# Group 8 presentation

Stat 443 Forecasting
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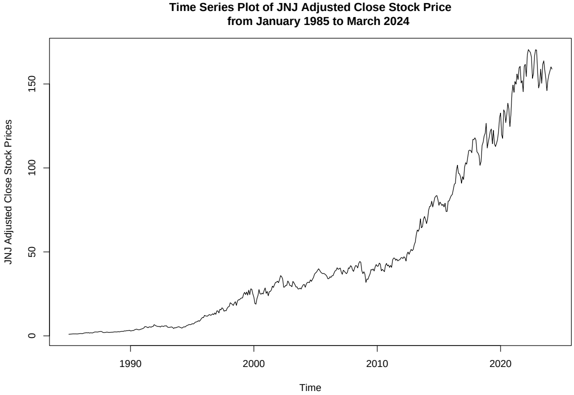
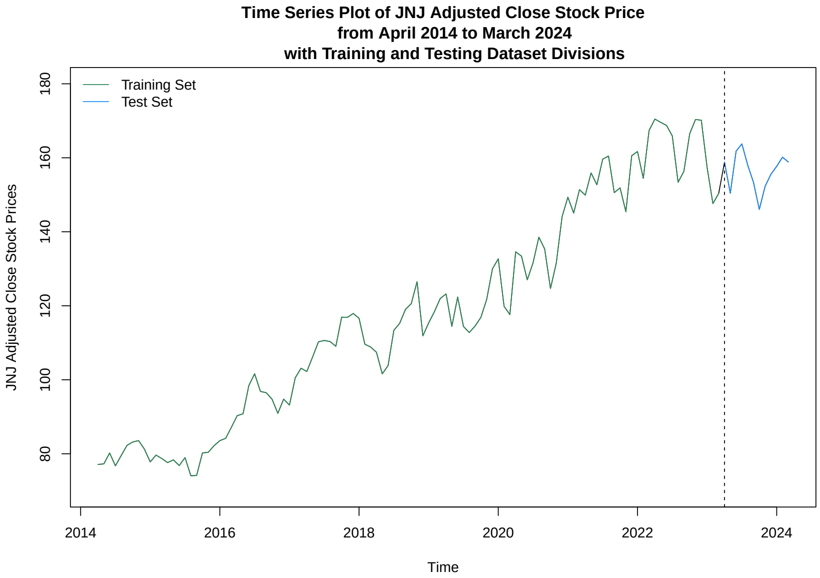
# Data Description

Table 1: First Five Rows of JNJ Historical Stock Prices

| Date | Open | High | Low | Close | Adj.Close | Volume |
|---|---|---|---|---|---|---|
| 1985-01-01 | 2.242188 | 2.453125 | 2.195313 | 2.437500 | 0.975024 | 141102400 |
| 1985-02-01 | 2.390625 | 2.507813 | 2.312500 | 2.460938 | 0.984401 | 131019200 |
| 1985-03-01 | 2.437500 | 2.632813 | 2.421875 | 2.625000 | 1.058037 | 149992000 |
| 1985-04-01 | 2.609375 | 2.796875 | 2.523438 | 2.742188 | 1.105271 | 183592000 |
| 1985-05-01 | 2.726563 | 2.960938 | 2.679688 | 2.937500 | 1.183994 | 136675200 |



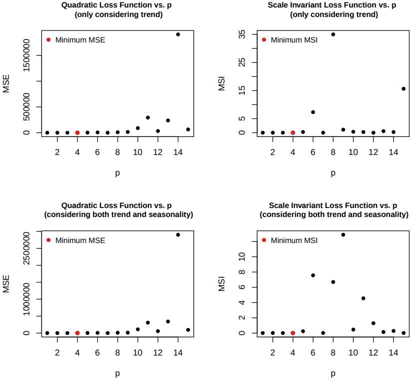
# Train and test



# Possible Solutions

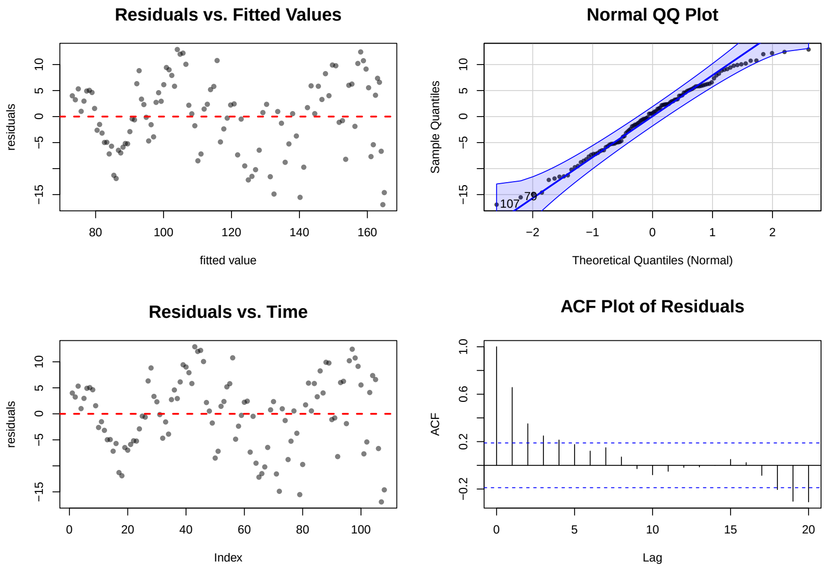
```
##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  JNJ.ts and seg
## Fligner-Killeen:med chi-squared = 16.225, df = 9, p-value = 0.06233
```

# Regression Modelling




| Regression | MSE | MSI |
|---|---:|---:|
| Only consider the trend | 120.4273 | 0.0034556 |
| Consider both the trend and seasonality | 140.2979 | 0.0041335 |

# Regression Modelling



# Regression Modelling

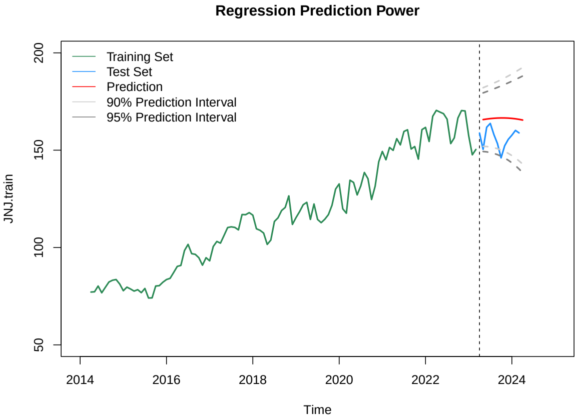
```
##
##  Shapiro-Wilk normality test
##
## data:  residuals(mod.regression)
## W = 0.98043, p-value = 0.1128

##
##  Fligner-Killeen test of homogeneity of variances
##
## data:  residuals(mod.regression) and segment
## Fligner-Killeen:med chi-squared = 20.584, df = 8, p-value = 0.008338

##
##  Difference Sign Test
##
## data:  residuals(mod.regression)
## statistic = 0.4977, n = 108, p-value = 0.6187
## alternative hypothesis: nonrandomness

##
##  Runs Test
##
## data:  residuals(mod.regression)
## statistic = -5.994, runs = 24, n1 = 54, n2 = 54, n = 108, p-value =
## 2.047e-09
## alternative hypothesis: nonrandomness
```

# Regression Modelling




$$APSE = MSE_{pred.} = \frac{\sum_{y \in test} (y - \hat{y})^2}{n_{test}} = 120.5942$$

# Smoothing Methods

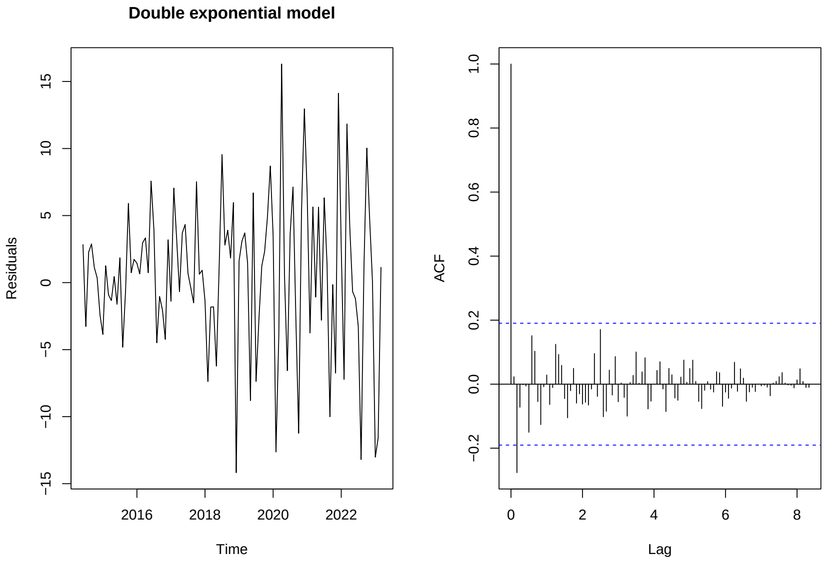
```r
# simple exponential smoothing
smoother1 = HoltWinters(JNJ.train, gamma = FALSE, beta = FALSE)
# double exponential smoothing
smoother2 = HoltWinters(JNJ.train, gamma = FALSE)
# additive HW
smoother3 = HoltWinters(JNJ.train, seasonal = "additive")
# multiplicative HW
smoother4 = HoltWinters(JNJ.train, seasonal = "multiplicative")
```

| SmoothingModel | APSE |
|---|---:|
| simple exponential | 61.92671 |
| double exponential | 45.57445 |
| additive HW | 62.05079 |
| multiplicative HW | 64.51194 |

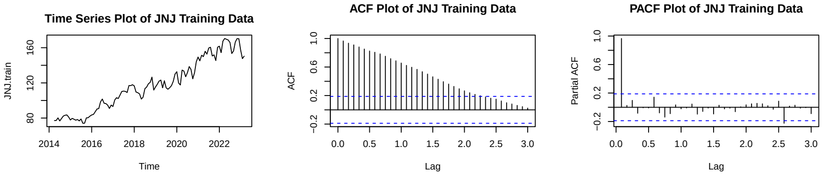
# Smoothing Methods

```
## Holt-Winters exponential smoothing with trend and without seasonal component
##
## Call:
## HoltWinters(x = JNJ.train, gamma = FALSE)
##
## Smoothing parameters:
##  alpha: 0.8814822
##  beta : 0.002122442
##  gamma: FALSE
##
## Coefficients:
##          [,1]
## a 150.2403648
## b   0.2402865
```

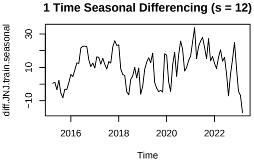
# Smoothing Methods

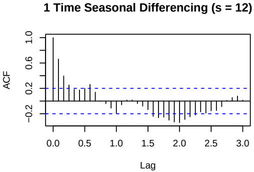


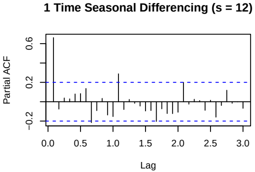
# Box-Jenkins Modelling



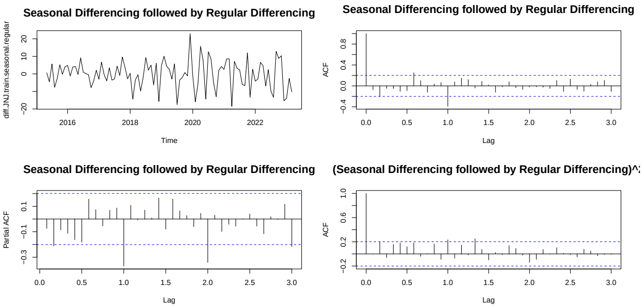
# Box-Jenkins Modelling



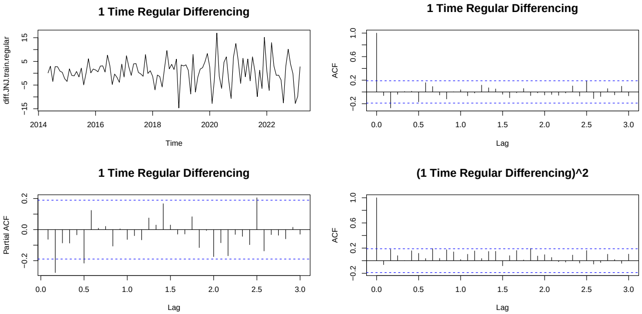
# Box-Jenkins Modelling



# Box-Jenkins Modelling

$$
\begin{array}{lll}
SARIMA(0,1,1)\times(0,1,0)_{12}, & SARIMA(1,1,1)\times(0,1,0)_{12}, & SARIMA(2,1,1)\times(0,1,0)_{12},\\
SARIMA(0,1,1)\times(0,1,1)_{12}, & SARIMA(1,1,1)\times(0,1,1)_{12}, & SARIMA(2,1,1)\times(0,1,1)_{12},\\
SARIMA(0,1,1)\times(1,1,0)_{12}, & SARIMA(1,1,1)\times(1,1,0)_{12}, & SARIMA(2,1,1)\times(1,1,0)_{12},\\
SARIMA(0,1,1)\times(1,1,1)_{12}, & SARIMA(1,1,1)\times(1,1,1)_{12}, & SARIMA(2,1,1)\times(1,1,1)_{12},\\
SARIMA(0,1,2)\times(0,1,0)_{12}, & SARIMA(1,1,2)\times(0,1,0)_{12}, & SARIMA(2,1,2)\times(0,1,0)_{12},\\
SARIMA(0,1,2)\times(0,1,1)_{12}, & SARIMA(1,1,2)\times(0,1,1)_{12}, & SARIMA(2,1,2)\times(0,1,1)_{12},\\
SARIMA(0,1,2)\times(1,1,0)_{12}, & SARIMA(1,1,2)\times(1,1,0)_{12}, & SARIMA(2,1,2)\times(1,1,0)_{12},\\
SARIMA(0,1,2)\times(1,1,1)_{12}, & SARIMA(1,1,2)\times(1,1,1)_{12}, & SARIMA(2,1,2)\times(1,1,1)_{12}.
\end{array}
$$

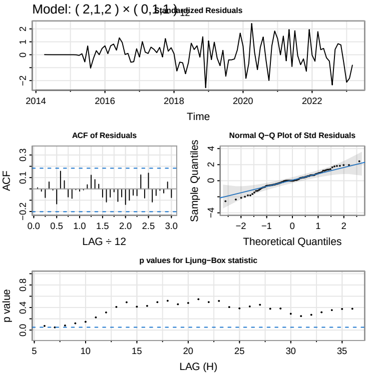
# Box-Jenkins Modelling

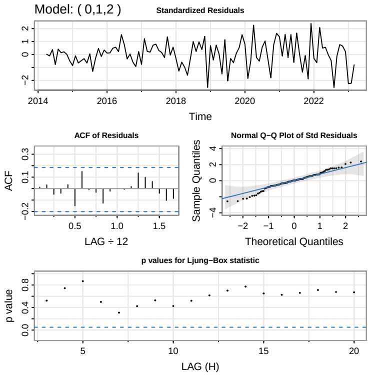


# Box-Jenkins Modelling

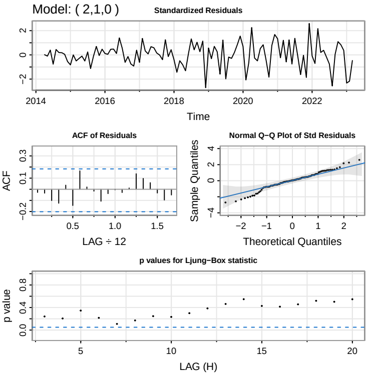
$$
\begin{array}{lll}
ARIMA(0,1,0), & ARIMA(0,1,1), & ARIMA(0,1,2), \\
ARIMA(1,1,0), & ARIMA(1,1,1), & ARIMA(1,1,2), \\
ARIMA(2,1,0), & ARIMA(2,1,1), & ARIMA(2,1,2).
\end{array}
$$

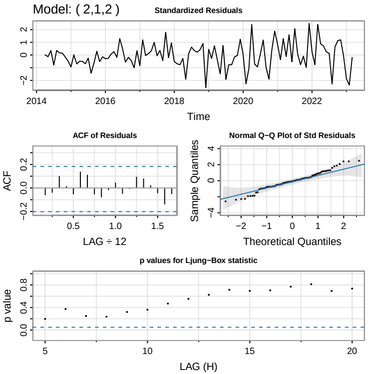
# Box-Jenkins Modelling



# Box-Jenkins Modelling

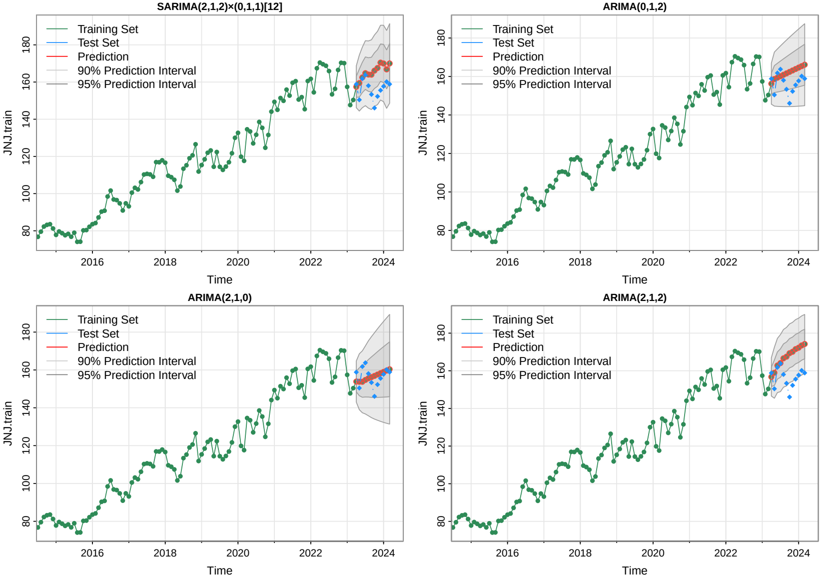


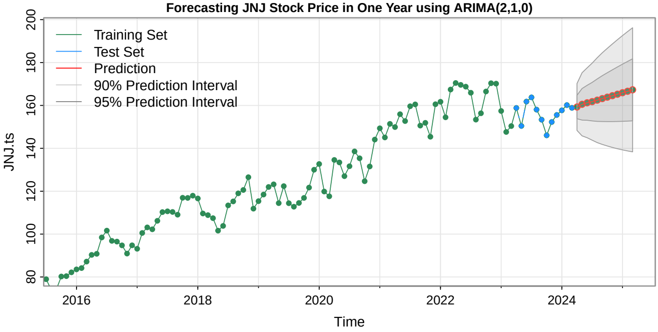
# Box-Jenkins Modelling

| Models | AIC | AICc | BIC | APSE |
|---|---|---|---|---|
| SARIMA(2,1,2)$\times$(0,1,1)[12] | 6.596083 | 6.603179 | 6.757380 | 117.58989 |
| ARIMA(0,1,2) | 6.263767 | 6.265944 | 6.363686 | 62.46785 |
| ARIMA(2,1,0) | 6.297085 | 6.299262 | 6.397004 | 29.37942 |
| ARIMA(2,1,2) | 6.237146 | 6.242698 | 6.387024 | 174.16916 |

# Box-Jenkins Modelling



# Conclusion



Forecasting JNJ Stock Price in One Year using ARIMA(2,1,0)
Training Set
Test Set
Prediction
90% Prediction Interval
95% Prediction Interval
JNJ.ts
80
100
120
140
160
180
200
2016
2018
2020
2022
2024
Time