```
fc <- forecast(model, h=20)
plot(fc)
```

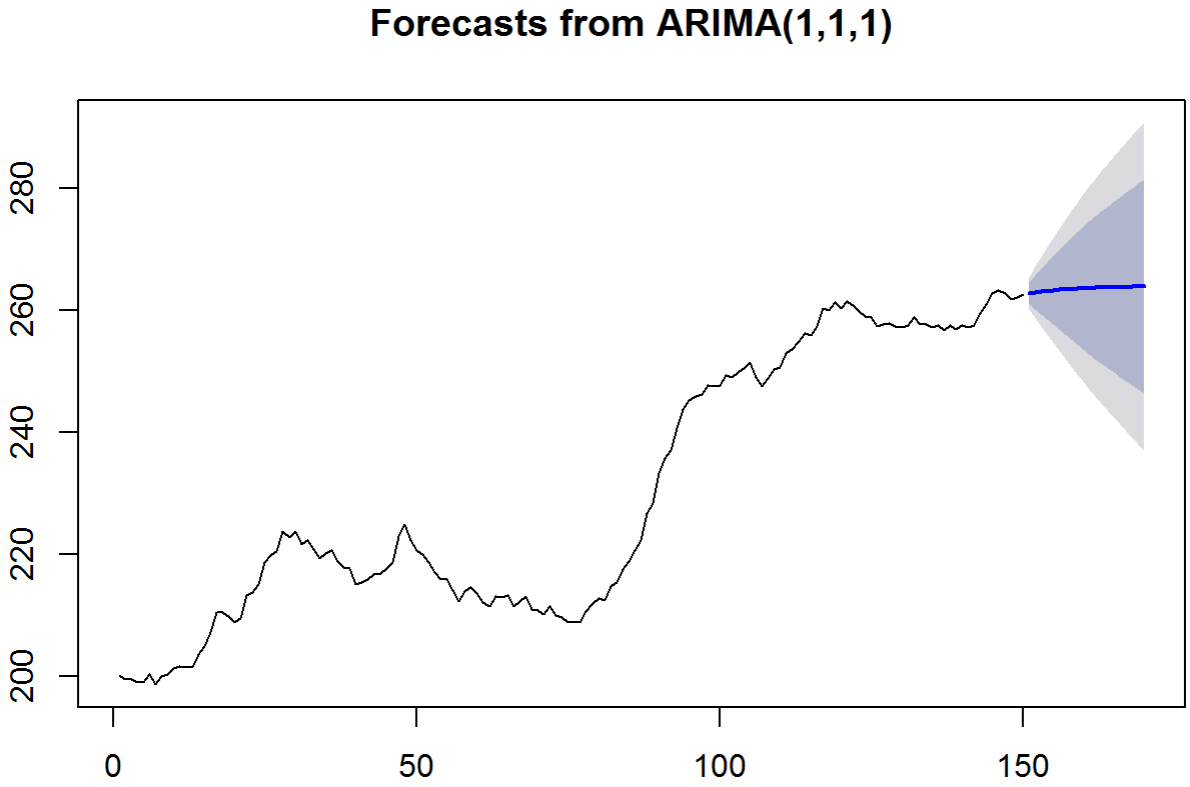


All this can also be done by auto.arima routine of forecast package.

```
model <- auto.arima(BJsales, seasonal = FALSE)
model
```

```
## Series: BJsales
## ARIMA(1,1,1)
##
## Coefficients:
##          ar1      ma1
##       0.8800  -0.6415
## s.e.  0.0644   0.1035
##
## sigma^2 estimated as 1.8:  log likelihood=-254.37
## AIC=514.74   AICc=514.9   BIC=523.75
```

```
fc <- forecast(model, h = 20)
plot(fc)
```



auto.arima has come up with different model, but it is okay.