Initial Code CIND 820

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#loading in packages, and Libraries

```
#install.packages("tidyverse")
#install.packages("tseries")
#install.packages("forecast")
#install.packages("fpp2")
#install.packages("tinytex")
#tinytex::install_tinytex()

library(tidyverse)
```

```
## Warning: package 'tidyverse' was built under R version 4.2.2
```

```
## Warning in Sys.timezone(): unable to identify current timezone 'C':
## please set environment variable 'TZ'
```

```
## -- Attaching packages --------------------------------------- tidyverse 1.3.2 --
## v ggplot2 3.4.0      v purrr   0.3.5
## v tibble  3.1.8      v dplyr   1.0.10
## v tidyr   1.2.1      v stringr 1.4.1
## v readr   2.1.3      v forcats 0.5.2
```

```
## Warning: package 'ggplot2' was built under R version 4.2.2
```

```
## Warning: package 'tibble' was built under R version 4.2.2
```

```
## Warning: package 'tidyr' was built under R version 4.2.2
```

```
## Warning: package 'readr' was built under R version 4.2.2
```

```
## Warning: package 'purrr' was built under R version 4.2.2
```

```
## Warning: package 'dplyr' was built under R version 4.2.2
```

```
## Warning: package 'stringr' was built under R version 4.2.2
```

```
## Warning: package 'forcats' was built under R version 4.2.2
```

```
## -- Conflicts ------------------------------------------ tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()    masks stats::lag()
```

```
library(forecast)
```

```
## Warning: package 'forecast' was built under R version 4.2.2
```

```
## Registered S3 method overwritten by 'quantmod':
##   method            from
##   as.zoo.data.frame zoo
```

```
library(tseries)
```

```
## Warning: package 'tseries' was built under R version 4.2.2
```

```
library(lubridate)
```

```
## Warning: package 'lubridate' was built under R version 4.2.2
```

```
## Loading required package: timechange
```

```
## Warning: package 'timechange' was built under R version 4.2.2
```

```
##
## Attaching package: 'lubridate'
##
## The following objects are masked from 'package:base':
##
##     date, intersect, setdiff, union
```

```
library(dplyr)
library(ggplot2)
```

```
#Importing Dataset
salesdata <- read.csv(file.choose())
head(salesdata)
```

```
##   ORDERNUMBER QUANTITYORDERED PRICEEACH ORDERLINENUMBER   SALES       ORDERDATE
## 1       10107              30     95.70               2 2871.00  2/24/2003 0:00
## 2       10121              34     81.35               5 2765.90   5/7/2003 0:00
## 3       10134              41     94.74               2 3884.34   7/1/2003 0:00
## 4       10145              45     83.26               6 3746.70  8/25/2003 0:00
## 5       10159              49    100.00              14 5205.27 10/10/2003 0:00
## 6       10168              36     96.66               1 3479.76 10/28/2003 0:00
##    STATUS QTR_ID MONTH_ID YEAR_ID PRODUCTLINE MSRP PRODUCTCODE
## 1 Shipped      1        2    2003 Motorcycles   95    S10_1678
## 2 Shipped      2        5    2003 Motorcycles   95    S10_1678
## 3 Shipped      3        7    2003 Motorcycles   95    S10_1678
## 4 Shipped      3        8    2003 Motorcycles   95    S10_1678
## 5 Shipped      4       10    2003 Motorcycles   95    S10_1678
## 6 Shipped      4       10    2003 Motorcycles   95    S10_1678
##               CUSTOMERNAME           PHONE                 ADDRESSLINE1
```

```
## 1        Land of Toys Inc.       2125557818       897 Long Airport Avenue
## 2       Reims Collectables       26.47.1555            59 rue de l'Abbaye
## 3          Lyon Souveniers +33 1 46 62 7555 27 rue du Colonel Pierre Avia
## 4        Toys4GrownUps.com       6265557265            78934 Hillside Dr.
## 5 Corporate Gift Ideas Co.       6505551386               7734 Strong St.
## 6     Technics Stores Inc.       6505556809             9408 Furth Circle
##   ADDRESSLINE2          CITY STATE POSTALCODE COUNTRY TERRITORY CONTACTLASTNAME
## 1                        NYC    NY      10022     USA      <NA>              Yu
## 2                      Reims            51100  France      EMEA         Henriot
## 3                      Paris            75508  France      EMEA        Da Cunha
## 4                   Pasadena    CA      90003     USA      <NA>           Young
## 5               San Francisco    CA                USA      <NA>           Brown
## 6                  Burlingame    CA      94217     USA      <NA>          Hirano
##   CONTACTFIRSTNAME DEALSIZE
## 1             Kwai    Small
## 2             Paul    Small
## 3           Daniel   Medium
## 4            Julie   Medium
## 5            Julie   Medium
## 6             Juri   Medium
```

```
#Unique Countries
unique(salesdata$COUNTRY)
```

```
##  [1] "USA"         "France"      "Norway"      "Australia"   "Finland"
##  [6] "Austria"     "UK"          "Spain"       "Sweden"      "Singapore"
## [11] "Canada"      "Japan"       "Italy"       "Denmark"     "Belgium"
## [16] "Philippines" "Germany"     "Switzerland" "Ireland"
```

```
#Unique Toys
unique(salesdata$PRODUCTLINE)
```

```
## [1] "Motorcycles"      "Classic Cars"     "Trucks and Buses" "Vintage Cars"
## [5] "Planes"           "Ships"            "Trains"
```

```
#creating backup dataset
salesdata2 <-salesdata
```

```
#Cleaning Data

#Removing timestamps from orderdate column
salesdata2$ORDERDATE <- gsub(" .*","",salesdata2$ORDERDATE)

#Changing OrderDate Class to "Date"
salesdata2$ORDERDATE <- mdy(salesdata2$ORDERDATE)

class(salesdata2$ORDERDATE)
```

```
## [1] "Date"
```

```r
#Re-ordering the Orderdate in ascending order
salesdata2 <- salesdata2[order(salesdata2$ORDERDATE),]
```

```r
#Checking to see the total sales per country
salesdata2 %>%
  group_by(COUNTRY)%>%
  summarise(sum_country = sum(SALES, na.rm = TRUE ))
```

```
## # A tibble: 19 x 2
##    COUNTRY     sum_country
##    <chr>             <dbl>
##  1 Australia       630623.
##  2 Austria         202063.
##  3 Belgium         108413.
##  4 Canada          224079.
##  5 Denmark         245637.
##  6 Finland         329582.
##  7 France         1110917.
##  8 Germany         220472.
##  9 Ireland          57756.
## 10 Italy           374674.
## 11 Japan           188168.
## 12 Norway          307464.
## 13 Philippines      94016.
## 14 Singapore       288488.
## 15 Spain          1215687.
## 16 Sweden          210014.
## 17 Switzerland     117714.
## 18 UK              478880.
## 19 USA            3627983.
```

```r
#Checking to see the total sales per Toy

salesdata2 %>%
  group_by(PRODUCTLINE)%>%
  summarise(sum_country = sum(SALES, na.rm = TRUE ))
```

```
## # A tibble: 7 x 2
##   PRODUCTLINE      sum_country
##   <chr>                  <dbl>
## 1 Classic Cars        3919616.
## 2 Motorcycles         1166388.
## 3 Planes               975004.
## 4 Ships                714437.
## 5 Trains               226243.
## 6 Trucks and Buses    1127790.
## 7 Vintage Cars        1903151.
```

```r
#Forecast 1, Part 1: Forecast test without variables

#Creating Time Series
sale <- ts(salesdata2[,5], start = c(2003,1), end = c(2005,5), frequency = 12)
sale
```

```
##          Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep
## 2003 5151.00 3390.00 1903.22 1689.03 3782.00 3773.38 1404.00 2472.96 4808.31
## 2004 3394.98 3920.00 1189.98 2242.89 2011.10 2539.50 4791.82 4228.20 1938.89
## 2005 3403.35 4460.82 5958.50 4615.78 3457.92
##          Oct     Nov     Dec
## 2003 2055.74 5404.62 5398.26
## 2004 3680.28 2873.00 3224.31
## 2005
```

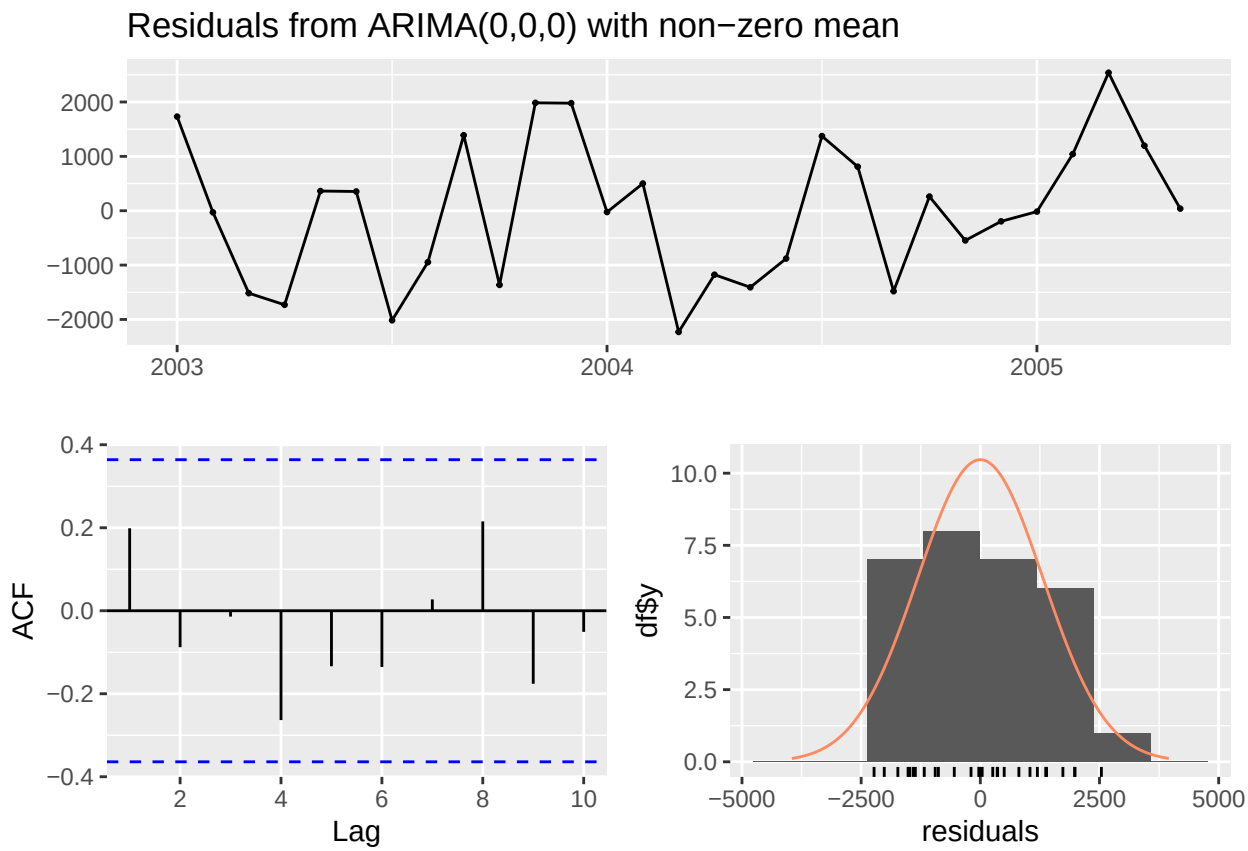
```
#Building Arima Model

Test_Model <- auto.arima(sale)
```

```
#Print Model Summary
print(summary(Test_Model))
```

```
## Series: sale
## ARIMA(0,0,0) with non-zero mean
##
## Coefficients:
##            mean
##       3419.4428
## s.e.   240.4282
##
## sigma^2 = 1736229:  log likelihood = -248.97
## AIC=501.93   AICc=502.39   BIC=504.66
##
## Training set error measures:
##                        ME     RMSE      MAE       MPE     MAPE      MASE
## Training set 2.901512e-13 1294.743 1073.013 -19.40661 41.16299 0.6072734
##                    ACF1
## Training set 0.1988037
```

```
#Note: ARIMA(0,0,0) means that the data is white noise
```

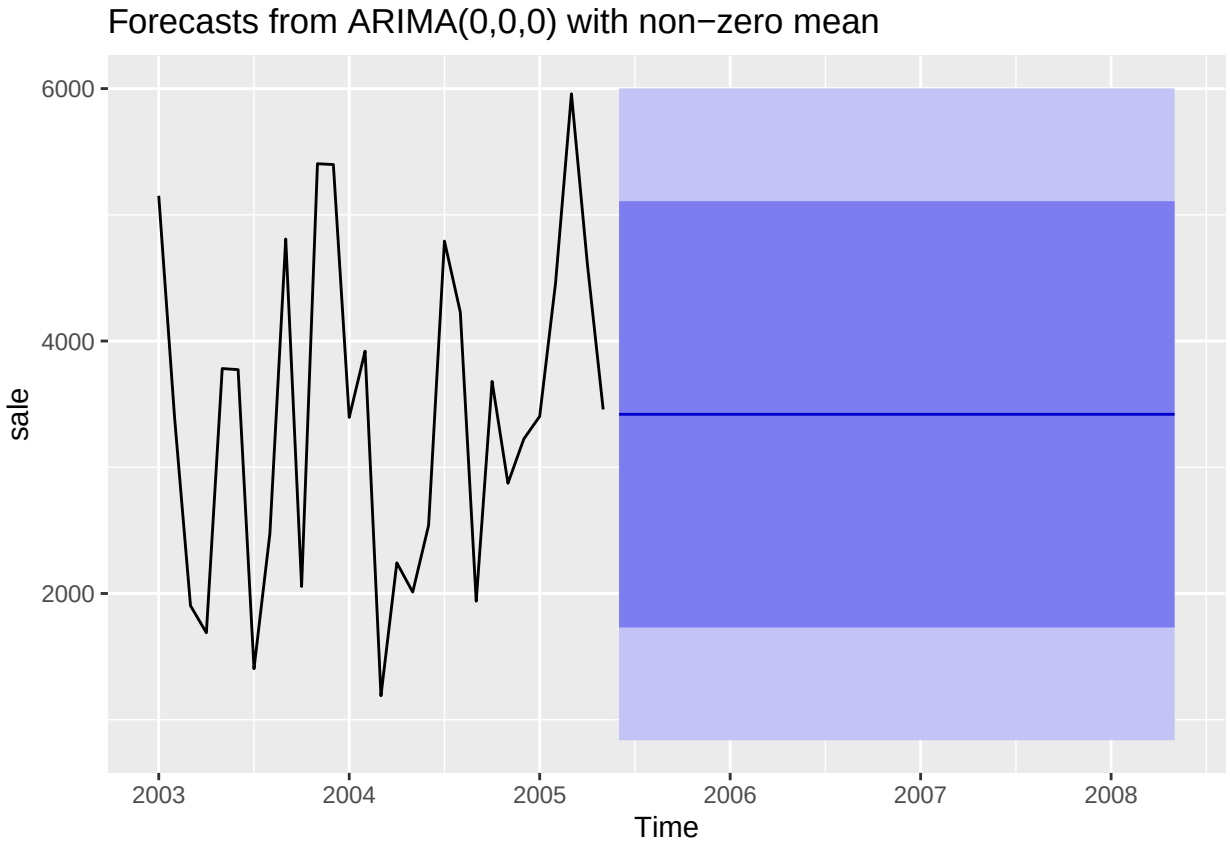
```
#Checking residual values of Model
checkresiduals(Test_Model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(0,0,0) with non-zero mean
## Q* = 5.415, df = 6, p-value = 0.4918
##
## Model df: 0.   Total lags used: 6
```

```
#Create Forecast of Model
#Forecast for the next two years
Test_Forecast <- forecast(Test_Model, h=36)
```

```
#Plot Forecast Results
#Showing the last 5 years
autoplot(Test_Forecast, include = 60)
```




```
#Print Summary of Forecast Results
print(summary(Test_Forecast))
```

```
##
## Forecast method: ARIMA(0,0,0) with non-zero mean
##
## Model Information:
## Series: sale
## ARIMA(0,0,0) with non-zero mean
##
## Coefficients:
##            mean
##       3419.4428
## s.e.   240.4282
##
## sigma^2 = 1736229:  log likelihood = -248.97
## AIC=501.93   AICc=502.39   BIC=504.66
##
## Error measures:
##                        ME     RMSE      MAE       MPE     MAPE      MASE
## Training set 2.901512e-13 1294.743 1073.013 -19.40661 41.16299 0.6072734
##                    ACF1
## Training set 0.1988037
##
## Forecasts:
##          Point Forecast    Lo 80    Hi 80    Lo 95   Hi 95
```

```
## Jun 2005       3419.443 1730.793 5108.093 836.8755 6002.01
## Jul 2005       3419.443 1730.793 5108.093 836.8755 6002.01
## Aug 2005       3419.443 1730.793 5108.093 836.8755 6002.01
## Sep 2005       3419.443 1730.793 5108.093 836.8755 6002.01
## Oct 2005       3419.443 1730.793 5108.093 836.8755 6002.01
## Nov 2005       3419.443 1730.793 5108.093 836.8755 6002.01
## Dec 2005       3419.443 1730.793 5108.093 836.8755 6002.01
## Jan 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Feb 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Mar 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Apr 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## May 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Jun 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Jul 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Aug 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Sep 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Oct 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Nov 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Dec 2006       3419.443 1730.793 5108.093 836.8755 6002.01
## Jan 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Feb 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Mar 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Apr 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## May 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Jun 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Jul 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Aug 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Sep 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Oct 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Nov 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Dec 2007       3419.443 1730.793 5108.093 836.8755 6002.01
## Jan 2008       3419.443 1730.793 5108.093 836.8755 6002.01
## Feb 2008       3419.443 1730.793 5108.093 836.8755 6002.01
## Mar 2008       3419.443 1730.793 5108.093 836.8755 6002.01
## Apr 2008       3419.443 1730.793 5108.093 836.8755 6002.01
## May 2008       3419.443 1730.793 5108.093 836.8755 6002.01
```

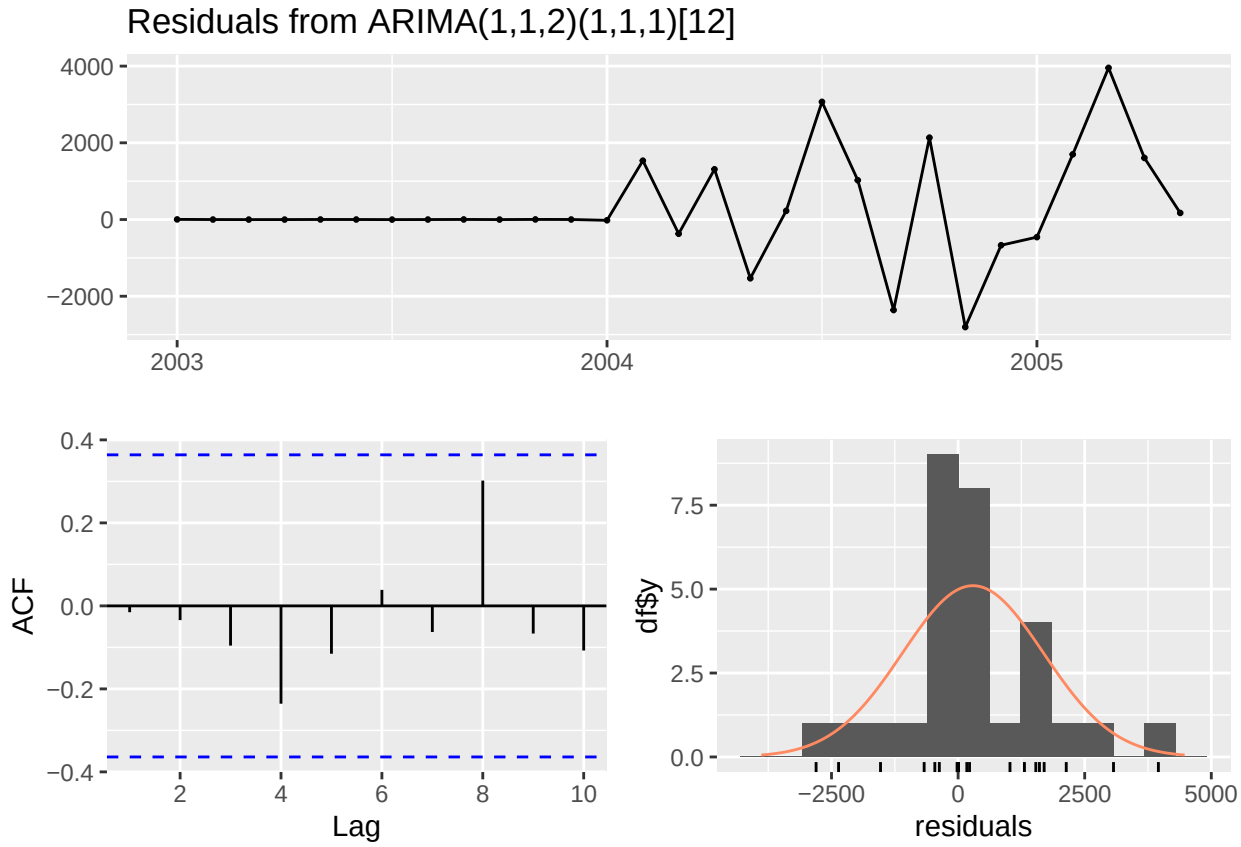
```
#Forecast 1, Part 2: Testing Forecast with manual ARIMA variables

#Building second test model
test2_model <-arima(sale,order = c(1,1,2), seasonal = list(order = c(1,1,1)))
```

```
#Print Manual Arima Model Summary
print(summary(test2_model))
```

```
##
## Call:
## arima(x = sale, order = c(1, 1, 2), seasonal = list(order = c(1, 1, 1)))
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced
```

```
##           ar1      ma1      ma2     sar1    sma1
##       -0.5240  -0.2090  -0.7909  -0.2296  -0.263
## s.e.   0.4451   0.5139   0.4627      NaN     NaN
##
## sigma^2 estimated as 3554617:  log likelihood = -146.26,  aic = 304.51
##
## Training set error measures:
##                     ME     RMSE      MAE      MPE     MAPE     MASE        ACF1
## Training set 293.7786 1400.422 860.8828 1.217806 26.17624 0.638426 -0.01521605
```

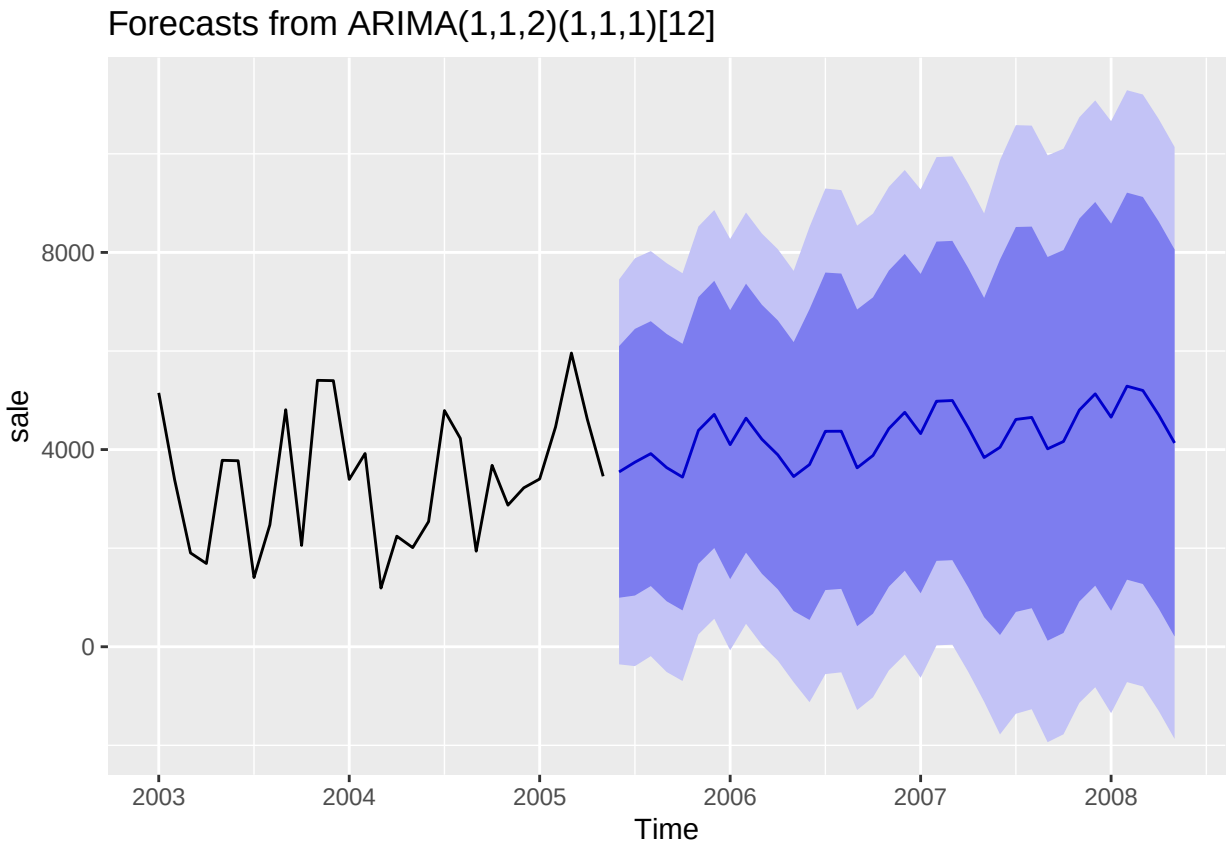
```
#Checking residual values of Manual Arima Model
checkresiduals(test2_model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(1,1,2)(1,1,1)[12]
## Q* = 6.9817, df = 3, p-value = 0.07248
##
## Model df: 5.   Total lags used: 8
```

```
#Create Forecast for Manual ARIMA Model
#Forecast for the next two years
Test2_Forecast <- forecast(test2_model, h=36)
```

```r
#Plot Forecast Results
#Showing the last 5 years
autoplot(Test2_Forecast, include = 60)
```




```r
#Print Summary Forecast Results
print(summary(Test2_Forecast))
```

```
##
## Forecast method: ARIMA(1,1,2)(1,1,1)[12]
##
## Model Information:
##
## Call:
## arima(x = sale, order = c(1, 1, 2), seasonal = list(order = c(1, 1, 1)))
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced

##           ar1      ma1      ma2     sar1    sma1
##       -0.5240  -0.2090  -0.7909  -0.2296  -0.263
## s.e.   0.4451   0.5139   0.4627      NaN     NaN
##
## sigma^2 estimated as 3554617:  log likelihood = -146.26,  aic = 304.51
```

```
##
## Error measures:
##                      ME     RMSE      MAE      MPE     MAPE      MASE        ACF1
## Training set 293.7786 1400.422 860.8828 1.217806 26.17624 0.4872179 -0.01521605
##
## Forecasts:
##          Point Forecast     Lo 80    Hi 80       Lo 95     Hi 95
## Jun 2005       3546.564  994.1562 6098.971  -357.00658  7450.134
## Jul 2005       3744.003 1039.2497 6448.756  -392.56005  7880.565
## Aug 2005       3917.844 1231.4215 6604.266  -190.68463  8026.373
## Sep 2005       3633.973  922.6706 6345.275  -512.60609  7780.552
## Oct 2005       3441.519  737.1683 6145.869  -694.42833  7577.466
## Nov 2005       4388.843 1683.1593 7094.527   250.85673  8526.830
## Dec 2005       4713.941 2003.5513 7424.331   568.75772  8859.124
## Jan 2006       4100.020 1371.2775 6828.762   -73.23145  8273.271
## Feb 2006       4637.255 1909.3836 7365.126   465.33589  8809.174
## Mar 2006       4209.310 1480.9810 6937.639    36.69079  8381.929
## Apr 2006       3893.838 1165.7374 6621.939  -278.43207  8066.109
## May 2006       3452.943  724.7416 6181.145  -719.48123  7625.368
## Jun 2006       3696.173  544.2984 6848.048 -1124.20319  8516.549
## Jul 2006       4370.846 1150.2564 7591.436  -554.62097  9296.314
## Aug 2006       4372.514 1174.2059 7570.822  -518.87617  9263.904
## Sep 2006       3629.726  417.1071 6842.344 -1283.55044  8543.002
## Oct 2006       3880.466  672.6117 7088.320 -1025.52381  8786.456
## Nov 2006       4425.372 1218.3127 7632.432  -479.40223  9330.147
## Dec 2006       4756.272 1542.7633 7969.781  -158.36556  9670.910
## Jan 2007       4324.516 1085.3996 7563.632  -629.28486  9278.316
## Feb 2007       4981.129 1742.5890 8219.670    28.20932  9934.049
## Mar 2007       4995.310 1756.4713 8234.148    41.93390  9948.685
## Apr 2007       4443.981 1205.2886 7682.674  -509.17169  9397.134
## May 2007       3838.491  599.7408 7077.241 -1114.74991  8791.731
## Jun 2007       4046.225  237.9480 7854.503 -1778.03224  9870.483
## Jul 2007       4611.335  707.1005 8515.570 -1359.67661 10582.347
## Aug 2007       4652.530  781.6329 8523.427 -1267.49628 10572.557
## Sep 2007       4015.103  123.5276 7906.678 -1936.54775  9966.753
## Oct 2007       4164.092  279.9070 8048.277 -1776.25644 10104.441
## Nov 2007       4801.388  917.4656 8685.310 -1138.55863 10741.334
## Dec 2007       5130.955 1239.0692 9022.841  -821.17087 11083.081
## Jan 2008       4657.377  730.8464 8583.907 -1347.73317 10662.487
## Feb 2008       5286.583 1360.8770 9212.289  -717.26613 11290.432
## Mar 2008       5199.258 1273.1249 9125.391  -805.24448 11203.761
## Apr 2008       4702.079  776.1564 8628.001 -1302.10132 10706.259
## May 2008       4134.377  208.3678 8060.386 -1869.93587 10138.689
```

```
#Forecast 2: Forecast with Variables

#Creating Time Series
sale <- ts(salesdata2[,5], start = c(2003,1), end = c(2005,5), frequency = 12)
sale
```

```
##          Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep
## 2003 5151.00 3390.00 1903.22 1689.03 3782.00 3773.38 1404.00 2472.96 4808.31
## 2004 3394.98 3920.00 1189.98 2242.89 2011.10 2539.50 4791.82 4228.20 1938.89
## 2005 3403.35 4460.82 5958.50 4615.78 3457.92
```

```
##          Oct     Nov     Dec
## 2003 2055.74 5404.62 5398.26
## 2004 3680.28 2873.00 3224.31
## 2005
```

```
#Built Fit Arima Model
#Taking first difference of the data
#Getting rid of seasonality by taking first seasonal difference

AR_Model <- auto.arima(sale, d=1, D=1, stepwise = FALSE, approximation = FALSE, trace = TRUE)
```

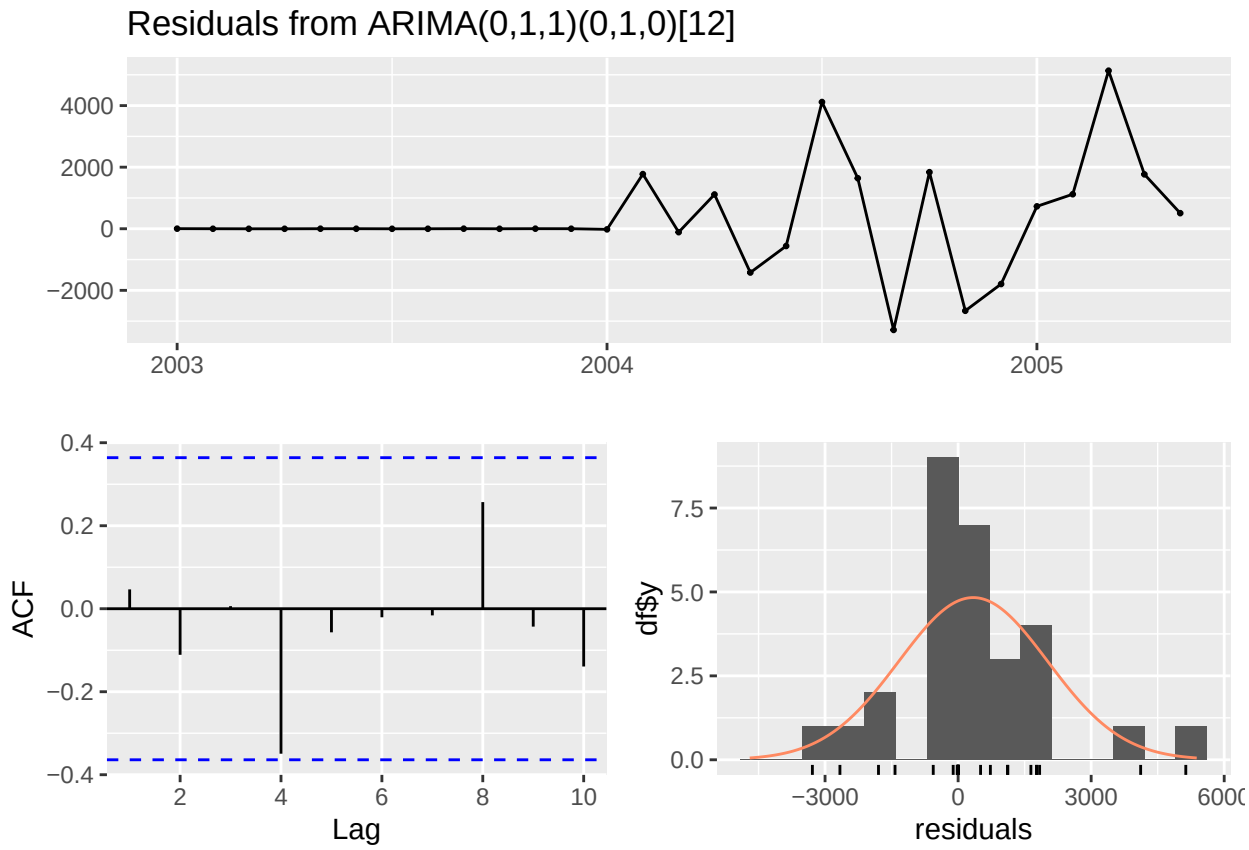
```
##
##  ARIMA(0,1,0)(0,1,0)[12]                    : 301.8345
##  ARIMA(0,1,1)(0,1,0)[12]                    : 298.6723
##  ARIMA(0,1,2)(0,1,0)[12]                    : 301.4452
##  ARIMA(0,1,3)(0,1,0)[12]                    : 305.0502
##  ARIMA(0,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,5)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,0)(0,1,0)[12]                    : 301.691
##  ARIMA(1,1,1)(0,1,0)[12]                    : 301.4556
##  ARIMA(1,1,2)(0,1,0)[12]                    : 304.5768
##  ARIMA(1,1,3)(0,1,0)[12]                    : 308.9399
##  ARIMA(1,1,4)(0,1,0)[12]                    : 313.8526
##  ARIMA(2,1,0)(0,1,0)[12]                    : 302.386
##  ARIMA(2,1,1)(0,1,0)[12]                    : 305.0913
##  ARIMA(2,1,2)(0,1,0)[12]                    : 308.9395
##  ARIMA(2,1,3)(0,1,0)[12]                    : 314.2561
##  ARIMA(3,1,0)(0,1,0)[12]                    : 305.9916
##  ARIMA(3,1,1)(0,1,0)[12]                    : 309.3616
##  ARIMA(3,1,2)(0,1,0)[12]                    : 313.8845
##  ARIMA(4,1,0)(0,1,0)[12]                    : 308.8125
##  ARIMA(4,1,1)(0,1,0)[12]                    : 312.9575
##  ARIMA(5,1,0)(0,1,0)[12]                    : 314.1303
##
##
##
##  Best model: ARIMA(0,1,1)(0,1,0)[12]
```

```
#Printing AR Model Summary
print(summary(AR_Model))
```

```
## Series: sale
## ARIMA(0,1,1)(0,1,0)[12]
##
## Coefficients:
##          ma1
##       -0.8112
## s.e.   0.2503
##
## sigma^2 = 5492903:  log likelihood = -146.87
## AIC=297.75   AICc=298.67   BIC=299.29
##
## Training set error measures:
```

```
##                     ME     RMSE      MAE      MPE     MAPE      MASE       ACF1
## Training set 340.9011 1685.573 1021.186 1.189803 30.21683 0.5779418 0.04659647
```

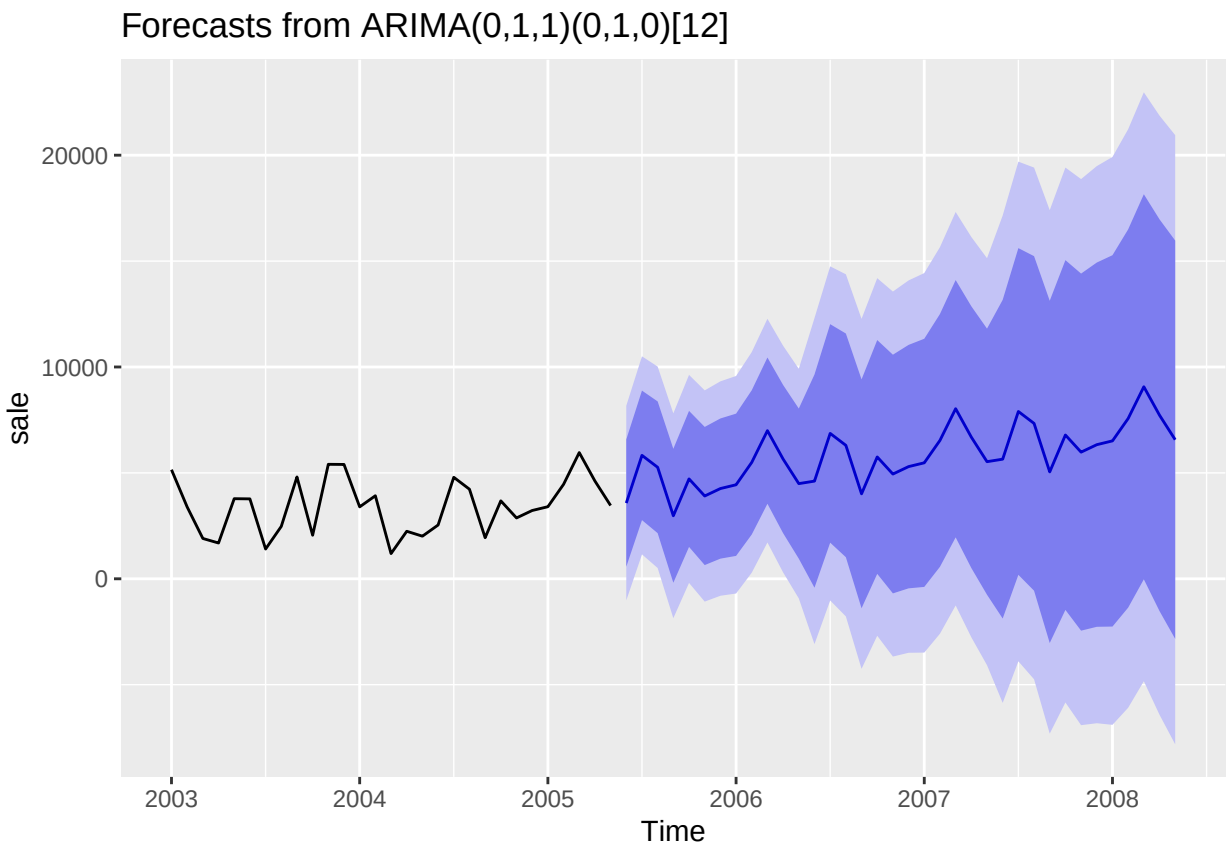
```
#Checking Residuals of AR_Model
checkresiduals(AR_Model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(0,1,1)(0,1,0)[12]
## Q* = 5.0074, df = 5, p-value = 0.415
##
## Model df: 1.   Total lags used: 6
```

```
#Forecasting ARIMA Model
#forecast two years ahead
AR_Model_Forecast <- forecast(AR_Model, h=36)
```

```
#Plotting AR Model Forecast
#including the last 5 years
autoplot(AR_Model_Forecast, include = 60)
```




```
#Print Summary of AR Model Forecast
print(summary(AR_Model_Forecast))
```

```
##
## Forecast method: ARIMA(0,1,1)(0,1,0)[12]
##
## Model Information:
## Series: sale
## ARIMA(0,1,1)(0,1,0)[12]
##
## Coefficients:
##           ma1
##       -0.8112
## s.e.   0.2503
##
## sigma^2 = 5492903:  log likelihood = -146.87
## AIC=297.75   AICc=298.67   BIC=299.29
##
## Error measures:
##                     ME     RMSE      MAE      MPE     MAPE      MASE       ACF1
## Training set 340.9011 1685.573 1021.186 1.189803 30.21683 0.5779418 0.04659647
##
## Forecasts:
##          Point Forecast      Lo 80     Hi 80      Lo 95     Hi 95
## Jun 2005       3575.410   571.4262  6579.393 -1018.7867  8169.606
## Jul 2005       5827.730  2770.7051  8884.754  1152.4140 10503.045
```

```
## Aug 2005       5264.110  2154.9487  8373.271   509.0583 10019.161
## Sep 2005       2974.800  -185.6377  6135.237 -1858.6721  7808.272
## Oct 2005       4716.190  1505.2947  7927.085  -194.4504  9626.830
## Nov 2005       3908.910   648.3378  7169.482 -1077.7047  8895.524
## Dec 2005       4260.220   950.7165  7569.723  -801.2287  9321.668
## Jan 2006       4439.260  1081.5382  7796.981  -695.9322  9574.452
## Feb 2006       5496.730  2091.4726  8901.987   288.8383 10704.621
## Mar 2006       6994.410  3542.2714 10446.548  1714.8198 12274.000
## Apr 2006       5651.690  2153.2985  9150.081   301.3621 11002.017
## May 2006       4493.830   949.7892  8037.870  -926.3126  9913.972
## Jun 2006       4611.319  -420.2468  9642.886 -3083.7971 12306.436
## Jul 2006       6863.639  1705.8697 12021.409 -1024.4886 14751.767
## Aug 2006       6300.019  1019.0614 11580.977 -1776.5089 14376.548
## Sep 2006       4010.709 -1390.6281  9412.047 -4249.9235 12271.342
## Oct 2006       5752.099   233.0074 11271.191 -2688.6234 14192.822
## Nov 2006       4944.819  -689.5667 10579.205 -3672.2305 13561.869
## Dec 2006       5296.129  -451.2383 11043.497 -3493.7110 14085.970
## Jan 2007       5475.169  -383.0014 11333.340 -3484.1297 14434.468
## Feb 2007       6532.639   565.7227 12499.556 -2592.9722 15658.251
## Mar 2007       8030.319  1956.6035 14104.035 -1258.6274 17319.266
## Apr 2007       6687.599   508.9301 12866.269 -2761.8598 16137.059
## May 2007       5529.739  -752.1300 11811.609 -4077.5508 15137.030
## Jun 2007       5647.229 -1875.6561 13170.114 -5858.0309 17152.489
## Jul 2007       7899.549   186.7582 15612.340 -3896.1466 19695.245
## Aug 2007       7335.929  -562.2026 15234.061 -4743.2209 19415.079
## Sep 2007       5046.619 -3032.6027 13125.841 -7309.4844 17402.723
## Oct 2007       6788.009 -1468.3319 15044.350 -5838.9748 19414.993
## Nov 2007       5980.729 -2449.0104 14410.469 -6911.4450 18872.903
## Dec 2007       6332.039 -2267.6033 14931.681 -6819.9790 19484.057
## Jan 2008       6511.079 -2255.1739 15277.332 -6895.7479 19917.906
## Feb 2008       7568.549 -1361.2064 16498.305 -6088.3334 21225.431
## Mar 2008       9066.229   -24.0885 18156.547 -4836.2119 22968.670
## Apr 2008       7723.509 -1524.5834 16971.602 -6420.2279 21867.246
## May 2008       6565.649 -2837.5715 15968.870 -7815.3357 20946.634
```

```
#Forecast 3, Part 1: Forecasting with focus on USA data

#Sub-setting the data to only show sales in USA
USA_Sales <- subset(salesdata2, COUNTRY == "USA")
head(USA_Sales)
```

```
##      ORDERNUMBER QUANTITYORDERED PRICEEACH ORDERLINENUMBER   SALES  ORDERDATE
## 579        10100              30    100.00               3 5151.00 2003-01-06
## 681        10100              50     67.80               2 3390.00 2003-01-06
## 1268       10100              22     86.51               4 1903.22 2003-01-06
## 2025       10100              49     34.47               1 1689.03 2003-01-06
## 476        10102              39    100.00               2 4808.31 2003-01-10
## 502        10102              41     50.14               1 2055.74 2003-01-10
##       STATUS QTR_ID MONTH_ID YEAR_ID  PRODUCTLINE MSRP PRODUCTCODE
## 579  Shipped      1        1    2003 Vintage Cars  170    S18_1749
## 681  Shipped      1        1    2003 Vintage Cars   60    S18_2248
## 1268 Shipped      1        1    2003 Vintage Cars   92    S18_4409
## 2025 Shipped      1        1    2003 Vintage Cars   41    S24_3969
## 476  Shipped      1        1    2003 Vintage Cars  102    S18_1342
```

```
## 502  Shipped      1        1    2003 Vintage Cars   53    S18_1367
##                       CUSTOMERNAME      PHONE             ADDRESSLINE1
## 579  Online Diecast Creations Co. 6035558647 2304 Long Airport Avenue
## 681  Online Diecast Creations Co. 6035558647 2304 Long Airport Avenue
## 1268 Online Diecast Creations Co. 6035558647 2304 Long Airport Avenue
## 2025 Online Diecast Creations Co. 6035558647 2304 Long Airport Avenue
## 476               Vitachrome Inc. 2125551500        2678 Kingston Rd.
## 502               Vitachrome Inc. 2125551500        2678 Kingston Rd.
##      ADDRESSLINE2   CITY STATE POSTALCODE COUNTRY TERRITORY CONTACTLASTNAME
## 579               Nashua    NH      62005     USA      <NA>           Young
## 681               Nashua    NH      62005     USA      <NA>           Young
## 1268              Nashua    NH      62005     USA      <NA>           Young
## 2025              Nashua    NH      62005     USA      <NA>           Young
## 476     Suite 101    NYC    NY      10022     USA      <NA>           Frick
## 502     Suite 101    NYC    NY      10022     USA      <NA>           Frick
##      CONTACTFIRSTNAME DEALSIZE
## 579           Valarie   Medium
## 681           Valarie   Medium
## 1268          Valarie    Small
## 2025          Valarie    Small
## 476           Michael   Medium
## 502           Michael    Small
```

```
#Creating Time Series
US_sales <- ts(USA_Sales[,5], start = c(2003,1), end = c(2005,5), frequency = 12)
US_sales
```

```
##          Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep
## 2003 5151.00 3390.00 1903.22 1689.03 4808.31 2055.74 2871.00 3896.49 6065.55
## 2004 3155.14 1858.00 4379.18 4432.70 3157.44 8257.00 6241.60  930.90 3288.78
## 2005 4178.85 2253.68 3415.44 4916.66 2490.50
##          Oct     Nov     Dec
## 2003 3036.60 2055.23 2845.75
## 2004 2354.88 1801.24 4818.15
## 2005
```

```
#Build Fit Arima Model
#Taking first difference of the data
#Getting rid of seasonality by taking first seasonal difference

US_AR_Model <- auto.arima(US_sales, d=1, D=1, stepwise = FALSE, approximation = FALSE, trace = TRUE)
```

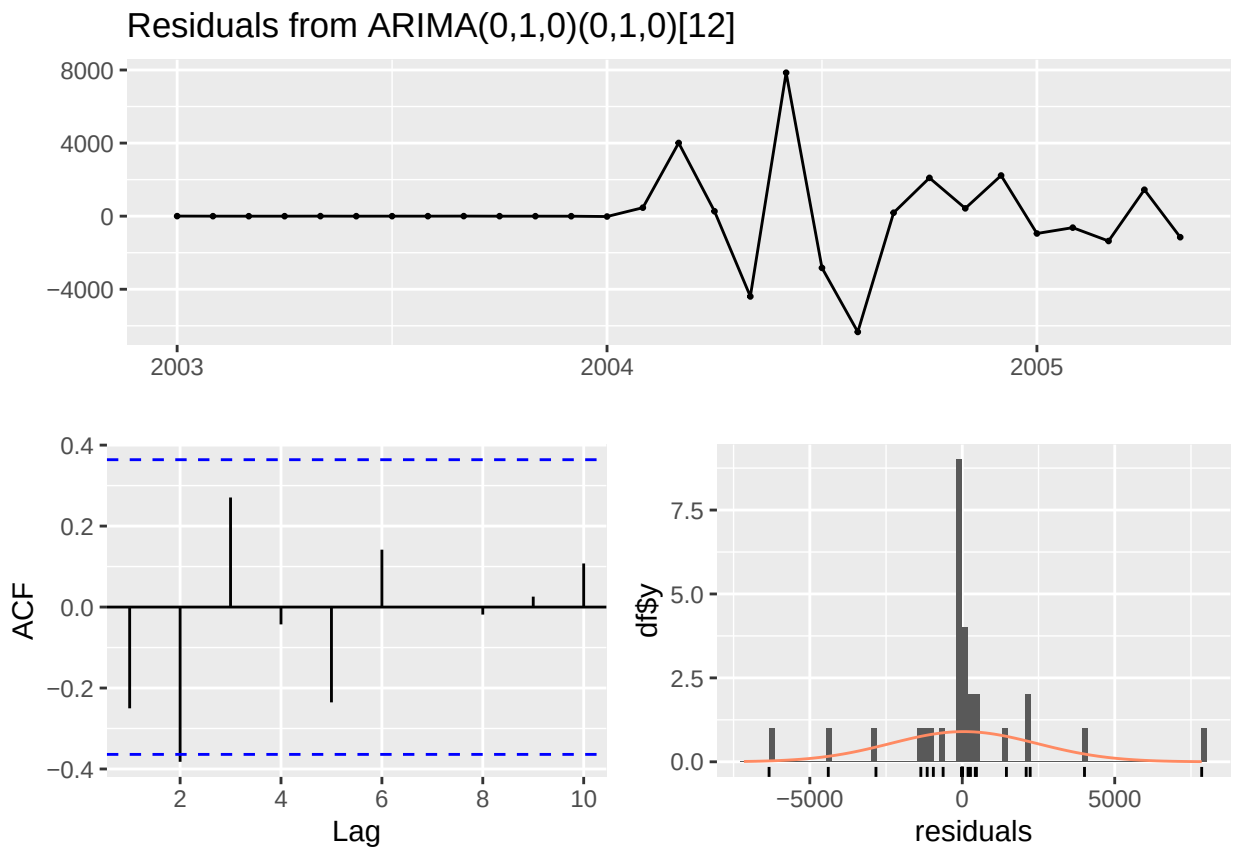
```
##
##  ARIMA(0,1,0)(0,1,0)[12]                    : 305.7411
##  ARIMA(0,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,5)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,0)(0,1,0)[12]                    : 307.4029
##  ARIMA(1,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,3)(0,1,0)[12]                    : Inf
```

```
##  ARIMA(1,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,0)(0,1,0)[12]                    : 306.299
##  ARIMA(2,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,0)(0,1,0)[12]                    : 309.9308
##  ARIMA(3,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(4,1,0)(0,1,0)[12]                    : 313.9995
##  ARIMA(4,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(5,1,0)(0,1,0)[12]                    : 315.5938
##
##
##
##  Best model: ARIMA(0,1,0)(0,1,0)[12]
```

```
#Printing AR Model Summary
print(summary(US_AR_Model))
```

```
## Series: US_sales
## ARIMA(0,1,0)(0,1,0)[12]
##
## sigma^2 = 10100398:  log likelihood = -151.73
## AIC=305.46   AICc=305.74   BIC=306.23
##
## Training set error measures:
##                    ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
## Training set 45.20457 2360.643 1264.177 -20.37292 48.77984 0.6683622 -0.250164
```

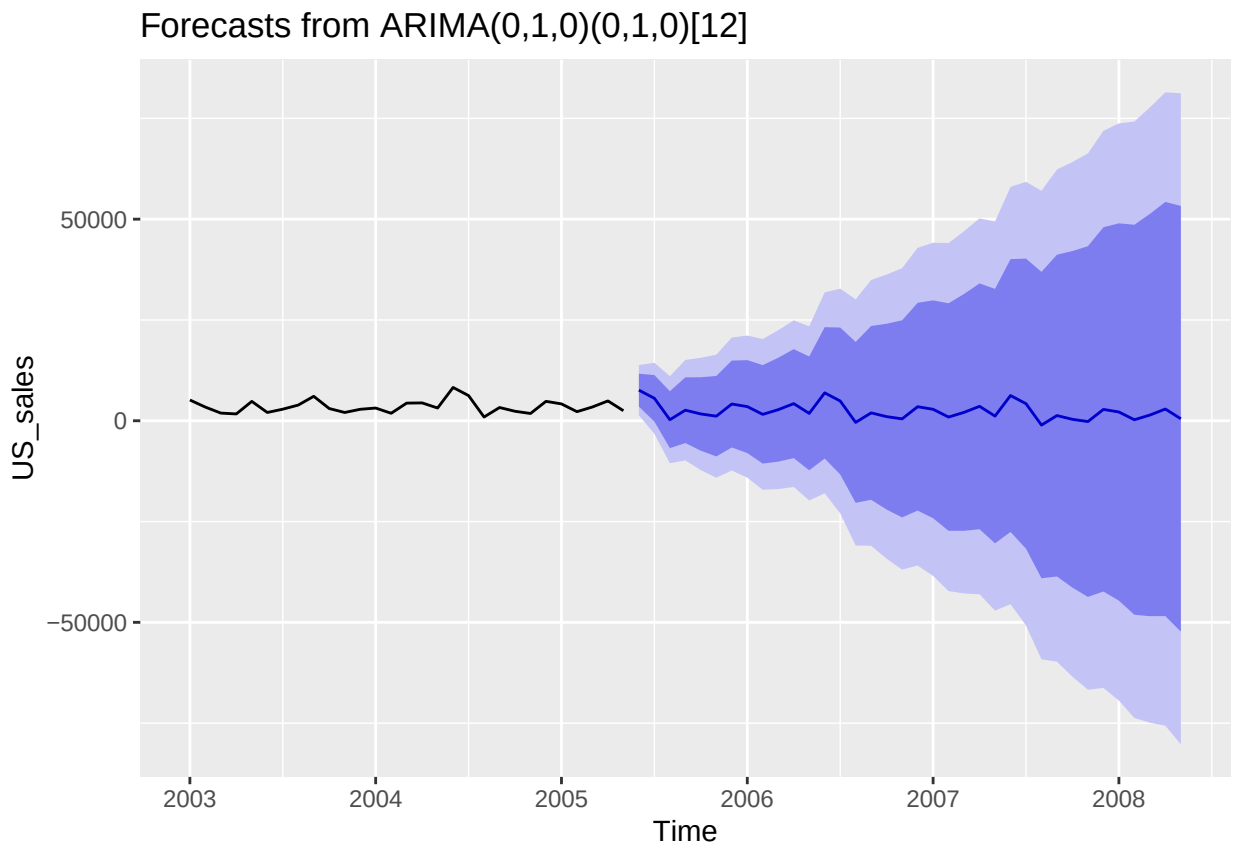
```
#Checking Residuals of AR_Model
checkresiduals(US_AR_Model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(0,1,0)(0,1,0)[12]
## Q* = 12.335, df = 6, p-value = 0.05491
##
## Model df: 0.   Total lags used: 6
```

```
#Forecasting ARIMA Model
#forecast two years ahead
US_AR_Model_Forecast <- forecast(US_AR_Model, h=36)
```

```
#Plotting AR Model Forecast
#including the last 5 years
autoplot(US_AR_Model_Forecast, include = 60)
```




```
#Print Summary of AR Model Forecast
print(summary(US_AR_Model_Forecast))
```

```
##
## Forecast method: ARIMA(0,1,0)(0,1,0)[12]
##
## Model Information:
## Series: US_sales
## ARIMA(0,1,0)(0,1,0)[12]
##
## sigma^2 = 10100398:  log likelihood = -151.73
## AIC=305.46   AICc=305.74   BIC=306.23
##
## Error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
## Training set 45.20457 2360.643 1264.177 -20.37292 48.77984 0.6683622 -0.250164
##
## Forecasts:
##          Point Forecast       Lo 80     Hi 80      Lo 95    Hi 95
## Jun 2005        7590.06   3517.1452 11662.975   1361.074 13819.05
## Jul 2005        5574.66   -185.3114 11334.631  -3234.456 14383.78
## Aug 2005         263.96  -6790.5354  7318.455 -10524.960 11052.88
## Sep 2005        2621.84  -5523.9897 10767.670  -9836.131 15079.81
## Oct 2005        1687.94  -7419.3744 10795.254 -12240.495 15616.38
## Nov 2005        1134.30  -8842.2631 11110.863 -14123.537 16392.14
## Dec 2005        4151.21  -6624.7098 14927.130 -12329.137 20631.56
```

```
## Jan 2006        3511.91  -8008.0328 15031.853 -14106.322 21130.14
## Feb 2006        1586.74 -10632.0045 13805.485 -17100.217 20273.70
## Mar 2006        2748.50 -10131.1876 15628.188 -16949.282 22446.28
## Apr 2006        4249.72  -9258.6103 17758.050 -16409.488 24908.93
## May 2006        1823.56 -12285.4309 15932.551 -19754.279 23401.40
## Jun 2006        6923.12  -9368.5394 23214.779 -17992.823 31839.06
## Jul 2006        4907.72 -13306.9089 23122.349 -22949.151 32764.59
## Aug 2006        -402.98 -20356.1062 19550.146 -30918.653 30112.69
## Sep 2006        1954.90 -19596.9395 23506.740 -31005.794 34915.59
## Oct 2006        1021.00 -22018.8856 24060.886 -34215.464 36257.46
## Nov 2006         467.36 -23970.1290 24904.849 -36906.554 37841.27
## Dec 2006        3484.27 -22275.1052 29243.645 -35911.295 42879.83
## Jan 2007        2844.97 -24171.6906 29861.631 -38473.447 44163.39
## Feb 2007         919.80 -27298.1817 29137.782 -42235.879 44075.48
## Mar 2007        2081.56 -27288.6466 31451.767 -42836.295 46999.41
## Apr 2007        3582.78 -26896.1238 34061.684 -43030.681 50196.24
## May 2007        1156.62 -30392.0427 32705.283 -47092.896 49406.14
## Jun 2007        6256.18 -27575.9916 40088.352 -45485.661 57998.02
## Jul 2007        4240.78 -31730.2299 40211.790 -50772.132 59253.69
## Aug 2007       -1069.92 -39059.5405 36919.701 -59170.031 57030.19
## Sep 2007        1287.96 -38618.2925 41194.212 -59743.386 62319.31
## Oct 2007         354.06 -41380.8978 42089.018 -63474.050 64182.17
## Nov 2007        -199.58 -43686.4104 43287.250 -66706.948 66307.79
## Dec 2007        2817.33 -42353.4807 47988.141 -66265.463 71900.12
## Jan 2008        2178.03 -44616.1989 48972.259 -69387.567 73743.63
## Feb 2008         252.86 -48110.3241 48616.044 -73712.247 74217.97
## Mar 2008        1414.62 -48468.1956 51297.436 -74874.563 77703.80
## Apr 2008        2915.84 -48441.6620 54273.342 -75628.681 81460.36
## May 2008         489.68 -52301.3299 53280.690 -80247.202 81226.56
```

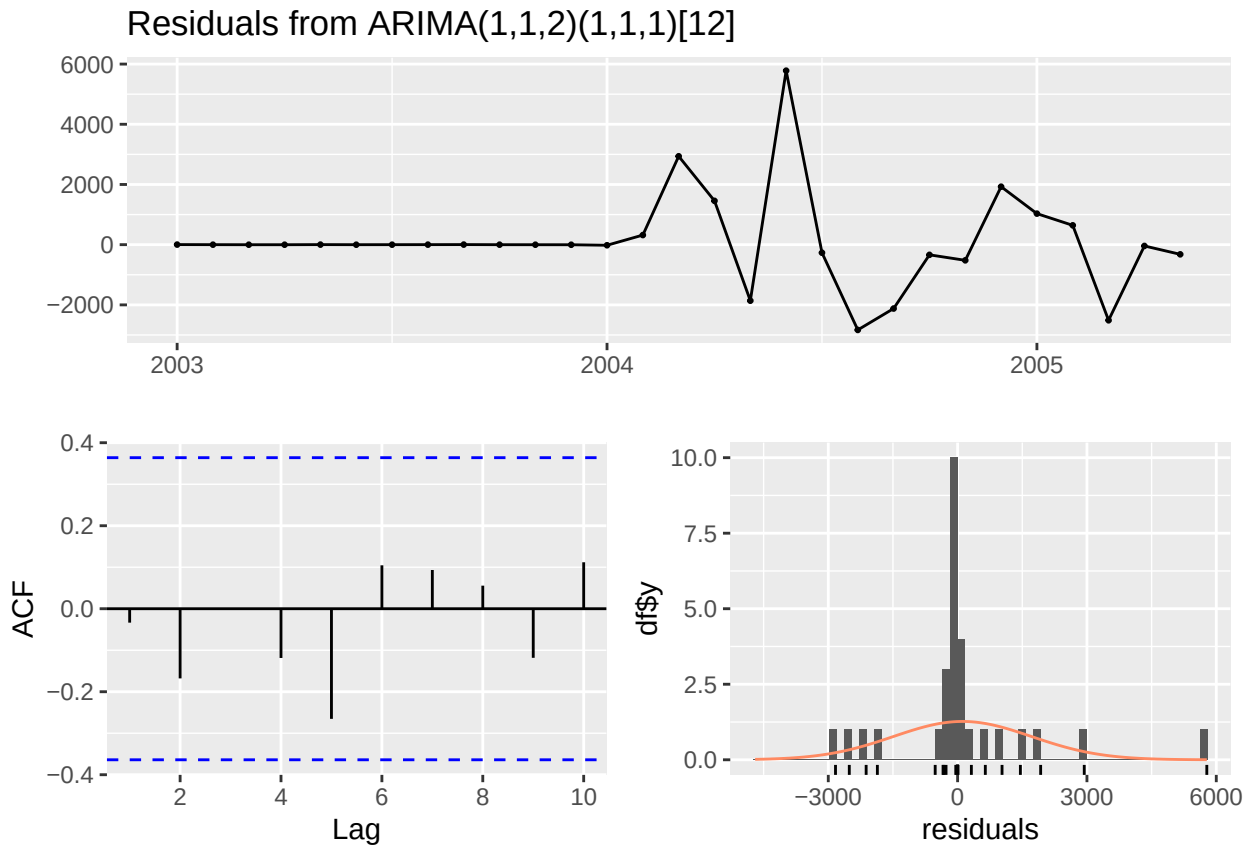
```
#Forecast 3, Part 2: Testing USA Sales Forecast with manual ARIMA variables

#Building second USA model
US2_model <-arima(US_sales,order = c(1,1,2), seasonal = list(order = c(1,1,1)))
```

```
#Print Manual Arima Model Summary
print(summary(US2_model))
```

```
##
## Call:
## arima(x = US_sales, order = c(1, 1, 2), seasonal = list(order = c(1, 1, 1)))
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced

##           ar1      ma1      ma2    sar1    sma1
##       -0.2617  -0.3827  -0.6172  0.2606  0.2604
## s.e.   0.3915   0.2986   0.2804     NaN     NaN
##
## sigma^2 estimated as 4519107:  log likelihood = -147.9,  aic = 307.81
##
## Training set error measures:
```

```
##                     ME     RMSE      MAE       MPE     MAPE      MASE        ACF1
## Training set 112.4188 1579.023 860.1448 -9.75588 29.09879 0.4765104 -0.03351387
```

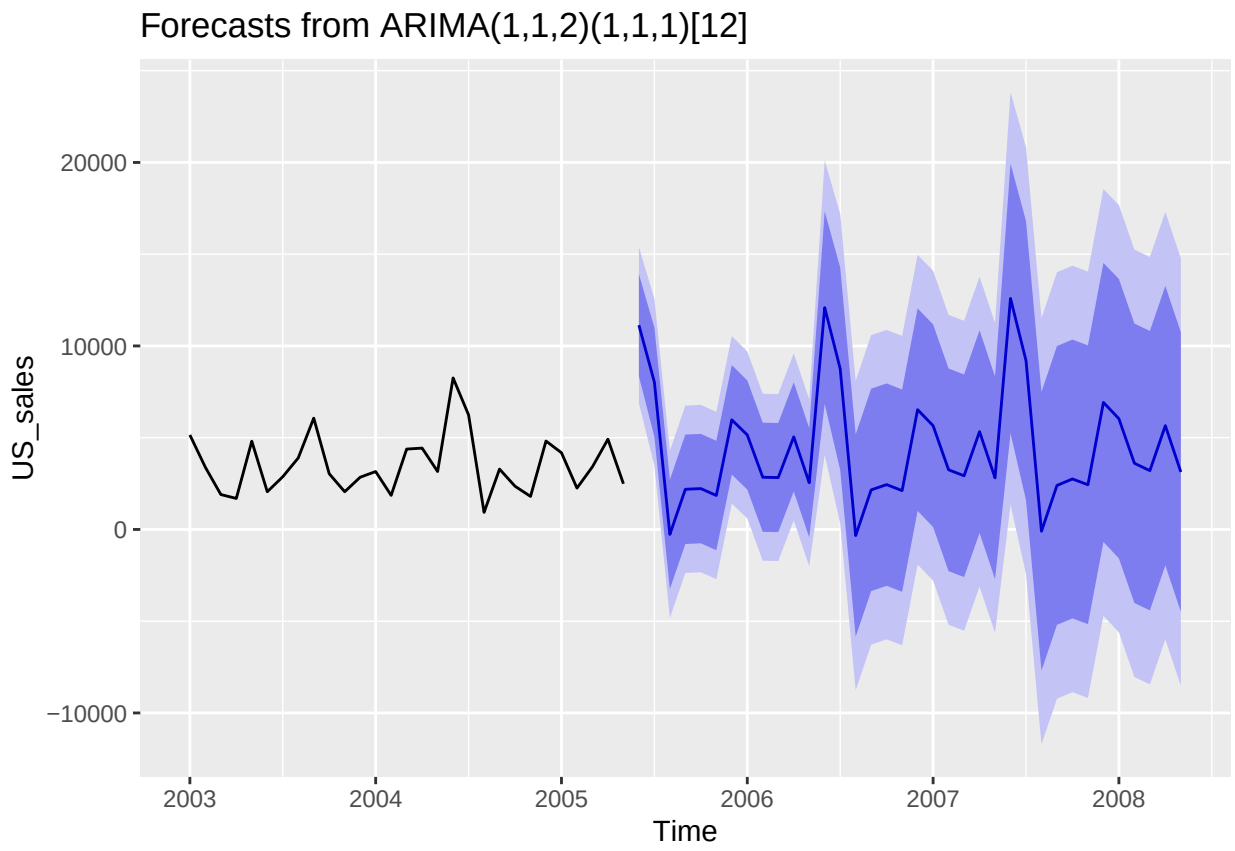
```
#Checking residual values of Manual Arima Model
checkresiduals(US2_model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(1,1,2)(1,1,1)[12]
## Q* = 5.0344, df = 3, p-value = 0.1693
##
## Model df: 5.   Total lags used: 8
```

```
#Create Forecast for Manual ARIMA Model
#Forecast for the next two years
US2_Forecast <- forecast(US2_model, h=36)
```

```
#Plot Forecast Results
#Showing the last 5 years
autoplot(US2_Forecast, include = 60)
```




```
#Print Summary Forecast Results
print(summary(US2_Forecast))
```

```
##
## Forecast method: ARIMA(1,1,2)(1,1,1)[12]
##
## Model Information:
##
## Call:
## arima(x = US_sales, order = c(1, 1, 2), seasonal = list(order = c(1, 1, 1)))
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced

##           ar1      ma1      ma2    sar1    sma1
##       -0.2617  -0.3827  -0.6172  0.2606  0.2604
## s.e.   0.3915   0.2986   0.2804     NaN     NaN
##
## sigma^2 estimated as 4519107:  log likelihood = -147.9,  aic = 307.81
##
## Error measures:
##                     ME     RMSE      MAE      MPE     MAPE      MASE        ACF1
## Training set 112.4188 1579.023 860.1448 -9.75588 29.09879 0.4547532 -0.03351387
##
```

```
## Forecasts:
##          Point Forecast      Lo 80     Hi 80       Lo 95     Hi 95
## Jun 2005    11132.10177  8350.3957 13913.808   6877.8494 15386.354
## Jul 2005     8027.96667  5052.8175 11003.116   3477.8687 12578.065
## Aug 2005     -268.74013 -3246.9283  2709.448  -4823.4859  4286.006
## Sep 2005     2190.08259  -790.8085  5170.974  -2368.7969  6748.962
## Oct 2005     2225.98132  -754.6596  5206.622  -2332.5156  6784.478
## Nov 2005     1850.75490 -1128.9582  4830.468  -2706.3231  6407.833
## Dec 2005     5974.21082  2993.2330  8955.189   1415.1987 10533.223
## Jan 2006     5149.27704  2175.1449  8123.409    600.7345  9697.820
## Feb 2006     2844.37886  -129.7505  5818.508  -1704.1595  7392.917
## Mar 2006     2828.10734  -146.0228  5802.237  -1720.4321  7376.647
## Apr 2006     5046.10801  2071.9781  8020.238    497.5689  9594.647
## May 2006     2545.87832  -428.2517  5520.008  -2002.6611  7094.418
## Jun 2006    12087.95238  6841.7430 17334.162   4064.5675 20111.337
## Jul 2006     8756.50736  3244.2386 14268.776    326.2197 17186.795
## Aug 2006     -332.99963 -5841.9433  5175.944  -8758.2019  8092.203
## Sep 2006     2155.98648 -3358.1465  7670.119  -6277.1522 10589.125
## Oct 2006     2443.56935 -3069.9022  7957.041  -5988.5578 10875.696
## Nov 2006     2115.09556 -3396.9004  7627.092  -6314.7748 10544.966
## Dec 2006     6526.80837  1010.4846 12043.132  -1909.6808 14963.298
## Jan 2007     5653.52321   133.5193 11173.527  -2788.5942 14095.641
## Feb 2007     3249.67677 -2270.3215  8769.675  -5192.4321 11691.786
## Mar 2007     2926.45382 -2593.5459  8446.454  -5515.6573 11368.565
## Apr 2007     5331.22145  -188.7779 10851.221  -3110.8891 13773.332
## May 2007     2811.69194 -2708.3077  8331.692  -5630.4190 11253.803
## Jun 2007    12588.39670  5244.1353 19932.658   1356.3182 23820.475
## Jul 2007     9197.72289  1595.8557 16799.590  -2428.3297 20823.776
## Aug 2007      -98.35935 -7689.5092  7492.791 -11708.0212 11511.303
## Sep 2007     2398.48627 -5199.1405  9996.113  -9221.0811 14018.054
## Oct 2007     2751.64897 -4845.0546 10348.353  -8866.5065 14369.804
## Nov 2007     2435.35725 -5159.5199 10030.234  -9180.0051 14050.720
## Dec 2007     6922.17943  -679.1801 14523.539  -4703.0968 18547.456
## Jan 2008     6036.29564 -1576.8372 13649.429  -5606.9864 17679.578
## Feb 2008     3606.66685 -4006.4587 11219.792  -8036.6040 15249.938
## Mar 2008     3203.46338 -4409.6642 10816.591  -8439.8104 14846.737
## Apr 2008     5656.89577 -1956.2312 13270.023  -5986.3772 17300.169
## May 2008     3132.33742 -4480.7899 10745.465  -8510.9361 14775.611
```

```
#Forecast 4, Part 1: Forecasting with Focus on Spain Data

#Sub-setting the data to only show sales in Spain
Spain_Sales <- subset(salesdata2, COUNTRY == "Spain")
head(Spain_Sales)
```

```
##      ORDERNUMBER QUANTITYORDERED PRICEEACH ORDERLINENUMBER   SALES  ORDERDATE
## 267        10104              34       100               1 5958.50 2003-01-31
## 368        10104              41       100               9 4615.78 2003-01-31
## 654        10104              24       100               8 3457.92 2003-01-31
## 703        10104              29       100              12 3772.61 2003-01-31
## 1014       10104              23       100              13 4556.99 2003-01-31
## 1242       10104              38       100               3 5348.50 2003-01-31
##       STATUS QTR_ID MONTH_ID YEAR_ID      PRODUCTLINE MSRP PRODUCTCODE
## 267  Shipped      1        1    2003     Classic Cars  151    S12_3148
```

```
## 368  Shipped      1        1    2003 Trucks and Buses  118    S12_4473
## 654  Shipped      1        1    2003     Classic Cars  163    S18_2238
## 703  Shipped      1        1    2003 Trucks and Buses  122    S18_2319
## 1014 Shipped      1        1    2003     Classic Cars  169    S18_3232
## 1242 Shipped      1        1    2003     Classic Cars  143    S18_4027
##               CUSTOMERNAME          PHONE       ADDRESSLINE1 ADDRESSLINE2
## 267  Euro Shopping Channel (91) 555 94 44 C/ Moralzarzal, 86
## 368  Euro Shopping Channel (91) 555 94 44 C/ Moralzarzal, 86
## 654  Euro Shopping Channel (91) 555 94 44 C/ Moralzarzal, 86
## 703  Euro Shopping Channel (91) 555 94 44 C/ Moralzarzal, 86
## 1014 Euro Shopping Channel (91) 555 94 44 C/ Moralzarzal, 86
## 1242 Euro Shopping Channel (91) 555 94 44 C/ Moralzarzal, 86
##        CITY STATE POSTALCODE COUNTRY TERRITORY CONTACTLASTNAME CONTACTFIRSTNAME
## 267  Madrid            28034   Spain      EMEA          Freyre            Diego
## 368  Madrid            28034   Spain      EMEA          Freyre            Diego
## 654  Madrid            28034   Spain      EMEA          Freyre            Diego
## 703  Madrid            28034   Spain      EMEA          Freyre            Diego
## 1014 Madrid            28034   Spain      EMEA          Freyre            Diego
## 1242 Madrid            28034   Spain      EMEA          Freyre            Diego
##      DEALSIZE
## 267    Medium
## 368    Medium
## 654    Medium
## 703    Medium
## 1014   Medium
## 1242   Medium
```

```
#Creating Time Series
Spain_sales <- ts(Spain_Sales[,5], start = c(2003,1), end = c(2005,5), frequency = 12)
Spain_sales
```

```
##          Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep
## 2003 5958.50 4615.78 3457.92 3772.61 4556.99 5348.50 1942.15 1742.40 2921.62
## 2004 1705.92 4219.20 7329.06 3347.74 2439.57 3857.00 2309.58 2795.86 2795.27
## 2005 7083.00 2314.69 3415.77 3576.12 4141.33
##          Oct     Nov     Dec
## 2003 1666.70 3227.63 3705.24
## 2004 3390.20 2921.70 3128.92
## 2005
```

```
#Build Fit Arima Model
#Taking first difference of the data
#Getting rid of seasonality by taking first seasonal difference

Spain_AR_Model <- auto.arima(Spain_sales, d=1, D=1, stepwise = FALSE, approximation = FALSE, trace = TRU
```

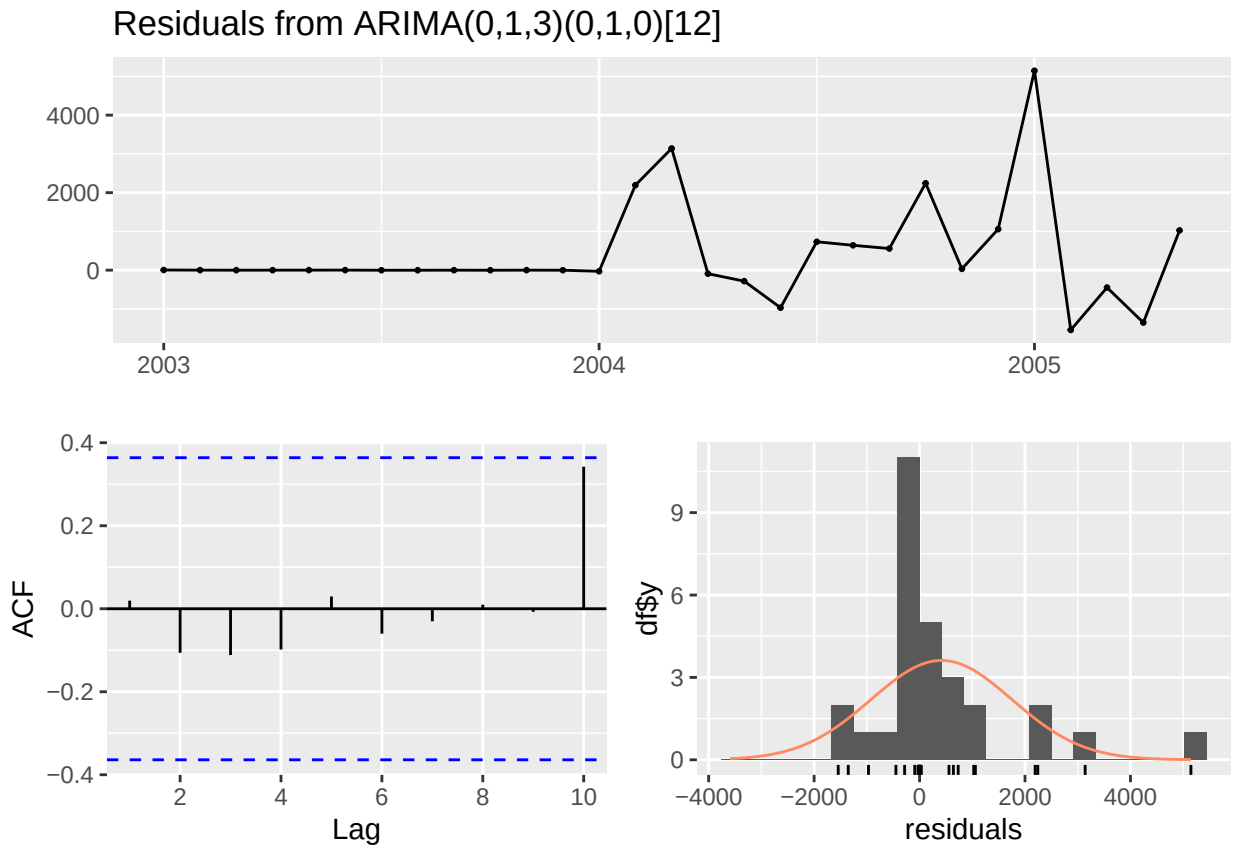
```
##
##  ARIMA(0,1,0)(0,1,0)[12]                    : 307.4258
##  ARIMA(0,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,3)(0,1,0)[12]                    : 302.8597
##  ARIMA(0,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,5)(0,1,0)[12]                    : Inf
```

```
##  ARIMA(1,1,0)(0,1,0)[12]                    : 309.5293
##  ARIMA(1,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,3)(0,1,0)[12]                    : 307.1979
##  ARIMA(1,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,0)(0,1,0)[12]                    : 304.3293
##  ARIMA(2,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,0)(0,1,0)[12]                    : 306.4106
##  ARIMA(3,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(4,1,0)(0,1,0)[12]                    : 307.4779
##  ARIMA(4,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(5,1,0)(0,1,0)[12]                    : 312.7335
##
##
##
##  Best model: ARIMA(0,1,3)(0,1,0)[12]
```

```
#Printing AR Model Summary
print(summary(Spain_AR_Model))
```

```
## Series: Spain_sales
## ARIMA(0,1,3)(0,1,0)[12]
##
## Coefficients:
##          ma1      ma2     ma3
##       -0.9670  -0.7277  0.7913
## s.e.   0.4764   0.3612  0.5304
##
## sigma^2 = 4236114:  log likelihood = -145.61
## AIC=299.22   AICc=302.86   BIC=302.31
##
## Training set error measures:
##                    ME     RMSE     MAE      MPE     MAPE      MASE       ACF1
## Training set 415.5884 1378.023 741.585 7.201743 18.18483 0.4225967 0.01957441
```

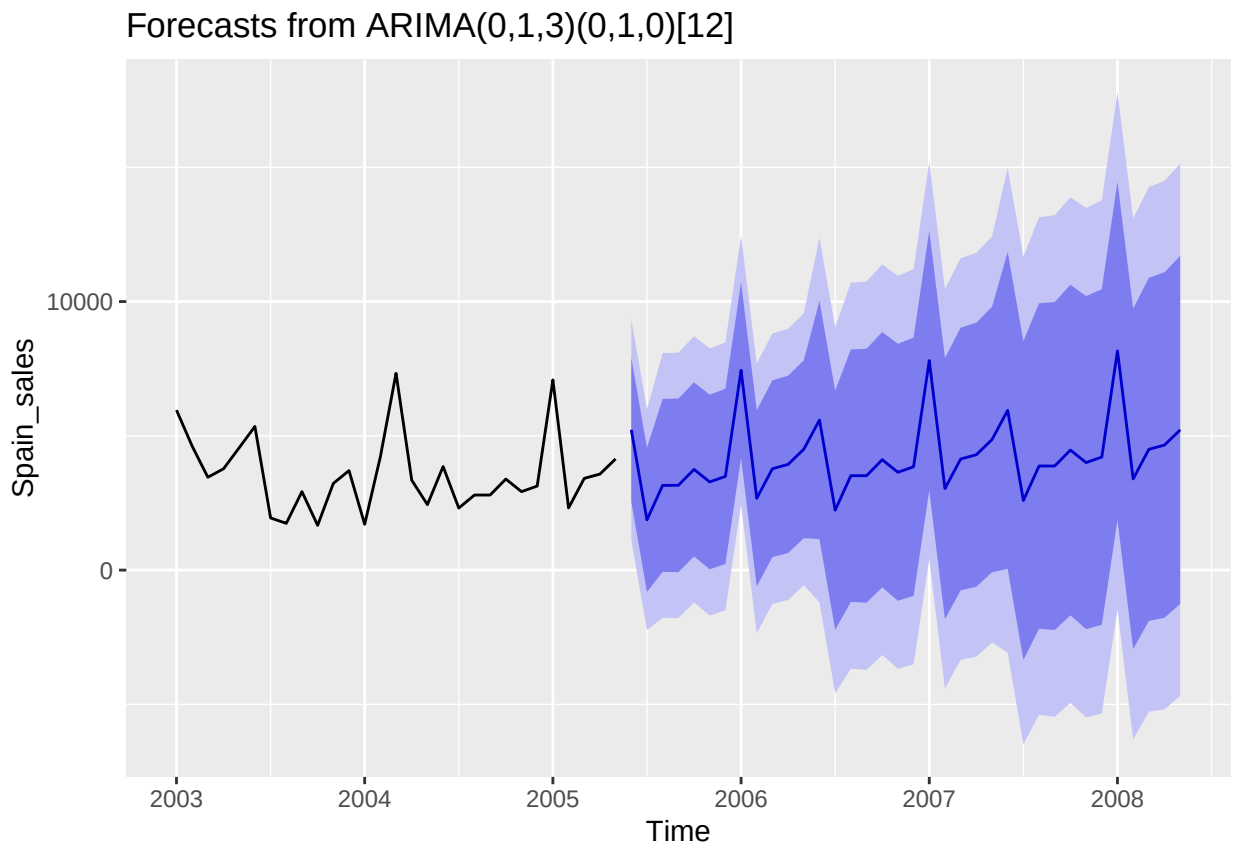
```
#Checking Residuals of AR_Model
checkresiduals(Spain_AR_Model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(0,1,3)(0,1,0)[12]
## Q* = 1.3391, df = 3, p-value = 0.7199
##
## Model df: 3.   Total lags used: 6
```

```
#Forecasting ARIMA Model
#forecast two years ahead
Spain_AR_Model_Forecast <- forecast(Spain_AR_Model, h=36)
```

```
#Plotting AR Model Forecast
#including the last 5 years
autoplot(Spain_AR_Model_Forecast, include = 60)
```




```
#Print Summary of AR Model Forecast
print(summary(Spain_AR_Model_Forecast))
```

```
##
## Forecast method: ARIMA(0,1,3)(0,1,0)[12]
##
## Model Information:
## Series: Spain_sales
## ARIMA(0,1,3)(0,1,0)[12]
##
## Coefficients:
##           ma1      ma2     ma3
##       -0.9670  -0.7277  0.7913
## s.e.   0.4764   0.3612  0.5304
##
## sigma^2 = 4236114:  log likelihood = -145.61
## AIC=299.22   AICc=302.86   BIC=302.31
##
## Error measures:
##                     ME     RMSE     MAE      MPE     MAPE      MASE        ACF1
## Training set 415.5884 1378.023 741.585 7.201743 18.18483 0.4225967 0.01957441
##
## Forecasts:
##          Point Forecast       Lo 80     Hi 80      Lo 95     Hi 95
## Jun 2005       5227.953  2547.17935  7908.727  1128.0633  9327.843
## Jul 2005       1870.941  -813.73515  4555.616 -2234.9166  5976.798
```

```
## Aug 2005       3156.232   -64.96746  6377.431 -1770.1673  8082.631
## Sep 2005       3155.642   -75.62026  6386.904 -1786.1470  8097.430
## Oct 2005       3750.572   509.27817  6991.865 -1206.5590  8707.702
## Nov 2005       3282.072    30.77755  6533.366 -1690.3536  8254.497
## Dec 2005       3489.292   228.02760  6750.556 -1498.3813  8476.965
## Jan 2006       7443.372  4172.16804 10714.575  2440.4974 12446.246
## Feb 2006       2675.062  -606.05141  5956.175 -2342.9678  7693.091
## Mar 2006       3776.142   485.14897  7067.134 -1256.9974  8809.281
## Apr 2006       3936.492   635.64893  7237.335 -1111.7117  8984.695
## May 2006       4501.702  1191.03819  7812.365  -561.5212  9564.925
## Jun 2006       5588.325  1152.33733 10024.313 -1195.9327 12372.583
## Jul 2006       2231.312 -2222.70864  6685.333 -4580.5249  9043.150
## Aug 2006       3516.603 -1183.69195  8216.899 -3671.8780 10705.085
## Sep 2006       3516.013 -1211.82923  8243.856 -3714.5980 10746.625
## Oct 2006       4110.943  -644.28692  8866.174 -3161.5538 11383.441
## Nov 2006       3642.443 -1140.01778  8424.905 -3671.6998 10956.587
## Dec 2006       3849.663  -959.87446  8659.201 -3505.8900 11205.217
## Jan 2007       7803.743  2967.28044 12640.206   407.0116 15200.475
## Feb 2007       3035.433 -1827.80558  7898.672 -4402.2488 10473.116
## Mar 2007       4136.513  -753.35500  9026.382 -3341.8950 11614.922
## Apr 2007       4296.863  -619.49017  9213.217 -3222.0506 11815.777
## May 2007       4862.073   -80.62343  9804.770 -2697.1291 12421.276
## Jun 2007       5948.697    48.81958 11848.574 -3074.3867 14971.780
## Jul 2007       2591.684 -3344.48538  8527.853 -6486.9036 11670.272
## Aug 2007       3876.975 -2181.76027  9935.711 -5389.0611 13143.011
## Sep 2007       3876.385 -2230.38517  9983.156 -5463.1141 13215.884
## Oct 2007       4471.315 -1683.11517 10625.746 -4941.0738 13883.704
## Nov 2007       4002.815 -2198.90892 10204.539 -5481.9034 13487.534
## Dec 2007       4210.035 -2038.62474 10458.695 -5346.4655 13766.536
## Jan 2008       8164.115  1868.86938 14459.361 -1463.6324 17791.863
## Feb 2008       3395.805 -2945.68428  9737.295 -6302.6660 13094.276
## Mar 2008       4496.885 -1890.51315 10884.283 -5271.7976 14265.568
## Apr 2008       4657.235 -1775.74440 11090.215 -5181.1581 14495.628
## May 2008       5222.445 -1255.79495 11700.685 -4685.1681 15130.058
```

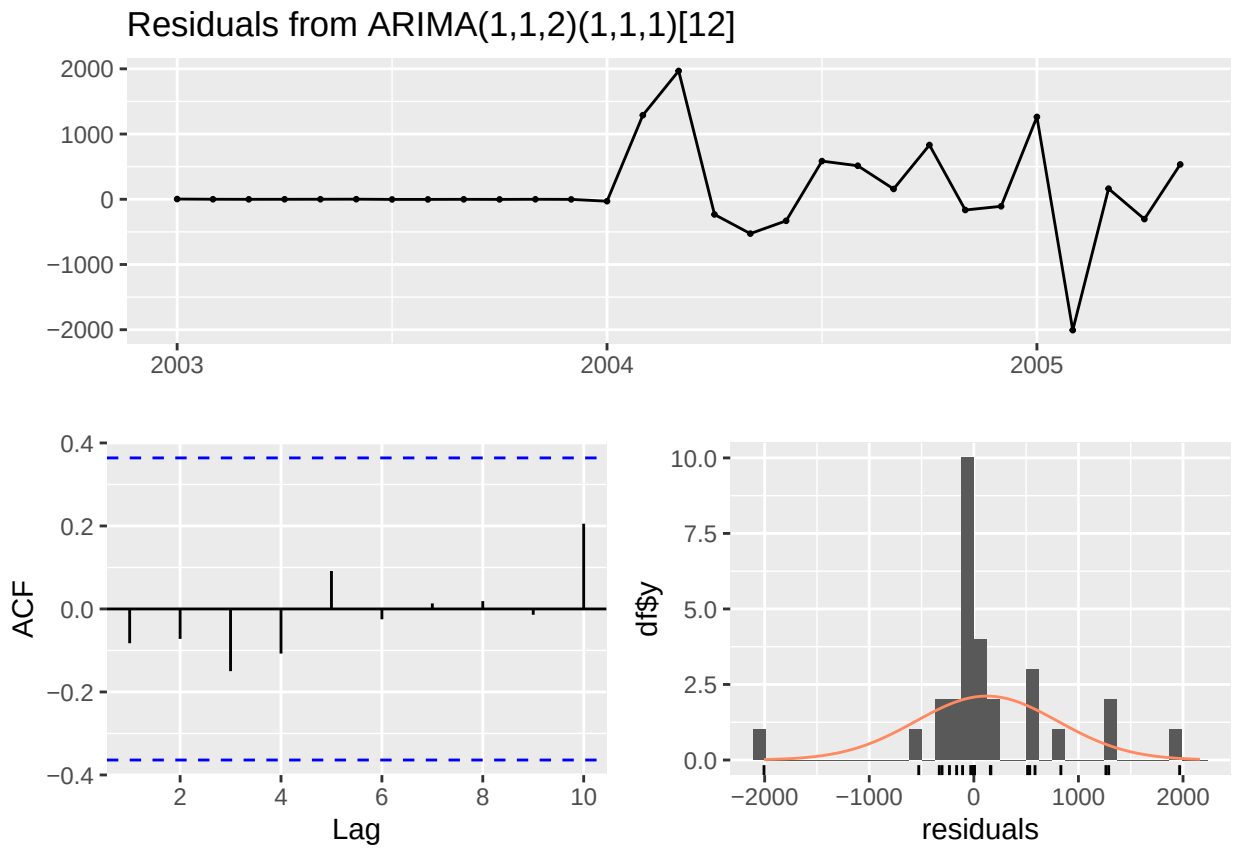
```
#Forecast 4, Part 2: Testing Spain Sales Forecast with manual ARIMA variables

#Building second Spain model
Spain2_model <-arima(Spain_sales,order = c(1,1,2), seasonal = list(order = c(1,1,1)))
```

```
#Print Manual Arima Model Summary
print(summary(Spain2_model))
```

```
##
## Call:
## arima(x = Spain_sales, order = c(1, 1, 2), seasonal = list(order = c(1, 1, 1)))
##
## Coefficients:
##           ar1      ma1      ma2     sar1     sma1
##       -0.6549  -0.0103  -0.9896  -0.5987  -0.8971
## s.e.   0.2738   2.1122   2.1118   0.3323   6.2131
##
## sigma^2 estimated as 835194:  log likelihood = -144.03,  aic = 300.06
```

```
##
## Training set error measures:
##                     ME    RMSE      MAE       MPE     MAPE     MASE        ACF1
## Training set 124.1344 678.843 380.1319 0.8057485 10.70574 0.264418 -0.08251263
```

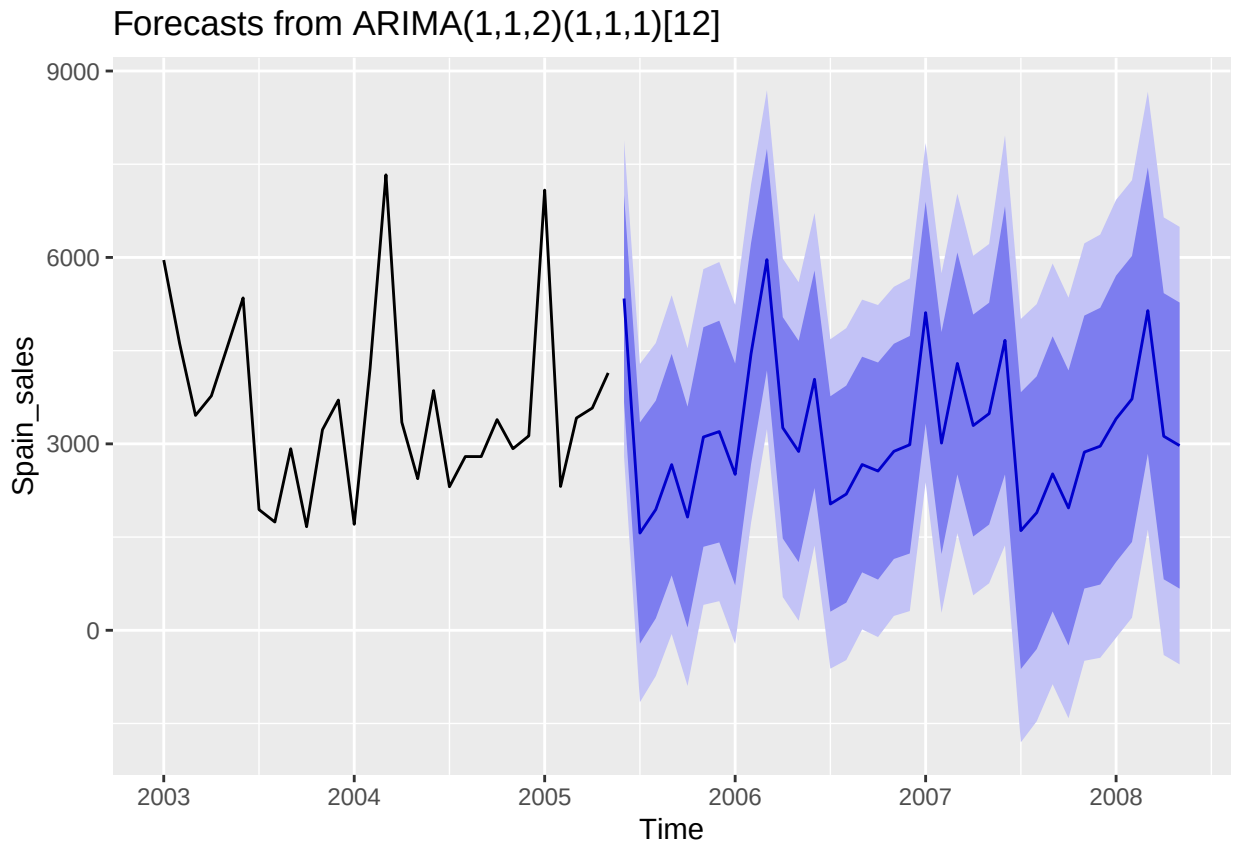
```
#Checking residual values of Manual Arima Model
checkresiduals(Spain2_model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(1,1,2)(1,1,1)[12]
## Q* = 1.9439, df = 3, p-value = 0.5841
##
## Model df: 5.   Total lags used: 8
```

```
#Create Forecast for Manual ARIMA Model
#Forecast for the next two years
Spain2_Forecast <- forecast(Spain2_model, h=36)
```

```
#Plot Forecast Results
#Showing the last 5 years
autoplot(Spain2_Forecast, include = 60)
```




```
#Print Summary Forecast Results
print(summary(Spain2_Forecast))
```

```
##
## Forecast method: ARIMA(1,1,2)(1,1,1)[12]
##
## Model Information:
##
## Call:
## arima(x = Spain_sales, order = c(1, 1, 2), seasonal = list(order = c(1, 1, 1)))
##
## Coefficients:
##           ar1      ma1      ma2     sar1     sma1
##       -0.6549  -0.0103  -0.9896  -0.5987  -0.8971
## s.e.   0.2738   2.1122   2.1118   0.3323   6.2131
##
## sigma^2 estimated as 835194:  log likelihood = -144.03,  aic = 300.06
##
## Error measures:
##                     ME    RMSE      MAE       MPE     MAPE      MASE        ACF1
## Training set 124.1344 678.843 380.1319 0.8057485 10.70574 0.2166204 -0.08251263
##
## Forecasts:
##          Point Forecast      Lo 80    Hi 80       Lo 95    Hi 95
## Jun 2005       5338.919 3674.85873 7002.979  2793.95839 7883.880
## Jul 2005       1564.634 -214.99233 3344.260 -1157.06947 4286.337
```

```
## Aug 2005       1943.854  192.27678 3695.432  -734.95244 4622.661
## Sep 2005       2666.011  884.15183 4447.871   -59.10757 5391.130
## Oct 2005       1821.639   45.14929 3598.129  -895.26760 4538.546
## Nov 2005       3110.397 1344.05220 4876.741   409.00593 5811.787
## Dec 2005       3197.668 1413.49694 4981.838   469.01402 5926.321
## Jan 2006       2508.932  725.34851 4292.516  -218.82362 5236.688
## Feb 2006       4448.932 2669.50873 6228.355  1727.53906 7170.325
## Mar 2006       5963.929 4182.05186 7745.807  3238.78293 8689.076
## Apr 2006       3258.450 1477.62709 5039.272   534.91660 5981.983
## May 2006       2877.406 1096.68763 4658.125   154.03208 5600.781
## Jun 2006       4039.347 2290.23803 5788.457  1364.31550 6714.379
## Jul 2006       2032.702  299.75711 3765.646  -617.60828 4683.011
## Aug 2006       2191.510  445.21175 3937.809  -479.22292 4862.244
## Sep 2006       2667.292  932.36688 4402.217    13.95308 5320.631
## Oct 2006       2562.598  815.92799 4309.268  -108.70326 5233.899
## Nov 2006       2879.205 1147.61169 4610.797   230.96181 5527.447
## Dec 2006       2985.940 1235.74299 4736.137   309.24470 5662.635
## Jan 2007       5111.173 3326.52440 6895.823  2381.78825 7840.559
## Feb 2007       3012.410 1226.29044 4798.530   280.77566 5744.045
## Mar 2007       4294.300 2509.27789 6079.322  1564.34423 7024.256
## Apr 2007       3294.978 1509.02153 5080.935   563.59317 6026.363
## May 2007       3486.771 1701.75323 5271.790   756.82167 6216.721
## Jun 2007       4665.923 2510.08957 6821.757  1368.86013 7962.986
## Jul 2007       1603.687 -623.55629 3830.930 -1802.58754 5009.961
## Aug 2007       1892.685 -302.22306 4087.593 -1464.13731 5249.508
## Sep 2007       2517.134  303.86557 4730.402  -867.76792 5902.036
## Oct 2007       1968.830 -243.66760 4181.327 -1414.89295 5352.552
## Nov 2007       2867.967  671.83296 5064.101  -490.73025 6226.665
## Dec 2007       2962.723  736.21051 5189.235  -442.43399 6367.880
## Jan 2008       3403.429 1099.60116 5707.257  -119.97169 6926.830
## Feb 2008       3722.559 1421.14733 6023.970   202.85369 7242.264
## Mar 2008       5144.103 2841.42391 7446.782  1622.45912 8665.747
## Apr 2008       3123.234  820.88040 5425.587  -397.91194 6644.380
## May 2008       2972.106  670.30390 5273.907  -548.19635 6492.408
```

```
#Forecast 5, Part 1: Forecasting with focus on Classic Cars

#Sub-setting the data to only show sales in
Class_Car_Sales <- subset(salesdata2, PRODUCTLINE == "Classic Cars")
head(Class_Car_Sales)
```

```
##      ORDERNUMBER QUANTITYORDERED PRICEEACH ORDERLINENUMBER   SALES  ORDERDATE
## 27         10103              26       100              11 5404.62 2003-01-29
## 134        10103              42       100               4 5398.26 2003-01-29
## 2615       10103              42       100               6 4460.82 2003-01-29
## 267        10104              34       100               1 5958.50 2003-01-31
## 654        10104              24       100               8 3457.92 2003-01-31
## 1014       10104              23       100              13 4556.99 2003-01-31
##       STATUS QTR_ID MONTH_ID YEAR_ID  PRODUCTLINE MSRP PRODUCTCODE
## 27   Shipped      1        1    2003 Classic Cars  214    S10_1949
## 134  Shipped      1        1    2003 Classic Cars  147    S10_4962
## 2615 Shipped      1        1    2003 Classic Cars  101   S700_2824
## 267  Shipped      1        1    2003 Classic Cars  151    S12_3148
## 654  Shipped      1        1    2003 Classic Cars  163    S18_2238
```

```
## 1014 Shipped      1        1    2003 Classic Cars  169    S18_3232
##                CUSTOMERNAME          PHONE           ADDRESSLINE1 ADDRESSLINE2
## 27       Baane Mini Imports     07-98 9555 Erling Skakkes gate 78
## 134      Baane Mini Imports     07-98 9555 Erling Skakkes gate 78
## 2615     Baane Mini Imports     07-98 9555 Erling Skakkes gate 78
## 267   Euro Shopping Channel (91) 555 94 44     C/ Moralzarzal, 86
## 654   Euro Shopping Channel (91) 555 94 44     C/ Moralzarzal, 86
## 1014  Euro Shopping Channel (91) 555 94 44     C/ Moralzarzal, 86
##          CITY STATE POSTALCODE COUNTRY TERRITORY CONTACTLASTNAME
## 27    Stavern              4110  Norway      EMEA      Bergulfsen
## 134   Stavern              4110  Norway      EMEA      Bergulfsen
## 2615  Stavern              4110  Norway      EMEA      Bergulfsen
## 267    Madrid             28034   Spain      EMEA          Freyre
## 654    Madrid             28034   Spain      EMEA          Freyre
## 1014   Madrid             28034   Spain      EMEA          Freyre
##       CONTACTFIRSTNAME DEALSIZE
## 27               Jonas   Medium
## 134              Jonas   Medium
## 2615             Jonas   Medium
## 267              Diego   Medium
## 654              Diego   Medium
## 1014             Diego   Medium
```

```
#Creating Time Series
Class_Car_sales <- ts(Class_Car_Sales[,5], start = c(2003,1), end = c(2005,5), frequency = 12)
Class_Car_sales
```

```
##          Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep
## 2003 5404.62 5398.26 4460.82 5958.50 3457.92 4556.99 5348.50 1942.15 1742.40
## 2004 4566.05 5265.15 6130.35 3485.82 3731.04 3130.82 1777.10 4049.56 5565.12
## 2005 4379.18 4432.70 3157.44 8257.00 6241.60
##          Oct     Nov     Dec
## 2003 2921.62 7208.00 8690.36
## 2004 1892.10 5448.80 2130.01
## 2005
```

```
#Build Fit Arima Model
#Taking first differnce of the data
#Getting rid of seasonality by taking first seasonal difference

CC_AR_Model <- auto.arima(Class_Car_sales, d=1, D=1, stepwise = FALSE, approximation = FALSE, trace = TR
```

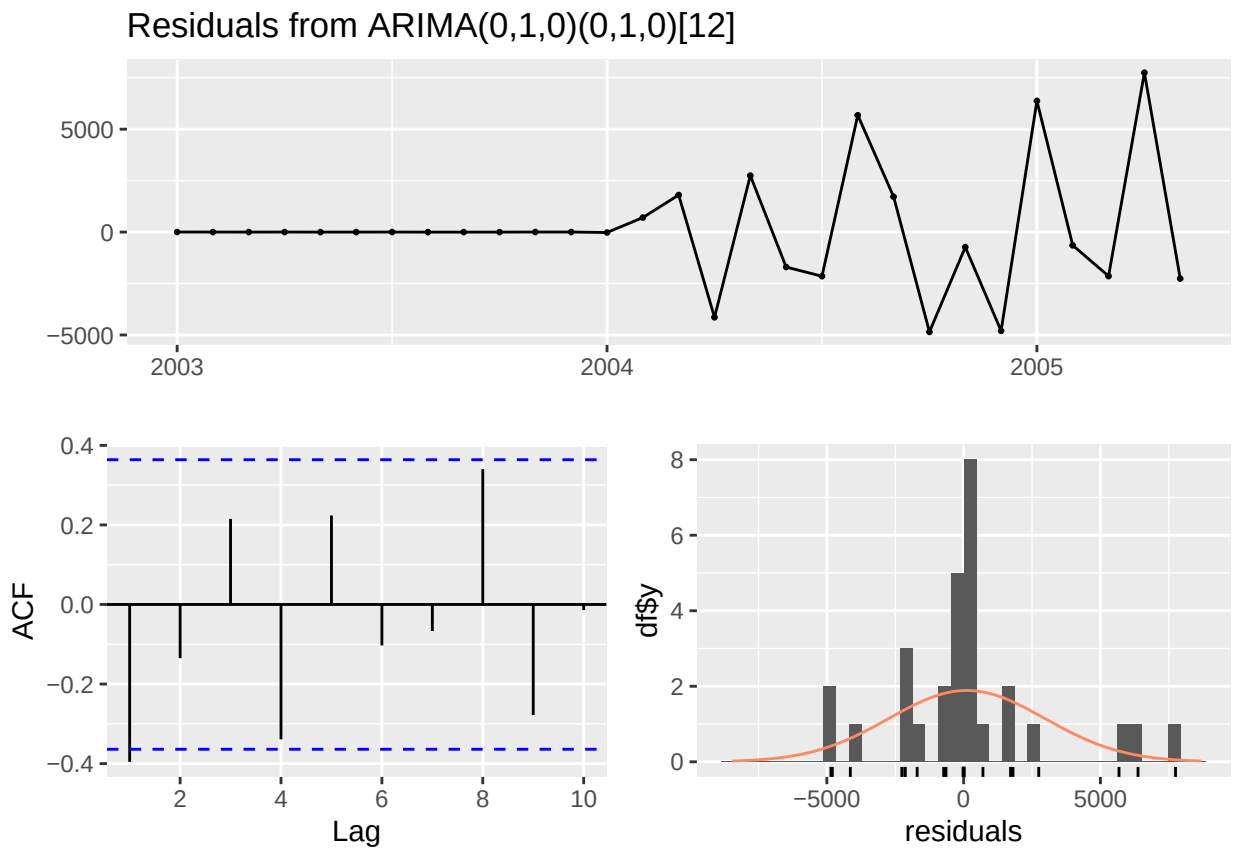
```
##
##  ARIMA(0,1,0)(0,1,0)[12]                    : 311.3148
##  ARIMA(0,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,5)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,0)(0,1,0)[12]                    : 311.3759
##  ARIMA(1,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,3)(0,1,0)[12]                    : Inf
```

```
##  ARIMA(1,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,0)(0,1,0)[12]                    : 312.4
##  ARIMA(2,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,0)(0,1,0)[12]                    : 315.9898
##  ARIMA(3,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(4,1,0)(0,1,0)[12]                    : 317.3993
##  ARIMA(4,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(5,1,0)(0,1,0)[12]                    : 322.7064
##
##
##
##  Best model: ARIMA(0,1,0)(0,1,0)[12]
```

```
#Printing AR Model Summary
print(summary(CC_AR_Model))
```

```
## Series: Class_Car_sales
## ARIMA(0,1,0)(0,1,0)[12]
##
## sigma^2 = 14309652:  log likelihood = -154.51
## AIC=311.03   AICc=311.31   BIC=311.8
##
## Training set error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
## Training set 114.9285 2809.801 1731.863 -13.15426 49.49796 0.7970617 -0.3954847
```

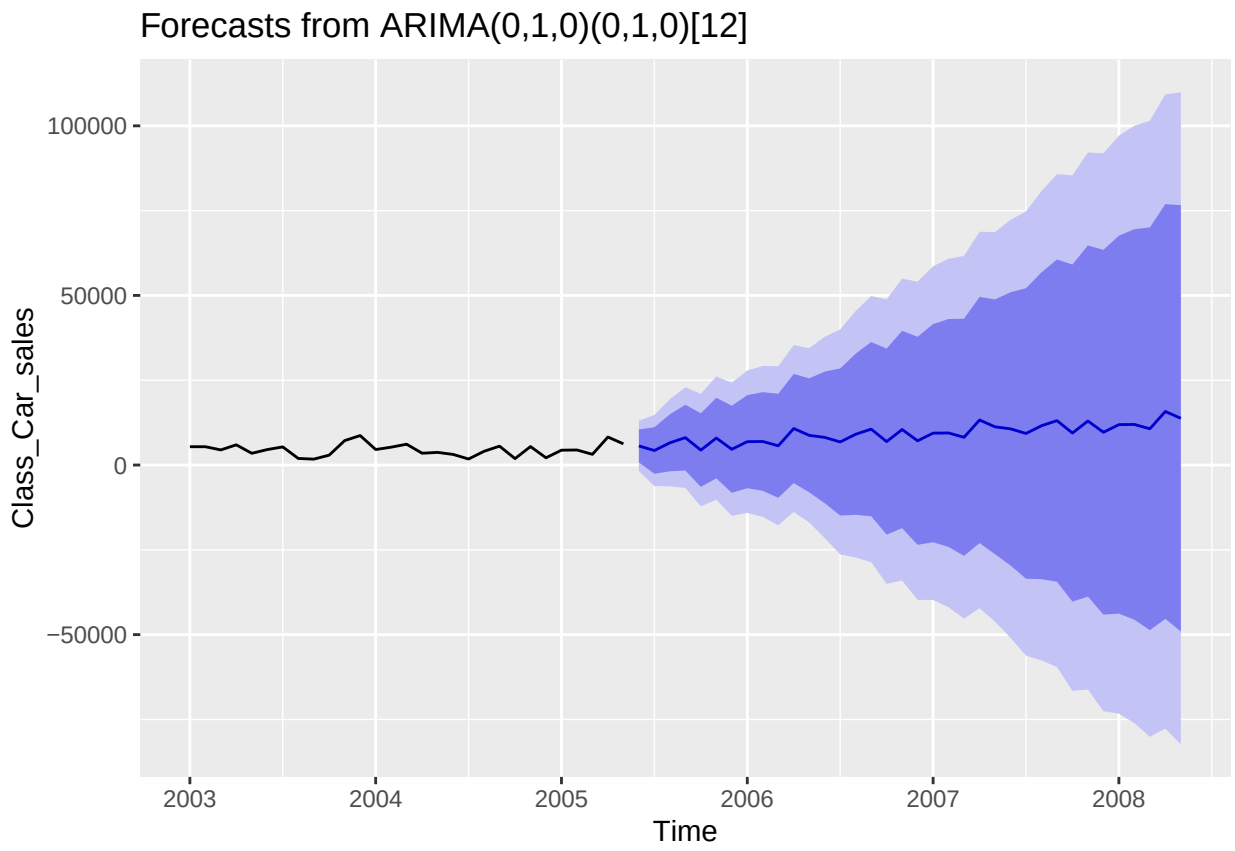
```
#Checking Residuals of AR_Model
checkresiduals(CC_AR_Model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(0,1,0)(0,1,0)[12]
## Q* = 13.648, df = 6, p-value = 0.03382
##
## Model df: 0.   Total lags used: 6
```

```
#Forecasting ARIMA Model
#forecast two years ahead
CC_AR_Model_Forecast <- forecast(CC_AR_Model, h=36)
```

```
#Plotting AR Model Forecast
#including the last 5 years
autoplot(CC_AR_Model_Forecast, include = 60)
```




```
#Print Summary of AR Model Forecast
print(summary(CC_AR_Model_Forecast))
```

```
##
## Forecast method: ARIMA(0,1,0)(0,1,0)[12]
##
## Model Information:
## Series: Class_Car_sales
## ARIMA(0,1,0)(0,1,0)[12]
##
## sigma^2 = 14309652:  log likelihood = -154.51
## AIC=311.03   AICc=311.31   BIC=311.8
##
## Error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
## Training set 114.9285 2809.801 1731.863 -13.15426 49.49796 0.7970617 -0.3954847
##
## Forecasts:
##          Point Forecast       Lo 80    Hi 80      Lo 95     Hi 95
## Jun 2005        5641.38    793.5138 10489.25  -1772.792  13055.55
## Jul 2005        4287.66  -2568.2581 11143.58  -6197.562  14772.88
## Aug 2005        6560.12  -1836.6306 14956.87  -6281.602  19401.84
## Sep 2005        8075.68  -1620.0524 17771.41  -6752.663  22904.02
## Oct 2005        4402.66  -6437.4984 15242.82 -12175.932  20981.25
## Nov 2005        7959.36  -3915.4385 19834.16 -10201.577  26120.30
## Dec 2005        4640.57  -8185.6783 17466.82 -14975.484  24256.62
```

```
## Jan 2006        6889.74  -6822.0962 20601.58 -14080.704  27860.18
## Feb 2006        6943.26  -7600.3386 21486.86 -15299.255  29185.77
## Mar 2006        5668.00  -9662.2990 20998.30 -17777.669  29113.67
## Apr 2006       10767.56  -5310.9932 26846.11 -13822.465  35357.59
## May 2006        8752.16  -8041.3411 25545.66 -16931.284  34435.60
## Jun 2006        8151.94 -11239.5248 27543.40 -21504.746  37808.63
## Jul 2006        6798.22 -14882.0967 28478.54 -26358.963  39955.40
## Aug 2006        9070.68 -14678.9170 32820.28 -27251.194  45392.55
## Sep 2006       10586.24 -15066.2567 36238.74 -28645.868  49818.35
## Oct 2006        6913.22 -20510.4525 34336.89 -35027.668  48854.11
## Nov 2006       10469.92 -18617.2772 39557.12 -34015.109  54954.95
## Dec 2006        7151.13 -23509.4679 37811.73 -39740.208  54042.47
## Jan 2007        9400.30 -22756.8064 41557.41 -39779.750  58580.35
## Feb 2007        9453.82 -24133.1822 43040.82 -41913.067  60820.71
## Mar 2007        8178.56 -26779.9003 43137.02 -45285.791  61642.91
## Apr 2007       13278.12 -22999.9887 49556.23 -42204.459  68760.70
## May 2007       11262.72 -26288.6901 48814.13 -46167.206  68692.65
## Jun 2007       10662.50 -29606.9010 50931.90 -50924.234  72249.23
## Jul 2007        9308.78 -33506.4150 52123.97 -56171.410  74788.97
## Aug 2007       11581.24 -33636.6456 56799.13 -57573.548  80736.03
## Sep 2007       13096.80 -34402.3941 60595.99 -59546.949  85740.55
## Oct 2007        9423.78 -40252.0662 59099.63 -66548.871  85396.43
## Nov 2007       12980.48 -38780.5667 64741.53 -66181.210  92142.17
## Dec 2007        9661.69 -44103.7470 63427.13 -72565.450  91888.83
## Jan 2008       11910.86 -43786.8821 67608.60 -73271.486  97093.21
## Feb 2008       11964.38 -45600.8416 69529.60 -76074.029 100002.79
## Mar 2008       10689.12 -48684.8726 70063.11 -80115.566 101493.81
## Apr 2008       15788.68 -45340.5868 76917.95 -77700.466 109277.83
## May 2008       13773.28 -49062.2475 76608.81 -82325.367 109871.93
```

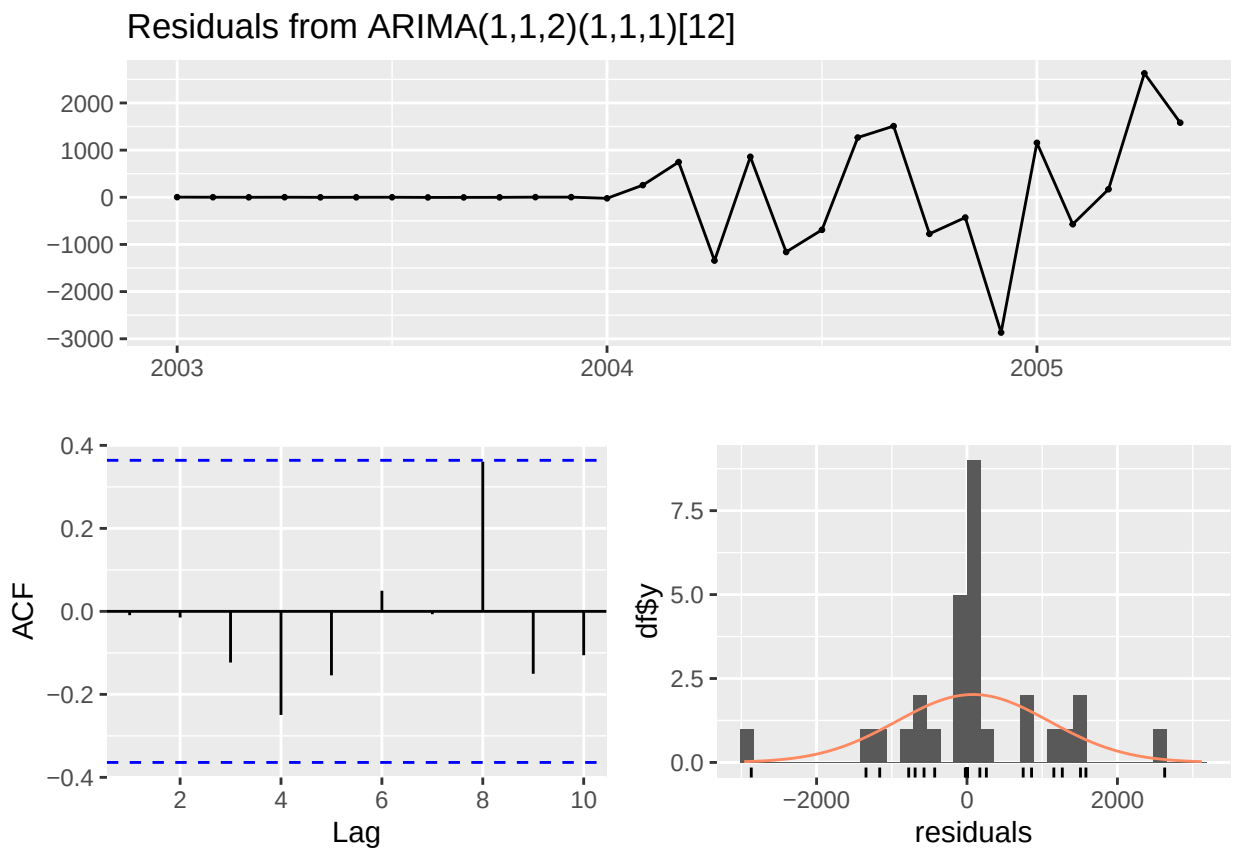
```
#Forecast 5, Part 2: Testing Classic Cars Sales Forecast with manual ARIMA variables

#Building second Classic Cars model
CC2_model <-arima(Class_Car_sales,order = c(1,1,2), seasonal = list(order = c(1,1,1)))
```

```
#Print Manual Arima Model Summary
print(summary(CC2_model))
```

```
##
## Call:
## arima(x = Class_Car_sales, order = c(1, 1, 2), seasonal = list(order = c(1,
##     1, 1)))
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced

##           ar1     ma1      ma2     sar1     sma1
##       -0.5019  0.0000  -0.9999  -0.6247  -0.6696
## s.e.   0.2367  0.5865   0.5864      NaN      NaN
##
## sigma^2 estimated as 1811390:  log likelihood = -148.88,  aic = 309.76
##
```

```
## Training set error measures:
##                     ME     RMSE      MAE       MPE     MAPE     MASE
## Training set 80.06016 999.7029 622.5583 -4.275056 17.21661 0.329219
##                       ACF1
## Training set -0.009113655
```

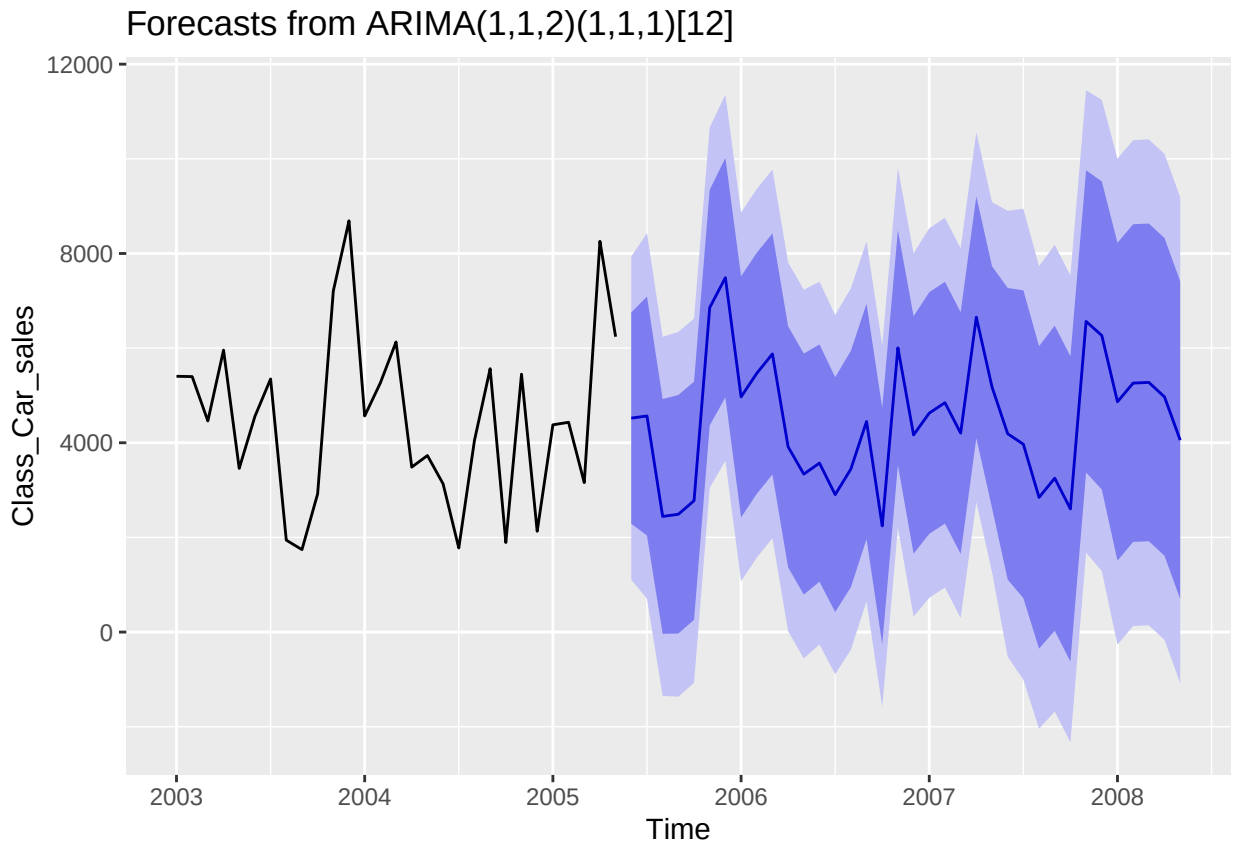
```
#Checking residual values of Manual Arima Model
checkresiduals(CC2_model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(1,1,2)(1,1,1)[12]
## Q* = 9.3368, df = 3, p-value = 0.02513
##
## Model df: 5.   Total lags used: 8
```

```
#Create Forecast for Manual ARIMA Model
#Forecast for the next two years
CC2_Forecast <- forecast(CC2_model, h=36)
```

```
#Plot Forecast Results
#Showing the last 5 years
autoplot(CC2_Forecast, include = 60)
```




```
#Print Summary Forecast Results
print(summary(CC2_Forecast))
```

```
##
## Forecast method: ARIMA(1,1,2)(1,1,1)[12]
##
## Model Information:
##
## Call:
## arima(x = Class_Car_sales, order = c(1, 1, 2), seasonal = list(order = c(1,
##     1, 1)))
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced

##           ar1     ma1      ma2     sar1     sma1
##       -0.5019  0.0000  -0.9999  -0.6247  -0.6696
## s.e.   0.2367  0.5865   0.5864      NaN      NaN
##
## sigma^2 estimated as 1811390:  log likelihood = -148.88,  aic = 309.76
##
## Error measures:
##                      ME     RMSE      MAE       MPE     MAPE      MASE
## Training set 80.06016 999.7029 622.5583 -4.275056 17.21661 0.2865224
```

```
##                      ACF1
## Training set -0.009113655
##
## Forecasts:
##          Point Forecast      Lo 80     Hi 80       Lo 95     Hi 95
## Jun 2005       4520.653 2288.40668  6752.899  1106.72686  7934.579
## Jul 2005       4566.197 2041.61055  7090.783   705.17545  8427.218
## Aug 2005       2443.141  -37.32573  4923.608 -1350.40557  6236.688
## Sep 2005       2489.158  -30.37715  5008.692 -1364.13826  6342.453
## Oct 2005       2775.914  259.51880  5292.309 -1072.58035  6624.408
## Nov 2005       6856.534 4366.68813  9346.379  3048.64348 10664.424
## Dec 2005       7488.499 4960.03856 10016.960  3621.55230 11355.446
## Jan 2006       4969.094 2421.63814  7516.549  1073.09662  8865.091
## Feb 2006       5467.812 2921.76279  8013.862  1573.96553  9361.659
## Mar 2006       5877.323 3330.63057  8424.015  1982.49304  9772.153
## Apr 2006       3914.539 1368.03488  6461.043    19.99696  7809.081
## May 2006       3338.242  791.90916  5884.575  -556.03794  7232.522
## Jun 2006       3570.923 1064.60923  6077.236  -262.15302  7403.999
## Jul 2006       2904.338  422.84221  5385.835  -890.78252  6699.459
## Aug 2006       3445.724  948.77463  5942.673  -373.03044  7264.478
## Sep 2006       4450.499 1963.86164  6937.137   647.51516  8253.483
## Oct 2006       2243.259 -254.22094  4740.739 -1576.30699  6062.825
## Nov 2006       6006.880 3527.15261  8486.607  2214.46431  9799.295
## Dec 2006       4165.799 1657.47003  6674.128   329.64097  8001.957
## Jan 2007       4627.733 2074.48869  7180.977   722.88276  8532.583
## Feb 2007       4847.054 2293.45673  7400.651   941.66405  8752.444
## Mar 2007       4204.803 1651.40791  6758.198   299.72234  8109.883
## Apr 2007       6653.275 4099.72824  9206.823  2747.96201 10558.589
## May 2007       5178.188 2624.81886  7731.558  1273.14669  9083.230
## Jun 2007       4190.428 1110.27143  7270.585  -520.26504  8901.121
## Jul 2007       3968.725  715.23581  7222.214 -1007.05732  8944.507
## Aug 2007       2845.712 -349.71774  6041.143 -2041.27632  7732.701
## Sep 2007       3251.597   28.23774  6474.957 -1678.10570  8181.300
## Oct 2007       2602.259 -622.30298  5826.821 -2329.28286  7533.800
## Nov 2007       6563.900 3370.79067  9757.009  1680.46087 11447.338
## Dec 2007       6267.638 3012.25946  9523.016  1288.96637 11246.309
## Jan 2008       4867.240 1510.09257  8224.388  -267.07409 10001.555
## Feb 2008       5261.090 1904.87998  8617.301   128.20956 10393.971
## Mar 2008       5275.836 1919.21814  8632.453   142.33210 10409.339
## Apr 2008       4968.760 1612.21926  8325.301  -164.62628 10102.147
## May 2008       4055.114  698.78893  7411.439 -1077.94218  9188.170
```

```
#Forecast 6, Part 1: Forecasting with focus on Vintage Cars

#Sub-setting the data to only show sales in
Vintage_Car_Sales <- subset(salesdata2, PRODUCTLINE == "Vintage Cars")
head(Vintage_Car_Sales)
```

```
##      ORDERNUMBER QUANTITYORDERED PRICEEACH ORDERLINENUMBER   SALES  ORDERDATE
## 579        10100              30    100.00               3 5151.00 2003-01-06
## 681        10100              50     67.80               2 3390.00 2003-01-06
## 1268       10100              22     86.51               4 1903.22 2003-01-06
## 2025       10100              49     34.47               1 1689.03 2003-01-06
## 729        10101              25    100.00               4 3782.00 2003-01-09
```

```
## 831        10101              26    100.00               1 3773.38 2003-01-09
##       STATUS QTR_ID MONTH_ID YEAR_ID  PRODUCTLINE MSRP PRODUCTCODE
## 579  Shipped      1        1    2003 Vintage Cars  170    S18_1749
## 681  Shipped      1        1    2003 Vintage Cars   60    S18_2248
## 1268 Shipped      1        1    2003 Vintage Cars   92    S18_4409
## 2025 Shipped      1        1    2003 Vintage Cars   41    S24_3969
## 729  Shipped      1        1    2003 Vintage Cars  127    S18_2325
## 831  Shipped      1        1    2003 Vintage Cars  168    S18_2795
##                       CUSTOMERNAME             PHONE             ADDRESSLINE1
## 579  Online Diecast Creations Co.        6035558647 2304 Long Airport Avenue
## 681  Online Diecast Creations Co.        6035558647 2304 Long Airport Avenue
## 1268 Online Diecast Creations Co.        6035558647 2304 Long Airport Avenue
## 2025 Online Diecast Creations Co.        6035558647 2304 Long Airport Avenue
## 729          Blauer See Auto, Co. +49 69 66 90 2555            Lyonerstr. 34
## 831          Blauer See Auto, Co. +49 69 66 90 2555            Lyonerstr. 34
##      ADDRESSLINE2      CITY STATE POSTALCODE COUNTRY TERRITORY CONTACTLASTNAME
## 579                  Nashua    NH      62005     USA      <NA>           Young
## 681                  Nashua    NH      62005     USA      <NA>           Young
## 1268                 Nashua    NH      62005     USA      <NA>           Young
## 2025                 Nashua    NH      62005     USA      <NA>           Young
## 729               Frankfurt            60528 Germany      EMEA          Keitel
## 831               Frankfurt            60528 Germany      EMEA          Keitel
##      CONTACTFIRSTNAME DEALSIZE
## 579           Valarie   Medium
## 681           Valarie   Medium
## 1268          Valarie    Small
## 2025          Valarie    Small
## 729            Roland   Medium
## 831            Roland   Medium
```

```
#Creating Time Series
Vintage_Car_sales <- ts(Vintage_Car_Sales[,5], start = c(2003,1), end = c(2005,5), frequency = 12)
Vintage_Car_sales
```

```
##          Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep
## 2003 5151.00 3390.00 1903.22 1689.03 3782.00 3773.38 1404.00 2472.96 4808.31
## 2004 2539.50 4791.82 1938.89 2873.00 3065.04 3382.50 3193.52 3983.50 4774.86
## 2005 6069.00 1608.00 3859.68 5074.39 2499.56
##          Oct     Nov     Dec
## 2003 2055.74 2242.89 2011.10
## 2004 1630.60 2406.36 1565.85
## 2005
```

```
#Build Fit Arima Model
#Taking first differnce of the data
#Getting rid of seasonality by taking first seasonal difference

Vintage_AR_Model <- auto.arima(Vintage_Car_sales, d=1, D=1, stepwise = FALSE, approximation = FALSE, tra
```

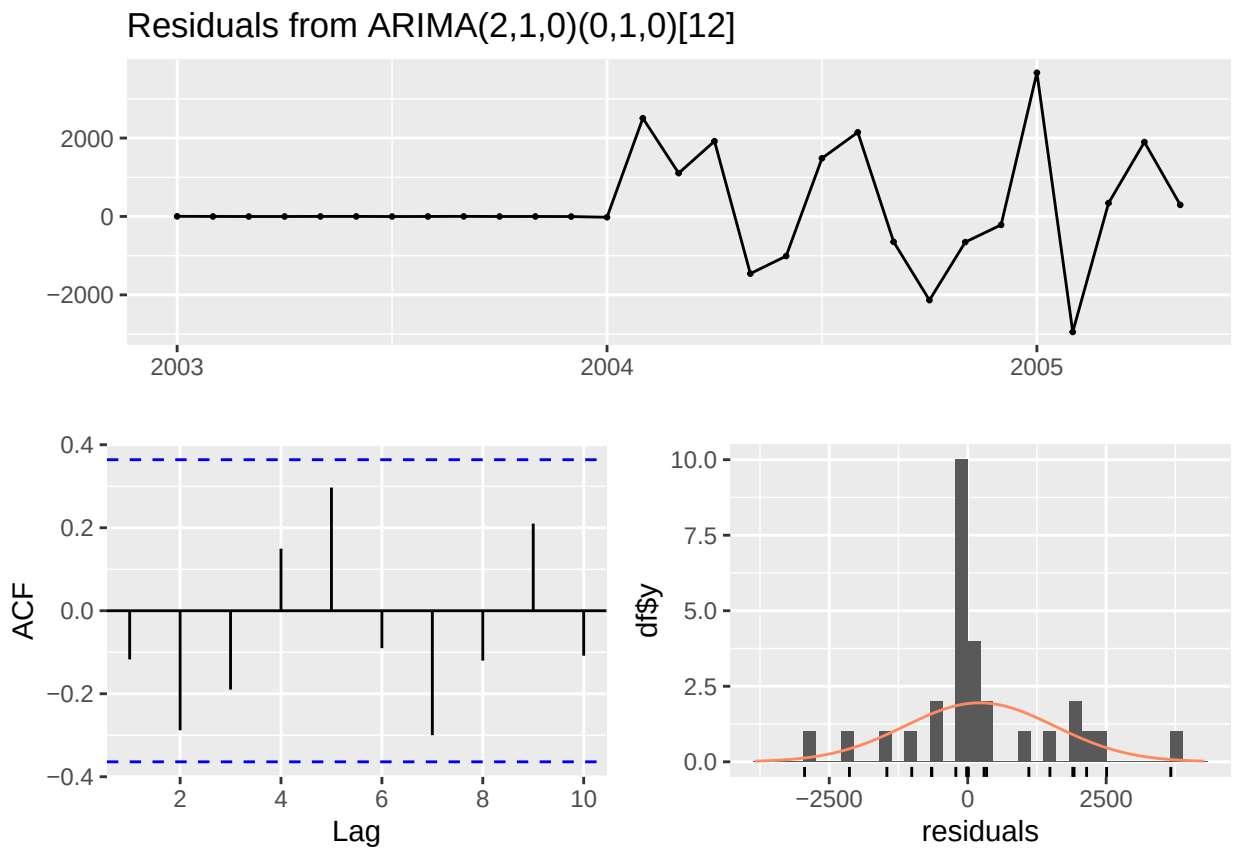
```
##
##  ARIMA(0,1,0)(0,1,0)[12]                    : 301.7281
##  ARIMA(0,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,2)(0,1,0)[12]                    : Inf
```

```
##  ARIMA(0,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,5)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,0)(0,1,0)[12]                    : 296.6916
##  ARIMA(1,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,0)(0,1,0)[12]                    : 294.7644
##  ARIMA(2,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,0)(0,1,0)[12]                    : 296.068
##  ARIMA(3,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(4,1,0)(0,1,0)[12]                    : 295.9752
##  ARIMA(4,1,1)(0,1,0)[12]                    : 299.8898
##  ARIMA(5,1,0)(0,1,0)[12]                    : 300.1159
##
##
##
##  Best model: ARIMA(2,1,0)(0,1,0)[12]
```

```
#Printing AR Model Summary
print(summary(Vintage_AR_Model))
```

```
## Series: Vintage_Car_sales
## ARIMA(2,1,0)(0,1,0)[12]
##
## Coefficients:
##           ar1      ar2
##       -1.0311  -0.5432
## s.e.   0.2239   0.2110
##
## sigma^2 = 3751904:  log likelihood = -143.38
## AIC=292.76   AICc=294.76   BIC=295.08
##
## Training set error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
## Training set 216.3675 1345.832 843.5712 -1.800827 29.04654 0.6486324 -0.117224
```

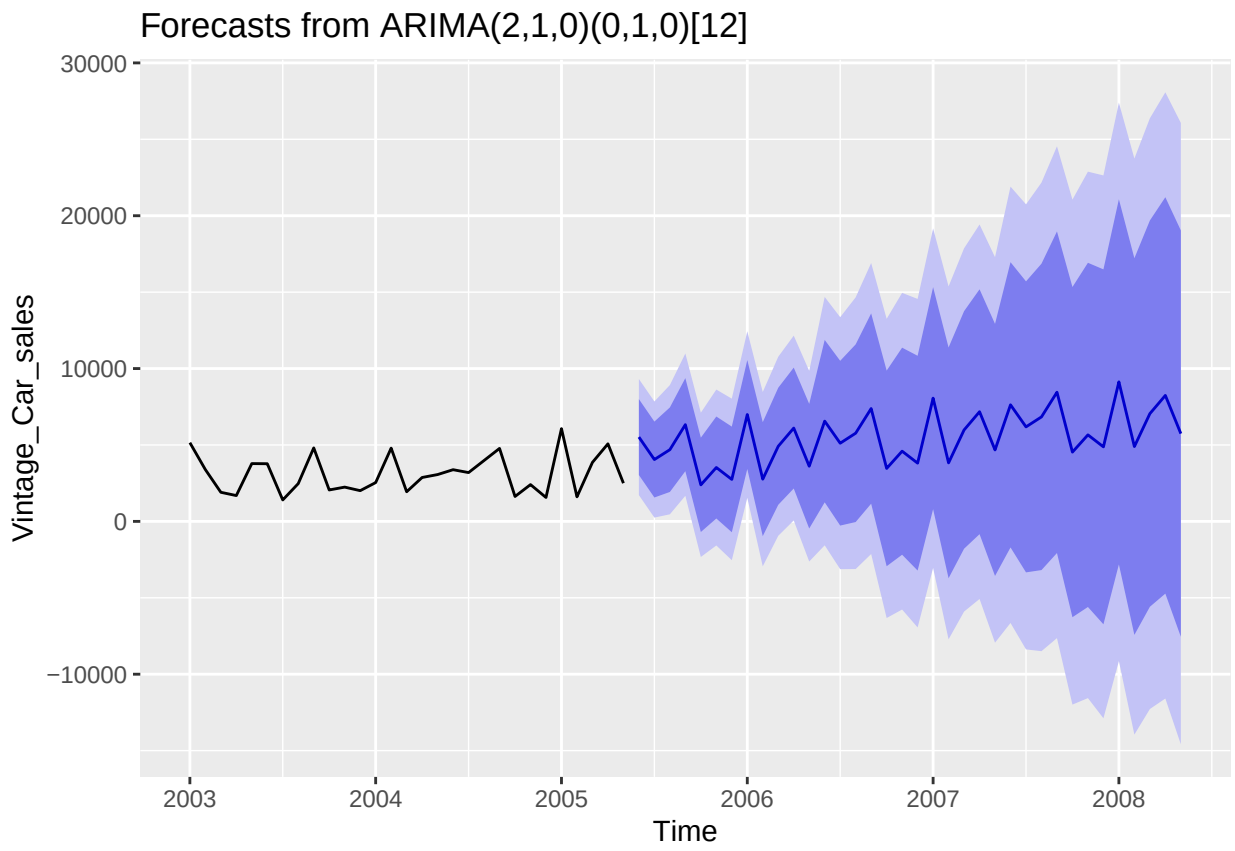
```
#Checking Residuals of AR_Model
checkresiduals(Vintage_AR_Model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(2,1,0)(0,1,0)[12]
## Q* = 8.8744, df = 4, p-value = 0.06432
##
## Model df: 2.   Total lags used: 6
```

```
#Forecasting ARIMA Model
#forecast two years ahead
VC_AR_Model_Forecast <- forecast(Vintage_AR_Model, h=36)
```

```
#Plotting AR Model Forecast
#including the last 5 years
autoplot(VC_AR_Model_Forecast, include = 60)
```




```
#Print Summary of AR Model Forecast
print(summary(VC_AR_Model_Forecast))
```

```
##
## Forecast method: ARIMA(2,1,0)(0,1,0)[12]
##
## Model Information:
## Series: Vintage_Car_sales
## ARIMA(2,1,0)(0,1,0)[12]
##
## Coefficients:
##           ar1      ar2
##       -1.0311  -0.5432
## s.e.   0.2239   0.2110
##
## sigma^2 = 3751904:  log likelihood = -143.38
## AIC=292.76   AICc=294.76   BIC=295.08
##
## Error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE      ACF1
## Training set 216.3675 1345.832 843.5712 -1.800827 29.04654 0.6486324 -0.117224
##
## Forecasts:
##          Point Forecast       Lo 80     Hi 80        Lo 95     Hi 95
## Jun 2005       5517.533  3035.18915  7999.877   1721.11564  9313.951
## Jul 2005       4046.962  1563.41799  6530.507    248.70899  7845.216
```

```
## Aug 2005       4691.521  1927.32338  7455.718    464.04573  8918.996
## Sep 2005       6328.965  3285.74520  9372.185   1674.76203 10983.168
## Oct 2005       2391.295  -694.46251  5477.052  -2327.96379  7110.554
## Nov 2005       3525.564   190.80022  6860.327  -1574.51698  8625.645
## Dec 2005       2746.361  -708.04143  6200.764  -2536.69177  8029.414
## Jan 2006       6991.561  3430.19992 10552.921   1544.92943 12438.192
## Feb 2006       2763.233  -964.02038  6490.487  -2937.10930  8463.576
## Mar 2006       4915.118  1085.84800  8744.388   -941.24522 10771.482
## Apr 2006       6106.343  2153.72290 10058.964     61.33204 12151.355
## May 2006       3609.936  -466.04868  7685.920  -2623.74452  9843.616
## Jun 2006       6559.804  1247.85290 11871.755  -1564.12404 14683.732
## Jul 2006       5116.859  -272.78180 10506.499  -3125.88514 13359.603
## Aug 2006       5769.926   -41.74889 11581.600  -3118.26355 14658.115
## Sep 2006       7383.591  1159.64732 13607.534  -2135.10930 16902.291
## Oct 2006       3465.818 -2933.26090  9864.896  -6320.72850 13252.364
## Nov 2006       4592.487 -2181.27311 11366.248  -5767.08523 14952.060
## Dec 2006       3810.313 -3215.85261 10836.478  -6935.27990 14555.905
## Jan 2007       8062.704   801.23441 15324.174  -3042.75561 19168.164
## Feb 2007       3828.575 -3719.53293 11376.684  -7715.26012 15372.411
## Mar 2007       5982.536 -1787.62509 13752.697  -5900.89975 17865.971
## Apr 2007       7174.772  -834.85029 15184.395  -5074.88832 19424.433
## May 2007       4676.194 -3569.40945 12921.798  -7934.36851 17286.757
## Jun 2007       7627.751 -1705.07038 16960.572  -6645.56749 21901.069
## Jul 2007       6184.244 -3335.16481 15703.652  -8374.43529 20742.923
## Aug 2007       6836.973 -3186.48051 16860.427  -8492.57633 22166.523
## Sep 2007       8451.292 -2068.17528 18970.758  -7636.84462 24539.428
## Oct 2007       4533.028 -6268.16327 15334.220 -11985.96864 21052.025
## Nov 2007       5659.848 -5601.44788 16921.145 -11562.81801 22882.515
## Dec 2007       4877.785 -6733.81057 16489.380 -12880.61791 22636.188
## Jan 2008       9129.980 -2813.91294 21073.873  -9136.62808 27396.589
## Feb 2008       4895.993 -7424.94315 17216.930 -13947.25296 23739.240
## Mar 2008       7049.914 -5587.07116 19686.899 -12276.68689 26376.514
## Apr 2008       8242.114 -4725.18182 21209.410 -11589.65370 28073.882
## May 2008       5743.595 -7549.03063 19036.221 -14585.72176 26072.912
```

```
#Forecast 6, Part 2: Testing Vintage Cars Sales Forecast with manual ARIMA variables

#Building second Vintage Cars model
Vintage2_model <-arima(Vintage_Car_sales,order = c(1,1,2), seasonal = list(order = c(1,1,1)))
```

```
#Print Manual Arima Model Summary
print(summary(Vintage2_model))
```

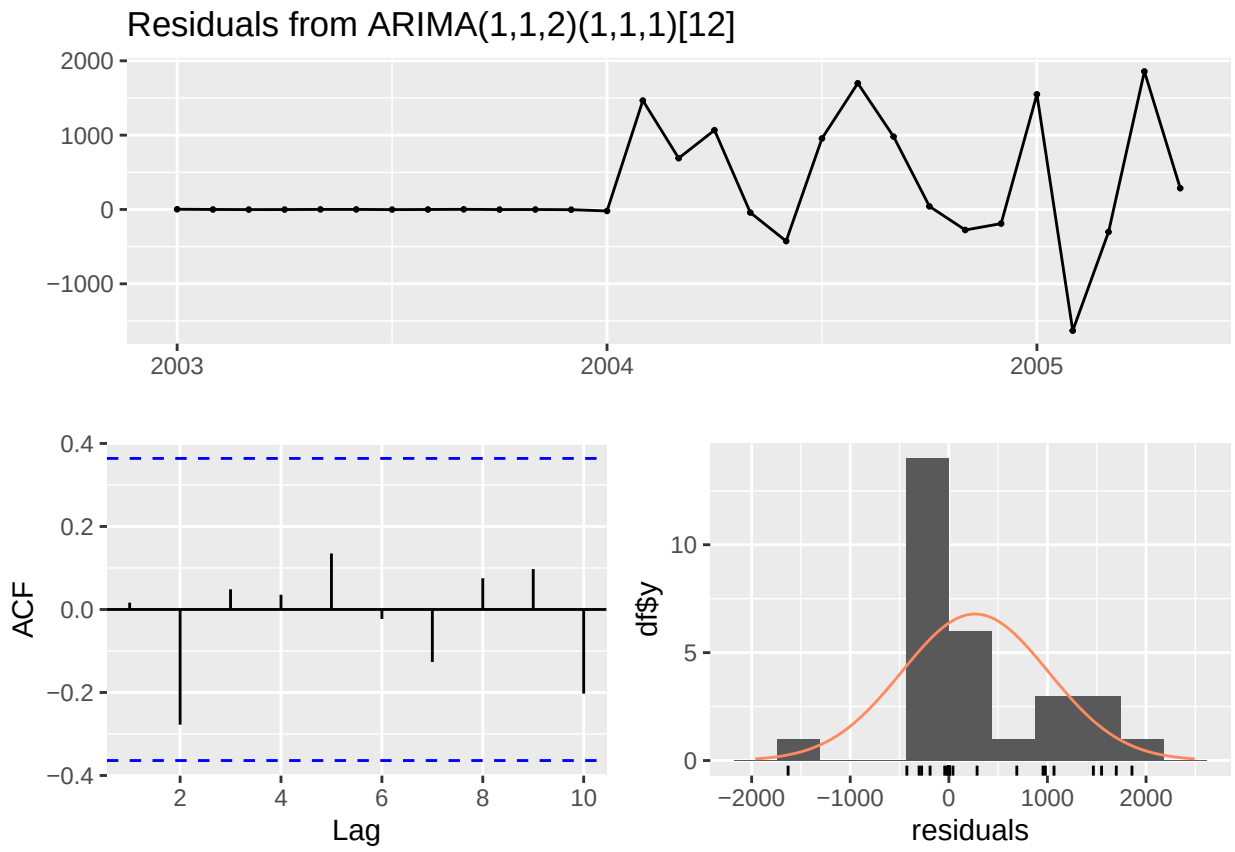
```
##
## Call:
## arima(x = Vintage_Car_sales, order = c(1, 1, 2), seasonal = list(order = c(1,
##     1, 1)))
##
## Coefficients:
```

```
## Warning in sqrt(diag(x$var.coef)): NaNs produced
```

```
##           ar1      ma1     ma2     sar1     sma1
```

```
##       -0.0308  -1.9180  1.0000  -0.2229  -0.2796
## s.e.   0.2637   0.2237  0.2277      NaN      NaN
##
## sigma^2 estimated as 1093447:  log likelihood = -138.47,  aic = 288.95
##
## Training set error measures:
##                     ME     RMSE      MAE      MPE     MAPE      MASE        ACF1
## Training set 265.599 776.7214 465.1846 4.297413 14.50478 0.3020522 0.01653682
```

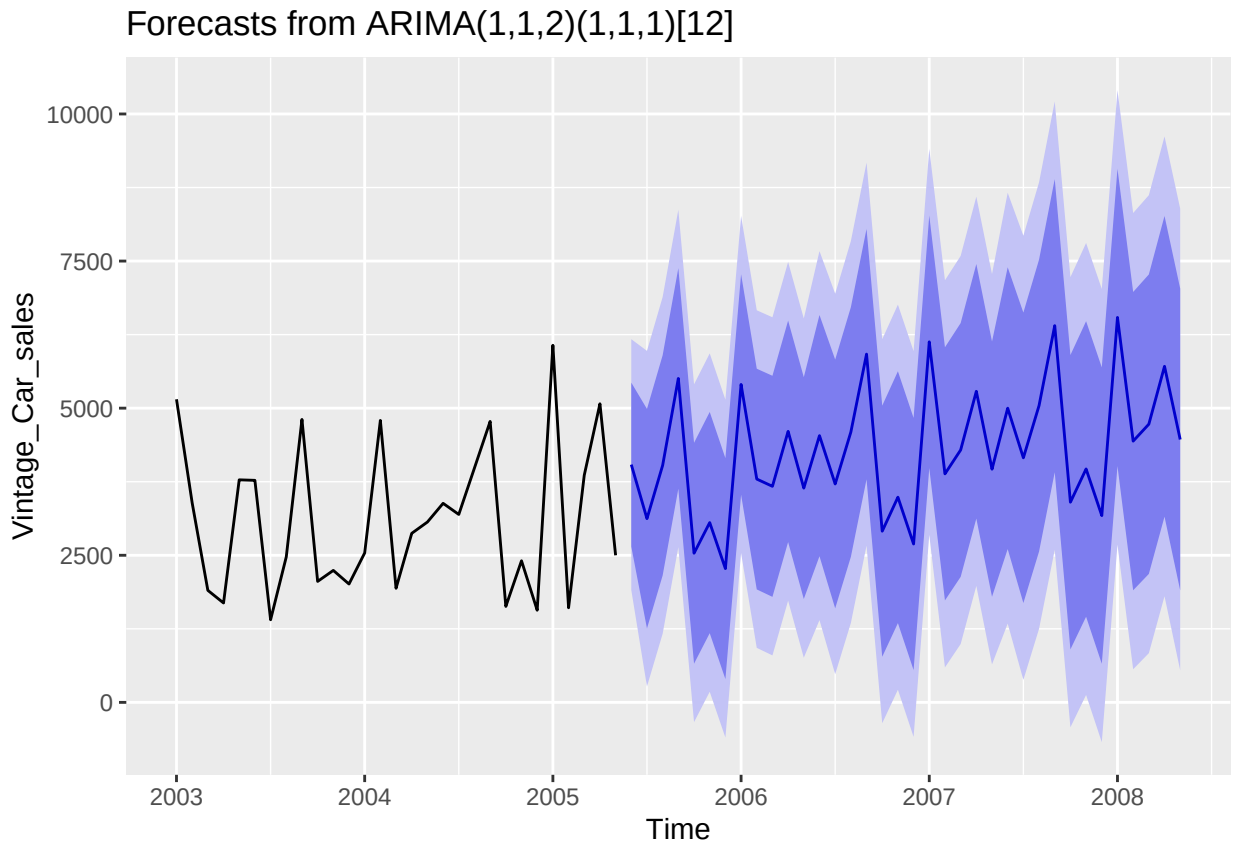
```
#Checking residual values of Manual Arima Model
checkresiduals(Vintage2_model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(1,1,2)(1,1,1)[12]
## Q* = 4.2998, df = 3, p-value = 0.2309
##
## Model df: 5.   Total lags used: 8
```

```
#Create Forecast for Manual ARIMA Model
#Forecast for the next two years
Vintage2_Forecast <- forecast(Vintage2_model, h=36)
```

```r
#Plot Forecast Results
#Showing the last 5 years
autoplot(Vintage2_Forecast, include = 60)
```




```r
#Print Summary Forecast Results
print(summary(Vintage2_Forecast))
```

```
##
## Forecast method: ARIMA(1,1,2)(1,1,1)[12]
##
## Model Information:
##
## Call:
## arima(x = Vintage_Car_sales, order = c(1, 1, 2), seasonal = list(order = c(1,
##     1, 1)))
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced

##           ar1      ma1     ma2     sar1     sma1
##       -0.0308  -1.9180  1.0000  -0.2229  -0.2796
## s.e.   0.2637   0.2237  0.2277      NaN      NaN
##
```

```
## sigma^2 estimated as 1093447:  log likelihood = -138.47,  aic = 288.95
##
## Error measures:
##                    ME     RMSE      MAE      MPE     MAPE      MASE       ACF1
## Training set 265.599 776.7214 465.1846 4.297413 14.50478 0.3576862 0.01653682
##
## Forecasts:
##          Point Forecast     Lo 80    Hi 80     Lo 95     Hi 95
## Jun 2005       4040.939 2647.5298 5434.349 1909.9034  6171.975
## Jul 2005       3121.903 1257.3036 4986.502  270.2443  5973.562
## Aug 2005       4028.379 2157.8169 5898.941 1167.6011  6889.157
## Sep 2005       5505.162 3631.5922 7378.732 2639.7842  8370.540
## Oct 2005       2534.520  657.8699 4411.170 -335.5687  5404.608
## Nov 2005       3055.589 1175.9191 4935.259  180.8820  5930.296
## Dec 2005       2273.210  396.2169 4150.202 -597.4031  5143.822
## Jan 2006       5403.052 3530.5707 7275.533 2539.3389  8266.765
## Feb 2006       3795.064 1919.5501 5670.577  926.7131  6663.414
## Mar 2006       3671.656 1793.1150 5550.197  798.6754  6544.637
## Apr 2006       4606.469 2724.9055 6488.033 1728.8658  7484.073
## May 2006       3641.452 1756.8707 5526.034  759.2334  6523.671
## Jun 2006       4533.574 2483.7992 6583.349 1398.7139  7668.434
## Jul 2006       3711.913 1598.3579 5825.467  479.5096  6944.315
## Aug 2006       4594.434 2473.0855 6715.782 1350.1116  7838.756
## Sep 2006       5918.383 3790.9975 8045.769 2664.8275  9171.939
## Oct 2006       2909.046  775.5891 5042.503 -353.7946  6171.886
## Nov 2006       3486.882 1347.3989 5626.365  214.8250  6758.939
## Dec 2006       2691.546  549.1418 4833.951 -584.9786  5968.071
## Jan 2007       6127.481 3982.8059 8272.155 2847.4838  9407.477
## Feb 2007       3883.594 1732.9855 6034.202  594.5222  7172.666
## Mar 2007       4289.562 2133.0361 6446.088  991.4403  7587.683
## Apr 2007       5286.760 3124.3333 7449.187 1979.6136  8593.907
## May 2007       3962.937 1794.6251 6131.249  646.7900  7279.085
## Jun 2007       4999.770 2606.0896 7393.450 1338.9518  8660.588
## Jul 2007       4156.405 1688.7065 6624.103  382.3858  7930.424
## Aug 2007       5044.265 2563.7901 7524.741 1250.7058  8837.825
## Sep 2007       6402.279 3911.6019 8892.957 2593.1169 10211.442
## Oct 2007       3401.567  900.6551 5902.478 -423.2475  7226.381
## Nov 2007       3966.750 1455.6719 6477.828  126.3873  7807.113
## Dec 2007       3174.302  656.1203 5692.484 -676.9246  7025.529
## Jan 2008       6542.013 4017.1643 9066.861 2680.5903 10403.435
## Feb 2008       4439.859 1905.0404 6974.678  563.1883  8316.530
## Mar 2008       4727.837 2183.0861 7272.587  835.9766  8619.696
## Apr 2008       5711.130 3156.4868 8265.773 1804.1403  9618.120
## May 2008       4467.280 1902.7822 7031.778  545.2189  8389.341
```

```
#Forecast 7, Part 1: Forecasting with focus on Ireland

#Sub-setting the data to only show sales in Ireland
Ireland_Sales <- subset(salesdata2, COUNTRY == "Ireland")
head(Ireland_Sales)
```

```
##      ORDERNUMBER QUANTITYORDERED PRICEEACH ORDERLINENUMBER   SALES  ORDERDATE
## 197        10220              32    100.00               2 7181.44 2004-02-12
## 277        10220              30    100.00               3 4713.60 2004-02-12
```

```
## 327        10220              27    100.00              1 5045.22 2004-02-12
## 1252       10220              50    100.00              5 8258.00 2004-02-12
## 1449       10220              26     56.07              8 1457.82 2004-02-12
## 2057       10220              37    100.00              7 5032.74 2004-02-12
##       STATUS QTR_ID MONTH_ID YEAR_ID  PRODUCTLINE MSRP PRODUCTCODE
## 197  Shipped      1        2    2004 Classic Cars  207    S12_1108
## 277  Shipped      1        2    2004 Classic Cars  151    S12_3148
## 327  Shipped      1        2    2004 Classic Cars  173    S12_3891
## 1252 Shipped      1        2    2004 Classic Cars  143    S18_4027
## 1449 Shipped      1        2    2004 Classic Cars   57    S24_1444
## 2057 Shipped      1        2    2004 Classic Cars  118    S24_4048
##                  CUSTOMERNAME           PHONE   ADDRESSLINE1 ADDRESSLINE2   CITY
## 197  Clover Collections, Co. +353 1862 1555 25 Maiden Lane  Floor No. 4 Dublin
## 277  Clover Collections, Co. +353 1862 1555 25 Maiden Lane  Floor No. 4 Dublin
## 327  Clover Collections, Co. +353 1862 1555 25 Maiden Lane  Floor No. 4 Dublin
## 1252 Clover Collections, Co. +353 1862 1555 25 Maiden Lane  Floor No. 4 Dublin
## 1449 Clover Collections, Co. +353 1862 1555 25 Maiden Lane  Floor No. 4 Dublin
## 2057 Clover Collections, Co. +353 1862 1555 25 Maiden Lane  Floor No. 4 Dublin
##      STATE POSTALCODE COUNTRY TERRITORY CONTACTLASTNAME CONTACTFIRSTNAME
## 197                2 Ireland      EMEA         Cassidy             Dean
## 277                2 Ireland      EMEA         Cassidy             Dean
## 327                2 Ireland      EMEA         Cassidy             Dean
## 1252               2 Ireland      EMEA         Cassidy             Dean
## 1449               2 Ireland      EMEA         Cassidy             Dean
## 2057               2 Ireland      EMEA         Cassidy             Dean
##      DEALSIZE
## 197     Large
## 277    Medium
## 327    Medium
## 1252    Large
## 1449    Small
## 2057   Medium
```

```
#Creating Time Series
Ireland_sales <- ts(Ireland_Sales[,5], start = c(2003,1), end = c(2005,5), frequency = 12)
Ireland_sales
```

```
##          Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep
## 2003 7181.44 4713.60 5045.22 8258.00 1457.82 5032.74 1056.40 3983.05 2056.20
## 2004 1666.35 2856.88 2234.40 3986.50 7181.44 4713.60 5045.22 8258.00 1457.82
## 2005 2056.20 2069.75 4061.76 2096.32 1666.35
##          Oct     Nov     Dec
## 2003 2069.75 4061.76 2096.32
## 2004 5032.74 1056.40 3983.05
## 2005
```

```
#Build Fit Arima Model
#Taking first differnce of the data
#Getting rid of seasonality by taking first seasonal difference

Ireland_AR_Model <- auto.arima(Ireland_sales, d=1, D=1, stepwise = FALSE, approximation = FALSE, trace =
```

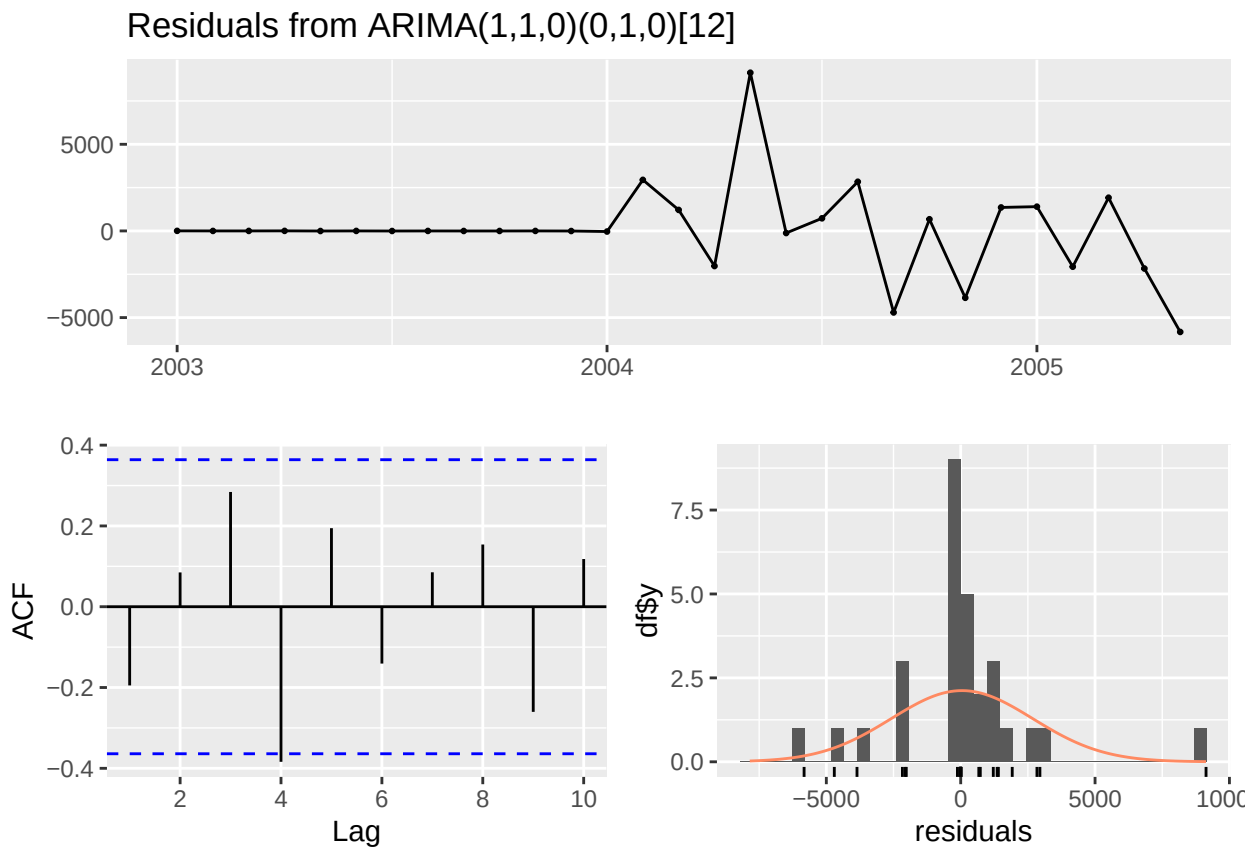
```
##
```

```
##  ARIMA(0,1,0)(0,1,0)[12]                    : 315.8979
##  ARIMA(0,1,1)(0,1,0)[12]                    : 312.4617
##  ARIMA(0,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,5)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,0)(0,1,0)[12]                    : 311.7407
##  ARIMA(1,1,1)(0,1,0)[12]                    : 314.0416
##  ARIMA(1,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,0)(0,1,0)[12]                    : 312.798
##  ARIMA(2,1,1)(0,1,0)[12]                    : 313.0919
##  ARIMA(2,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,0)(0,1,0)[12]                    : 312.7271
##  ARIMA(3,1,1)(0,1,0)[12]                    : 316.2446
##  ARIMA(3,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(4,1,0)(0,1,0)[12]                    : 315.0883
##  ARIMA(4,1,1)(0,1,0)[12]                    : 319.7976
##  ARIMA(5,1,0)(0,1,0)[12]                    : 319.5299
##
##
##
##  Best model: ARIMA(1,1,0)(0,1,0)[12]
```

```
#Printing AR Model Summary
print(summary(Ireland_AR_Model))
```

```
## Series: Ireland_sales
## ARIMA(1,1,0)(0,1,0)[12]
##
## Coefficients:
##          ar1
##       -0.5924
## s.e.   0.1960
##
## sigma^2 = 12938952:  log likelihood = -153.41
## AIC=310.82   AICc=311.74   BIC=312.36
##
## Training set error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
## Training set 48.03123 2586.999 1483.938 -27.62018 61.84773 0.5297139 -0.1947669
```

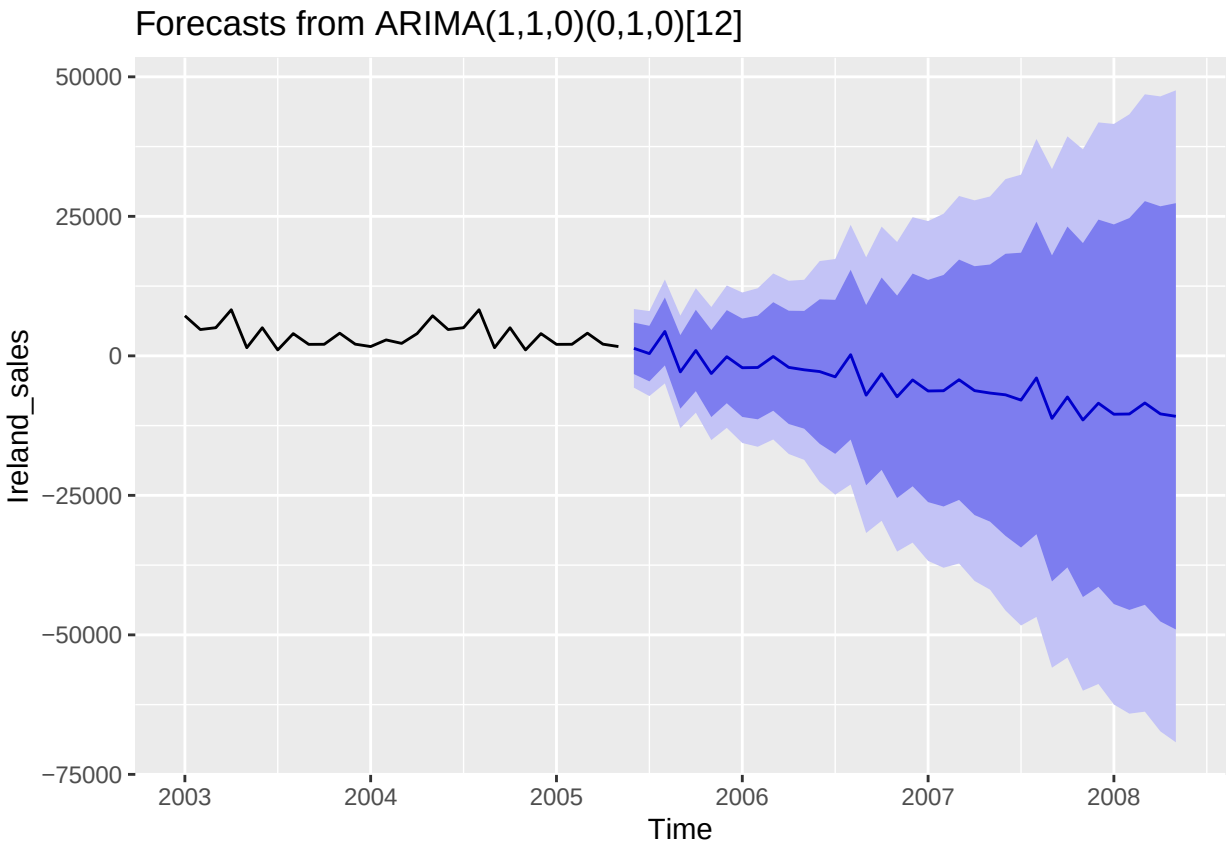
```
#Checking Residuals of AR_Model
checkresiduals(Ireland_AR_Model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(1,1,0)(0,1,0)[12]
## Q* = 11.739, df = 5, p-value = 0.03855
##
## Model df: 1.   Total lags used: 6
```

```
#Forecasting ARIMA Model
#forecast two years ahead
IR_AR_Model_Forecast <- forecast(Ireland_AR_Model, h=36)
```

```
#Plotting AR Model Forecast
#including the last 5 years
autoplot(IR_AR_Model_Forecast, include = 60)
```




```
#Print Summary of AR Model Forecast
print(summary(IR_AR_Model_Forecast))
```

```
##
## Forecast method: ARIMA(1,1,0)(0,1,0)[12]
##
## Model Information:
## Series: Ireland_sales
## ARIMA(1,1,0)(0,1,0)[12]
##
## Coefficients:
##           ar1
##       -0.5924
## s.e.   0.1960
##
## sigma^2 = 12938952:  log likelihood = -153.41
## AIC=310.82   AICc=311.74   BIC=312.36
##
## Error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
## Training set 48.03123 2586.999 1483.938 -27.62018 61.84773 0.5297139 -0.1947669
##
## Forecasts:
##          Point Forecast      Lo 80     Hi 80      Lo 95     Hi 95
## Jun 2005      1345.9355  -3263.902  5955.773  -5704.203  8396.074
## Jul 2005       405.4036  -4572.648  5383.455  -7207.869  8018.676
```

```
## Aug 2005      4371.8164  -1711.620 10455.253  -4931.997 13675.630
## Sep 2005     -2874.8217  -9466.587  3716.944 -12956.057  7206.414
## Oct 2005       964.5837  -6322.340  8251.508 -10179.805 12108.972
## Nov 2005     -3168.4395 -10964.003  4627.124 -15090.725  8753.846
## Dec 2005      -148.9692  -8490.782  8192.844 -12906.671 12608.733
## Jan 2006     -2130.8067 -10946.354  6684.741 -15613.024 11351.410
## Feb 2006     -2084.6816 -11371.529  7202.166 -16287.689 12118.326
## Mar 2006      -111.9694  -9834.978  9611.040 -14982.029 14758.090
## Apr 2006     -2065.9772 -12213.401  8081.446 -17585.123 13453.168
## May 2006     -2502.7197 -13053.515  8048.076 -18638.769 13633.329
## Jun 2006     -2819.1222 -15768.572 10130.327 -22623.596 16985.352
## Jul 2006     -3762.0309 -17562.736 10038.674 -24868.388 17344.326
## Aug 2006       205.7900 -15003.639 15415.220 -23055.025 23466.605
## Sep 2006     -7041.6822 -23192.207  9108.842 -31741.778 17658.413
## Oct 2006     -3201.7827 -20431.294 14027.728 -29552.046 23148.481
## Nov 2006     -7335.0987 -25471.845 10801.648 -35072.859 20402.661
## Dec 2006     -4315.4549 -23376.632 14745.722 -33467.010 24836.100
## Jan 2007     -6297.3951 -26205.745 13610.955 -36744.589 24149.799
## Feb 2007     -6251.2092 -26991.660 14489.242 -37970.992 25468.574
## Mar 2007     -4278.5330 -25807.797 17250.731 -37204.701 28647.635
## Apr 2007     -6232.5195 -28529.081 16064.042 -40332.167 27867.128
## May 2007     -6669.2746 -29703.930 16365.381 -41897.740 28559.191
## Jun 2007     -6985.6696 -32260.439 18289.100 -45640.094 31668.755
## Jul 2007     -7928.5827 -34340.584 18483.419 -48322.253 32465.088
## Aug 2007     -3960.7592 -31958.153 24036.635 -46779.078 38857.560
## Sep 2007    -11208.2330 -40417.826 18001.360 -55880.451 33463.985
## Oct 2007     -7368.3326 -37902.641 23165.976 -54066.527 39329.862
## Nov 2007    -11501.6491 -43212.932 20209.634 -59999.871 36996.573
## Dec 2007     -8482.0050 -41380.700 24416.690 -58796.217 41832.208
## Jan 2008    -10463.9454 -44478.430 23550.539 -62484.610 41556.719
## Feb 2008    -10417.7594 -45529.890 24694.372 -64117.130 43281.611
## Mar 2008     -8445.0832 -44611.601 27721.435 -63757.000 46866.833
## Apr 2008    -10399.0697 -47595.833 26797.694 -67286.610 46488.471
## May 2008    -10835.8249 -49031.746 27360.096 -69251.445 47579.795
```

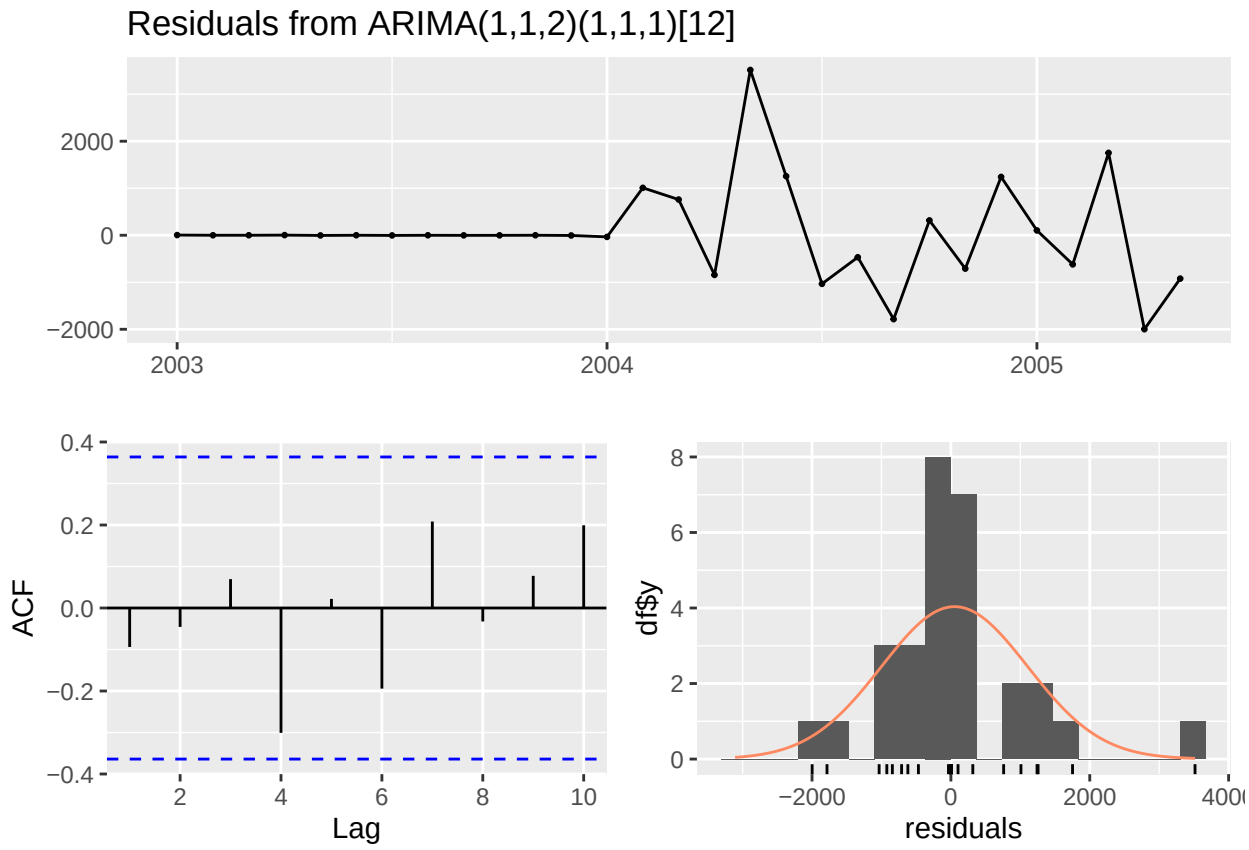
```
#Forecast 7, Part 2: Testing Ireland Sales Forecast with manual ARIMA variables

#Building second Ireland model
Ireland2_model <-arima(Ireland_sales,order = c(1,1,2), seasonal = list(order = c(1,1,1)))
```

```
#Print Manual Arima Model Summary
print(summary(Ireland2_model))
```

```
##
## Call:
## arima(x = Ireland_sales, order = c(1, 1, 2), seasonal = list(order = c(1, 1,
##     1)))
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced

##           ar1      ma1     ma2     sar1     sma1
```

```
##       -0.3965  -0.5348  1.0000  -0.5585  -0.6755
## s.e.   0.2392   0.1295  0.1486      NaN      NaN
##
## sigma^2 estimated as 1947937:  log likelihood = -147.51,  aic = 307.03
##
## Training set error measures:
##                     ME     RMSE      MAE      MPE     MAPE      MASE        ACF1
## Training set 52.73706 1036.711 634.1176 -6.55304 22.45482 0.2690344 -0.09384108
```

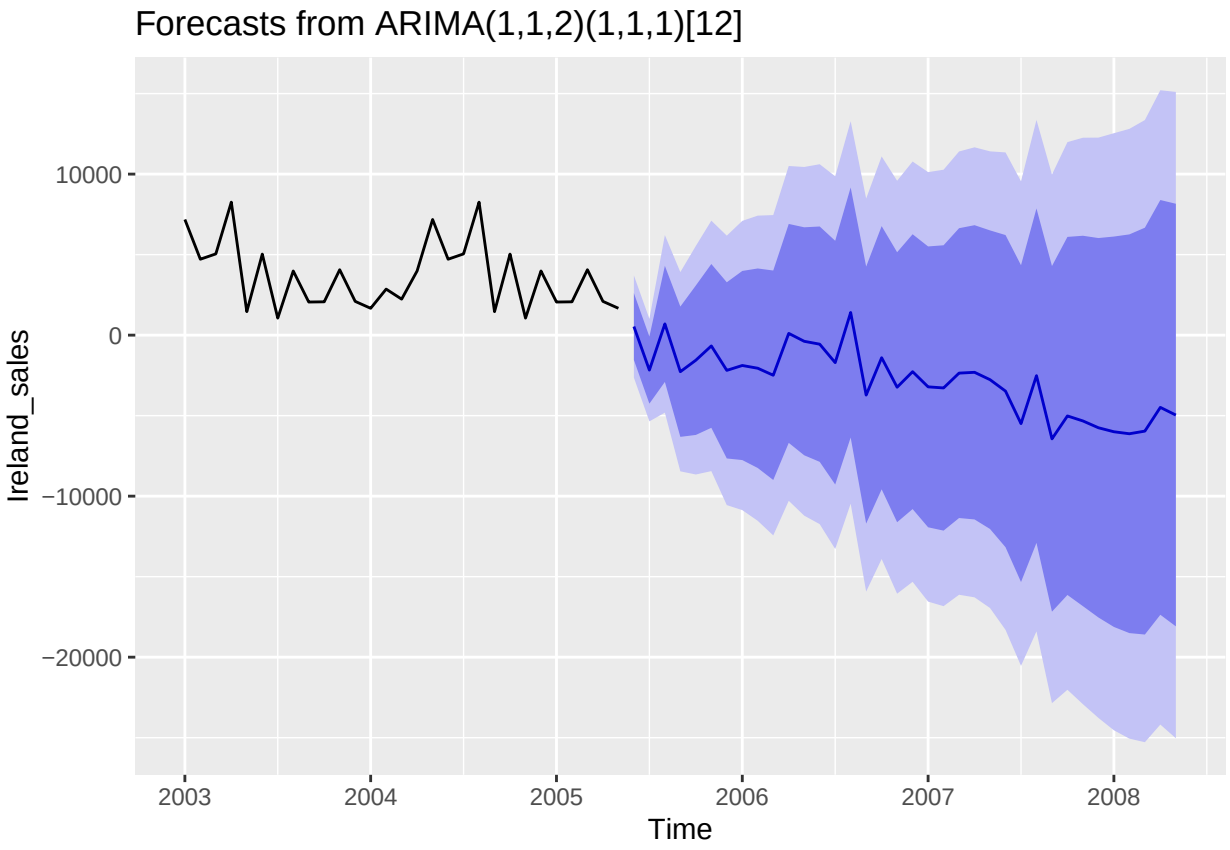
```
#Checking residual values of Manual Arima Model
checkresiduals(Ireland2_model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(1,1,2)(1,1,1)[12]
## Q* = 7.085, df = 3, p-value = 0.06924
##
## Model df: 5.   Total lags used: 8
```

```
#Create Forecast for Manual ARIMA Model
#Forecast for the next two years
Ireland2_Forecast <- forecast(Ireland2_model, h=36)
```

```r
#Plot Forecast Results
#Showing the last 5 years
autoplot(Ireland2_Forecast, include = 60)
```




```r
#Print Summary Forecast Results
print(summary(Ireland2_Forecast))
```

```
##
## Forecast method: ARIMA(1,1,2)(1,1,1)[12]
##
## Model Information:
##
## Call:
## arima(x = Ireland_sales, order = c(1, 1, 2), seasonal = list(order = c(1, 1,
##     1)))
##
## Coefficients:

## Warning in sqrt(diag(x$var.coef)): NaNs produced

##           ar1      ma1     ma2     sar1     sma1
##       -0.3965  -0.5348  1.0000  -0.5585  -0.6755
## s.e.   0.2392   0.1295  0.1486      NaN      NaN
##
```

```
## sigma^2 estimated as 1947937:  log likelihood = -147.51,  aic = 307.03
##
## Error measures:
##                     ME     RMSE      MAE      MPE     MAPE      MASE        ACF1
## Training set 52.73706 1036.711 634.1176 -6.55304 22.45482 0.2263577 -0.09384108
##
## Forecasts:
##          Point Forecast      Lo 80      Hi 80      Lo 95     Hi 95
## Jun 2005       534.6773  -1539.913 2609.26753  -2638.135  3707.489
## Jul 2005     -2172.6543  -4253.070  -92.23849  -5354.376  1009.067
## Aug 2005       697.8528  -2905.843 4301.54849  -4813.524  6209.230
## Sep 2005     -2271.5631  -6316.660 1773.53412  -8458.005  3914.879
## Oct 2005     -1558.2059  -6197.535 3081.12292  -8653.447  5537.035
## Nov 2005      -669.3083  -5753.882 4415.26565  -8445.493  7106.876
## Dec 2005     -2188.1167  -7658.321 3282.08777 -10554.072  6177.839
## Jan 2006     -1885.9198  -7757.415 3985.57566 -10865.597  7093.758
## Feb 2006     -2055.8738  -8251.979 4140.23111 -11531.998  7420.251
## Mar 2006     -2490.6806  -8994.032 4012.67040 -12436.698  7455.336
## Apr 2006       107.7577  -6689.375 6904.89081 -10287.560 10503.076
## May 2006      -383.0467  -7461.712 6695.61859 -11208.931 10442.838
## Jun 2006      -561.5982  -7868.453 6745.25701 -11736.469 10613.272
## Jul 2006     -1708.3126  -9275.023 5858.39753 -13280.597  9863.972
## Aug 2006      1407.5839  -6356.008 9171.17565 -10465.805 13280.973
## Sep 2006     -3722.9566 -11701.749 4255.83607 -15925.467  8479.554
## Oct 2006     -1402.7842  -9575.123 6769.55443 -13901.298 11095.729
## Nov 2006     -3234.6887 -11617.990 5148.61243 -16055.841  9586.464
## Dec 2006     -2269.1969 -10802.180 6263.78647 -15319.269 10780.875
## Jan 2007     -3212.5401 -11932.216 5507.13594 -16548.134 10123.054
## Feb 2007     -3279.7895 -12140.465 5580.88651 -16831.024 10271.445
## Mar 2007     -2359.2085 -11358.818 6640.40141 -16122.924 11404.507
## Apr 2007     -2309.8400 -11446.198 6826.51768 -16282.693 11663.013
## May 2007     -2766.6792 -12037.840 6504.48117 -16945.695 11412.337
## Jun 2007     -3477.5806 -13170.334 6215.17266 -18301.367 11346.206
## Jul 2007     -5495.9623 -15332.736 4340.81170 -20540.010  9548.085
## Aug 2007     -2517.1245 -12899.643 7865.39411 -18395.816 13361.567
## Sep 2007     -6440.5934 -17172.024 4290.83740 -22852.901  9971.714
## Oct 2007     -5017.8895 -16136.440 6100.66114 -22022.245 11986.466
## Nov 2007     -5330.1206 -16831.233 6170.99156 -22919.554 12259.313
## Dec 2007     -5752.2067 -17533.254 6028.84051 -23769.764 12265.350
## Jan 2008     -5999.8675 -18122.097 6122.36216 -24539.218 12539.483
## Feb 2008     -6124.4814 -18504.365 6255.40225 -25057.880 12808.917
## Mar 2008     -5960.9370 -18592.799 6670.92479 -25279.703 13357.829
## Apr 2008     -4487.8142 -17366.856 8391.22769 -24184.609 15208.981
## May 2008     -4963.6244 -18085.219 8157.97001 -25031.371 15104.122
```

```
#Forecast 8, Part 1: Forecasting with focus on Trains

#Sub-setting the data to only show sales of Trains
Trains_Sales <- subset(salesdata2, PRODUCTLINE == "Trains")
head(Trains_Sales)
```

```
##      ORDERNUMBER QUANTITYORDERED PRICEEACH ORDERLINENUMBER   SALES  ORDERDATE
## 2251       10104              49     65.87               4 3227.63 2003-01-31
## 2407       10104              32     53.31               2 1705.92 2003-01-31
```

```
## 1066       10105              38    100.00              13 4330.10 2003-02-11
## 2252       10116              27     63.38               1 1711.26 2003-04-11
## 1067       10117              21     95.80               7 2011.80 2003-04-16
## 2408       10117              21     49.21              11 1033.41 2003-04-16
##       STATUS QTR_ID MONTH_ID YEAR_ID PRODUCTLINE MSRP PRODUCTCODE
## 2251 Shipped      1        1    2003      Trains   62    S32_3207
## 2407 Shipped      1        1    2003      Trains   58    S50_1514
## 1066 Shipped      1        2    2003      Trains  100    S18_3259
## 2252 Shipped      2        4    2003      Trains   62    S32_3207
## 1067 Shipped      2        4    2003      Trains  100    S18_3259
## 2408 Shipped      2        4    2003      Trains   58    S50_1514
##                 CUSTOMERNAME            PHONE
## 2251    Euro Shopping Channel   (91) 555 94 44
## 2407    Euro Shopping Channel   (91) 555 94 44
## 1066 Danish Wholesale Imports       31 12 3555
## 2252             Royale Belge (071) 23 67 2555
## 1067  Dragon Souveniers, Ltd.     +65 221 7555
## 2408  Dragon Souveniers, Ltd.     +65 221 7555
##                            ADDRESSLINE1 ADDRESSLINE2      CITY STATE
## 2251                  C/ Moralzarzal, 86                Madrid
## 2407                  C/ Moralzarzal, 86                Madrid
## 1066                       Vinb'ltet 34              Kobenhavn
## 2252                 Boulevard Tirou, 255              Charleroi
## 1067 Bronz Sok., Bronz Apt. 3/6 Tesvikiye              Singapore
## 2408 Bronz Sok., Bronz Apt. 3/6 Tesvikiye              Singapore
##      POSTALCODE   COUNTRY TERRITORY CONTACTLASTNAME CONTACTFIRSTNAME DEALSIZE
## 2251      28034     Spain      EMEA          Freyre            Diego   Medium
## 2407      28034     Spain      EMEA          Freyre            Diego    Small
## 1066       1734   Denmark      EMEA        Petersen            Jytte   Medium
## 2252     B-6000   Belgium      EMEA        Cartrain          Pascale    Small
## 1067      79903 Singapore     Japan       Natividad             Eric    Small
## 2408      79903 Singapore     Japan       Natividad             Eric    Small
```

```
#Creating Time Series
Trains_sales <- ts(Trains_Sales[,5], start = c(2003,1), end = c(2005,5), frequency = 12)
Trains_sales
```

```
##          Jan     Feb     Mar     Apr     May     Jun     Jul     Aug     Sep
## 2003 3227.63 1705.92 4330.10 1711.26 2011.80 1033.41 2054.36 3179.52 4837.18
## 2004 1681.35 2573.46 1779.71 5344.50 2351.36 2537.64 1408.00 2448.72 3070.52
## 2005 1804.44 3564.75 2856.14 2544.75 5614.56
##          Oct     Nov     Dec
## 2003 2151.82 3131.94 2091.18
## 2004 3952.83 2445.60  972.40
## 2005
```

```
#Build Fit Arima Model
#Taking first differnce of the data
#Getting rid of seasonality by taking first seasonal difference

Trains_AR_Model <- auto.arima(Trains_sales, d=1, D=1, stepwise = FALSE, approximation = FALSE, trace = T
```

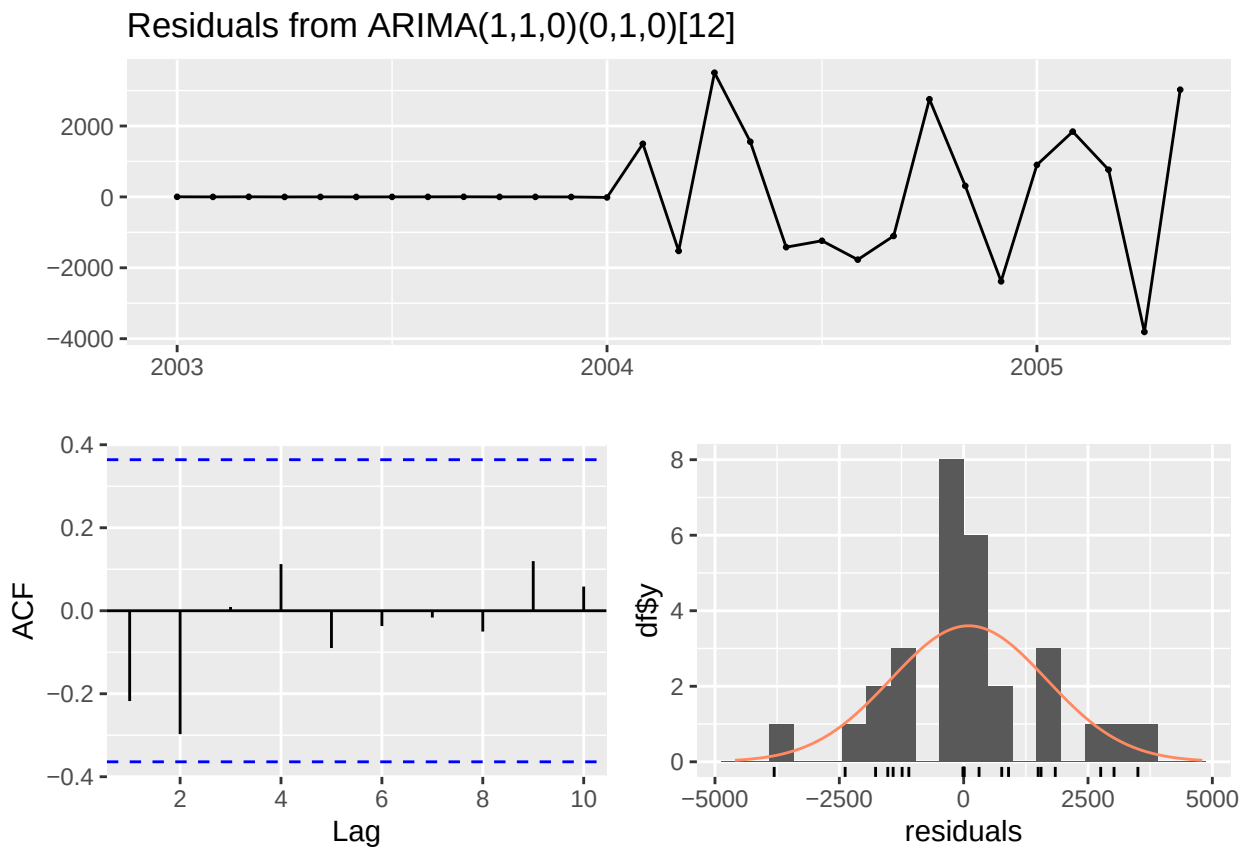
```
##
```

```
##  ARIMA(0,1,0)(0,1,0)[12]                    : 304.2086
##  ARIMA(0,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(0,1,5)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,0)(0,1,0)[12]                    : 295.7086
##  ARIMA(1,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(1,1,4)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,0)(0,1,0)[12]                    : 297.7131
##  ARIMA(2,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(2,1,3)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,0)(0,1,0)[12]                    : 298.4716
##  ARIMA(3,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(3,1,2)(0,1,0)[12]                    : Inf
##  ARIMA(4,1,0)(0,1,0)[12]                    : 302.1822
##  ARIMA(4,1,1)(0,1,0)[12]                    : Inf
##  ARIMA(5,1,0)(0,1,0)[12]                    : 307.3804
##
##
##
##  Best model: ARIMA(1,1,0)(0,1,0)[12]
```

```
#Printing AR Model Summary
print(summary(Trains_AR_Model))
```

```
## Series: Trains_sales
## ARIMA(1,1,0)(0,1,0)[12]
##
## Coefficients:
##           ar1
##       -0.7842
## s.e.   0.1702
##
## sigma^2 = 4597944:  log likelihood = -145.39
## AIC=294.79   AICc=295.71   BIC=296.33
##
## Training set error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
## Training set 99.93263 1542.157 1014.844 -9.612831 40.98315 0.6780262 -0.2175376
```

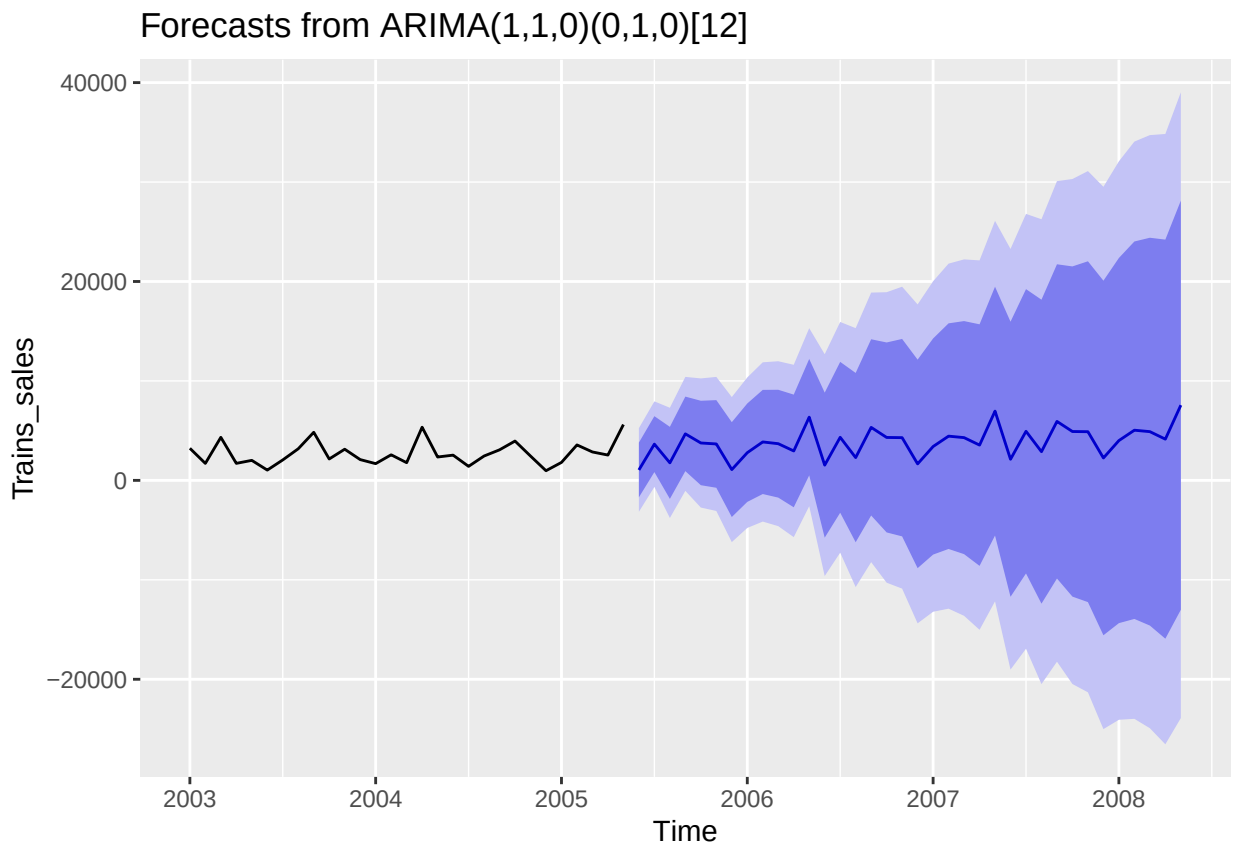
```
#Checking Residuals of AR_Model
checkresiduals(Trains_AR_Model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(1,1,0)(0,1,0)[12]
## Q* = 5.2742, df = 5, p-value = 0.3833
##
## Model df: 1.   Total lags used: 6
```

```
#Forecasting ARIMA Model
#forecast two years ahead
Trains_AR_Model_Forecast <- forecast(Trains_AR_Model, h=36)
```

```
#Plotting AR Model Forecast
#including the last 5 years
autoplot(Trains_AR_Model_Forecast, include = 60)
```




```
#Print Summary of AR Model Forecast
print(summary(Trains_AR_Model_Forecast))
```

```
##
## Forecast method: ARIMA(1,1,0)(0,1,0)[12]
##
## Model Information:
## Series: Trains_sales
## ARIMA(1,1,0)(0,1,0)[12]
##
## Coefficients:
##           ar1
##       -0.7842
## s.e.   0.1702
##
## sigma^2 = 4597944:  log likelihood = -145.39
## AIC=294.79   AICc=295.71   BIC=296.33
##
## Error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE       ACF1
## Training set 99.93263 1542.157 1014.844 -9.612831 40.98315 0.6780262 -0.2175376
##
## Forecasts:
##          Point Forecast       Lo 80     Hi 80       Lo 95     Hi 95
## Jun 2005       1046.495  -1701.5130  3794.502  -3156.2204  5249.210
## Jul 2005       3645.040    833.7523  6456.327   -654.4533  7944.533
```

```
## Aug 2005       1762.252  -1859.2102  5383.715  -3776.2967  7300.801
## Sep 2005       4676.561    930.5707  8422.551  -1052.4367 10405.558
## Oct 2005       3761.169   -483.8376  8006.175  -2731.0082 10253.346
## Nov 2005       3663.631   -742.8924  8070.155  -3075.5653 10402.828
## Dec 2005       1085.002  -3682.9803  5852.983  -6206.9974  8377.001
## Jan 2006       2783.880  -2163.4512  7731.210  -4782.4099 10350.169
## Feb 2006       3864.447  -1371.0205  9099.914  -4142.5094 11871.403
## Mar 2006       3688.866  -1731.7989  9109.532  -4601.3258 11979.059
## Apr 2006       2959.494  -2705.6860  8624.674  -5704.6511 11623.639
## May 2006       6357.071    507.5420 12206.599  -2589.0113 15303.153
## Jun 2006       1531.982  -5759.8038  8823.769  -9619.8423 12683.807
## Jul 2006       4332.075  -3251.1597 11915.311  -7265.4819 15929.633
## Aug 2006       2291.241  -6219.3613 10801.844 -10724.6023 15307.085
## Sep 2006       5329.484  -3531.3479 14190.316  -8221.9891 18880.958
## Oct 2006       4316.907  -5233.0082 13866.823 -10288.4282 18922.243
## Nov 2006       4295.579  -5629.4864 14220.644 -10883.4986 19474.657
## Dec 2006       1657.189  -8826.4799 12140.858 -14376.1989 17690.577
## Jan 2007       3402.929  -7460.7856 14266.643 -13211.6885 20017.546
## Feb 2007       4446.748  -6896.2638 15789.761 -12900.8918 21794.389
## Mar 2007       4299.984  -7417.2718 16017.240 -13620.0124 22219.981
## Apr 2007       3548.015  -8596.3372 15692.368 -15025.1690 22121.199
## May 2007       6963.311  -5544.3428 19470.965 -12165.4949 26092.117
## Jun 2007       2124.328 -11703.8768 15952.533 -19024.0864 23272.743
## Jul 2007       4935.317  -9358.7627 19229.397 -16925.5915 26796.226
## Aug 2007       2885.939 -12396.1411 18168.019 -20485.9855 26257.863
## Sep 2007       5930.882  -9867.3063 21729.070 -18230.3618 30092.125
## Oct 2007       4913.051 -11688.9719 21515.074 -20477.5520 30303.654
## Nov 2007       4895.842 -12239.5869 22031.272 -21310.5353 31102.220
## Dec 2007       2254.222 -15572.8542 20081.298 -25009.9381 29518.381
## Jan 2008       4002.495 -14356.6543 22361.644 -24075.4009 32080.391
## Feb 2008       5044.328 -13932.7358 24021.392 -23978.5865 34067.243
## Mar 2008       4899.121 -14599.0145 24397.257 -24920.7042 34718.947
## Apr 2008       4145.931 -15918.4066 24210.269 -26539.8253 34831.687
## May 2008       7562.185 -13007.7593 28132.129 -23896.8300 39021.200
```

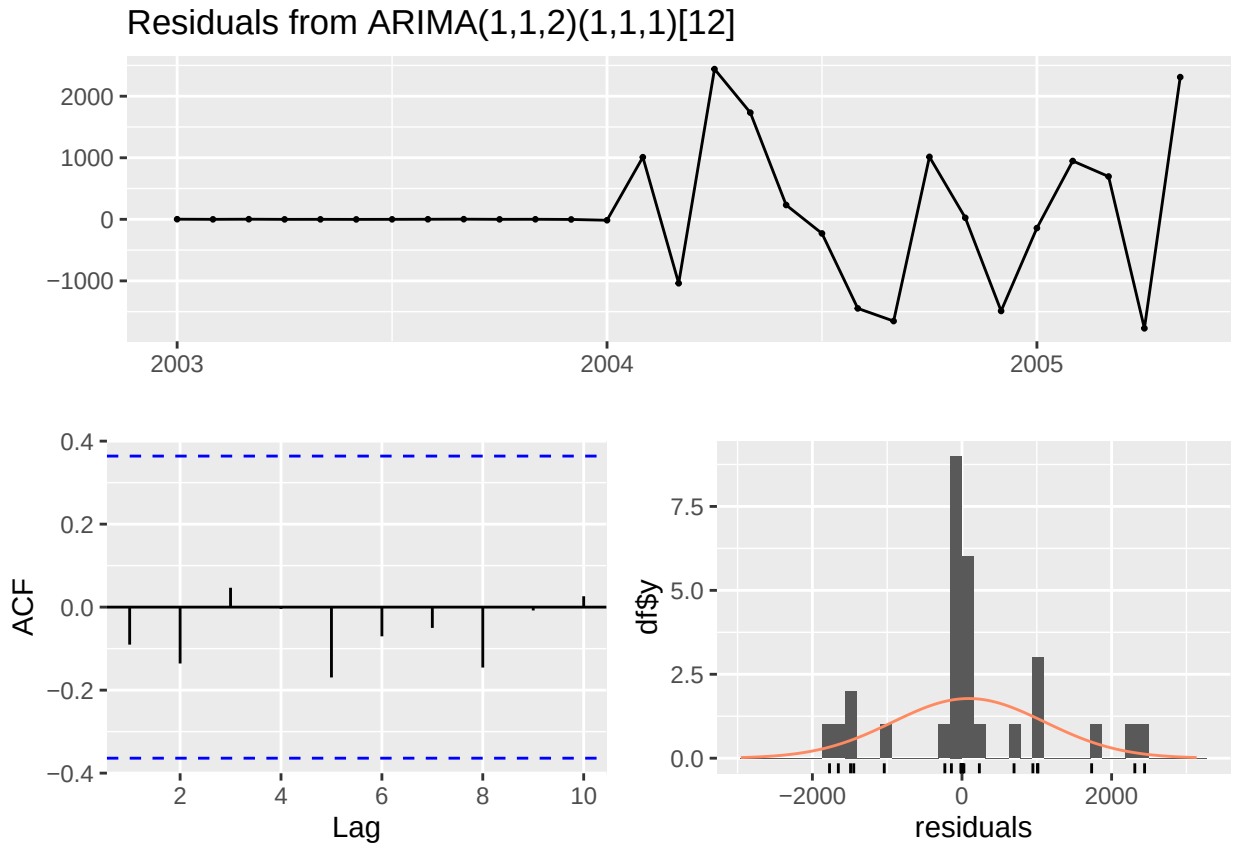
```
#Forecast 8, Part 2: Testing Train Sales Forecast with manual ARIMA variables

#Building second Train model
Train2_model <-arima(Trains_sales,order = c(1,1,2), seasonal = list(order = c(1,1,1)))
```

```
#Print Manual Arima Model Summary
print(summary(Train2_model))
```

```
##
## Call:
## arima(x = Trains_sales, order = c(1, 1, 2), seasonal = list(order = c(1, 1,
##     1)))
##
## Coefficients:
##           ar1      ma1      ma2    sar1     sma1
##       -0.8463  -0.5232  -0.4768  0.4759  -0.9962
## s.e.   0.3544   0.5575   0.5298  0.7112   1.7424
##
```

```
## sigma^2 estimated as 1819965:  log likelihood = -142.16,  aic = 296.32
##
## Training set error measures:
##                     ME     RMSE      MAE       MPE     MAPE      MASE
## Training set 90.54335 1002.062 627.9016 -4.576541 24.35332 0.4539364
##                      ACF1
## Training set -0.09034899
```

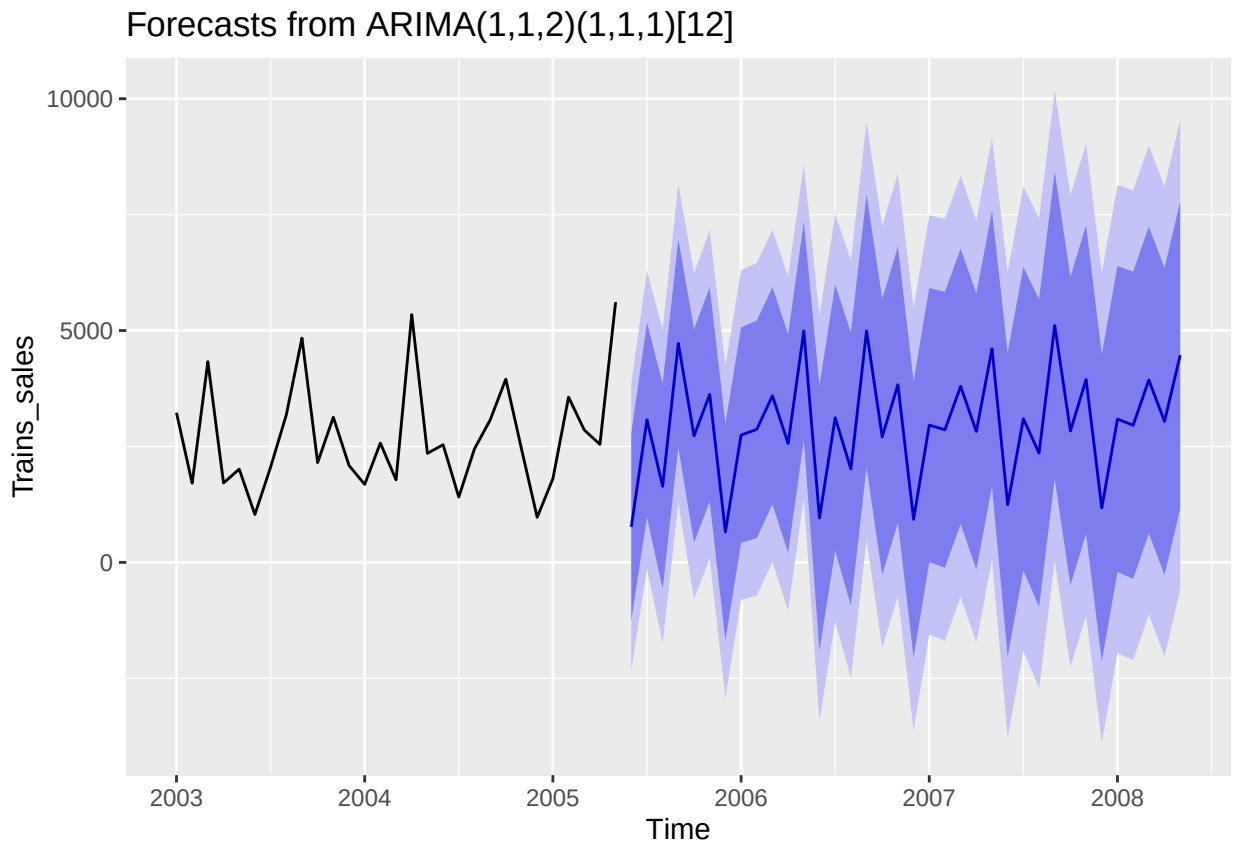
```
#Checking residual values of Manual Arima Model
checkresiduals(Train2_model)
```




```
##
##  Ljung-Box test
##
## data:  Residuals from ARIMA(1,1,2)(1,1,1)[12]
## Q* = 3.2308, df = 3, p-value = 0.3574
##
## Model df: 5.   Total lags used: 8
```

```
#Create Forecast for Manual ARIMA Model
#Forecast for the next two years
Train2_Forecast <- forecast(Train2_model, h=36)
```

```r
#Plot Forecast Results
#Showing the last 5 years
autoplot(Train2_Forecast, include = 60)
```




```r
#Print Summary Forecast Results
print(summary(Train2_Forecast))
```

```
##
## Forecast method: ARIMA(1,1,2)(1,1,1)[12]
##
## Model Information:
##
## Call:
## arima(x = Trains_sales, order = c(1, 1, 2), seasonal = list(order = c(1, 1,
##     1)))
##
## Coefficients:
##           ar1      ma1      ma2    sar1     sma1
##       -0.8463  -0.5232  -0.4768  0.4759  -0.9962
## s.e.   0.3544   0.5575   0.5298  0.7112   1.7424
##
## sigma^2 estimated as 1819965:  log likelihood = -142.16,  aic = 296.32
##
## Error measures:
##                    ME     RMSE      MAE       MPE     MAPE      MASE
```

```
## Training set 90.54335 1002.062 627.9016 -4.576541 24.35332 0.4195067
##                     ACF1
## Training set -0.09034899
##
## Forecasts:
##          Point Forecast        Lo 80    Hi 80       Lo 95     Hi 95
## Jun 2005       766.3201 -1251.092538 2783.733 -2319.04630  3851.687
## Jul 2005      3075.1172   978.787489 5171.447  -130.94243  6281.177
## Aug 2005      1640.8463  -572.208552 3853.901 -1743.72904  5025.422
## Sep 2005      4723.2414  2479.617464 6966.865  1291.91471  8154.568
## Oct 2005      2728.3066   427.272963 5029.340  -790.82067  6247.434
## Nov 2005      3622.6099  1310.494863 5934.725    86.53511  7158.685
## Dec 2005       656.7795 -1678.732416 2992.291 -2915.07775  4228.637
## Jan 2006      2744.8201   421.977394 5067.663  -807.66125  6297.301
## Feb 2006      2869.4706   523.704315 5215.237  -718.06933  6457.010
## Mar 2006      3593.2305  1251.615199 5934.846    12.03893  7174.422
## Apr 2006      2564.1171   209.486260 4918.748 -1036.98001  6165.214
## May 2006      4988.8220  2637.325402 7340.319  1392.51831  8585.126
## Jun 2006       956.4992 -1901.223272 3814.222 -3414.01018  5327.009
## Jul 2006      3119.9629   249.327422 5990.598 -1270.29522  7510.221
## Aug 2006      2015.5980  -926.944994 4958.141 -2484.63316  6515.829
## Sep 2006      4993.0164  2048.936955 7937.096   490.43545  9495.597
## Oct 2006      2708.6478  -266.809508 5684.105 -1841.92147  7259.217
## Nov 2006      3832.0078   856.929483 6807.086  -717.98182  8381.997
## Dec 2006       929.1522 -2047.068042 3905.373 -3622.58389  5480.888
## Jan 2007      2960.4937     3.936854 5917.051 -1561.16979  7482.157
## Feb 2007      2860.5806  -113.565381 5834.727 -1687.98315  7409.144
## Mar 2007      3797.3031   830.146941 6764.459  -740.57064  8335.177
## Apr 2007      2823.2472  -152.703028 5799.197 -1728.07590  7374.570
## May 2007      4605.3590  1632.416423 7578.302    58.63569  9152.082
## Jun 2007      1245.3138 -2035.793967 4526.422 -3772.70750  6263.335
## Jul 2007      3099.2636  -172.286784 6370.814 -1904.14097  8102.668
## Aug 2007      2355.2903  -962.801448 5673.382 -2719.29310  7429.874
## Sep 2007      5110.6212  1798.729939 8422.512    45.52061 10175.722
## Oct 2007      2834.1954  -491.055556 6159.446 -2251.33708  7919.728
## Nov 2007      3943.2769   617.699978 7268.854 -1142.75411  9029.308
## Dec 2007      1174.7118 -2134.668694 4484.092 -3886.54891  6235.973
## Jan 2008      3090.7876  -209.806768 6391.382 -1957.03587  8138.611
## Feb 2008      2958.7278  -354.304423 6271.760 -2108.11773  8025.573
## Mar 2008      3933.5626   626.279319 7240.846 -1124.49071  8991.616
## Apr 2008      3039.2122  -272.439059 6350.864 -2025.52136  8103.946
## May 2008      4470.2640  1159.099220 7781.429  -593.72553  9534.254
```