Portland Housing Price Prediction by Neighborhood

Introduction

For our team project we chose to do an analysis of real estate pricing information for Portland Oregon. Our interest is to predict how quickly the median housing price will climb within the city. We will break that into geographic regions, and try to identify any major trends from this prediction. Exceptional growth in urban housing prices has led to gentrification to many urban towns in recent days. With Portland being one of the most attrative cities to move to, housing prices, new development, and decades of strong urban renewal projects have culminated in housing prices soaring faster than most other American cities.

Business problem

In order to better understand the Portland housing market, we will be analyzing the trends in housing prices and attempt to predict the future prices of housing by neighborhood. This will provide us an indication of affordability and allow us to predict where the next bursts in housing price inflation might occur. If you are in real estate, then you should invest in these areas. If you are a city planner, you should focus your anti-gentrification and housing affordability efforts in these neighborhoods to reduce displacement in the local populations.

Relevant data driven, analytical work in this area

The majority of our work has focused on the isolation of approriate data from our initial dataset and preparation for time series analysis. There are a number of research papers evaluating this particular topic of affordability in metropolitan areas and some specifically in Portland. Oregon Live is hosting an interactive map on this topic, showcasing similar results to those that we are seeking to understand: what neighborhoods are under pressure from gentrification and which are likely to be next.

Data Source, Data Exploration, Descriptive Statistics, Variable Selection

Our data was sourced from the Redfin Data Center. The dataset was quite large and we initially reviewed the 47 variables for validity with our analysis in mind. We ultimately limited this to 13 variables, seven related to cost and availability which could be used for our preditinos. Another three variables related to the time series, and three related to the regions were selected to allow us to do appropriate filtering of our dataset from a nationwide, nearly 1.5 gigabyte CSV into a more manageable, Oregon-only dataset.

As part of our data cleaning, we realized that the dataset periods offered were 90 day time slices, so we decided to select periods of January-March, April-June, July-September, and October-December in order to avoid overlapping data sets. It does appears that Redfin's analysis of this data used each 90-day average to represent the month in which the period ended. This causes some overlapping but also results in smoother data and more data points. If we ultimately decide that four data points per year is too few, we may consider re-factoring our data segmentation in a similar way.

Methodologies Considered

With the project selection, we are limited to time series-based modeling. We initially used the linear trend time series modeling technique and compared this to the naive approach. We are also considering caomparing the accuracy of these two models to a model involving trend and seasonality if there is time.

Next Steps

- Run time series model on training and validation sets - done
- Try various time series models and compare accuracy - done
  - Trend and seasonality
  - Linear, and polynomial
  - Naive
- Compare accuracy between these models - need write up
- Create comparison array to evaluate neighborhood predictions - need to do
- Investigate possibility of visualizing with a mapping tool - need to do
- Beautify graphs/visualizations - done

References

Redfin Data Center: Downloadable Housing Market Data From Redfin

Gentrification and Displacement Study: implementing an equitable inclusive development strategy in the context of gentrification

Load all of the libraries needed for forecasting.

```
#Load library and suppress warnings
suppressWarnings(suppressMessages(library(dplyr)))
suppressWarnings(suppressMessages(library(fpp)))
suppressWarnings(suppressMessages(library(forecast)))
```

Load all of the redfin data into the data frame. We will only be using median price in the timeseries, but this is interesting data that was analyzed prior to deciding on the final solution.

```
# load all redfin data into the data frame
Oregon.df <- read.csv("Redfin Data Portland_ All Residential_filtered.csv")
```

Print out some variables in the dataset. We will only be using median price in the timeseries, but this is interesting data that was analyzed prior to deciding on the final solution.

```
#Select and summarize only the home variables
selected.var <-c(2, 6, 9, 24, 27, 30, 39)
Home_data.df = Oregon.df[, selected.var]
print("Relevent Housing variables summary")
```

```
## [1] "Relevent Housing variables summary"
```

```
summary(Home_data.df)
```

```
##  Avg.Sale.To.List   Homes.Sold        Inventory      Median.Sale.Price
##  Min.   :0.7710   Min.   :  1.0   Min.   :  1.0   Min.   :  98000
##  1st Qu.:0.9857   1st Qu.: 14.0   1st Qu.:  8.0   1st Qu.: 267000
##  Median :0.9985   Median : 25.0   Median : 14.0   Median : 356500
##  Mean   :1.0010   Mean   : 53.8   Mean   : 32.7   Mean   : 380111
##  3rd Qu.:1.0142   3rd Qu.: 47.0   3rd Qu.: 28.0   3rd Qu.: 456438
##  Max.   :1.2165   Max.   :729.0   Max.   :537.0   Max.   :2060000
##                                   NA's   :20
##  Months.Of.Supply  New.Listings          Property.Type
##  Mode:logical    Min.   :  1.00   All Residential:6836
##  NA's:6836       1st Qu.: 14.00
##                  Median : 26.00
##                  Mean   : 55.33
```

```
##                 3rd Qu.: 48.00
##                 Max.   :855.00
##
```

```r
#Select and summarize only the time variables
selected.var <-c(33, 34, 35)
Time_data.df = Oregon.df[, selected.var]
print("Relevent Time variables summary")
```

```
## [1] "Relevent Time variables summary"
```

```r
summary(Time_data.df)
```

```
##    Period.Begin  Period.Duration   Period.End
##   1/1/13 :  95   Min.   :90      1/31/12:  95
##   1/1/14 :  95   1st Qu.:90      1/31/13:  95
##   1/1/15 :  95   Median :90      1/31/14:  95
##   1/1/16 :  95   Mean   :90      1/31/15:  95
##   1/1/17 :  95   3rd Qu.:90      1/31/16:  95
##   10/1/12:  95   Max.   :90      1/31/17:  95
##   (Other):6266                   (Other):6266
```

```r
#Select and summarize only the time variables
selected.var <-c(40, 41, 45)
Time_data.df = Oregon.df[, selected.var]
print("Relavent Location variables summary")
```

```
## [1] "Relavent Location variables summary"
```

```r
summary(Time_data.df)
```

```
##                                  Region          Region.Type       State
##   Portland, OR - Alameda          :  72   neighborhood:6836   Oregon:6836
##   Portland, OR - Arbor Lodge      :  72
##   Portland, OR - Argay            :  72
##   Portland, OR - Arnold Creek     :  72
##   Portland, OR - Ashcreek         :  72
##   Portland, OR - Beaumont-Wilshire:  72
##   (Other)                         :6404
```

We only care about the "neighborhood" type records. There are lots of other types in this dataset that we don't care about, such as by zipcode.

```r
# filter to just neighborhood records - the full set has by zipcode, and other breakdowns we don't care
neighborhoods.df <- Oregon.df[Oregon.df$Region.Type == "neighborhood",]
```

Now load only the unique neighborhood names into an array. This array will be iterated over in our for-loop.

```r
# load the training data list of unique neighborhoods into an array for iteration
 neighborhoods.array <- unique(neighborhoods.df$Region, incomparables = FALSE)
```

We have a plan to store accuracy and other metrics by neighborhood. Not sure that we will use this, but leaving in our codebase for now.

```r
# Not sure if will use this. Clean up if not.
# Create a storage array for our results
neighborhoodsSummary.array <- array()

#We want to store: neighborhood name, timeseries
neighborhoodsSummary.array <- c("")
```

Appendix: Neighborhood Analysis

- For each neighborhood we will:
  - pull the relevant observations and create a timeseries.
  - filter out the non-January,April, July and October records as each of our observations is for three months and we want to do seasonal analysis
  - select only the median price colum
  - load that dataframe into a OneNeighborhood timeseries
  - Create the training and validation sets based on year
  - Run seasonal naive forecasting on the training set.
  - Compare the snaive forecast to the test set
  - Run seasonal naive forecasting on the entire timeseries (not just training)
  - Plot holt winters timeseries and accuracy
  - Run holt winters forecasting on the training set.
  - Compare the holt winters forecast to the test set
  - Run holt winters forecasting on the entire timeseries (not just training)
  - Plot holt winters timeseries and accuracy
  - Plot the training set, test set, and both of our forecasts

```r
# For loop
#loop through all the neighboorhoods and for each create a timeseries and print the plot
for (neighborhood in neighborhoods.array){

    # use if just want to look at one neighborhood: for (neighborhood in c("Portland, OR - Rose City Pa
    #select a neighborhood into a dataframe
    oneNeighborhood.df <- neighborhoods.df[Oregon.df$Region == neighborhood,]

    #filter out the observations for months that aren't January (1), April (4), July (7), October (10).
    #Note that had to invert, so selected ones that did not have these patterns matched.
    oneNeighborhood.df<-oneNeighborhood.df[grep("2/|3/|5/|6/|8/|9/|11/|12/", oneNeighborhood.df$Period.
    # somehow they are out of order, now to sort the period.begin
    oneNeighborhood.df <- oneNeighborhood.df[order(as.Date(oneNeighborhood.df$Period.Begin, format="%m/
    dat1 <- oneNeighborhood.df # save for debugging prior to removing columns

    #log how many rows each neighborhood has available
    #cat(neighborhood, " has ", nrow(oneNeighborhood.df), " rows. \n")

  # select the median price column for the timeseries
  oneNeighborhood.df <- oneNeighborhood.df[c(18)]

  # create the timeseries
  oneNeighborhood.timeseries <- ts(oneNeighborhood.df, frequency=4, start=c(2012,1))

  #str(oneNeighborhood.timeseries)

  # divide the timeseries that was created into two parts
  trainingData = window(oneNeighborhood.timeseries, start=c(2012,1), end=c(2015,4)) ### Training set (4
  testData = window(oneNeighborhood.timeseries, start=c(2016,1), end=c(2017,4), frequency=4)  ### Test s

  # Generic plot of timeseries without any modeling --------------------
  # plot and set title to the appropriate heading
  options(scipen=999)
```

```
plot(oneNeighborhood.timeseries, main=neighborhood)


# Seasonal Naive Plots ---------------------------------------------------

# train on data from 2012 to the end of 2015, Forecast for four more years (2016 through 2019)
snaive.forecast <- snaive(trainingData, h = 16 )
snaive.full.forecast <- snaive(oneNeighborhood.timeseries, h = 8)

# Forecast plot for Seasonal Naive ---------
plotTitle <- paste(neighborhood, ": Naive Model Forecast")
options(scipen=999)
# plots both the train data, test data and prediction
plot(snaive.forecast, main=plotTitle, ylab = "Median House Price", xlab = "Year")
lines(testData, col="red") # color the test data to tell it from the train data
legend("topleft",lty=1,bty = "n",col=c("black", "red","blue"),c("Train Data", "Test Data","Seasonal N

# Plot Seasonal Naive Accuracy ---------
snaive.accuracy <- accuracy(snaive.forecast,testData)
options(scipen=999)
tsdisplay(residuals(snaive.forecast), main = paste(plotTitle, " Residuals"))

# Holt Winters Plots --------------------------------------------------------

  # Apply Forecasting Method to timeseries - Holt Winters Method
hwinters.forecast <- forecast(HoltWinters(trainingData), h = 16)
hwinters.full.forecast <- forecast(HoltWinters(oneNeighborhood.timeseries), h = 8)

# Forecast plot for Holt Winters ---------
plotTitle <- paste(neighborhood, ": Holt Winters Model Forecast")
options(scipen=999)

# plots both the train data, test data and prediction
plot(hwinters.forecast, main=plotTitle, ylab = "Median House Price", xlab = "Year")
lines(testData, col="red") # color the test data to tell it from the train data
legend("topleft",lty=1,bty = "n",col=c("black", "red","blue"),c("Train Data", "Test Data","Holt Winter

# Plot Holt Winters Accuracy ---------
hwinters.accuracy <- accuracy(hwinters.forecast,testData)

options(scipen=999)
tsdisplay(residuals(hwinters.forecast), main = paste(plotTitle, " Residuals"))


# Compare Accuracy ----------------------------------------------------------
#print("Accuracy for Seasonal and Holt Winters")
# Seasonal Naive
print(paste("Seasonal Naive Accuracy for ", neighborhood))
print(snaive.accuracy)

knitr::kable(snaive.accuracy, caption = paste("Seasonal Naive Accuracy for ", neighborhood))

# Holt Winters
```

```r
  print(paste("Holt Winters Accuracy for ", neighborhood))
  print(hwinters.accuracy)

  knitr::kable(hwinters.accuracy, caption = paste("Holt Winters Accuracy for ", neighborhood))

  combined.accuracy <-rbind(snaive.accuracy, hwinters.accuracy)
  #plot(snaive.accuracy)

  # Forecast plot for Combined models ---------
  plotTitle <- paste(neighborhood, ": TS Training Model Comparison")
  options(scipen=999)
  # plots both the train data, test data and both predictions
  plot(oneNeighborhood.timeseries, main=plotTitle, ylab = "Median House Price", xlab = "Year")
  lines(hwinters.forecast$mean,col="blue", lty="dashed")
  lines(snaive.forecast$mean, col="green", lty="dashed")
  lines(testData, col="red") # color the test data to tell it from the train data
  legend("topleft",lty=1,bty = "n",col=c("black", "red","blue", "green"),c("Train Data", "Test Data","H


  # Forecast plot for Combined models ---------
  plotTitle <- paste(neighborhood, ": Full TS Models Comparison")
  options(scipen=999)
  # plots both the train data, test data and both predictions
  plot(oneNeighborhood.timeseries, main=plotTitle, ylab = "Median House Price", xlab = "Year", xlim=c(2(
  lines(hwinters.full.forecast$mean,col="blue", lty="dashed")
  lines(snaive.full.forecast$mean, col="green", lty="dashed")
  lines(testData, col="red") # color the test data to tell it from the train data
  legend("topleft",lty=1,bty = "n",col=c("black", "red","blue", "green"),c("Train Data", "Test Data","H

}
```

Portland, OR – University Park
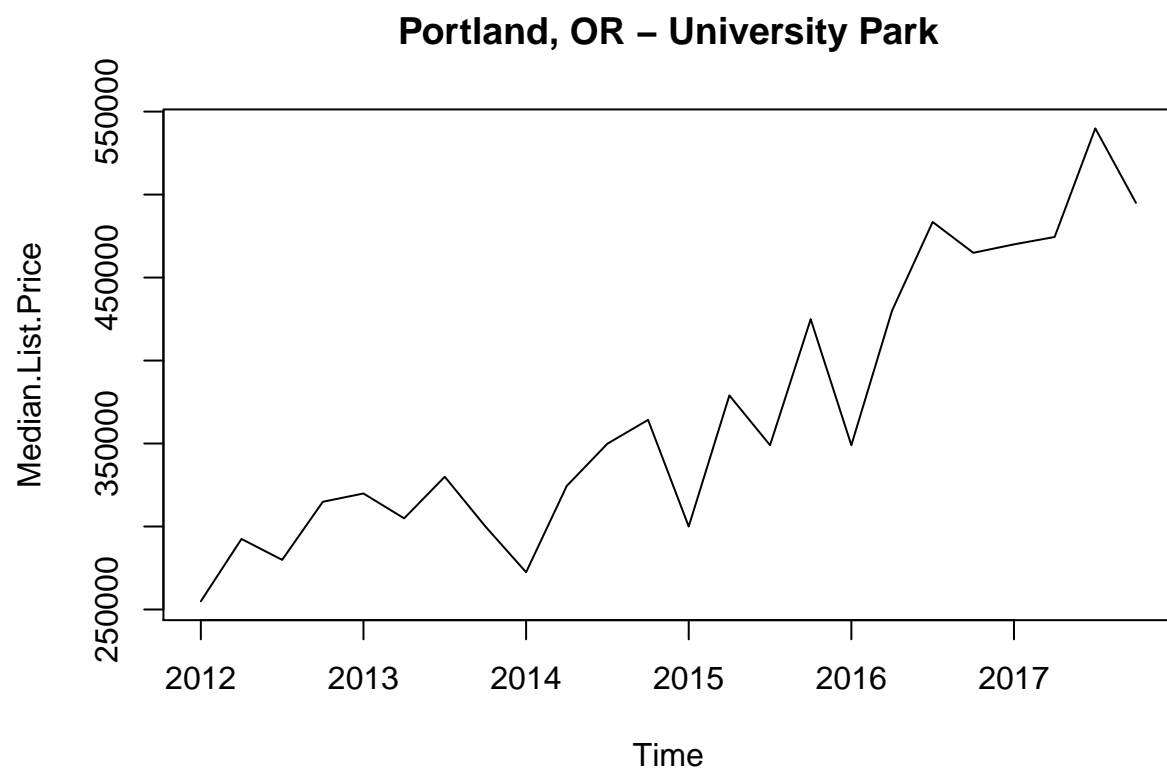
Portland, OR – University Park : Naive Model Forecast
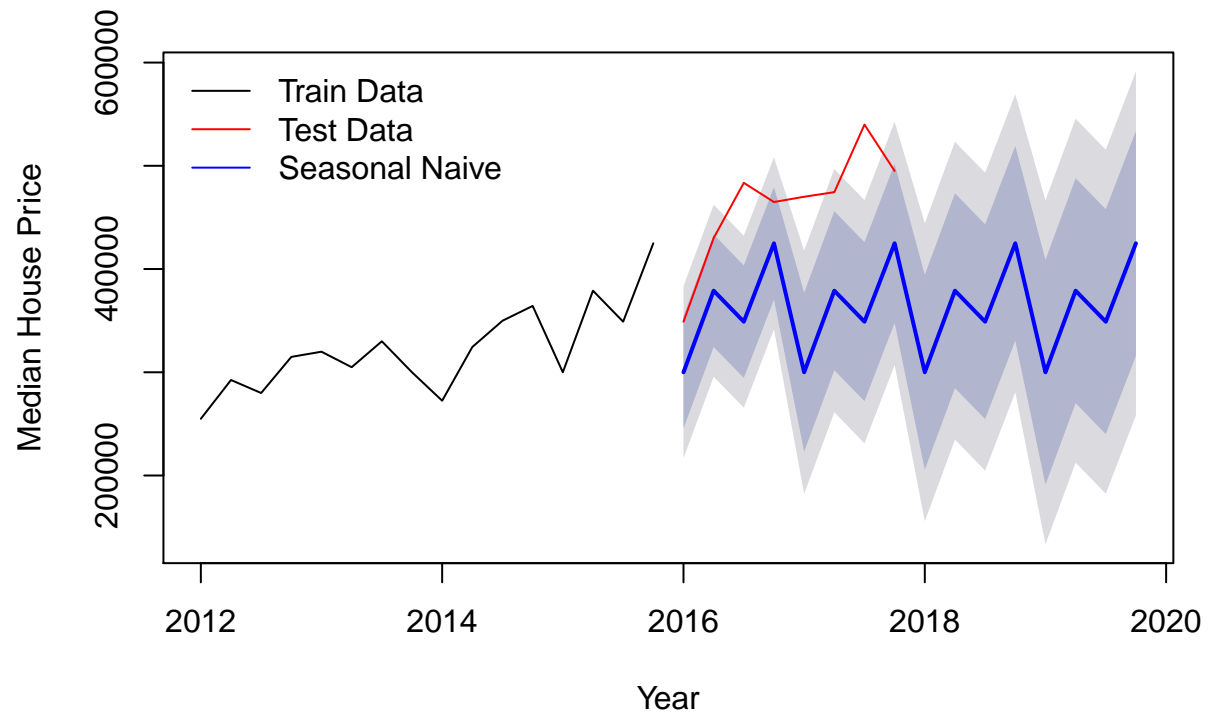
Portland, OR – University Park : Naive Model Forecast Residuals
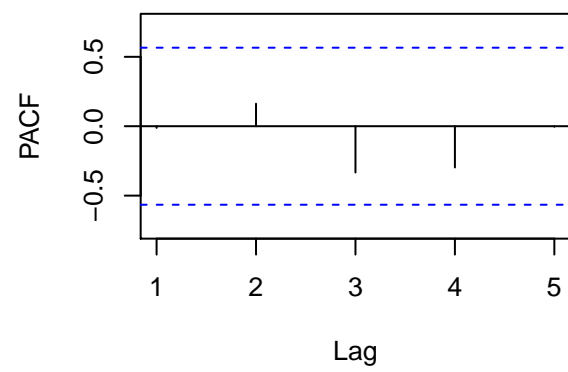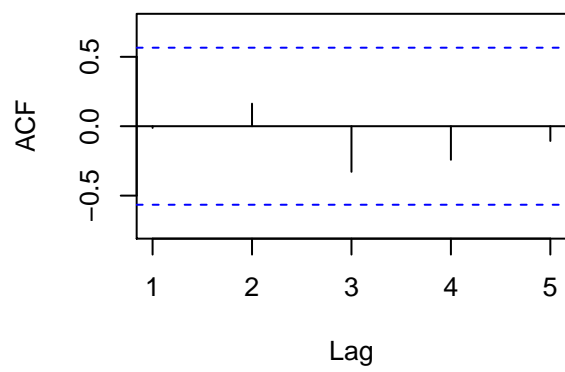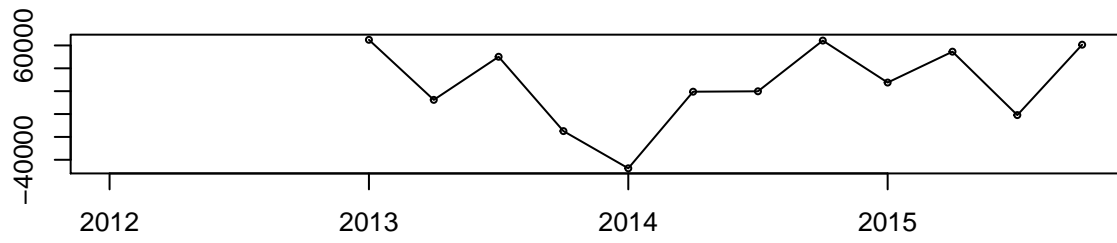
Portland, OR – University Park : Holt Winters Model Forecast
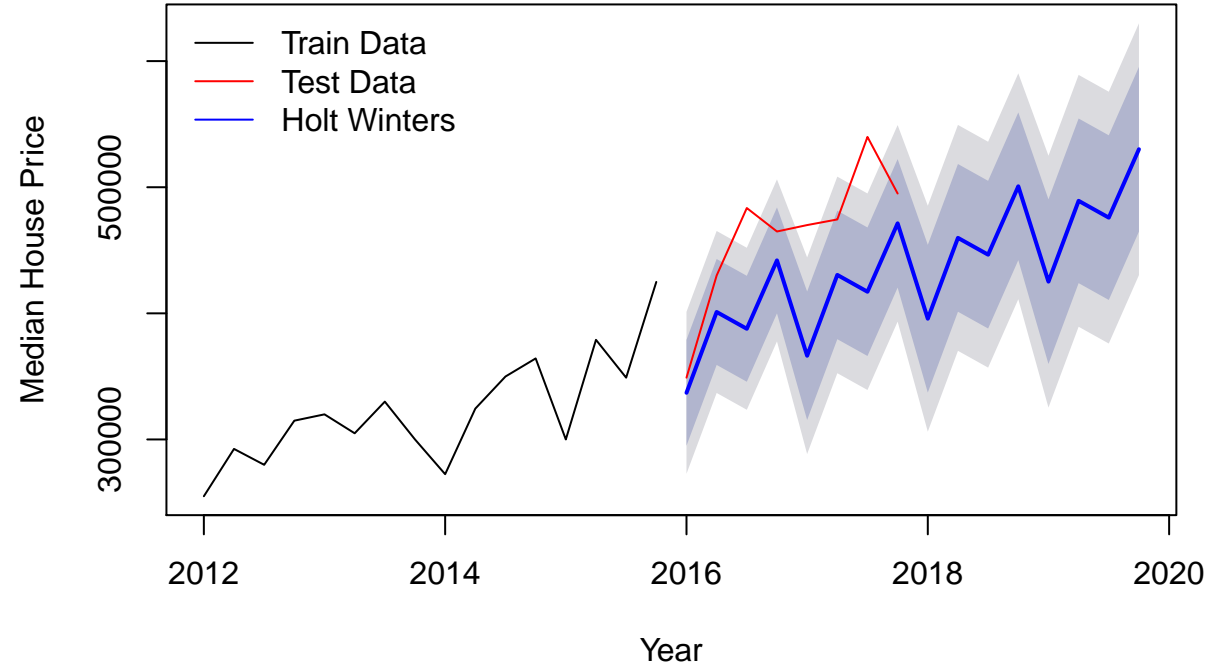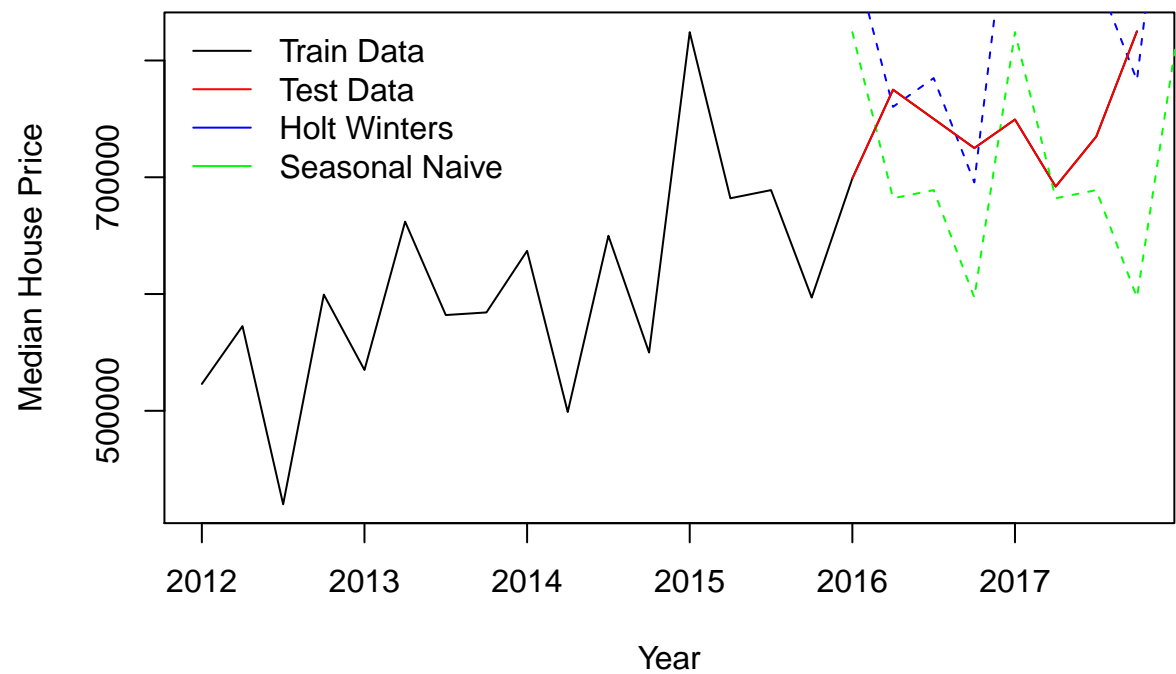
Portland, OR – University Park : Holt Winters Model Forecast Residuals
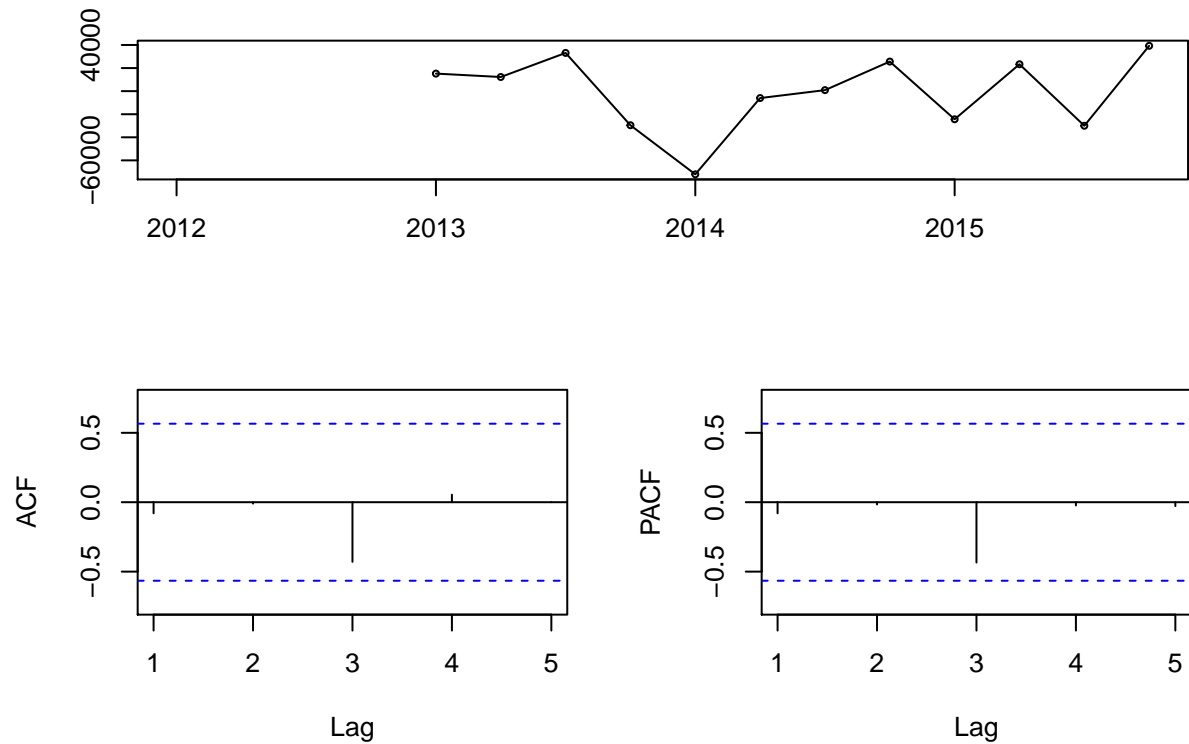

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - University Park"
##                     ME     RMSE      MAE      MPE     MAPE     MASE
## Training set  25885.42   42497.5  36427.08  7.008834 10.78227 1.00000
## Test set     100118.75 114050.3 100118.75 21.016354 21.01635 2.74847
##                   ACF1 Theil's U
## Training set -0.01200592        NA
## Test set     -0.37374805  2.224126
## [1] "Holt Winters Accuracy for  Portland, OR - University Park"
##                     ME     RMSE      MAE      MPE     MAPE     MASE
## Training set -1024.014 31384.93 25972.89 -1.114452  8.03032 0.7130105
## Test set     56695.957 69796.37 56695.96 11.715301 11.71530 1.5564232
##                  ACF1 Theil's U
## Training set -0.0802167        NA
## Test set     -0.4803334  1.384819
```

Portland, OR – University Park : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price (250000 to 550000)
X-axis: Year (2012 to 2017)
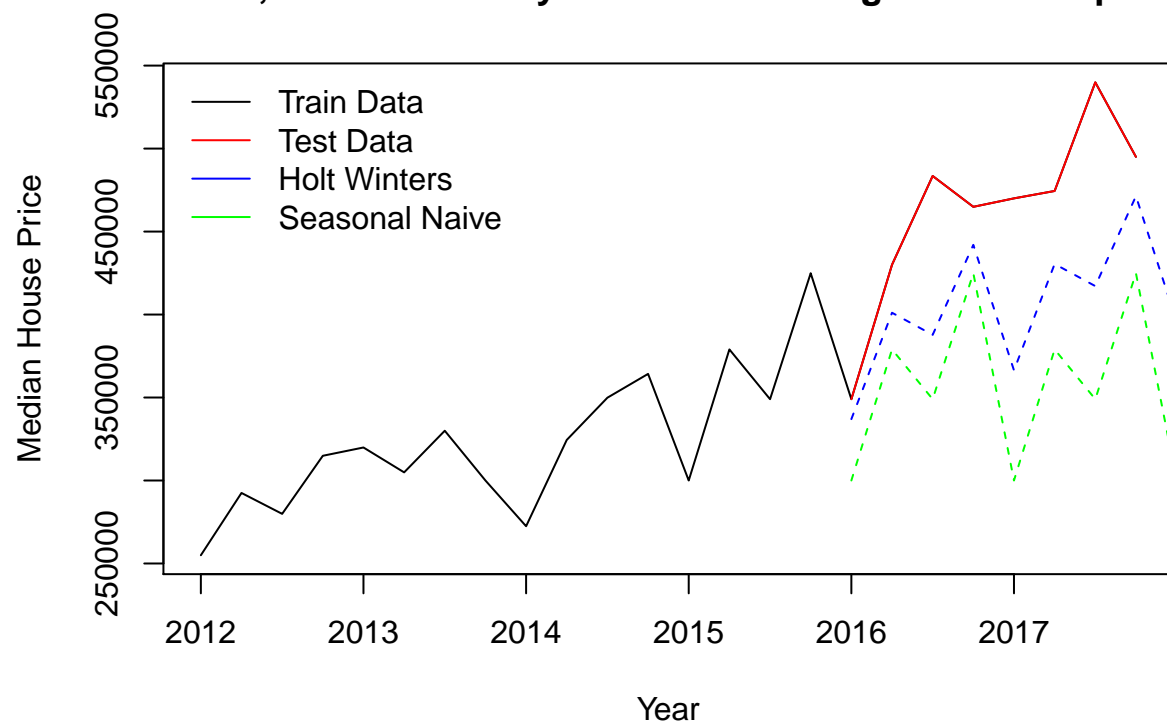
Portland, OR – University Park : Full TS Models Comparison
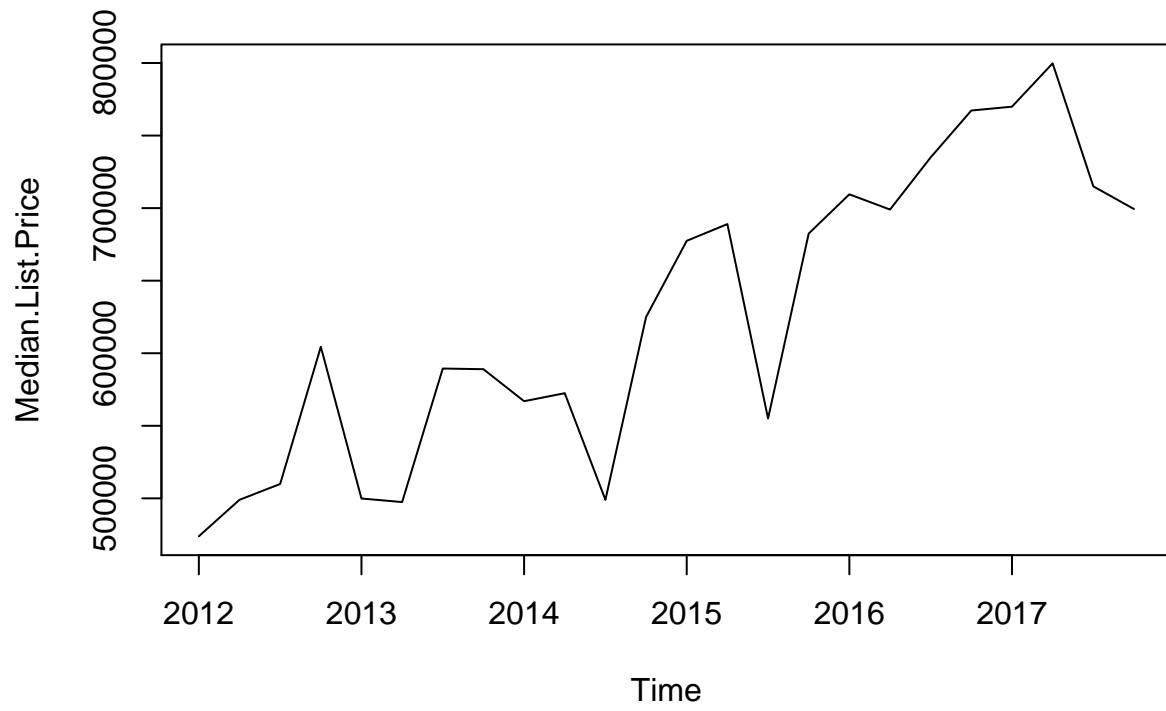
— Train Data
— Test Data
— Holt Winters
— Seasonal Naive

Median House Price

Year

Portland, OR – Laurelhurst

Portland, OR – Laurelhurst : Naive Model Forecast
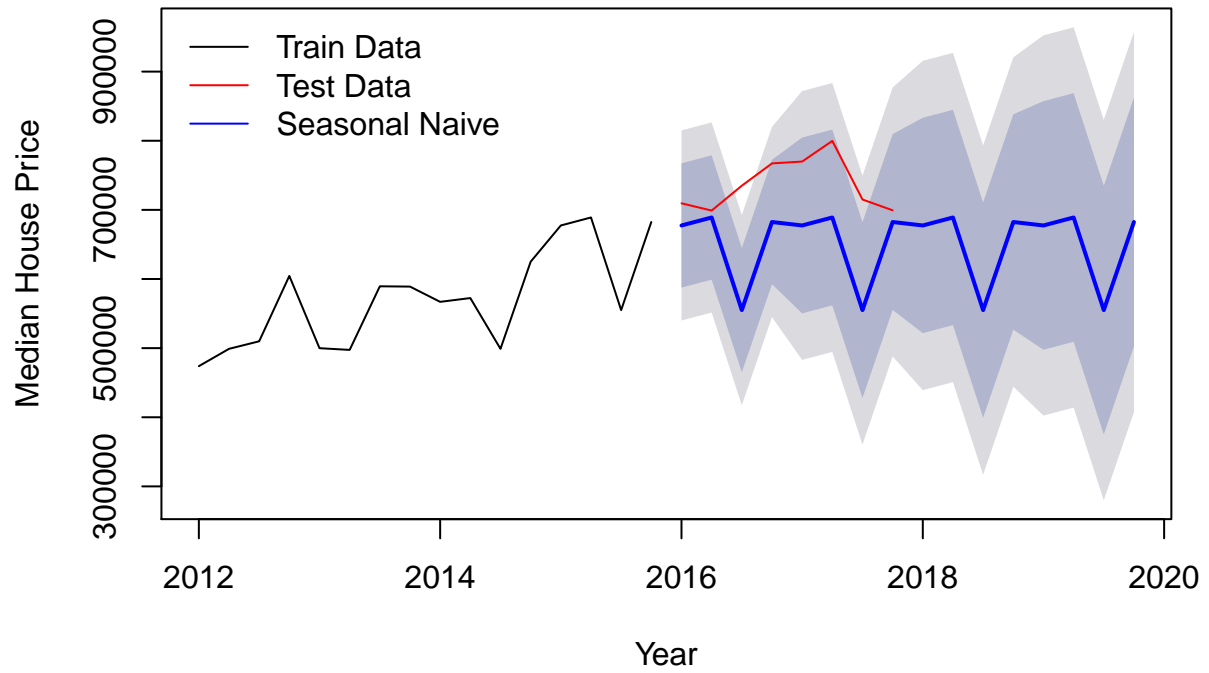
Portland, OR – Laurelhurst : Naive Model Forecast Residuals
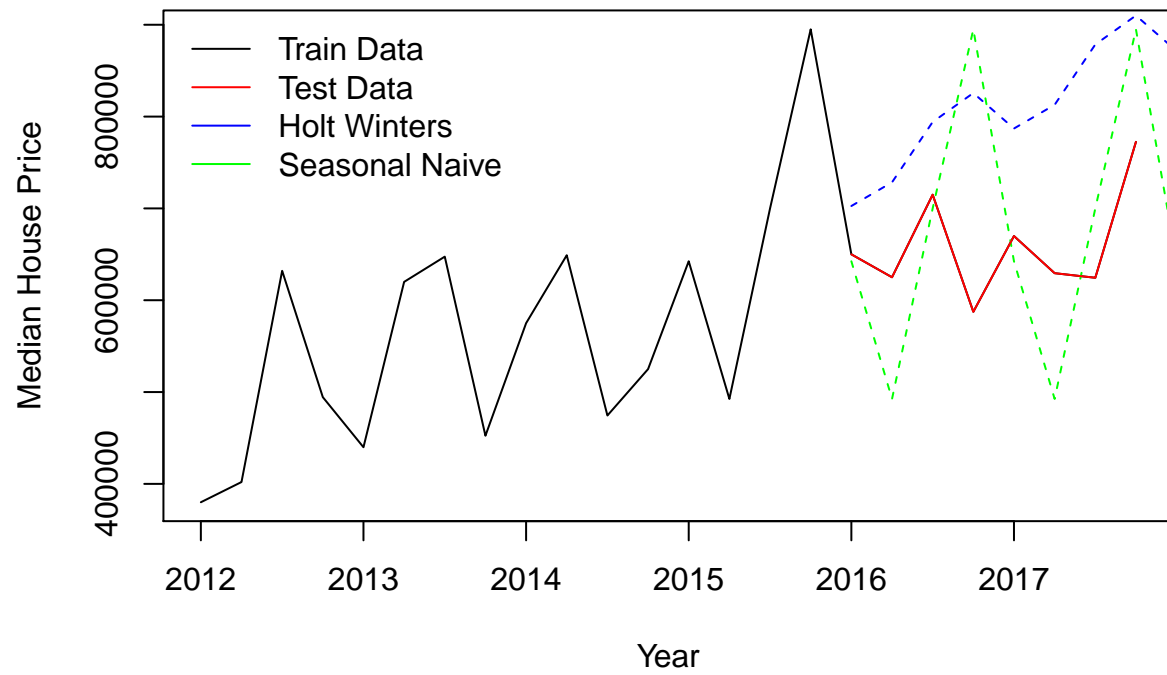
Portland, OR – Laurelhurst : Holt Winters Model Forecast
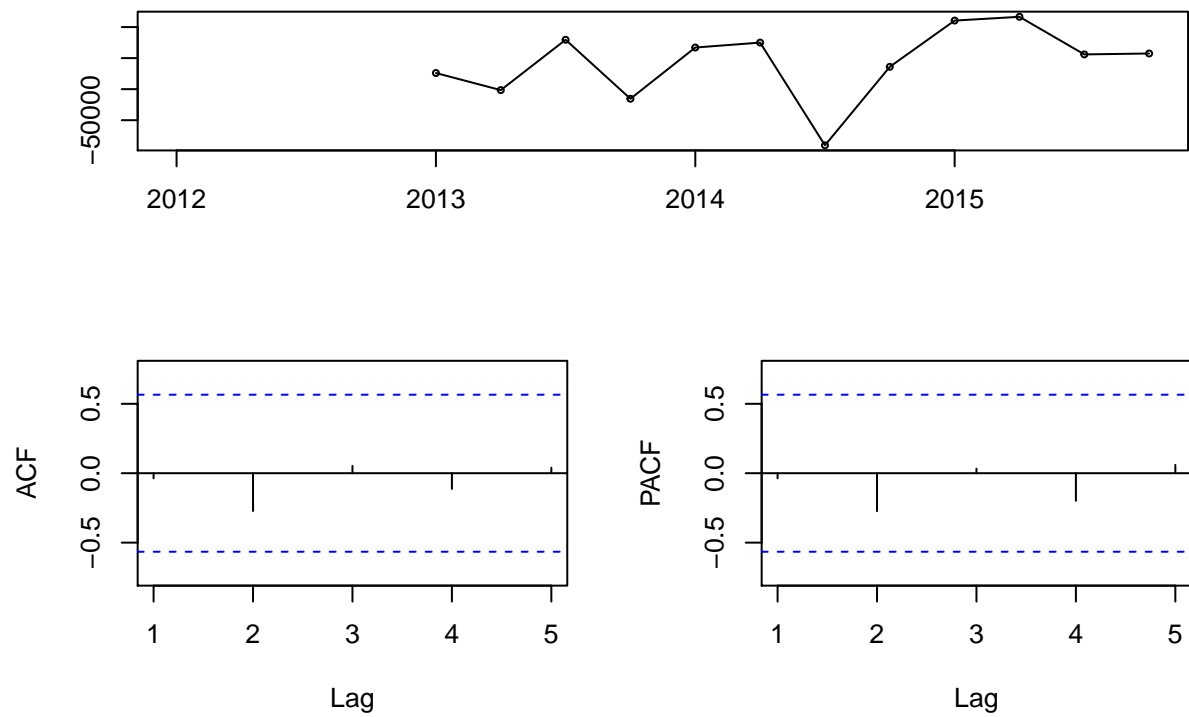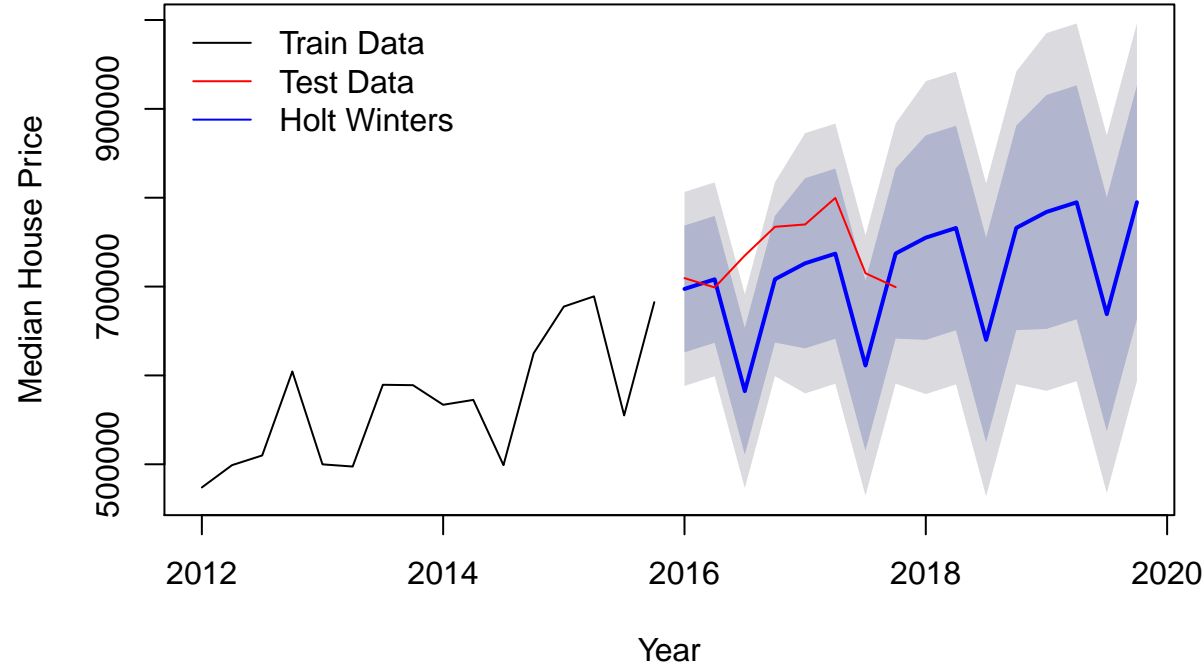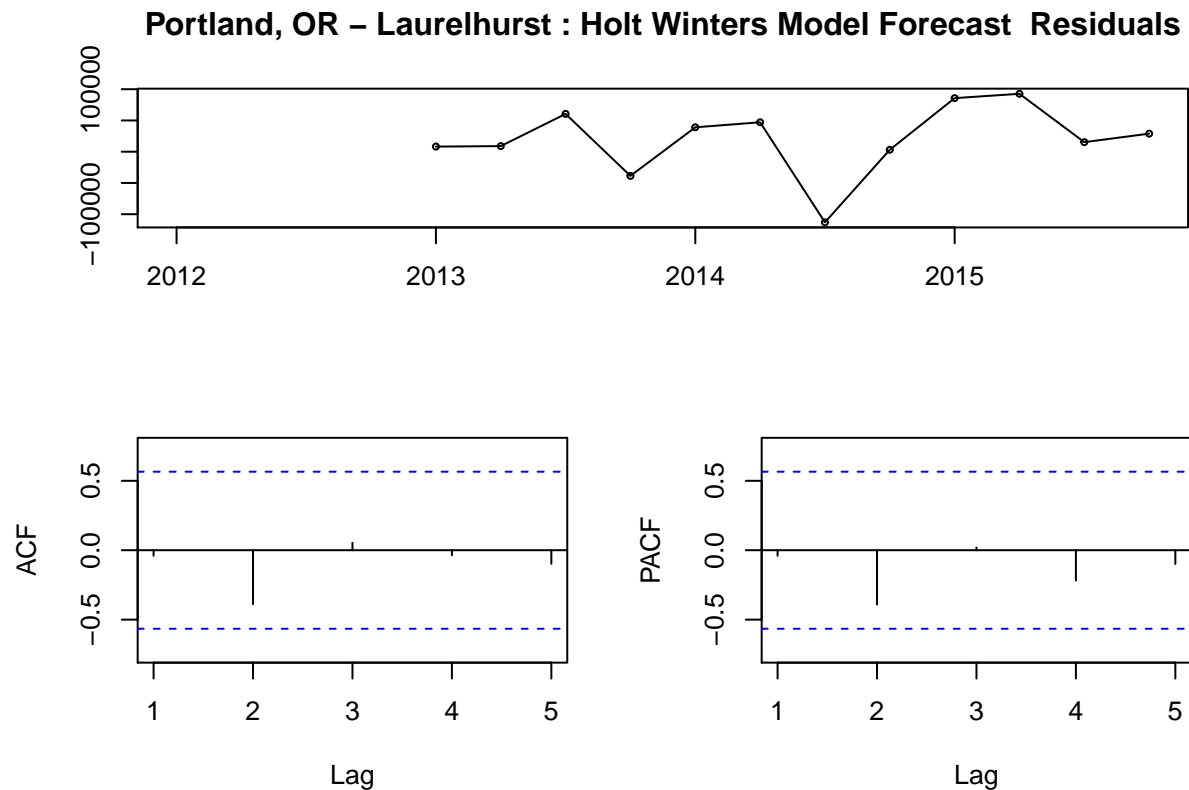
Portland, OR – Laurelhurst : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Laurelhurst"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 43054.17  70162.83 60962.50  6.671586 10.18174 1.000000
## Test set     85868.69 104522.77 85868.69 11.517774 11.51777 1.408549
##                   ACF1 Theil's U
## Training set -0.03648456        NA
## Test set     -0.22043044  2.938658
## [1] "Holt Winters Accuracy for  Portland, OR - Laurelhurst"
##                   ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 19790.64 56864.47 45070.81 2.761935 7.630577 0.7393202
## Test set     48390.00 75056.32 60122.03 6.437787 8.115415 0.9862133
##                   ACF1 Theil's U
## Training set -0.04008784        NA
## Test set     -0.26258388  2.157108
```

Portland, OR – Laurelhurst : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Median House Price

Year
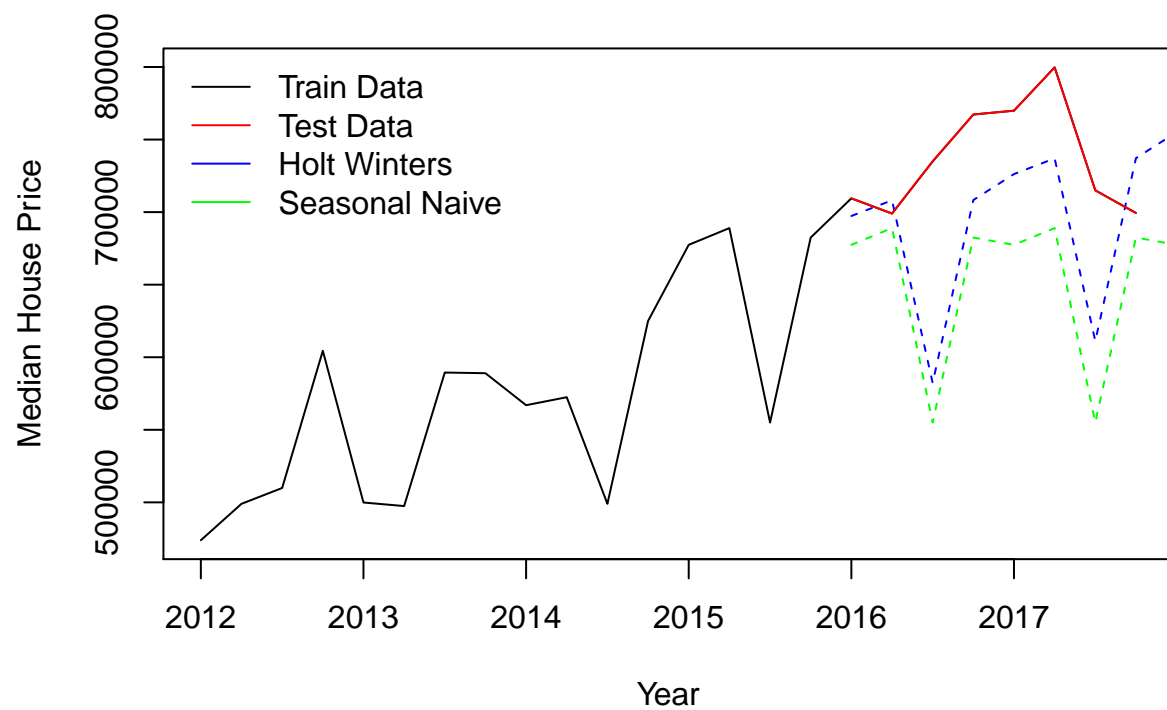
Portland, OR – Laurelhurst : Full TS Models Comparison
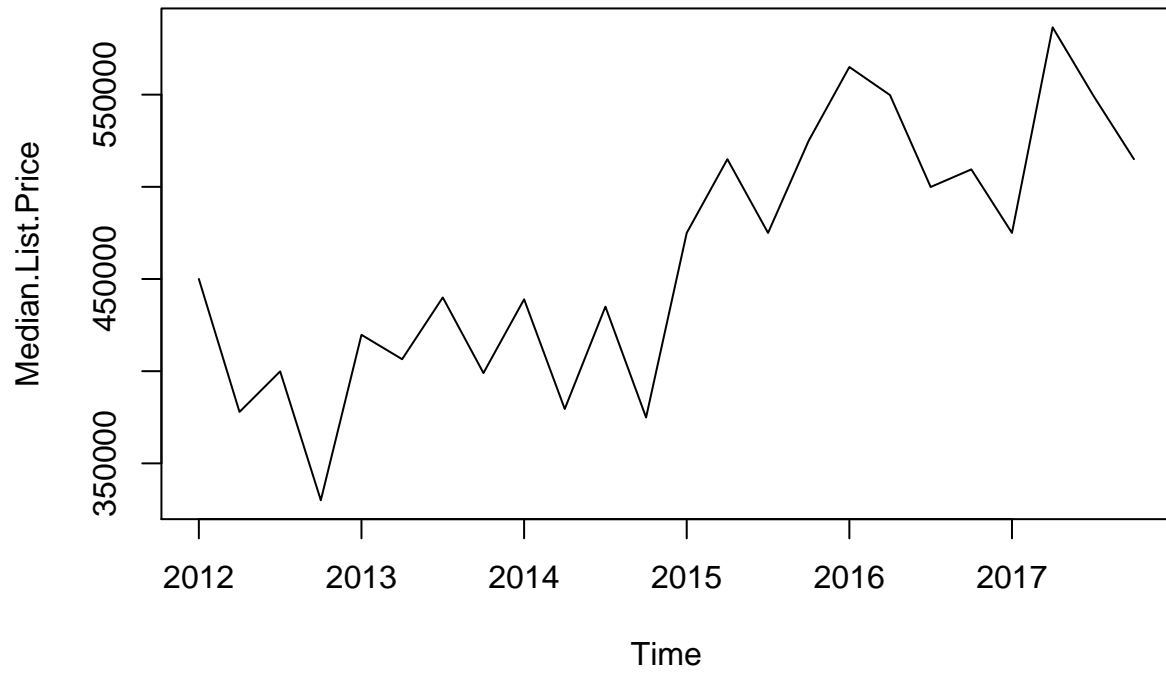
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price
X-axis: Year

Portland, OR – Hillsdale

Portland, OR – Hillsdale : Naive Model Forecast
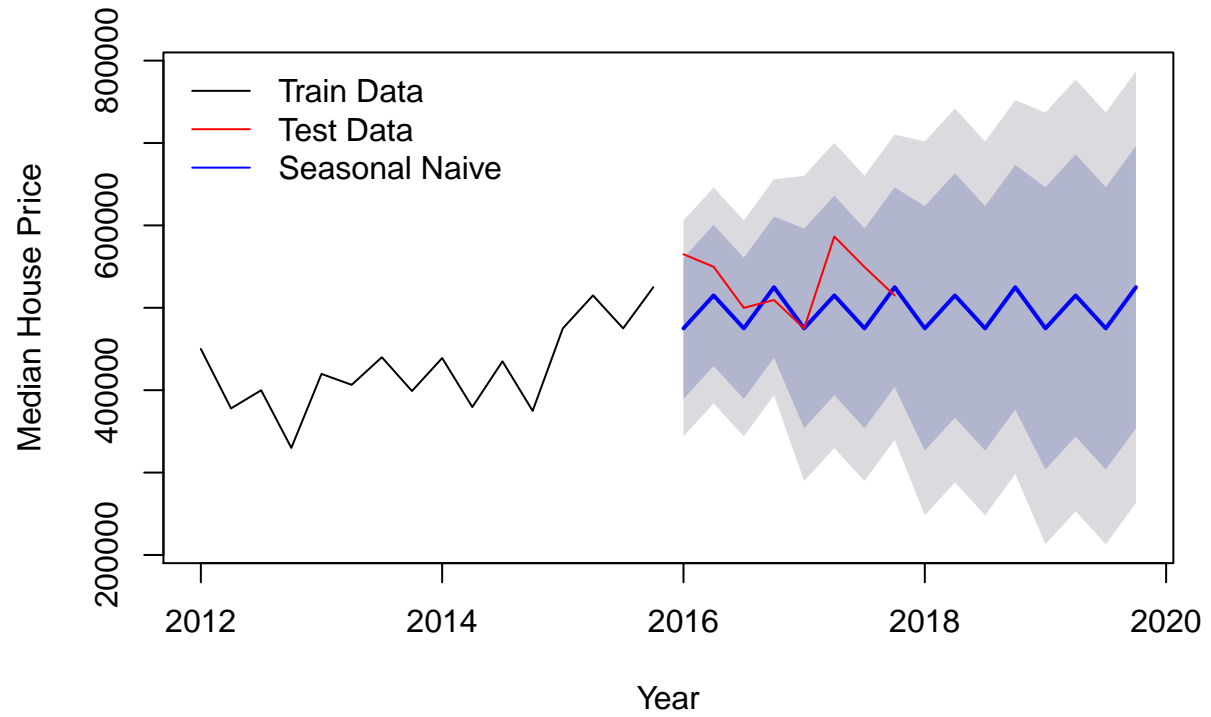
Portland, OR – Hillsdale : Naive Model Forecast Residuals

Portland, OR – Hillsdale : Holt Winters Model Forecast
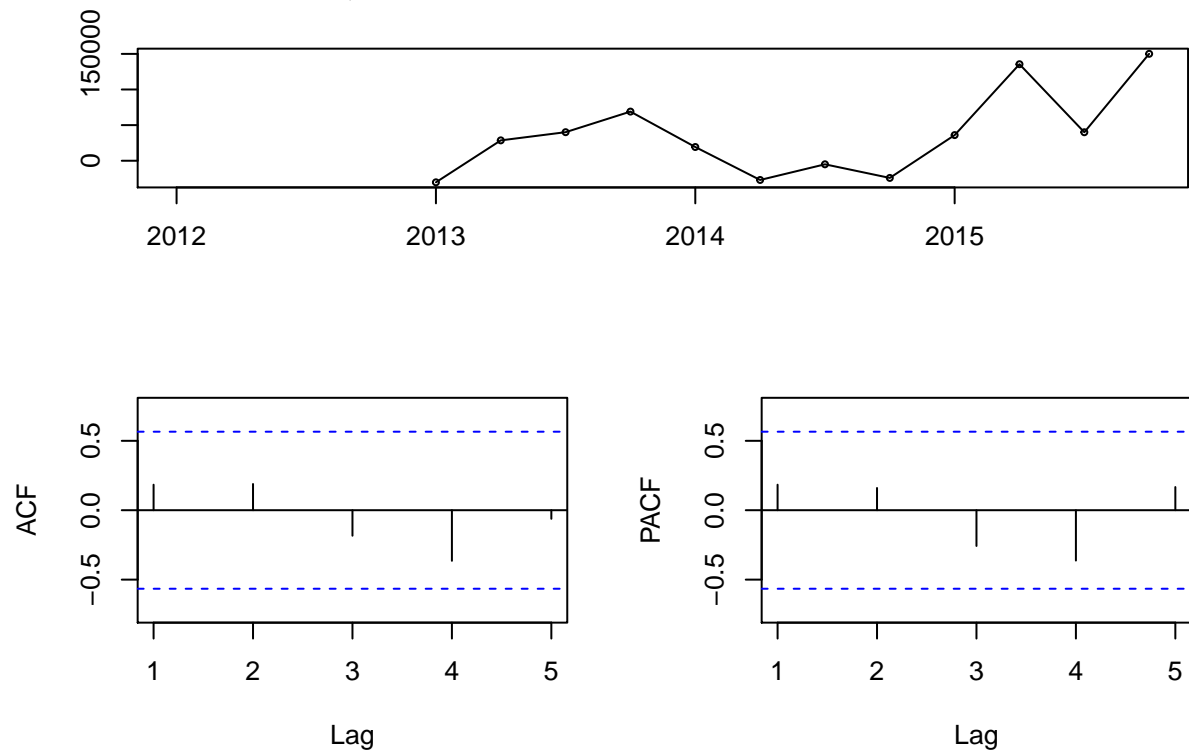
Portland, OR – Hillsdale : Holt Winters Model Forecast Residuals
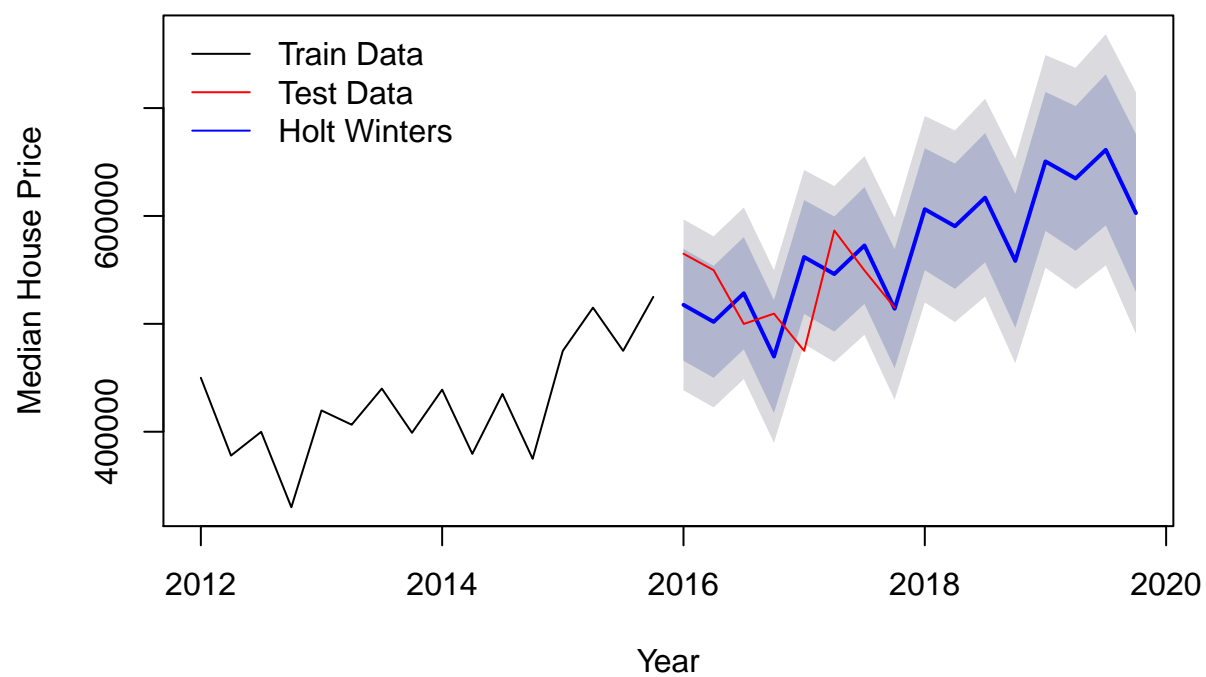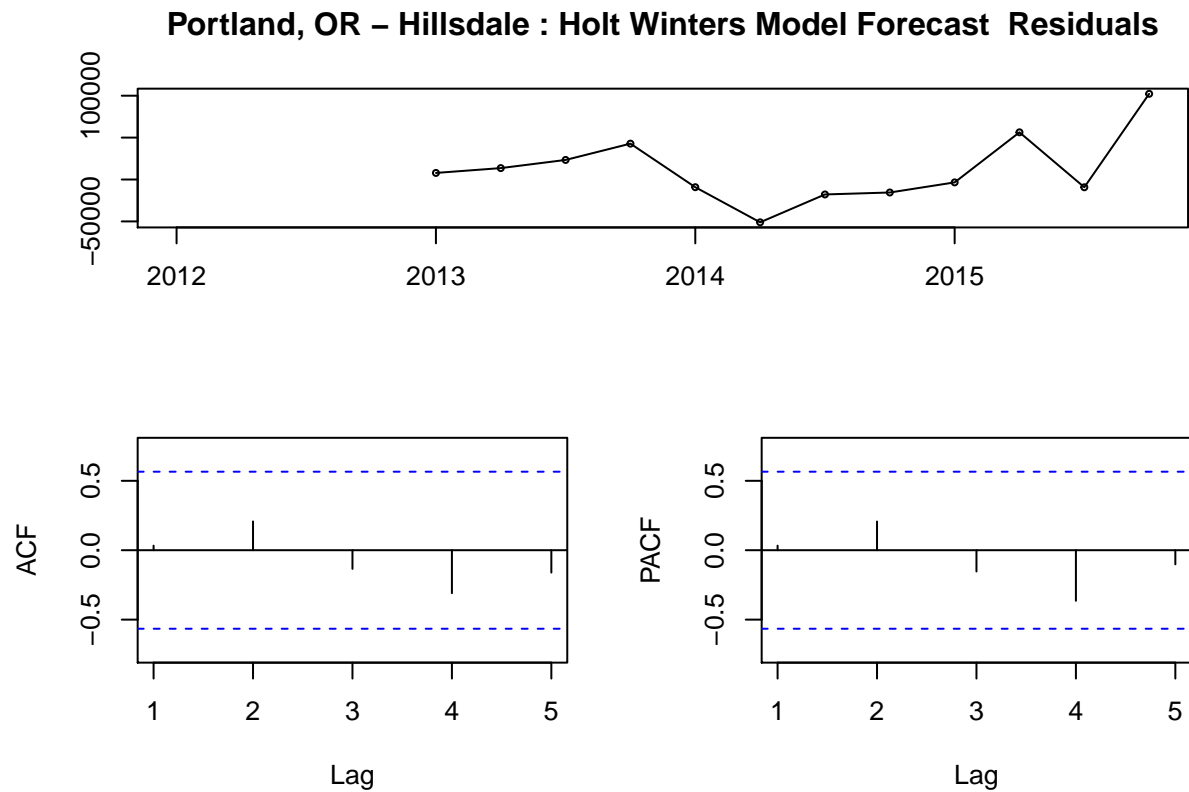

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Hillsdale"
##                    ME      RMSE      MAE      MPE     MAPE      MASE
## Training set 36016.58 66830.67 50412.42 7.235723 10.886638 1.0000000
## Test set     33762.75 51151.83 40150.25 5.998290  7.246805 0.7964357
##                  ACF1 Theil's U
## Training set 0.18404603        NA
## Test set     0.05325808 0.7727486
## [1] "Holt Winters Accuracy for  Portland, OR - Hillsdale"
##                    ME      RMSE      MAE      MPE     MAPE      MASE
## Training set 11656.48 40406.97 29364.52 2.1004318 6.508379 0.5824858
## Test set      4732.51 45620.96 39357.41 0.4714847 7.521282 0.7807087
##                   ACF1 Theil's U
## Training set  0.03315418        NA
## Test set     -0.49251796 0.8385261
```

Portland, OR – Hillsdale : TS Training Model Comparison
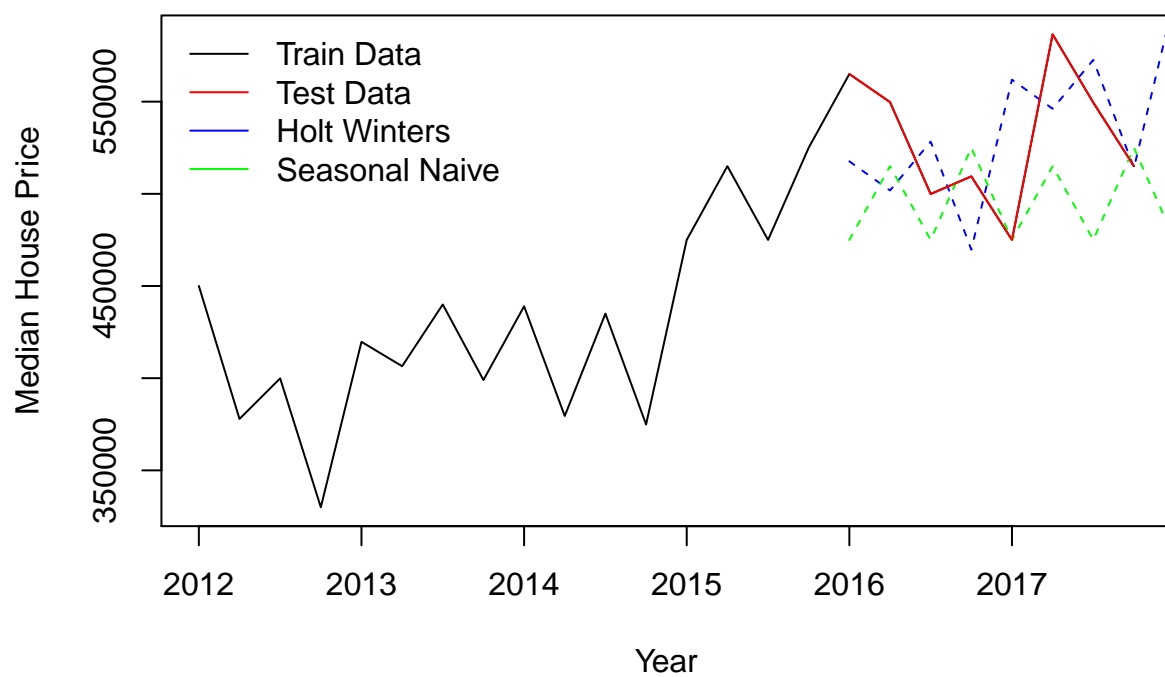
Portland, OR – Hillsdale : Full TS Models Comparison
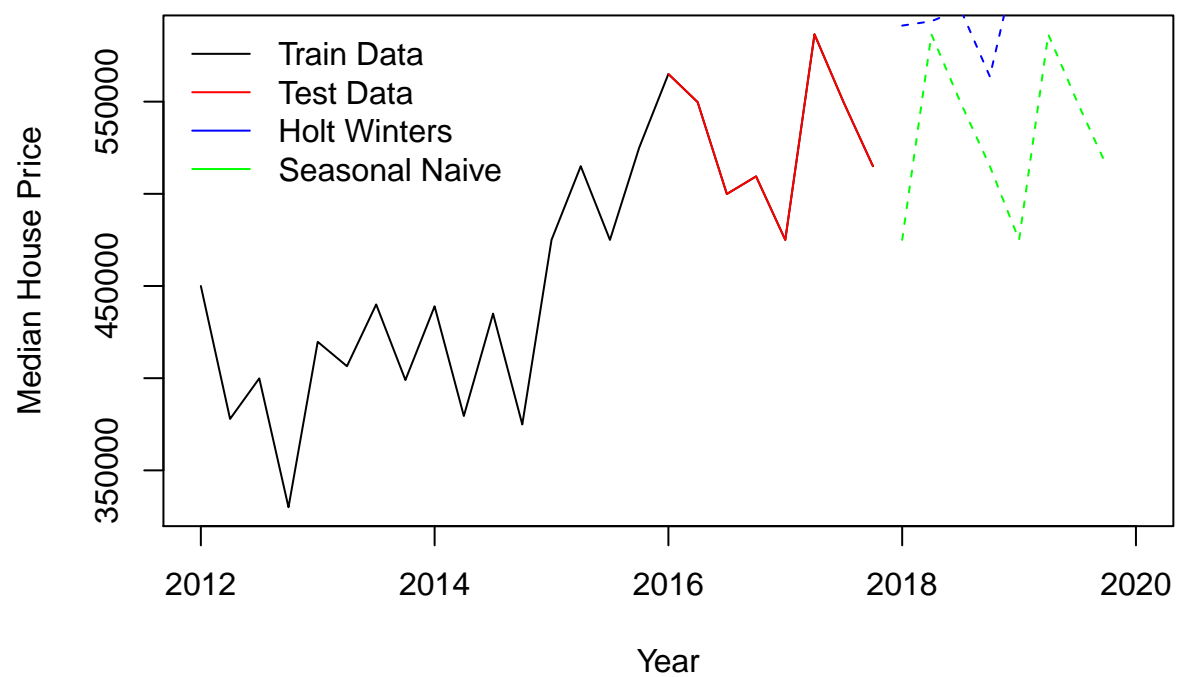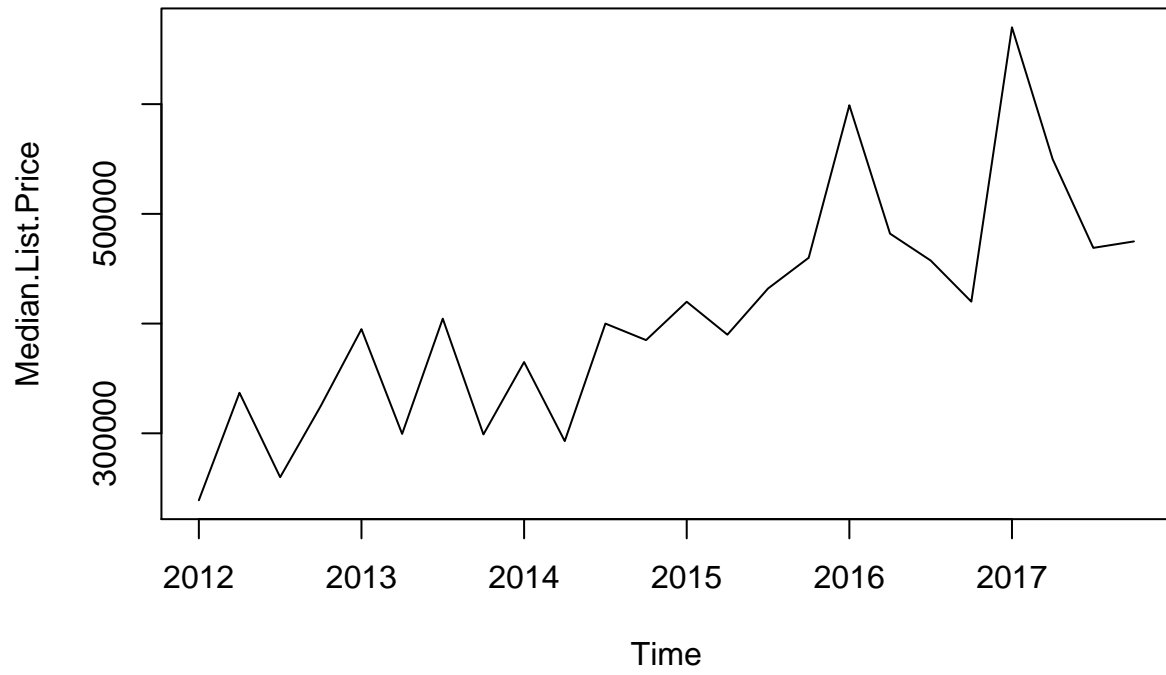
Portland, OR – Reed

Portland, OR – Reed : Naive Model Forecast
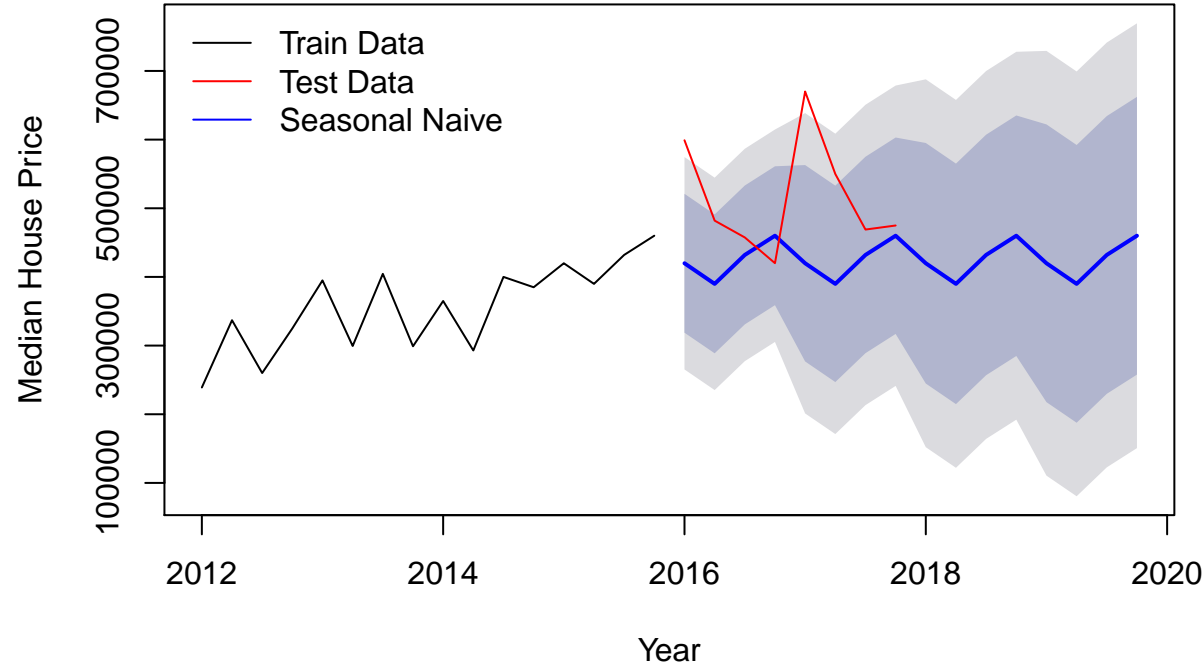
Portland, OR – Reed : Naive Model Forecast Residuals
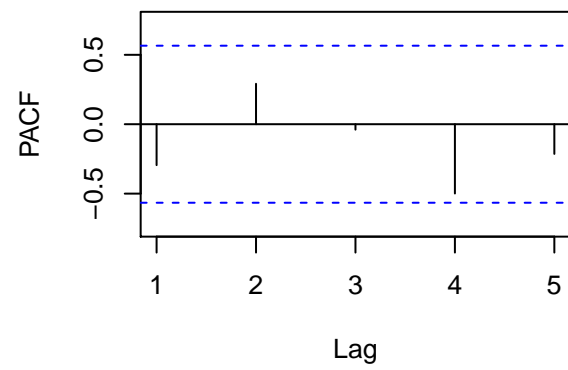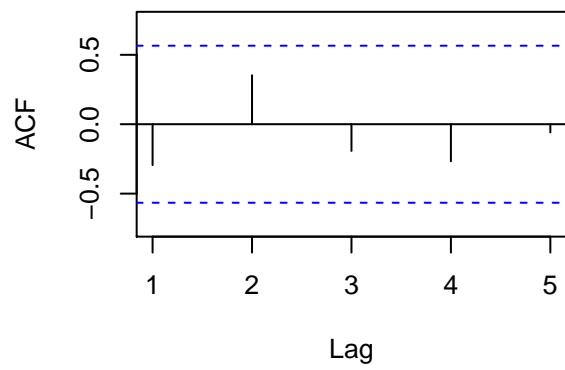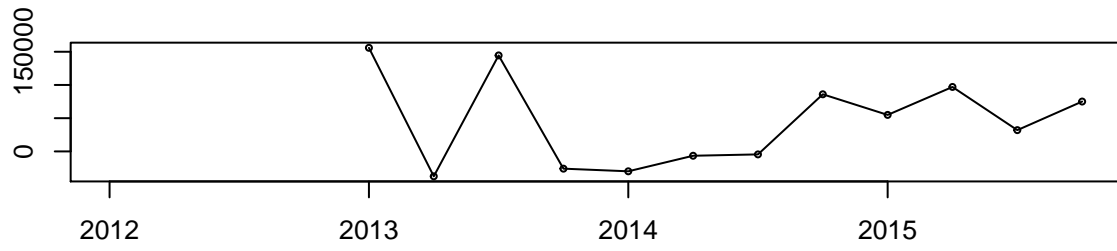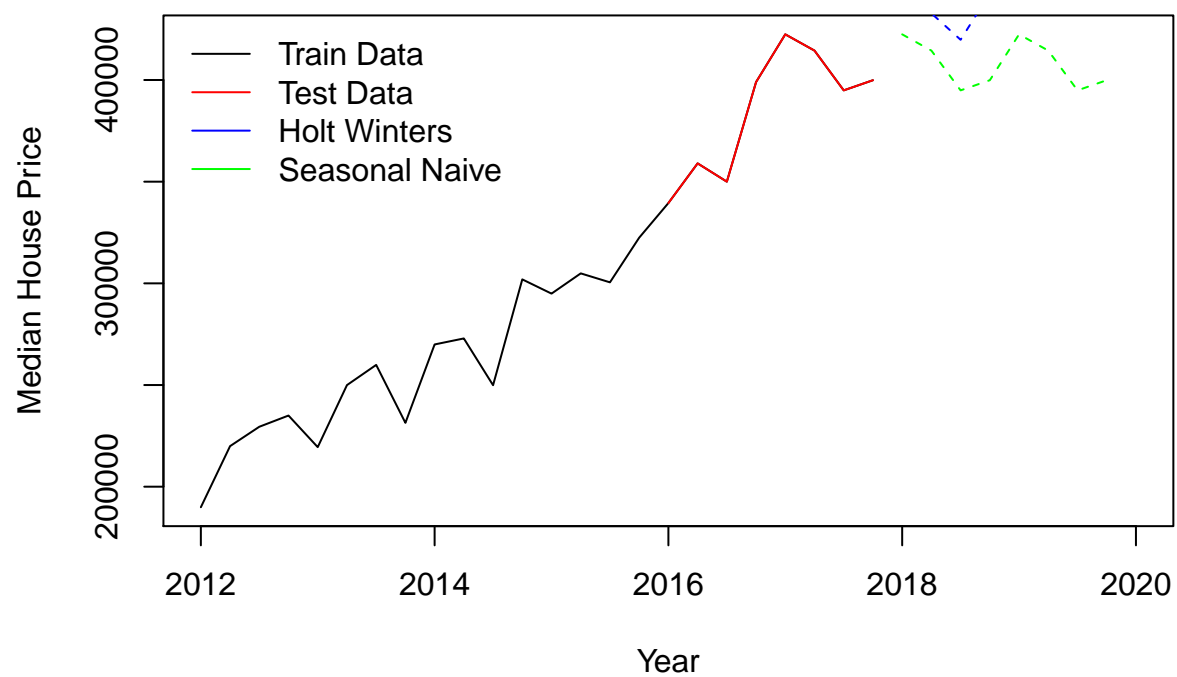
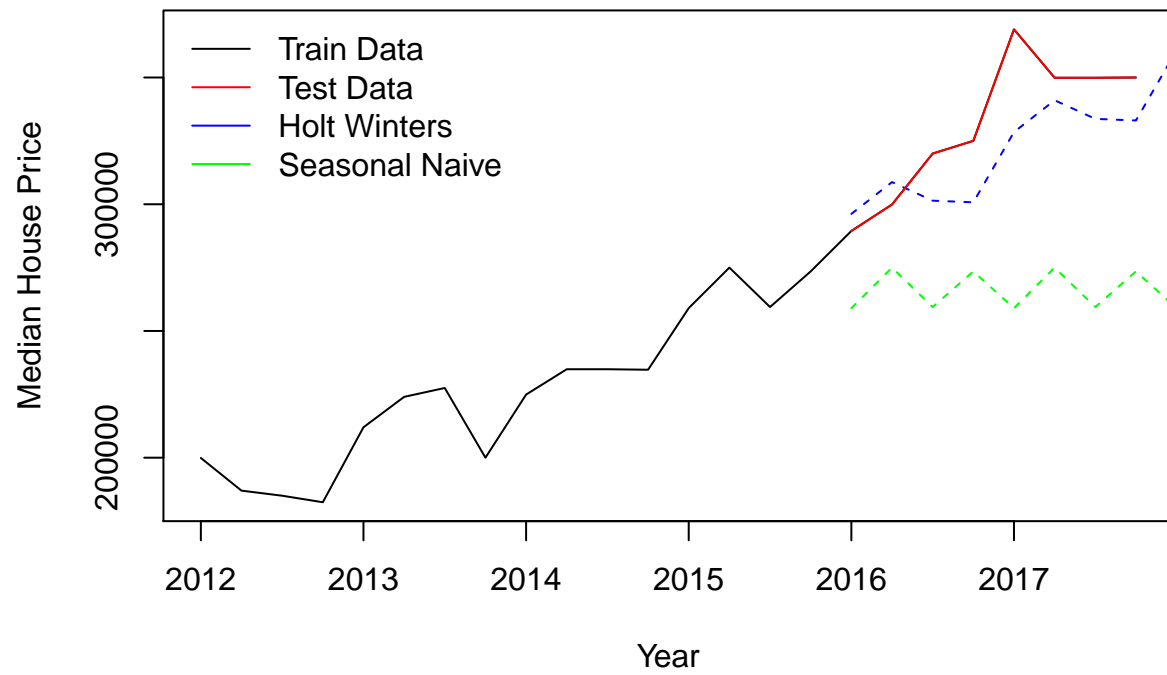**Portland, OR – Reed : Holt Winters Model Forecast**
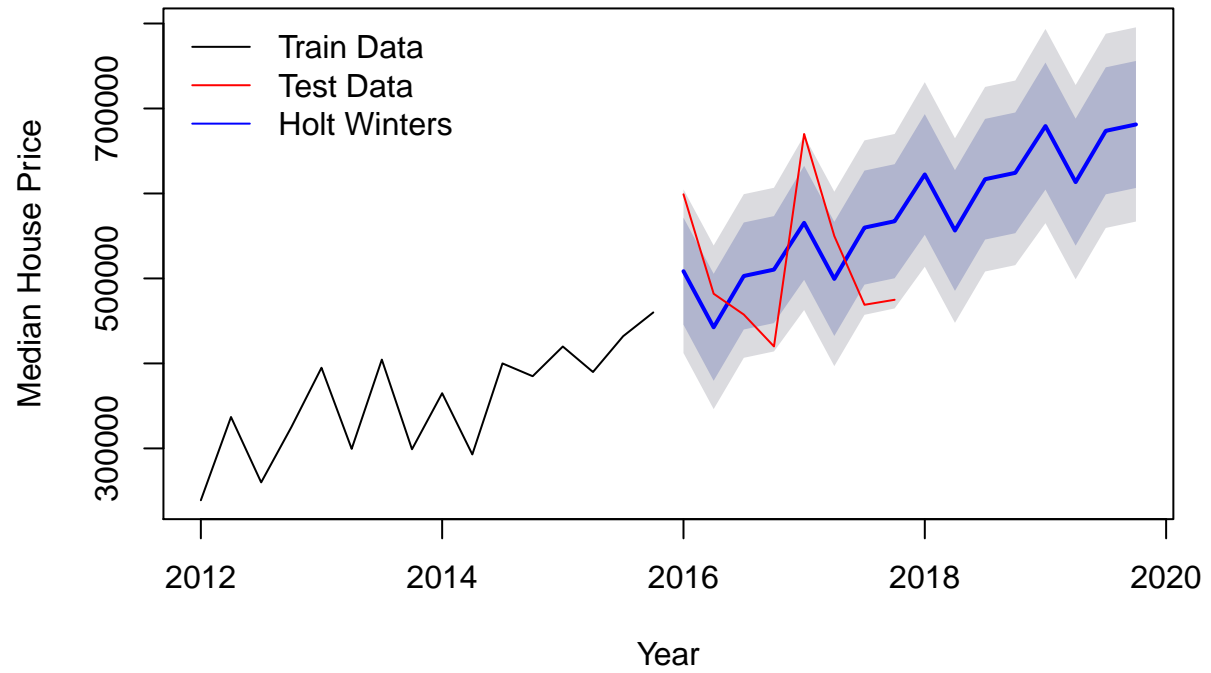
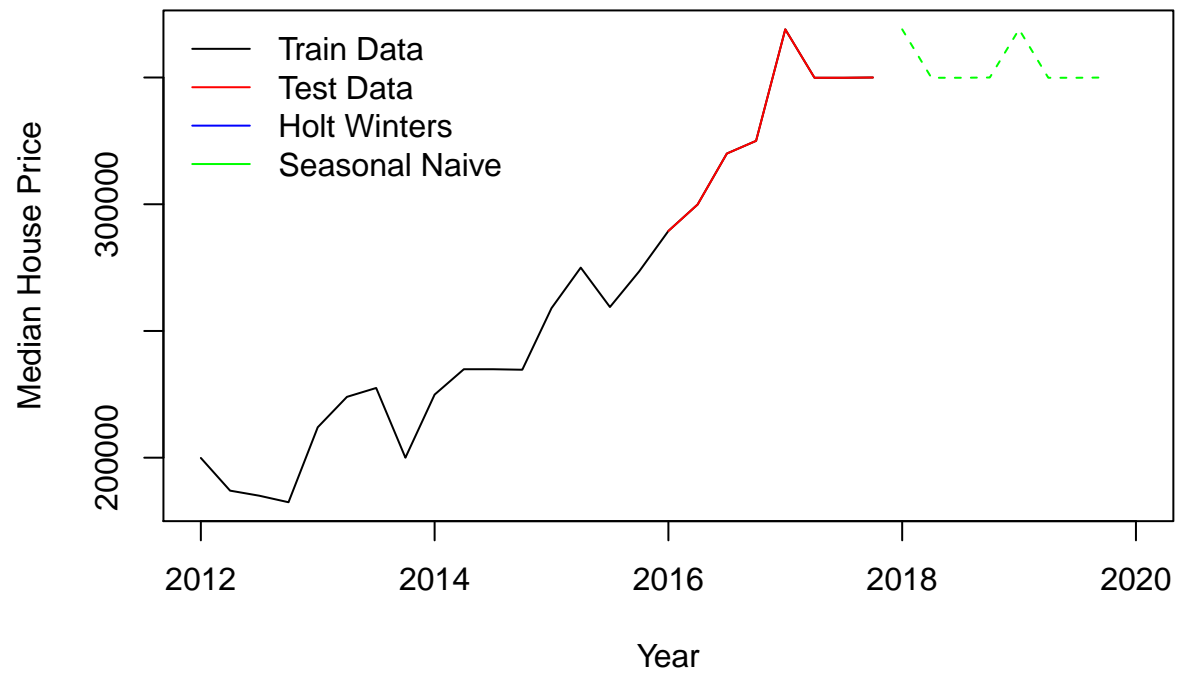## Portland, OR – Reed : Holt Winters Model Forecast Residuals
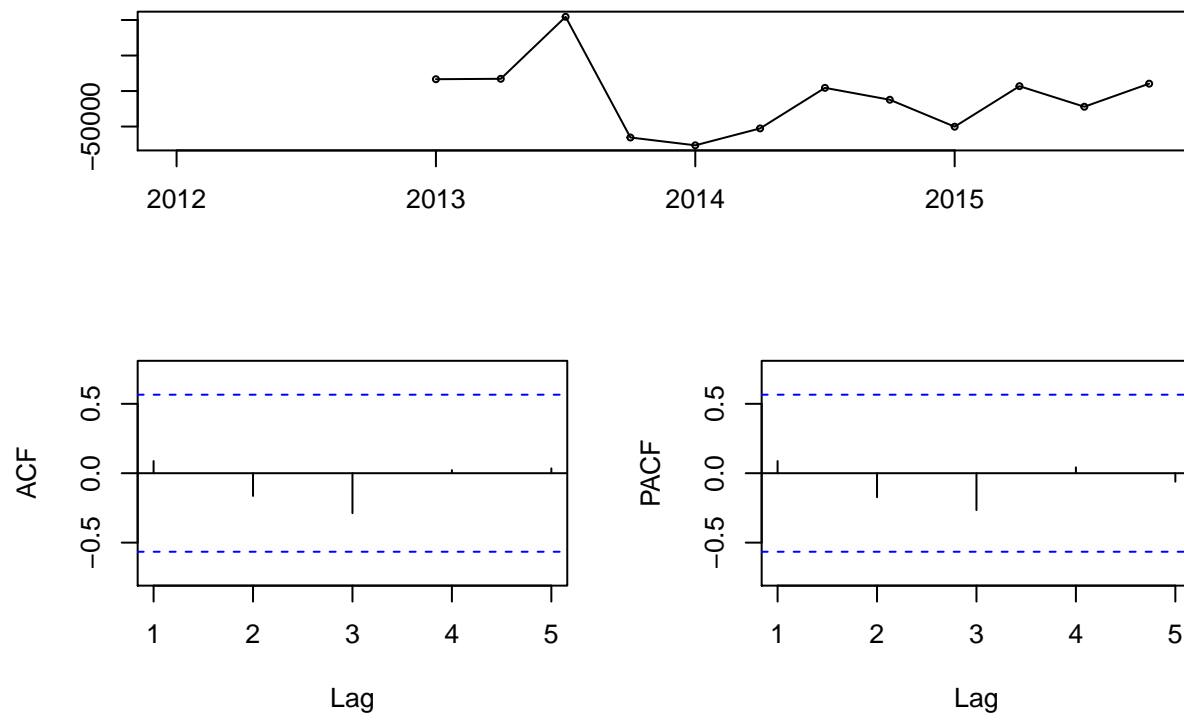

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Reed"
##                    ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 45070.83  78903.52 62491.75 10.53557 16.00114 1.000000
## Test set     89837.50 128719.89 99837.50 15.31361 17.69456 1.597611
##                   ACF1 Theil's U
## Training set -0.29490796        NA
## Test set     -0.01326119 0.9950992
## [1] "Holt Winters Accuracy for  Portland, OR - Reed"
##                    ME      RMSE      MAE       MPE     MAPE      MASE
## Training set -9903.259 48058.84 36594.91 -3.339861 10.16543 0.5855959
## Test set     -4252.084 79255.13 75504.74 -2.773244 14.79421 1.2082353
##                   ACF1 Theil's U
## Training set 0.08760349        NA
## Test set     0.10709405  0.638909
```

Portland, OR – Reed : TS Training Model Comparison
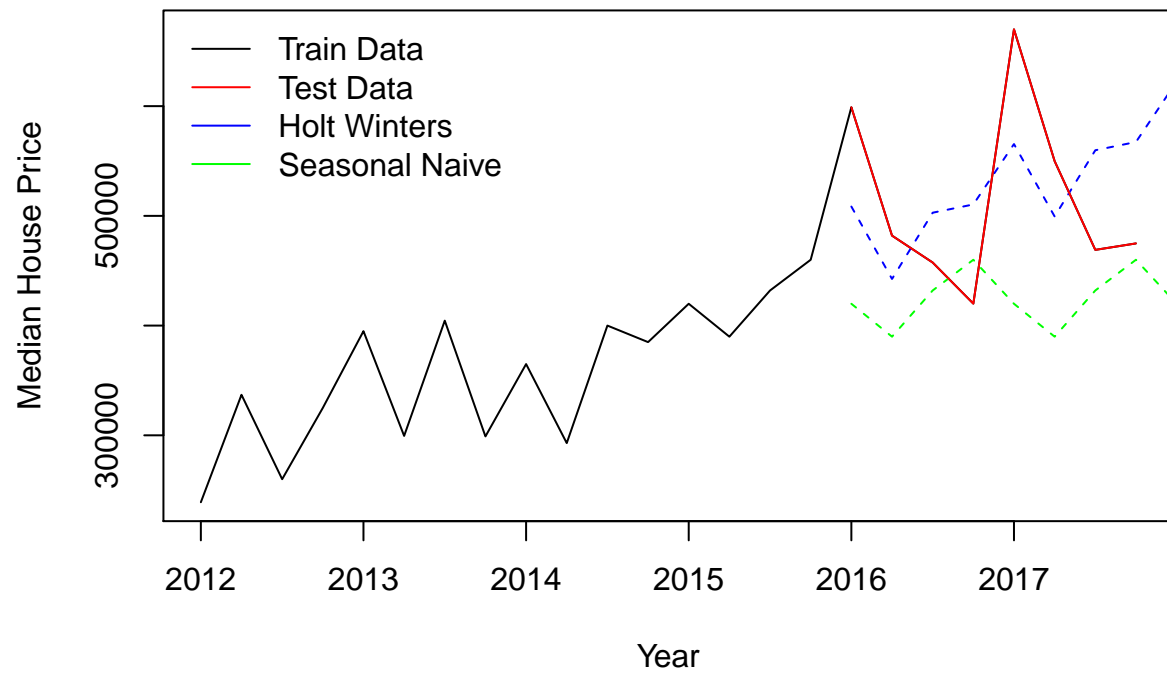
Portland, OR – Reed : Full TS Models Comparison
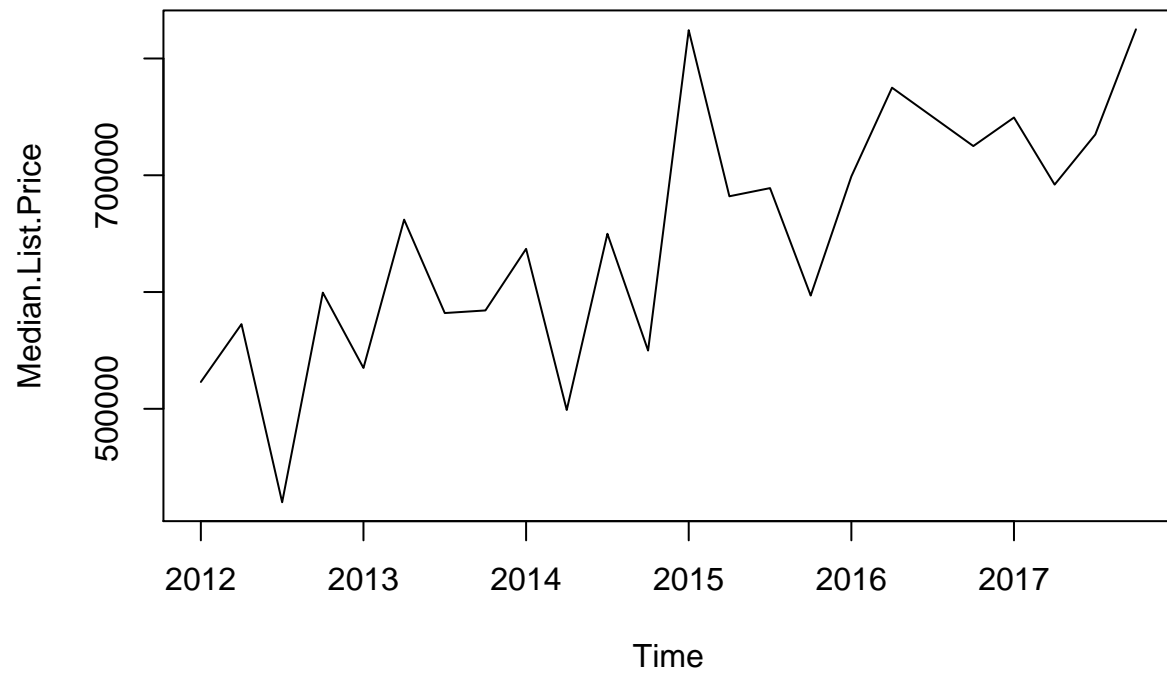
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

Portland, OR – Irvington

Portland, OR – Irvington : Naive Model Forecast
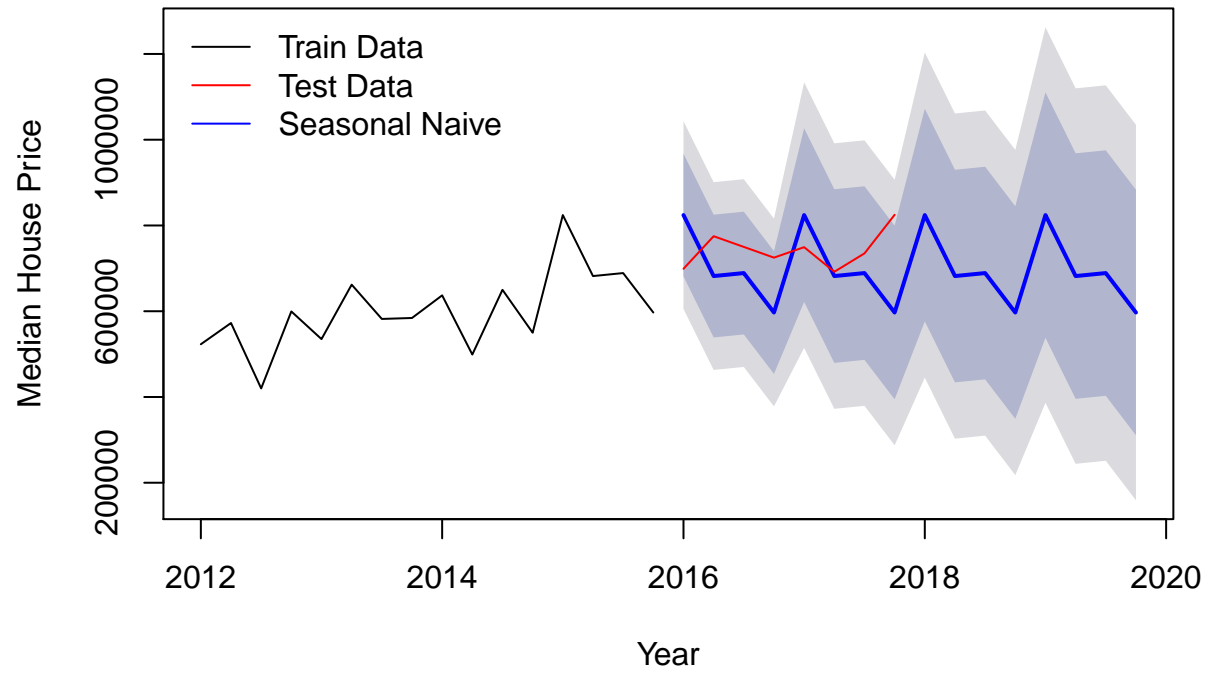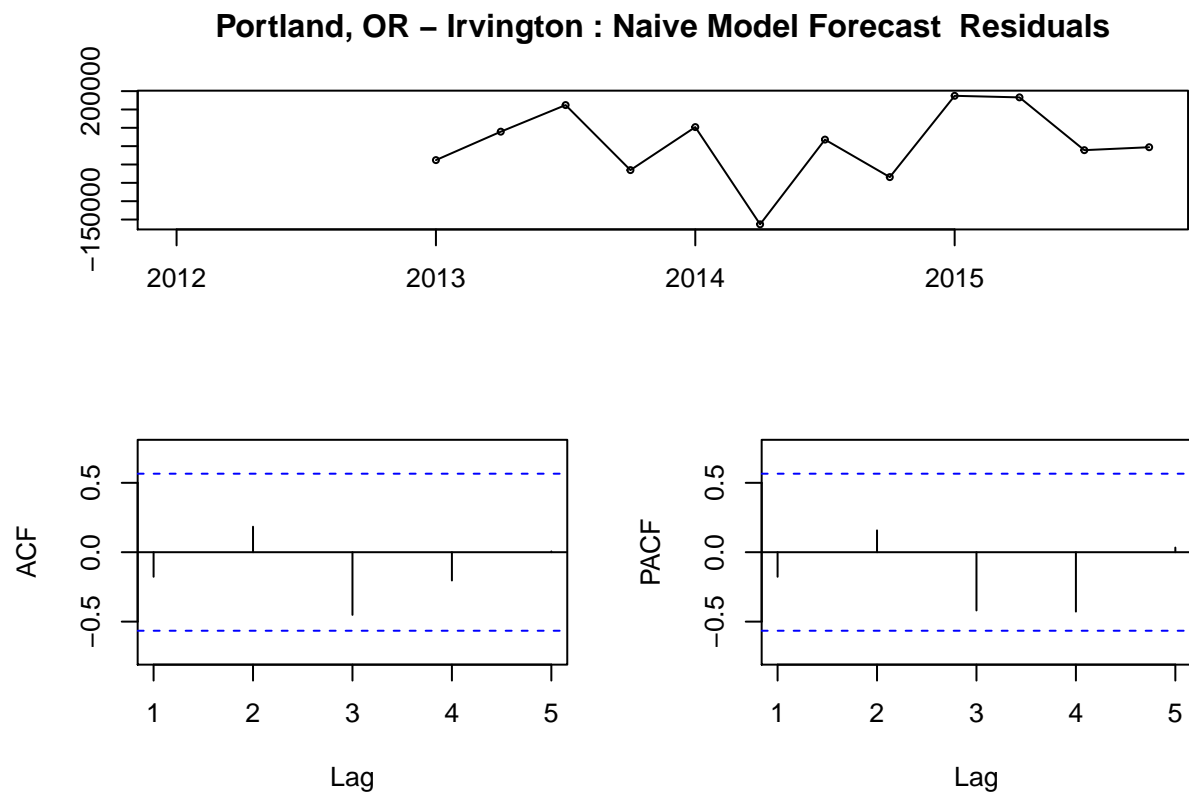
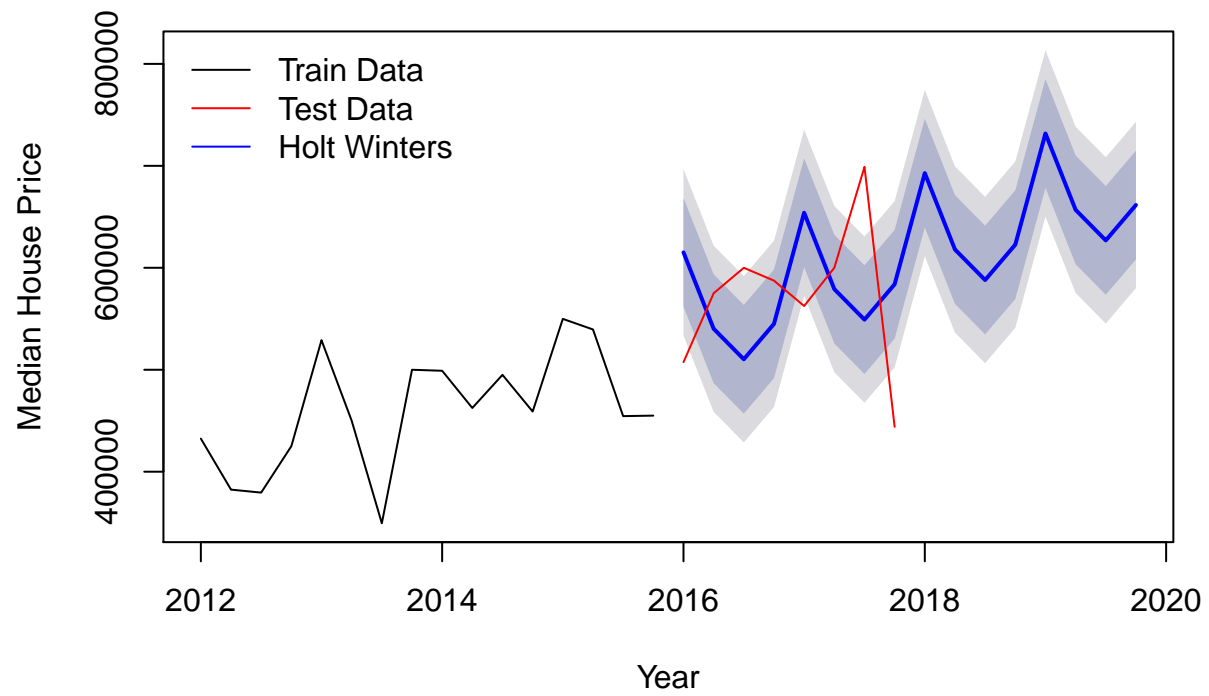**Portland, OR – Irvington : Naive Model Forecast Residuals**

Portland, OR – Irvington : Holt Winters Model Forecast
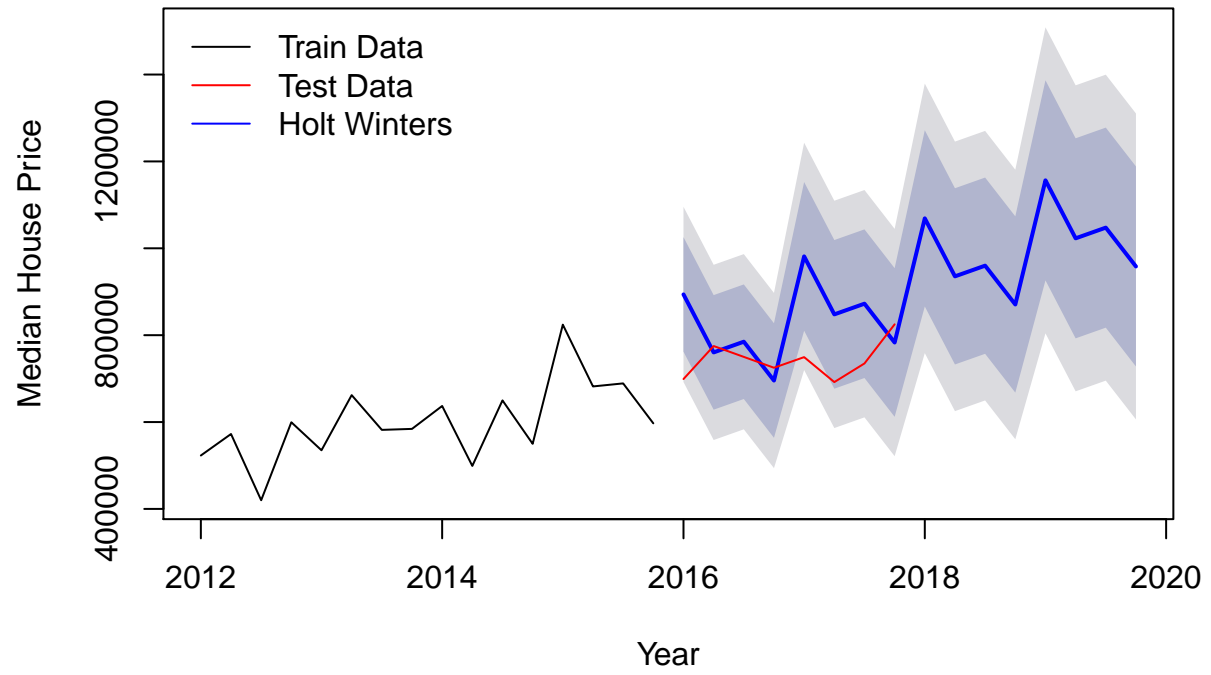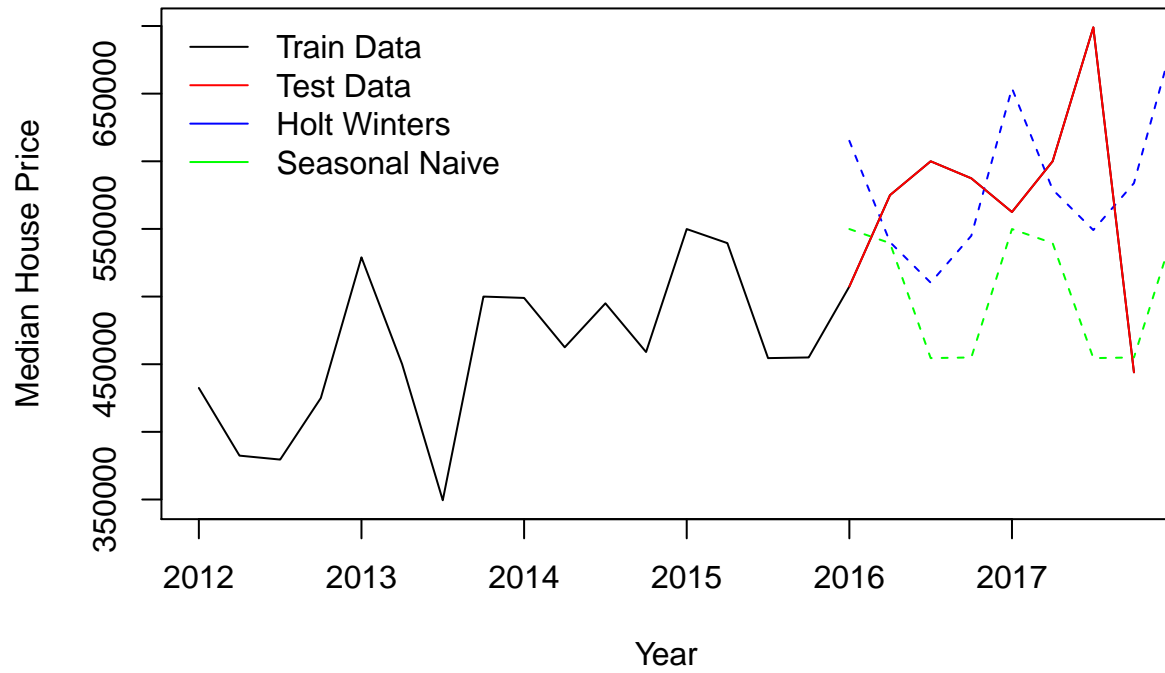
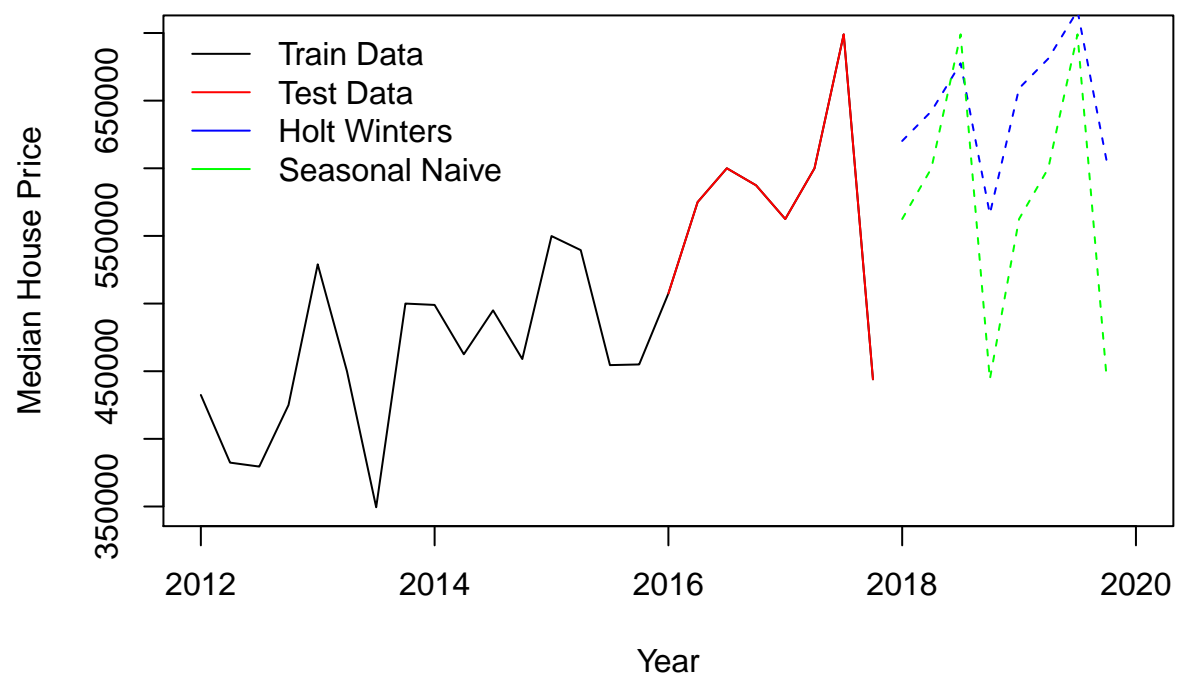## Portland, OR – Irvington : Holt Winters Model Forecast Residuals
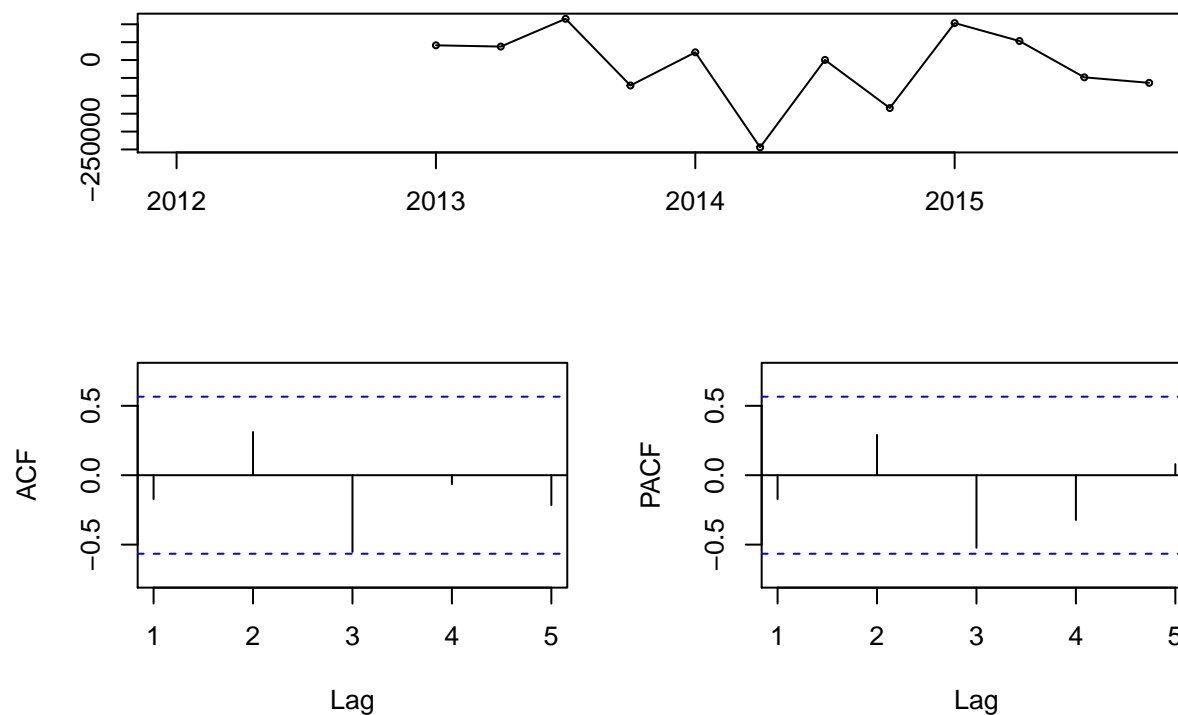

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Irvington"
##                    ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 56437.71 111688.9 91870.62 7.637594 14.55787 1.00000
## Test set     45725.00 114129.6 95737.50 5.651526 12.62630 1.04209
##                   ACF1 Theil's U
## Training set -0.1769002        NA
## Test set     -0.1336189  2.031616
## [1] "Holt Winters Accuracy for  Portland, OR - Irvington"
##                    ME      RMSE      MAE        MPE     MAPE      MASE
## Training set -15732.23  99758.42  77847.25  -3.849582 13.34719 0.8473573
## Test set     -83651.86 131826.88 105131.86 -11.712513 14.46787 1.1443468
##                   ACF1 Theil's U
## Training set -0.1717025        NA
## Test set     -0.1151691  2.197225
```

Portland, OR – Irvington : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

Portland, OR – Irvington : Full TS Models Comparison
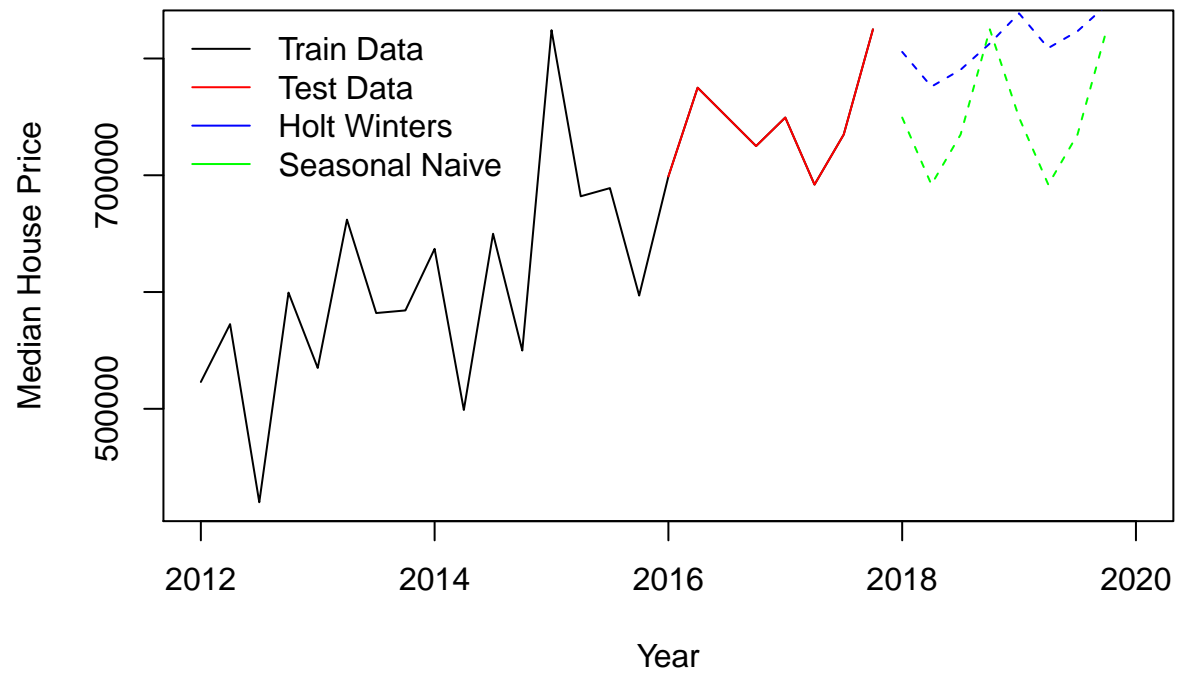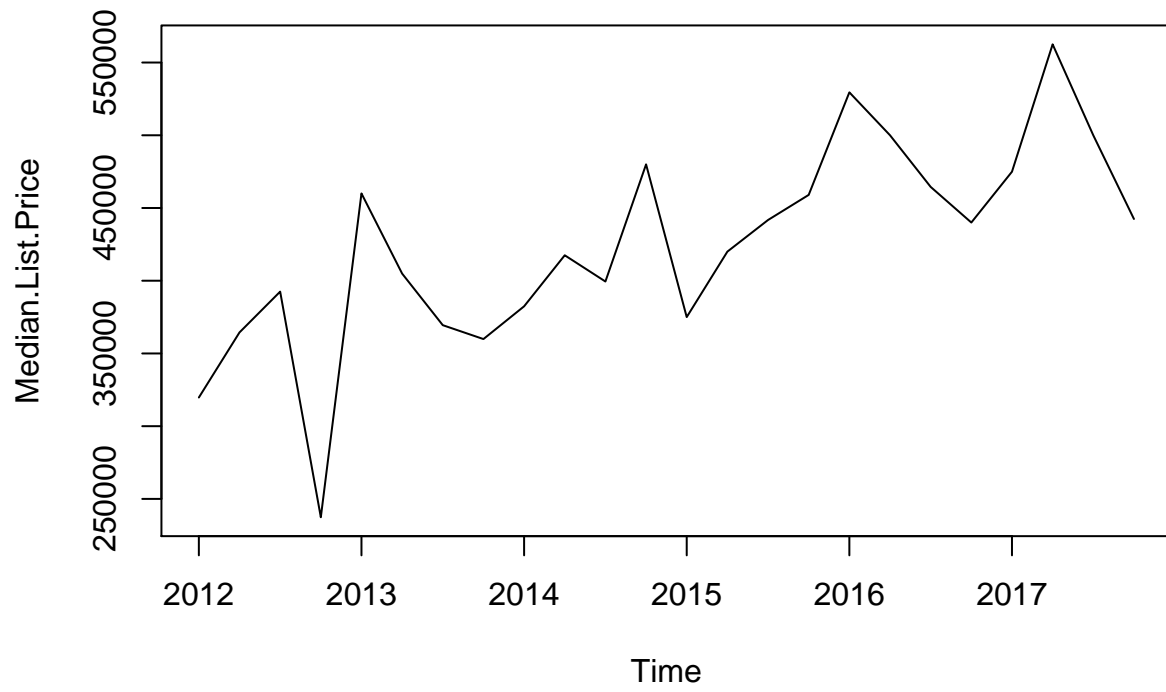
Portland, OR – South Burlingame

Portland, OR – South Burlingame : Naive Model Forecast
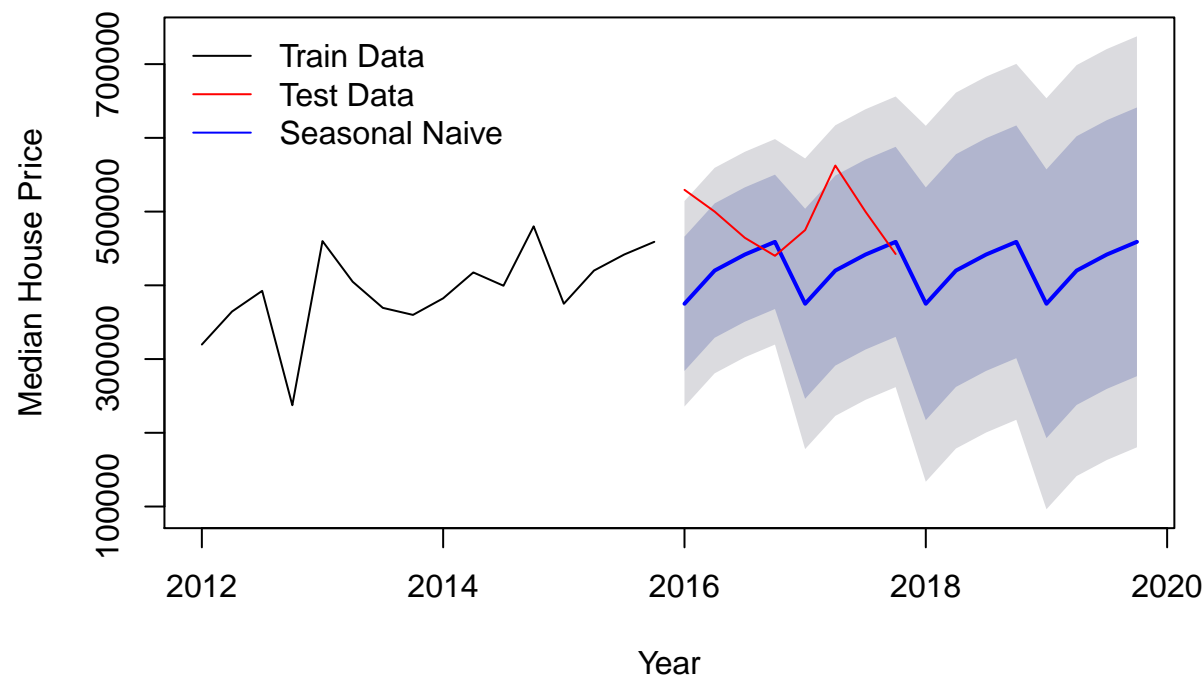
Portland, OR – South Burlingame : Naive Model Forecast Residuals
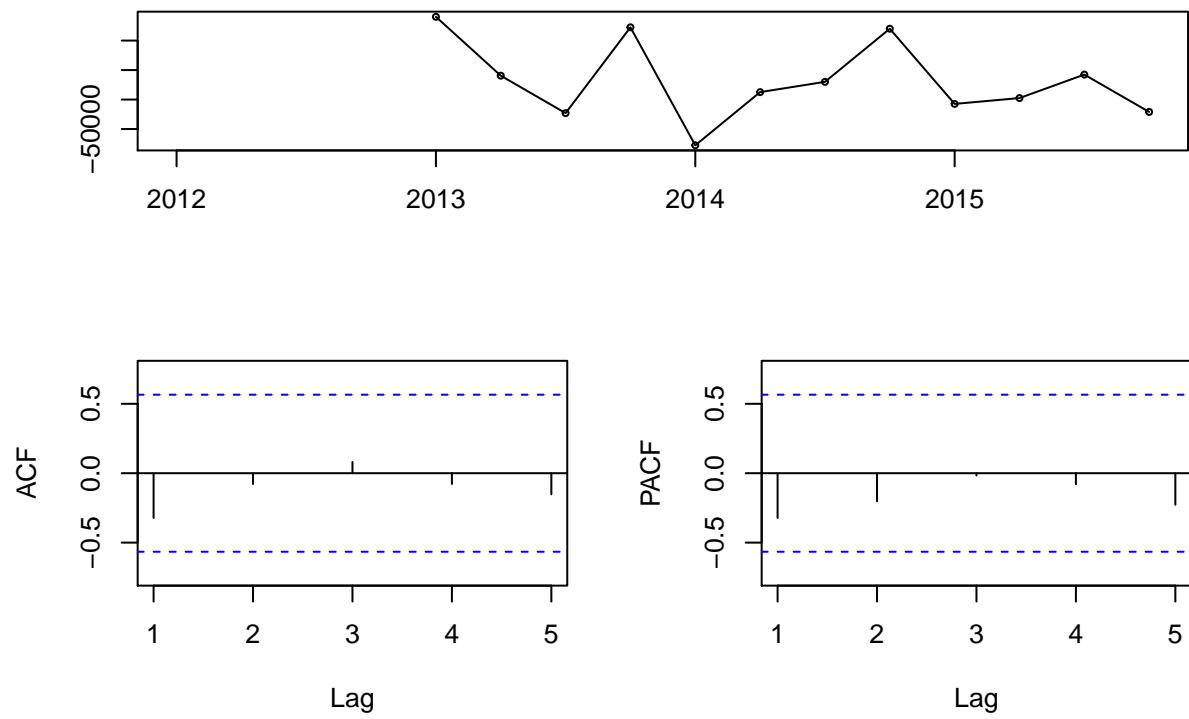
Portland, OR – South Burlingame : Holt Winters Model Forecast
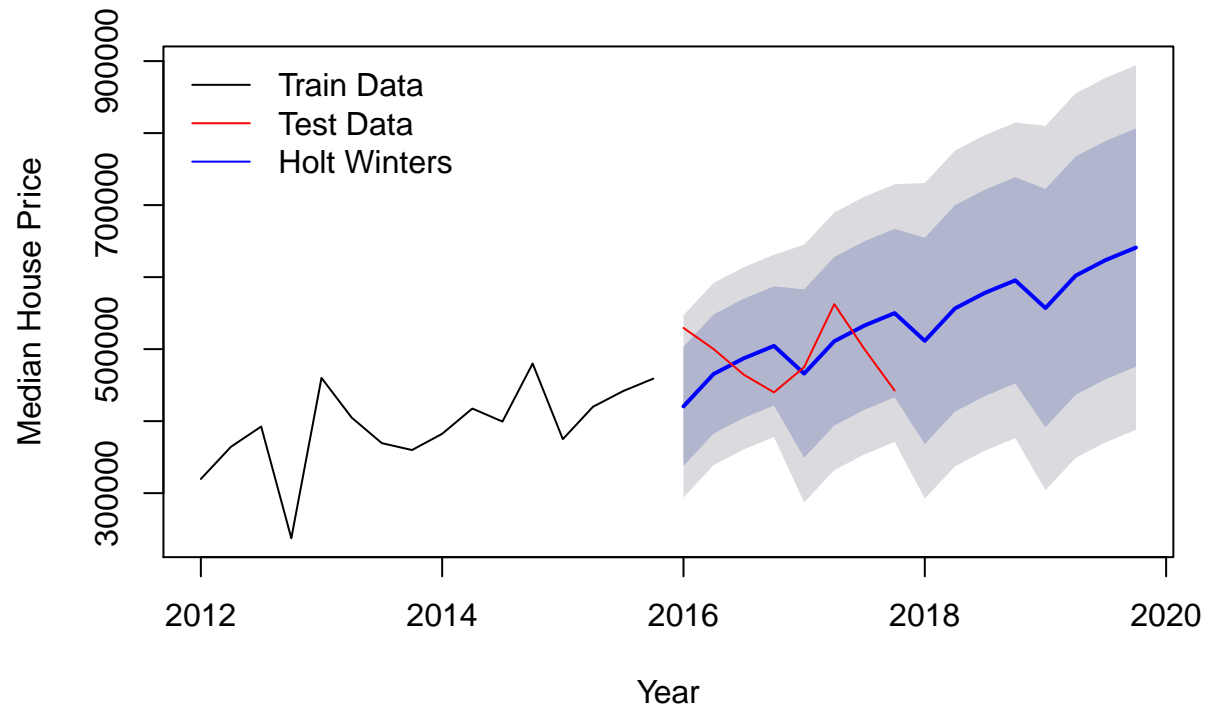
Portland, OR – South Burlingame : Holt Winters Model Forecast Residuals
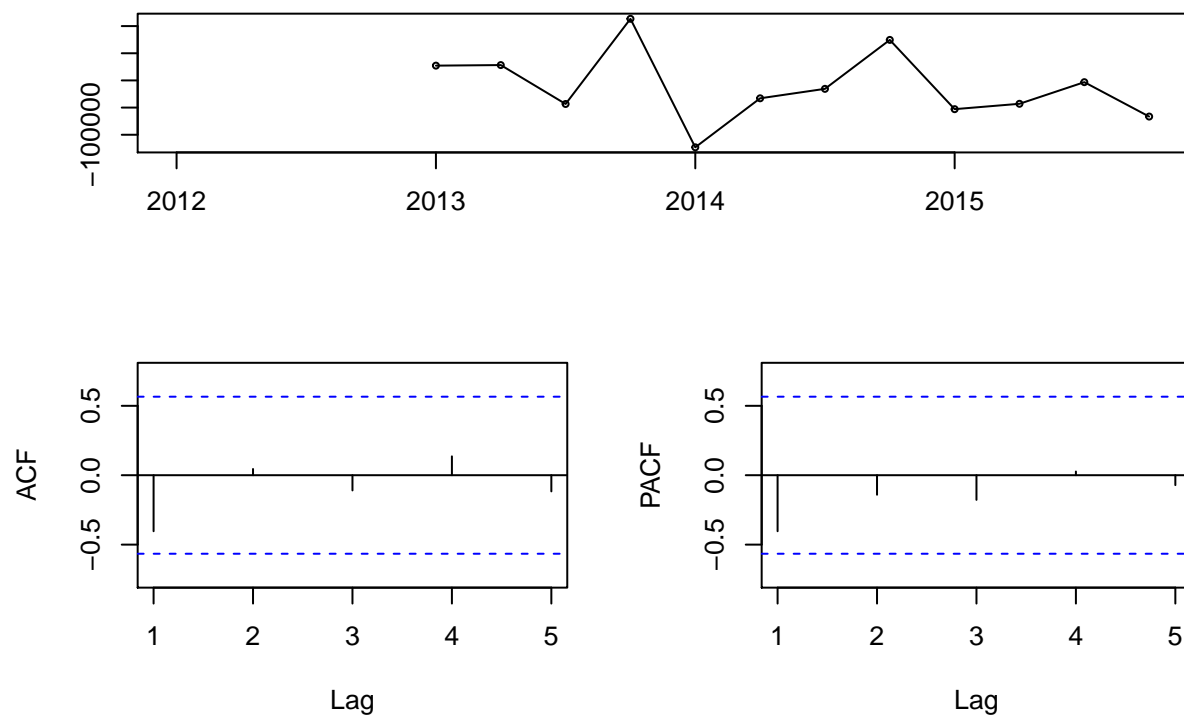

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - South Burlingame"
##                   ME      RMSE      MAE       MPE     MAPE     MASE
## Training set 31808.33 71094.65 53316.50  7.263912 12.77727 1.000000
## Test set     65293.69 90212.29 74181.19 12.504530 14.51921 1.391336
##                   ACF1 Theil's U
## Training set -0.3222211        NA
## Test set      0.1309570   1.53081
## [1] "Holt Winters Accuracy for  Portland, OR - South Burlingame"
##                    ME      RMSE      MAE       MPE     MAPE      MASE
## Training set -11424.375 62852.01 51998.79 -2.943764 12.93374 0.9752852
## Test set      -2971.312 64348.93 53943.69 -1.490572 11.11899 1.0117635
##                   ACF1 Theil's U
## Training set -0.4035246        NA
## Test set      0.1840282  1.067099
```

Portland, OR – South Burlingame : TS Training Model Comparison
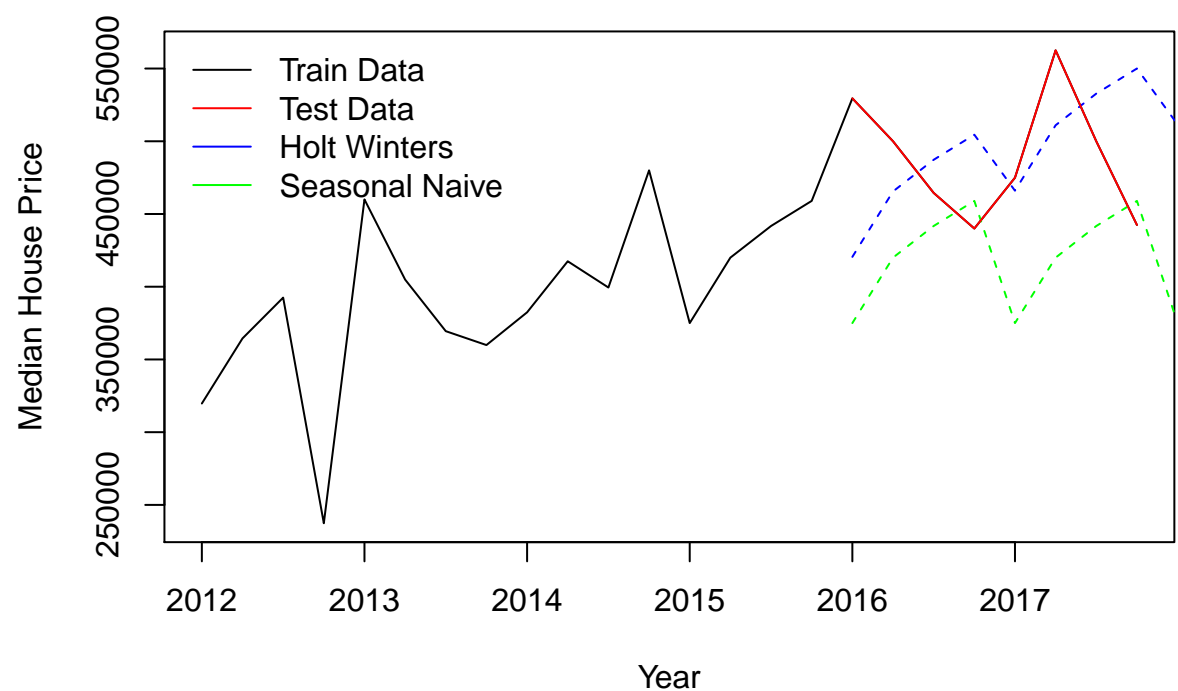
Portland, OR – South Burlingame : Full TS Models Comparison
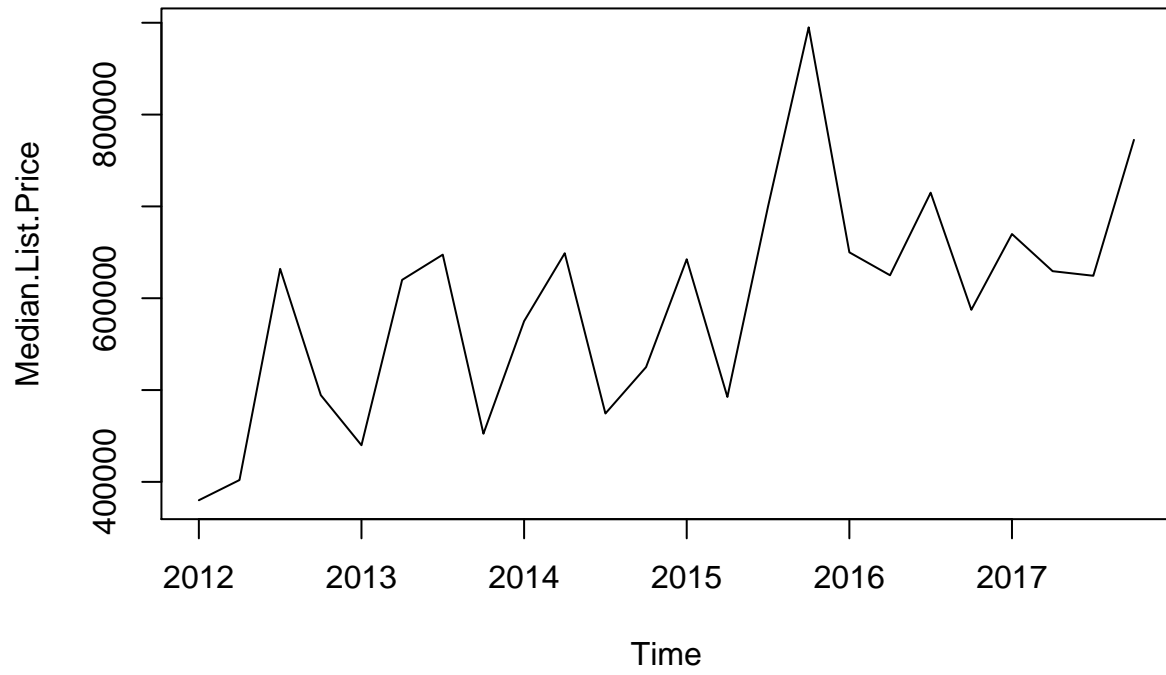
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

Portland, OR – Sylvan–Highlands

Portland, OR – Sylvan–Highlands : Naive Model Forecast
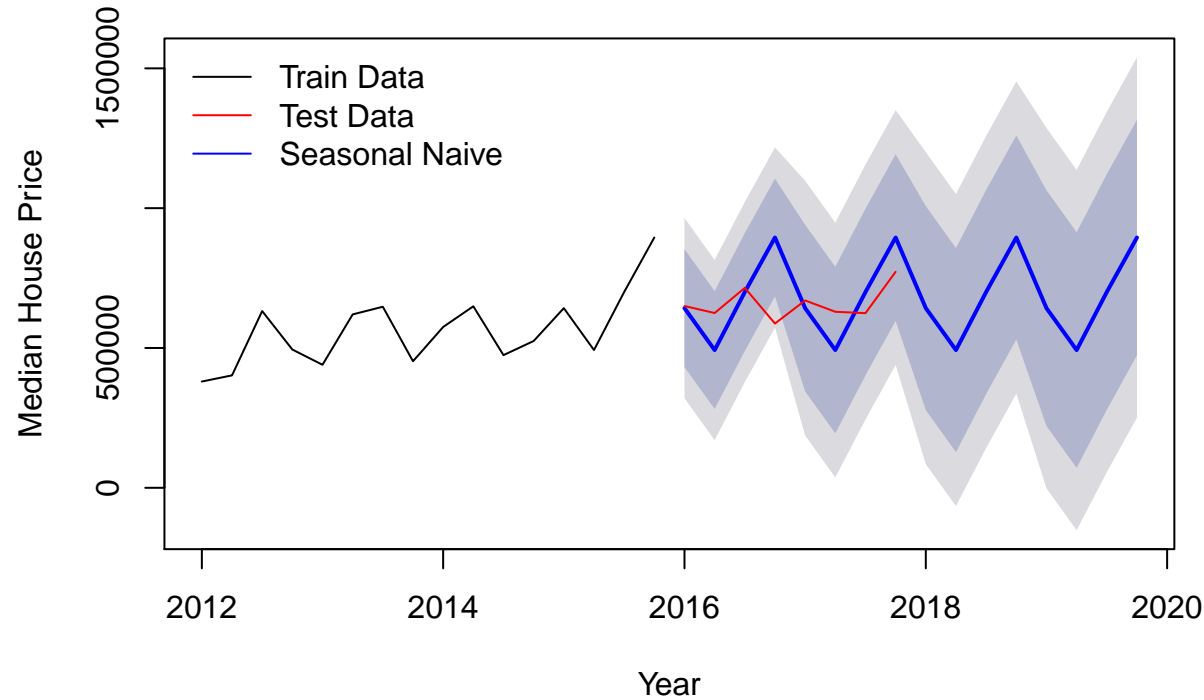
Portland, OR – Sylvan–Highlands : Naive Model Forecast Residuals
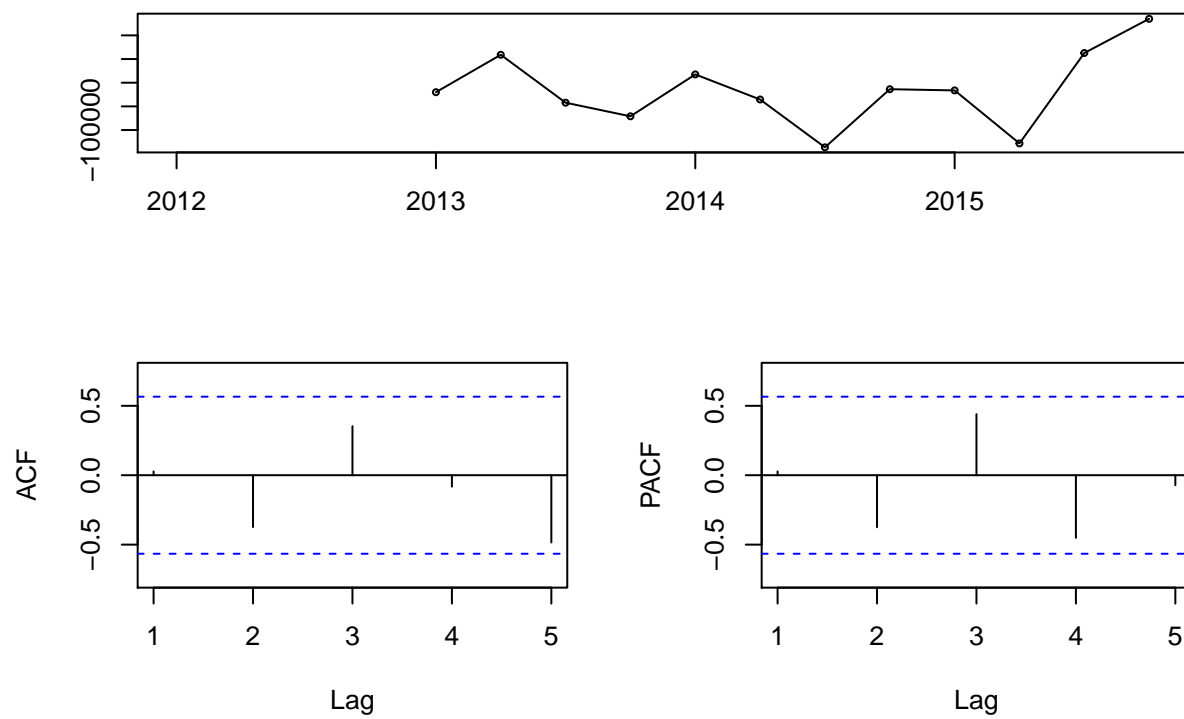
Portland, OR – Sylvan–Highlands : Holt Winters Model Forecast
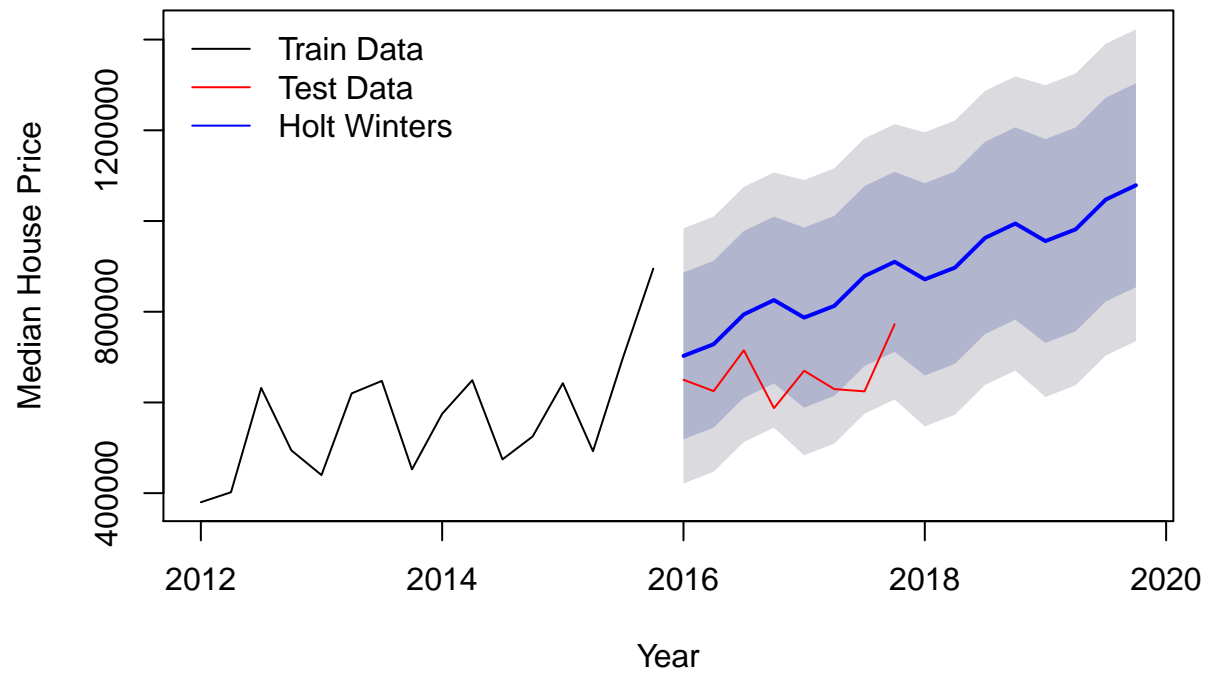
Portland, OR – Sylvan–Highlands : Holt Winters Model Forecast Residuals
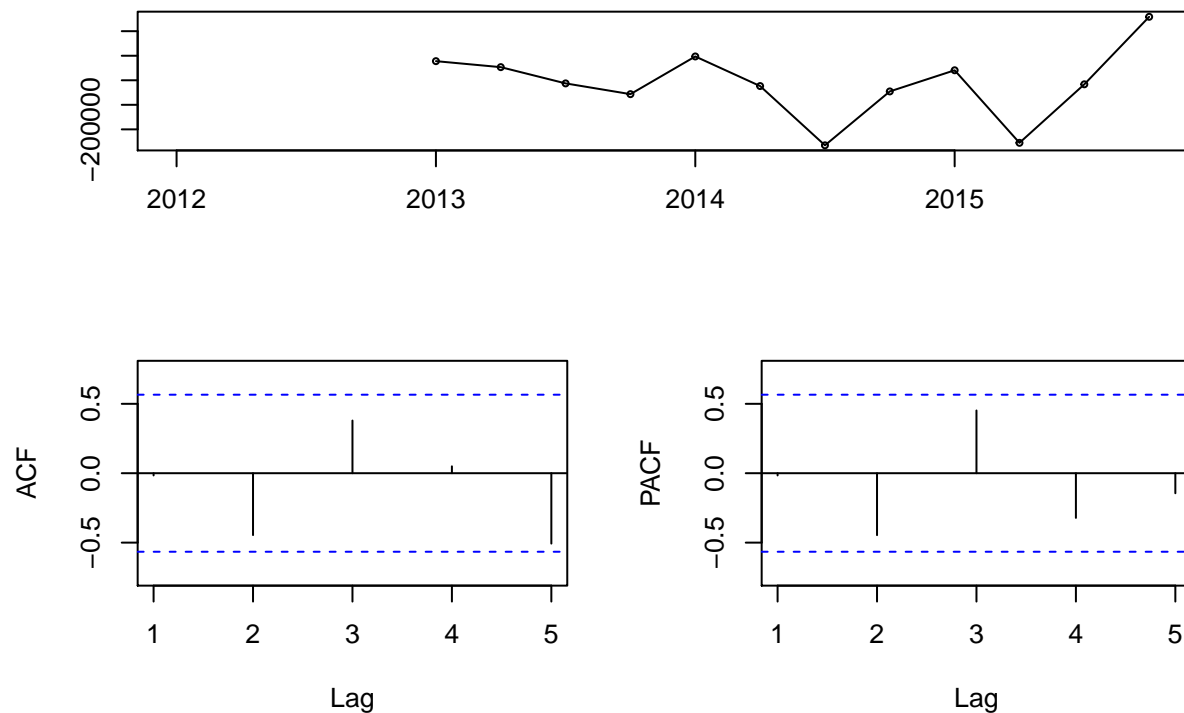

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Sylvan-Highlands"
##                     ME     RMSE      MAE       MPE     MAPE     MASE
## Training set  68458.54 164371.3 130375.2  8.290529 21.21098 1.0000000
## Test set     -23287.50 138152.8 103137.5 -3.752850 16.32968 0.7910821
##                     ACF1 Theil's U
## Training set  0.02780491        NA
## Test set     -0.06465968  1.557435
## [1] "Holt Winters Accuracy for  Portland, OR - Sylvan-Highlands"
##                     ME     RMSE      MAE       MPE     MAPE     MASE
## Training set  -12232.07 137935.2 100197.0  -4.854105 17.92967 0.768528
## Test set     -145708.14 160987.8 145708.1 -22.674836 22.67484 1.117606
##                     ACF1 Theil's U
## Training set -0.016032771        NA
## Test set      0.001861636  1.892503
```

Portland, OR – Sylvan–Highlands : TS Training Model Comparison

Portland, OR – Sylvan–Highlands : Full TS Models Comparison
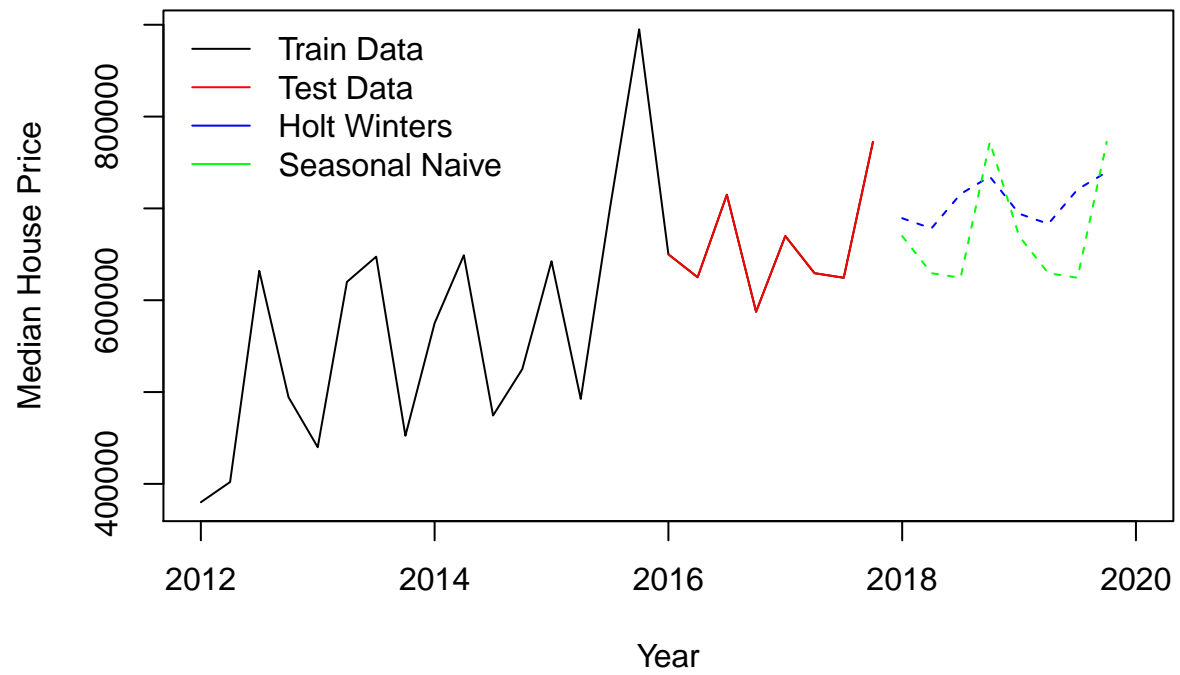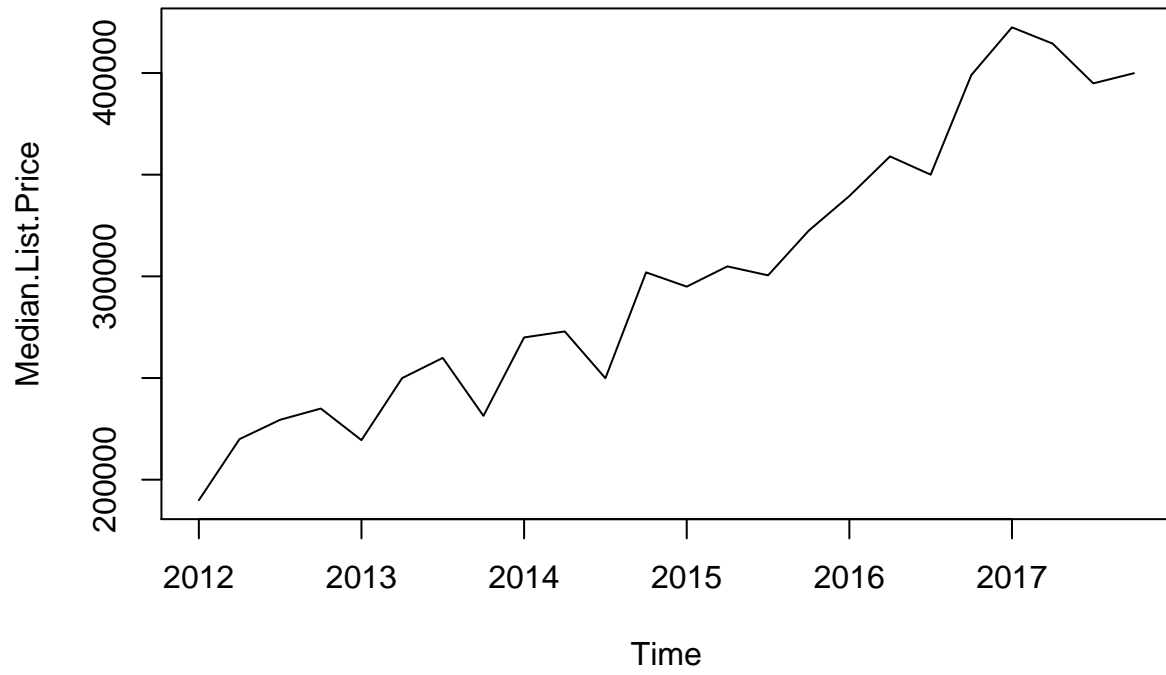
Portland, OR – Kenton

Portland, OR – Kenton : Naive Model Forecast
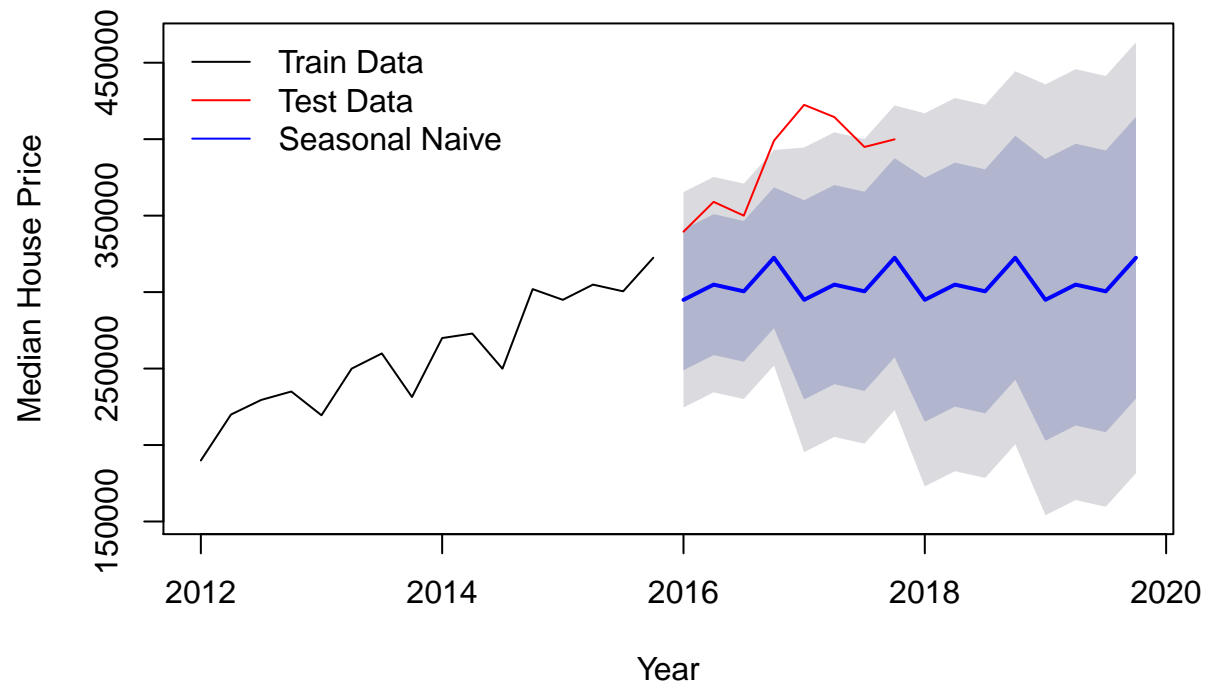
Portland, OR – Kenton : Naive Model Forecast Residuals

Portland, OR – Kenton : Holt Winters Model Forecast
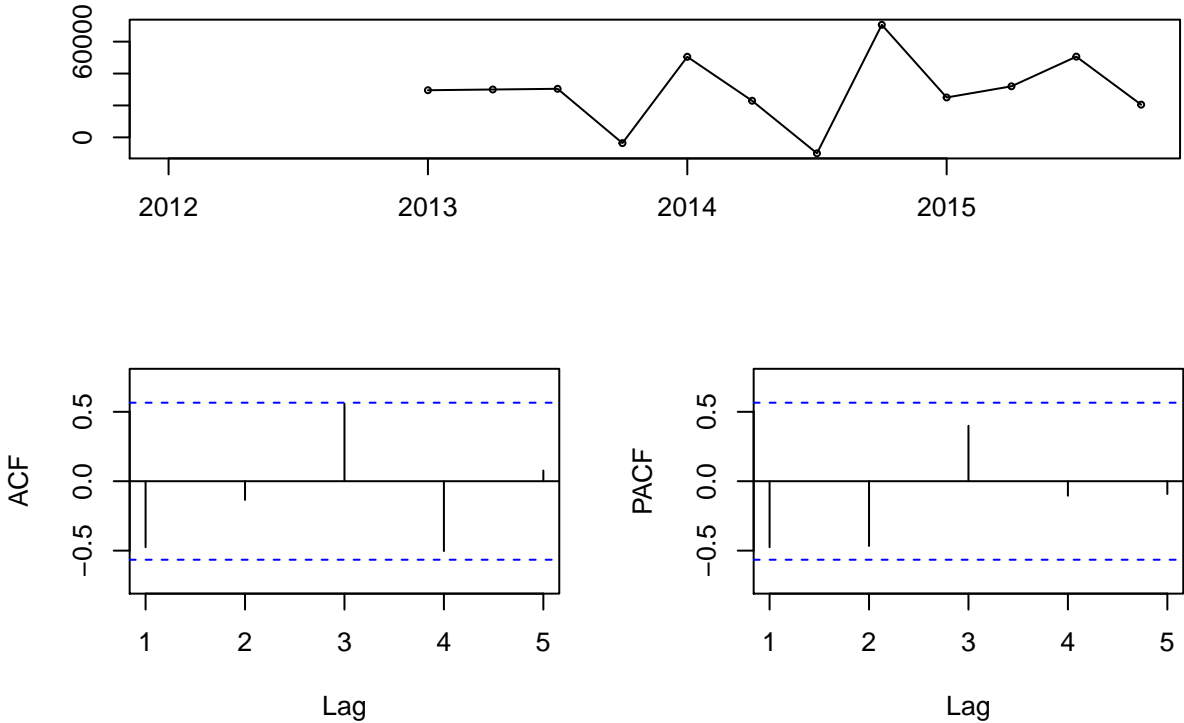
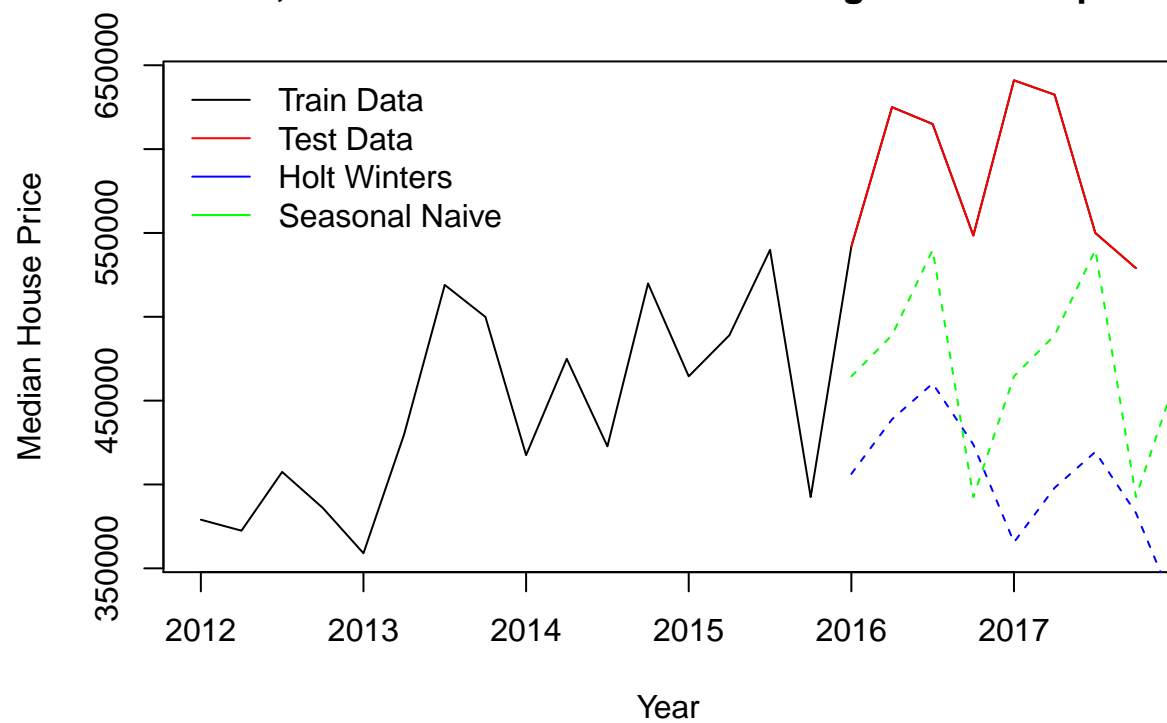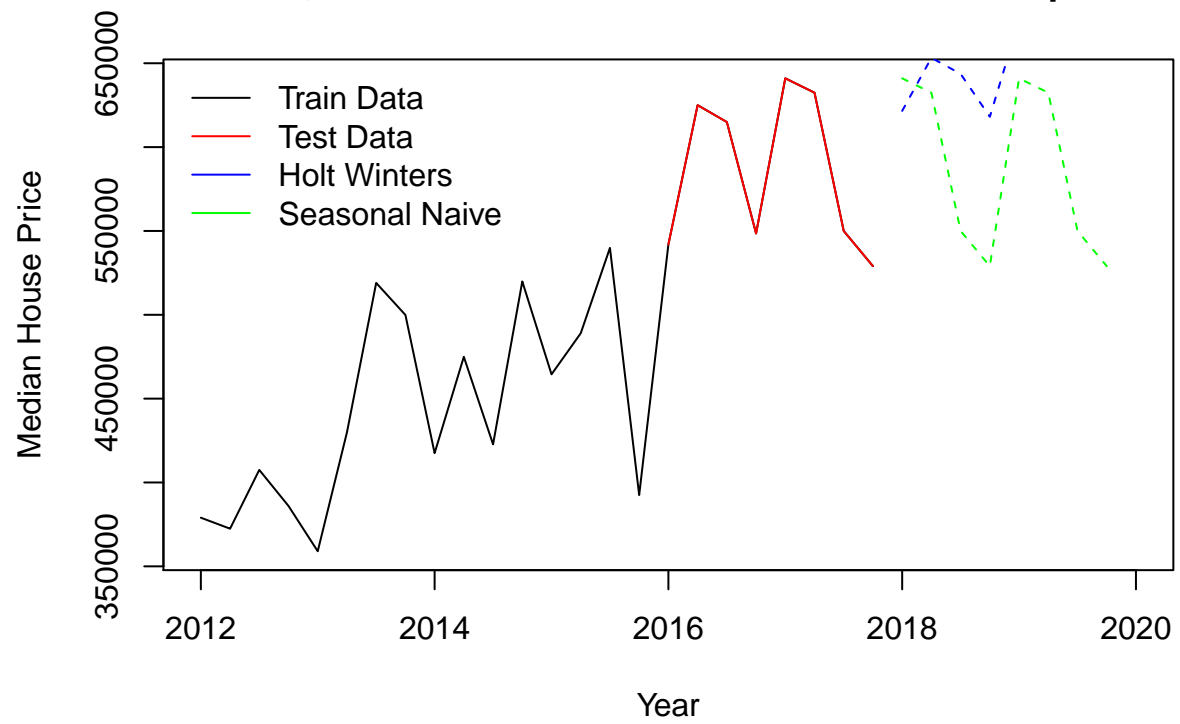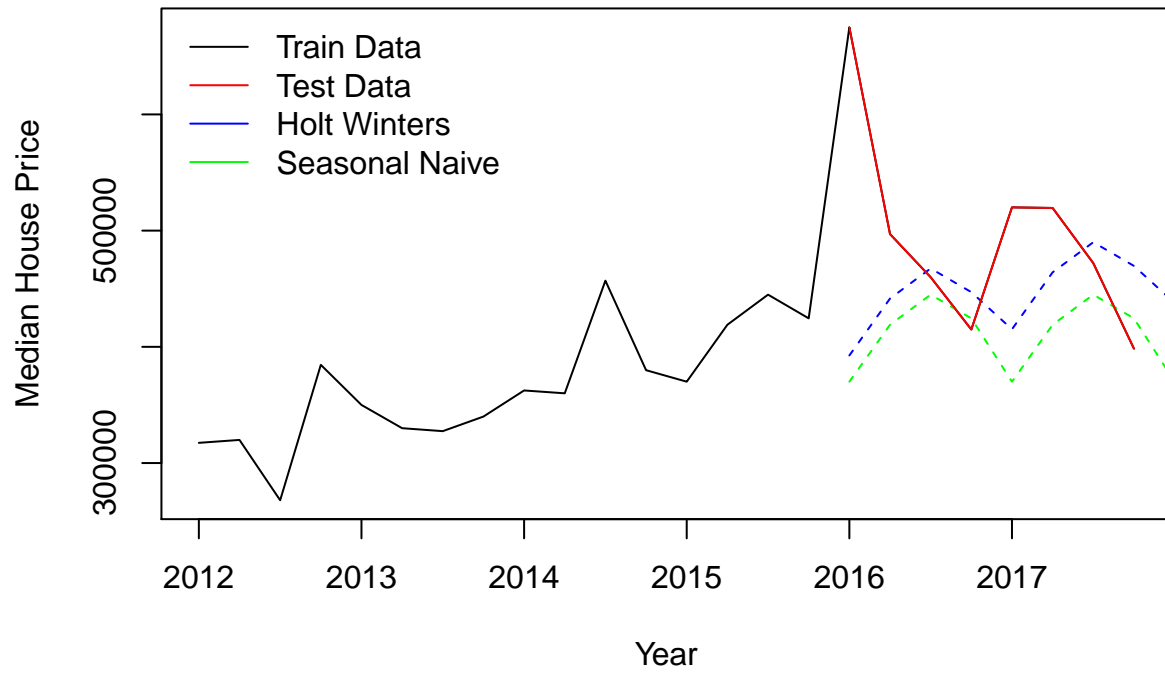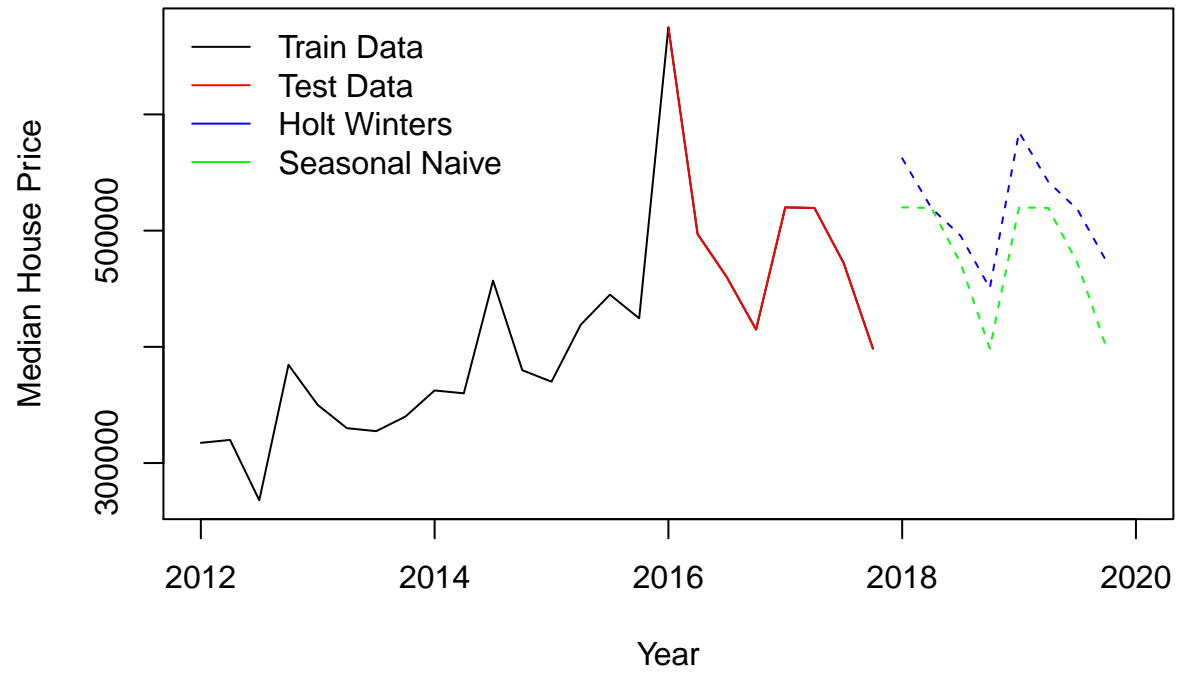## Portland, OR – Kenton : Holt Winters Model Forecast Residuals
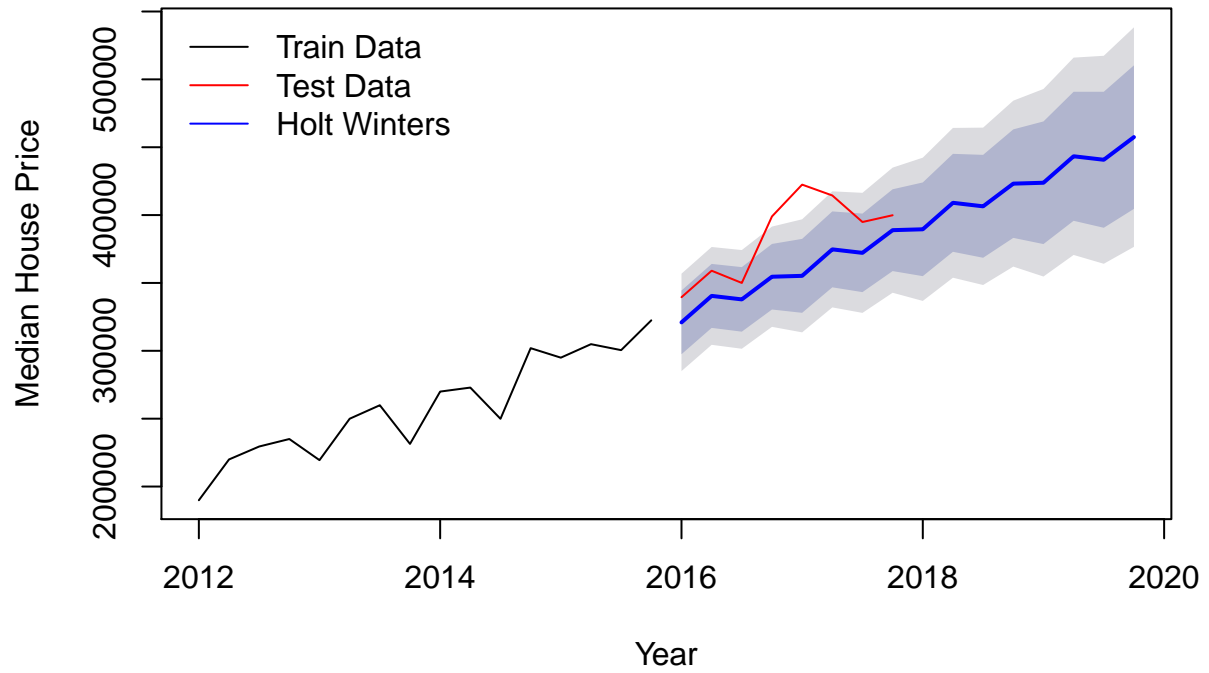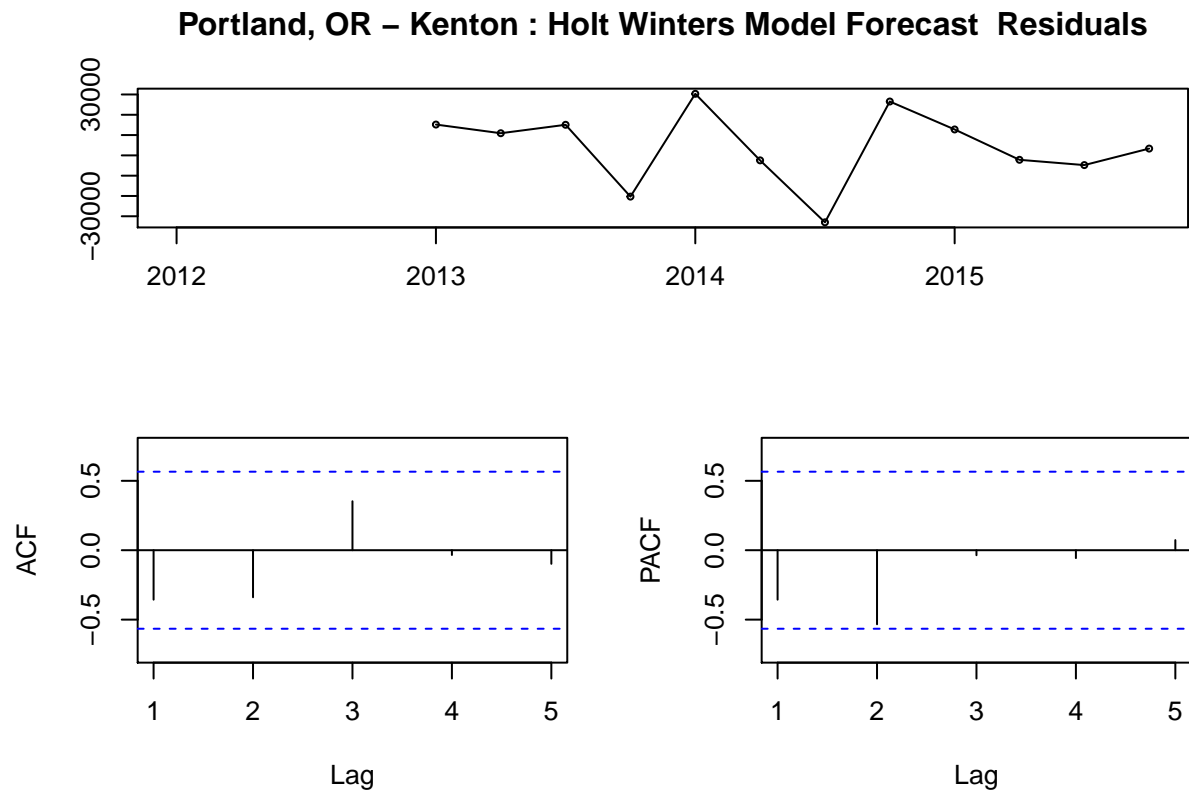

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Kenton"
##                   ME     RMSE      MAE      MPE     MAPE     MASE
## Training set 29039.58 35934.79 31306.25 10.35550 11.28173 1.000000
## Test set     79200.00 83956.07 79200.00 20.17575 20.17575 2.529846
##                   ACF1 Theil's U
## Training set -0.4756741        NA
## Test set      0.5584082  3.440892
## [1] "Holt Winters Accuracy for  Portland, OR - Kenton"
##                  ME     RMSE      MAE      MPE     MAPE      MASE
## Training set  4282.655 18046.33 14739.14 1.439729 5.638234 0.4708050
## Test set     29288.808 34533.03 29288.81 7.403719 7.403719 0.9355578
##                   ACF1 Theil's U
## Training set -0.3562911        NA
## Test set      0.3959399  1.435154
```

Portland, OR – Kenton : TS Training Model Comparison
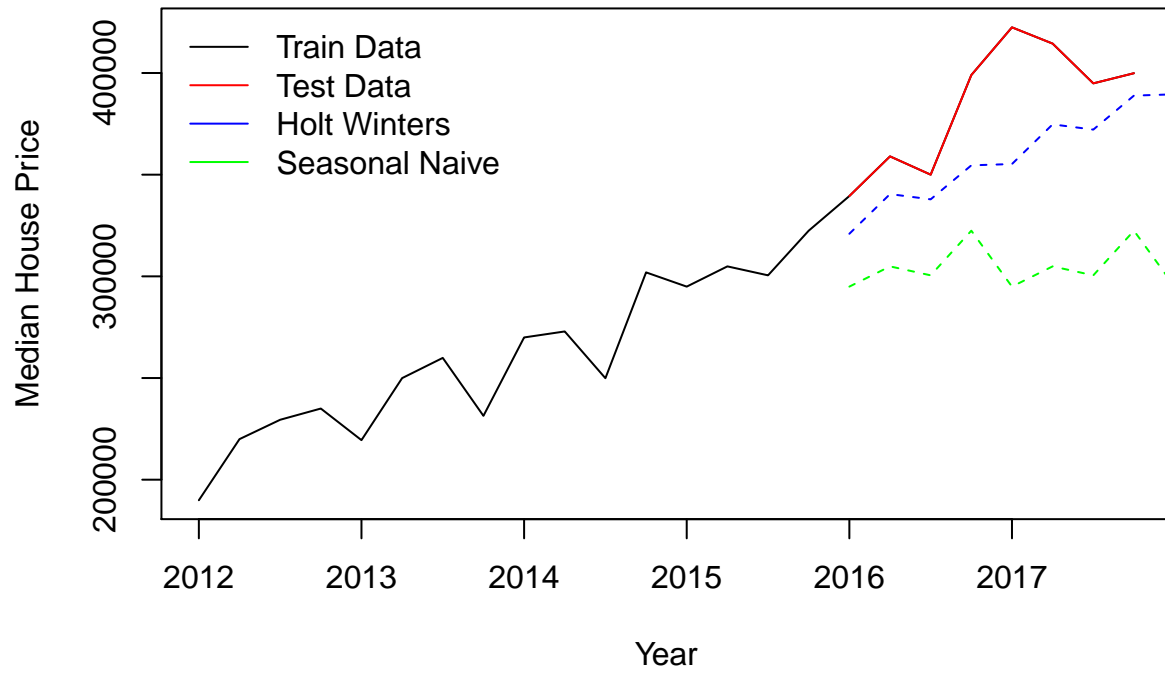
Portland, OR – Kenton : Full TS Models Comparison
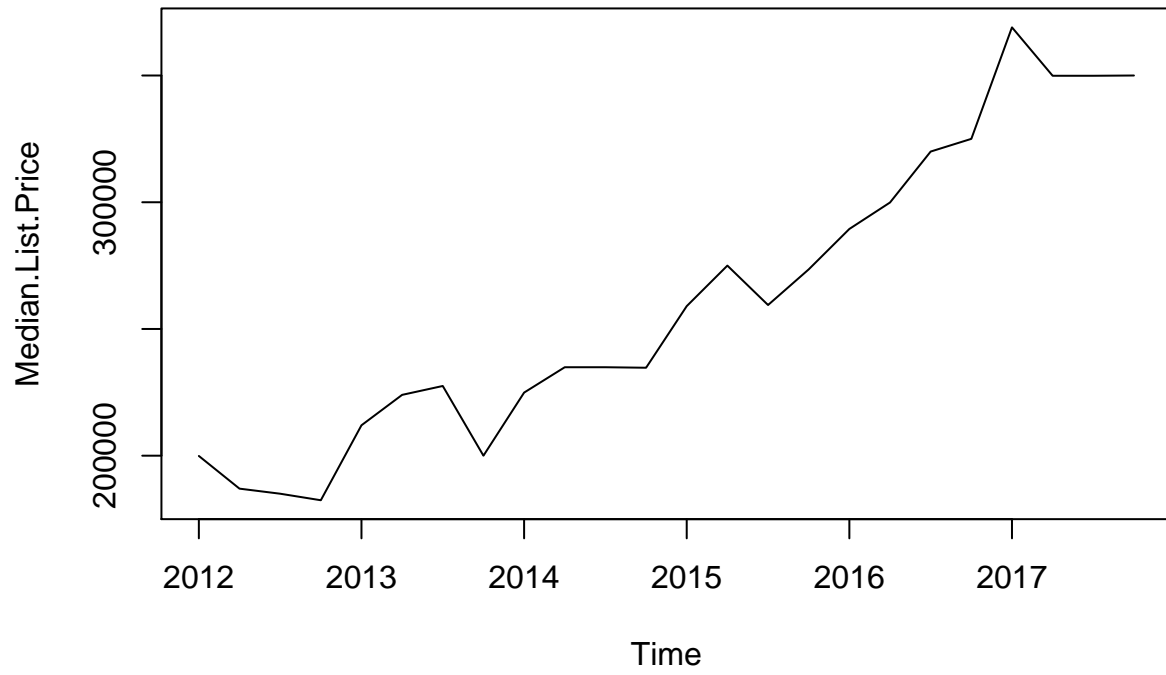
Median House Price vs Year line chart with legend: Train Data (black), Test Data (red), Holt Winters (blue), Seasonal Naive (green).

Portland, OR – St. Johns

Portland, OR – St. Johns : Naive Model Forecast
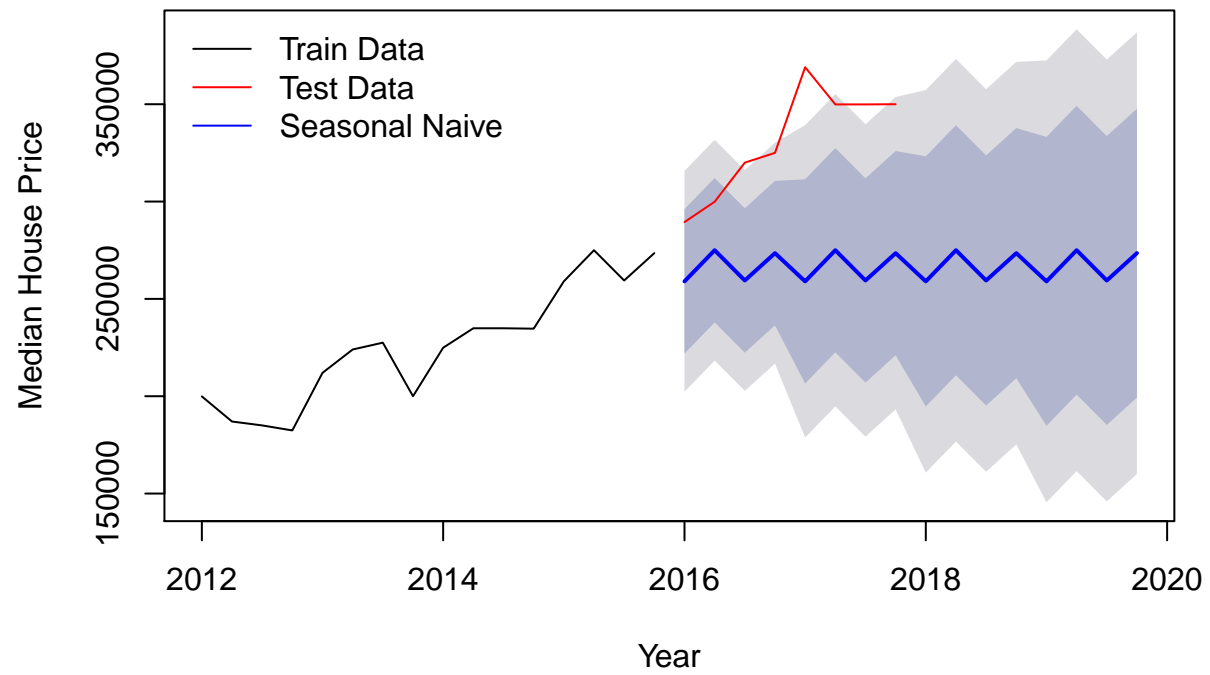
Portland, OR – St. Johns : Naive Model Forecast Residuals
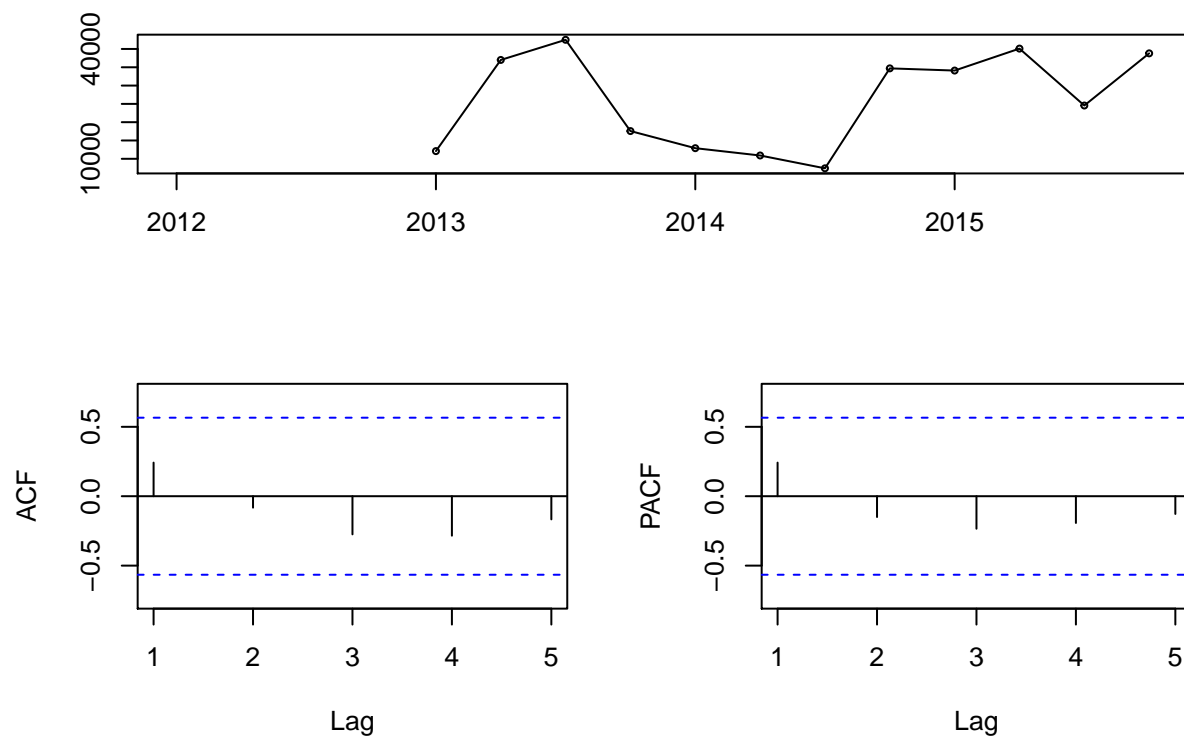
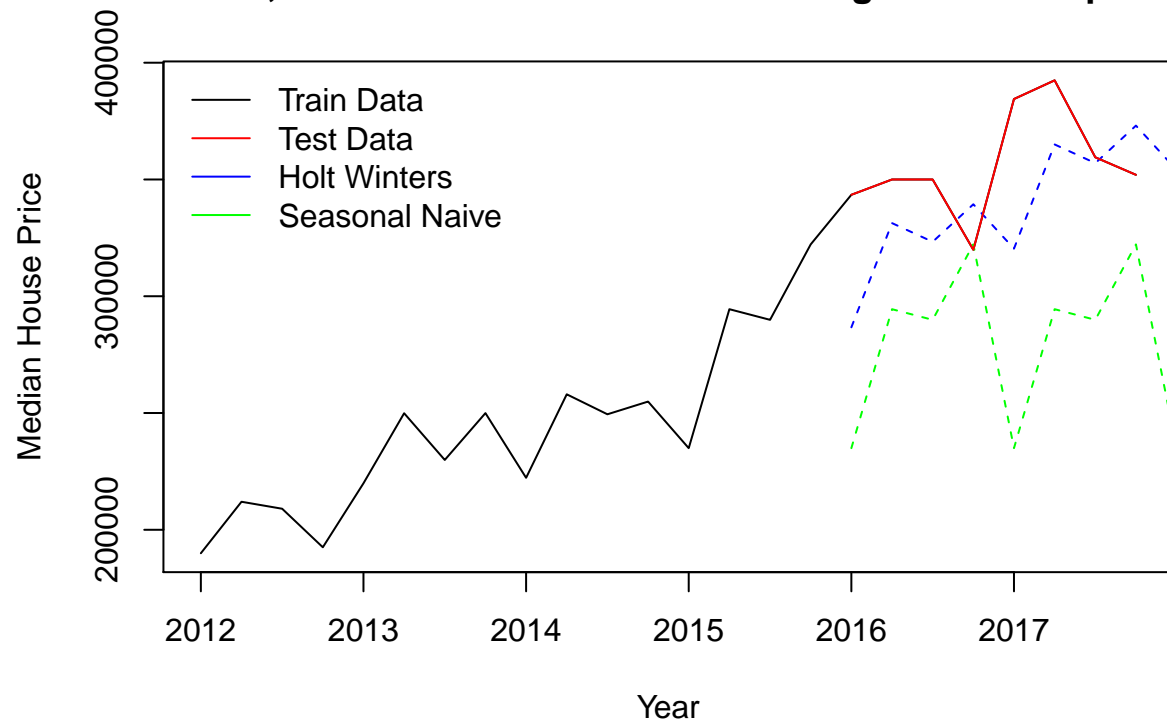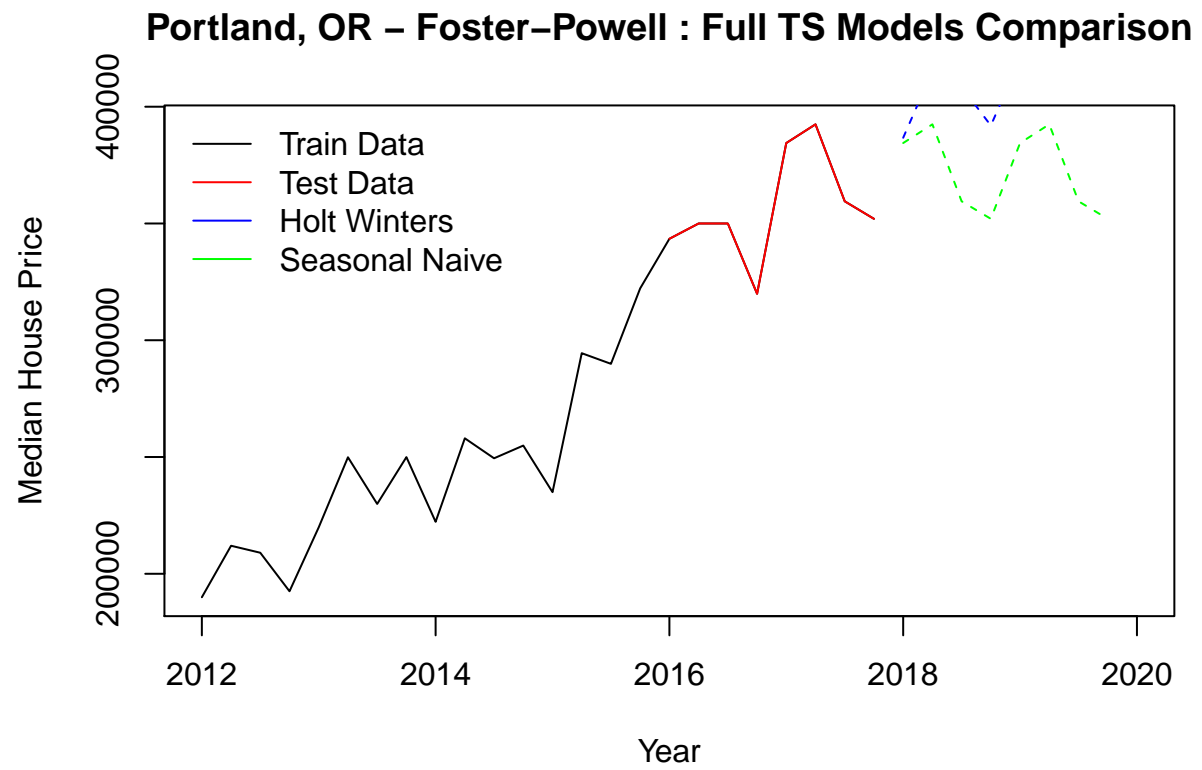# Portland, OR – St. Johns : Holt Winters Model Forecast
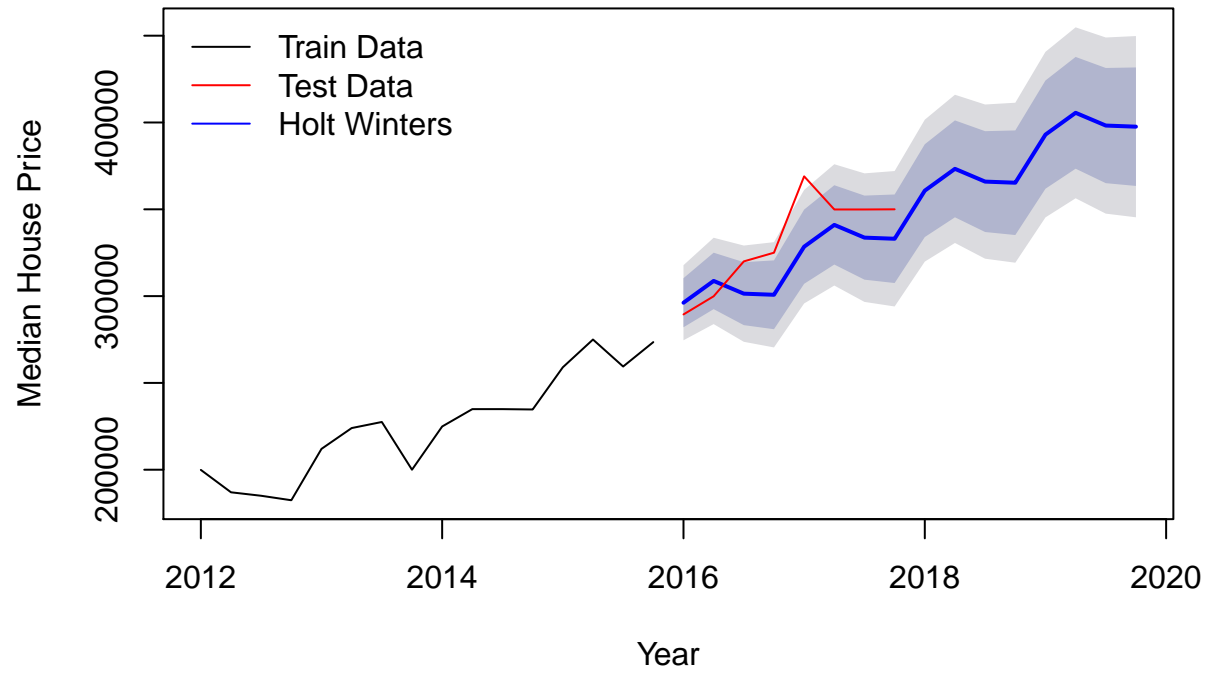
Portland, OR – St. Johns : Holt Winters Model Forecast Residuals
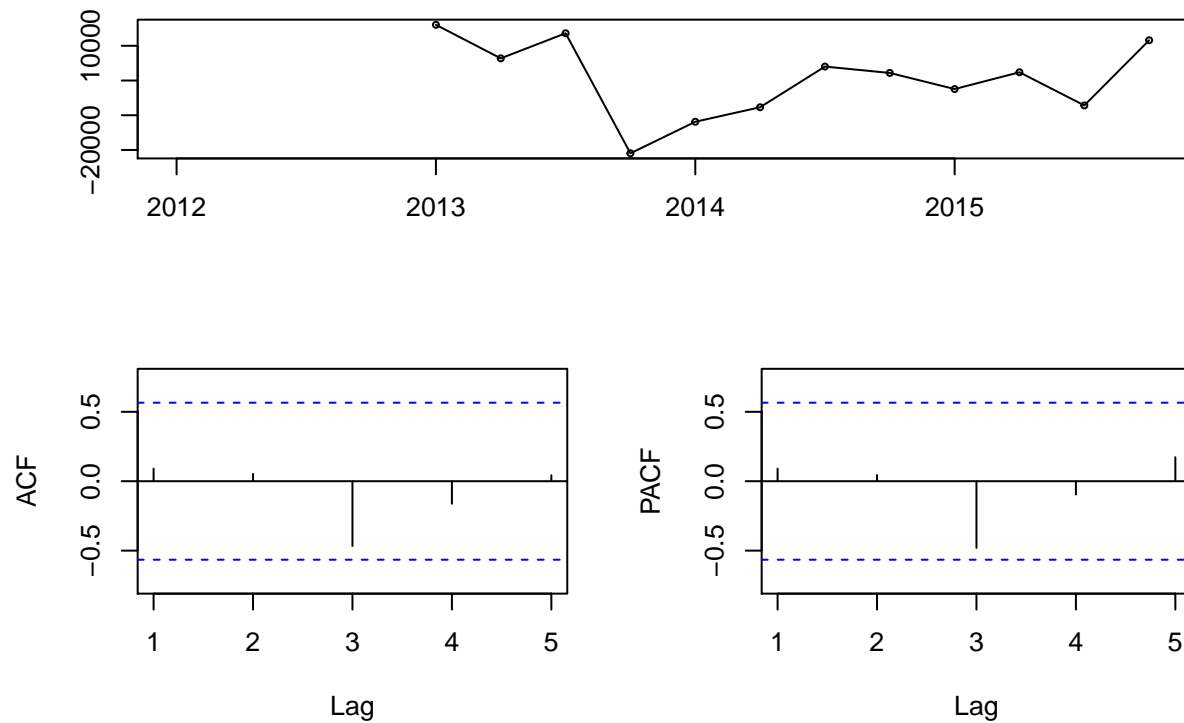

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - St. Johns"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 26052.08 28944.74 26052.08 10.78351 10.78351 1.000000
## Test set     64906.12 70364.30 64906.12 19.06429 19.06429 2.491399
##                 ACF1 Theil's U
## Training set 0.2422093       NA
## Test set     0.3400692 3.568565
## [1] "Holt Winters Accuracy for  Portland, OR - St. Johns"
##                   ME      RMSE      MAE       MPE     MAPE      MASE
## Training set   500.3233 10574.05  8864.883 0.1146364 3.908180 0.3402754
## Test set     13728.1444 20400.33 17626.432 3.8737207 5.193873 0.6765843
##                 ACF1 Theil's U
## Training set 0.09076774       NA
## Test set     0.30245743  1.073106
```

Portland, OR – St. Johns : TS Training Model Comparison

Portland, OR – St. Johns : Full TS Models Comparison
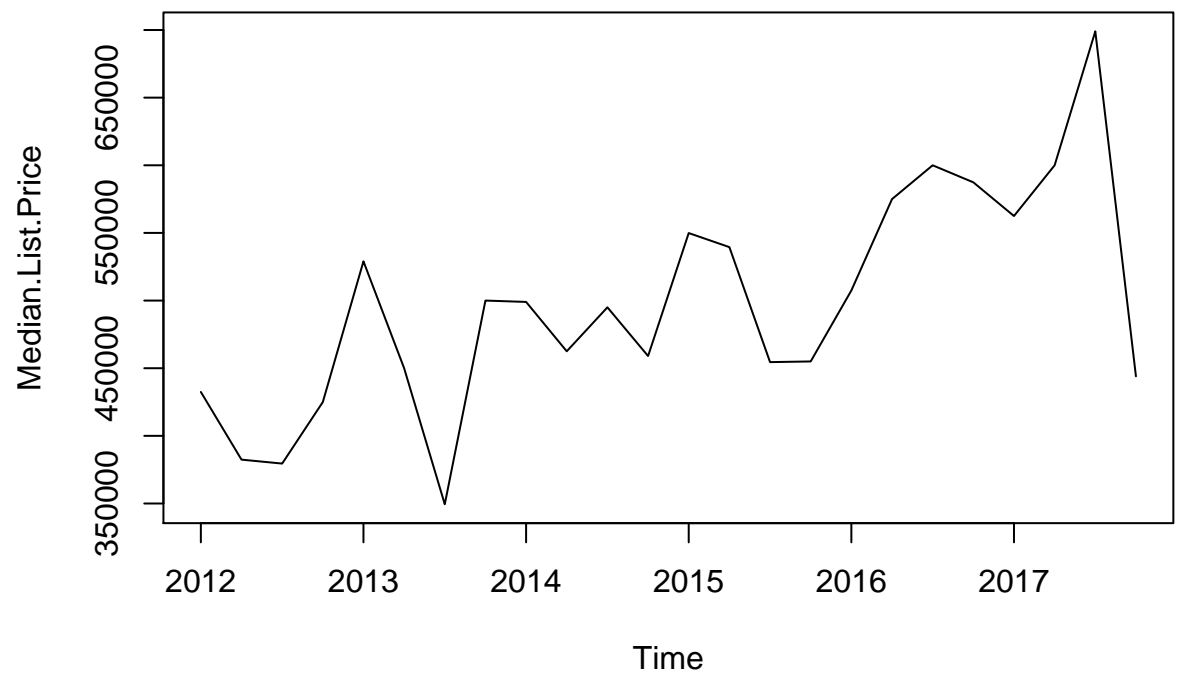
Portland, OR – Bridlemile

Portland, OR – Bridlemile : Naive Model Forecast
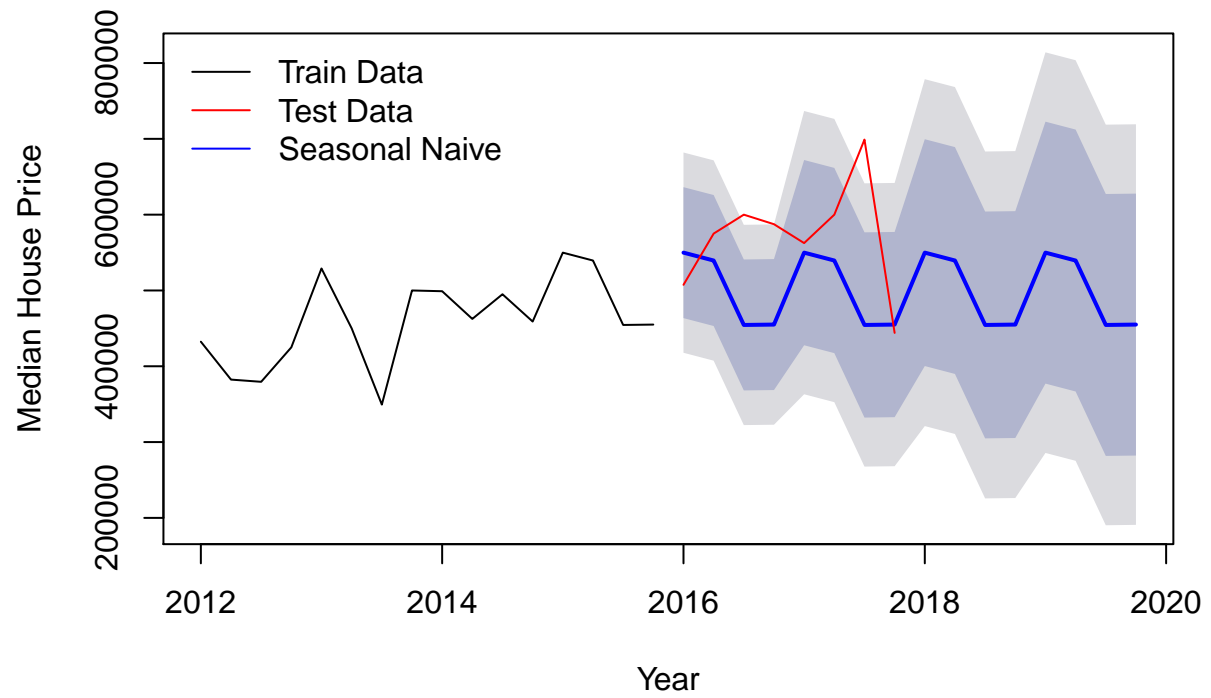
Portland, OR – Bridlemile : Naive Model Forecast Residuals
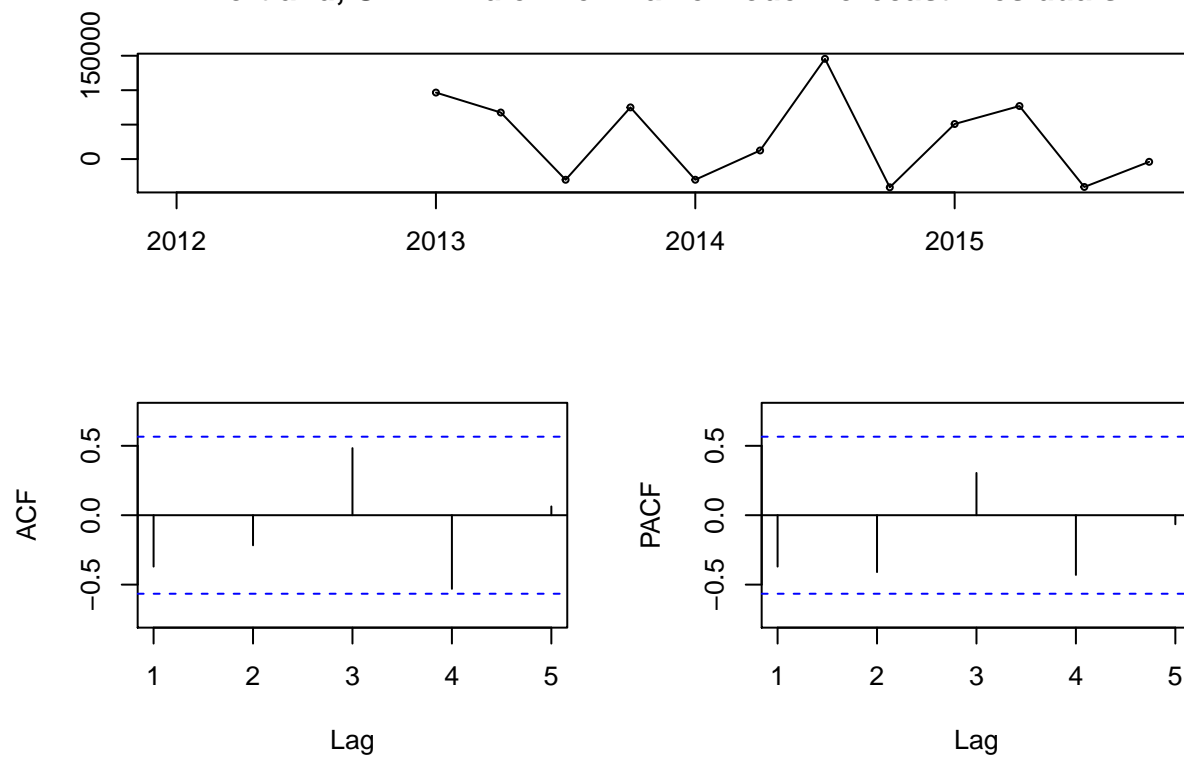
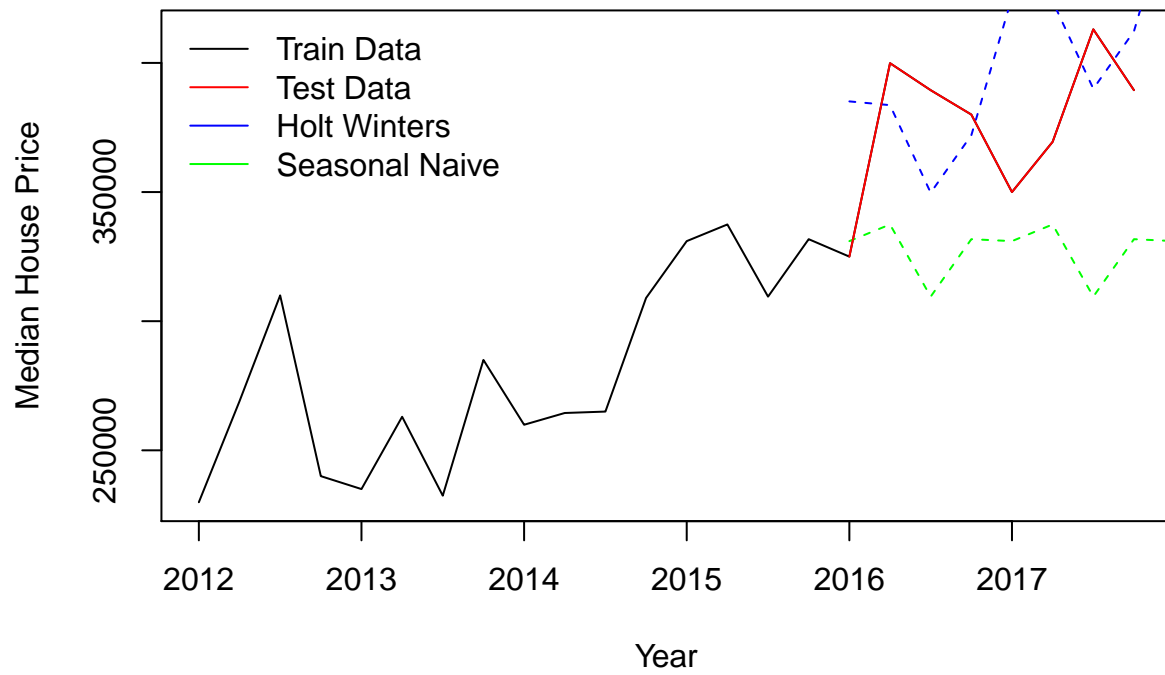# Portland, OR – Bridlemile : Holt Winters Model Forecast

Portland, OR – Bridlemile : Holt Winters Model Forecast Residuals
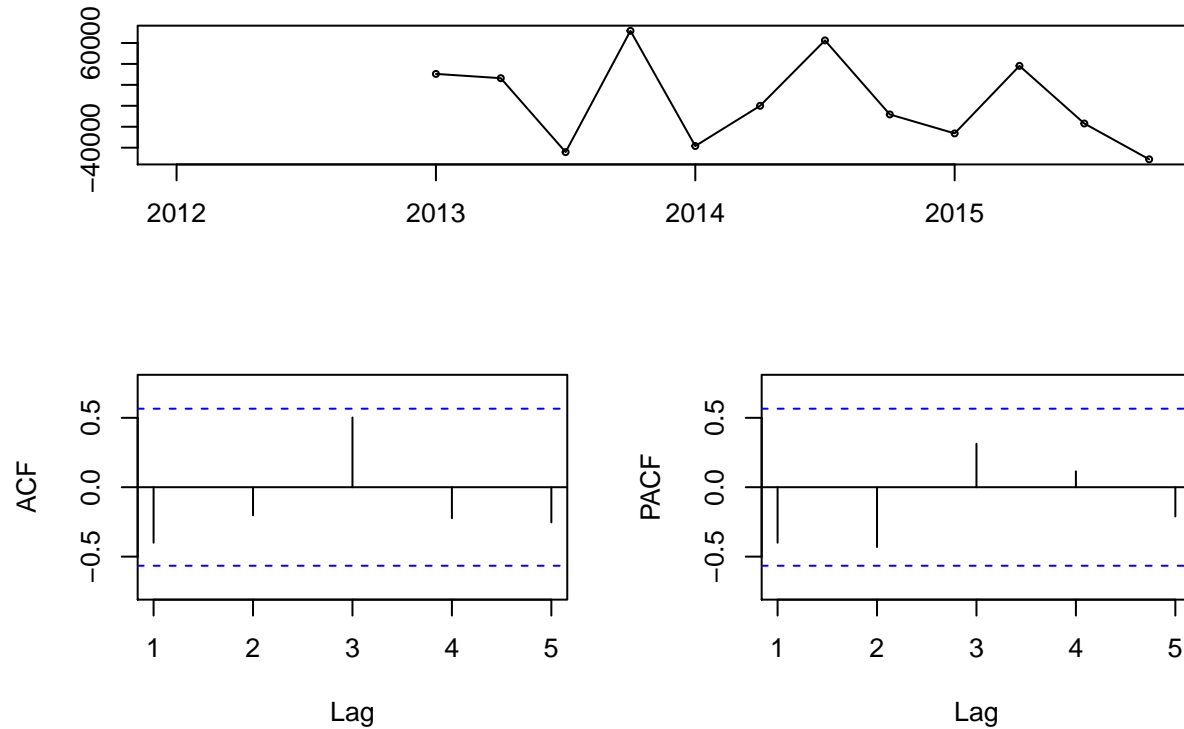

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Bridlemile"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 31627.08  67400.65 55885.25  5.880821 11.43641 1.000000
## Test set     72193.75 114827.33 85556.25 11.177870 13.88858 1.530927
##                   ACF1 Theil's U
## Training set -0.3701048        NA
## Test set     -0.2086699  1.259366
## [1] "Holt Winters Accuracy for  Portland, OR - Bridlemile"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 3655.4625 40000.64 34524.93  0.3124594  7.293587 0.6177826
## Test set     -161.7875 95837.20 84589.92 -1.9784828 15.266353 1.5136358
##                   ACF1 Theil's U
## Training set -0.3998330        NA
## Test set     -0.2775668 0.9320451
```

Portland, OR – Bridlemile : TS Training Model Comparison

Portland, OR – Bridlemile : Full TS Models Comparison
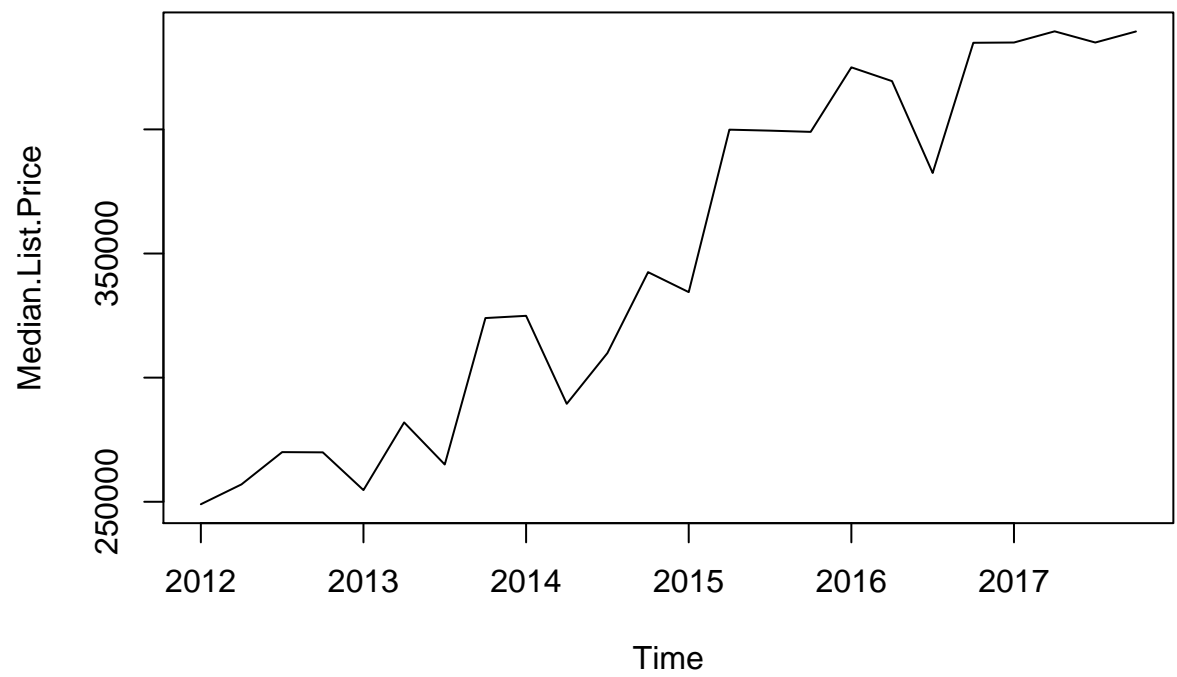
Portland, OR – Woodlawn

Portland, OR – Woodlawn : Naive Model Forecast
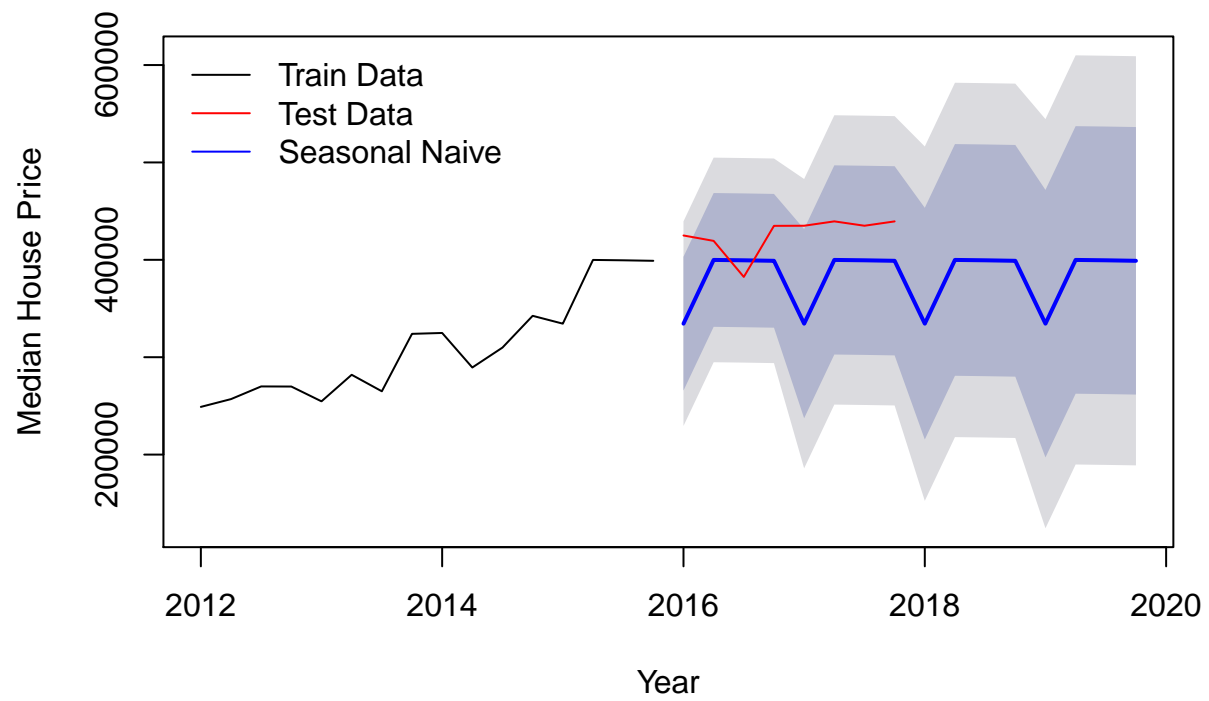
Portland, OR – Woodlawn : Naive Model Forecast Residuals
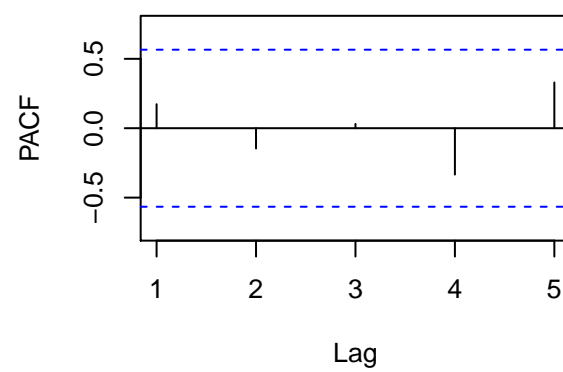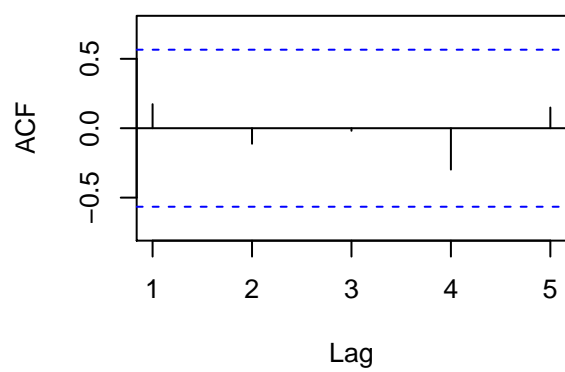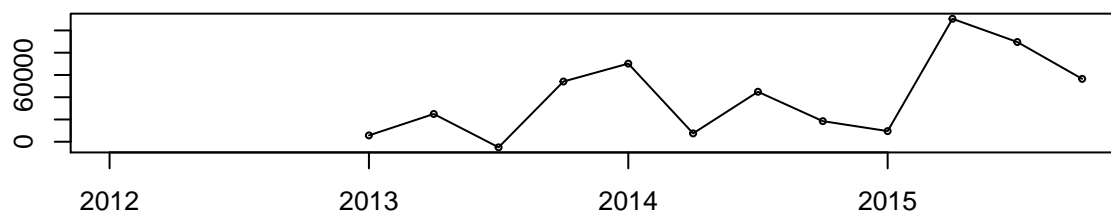
Portland, OR – Woodlawn : Holt Winters Model Forecast
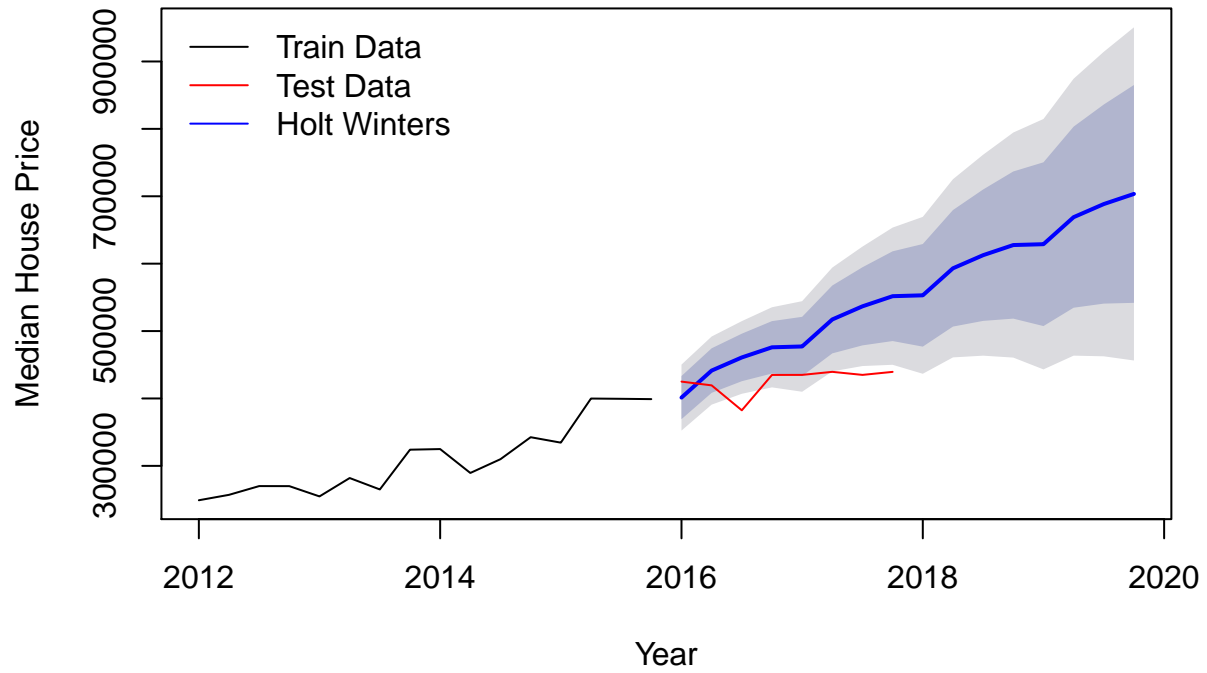
Portland, OR – Woodlawn : Holt Winters Model Forecast Residuals
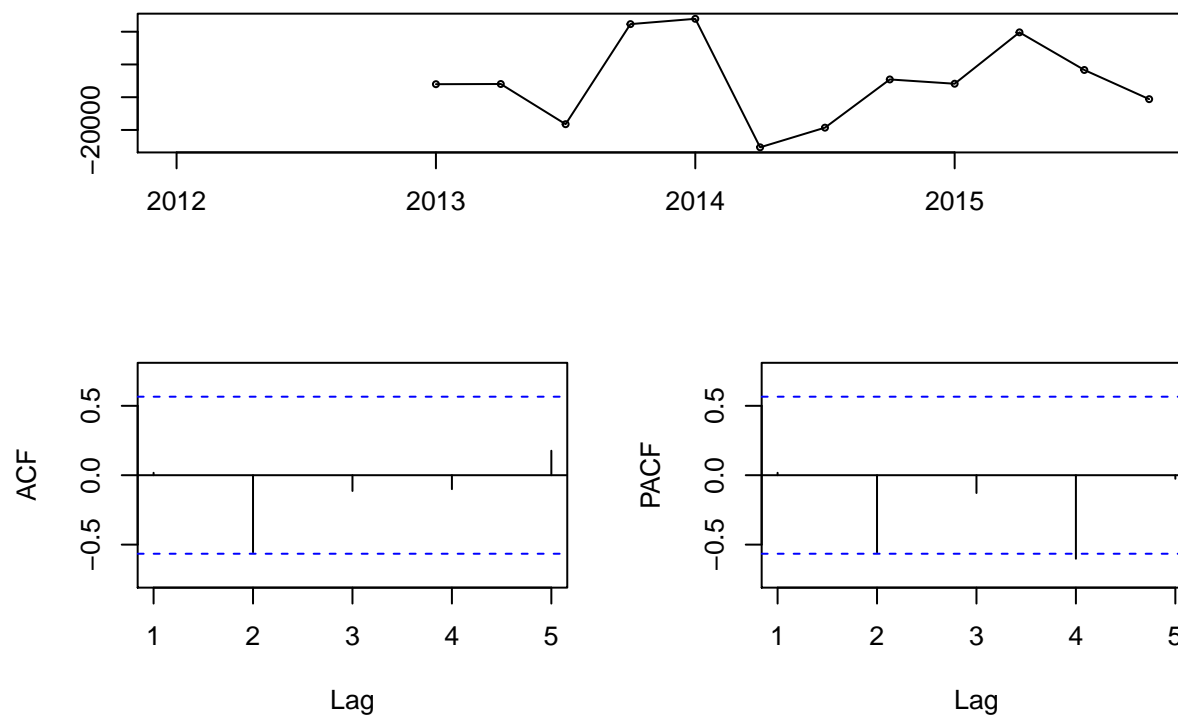

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Woodlawn"
##                   ME      RMSE      MAE        MPE     MAPE      MASE
## Training set 40579.17 53588.09 41412.50  11.420732 11.7352 1.000000
## Test set     43131.25 55605.68 47393.75   9.906776 11.0213 1.144431
##                   ACF1 Theil's U
## Training set 0.17321186        NA
## Test set     0.01680431  1.818026
## [1] "Holt Winters Accuracy for  Portland, OR - Woodlawn"
##                   ME      RMSE      MAE        MPE      MAPE      MASE
## Training set   9747.733 25814.80 20888.82   2.591646  6.438765 0.5044085
## Test set     -56447.968 70403.35 62371.24 -13.238208 14.631919 1.5060970
##                   ACF1 Theil's U
## Training set 0.01754832        NA
## Test set     0.35856337  2.789326
```

Portland, OR – Woodlawn : TS Training Model Comparison
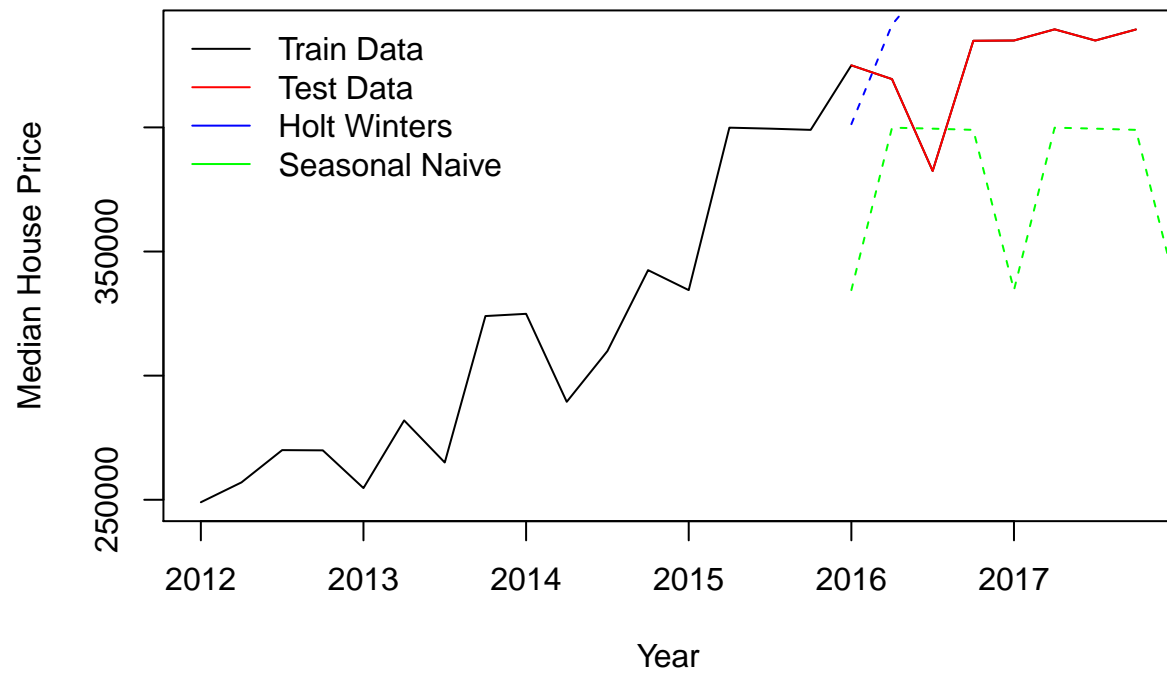
Portland, OR – Woodlawn : Full TS Models Comparison
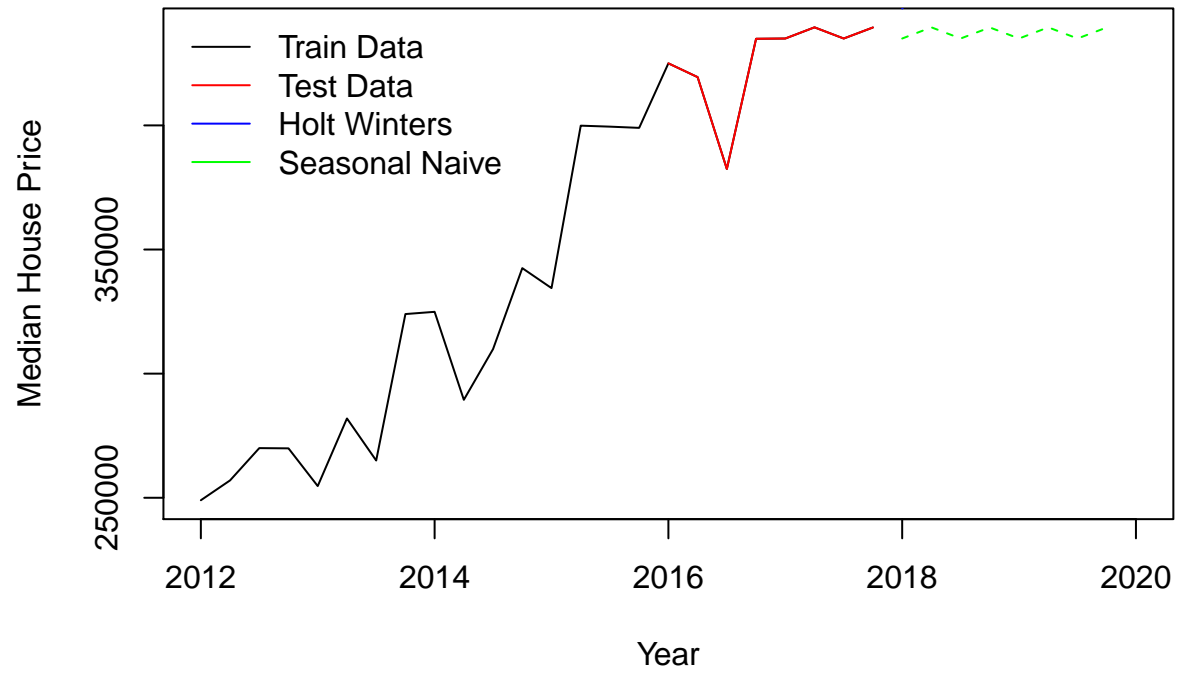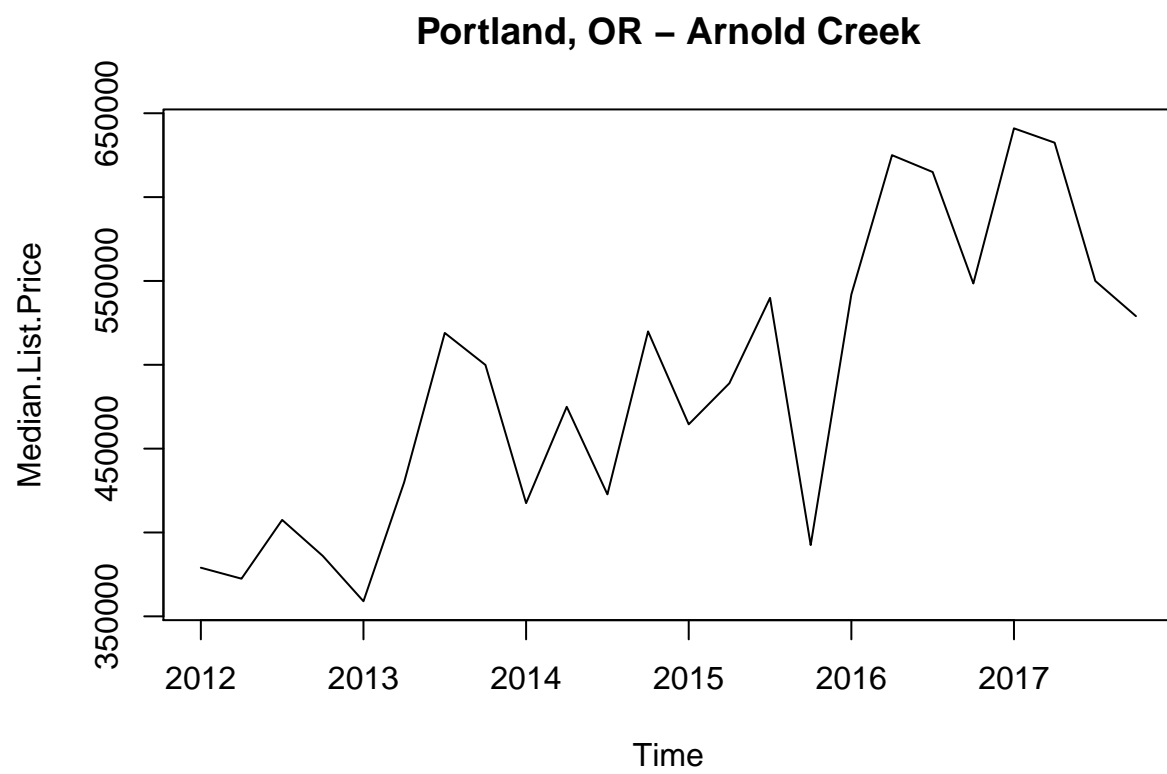
## Portland, OR – Arnold Creek

Portland, OR – Arnold Creek : Naive Model Forecast
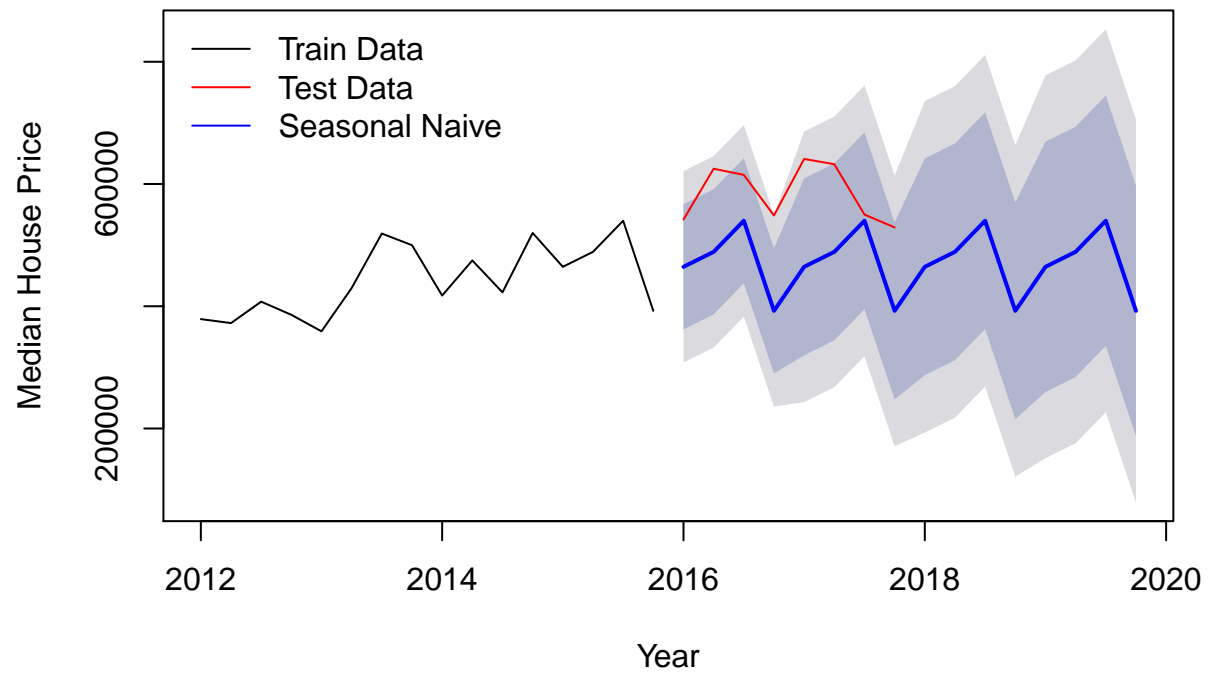
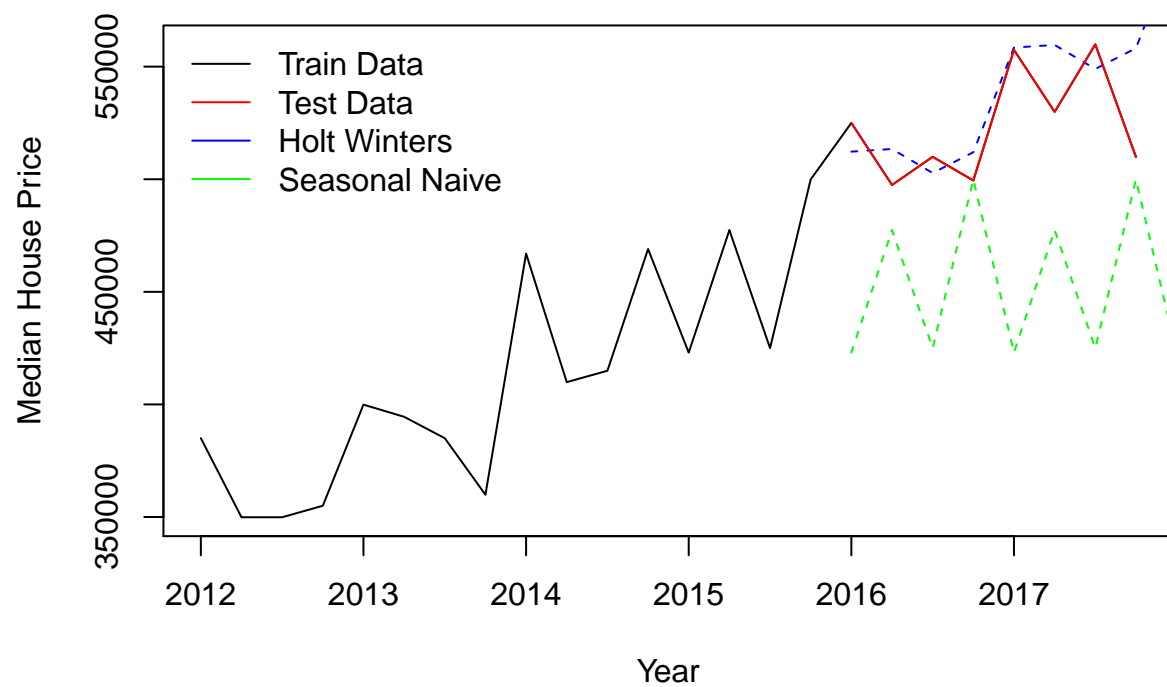# Portland, OR – Arnold Creek : Naive Model Forecast Residuals
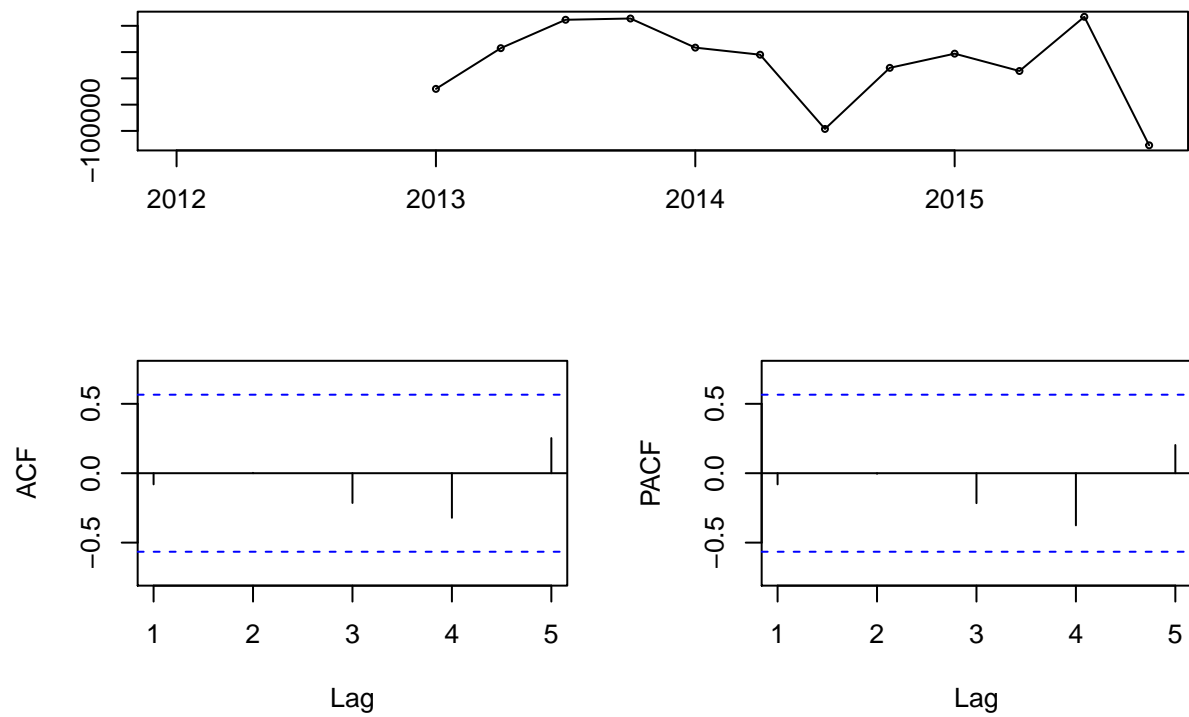
Portland, OR – Arnold Creek : Holt Winters Model Forecast
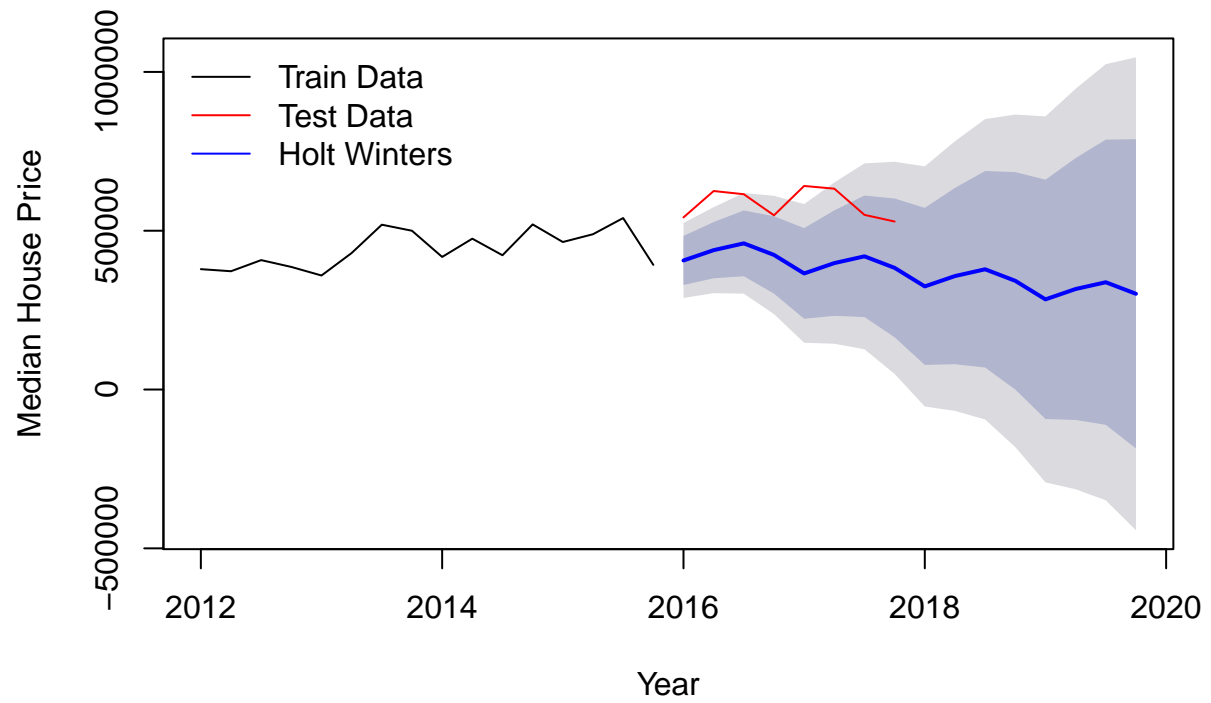
Portland, OR – Arnold Creek : Holt Winters Model Forecast Residuals
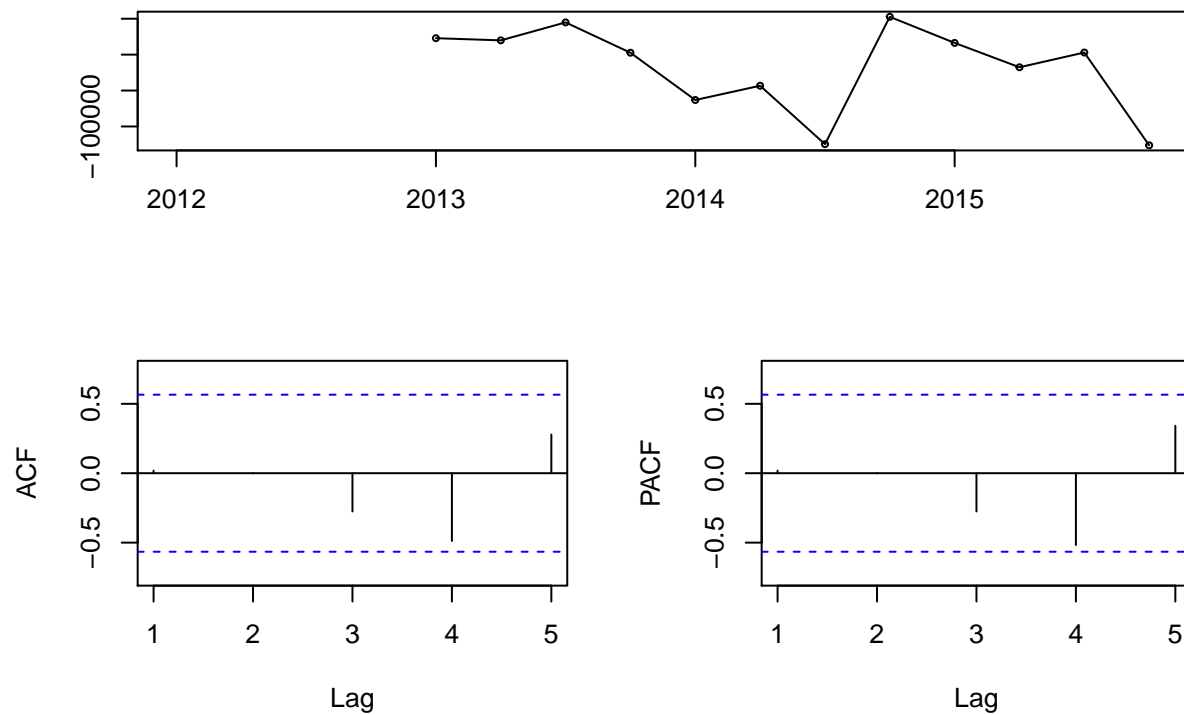

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Arnold Creek"
##                    ME       RMSE        MAE       MPE      MAPE      MASE
## Training set  28412.29   79886.81   69020.62  4.905684  15.03855  1.000000
## Test set     113881.88  124964.34  113881.88 19.319223  19.31922  1.649969
##                   ACF1 Theil's U
## Training set -0.08022904        NA
## Test set     -0.19961775  2.081004
## [1] "Holt Winters Accuracy for  Portland, OR - Arnold Creek"
##                    ME       RMSE        MAE       MPE      MAPE      MASE
## Training set  -17725.54   60303.48   44765.53  -4.59364  10.32179  0.648582
## Test set      173444.97  180868.36  173444.97 29.25827  29.25827  2.512944
##                      ACF1 Theil's U
## Training set 0.01912064745        NA
## Test set     0.00007580759  2.953076
```

Portland, OR – Arnold Creek : TS Training Model Comparison

Median House Price

Year

- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Portland, OR – Arnold Creek : Full TS Models Comparison
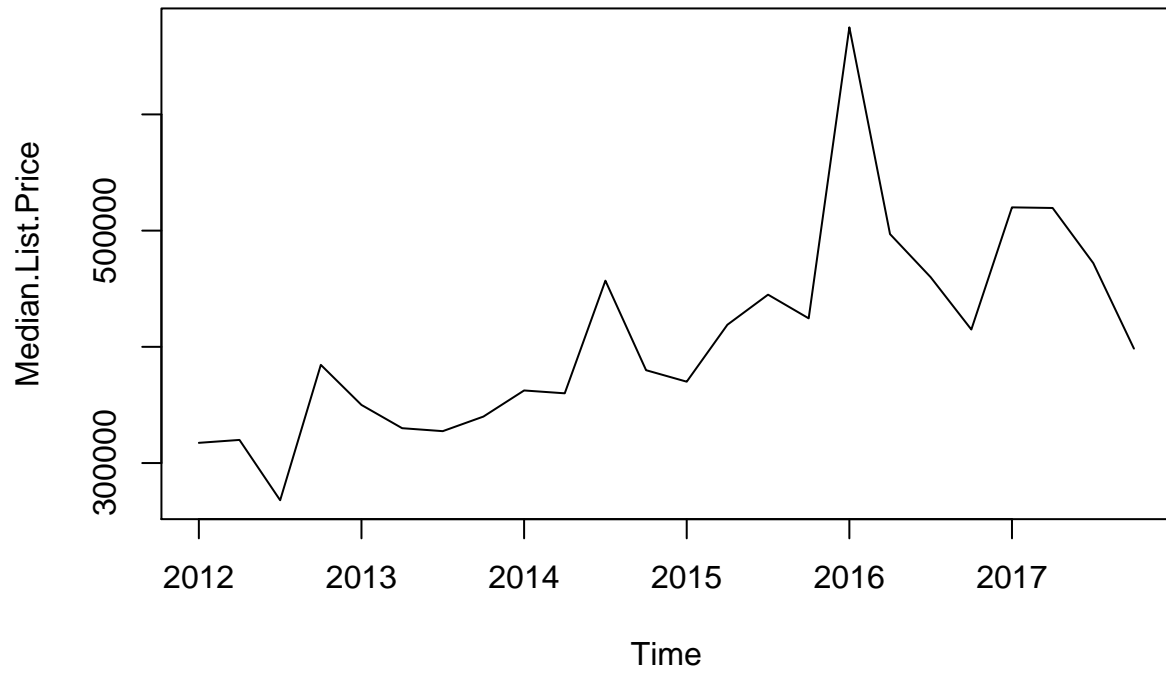
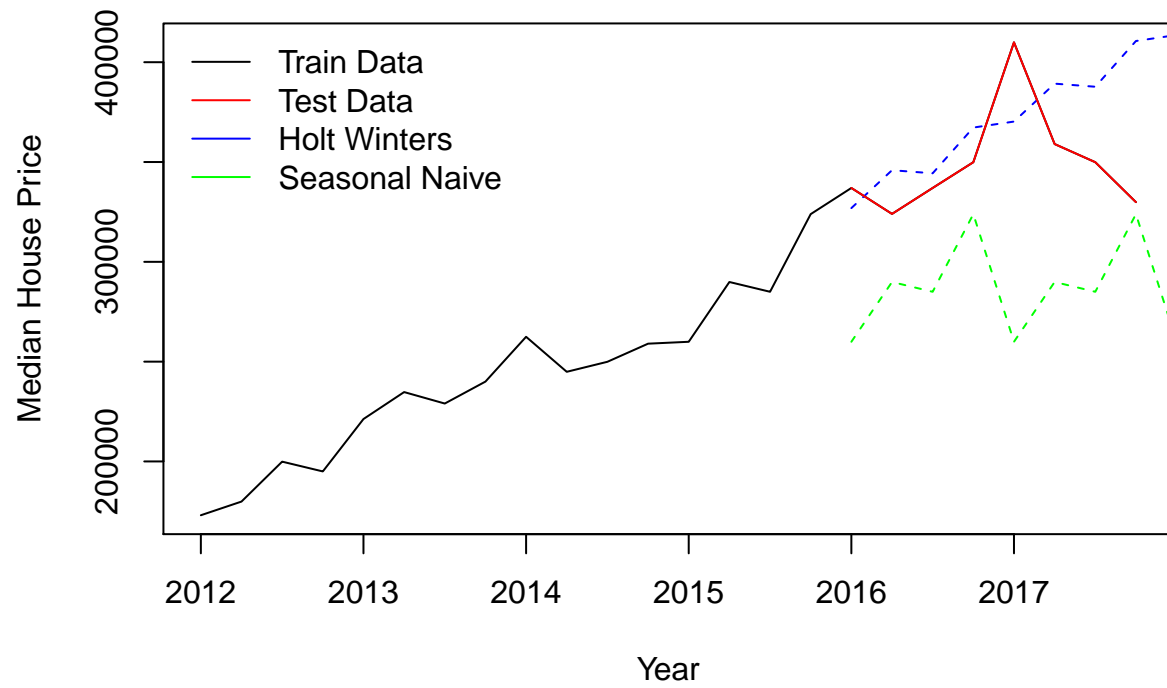# Portland, OR – Maplewood

Portland, OR – Maplewood : Naive Model Forecast
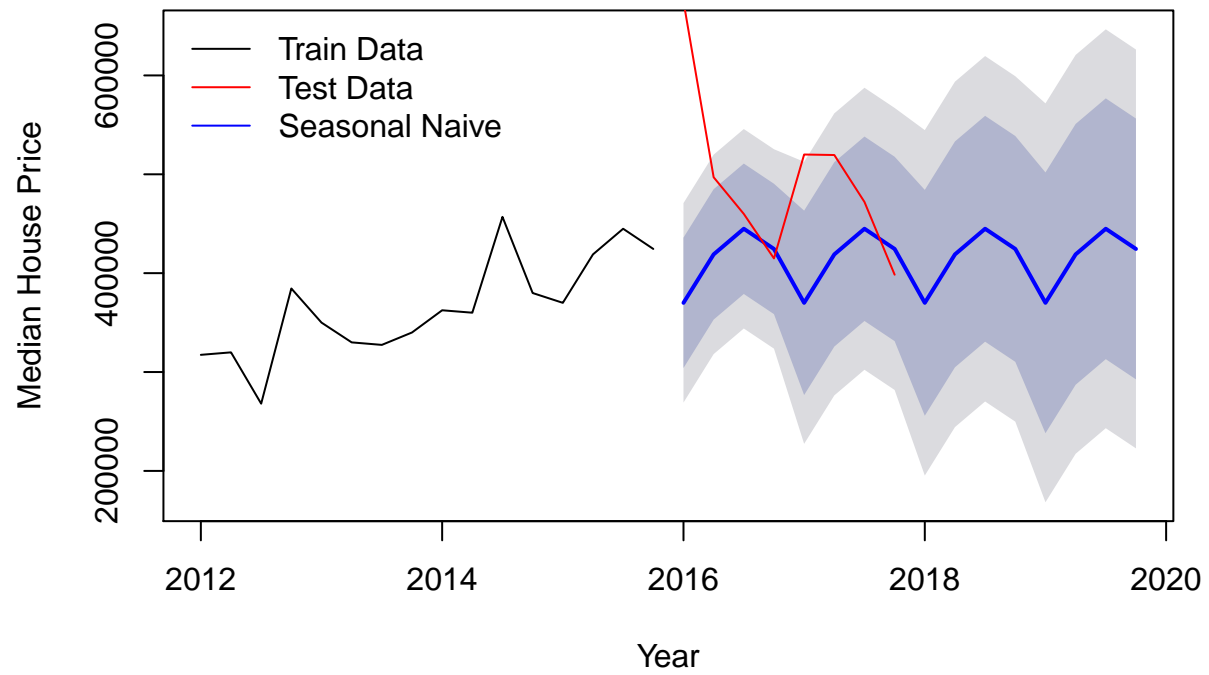
Portland, OR – Maplewood : Naive Model Forecast Residuals

Portland, OR – Maplewood : Holt Winters Model Forecast
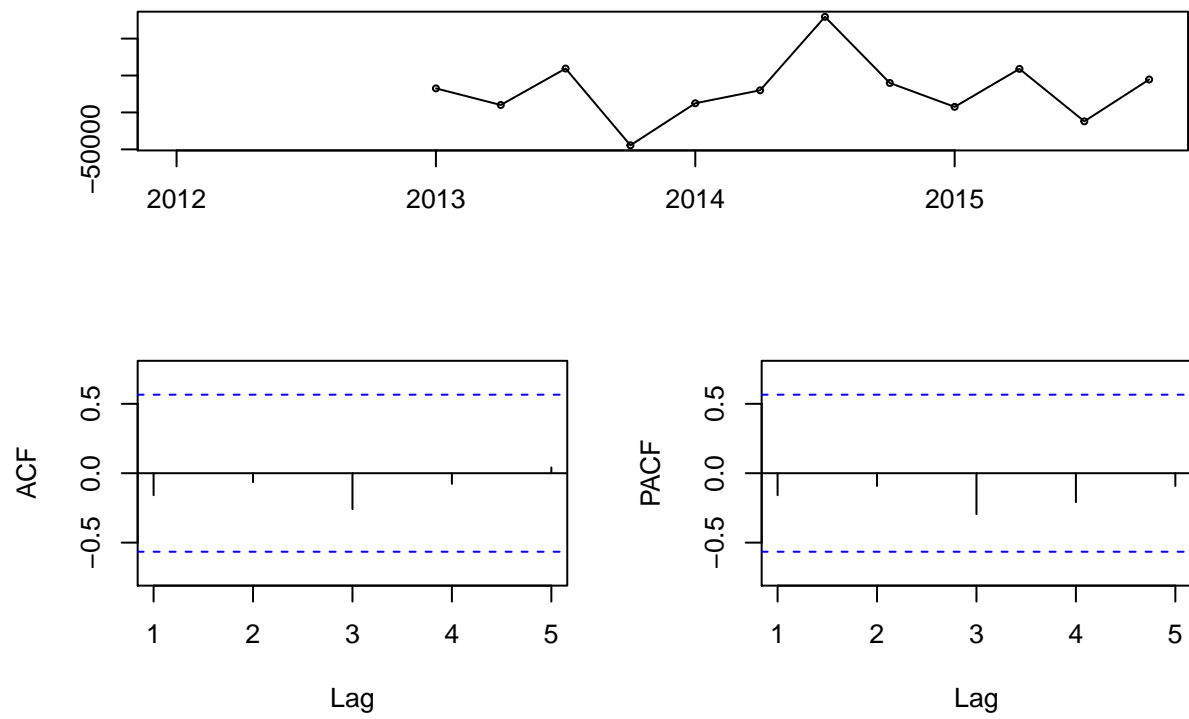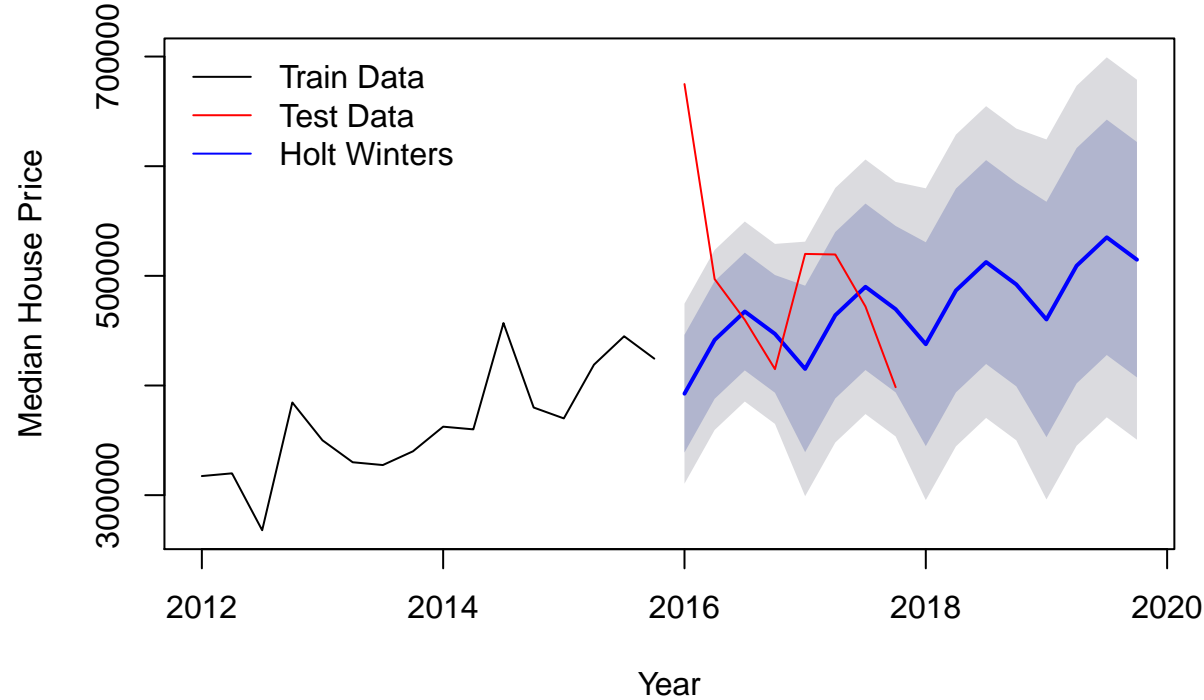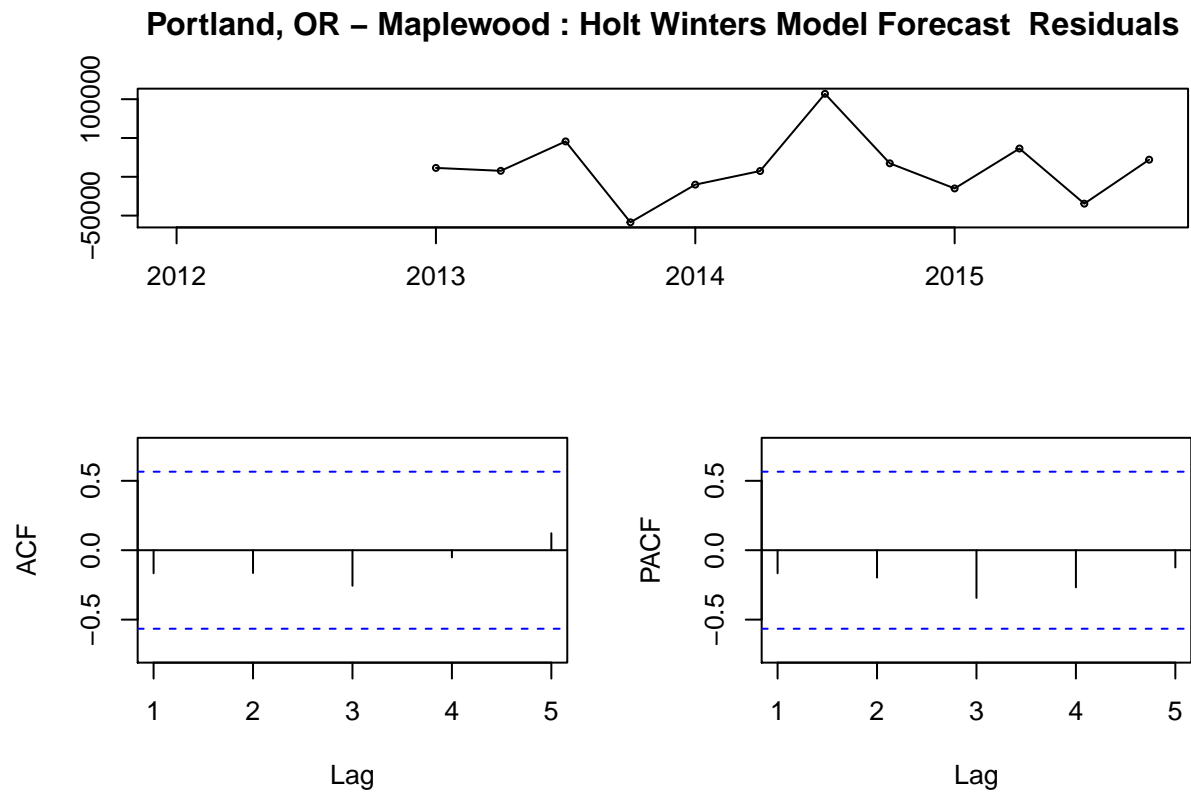
Portland, OR – Maplewood : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Maplewood"
##                    ME       RMSE      MAE      MPE     MAPE     MASE
## Training set 30716.67   51453.01 40141.67  7.66441 10.29720 1.000000
## Test set     79978.12 129118.84 88890.62 13.65131 15.86422 2.214423
##                    ACF1 Theil's U
## Training set -0.15847626        NA
## Test set      0.06313473  1.019325
## [1] "Holt Winters Accuracy for  Portland, OR - Maplewood"
##                    ME      RMSE      MAE      MPE     MAPE      MASE
## Training set 11380.94  41674.99 31110.68 2.631446  7.94398 0.7750221
## Test set     46141.88 113653.51 78365.62 6.593263 14.36105 1.9522265
##                   ACF1 Theil's U
## Training set -0.1659943        NA
## Test set      0.1017166 0.7823319
```

Portland, OR – Maplewood : TS Training Model Comparison

Portland, OR – Maplewood : Full TS Models Comparison
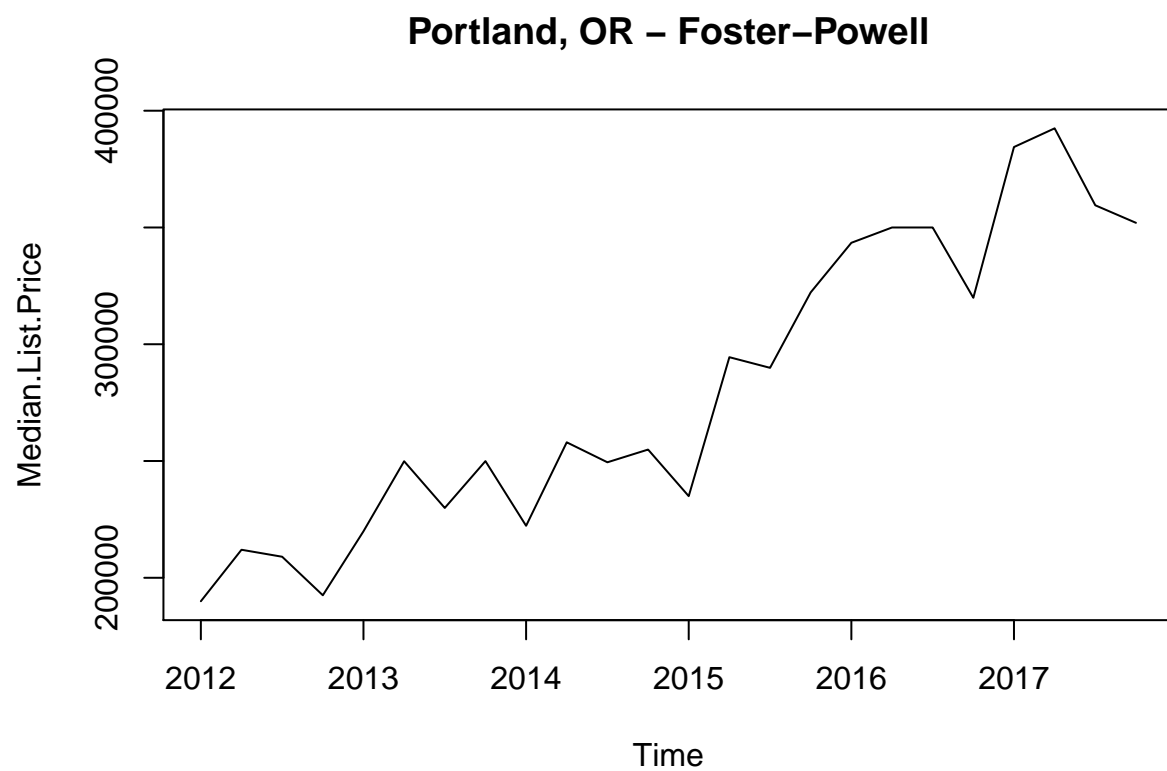
Portland, OR – Foster–Powell

Portland, OR – Foster–Powell : Naive Model Forecast
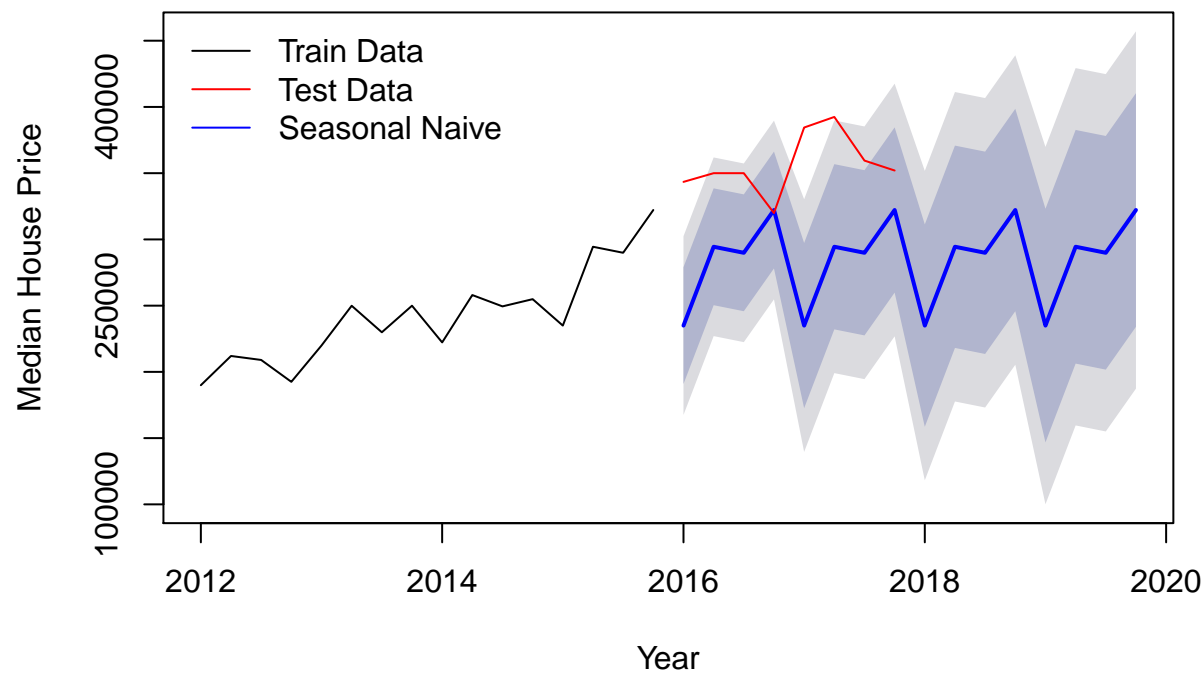
Portland, OR – Foster–Powell : Naive Model Forecast Residuals
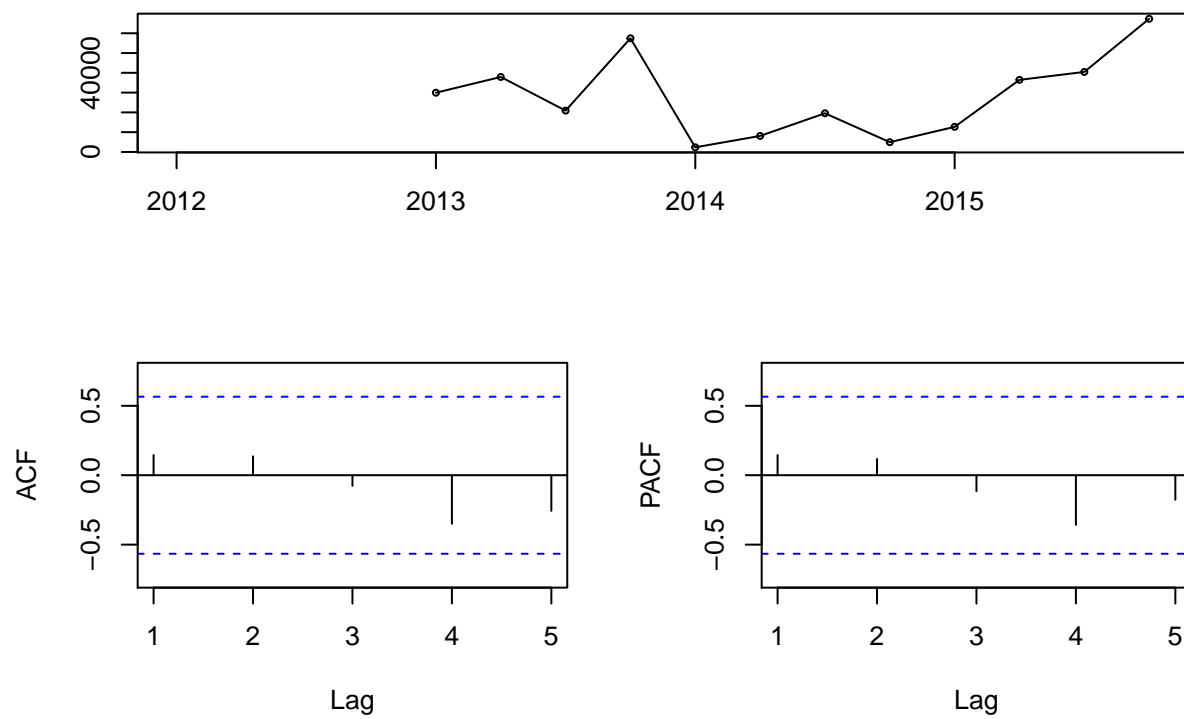
Portland, OR – Foster–Powell : Holt Winters Model Forecast
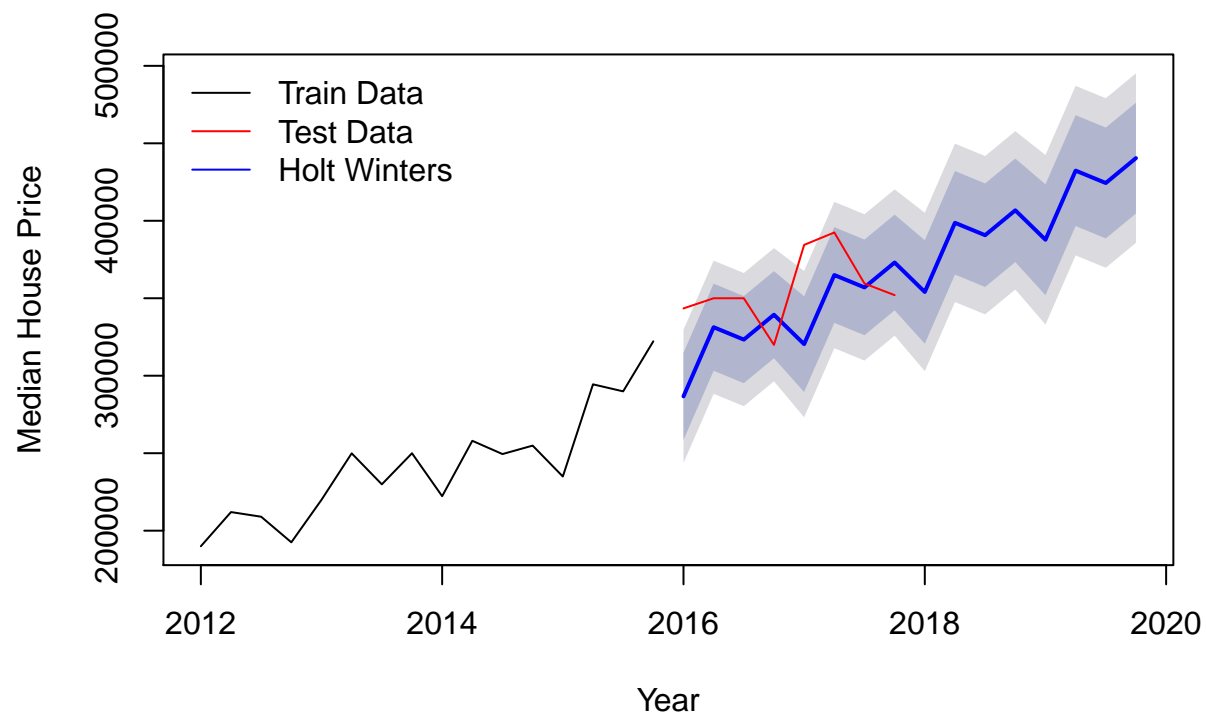
Portland, OR – Foster–Powell : Holt Winters Model Forecast Residuals
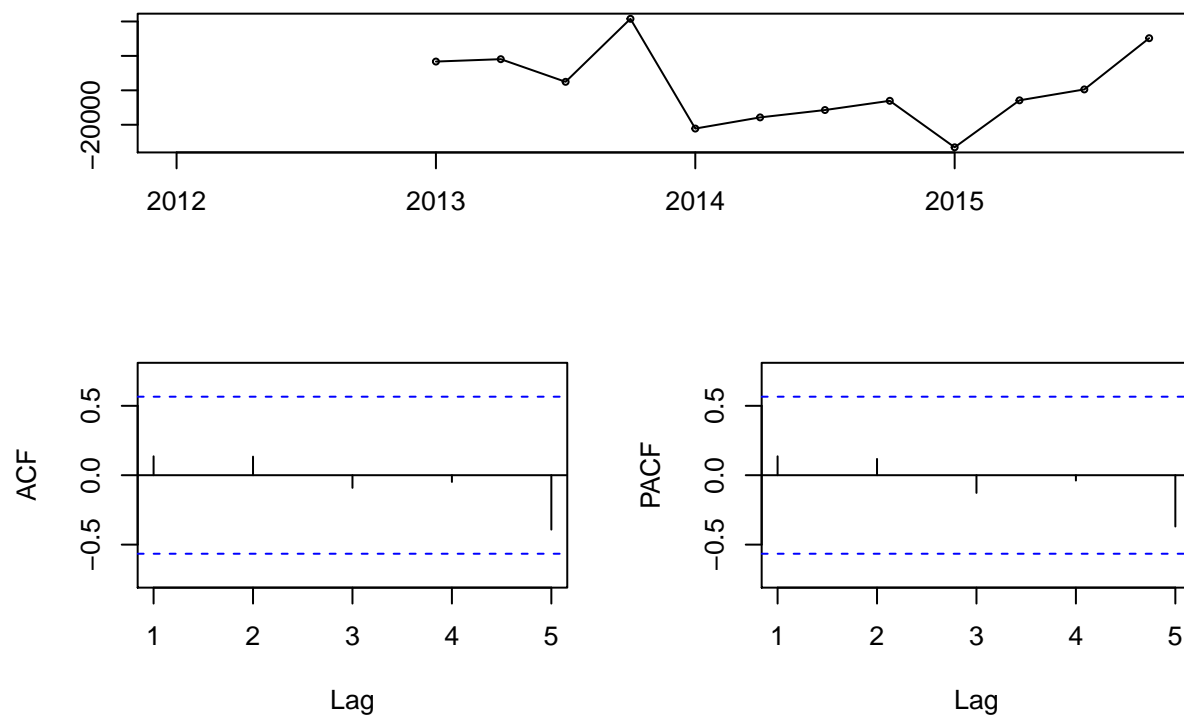

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Foster-Powell"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 28170.83 34404.39 28170.83 10.62189 10.62189 1.000000
## Test set     71092.88 83785.71 71667.88 19.44973 19.62948 2.544045
##                 ACF1 Theil's U
## Training set  0.1457925        NA
## Test set     -0.2051904    2.5869
## [1] "Holt Winters Accuracy for  Portland, OR - Foster-Powell"
##                   ME      RMSE      MAE       MPE     MAPE      MASE
## Training set  1473.453 21044.43 17209.39 0.3373027 6.860916 0.6108939
## Test set     19451.887 35302.92 29587.08 5.2217612 8.239872 1.0502735
##                 ACF1 Theil's U
## Training set  0.1362560        NA
## Test set     -0.1648538  1.036257
```

Portland, OR – Foster–Powell : TS Training Model Comparison

Portland, OR – Foster–Powell : Full TS Models Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

X-axis: Year
Y-axis: Median House Price

Portland, OR – Goose Hollow
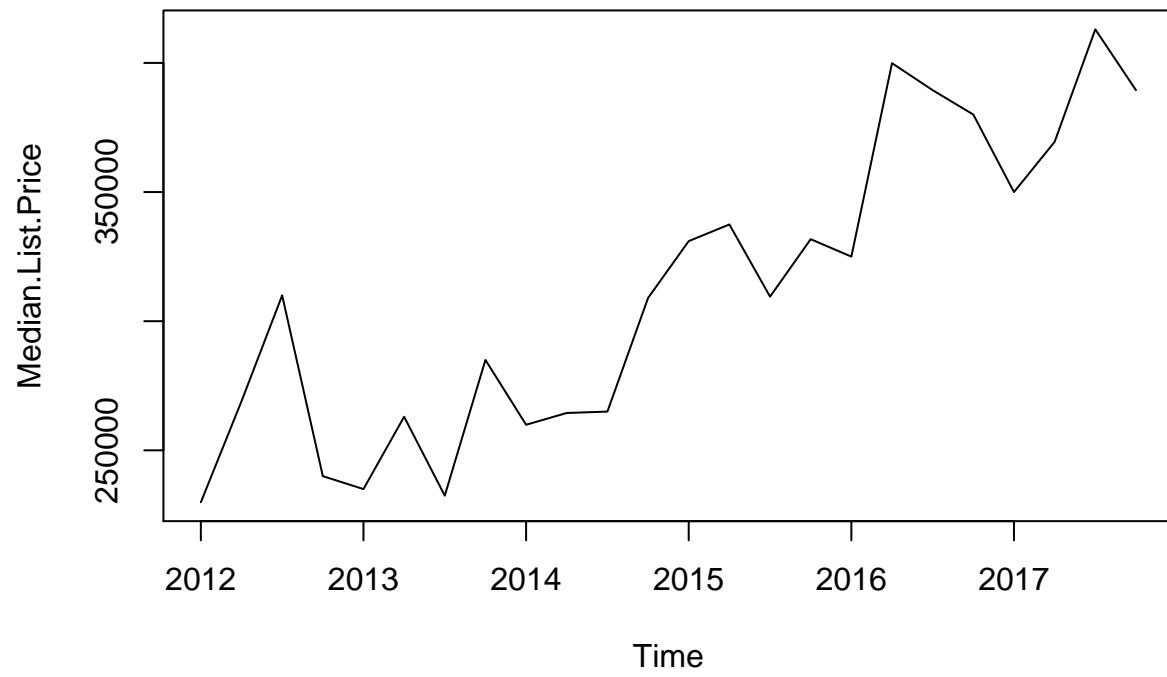
Portland, OR – Goose Hollow : Naive Model Forecast
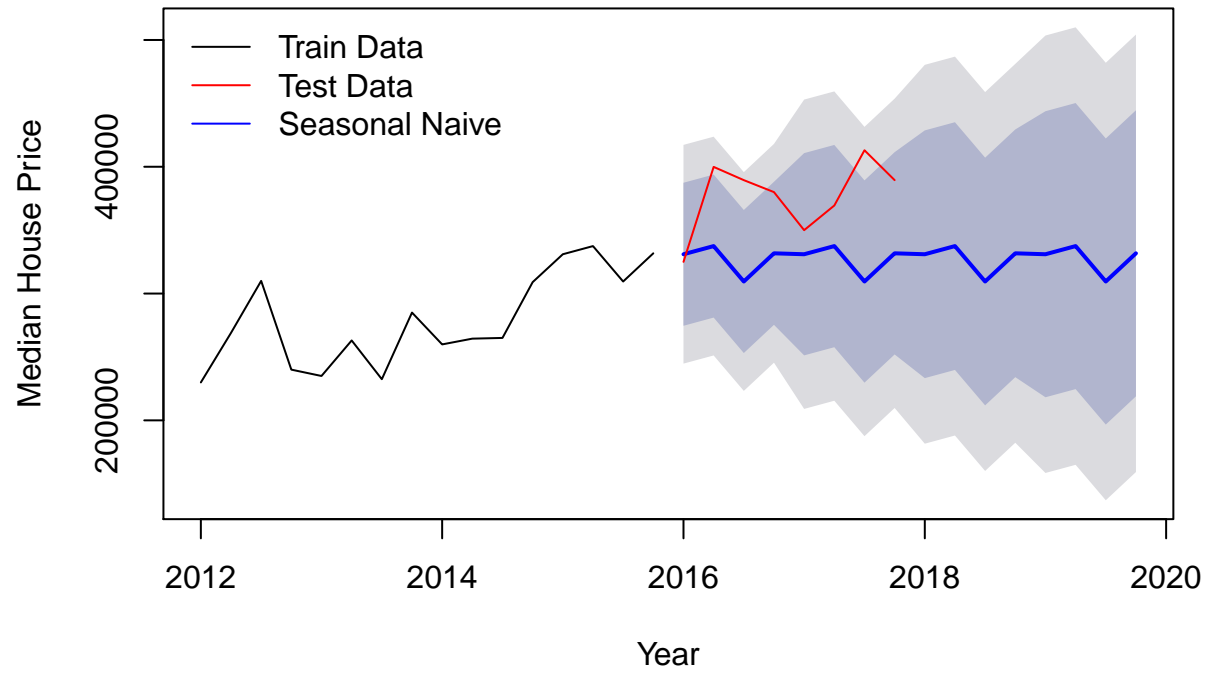
Portland, OR – Goose Hollow : Naive Model Forecast Residuals
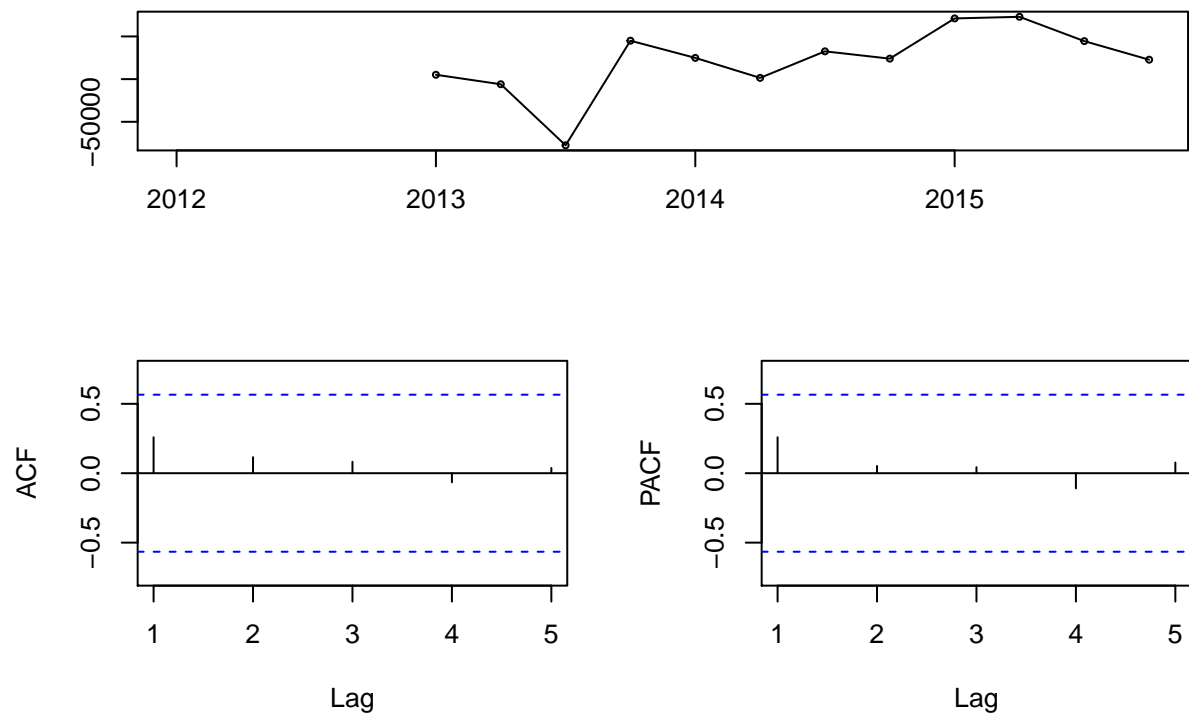
Portland, OR – Goose Hollow : Holt Winters Model Forecast
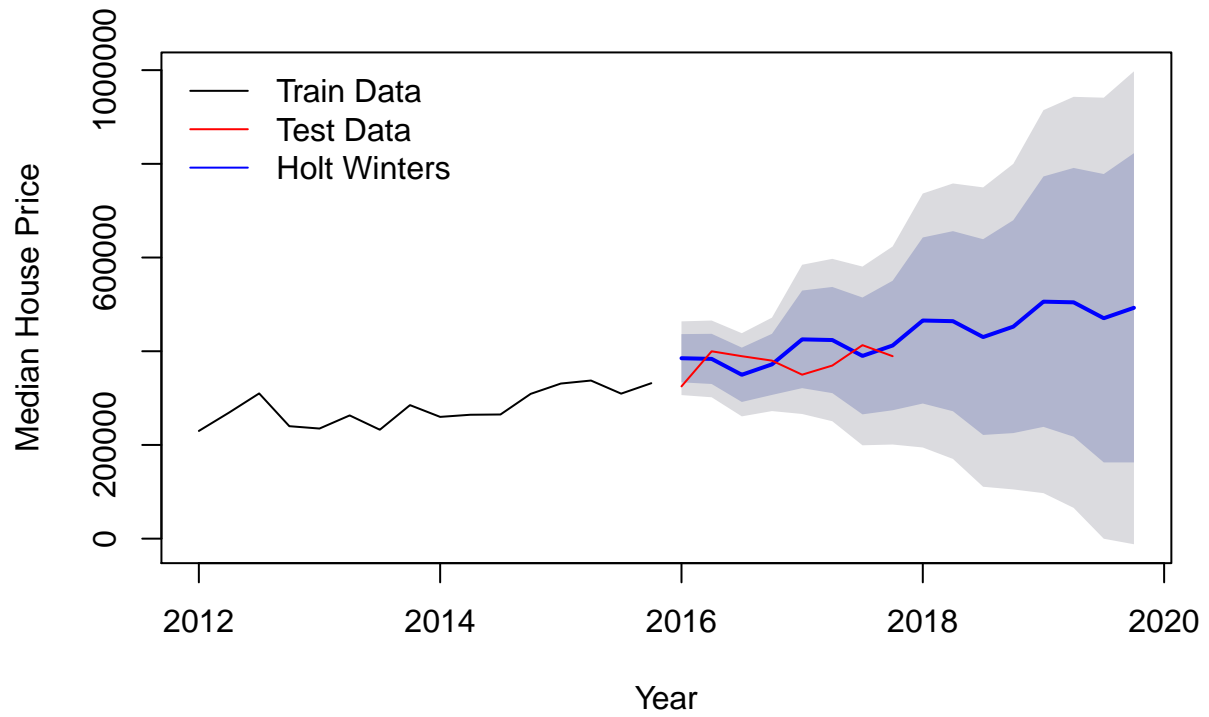
Legend:
- Train Data
- Test Data
- Holt Winters

Y-axis: Median House Price

X-axis: Year

Portland, OR – Goose Hollow : Holt Winters Model Forecast Residuals
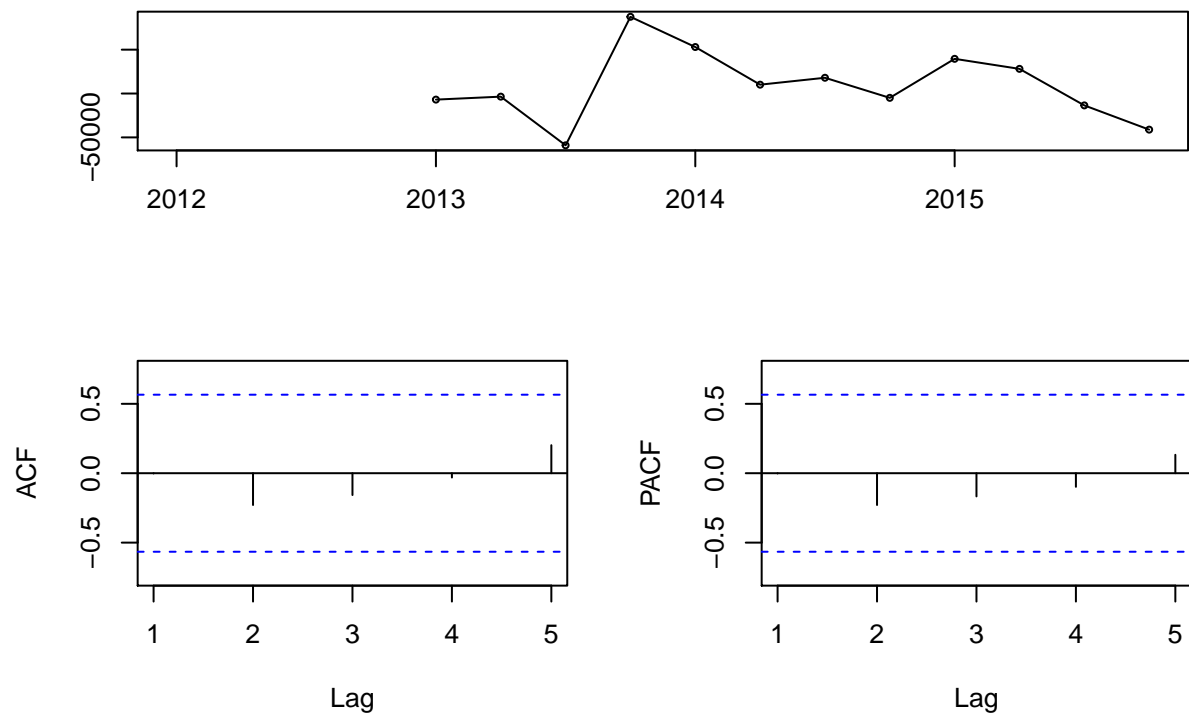

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Goose Hollow"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 21734.17 44006.72 35657.50  6.404028 12.34387 1.000000
## Test set     49606.25 59248.00 51106.25 12.620370 13.08191 1.433254
##                   ACF1 Theil's U
## Training set  0.25908900        NA
## Test set     -0.03548109  1.577117
## [1] "Holt Winters Accuracy for  Portland, OR - Goose Hollow"
##                   ME      RMSE      MAE       MPE      MAPE       MASE
## Training set   8925.191 39451.12 30436.95  2.825594 10.83317 0.8535917
## Test set     -15715.879 43601.36 37458.13 -4.834546 10.31865 1.0504979
##                    ACF1 Theil's U
## Training set -0.001865459        NA
## Test set      0.059582923  1.014562
```

Portland, OR – Goose Hollow : TS Training Model Comparison

Portland, OR – Goose Hollow : Full TS Models Comparison
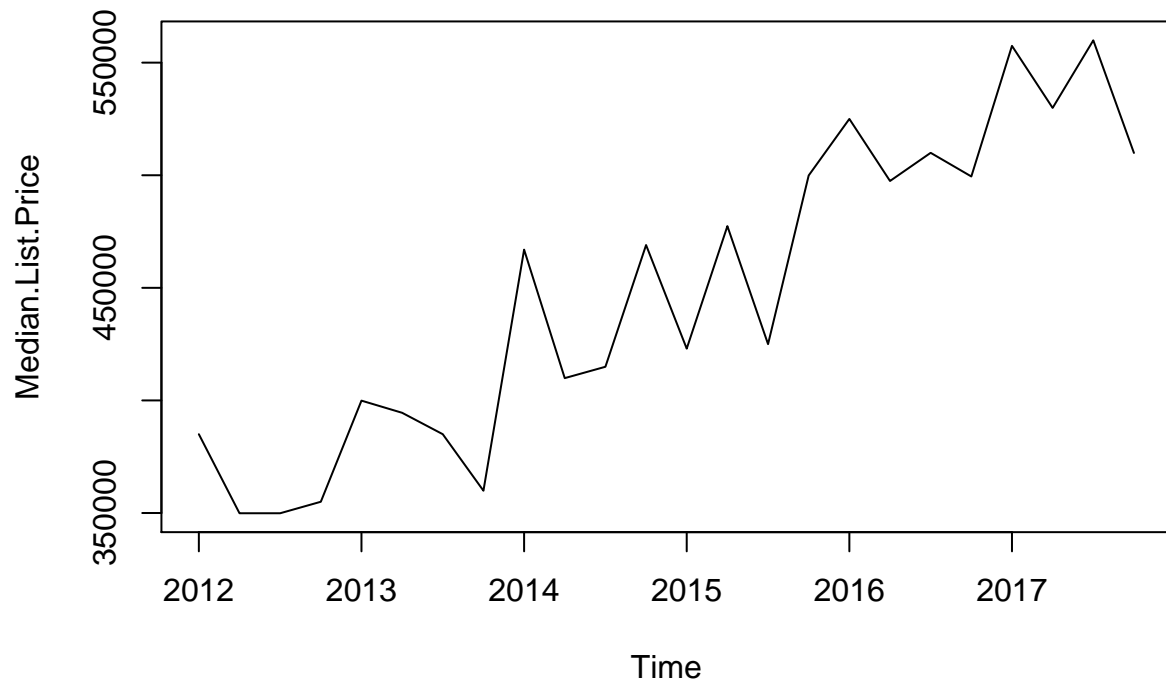
Legend:
- Train Data (black)
- Test Data (red)
- Holt Winters (blue)
- Seasonal Naive (green)

Y-axis: Median House Price

X-axis: Year

Portland, OR – Rose City Park

Portland, OR – Rose City Park : Naive Model Forecast
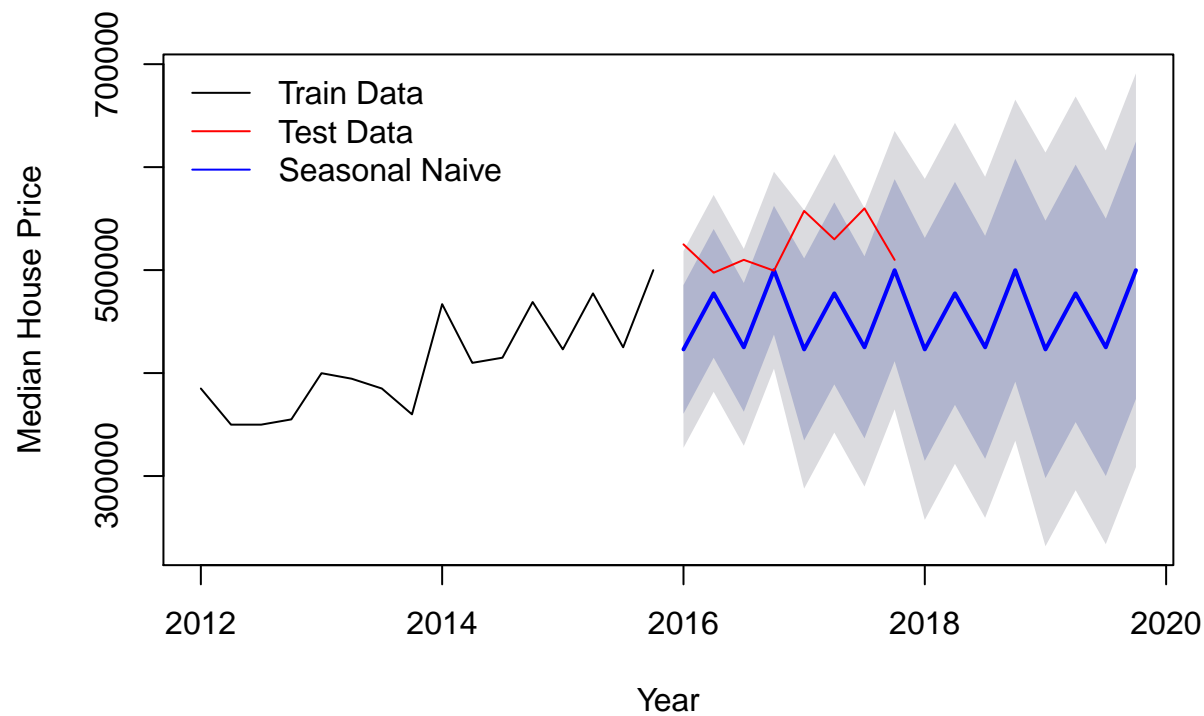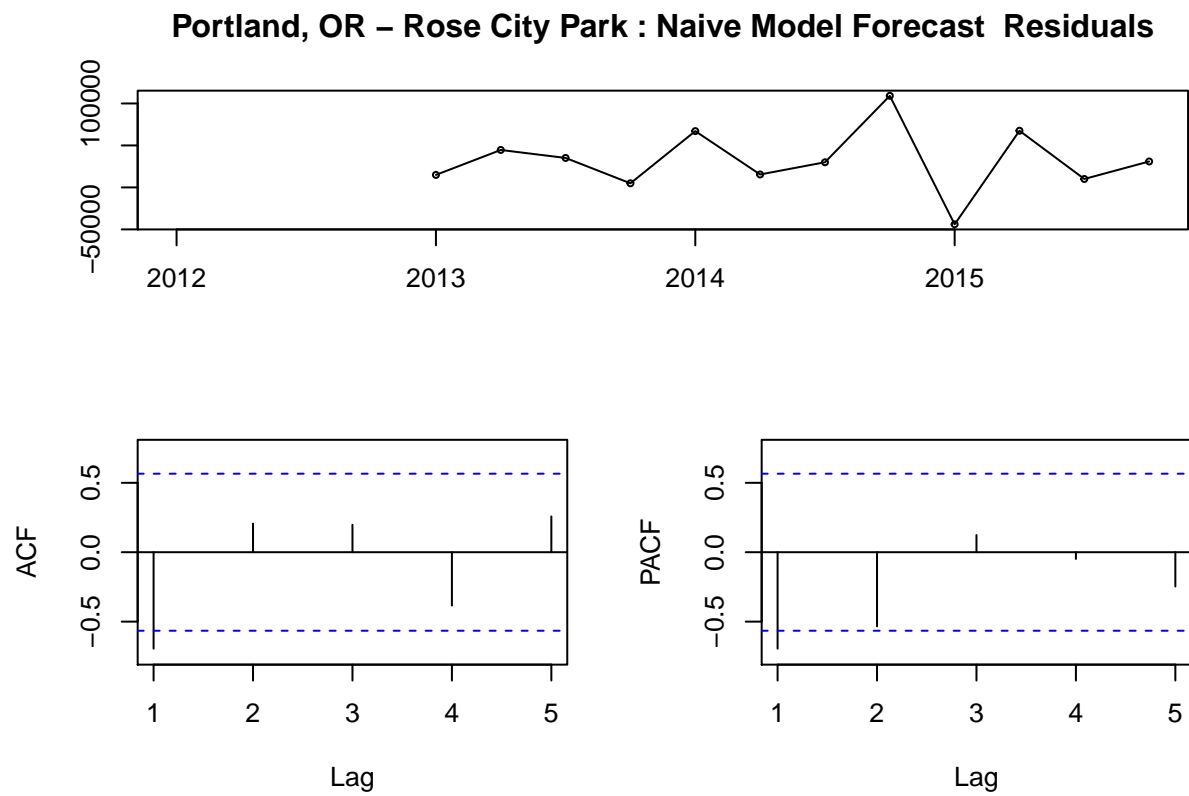
Portland, OR – Rose City Park : Naive Model Forecast Residuals

Portland, OR – Rose City Park : Holt Winters Model Forecast
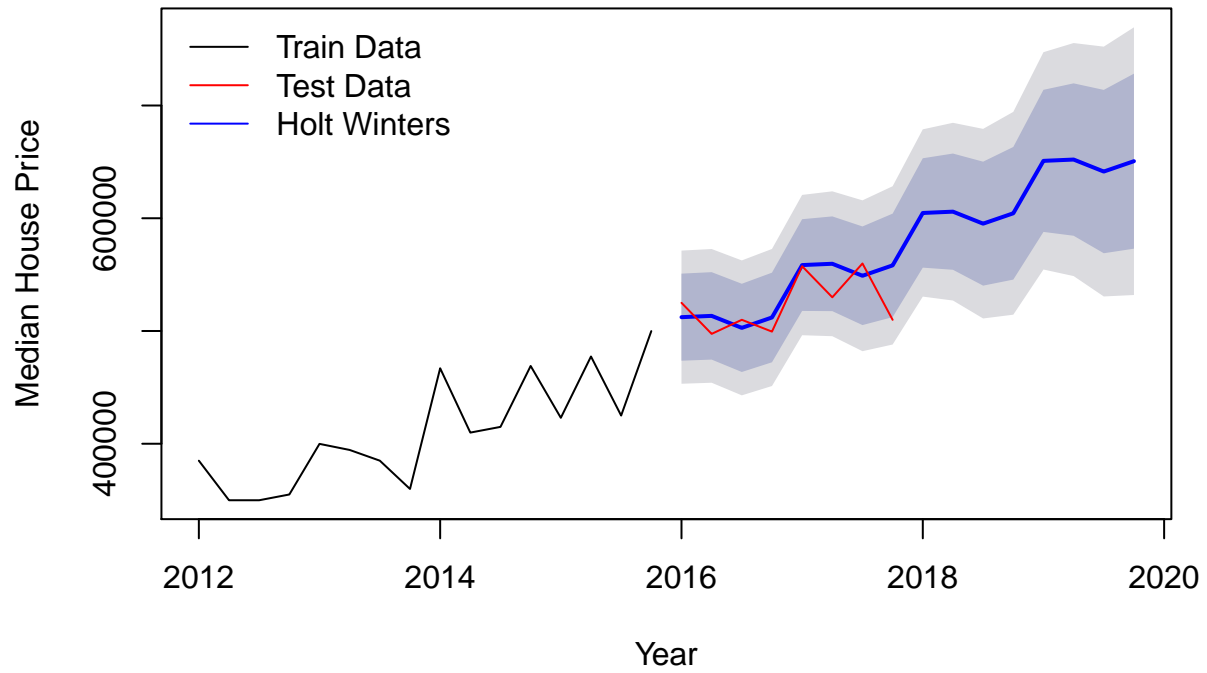
Portland, OR – Rose City Park : Holt Winters Model Forecast Residuals
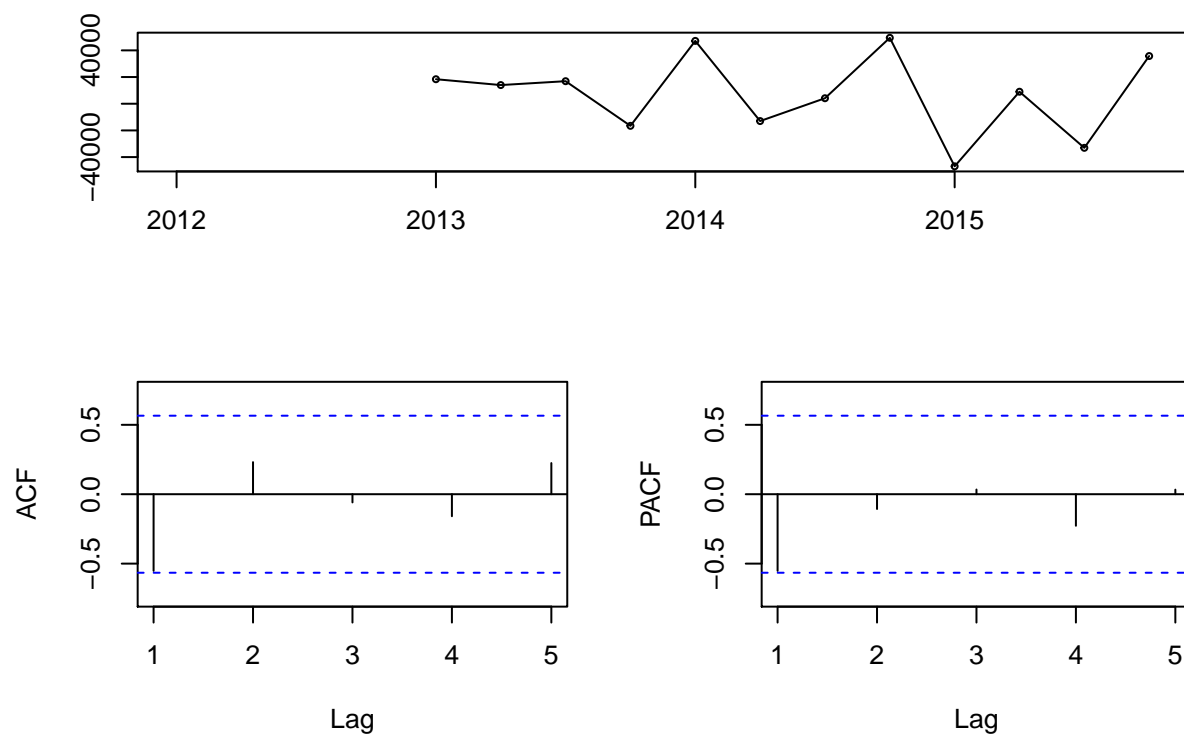

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Rose City Park"
##                    ME       RMSE      MAE       MPE      MAPE      MASE
## Training set 32125.00 48771.17 39450.00  7.200072  8.93175 1.000000
## Test set     67299.94 84523.43 67412.44 12.513561 12.53609 1.708807
##                   ACF1 Theil's U
## Training set -0.6946847        NA
## Test set     -0.6733672  2.393273
## [1] "Holt Winters Accuracy for  Portland, OR - Rose City Park"
##                    ME       RMSE      MAE       MPE      MAPE      MASE
## Training set  7090.340 29703.81 25342.55  1.377808 5.817465 0.6423966
## Test set     -9591.336 22256.24 17298.84 -1.900490 3.346271 0.4385004
##                   ACF1 Theil's U
## Training set -0.5524141        NA
## Test set     -0.5278417  0.634629
```

Portland, OR – Rose City Park : TS Training Model Comparison

Median House Price

Year

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Portland, OR – Rose City Park : Full TS Models Comparison
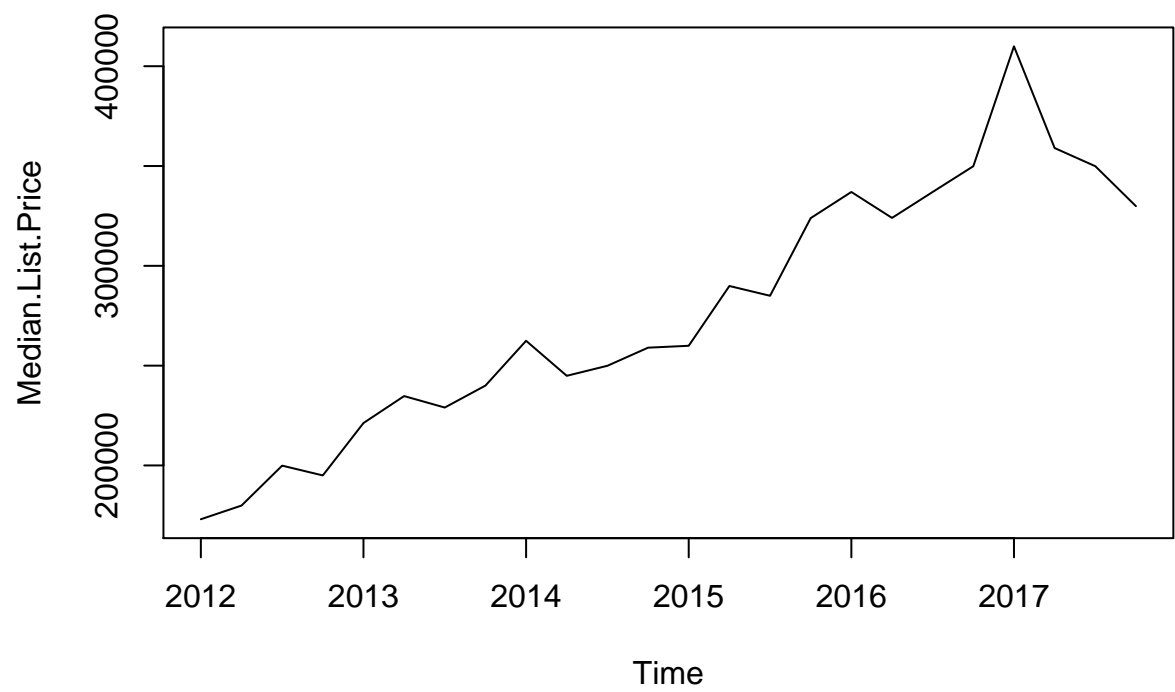
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

X-axis: Year
Y-axis: Median House Price

Portland, OR – Mount Scott–Arleta

Portland, OR – Mount Scott–Arleta : Naive Model Forecast
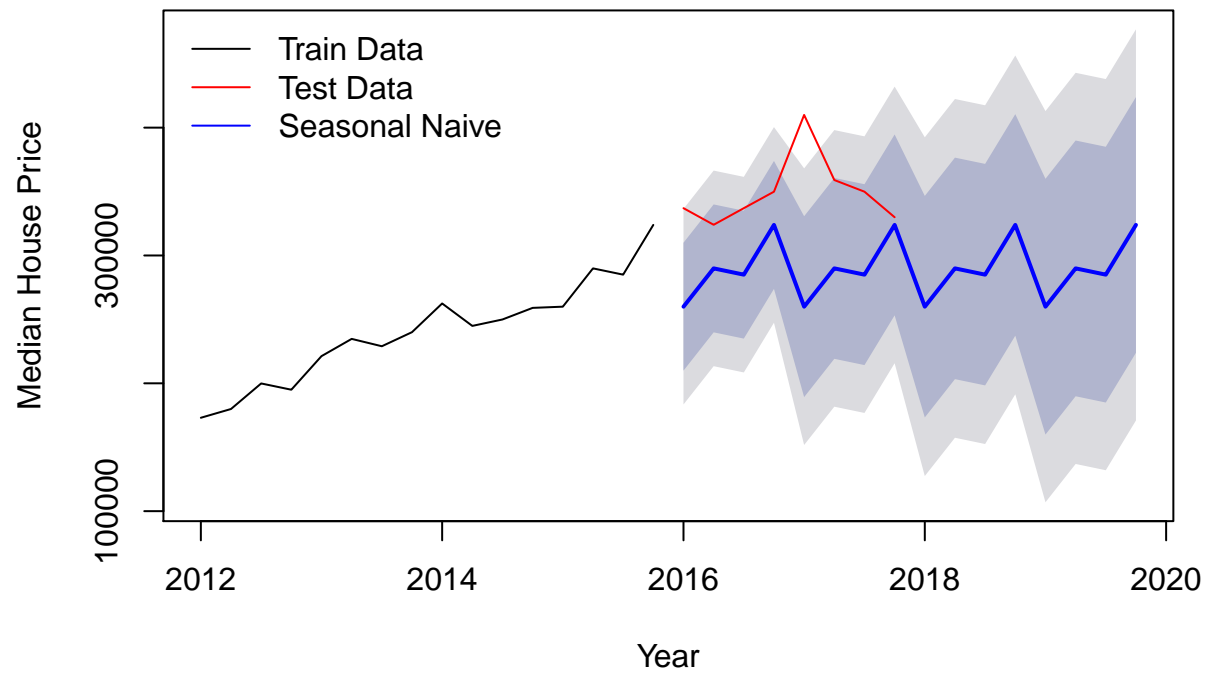
Portland, OR – Mount Scott–Arleta : Naive Model Forecast Residuals
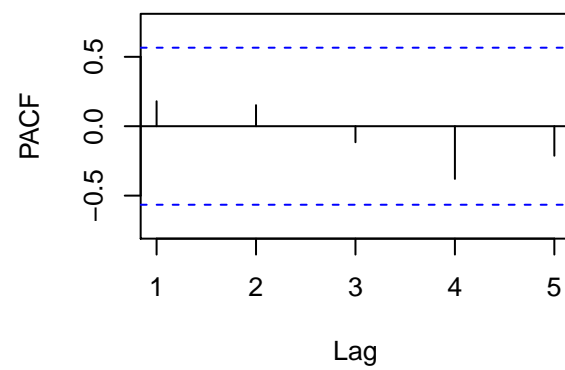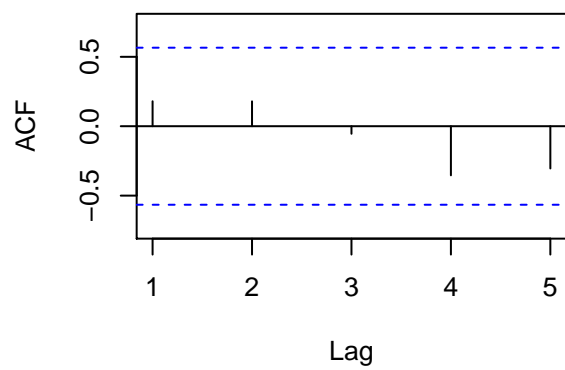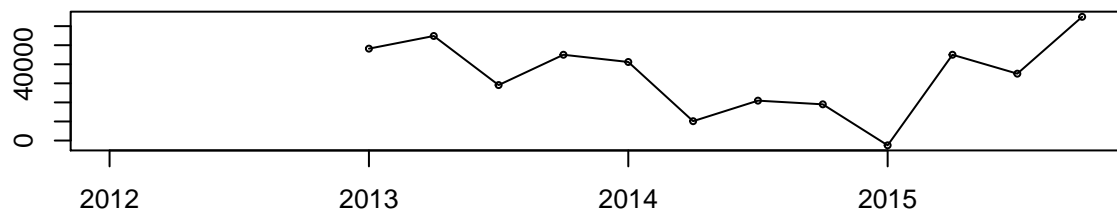
Portland, OR – Mount Scott–Arleta : Holt Winters Model Forecast
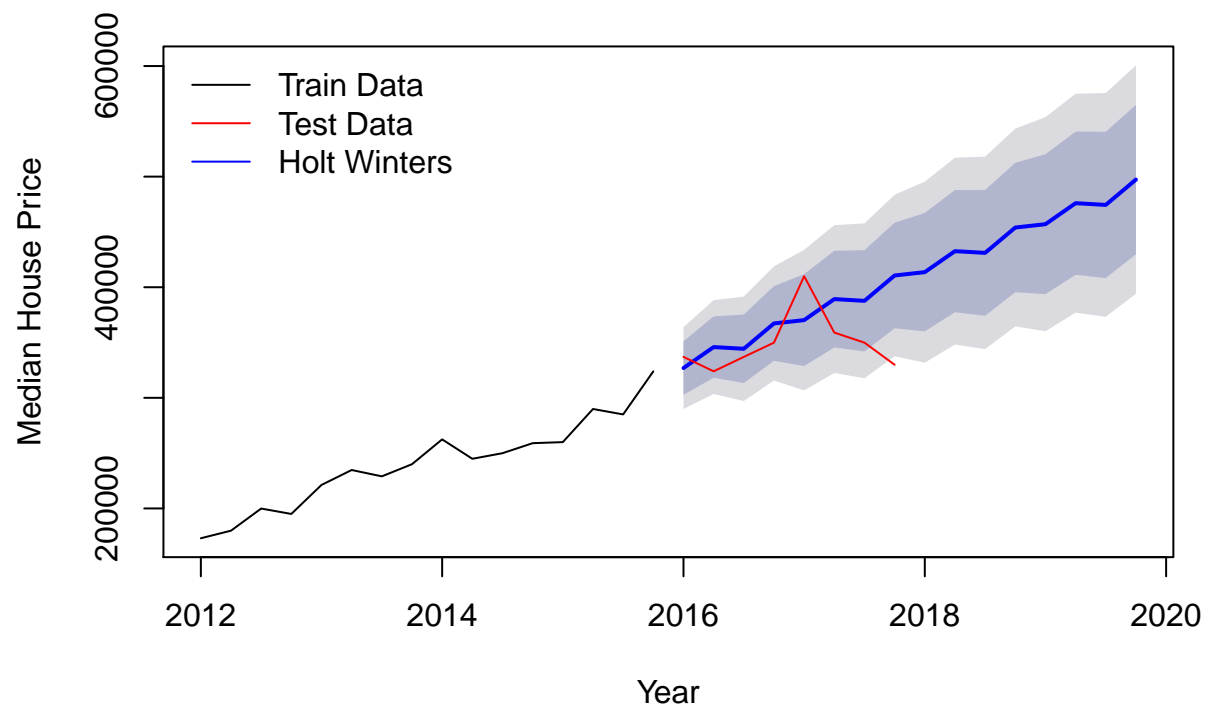
Portland, OR – Mount Scott–Arleta : Holt Winters Model Forecast Residuals
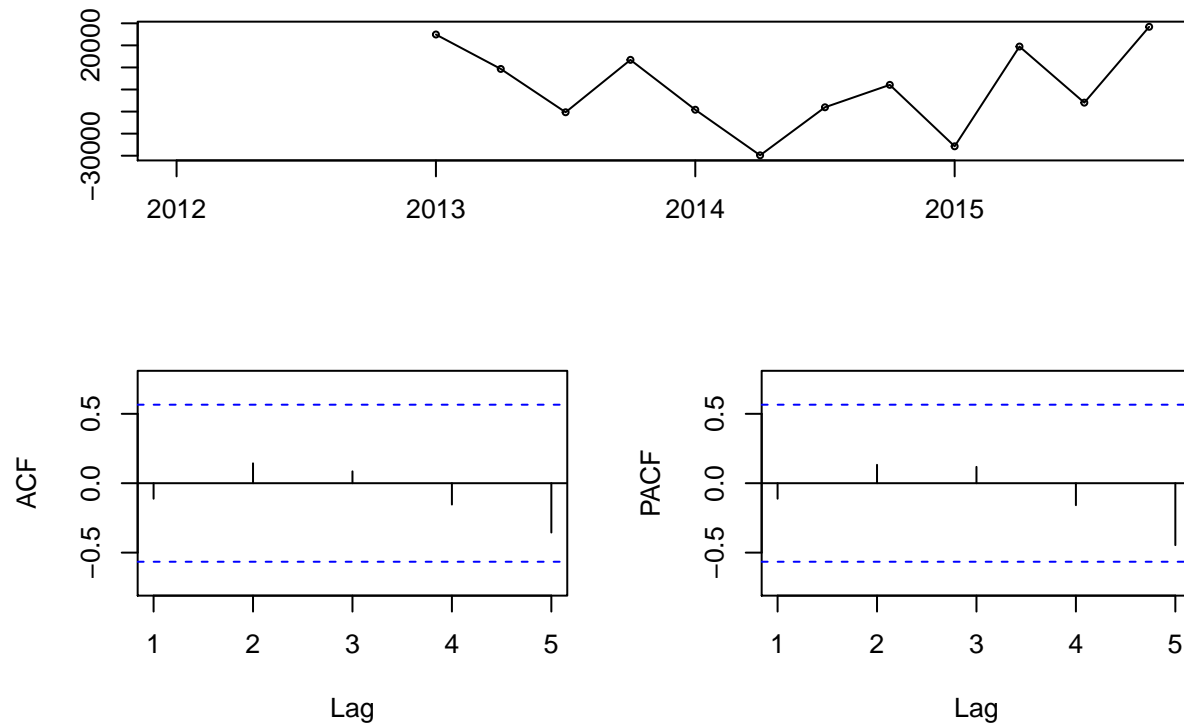

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Mount Scott-Arleta"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 34241.67 39026.04 34658.33 13.25535 13.41563 1.00000
## Test set     59893.75 72458.90 59893.75 16.55672 16.55672 1.72812
##                   ACF1 Theil's U
## Training set  0.1798666        NA
## Test set     -0.1818654  2.319356
## [1] "Holt Winters Accuracy for  Portland, OR - Mount Scott-Arleta"
##                    ME      RMSE      MAE       MPE     MAPE      MASE
## Training set   720.2183 18077.16 15559.02  0.1464793 6.043161 0.4489258
## Test set     -18206.2823 37705.90 30648.87 -5.6171485 8.785513 0.8843147
##                   ACF1 Theil's U
## Training set -0.1116302        NA
## Test set      0.0776605  1.298733
```

Portland, OR – Mount Scott–Arleta : TS Training Model Comparison

Portland, OR – Mount Scott–Arleta : Full TS Models Comparison
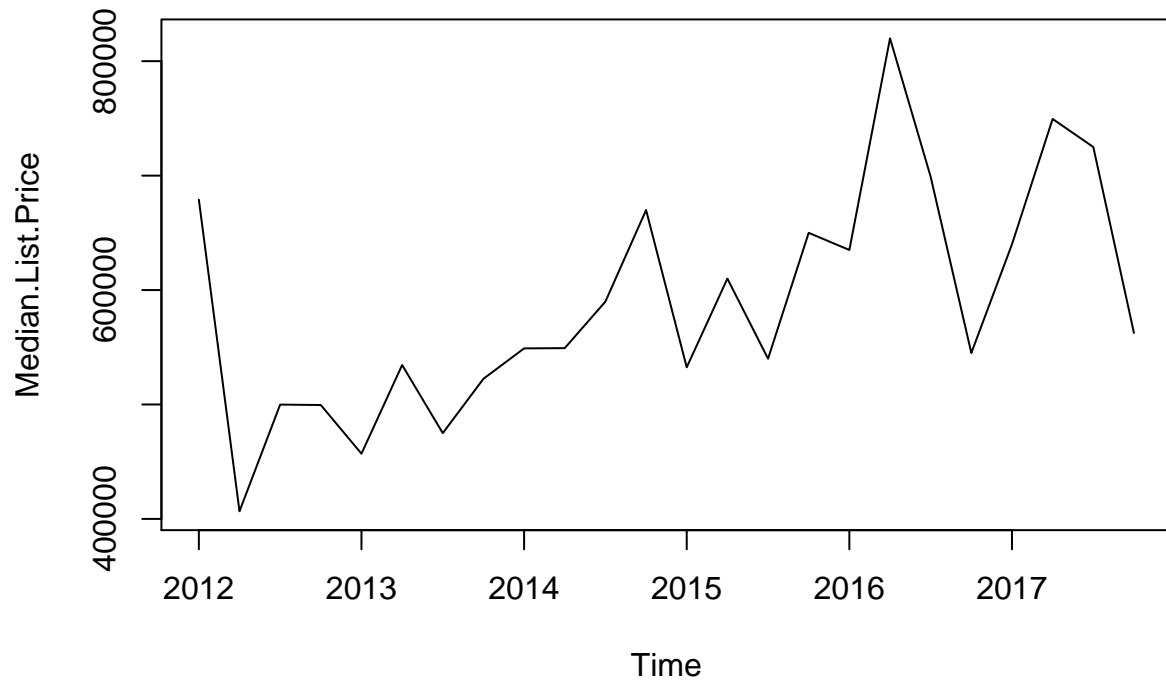
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

Portland, OR – Grant Park
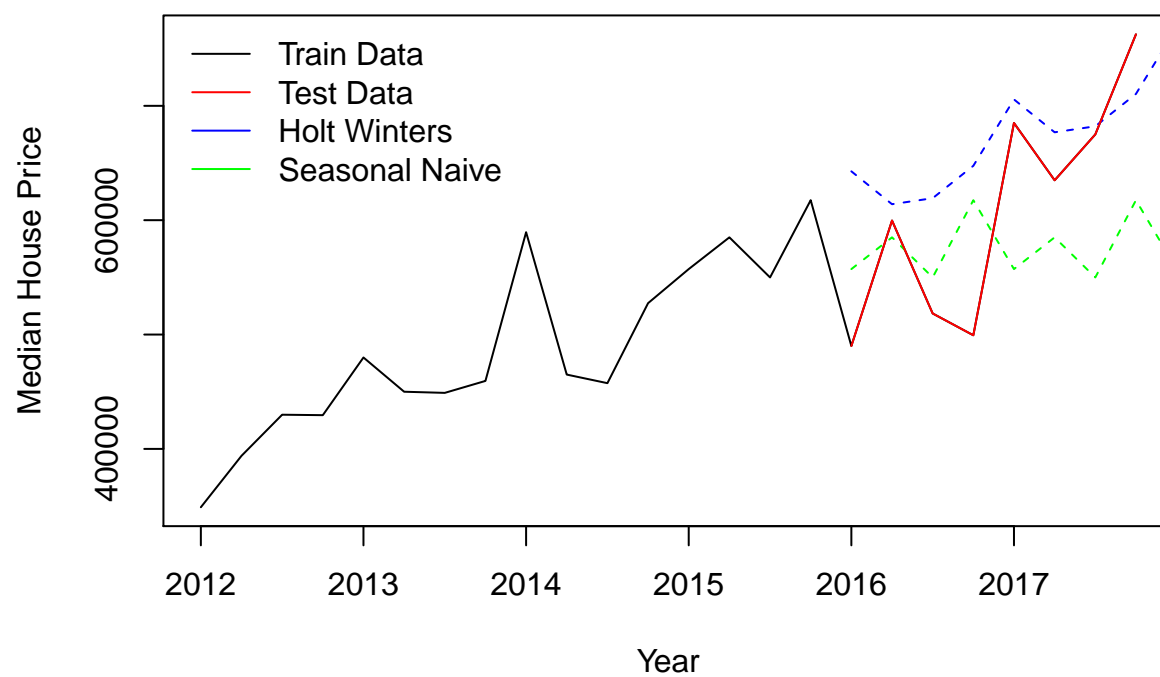
Portland, OR – Grant Park : Naive Model Forecast
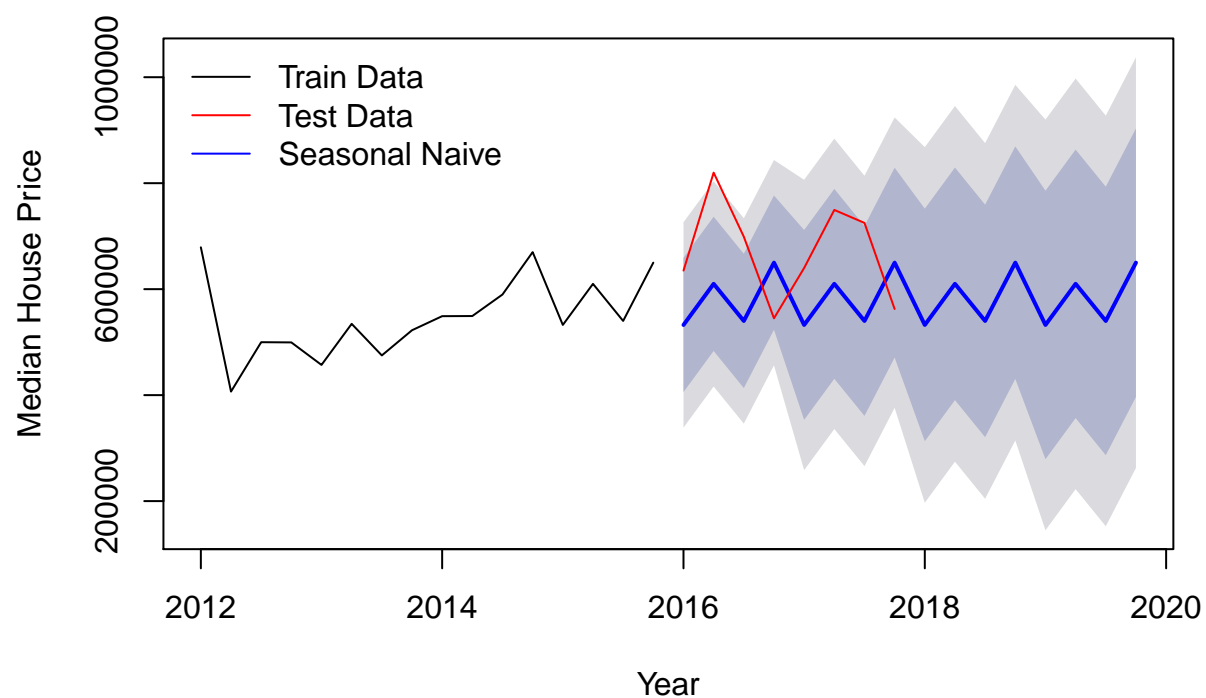
Portland, OR – Grant Park : Naive Model Forecast Residuals

Portland, OR – Grant Park : Holt Winters Model Forecast
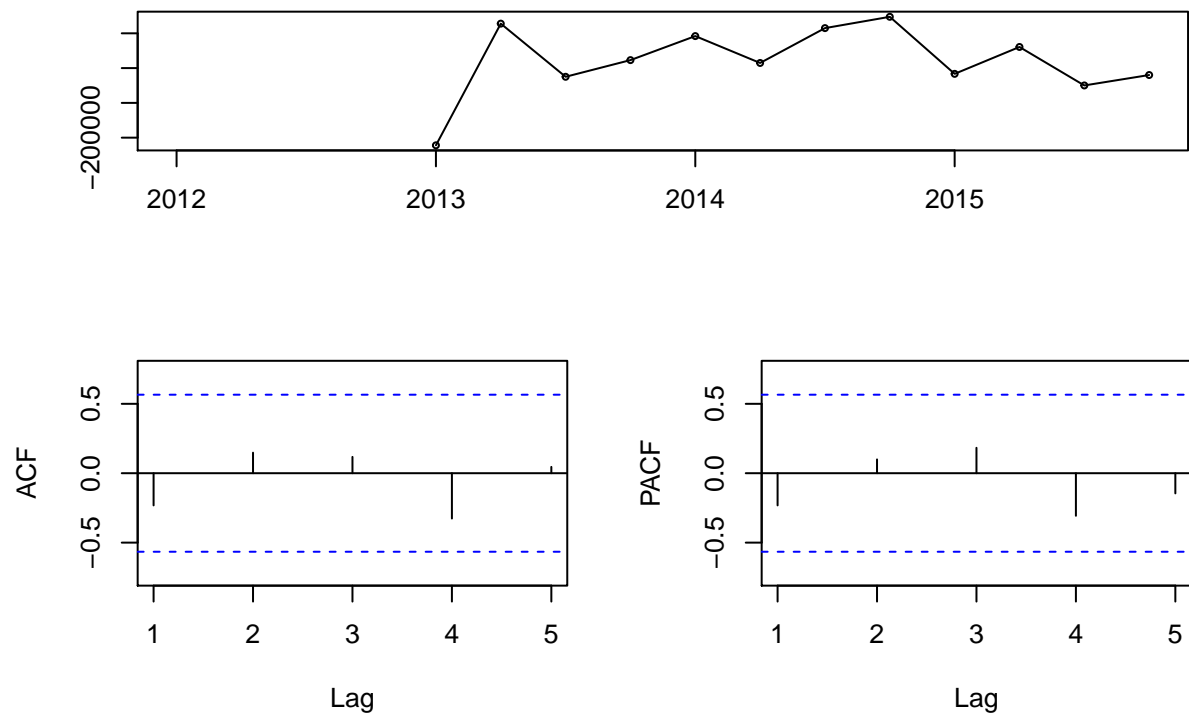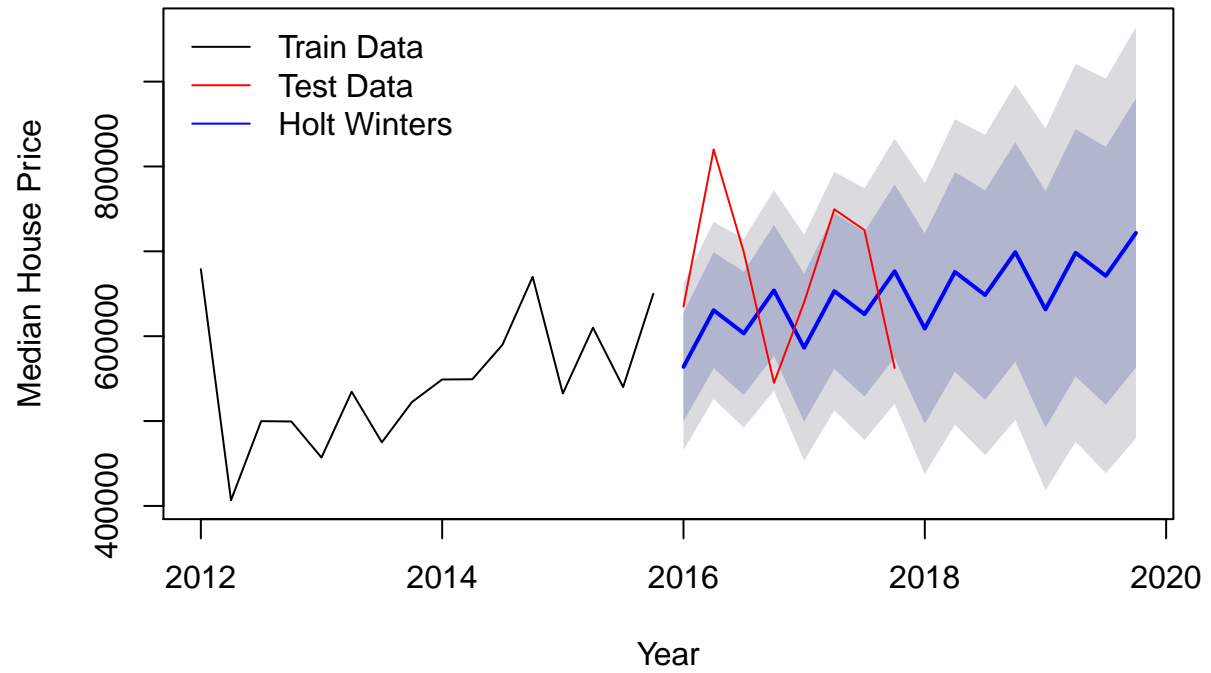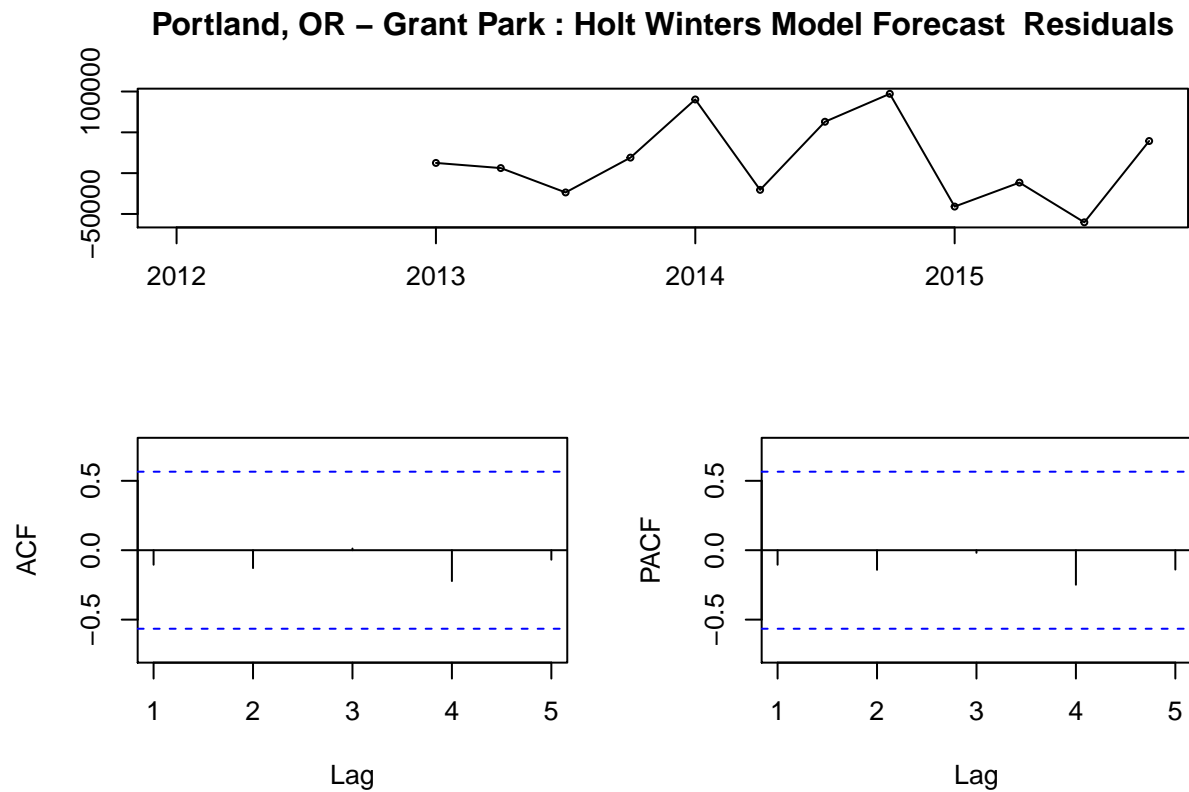
Portland, OR – Grant Park : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Grant Park"
##                     ME       RMSE        MAE        MPE      MAPE      MASE
## Training set 20614.58   98848.48   76160.42   2.497144  14.03657  1.000000
## Test set     88868.75  143085.97  136993.75  11.324999  20.03040  1.798753
##                   ACF1 Theil's U
## Training set -0.2319123        NA
## Test set     -0.1809366  1.115956
## [1] "Holt Winters Accuracy for  Portland, OR - Grant Park"
##                     ME       RMSE        MAE        MPE      MAPE      MASE
## Training set 14226.43   50067.79   40364.54  2.148620  7.055308  0.5299937
## Test set     47770.79  110065.94  103515.88  5.326169  15.391896  1.3591821
##                   ACF1 Theil's U
## Training set -0.1047061        NA
## Test set     -0.0488198 0.8699483
```

Portland, OR – Grant Park : TS Training Model Comparison
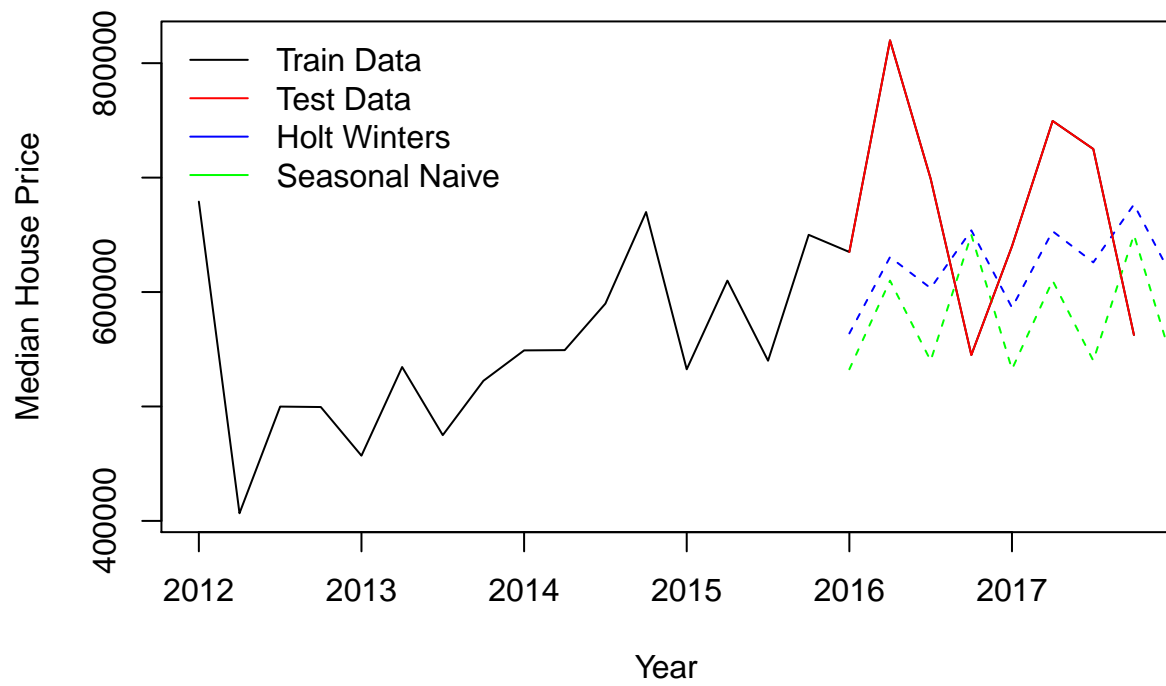
Portland, OR – Grant Park : Full TS Models Comparison
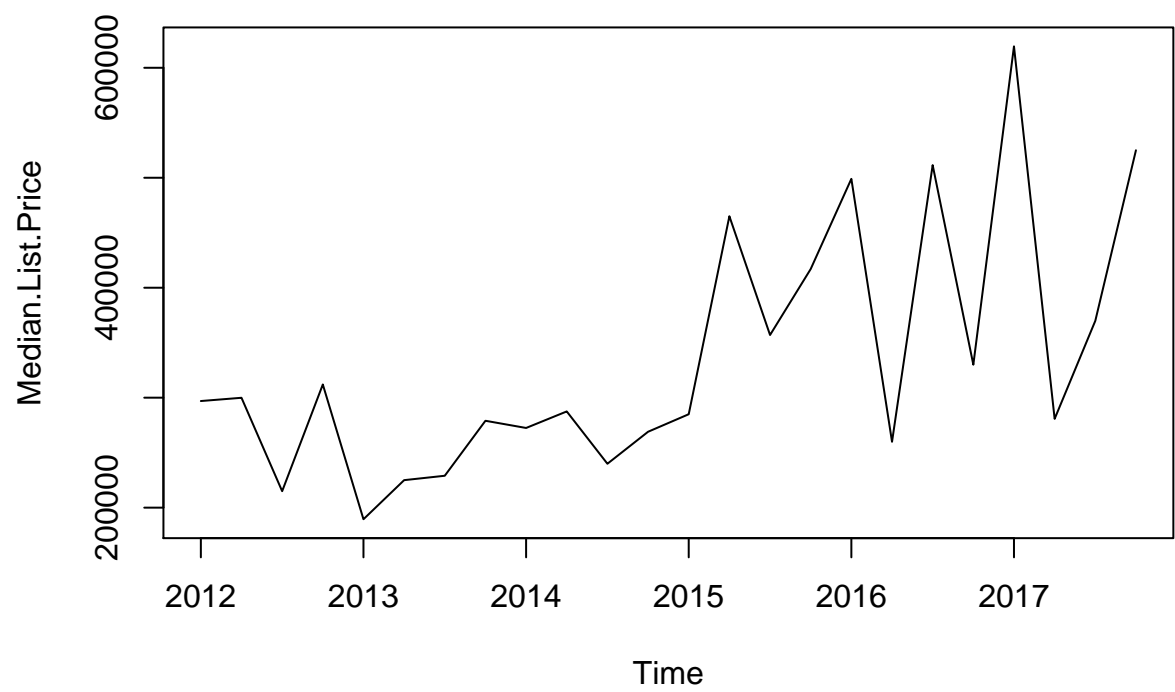
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

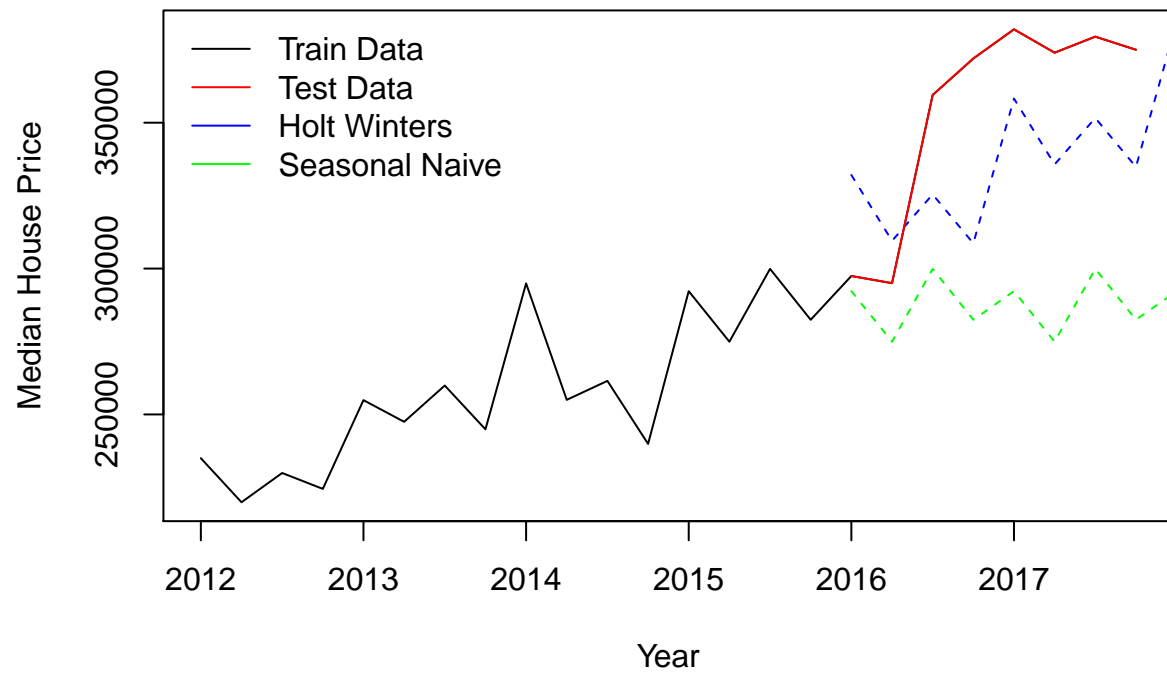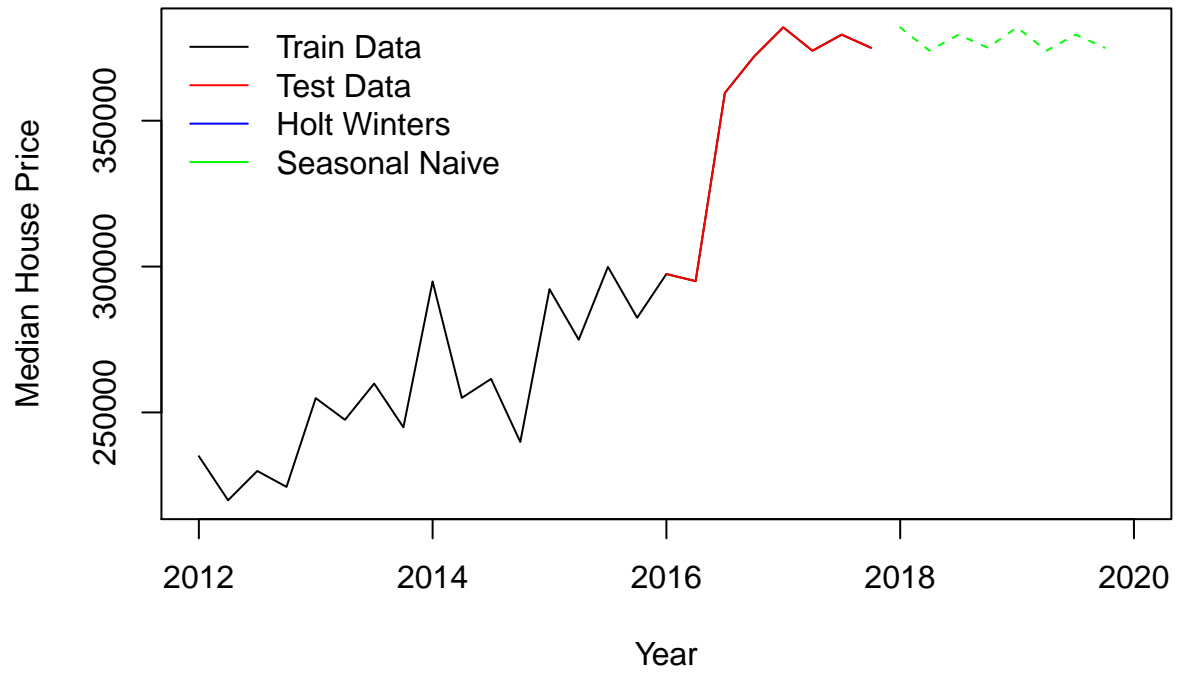# Portland, OR – Sullivan's Gulch

Portland, OR – Sullivan's Gulch : Naive Model Forecast
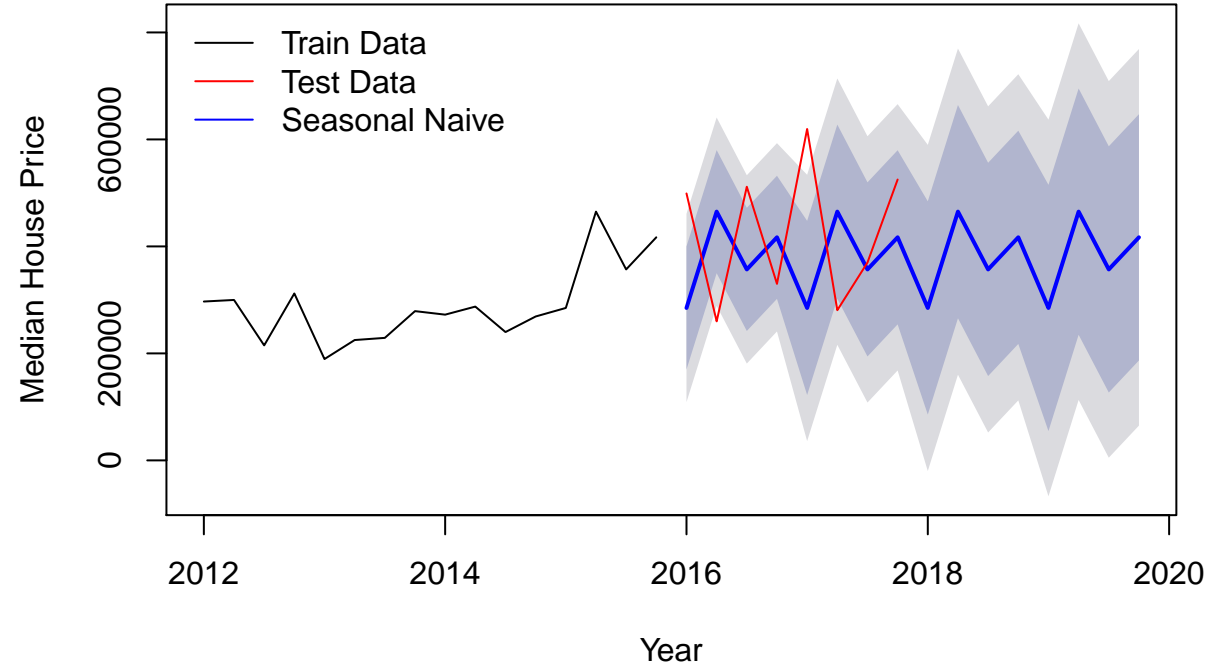
Portland, OR – Sullivan's Gulch : Naive Model Forecast Residuals
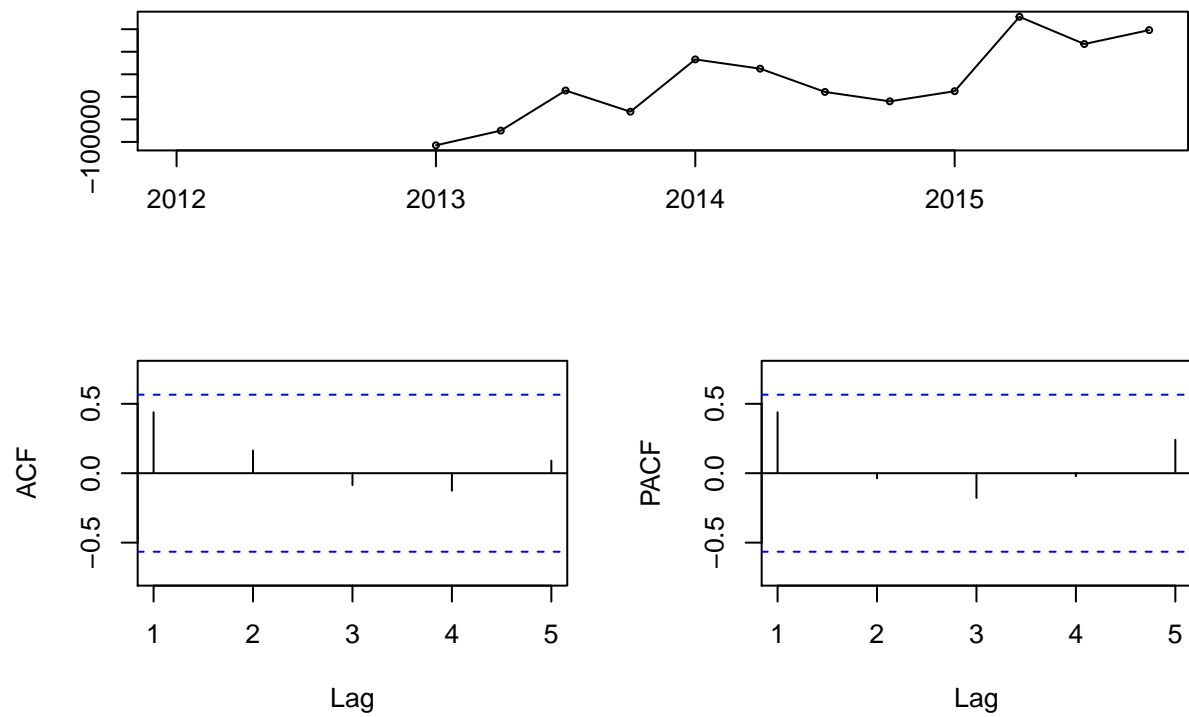
Portland, OR – Sullivan's Gulch : Holt Winters Model Forecast
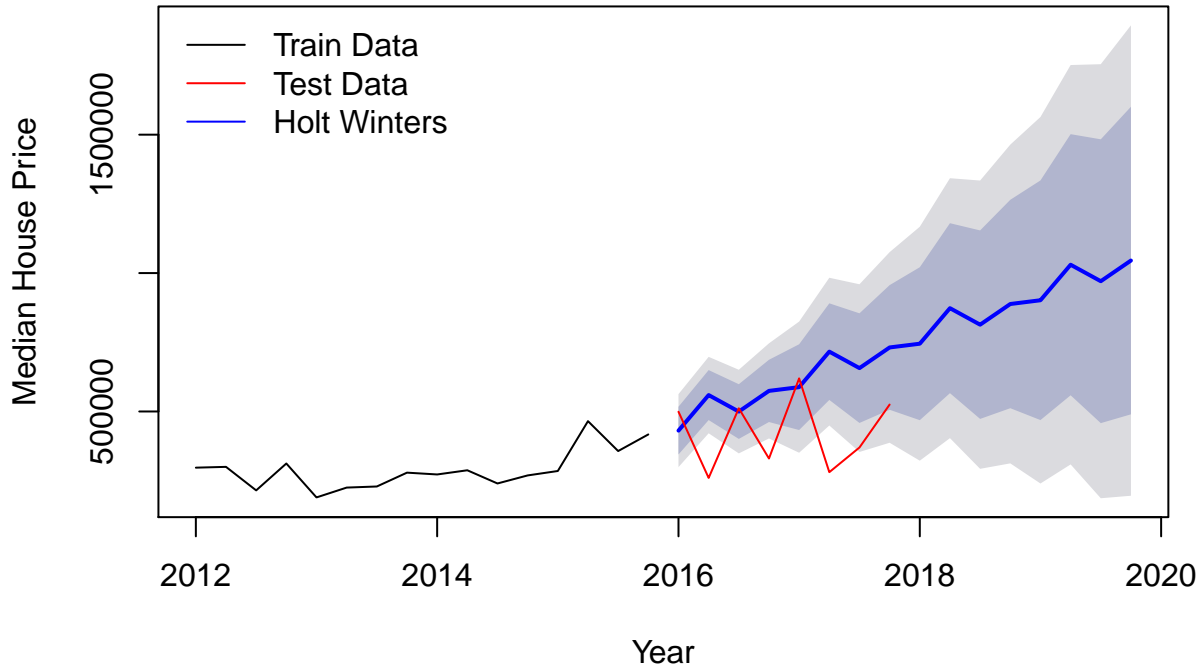
Portland, OR – Sullivan's Gulch : Holt Winters Model Forecast Residuals
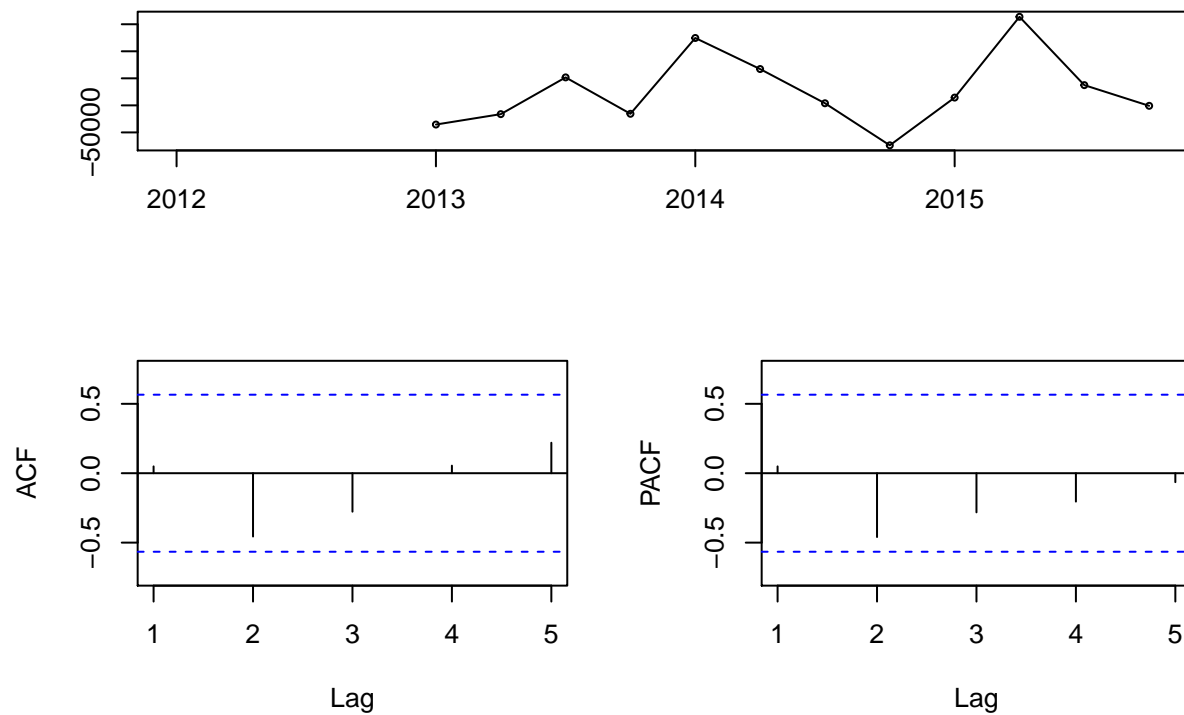

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Sullivan's Gulch"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 33345.83  89789.45  70912.5  5.679693 23.27595 1.000000
## Test set     43456.25 186086.28 162543.8 -2.467904 40.25869 2.292173
##                  ACF1 Theil's U
## Training set  0.4395742       NA
## Test set     -0.7016045 0.8156198
## [1] "Holt Winters Accuracy for  Portland, OR - Sullivan's Gulch"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set   26748.63  69735.31  50405.99   7.073889 16.93471 0.7108195
## Test set     -170040.43 242230.71 197965.62 -54.999428 60.27253 2.7916886
##                  ACF1 Theil's U
## Training set  0.04921221       NA
## Test set     -0.42478402 0.9631414
```

Portland, OR – Sullivan's Gulch : TS Training Model Comparison
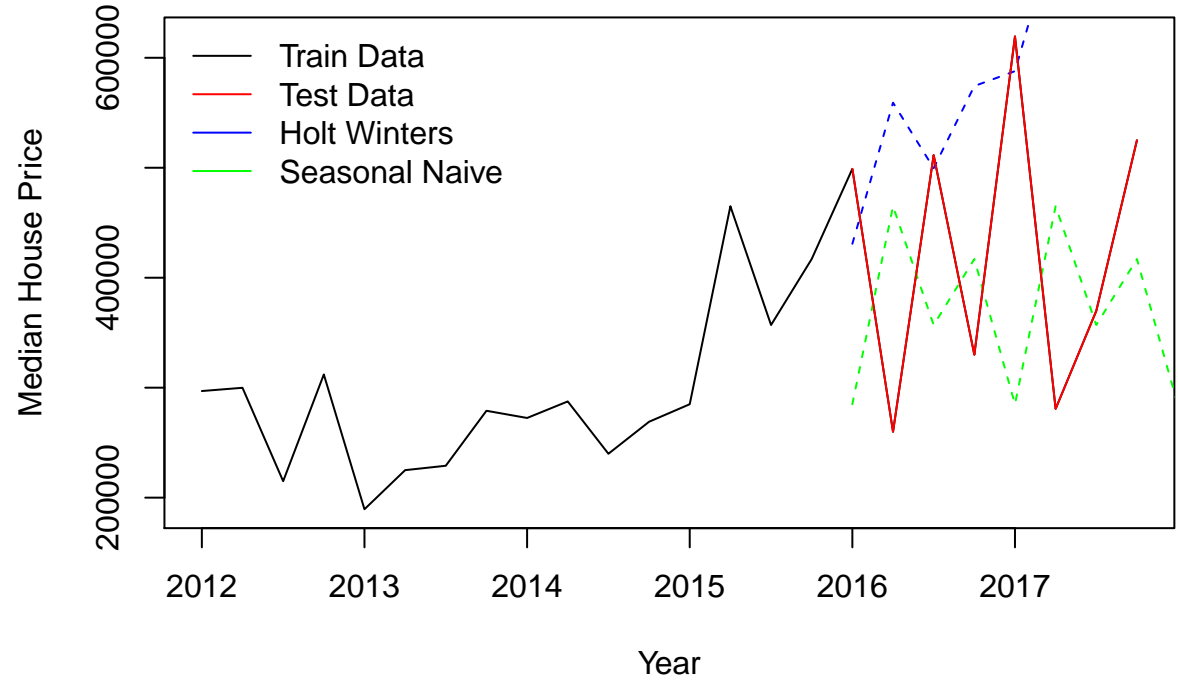
# Portland, OR – Sullivan's Gulch : Full TS Models Comparison
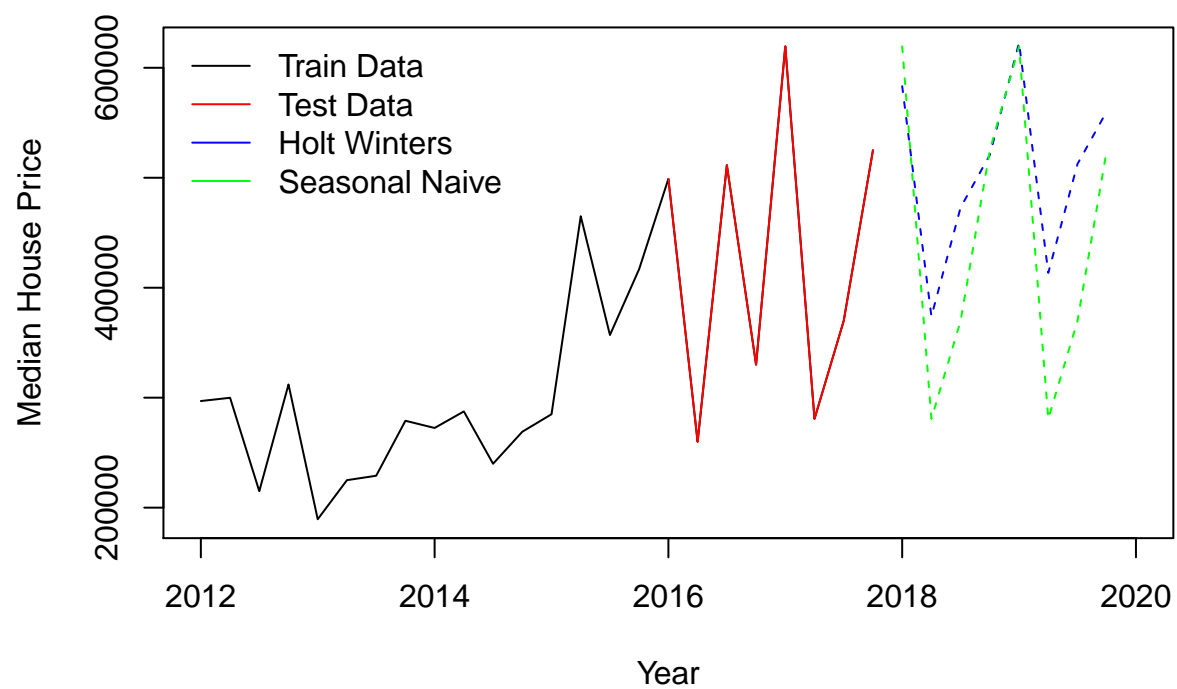
Portland, OR − Piedmont
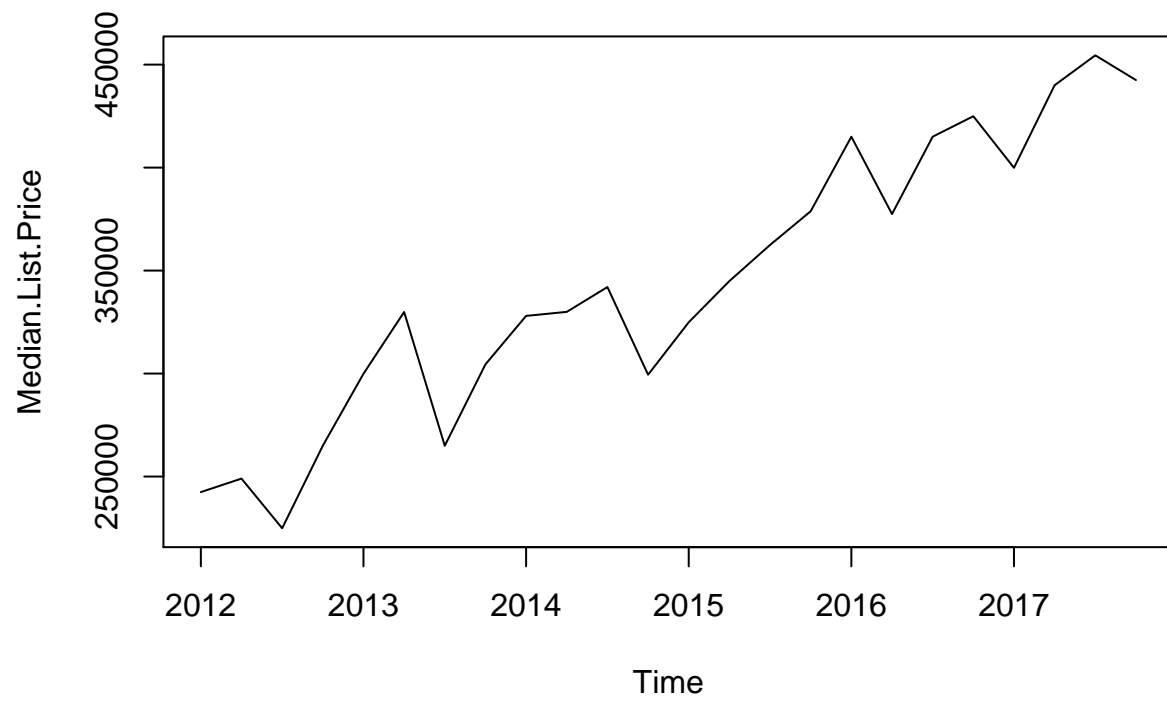
Portland, OR – Piedmont : Naive Model Forecast
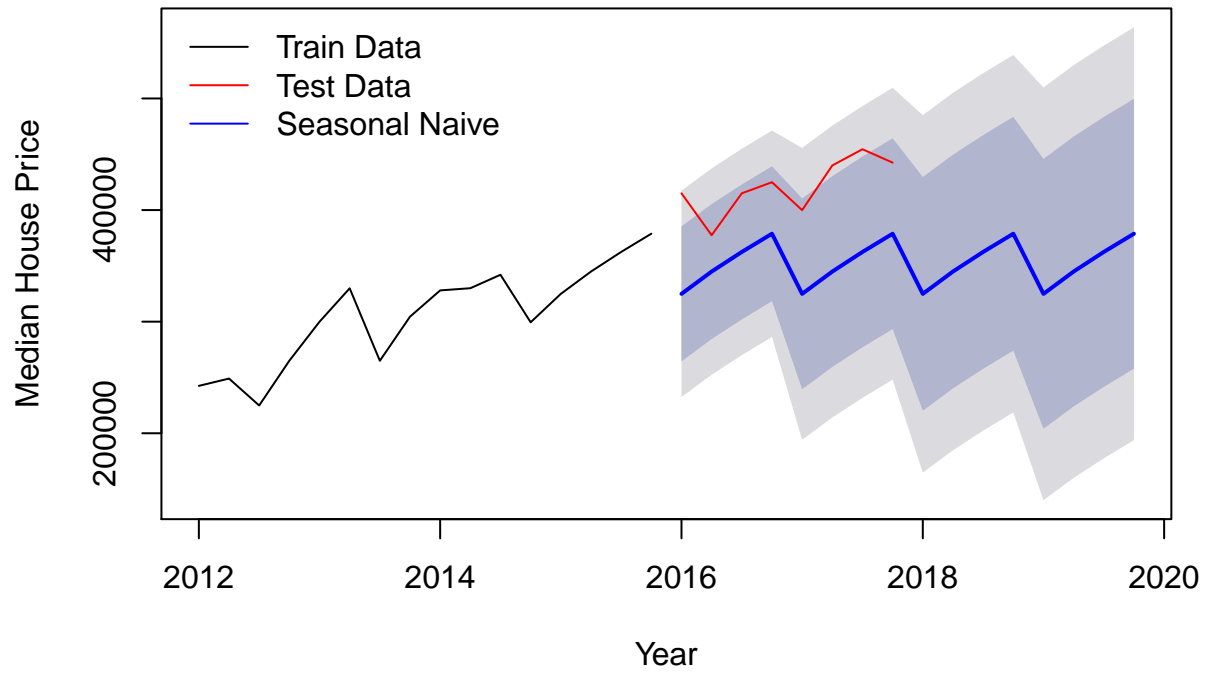
Portland, OR – Piedmont : Naive Model Forecast Residuals

Portland, OR – Piedmont : Holt Winters Model Forecast
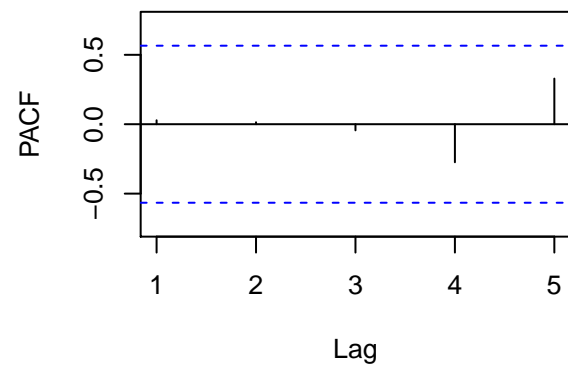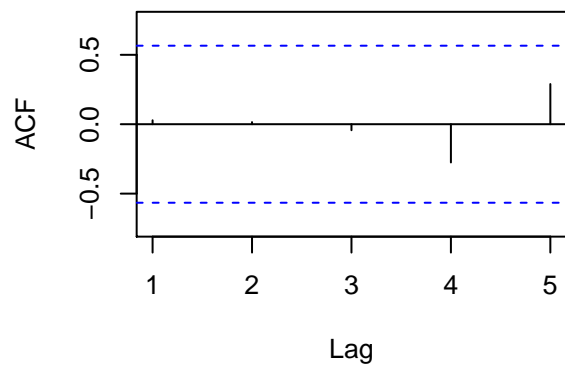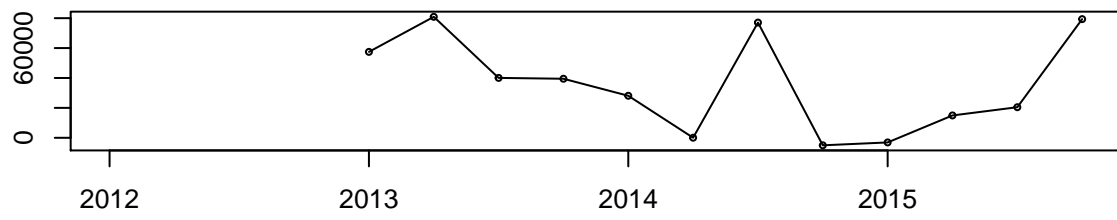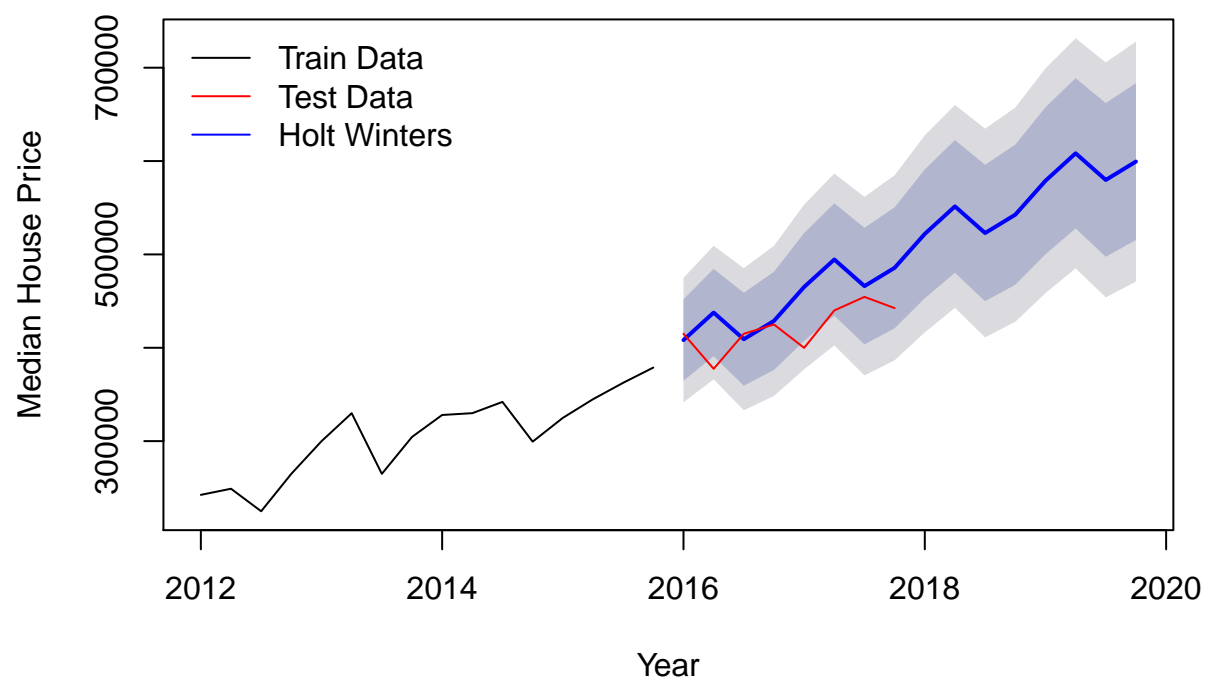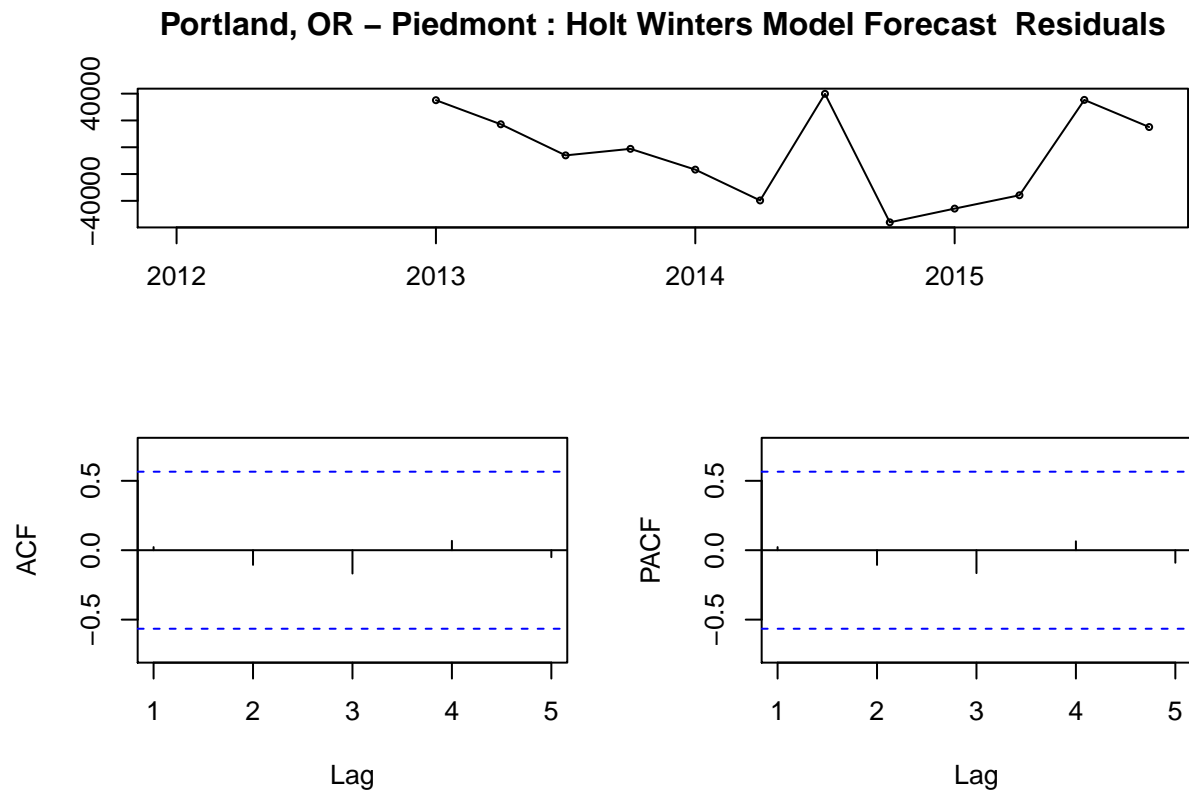
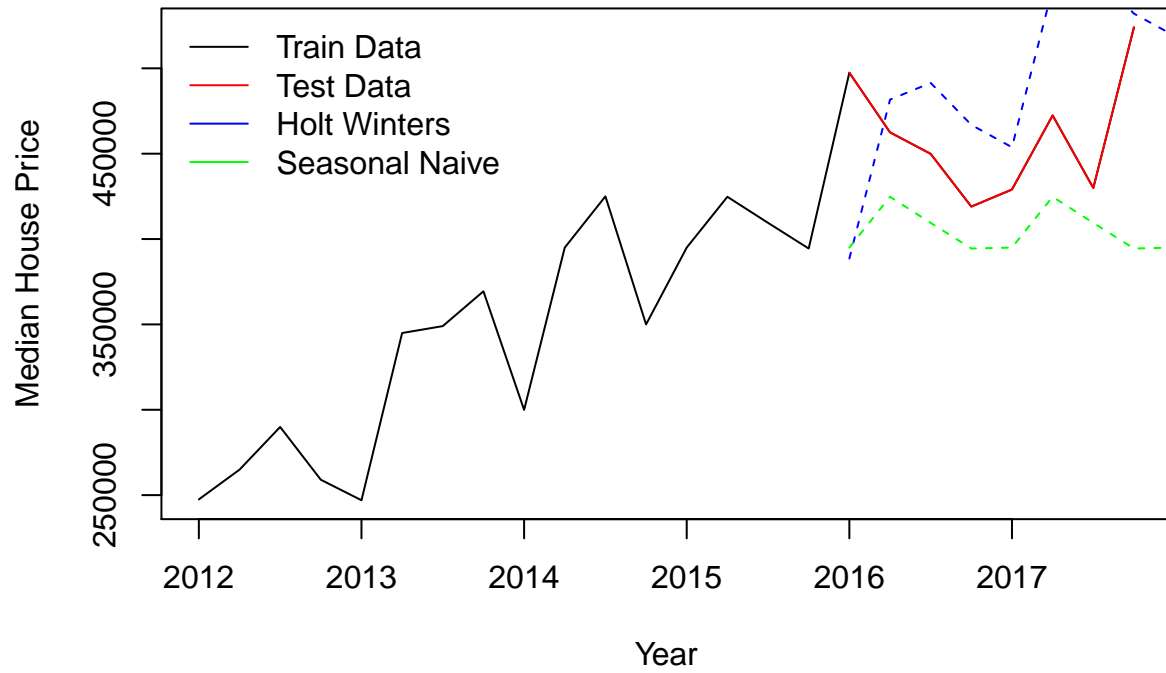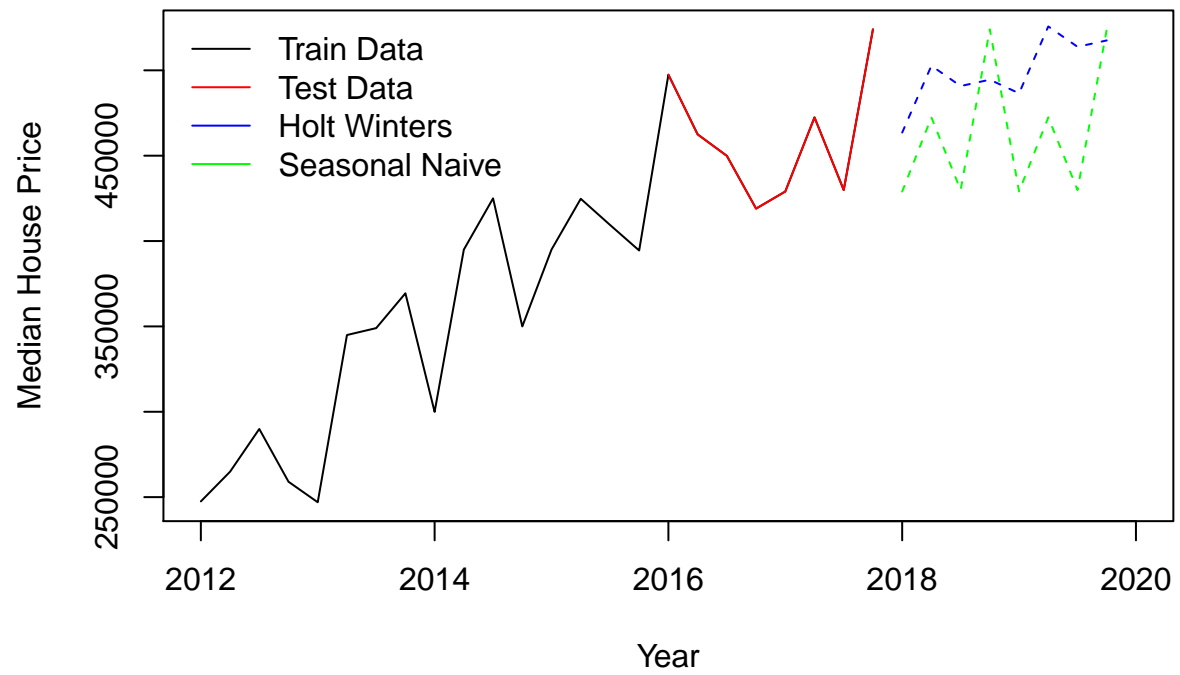## Portland, OR – Piedmont : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Piedmont"
##                   ME     RMSE      MAE      MPE     MAPE     MASE
## Training set 35808.33 47175.99 37162.5 10.93031 11.36901 1.000000
## Test set     68400.00 71823.34 68400.0 16.10926 16.10926 1.840565
##                   ACF1 Theil's U
## Training set 0.02855308        NA
## Test set     0.18035498  2.358779
## [1] "Holt Winters Accuracy for  Portland, OR - Piedmont"
##                   ME     RMSE      MAE       MPE     MAPE      MASE
## Training set  -4889.262 32915.01 28649.83 -1.722952 8.772781 0.7709338
## Test set     -28254.579 40238.38 31400.71 -6.855872 7.613976 0.8449569
##                   ACF1 Theil's U
## Training set  0.02248601        NA
## Test set     -0.30415451  1.468774
```

Portland, OR – Piedmont : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year
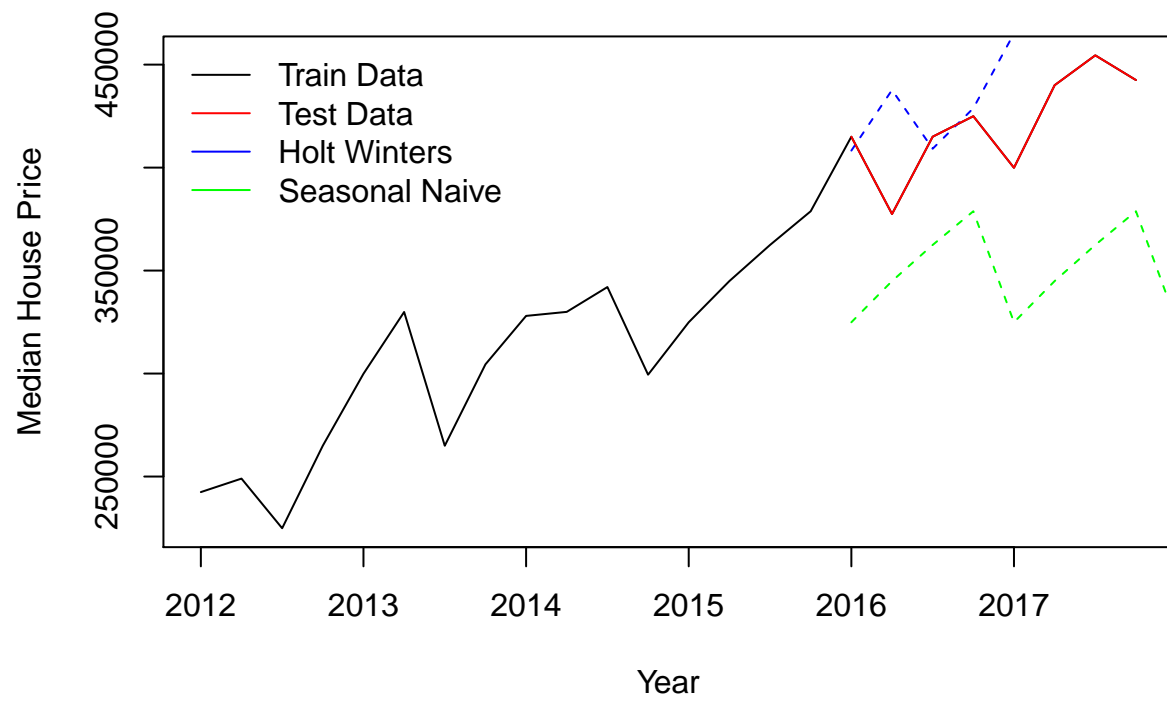
Portland, OR – Piedmont : Full TS Models Comparison
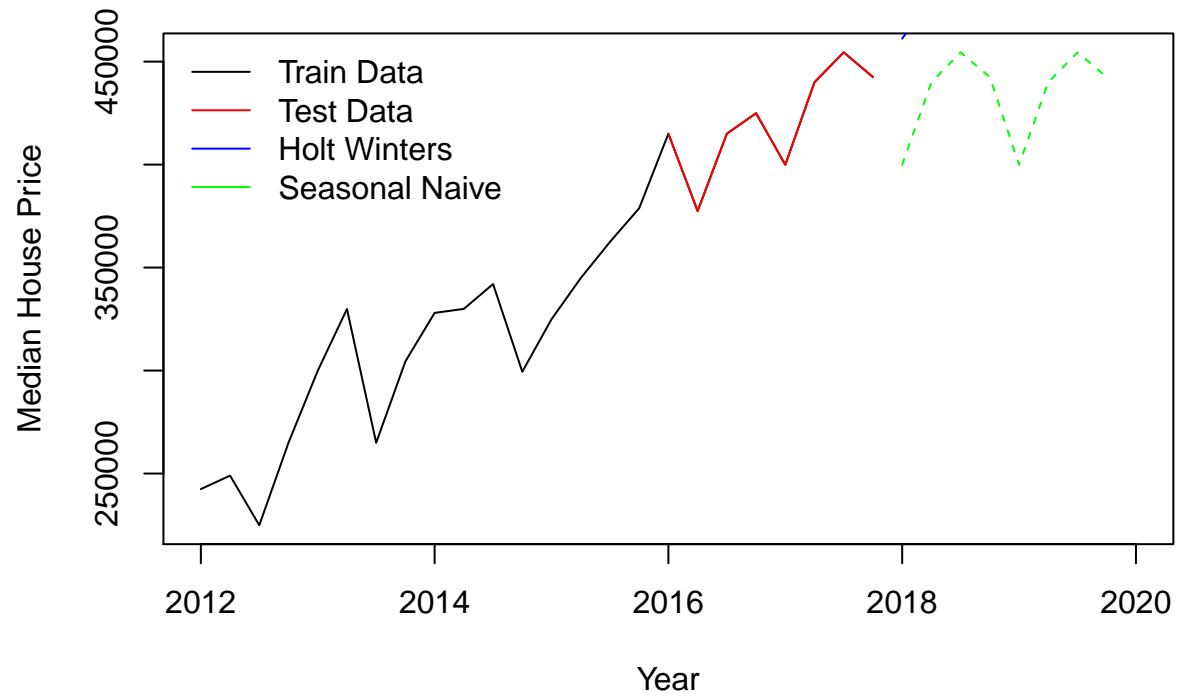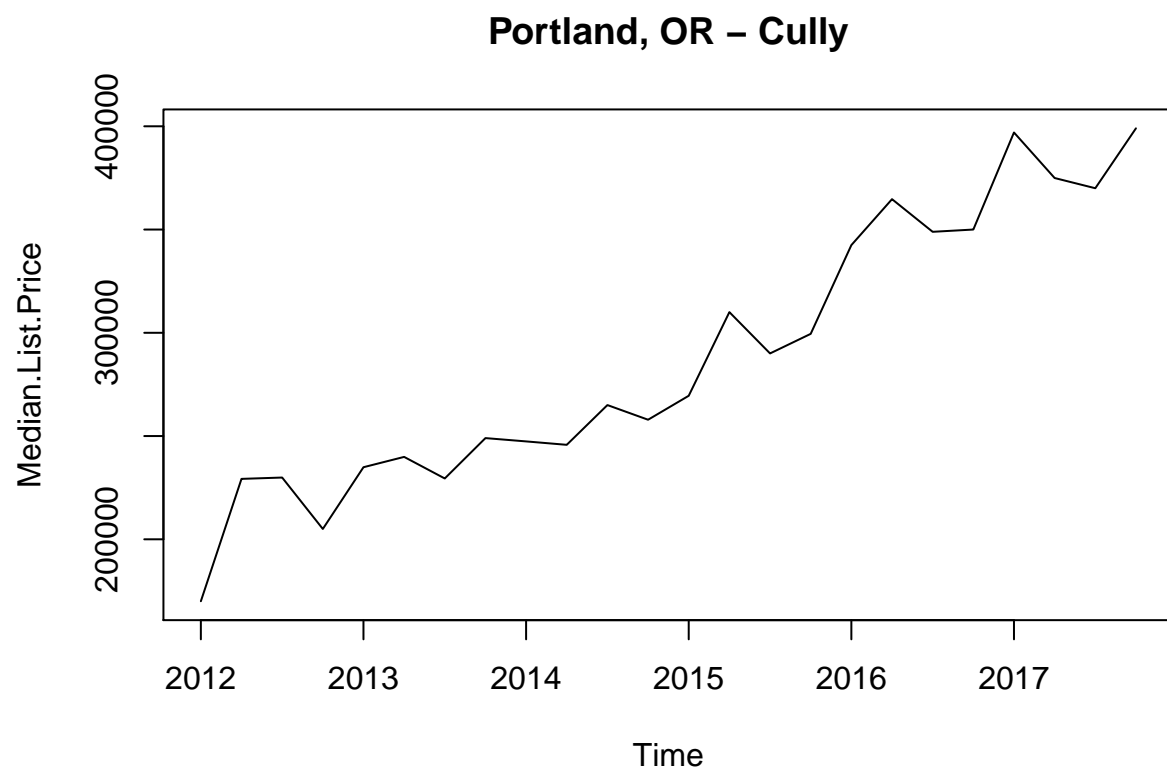
Median House Price

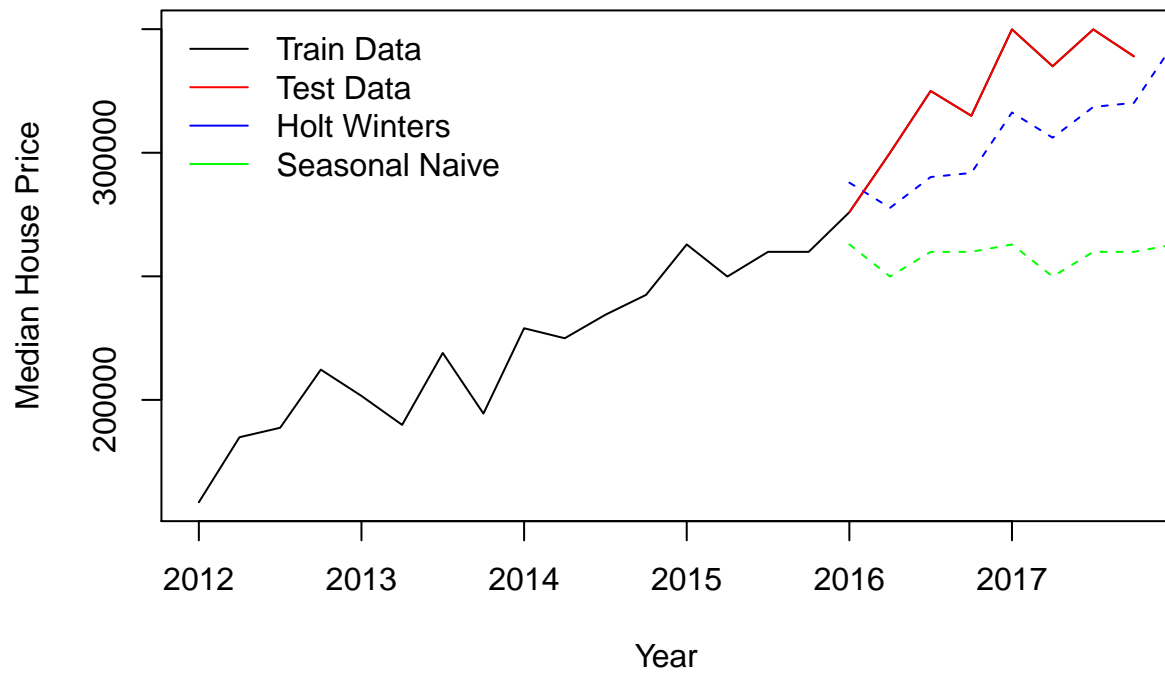Year

Portland, OR – Cully

Portland, OR – Cully : Naive Model Forecast
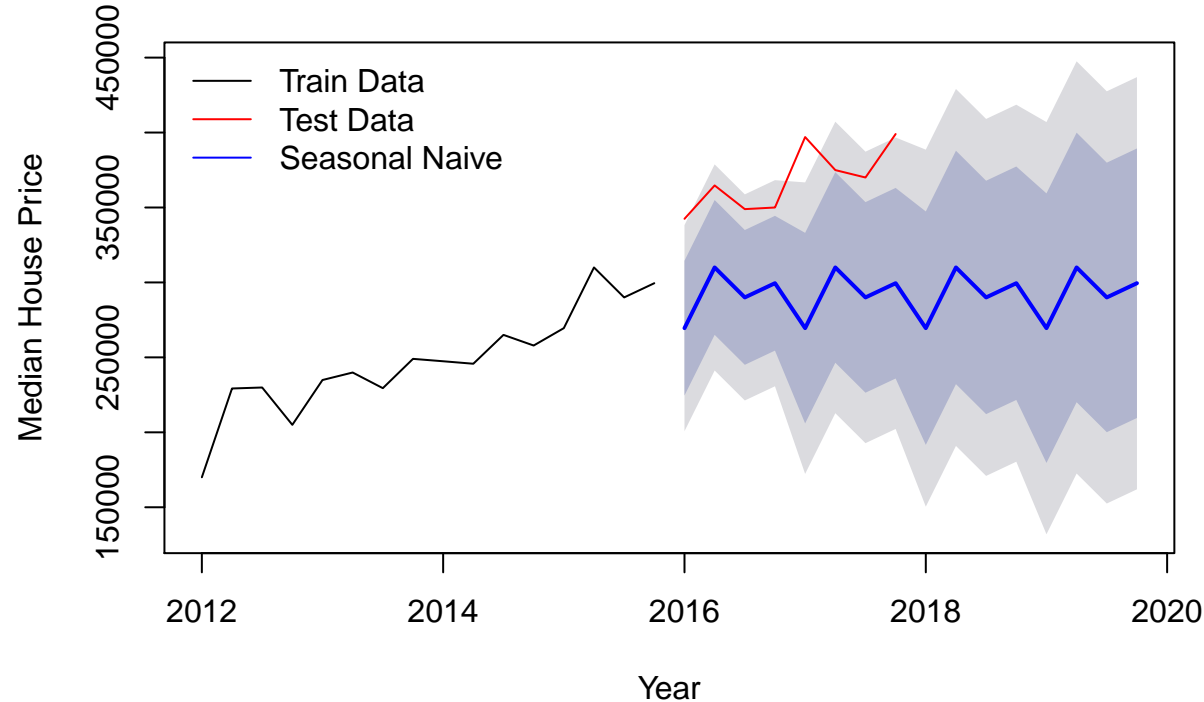
Portland, OR – Cully : Naive Model Forecast Residuals
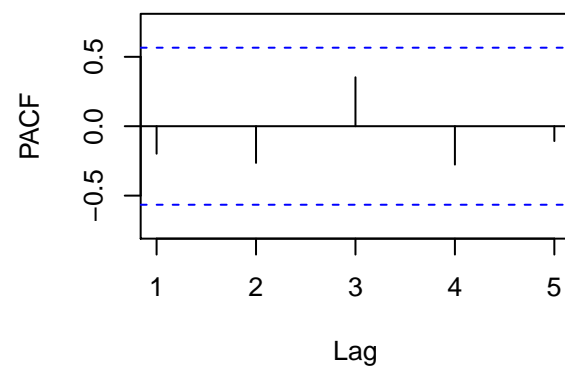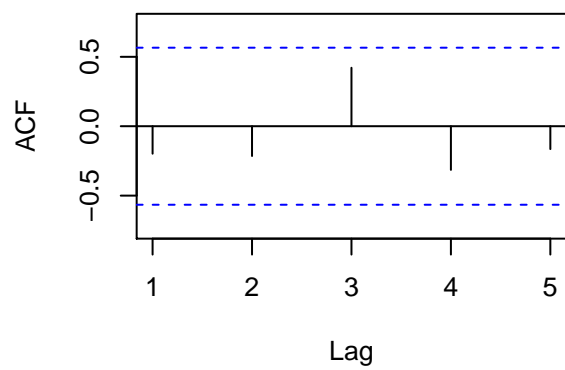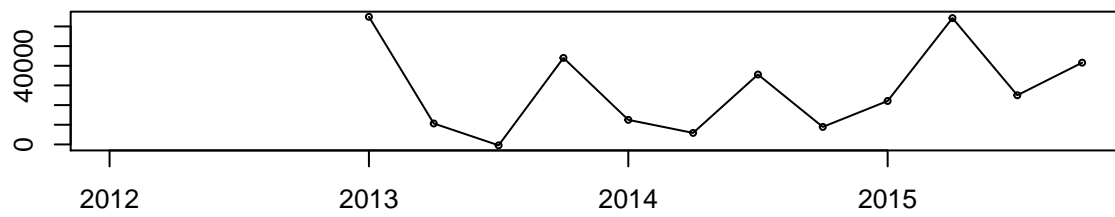
Portland, OR – Cully : Holt Winters Model Forecast
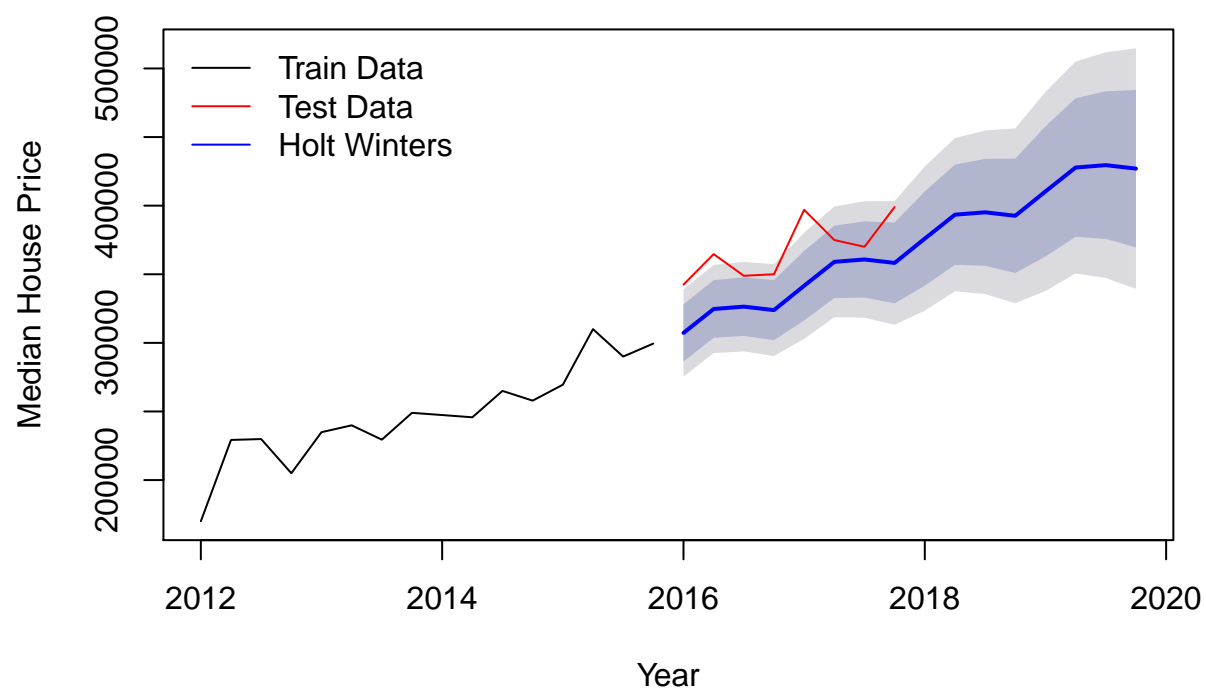
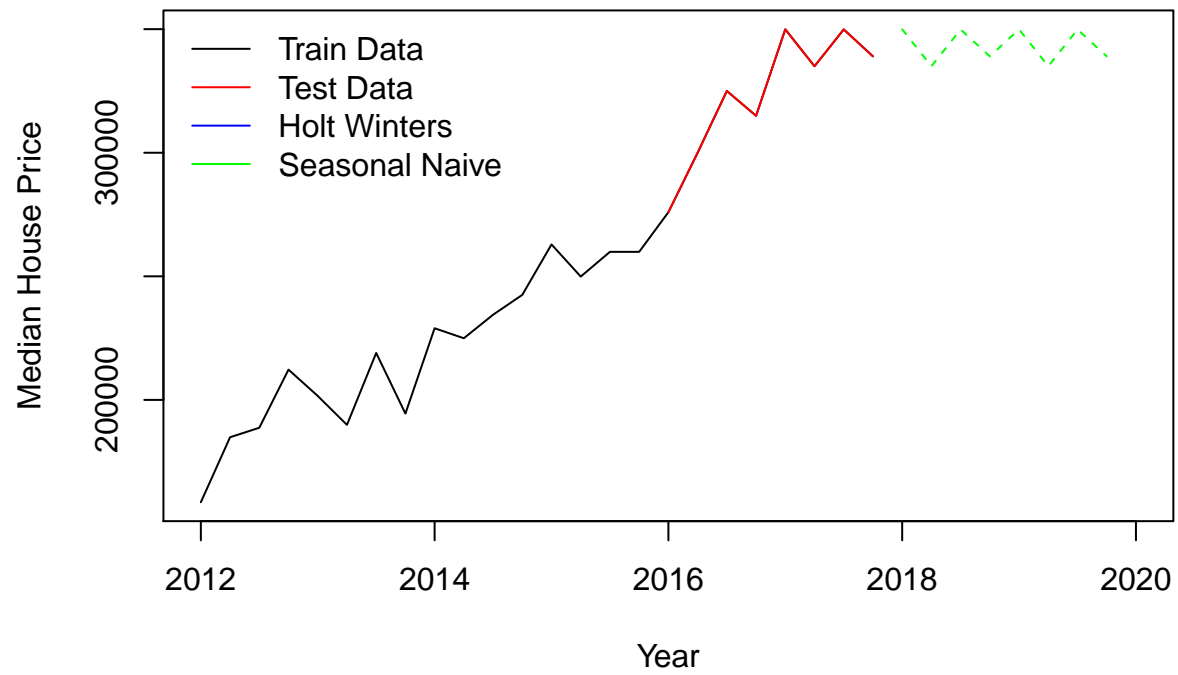**Portland, OR – Cully : Holt Winters Model Forecast Residuals**
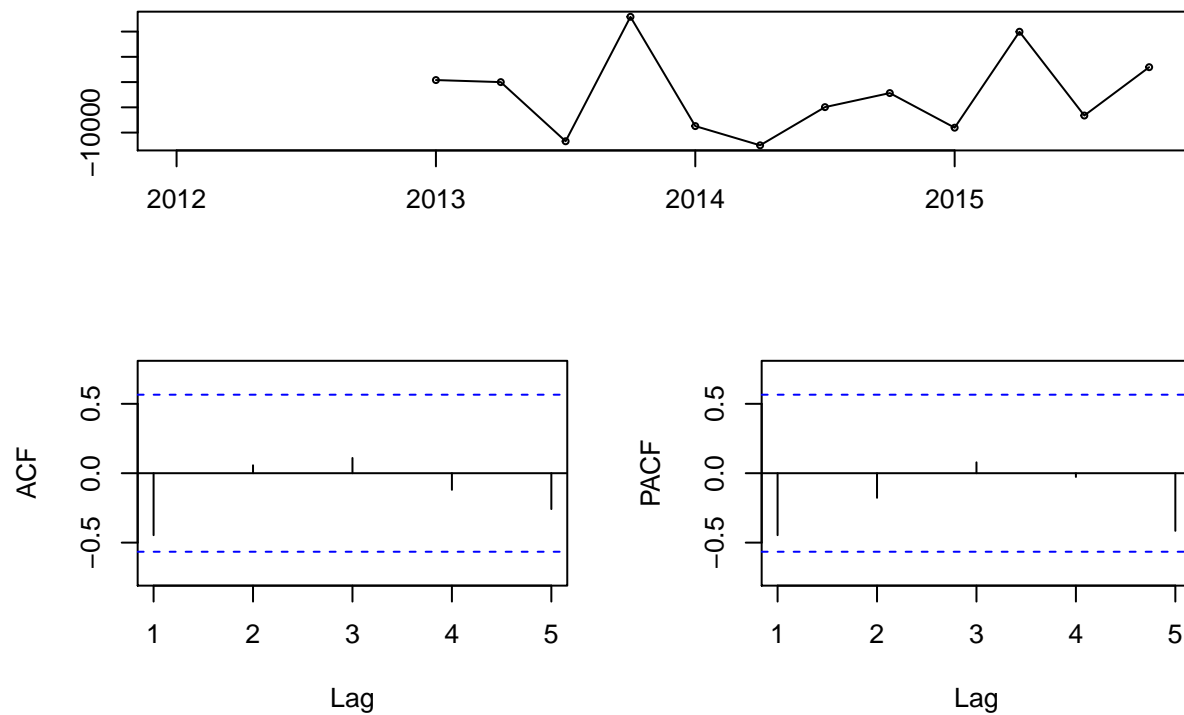

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Cully"
##                    ME     RMSE      MAE      MPE     MAPE    MASE
## Training set 27902.08 35077.38 27977.08 10.43927 10.47196  1.0000
## Test set     76131.25 79934.16 76131.25 20.45272 20.45272  2.7212
##                    ACF1 Theil's U
## Training set -0.1979891        NA
## Test set     -0.2029874  3.229818
## [1] "Holt Winters Accuracy for  Portland, OR - Cully"
##                    ME     RMSE      MAE      MPE     MAPE      MASE
## Training set  5082.098 16379.30 12950.19 1.771158 4.952387 0.4628855
## Test set     30640.942 33722.36 30640.94 8.258663 8.258663 1.0952157
##                    ACF1 Theil's U
## Training set -0.4464504        NA
## Test set     -0.2358076  1.364573
```

Portland, OR – Cully : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year
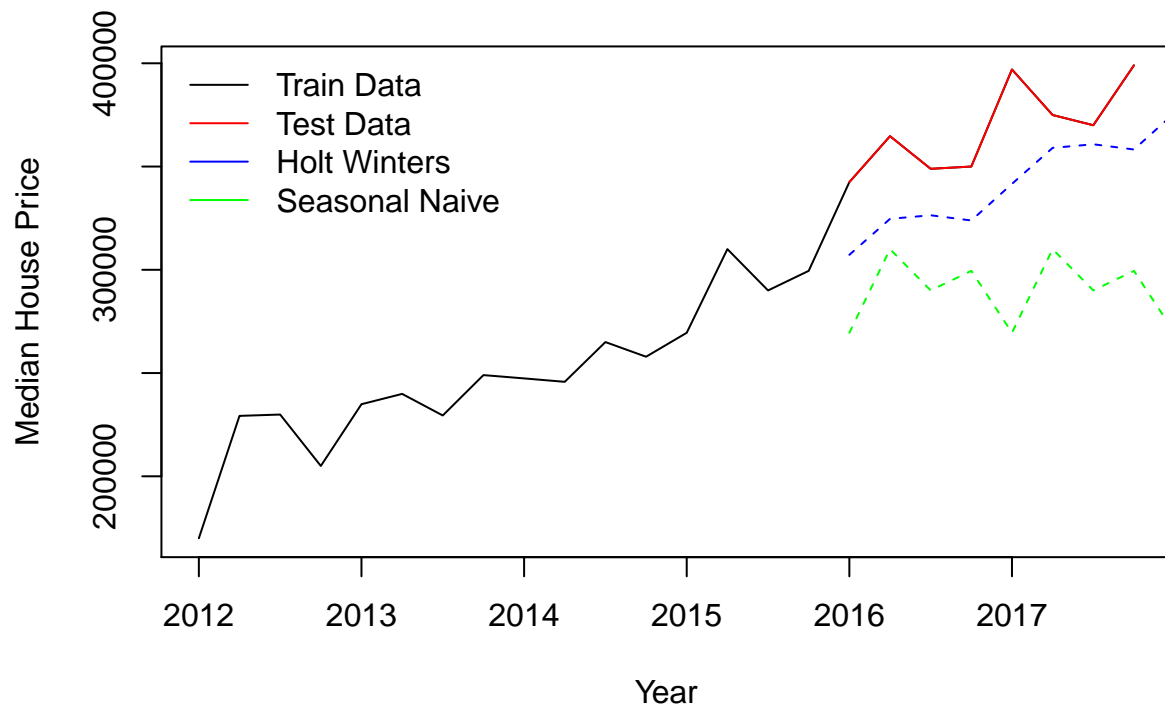
Portland, OR – Cully : Full TS Models Comparison
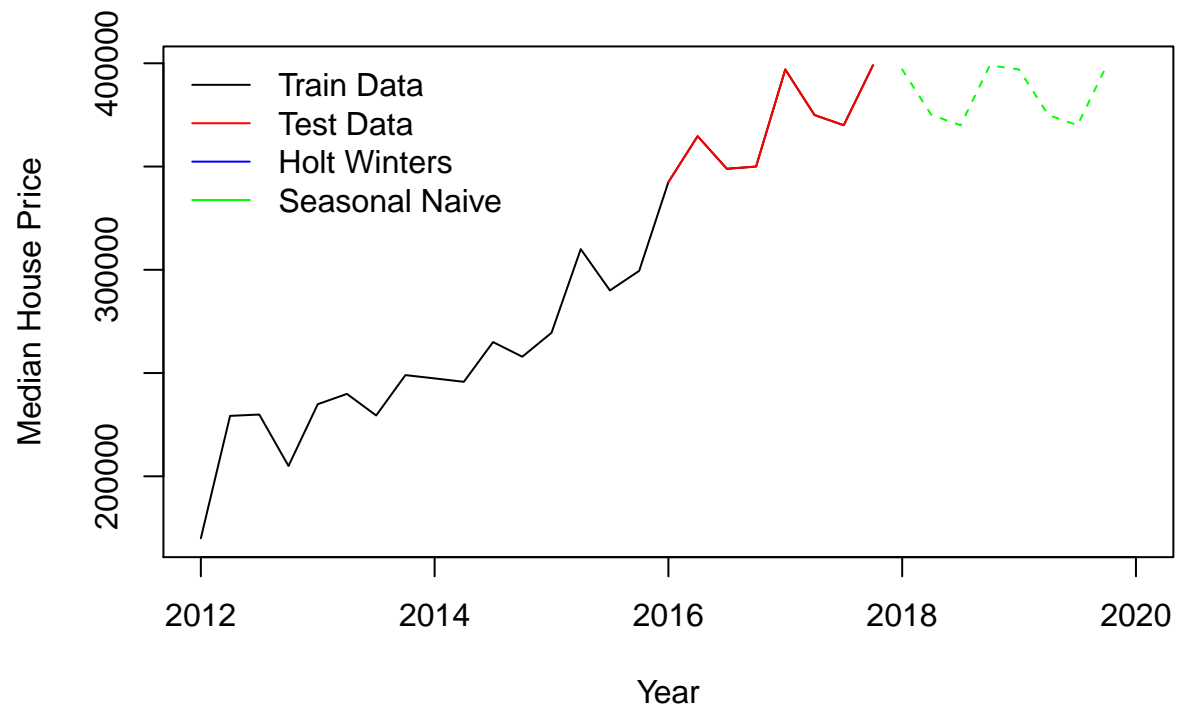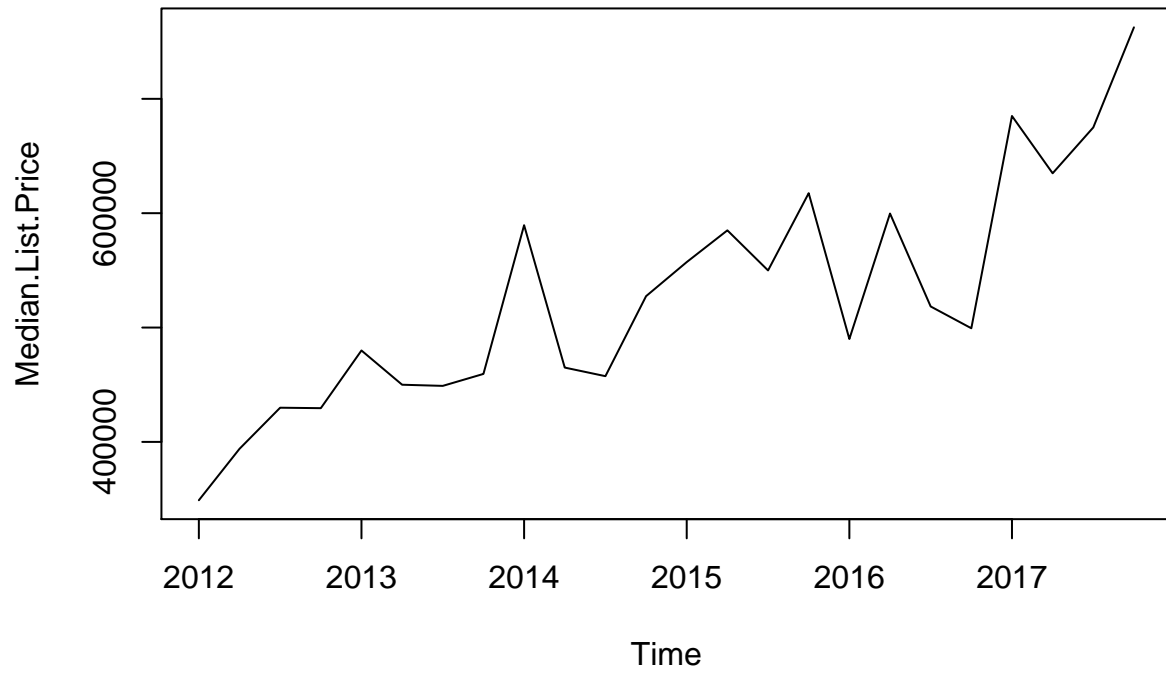
# Portland, OR – Sabin

Portland, OR – Sabin : Naive Model Forecast
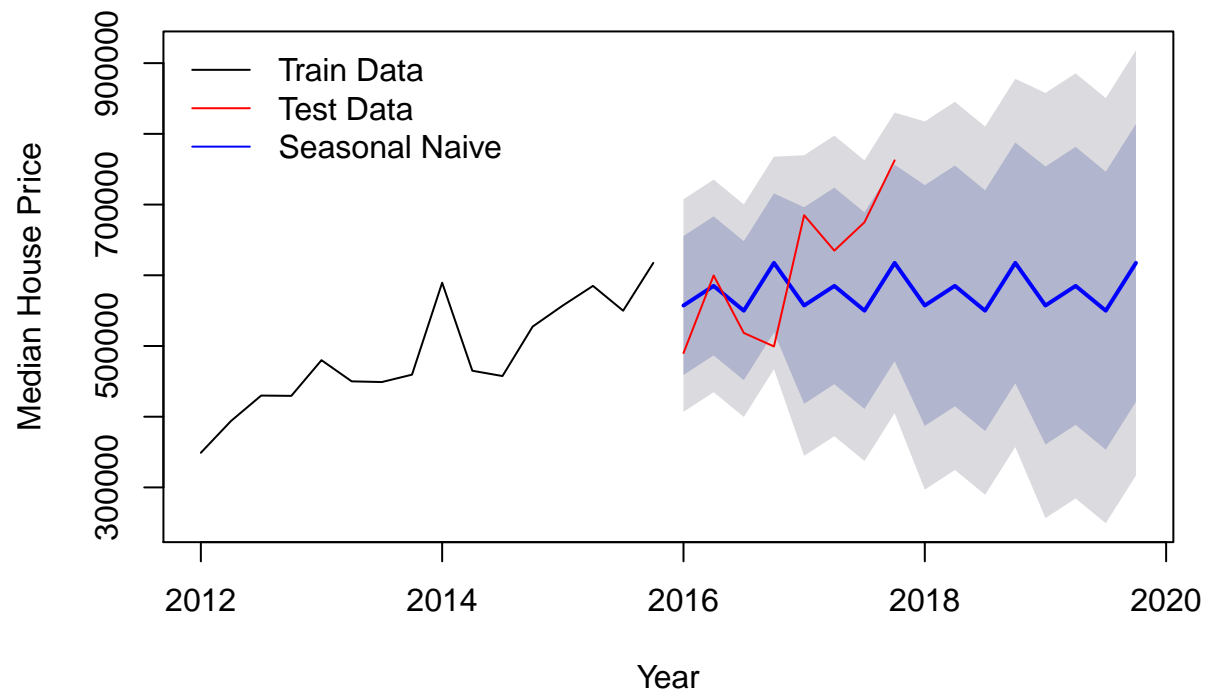

```
## Warning in HoltWinters(trainingData): optimization difficulties: ERROR:
## ABNORMAL_TERMINATION_IN_LNSRCH
```

Portland, OR – Sabin : Naive Model Forecast Residuals
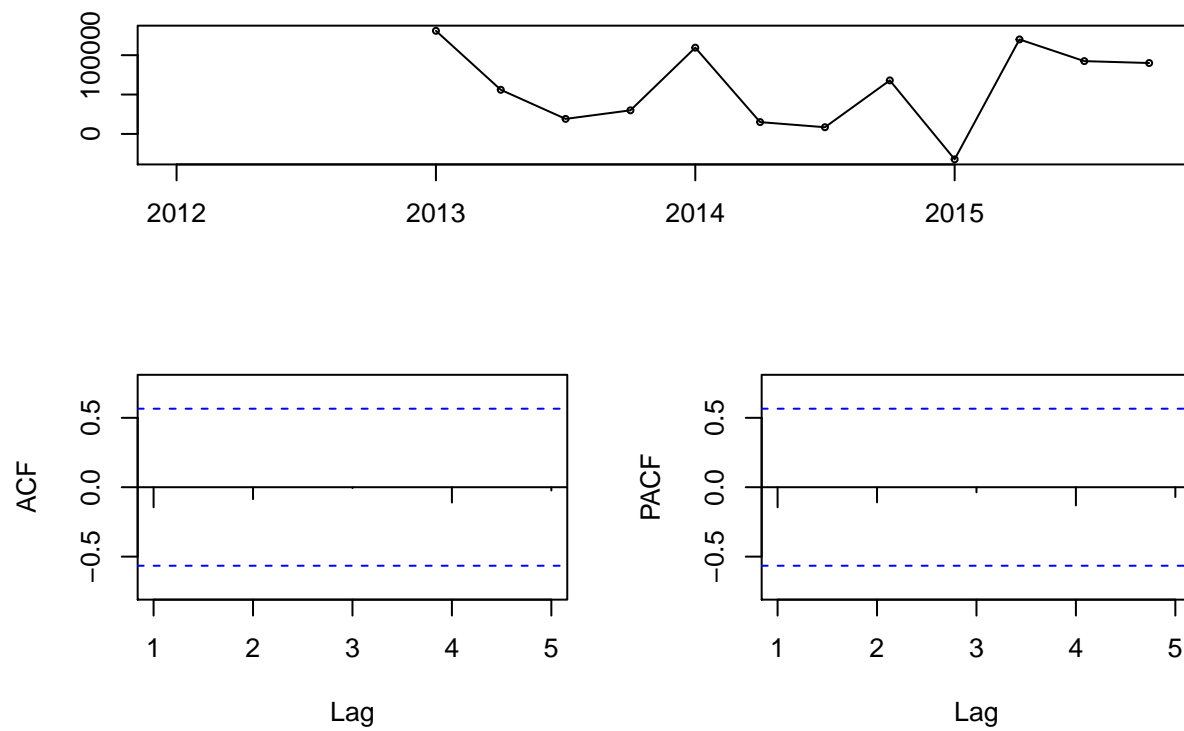
Portland, OR – Sabin : Holt Winters Model Forecast
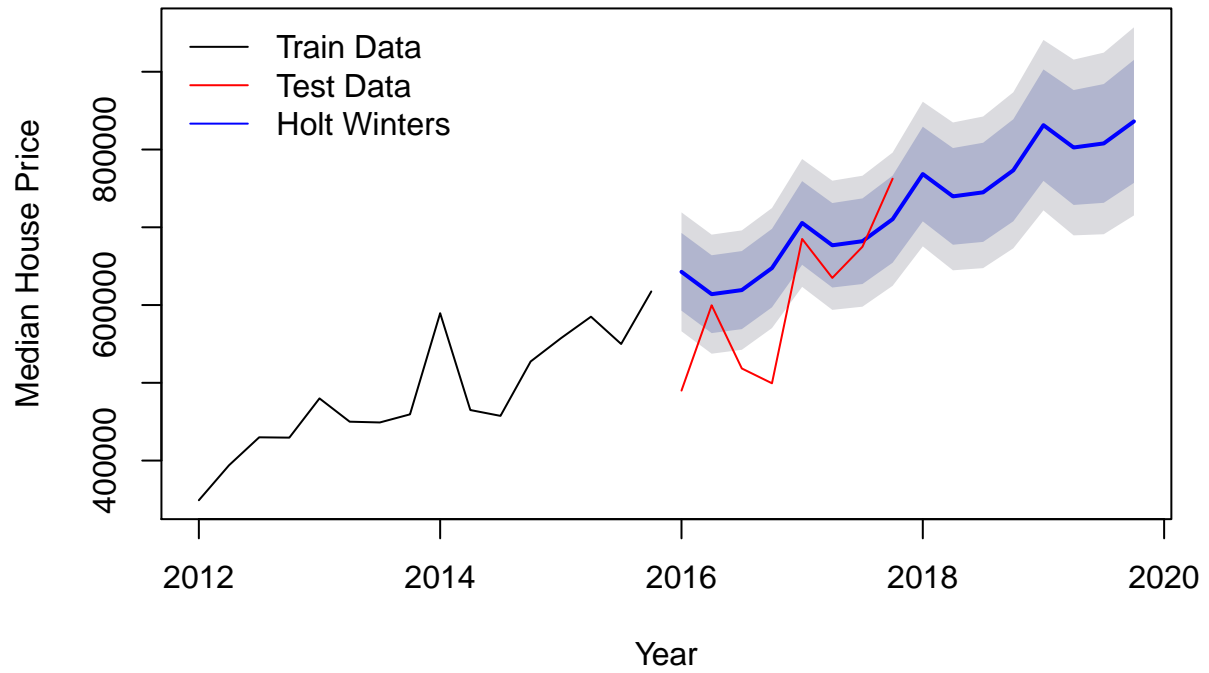
Portland, OR – Sabin : Holt Winters Model Forecast Residuals
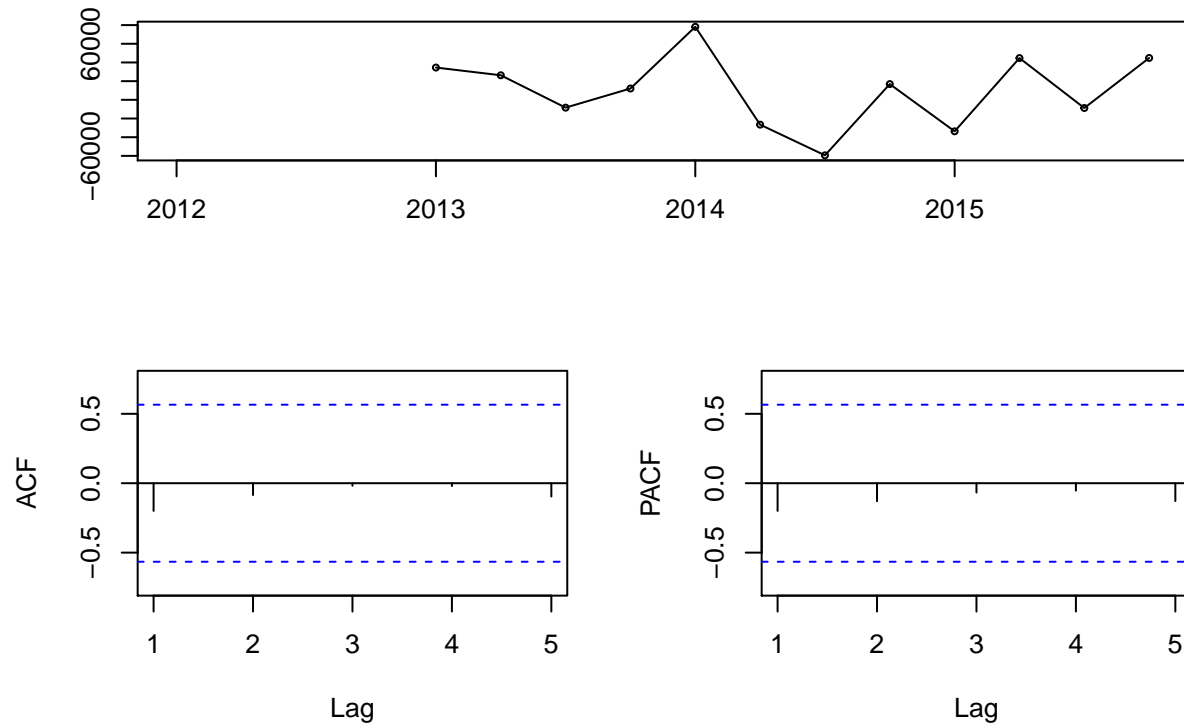

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Sabin"
##                     ME      RMSE      MAE       MPE     MAPE     MASE
## Training set 58945.83 76686.46 64320.83 11.099234 12.06379 1.000000
## Test set     30690.62 96925.87 84909.38  2.880978 13.74469 1.320091
##                   ACF1 Theil's U
## Training set -0.1445815        NA
## Test set      0.1750146 0.9498755
## [1] "Holt Winters Accuracy for  Portland, OR - Sabin"
##                     ME      RMSE      MAE       MPE     MAPE      MASE
## Training set  10059.99 38671.55 32852.92   1.569589  6.268449 0.5107664
## Test set     -54186.98 87022.41 67207.78 -10.811360 12.519006 1.0448836
##                    ACF1 Theil's U
## Training set -0.19963546        NA
## Test set      0.03831579 0.7227155
```

Portland, OR – Sabin : TS Training Model Comparison

Portland, OR – Sabin : Full TS Models Comparison
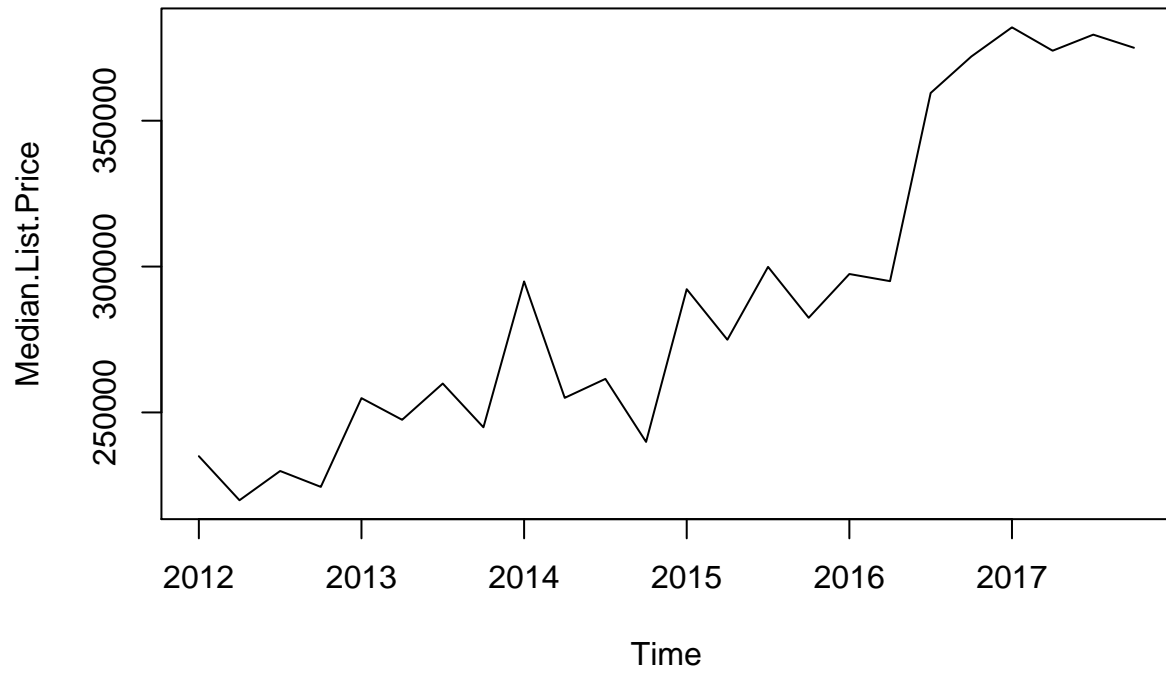
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price
X-axis: Year

Portland, OR – Argay

Portland, OR – Argay : Naive Model Forecast
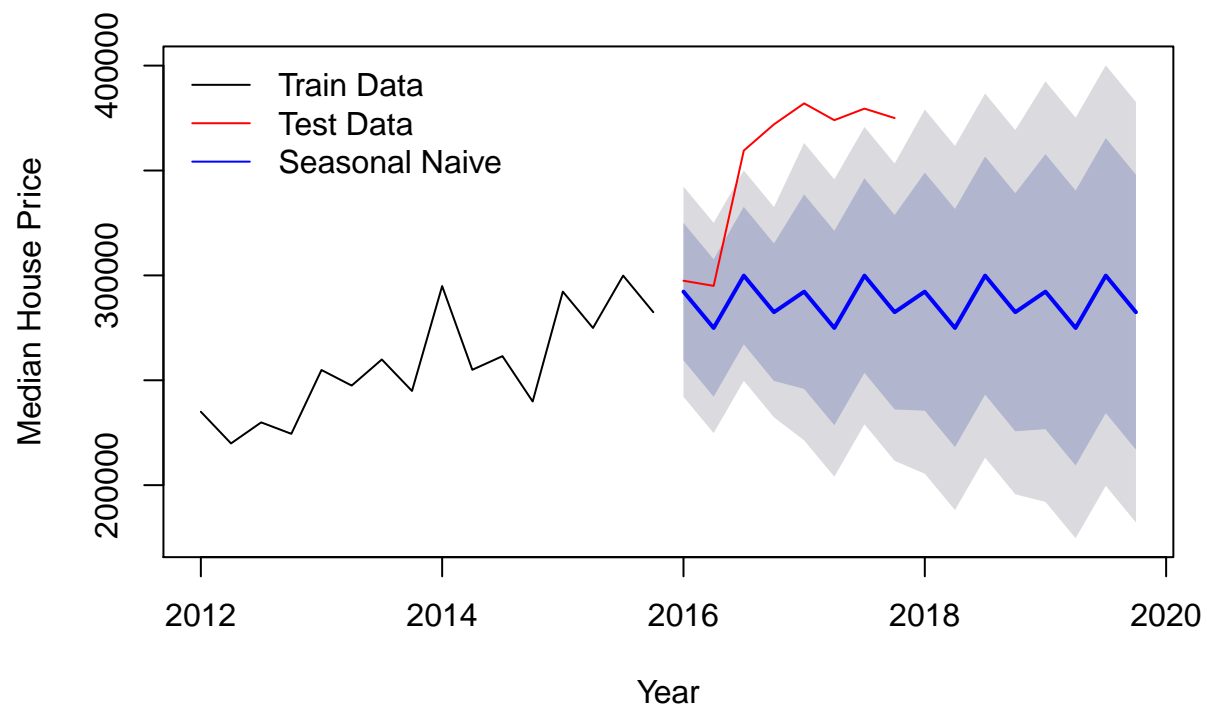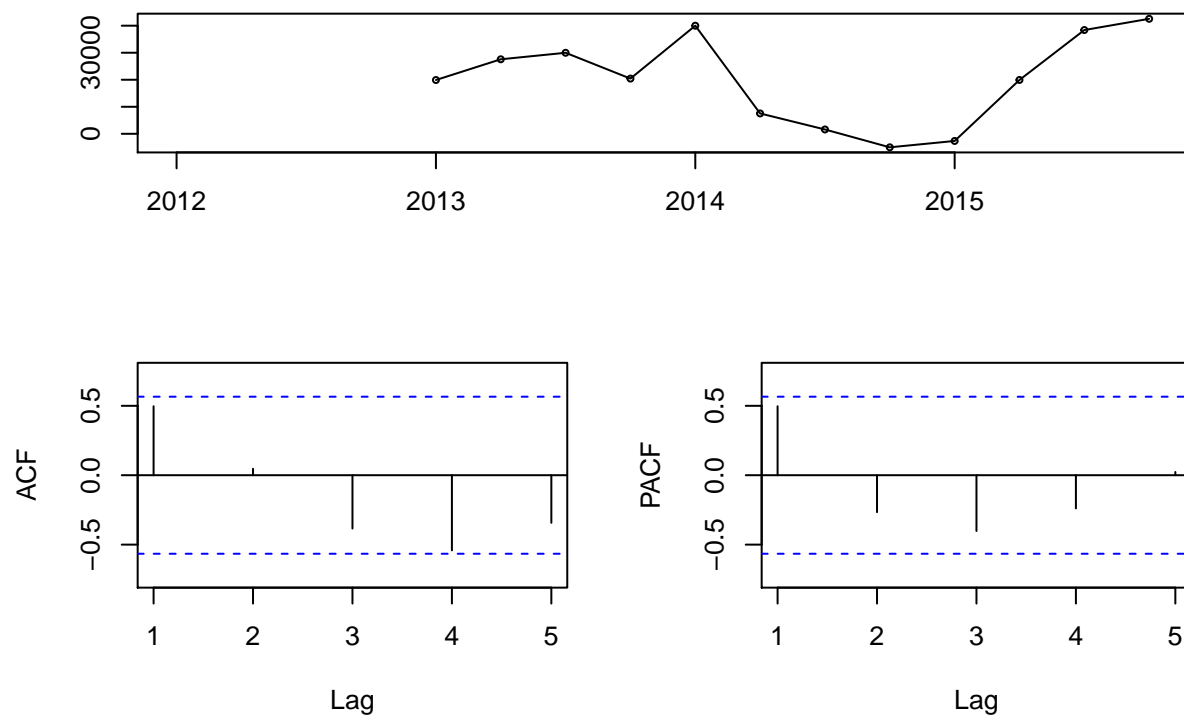
Portland, OR – Argay : Naive Model Forecast Residuals

Portland, OR – Argay : Holt Winters Model Forecast
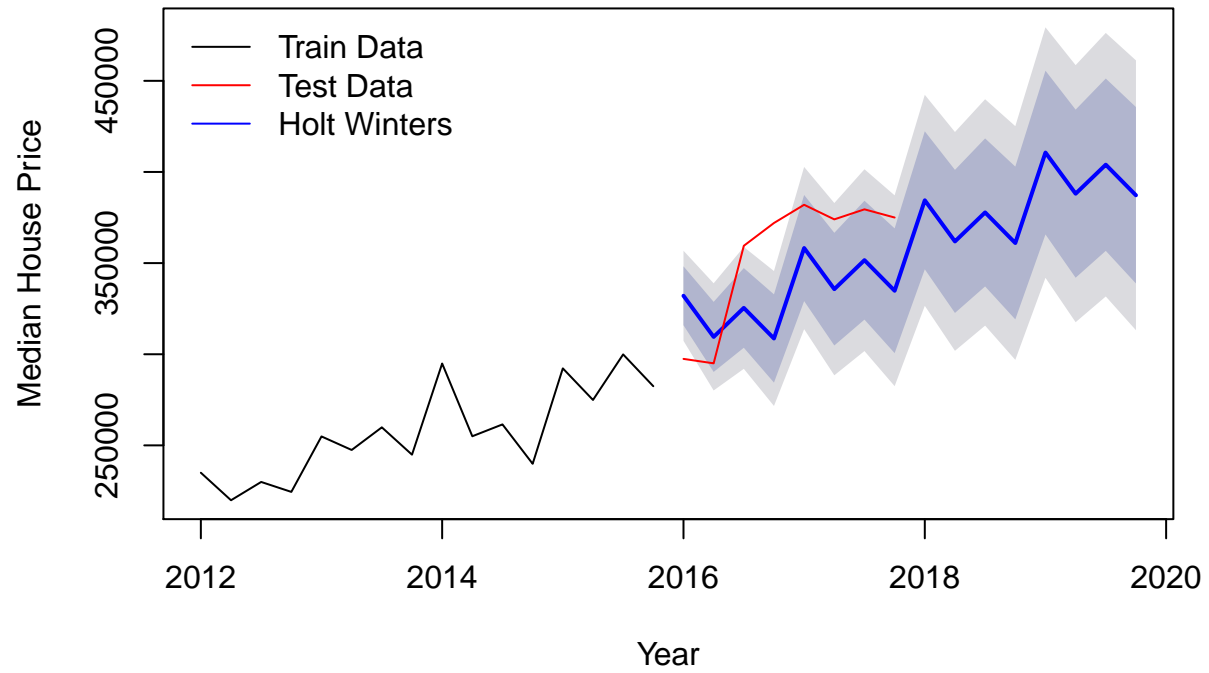
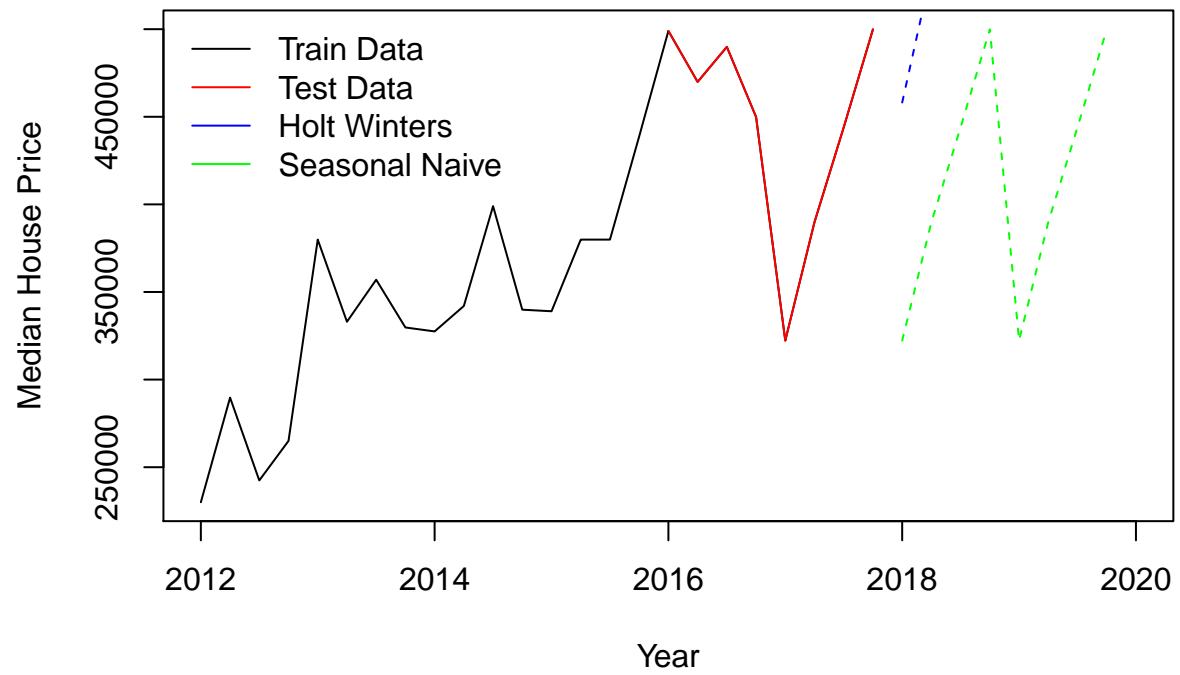**Portland, OR – Argay : Holt Winters Model Forecast Residuals**
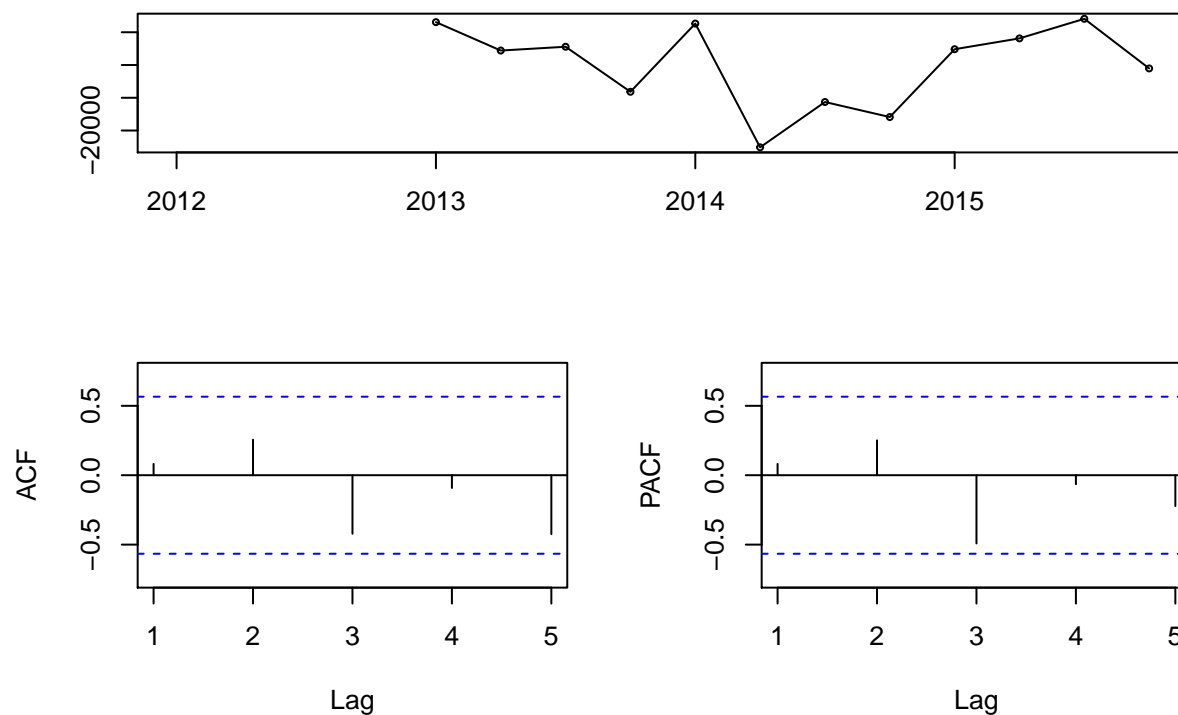

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Argay"
##                   ME      RMSE      MAE       MPE    MAPE      MASE
## Training set 20018.54 25568.84 21293.54  7.339507  7.8380  1.000000
## Test set     66925.00 74811.42 66925.00 18.105602 18.1056  3.142972
##                 ACF1 Theil's U
## Training set 0.4971198        NA
## Test set     0.5649304   2.58327
## [1] "Holt Winters Accuracy for  Portland, OR - Argay"
##                   ME      RMSE      MAE        MPE     MAPE      MASE
## Training set   102.9445 12073.11 10358.78 -0.1539419 3.930369 0.4864751
## Test set     22299.5443 37092.60 34584.25  5.5583398 9.698481 1.6241663
##                  ACF1 Theil's U
## Training set 0.08157386        NA
## Test set     0.34389143  1.239011
```

Portland, OR – Argay : TS Training Model Comparison

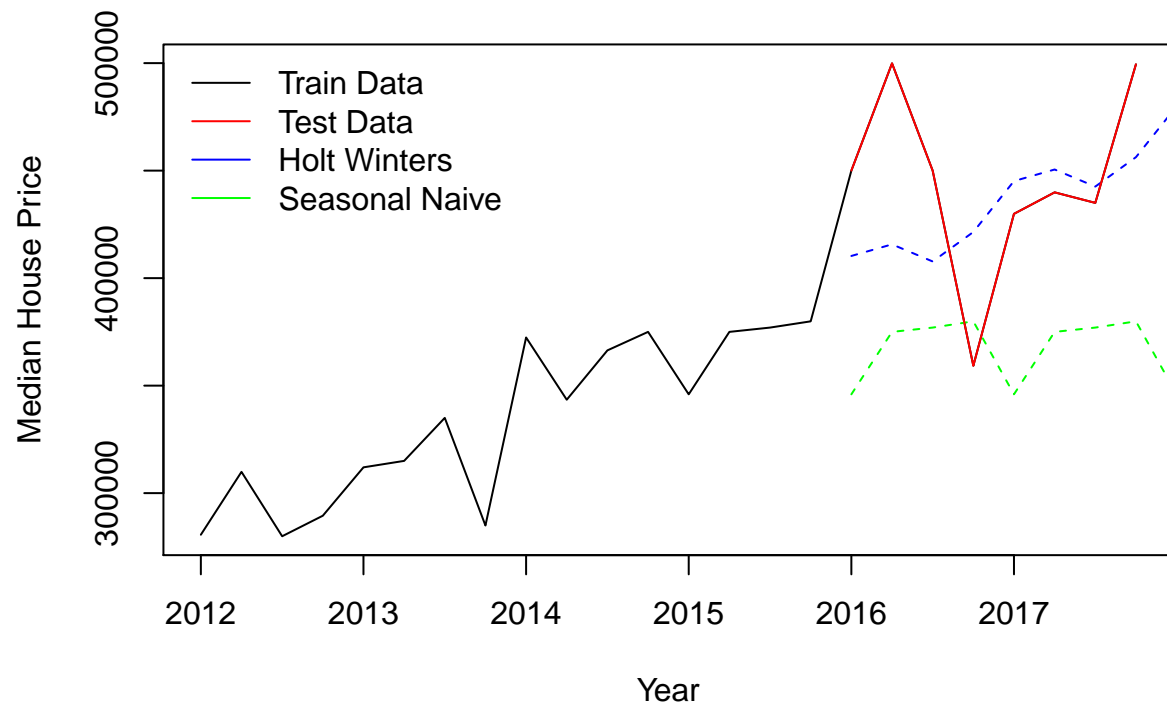# Portland, OR – Argay : Full TS Models Comparison
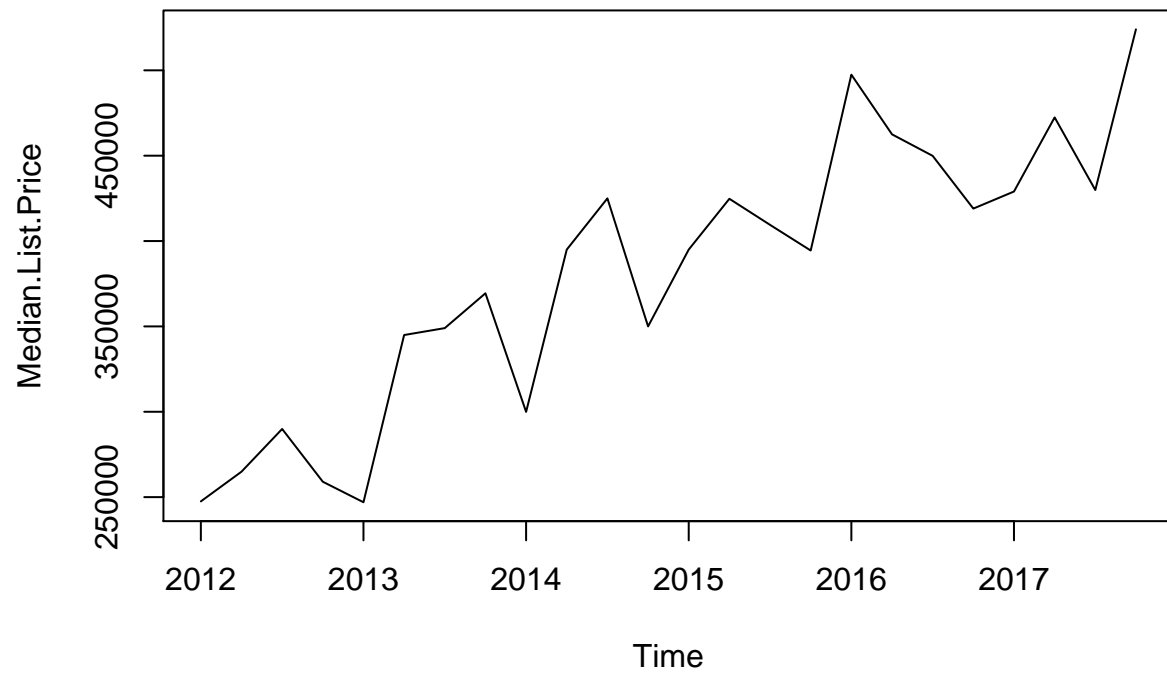
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

X-axis: Year
Y-axis: Median House Price

Portland, OR – Brooklyn

Portland, OR – Brooklyn : Naive Model Forecast
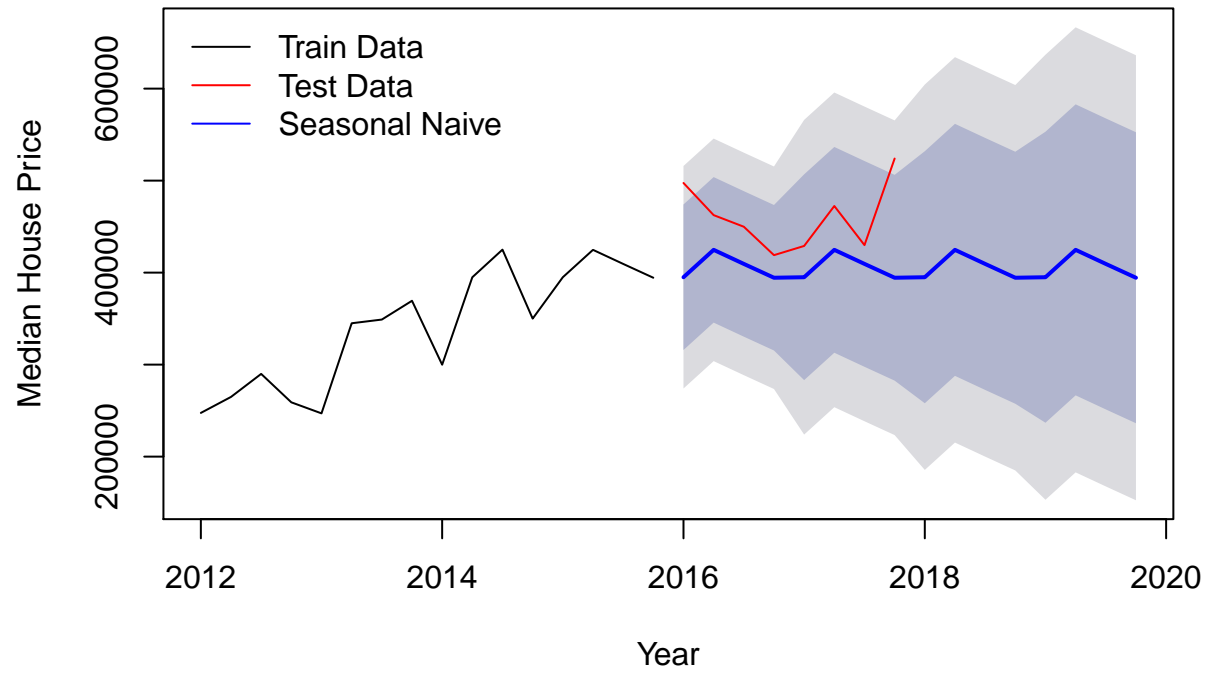
Portland, OR – Brooklyn : Naive Model Forecast Residuals
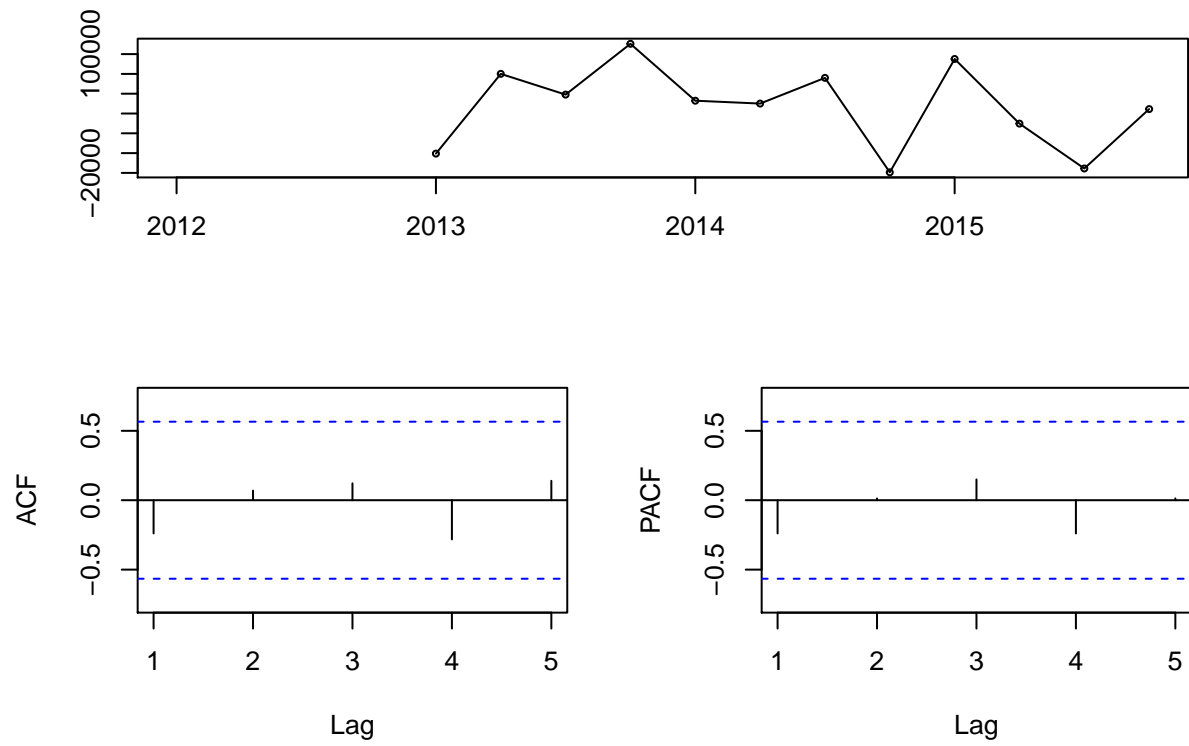
Portland, OR – Brooklyn : Holt Winters Model Forecast
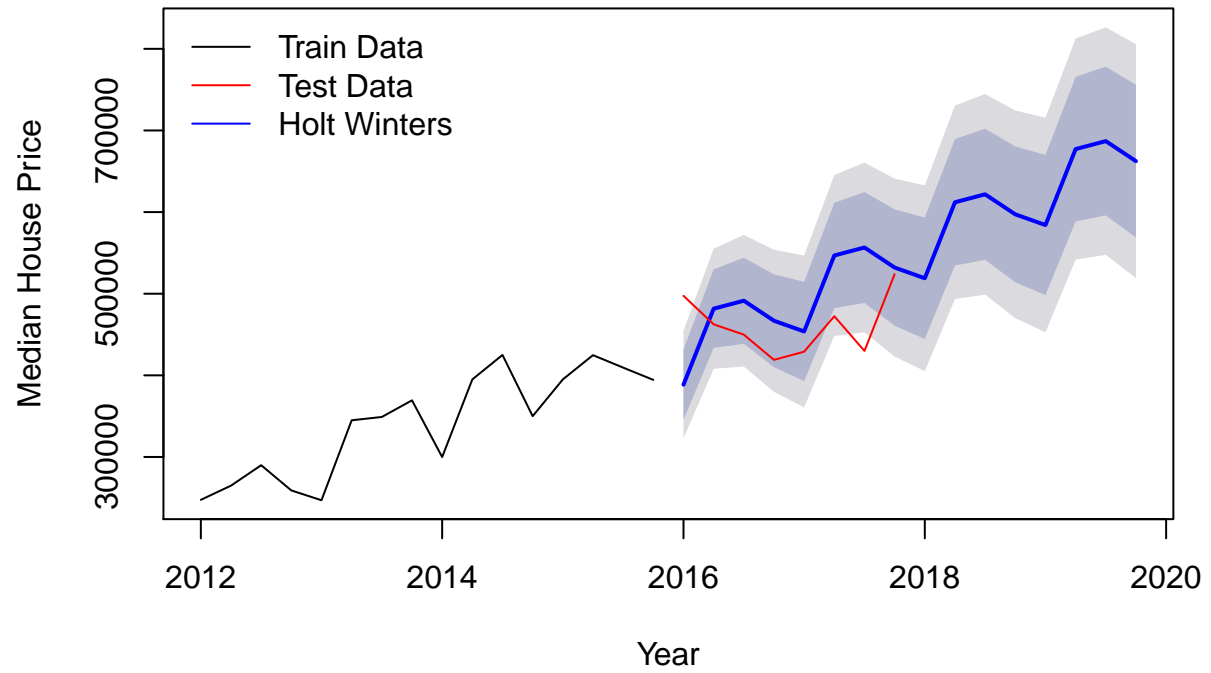
Portland, OR – Brooklyn : Holt Winters Model Forecast Residuals
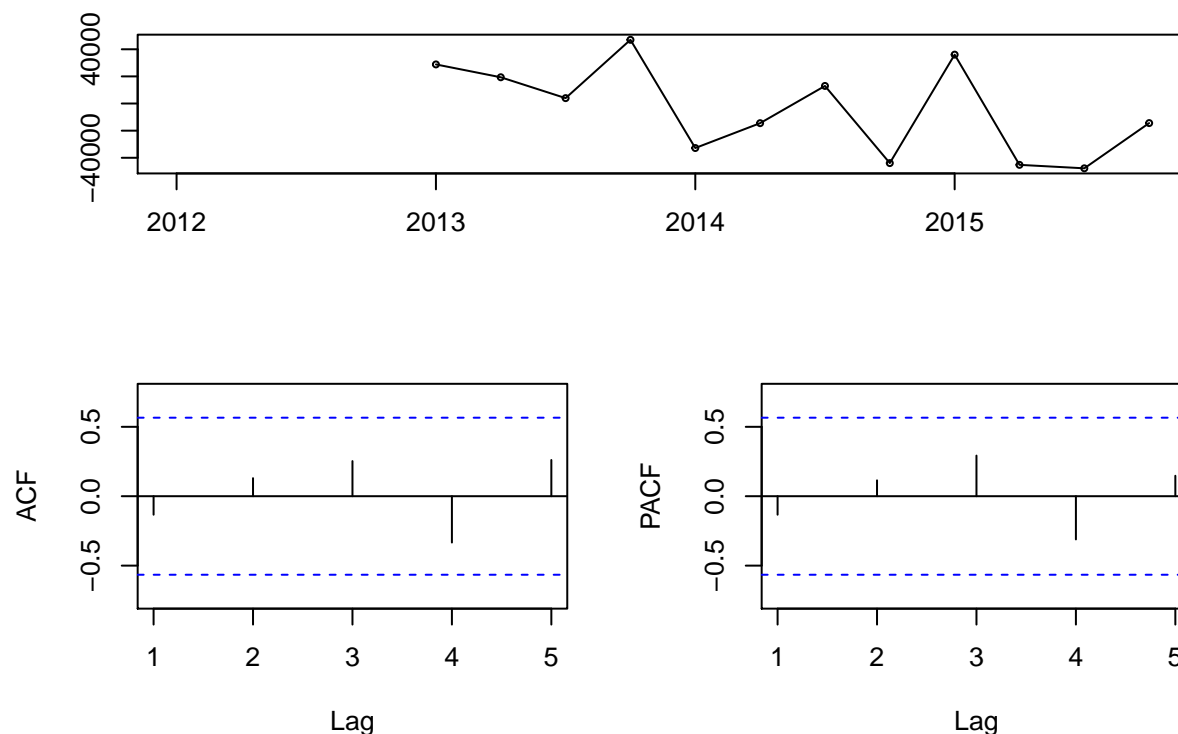

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Brooklyn"
##                   ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 46862.50 61701.44 52766.67 12.58542 14.17487 1.000000
## Test set     54603.12 65942.43 54603.12 11.38663 11.38663 1.034803
##                  ACF1 Theil's U
## Training set -0.2393351        NA
## Test set     -0.1558405  1.287384
## [1] "Holt Winters Accuracy for  Portland, OR - Brooklyn"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set  -4202.151 32459.28 28896.02 -0.816203  8.036047 0.5476189
## Test set     -29209.578 69379.46 56423.04 -6.932276 12.402869 1.0692933
##                  ACF1 Theil's U
## Training set -0.1331938        NA
## Test set      0.1122148  1.281169
```

Portland, OR – Brooklyn : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Median House Price vs Year

Portland, OR – Brooklyn : Full TS Models Comparison
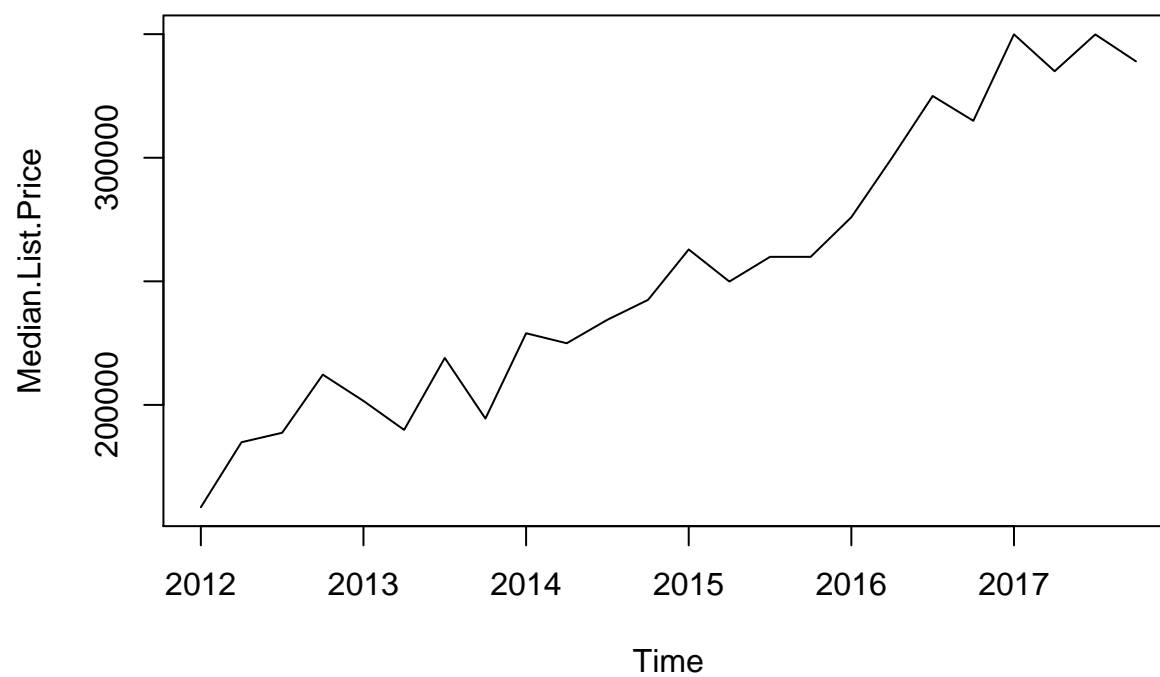
Portland, OR – Madison South

Portland, OR – Madison South : Naive Model Forecast
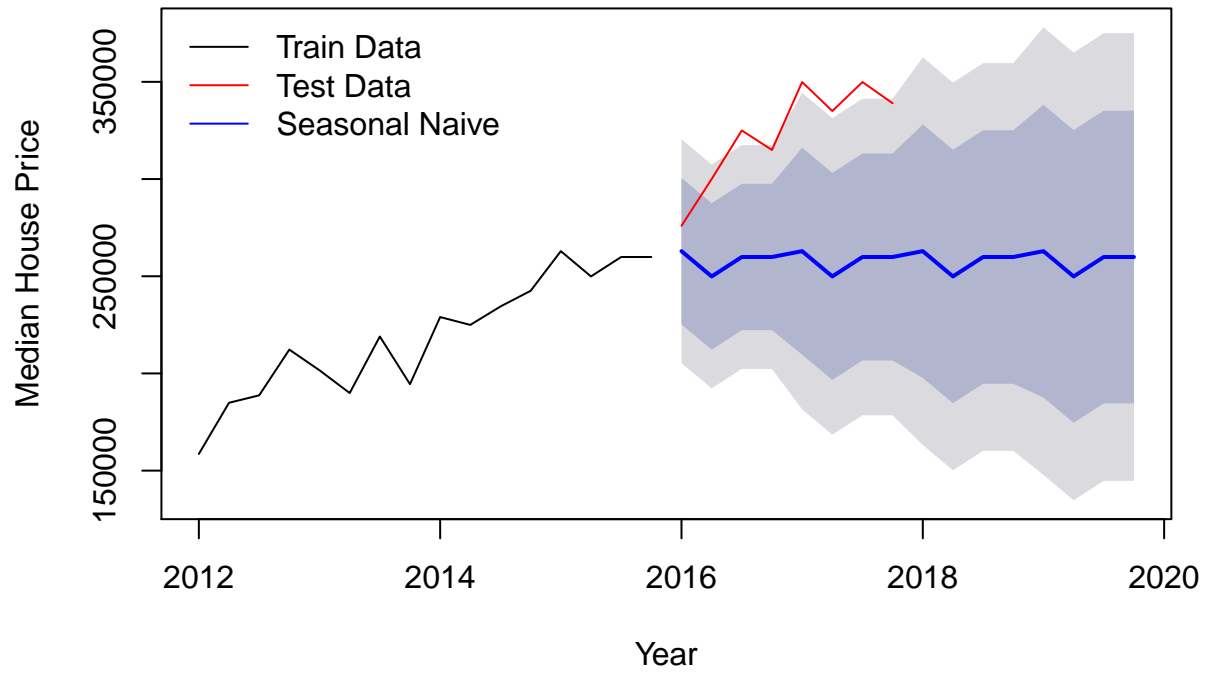
Portland, OR – Madison South : Naive Model Forecast Residuals
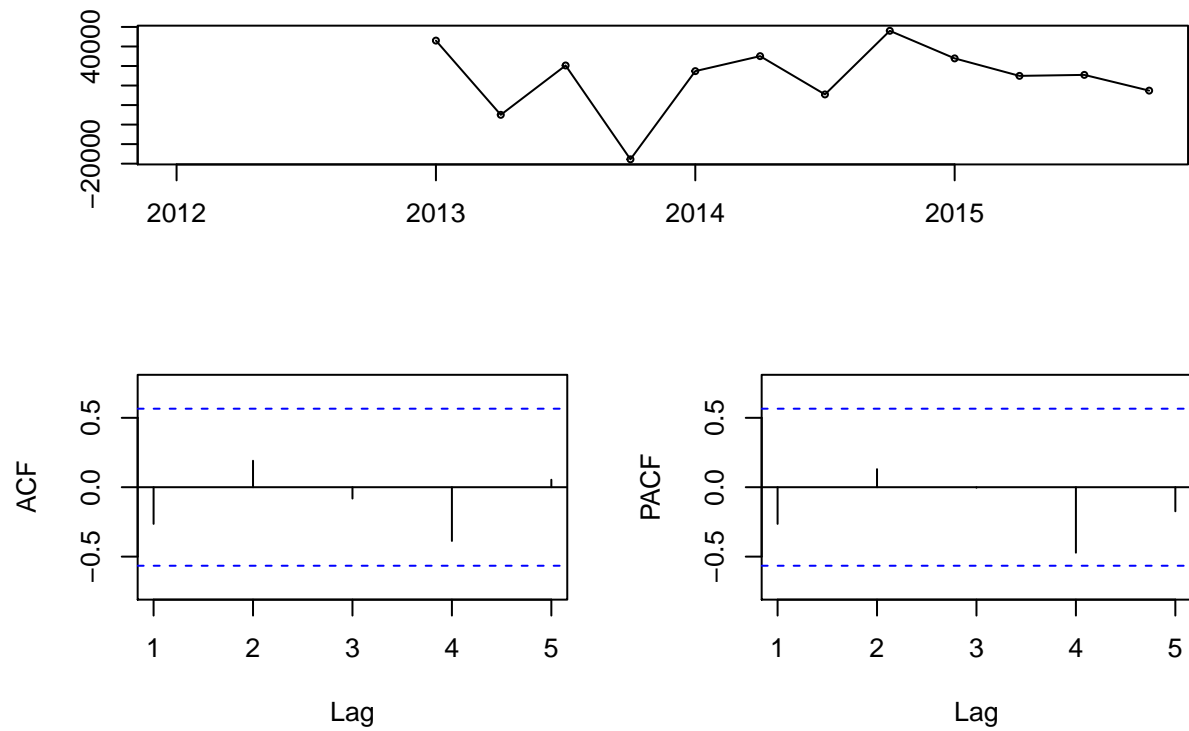
Portland, OR – Madison South : Holt Winters Model Forecast
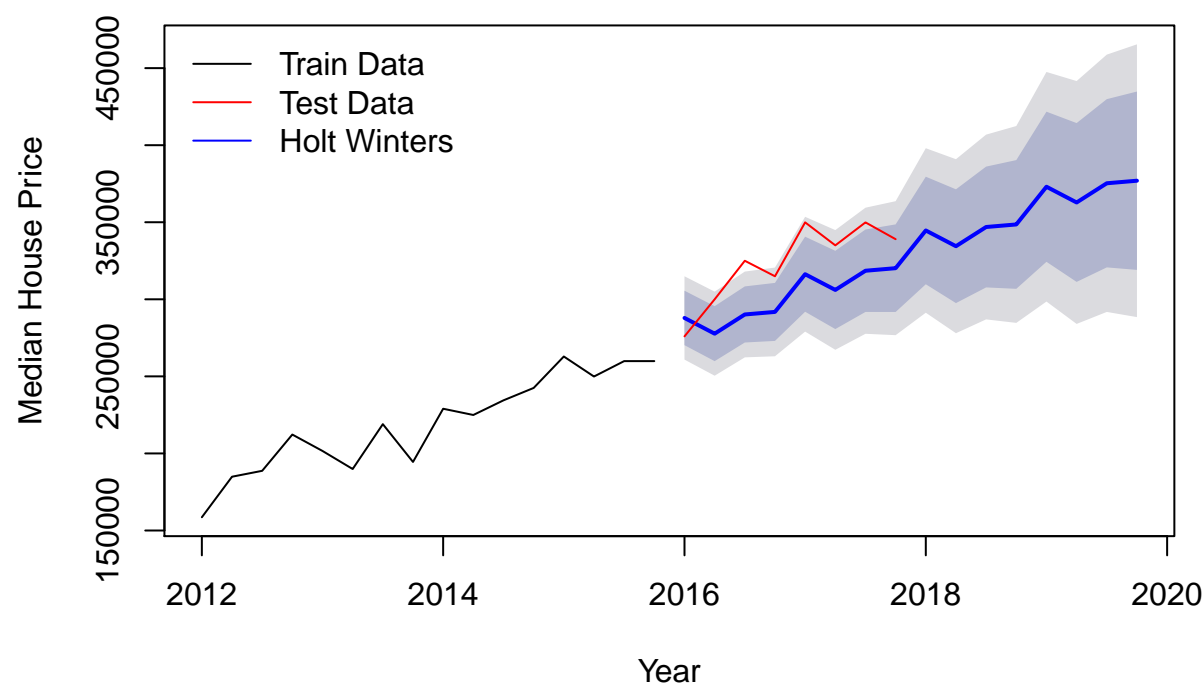
Portland, OR – Madison South : Holt Winters Model Forecast Residuals
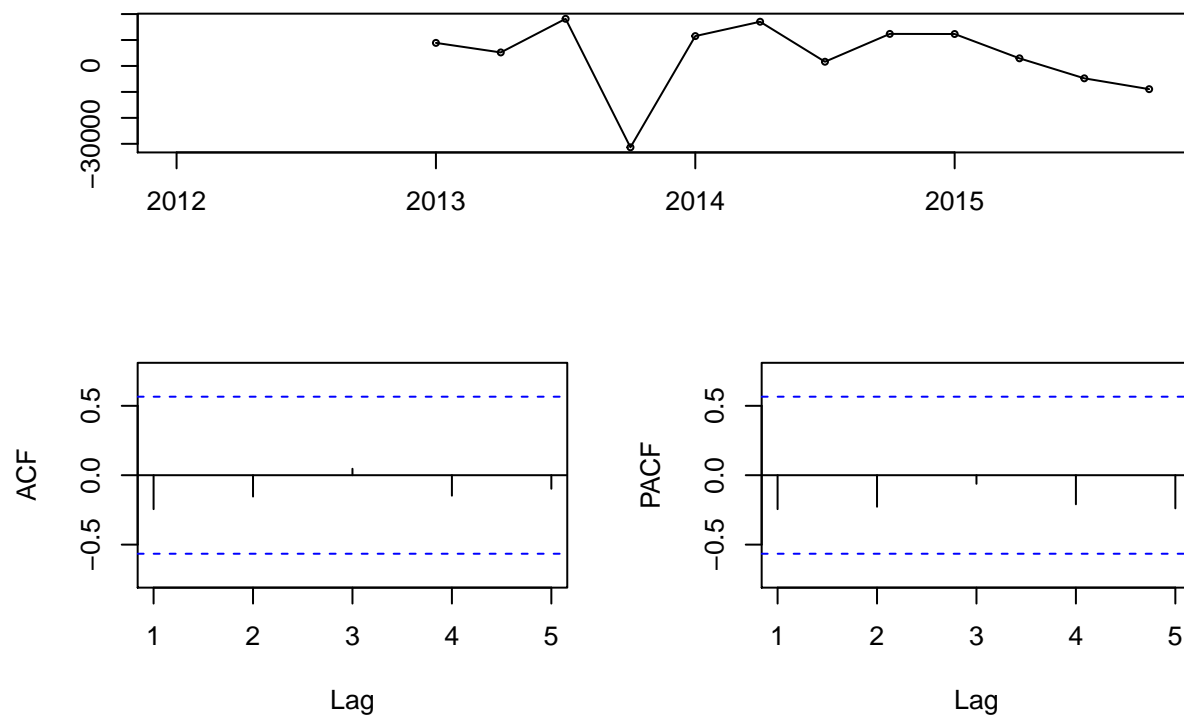

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Madison South"
##                    ME     RMSE      MAE      MPE     MAPE     MASE
## Training set 24010.42 29373.37 26972.92 10.16266 11.68599 1.000000
## Test set     65565.62 69929.42 65565.62 19.78330 19.78330 2.430795
##                   ACF1 Theil's U
## Training set -0.2641090        NA
## Test set      0.3859965    3.3578
## [1] "Holt Winters Accuracy for  Portland, OR - Madison South"
##                   ME     RMSE      MAE      MPE     MAPE      MASE
## Training set  3752.068 13722.51 11258.98 1.526511 5.091013 0.4174180
## Test set     22626.076 26676.68 25616.88 6.738842 7.822665 0.9497261
##                    ACF1 Theil's U
## Training set -0.24457567        NA
## Test set      0.06882079  1.298492
```

Portland, OR – Madison South : TS Training Model Comparison

Portland, OR – Madison South : Full TS Models Comparison
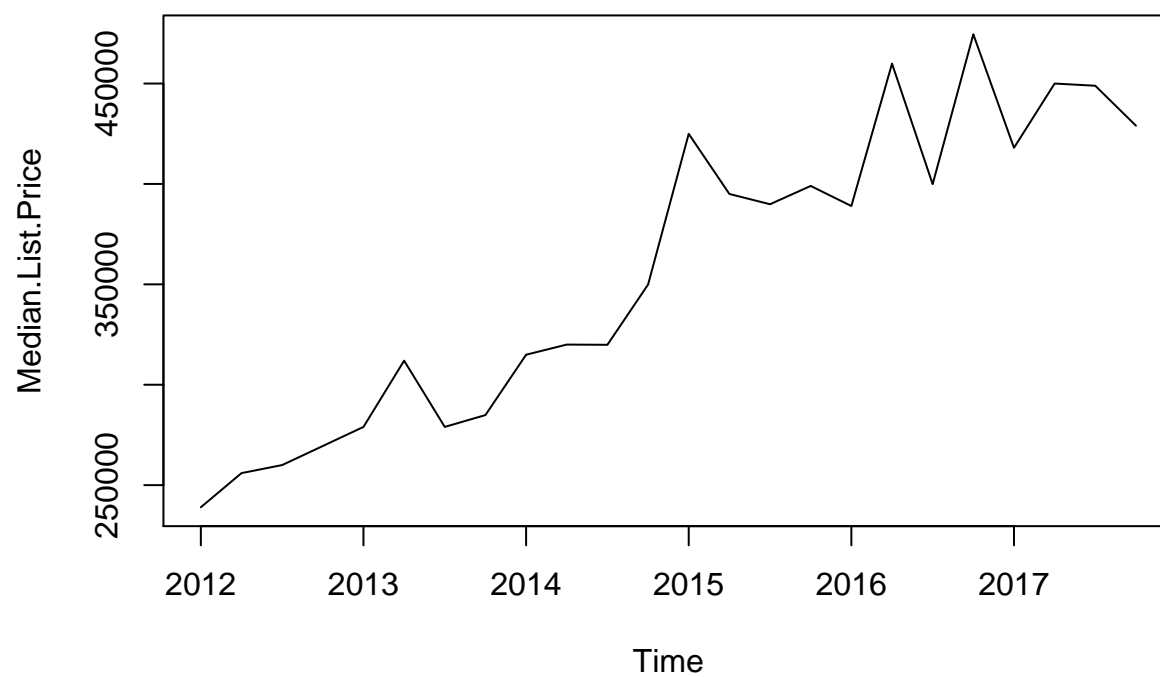
Portland, OR – Woodstock

Portland, OR – Woodstock : Naive Model Forecast
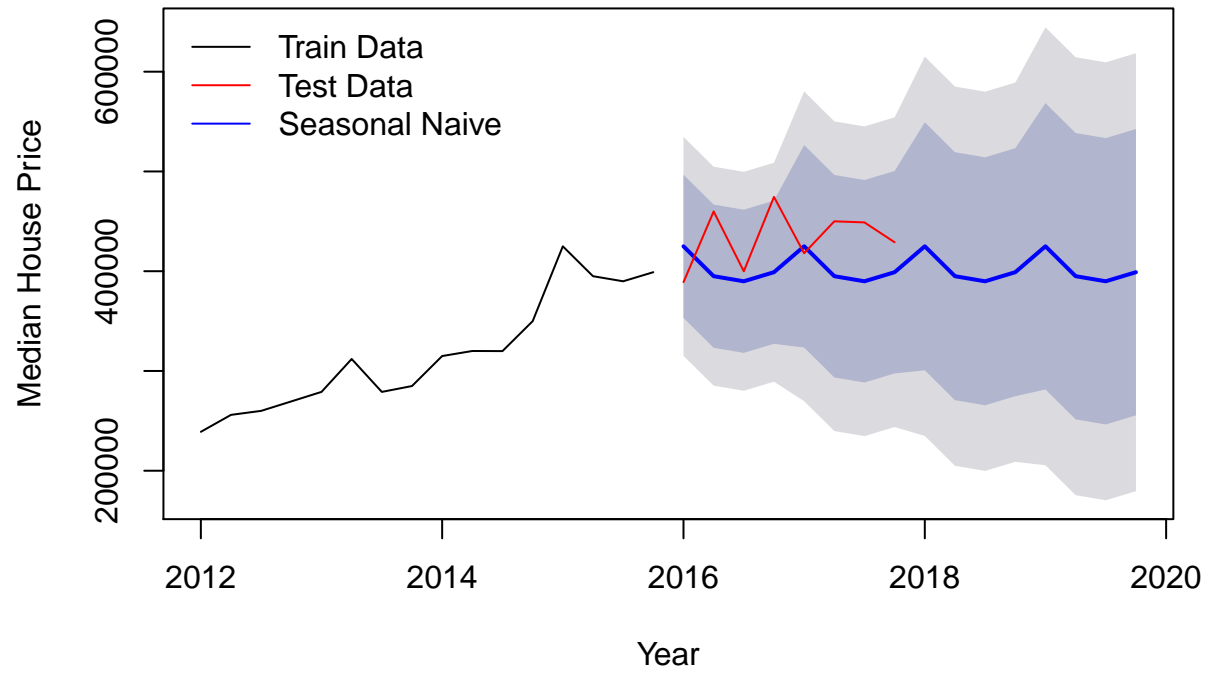
Portland, OR – Woodstock : Naive Model Forecast Residuals

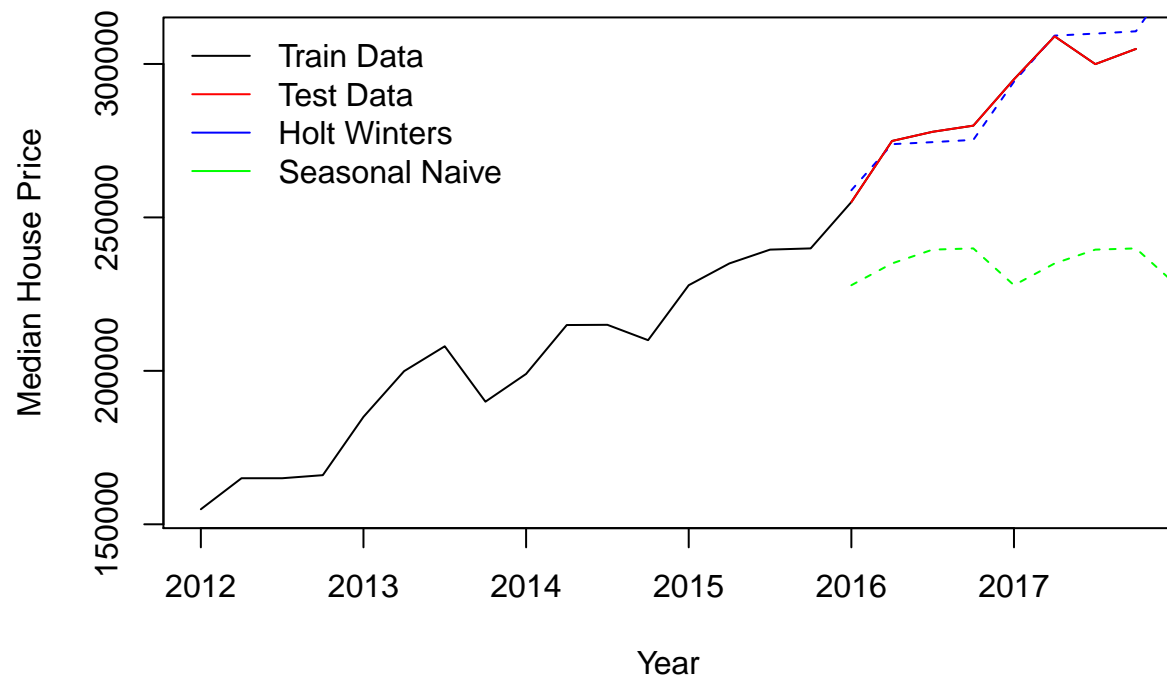Portland, OR – Woodstock : Holt Winters Model Forecast
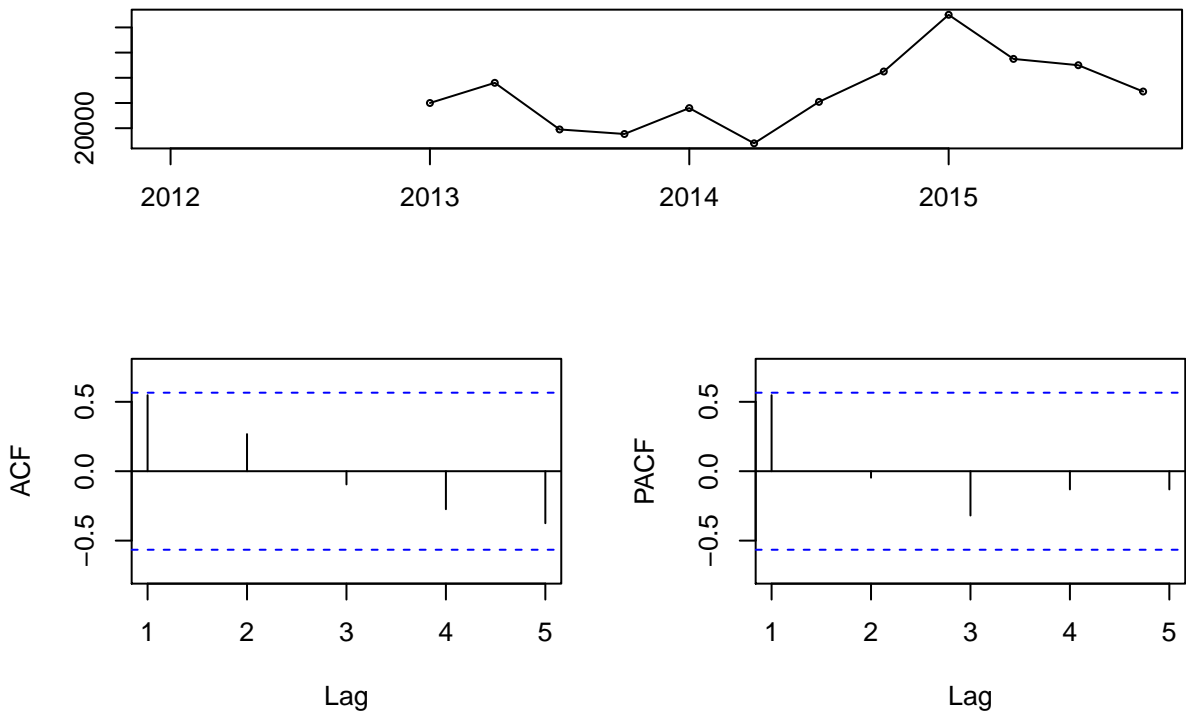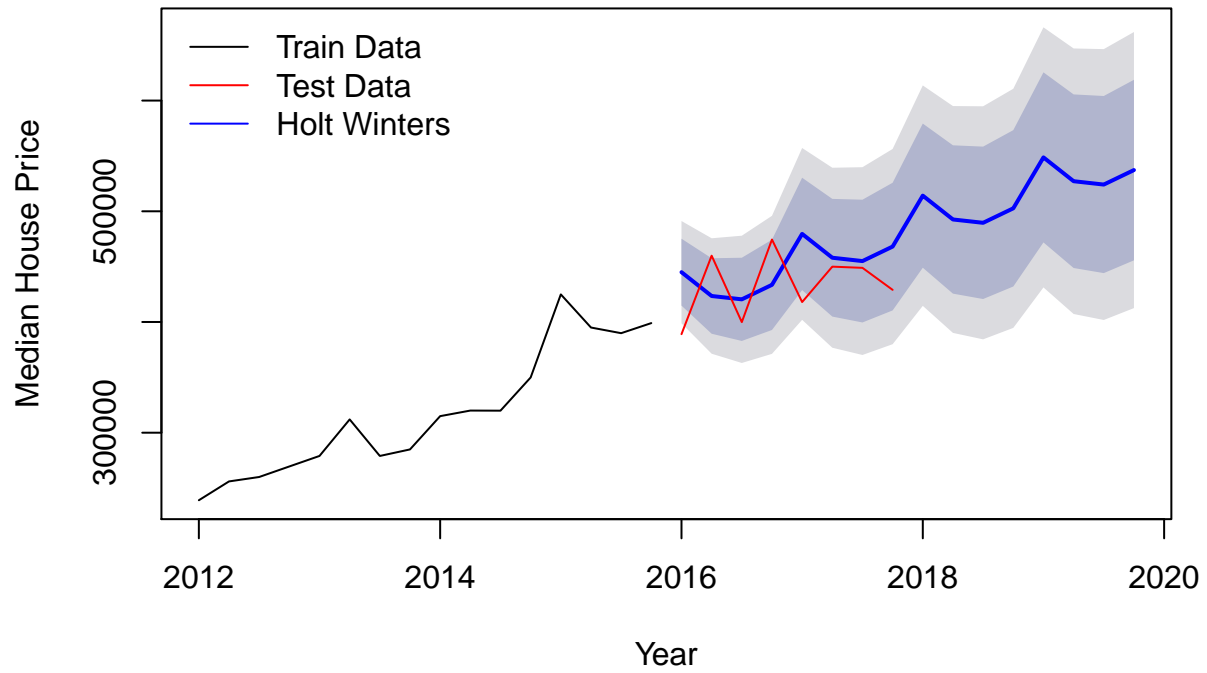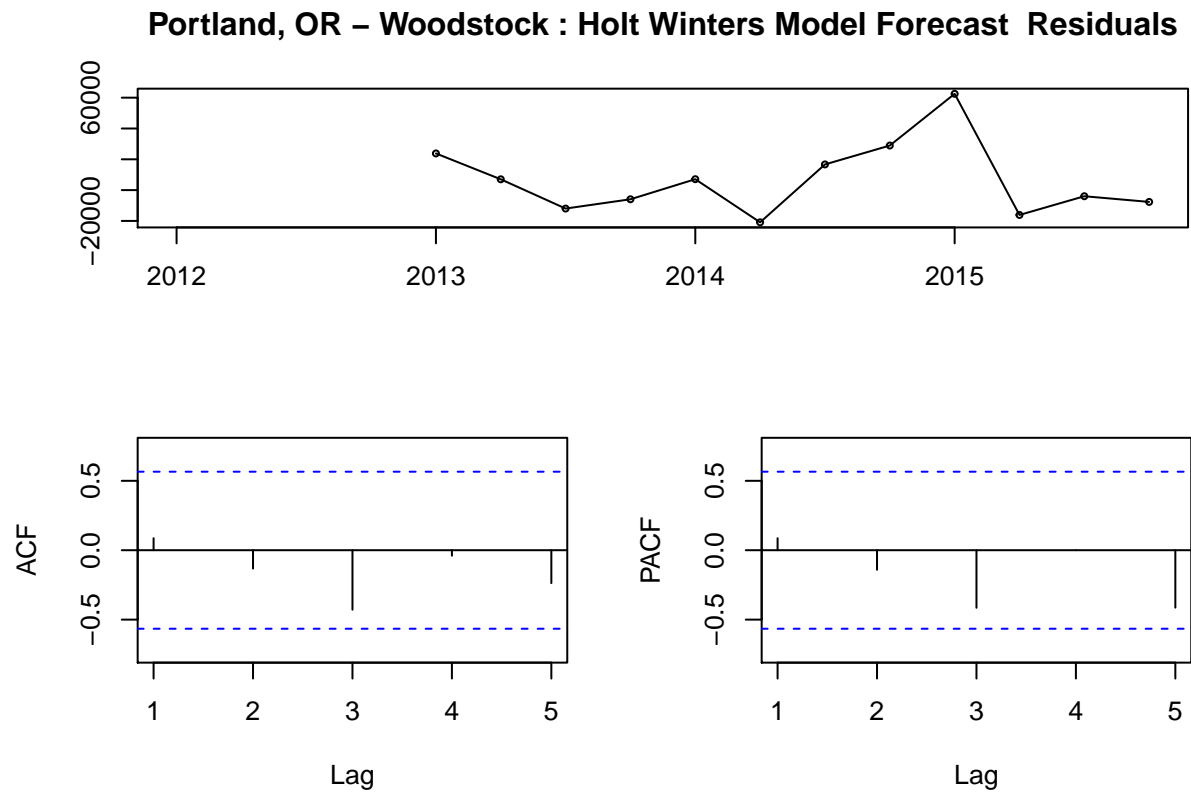
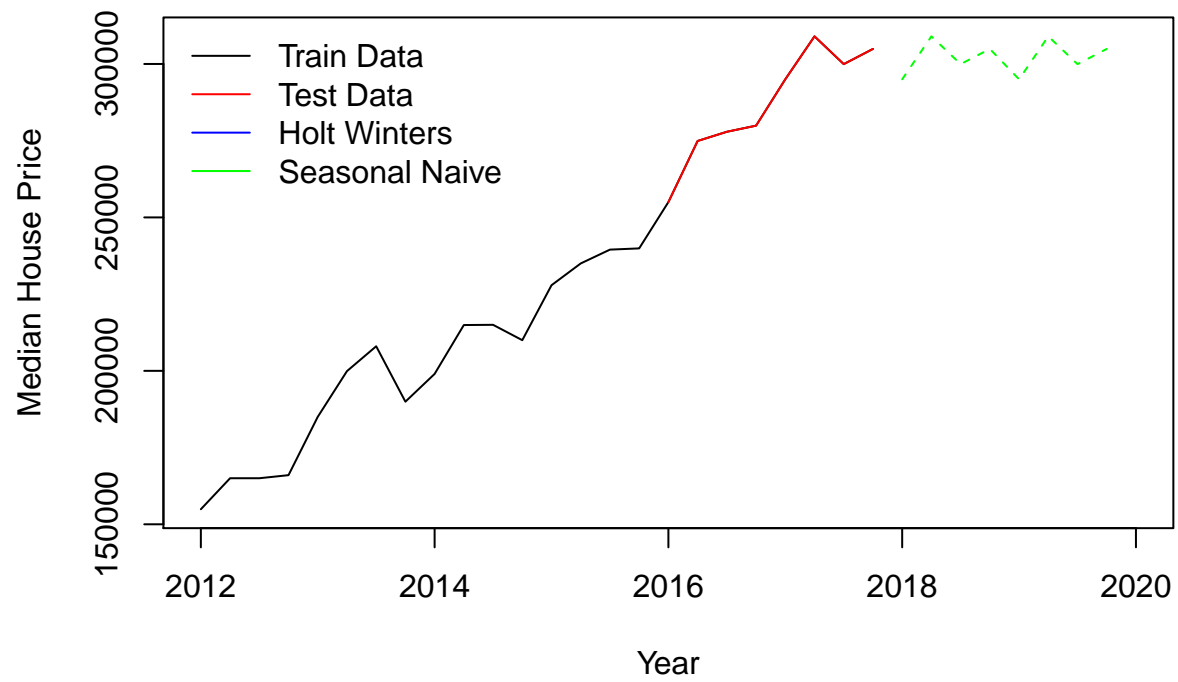## Portland, OR – Woodstock : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Woodstock"
##                    ME     RMSE      MAE       MPE     MAPE     MASE
## Training set 48695.83 55994.24 48695.83 13.742448 13.742448 1.000000
## Test set     31436.88 48422.89 42161.88  6.747141  9.473223 0.865821
##                   ACF1 Theil's U
## Training set  0.5477999        NA
## Test set     -0.5439267 0.9815581
## [1] "Holt Winters Accuracy for  Portland, OR - Woodstock"
##                    ME     RMSE      MAE       MPE     MAPE     MASE
## Training set   6624.219 23521.59 17716.26  1.775303 5.095996 0.3638148
## Test set     -14255.639 38702.22 33593.84 -3.748391 7.884817 0.6898710
##                   ACF1 Theil's U
## Training set  0.0867658        NA
## Test set     -0.5637674 0.6571253
```

Portland, OR – Woodstock : TS Training Model Comparison
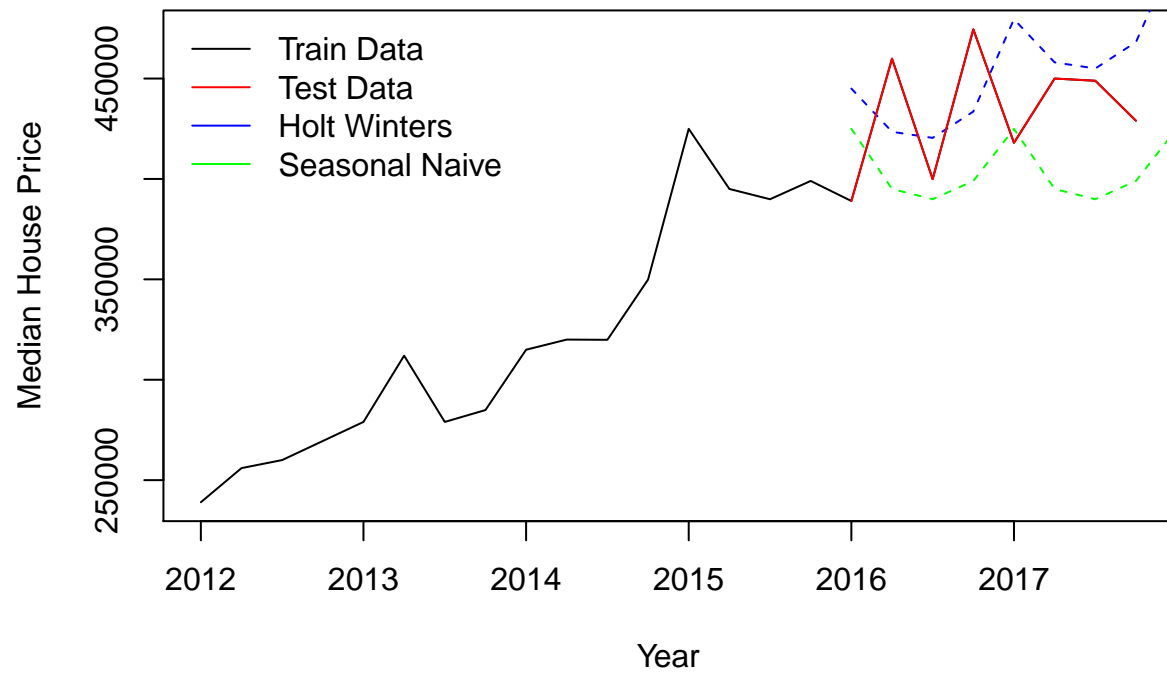
Portland, OR – Woodstock : Full TS Models Comparison
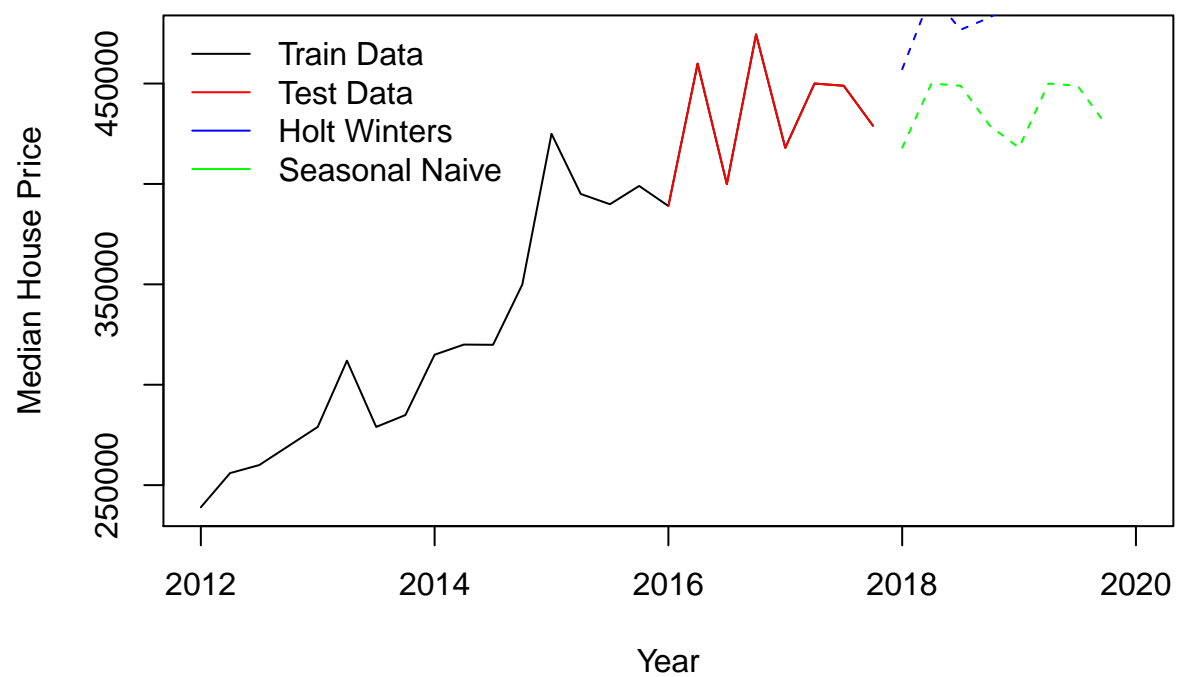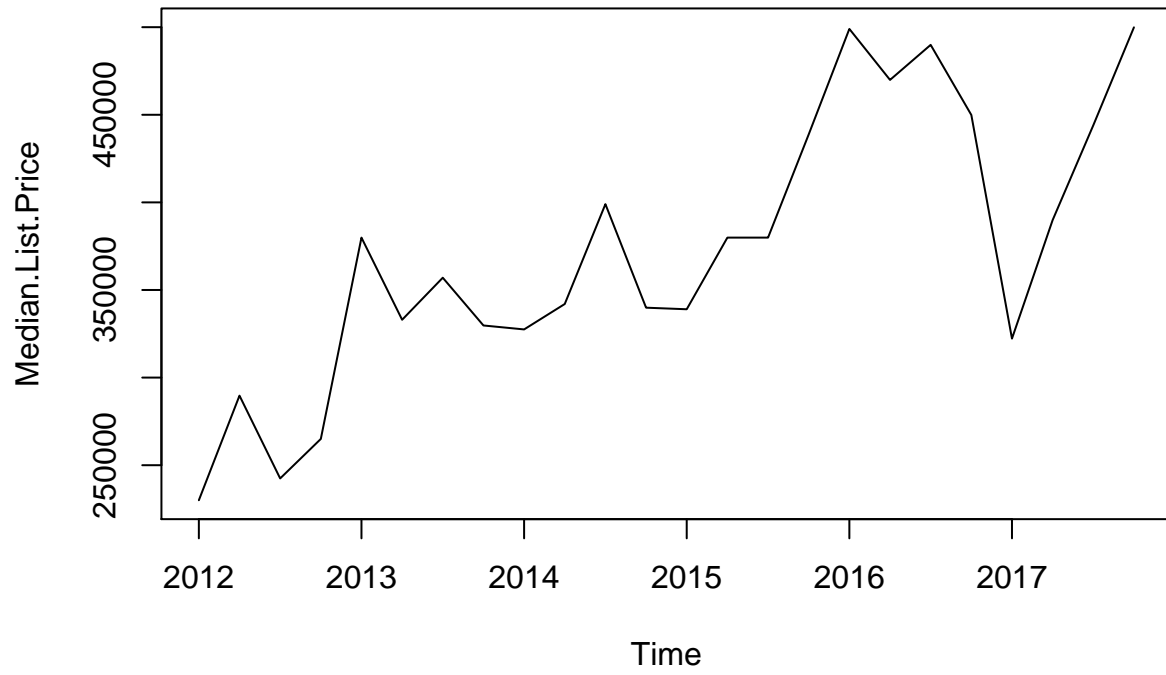
Portland, OR – Overlook

Portland, OR – Overlook : Naive Model Forecast
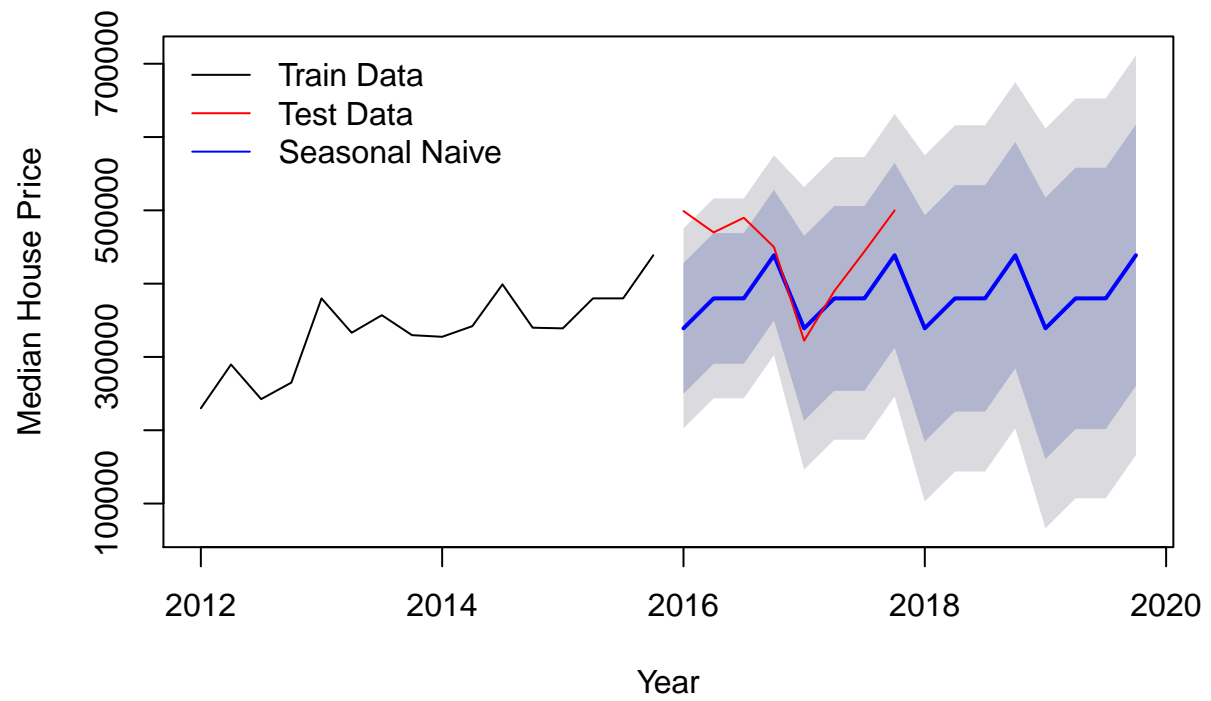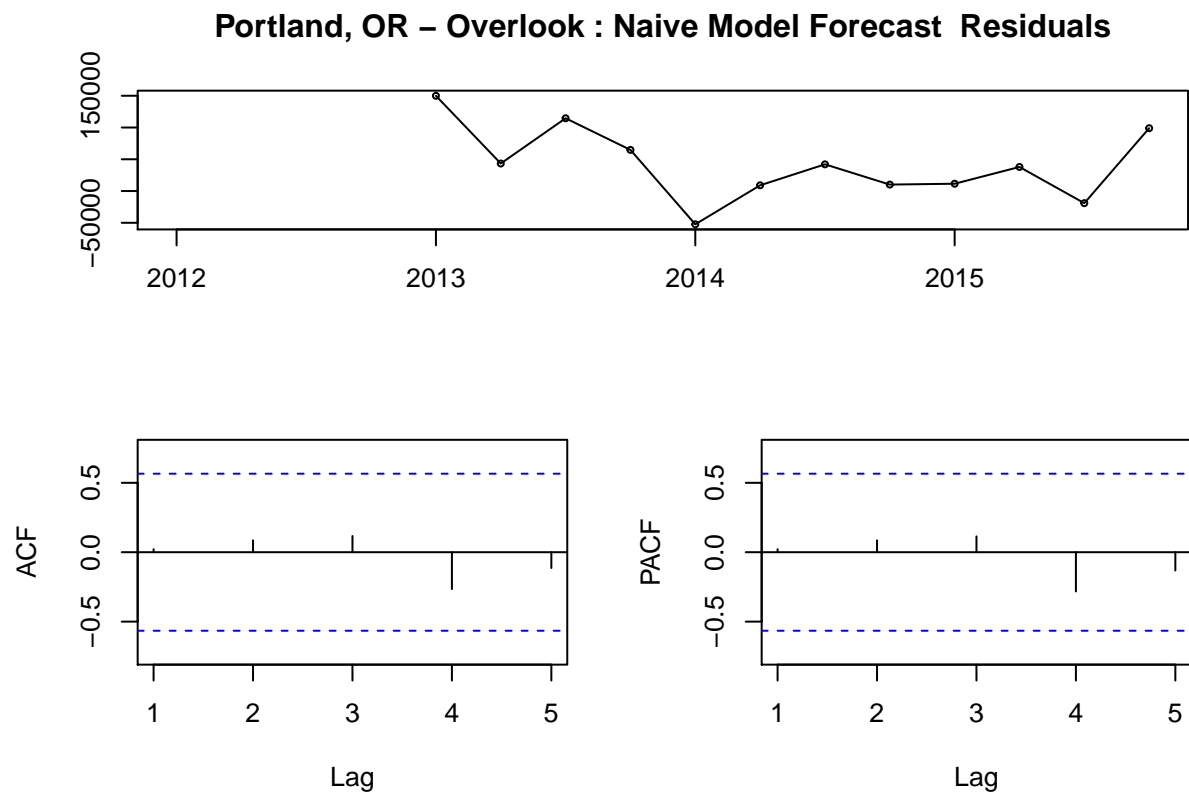
Portland, OR – Overlook : Naive Model Forecast Residuals
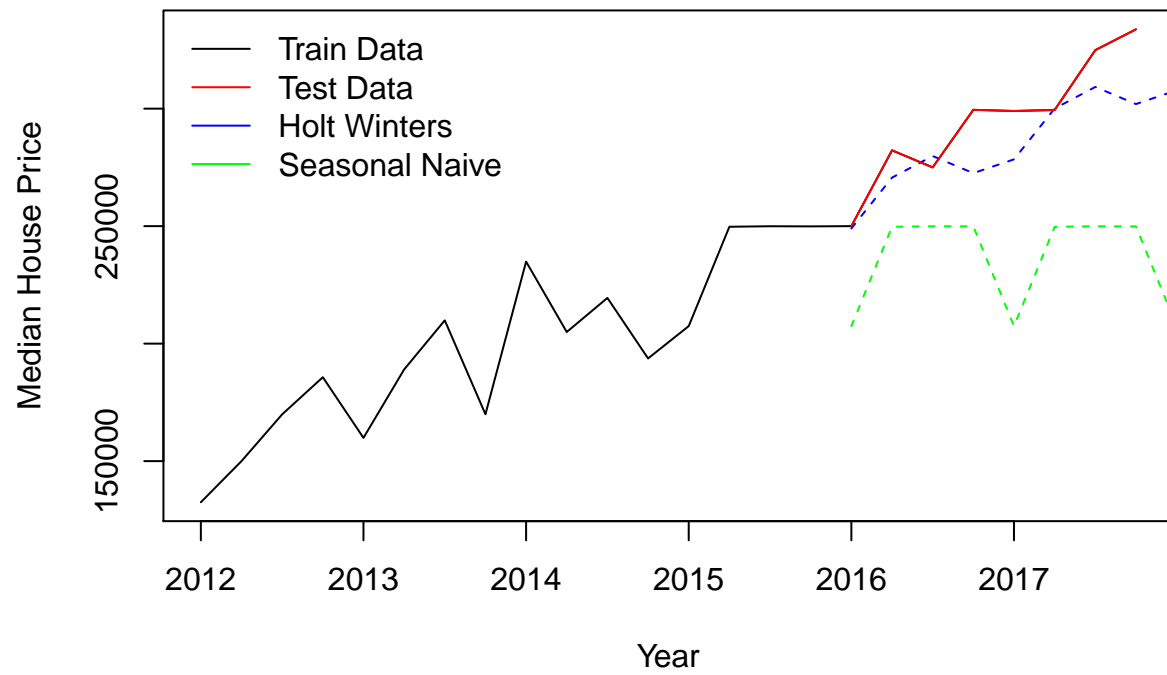
Portland, OR – Overlook : Holt Winters Model Forecast
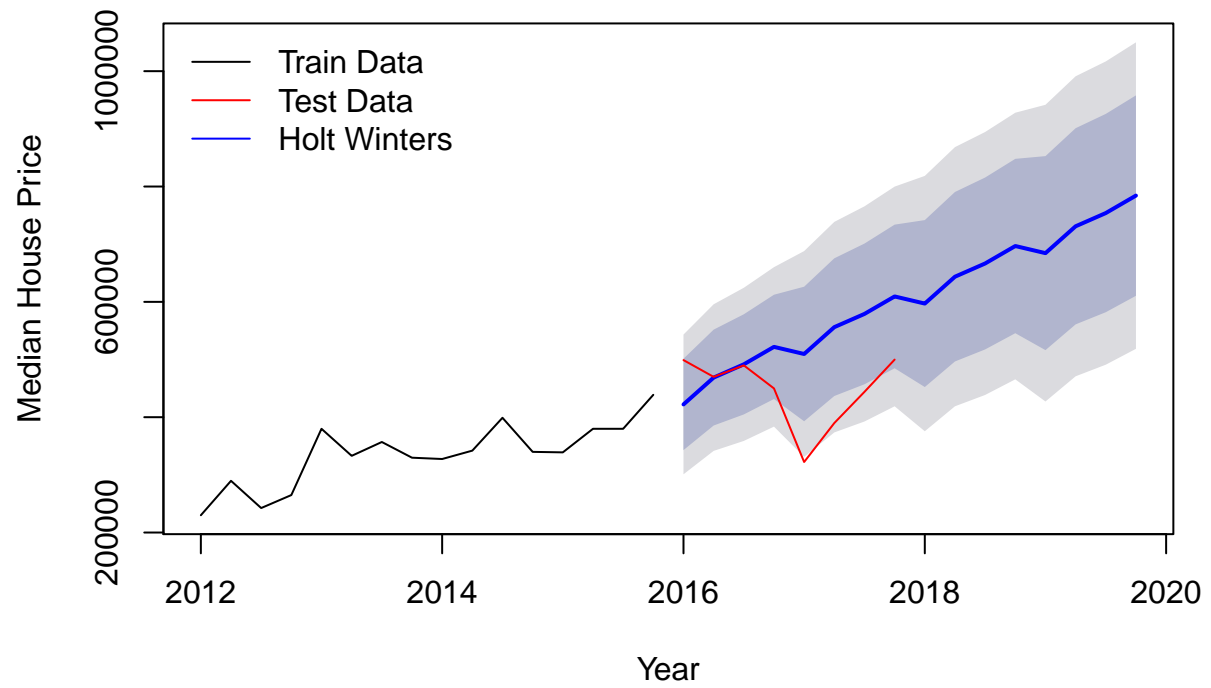
Portland, OR – Overlook : Holt Winters Model Forecast Residuals
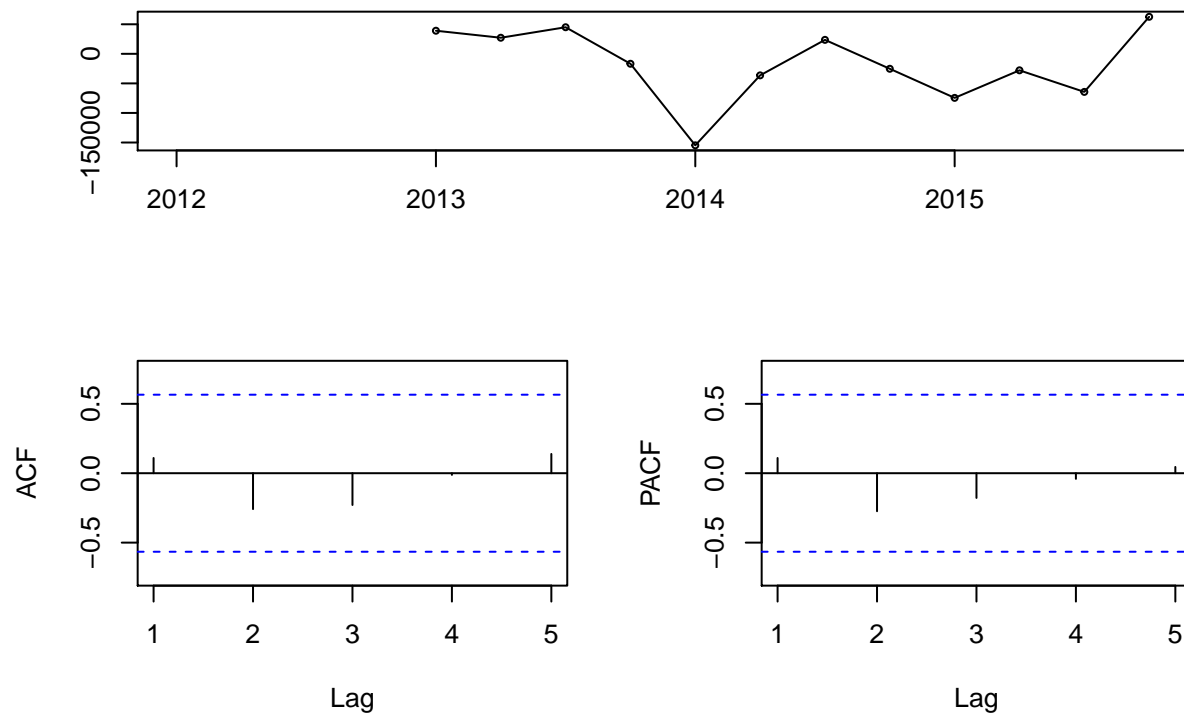

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Overlook"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 42536.21 69560.86 54452.88 11.26706 14.77167 1.000000
## Test set     61199.25 82270.59 65383.50 12.52188 13.82027 1.200735
##                   ACF1 Theil's U
## Training set 0.02224491        NA
## Test set     0.39494903 0.8909995
## [1] "Holt Winters Accuracy for  Portland, OR - Overlook"
##                    ME      RMSE      MAE       MPE     MAPE     MASE
## Training set -16873.62  61536.13 49797.75  -5.453462 13.99641 0.914511
## Test set     -74228.71 114049.64 93745.15 -19.224289 23.13915 1.721583
##                  ACF1 Theil's U
## Training set 0.1097878        NA
## Test set     0.5823110  1.934581
```

Portland, OR – Overlook : TS Training Model Comparison
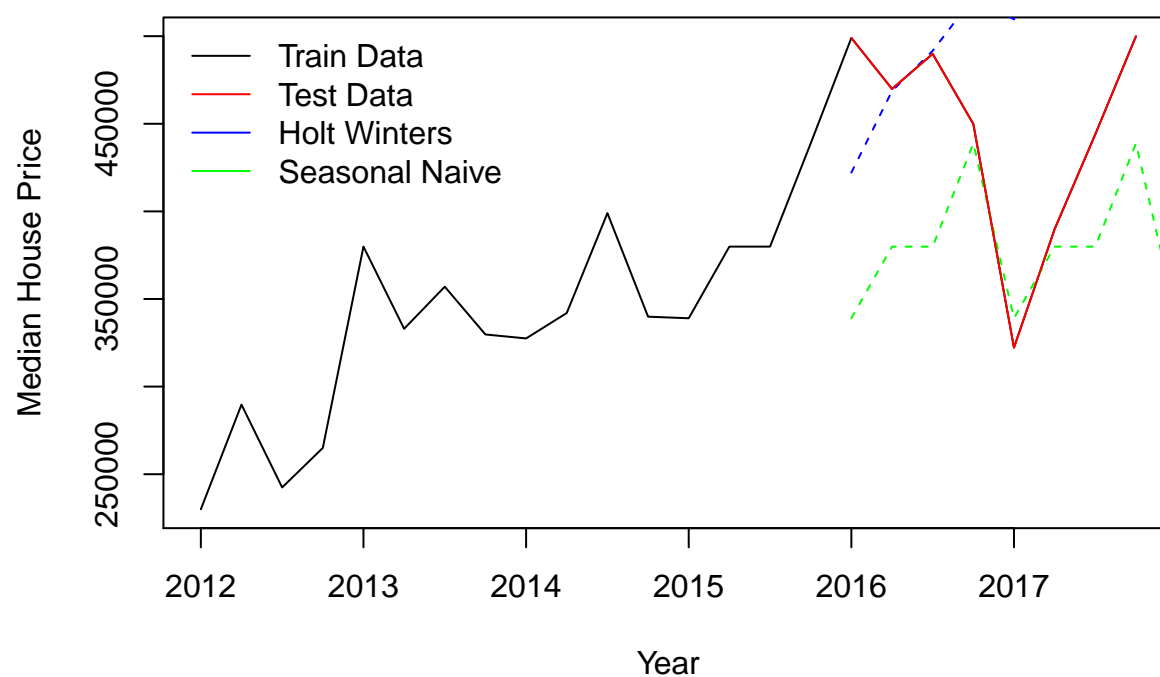
Portland, OR – Overlook : Full TS Models Comparison

Portland, OR – Ashcreek
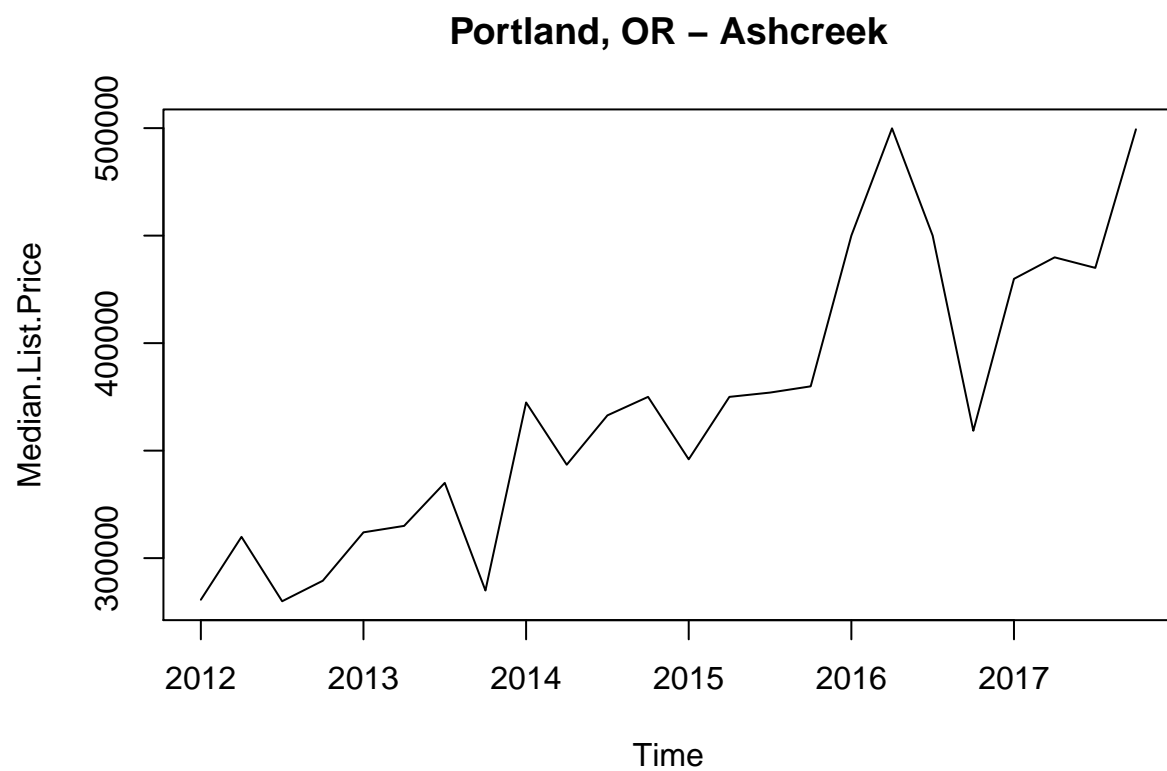
Portland, OR – Ashcreek : Naive Model Forecast
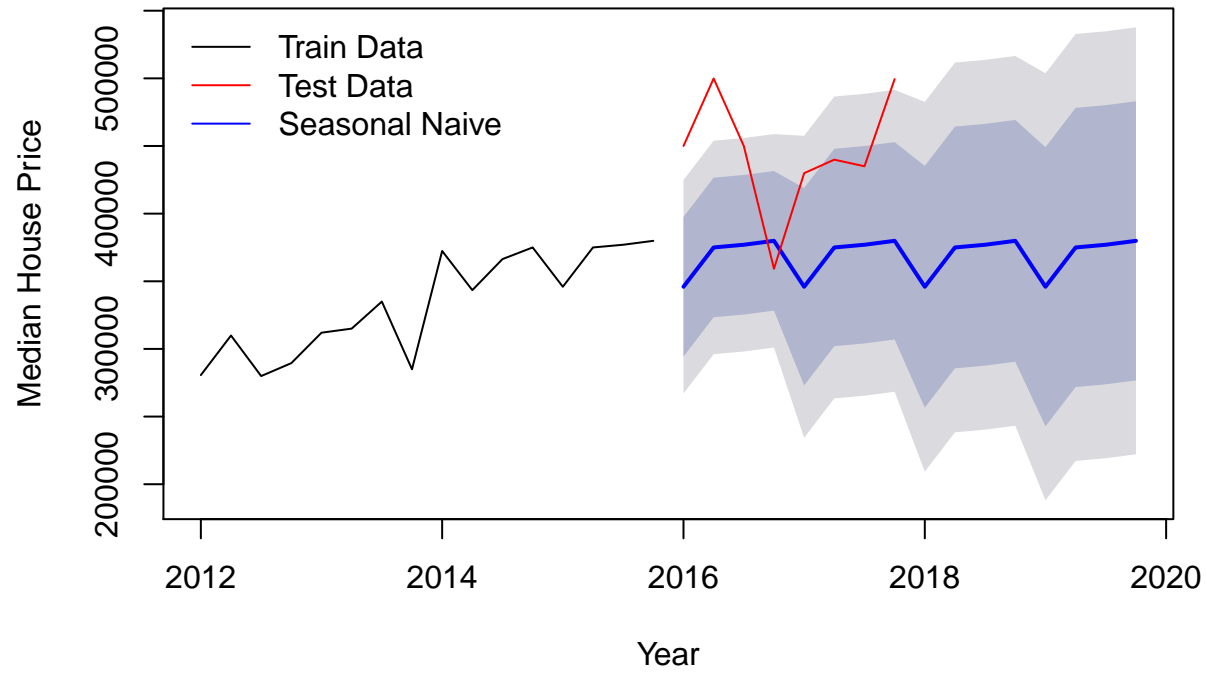
```
## Warning in HoltWinters(oneNeighborhood.timeseries): optimization
## difficulties: ERROR: ABNORMAL_TERMINATION_IN_LNSRCH
```

Portland, OR – Ashcreek : Naive Model Forecast Residuals
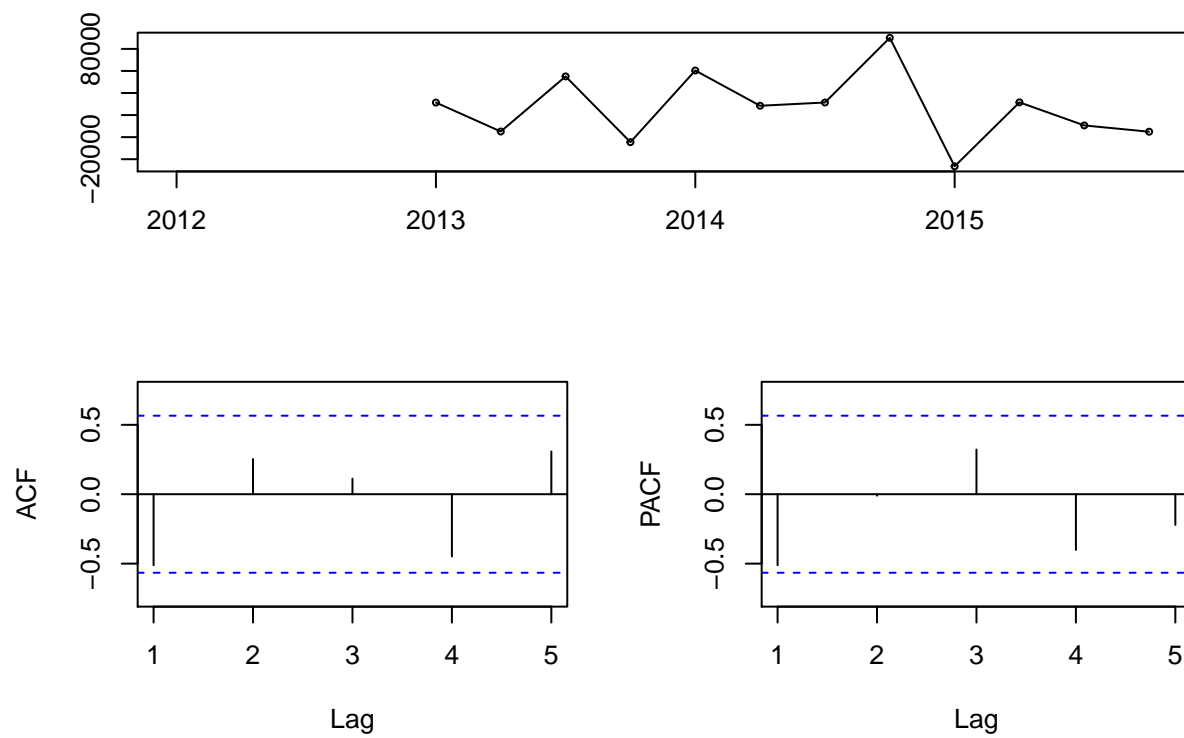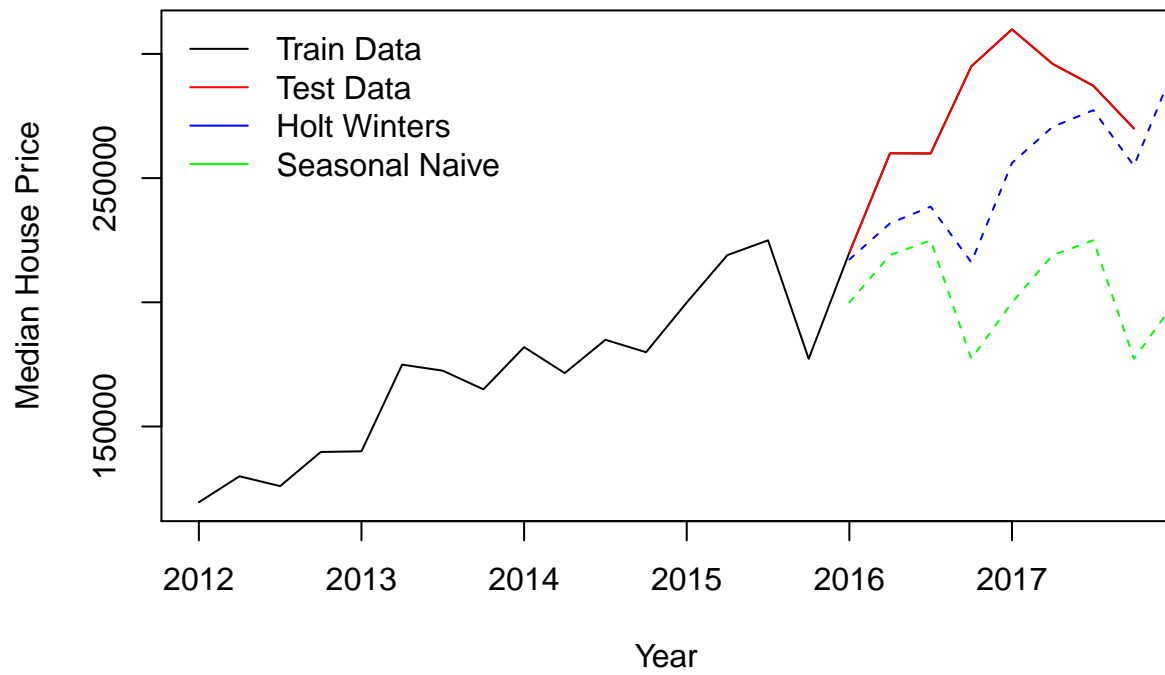
Portland, OR – Ashcreek : Holt Winters Model Forecast
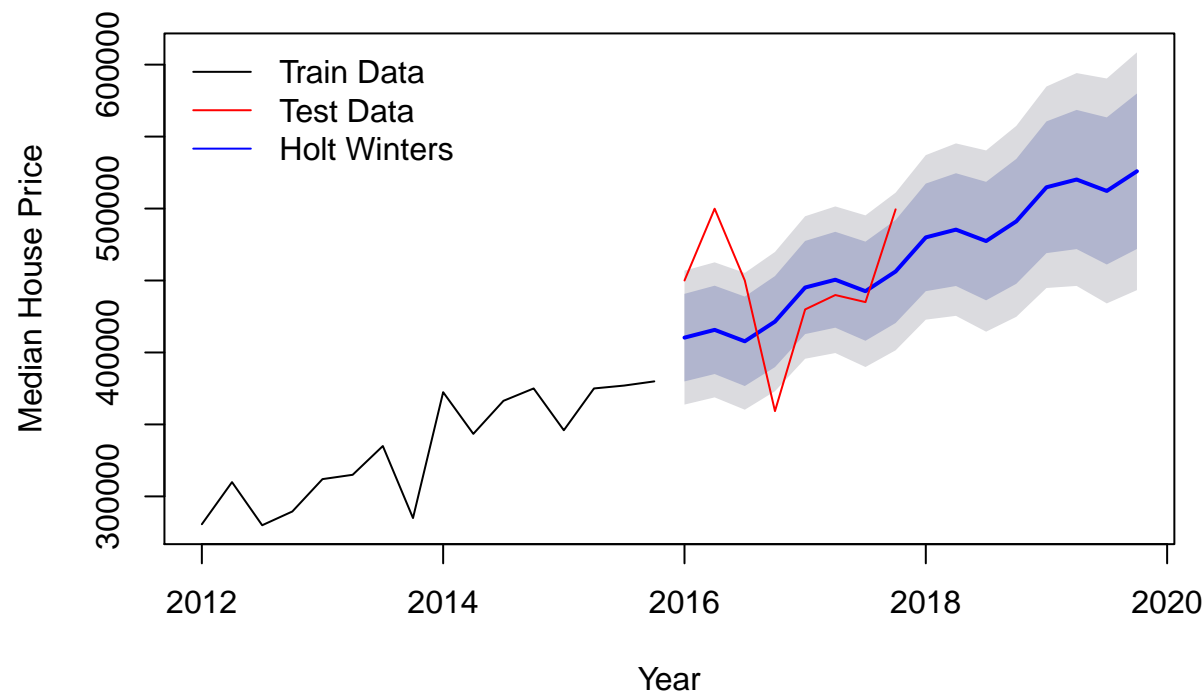
Portland, OR – Ashcreek : Holt Winters Model Forecast Residuals
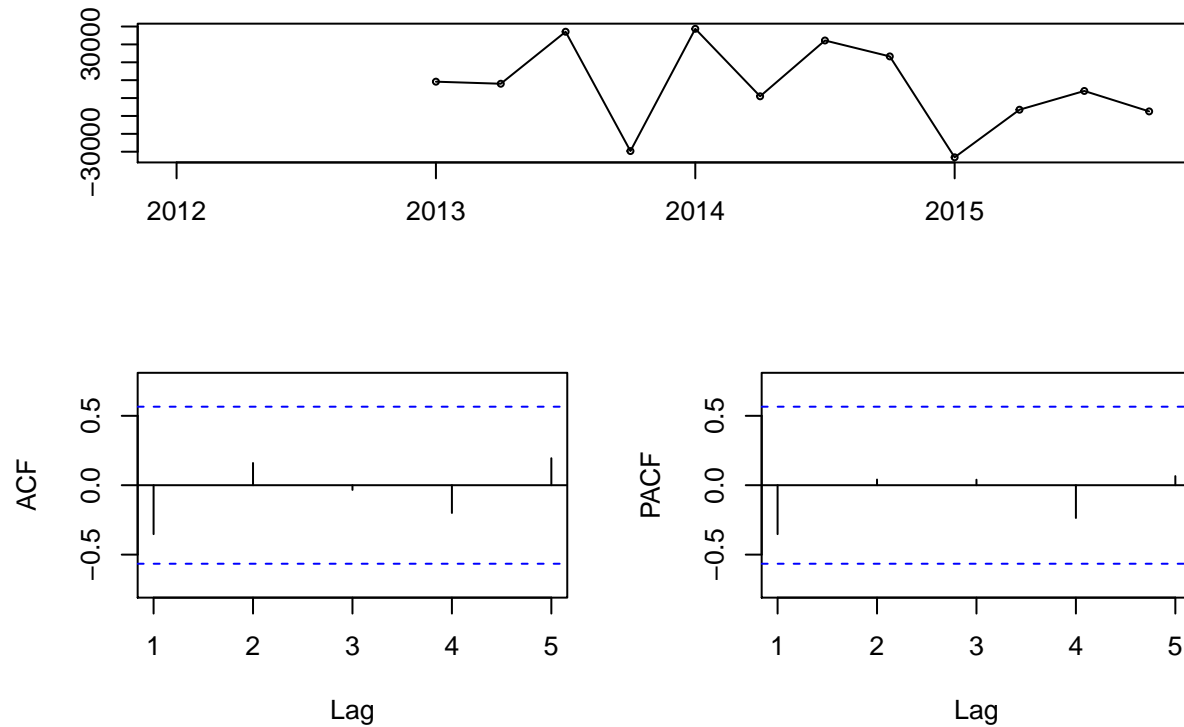

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Ashcreek"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 26487.5 40253.30 31654.17  7.371526  8.911923 1.000000
## Test set     75962.5 87391.11 81125.00 16.266521 17.703543 2.562854
##                    ACF1 Theil's U
## Training set -0.511188537        NA
## Test set      0.004786321  1.476416
## [1] "Holt Winters Accuracy for  Portland, OR - Ashcreek"
##                    ME      RMSE      MAE       MPE      MAPE       MASE
## Training set  6387.543 23608.56 19174.75 1.633387 5.578656 0.6057576
## Test set     14207.376 45530.32 38118.61 2.334721 8.588896 1.2042210
##                   ACF1 Theil's U
## Training set -0.3525892        NA
## Test set      0.3002404 0.7708392
```

Portland, OR – Ashcreek : TS Training Model Comparison

Median House Price

Year

| Train Data |
| Test Data |
| Holt Winters |
| Seasonal Naive |

Portland, OR – Ashcreek : Full TS Models Comparison
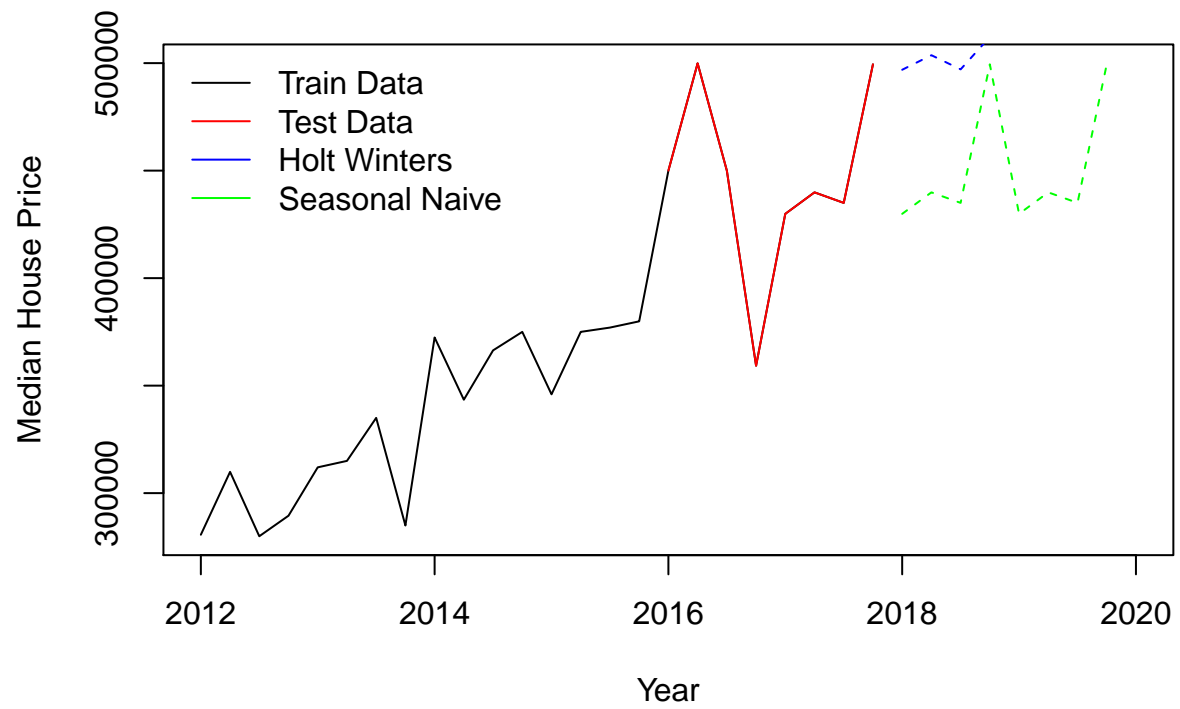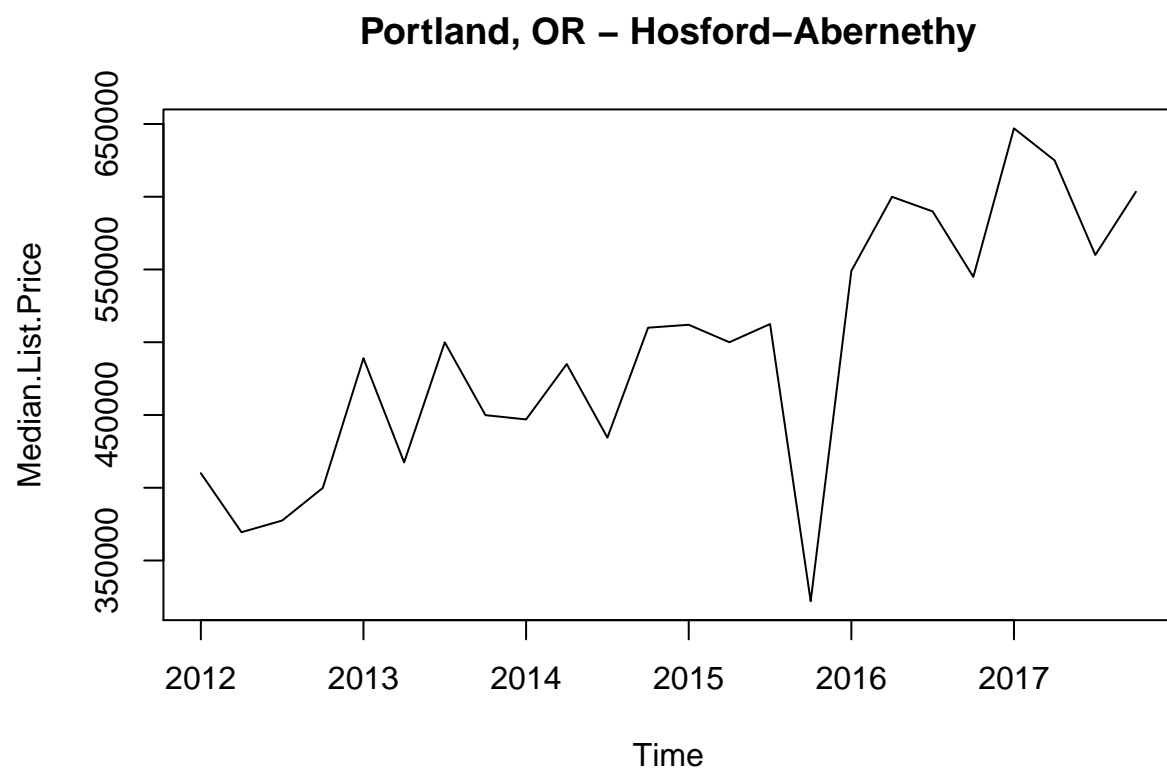
Portland, OR – Hosford–Abernethy

Portland, OR – Hosford–Abernethy : Naive Model Forecast
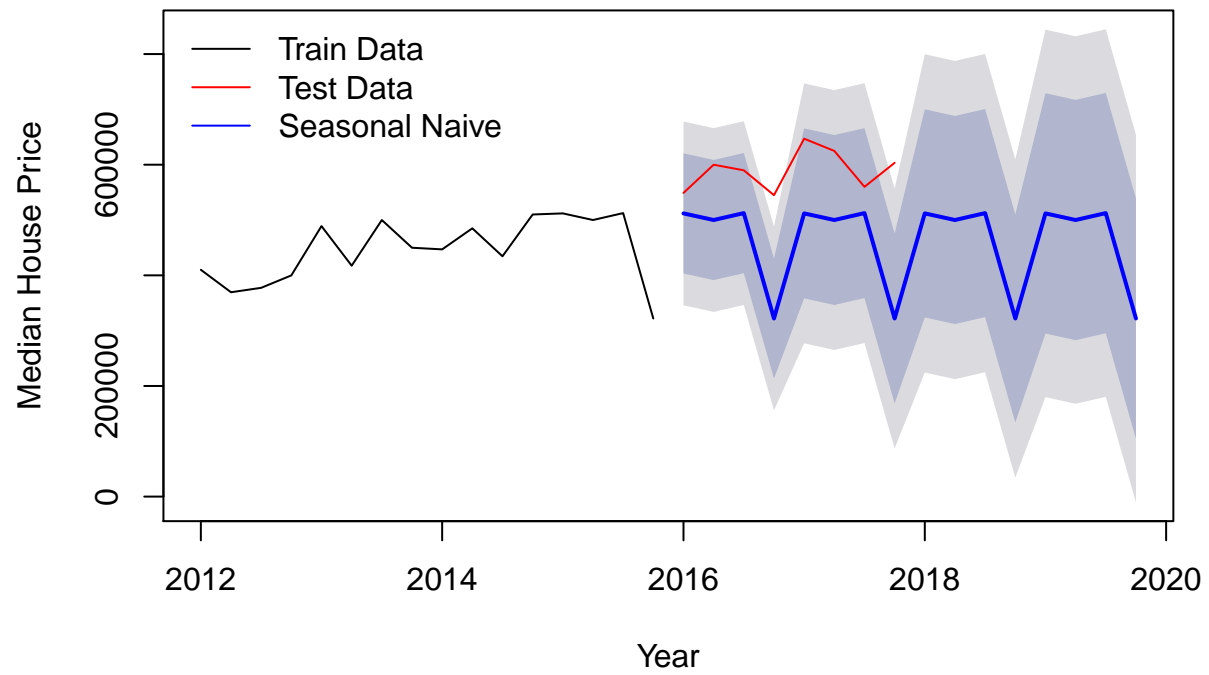
Portland, OR – Hosford–Abernethy : Naive Model Forecast Residuals
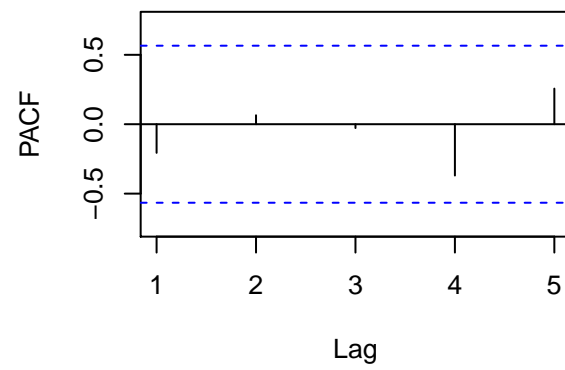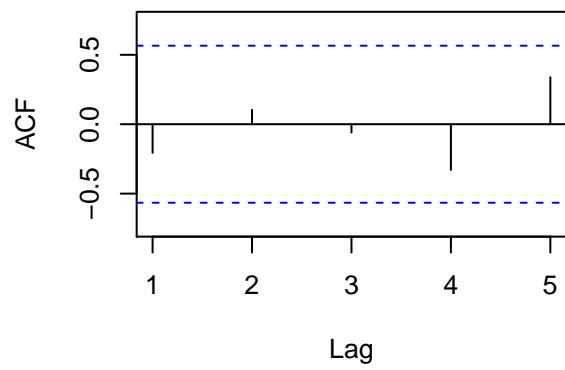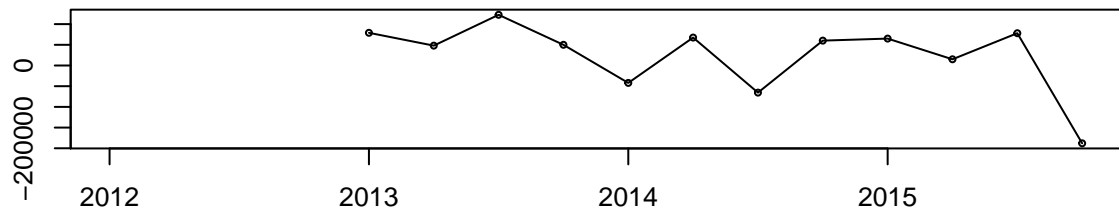
Portland, OR – Hosford–Abernethy : Holt Winters Model Forecast
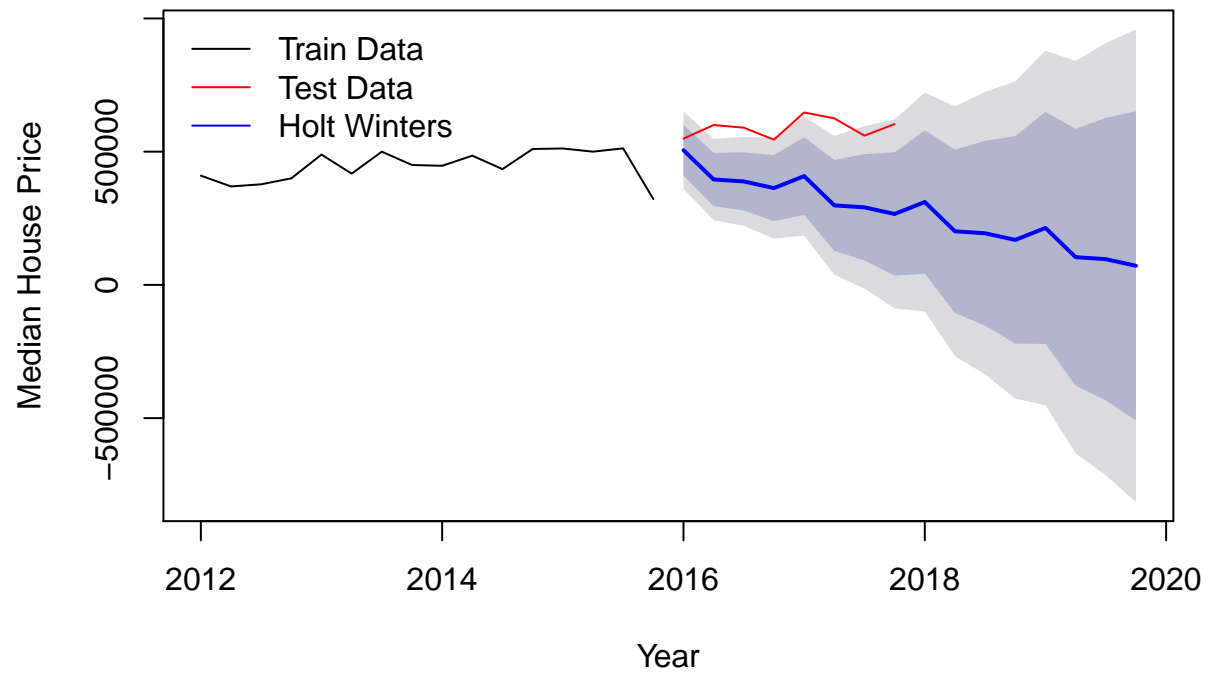
Portland, OR – Hosford–Abernethy : Holt Winters Model Forecast Residuals
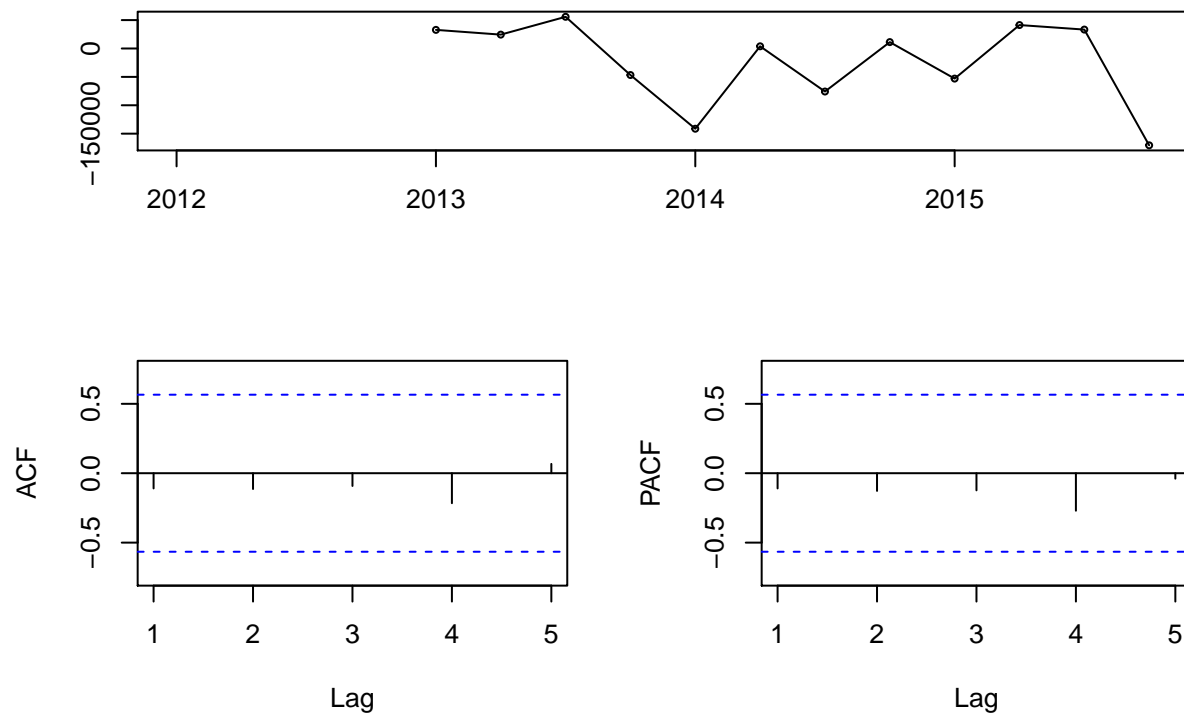

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Hosford-Abernethy"
##                     ME       RMSE       MAE      MPE     MAPE     MASE
## Training set  24141.67   84743.25   73400.0  3.087208 16.89885 1.000000
## Test set     128268.06 150972.47 128268.1 21.675904 21.67590 1.747521
##                   ACF1 Theil's U
## Training set -0.2062629        NA
## Test set     -0.2420950  2.847031
## [1] "Holt Winters Accuracy for  Portland, OR - Hosford-Abernethy"
##                     ME       RMSE       MAE       MPE     MAPE      MASE
## Training set -23720.44  75014.86  57507.43 -6.773556 13.68640 0.7834799
## Test set     225353.86 241641.63 225353.86 37.825318 37.82532 3.0702161
##                   ACF1 Theil's U
## Training set -0.1096262        NA
## Test set      0.2536206  4.447518
```

Portland, OR – Hosford–Abernethy : TS Training Model Comparison
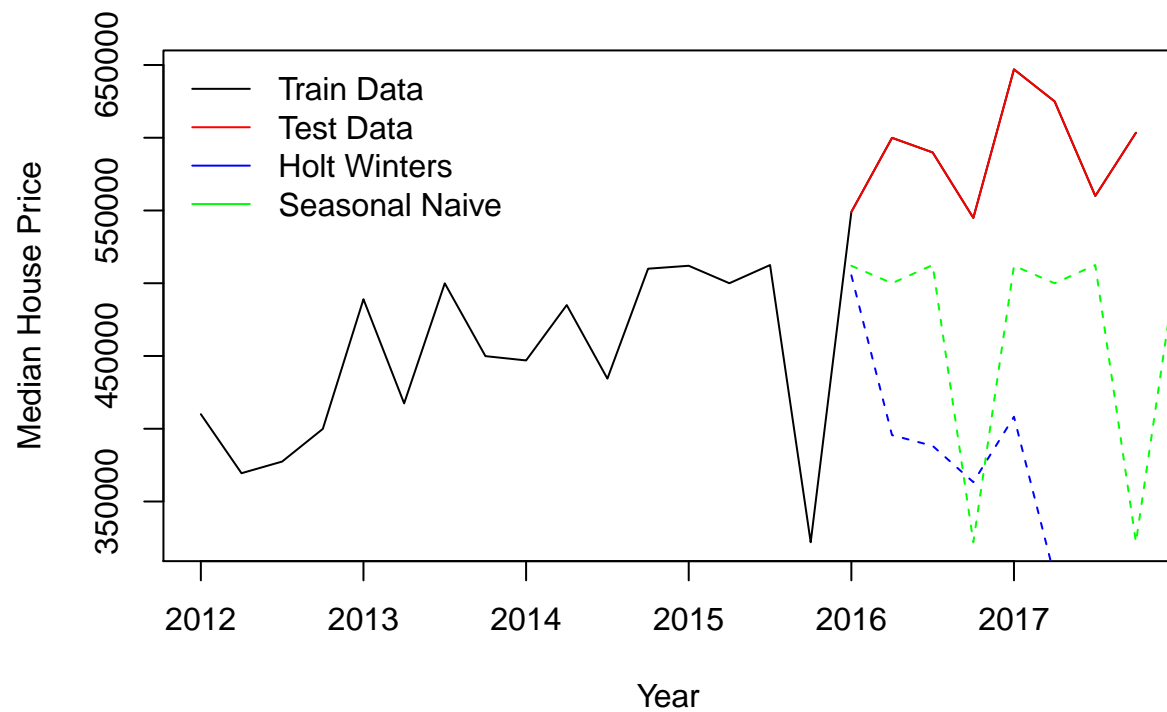
Portland, OR – Hosford–Abernethy : Full TS Models Comparison
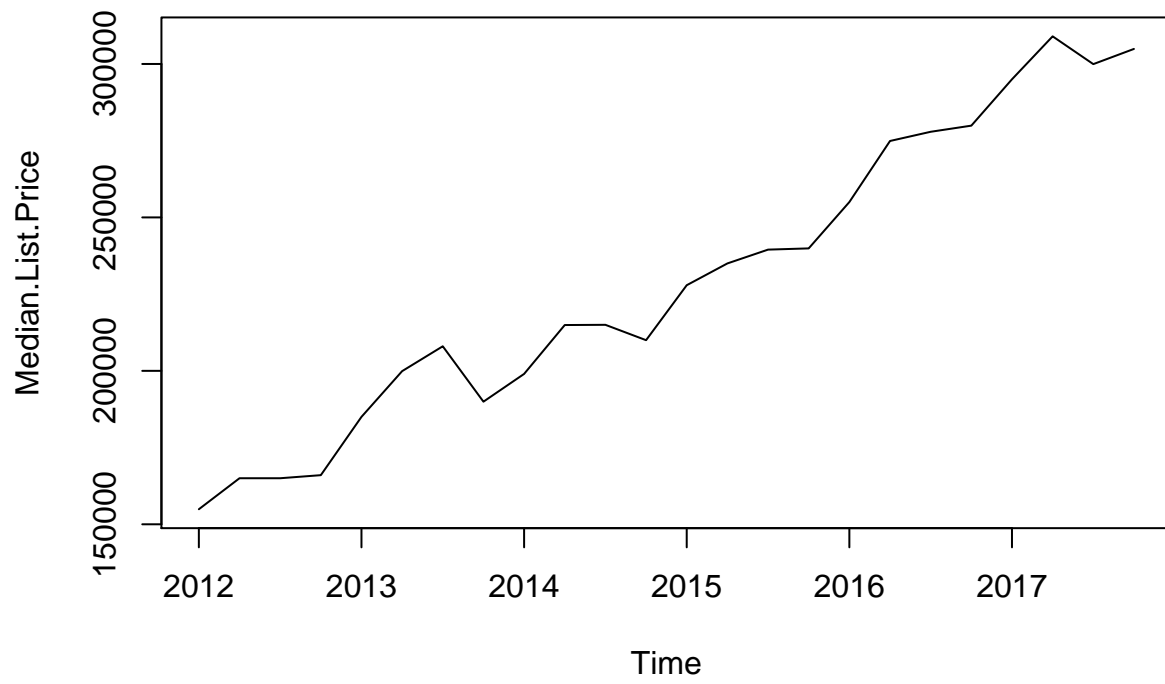
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

X-axis: Year
Y-axis: Median House Price

Portland, OR – East Portland

Portland, OR – East Portland : Naive Model Forecast
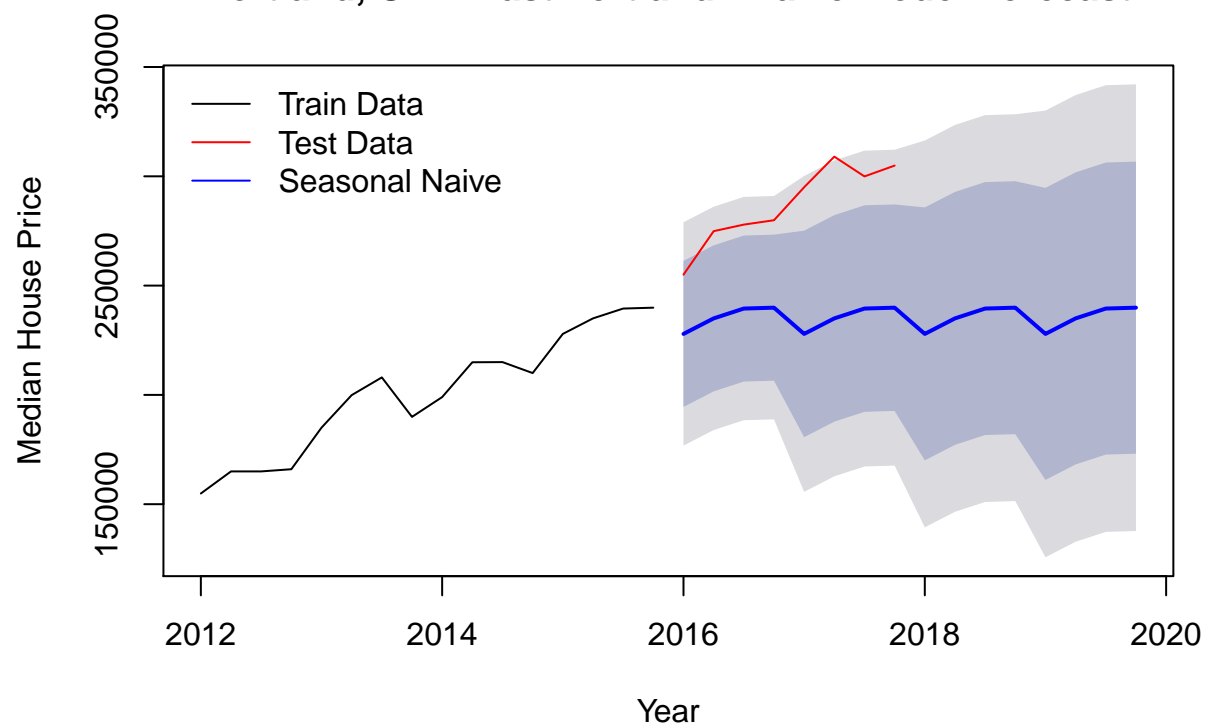
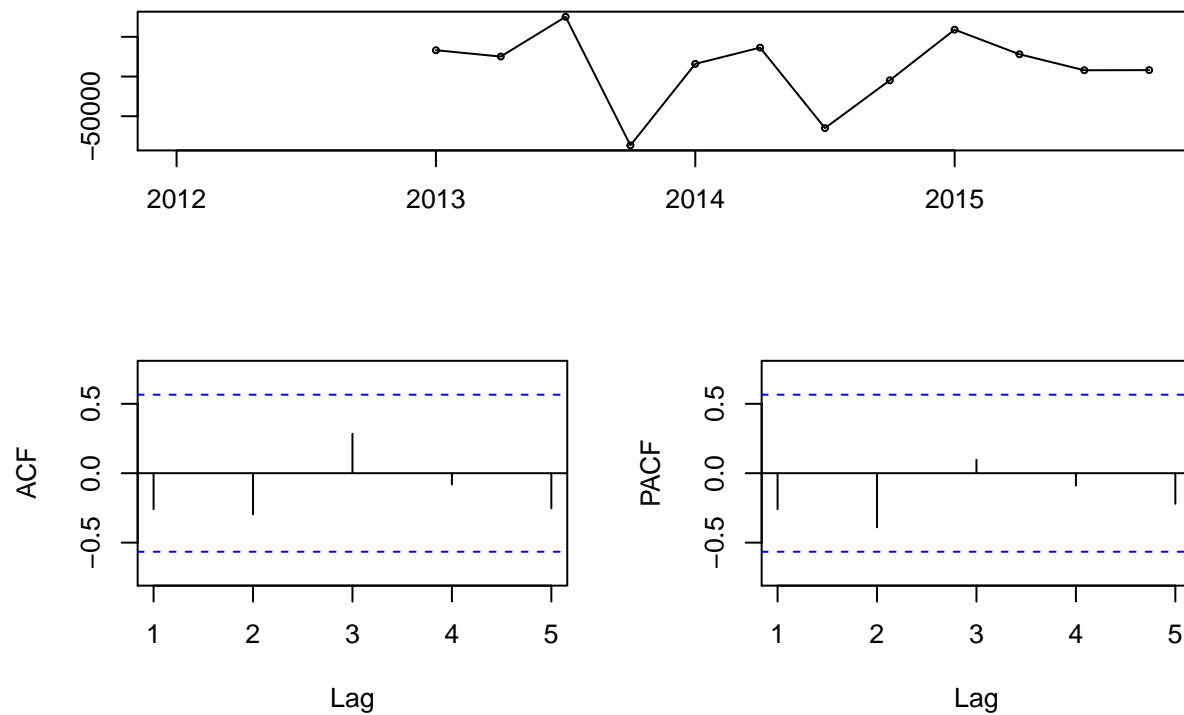**Portland, OR – East Portland : Naive Model Forecast Residuals**
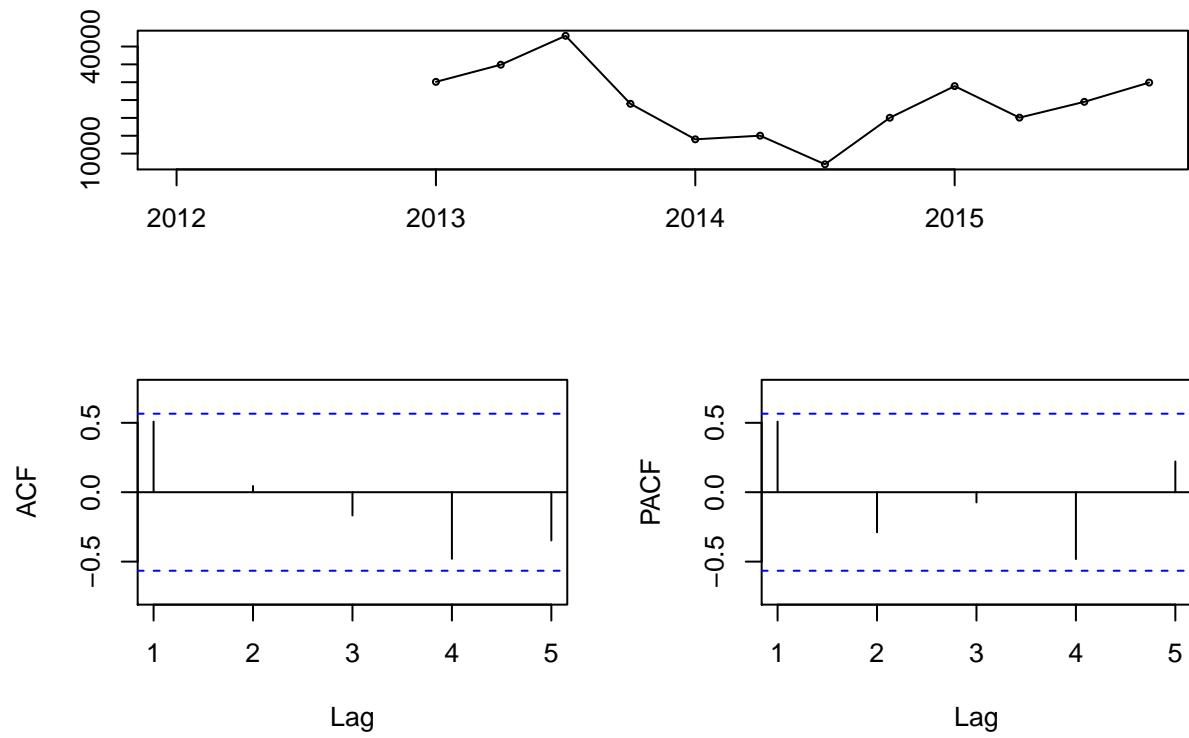
Portland, OR – East Portland : Holt Winters Model Forecast
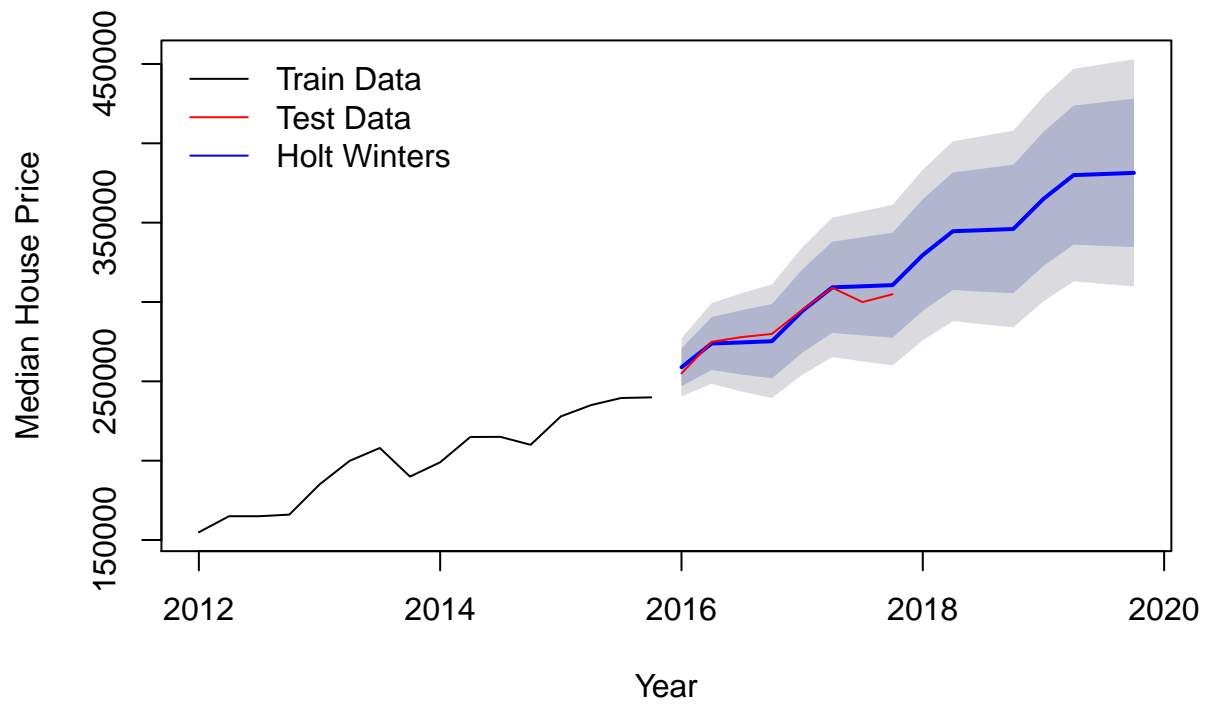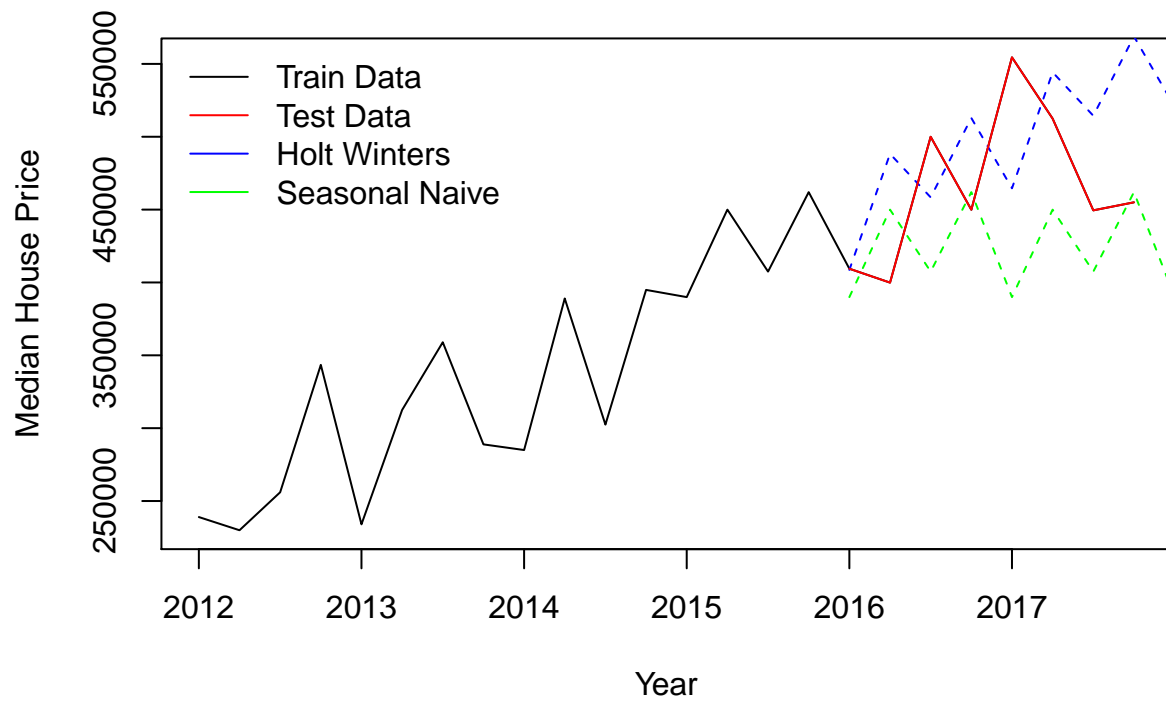
Portland, OR – East Portland : Holt Winters Model Forecast Residuals
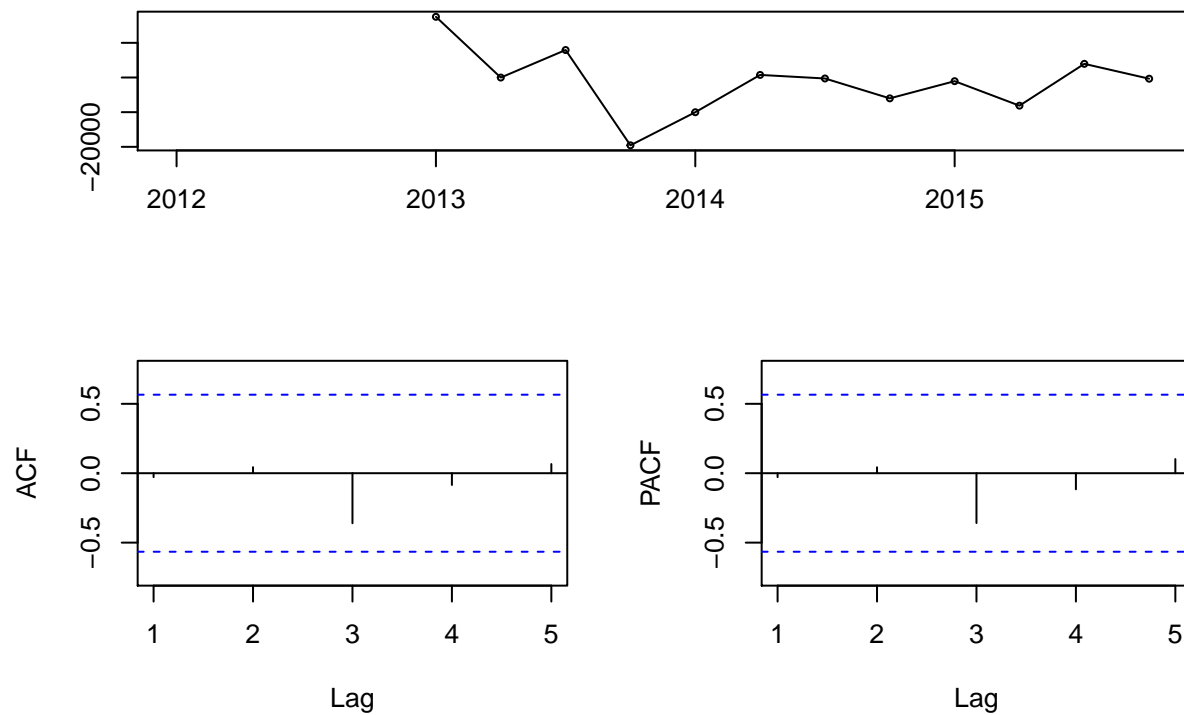

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - East Portland"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 24283.29 26063.91 24283.29 11.47971 11.47971 1.000000
## Test set     51493.88 53919.74 51493.88 17.67709 17.67709 2.120548
##                 ACF1 Theil's U
## Training set 0.5088656        NA
## Test set     0.5276834  4.640547
## [1] "Holt Winters Accuracy for  Portland, OR - East Portland"
##                   ME     RMSE      MAE        MPE     MAPE      MASE
## Training set -1277.575 8999.595 6296.117 -0.5957286 3.139479 0.2592777
## Test set     -1245.335 4761.394 3699.375 -0.4098233 1.286864 0.1523424
##                  ACF1 Theil's U
## Training set -0.02832162        NA
## Test set      0.44996132 0.3845842
```

# Portland, OR – East Portland : TS Training Model Comparison

# Portland, OR – East Portland : Full TS Models Comparison
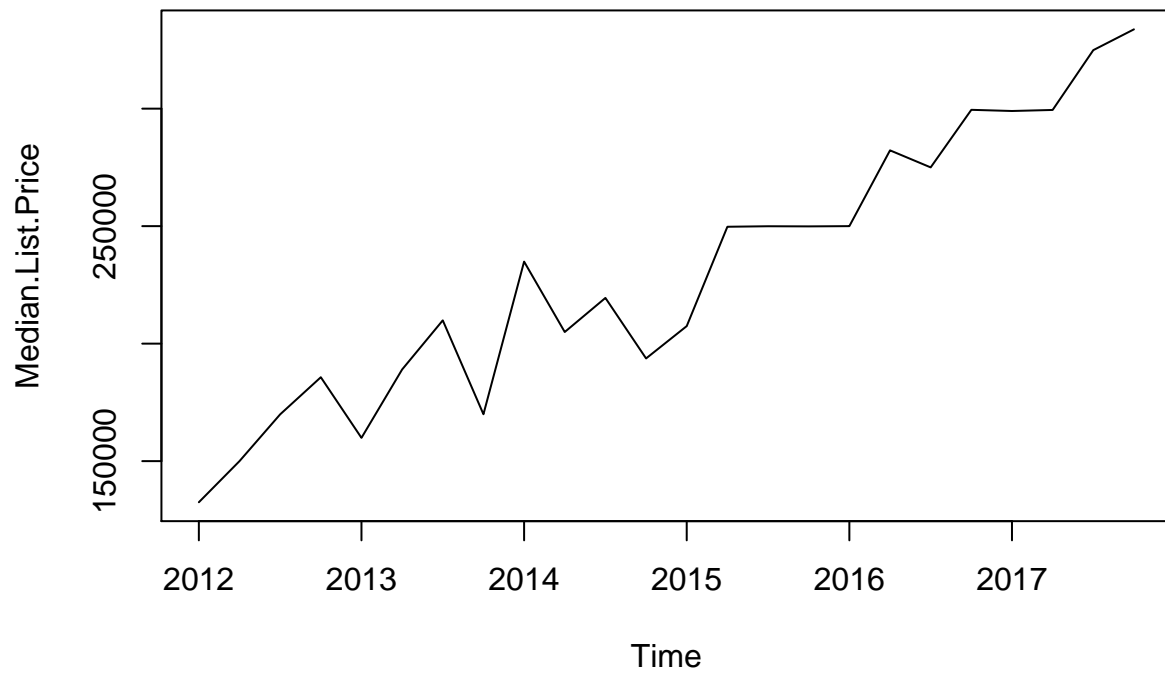
Portland, OR – Parkrose Heights

Portland, OR – Parkrose Heights : Naive Model Forecast
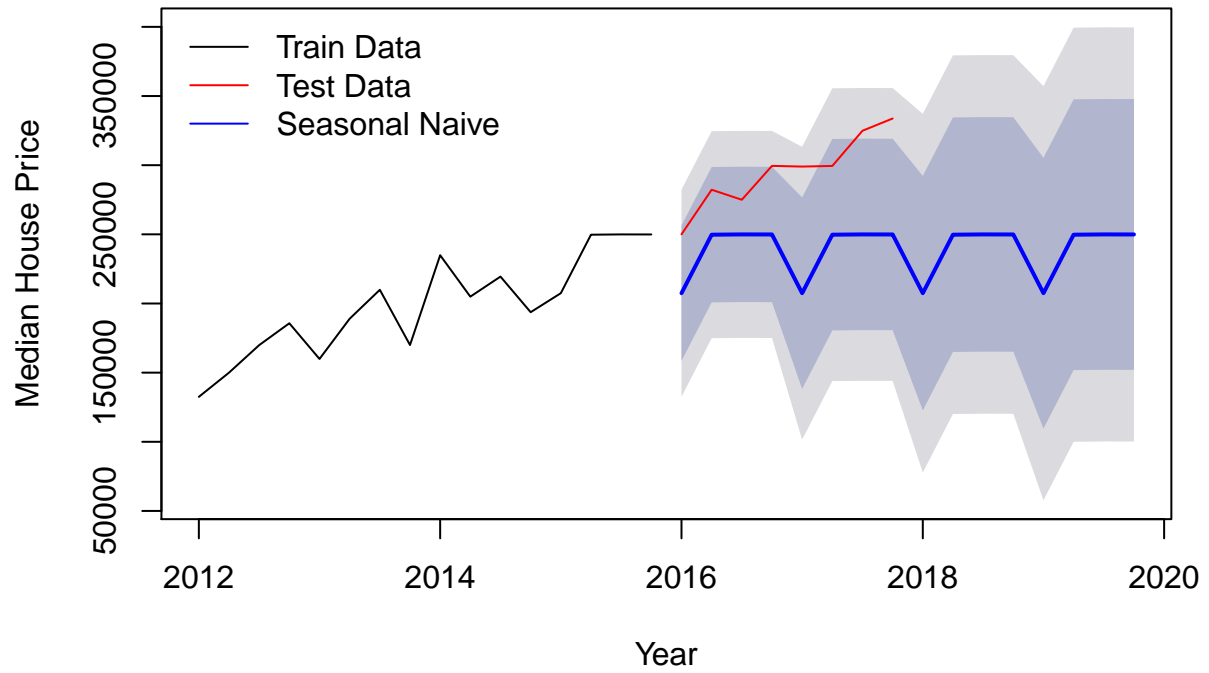
Portland, OR – Parkrose Heights : Naive Model Forecast Residuals
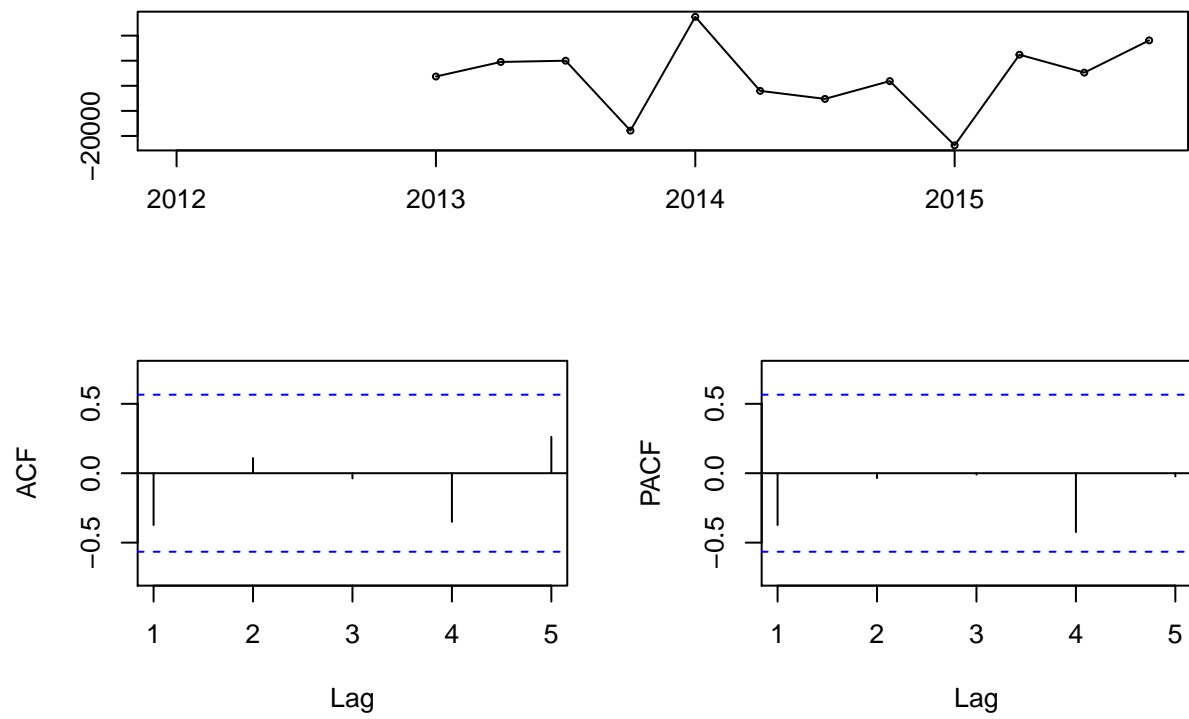
Portland, OR – Parkrose Heights : Holt Winters Model Forecast
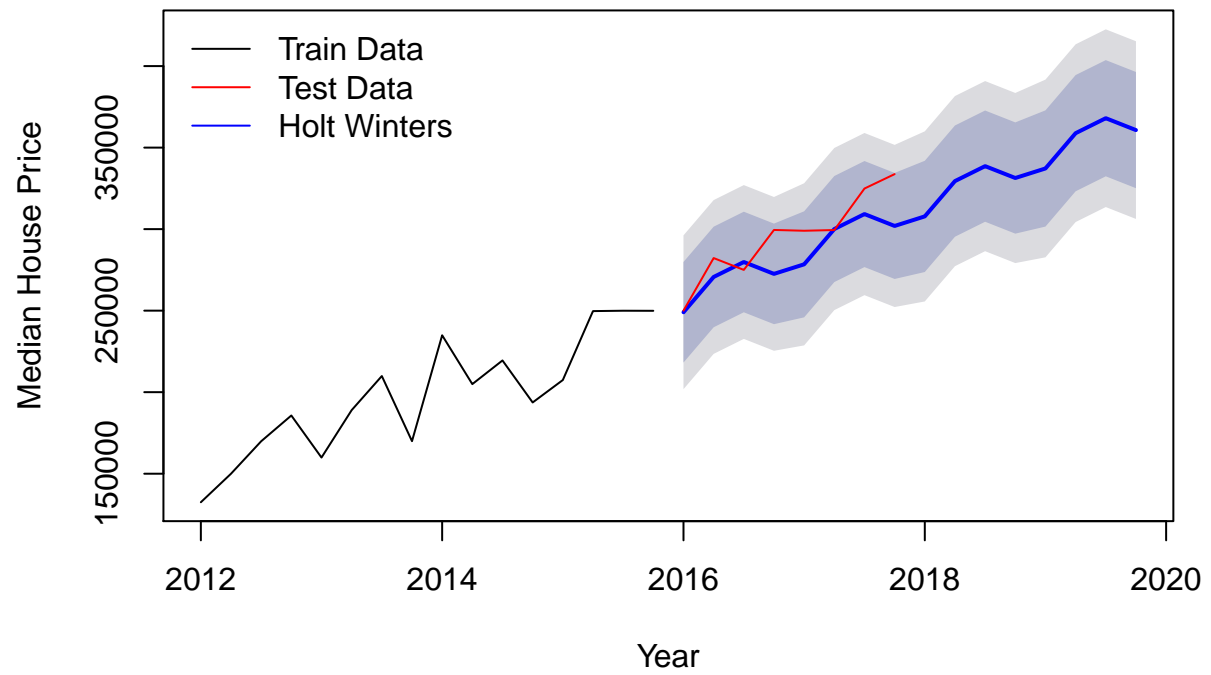
Portland, OR – Parkrose Heights : Holt Winters Model Forecast Residuals
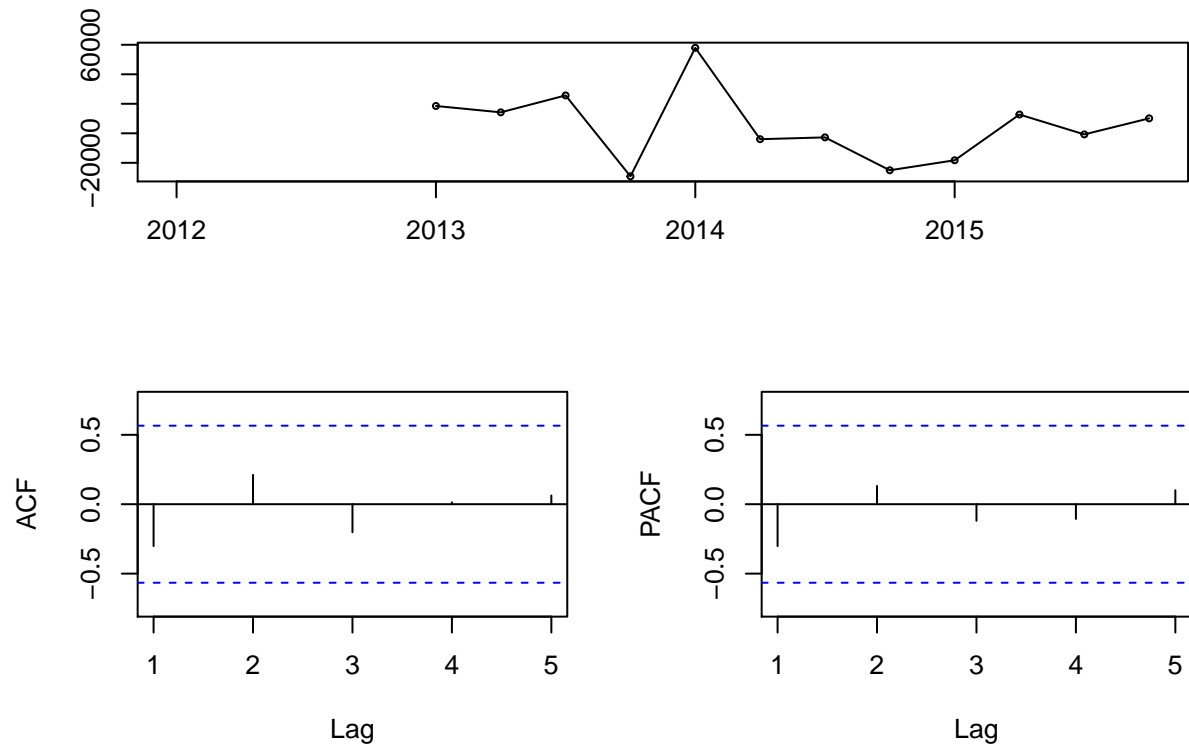
```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Parkrose Heights"
##                   ME      RMSE      MAE      MPE     MAPE      MASE
## Training set 26577.71 38190.48 33777.71 11.93961 15.68953 1.000000
## Test set     56222.69 60680.04 56222.69 18.70299 18.70299 1.664491
##                   ACF1 Theil's U
## Training set -0.3733233        NA
## Test set      0.2881616  3.043809
## [1] "Holt Winters Accuracy for  Portland, OR - Parkrose Heights"
##                   ME      RMSE      MAE      MPE     MAPE      MASE
## Training set  4937.859 23558.97 18264.18 1.897135 8.962044 0.5407169
## Test set     12766.014 17907.67 14126.63 4.096304 4.586601 0.4182235
##                   ACF1 Theil's U
## Training set -0.3024077        NA
## Test set     -0.1525747 0.9359406
```

# Portland, OR – Parkrose Heights : TS Training Model Comparison

Portland, OR – Parkrose Heights : Full TS Models Comparison
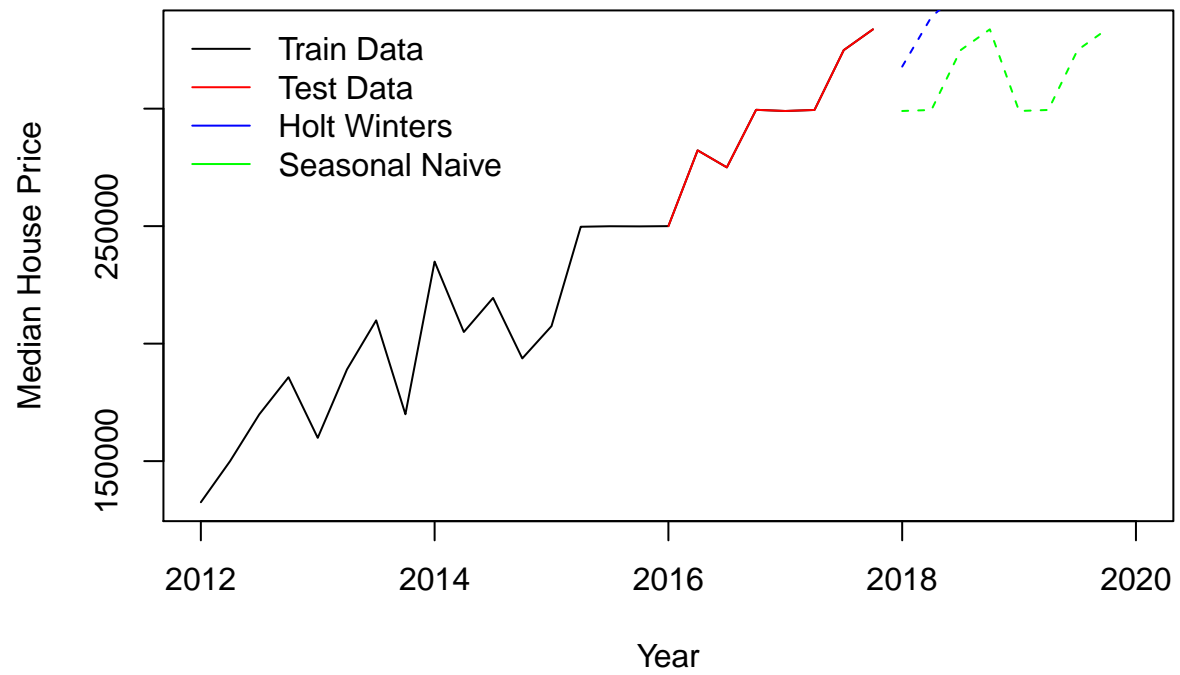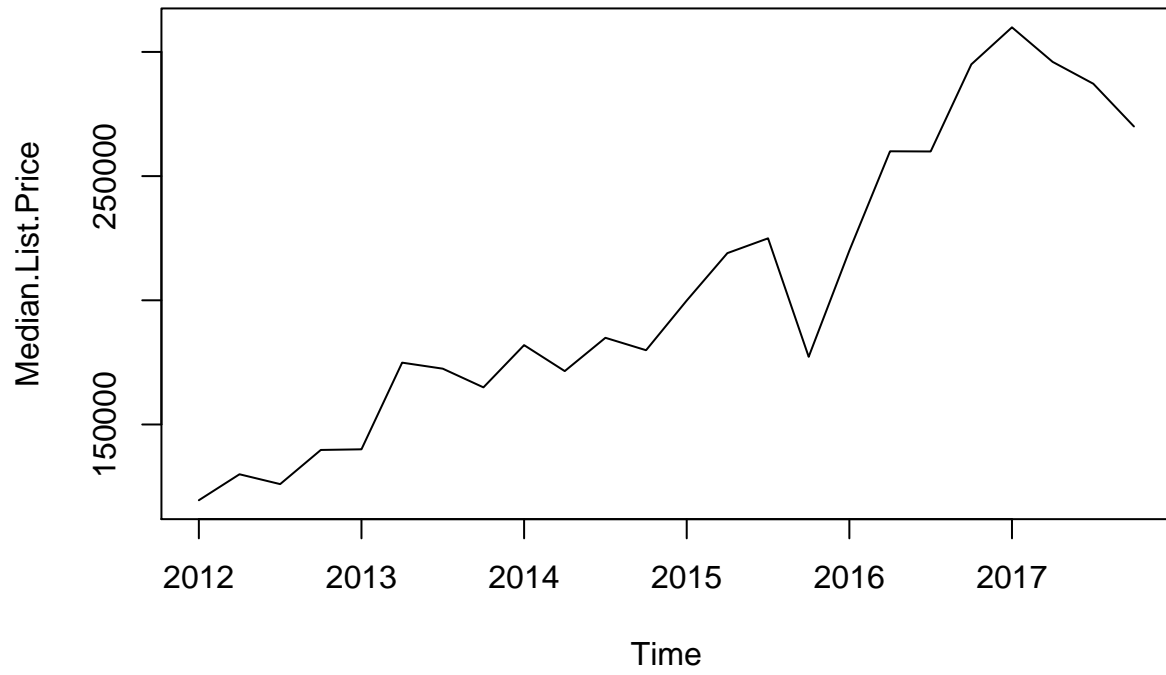
Portland, OR – Lents–Powellhurst–Gilbert

Portland, OR – Lents–Powellhurst–Gilbert : Naive Model Forecast
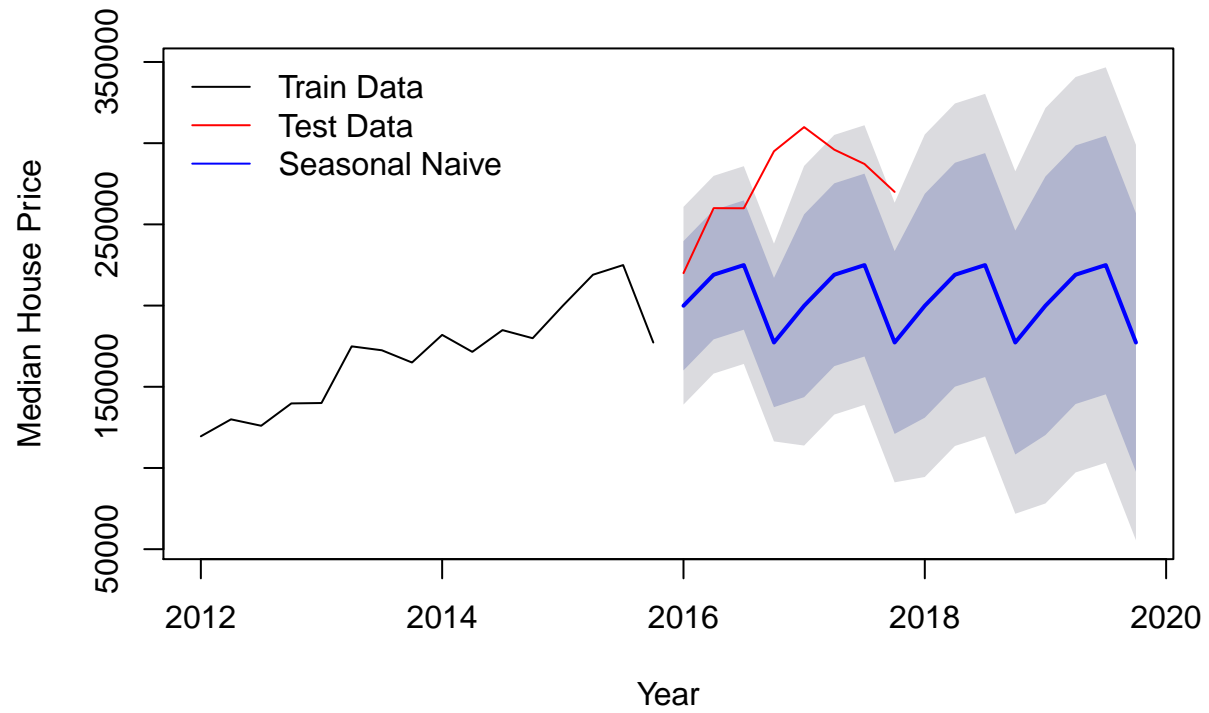
Portland, OR – Lents–Powellhurst–Gilbert : Naive Model Forecast Residuals
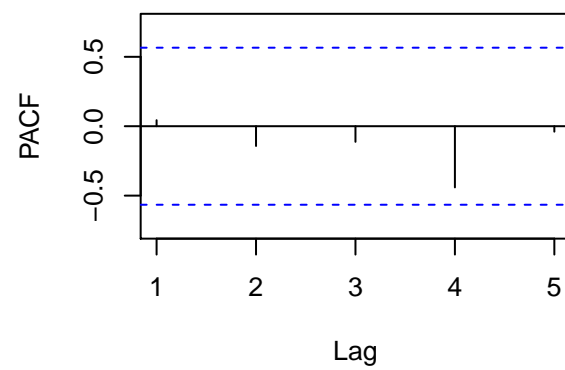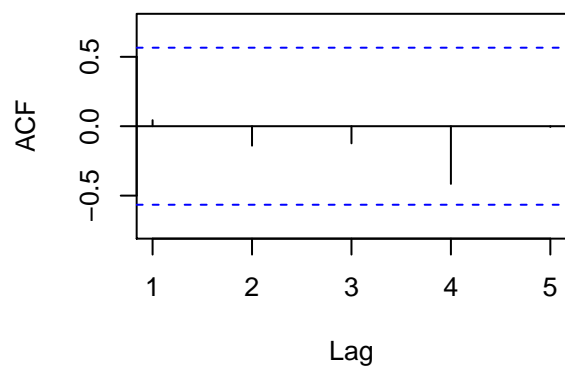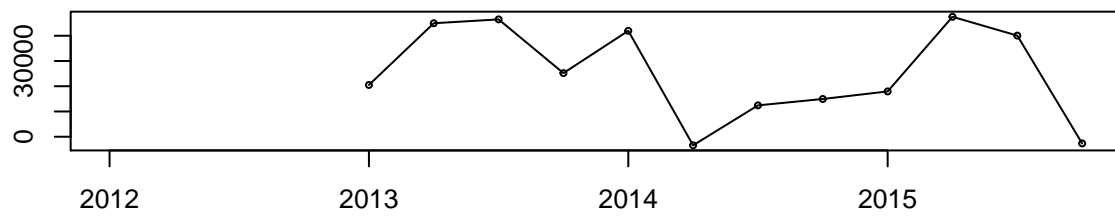
Portland, OR – Lents–Powellhurst–Gilbert : Holt Winters Model Forec
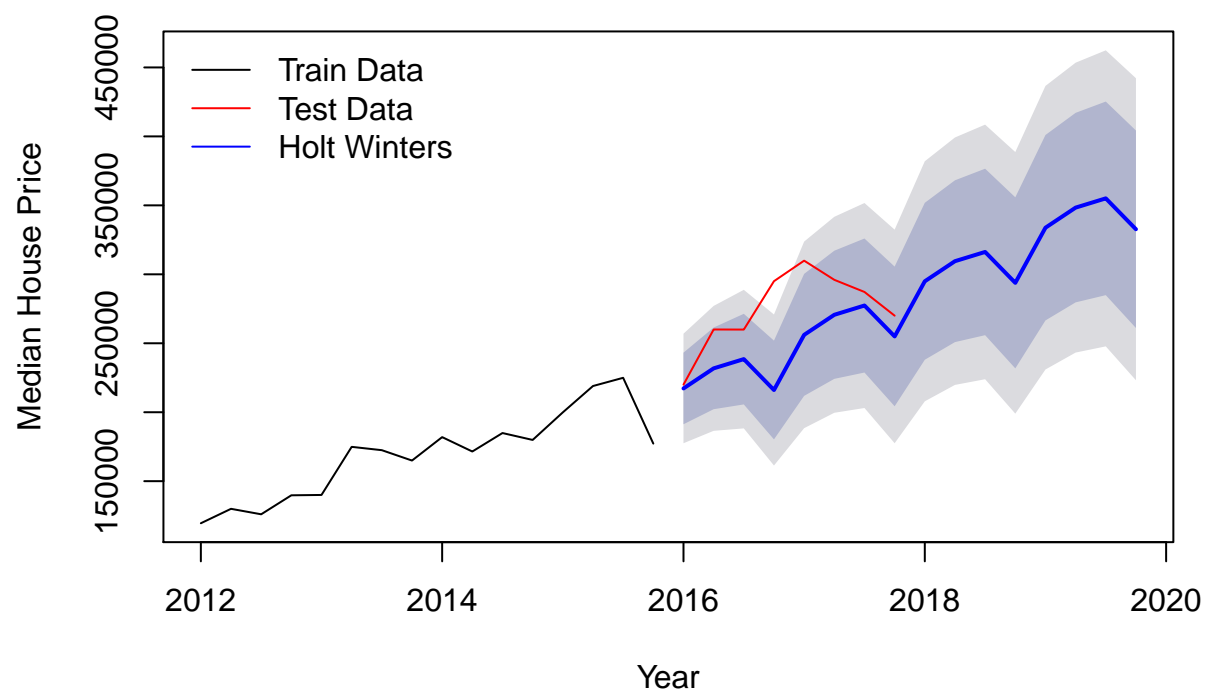
Portland, OR – Lents–Powellhurst–Gilbert : Holt Winters Model Forecast Residual
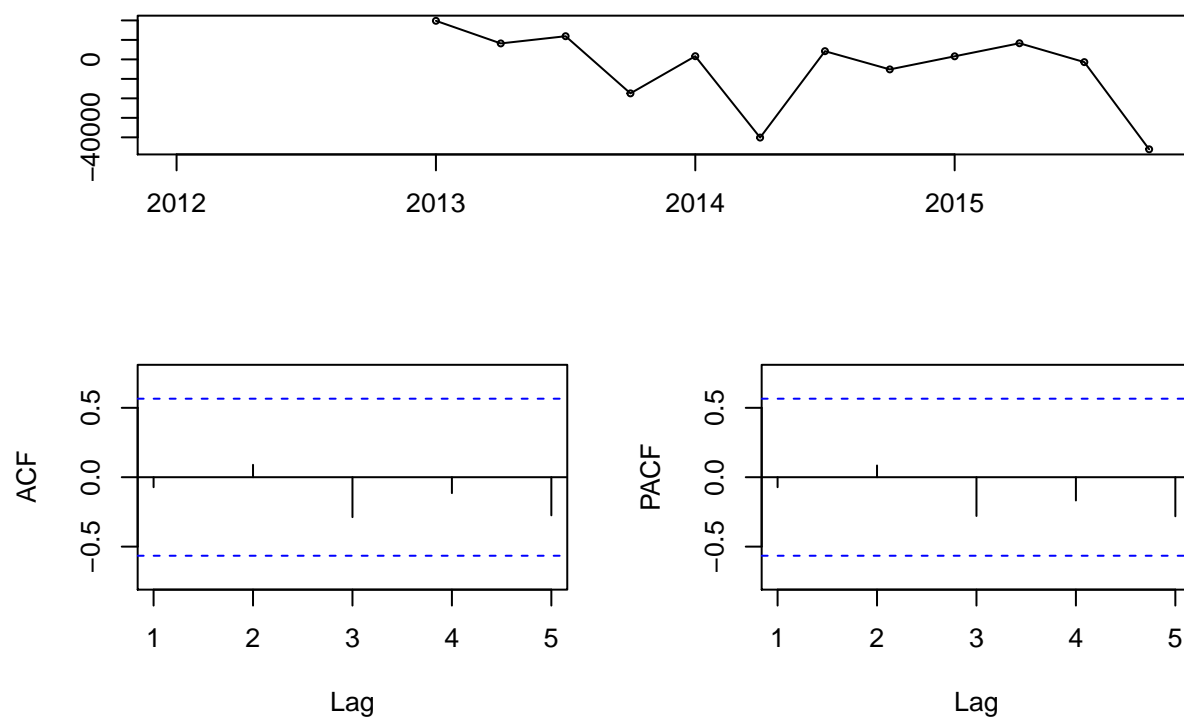

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Lents-Powellhurst-Gilbert"
##                   ME     RMSE      MAE      MPE     MAPE     MASE
## Training set 25492.08 31057.62 26500.42 13.80422 14.38381 1.000000
## Test set     69478.12 77200.99 69478.12 24.47652 24.47652 2.621775
##                   ACF1 Theil's U
## Training set 0.04350761        NA
## Test set     0.30472902  3.173634
## [1] "Holt Winters Accuracy for  Portland, OR - Lents-Powellhurst-Gilbert"
##                   ME     RMSE      MAE      MPE     MAPE     MASE
## Training set -4551.209 19922.77 13819.12 -2.498998  8.078837 0.5214679
## Test set     29414.995 37662.27 29415.00 10.251580 10.251580 1.1099824
##                   ACF1 Theil's U
## Training set -0.07191105        NA
## Test set      0.25198955  1.624651
```

Portland, OR – Lents–Powellhurst–Gilbert : TS Training Model Compar

Portland, OR – Lents–Powellhurst–Gilbert : Full TS Models Comparis
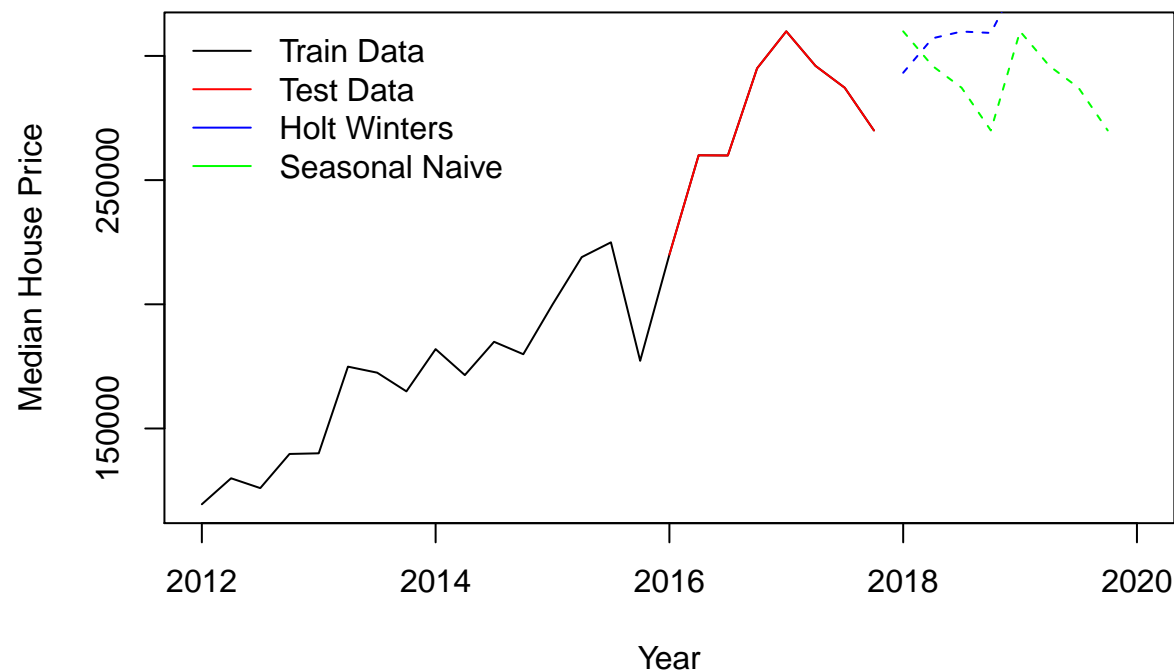
Portland, OR – Southwest Hills

Portland, OR – Southwest Hills : Naive Model Forecast
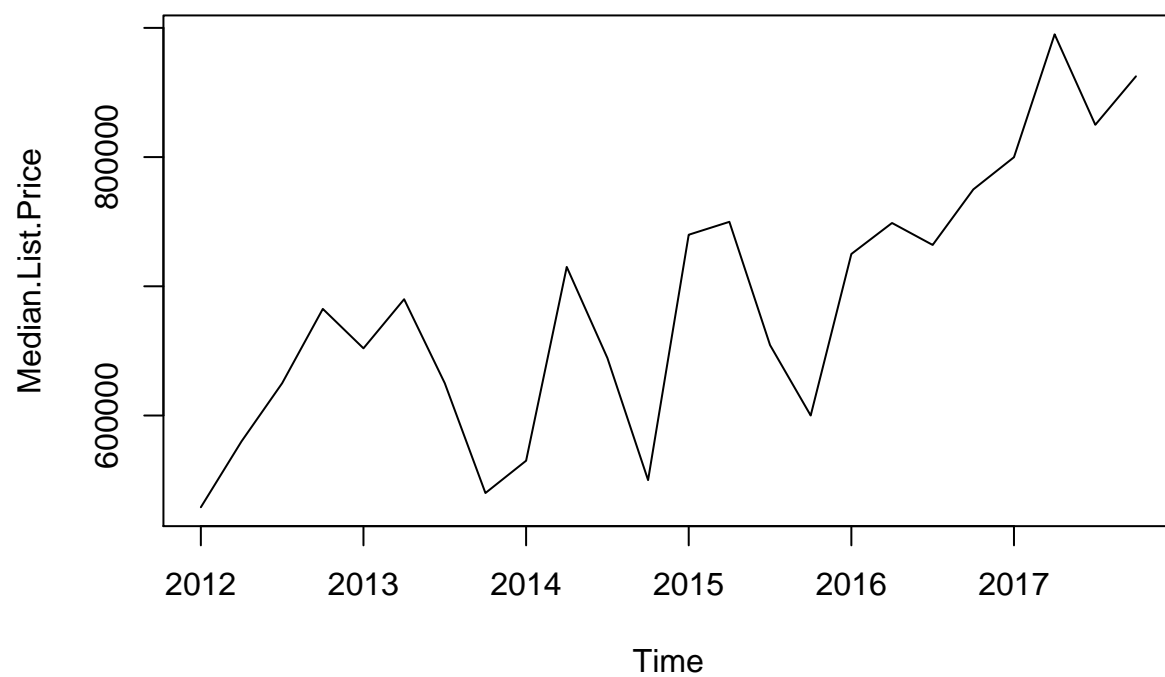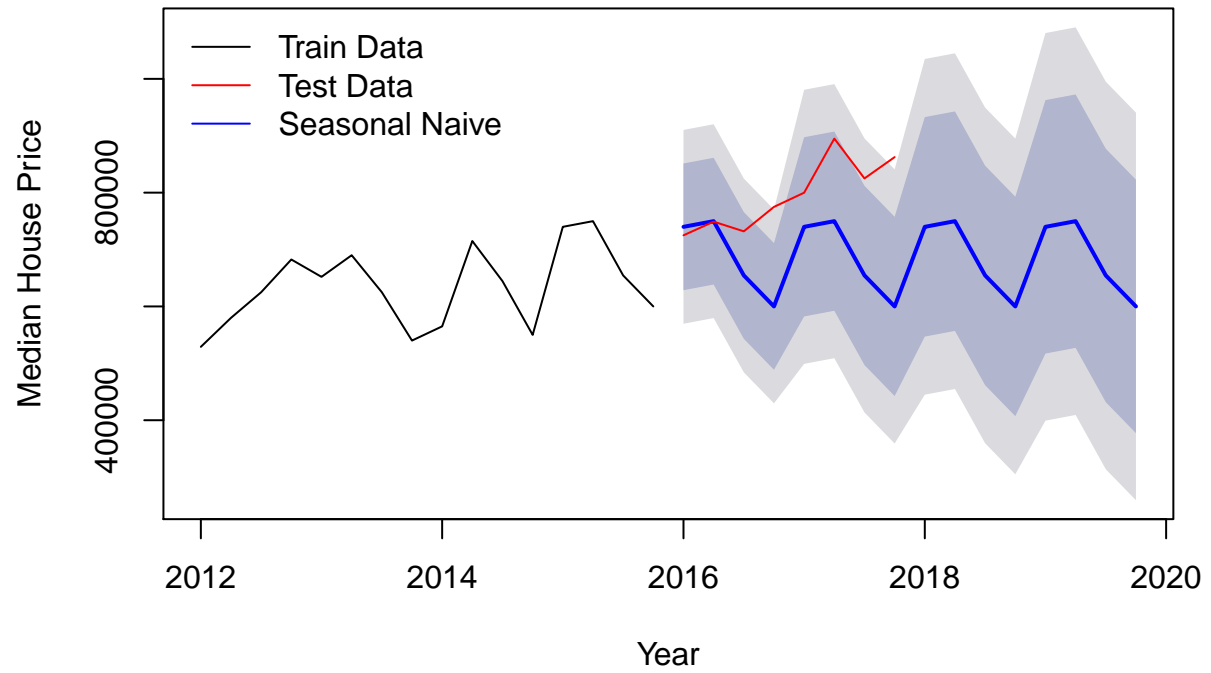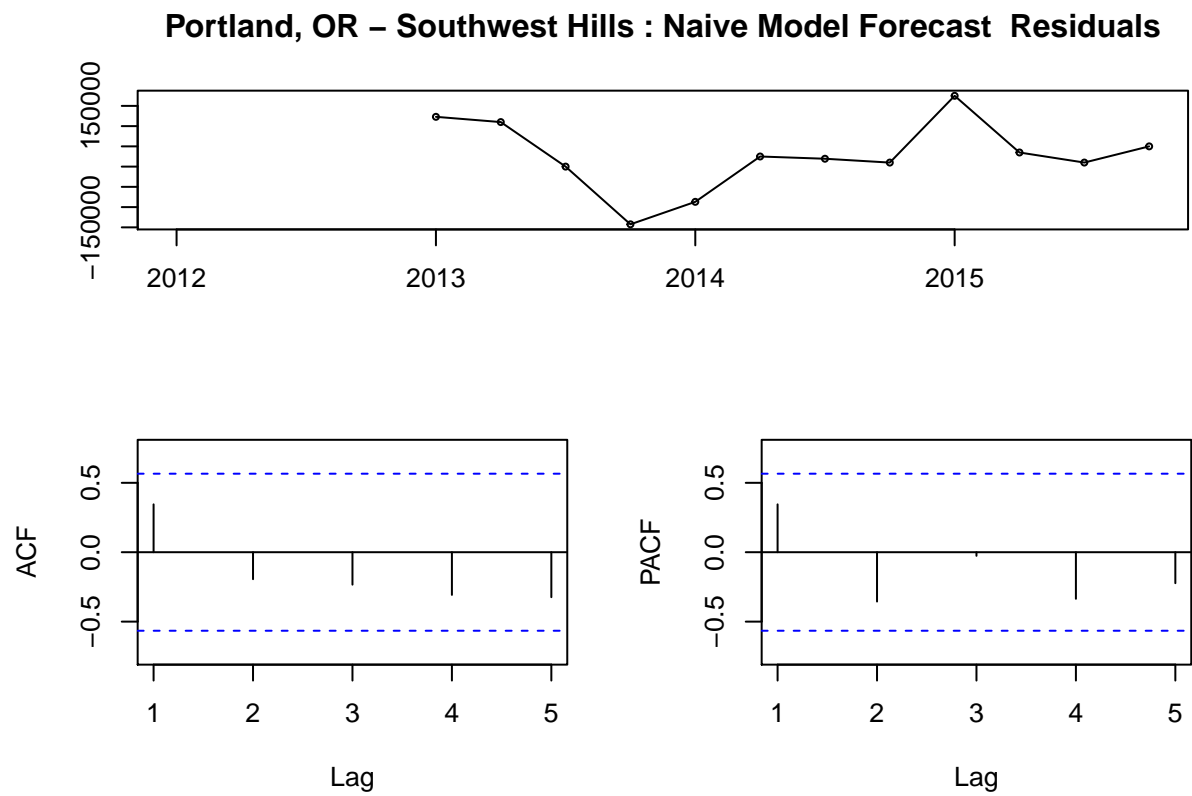
Portland, OR – Southwest Hills : Naive Model Forecast Residuals

Portland, OR – Southwest Hills : Holt Winters Model Forecast
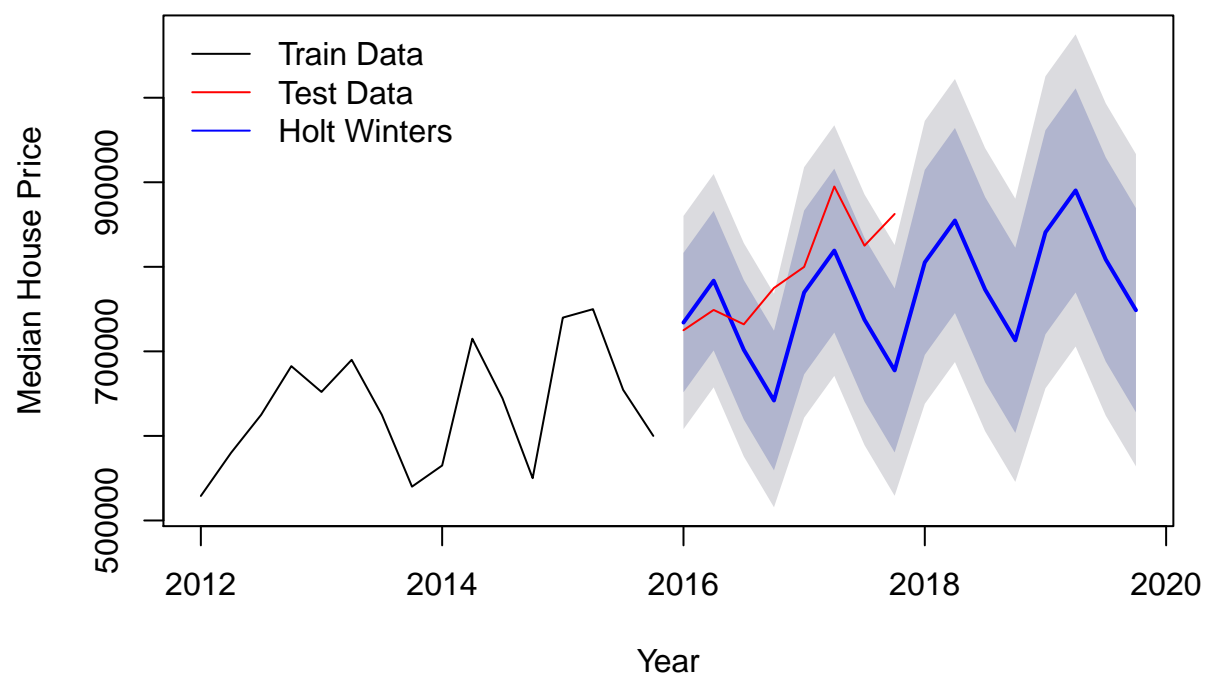
Portland, OR – Southwest Hills : Holt Winters Model Forecast Residuals
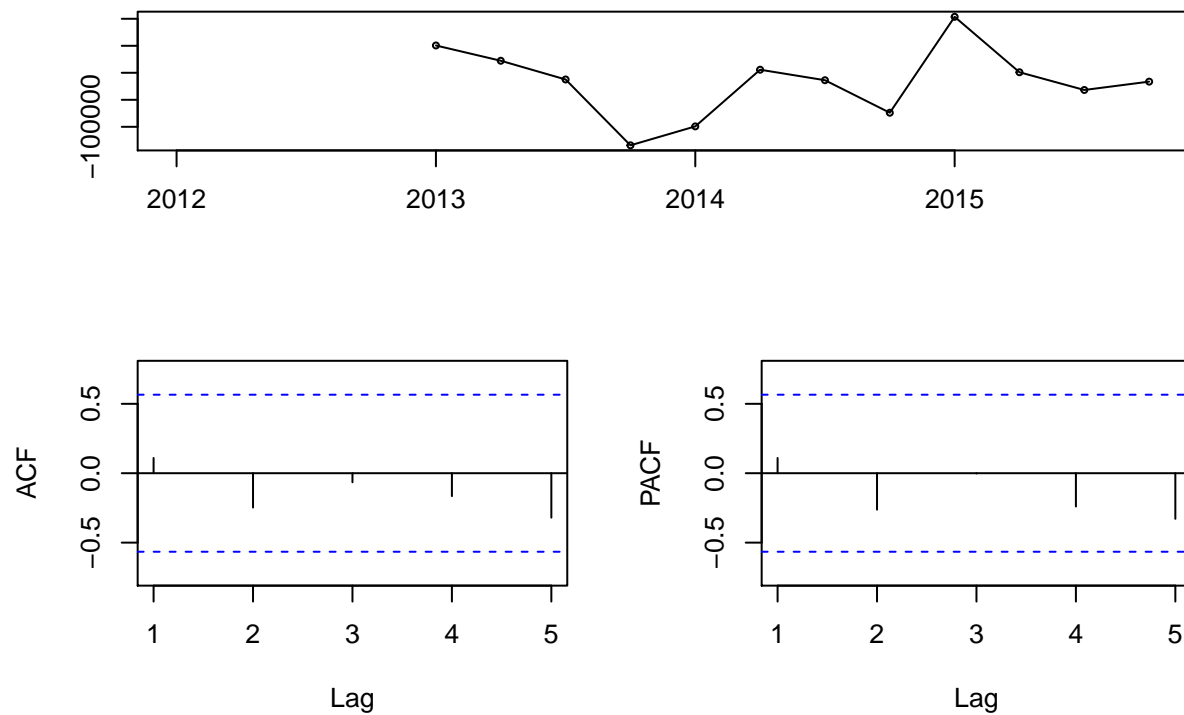

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Southwest Hills"
##                   ME      RMSE       MAE      MPE     MAPE     MASE
## Training set 27320.83  86904.19  65570.83  3.293419 10.25794 1.000000
## Test set    109350.00 141193.39 113300.00 13.225928 13.76976 1.727902
##                 ACF1 Theil's U
## Training set 0.3448884       NA
## Test set     0.3394618  2.932267
## [1] "Holt Winters Accuracy for  Portland, OR - Southwest Hills"
##                   ME      RMSE       MAE       MPE     MAPE      MASE
## Training set -16548.24 63768.52 47081.93 -3.471193 7.791971 0.7180316
## Test set      62273.94 92508.82 73194.25  7.467003 8.935024 1.1162622
##                 ACF1 Theil's U
## Training set 0.1101026       NA
## Test set     0.2268136  1.943598
```

Portland, OR – Southwest Hills : TS Training Model Comparison
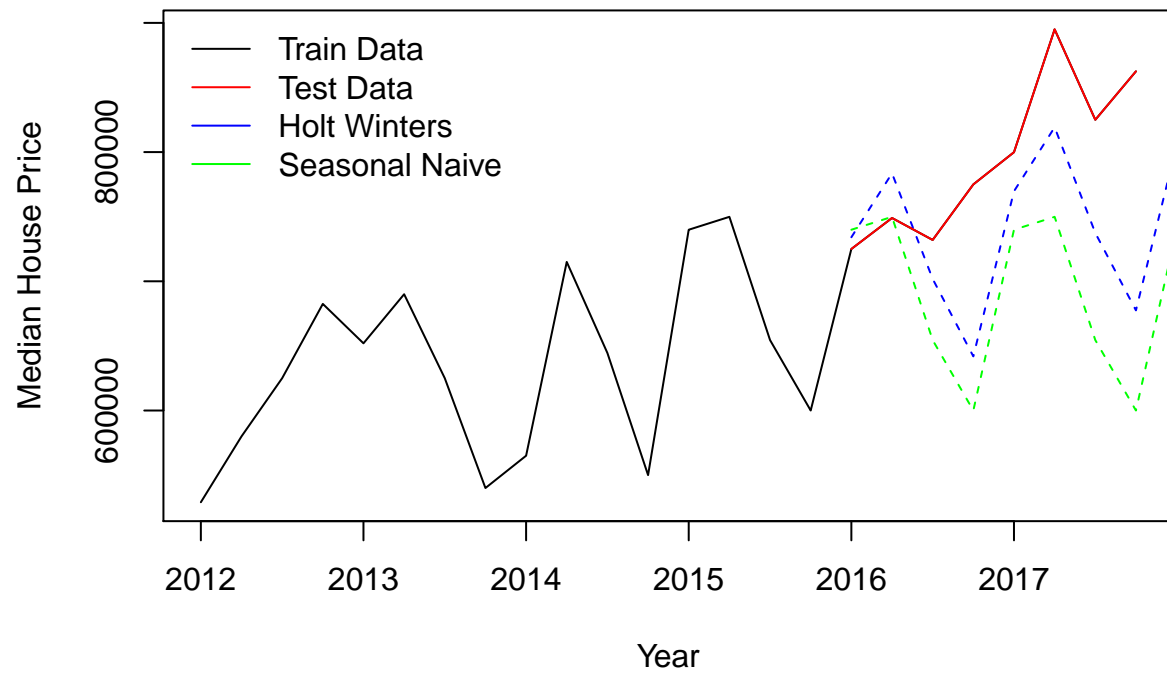
Portland, OR – Southwest Hills : Full TS Models Comparison

Portland, OR – Center

Portland, OR – Center : Naive Model Forecast

Portland, OR – Center : Naive Model Forecast Residuals
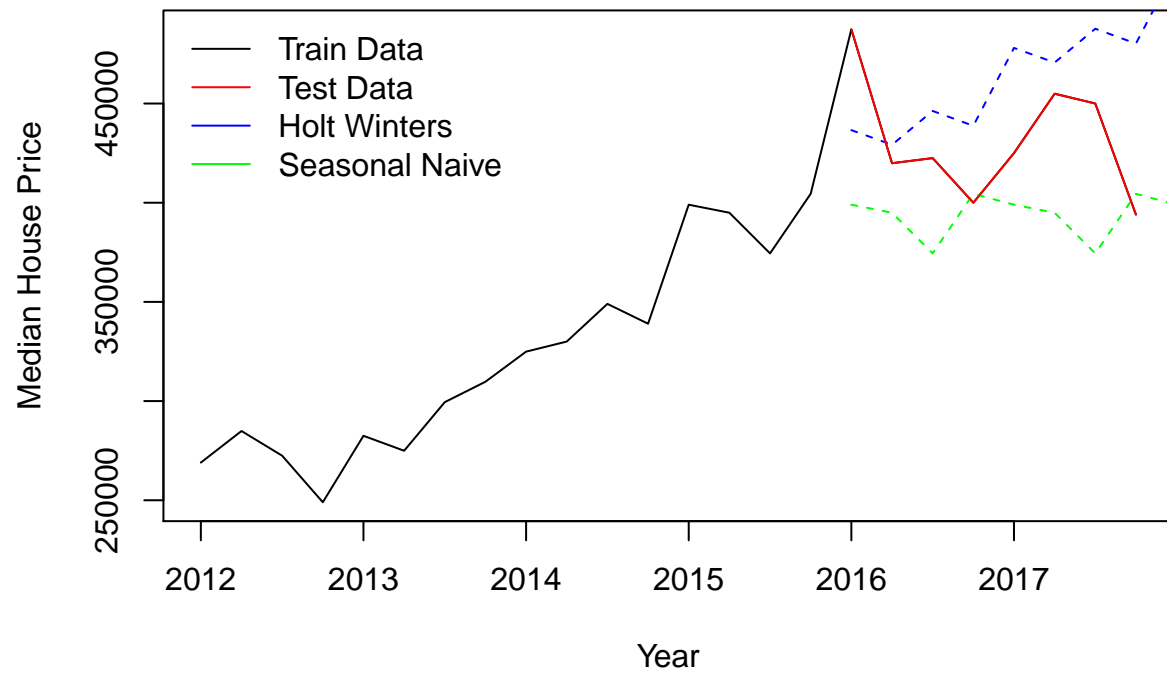
Portland, OR – Center : Holt Winters Model Forecast

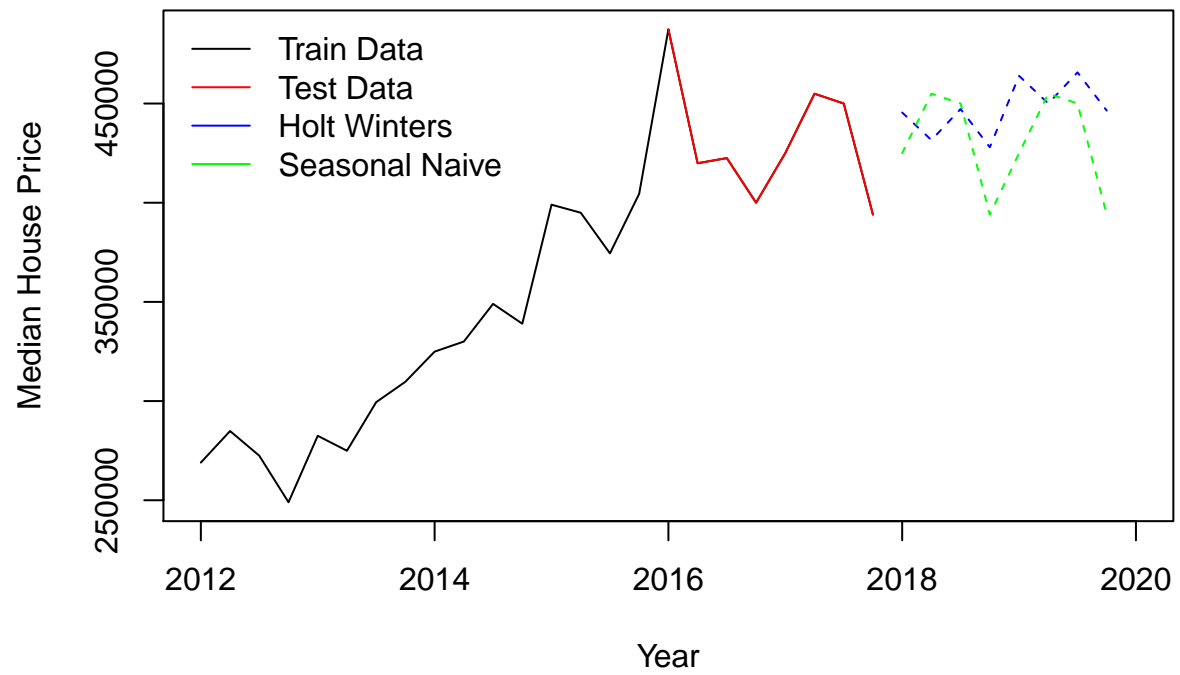## Portland, OR – Center : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Center"
##                     ME     RMSE      MAE       MPE     MAPE      MASE
## Training set 53416.62 78301.88 72766.62 13.379662 19.99934 1.0000000
## Test set     38987.50 74494.99 56287.50  7.216654 11.40567 0.7735346
##                   ACF1 Theil's U
## Training set -0.2422235        NA
## Test set     -0.2887973  1.225086
## [1] "Holt Winters Accuracy for  Portland, OR - Center"
##                     ME     RMSE      MAE       MPE     MAPE      MASE
## Training set  11062.33 45753.25 37116.06  2.546252 11.32352 0.5100699
## Test set     -28706.33 70514.45 61781.84 -7.130384 13.31302 0.8490409
##                   ACF1 Theil's U
## Training set -0.2586917        NA
## Test set     -0.2892384  1.151709
```

Portland, OR – Center : TS Training Model Comparison

Portland, OR – Center : Full TS Models Comparison
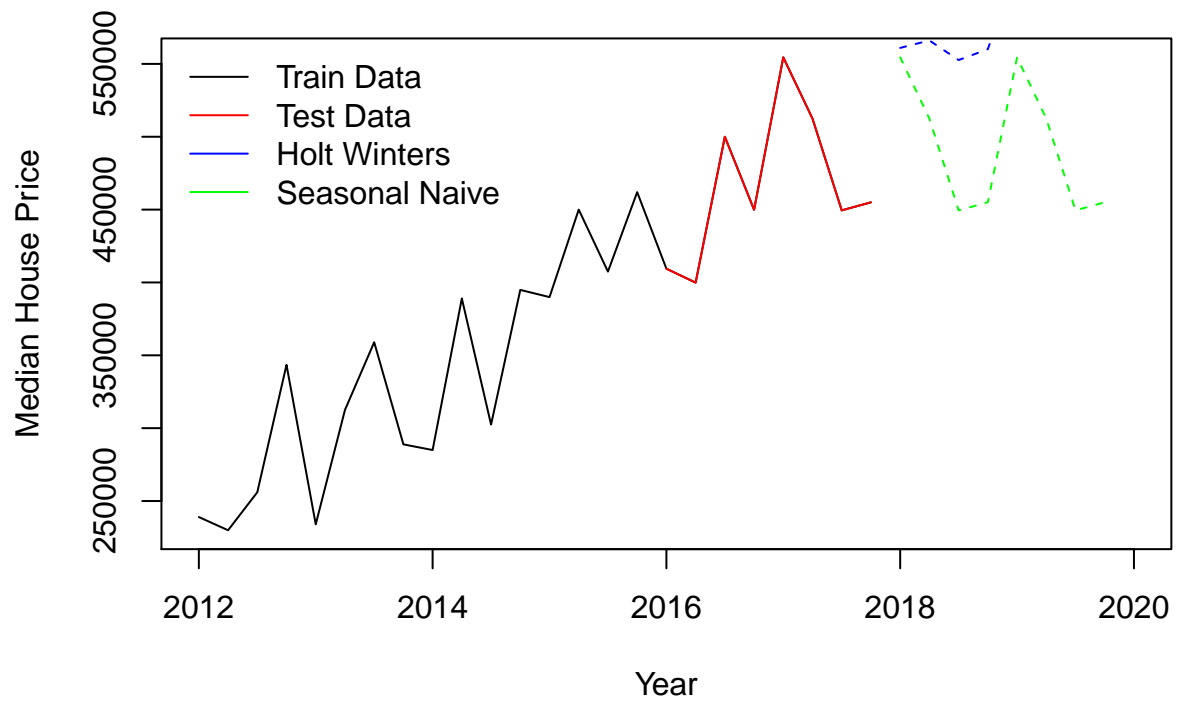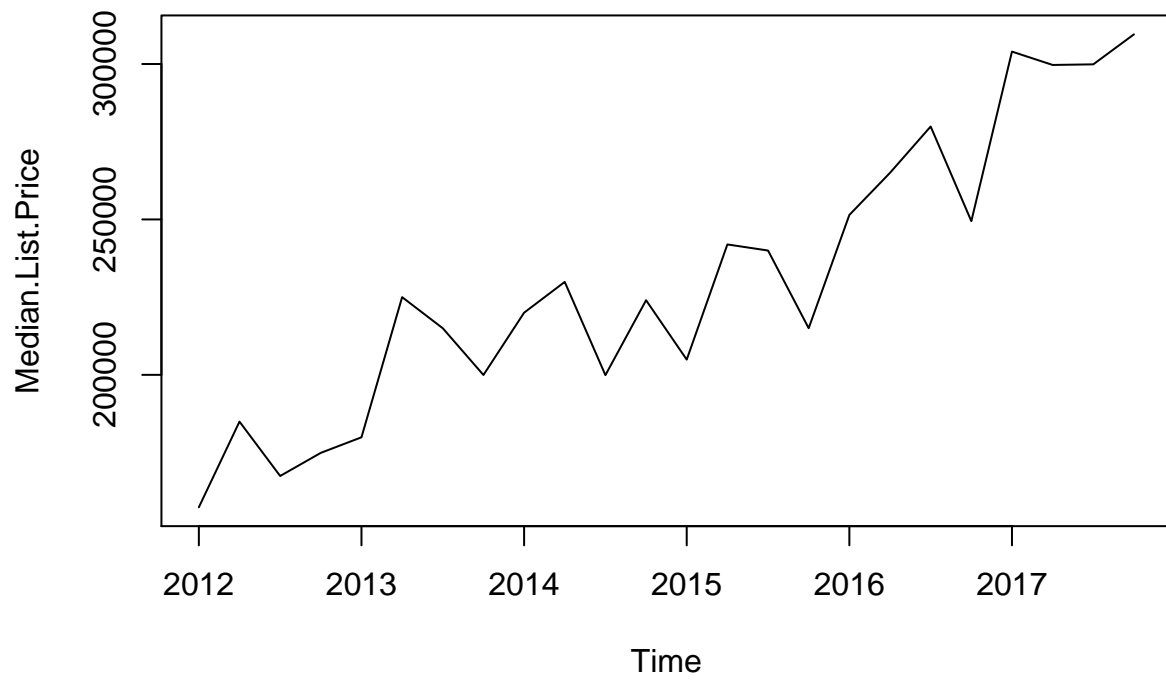
Portland, OR – Parkrose

Portland, OR – Parkrose : Naive Model Forecast
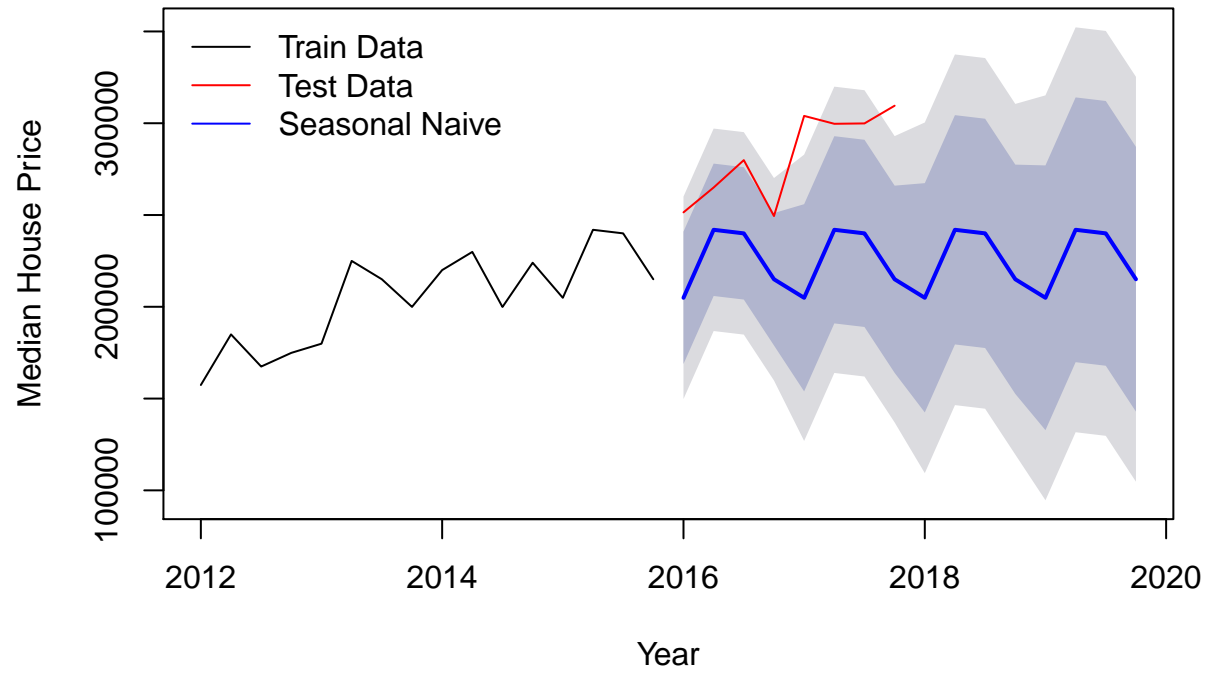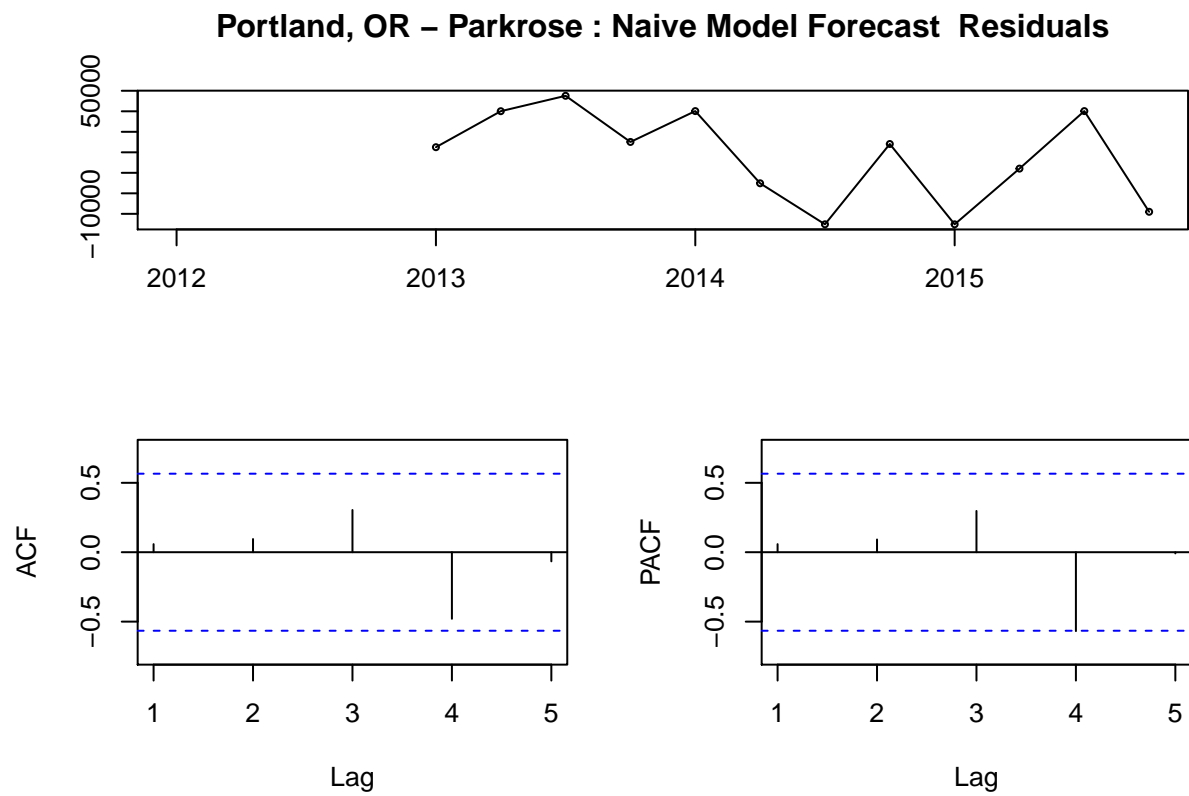
Portland, OR – Parkrose : Naive Model Forecast Residuals
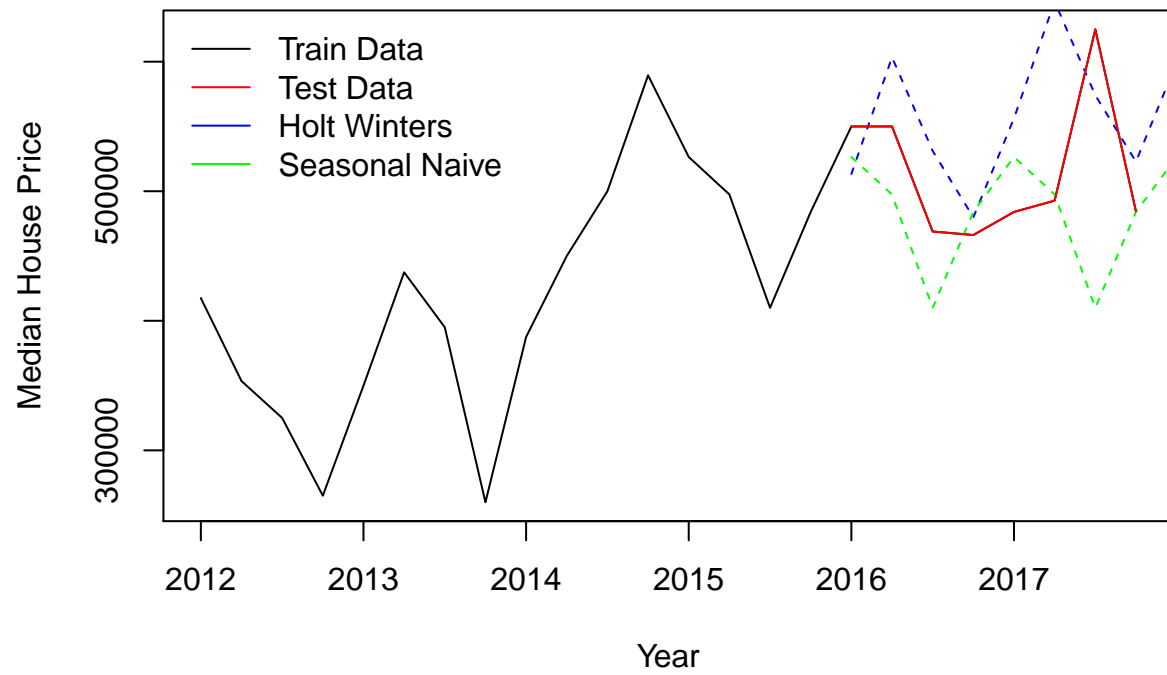
Portland, OR – Parkrose : Holt Winters Model Forecast

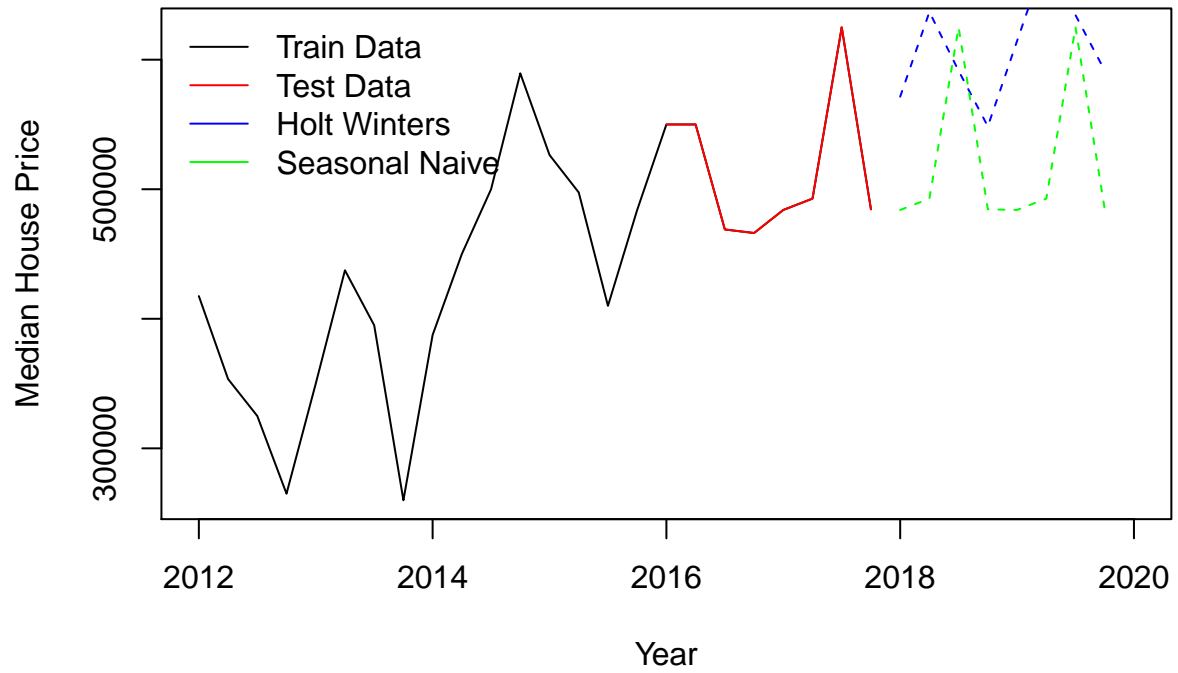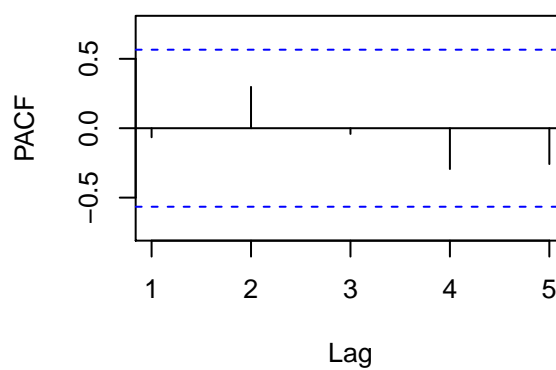**Portland, OR – Parkrose : Holt Winters Model Forecast Residuals**
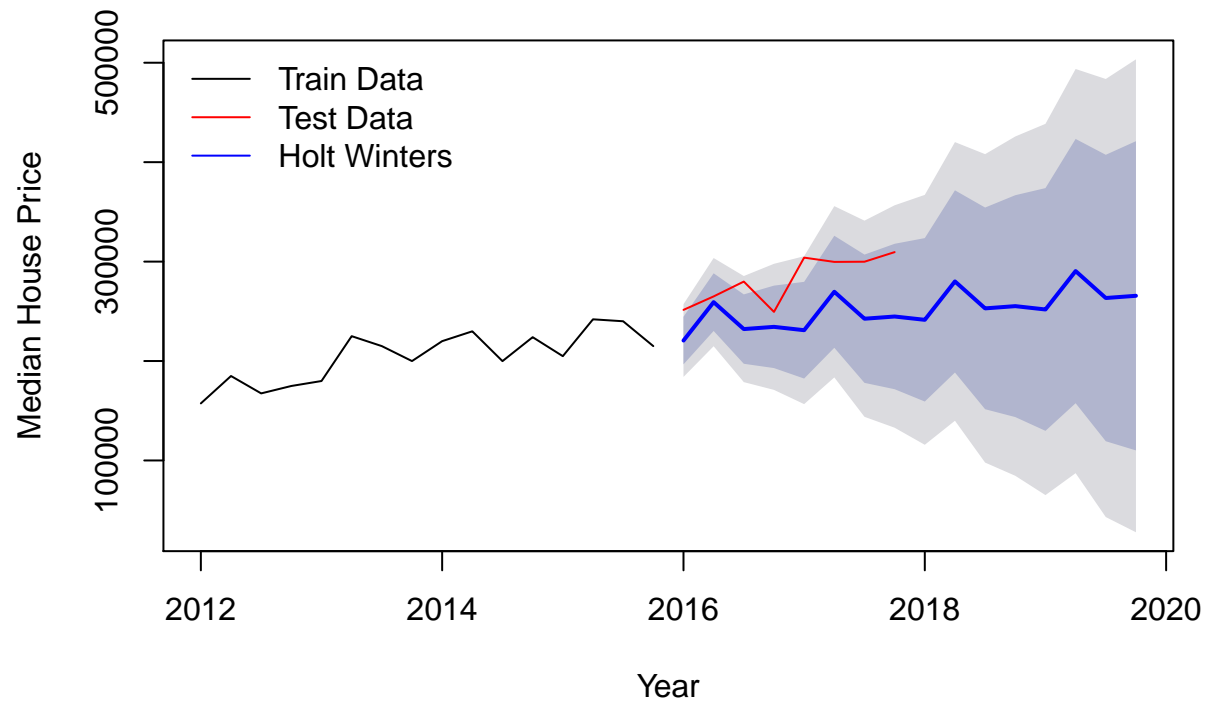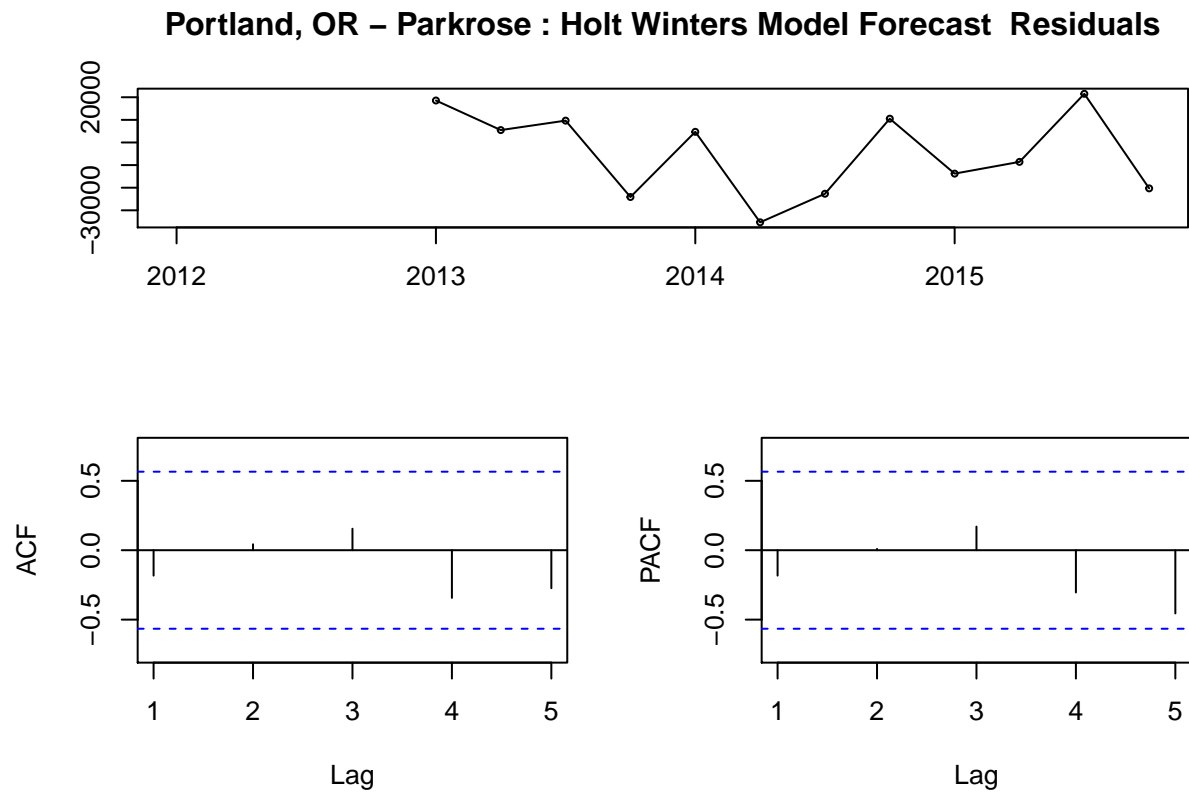

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Parkrose"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 18095.96 28135.46 24628.88  8.218918 11.40359 1.000000
## Test set     56905.62 62410.31 56905.62 19.707513 19.70751 2.310525
##                  ACF1 Theil's U
## Training set 0.05834388        NA
## Test set     0.09738893   2.38063
## [1] "Holt Winters Accuracy for  Portland, OR - Parkrose"
##                   ME      RMSE      MAE      MPE     MAPE      MASE
## Training set -4527.718 18437.76 16262.11 -2.119749  7.624555 0.6602863
## Test set     40569.691 46372.66 40569.69 13.951975 13.951975 1.6472409
##                  ACF1 Theil's U
## Training set -0.1829793        NA
## Test set     -0.2558337   1.789859
```

Portland, OR – Parkrose : TS Training Model Comparison
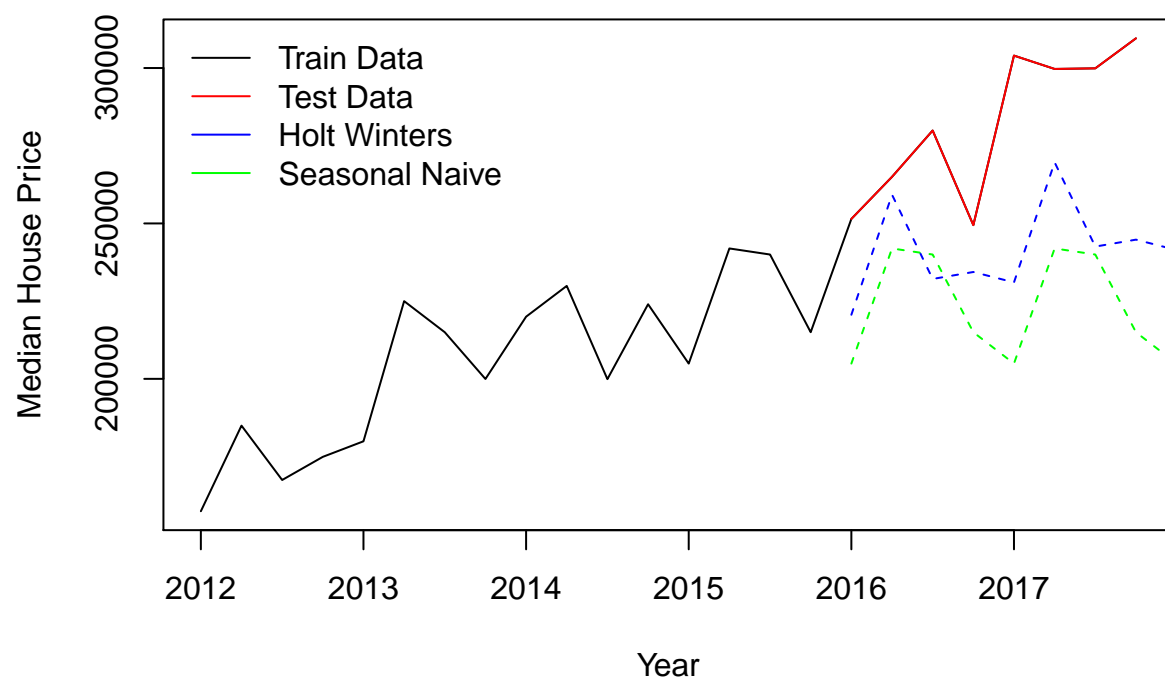
Portland, OR – Parkrose : Full TS Models Comparison
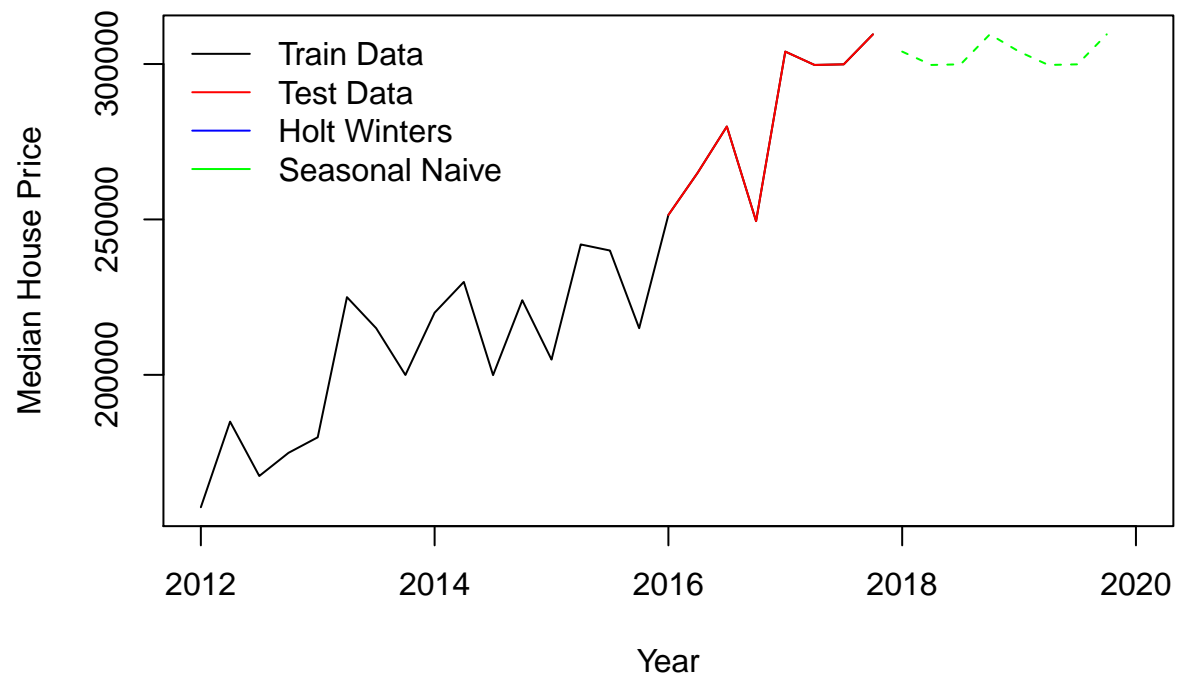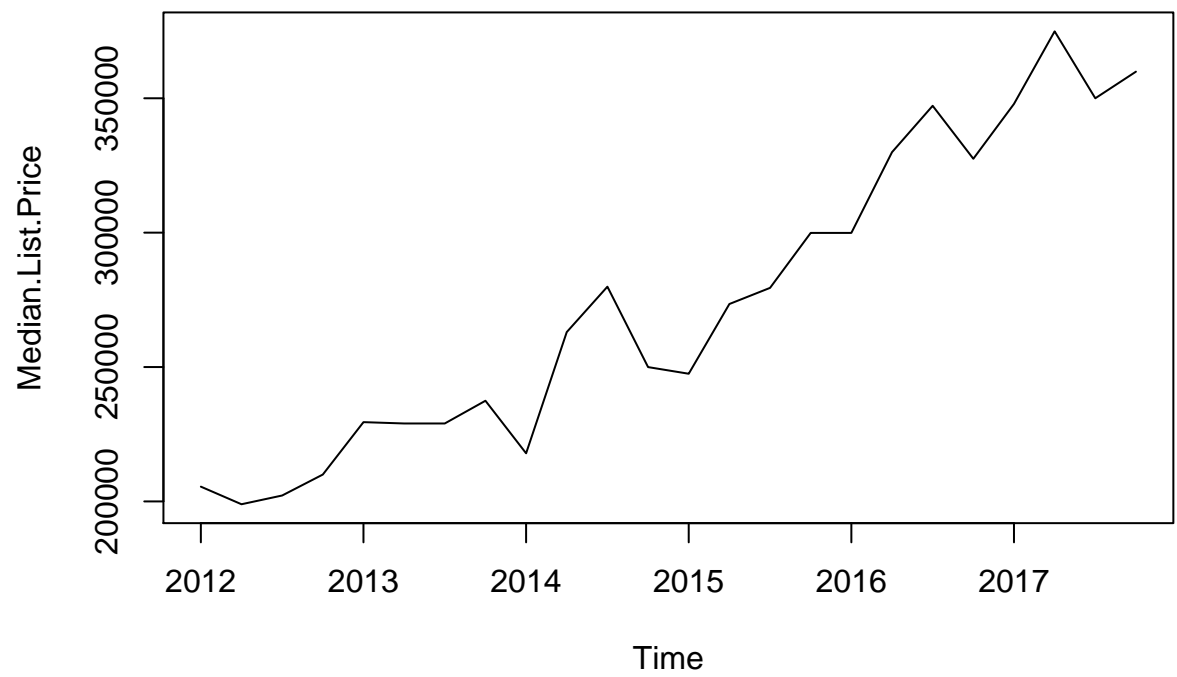
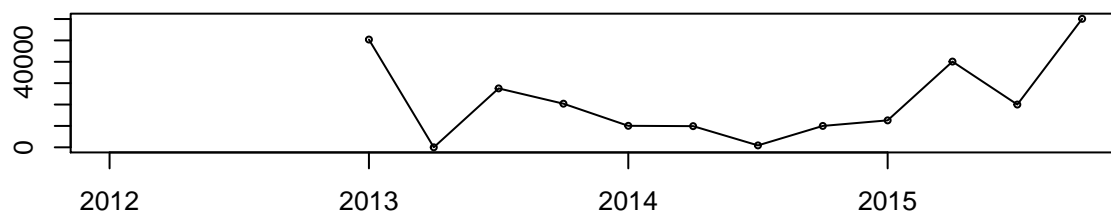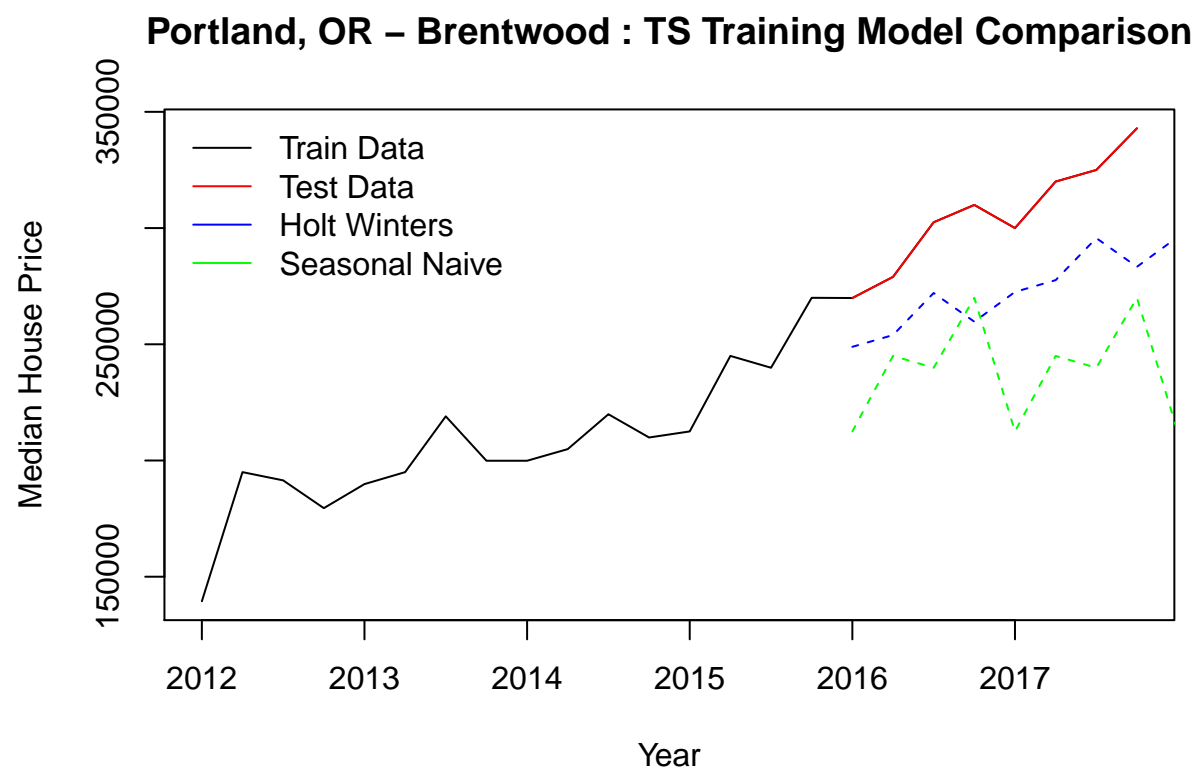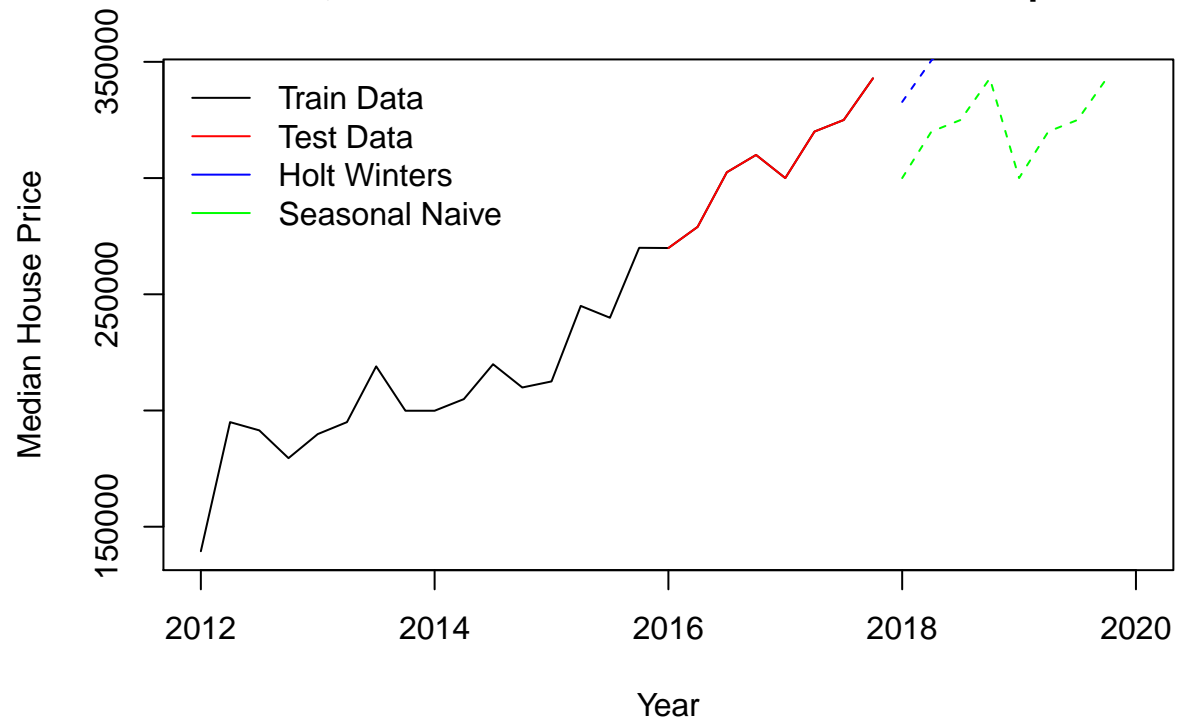# Portland, OR – Montavilla

Portland, OR – Montavilla : Naive Model Forecast
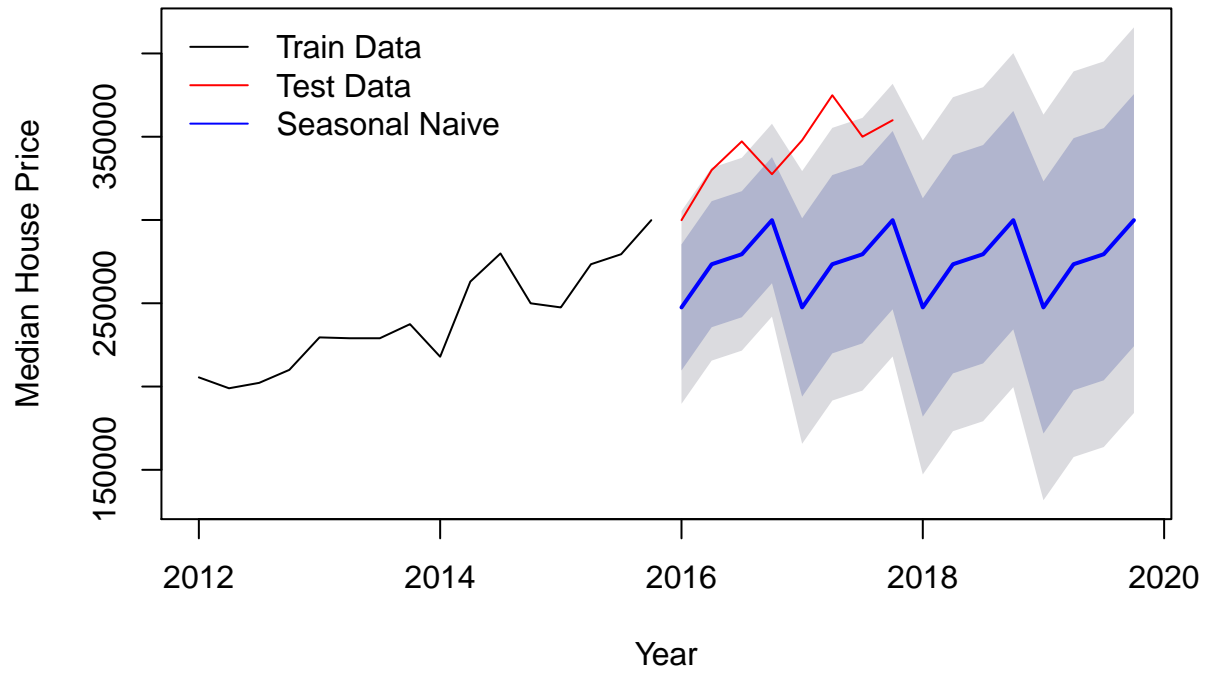
Portland, OR – Montavilla : Naive Model Forecast Residuals
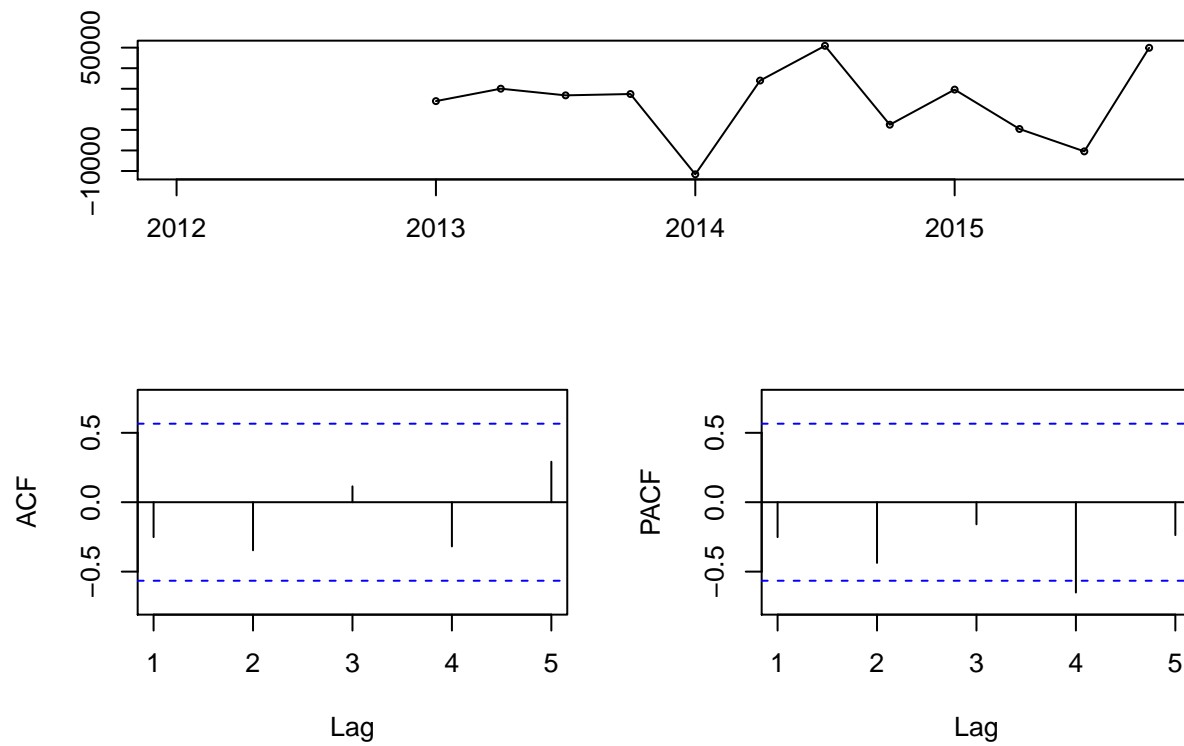
Portland, OR – Montavilla : Holt Winters Model Forecast
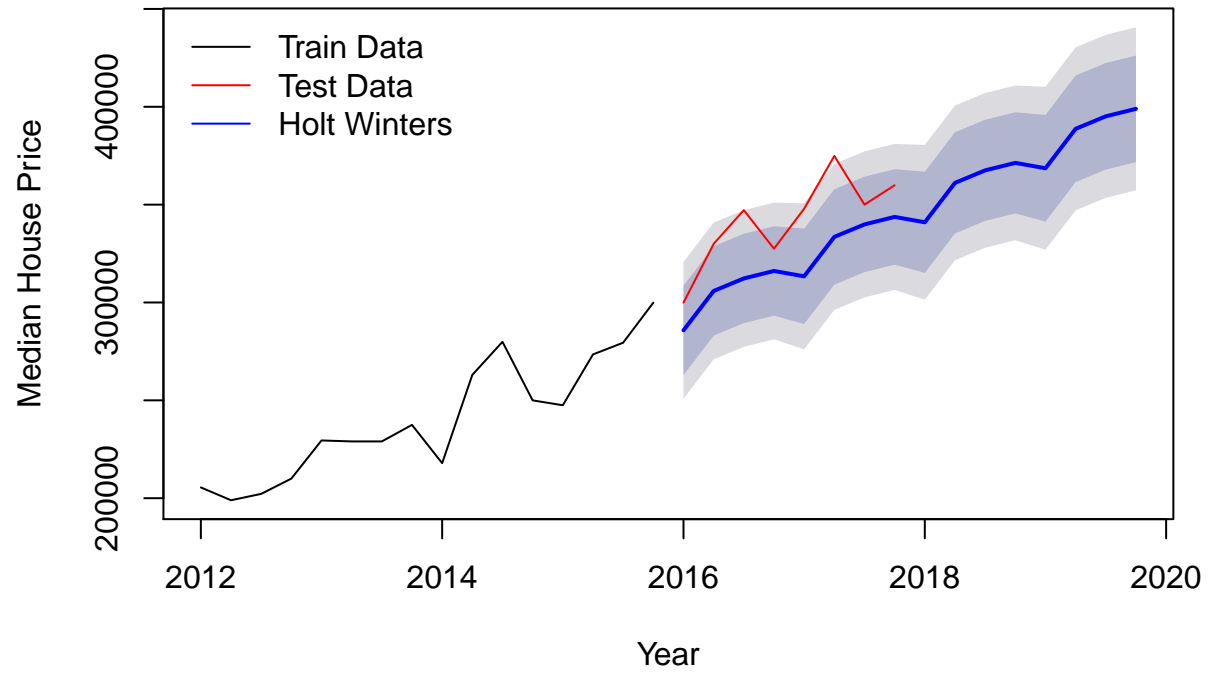
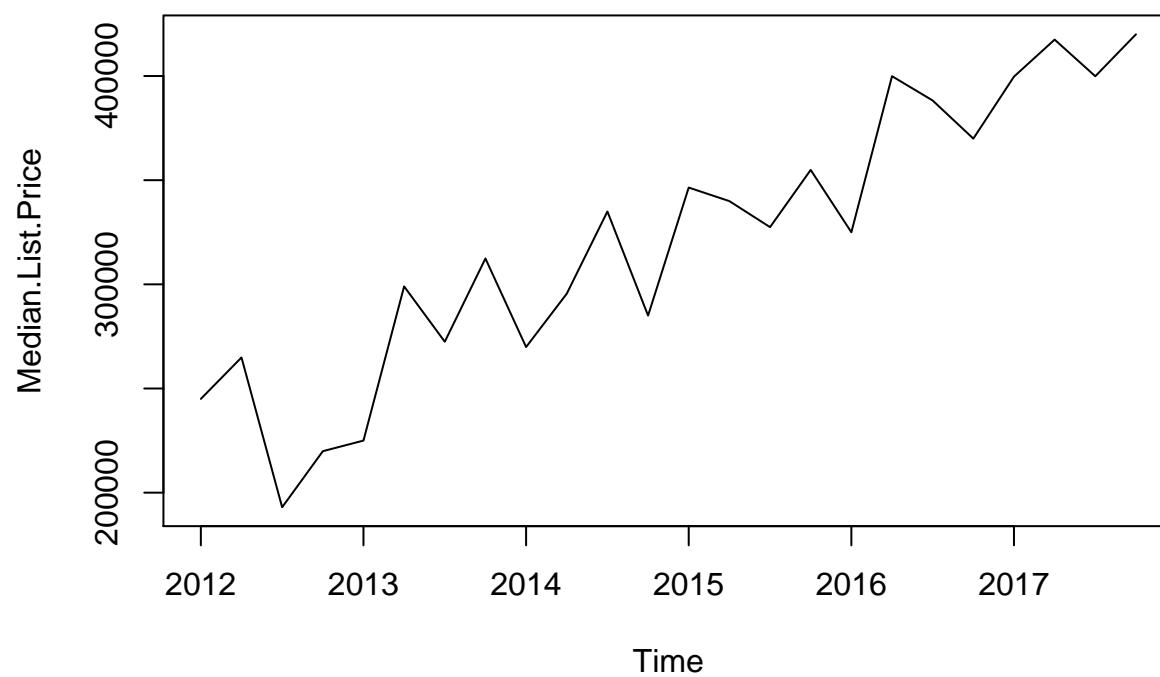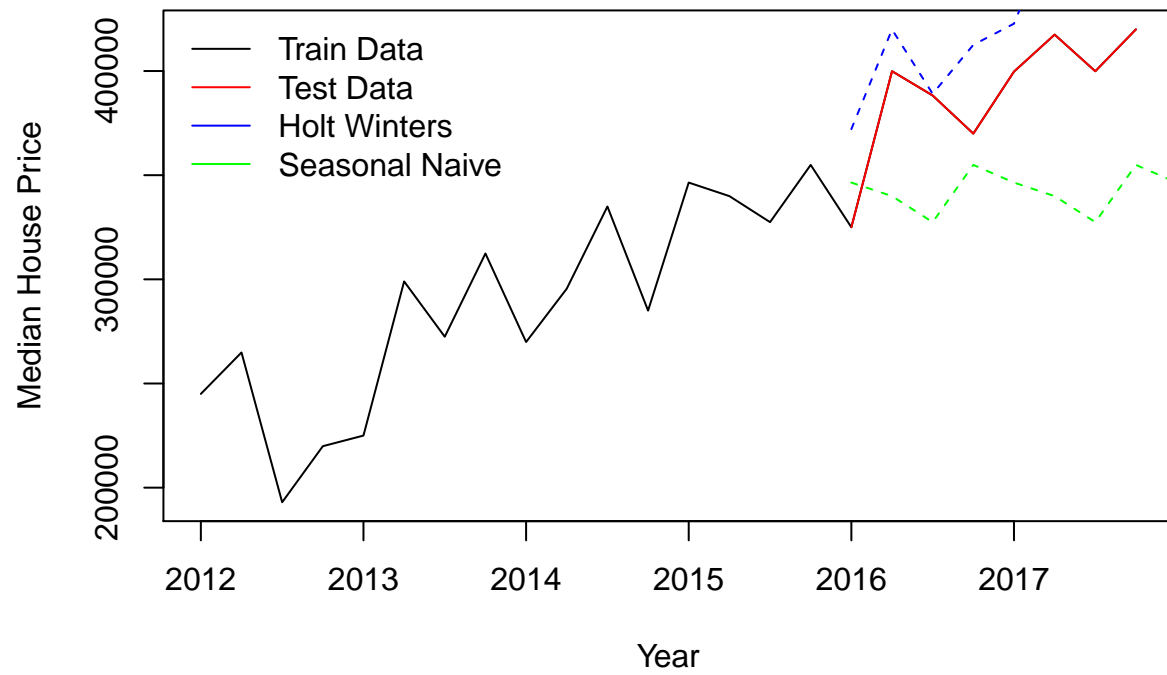## Portland, OR – Montavilla : Holt Winters Model Forecast Residuals
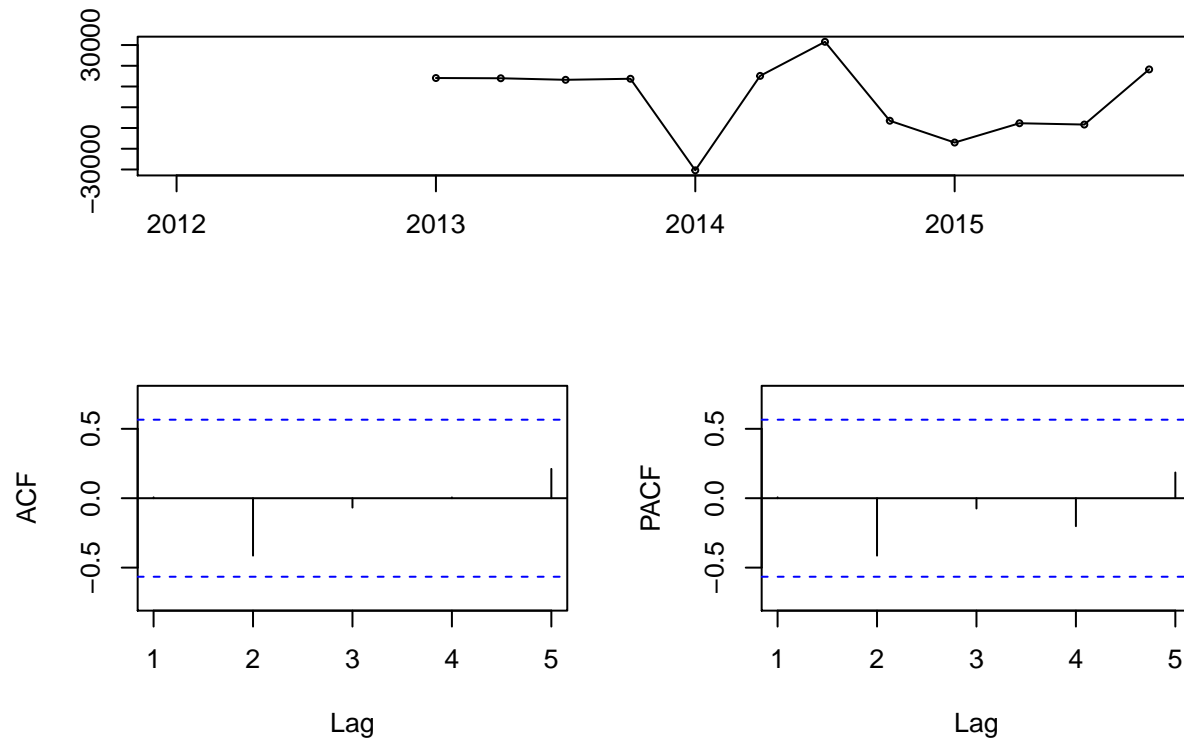

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Montavilla"
##                   ME     RMSE      MAE      MPE     MAPE     MASE
## Training set 23637.50 29533.97 25645.83  9.159189 10.07329 1.000000
## Test set     67081.25 70921.96 67081.25 19.410611 19.41061 2.615678
##                   ACF1 Theil's U
## Training set -0.25136652        NA
## Test set      0.01089043  3.246148
## [1] "Holt Winters Accuracy for  Portland, OR - Montavilla"
##                  ME     RMSE      MAE      MPE     MAPE      MASE
## Training set  4164.888 17559.82 15827.99 1.473139 6.345773 0.6171760
## Test set     23341.457 25977.05 23341.46 6.736969 6.736969 0.9101462
##                    ACF1 Theil's U
## Training set  0.006204082        NA
## Test set     -0.204356961  1.227308
```

Portland, OR – Montavilla : TS Training Model Comparison
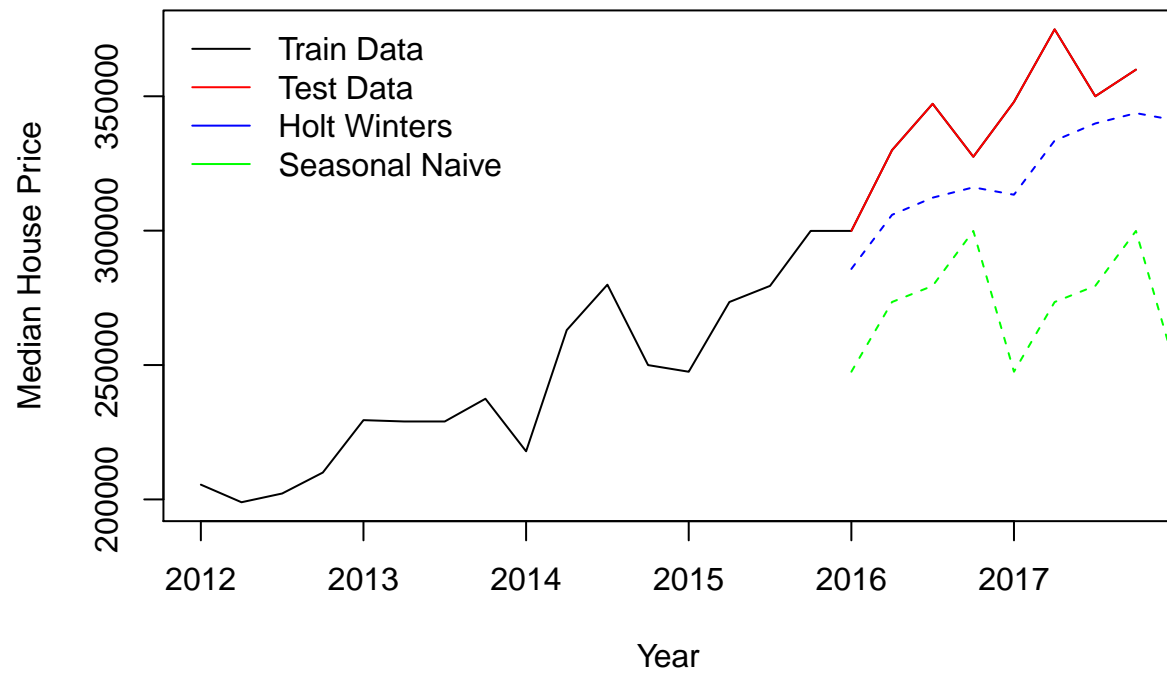
Portland, OR – Montavilla : Full TS Models Comparison
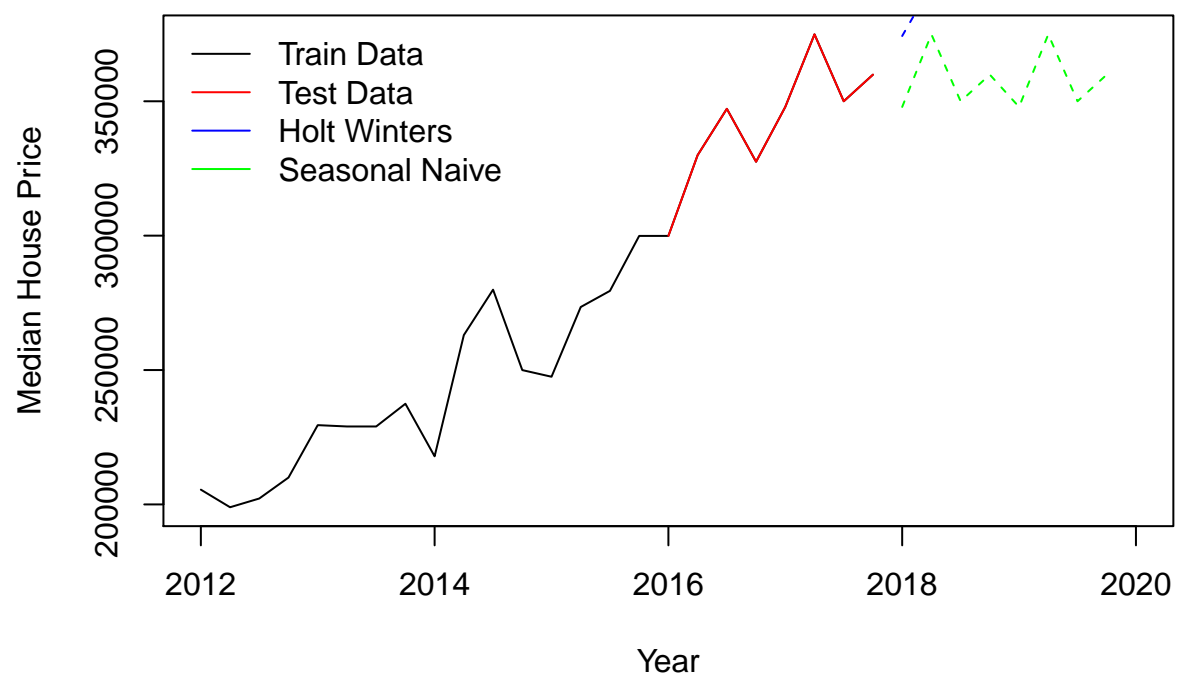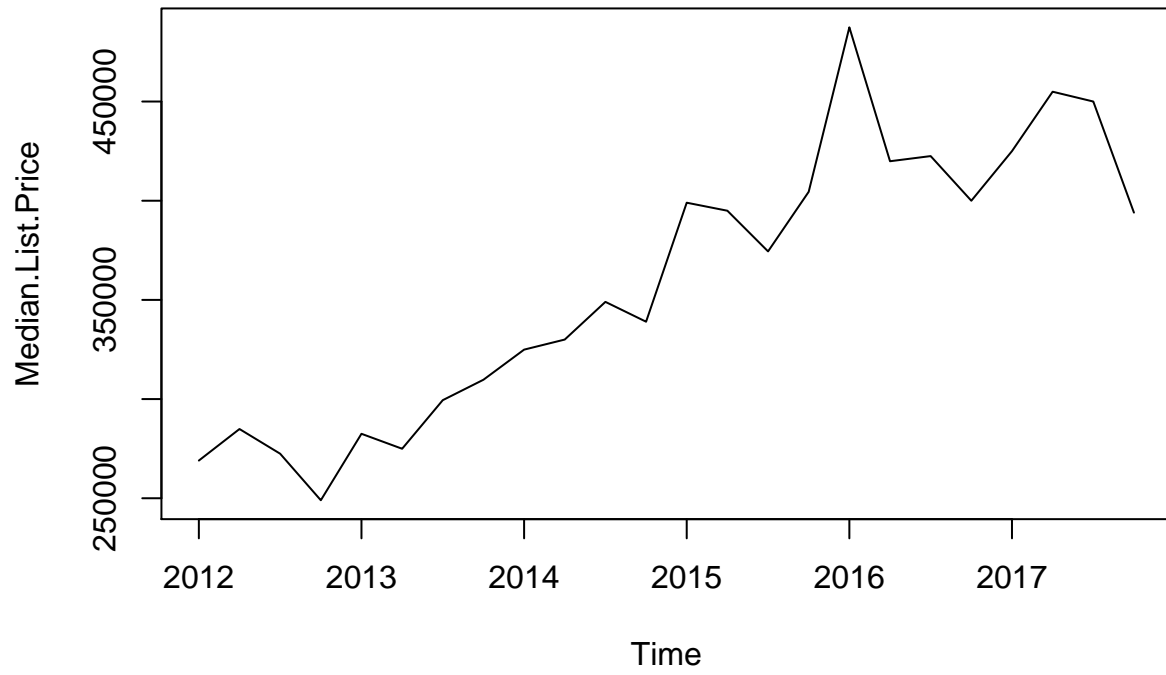
Portland, OR – Arbor Lodge

Portland, OR – Arbor Lodge : Naive Model Forecast
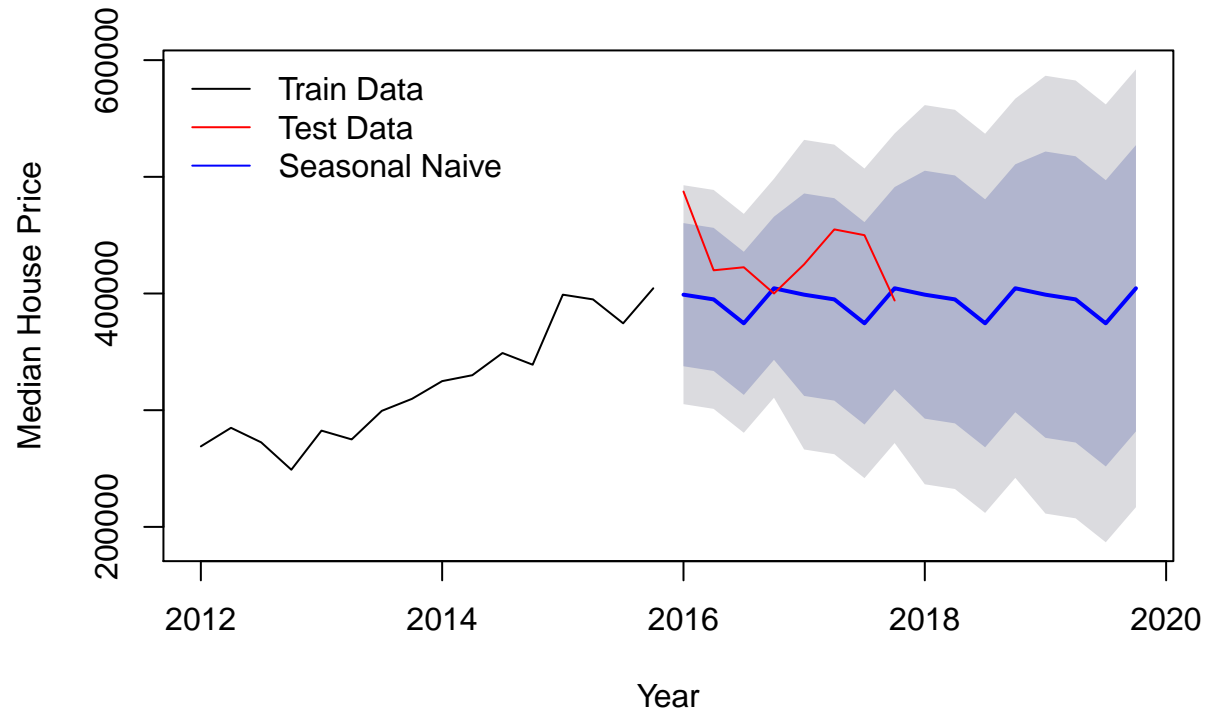
Portland, OR – Arbor Lodge : Naive Model Forecast Residuals
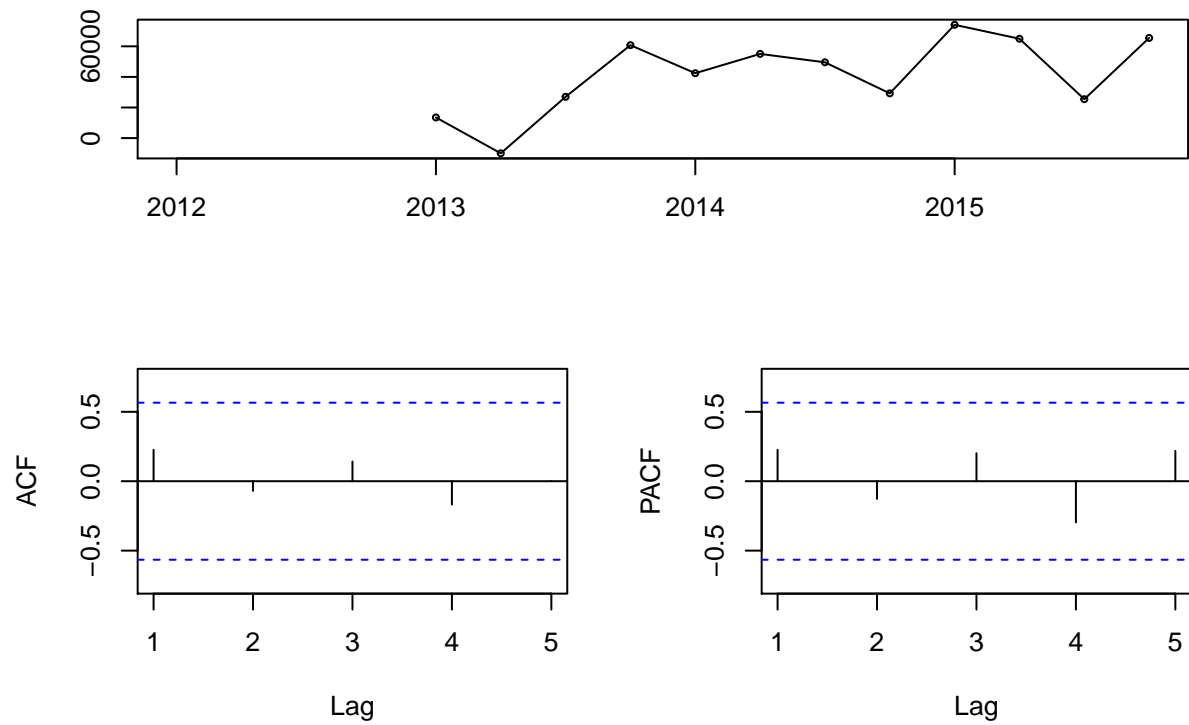
Portland, OR – Arbor Lodge : Holt Winters Model Forecast
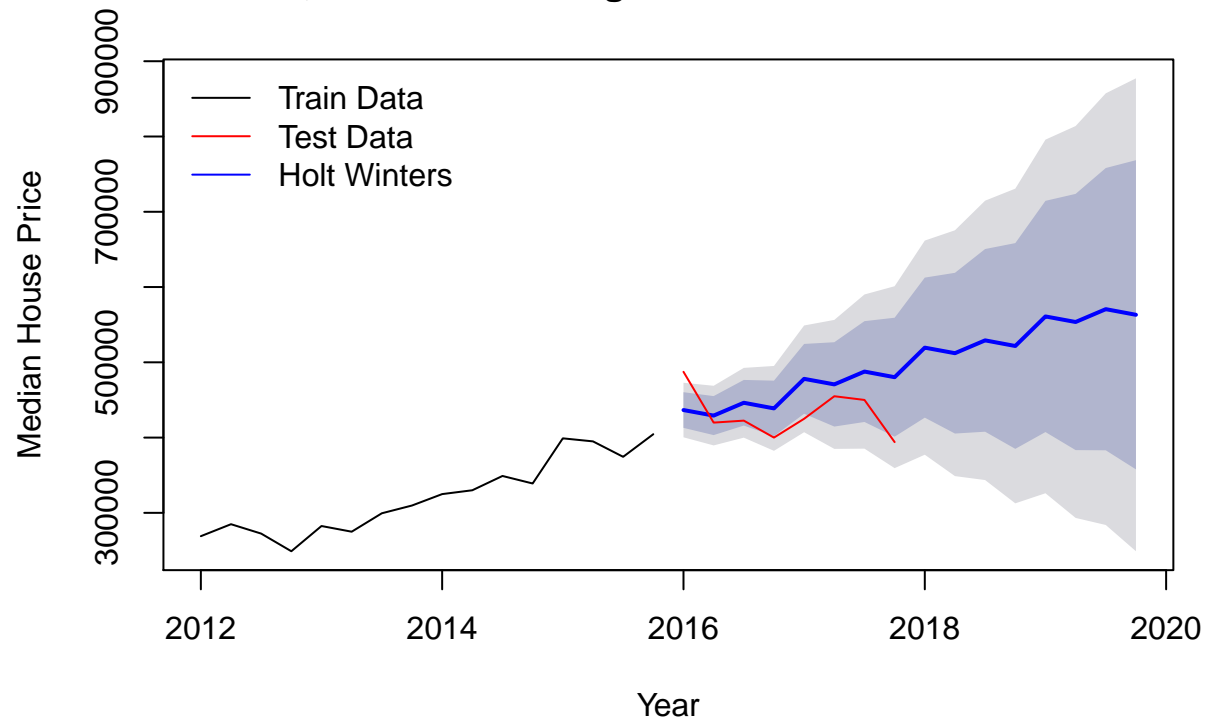
Portland, OR – Arbor Lodge : Holt Winters Model Forecast Residuals
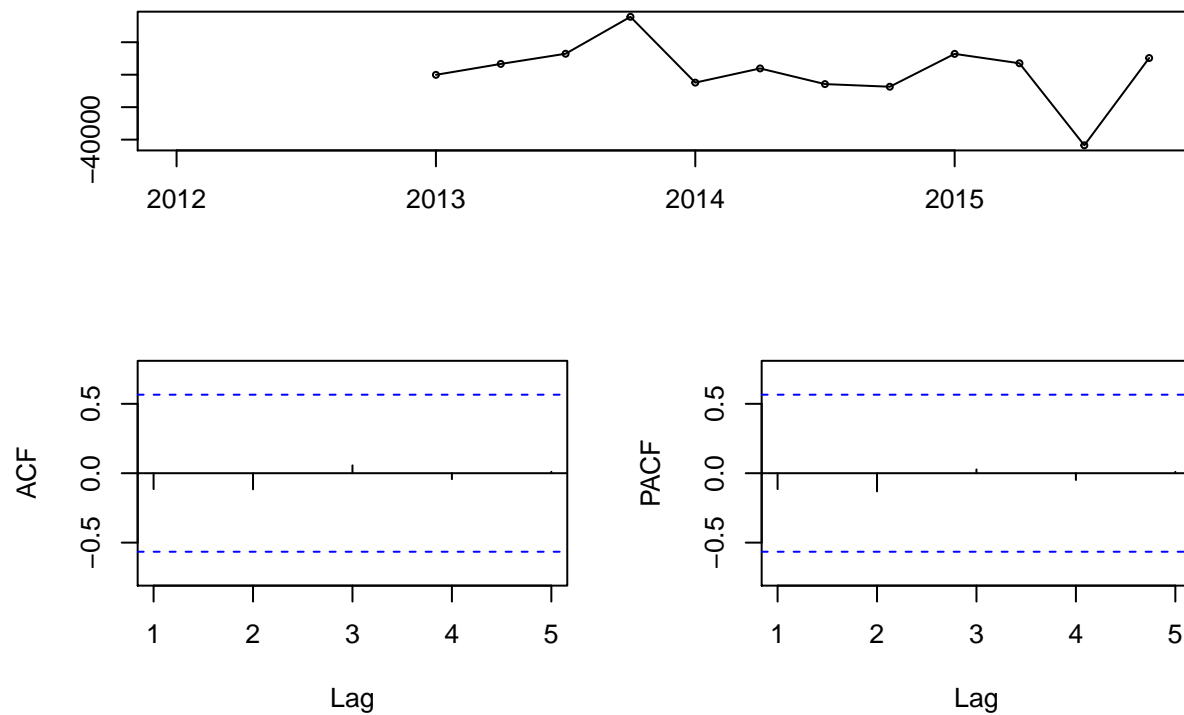

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Arbor Lodge"
##                     ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 41462.50 47858.75 43120.83 11.696125 12.299264 1.0000000
## Test set     38493.75 51063.89 42243.75  8.469569  9.417062 0.9796599
##                   ACF1 Theil's U
## Training set  0.2263326        NA
## Test set     -0.2183350  1.209817
## [1] "Holt Winters Accuracy for  Portland, OR - Arbor Lodge"
##                     ME      RMSE      MAE       MPE      MAPE      MASE
## Training set   2292.375 17844.92 12573.27  0.8283594 3.661753 0.2915822
## Test set     -26718.509 45629.90 39422.25 -6.6643122 9.270743 0.9142275
##                   ACF1 Theil's U
## Training set -0.1144846        NA
## Test set      0.1760275  1.265668
```

Portland, OR – Arbor Lodge : TS Training Model Comparison
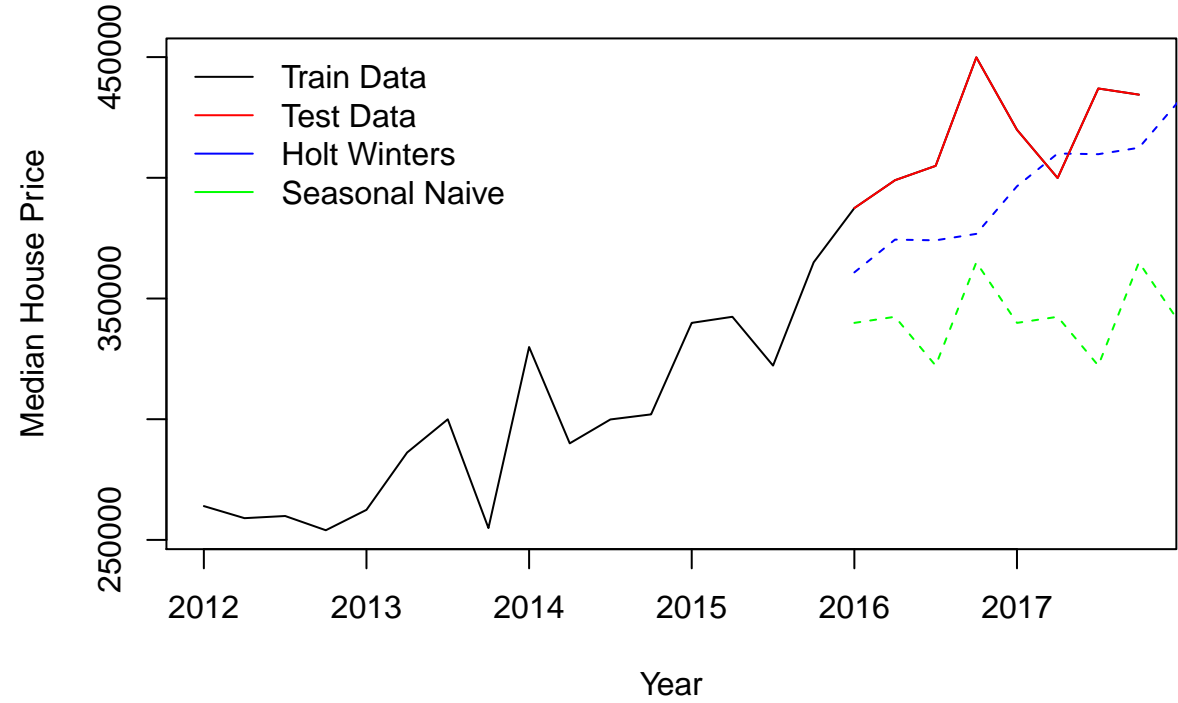
Portland, OR – Arbor Lodge : Full TS Models Comparison
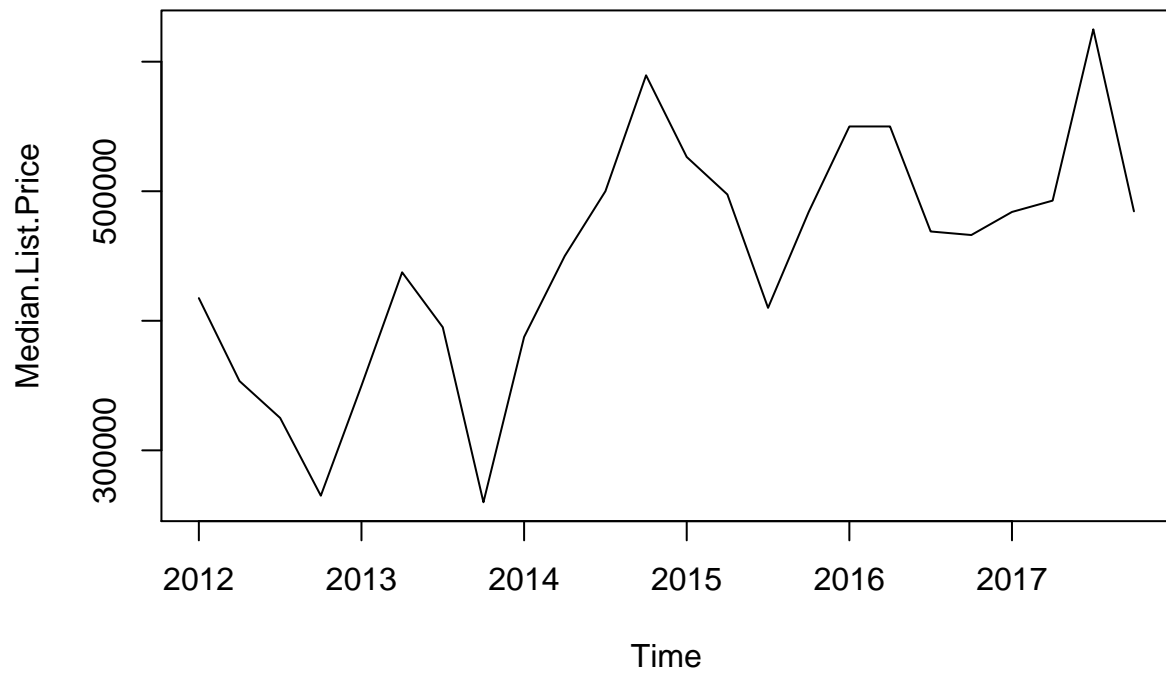
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

Portland, OR – Marshall Park

Portland, OR – Marshall Park : Naive Model Forecast
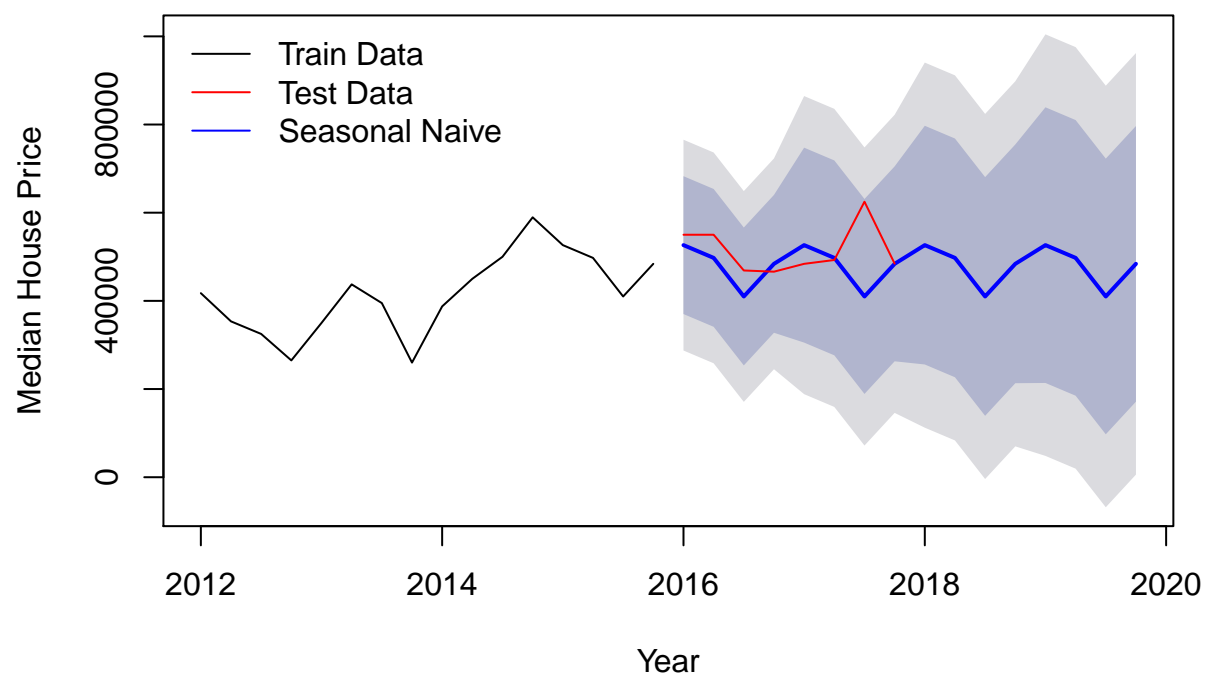
Portland, OR – Marshall Park : Naive Model Forecast Residuals
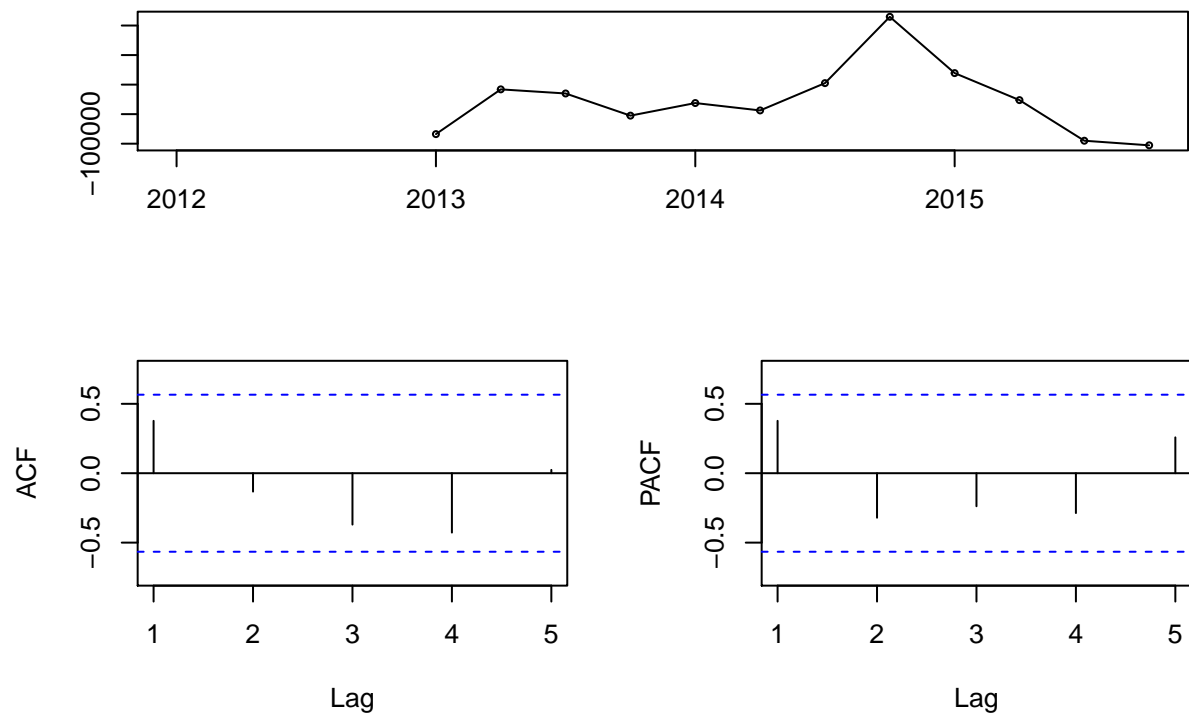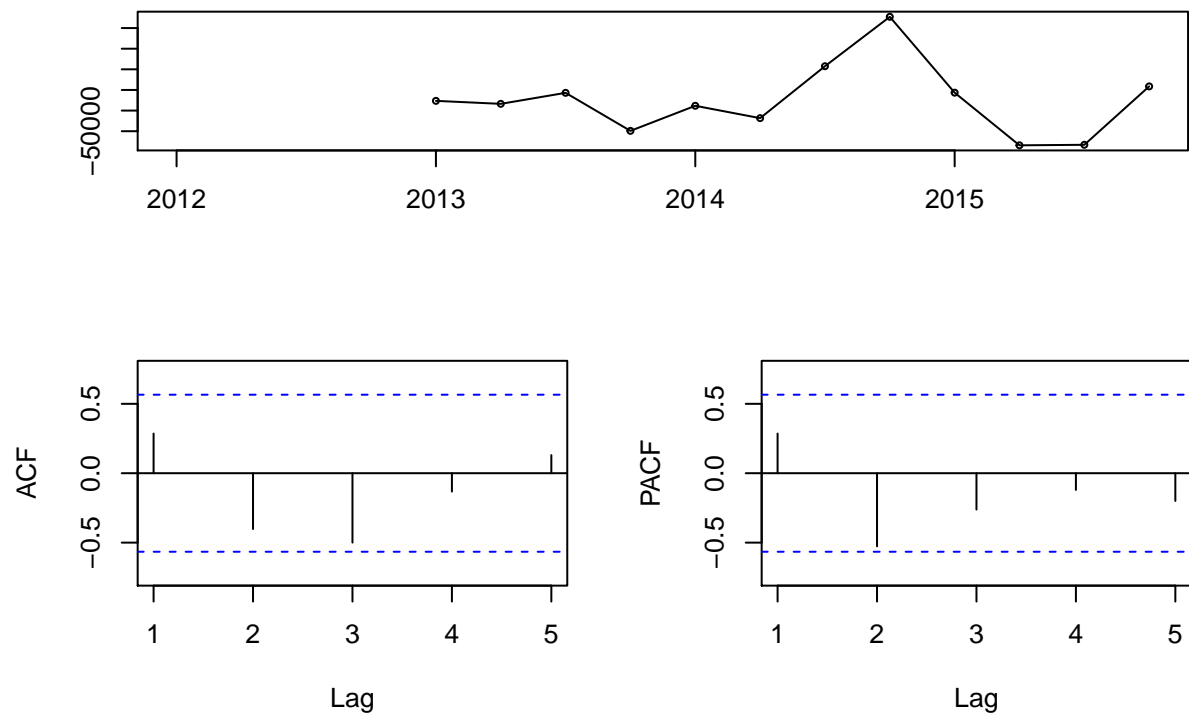
Portland, OR – Marshall Park : Holt Winters Model Forecast

Legend:
- Train Data
- Test Data
- Holt Winters

X-axis: Year
Y-axis: Median House Price

Portland, OR – Marshall Park : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Marshall Park"
##                    ME      RMSE    MAE      MPE     MAPE      MASE      ACF1
## Training set 46412.5 121966.7 91100 8.103518 18.93786 1.0000000  0.3774393
## Test set     35680.0  83013.6 51930 5.917684  9.30587 0.5700329 -0.1618543
##             Theil's U
## Training set       NA
## Test set     1.229466
## [1] "Holt Winters Accuracy for  Portland, OR - Marshall Park"
##                    ME     RMSE      MAE      MPE     MAPE      MASE
## Training set  24724.84 85664.85 63825.75  3.718840 13.74124 0.7006119
## Test set     -38249.46 71714.15 60135.20 -8.140546 11.84271 0.6601010
##                   ACF1 Theil's U
## Training set  0.2859306        NA
## Test set     -0.2908618  1.054253
```

Portland, OR – Marshall Park : TS Training Model Comparison

Portland, OR – Marshall Park : Full TS Models Comparison

Median House Price

Year

- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

# Portland, OR – Brentwood

Portland, OR – Brentwood : Naive Model Forecast

Portland, OR – Brentwood : Naive Model Forecast Residuals
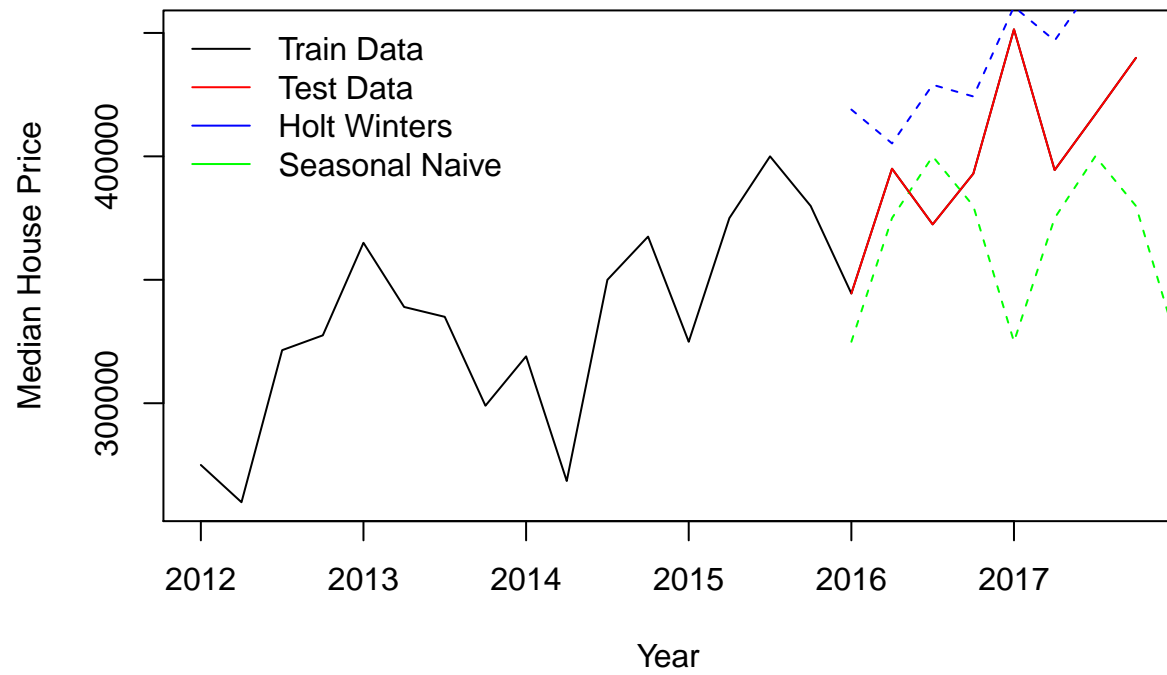
Portland, OR – Brentwood : Holt Winters Model Forecast

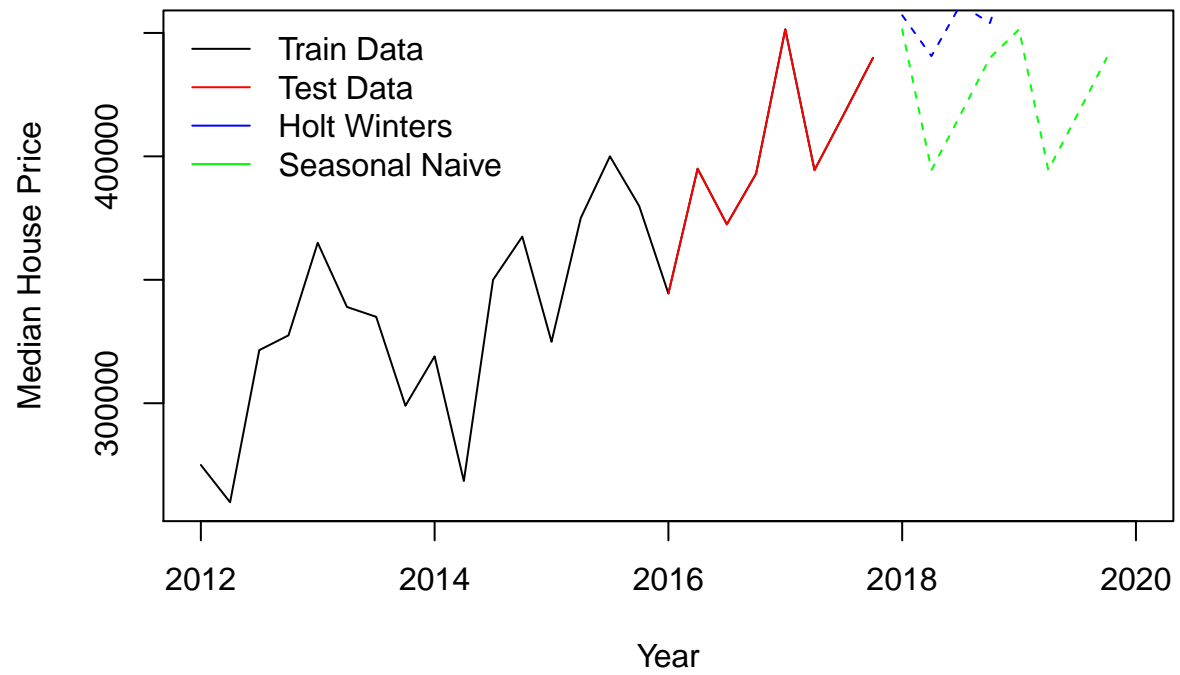## Portland, OR – Brentwood : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Brentwood"
##                    ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 21833.33 28568.52 21833.33  9.771475  9.771475 1.000000
## Test set     64306.25 66898.42 64306.25 20.885691 20.885691 2.945324
##                   ACF1 Theil's U
## Training set -0.0649892        NA
## Test set      0.1421418  4.440727
## [1] "Holt Winters Accuracy for  Portland, OR - Brentwood"
##                   ME      RMSE       MAE       MPE      MAPE       MASE
## Training set  3514.74 13581.07 11051.12  1.386235  4.878437 0.5061581
## Test set     35681.27 37877.09 35681.27 11.477190 11.477190 1.6342564
##                   ACF1 Theil's U
## Training set -0.1040843        NA
## Test set     -0.1806263  2.588907
```

Portland, OR – Brentwood : TS Training Model Comparison

Median House Price

Year

- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

# Portland, OR – Brentwood : Full TS Models Comparison

Portland, OR – Pleasant Valley

Portland, OR – Pleasant Valley : Naive Model Forecast
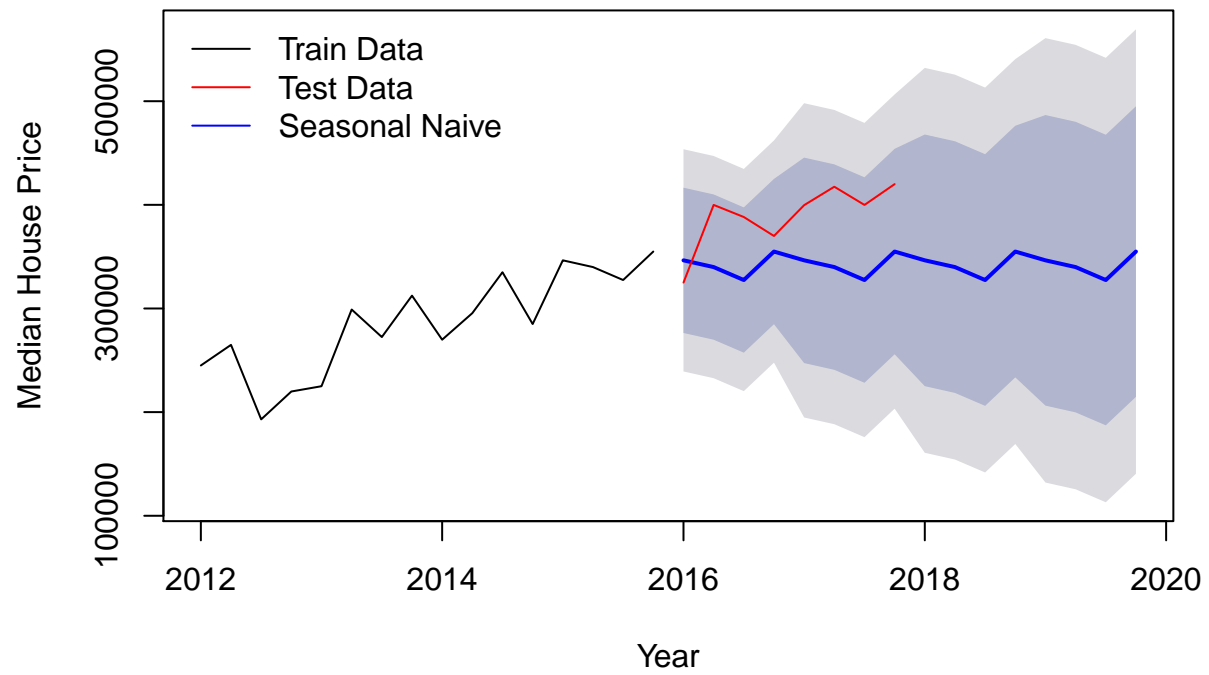
Portland, OR – Pleasant Valley : Naive Model Forecast Residuals
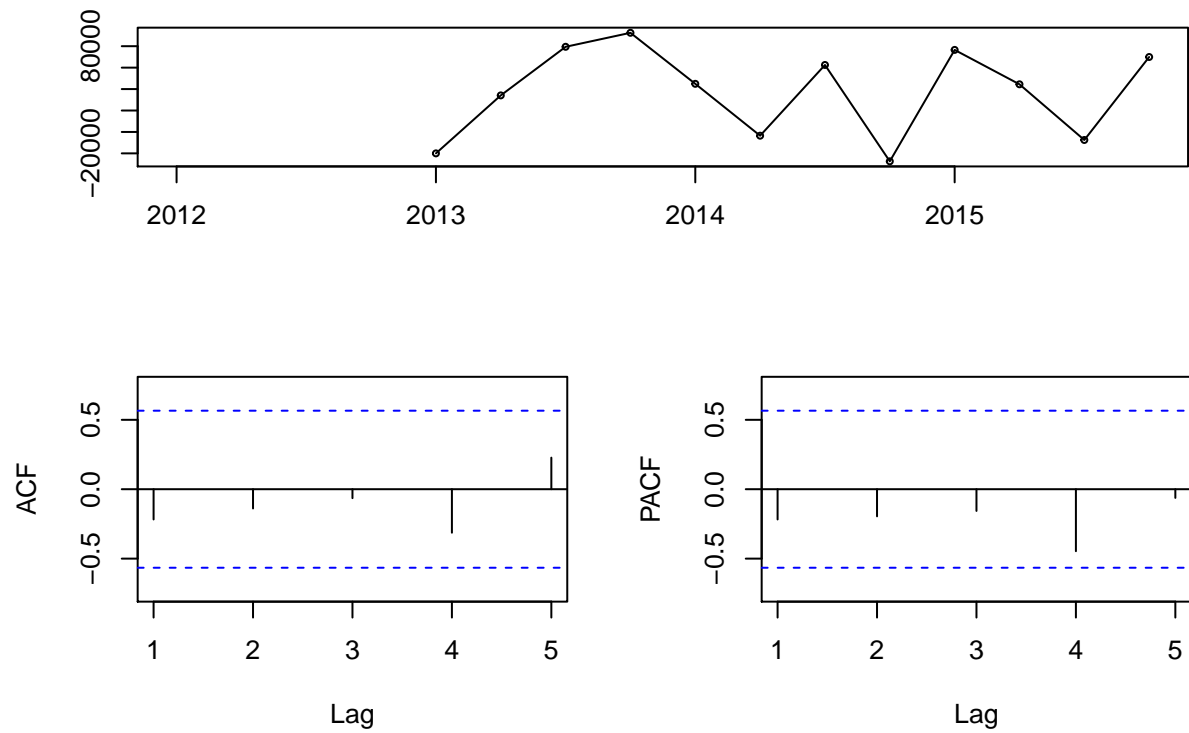
Portland, OR – Pleasant Valley : Holt Winters Model Forecast
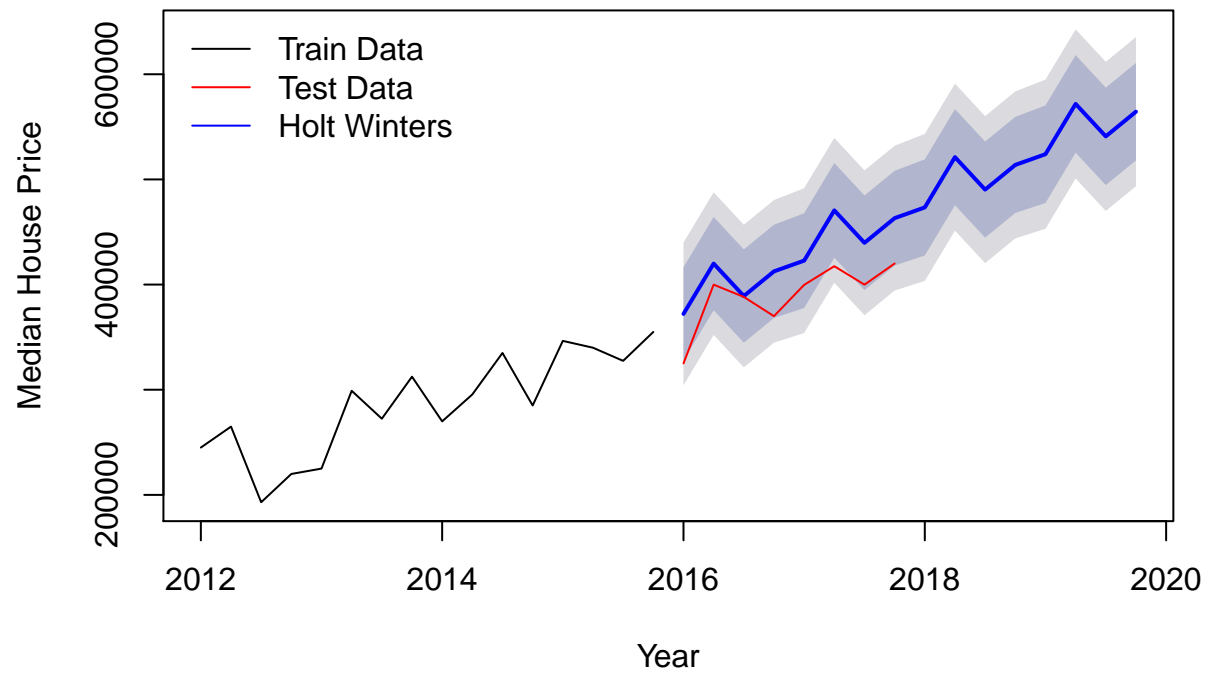
Portland, OR – Pleasant Valley : Holt Winters Model Forecast Residuals
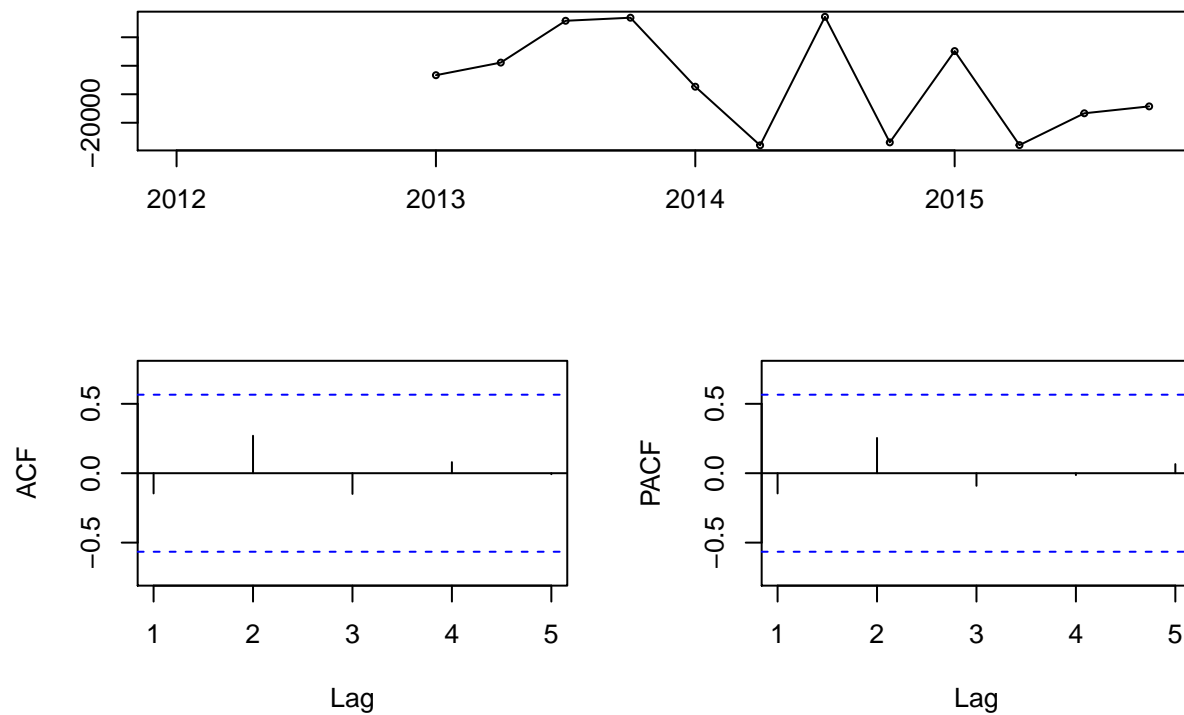

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Pleasant Valley"
##                    ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 37164.21 54694.31 46897.54 11.53035 15.19331 1.000000
## Test set     47831.62 57347.08 53194.12 11.70279 13.35279 1.134263
##                     ACF1 Theil's U
## Training set -0.217950563        NA
## Test set      0.003662754  1.586609
## [1] "Holt Winters Accuracy for  Portland, OR - Pleasant Valley"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set   8641.11 34234.70 29830.05  2.957559 9.781364 0.6360686
## Test set     -33703.27 37468.43 33703.27 -8.741821 8.741821 0.7186574
##                    ACF1 Theil's U
## Training set -0.14557402        NA
## Test set     -0.07109168 0.9177655
```

Portland, OR – Pleasant Valley : TS Training Model Comparison

Portland, OR – Pleasant Valley : Full TS Models Comparison
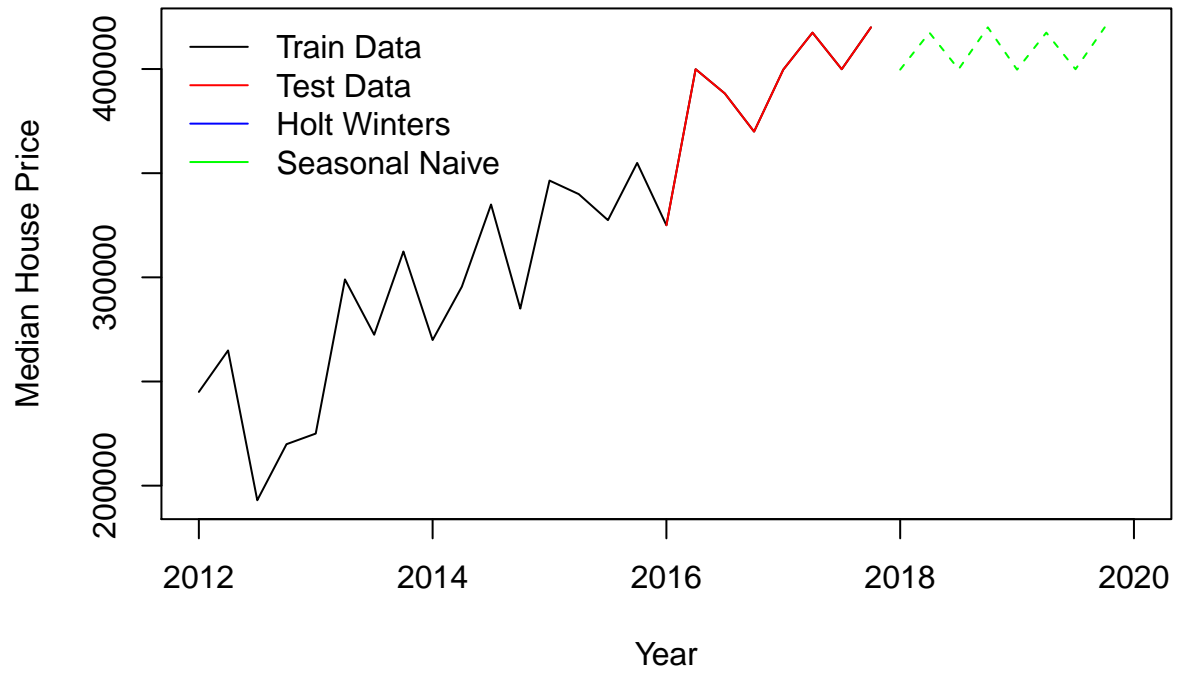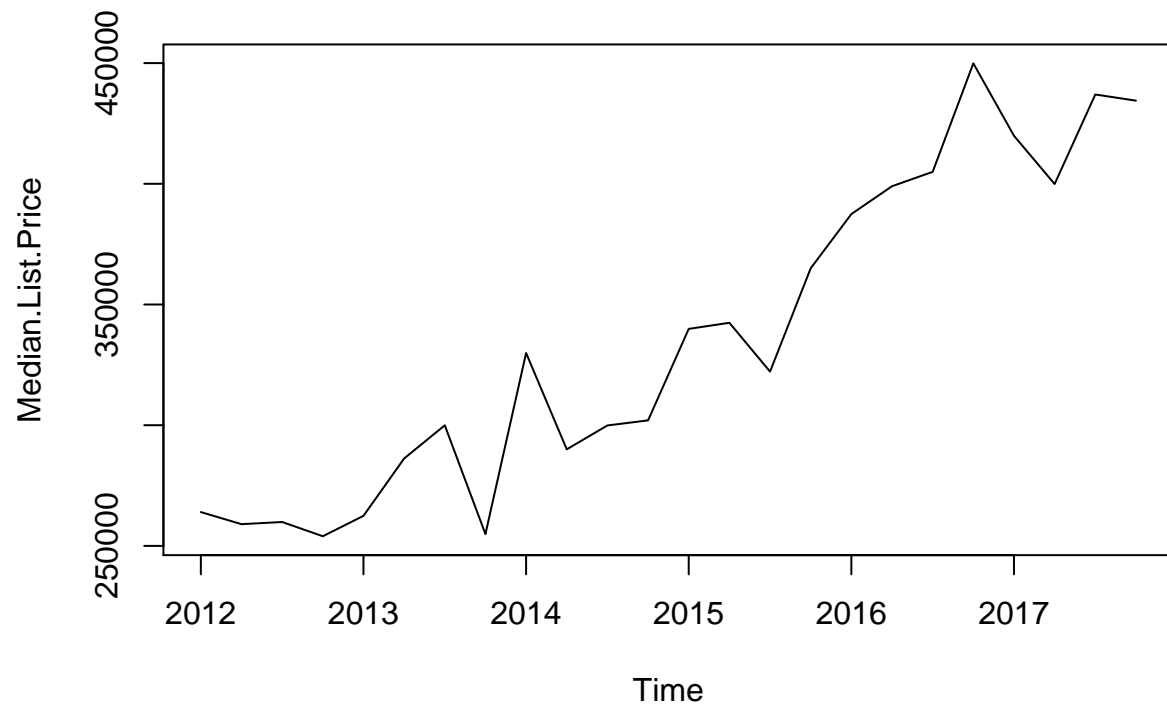
Portland, OR – Roseway

Portland, OR – Roseway : Naive Model Forecast
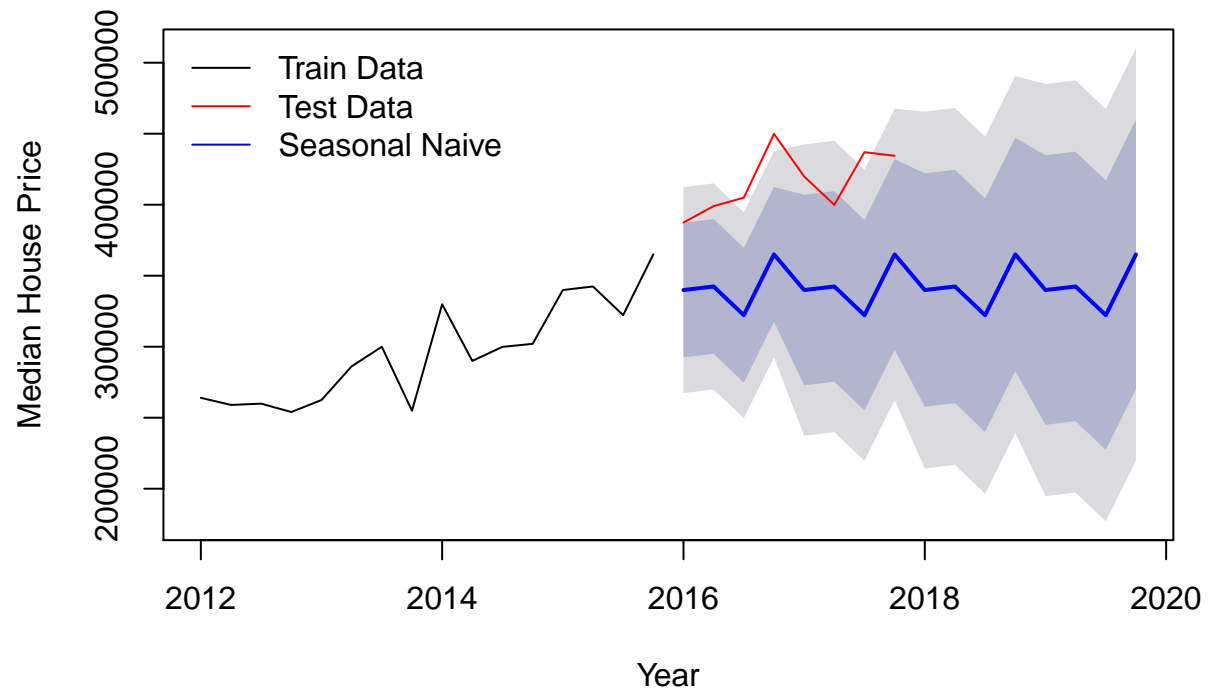
Portland, OR – Roseway : Naive Model Forecast Residuals
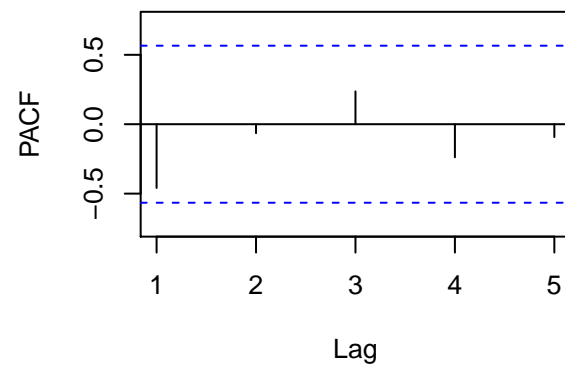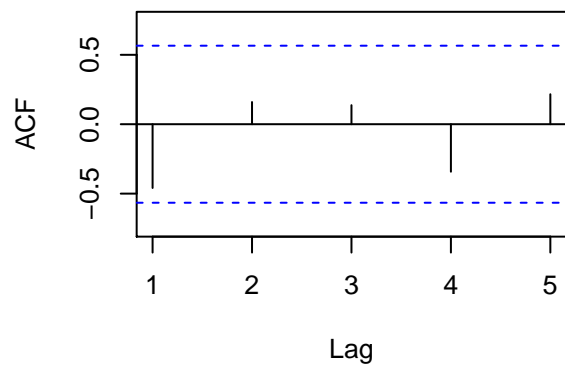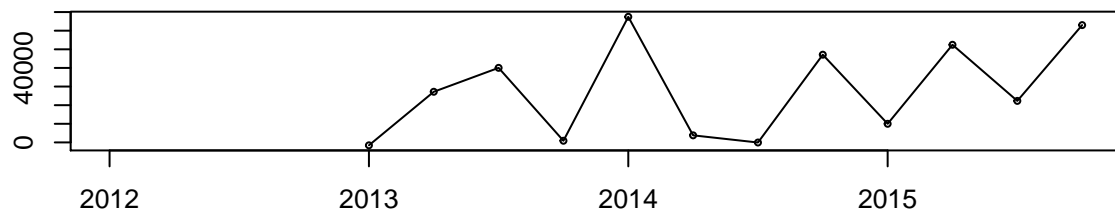
Portland, OR – Roseway : Holt Winters Model Forecast
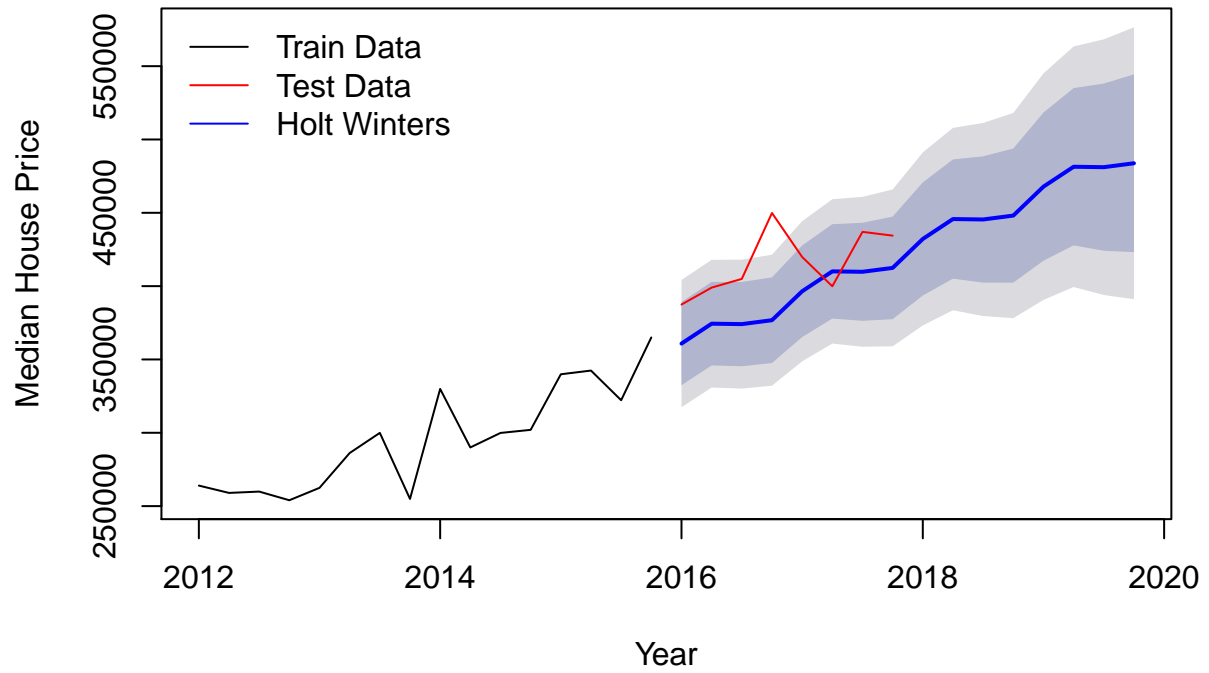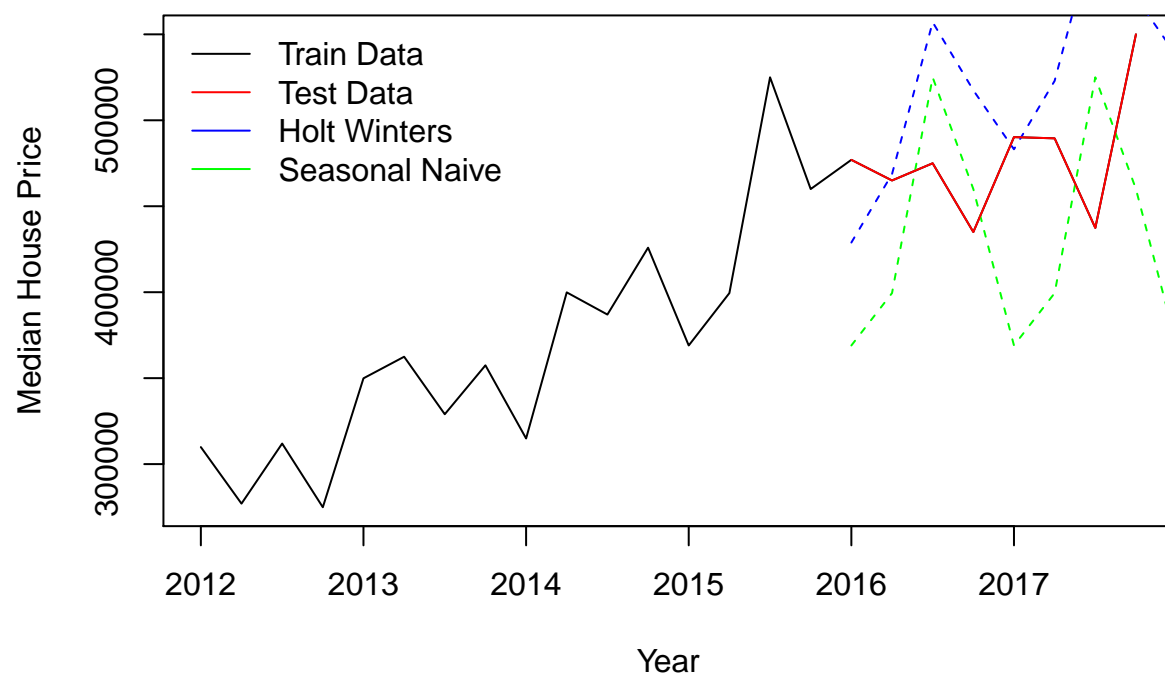
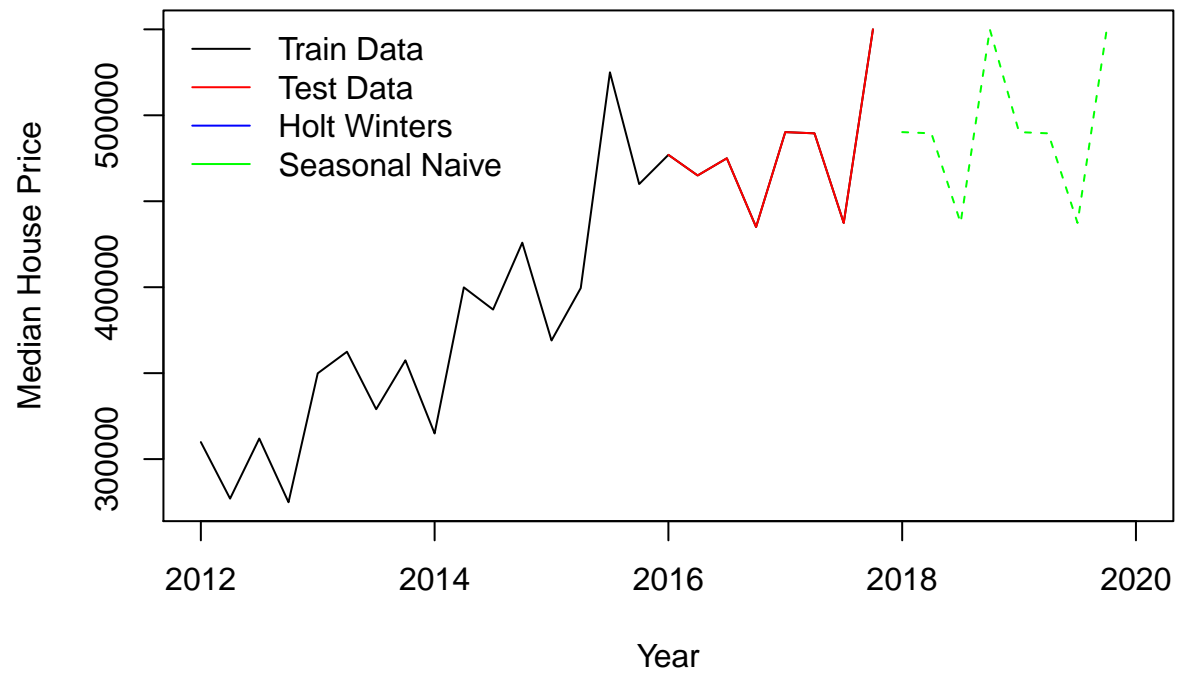**Portland, OR – Roseway : Holt Winters Model Forecast Residuals**
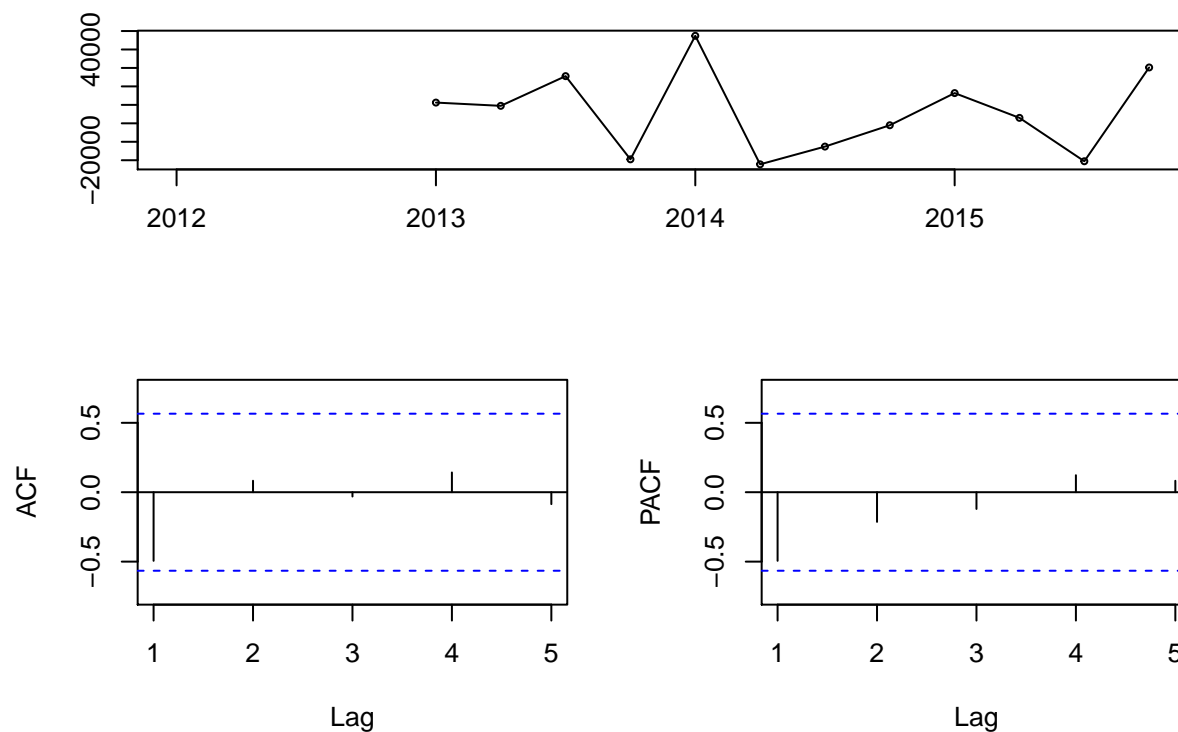

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Roseway"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 27718.75 37018.10 27985.42  8.532271  8.633481 1.000000
## Test set     74187.50 76830.19 74187.50 17.679685 17.679685 2.650934
##                   ACF1 Theil's U
## Training set -0.4592966        NA
## Test set     -0.1553340  3.041488
## [1] "Holt Winters Accuracy for  Portland, OR - Roseway"
##                   ME      RMSE      MAE      MPE      MAPE      MASE
## Training set  5615.089 21920.54 18265.40 1.518765 5.890964 0.6526755
## Test set     27211.391 34444.32 29752.79 6.405155 7.040665 1.0631535
##                   ACF1 Theil's U
## Training set -0.49422261        NA
## Test set      0.03530827  1.357981
```
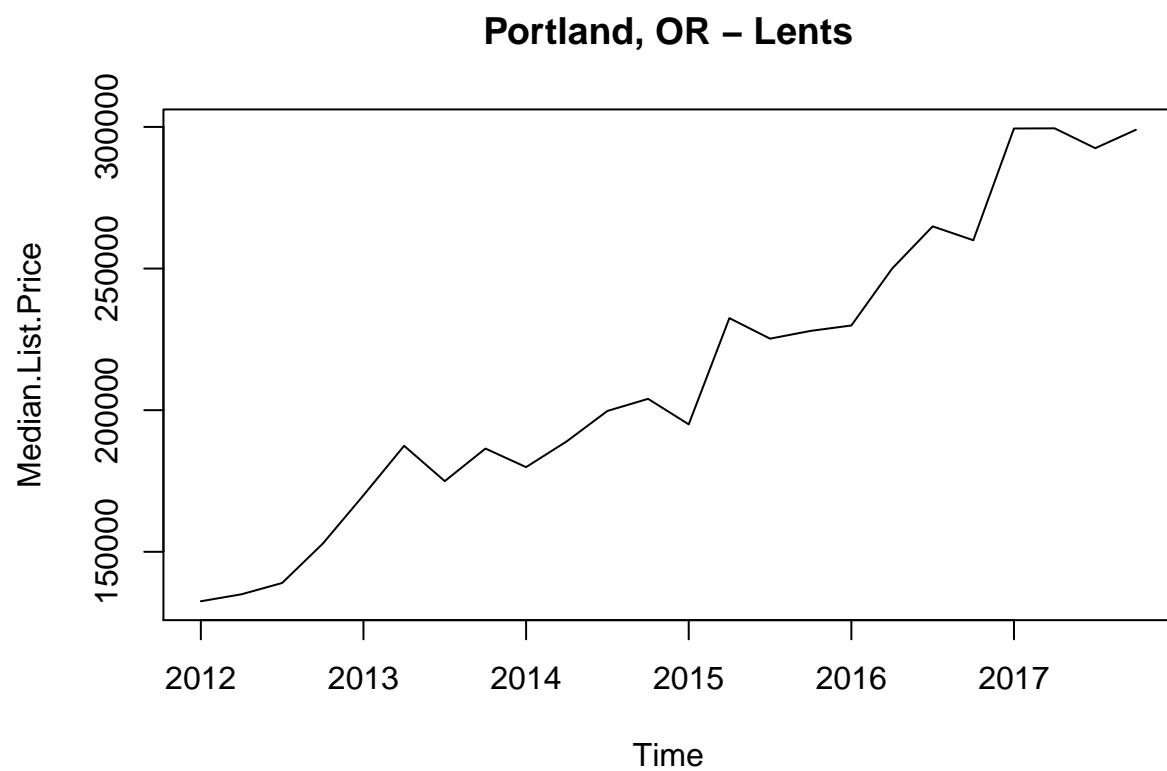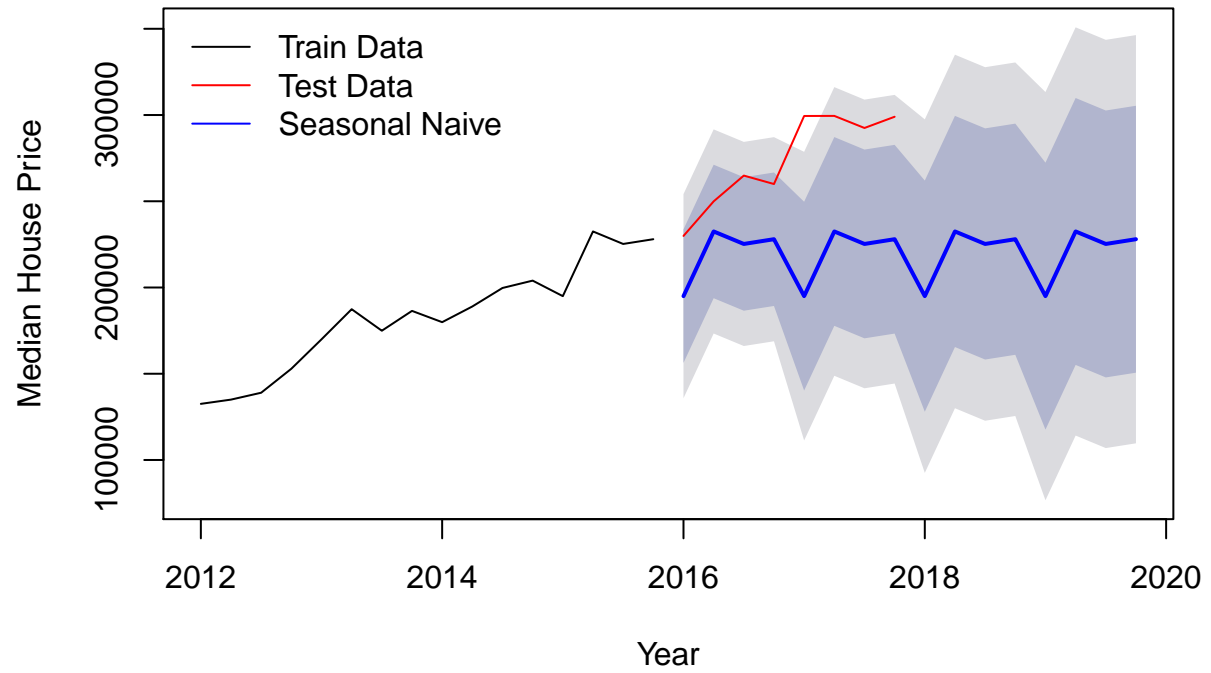
Portland, OR – Roseway : TS Training Model Comparison

Portland, OR – Roseway : Full TS Models Comparison
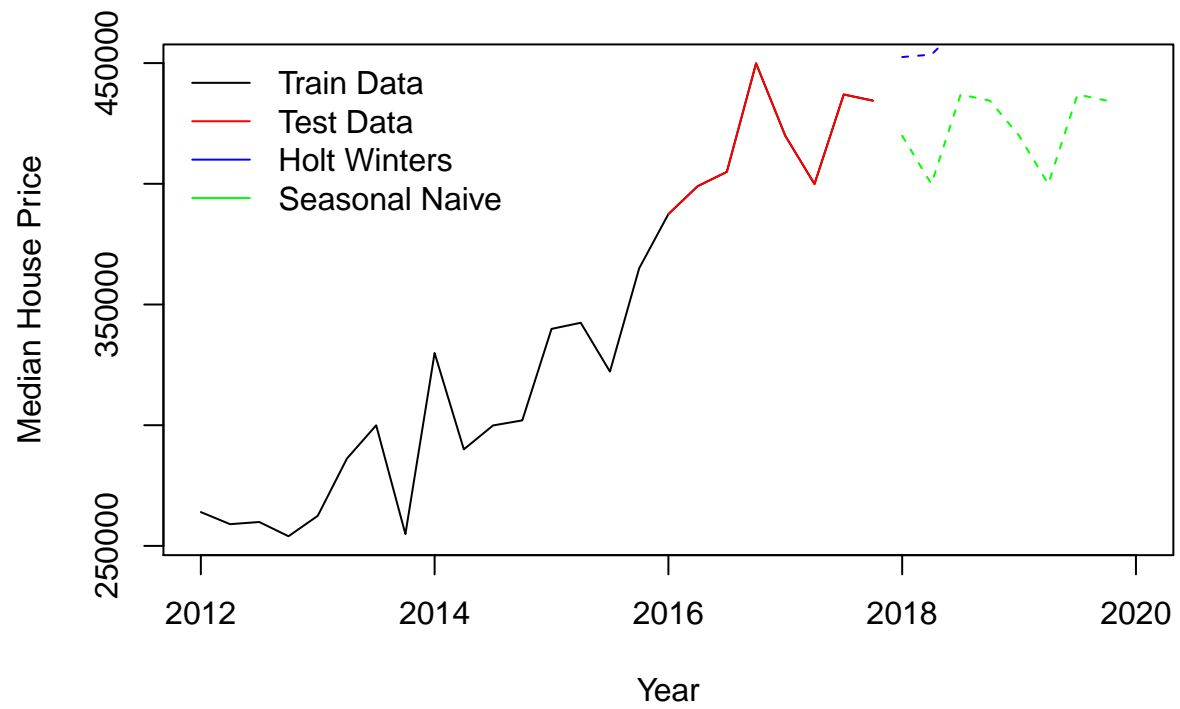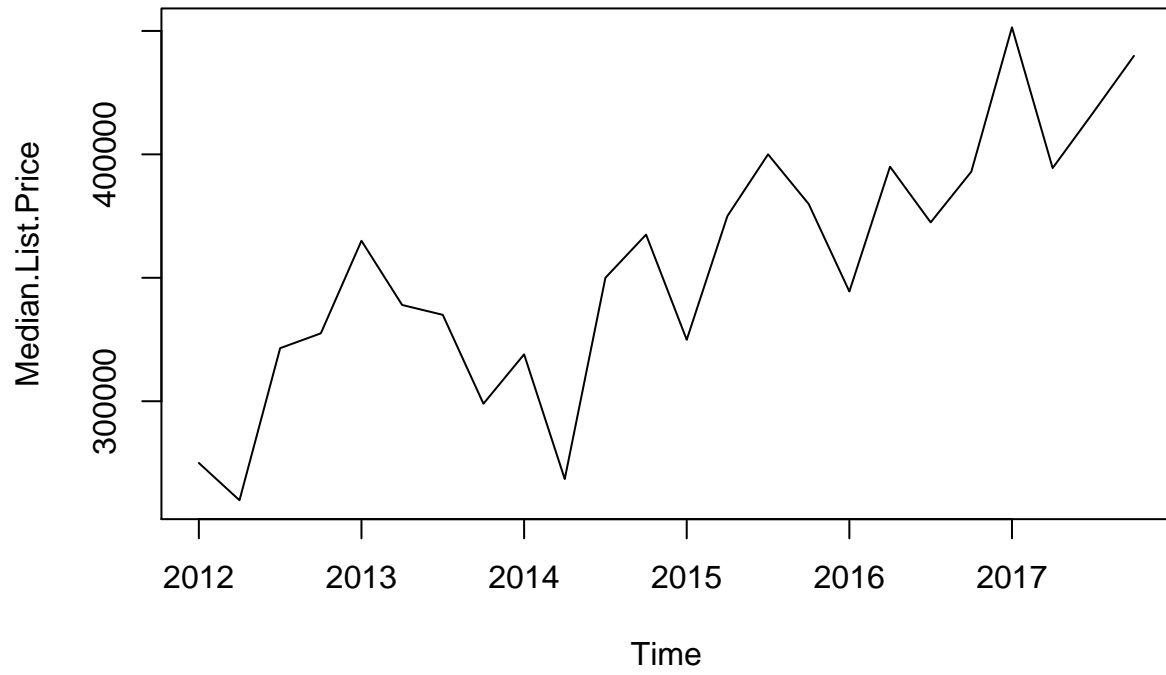
Portland, OR – Downtown Portland

Portland, OR – Downtown Portland : Naive Model Forecast
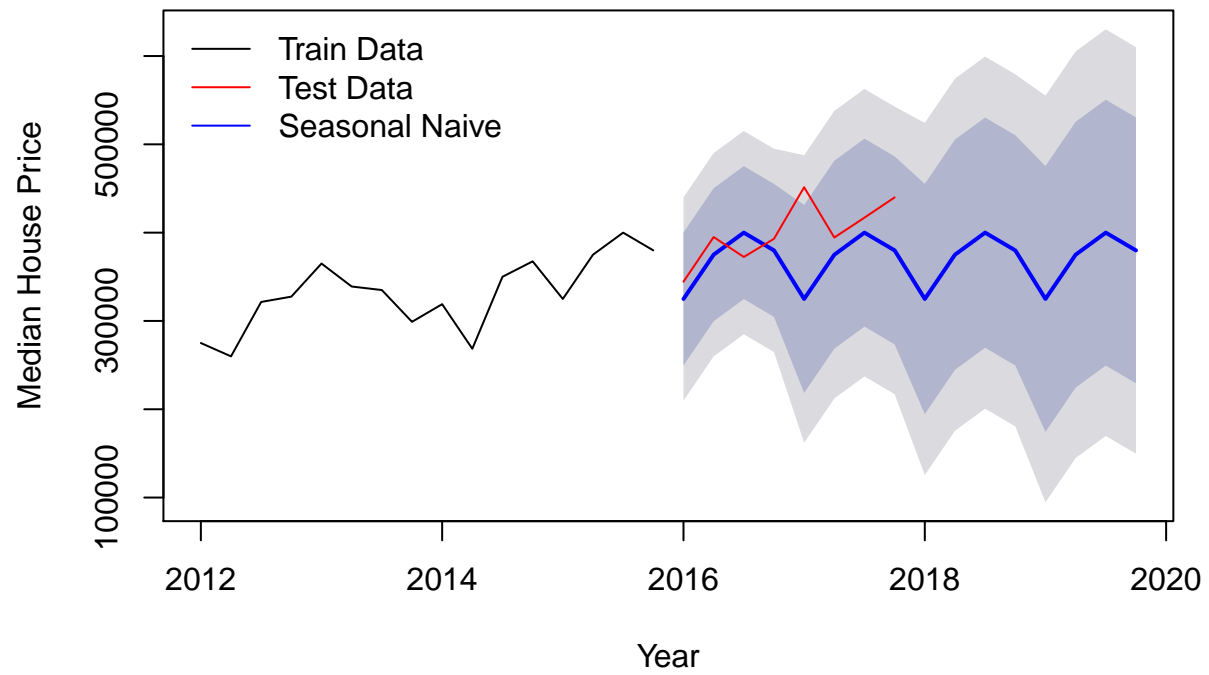
Portland, OR – Downtown Portland : Naive Model Forecast Residuals
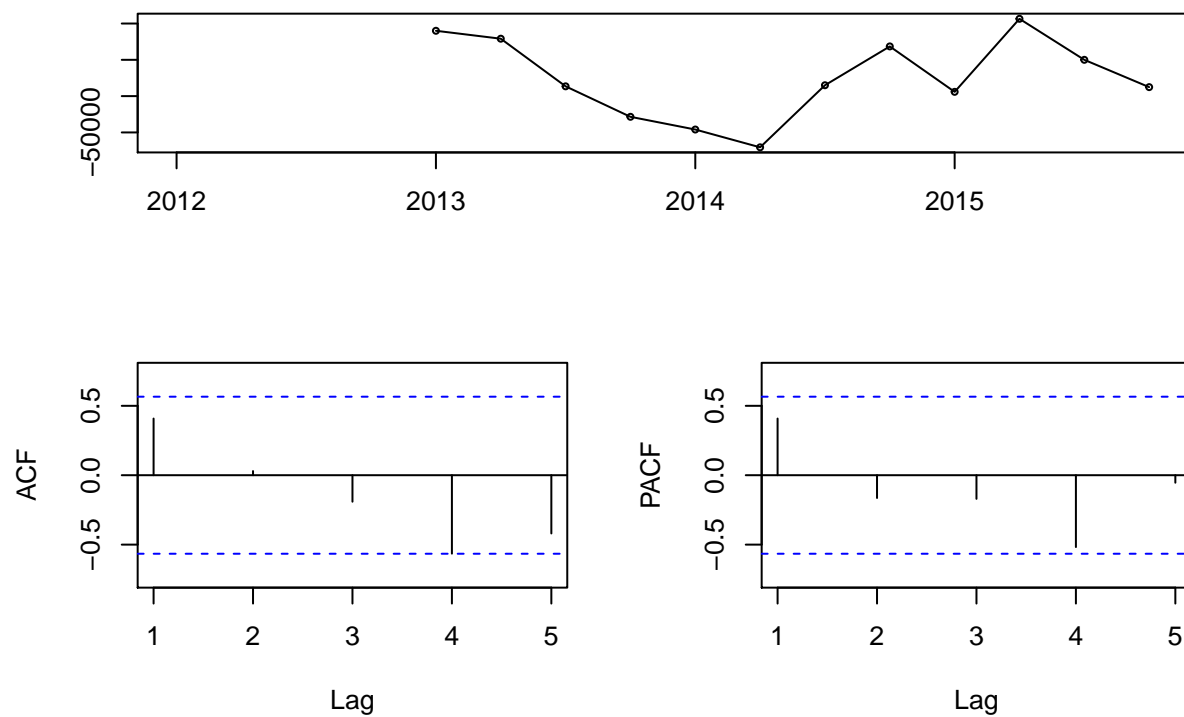
Portland, OR – Downtown Portland : Holt Winters Model Forecast
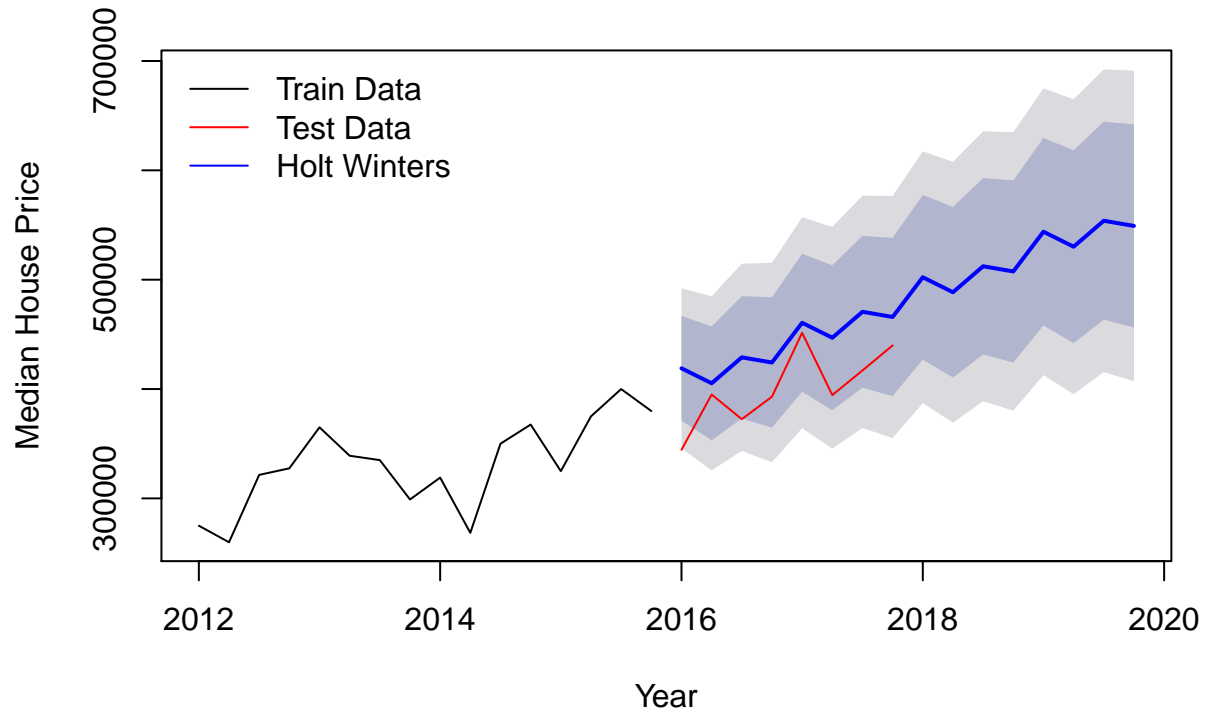
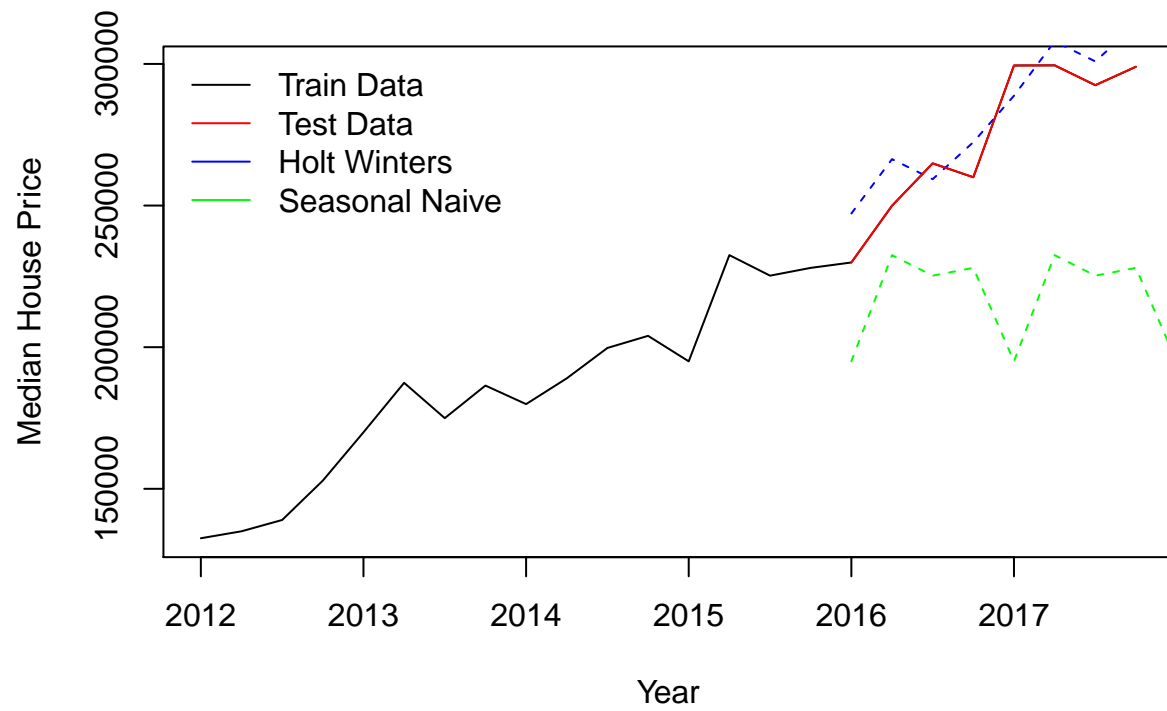**Portland, OR – Downtown Portland : Holt Winters Model Forecast Residuals**
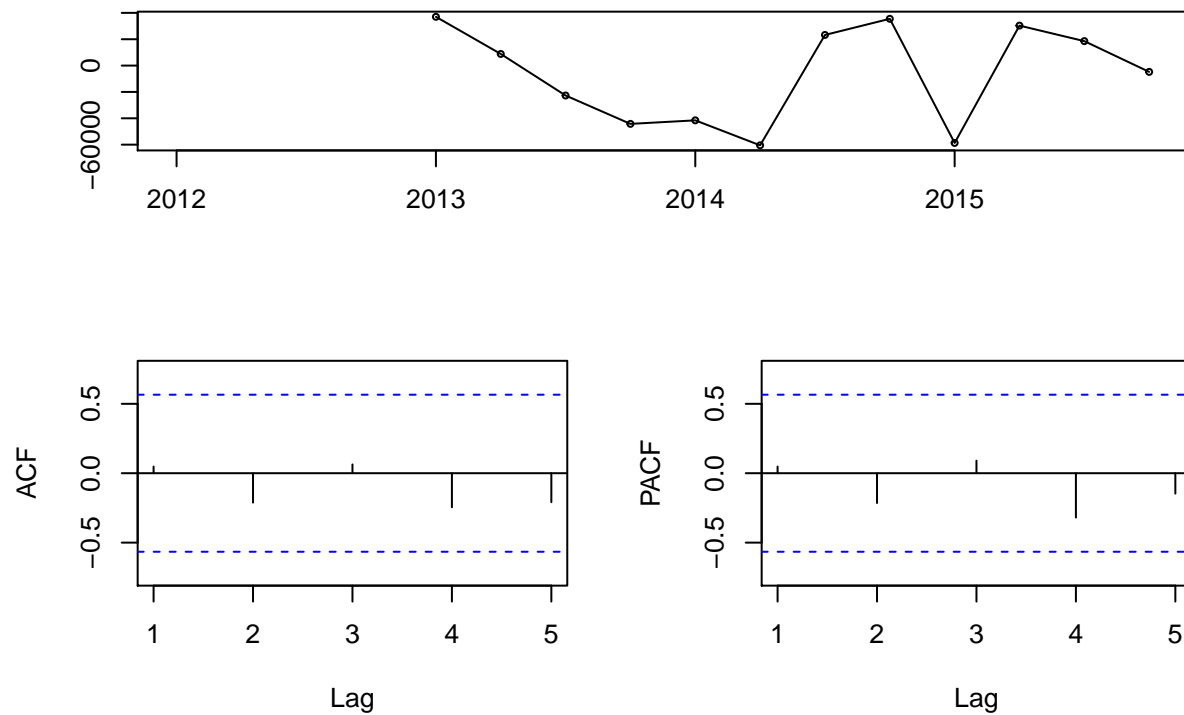

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Downtown Portland"
##                   ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 24658.33 58726.57 48825.08 5.893082 14.261249 1.0000000
## Test set     31012.44 52434.49 37899.94 7.169284  9.018526 0.7762391
##                   ACF1 Theil's U
## Training set  0.40846234        NA
## Test set     -0.08670784  1.380546
## [1] "Holt Winters Accuracy for  Portland, OR - Downtown Portland"
##                   ME      RMSE      MAE       MPE       MAPE      MASE
## Training set  -6583.342 36329.56 32161.04  -2.890142  9.852016 0.6586992
## Test set     -39221.517 45022.65 39221.52 -10.181524 10.181524 0.8033067
##                   ACF1 Theil's U
## Training set  0.04812447        NA
## Test set     -0.46561705 0.9476326
```

Portland, OR – Downtown Portland : TS Training Model Comparison

Portland, OR – Downtown Portland : Full TS Models Comparison
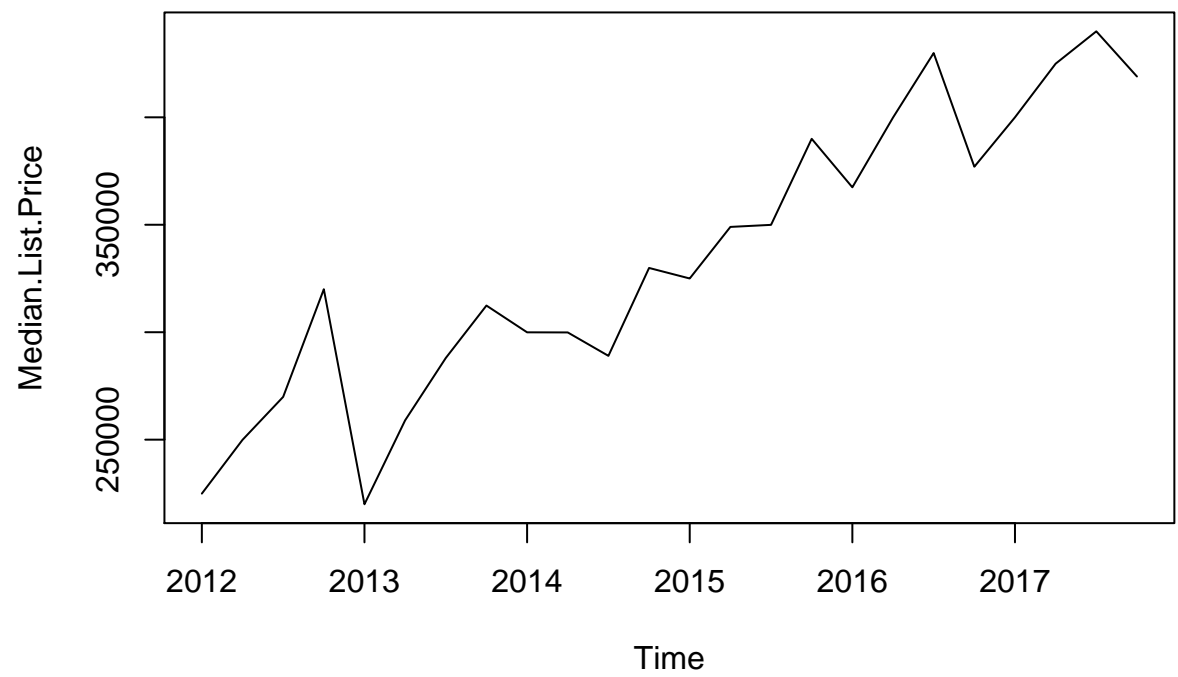
Portland, OR – South Tabor

Portland, OR – South Tabor : Naive Model Forecast
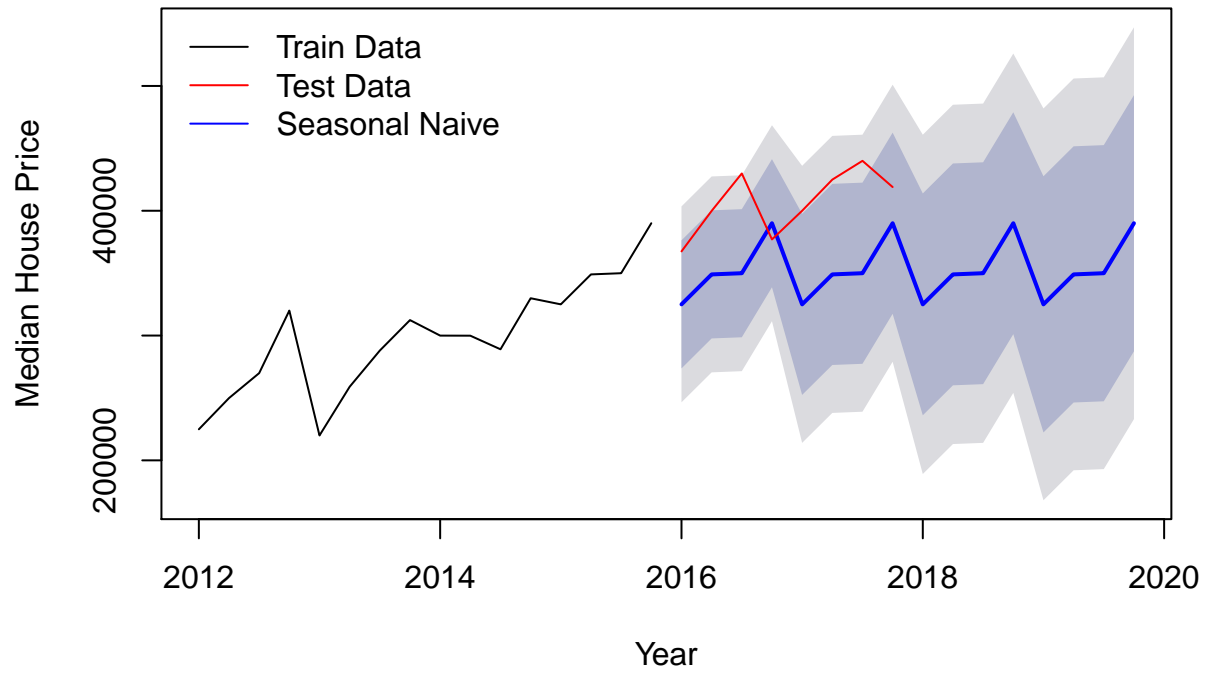
Portland, OR – South Tabor : Naive Model Forecast Residuals
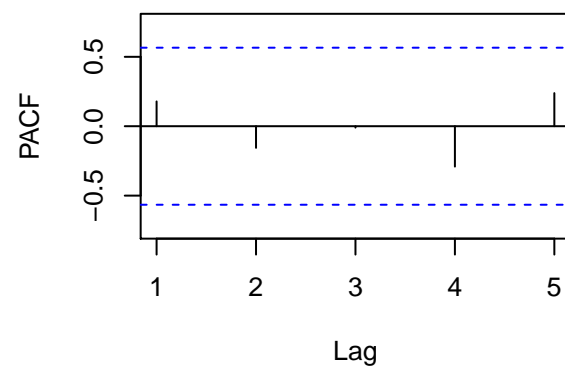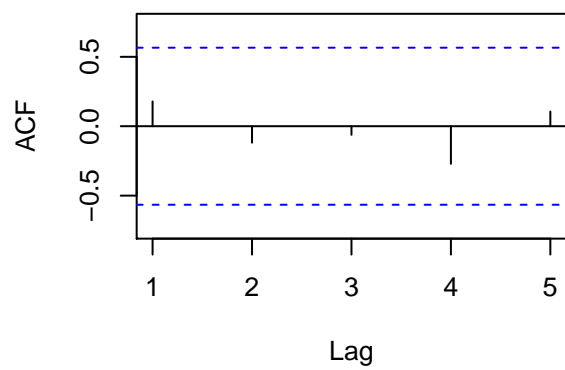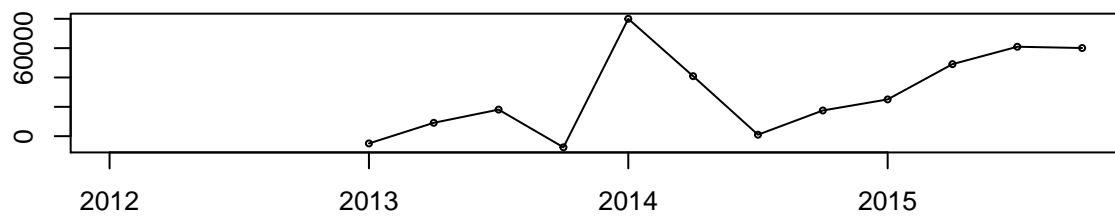
Portland, OR – South Tabor : Holt Winters Model Forecast
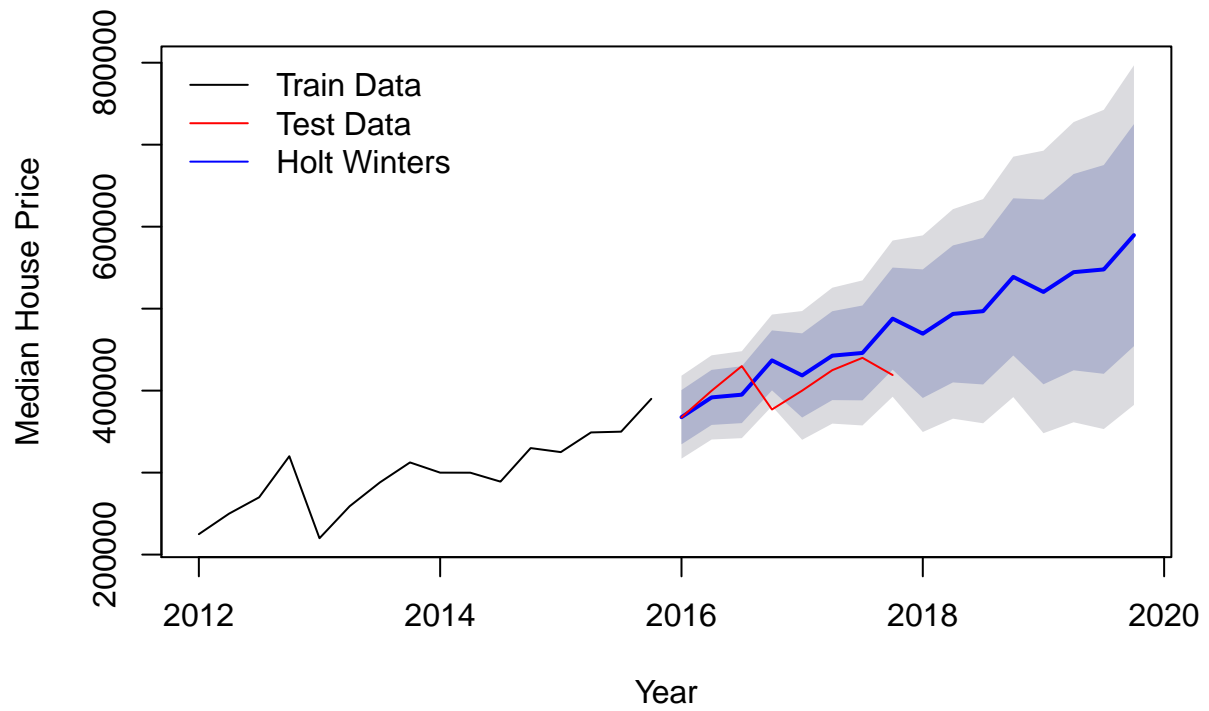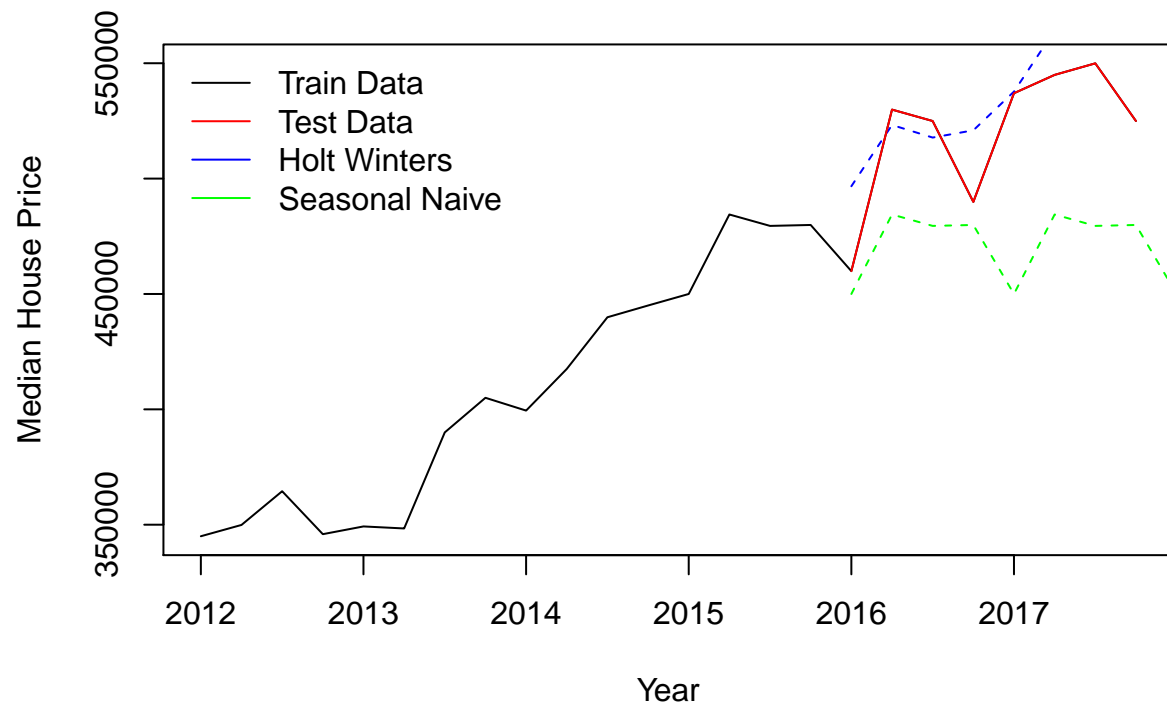
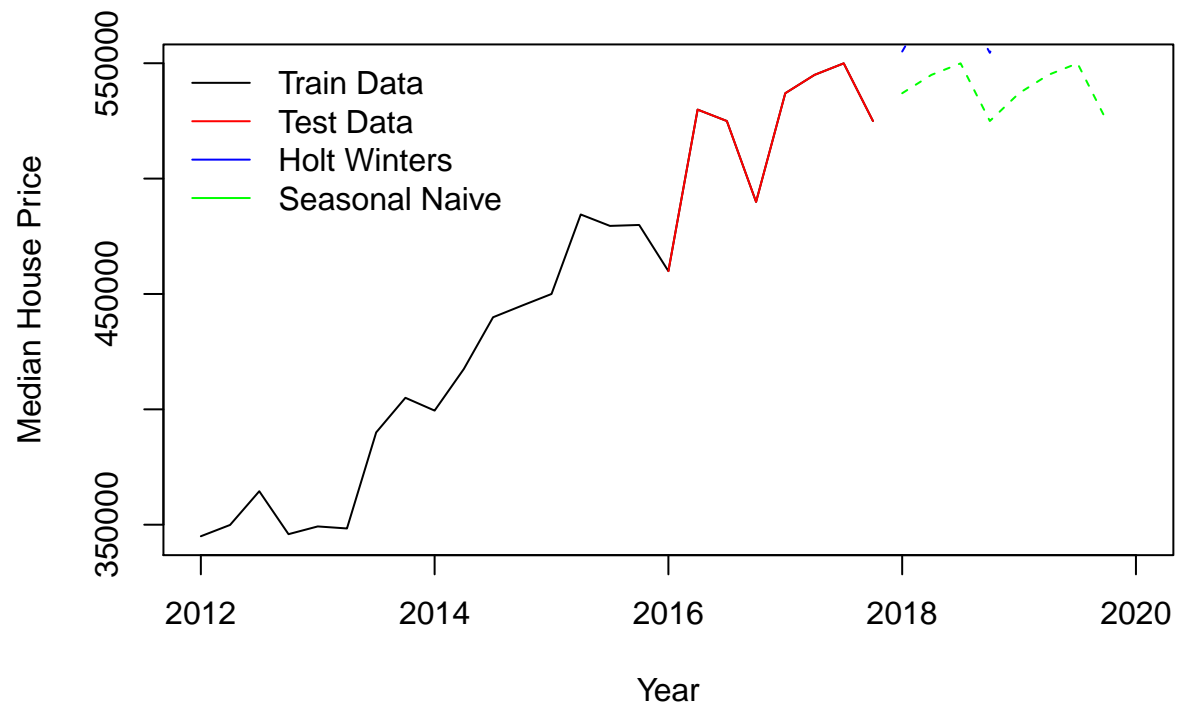**Portland, OR – South Tabor : Holt Winters Model Forecast Residuals**
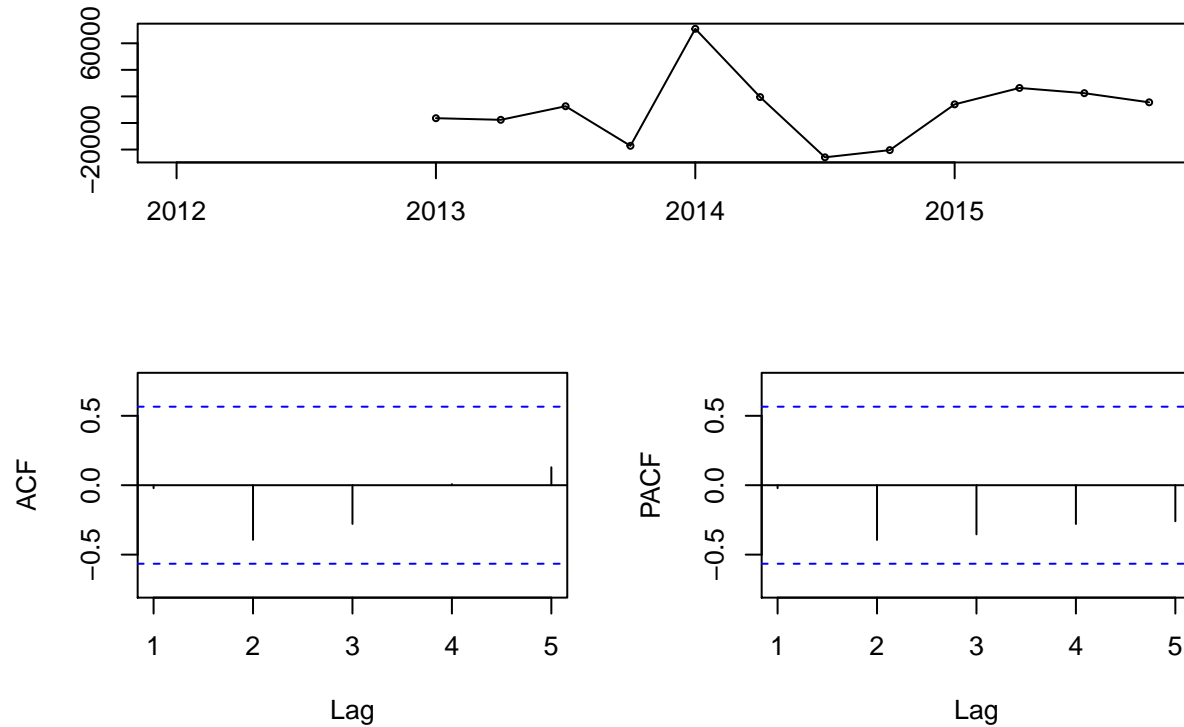

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - South Tabor"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 29104.58 40039.39 31195.42  8.806643  9.586925 1.000000
## Test set     53784.25 62544.93 57034.25 12.929183 13.791252 1.828289
##                   ACF1 Theil's U
## Training set  0.1787961        NA
## Test set     -0.3473204  2.157699
## [1] "Holt Winters Accuracy for  Portland, OR - South Tabor"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set  10326.16 26778.48 20906.62  3.225652 6.666289 0.6701823
## Test set     -16019.82 35877.44 26767.97 -4.048310 6.584049 0.8580737
##                    ACF1 Theil's U
## Training set -0.02116555        NA
## Test set     -0.12750839  1.192957
```

Portland, OR – South Tabor : TS Training Model Comparison

Median House Price

Year

- Train Data
- Test Data
- Holt Winters
- Seasonal Naive
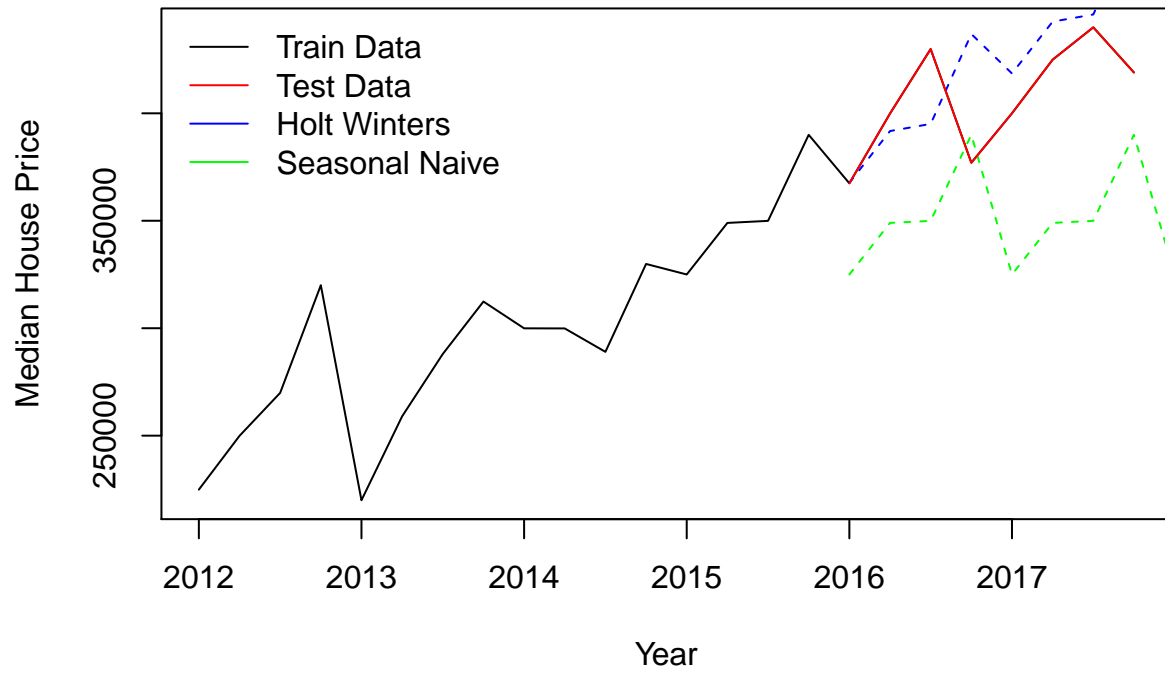
Portland, OR – South Tabor : Full TS Models Comparison
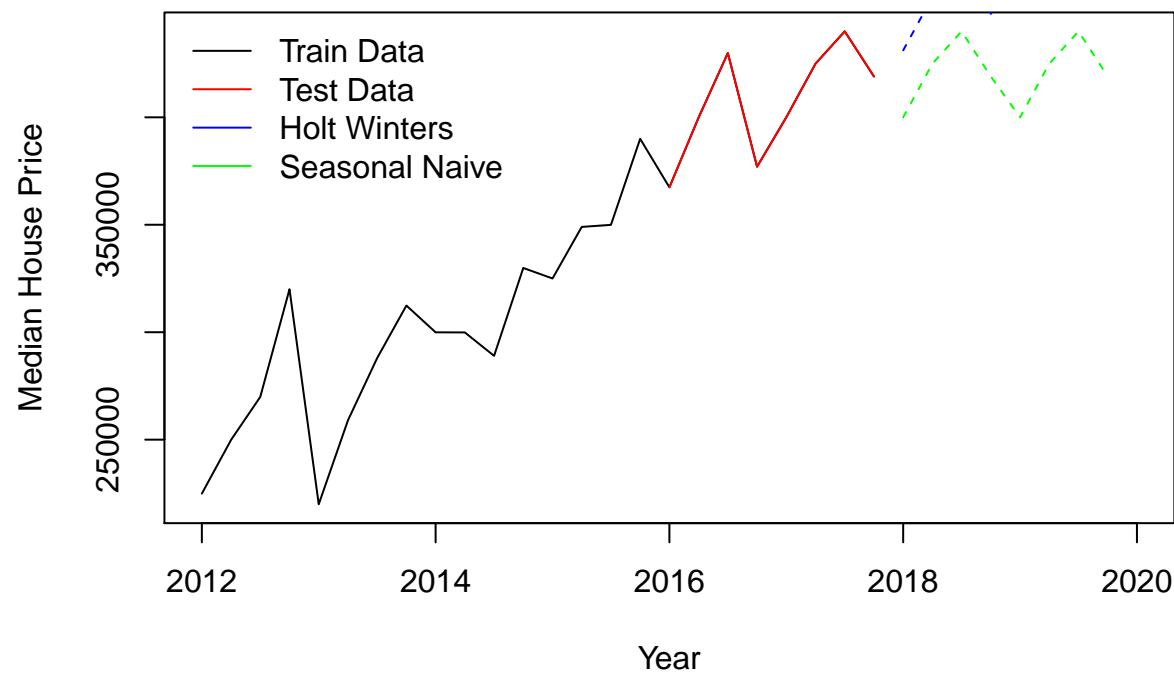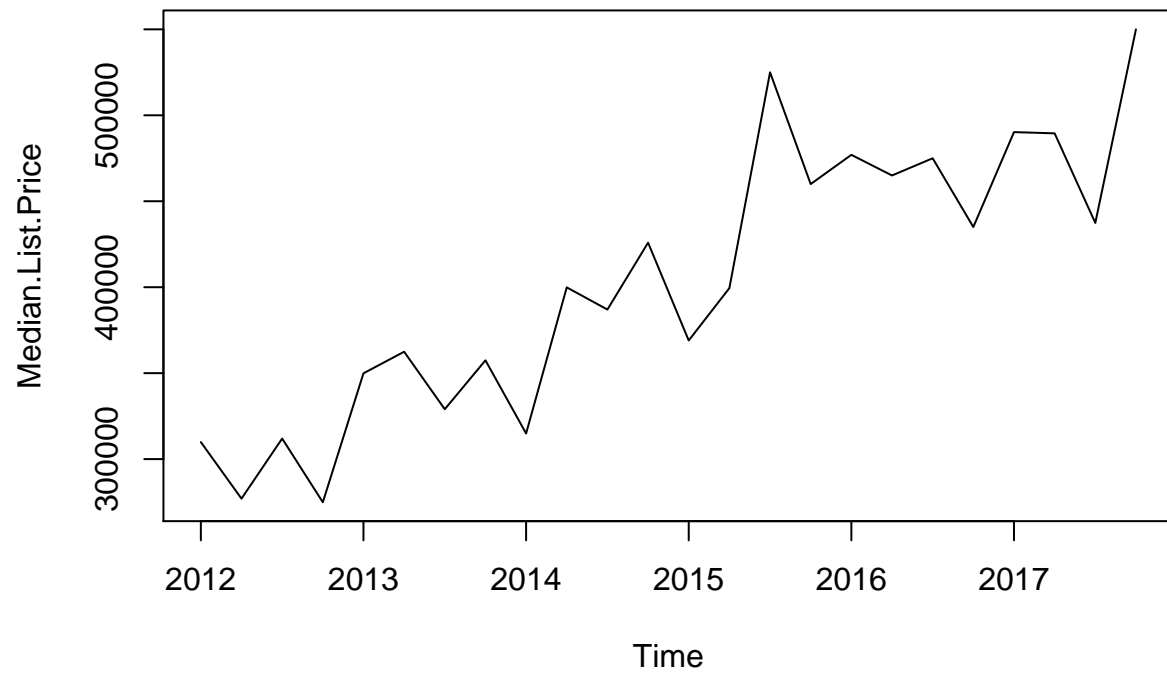
Portland, OR – Hayhurst

Portland, OR – Hayhurst : Naive Model Forecast
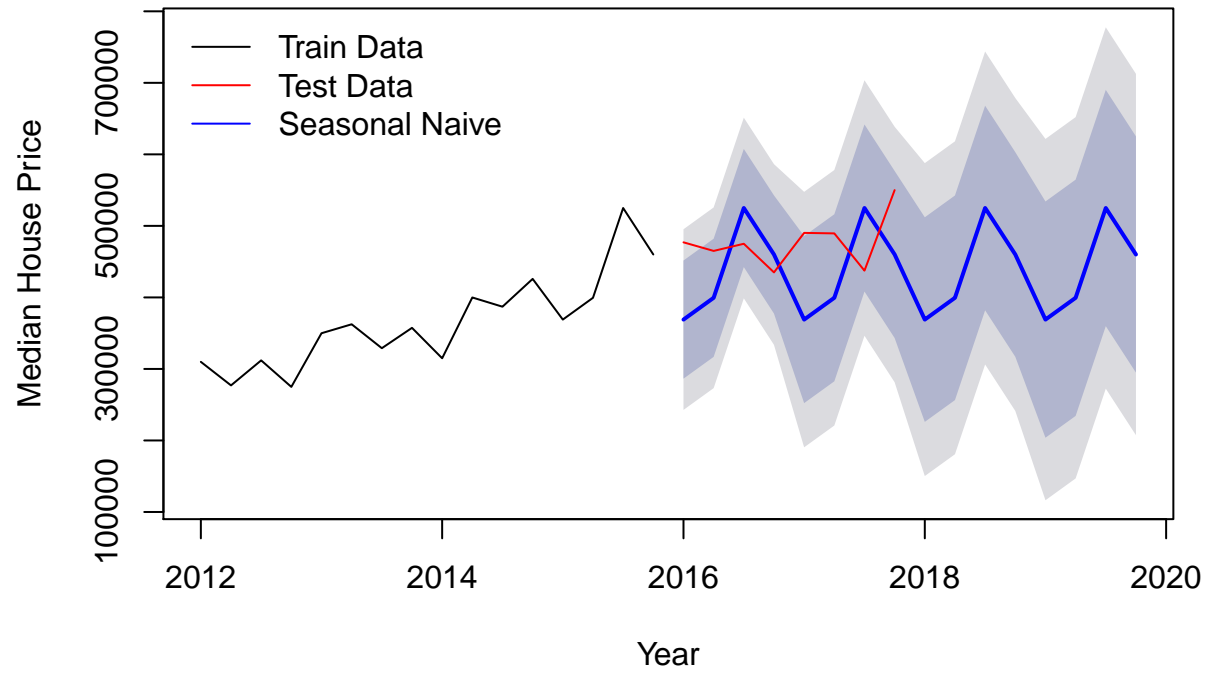
Portland, OR – Hayhurst : Naive Model Forecast Residuals
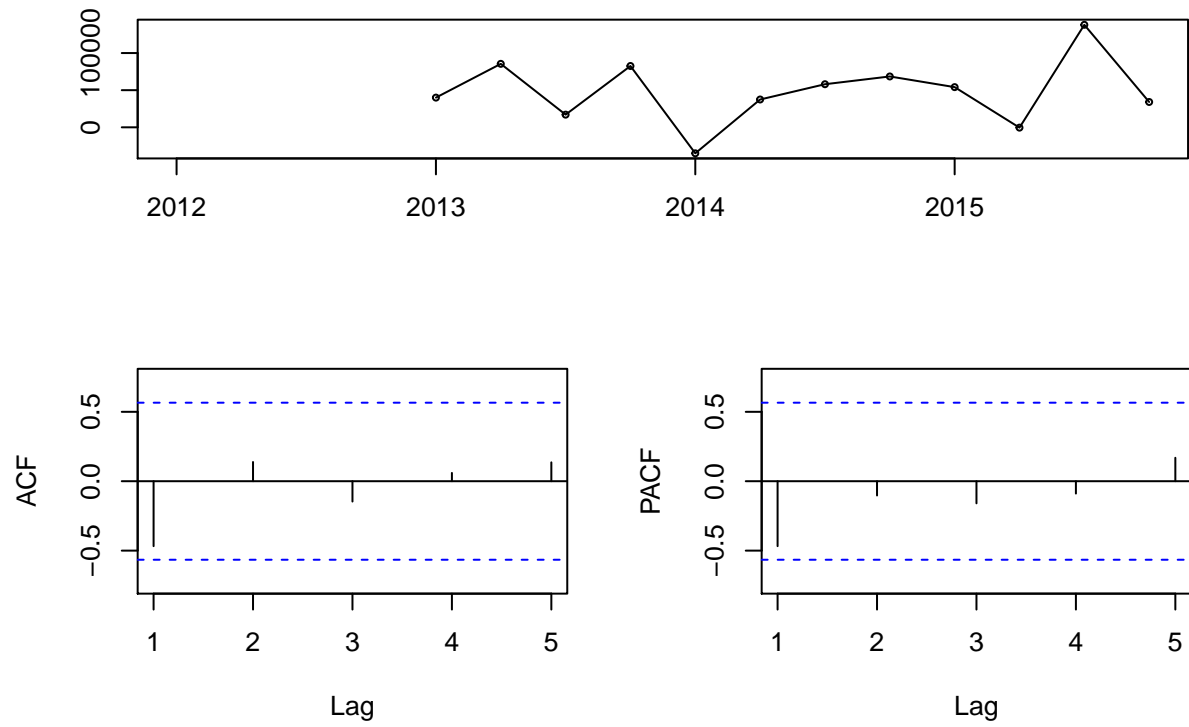
Portland, OR – Hayhurst : Holt Winters Model Forecast
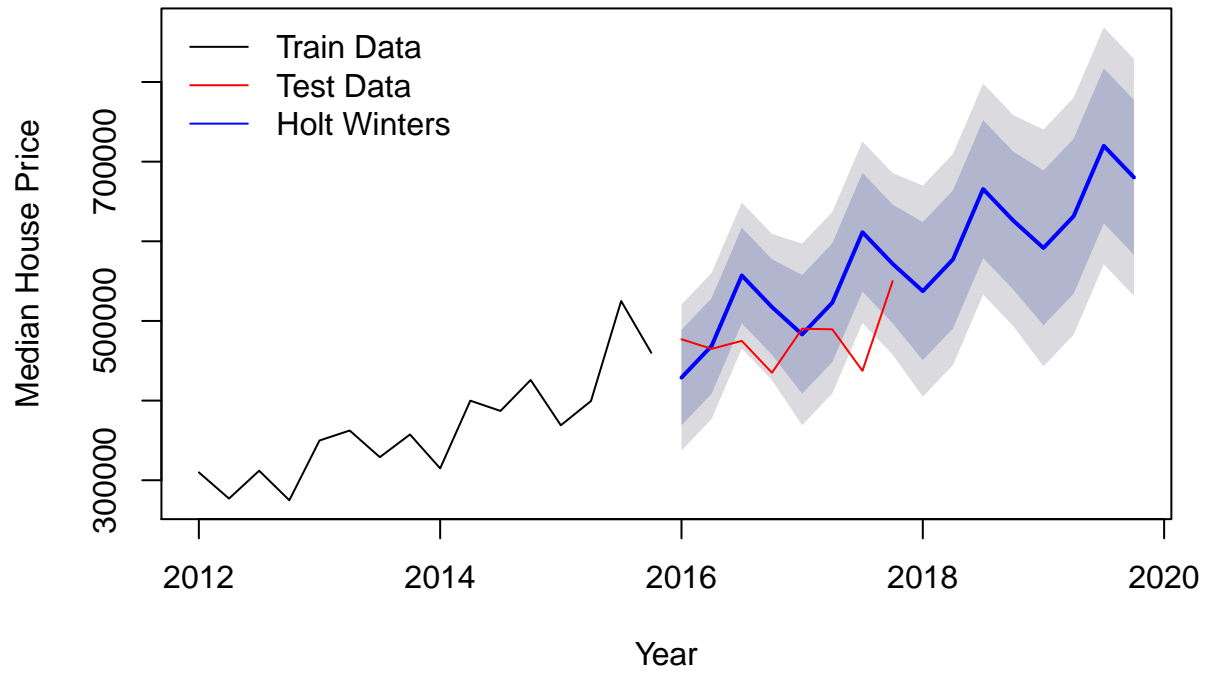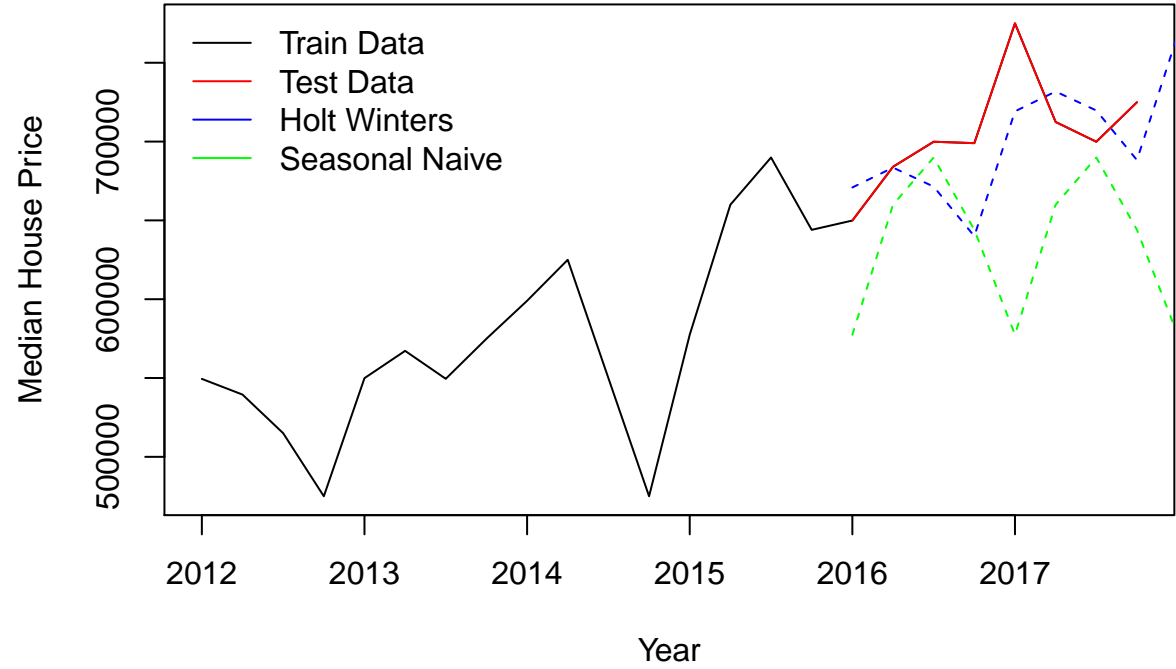
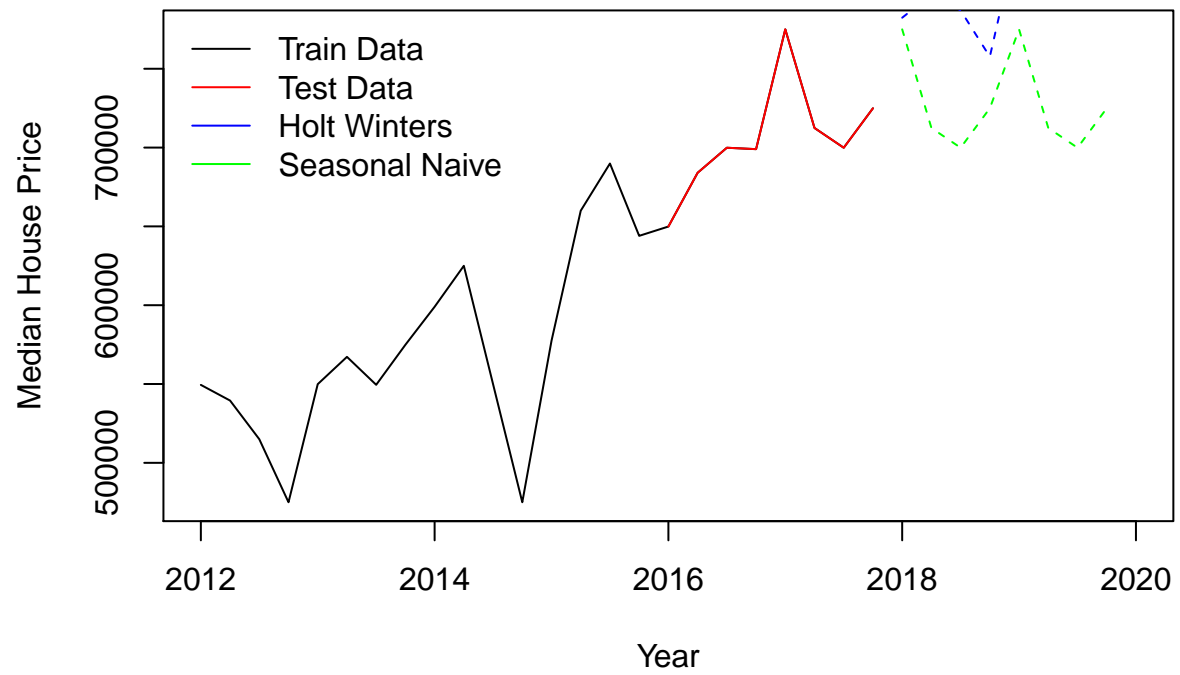## Portland, OR – Hayhurst : Holt Winters Model Forecast Residuals
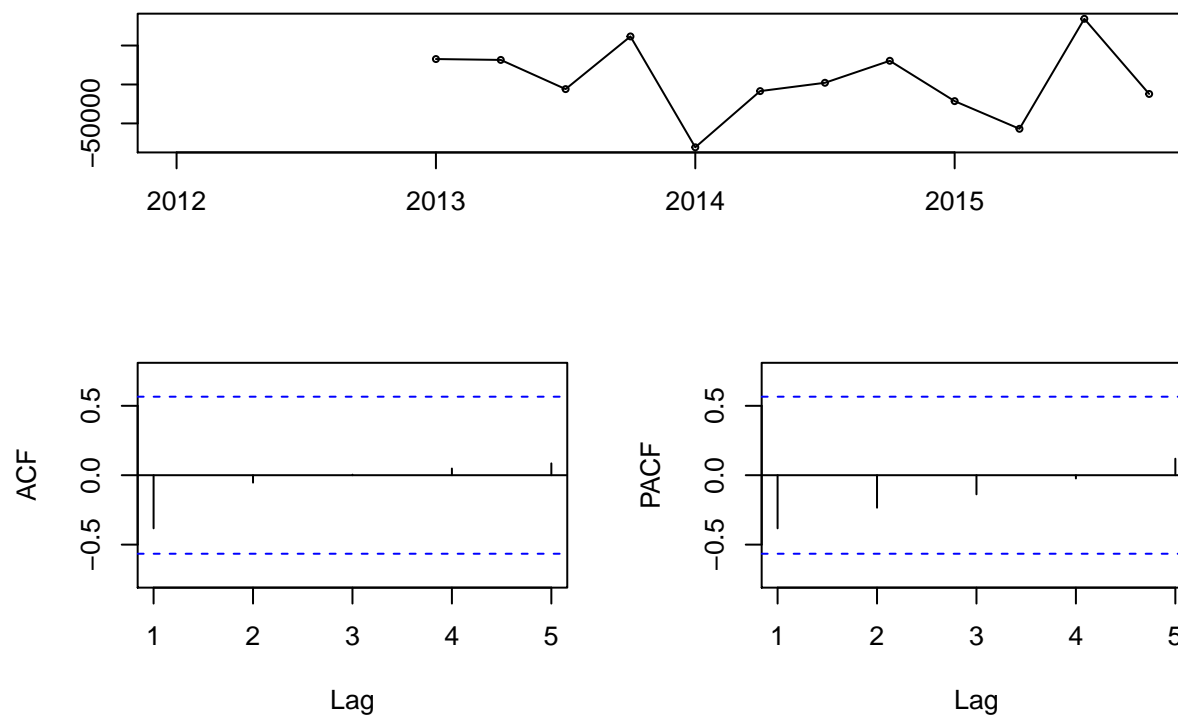

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Hayhurst"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 48310.42 64431.88 54214.58  11.737230  13.60740 1.000000
## Test set     39021.88 84894.26 79671.88   7.489415  16.56463 1.469565
##                    ACF1 Theil's U
## Training set -0.4680673        NA
## Test set     -0.1938468  1.465804
## [1] "Holt Winters Accuracy for  Portland, OR - Hayhurst"
##                   ME     RMSE      MAE        MPE      MAPE       MASE
## Training set  4766.39 45059.93 35695.49  0.5679515  9.273862 0.6584113
## Test set    -42767.63 77270.65 56571.91 -9.5059432 12.389894 1.0434814
##                     ACF1 Theil's U
## Training set -0.38275242        NA
## Test set     -0.05802772    1.3834
```

Portland, OR – Hayhurst : TS Training Model Comparison

Portland, OR – Hayhurst : Full TS Models Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

X-axis: Year
Y-axis: Median House Price

Portland, OR – Lents

Portland, OR – Lents : Naive Model Forecast

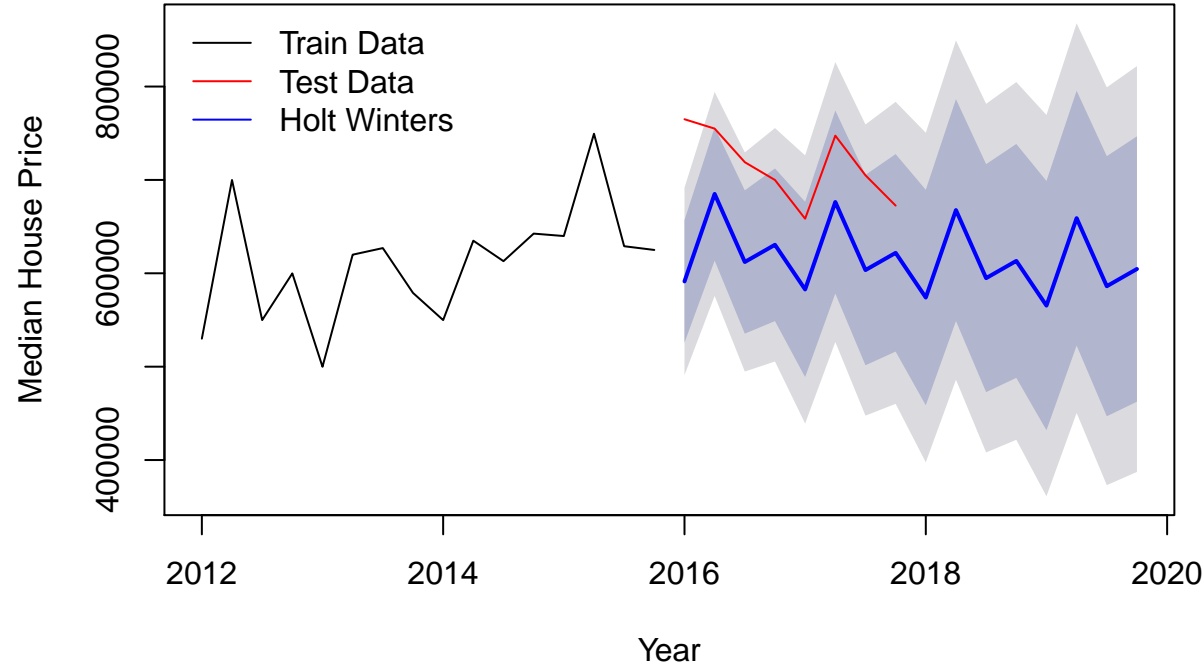**Portland, OR – Lents : Naive Model Forecast Residuals**
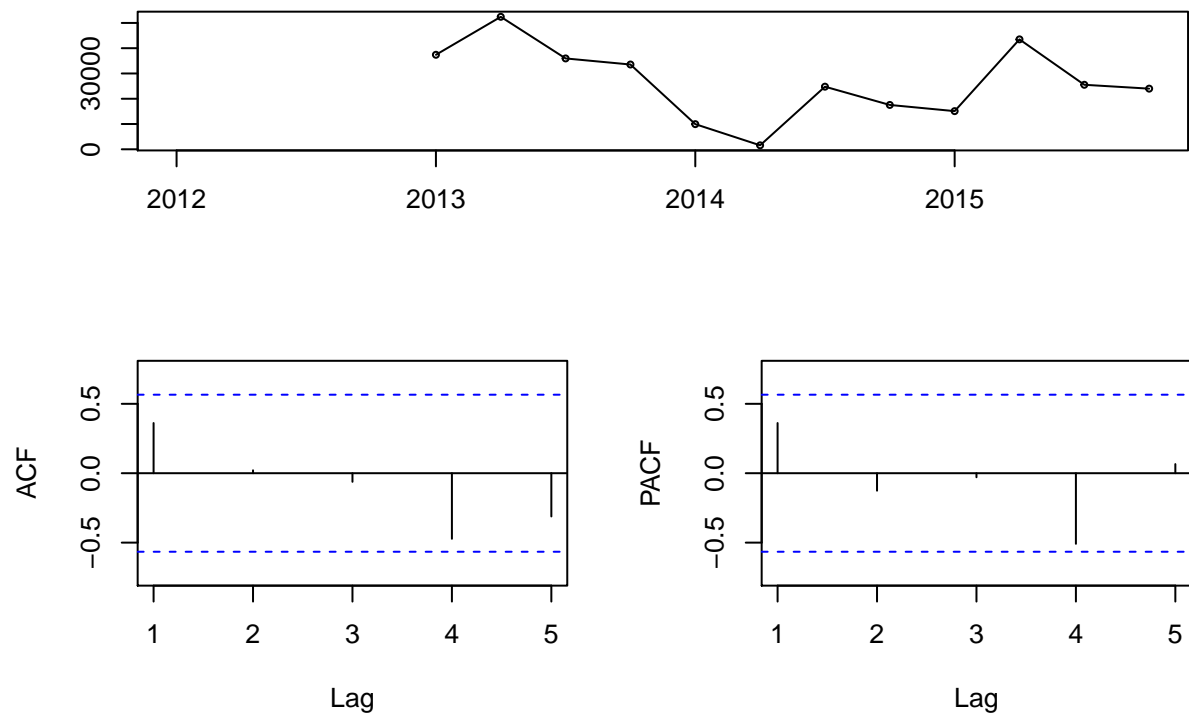
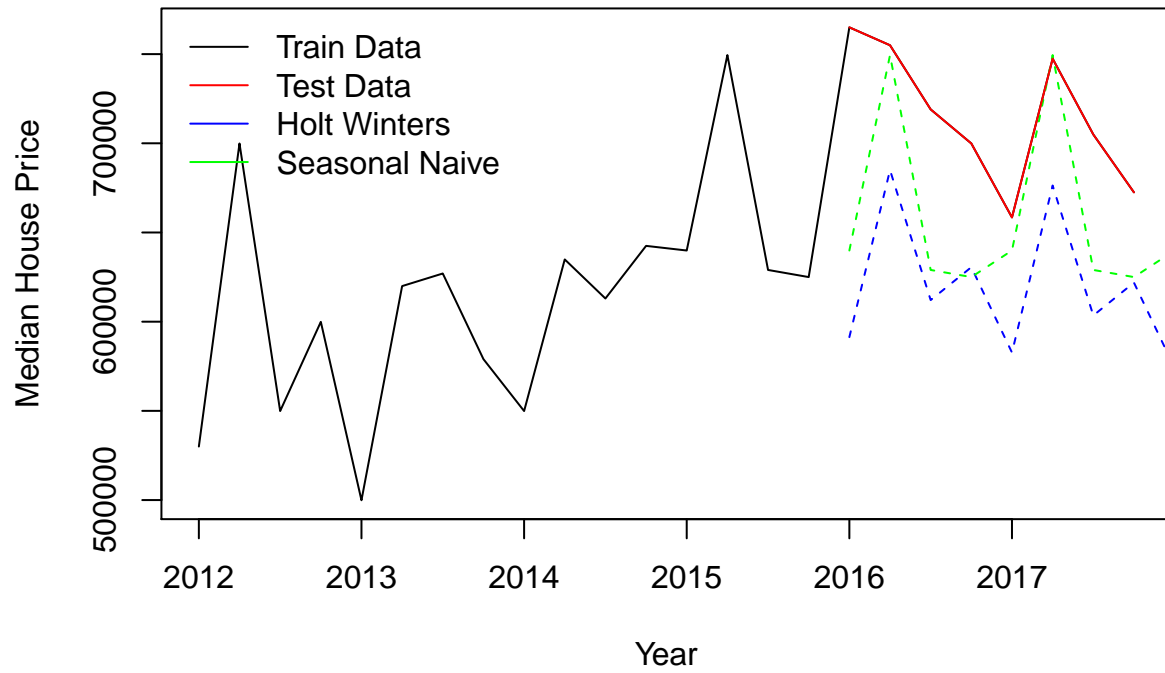**Portland, OR – Lents : Holt Winters Model Forecast**
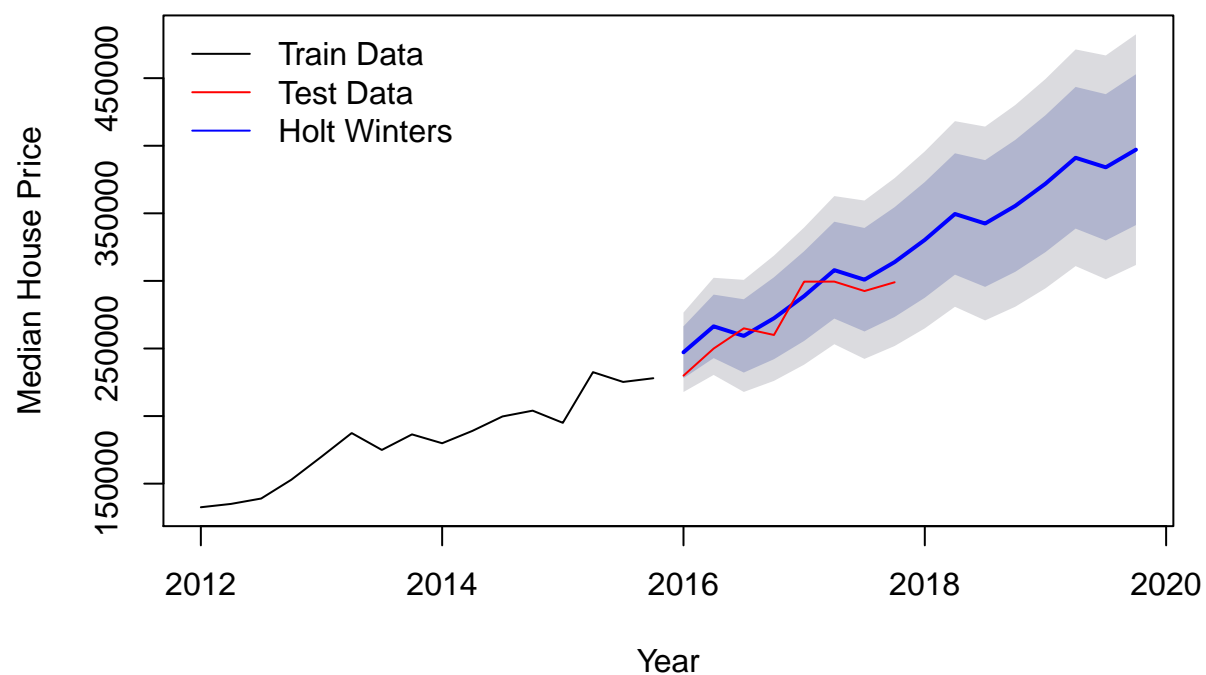
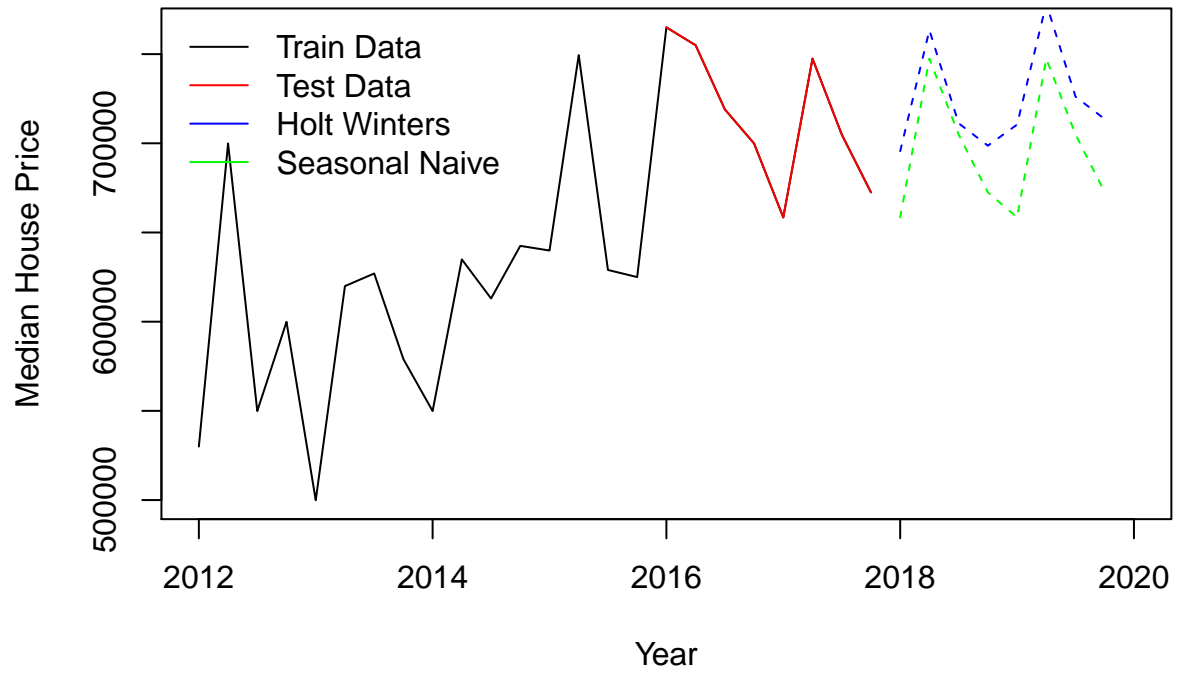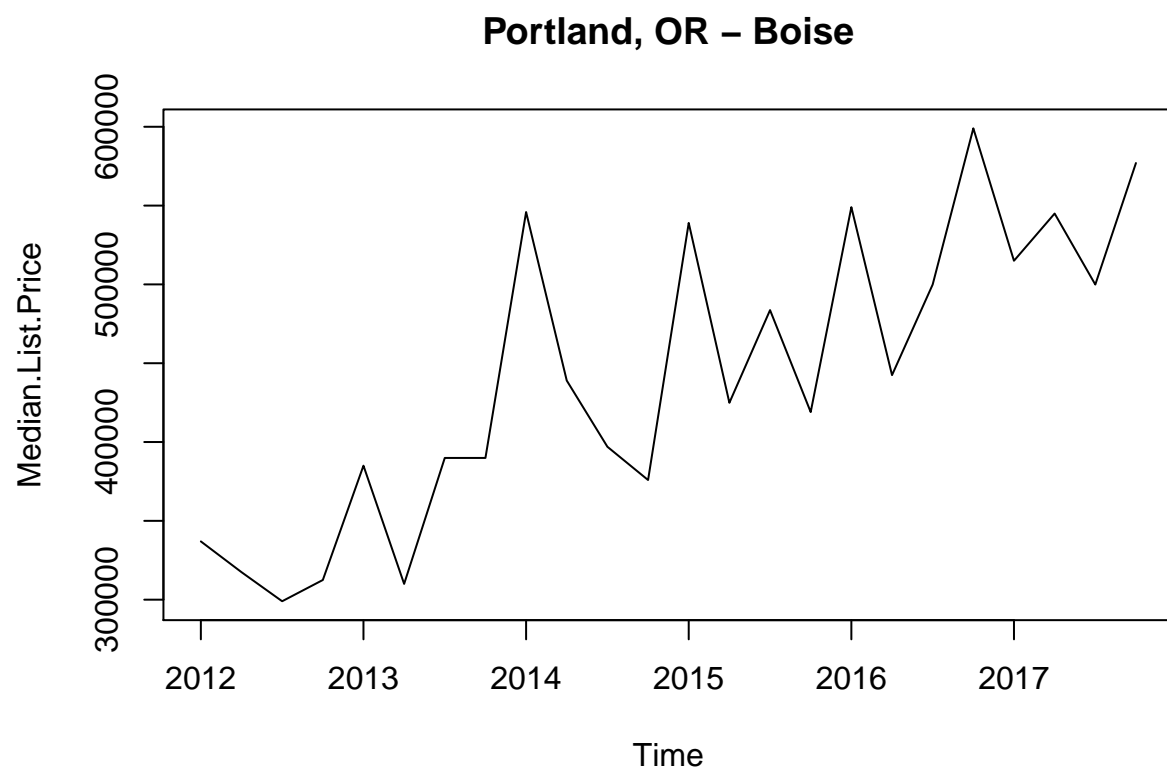## Portland, OR – Lents : Holt Winters Model Forecast Residuals
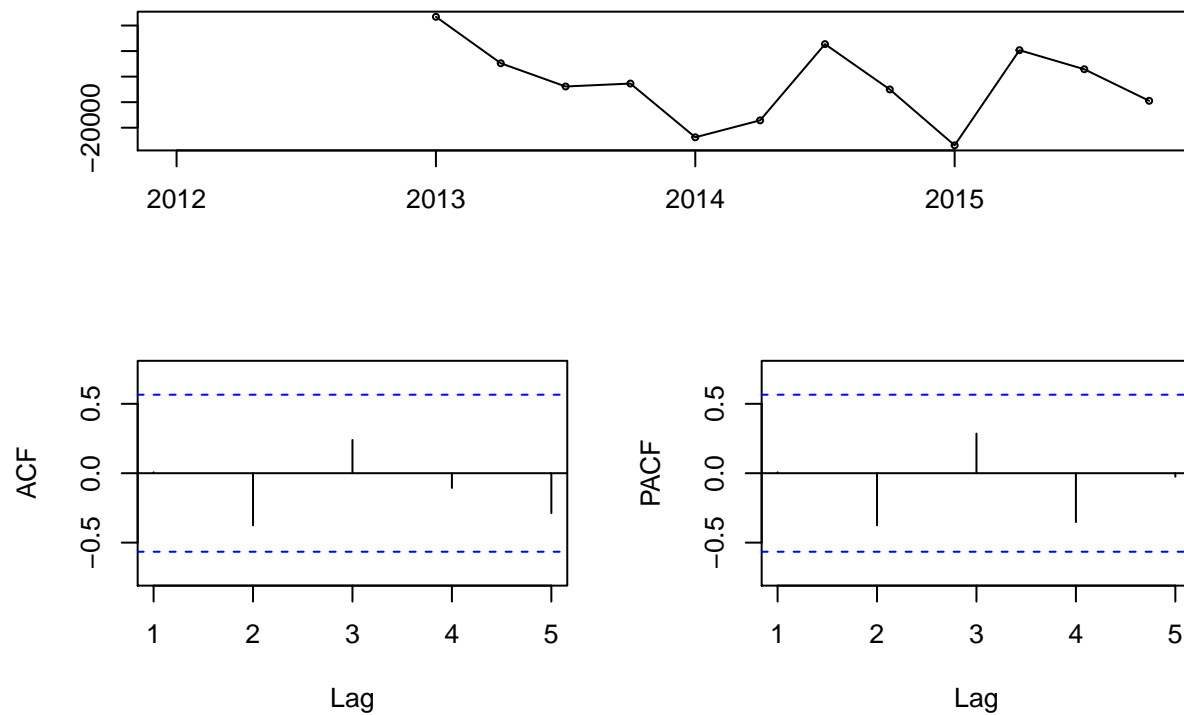

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Lents"
##                   ME     RMSE      MAE      MPE     MAPE     MASE      ACF1
## Training set 26775.0 30188.6 26775.0 13.68363 13.68363 1.000000 0.3616515
## Test set    54212.5 60292.0 54212.5 19.17825 19.17825 2.024743 0.2659157
##             Theil's U
## Training set       NA
## Test set     3.208269
## [1] "Holt Winters Accuracy for  Portland, OR - Lents"
##                    ME     RMSE      MAE       MPE     MAPE      MASE
## Training set -2848.524 14633.37 11950.42 -1.469713 6.248727 0.4463275
## Test set     -7702.609 12413.62 11769.59 -2.983660 4.402677 0.4395737
##                    ACF1 Theil's U
## Training set  0.006321704        NA
## Test set     -0.248775278  0.619744
```

Portland, OR – Lents : TS Training Model Comparison

Portland, OR – Lents : Full TS Models Comparison
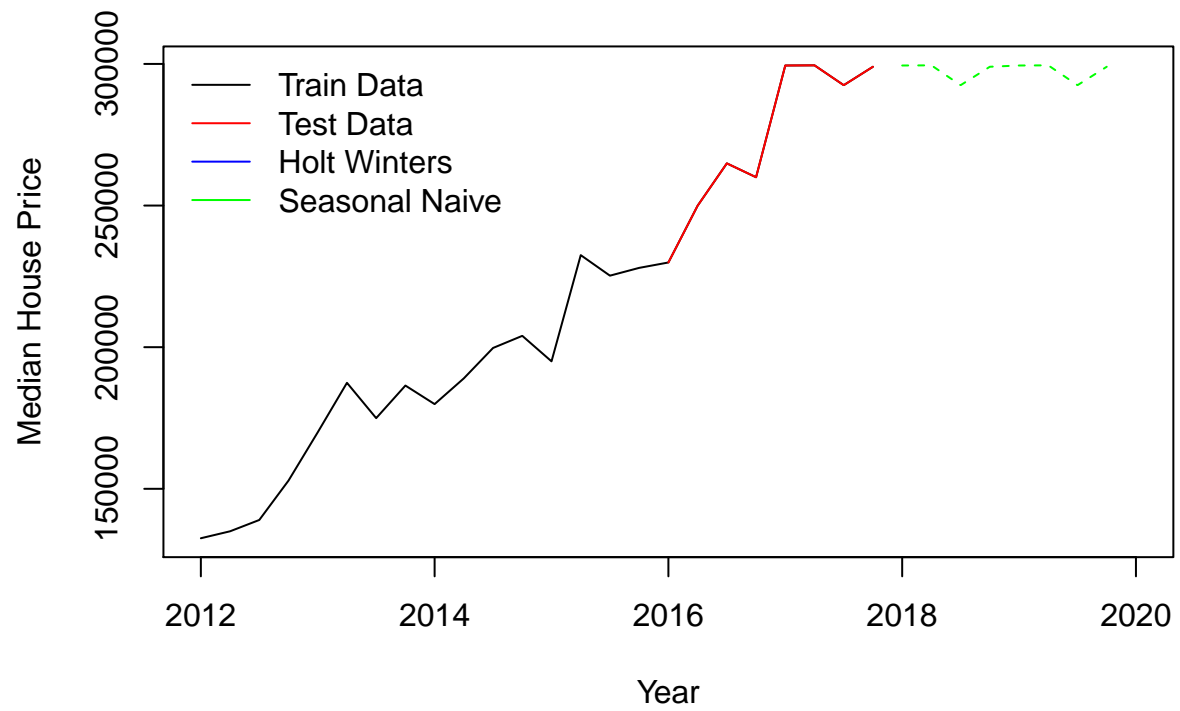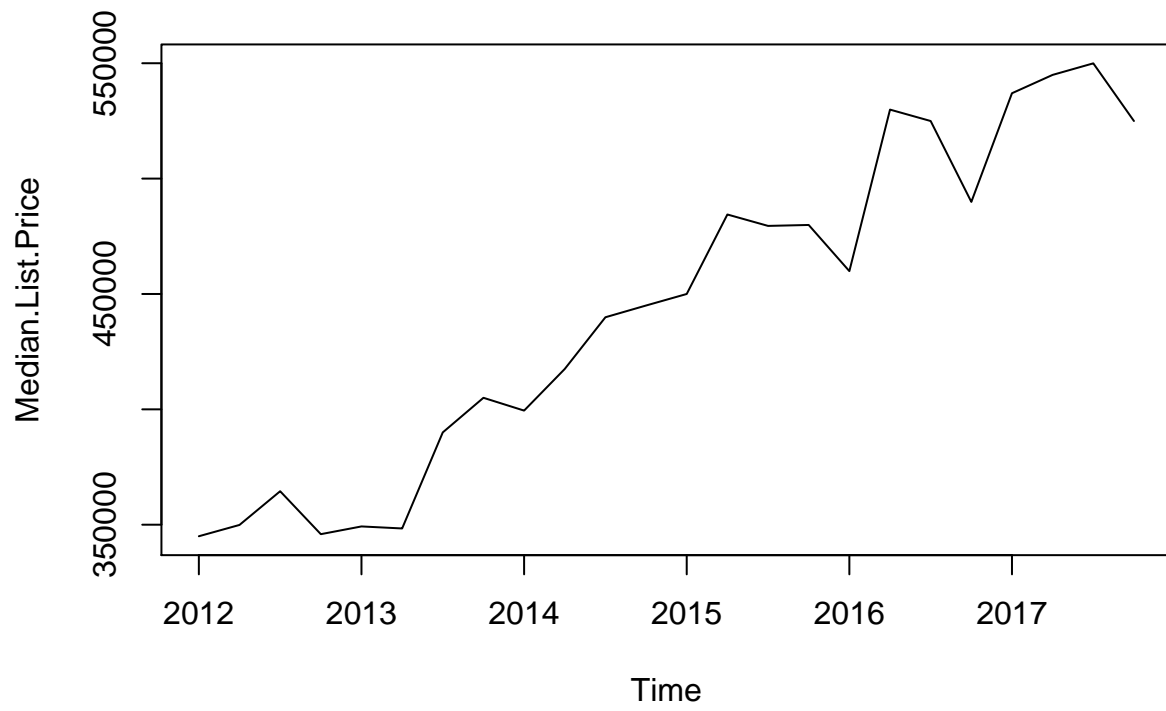
# Portland, OR – Richmond

Portland, OR – Richmond : Naive Model Forecast
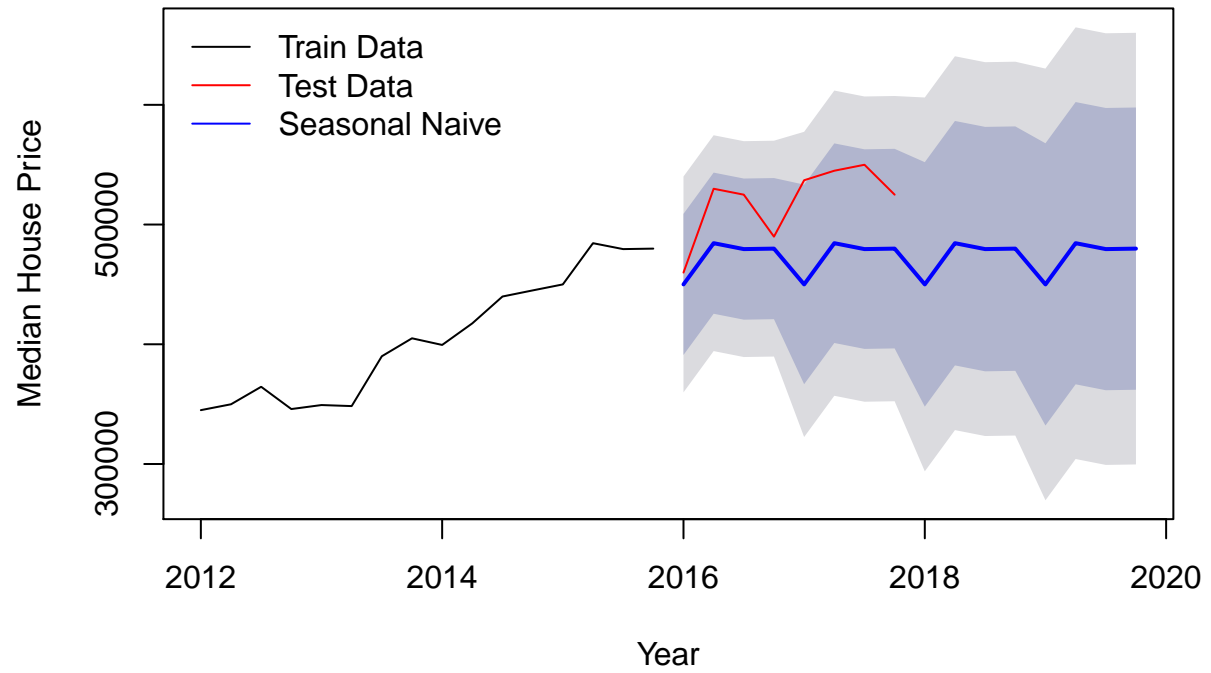
Portland, OR – Richmond : Naive Model Forecast Residuals
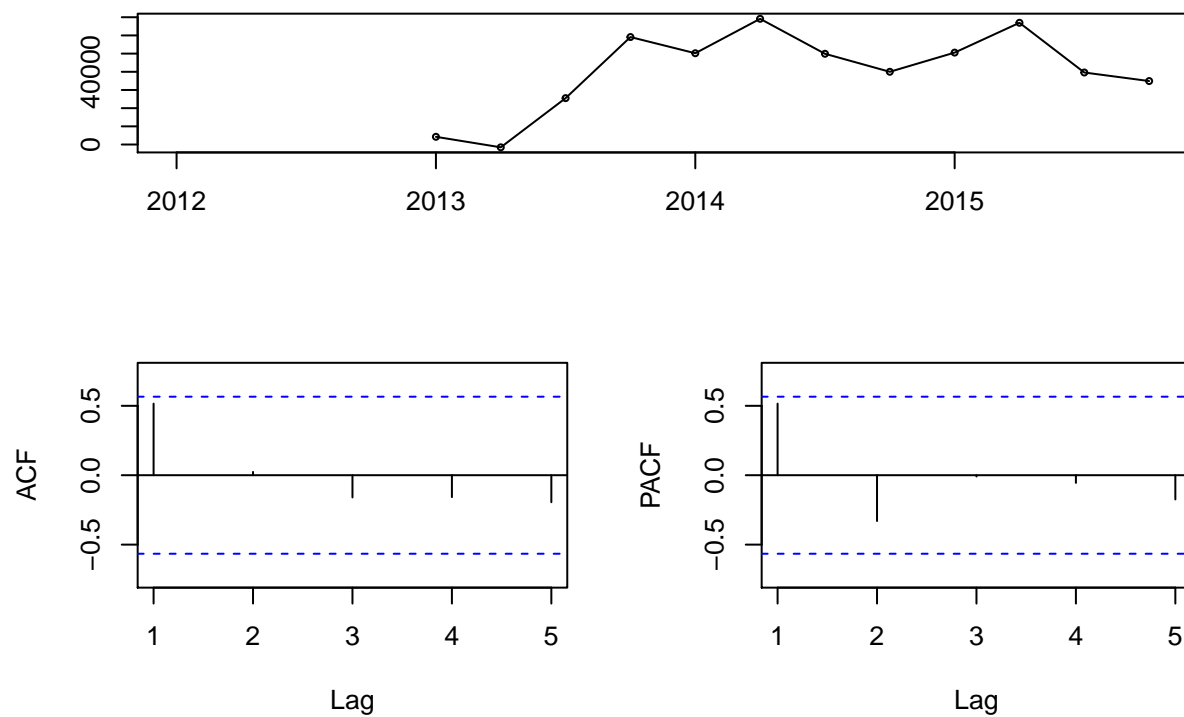
Portland, OR – Richmond : Holt Winters Model Forecast
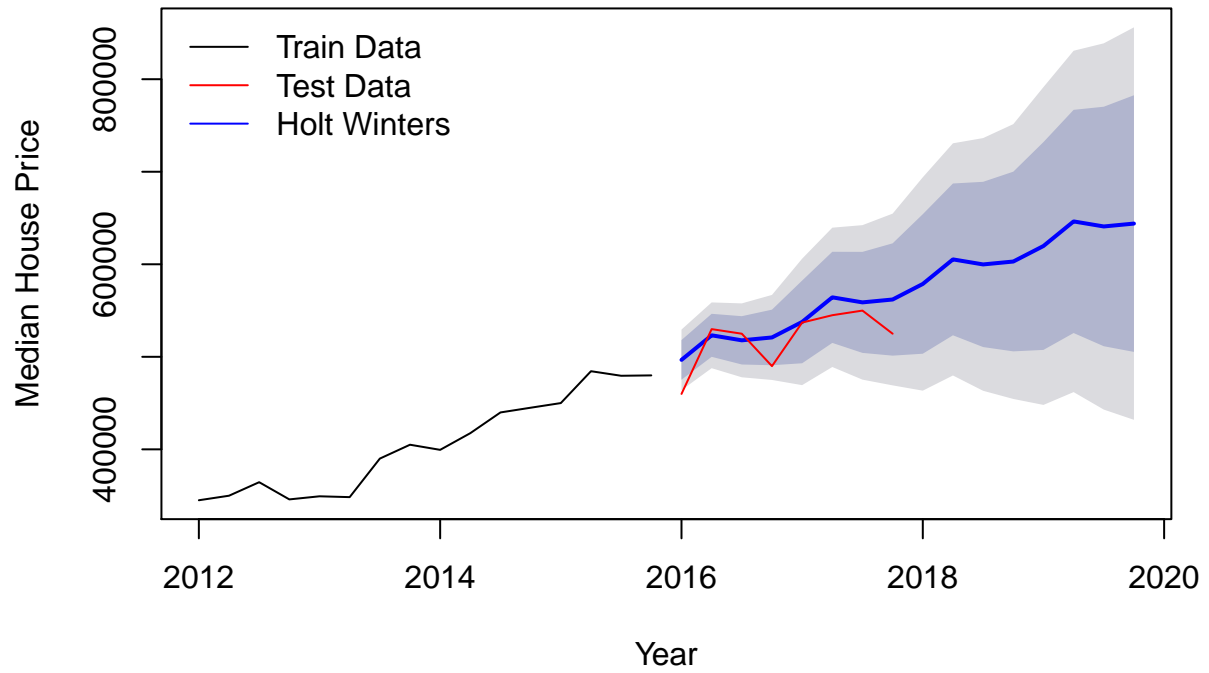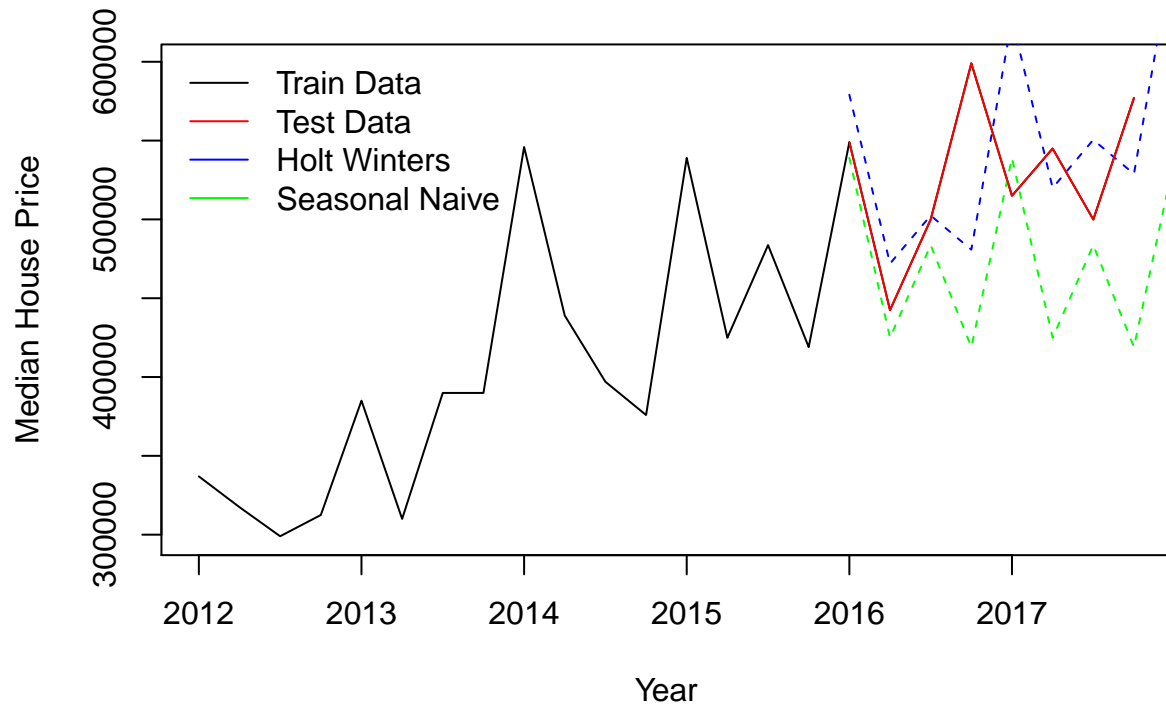
Portland, OR – Richmond : Holt Winters Model Forecast Residuals
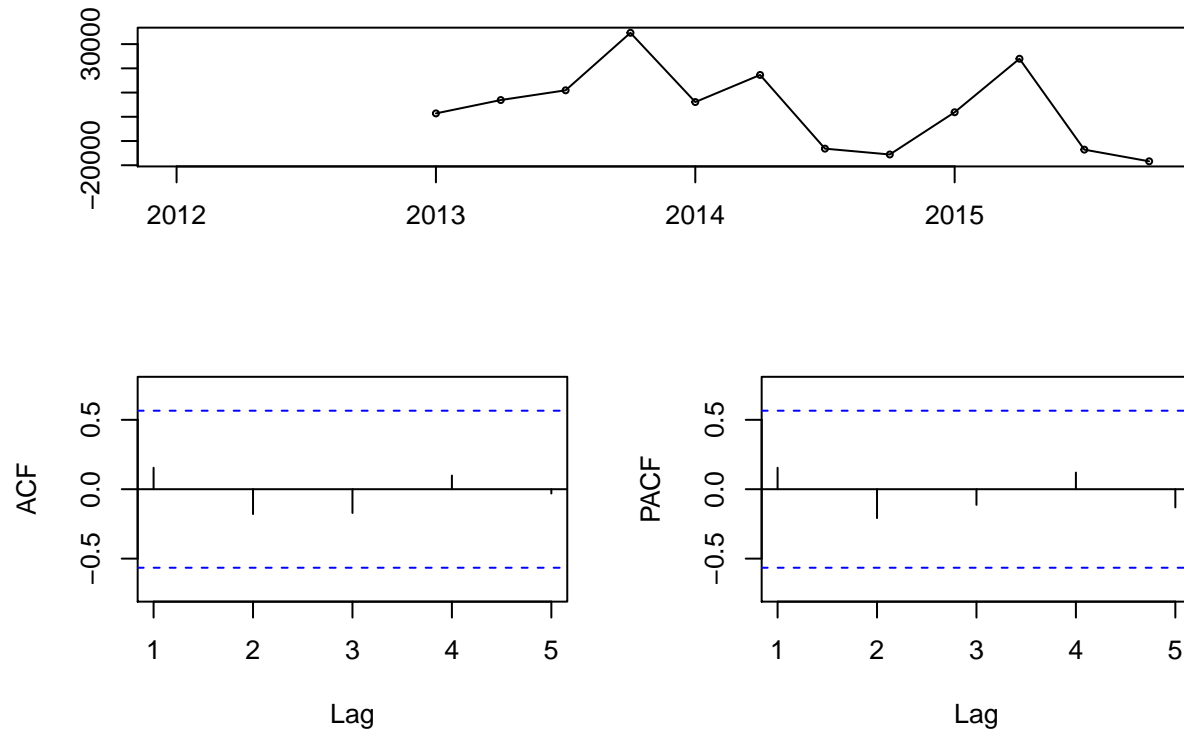

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Richmond"
##                   ME      RMSE      MAE       MPE     MAPE     MASE
## Training set 40712.5 45985.54 40967.25 9.329211 9.402337 1.000000
## Test set     46725.0 53093.51 46725.00 8.765501 8.765501 1.140545
##                   ACF1 Theil's U
## Training set  0.5158709        NA
## Test set     -0.1065441  1.471393
## [1] "Holt Winters Accuracy for  Portland, OR - Richmond"
##                     ME     RMSE      MAE        MPE     MAPE      MASE
## Training set   3537.817 16382.08 13645.64  0.9689242 3.159473 0.3330864
## Test set     -14981.338 22996.83 18435.58 -3.0052432 3.660294 0.4500078
##                   ACF1 Theil's U
## Training set  0.1547946        NA
## Test set     -0.3283517 0.5034104
```

Portland, OR – Richmond : TS Training Model Comparison

Portland, OR – Richmond : Full TS Models Comparison
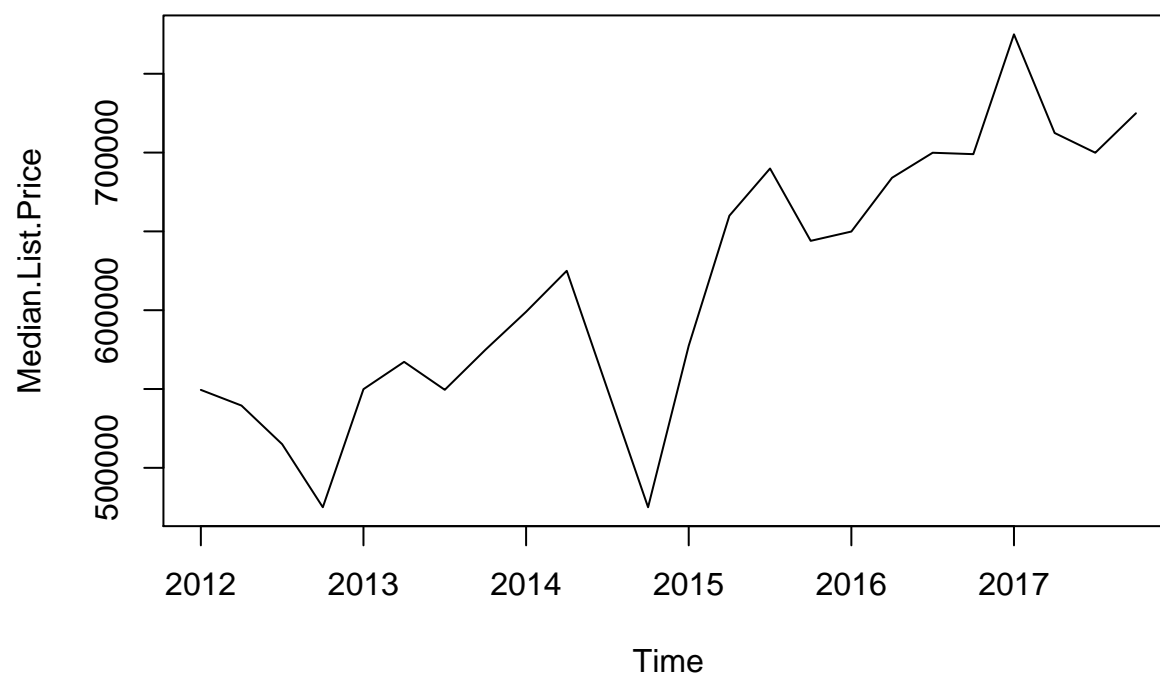
Portland, OR – Alameda

Portland, OR – Alameda : Naive Model Forecast
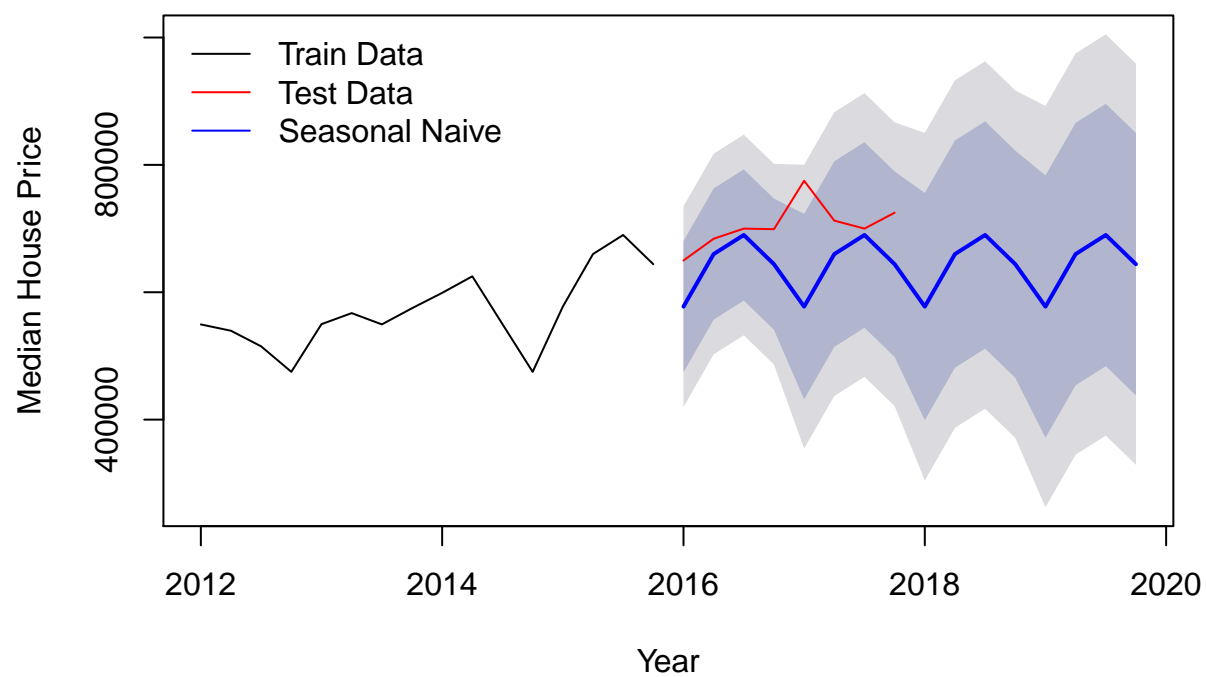
Portland, OR – Alameda : Naive Model Forecast Residuals
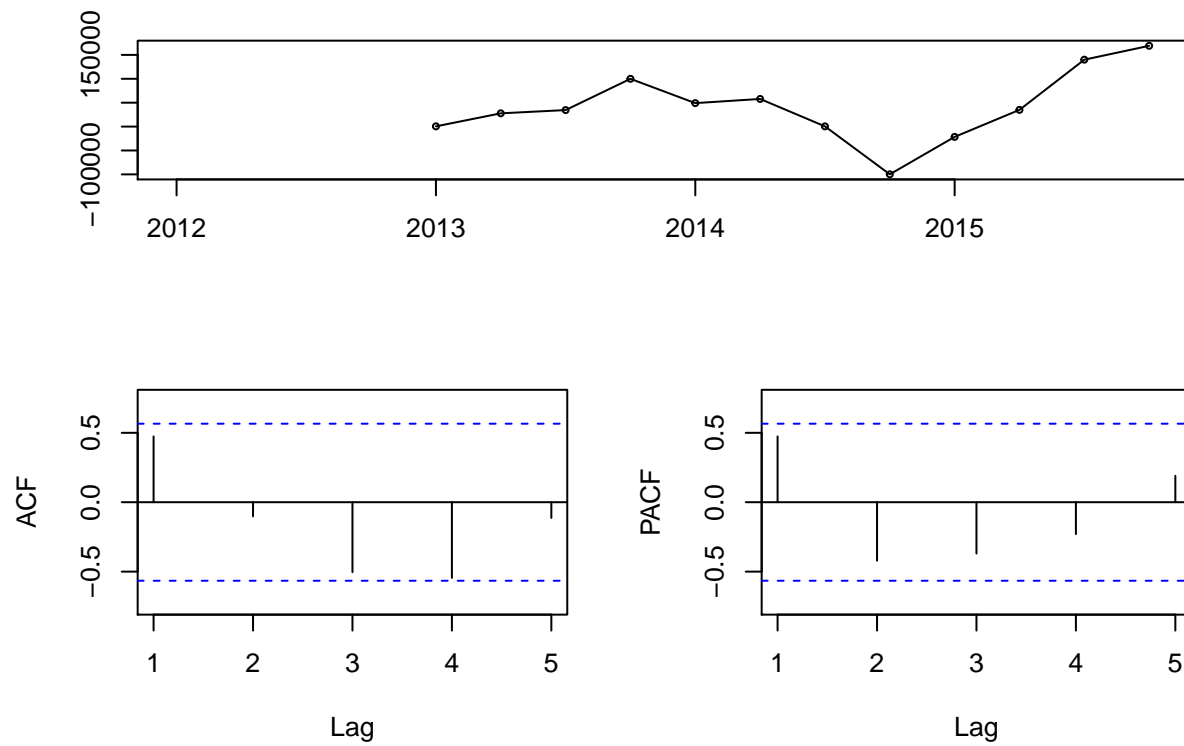
Portland, OR – Alameda : Holt Winters Model Forecast
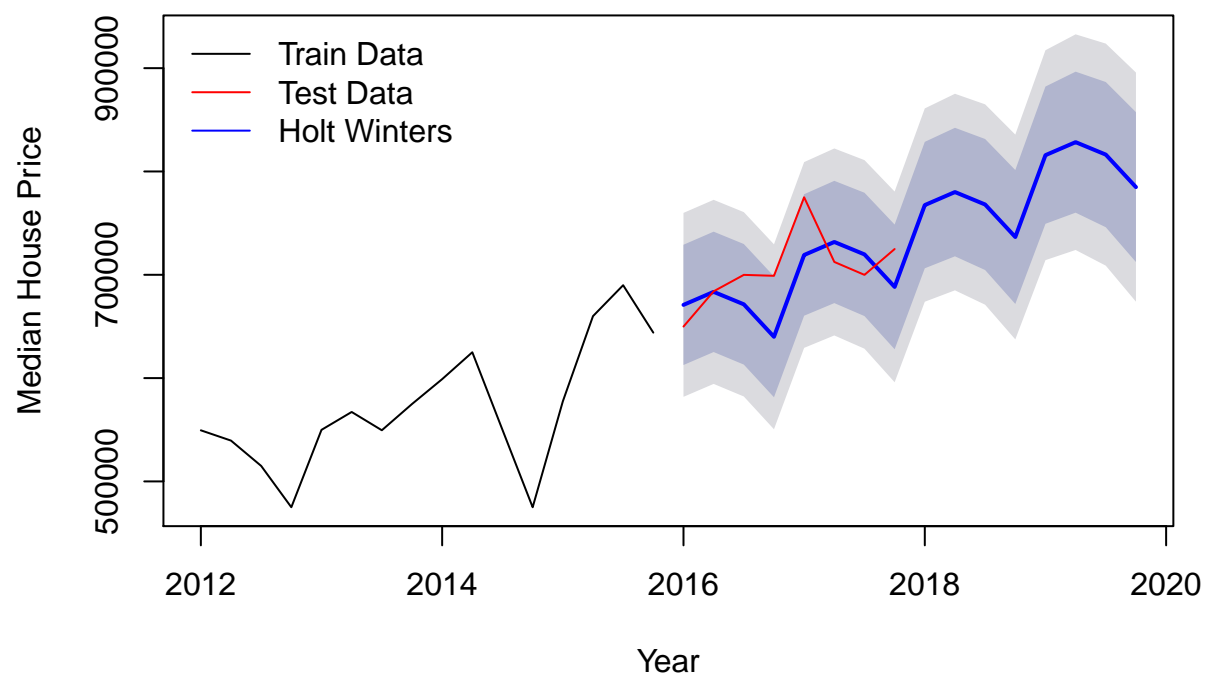
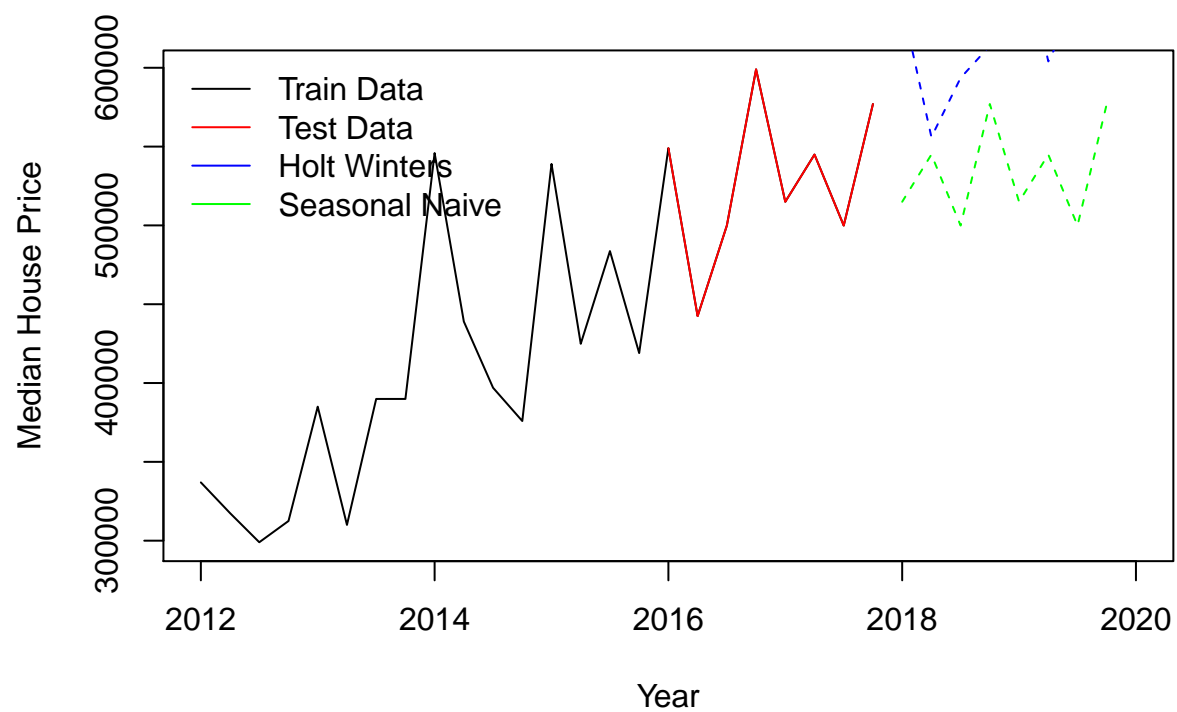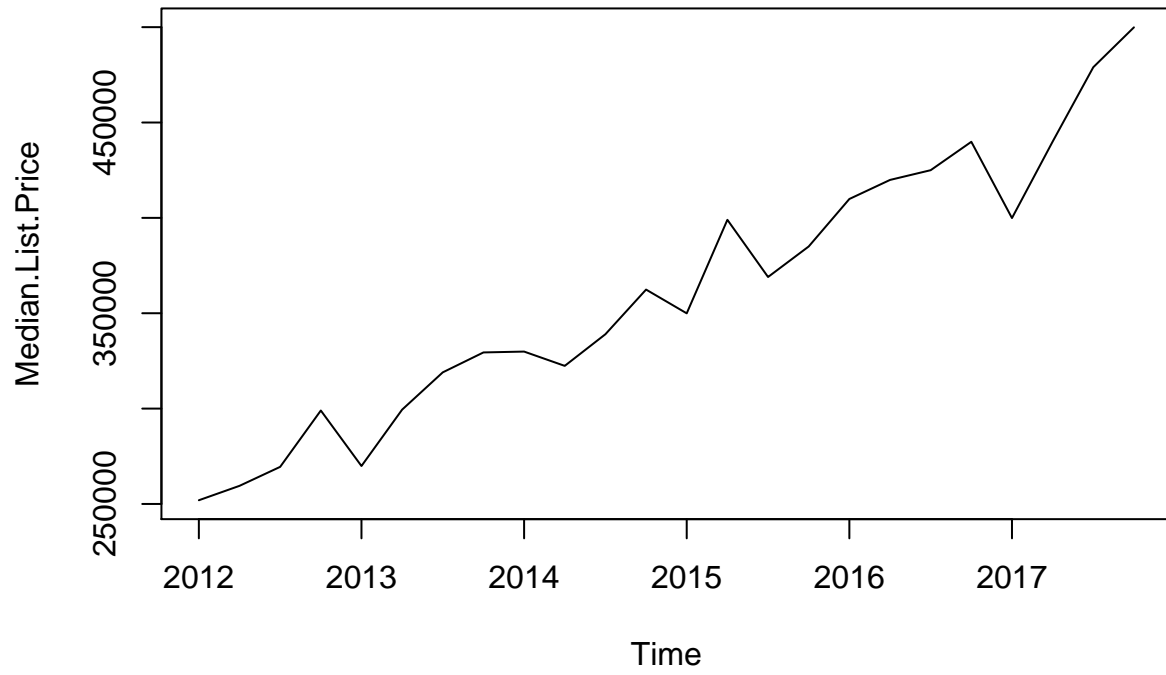**Portland, OR – Alameda : Holt Winters Model Forecast Residuals**
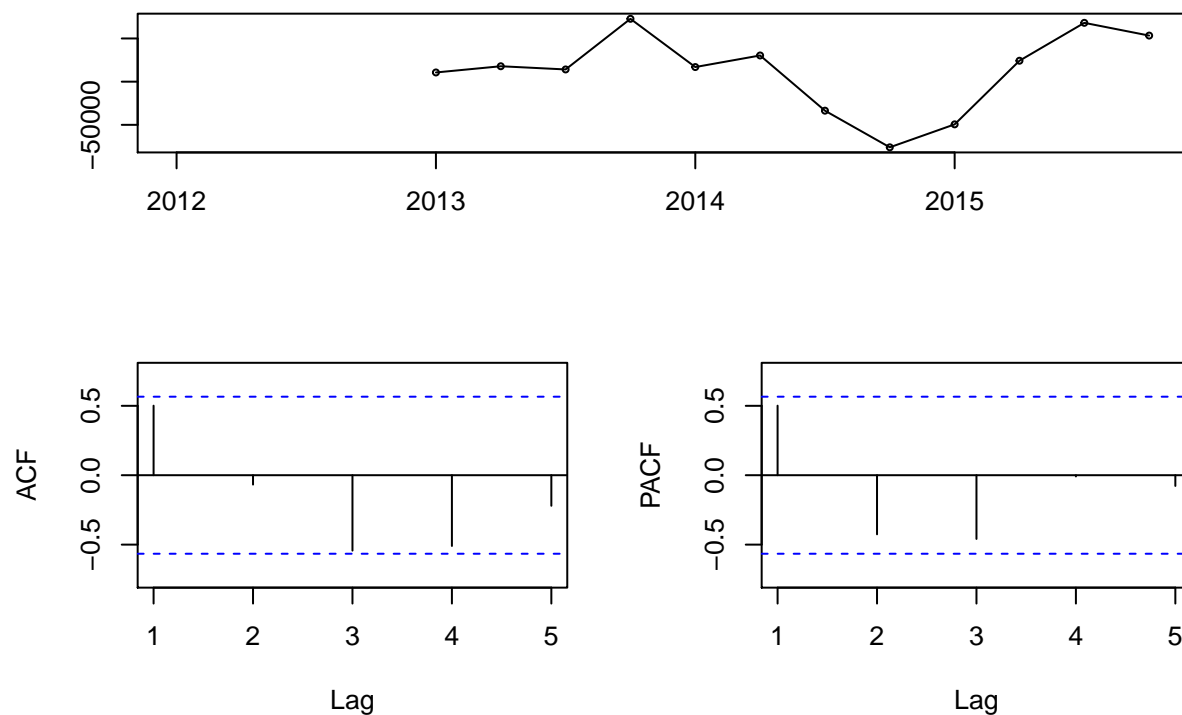

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Alameda"
##                    ME     RMSE      MAE      MPE     MAPE     MASE
## Training set 41029.17 80371.52 61270.83 6.100513 10.22776 1.00000
## Test set     62806.25 84691.27 62806.25 8.676140  8.67614 1.02506
##                   ACF1 Theil's U
## Training set  0.47390460        NA
## Test set     -0.02982154  2.134239
## [1] "Holt Winters Accuracy for  Portland, OR - Alameda"
##                    ME     RMSE      MAE      MPE     MAPE      MASE
## Training set 12429.71 45223.36 38933.54 1.593605 6.705096 0.6354335
## Test set     15044.70 35288.22 30080.79 2.009162 4.202977 0.4909479
##                  ACF1 Theil's U
## Training set 0.5012734        NA
## Test set     0.2153512 0.9131303
```

Portland, OR – Alameda : TS Training Model Comparison

Portland, OR – Alameda : Full TS Models Comparison
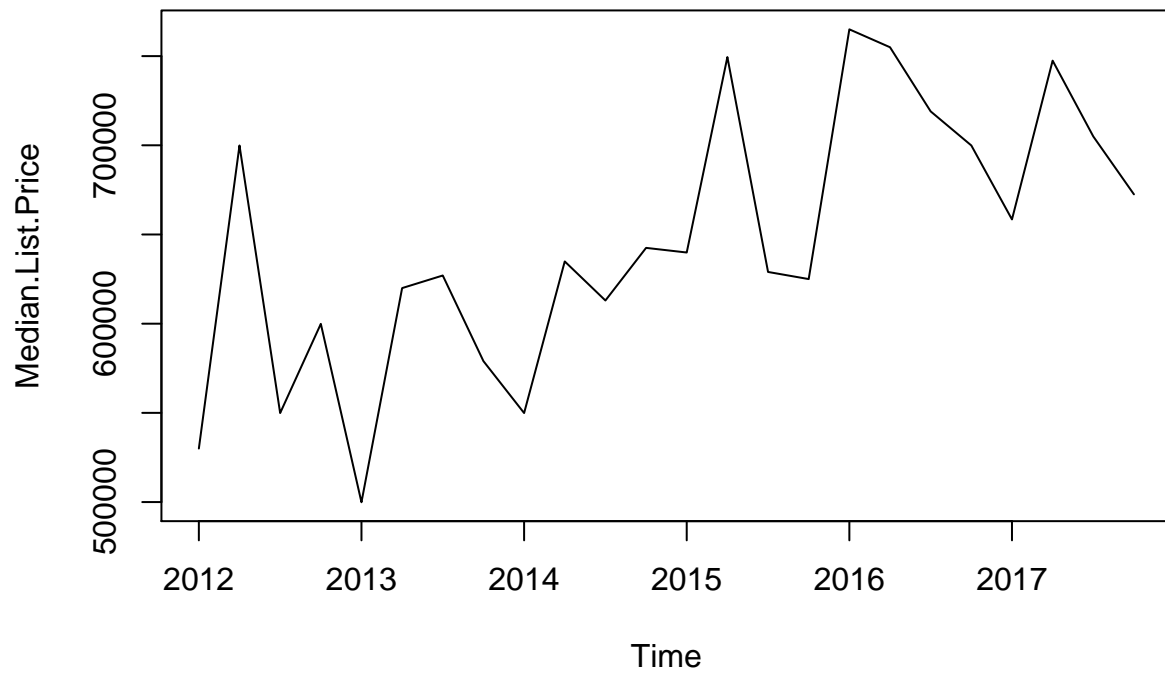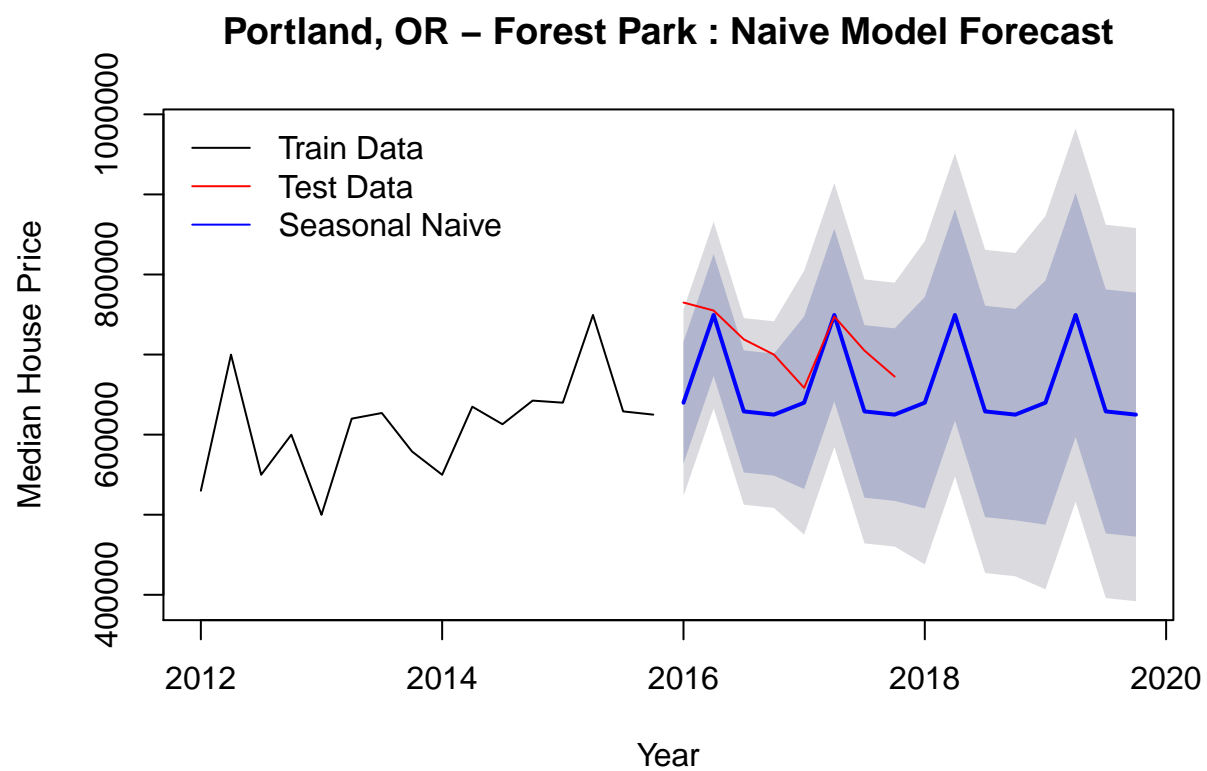
# Portland, OR – Forest Park

Portland, OR – Forest Park : Naive Model Forecast
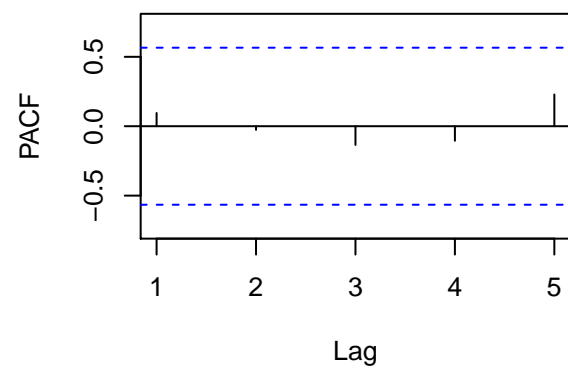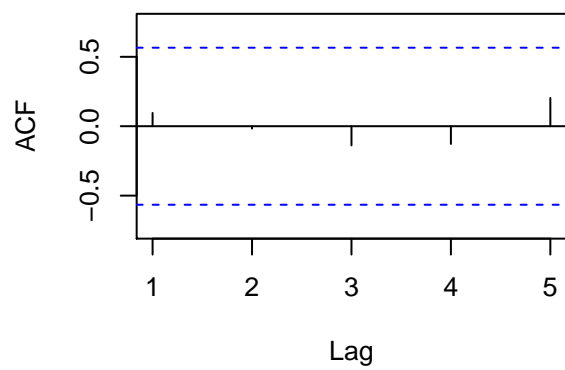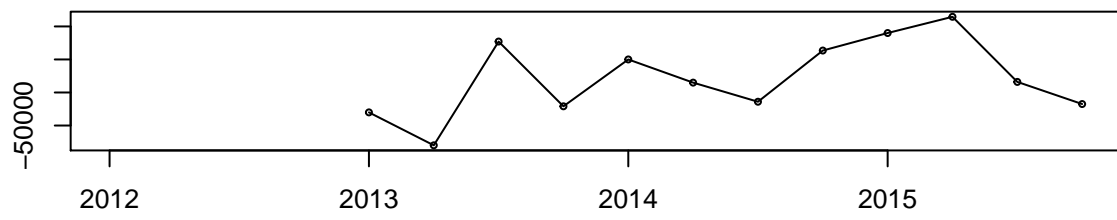
Portland, OR – Forest Park : Naive Model Forecast Residuals
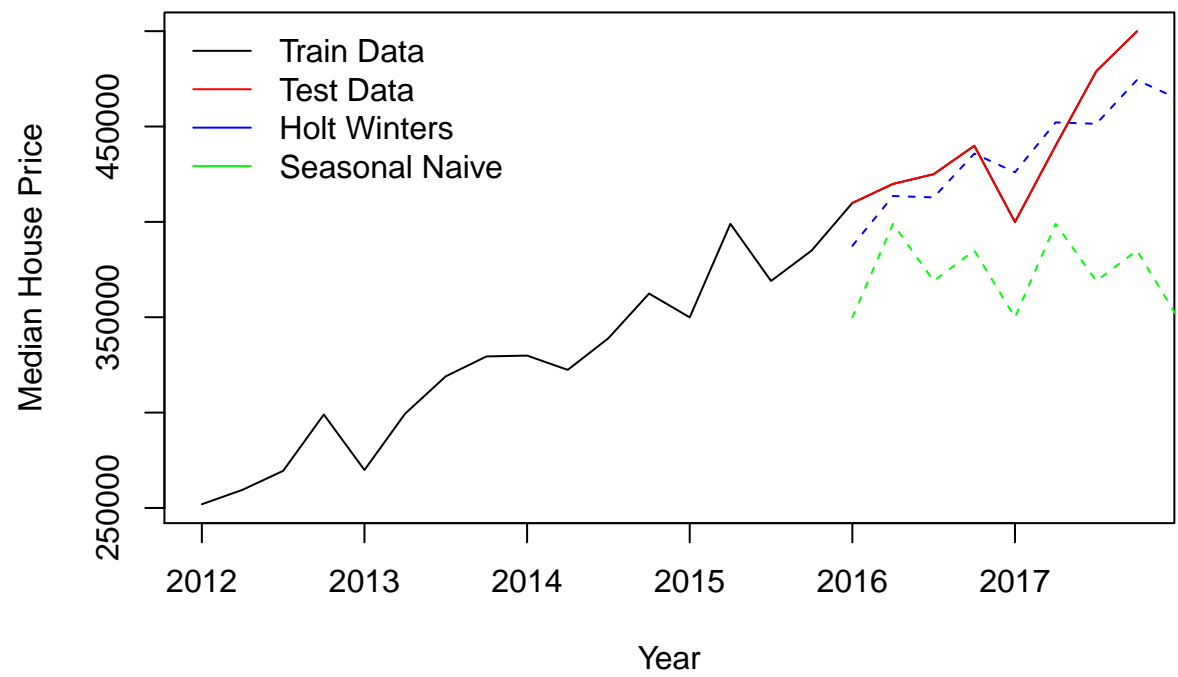
Portland, OR – Forest Park : Holt Winters Model Forecast

Portland, OR – Forest Park : Holt Winters Model Forecast Residuals
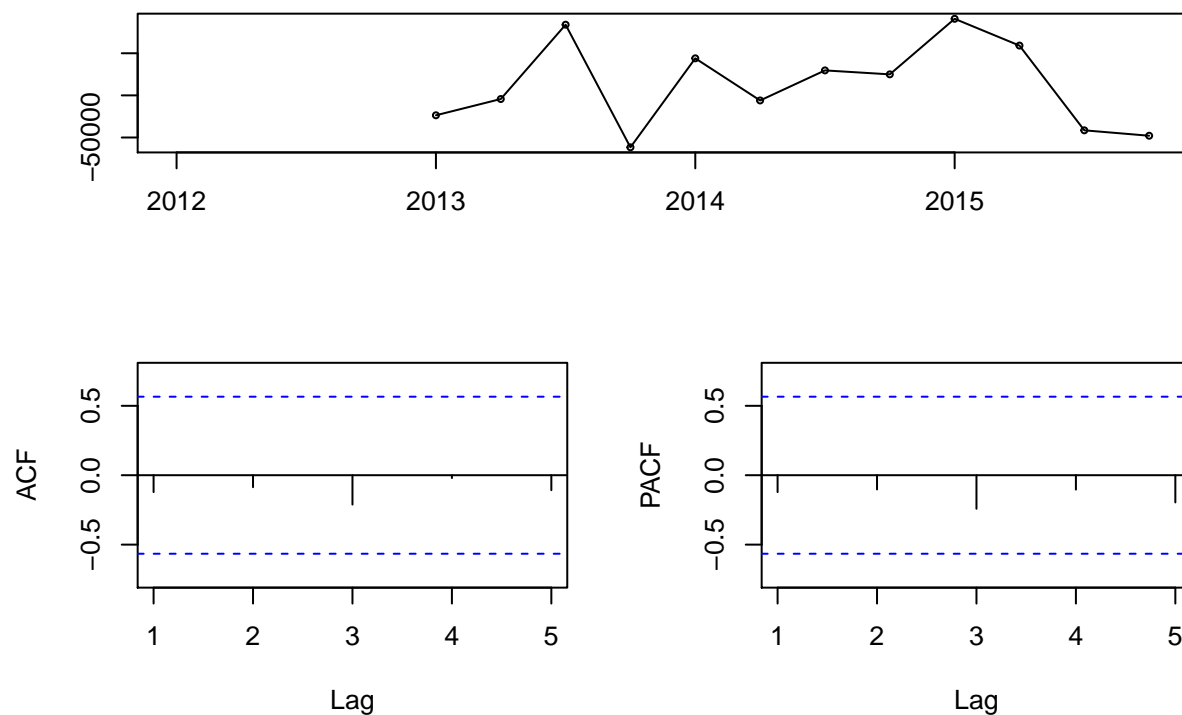

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Forest Park"
##                     ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 21970.83 59451.96 49045.83 3.159106 7.760933 1.000000
## Test set     54436.56 68703.88 54936.56 7.585763 7.652657 1.120107
##                   ACF1 Theil's U
## Training set  0.09533179        NA
## Test set     -0.32321601  1.159326
## [1] "Holt Winters Accuracy for  Portland, OR - Forest Park"
##                     ME      RMSE      MAE      MPE      MAPE       MASE
## Training set 12278.67 50542.74 43123.10  1.740898  6.955671 0.8792409
## Test set     89850.06 96785.76 89850.06 12.460045 12.460045 1.8319611
##                   ACF1 Theil's U
## Training set -0.1217892        NA
## Test set     -0.2391897  1.672399
```

Portland, OR – Forest Park : TS Training Model Comparison

Portland, OR – Forest Park : Full TS Models Comparison

Portland, OR – Boise

Portland, OR – Boise : Naive Model Forecast
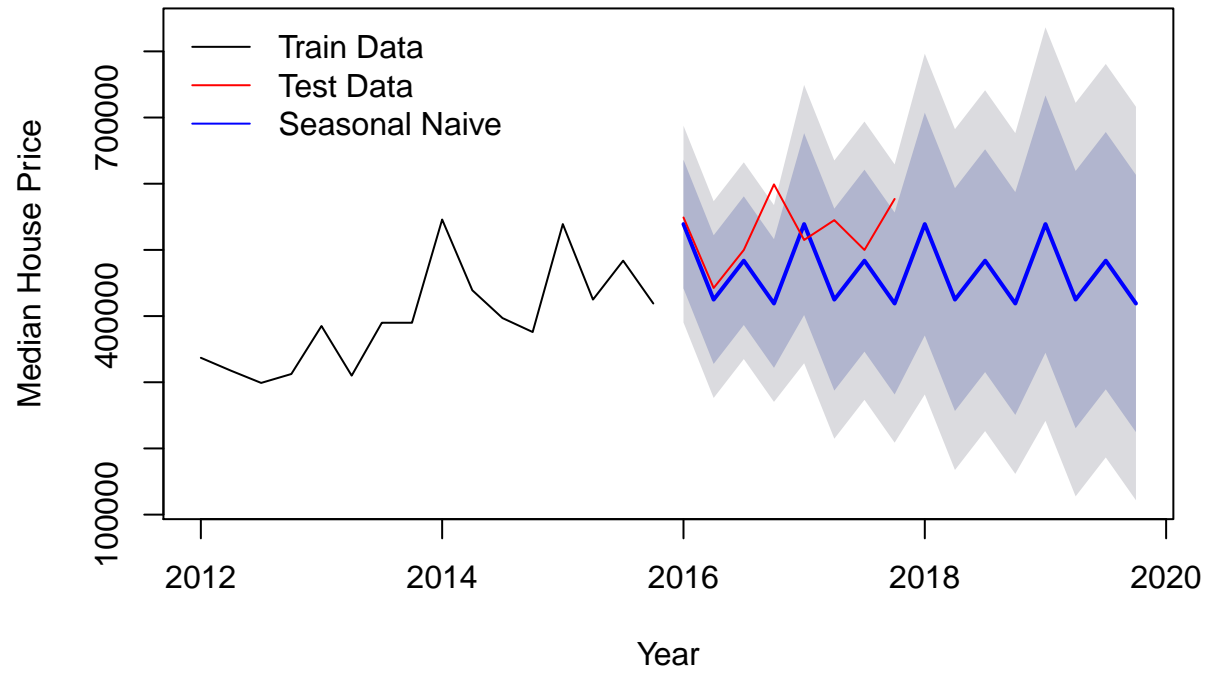
Portland, OR – Boise : Naive Model Forecast Residuals
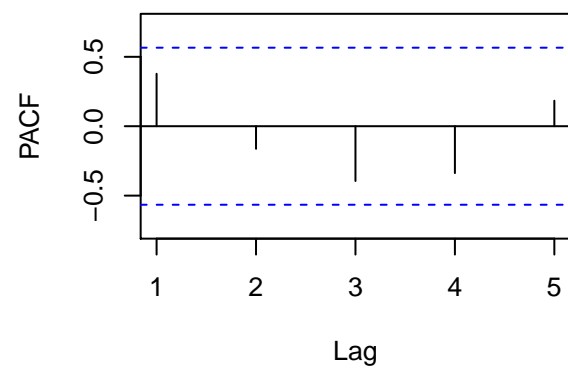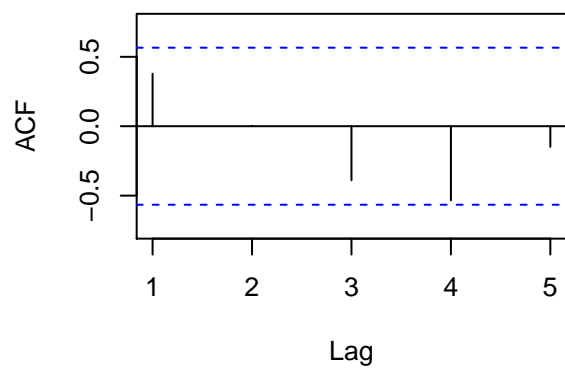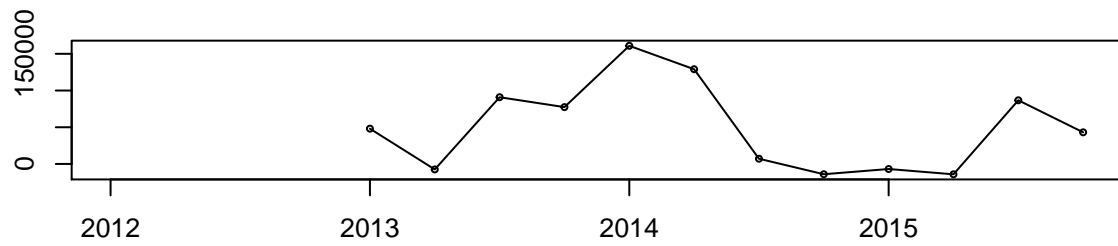
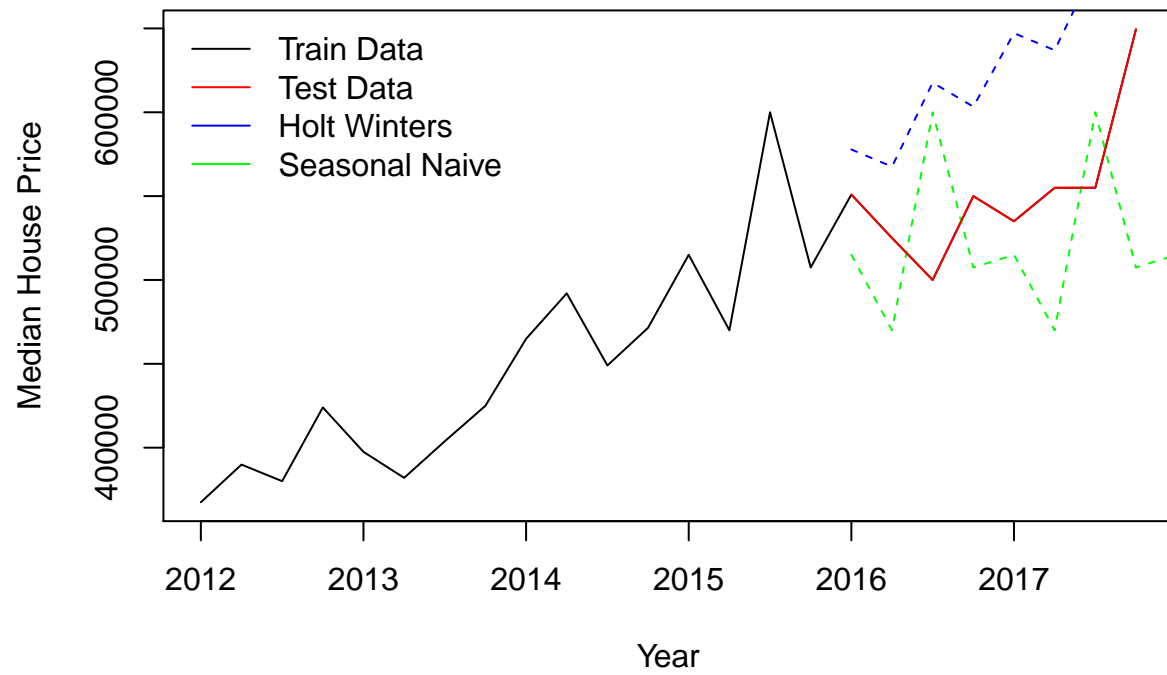Portland, OR – Boise : Holt Winters Model Forecast
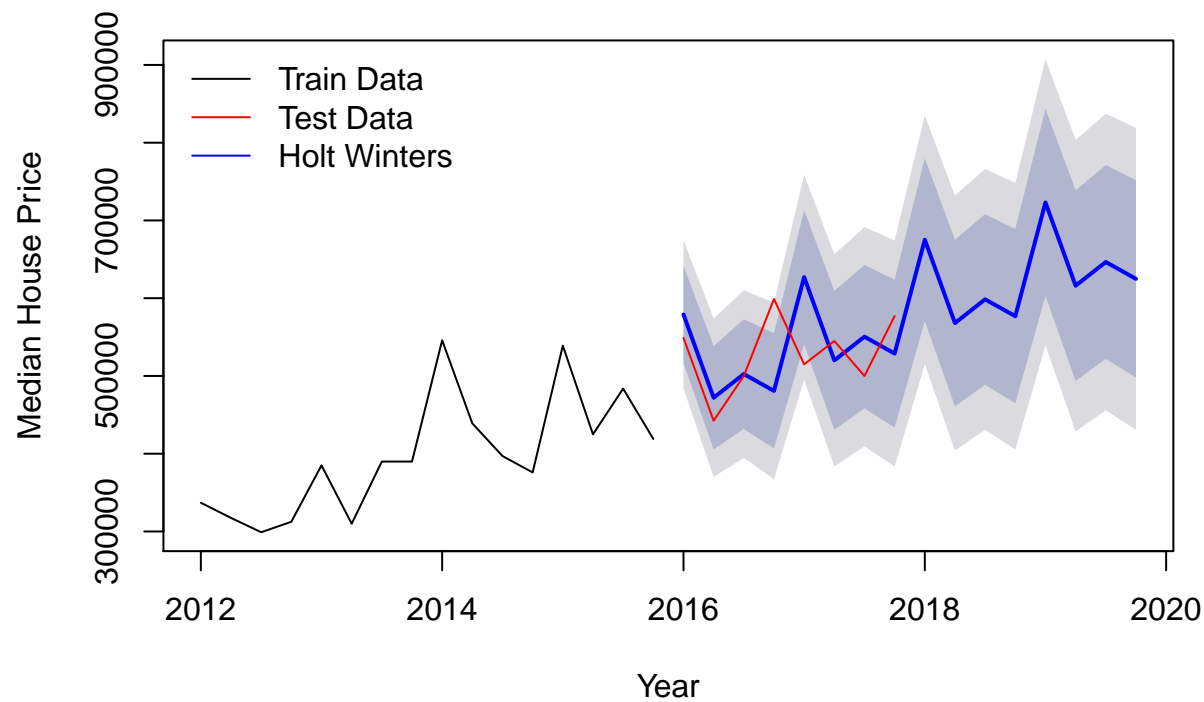
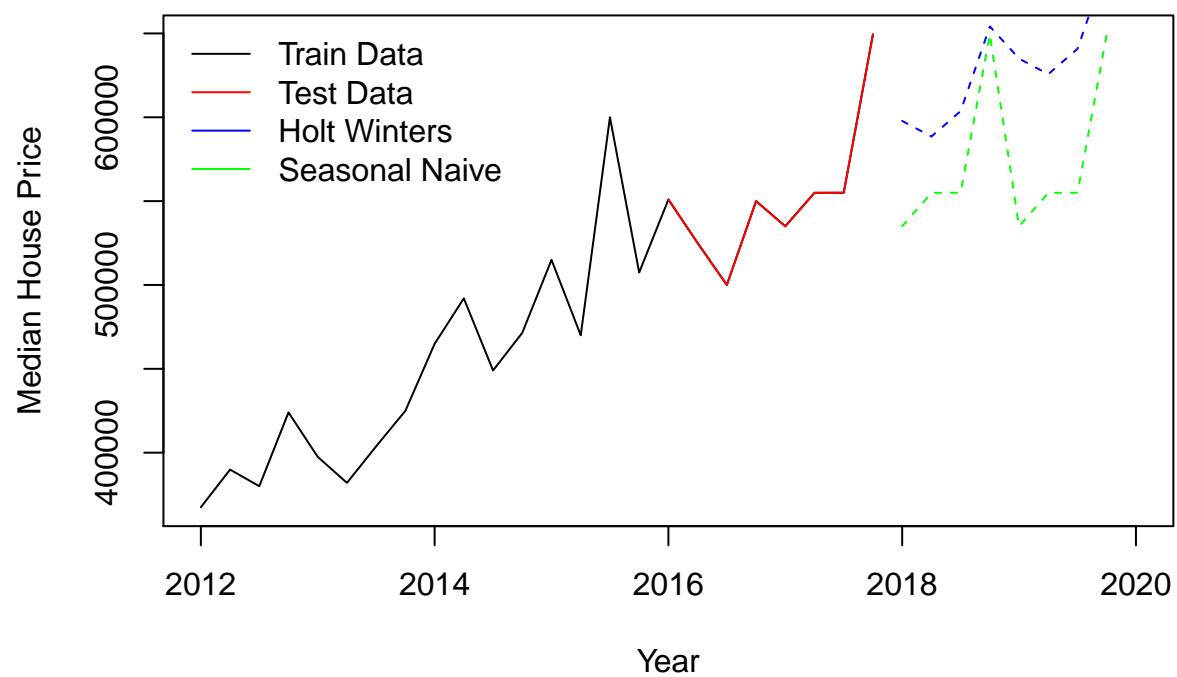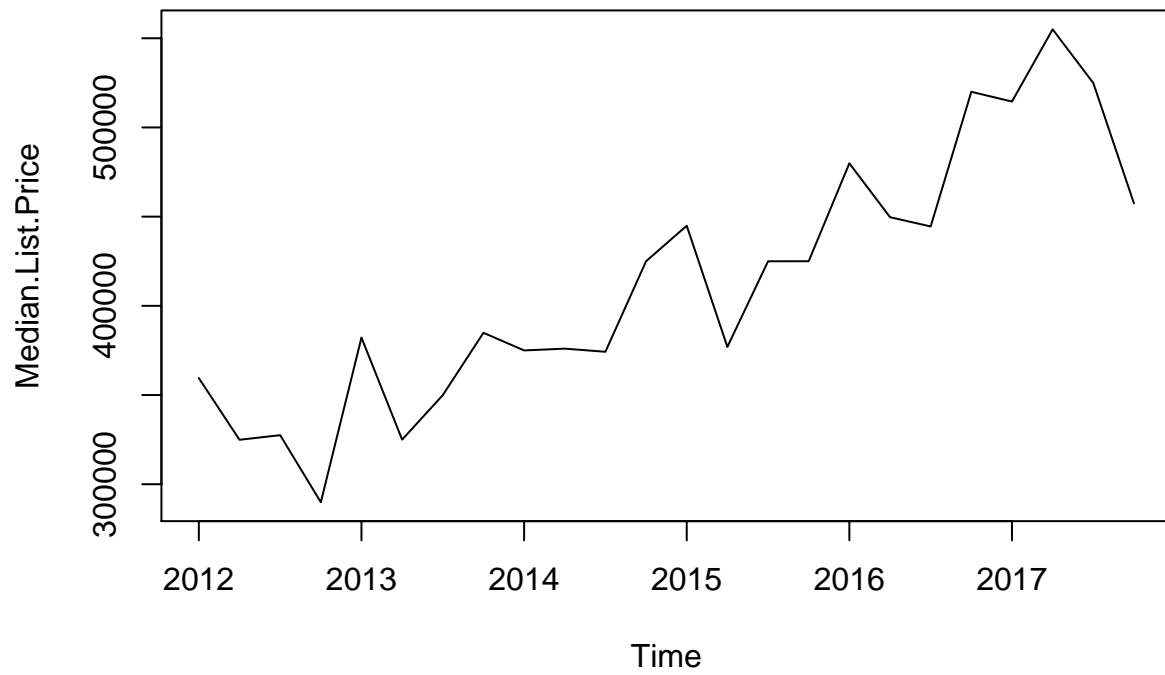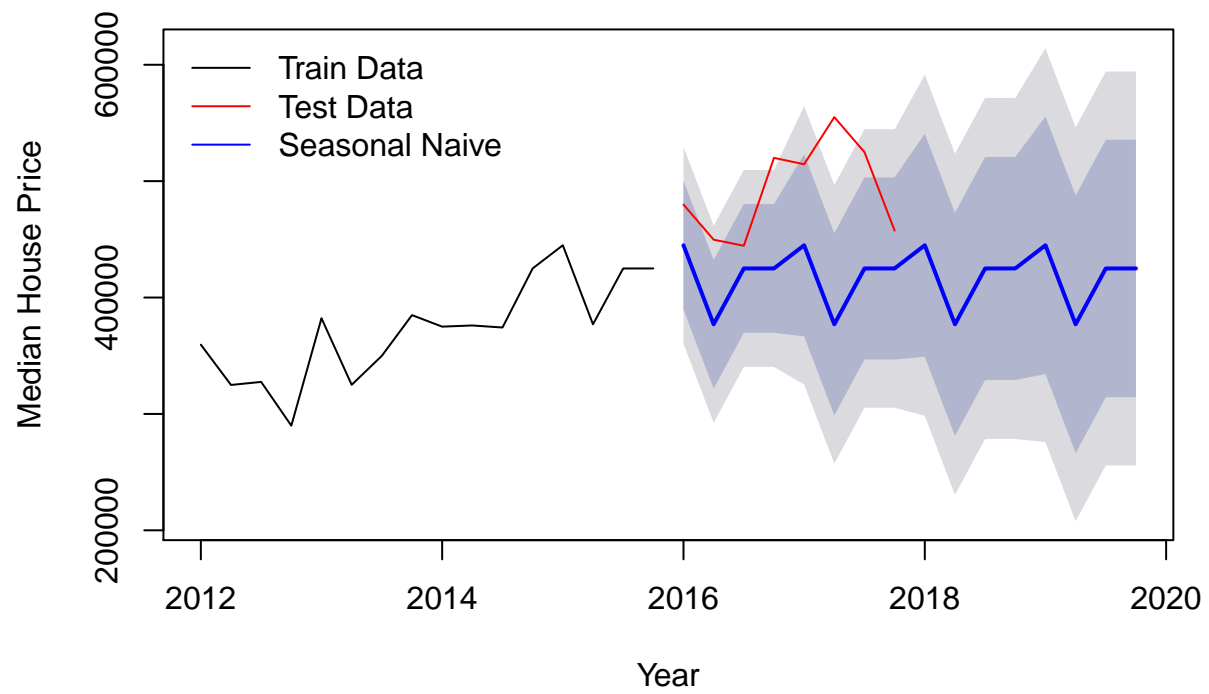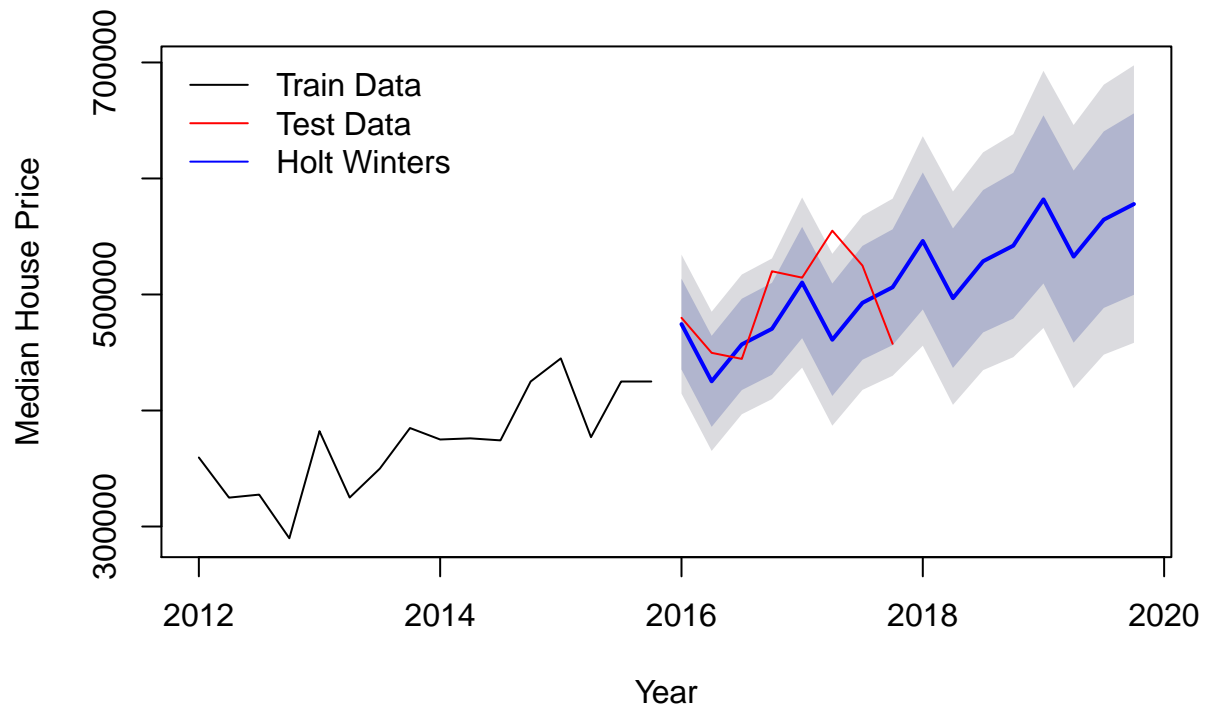**Portland, OR – Boise : Holt Winters Model Forecast Residuals**
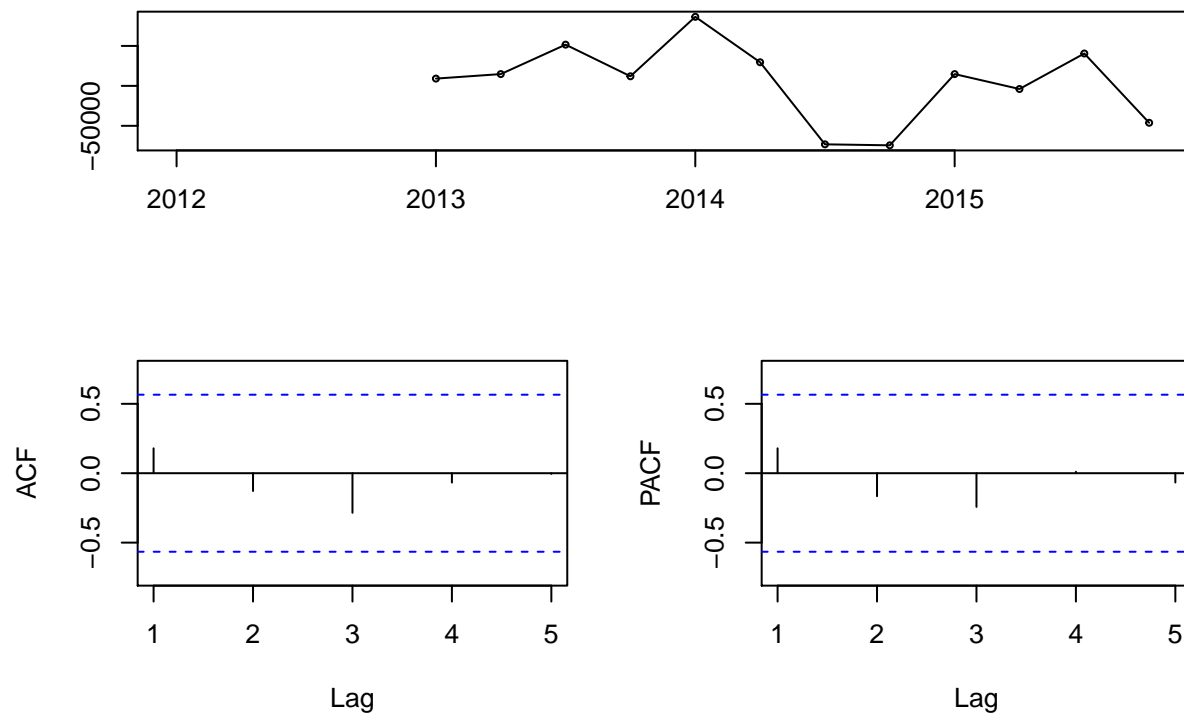

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Boise"
##                    ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 50060.42 75839.13 57135.42 11.14867 12.93637 1.000000
## Test set     61750.00 95711.08 67750.00 10.88397 12.04902 1.185779
##                   ACF1 Theil's U
## Training set  0.3781009        NA
## Test set     -0.5438133  1.399149
## [1] "Holt Winters Accuracy for  Portland, OR - Boise"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set  5084.242 46854.39 38026.28  0.5783518 8.938774 0.6655466
## Test set     -4192.653 65025.10 52024.43 -1.4866809 9.651863 0.9105461
##                   ACF1 Theil's U
## Training set  0.1796326        NA
## Test set     -0.5735509 0.8796162
```

Portland, OR – Boise : TS Training Model Comparison

Portland, OR – Boise : Full TS Models Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Median House Price

Year

Portland, OR – Creston–Kenilworth

Portland, OR – Creston–Kenilworth : Naive Model Forecast
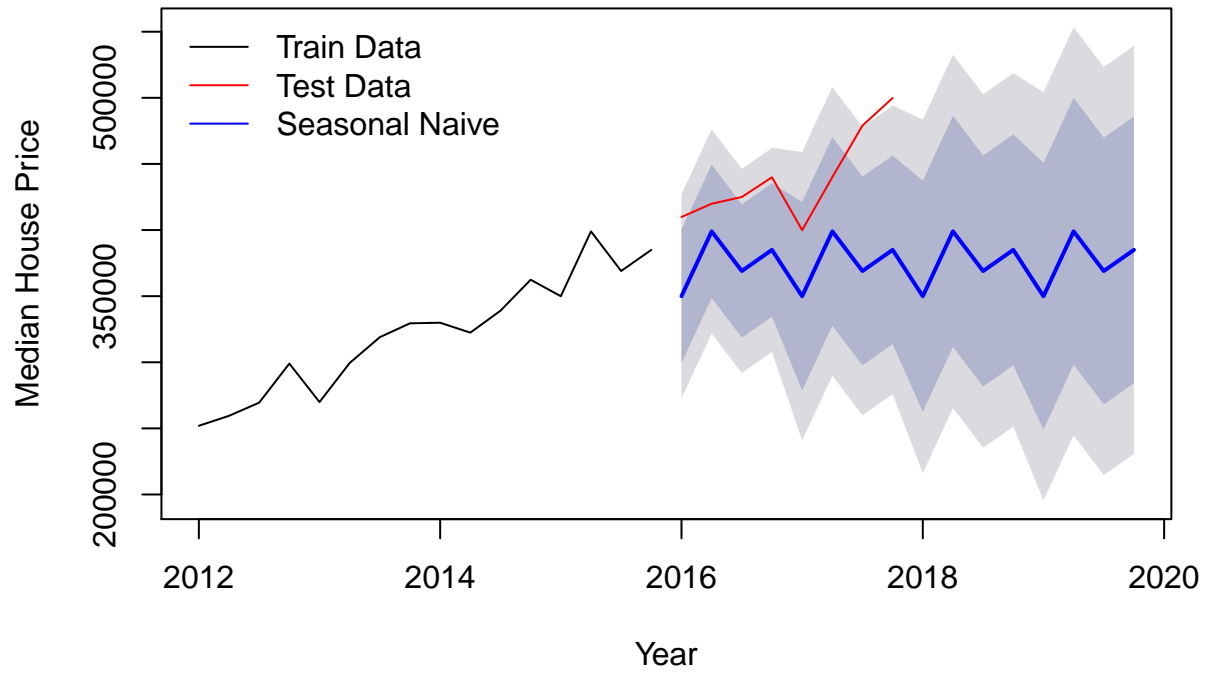
Portland, OR – Creston–Kenilworth : Naive Model Forecast Residuals
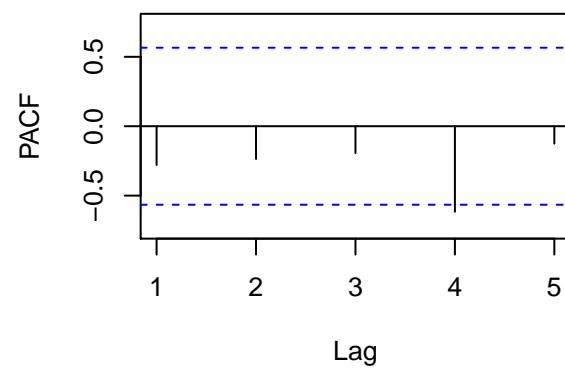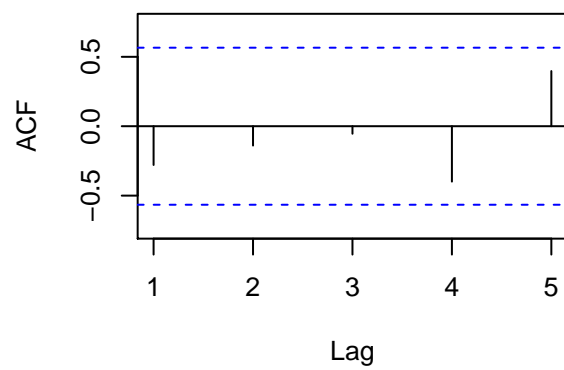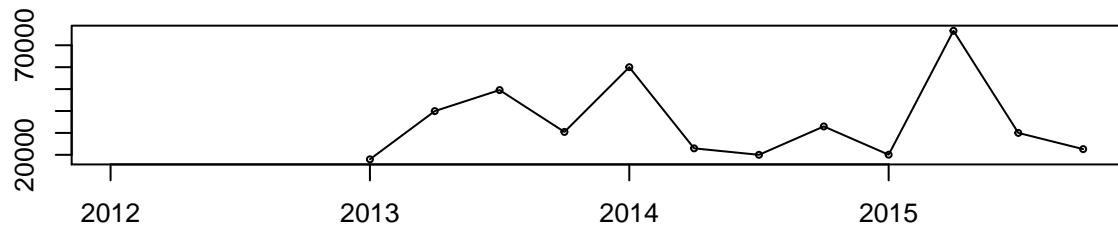
Portland, OR – Creston–Kenilworth : Holt Winters Model Forecast
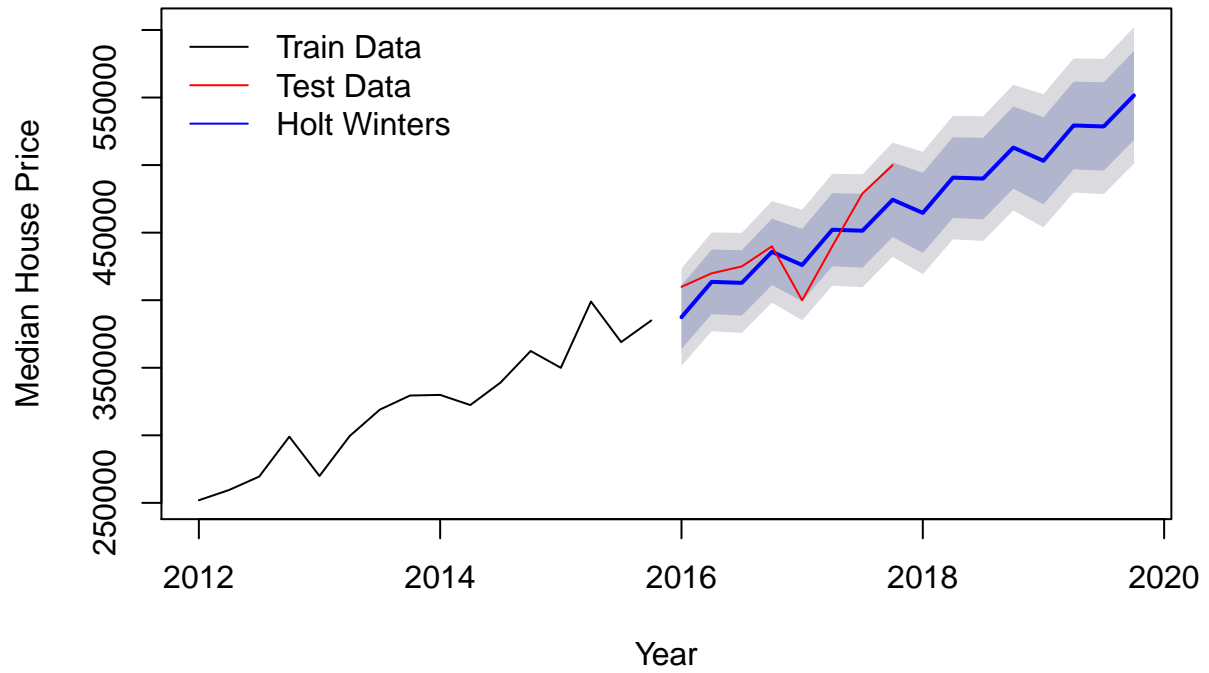
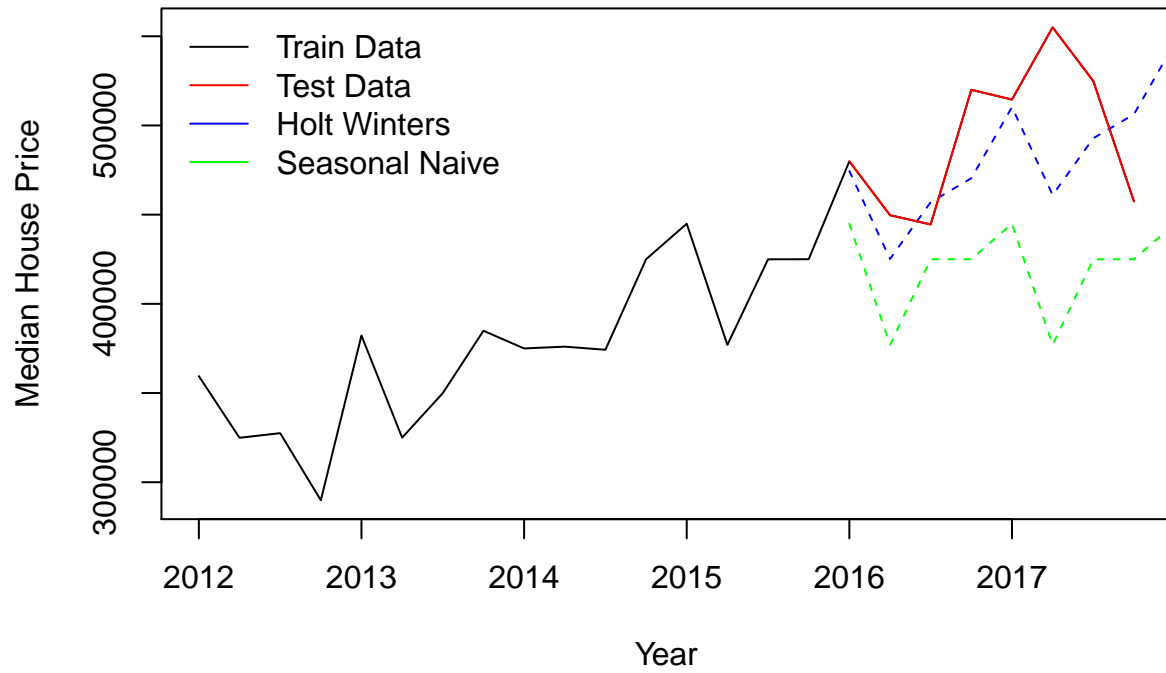## Portland, OR – Creston–Kenilworth : Holt Winters Model Forecast Residuals
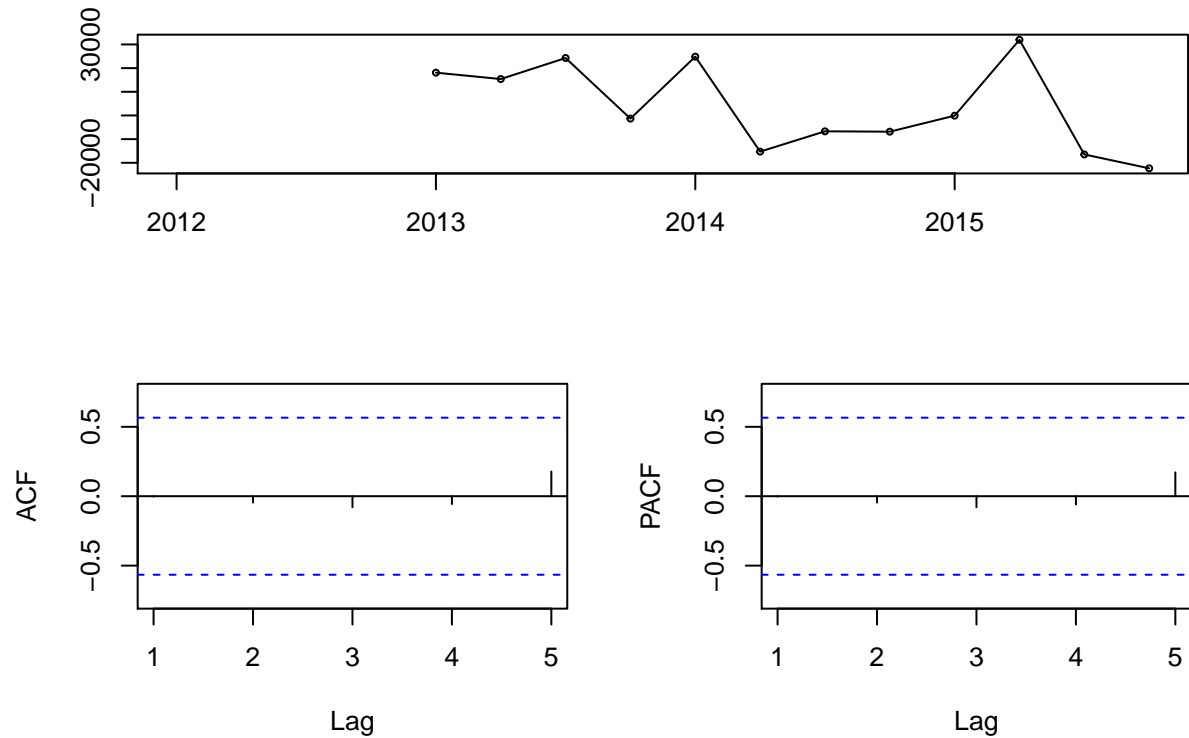

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Creston-Kenilworth"
##                    ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 35254.17 39362.99 35254.17 10.33272 10.33272 1.000000
## Test set     63448.25 70407.44 63448.25 14.12681 14.12681 1.799738
##                   ACF1 Theil's U
## Training set -0.2793307       NA
## Test set      0.3083121  2.450752
## [1] "Holt Winters Accuracy for  Portland, OR - Creston-Kenilworth"
##                    ME      RMSE      MAE      MPE     MAPE      MASE
## Training set 3792.630 17999.58 15297.98 1.307767 4.523413 0.4339339
## Test set     7487.638 19211.34 17059.26 1.544332 3.868534 0.4838934
##                     ACF1 Theil's U
## Training set -0.002380788        NA
## Test set      0.280738196 0.6421753
```

Portland, OR – Creston–Kenilworth : TS Training Model Comparison

Portland, OR – Creston–Kenilworth : Full TS Models Comparison
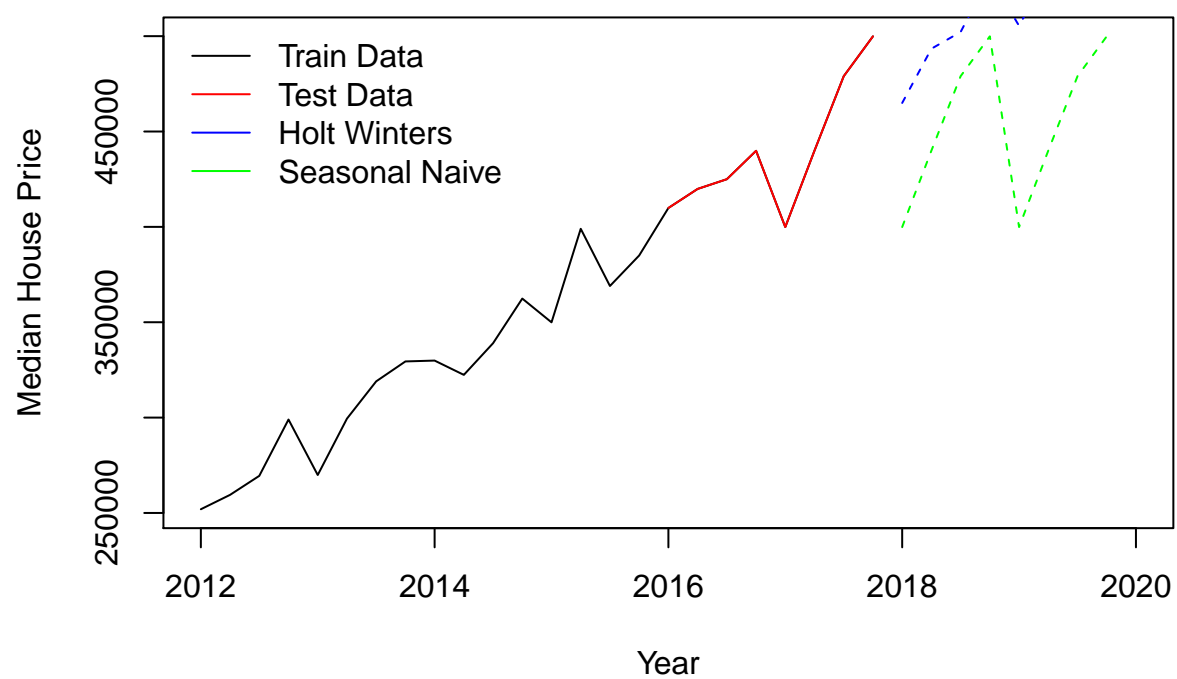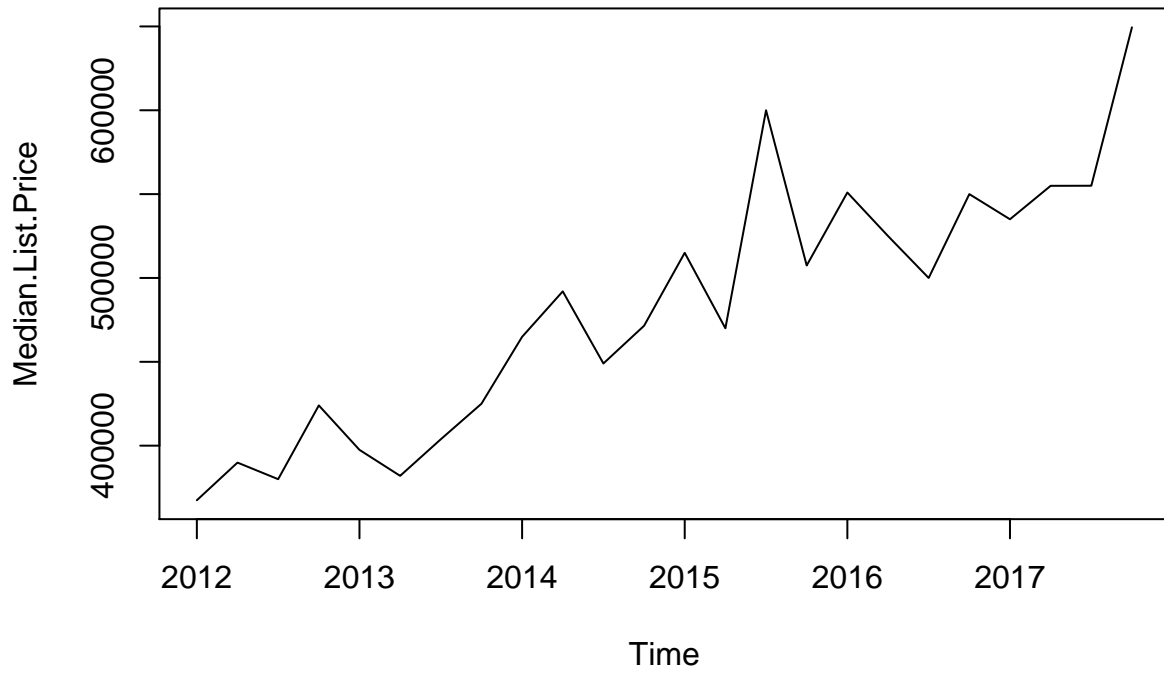
Portland, OR – Mount Tabor

Portland, OR – Mount Tabor : Naive Model Forecast
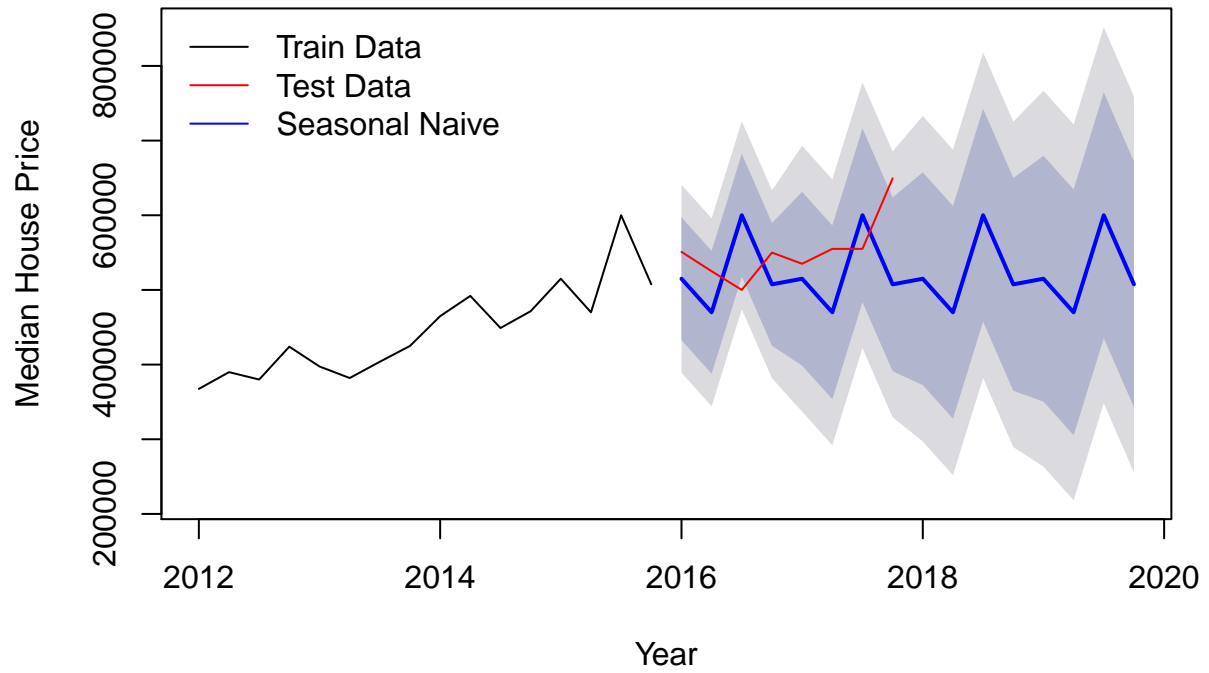
Portland, OR – Mount Tabor : Naive Model Forecast Residuals
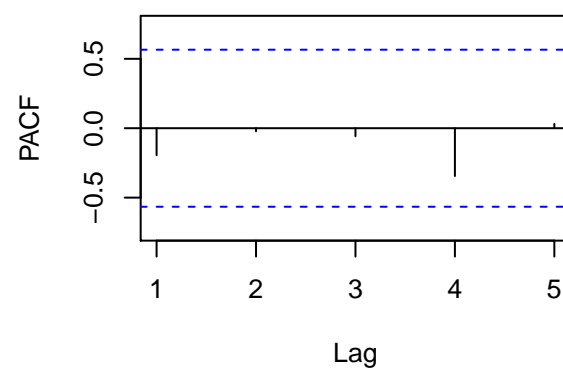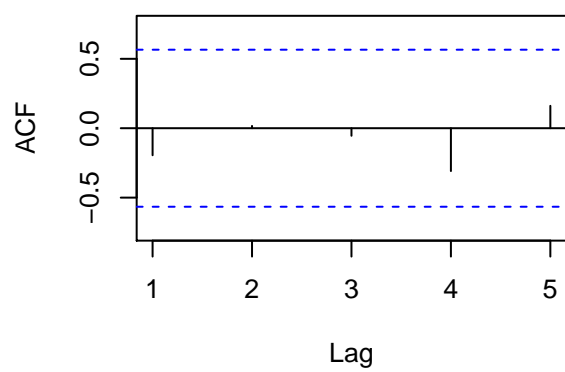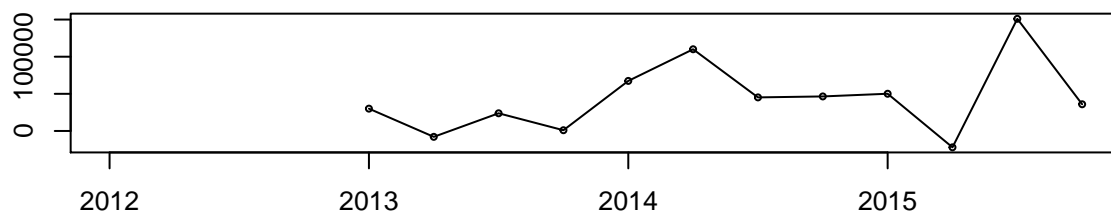
Portland, OR – Mount Tabor : Holt Winters Model Forecast
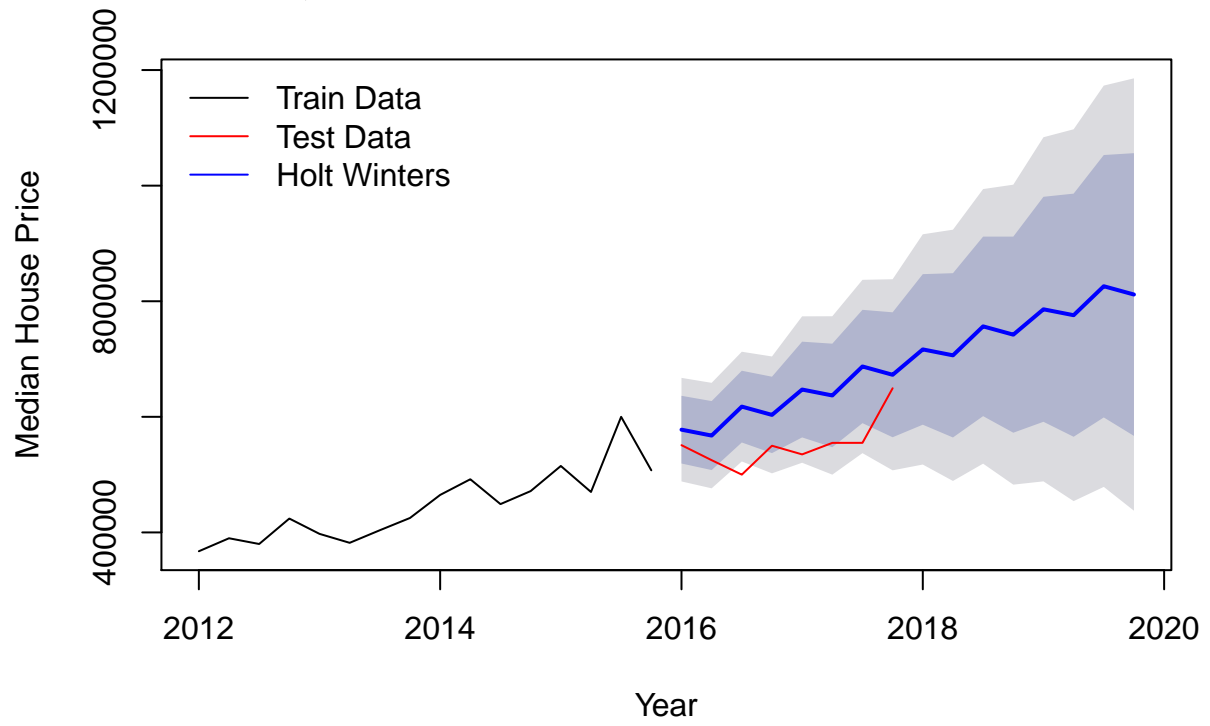
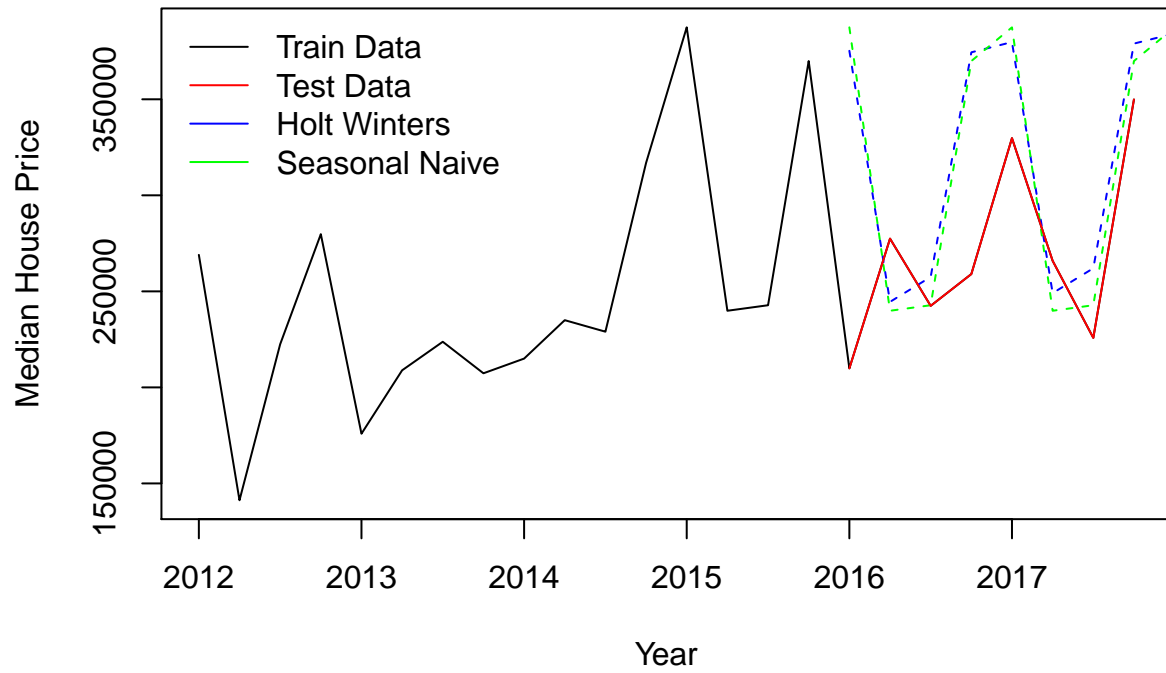**Portland, OR – Mount Tabor : Holt Winters Model Forecast Residuals**
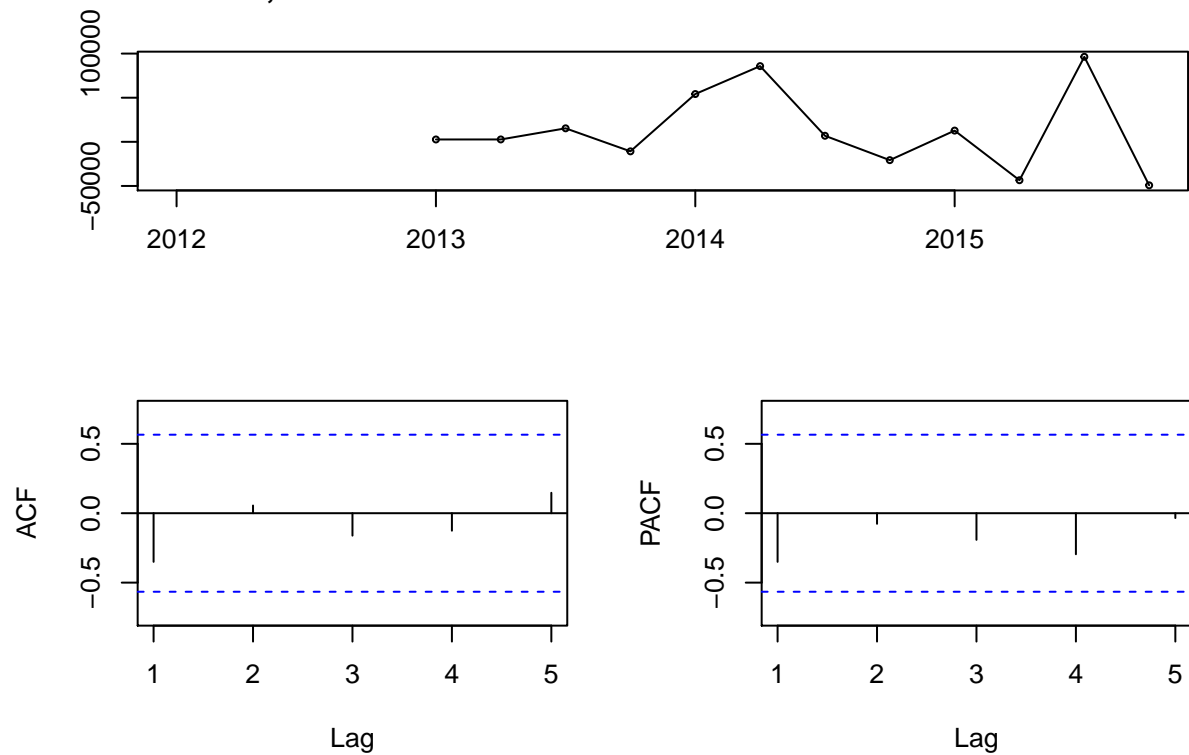

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Mount Tabor"
##                    ME     RMSE      MAE      MPE      MAPE     MASE
## Training set 44258.33 64205.60 49241.67 8.808652  9.933471 1.000000
## Test set     29431.25 75773.85 65681.25 4.692525 11.719552 1.333855
##                   ACF1 Theil's U
## Training set -0.1947356        NA
## Test set     -0.4614675  1.826477
## [1] "Holt Winters Accuracy for  Portland, OR - Mount Tabor"
##                    ME     RMSE      MAE        MPE      MAPE     MASE
## Training set  12691.60 45557.22 33411.41    2.368281  6.685923 0.678519
## Test set     -73761.82 84071.61 73761.82 -13.670447 13.670447 1.497955
##                   ACF1 Theil's U
## Training set -0.3503649        NA
## Test set     -0.2867079   2.04791
```

Portland, OR – Mount Tabor : TS Training Model Comparison

Portland, OR – Mount Tabor : Full TS Models Comparison

Portland, OR – Concordia

Portland, OR – Concordia : Naive Model Forecast

Portland, OR – Concordia : Naive Model Forecast Residuals

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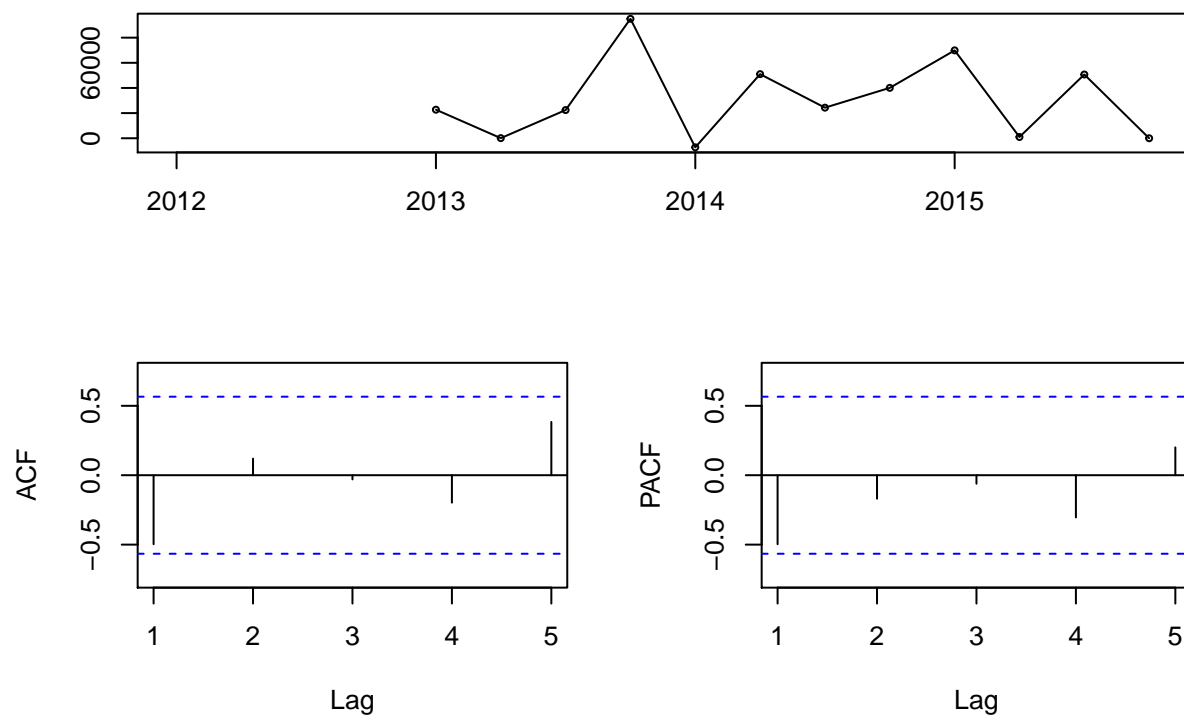
Portland, OR – Concordia : Holt Winters Model Forecast
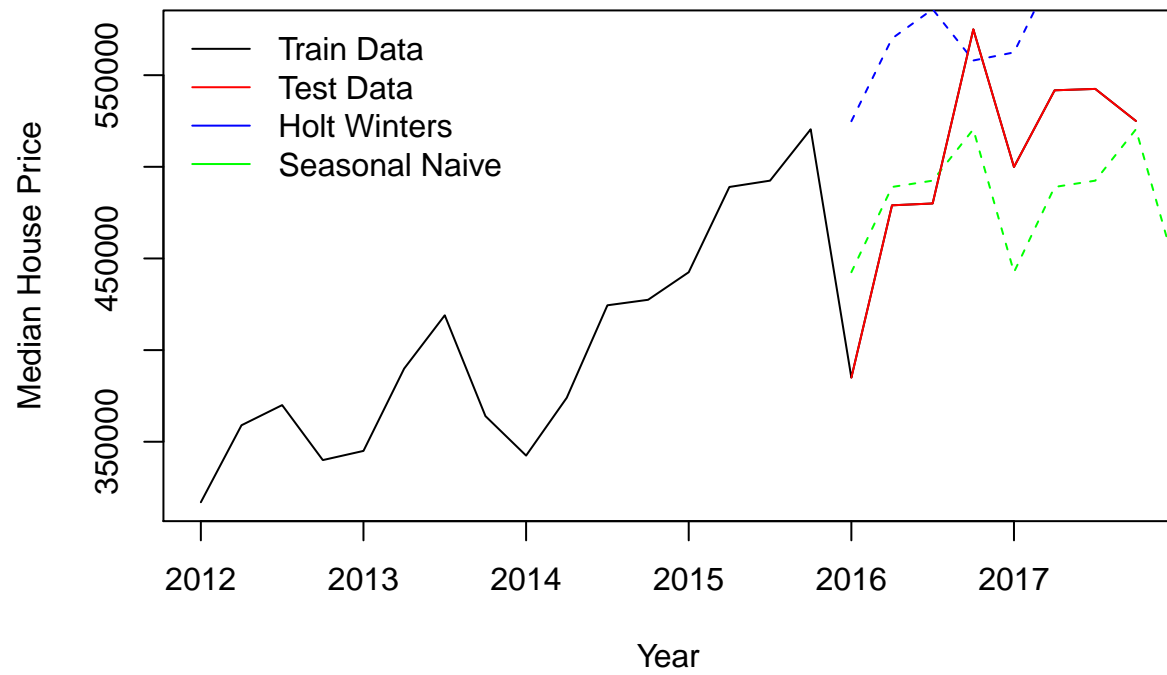
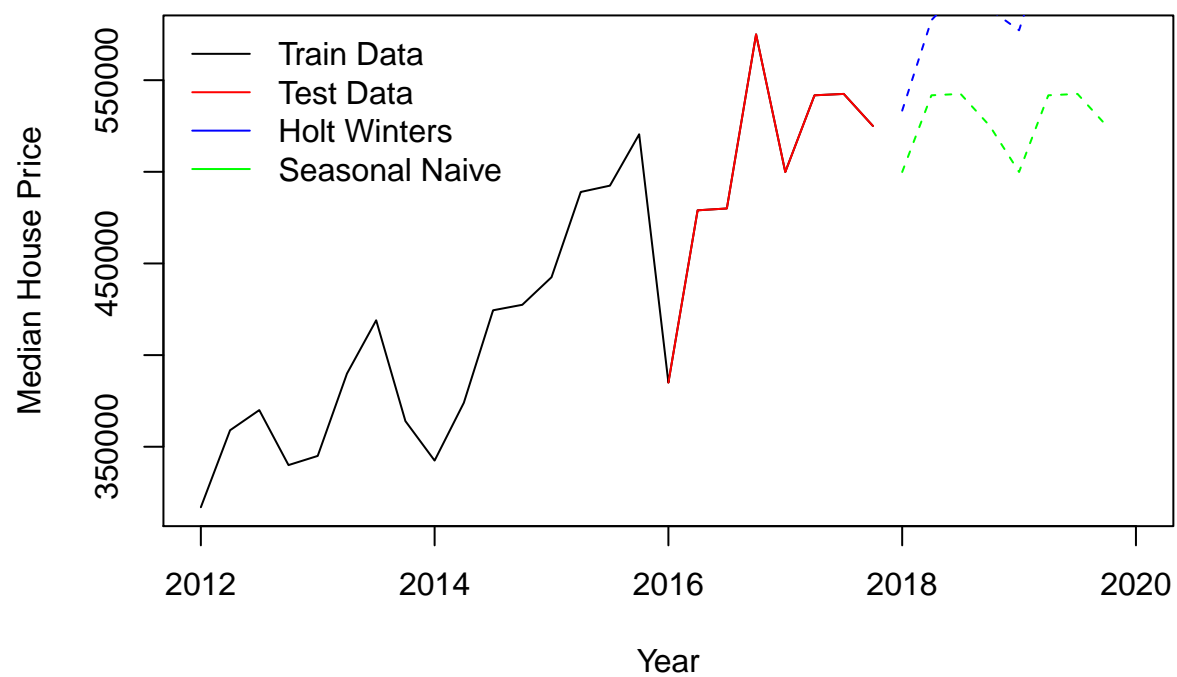**Portland, OR – Concordia : Holt Winters Model Forecast Residuals**
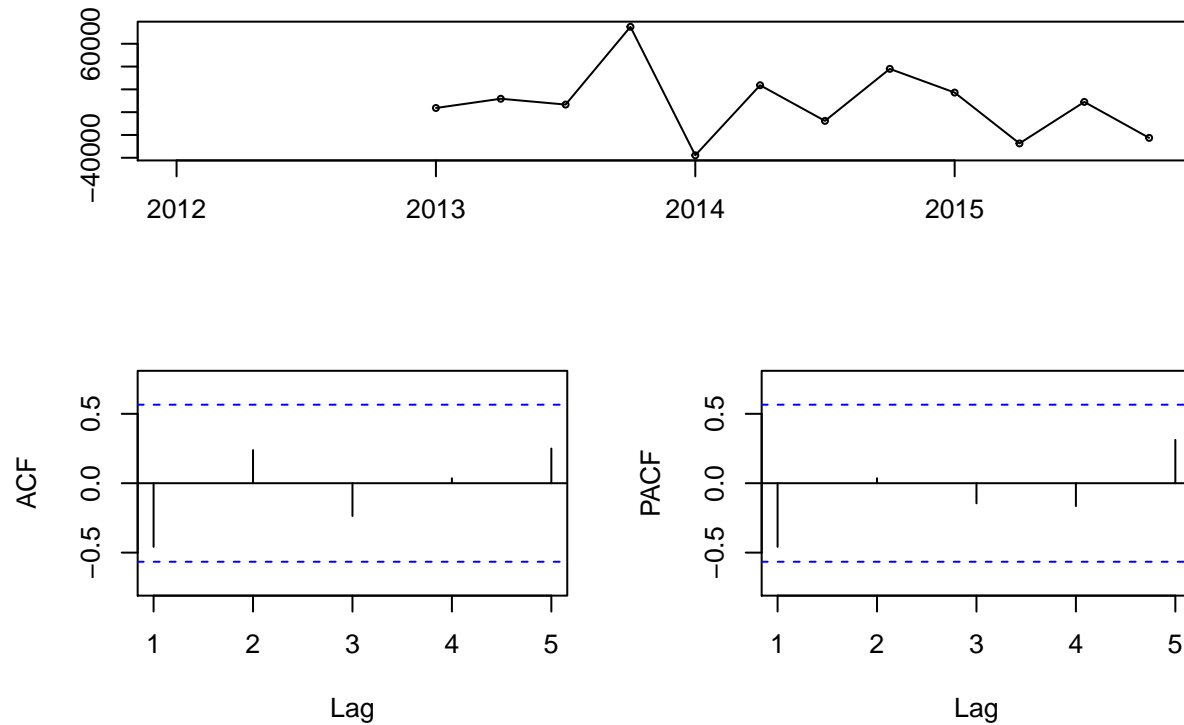

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Concordia"
##                   ME     RMSE      MAE       MPE      MAPE     MASE
## Training set 30840.42 43162.7 32040.42  7.712864  8.032864 1.000000
## Test set     75275.00 89080.5 75275.00 14.731466 14.731466 2.349376
##                   ACF1 Theil's U
## Training set -0.497229634        NA
## Test set     -0.003898899  2.040193
## [1] "Holt Winters Accuracy for  Portland, OR - Concordia"
##                   ME     RMSE      MAE      MPE      MAPE      MASE
## Training set  7438.277 30183.74 23354.48 1.867692 5.988275 0.7289068
## Test set     18567.932 44035.87 33893.22 3.313848 6.683888 1.0578270
##                   ACF1 Theil's U
## Training set -0.4583025        NA
## Test set     -0.2075833  1.021589
```

Portland, OR – Concordia : TS Training Model Comparison

Portland, OR – Concordia : Full TS Models Comparison
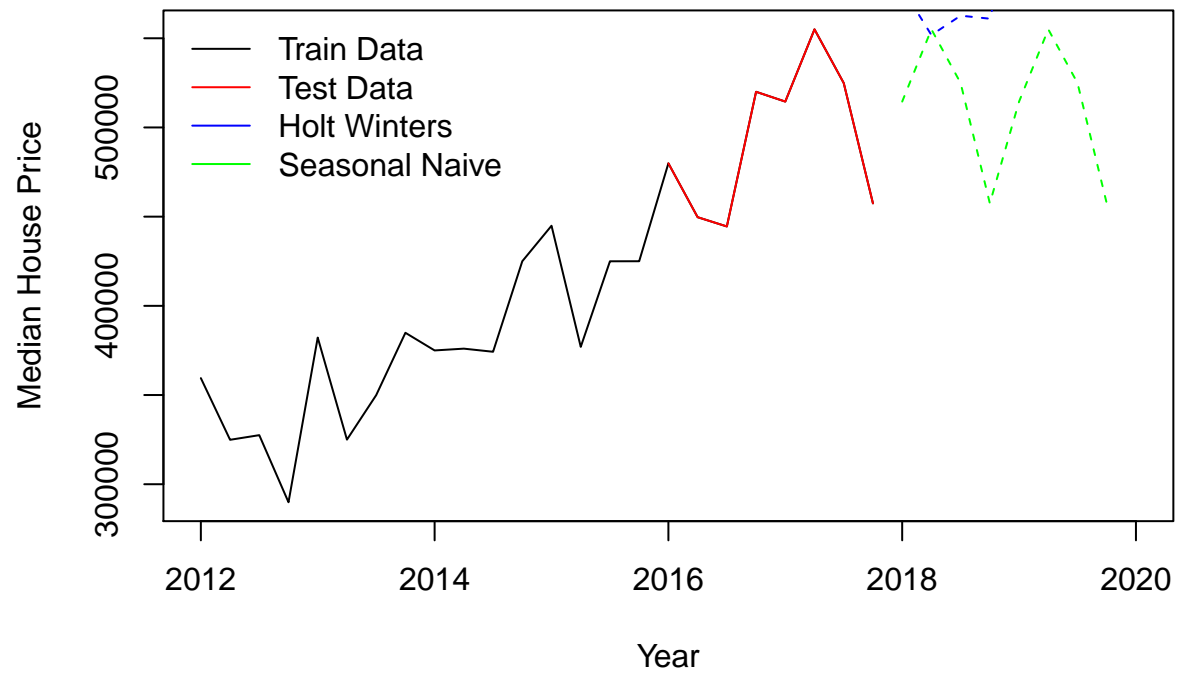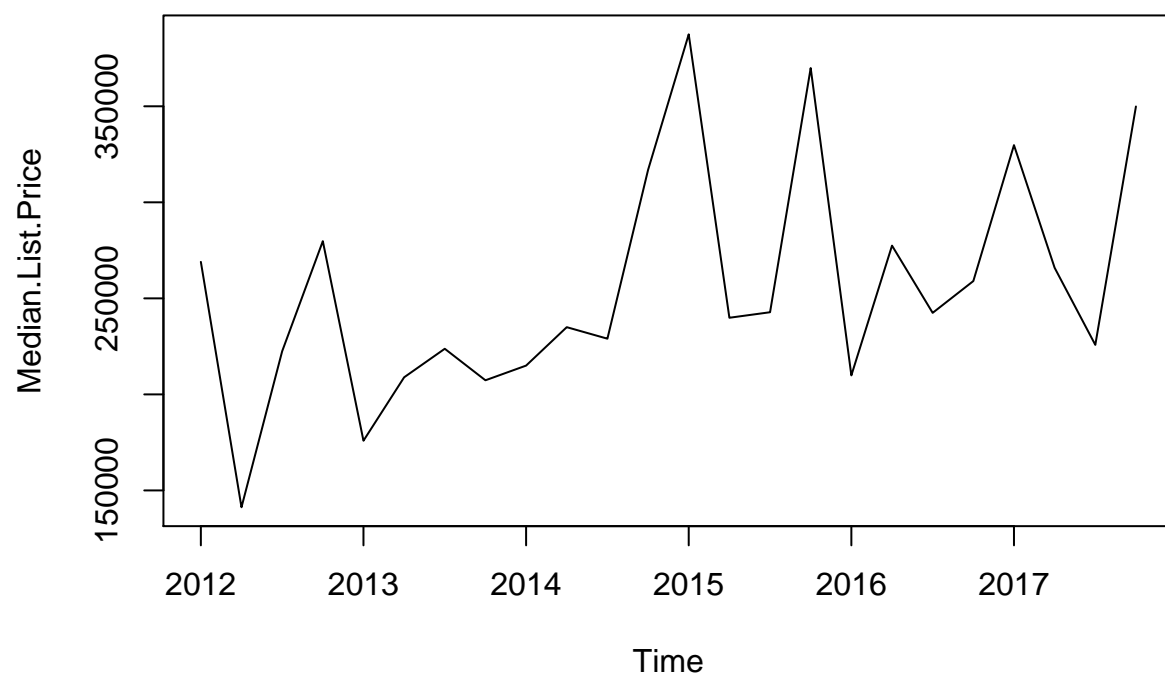
# Portland, OR – Hayden Island

Portland, OR – Hayden Island : Naive Model Forecast
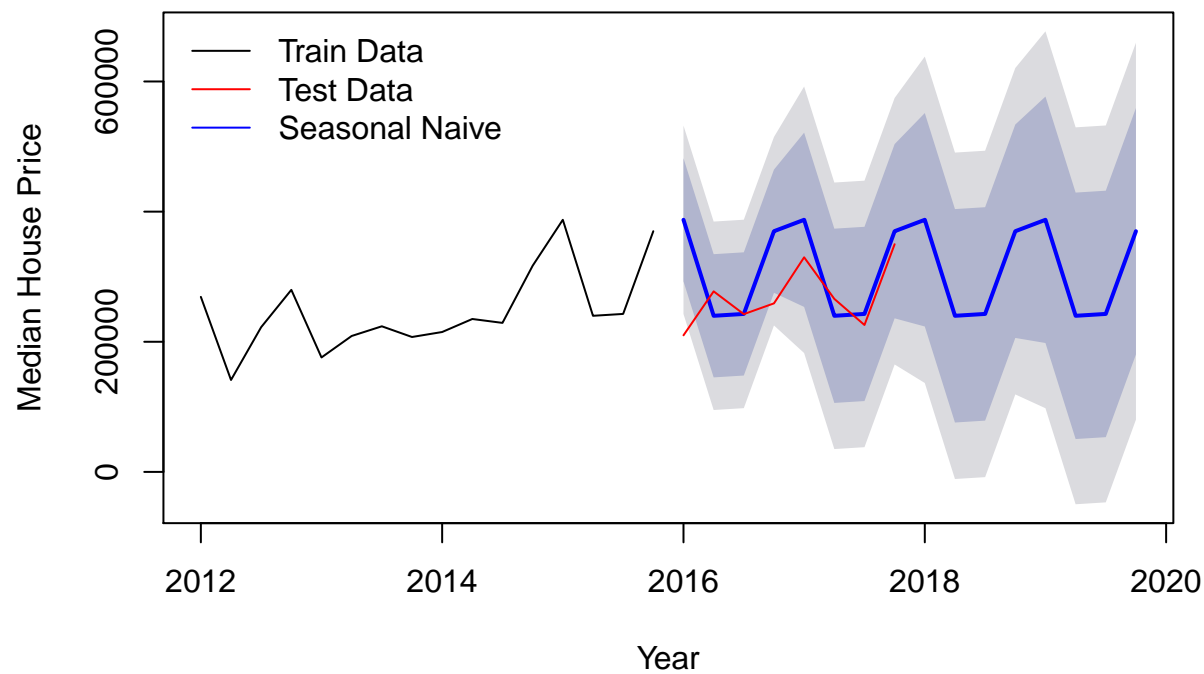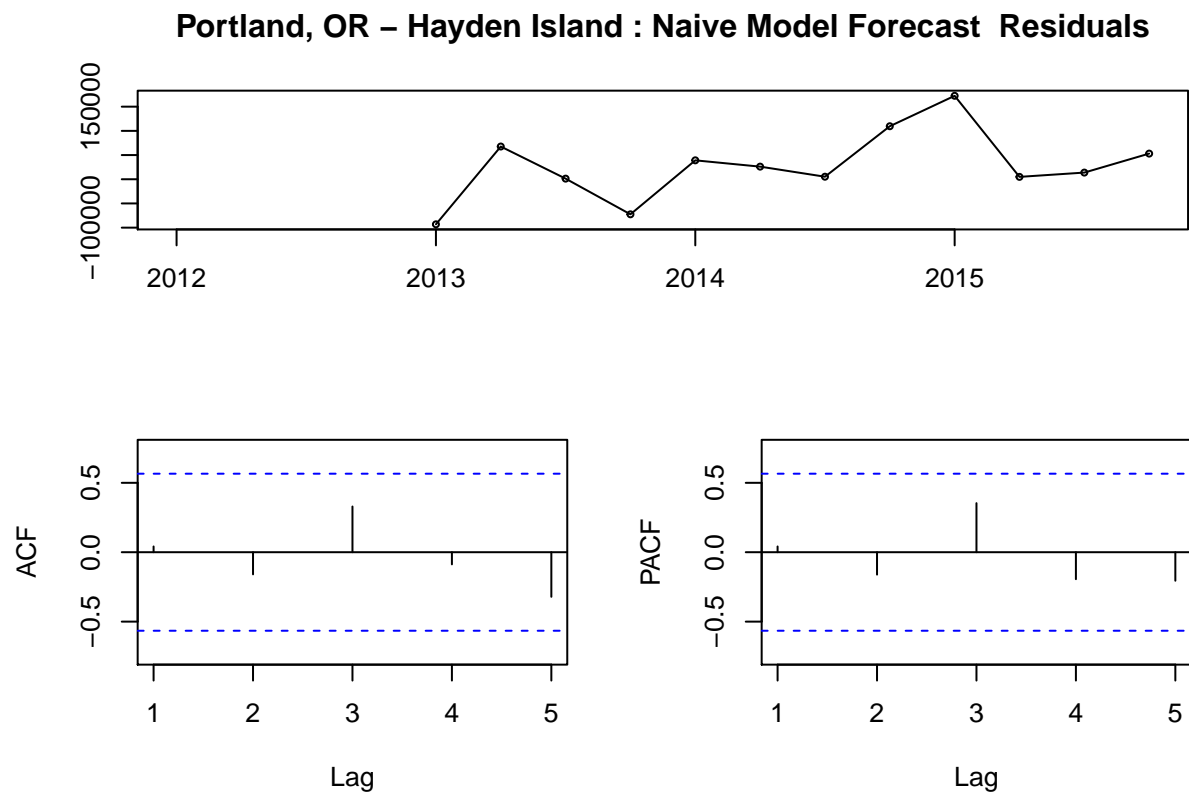
Portland, OR – Hayden Island : Naive Model Forecast Residuals

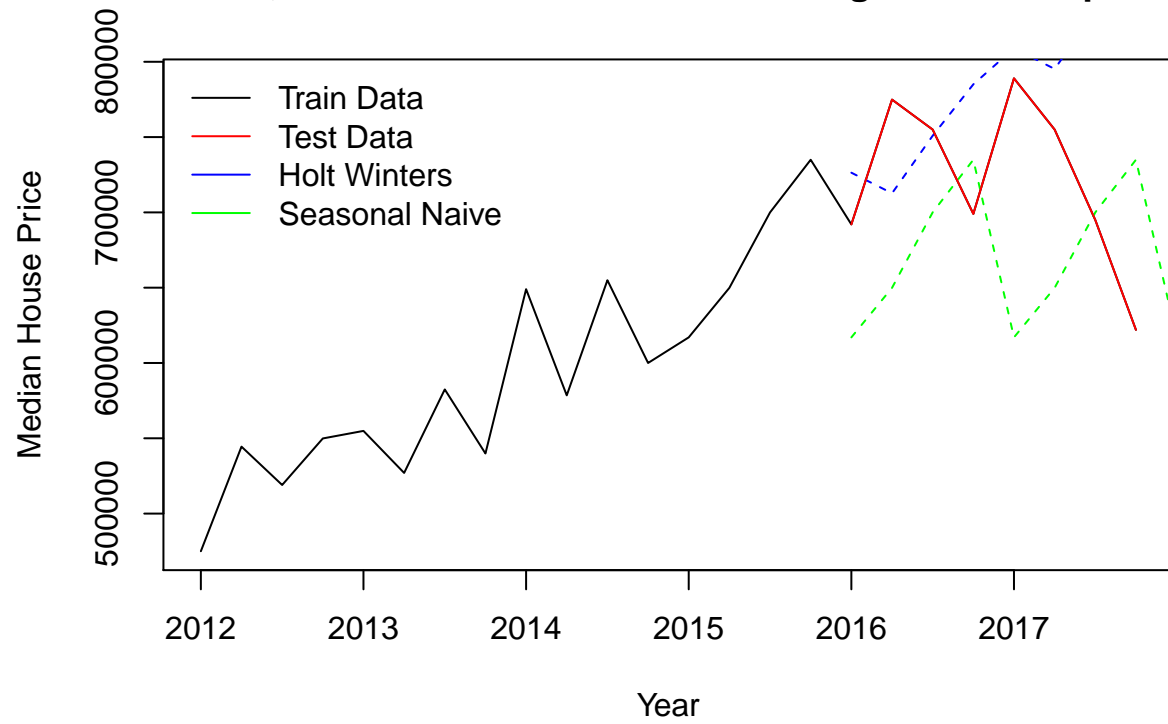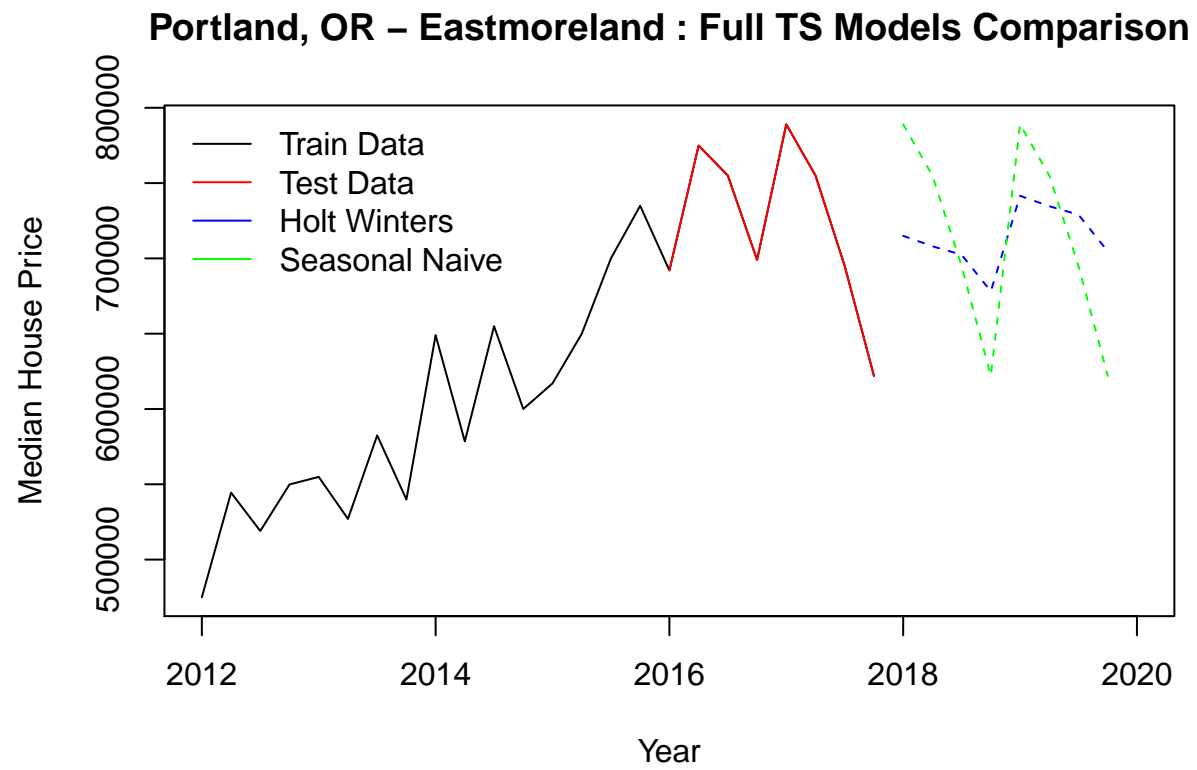# Portland, OR – Hayden Island : Holt Winters Model Forecast
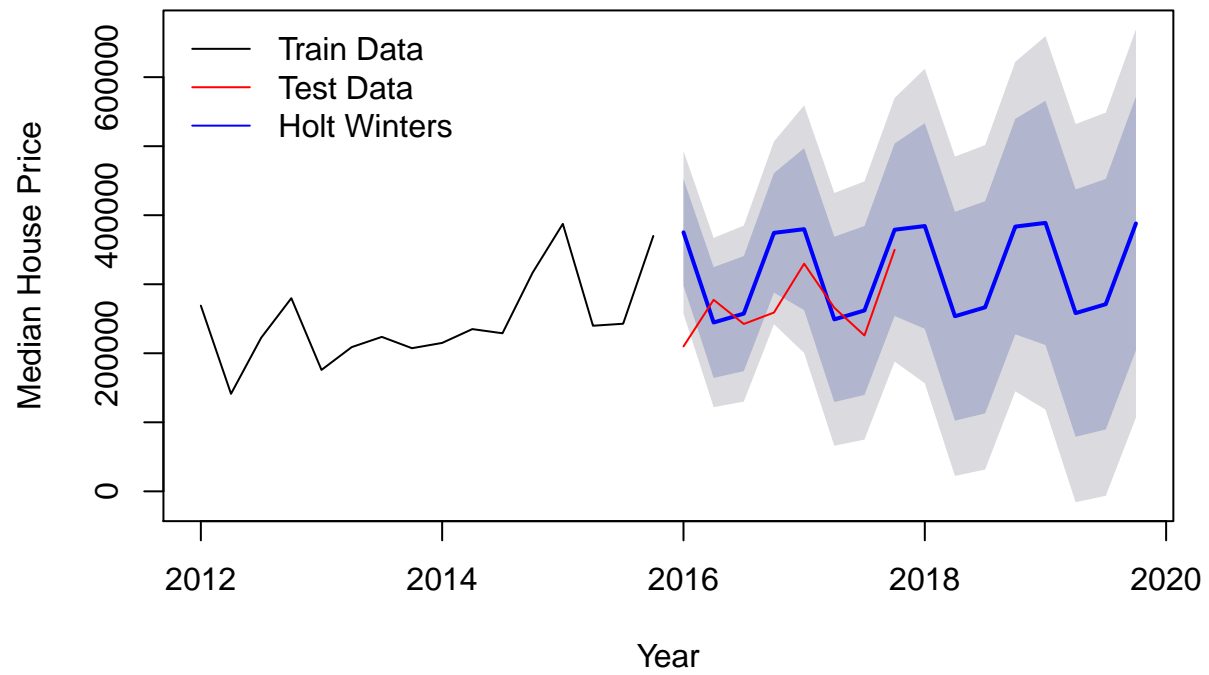
Portland, OR – Hayden Island : Holt Winters Model Forecast Residuals
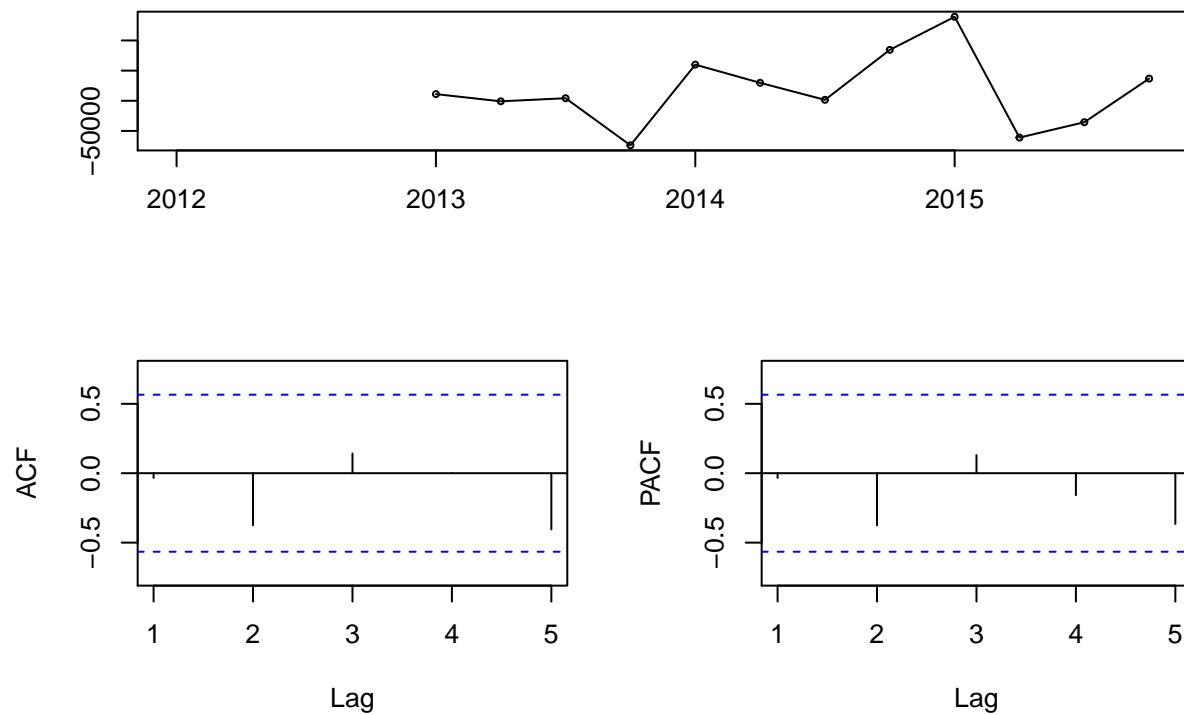

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Hayden Island"
##                    ME     RMSE      MAE       MPE     MAPE     MASE
## Training set  27295.83 73879.42 54887.50   6.484019 21.12987 1.000000
## Test set     -39989.19 78998.14 55876.69 -16.870999 22.69902 1.018022
##                    ACF1 Theil's U
## Training set  0.04153223        NA
## Test set     -0.22459486 0.7419511
## [1] "Holt Winters Accuracy for  Portland, OR - Hayden Island"
##                    ME     RMSE      MAE       MPE     MAPE      MASE
## Training set  16310.96 59796.46 44844.05   3.818842 16.49749 0.8170176
## Test set     -45178.14 76580.14 57609.06 -18.860808 23.40705 1.0495844
##                     ACF1 Theil's U
## Training set -0.03379111        NA
## Test set     -0.27491857 0.7659379
```

Portland, OR – Hayden Island : TS Training Model Comparison

Portland, OR – Hayden Island : Full TS Models Comparison
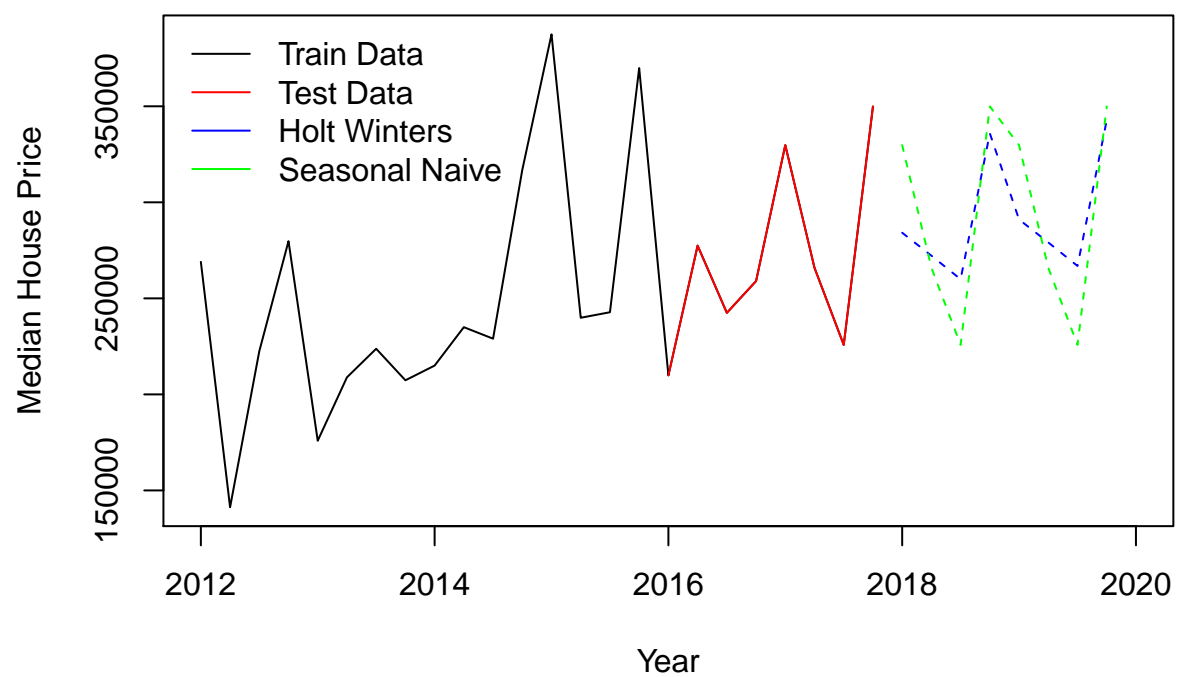
Portland, OR – Sunnyside
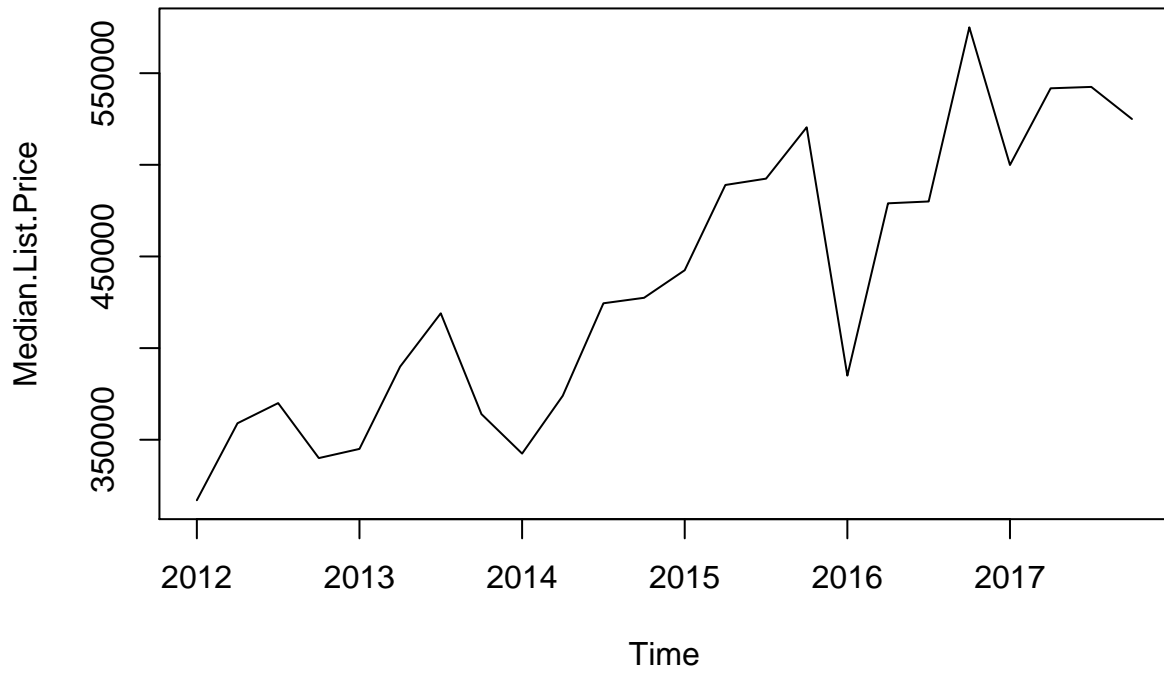
Portland, OR – Sunnyside : Naive Model Forecast
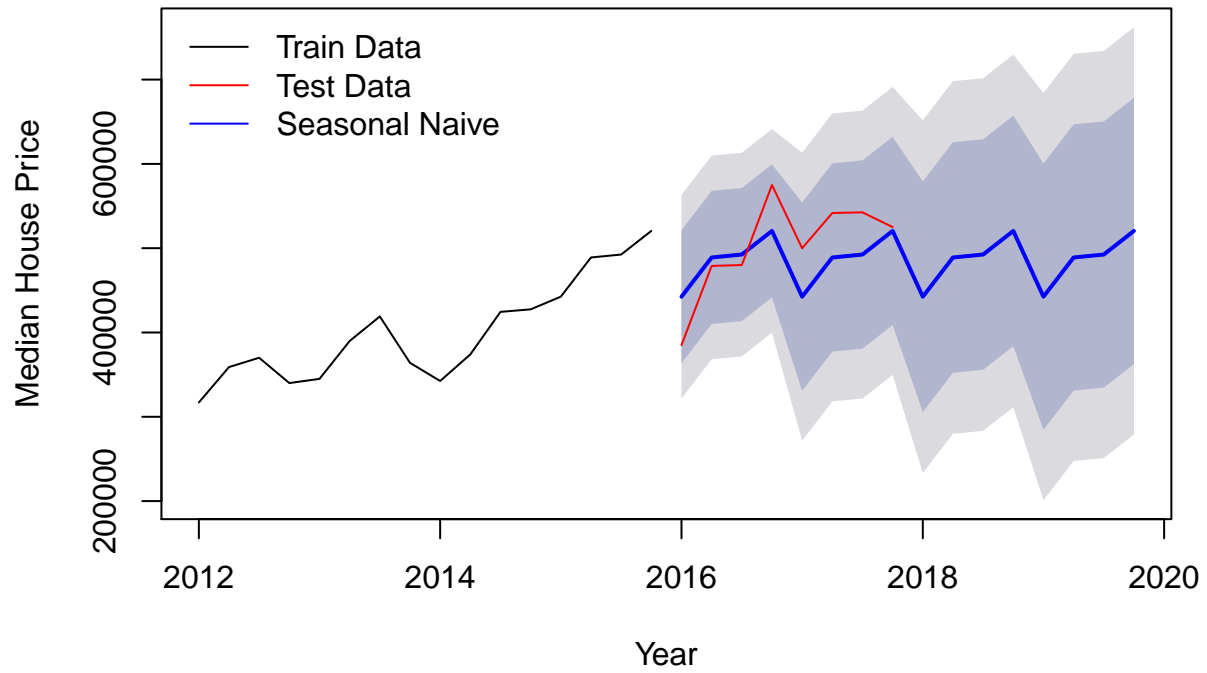
Portland, OR – Sunnyside : Naive Model Forecast Residuals
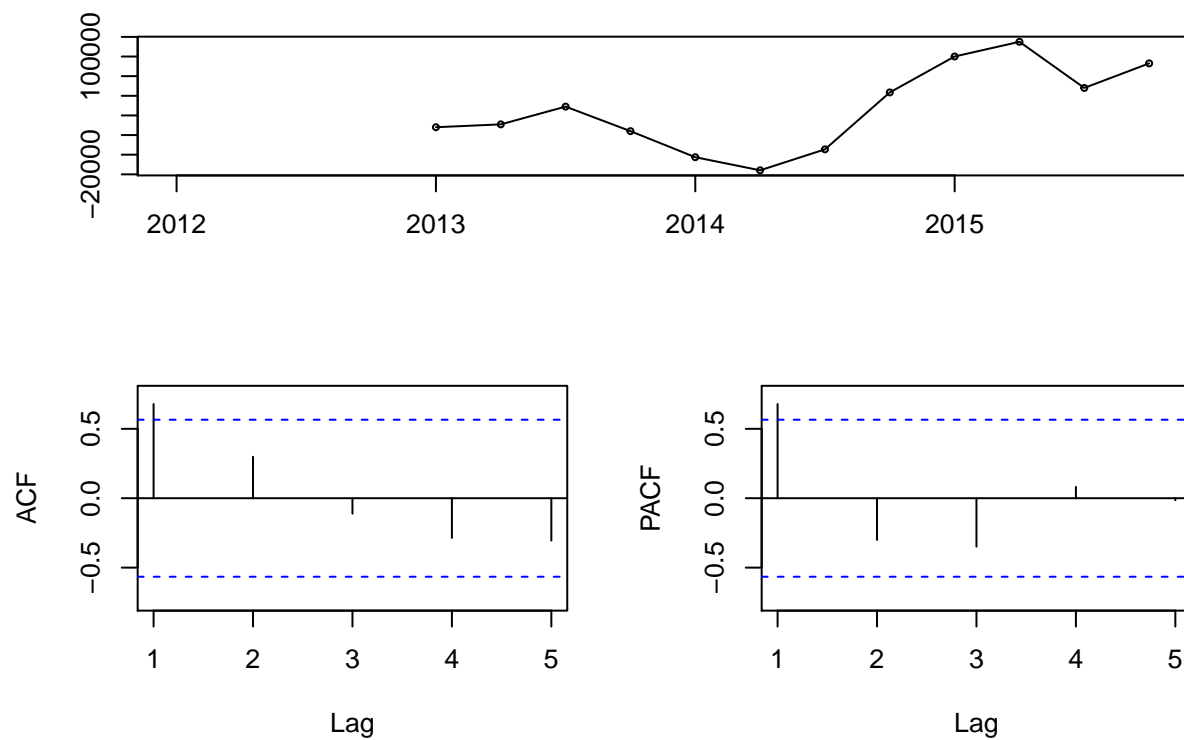
Portland, OR – Sunnyside : Holt Winters Model Forecast
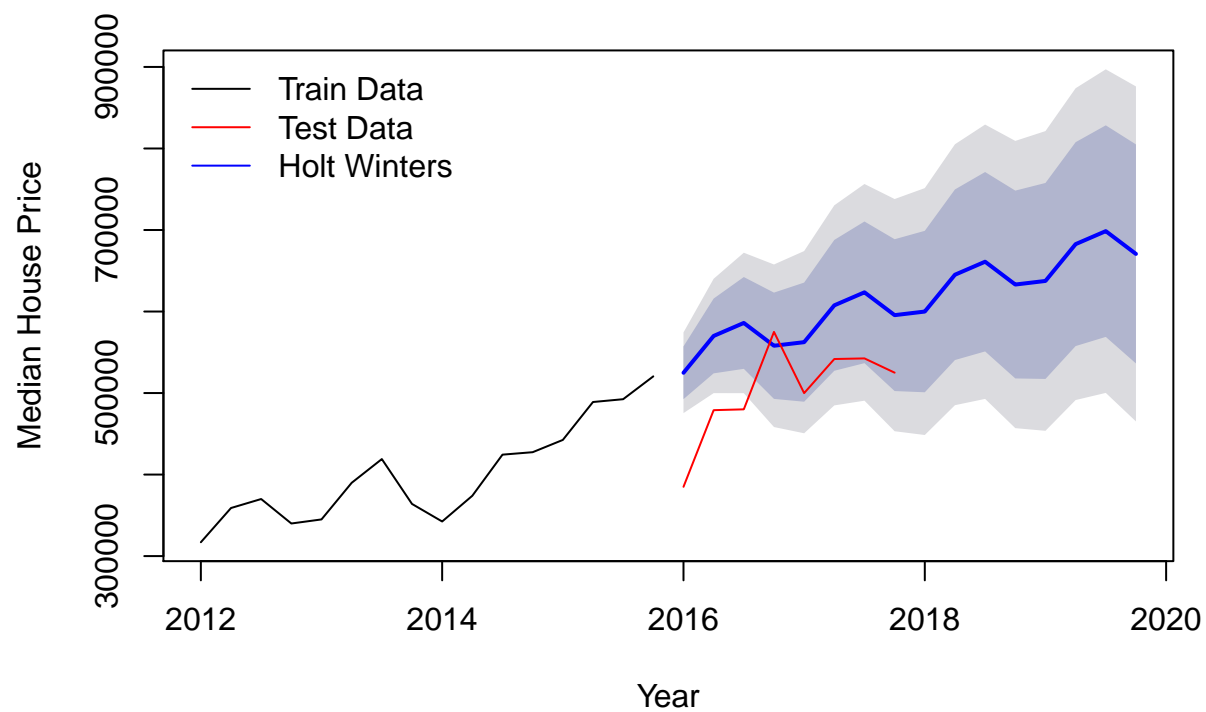
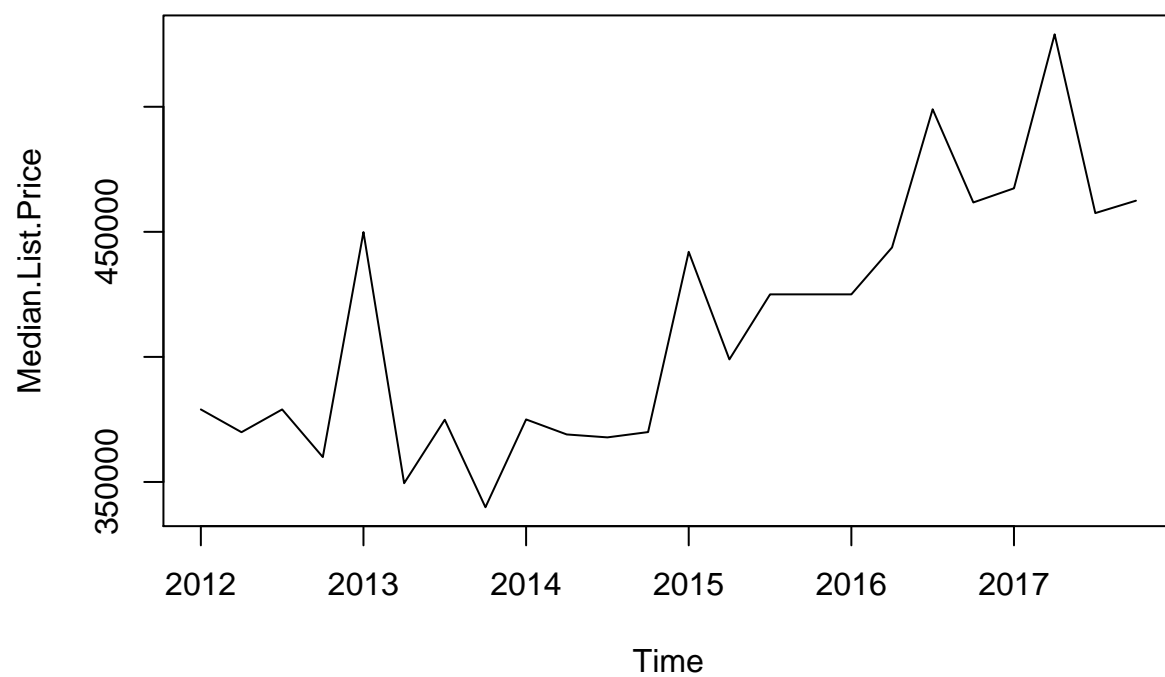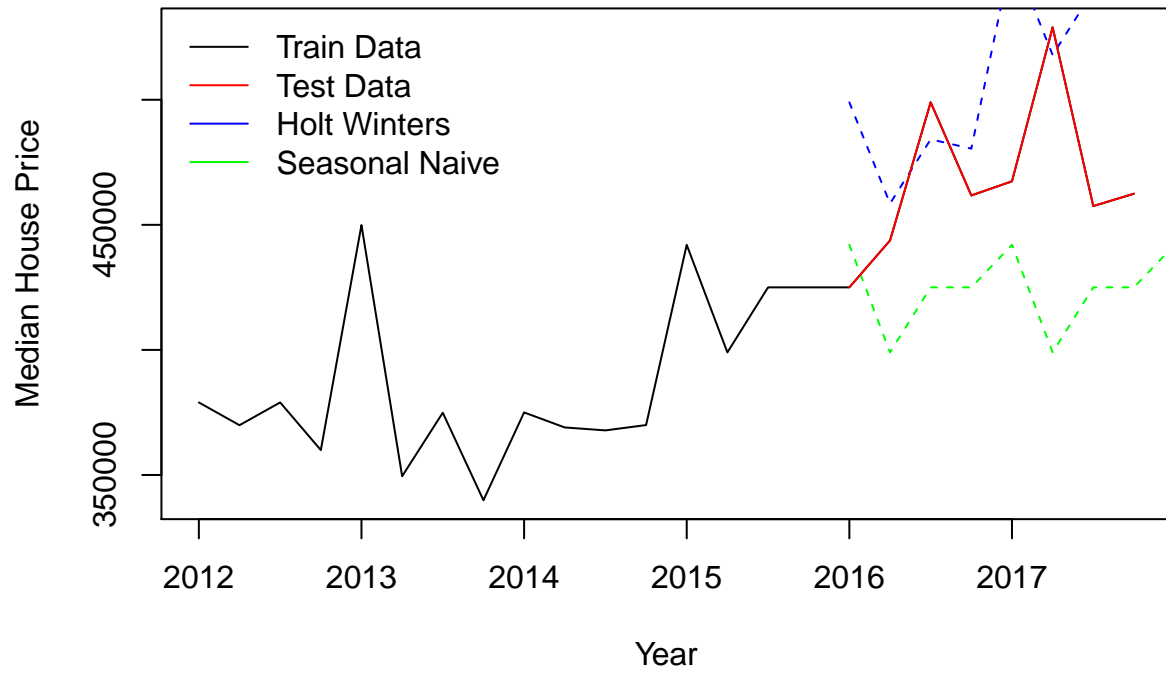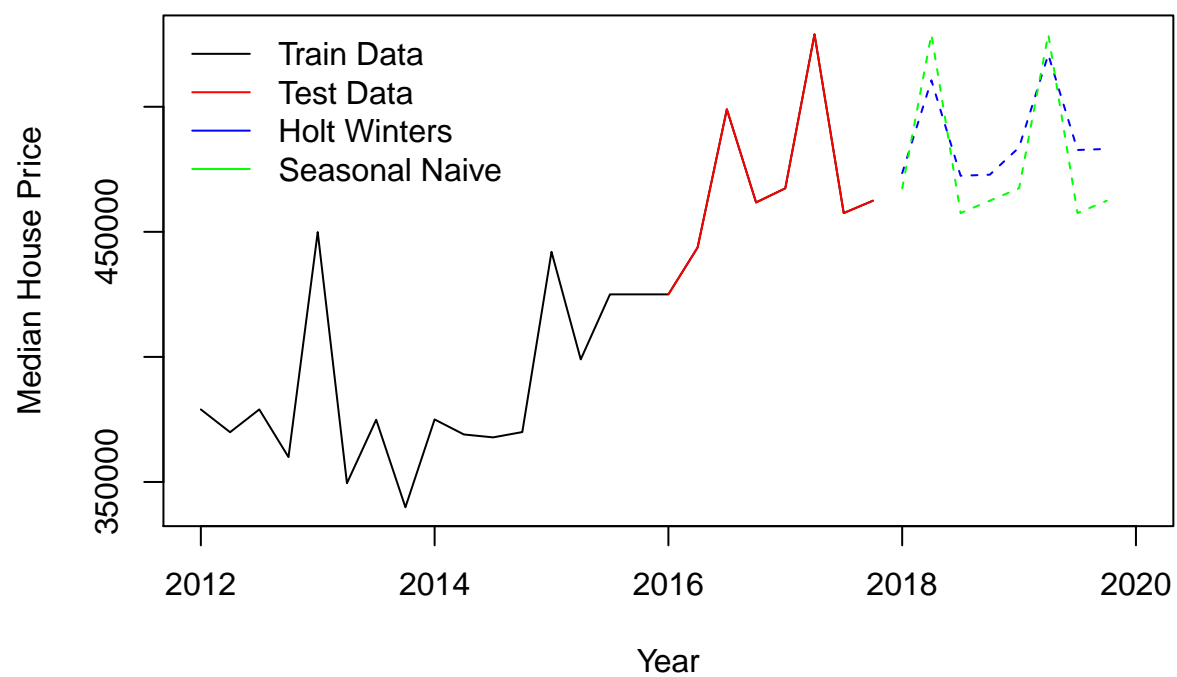**Portland, OR – Sunnyside : Holt Winters Model Forecast Residuals**
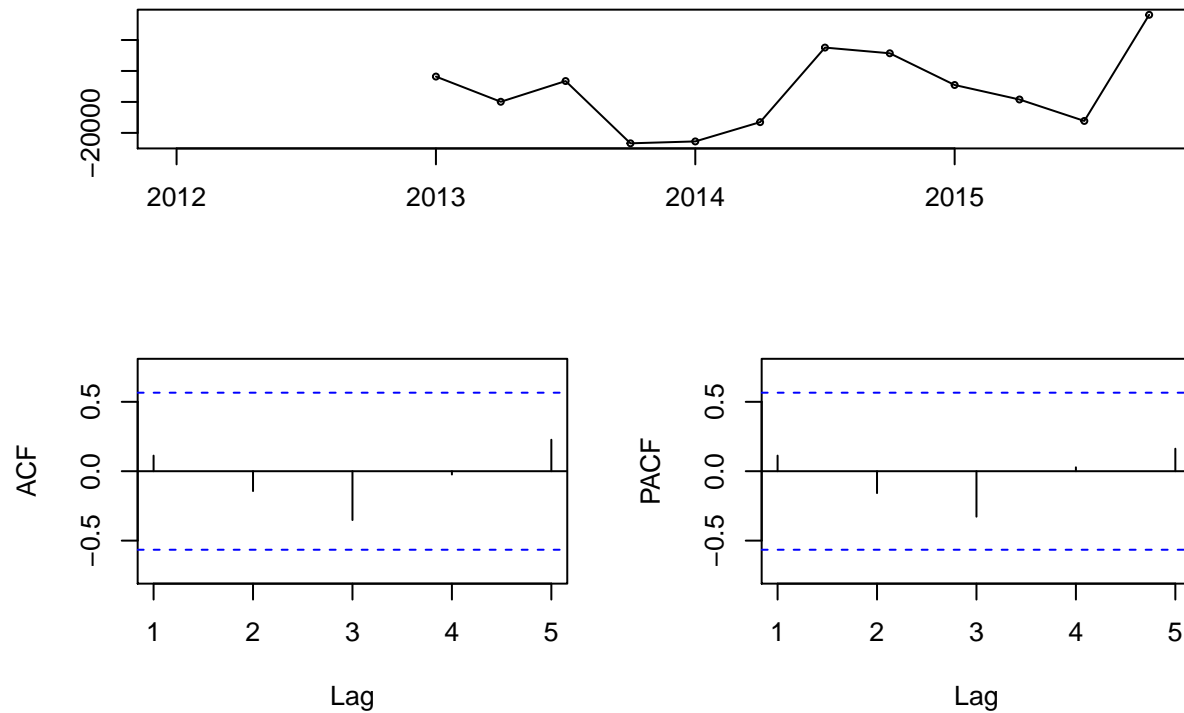

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Sunnyside"
##                     ME     RMSE      MAE       MPE     MAPE      MASE
## Training set 46535.42 61605.86 49610.42 10.272501 11.10516 1.0000000
## Test set     17412.50 43498.60 37400.00  2.646635  7.55076 0.7538739
##                   ACF1 Theil's U
## Training set 0.6787026        NA
## Test set     0.4243160 0.5956491
## [1] "Holt Winters Accuracy for  Portland, OR - Sunnyside"
##                     ME     RMSE      MAE        MPE      MAPE      MASE
## Training set   7310.966 25246.75 20243.02   1.370765  4.834325 0.4080398
## Test set     -74983.033 85996.18 79228.47 -15.937449 16.675786 1.5970128
##                    ACF1 Theil's U
## Training set  0.112575999        NA
## Test set     -0.009466582  1.187051
```

Portland, OR – Sunnyside : TS Training Model Comparison

Median House Price

Year

- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

# Portland, OR – Sunnyside : Full TS Models Comparison
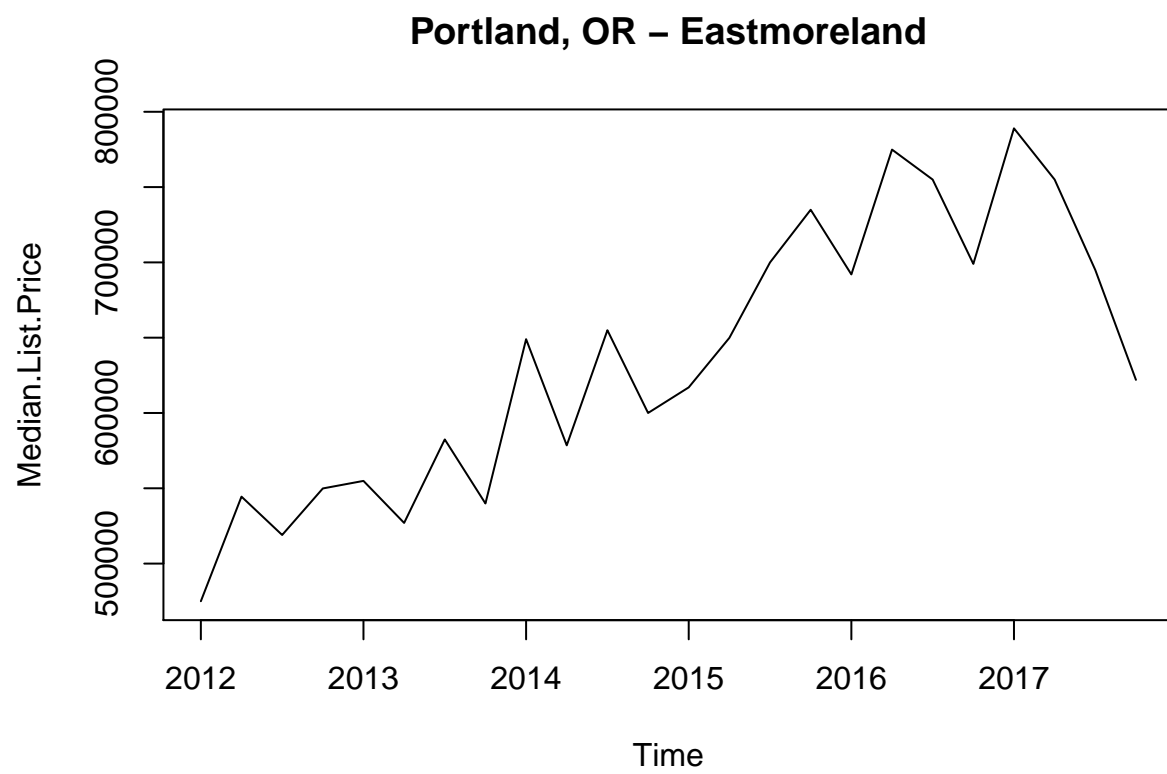
Portland, OR – Eastmoreland

Portland, OR – Eastmoreland : Naive Model Forecast
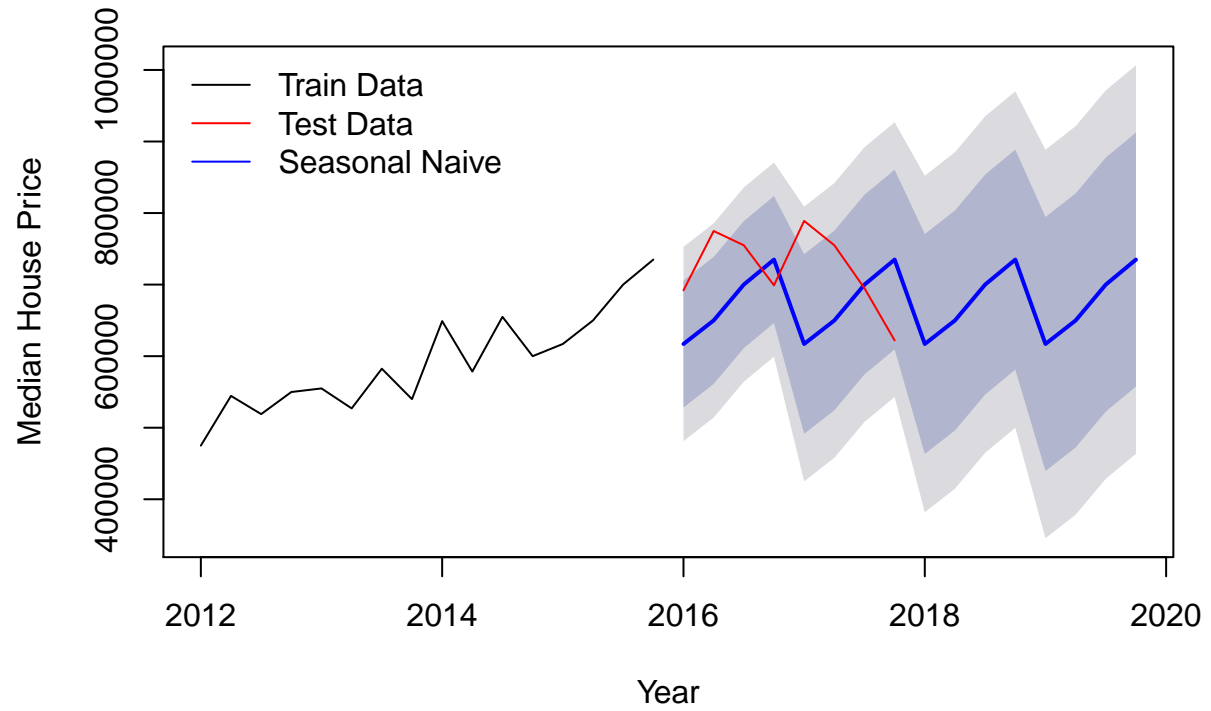
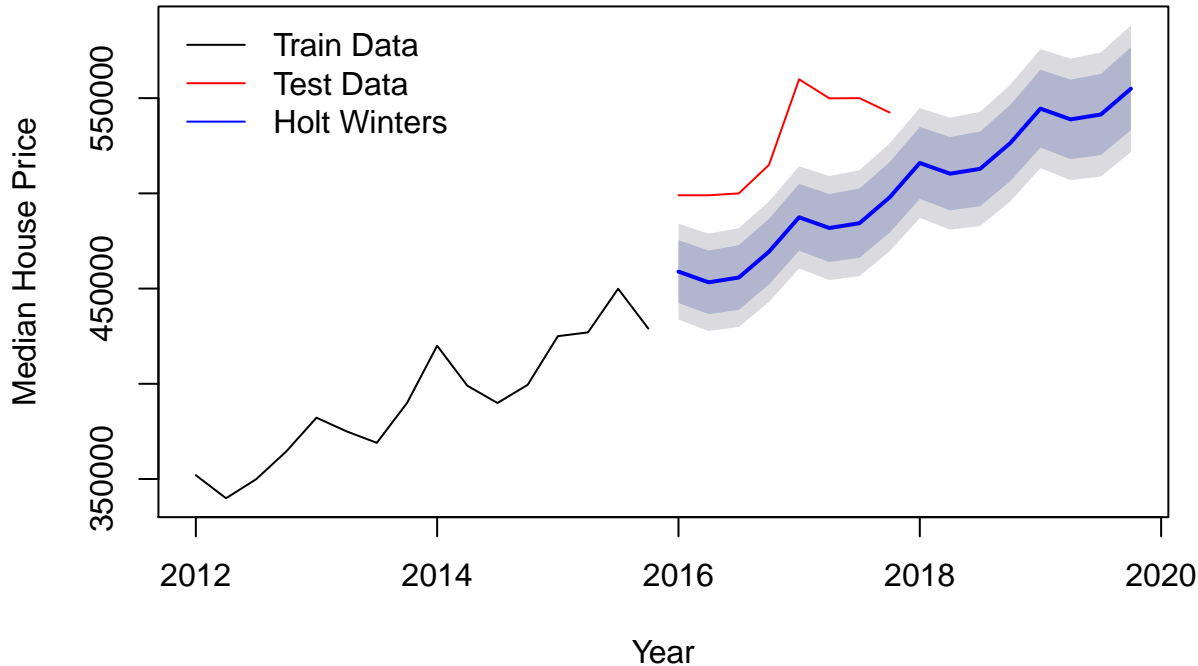**Portland, OR – Eastmoreland : Naive Model Forecast Residuals**
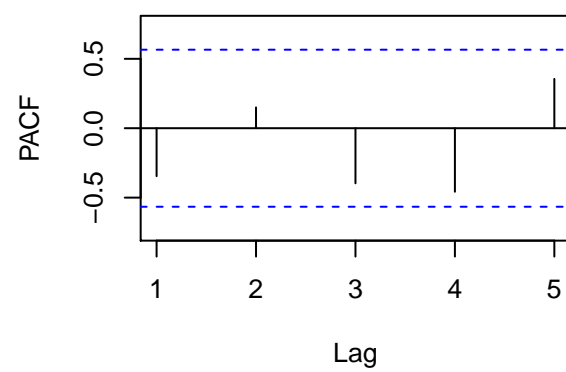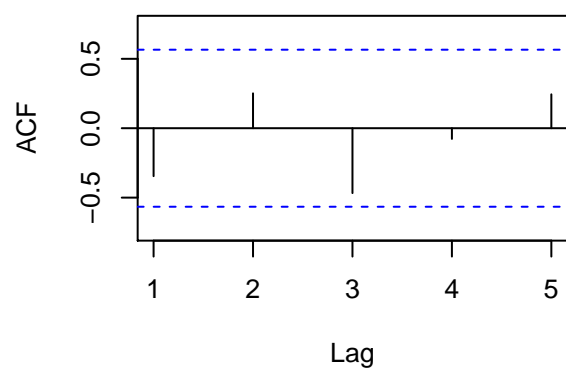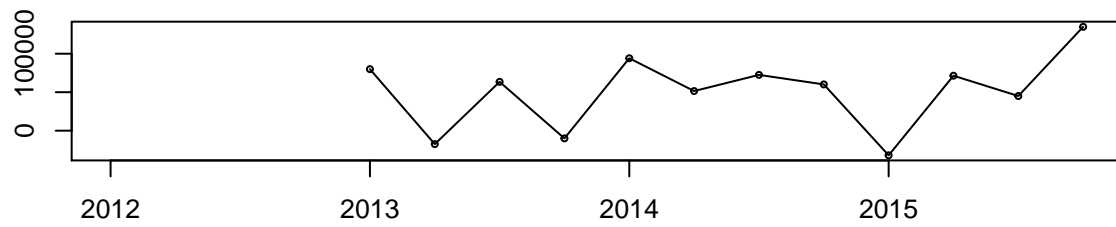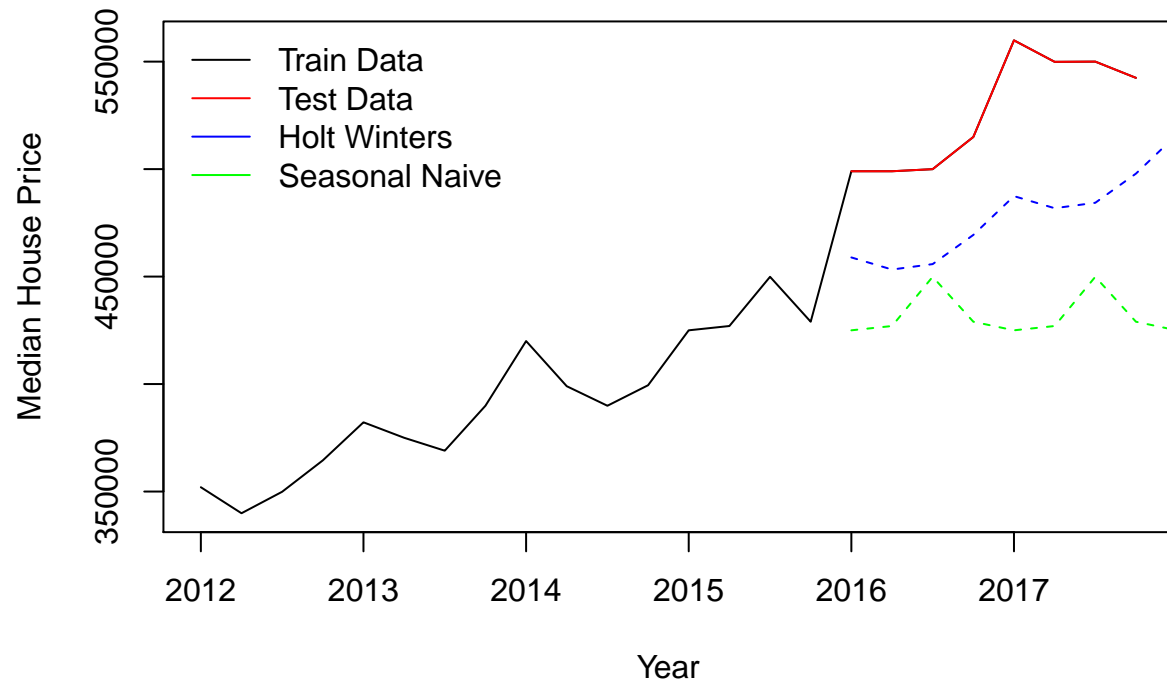
Portland, OR – Eastmoreland : Holt Winters Model Forecast
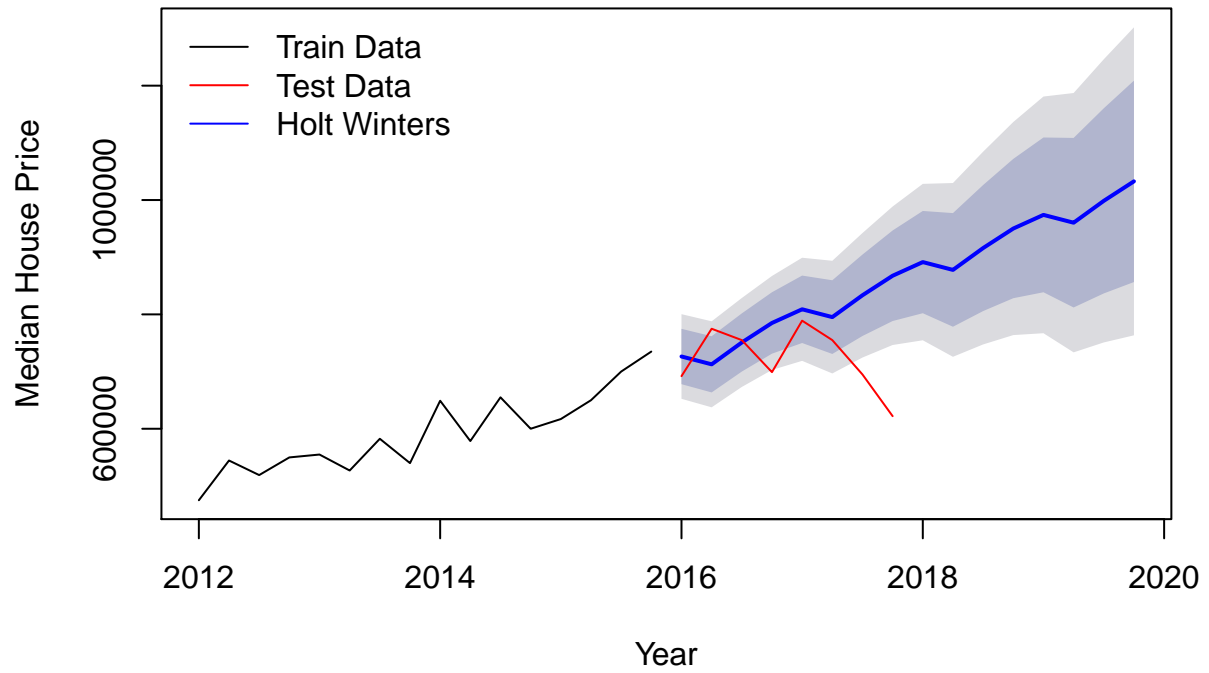
Portland, OR – Eastmoreland : Holt Winters Model Forecast Residuals
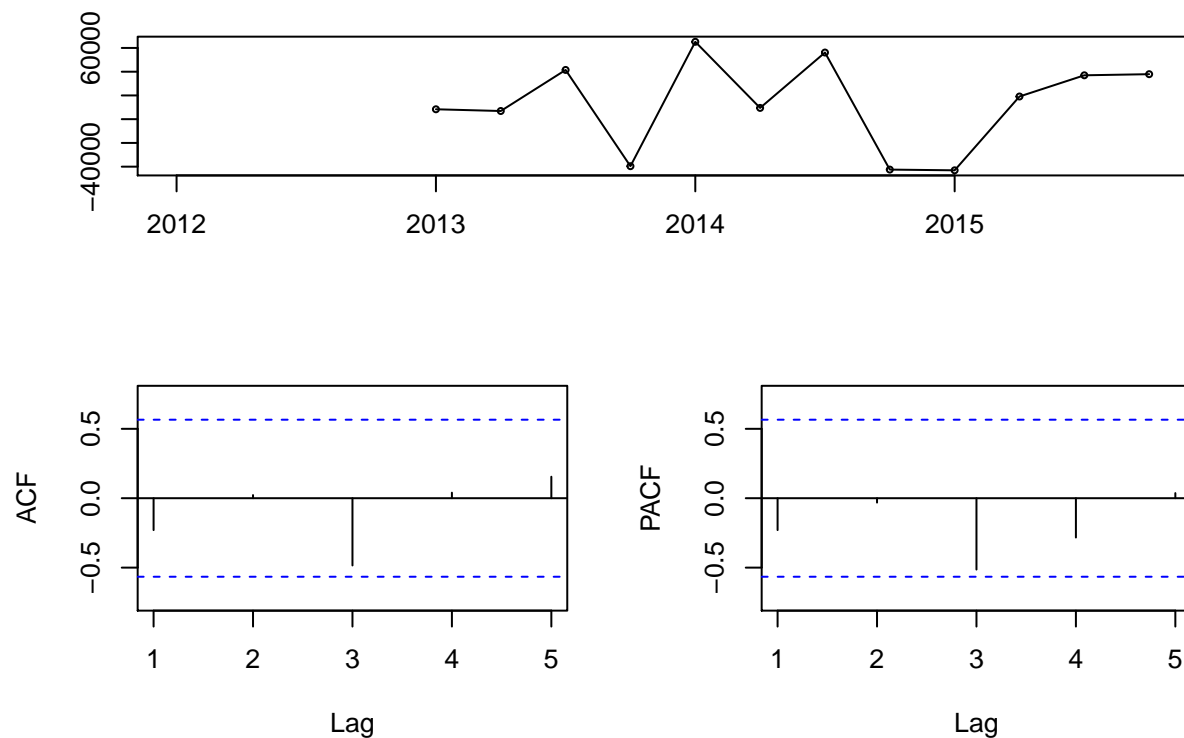

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Eastmoreland"
##                   ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 51124.96 69253.55 61033.29 7.934531  9.659494 1.000000
## Test set     47265.75 99361.03 85759.38 5.742741 11.750853 1.405125
##                   ACF1 Theil's U
## Training set -0.34545249        NA
## Test set      0.07046865  1.603243
## [1] "Holt Winters Accuracy for  Portland, OR - Eastmoreland"
##                   ME      RMSE      MAE      MPE      MAPE      MASE
## Training set  13029.30  38427.08 33884.44  1.847605  5.412951 0.5551796
## Test set     -62284.58 108381.42 78867.41 -9.495348 11.638847 1.2922032
##                  ACF1 Theil's U
## Training set -0.2297927        NA
## Test set      0.3556905  1.803213
```
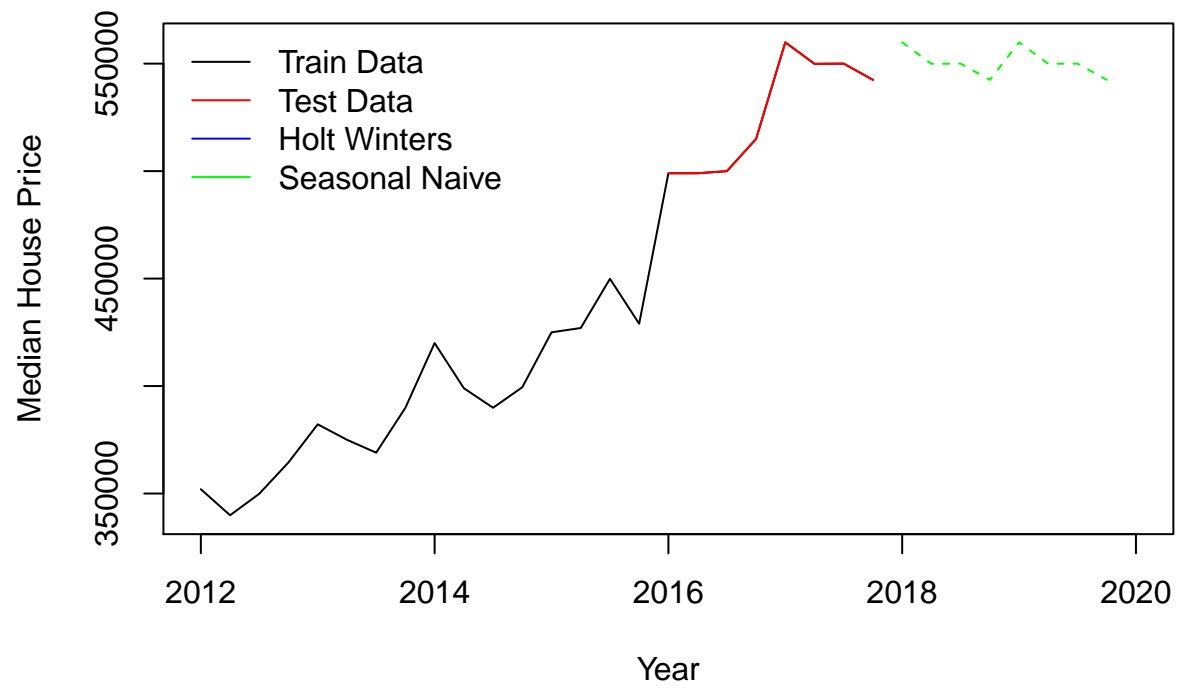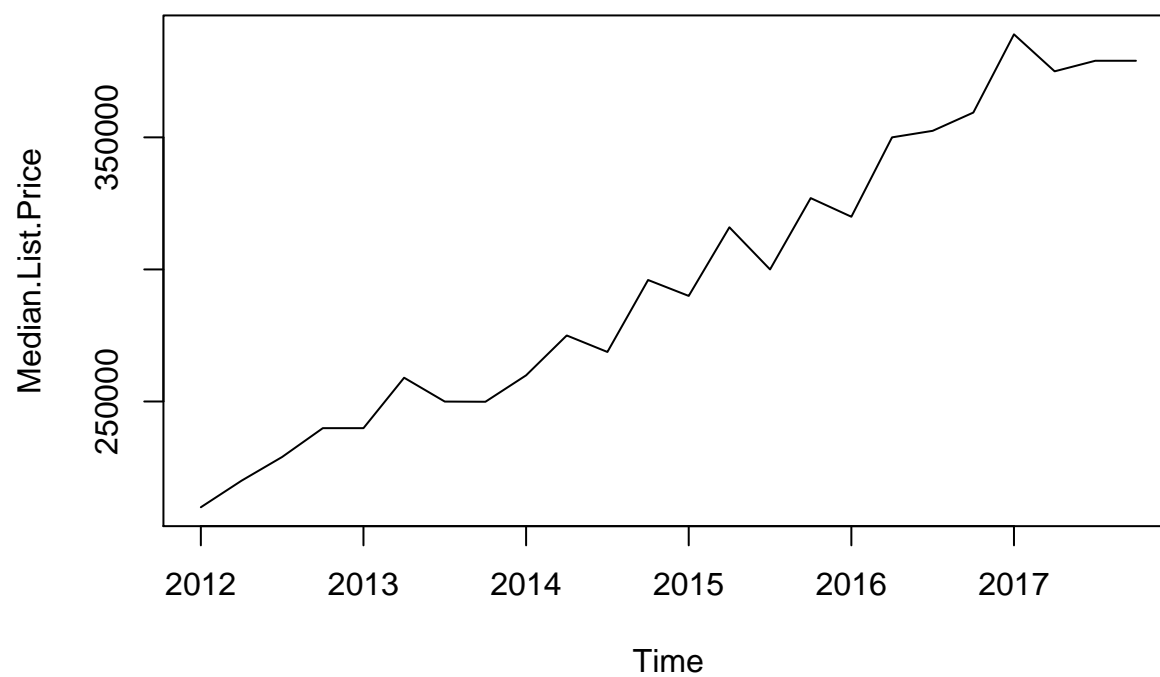
Portland, OR – Eastmoreland : TS Training Model Comparison

Portland, OR – Eastmoreland : Full TS Models Comparison

Portland, OR – Corbett

Portland, OR – Corbett : Naive Model Forecast
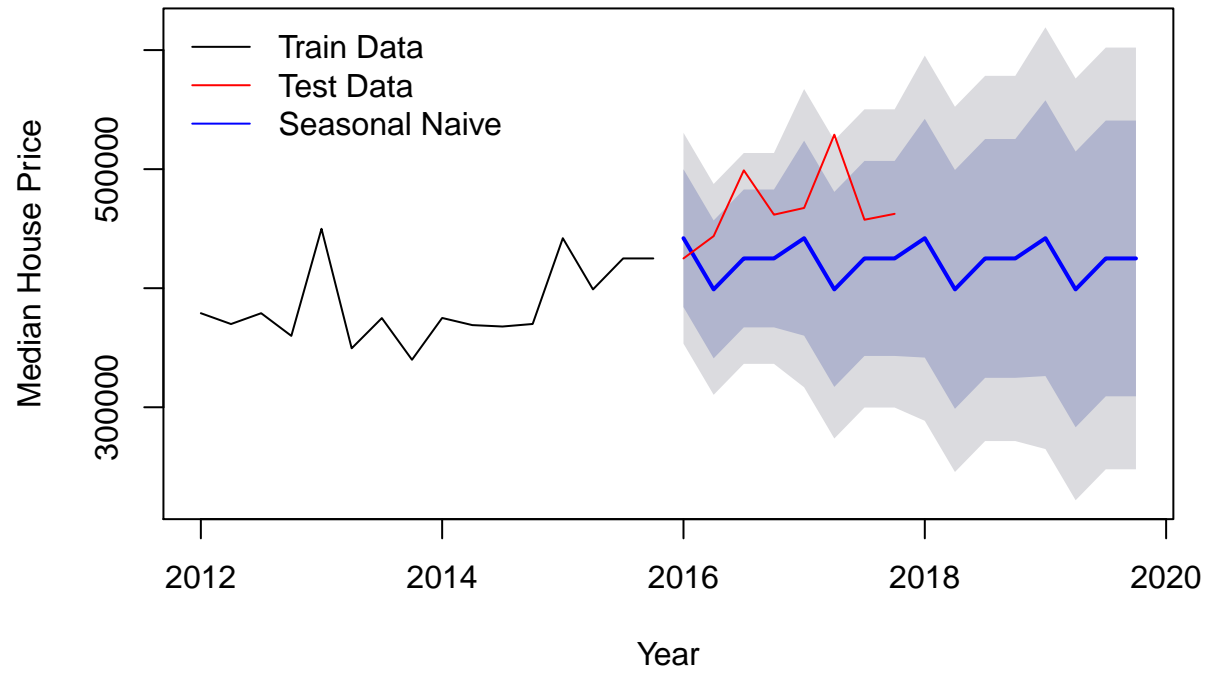

```
## Warning in HoltWinters(trainingData): optimization difficulties: ERROR:
## ABNORMAL_TERMINATION_IN_LNSRCH
```

Portland, OR – Corbett : Naive Model Forecast Residuals
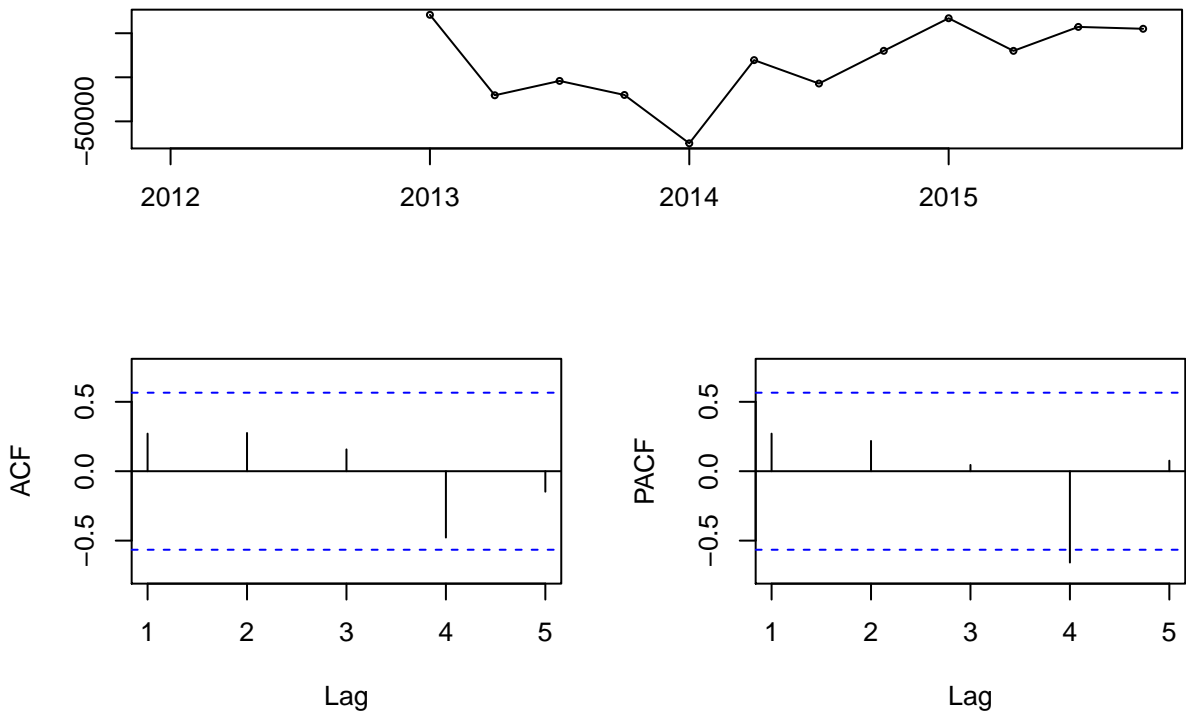
Portland, OR – Corbett : Holt Winters Model Forecast
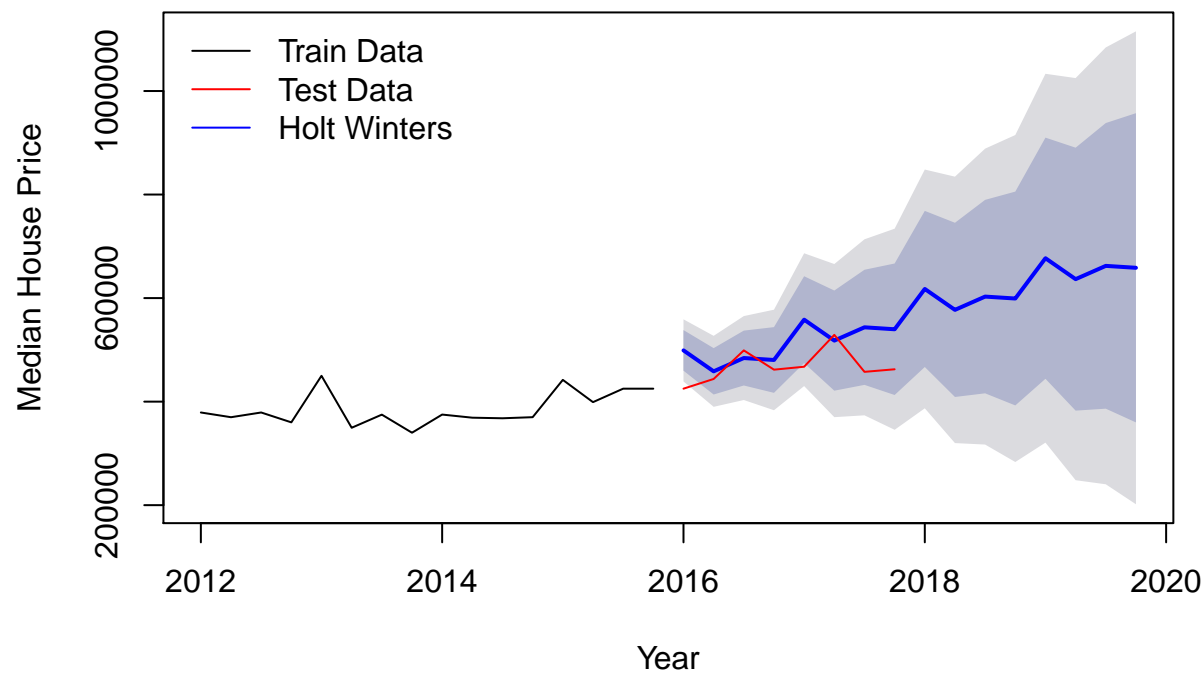
Portland, OR – Corbett : Holt Winters Model Forecast Residuals
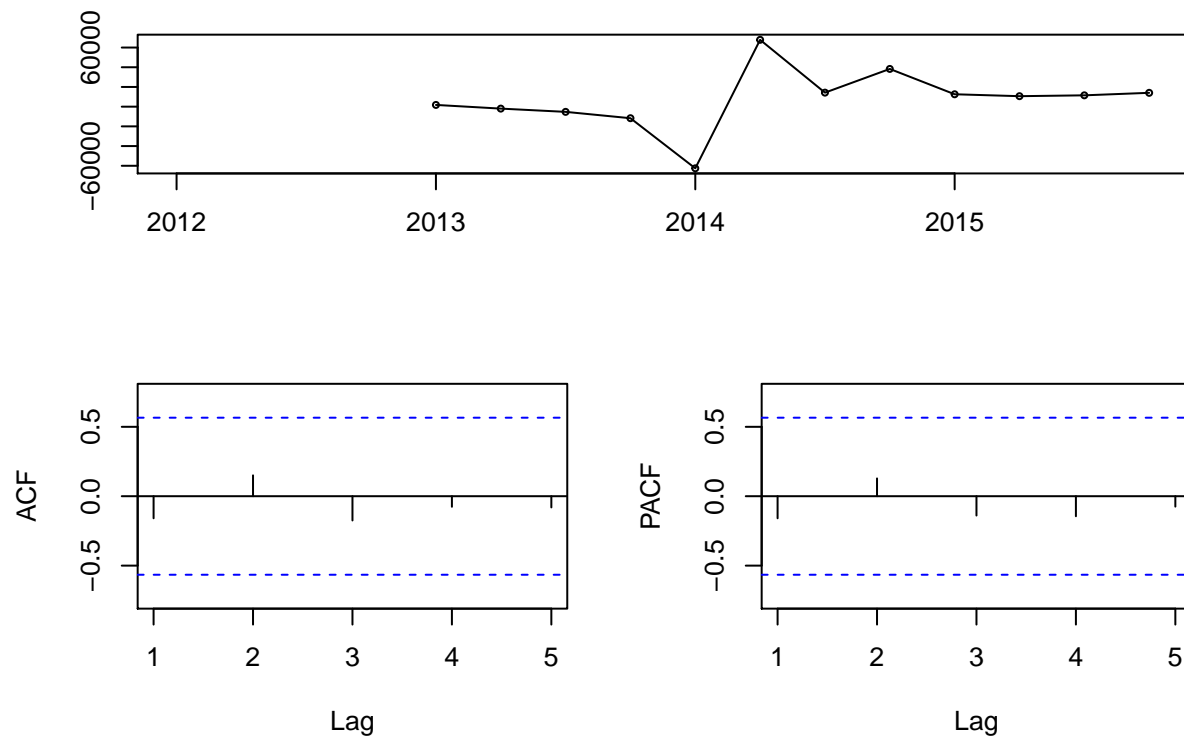

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Corbett"
##                   ME     RMSE      MAE      MPE     MAPE     MASE
## Training set 16929.17 45178.89 38016.67 3.626937  9.414626 1.000000
## Test set     45475.00 60321.06 49725.00 9.259609 10.259609 1.307979
##                ACF1 Theil's U
## Training set  0.2708537        NA
## Test set     -0.2178142  1.514939
## [1] "Holt Winters Accuracy for  Portland, OR - Corbett"
##                   ME     RMSE      MAE      MPE     MAPE      MASE
## Training set   7437.785 30218.36 21033.54  1.865775  5.551639 0.5532715
## Test set     -41983.623 59197.66 48456.70 -9.338395 10.604198 1.2746173
##                ACF1 Theil's U
## Training set -0.1589509        NA
## Test set     -0.1806312  1.290894
```

Portland, OR – Corbett : TS Training Model Comparison

Portland, OR – Corbett : Full TS Models Comparison
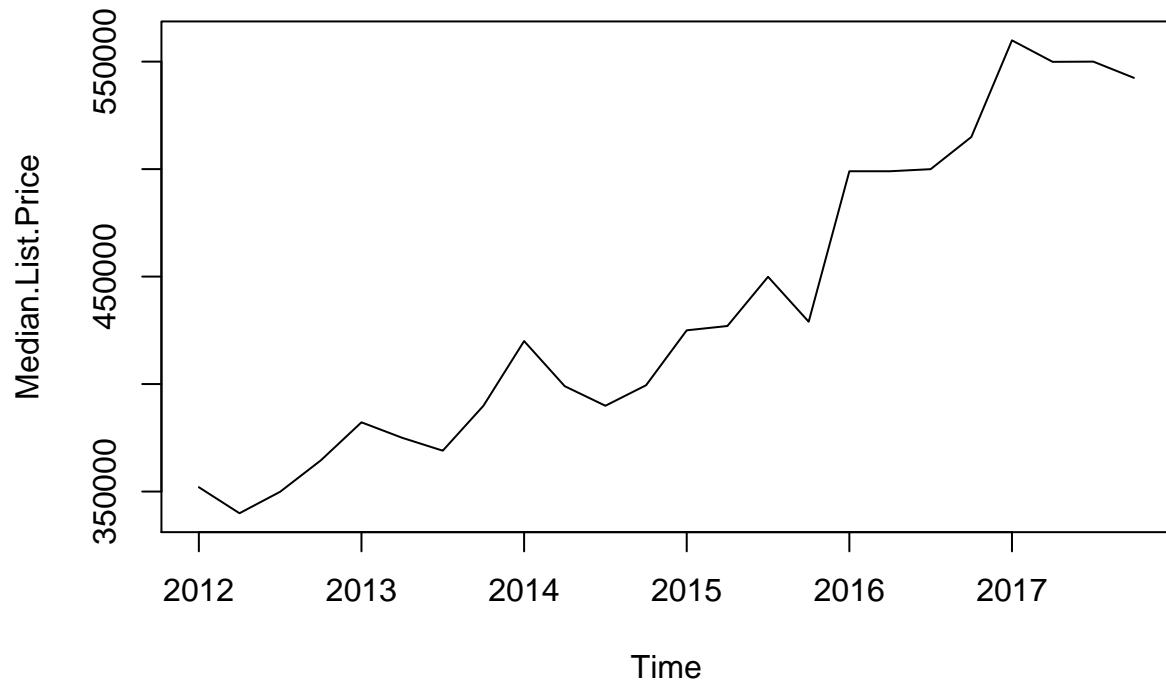
Portland, OR – Northeast Portland

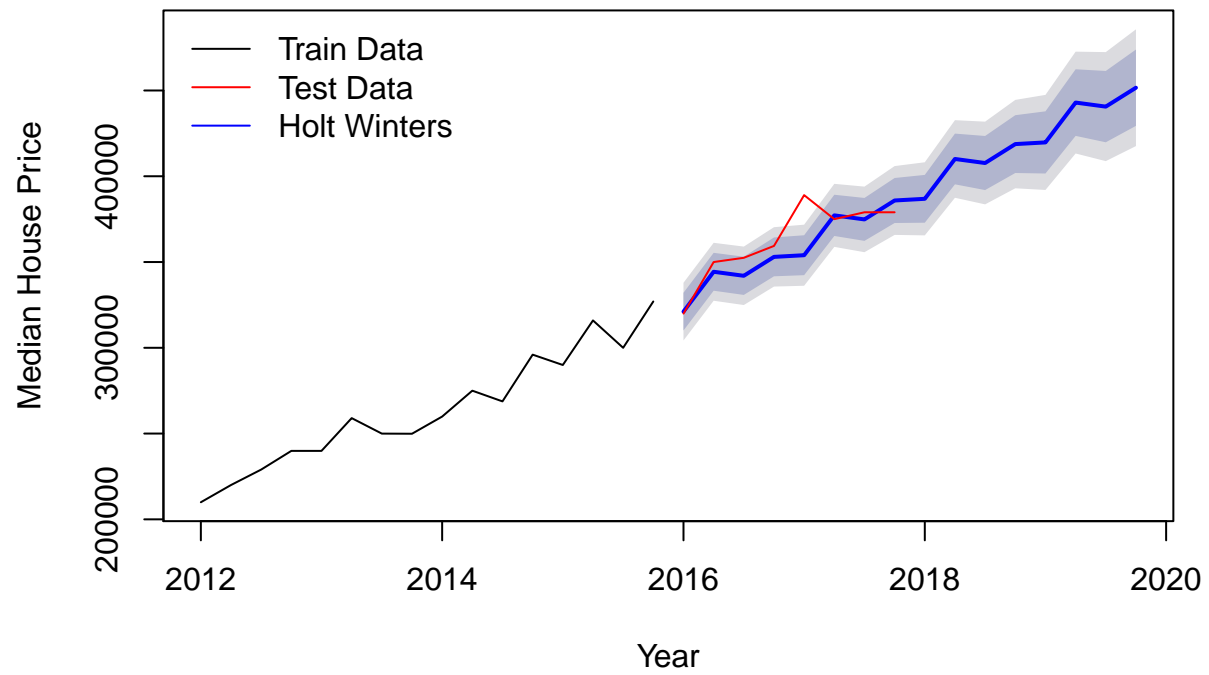**Portland, OR – Northeast Portland : Naive Model Forecast**
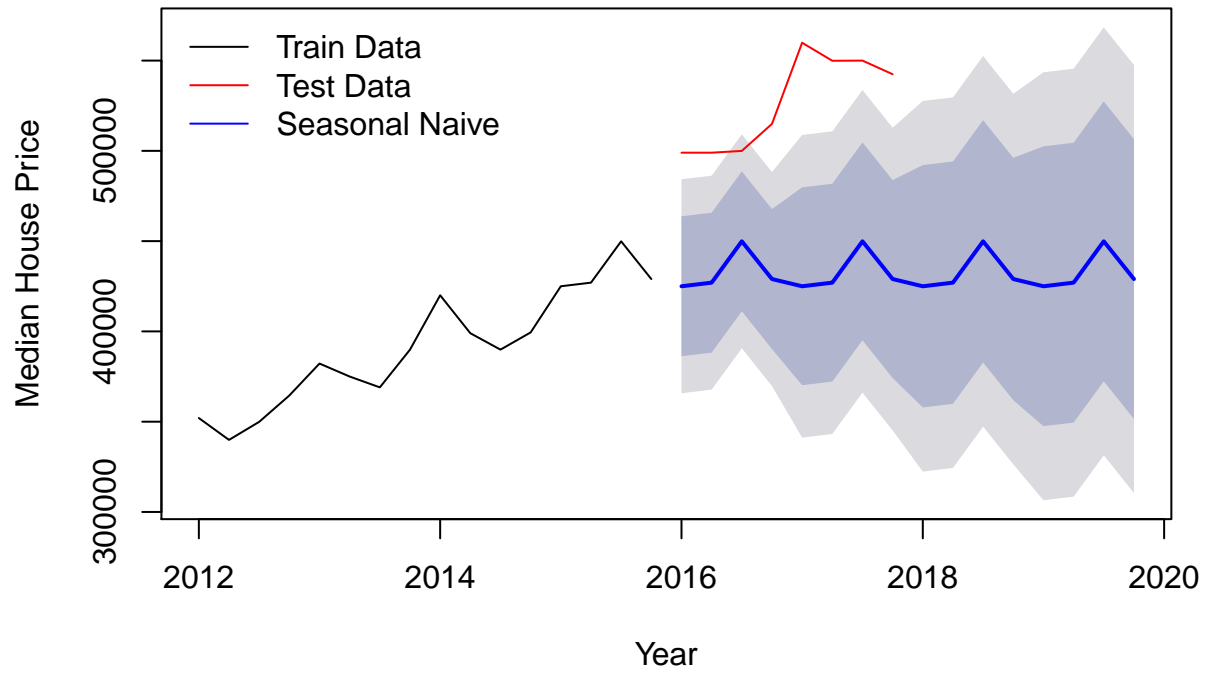
# Portland, OR – Northeast Portland : Naive Model Forecast Residuals
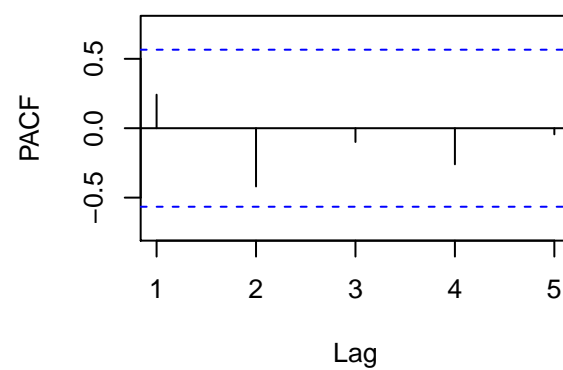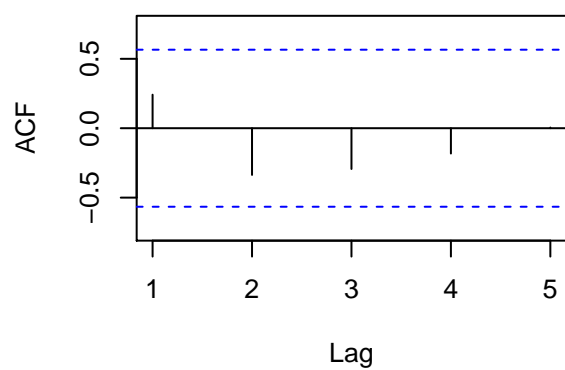
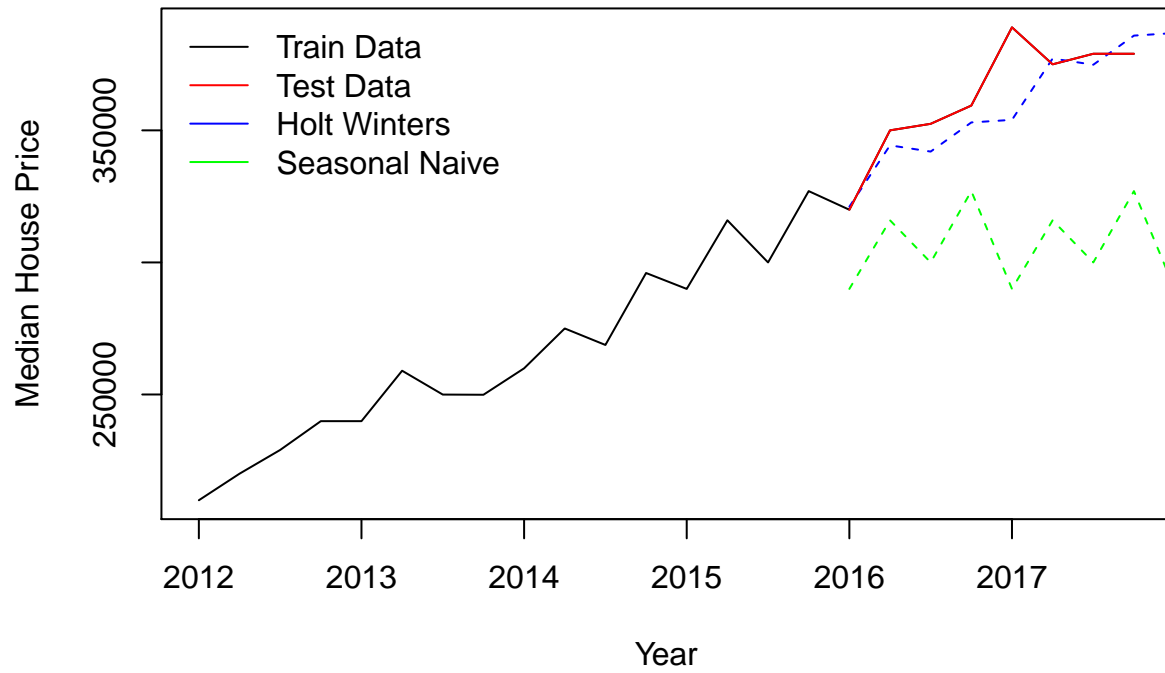# Portland, OR – Northeast Portland : Holt Winters Model Forecast

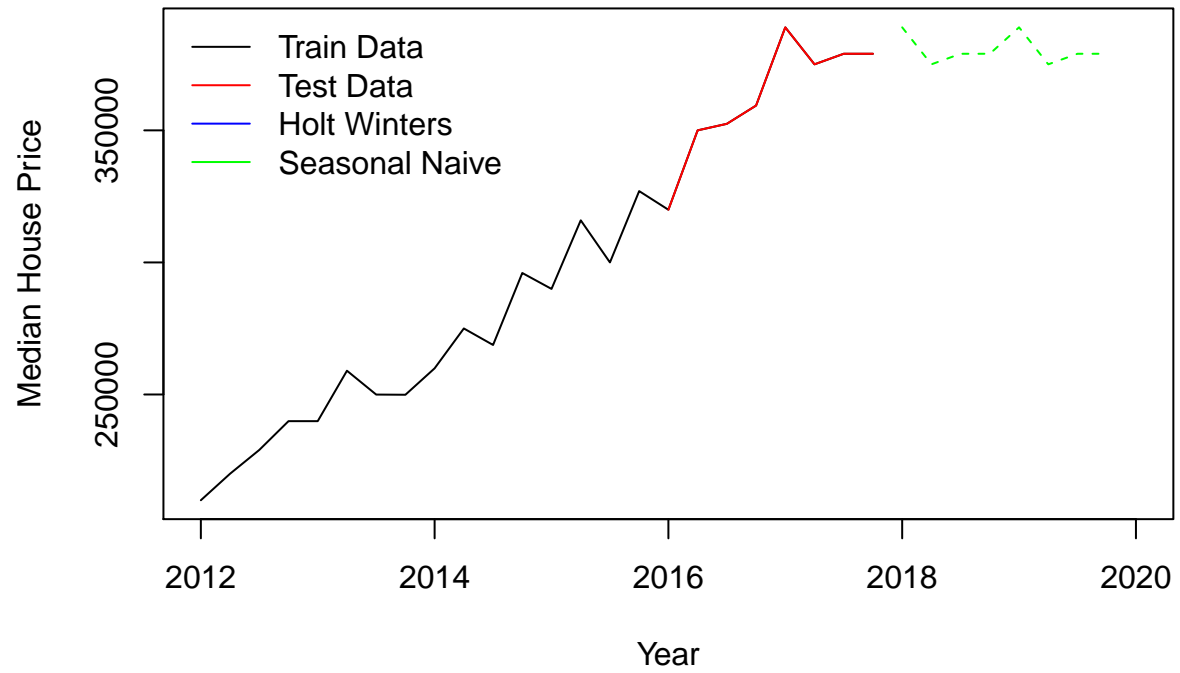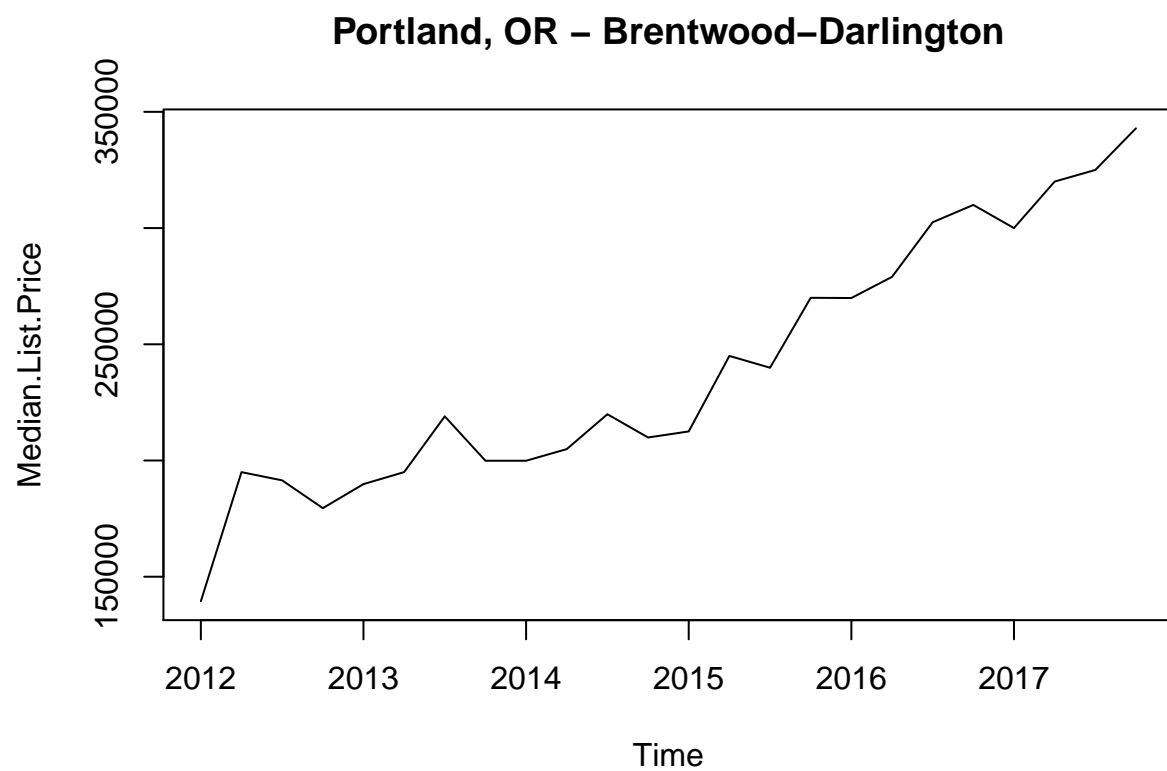**Portland, OR – Northeast Portland : Holt Winters Model Forecast Residuals**
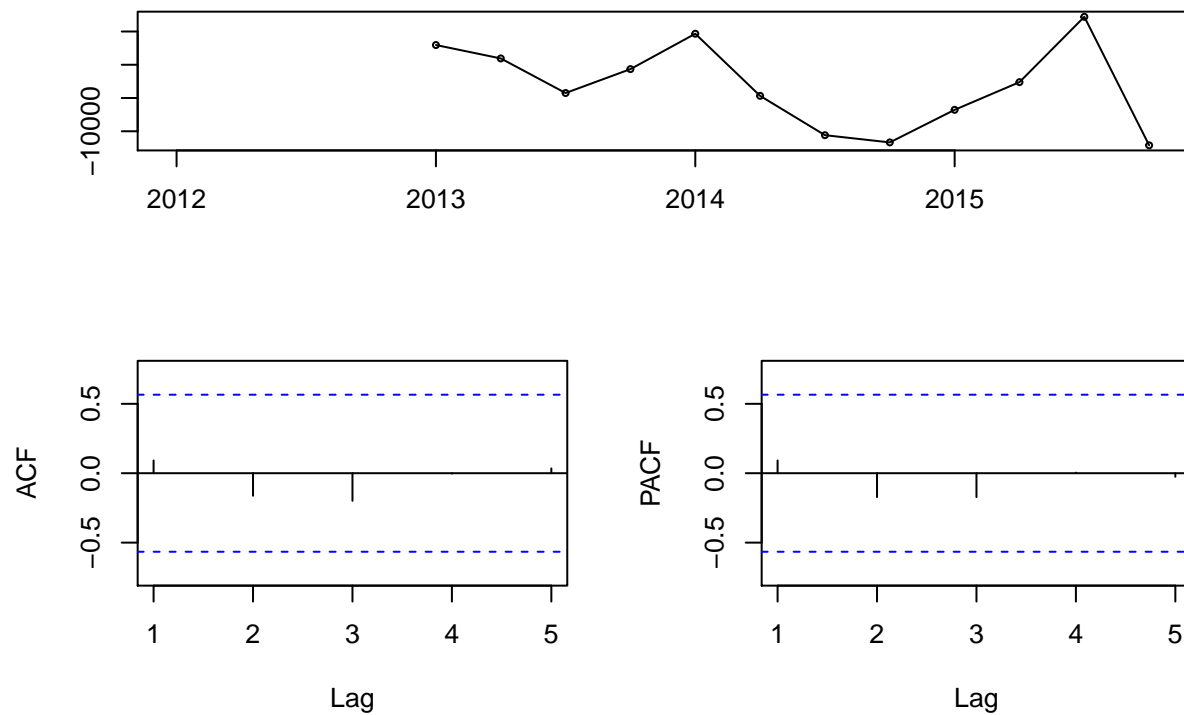

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Northeast Portland"
##                    ME      RMSE      MAE       MPE      MAPE   MASE
## Training set 27050.00 30233.91 27050.00  6.639725  6.639725 1.0000
## Test set     94171.88 97946.57 94171.88 17.690304 17.690304 3.4814
##                   ACF1 Theil's U
## Training set 0.2416746        NA
## Test set     0.5011262  5.293107
## [1] "Holt Winters Accuracy for  Portland, OR - Northeast Portland"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set  3740.124 12857.60 10789.74  0.9104444  2.636921 0.3988814
## Test set     53291.417 54670.11 53291.42 10.0448708 10.044871 1.9701078
##                    ACF1 Theil's U
## Training set 0.09199848        NA
## Test set     0.37810643  2.975952
```

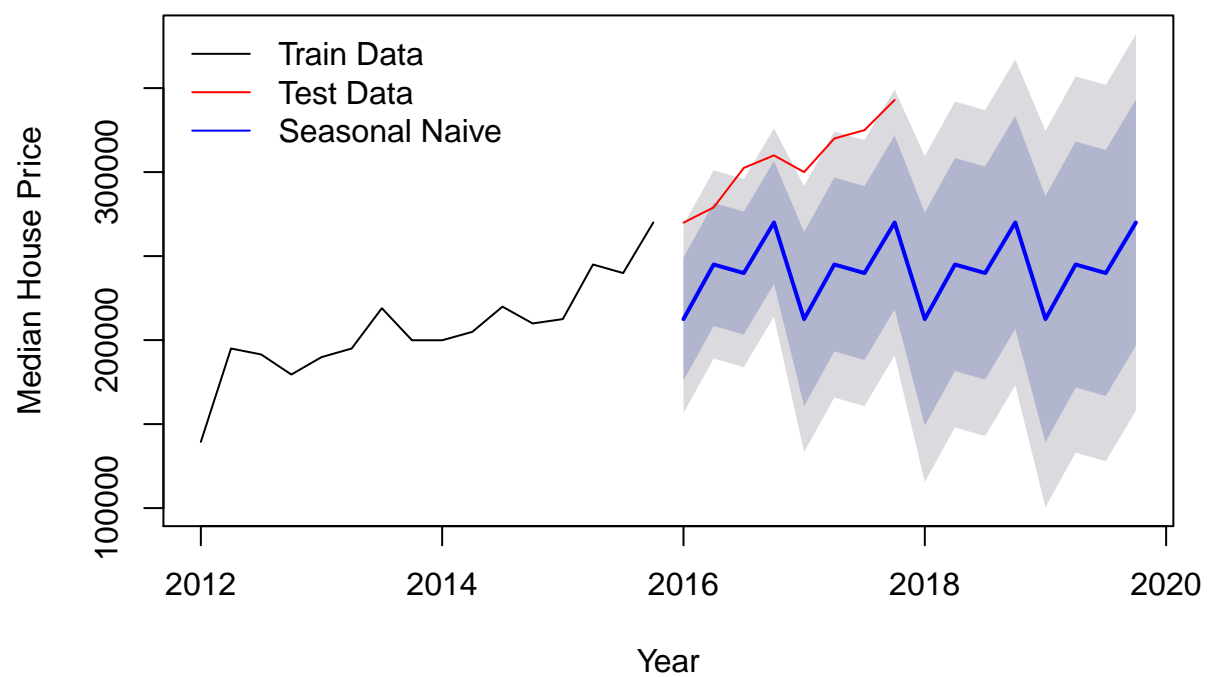Portland, OR – Northeast Portland : TS Training Model Comparisor

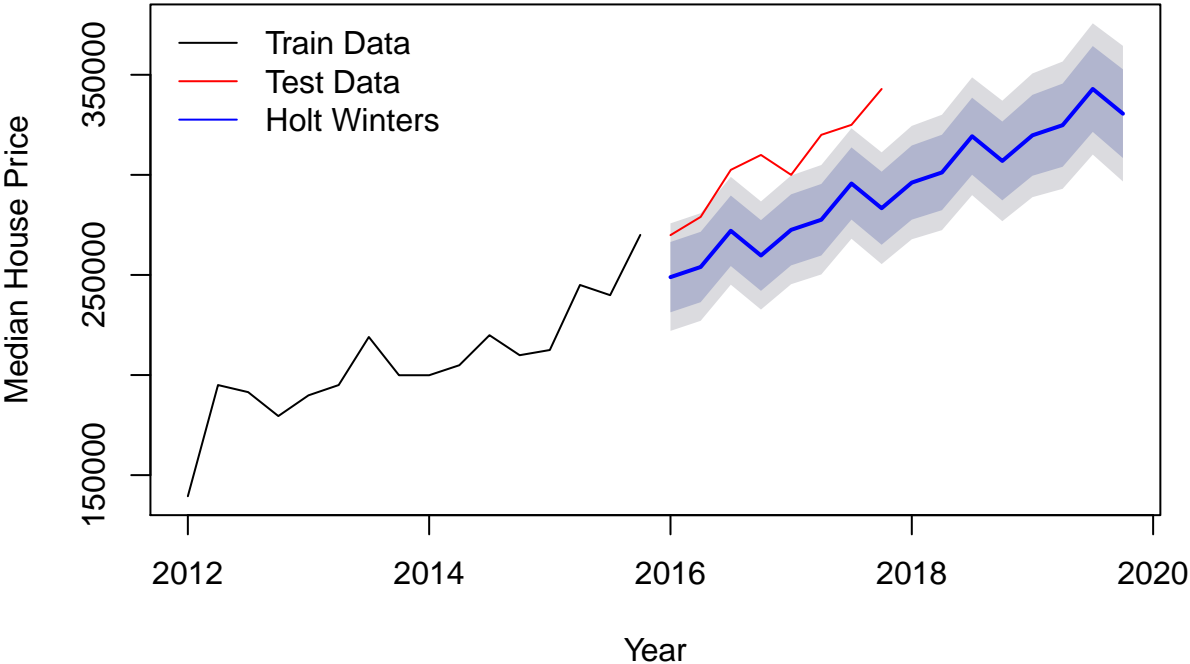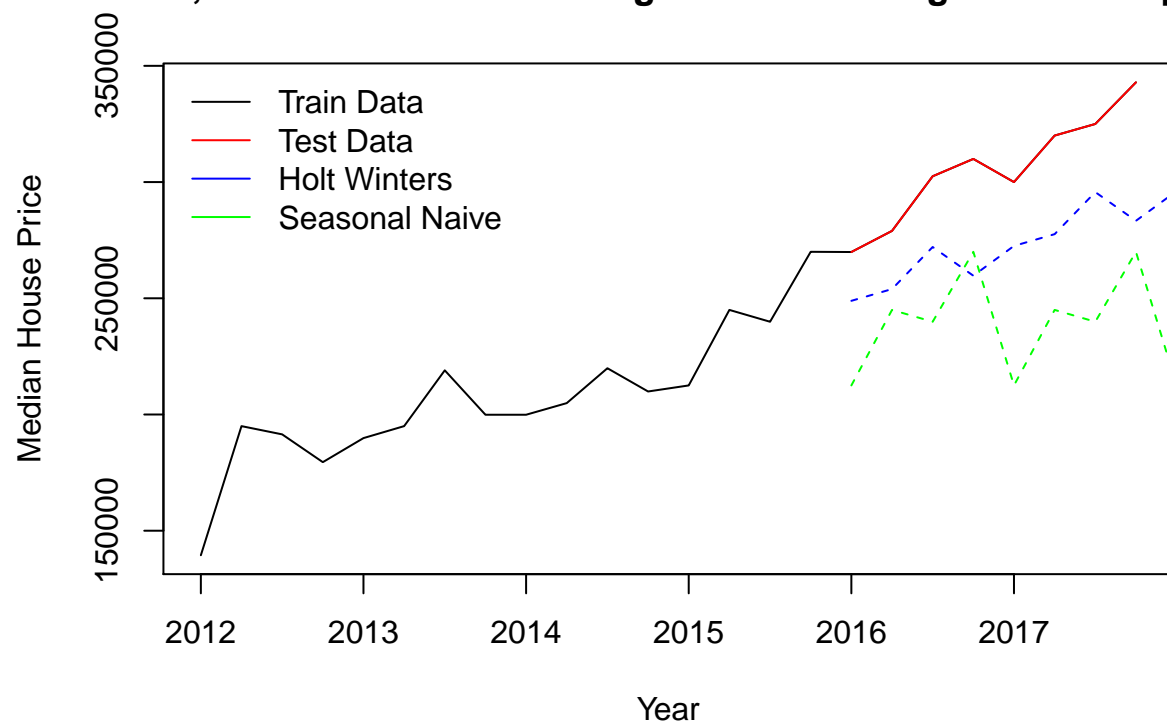**Portland, OR – Northeast Portland : Full TS Models Comparison**

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

X-axis: Year
Y-axis: Median House Price

Portland, OR – North Portland

Portland, OR – North Portland : Naive Model Forecast
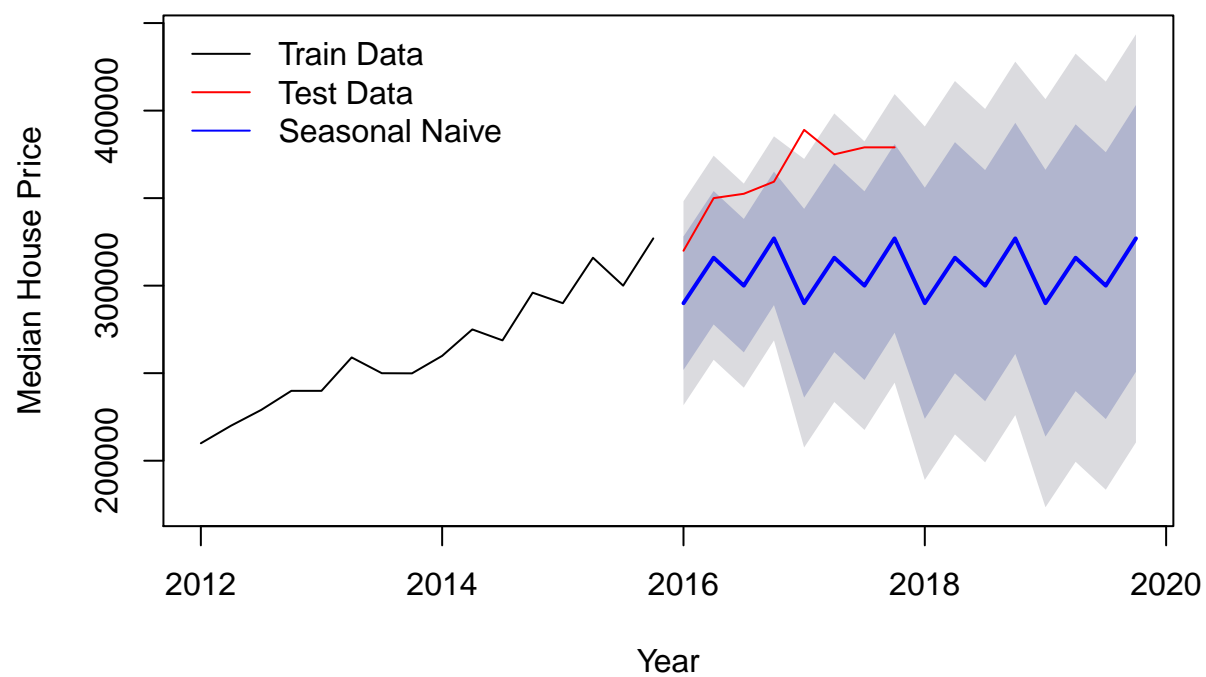
Portland, OR – North Portland : Naive Model Forecast Residuals
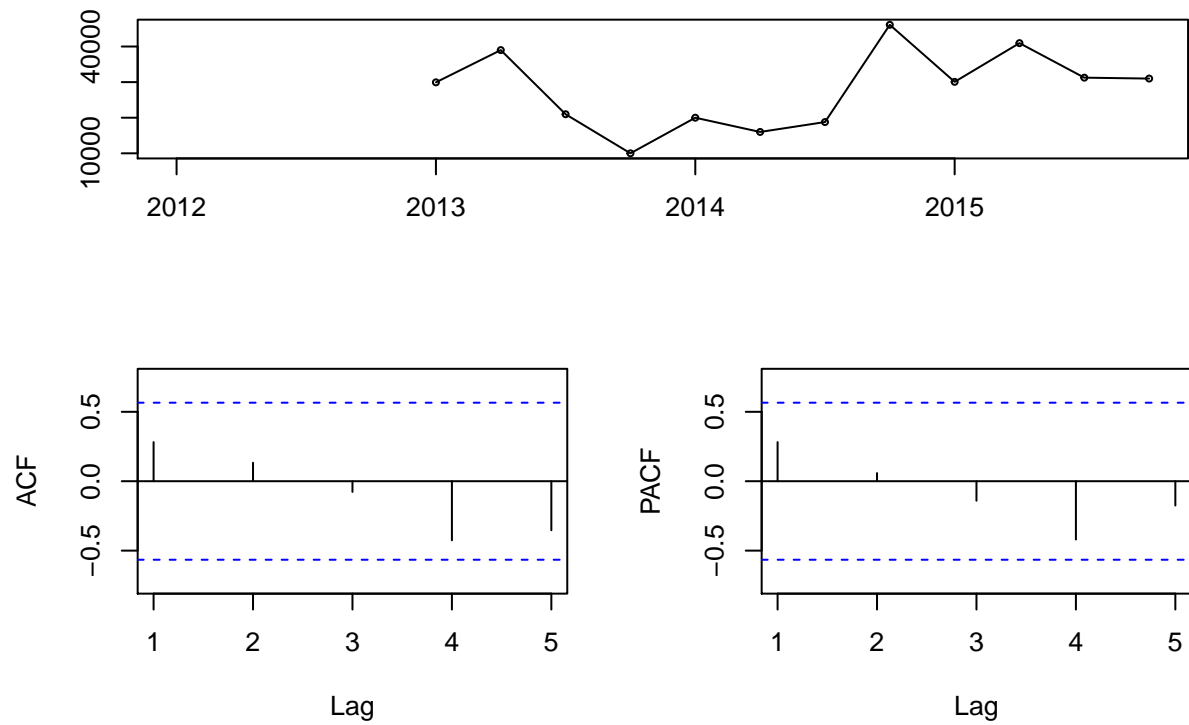
Portland, OR – North Portland : Holt Winters Model Forecast

Portland, OR – North Portland : Holt Winters Model Forecast Residuals
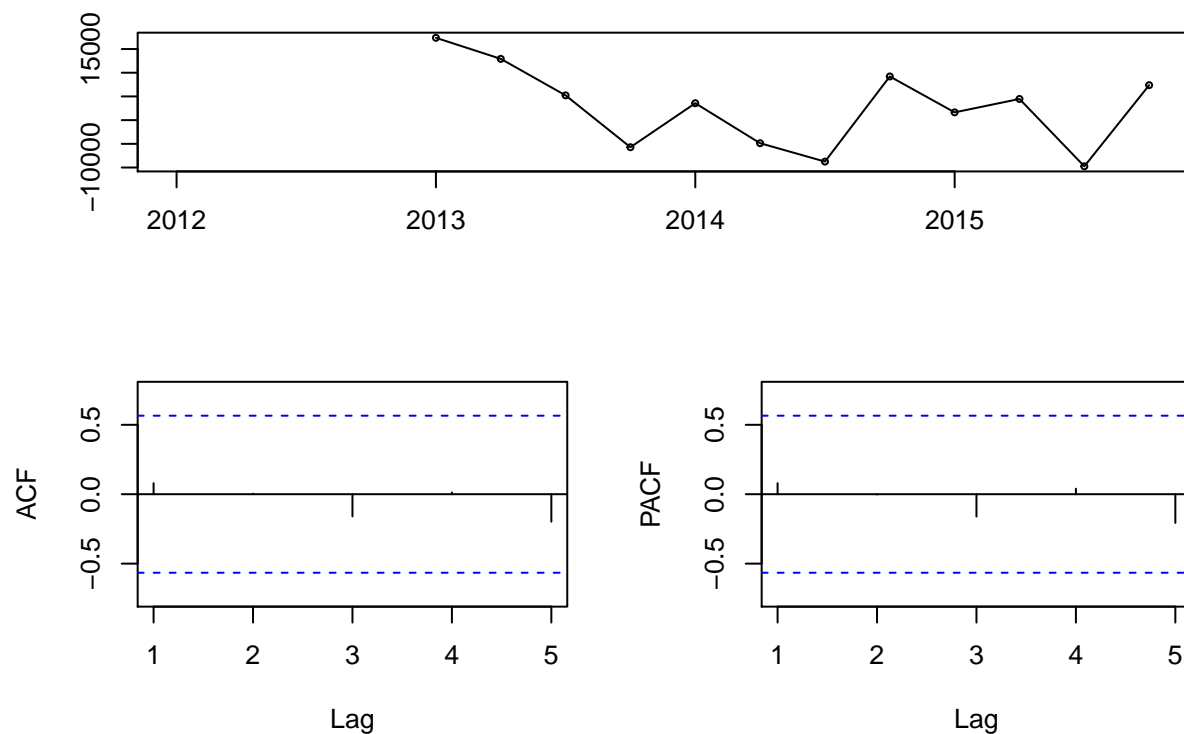

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - North Portland"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 27838.54 29734.78 27838.54  9.936051  9.936051 1.000000
## Test set     54745.44 59264.66 54745.44 14.845566 14.845566 1.966534
##                    ACF1 Theil's U
## Training set  0.28192717       NA
## Test set     -0.03667067  3.422276
## [1] "Holt Winters Accuracy for  Portland, OR - North Portland"
##                   ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 2723.962  8653.144 7571.670 1.039432 2.800171 0.2719852
## Test set     6441.030 13605.533 8997.244 1.715107 2.405099 0.3231938
##                    ACF1 Theil's U
## Training set  0.07943853       NA
## Test set     -0.17041426 0.8126438
```

Portland, OR – North Portland : TS Training Model Comparison

Portland, OR – North Portland : Full TS Models Comparison

Median House Price vs. Year, with legend: Train Data, Test Data, Holt Winters, Seasonal Naive.

Portland, OR – Brentwood–Darlington

Portland, OR – Brentwood–Darlington : Naive Model Forecast

Portland, OR – Brentwood–Darlington : Naive Model Forecast Residuals
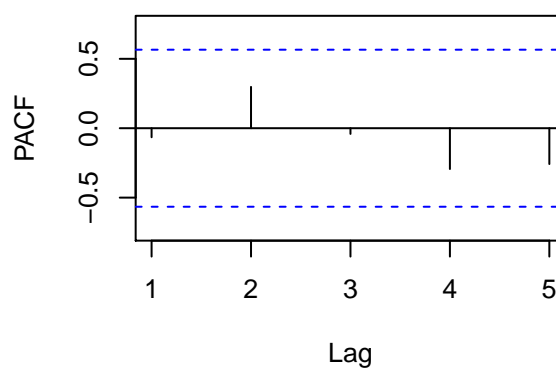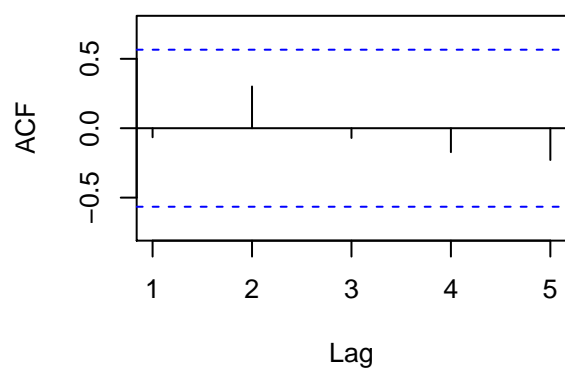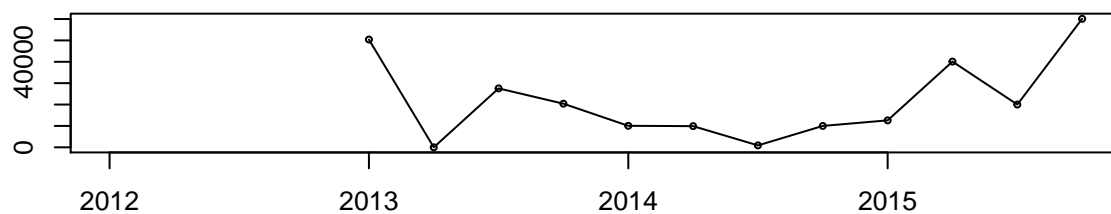
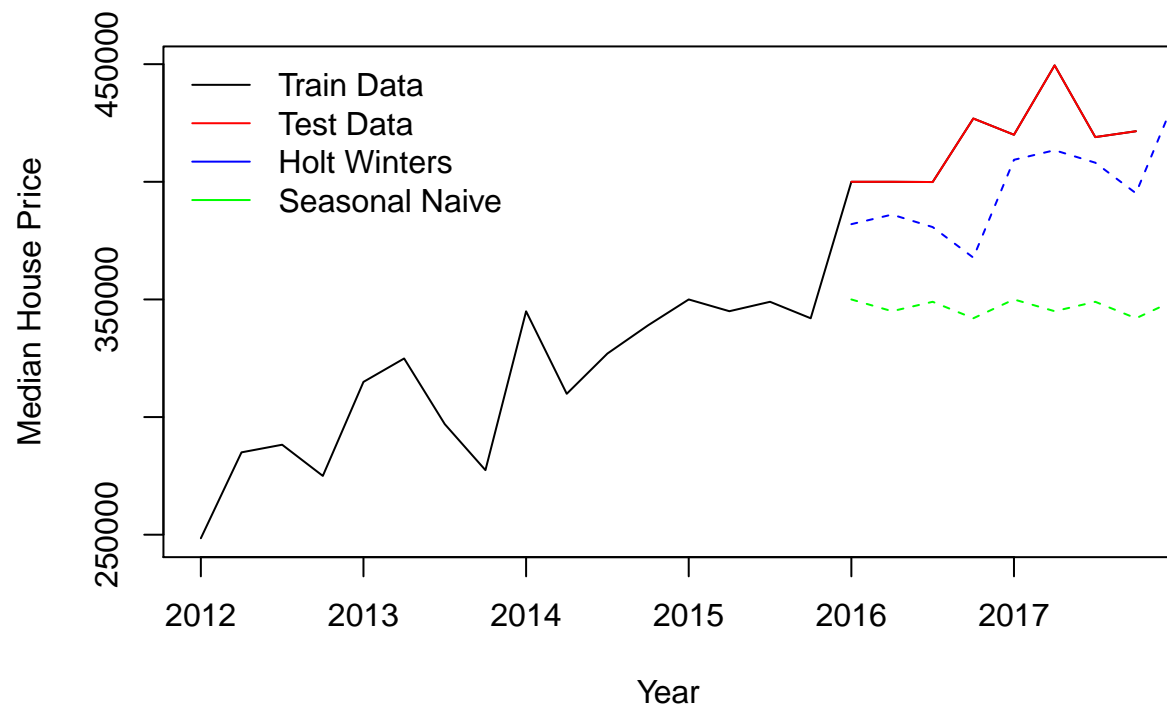**Portland, OR – Brentwood–Darlington : Holt Winters Model Forecas**

Portland, OR – Brentwood–Darlington : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Brentwood-Darlington"
##                    ME      RMSE      MAE       MPE      MAPE     MASE
## Training set 21833.33 28568.52 21833.33  9.771475  9.771475 1.000000
## Test set     64306.25 66898.42 64306.25 20.885691 20.885691 2.945324
##                   ACF1 Theil's U
## Training set -0.0649892        NA
## Test set      0.1421418  4.440727
## [1] "Holt Winters Accuracy for  Portland, OR - Brentwood-Darlington"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set  3514.74 13581.07 11051.12  1.386235  4.878437 0.5061581
## Test set     35681.27 37877.09 35681.27 11.477190 11.477190 1.6342564
##                   ACF1 Theil's U
## Training set -0.1040843        NA
## Test set     -0.1806263  2.588907
```

Portland, OR – Brentwood–Darlington : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

Portland, OR – Brentwood–Darlington : Full TS Models Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

X-axis: Year (2012, 2014, 2016, 2018, 2020)

Y-axis: Median House Price (150000, 250000, 350000)
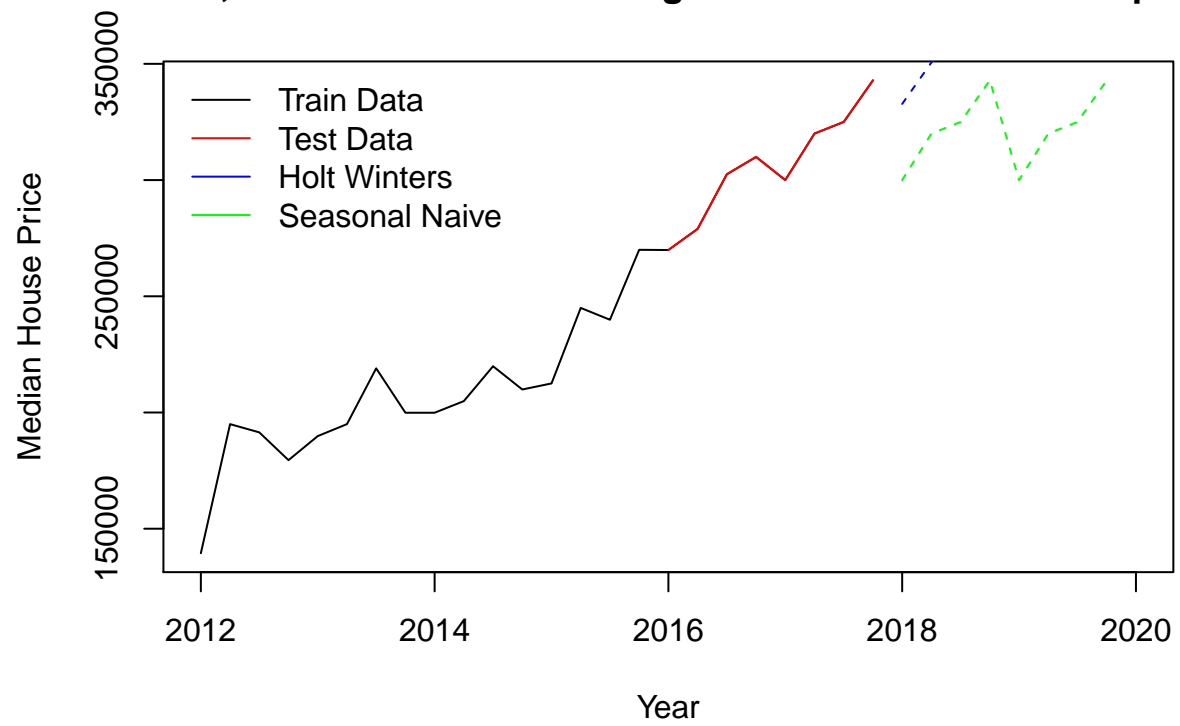
Portland, OR – Central Northeast Portland
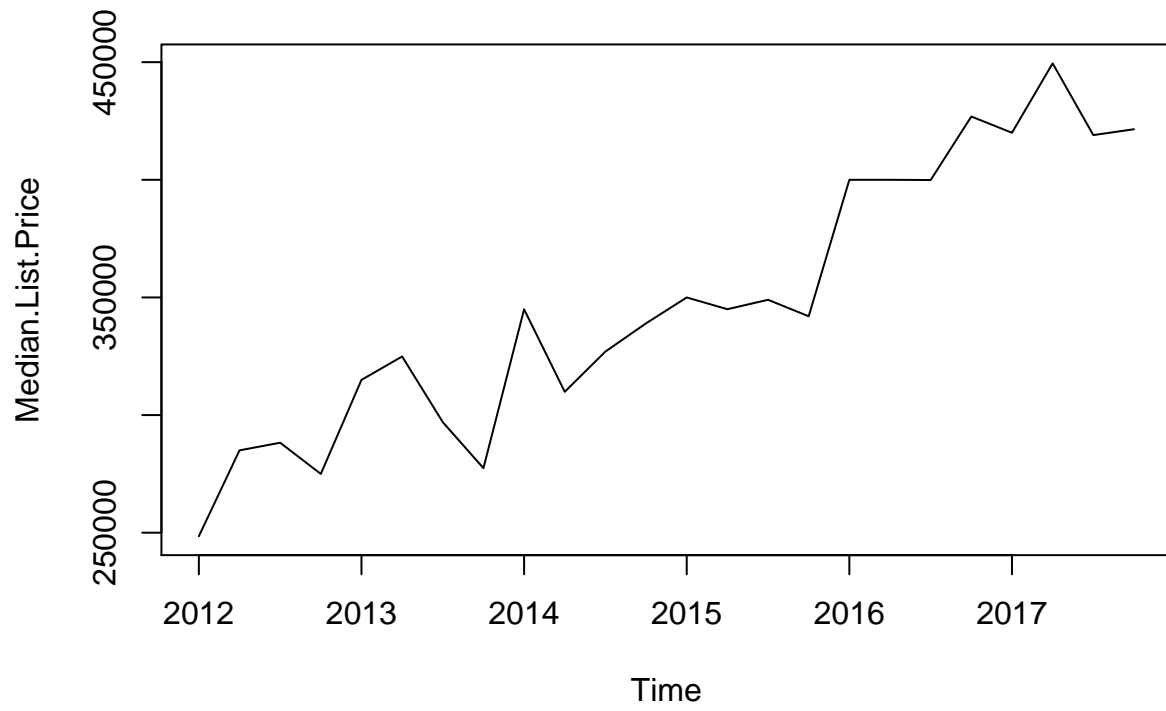
Portland, OR – Central Northeast Portland : Naive Model Forecast
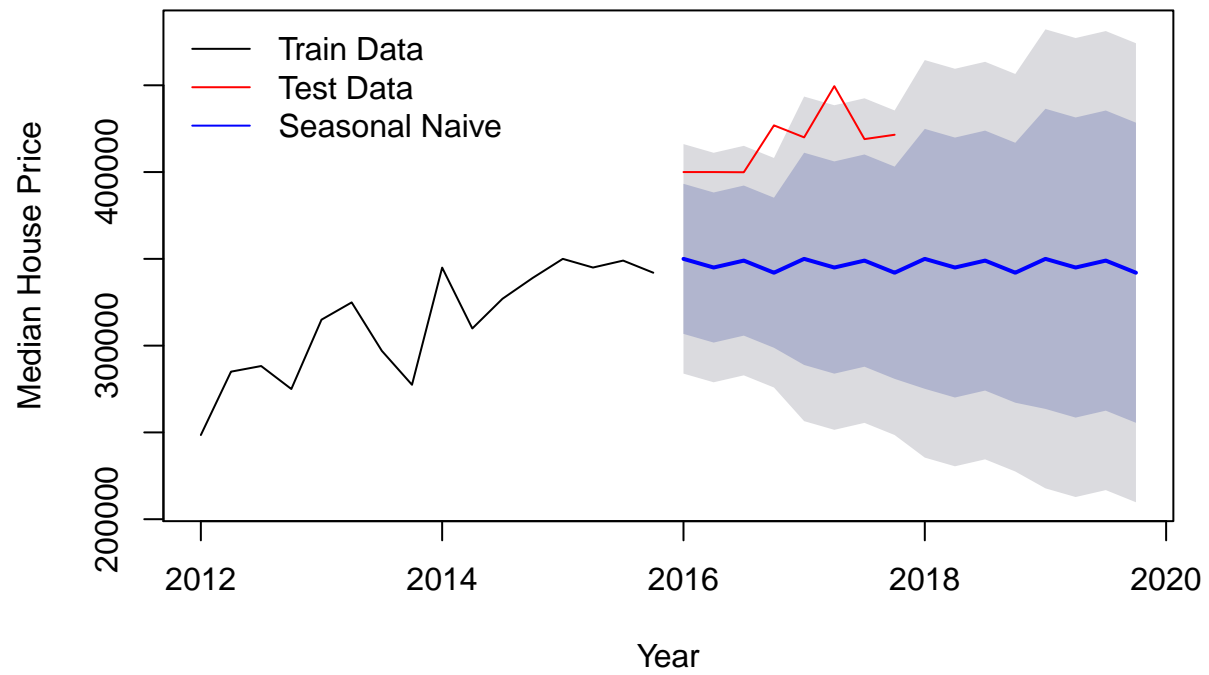
Portland, OR – Central Northeast Portland : Naive Model Forecast Residuals
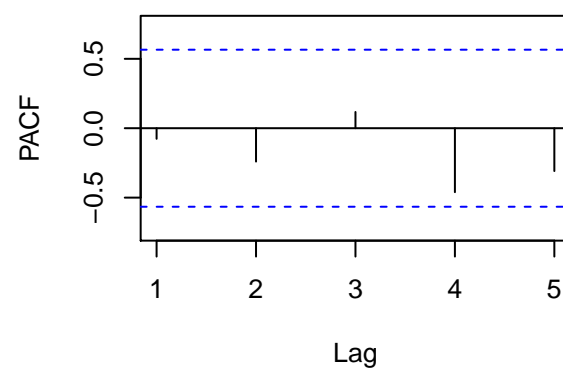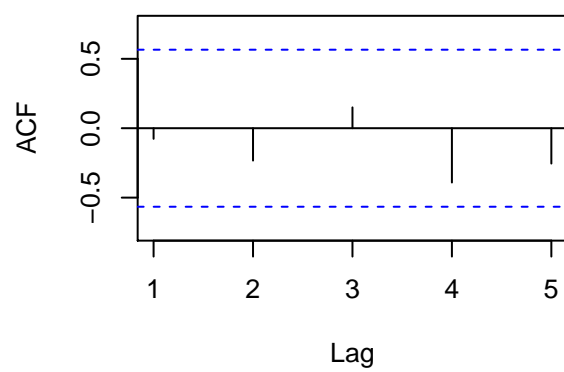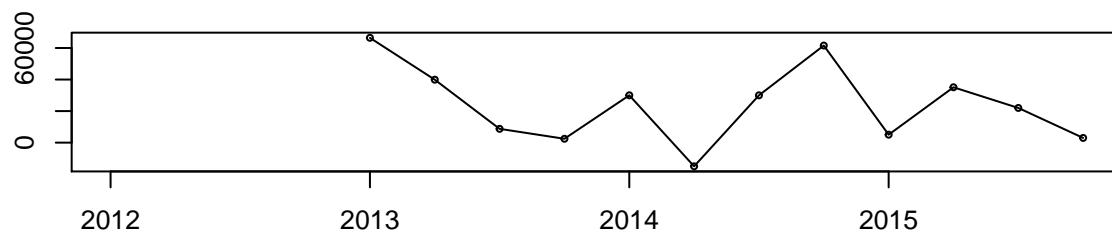
Portland, OR – Central Northeast Portland : Holt Winters Model Forec
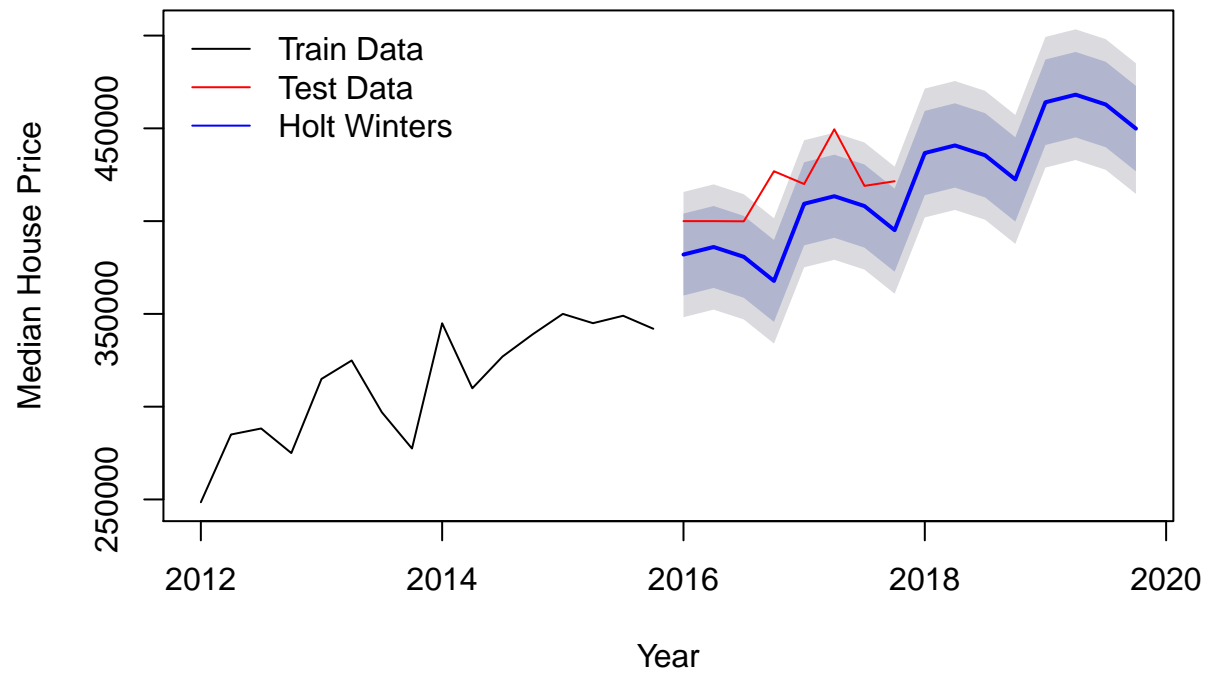
Portland, OR – Central Northeast Portland : Holt Winters Model Forecast Residu
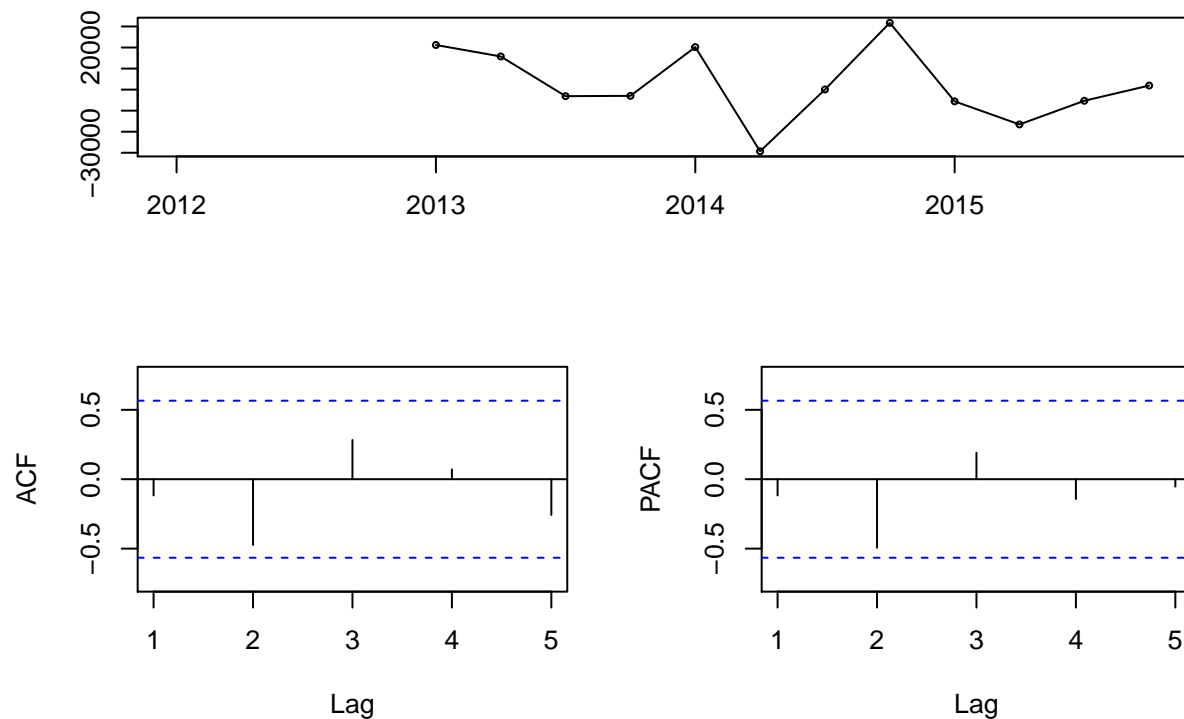

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Central Northeast Portland"
##                   ME      RMSE      MAE      MPE      MAPE     MASE
## Training set 24104.17 33731.90 26604.17  7.26612  8.072832 1.00000
## Test set     70600.00 72770.46 70600.00 16.79351 16.793515 2.65372
##                   ACF1 Theil's U
## Training set -0.07646058        NA
## Test set      0.11744408  3.990699
## [1] "Holt Winters Accuracy for  Portland, OR - Central Northeast Portland"
##                   ME     RMSE      MAE       MPE      MAPE      MASE
## Training set  2336.954 16650.73 12807.48 0.6575603 3.905165 0.4814087
## Test set     24272.646 28743.92 24272.65 5.7544429 5.754443 0.9123626
##                   ACF1 Theil's U
## Training set -0.1170061        NA
## Test set     -0.4656934  1.622999
```

Portland, OR – Central Northeast Portland : TS Training Model Compar

Portland, OR – Central Northeast Portland : Full TS Models Comparis
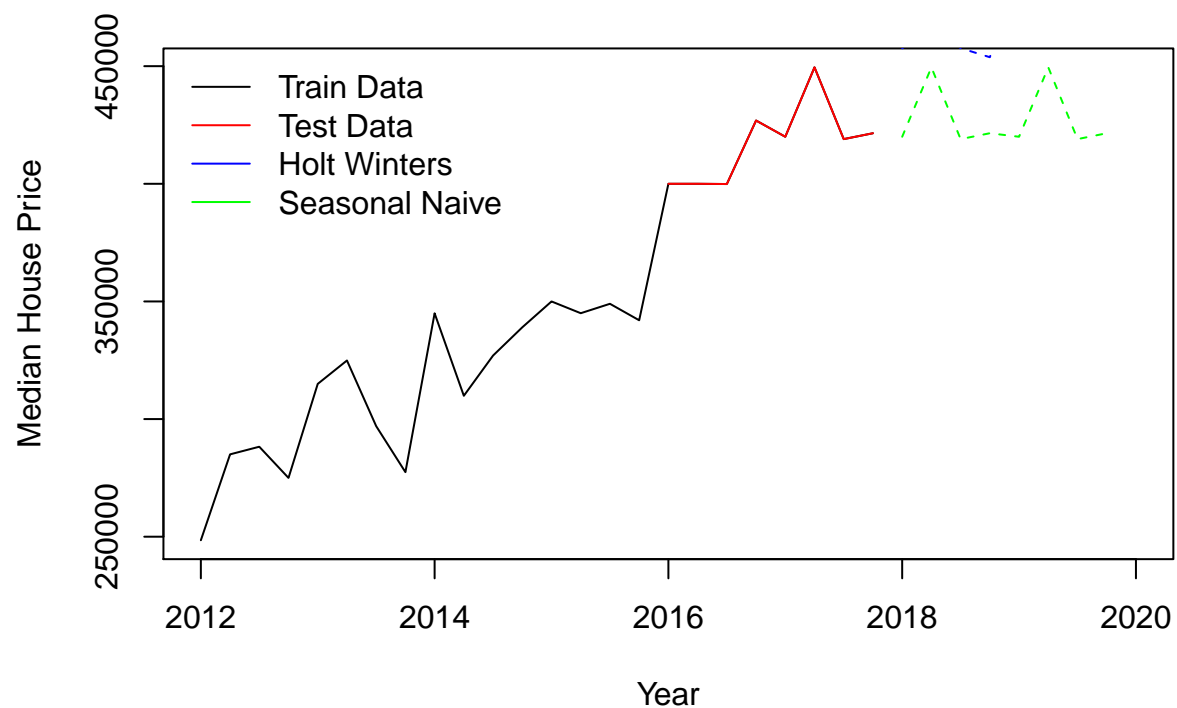
Portland, OR – Neighbors West–Northwest
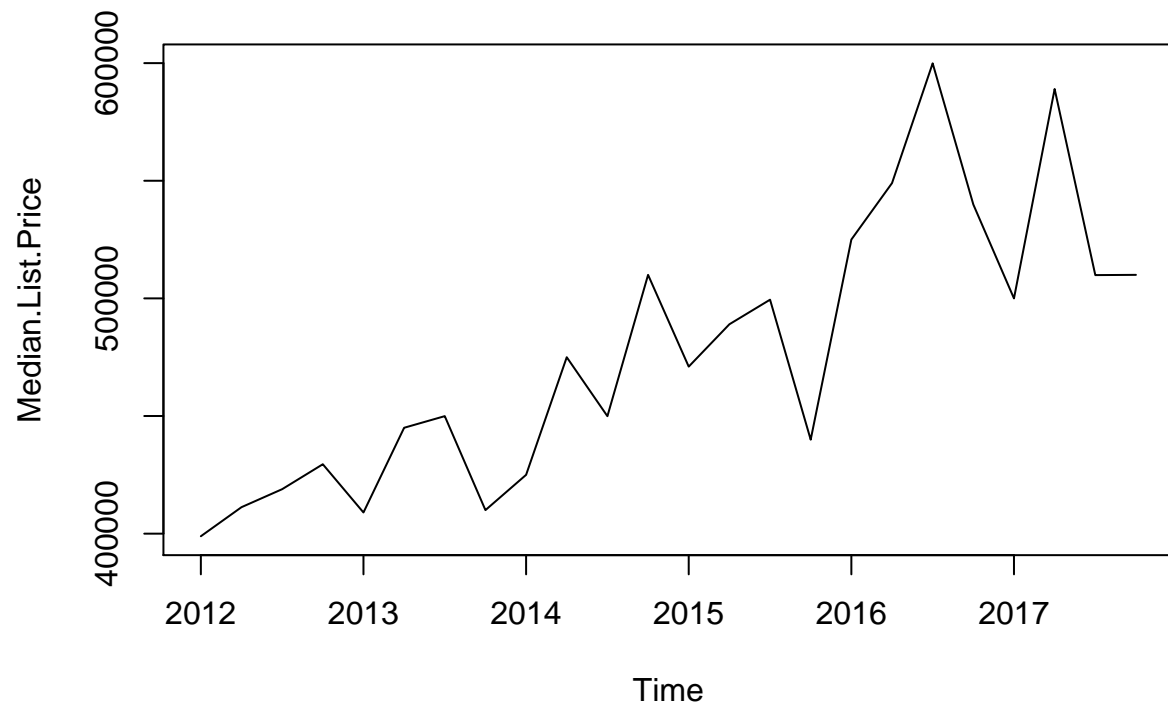
Portland, OR – Neighbors West–Northwest : Naive Model Forecast
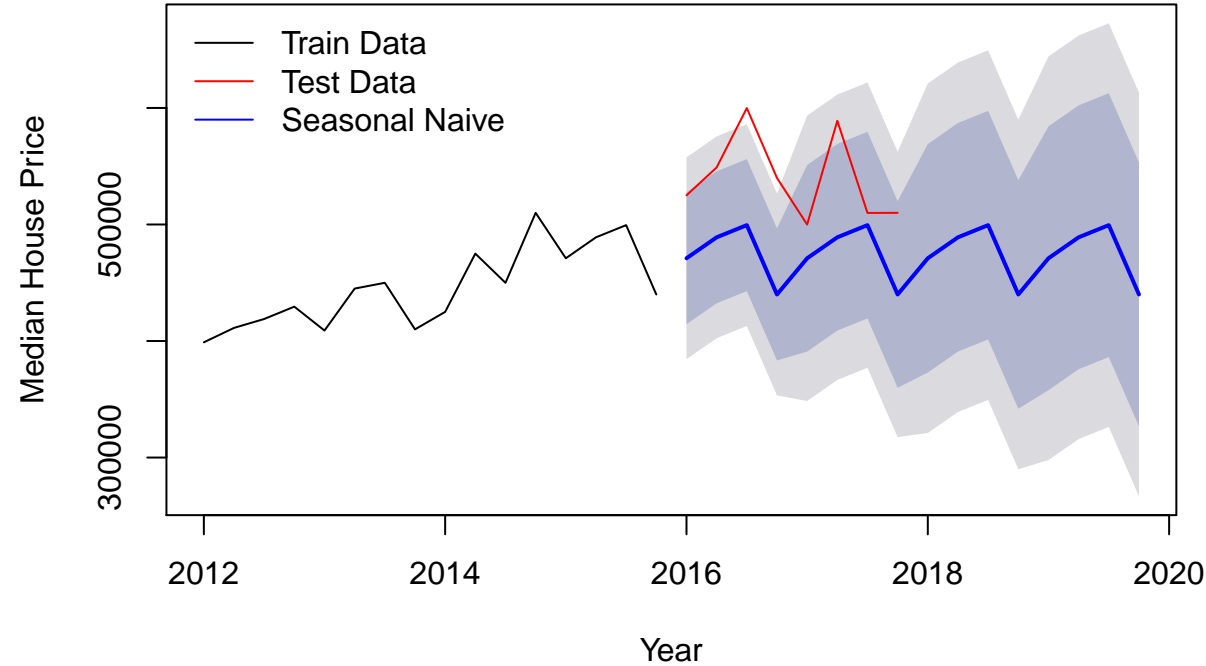
Portland, OR – Neighbors West–Northwest : Naive Model Forecast Residuals
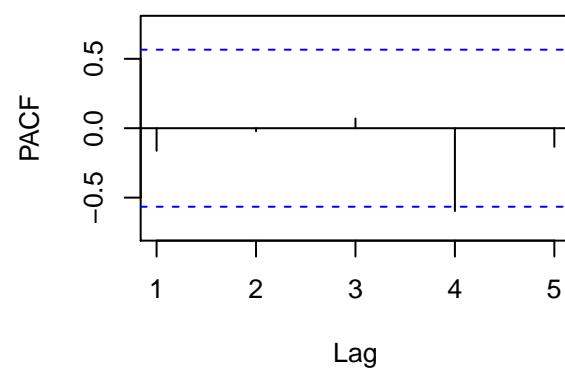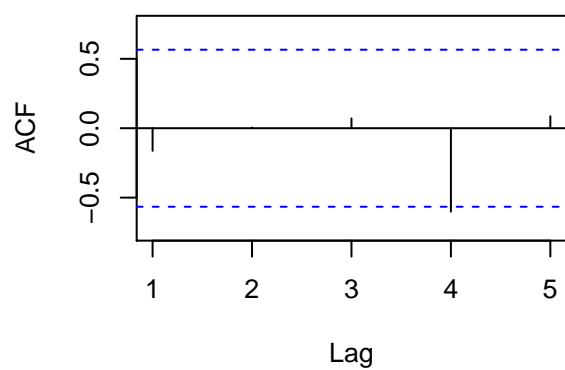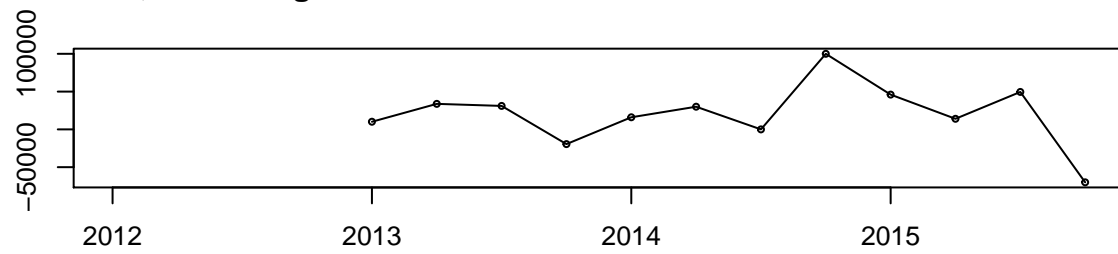
Portland, OR – Neighbors West–Northwest : Holt Winters Model Forec
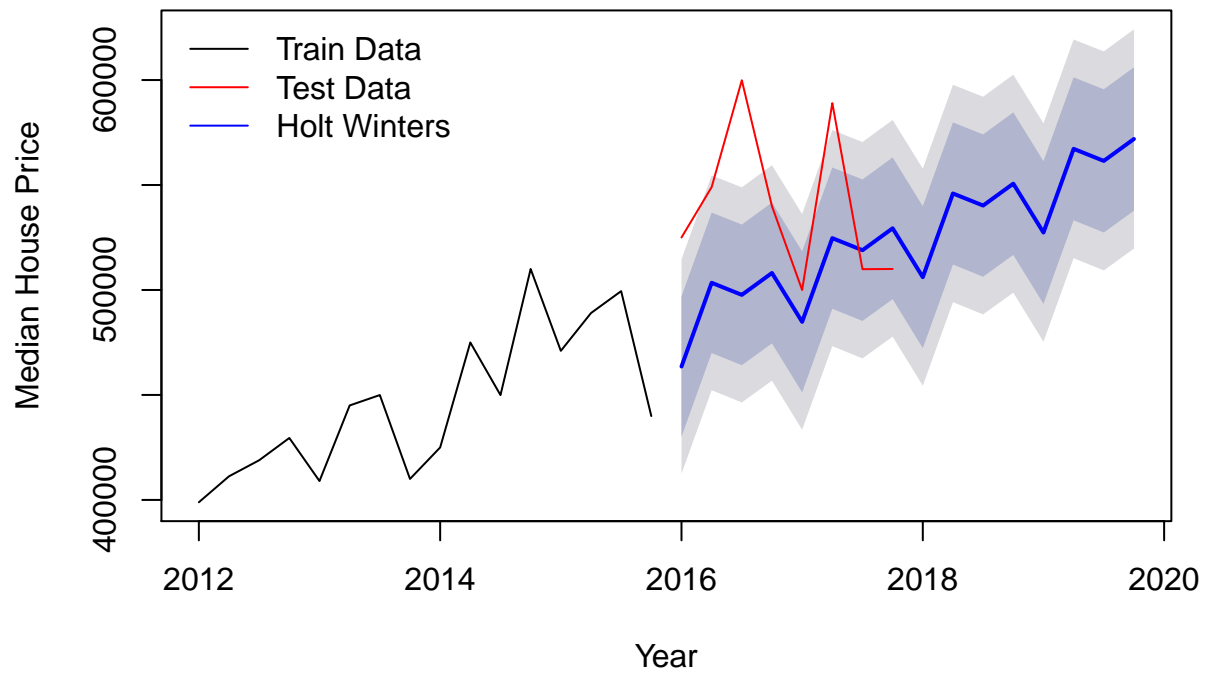
Portland, OR – Neighbors West–Northwest : Holt Winters Model Forecast Residu
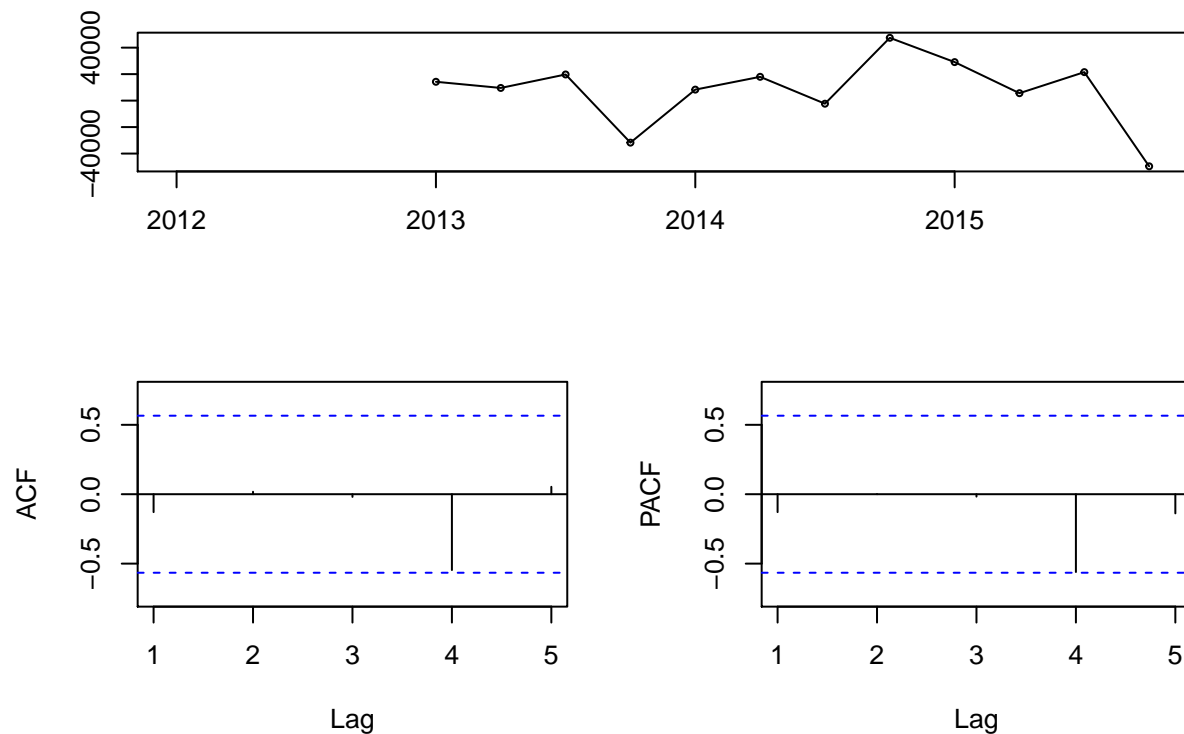

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Neighbors West-Northwest"
##                    ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 20070.83 44171.21 35000.00  4.04202  7.48934 1.000000
## Test set     65486.88 72846.69 65486.88 11.87919 11.87919 1.871054
##                  ACF1 Theil's U
## Training set -0.162760        NA
## Test set     -0.440962  1.340635
## [1] "Holt Winters Accuracy for  Portland, OR - Neighbors West-Northwest"
##                   ME     RMSE      MAE      MPE      MAPE      MASE
## Training set  7470.536 26041.6 21423.14 1.426696 4.683971 0.6120896
## Test set     36516.224 52605.4 43618.42 6.414991 7.807667 1.2462407
##                   ACF1 Theil's U
## Training set -0.1291345        NA
## Test set      0.1132227 0.9186544
```

Portland, OR – Neighbors West–Northwest : TS Training Model Compar
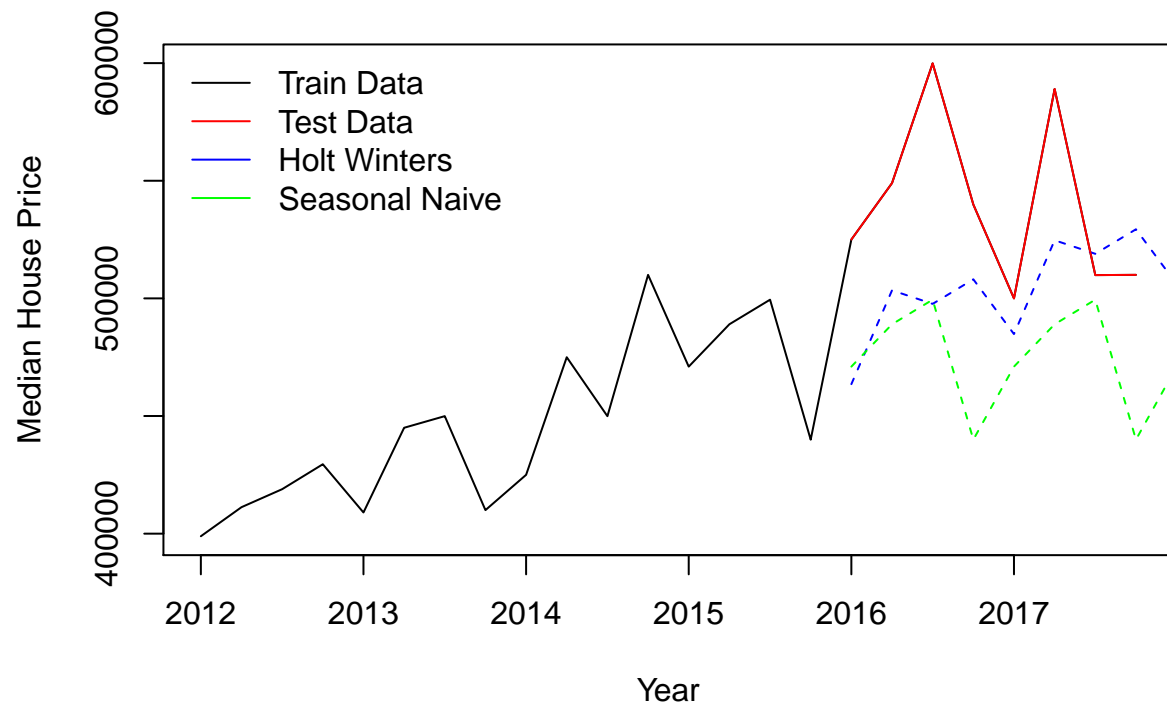
Portland, OR – Neighbors West–Northwest : Full TS Models Comparis
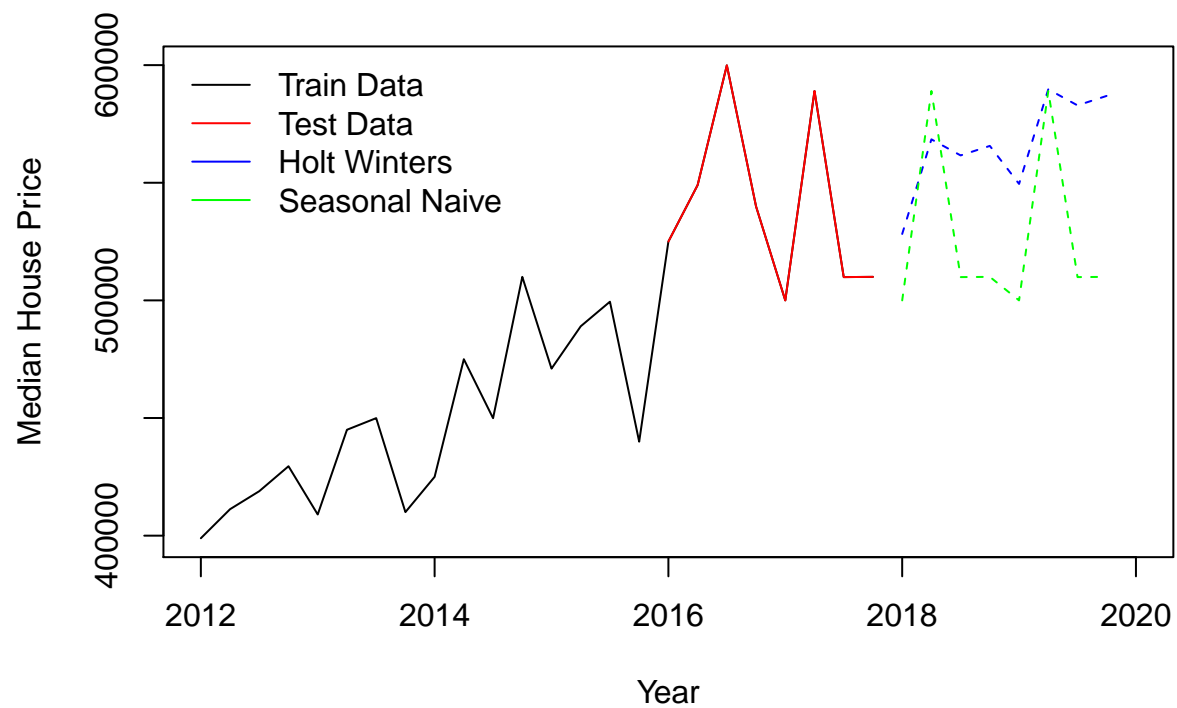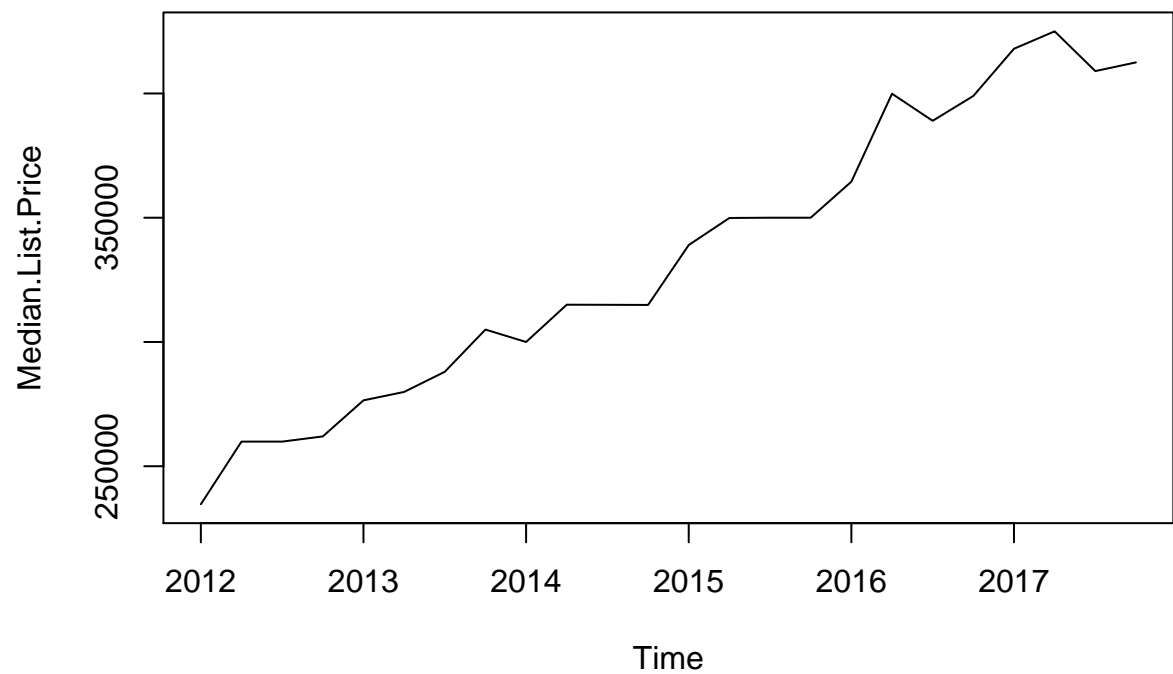
Portland, OR – Southeast Uplift

Portland, OR – Southeast Uplift : Naive Model Forecast
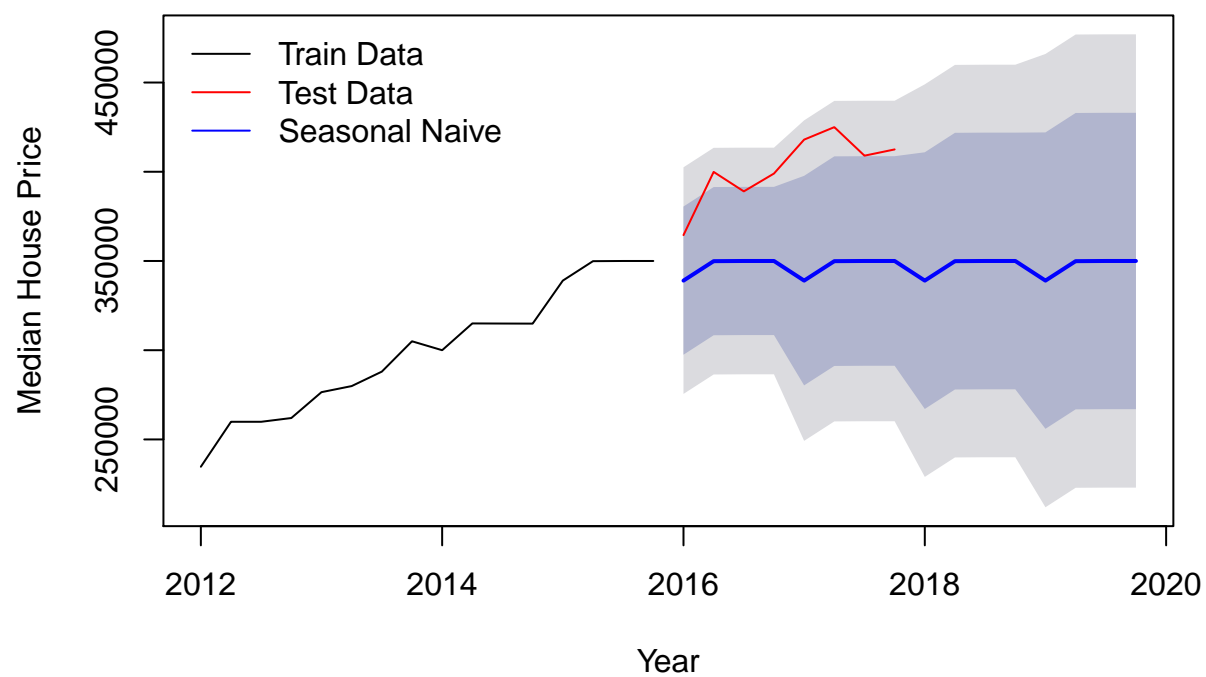
Portland, OR – Southeast Uplift : Naive Model Forecast Residuals
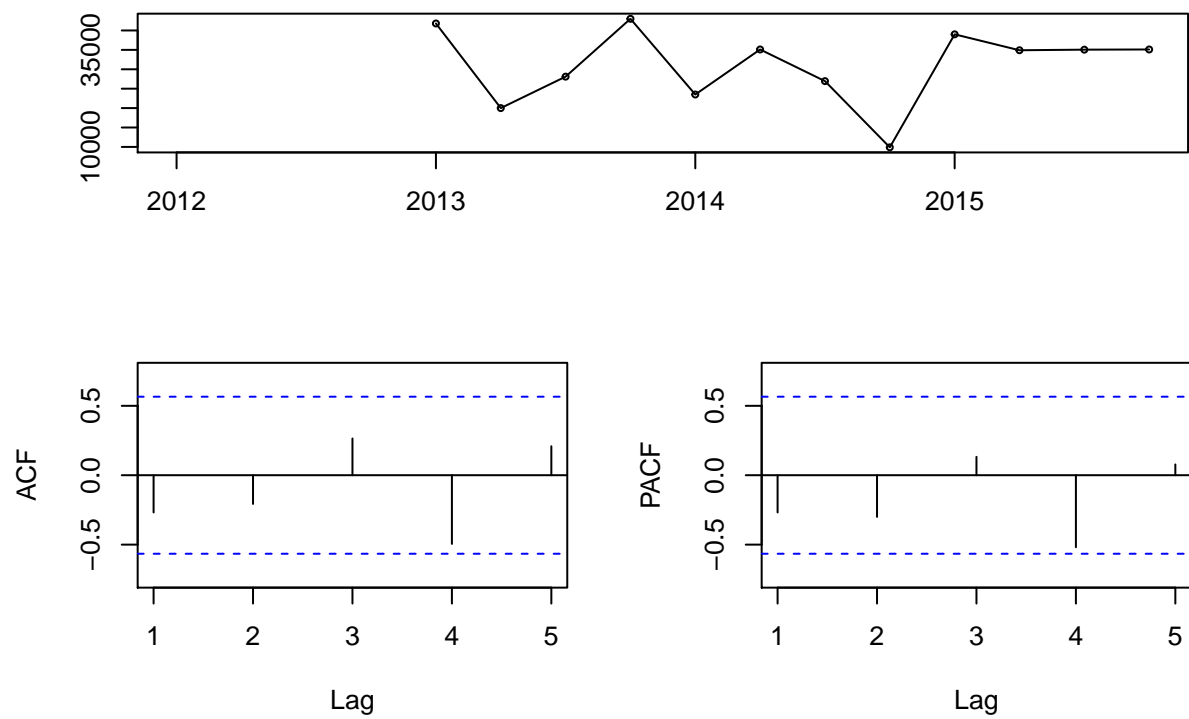
Portland, OR – Southeast Uplift : Holt Winters Model Forecast
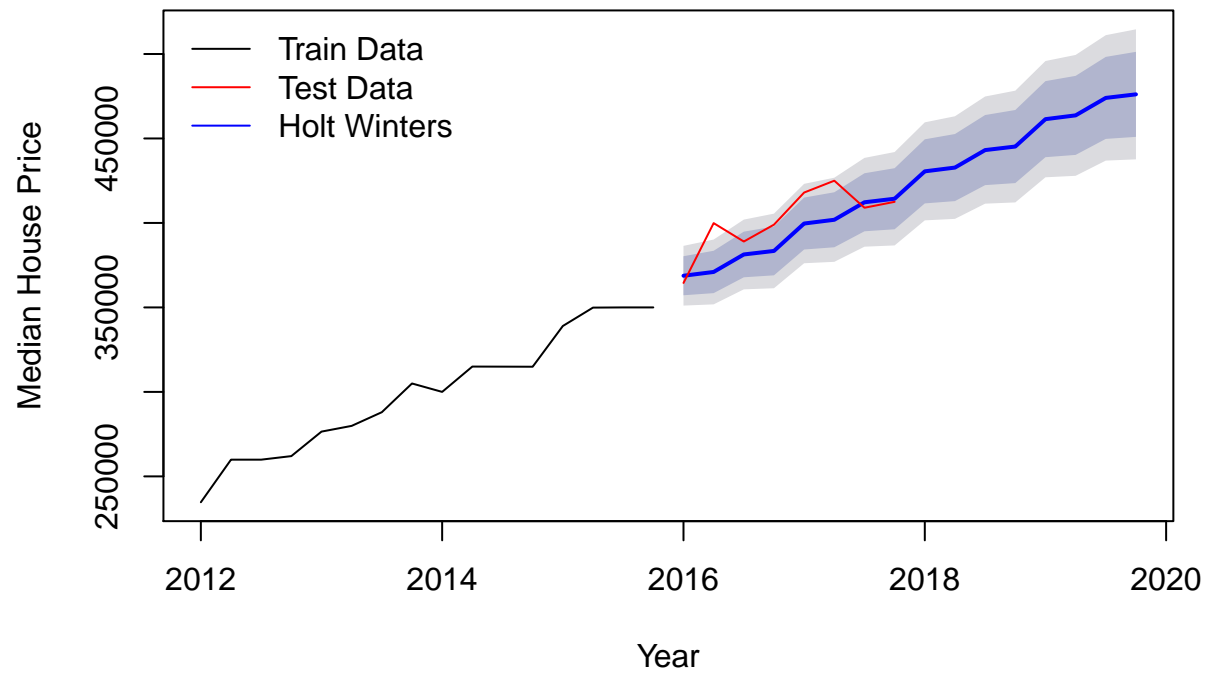
Portland, OR – Southeast Uplift : Holt Winters Model Forecast Residuals
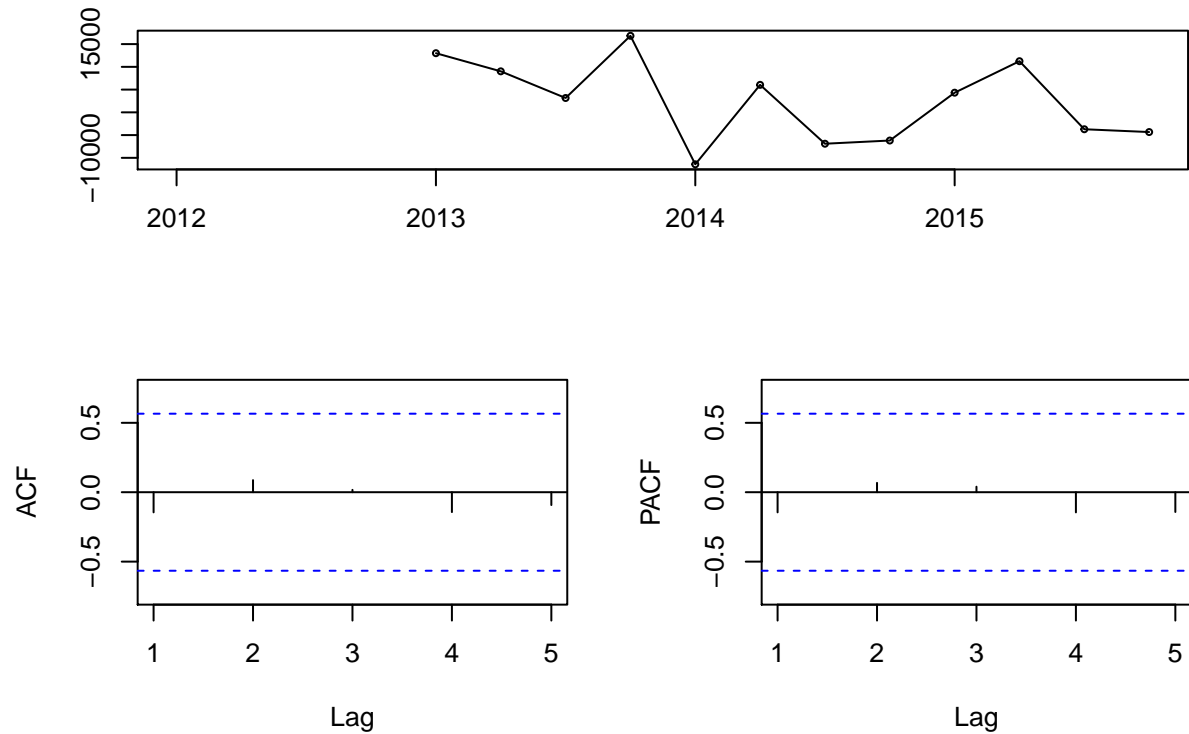

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Southeast Uplift"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 31033.33 32395.92 31033.33  9.859731  9.859731 1.000000
## Test set     54887.50 57380.87 54887.50 13.494059 13.494059 1.768663
##                   ACF1 Theil's U
## Training set -0.2683534        NA
## Test set      0.3459222  3.262262
## [1] "Holt Winters Accuracy for  Portland, OR - Southeast Uplift"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set  2587.141  9009.14  8014.197 0.8898649 2.600552 0.2582448
## Test set     10530.991 15964.41 12863.472 2.5647751 3.165908 0.4145050
##                   ACF1 Theil's U
## Training set -0.1452696        NA
## Test set     -0.1774669 0.9528202
```

Portland, OR – Southeast Uplift : TS Training Model Comparison

Median House Price

- —— Train Data
- —— Test Data
- —— Holt Winters
- —— Seasonal Naive

Year
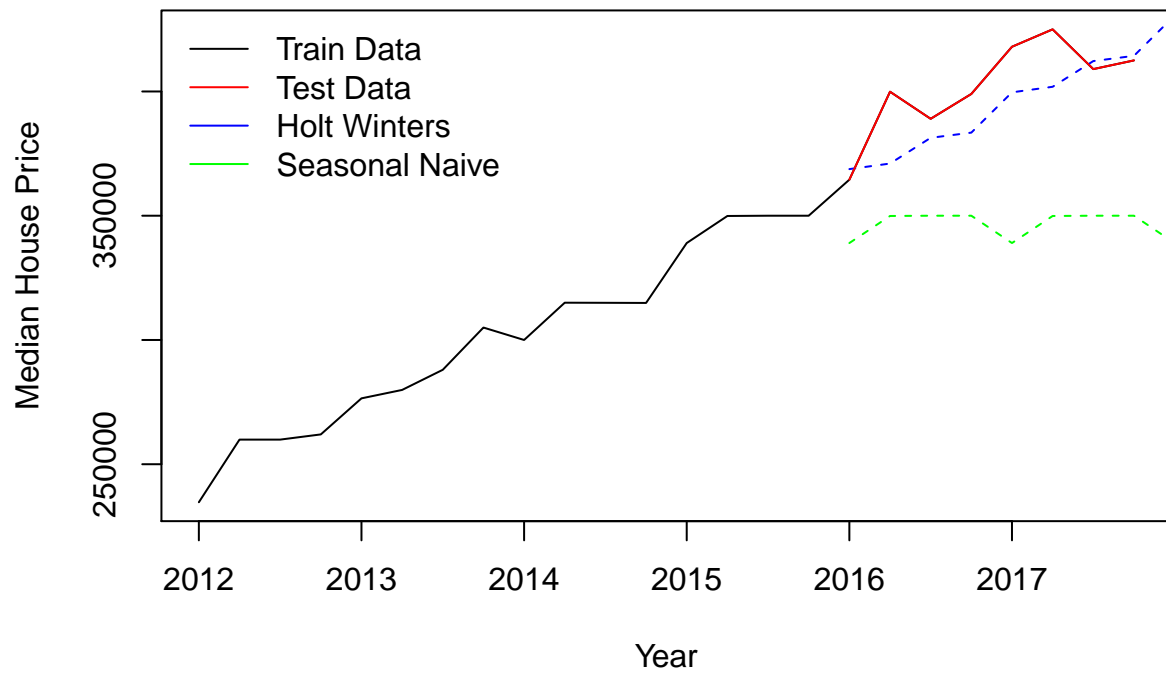
# Portland, OR – Southeast Uplift : Full TS Models Comparison
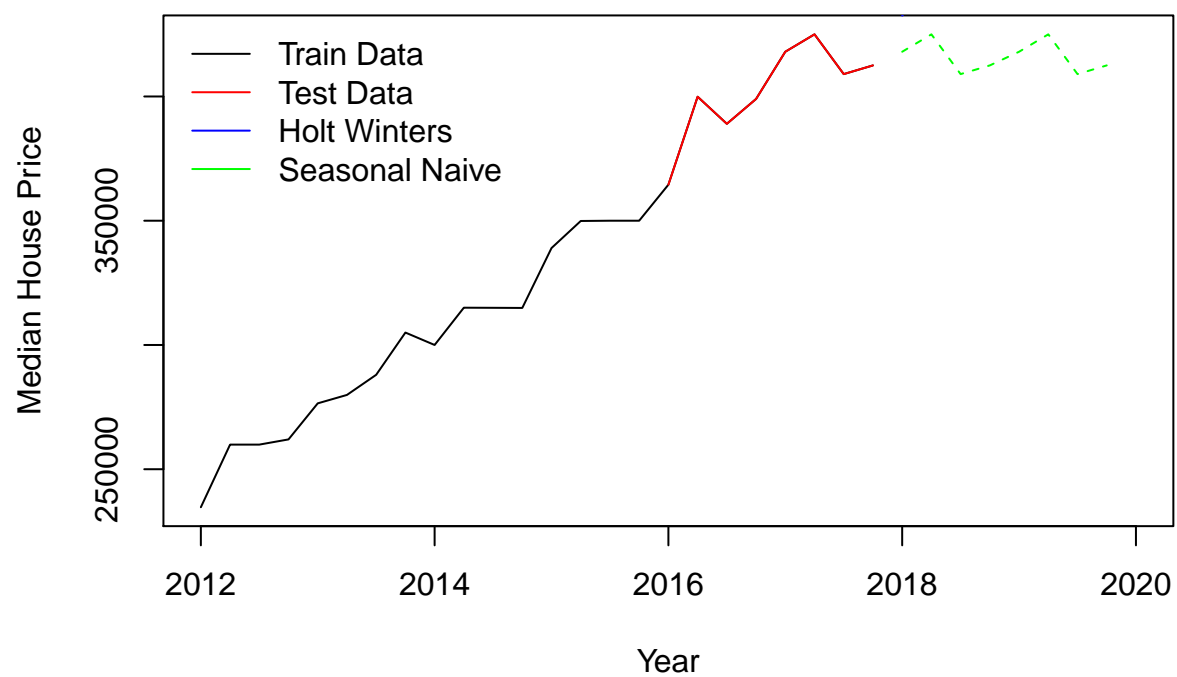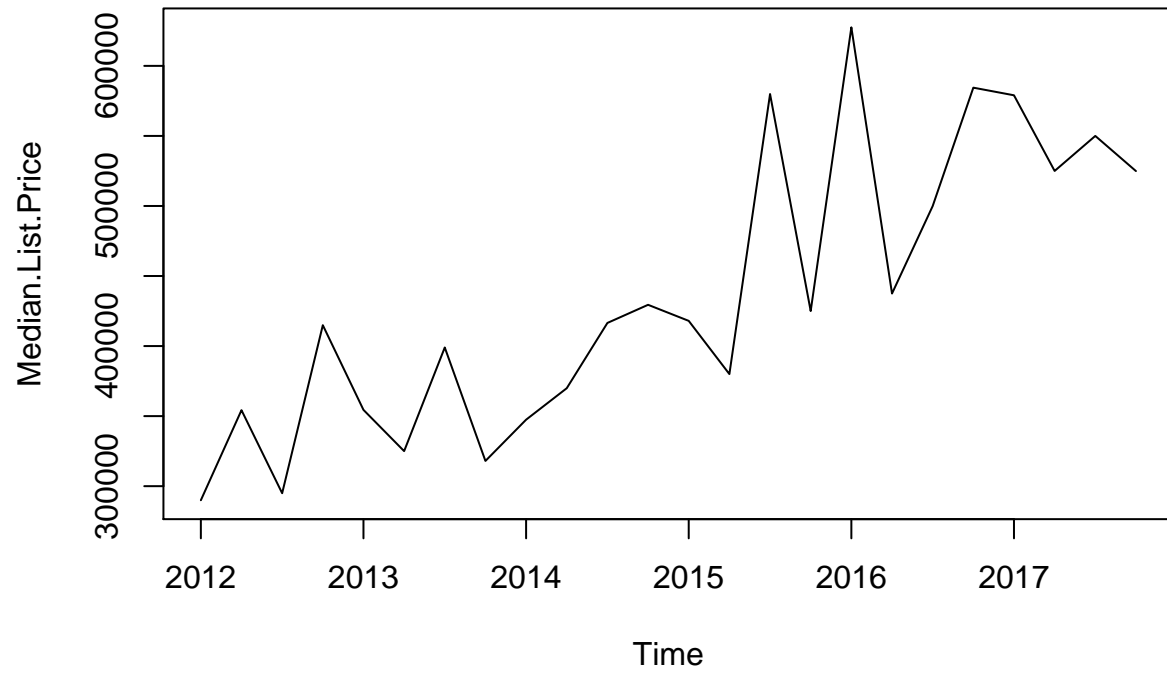
# Portland, OR – Vernon

Portland, OR – Vernon : Naive Model Forecast
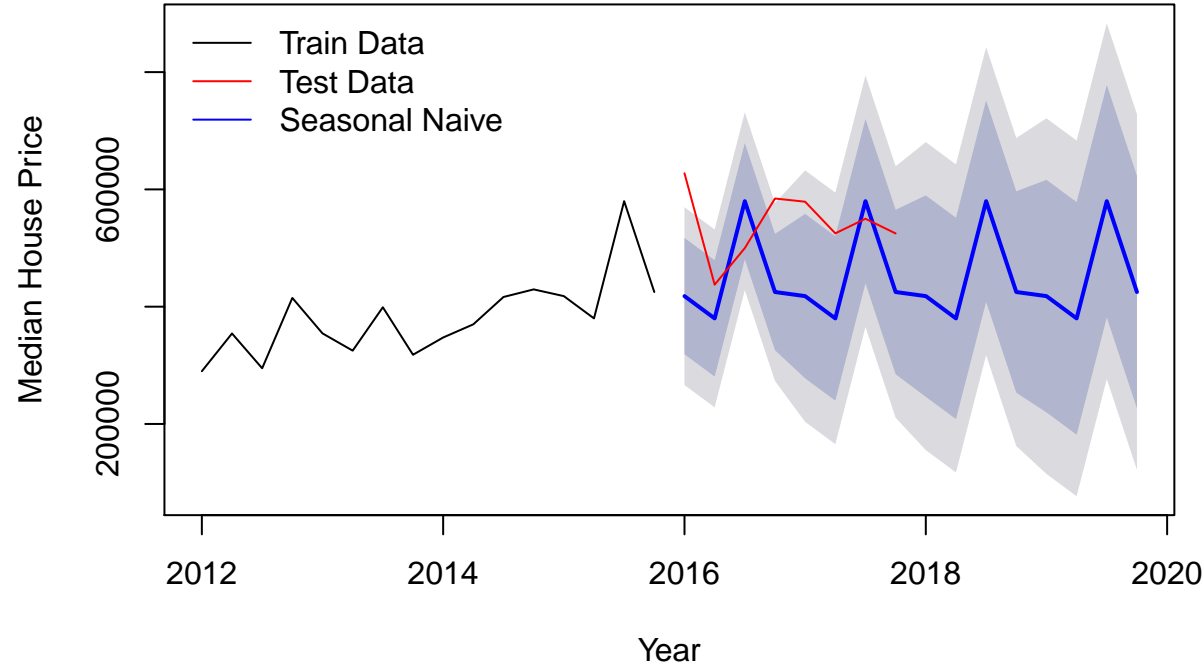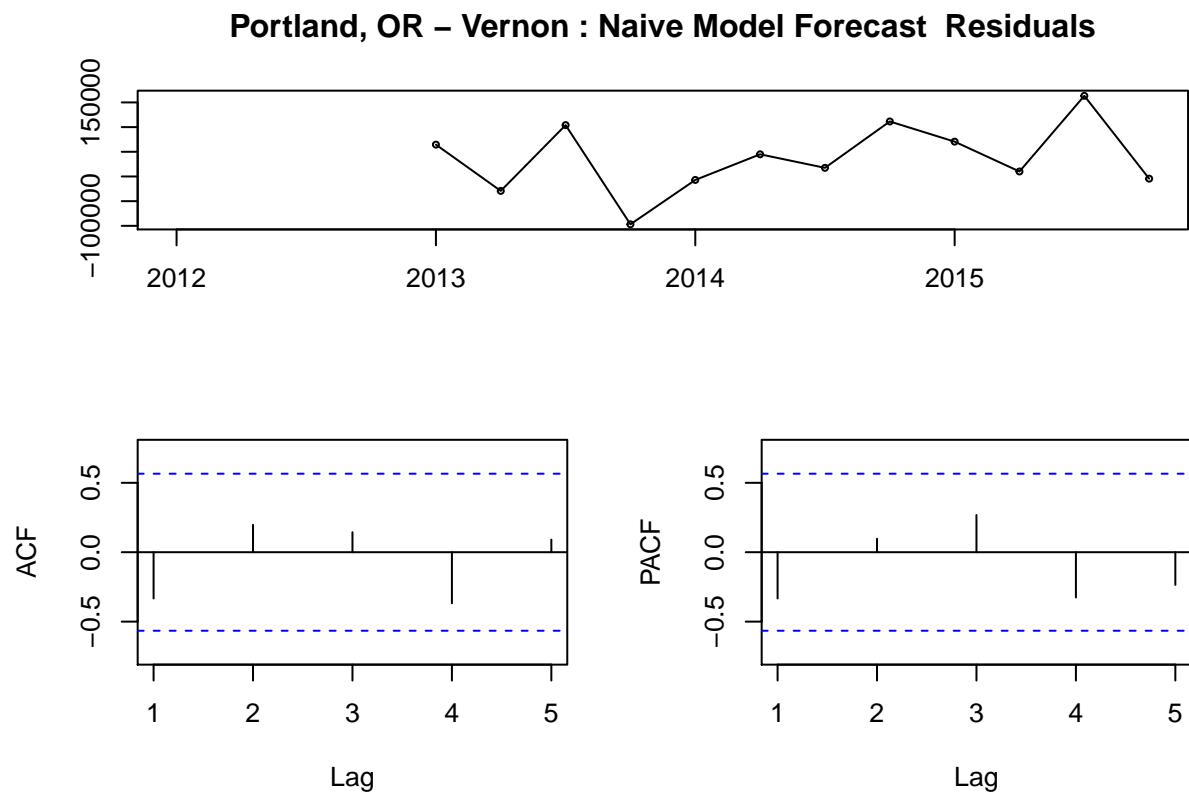
Portland, OR – Vernon : Naive Model Forecast Residuals

Portland, OR – Vernon : Holt Winters Model Forecast
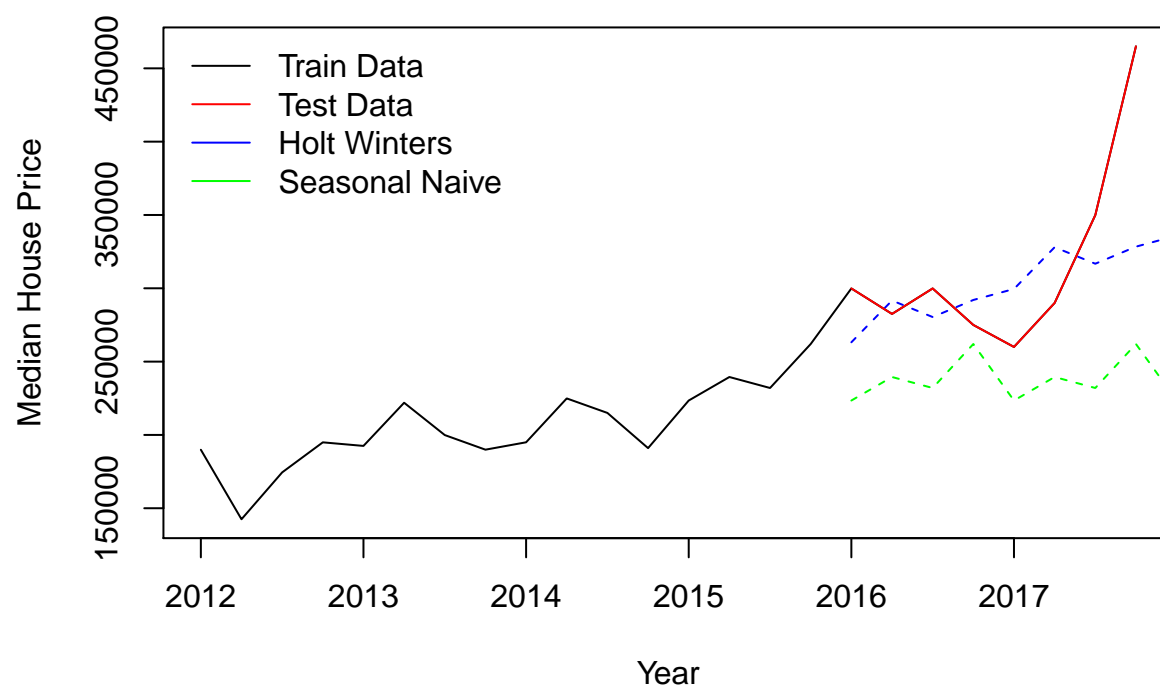
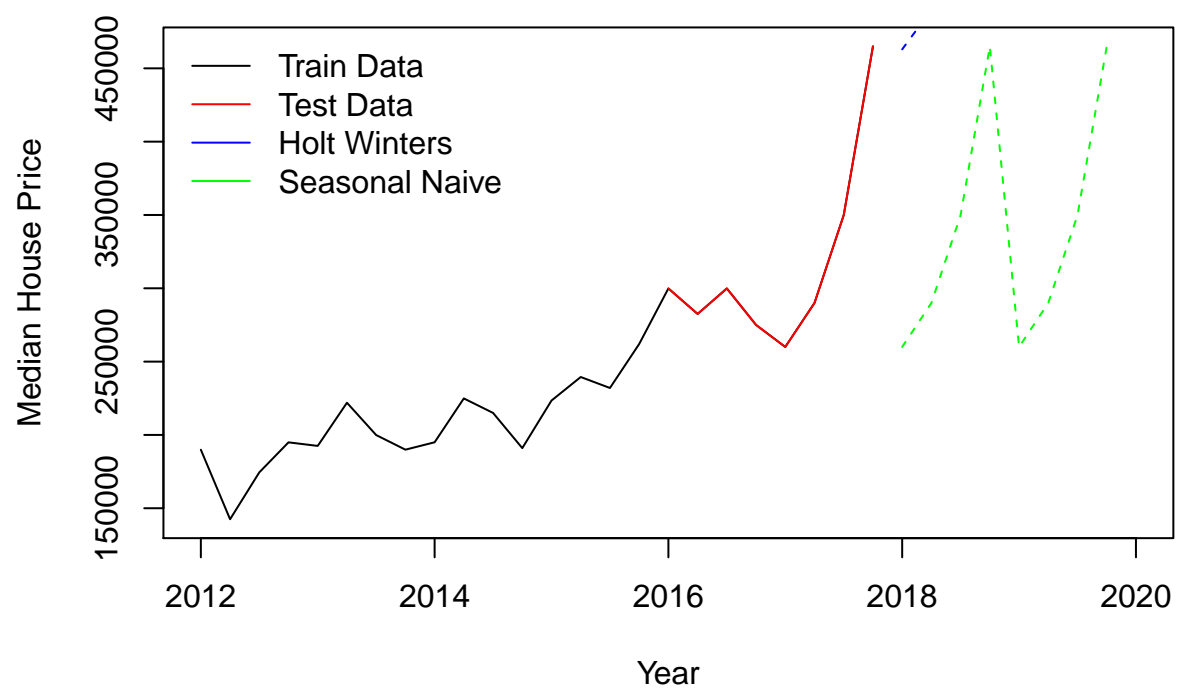## Portland, OR – Vernon : Holt Winters Model Forecast Residuals
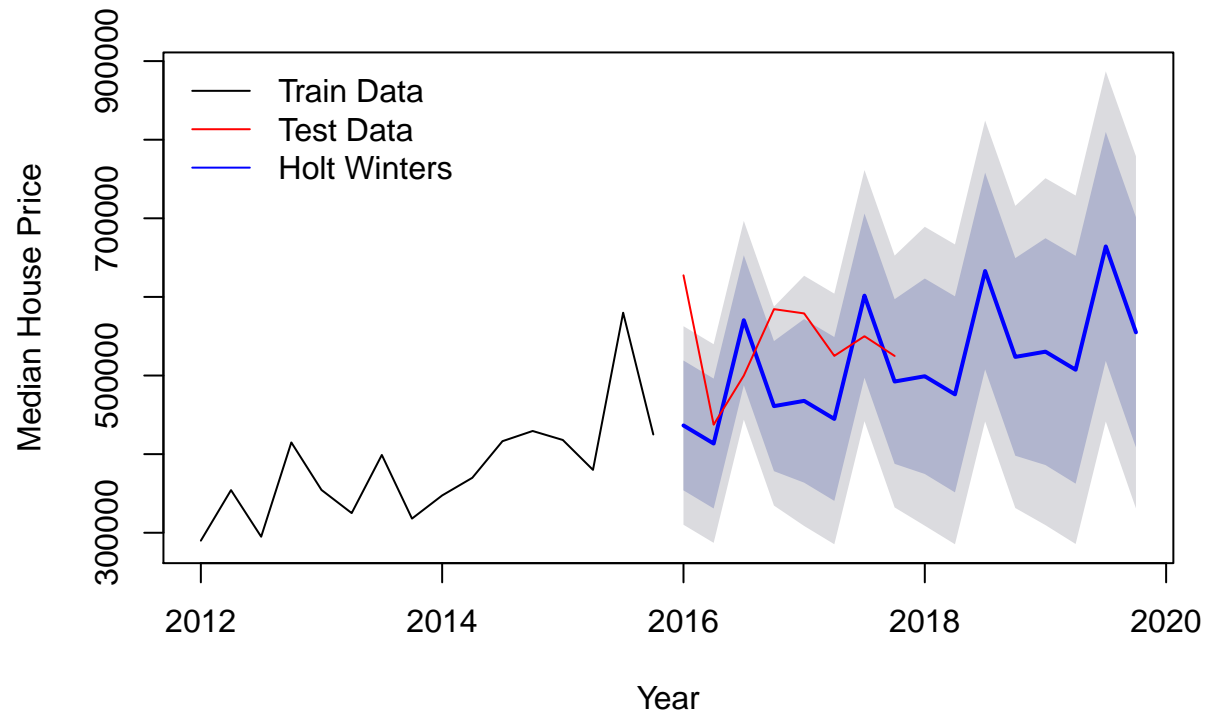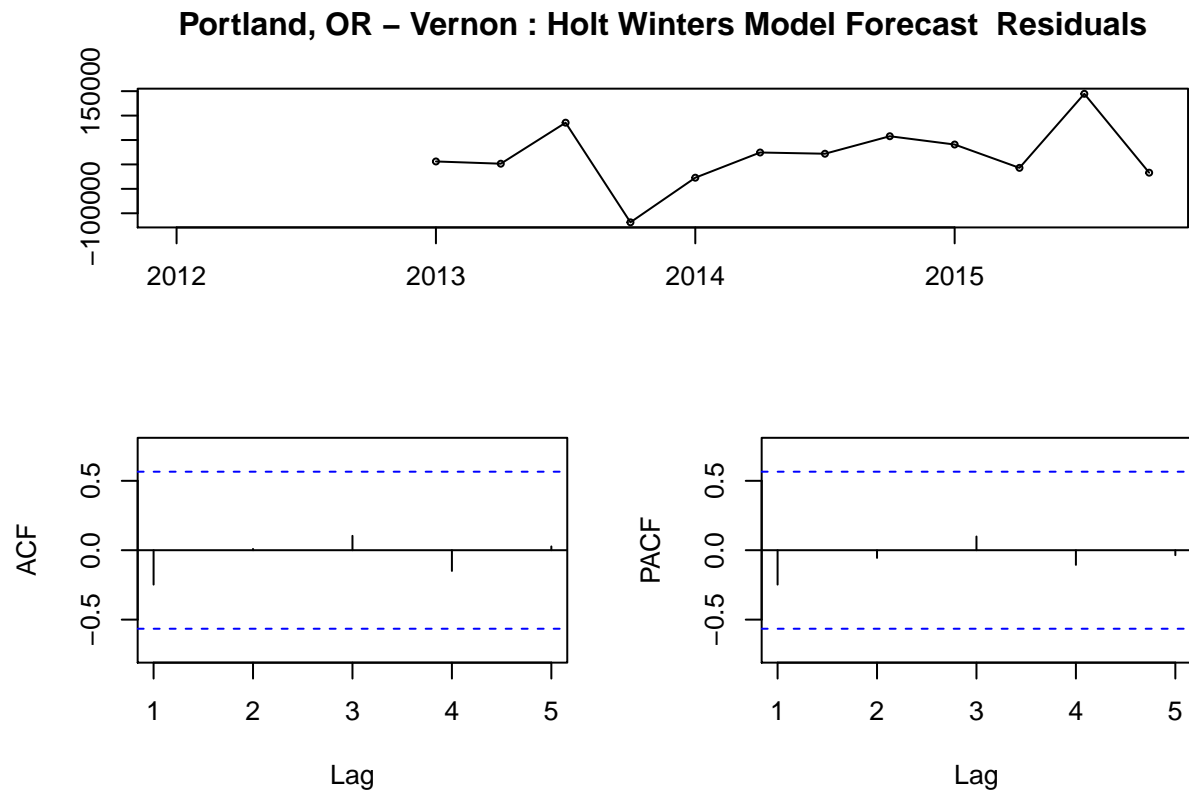

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Vernon"
##                    ME      RMSE       MAE      MPE     MAPE     MASE
## Training set 37404.17  77364.32   60337.5  7.645543 14.73445 1.000000
## Test set     90306.25 130786.48  117781.2 15.853702 21.21359 1.952041
##                   ACF1 Theil's U
## Training set -0.3335330        NA
## Test set     -0.1267059  1.439005
## [1] "Holt Winters Accuracy for  Portland, OR - Vernon"
##                    ME      RMSE       MAE      MPE     MAPE     MASE
## Training set 17743.60 64185.16 46009.27 2.724693 11.20935 0.762532
## Test set     55035.36 99859.44 85557.41 9.280515 15.15089 1.417981
##                     ACF1 Theil's U
## Training set -0.24769643        NA
## Test set     -0.07078851  1.010076
```
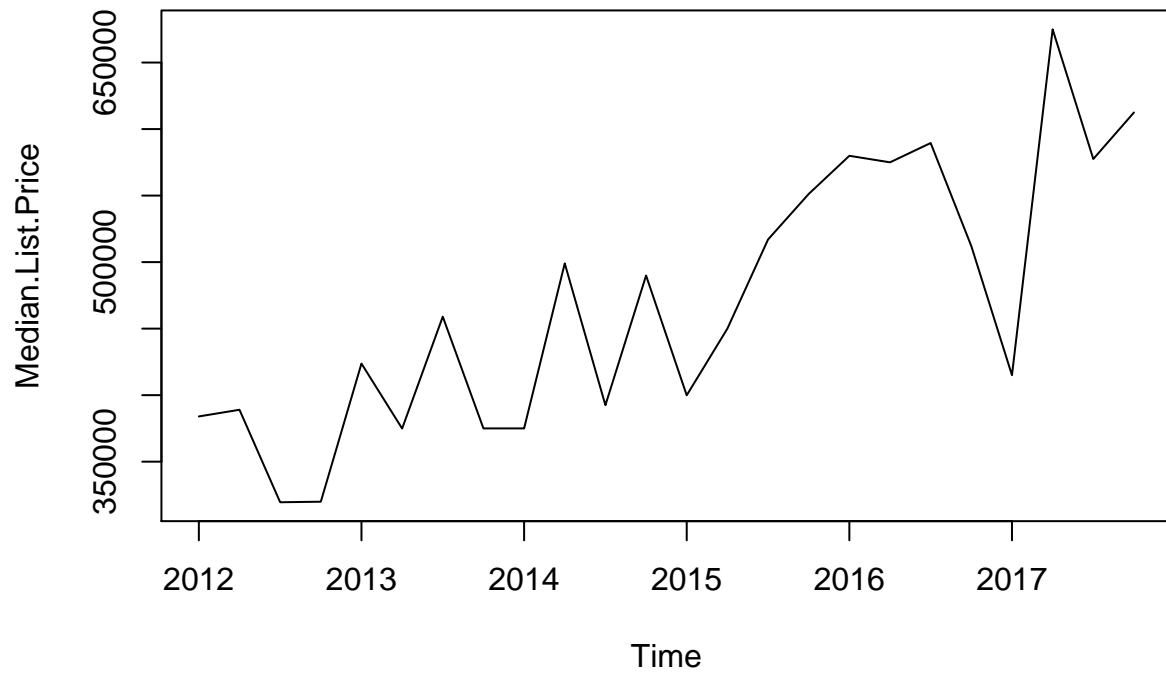
Portland, OR – Vernon : TS Training Model Comparison
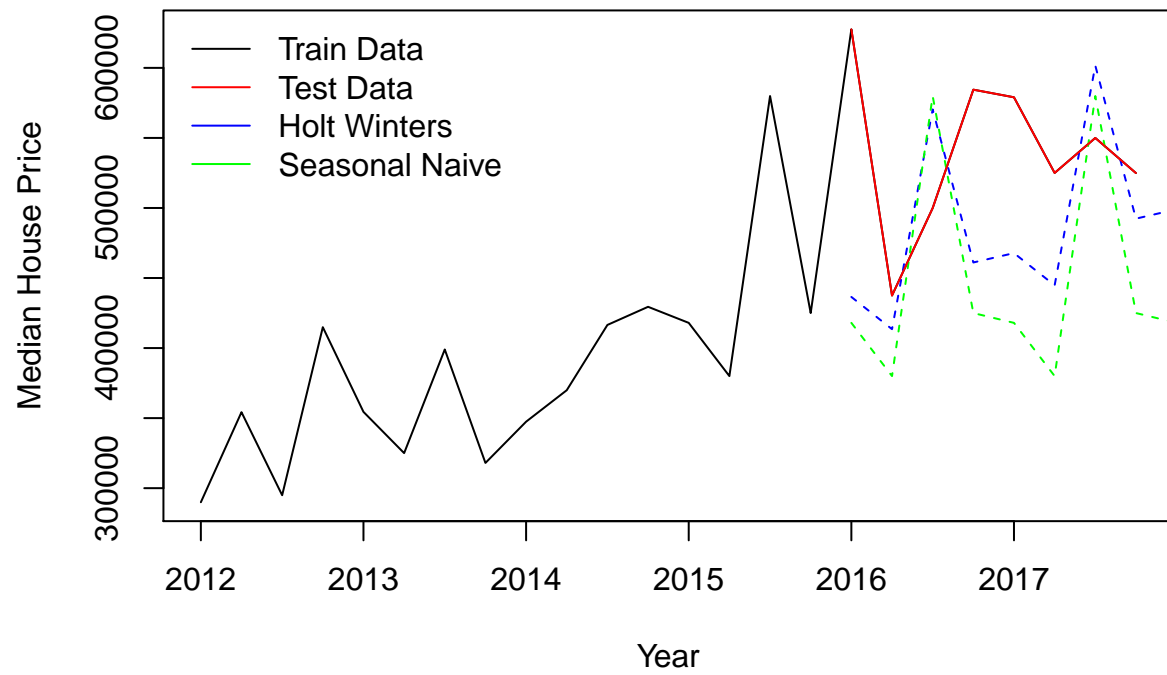
# Portland, OR – Vernon : Full TS Models Comparison
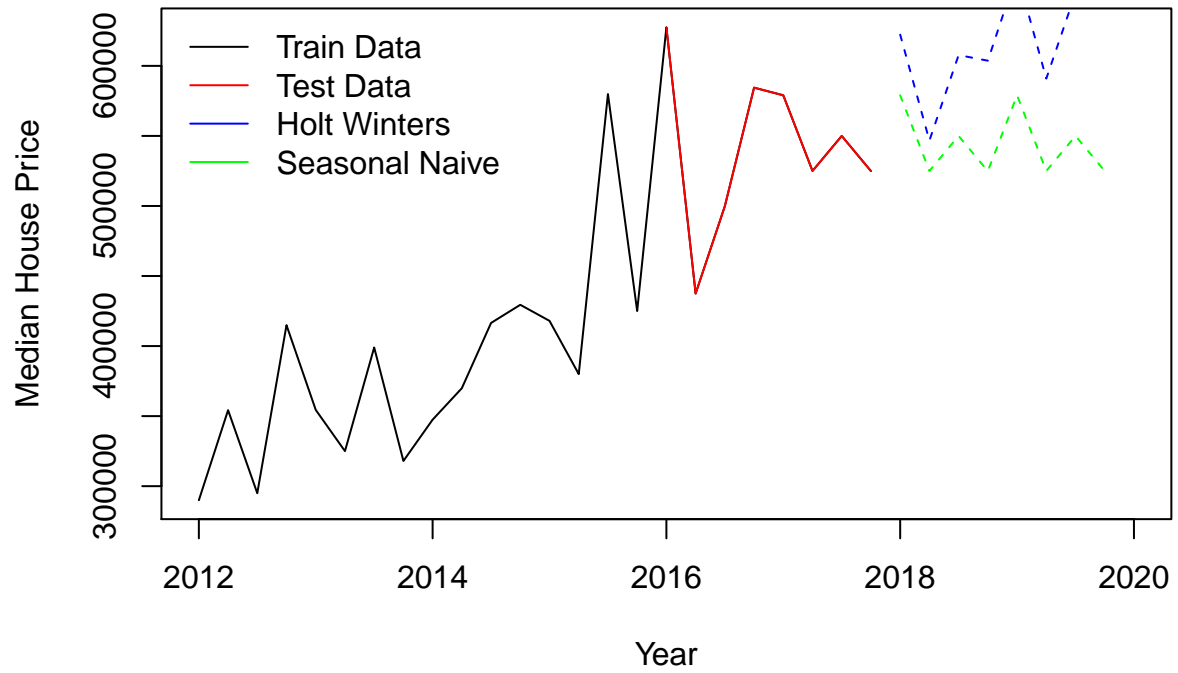
Portland, OR – Glenfair
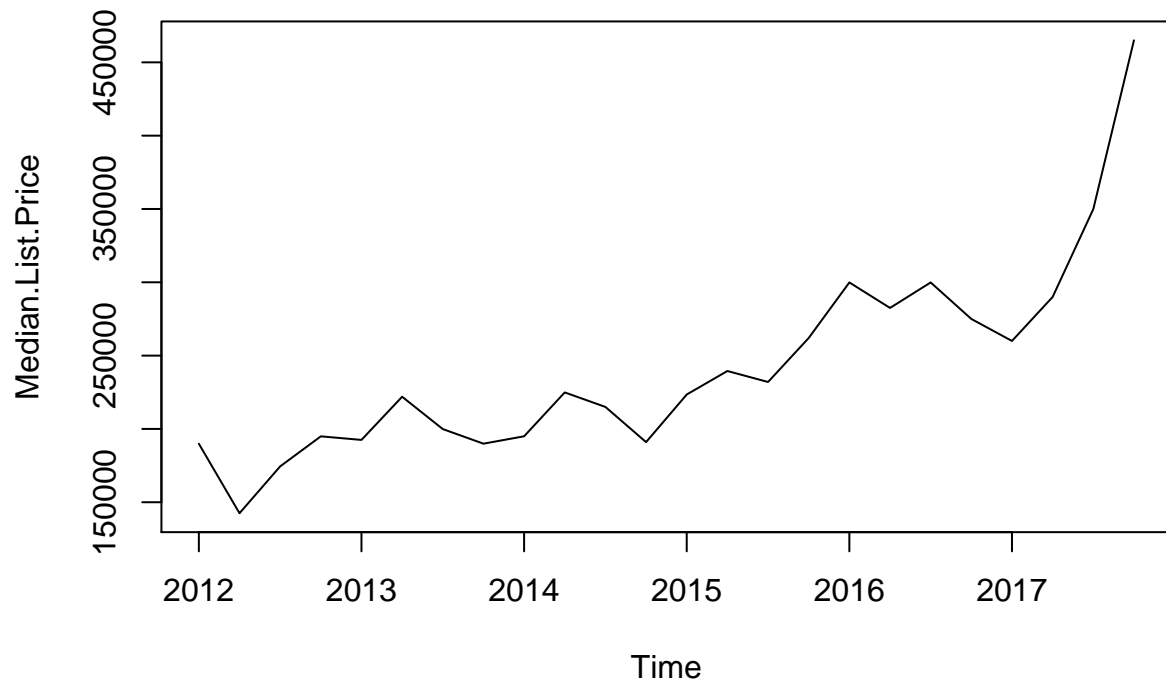
Portland, OR – Glenfair : Naive Model Forecast
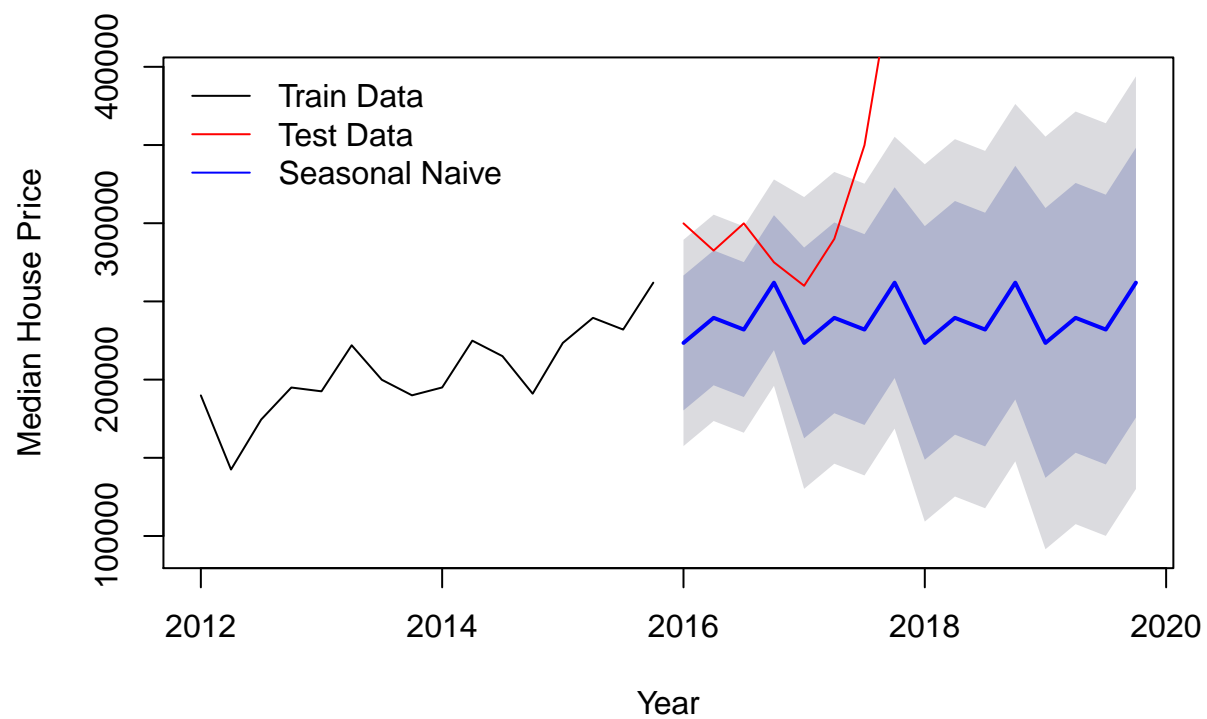
Portland, OR – Glenfair : Naive Model Forecast Residuals
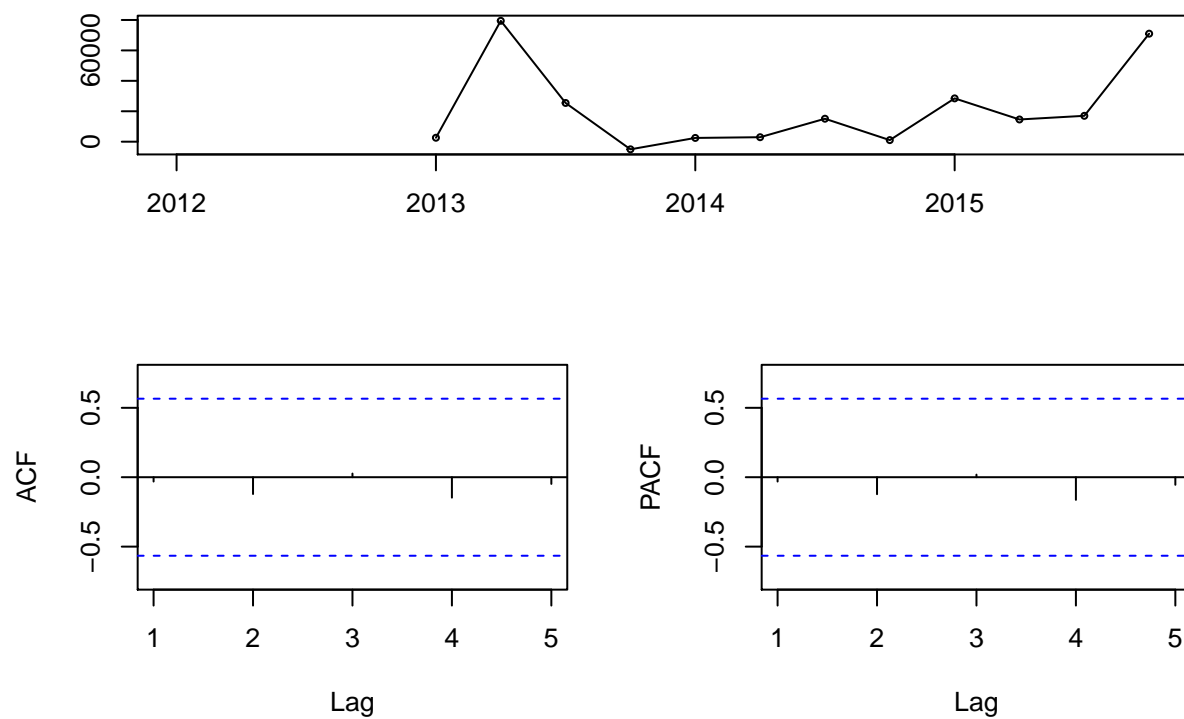
Portland, OR – Glenfair : Holt Winters Model Forecast
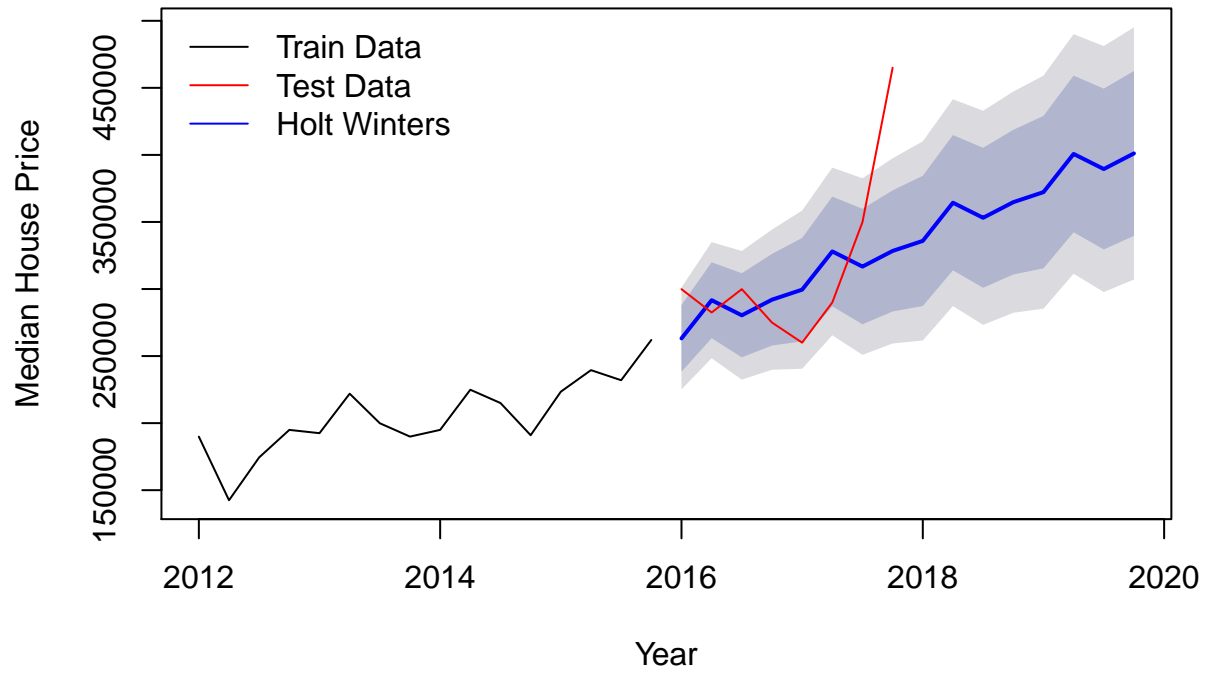
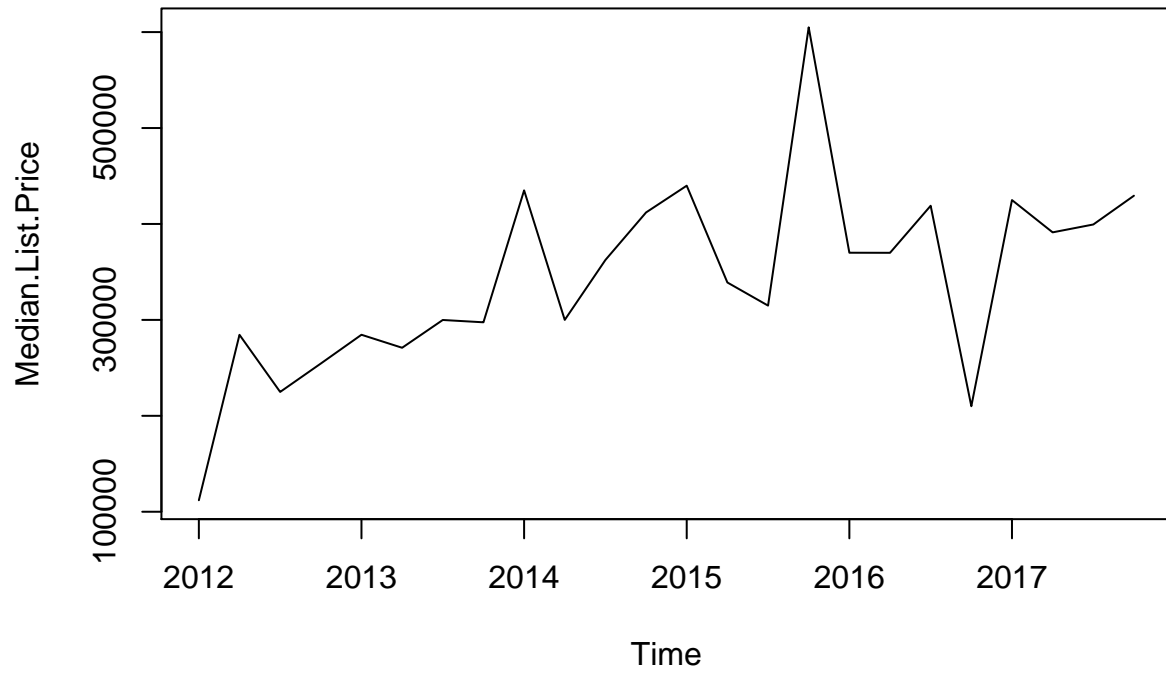**Portland, OR – Glenfair : Holt Winters Model Forecast Residuals**
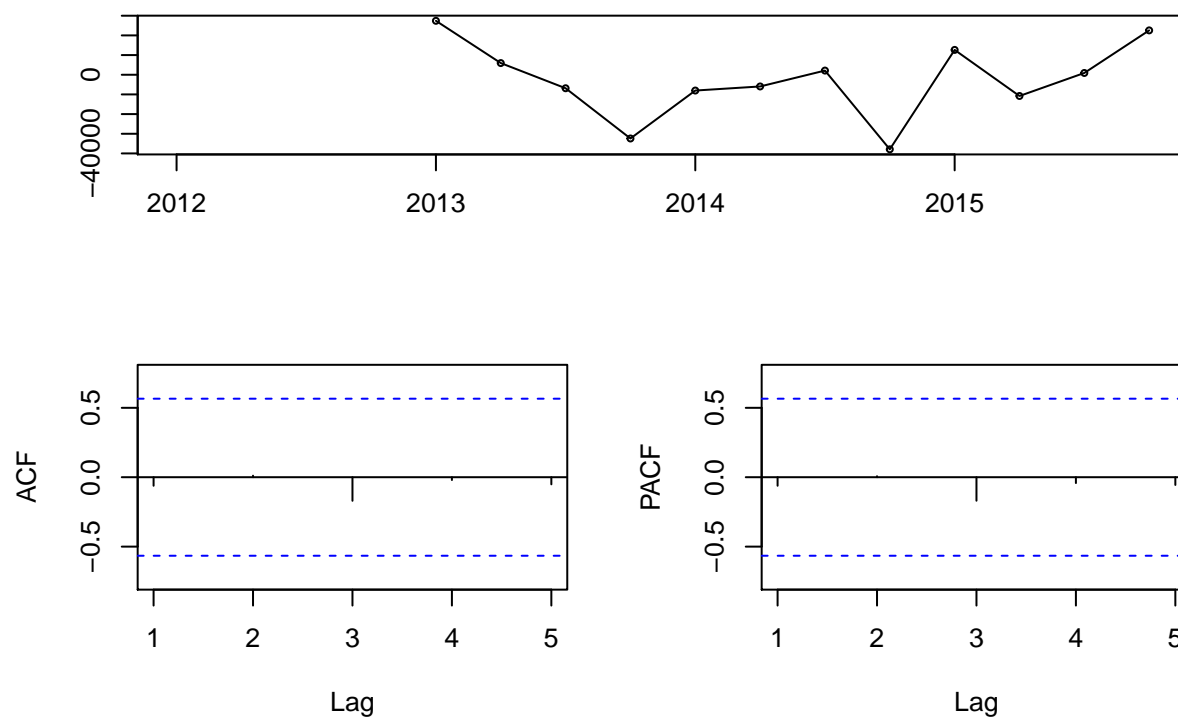

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Glenfair"
##                   ME      RMSE       MAE       MPE     MAPE     MASE
## Training set 21262.5 33652.26 22095.83  9.222198  9.66091 1.00000
## Test set     76037.5 94517.57 76037.50 22.112995 22.11300 3.44126
##                  ACF1 Theil's U
## Training set -0.03121027        NA
## Test set      0.33756510  1.875575
## [1] "Holt Winters Accuracy for  Portland, OR - Glenfair"
##                   ME      RMSE       MAE       MPE     MAPE     MASE
## Training set -2534.334 18730.87 14458.28 -1.588949  7.01328 0.654344
## Test set     15280.333 55756.25 41216.72  2.481421 11.91926 1.865362
##                  ACF1 Theil's U
## Training set -0.06162271        NA
## Test set      0.22362600   1.09289
```

Portland, OR – Glenfair : TS Training Model Comparison

Median House Price vs Year chart with legend:
- Train Data (black)
- Test Data (red)
- Holt Winters (blue)
- Seasonal Naive (green)

Portland, OR – Glenfair : Full TS Models Comparison

Portland, OR – Buckman

Portland, OR – Buckman : Naive Model Forecast
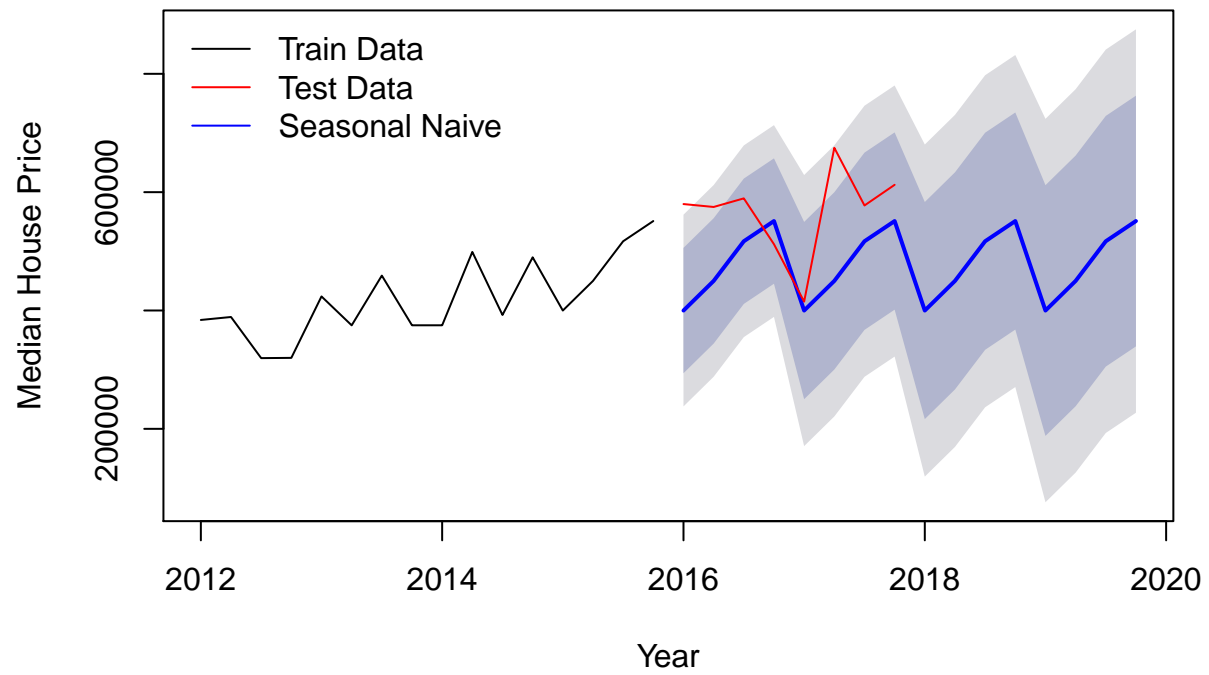
Portland, OR – Buckman : Naive Model Forecast Residuals

Portland, OR – Buckman : Holt Winters Model Forecast
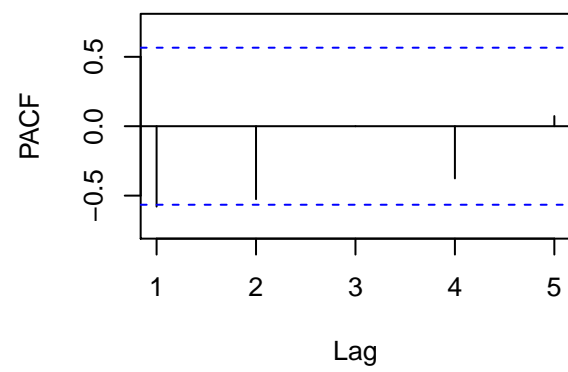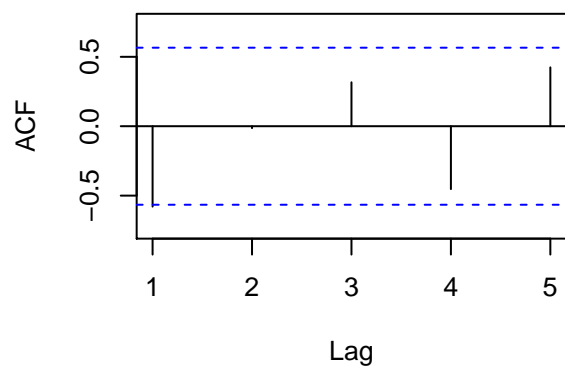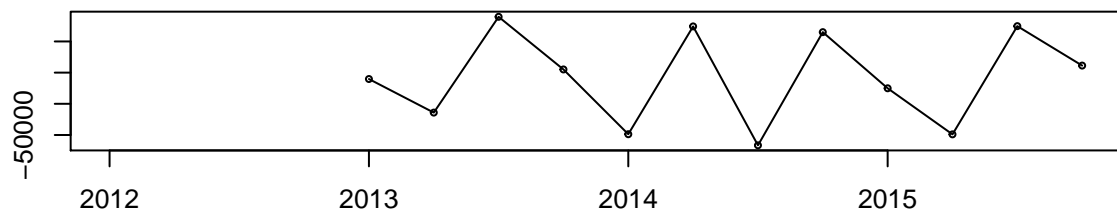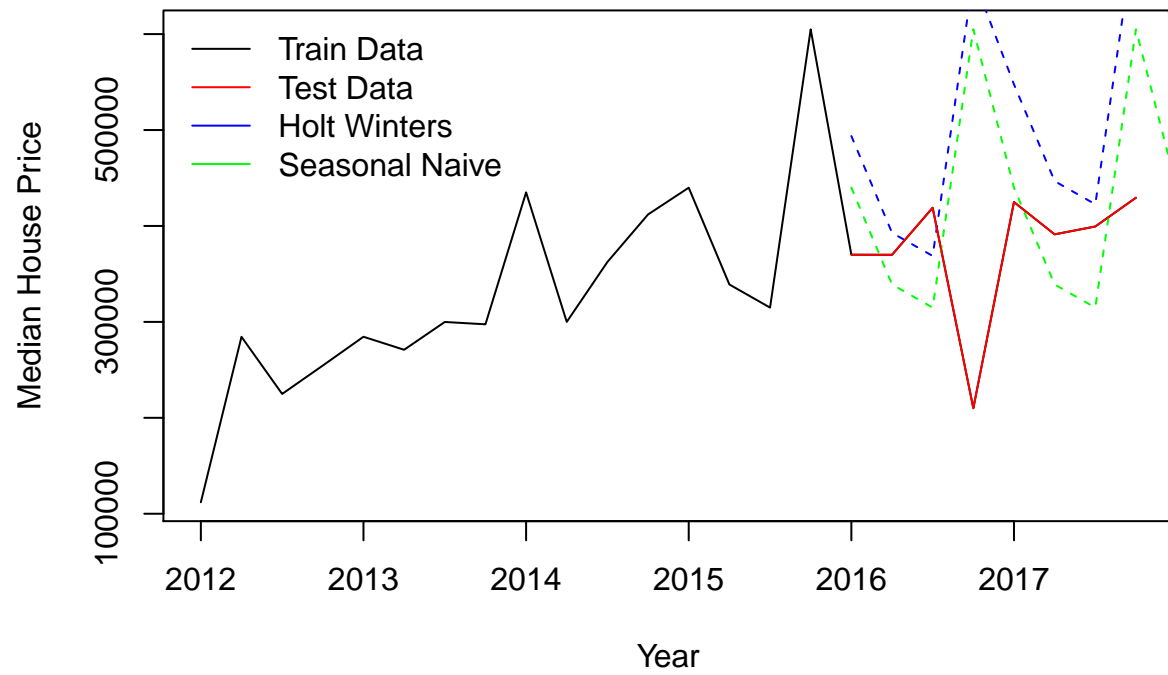
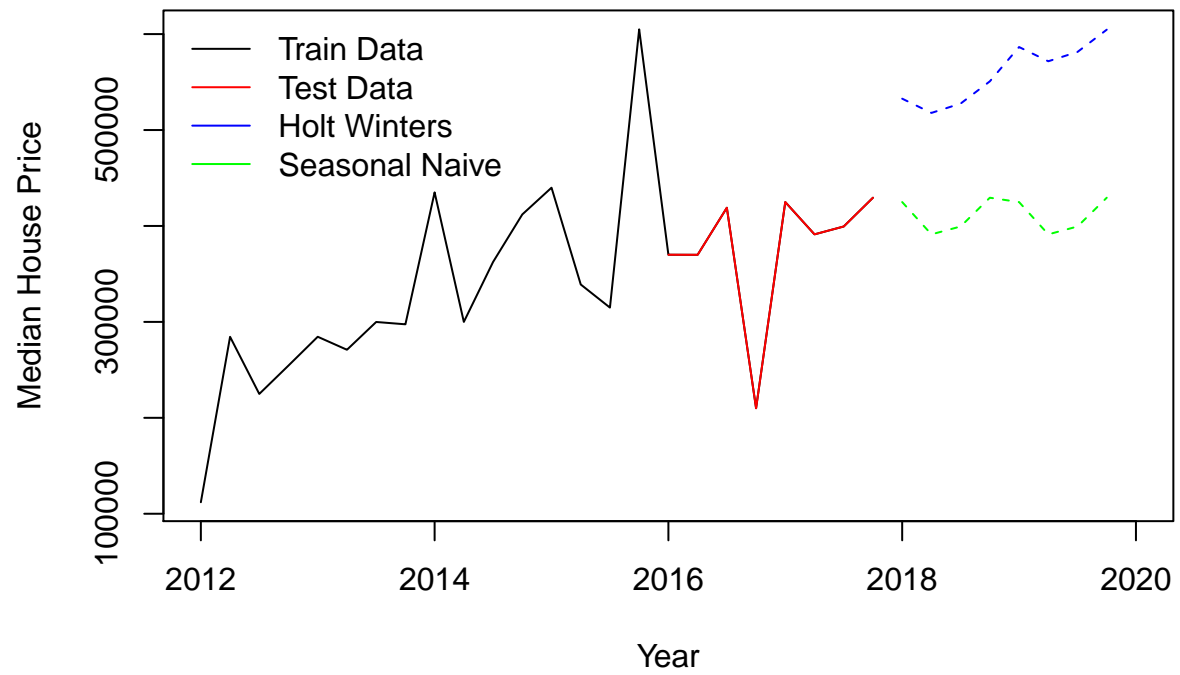## Portland, OR – Buckman : Holt Winters Model Forecast Residuals
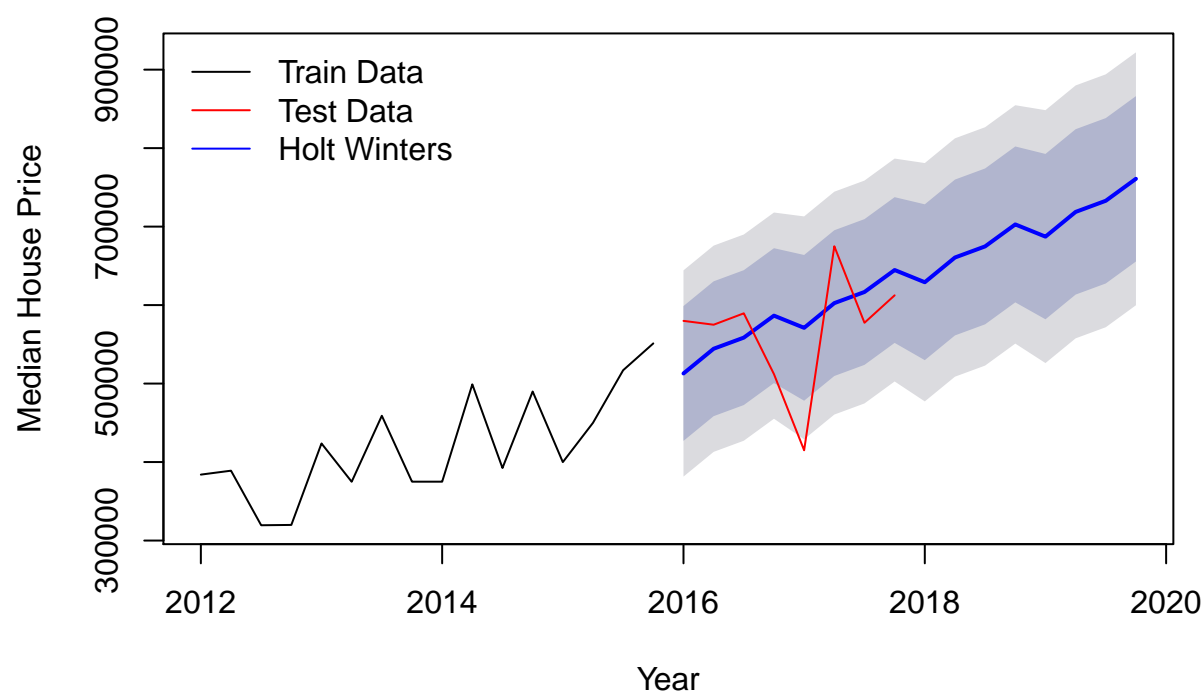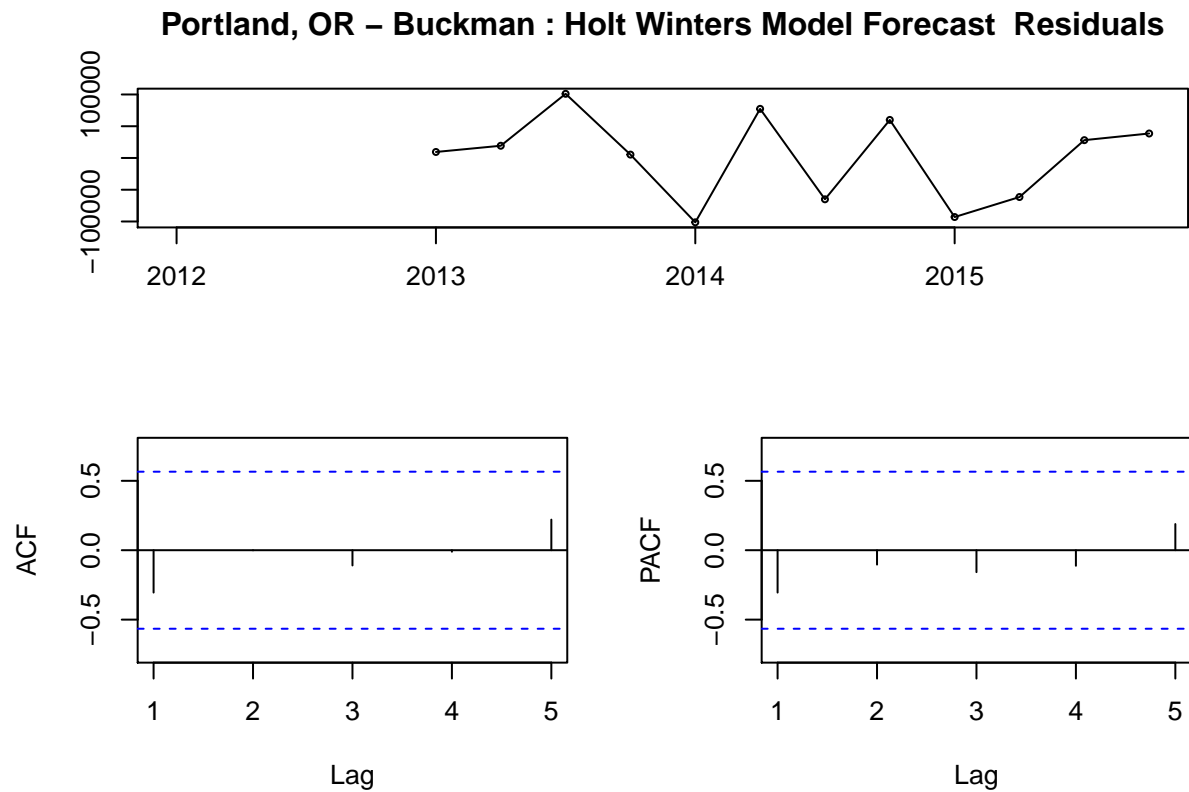

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Buckman"
##                    ME      RMSE      MAE       MPE     MAPE     MASE
## Training set 42141.67  82651.29 71875.0  8.301726 15.73630 1.000000
## Test set     87512.50 118880.30 97312.5 14.358154 16.27222 1.353913
##                   ACF1 Theil's U
## Training set -0.57922695        NA
## Test set      0.01982666 0.8993446
## [1] "Holt Winters Accuracy for  Portland, OR - Buckman"
##                    ME      RMSE      MAE        MPE     MAPE      MASE
## Training set   1513.833 64196.76 54976.14 -0.7951208 12.62032 0.7648854
## Test set     -12627.235 74251.58 62874.11 -3.9186153 12.13310 0.8747703
##                   ACF1 Theil's U
## Training set -0.30530737        NA
## Test set     -0.05663715 0.5672729
```

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Portland, OR – Buckman : TS Training Model Comparison
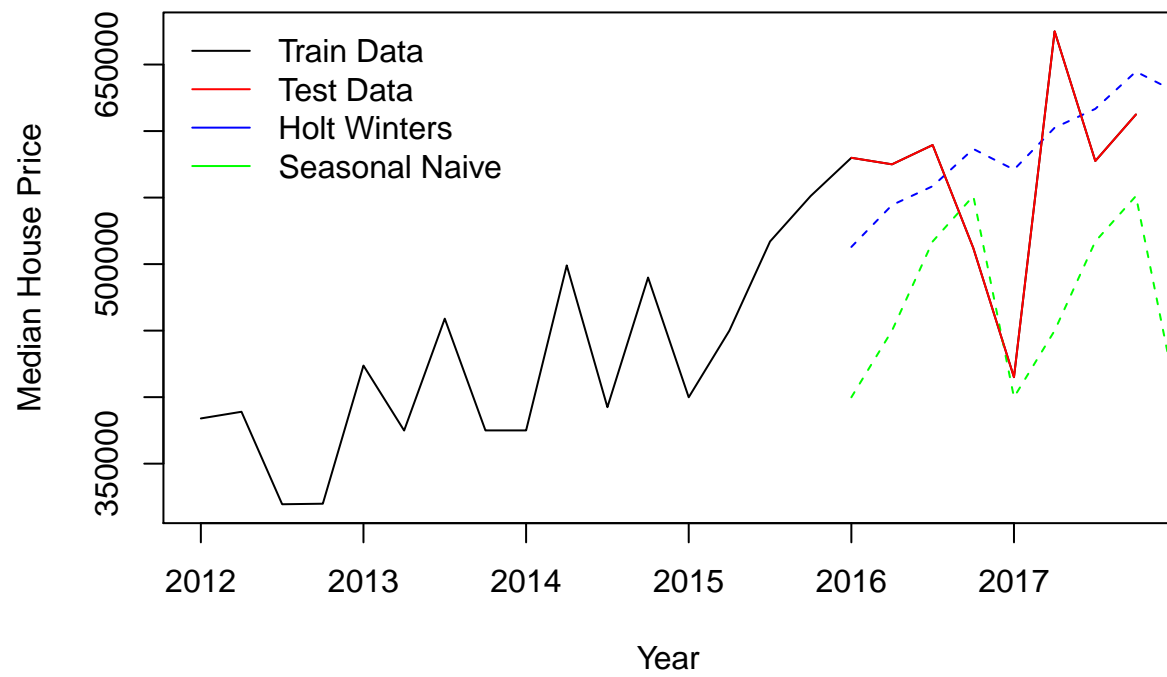
Portland, OR – Buckman : Full TS Models Comparison
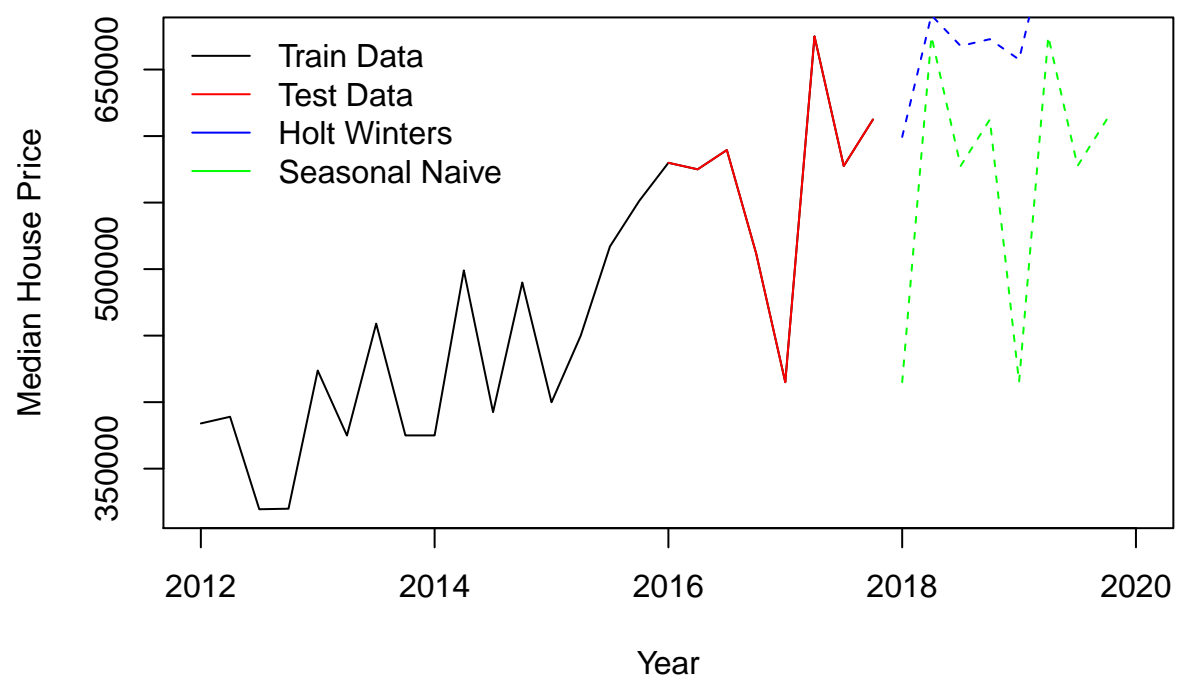
Portland, OR – Crestwood

Portland, OR – Crestwood : Naive Model Forecast
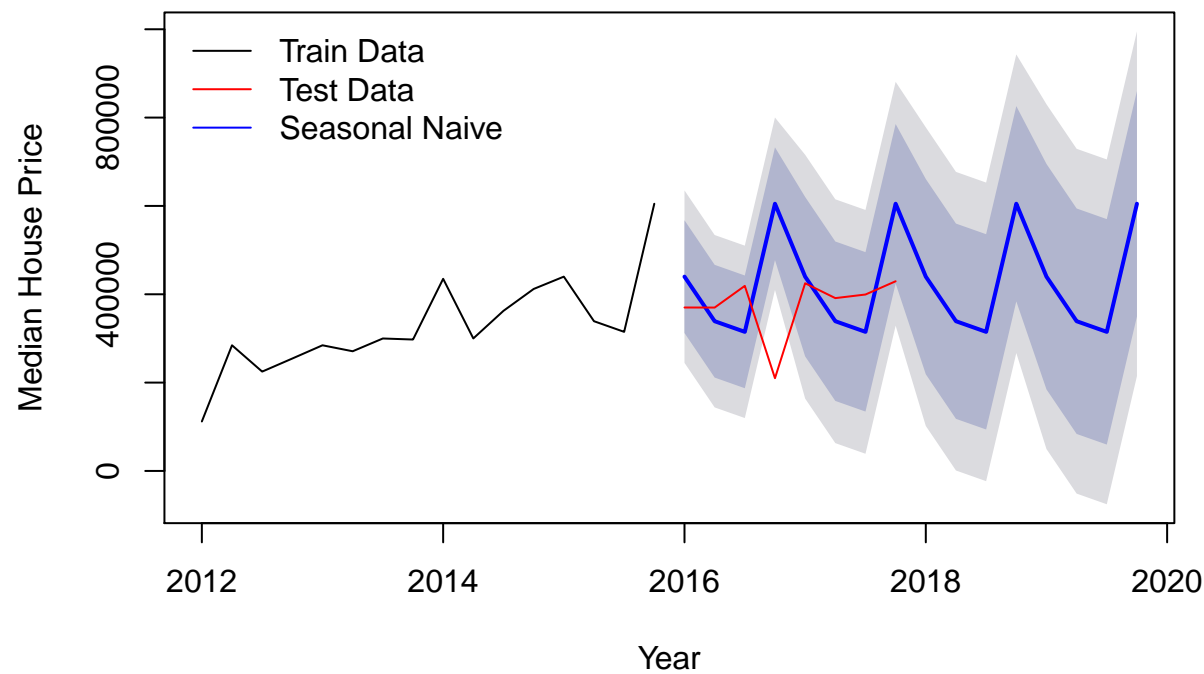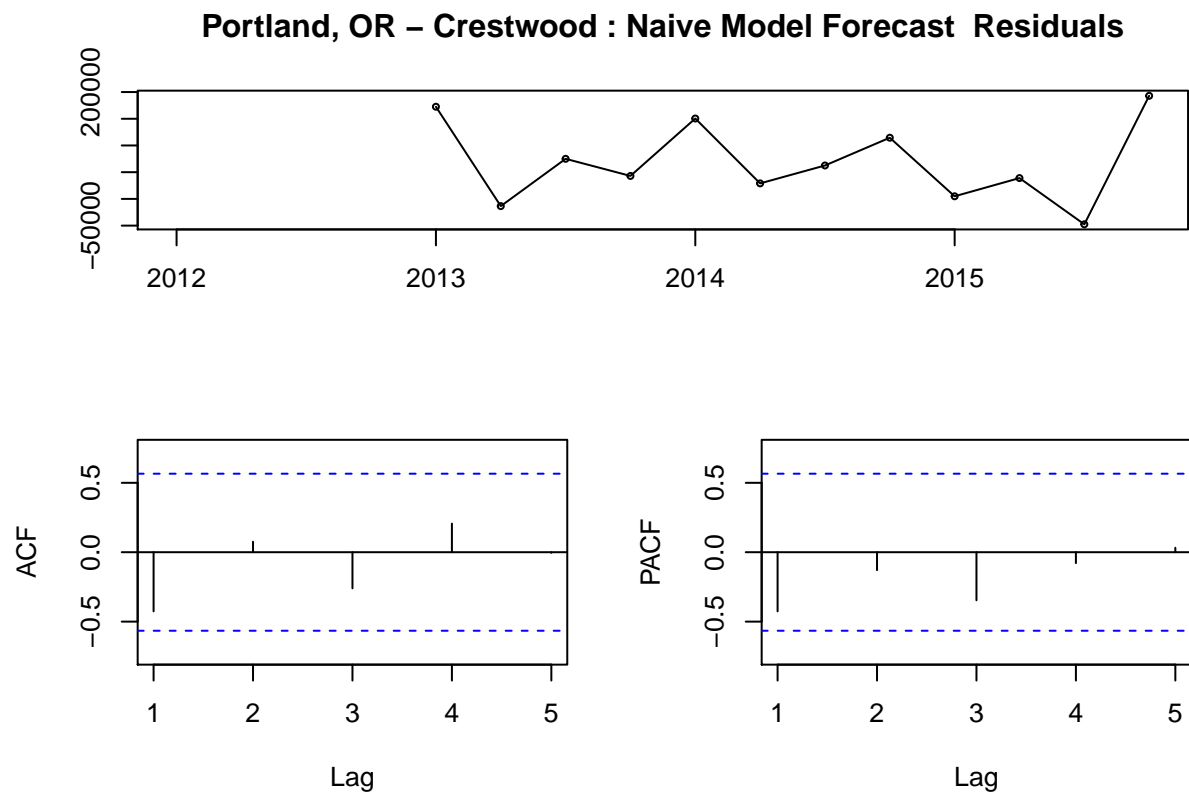
Portland, OR – Crestwood : Naive Model Forecast Residuals

Portland, OR – Crestwood : Holt Winters Model Forecast
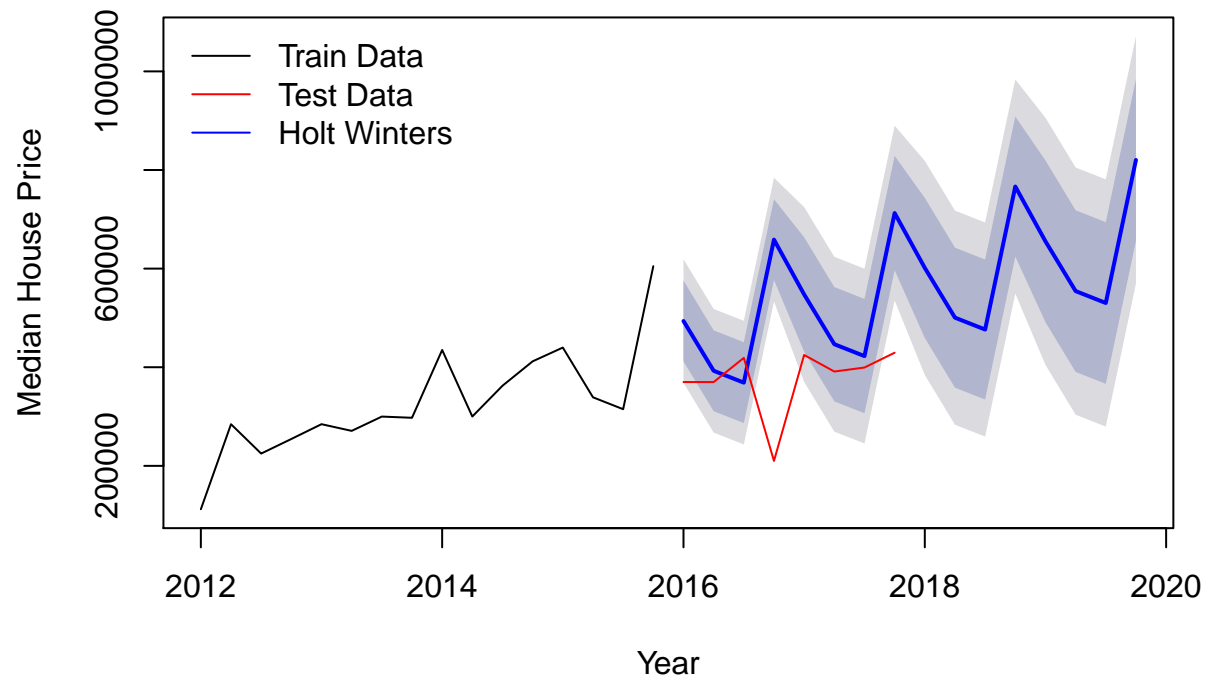
Portland, OR – Crestwood : Holt Winters Model Forecast Residuals
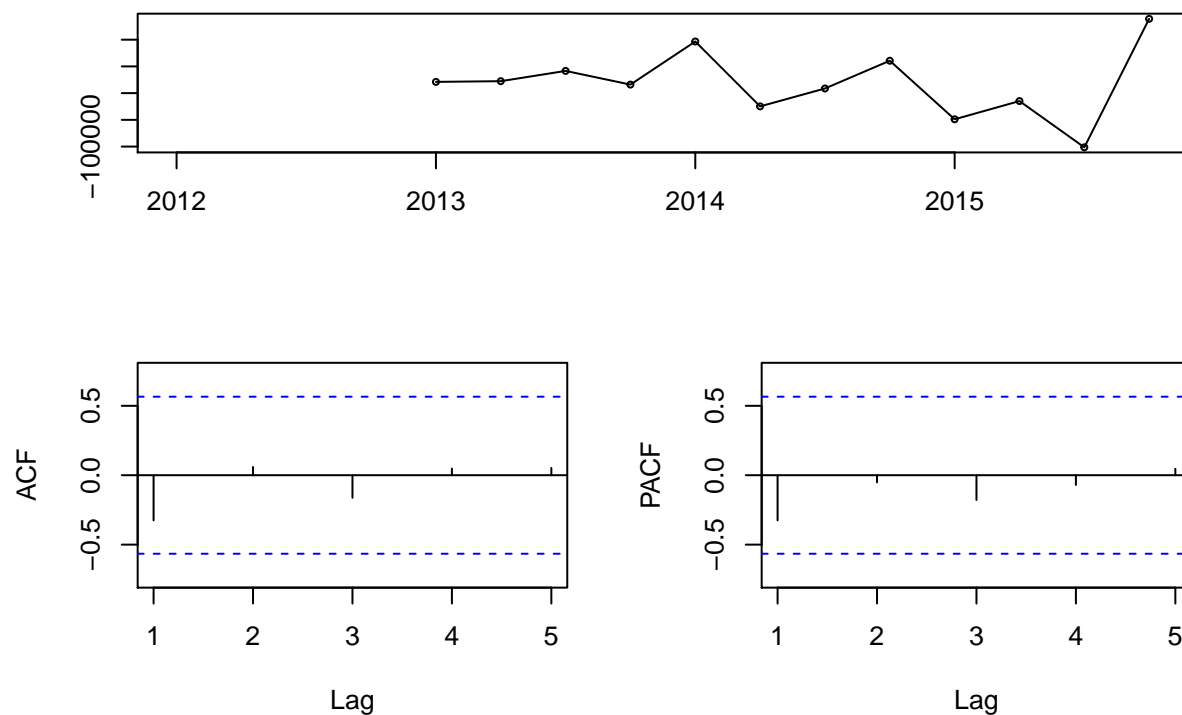

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Crestwood"
##                      ME      RMSE      MAE       MPE     MAPE      MASE
## Training set  68575.00  99567.87  78750.0  17.82131 21.16839 1.000000
## Test set     -47940.81 163389.34 115896.7 -22.95428 39.88567 1.471704
##                    ACF1 Theil's U
## Training set -0.4260496        NA
## Test set     -0.2779826 0.9649422
## [1] "Holt Winters Accuracy for  Portland, OR - Crestwood"
##                      ME      RMSE      MAE       MPE     MAPE      MASE
## Training set   18008.33  63826.76  49675.0  3.437958 12.76720 0.6307937
## Test set     -128715.81 199579.04 141278.3 -44.519402 47.51761 1.7940103
##                    ACF1 Theil's U
## Training set -0.3255043        NA
## Test set     -0.2572900  1.238584
```

Portland, OR – Crestwood : TS Training Model Comparison

Median House Price

Year

- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Portland, OR – Crestwood : Full TS Models Comparison

Portland, OR – West Portland Park
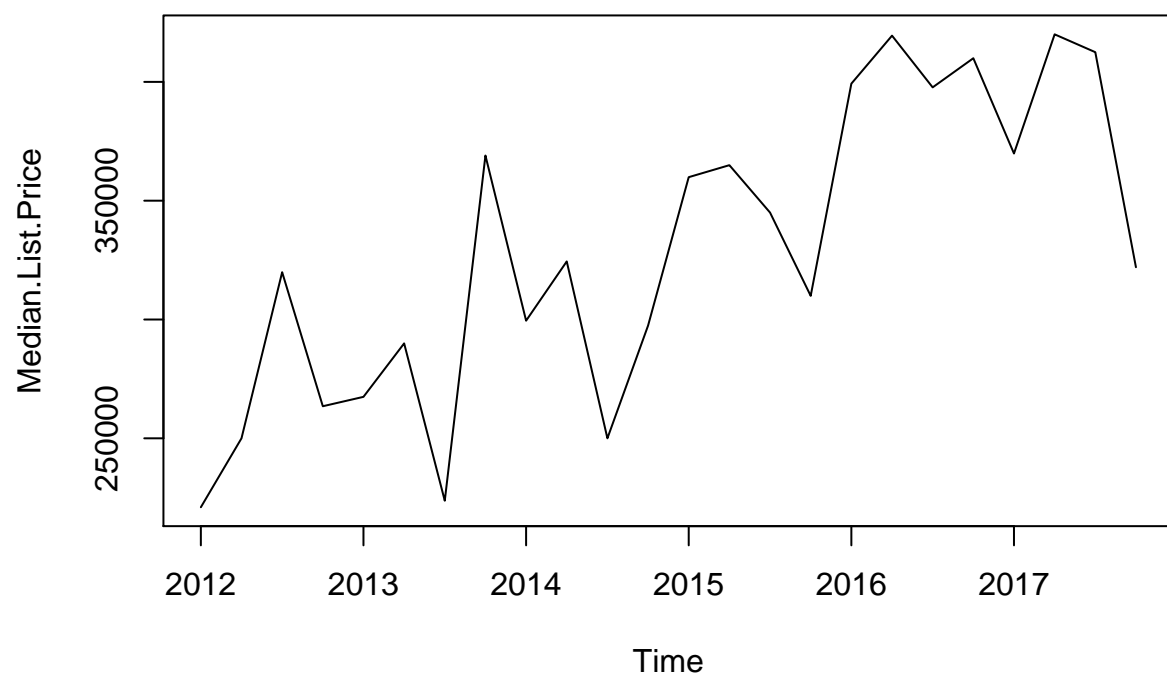
Portland, OR – West Portland Park : Naive Model Forecast
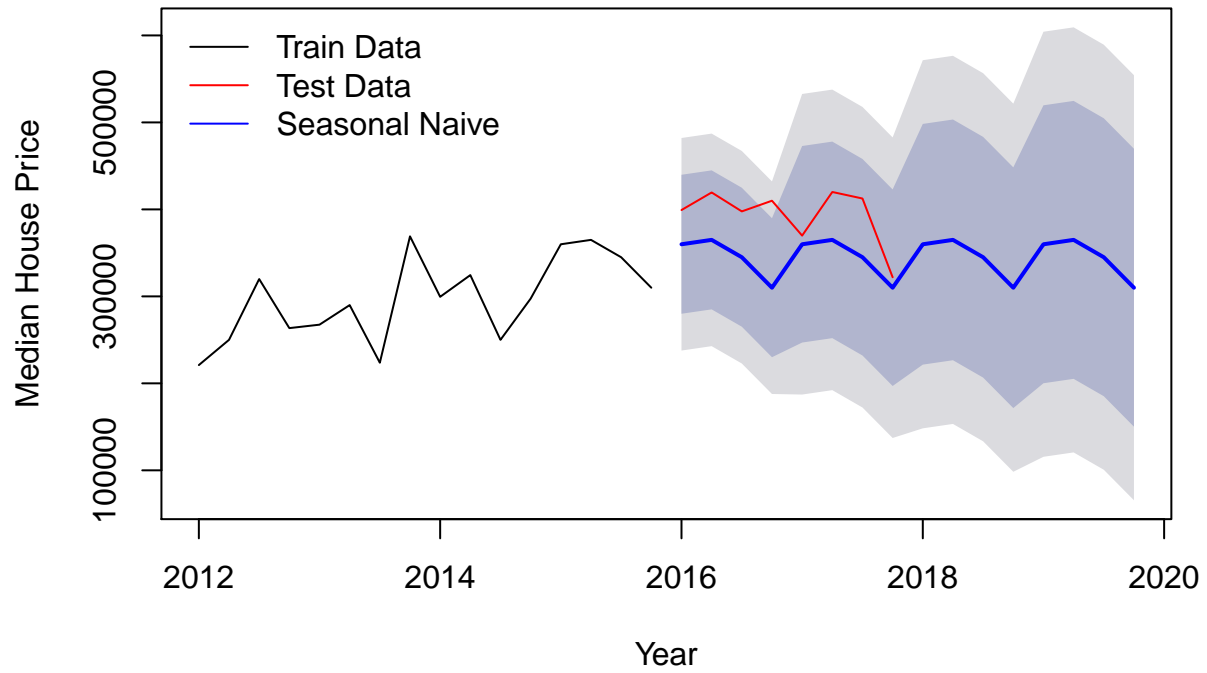
Portland, OR – West Portland Park : Naive Model Forecast Residuals
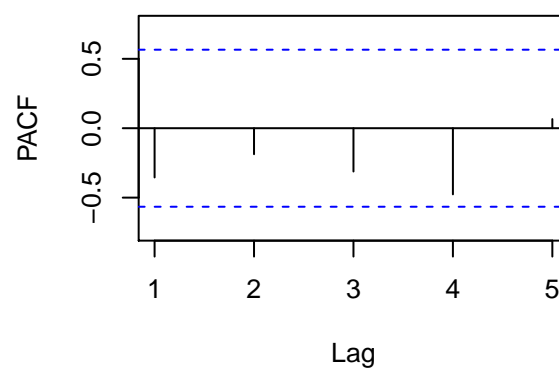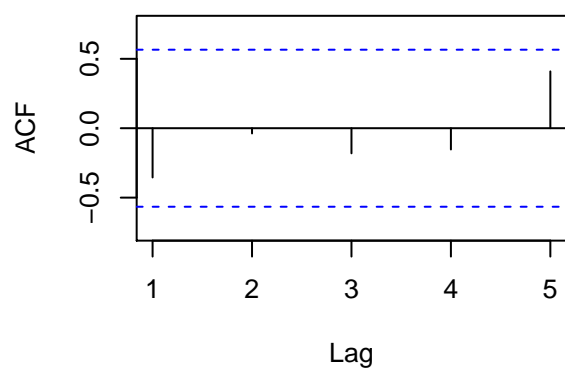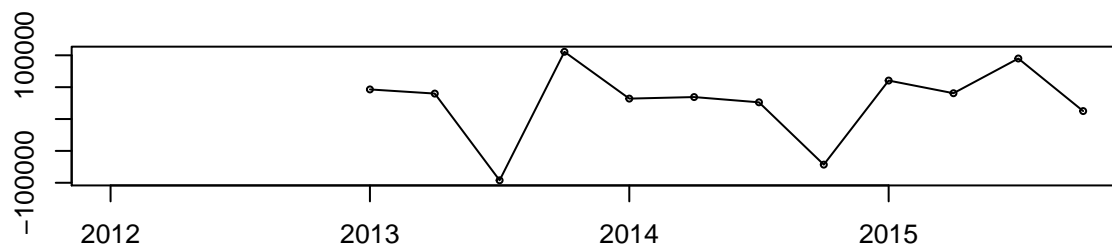
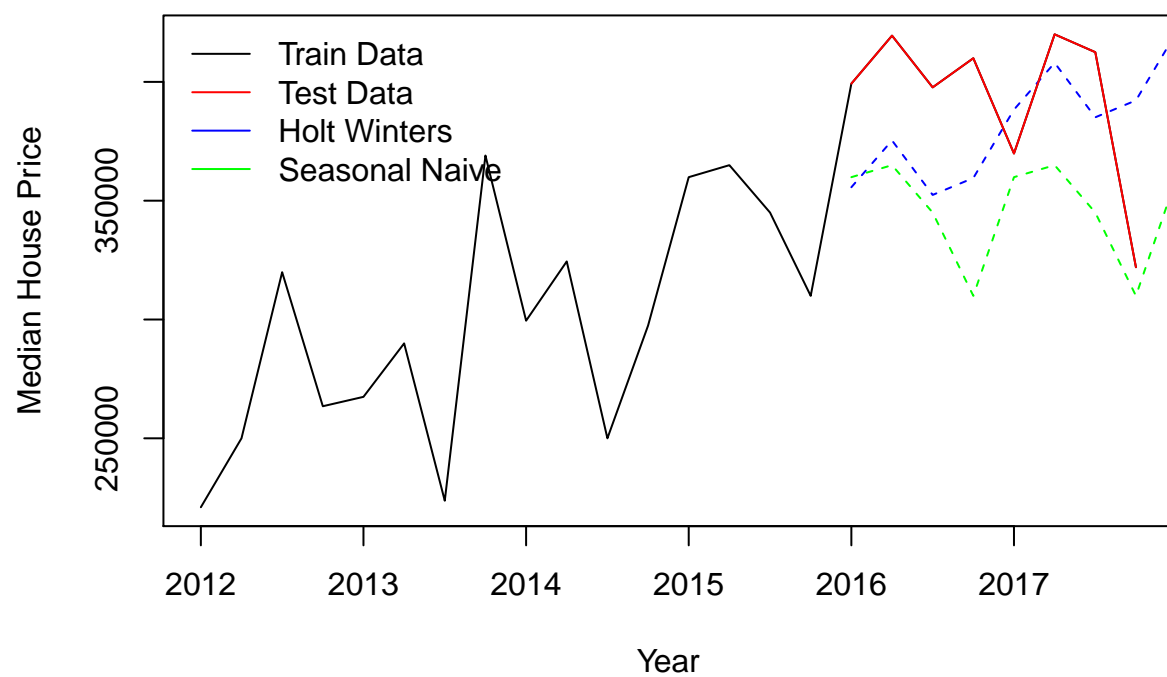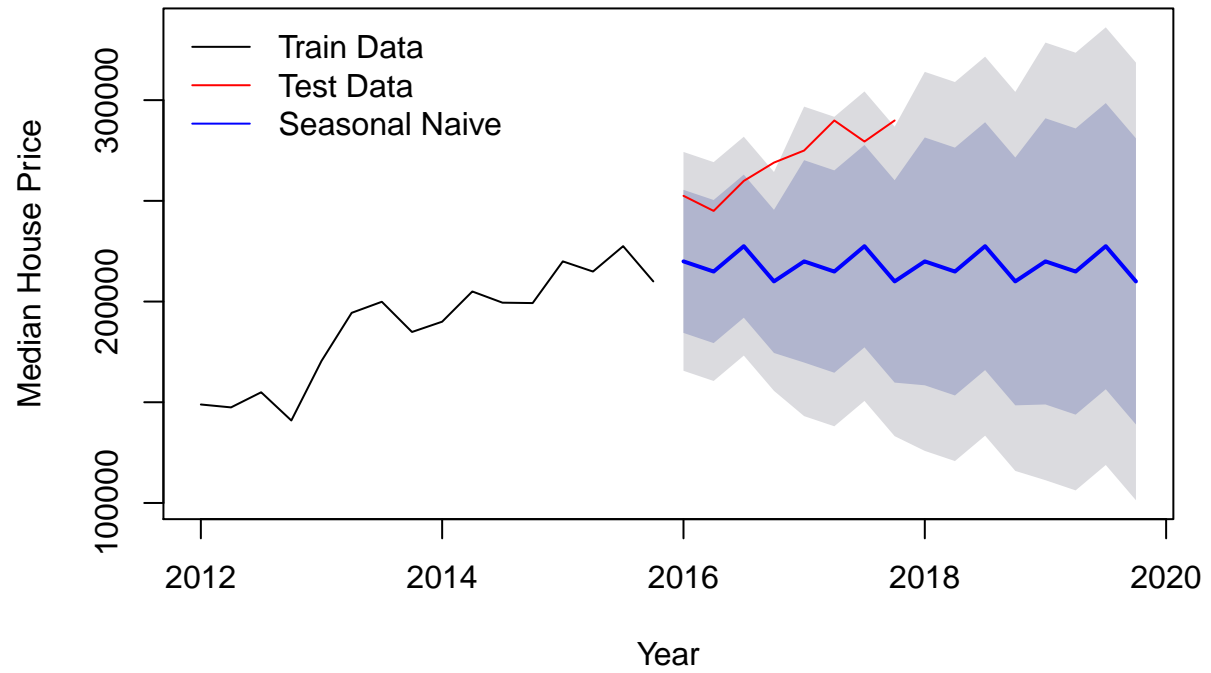# Portland, OR – West Portland Park : Holt Winters Model Forecast
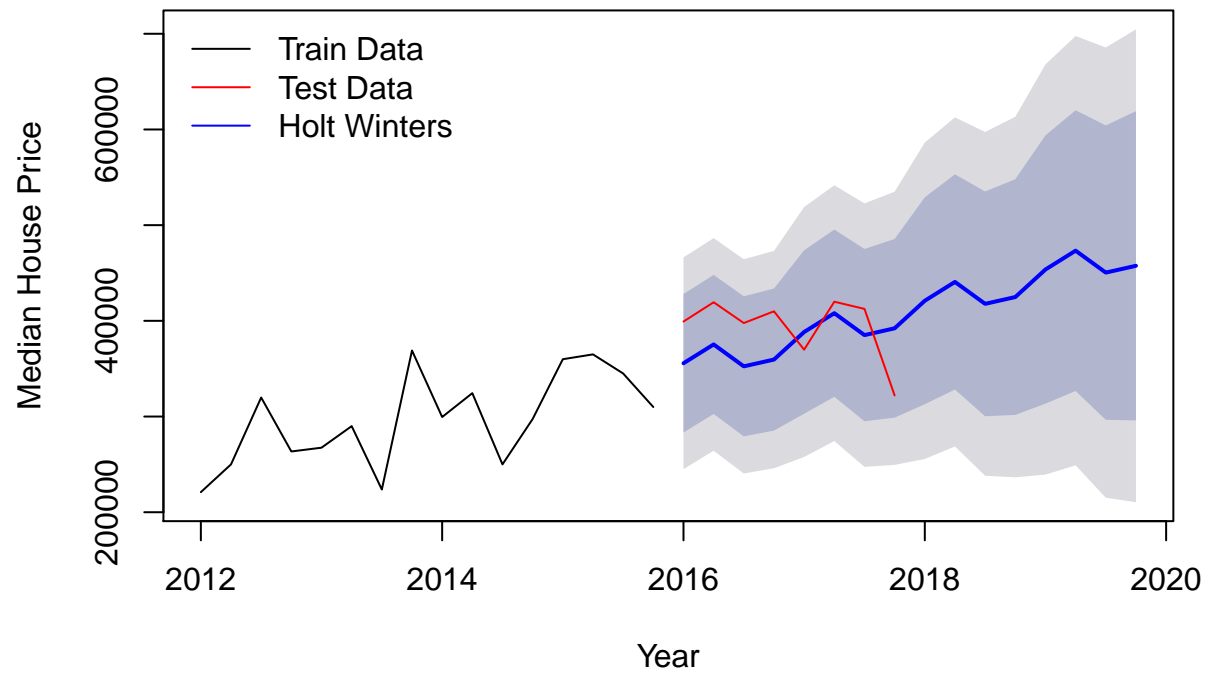
Portland, OR – West Portland Park : Holt Winters Model Forecast Residuals
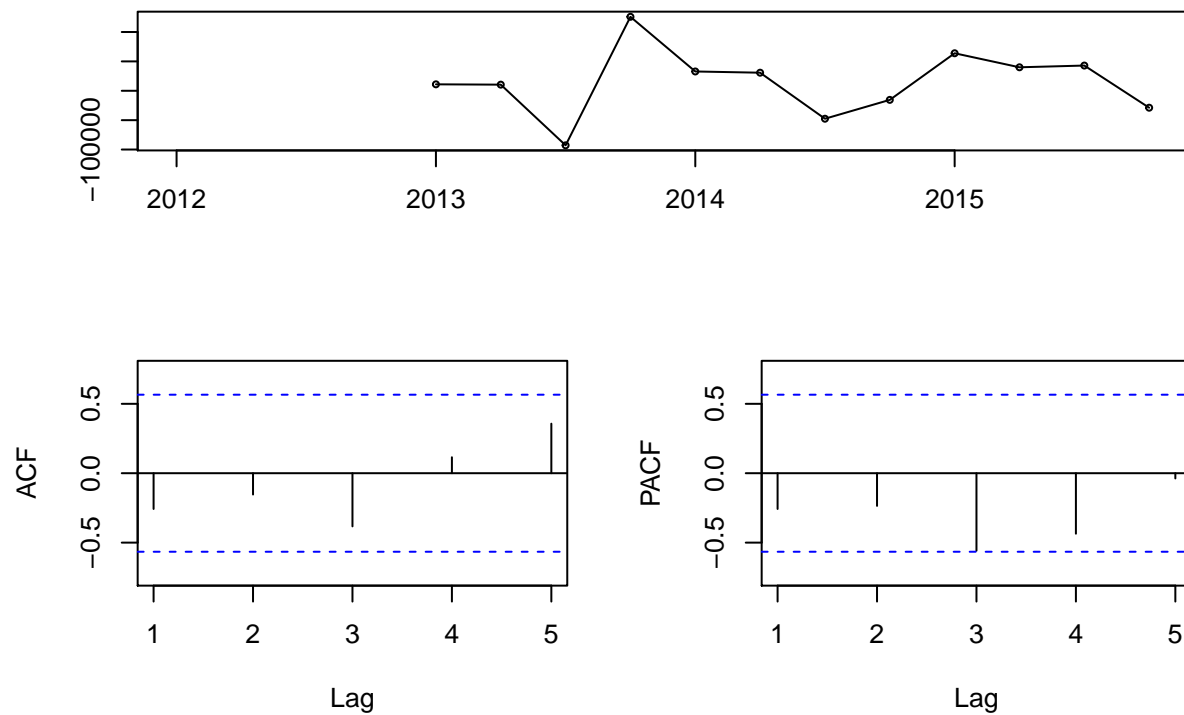

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - West Portland Park"
##                   ME     RMSE      MAE       MPE     MAPE      MASE
## Training set 27116.67 62332.68 55066.67  6.999479 18.17057 1.0000000
## Test set     48887.50 56043.42 48887.50 12.049612 12.04961 0.8877875
##                   ACF1 Theil's U
## Training set -0.3548985        NA
## Test set     -0.4392110  1.334325
## [1] "Holt Winters Accuracy for  Portland, OR - West Portland Park"
##                   ME     RMSE      MAE       MPE     MAPE      MASE
## Training set 14415.69 55945.71 45190.36 2.366795 14.86647 0.8206482
## Test set     16757.95 42719.08 38928.62 3.475793 10.17551 0.7069362
##                    ACF1 Theil's U
## Training set -0.25757987        NA
## Test set      0.03868145 0.9605563
```

Portland, OR – West Portland Park : TS Training Model Comparisor

Portland, OR – West Portland Park : Full TS Models Comparison
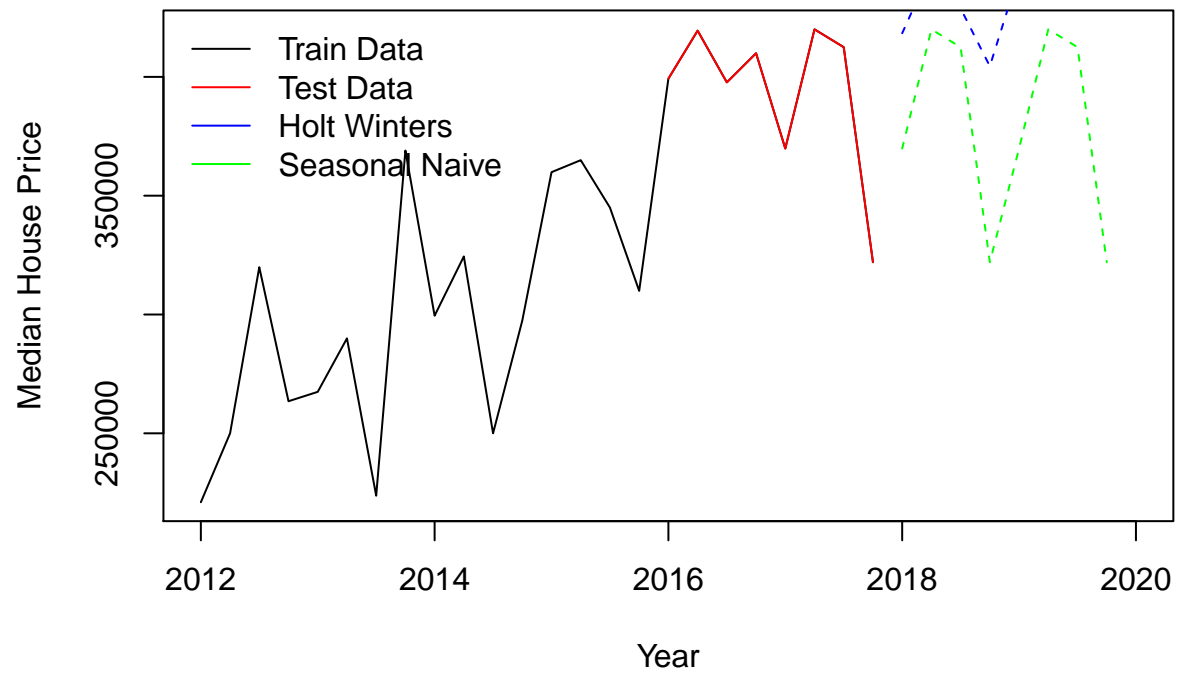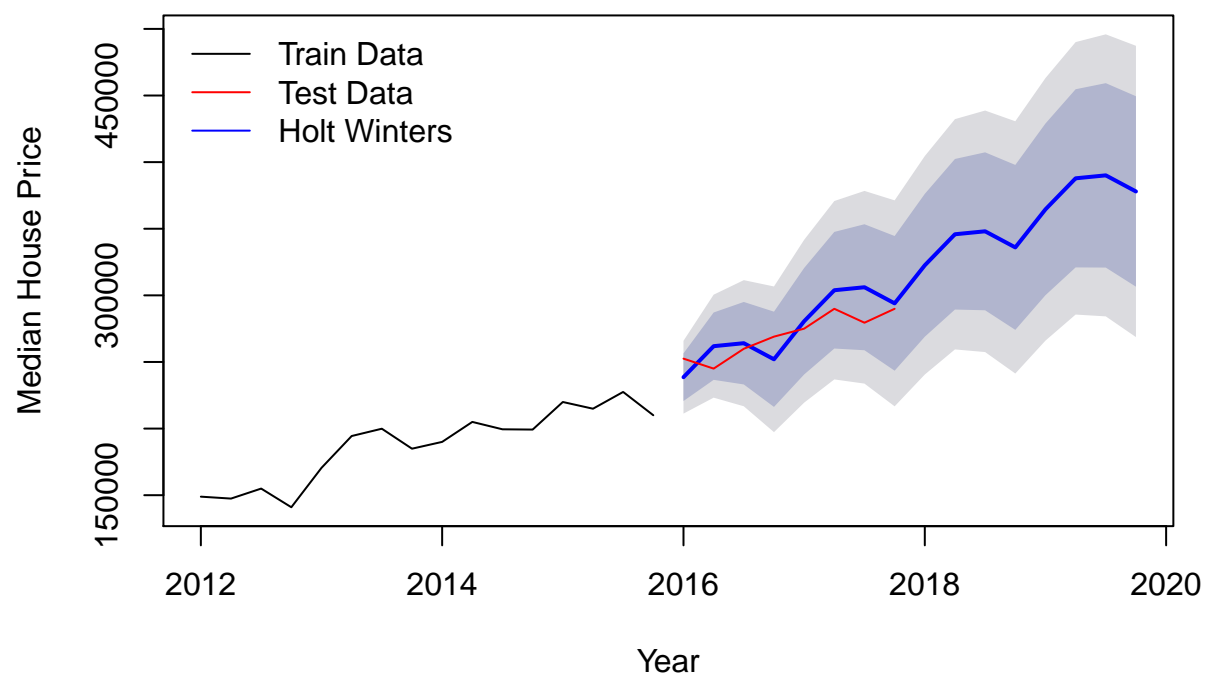
Portland, OR – Powellhurst–Gilbert
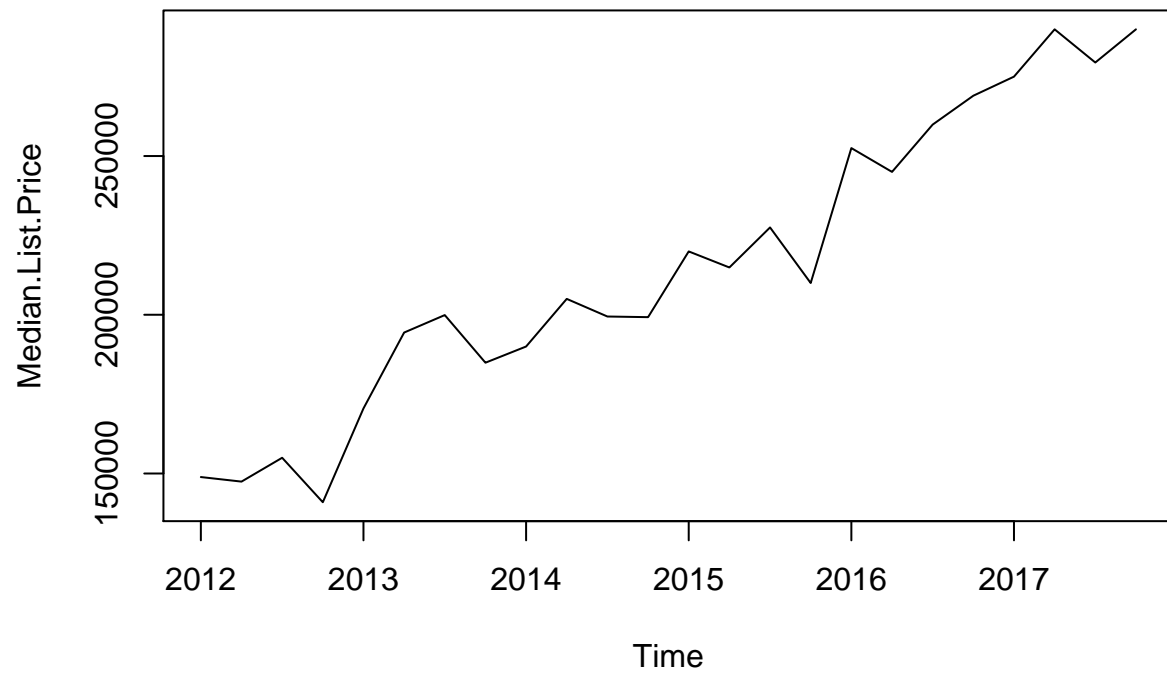
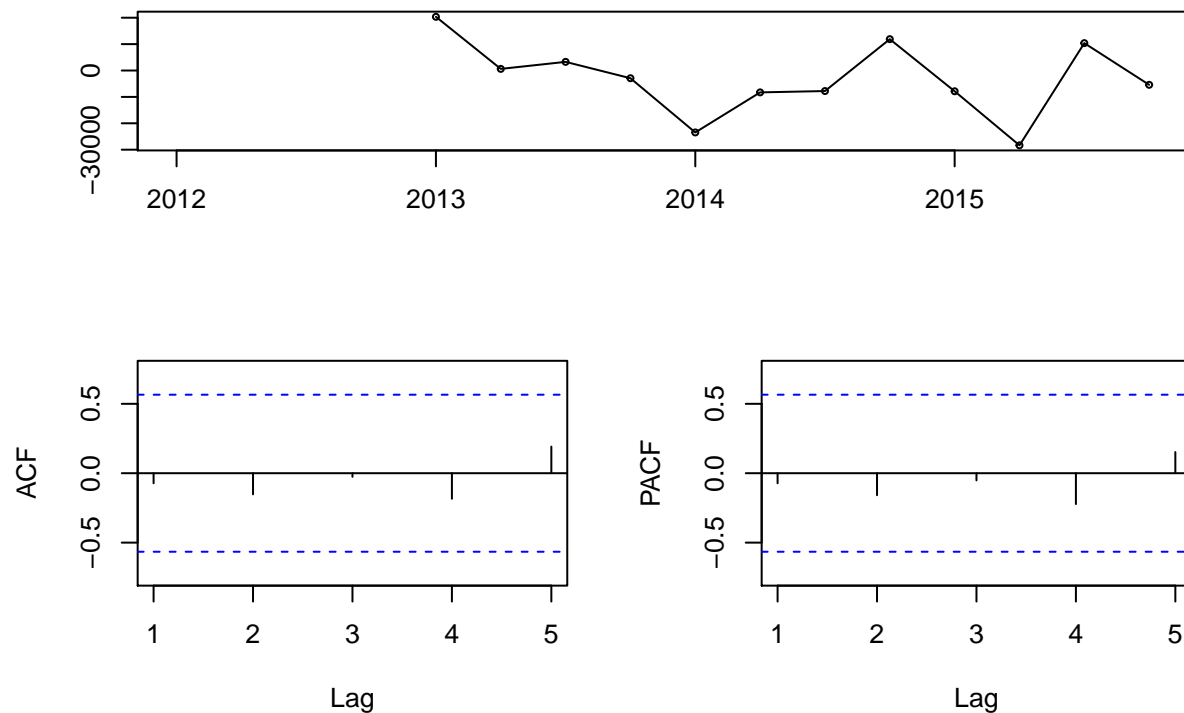**Portland, OR – Powellhurst–Gilbert : Naive Model Forecast**

Portland, OR – Powellhurst–Gilbert : Naive Model Forecast Residuals
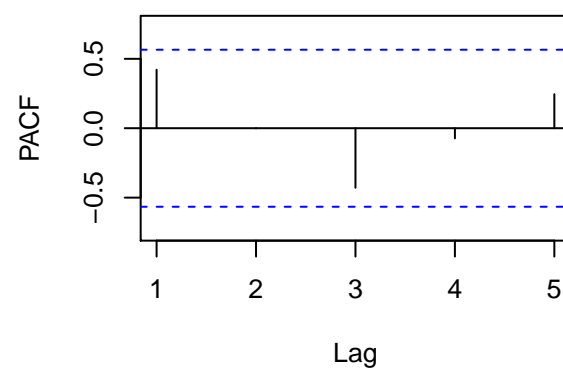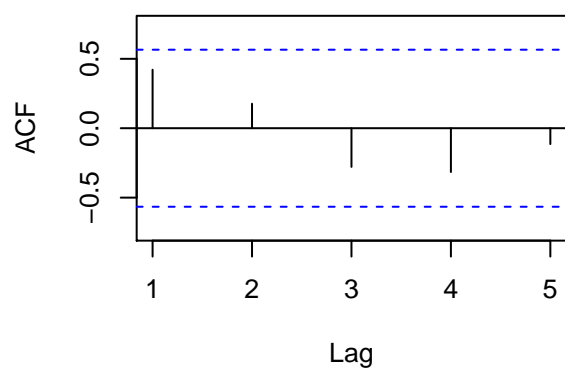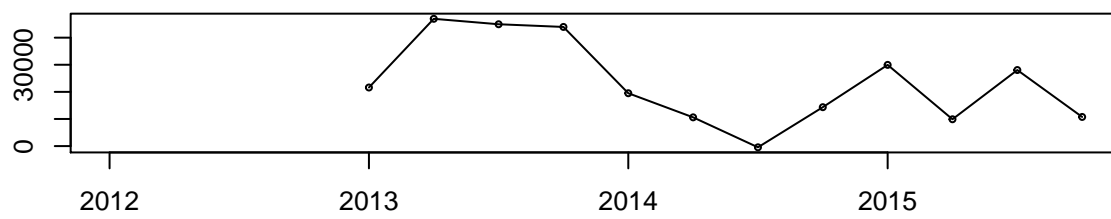
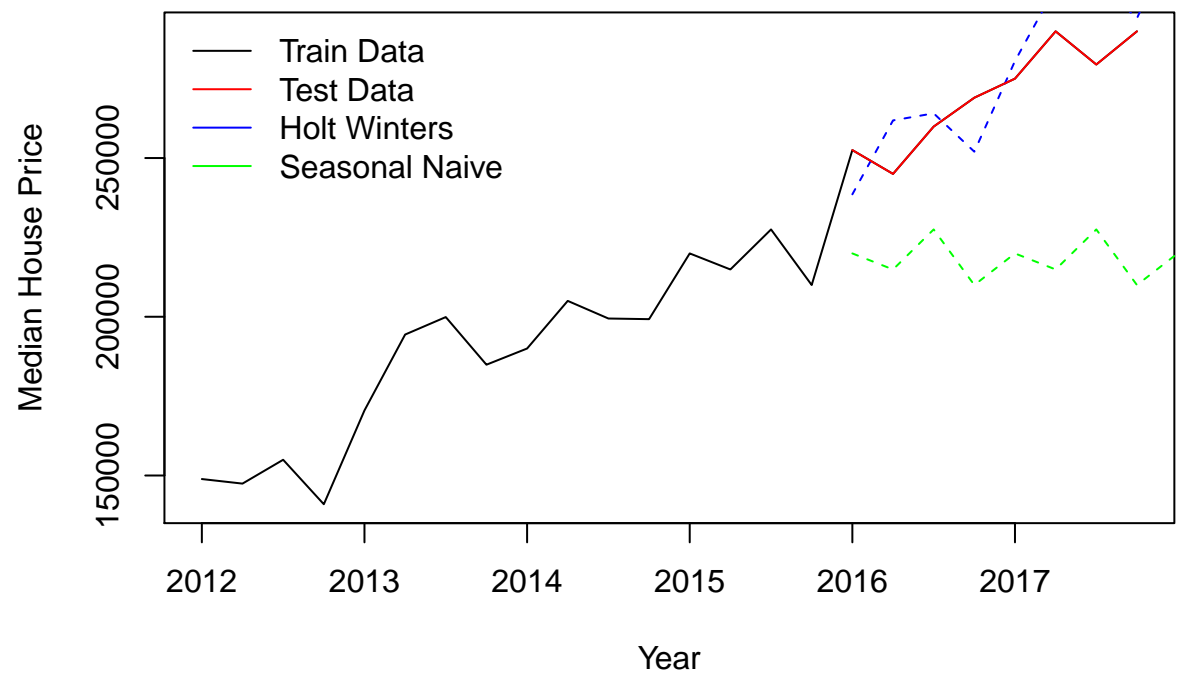**Portland, OR – Powellhurst–Gilbert : Holt Winters Model Forecast**

Portland, OR – Powellhurst–Gilbert : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Powellhurst-Gilbert"
##                    ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 23341.83 27716.87 23416.83 11.76336 11.80096 1.000000
## Test set     51993.75 55039.29 51993.75 18.95209 18.95209 2.220358
##                    ACF1 Theil's U
## Training set 0.4216185        NA
## Test set     0.3094182  5.123387
## [1] "Holt Winters Accuracy for  Portland, OR - Powellhurst-Gilbert"
##                    ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -3131.490 13712.03 10879.32 -1.400162 5.468285 0.4645938
## Test set     -5037.925 14729.57 12773.45 -1.801687 4.761992 0.5454815
##                    ACF1 Theil's U
## Training set -0.07252899        NA
## Test set     -0.03283277  1.315897
```

Portland, OR – Powellhurst–Gilbert : TS Training Model Comparison


```
## Warning in window.default(x, ...): 'end' value not changed
```

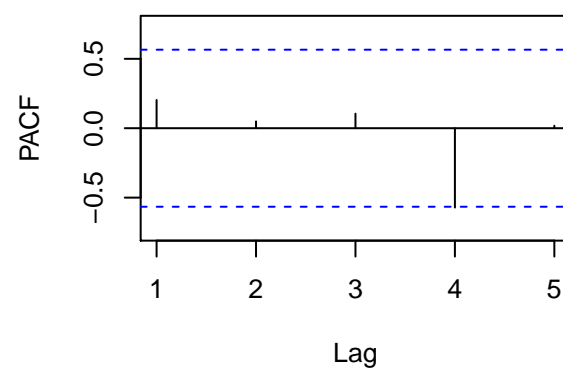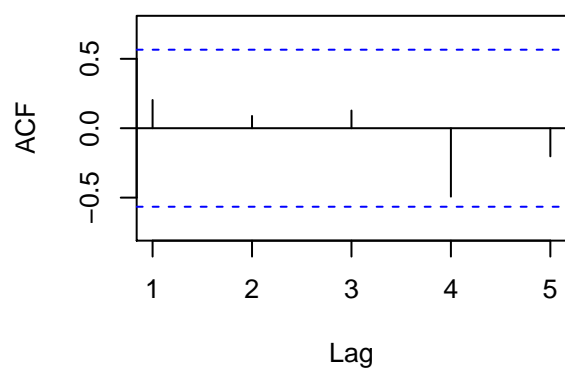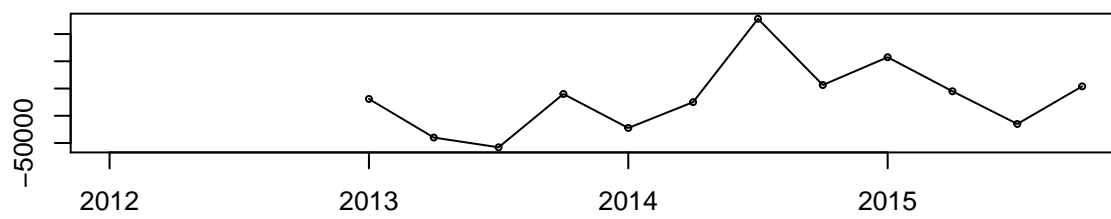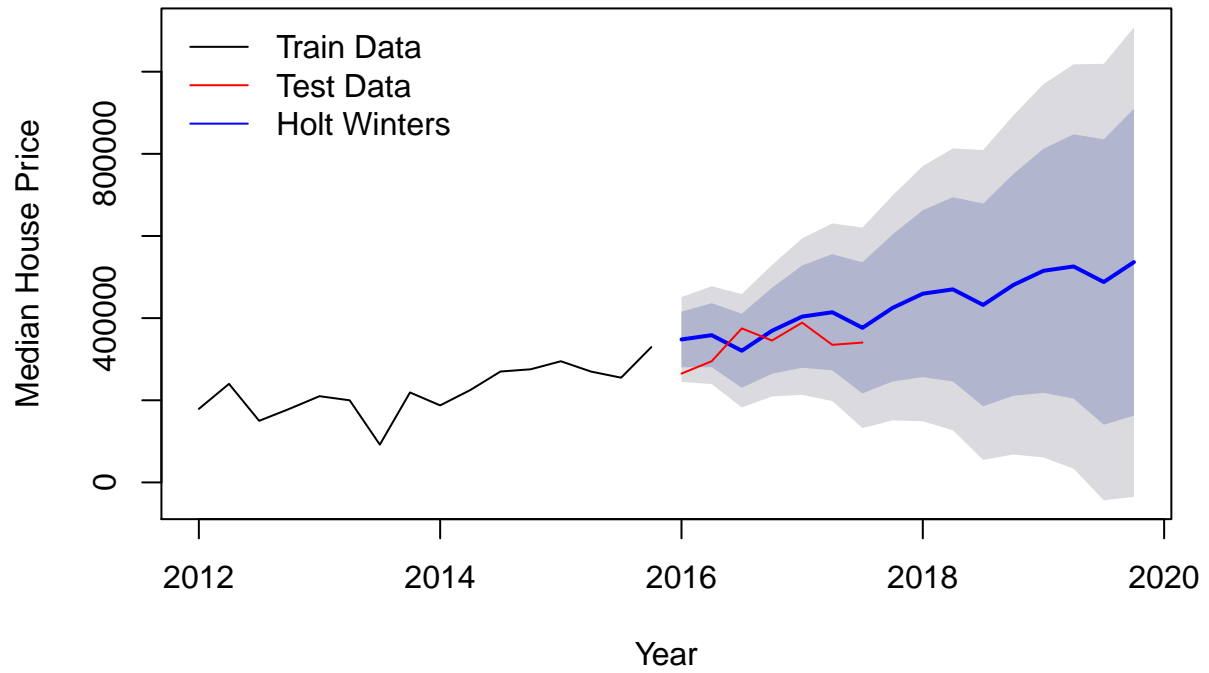# Portland, OR – Powellhurst–Gilbert : Full TS Models Comparison
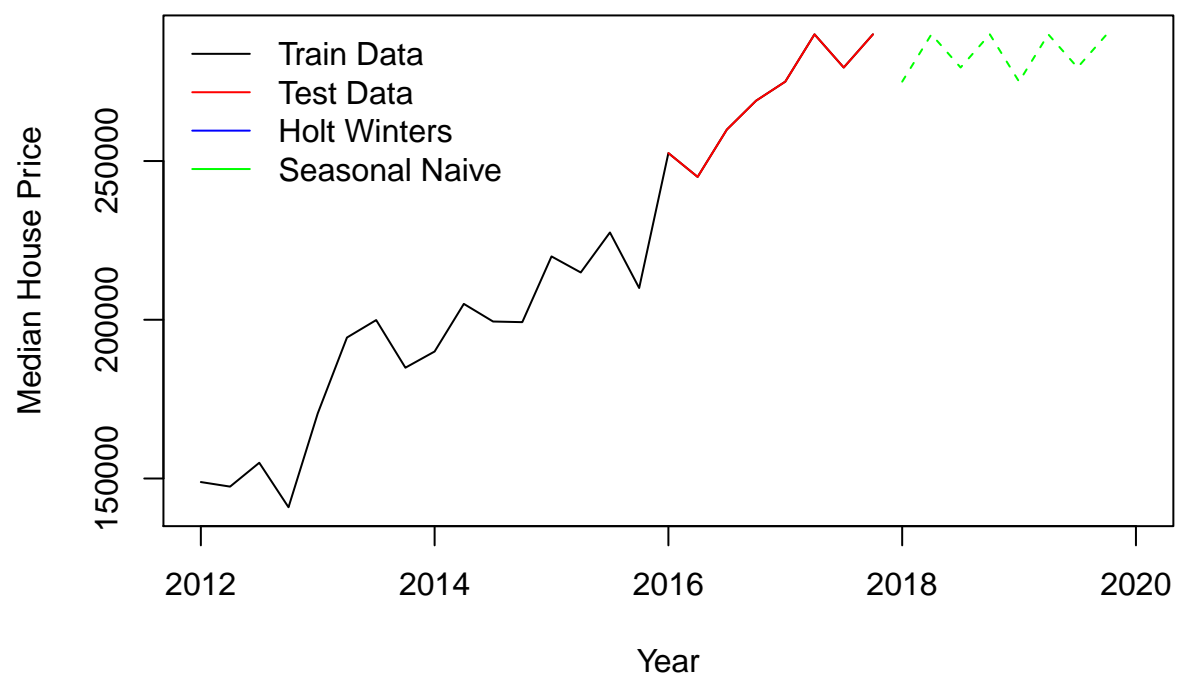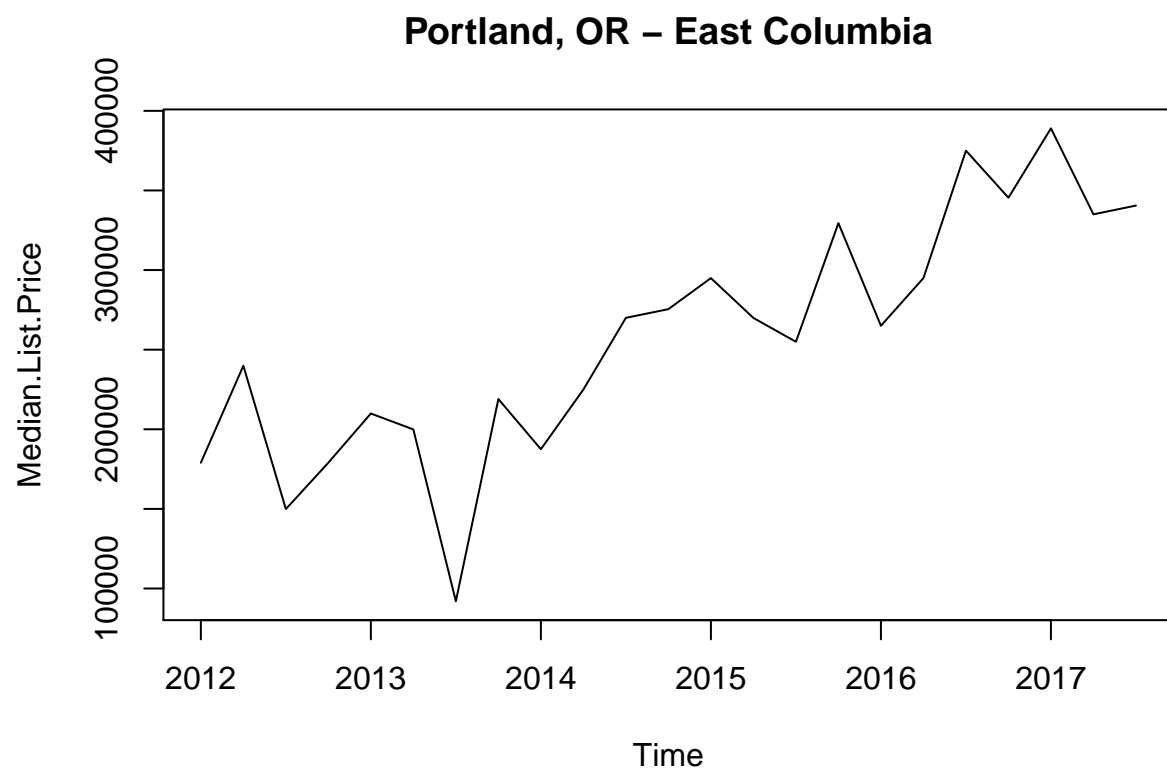
Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

X-axis: Year
Y-axis: Median House Price

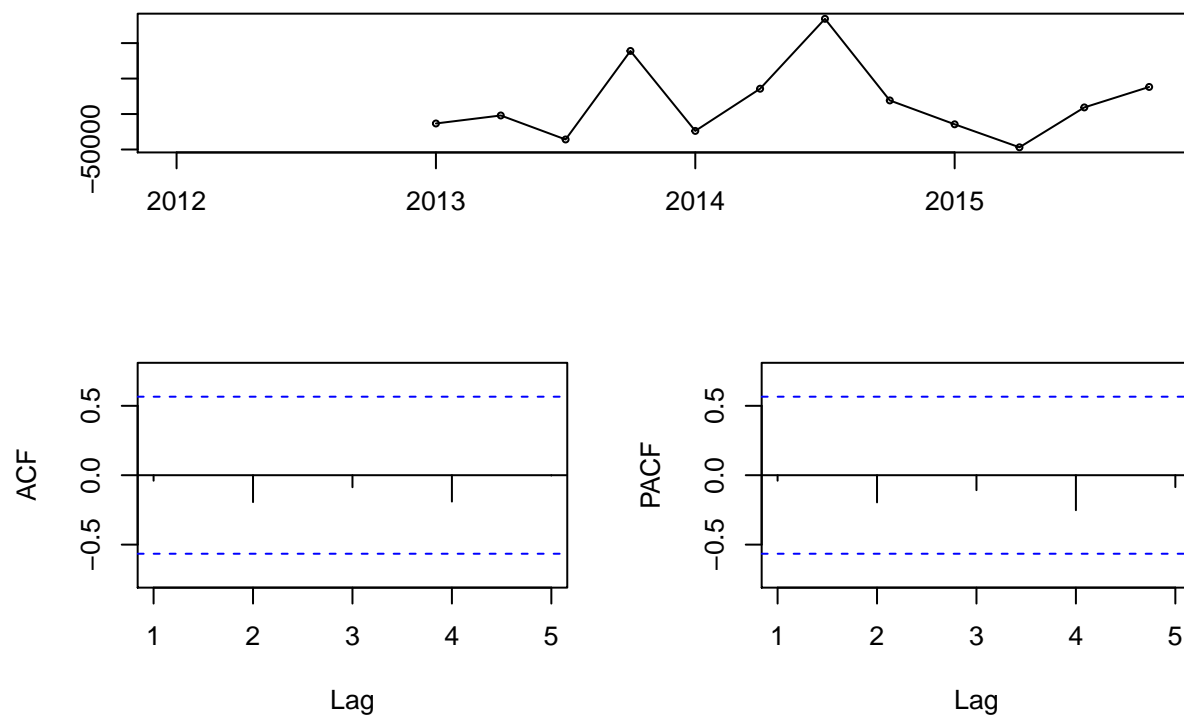# Portland, OR – East Columbia

Portland, OR – East Columbia : Naive Model Forecast
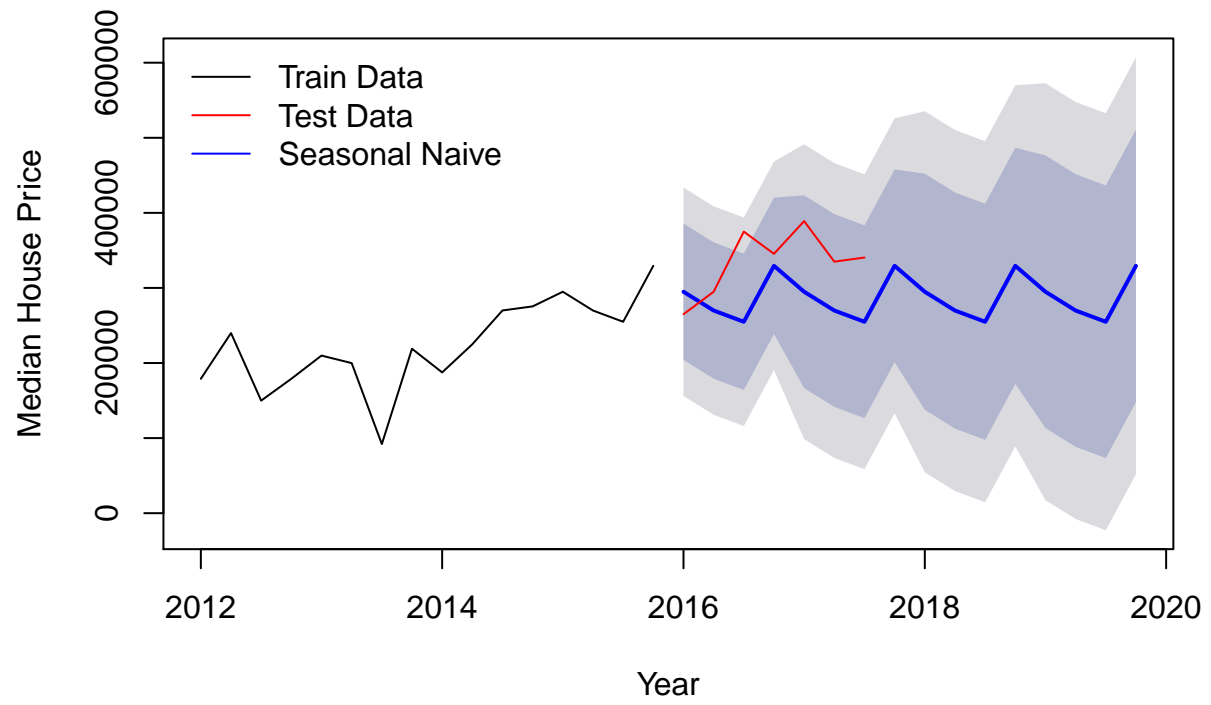
Portland, OR – East Columbia : Naive Model Forecast Residuals

Portland, OR – East Columbia : Holt Winters Model Forecast

Portland, OR – East Columbia : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - East Columbia"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 33456.25 70838.89 56014.58  8.269171 25.06827 1.00000
## Test set     53685.86 72299.26 62242.86 14.650780 17.87984 1.11119
##                   ACF1 Theil's U
## Training set  0.2033004        NA
## Test set     -0.1647591  1.638228
## [1] "Holt Winters Accuracy for  Portland, OR - East Columbia"
##                   ME      RMSE      MAE       MPE     MAPE      MASE
## Training set  15769.10 52881.18 38492.07   3.926723 17.47484 0.6871794
## Test set     -35117.42 56367.01 50654.33 -11.890689 16.03386 0.9043060
##                    ACF1 Theil's U
## Training set -0.03952382        NA
## Test set     -0.05885194  1.083608
```

Portland, OR – East Columbia : TS Training Model Comparison

Median House Price

Year

Train Data
Test Data
Holt Winters
Seasonal Naive
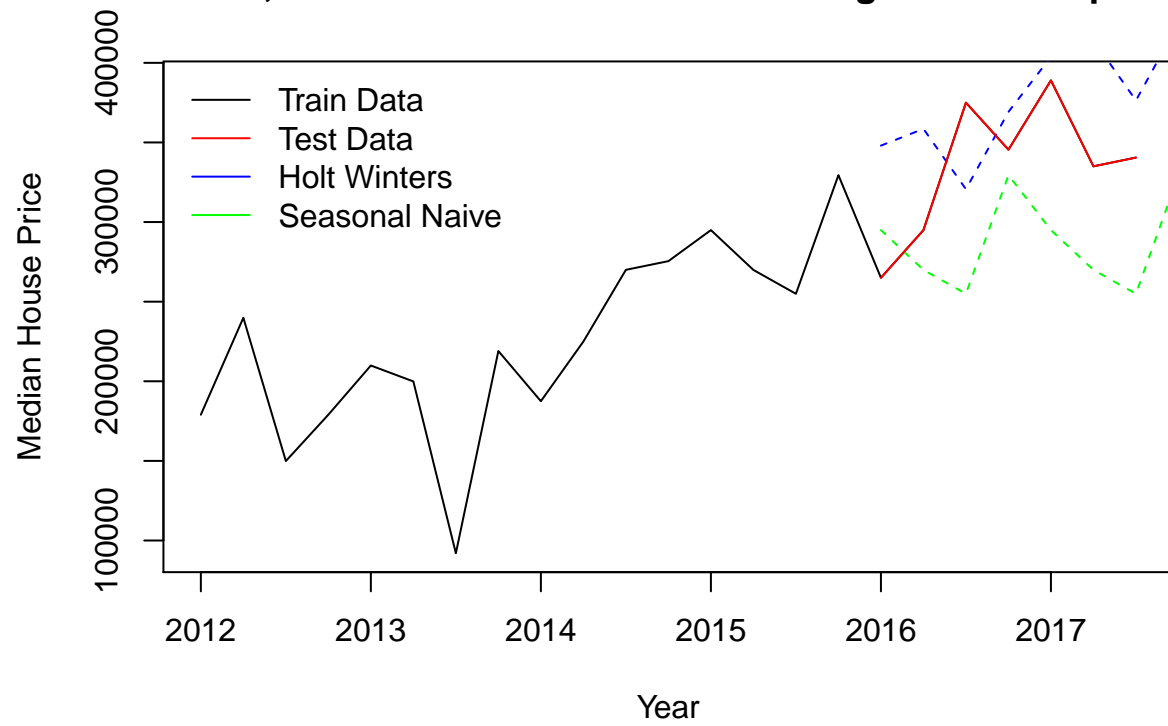
Portland, OR – East Columbia : Full TS Models Comparison
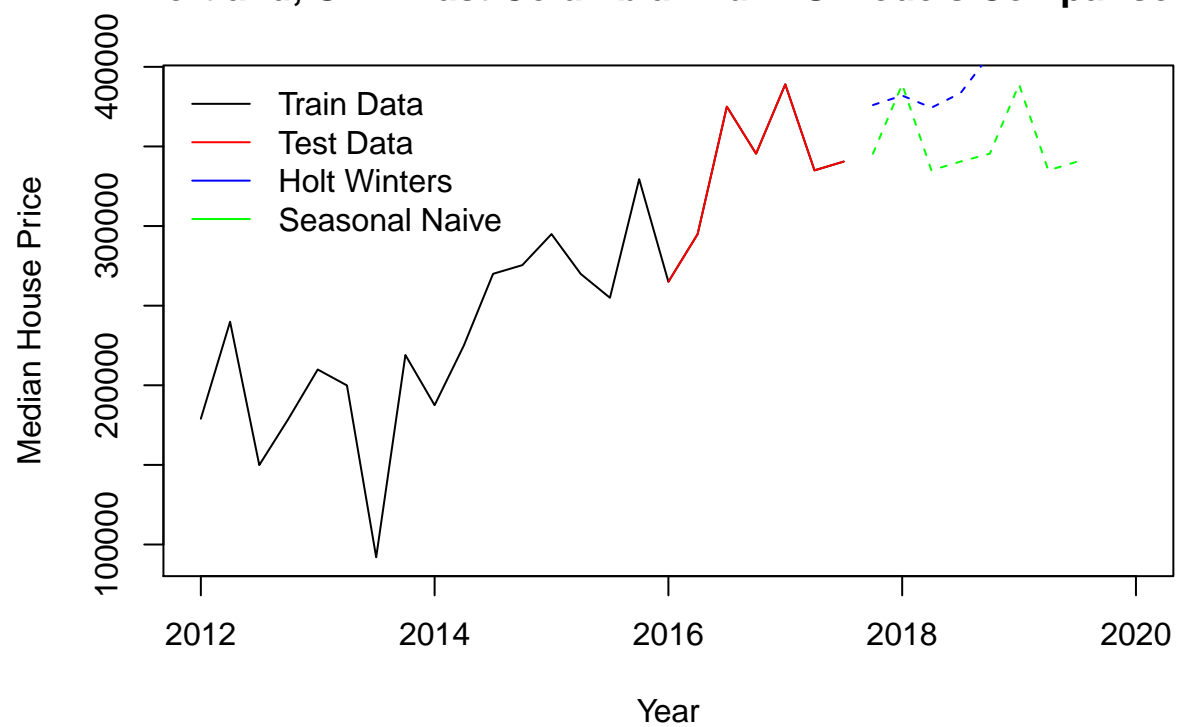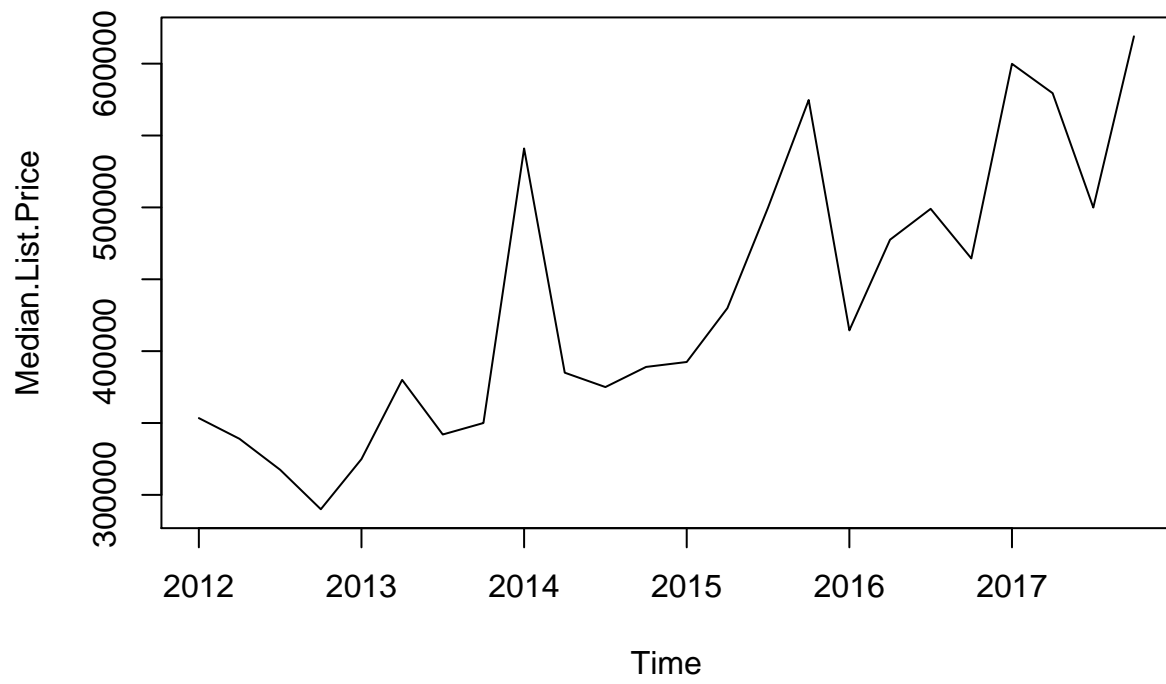
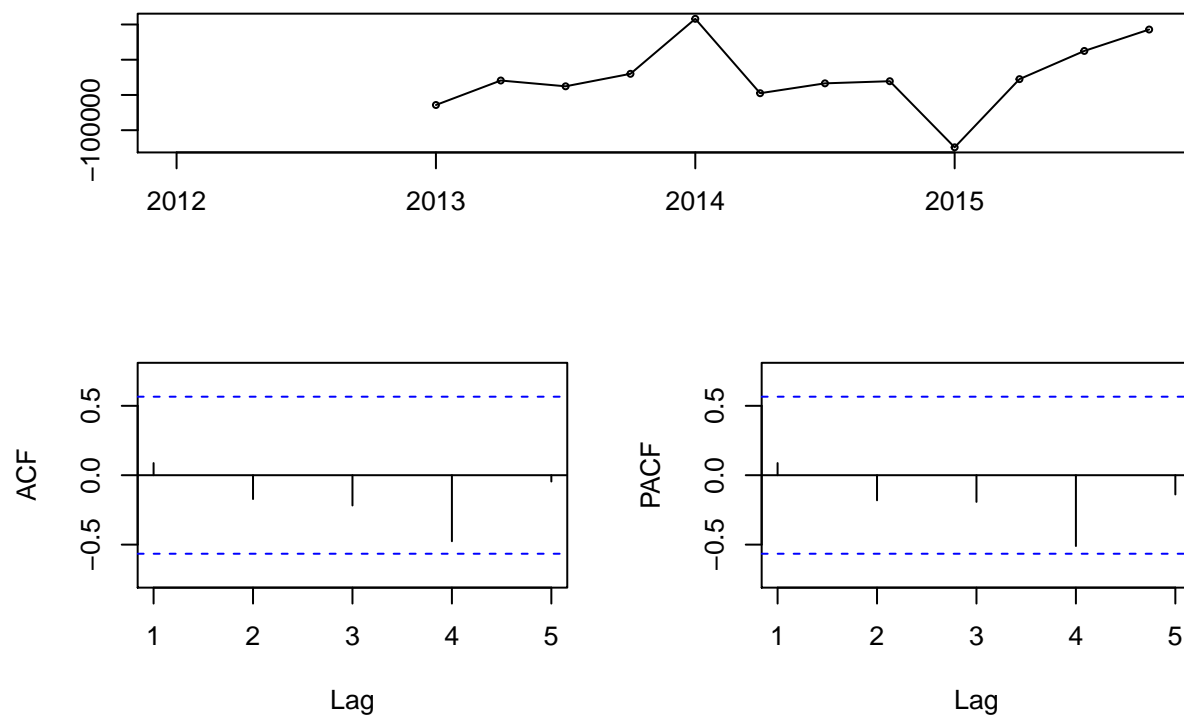**Portland, OR – Humboldt**
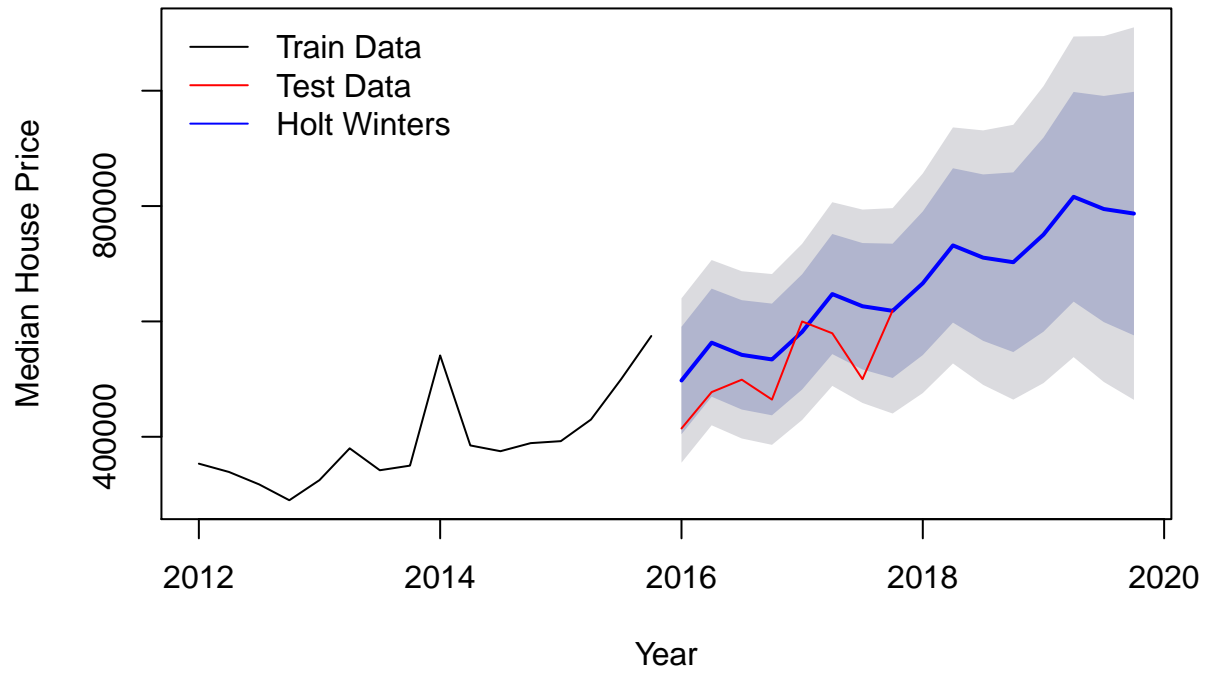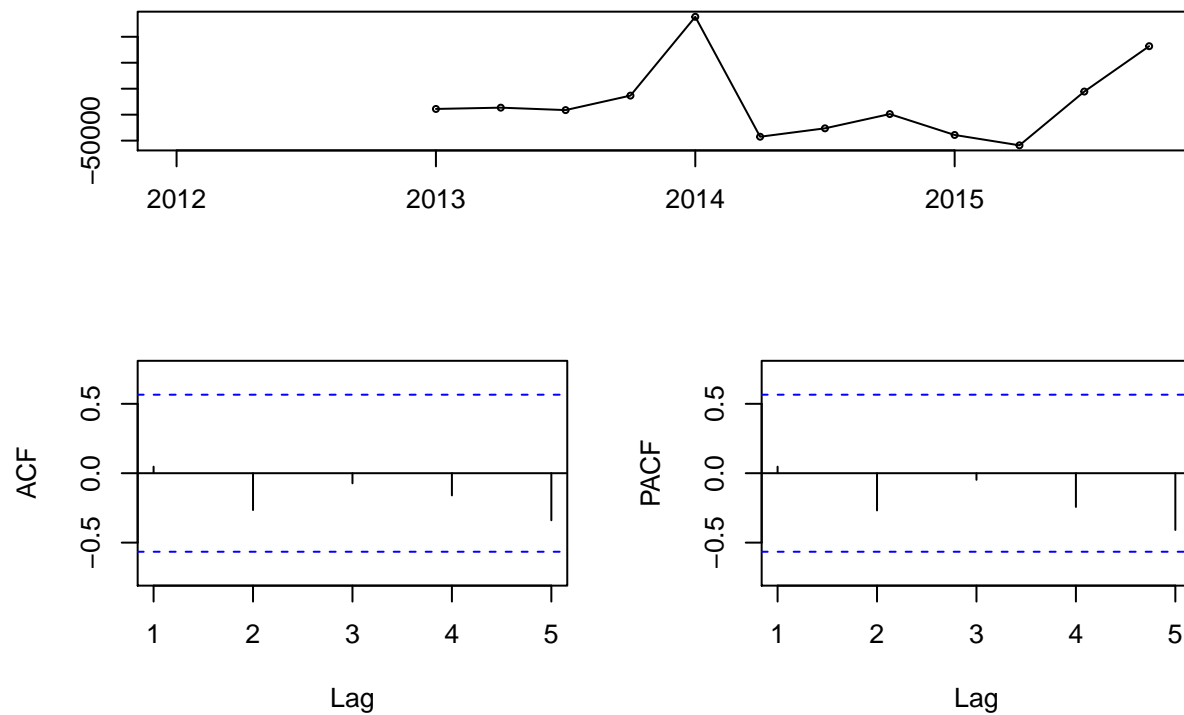
Portland, OR – Humboldt : Naive Model Forecast
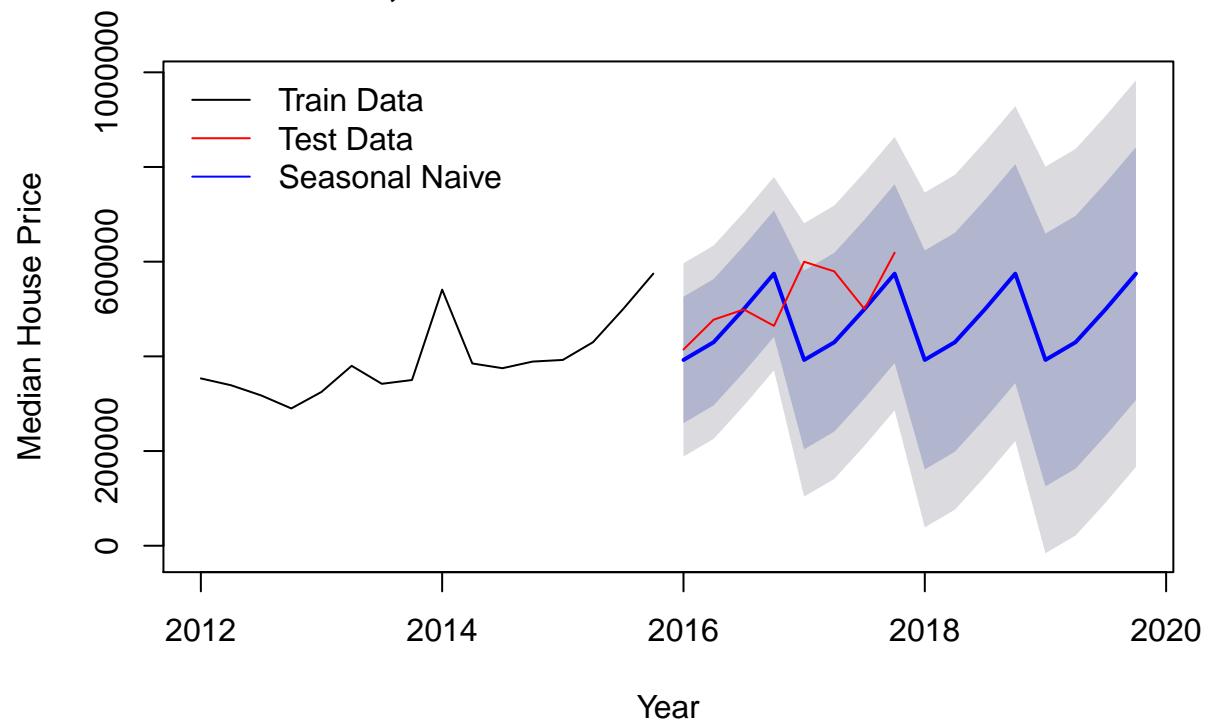
Portland, OR – Humboldt : Naive Model Forecast Residuals
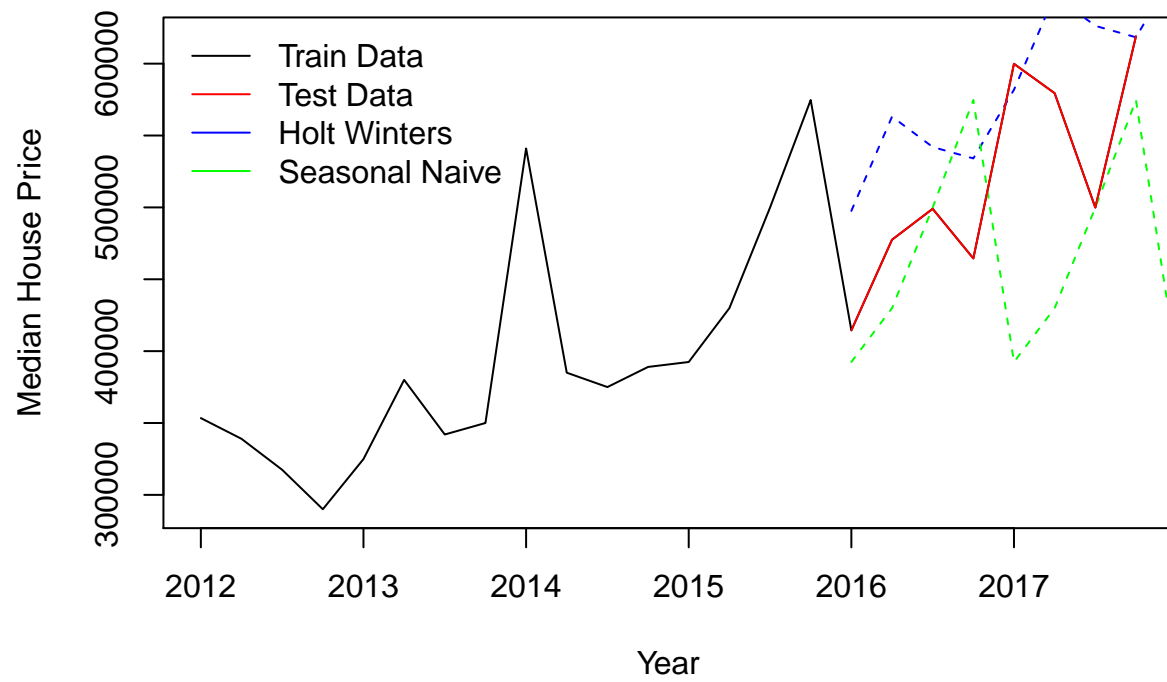
Portland, OR – Humboldt : Holt Winters Model Forecast

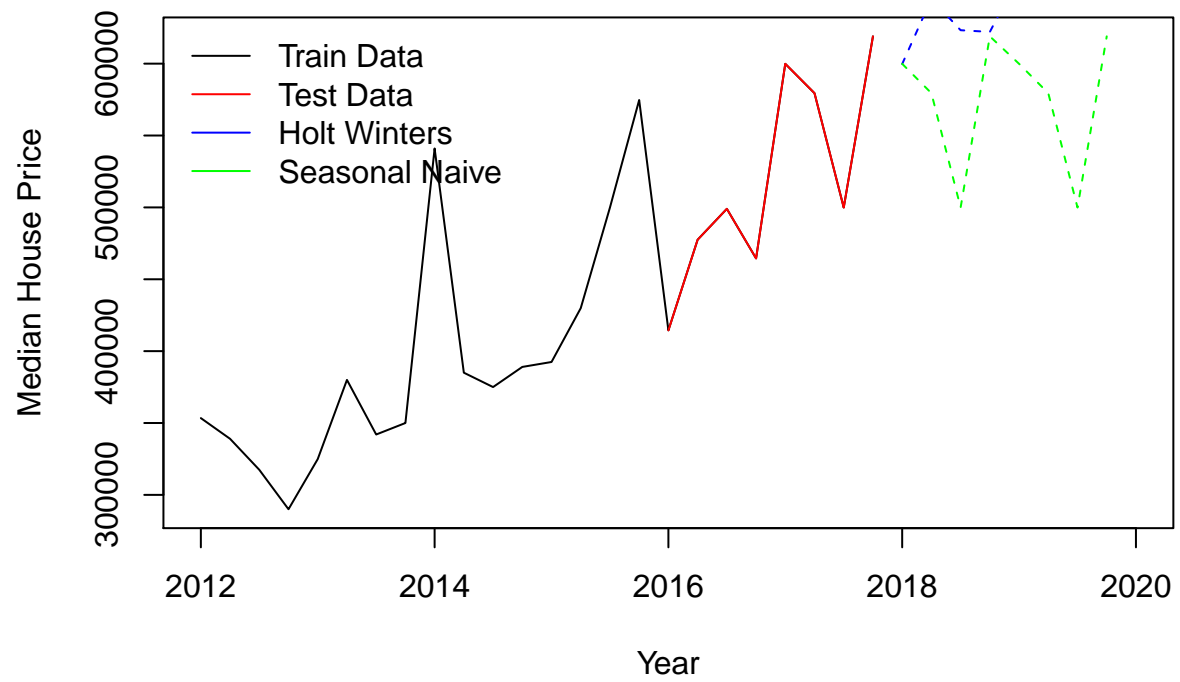## Portland, OR – Humboldt : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Humboldt"
##                    ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 49758.33 104162.4 79266.67 9.691465 17.46211 1.0000000
## Test set     44975.00 101401.3 72750.00 7.364807 13.34101 0.9177881
##                  ACF1 Theil's U
## Training set  0.08741245       NA
## Test set     -0.09014216  1.314892
## [1] "Holt Winters Accuracy for  Portland, OR - Humboldt"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set  22419.33 73098.38 50244.07   3.768662 10.72731 0.6338613
## Test set     -57130.57 72336.44 61804.62 -11.936765 12.71508 0.7797050
##                  ACF1 Theil's U
## Training set  0.04738651       NA
## Test set     -0.30722831  0.830482
```

Portland, OR – Humboldt : TS Training Model Comparison
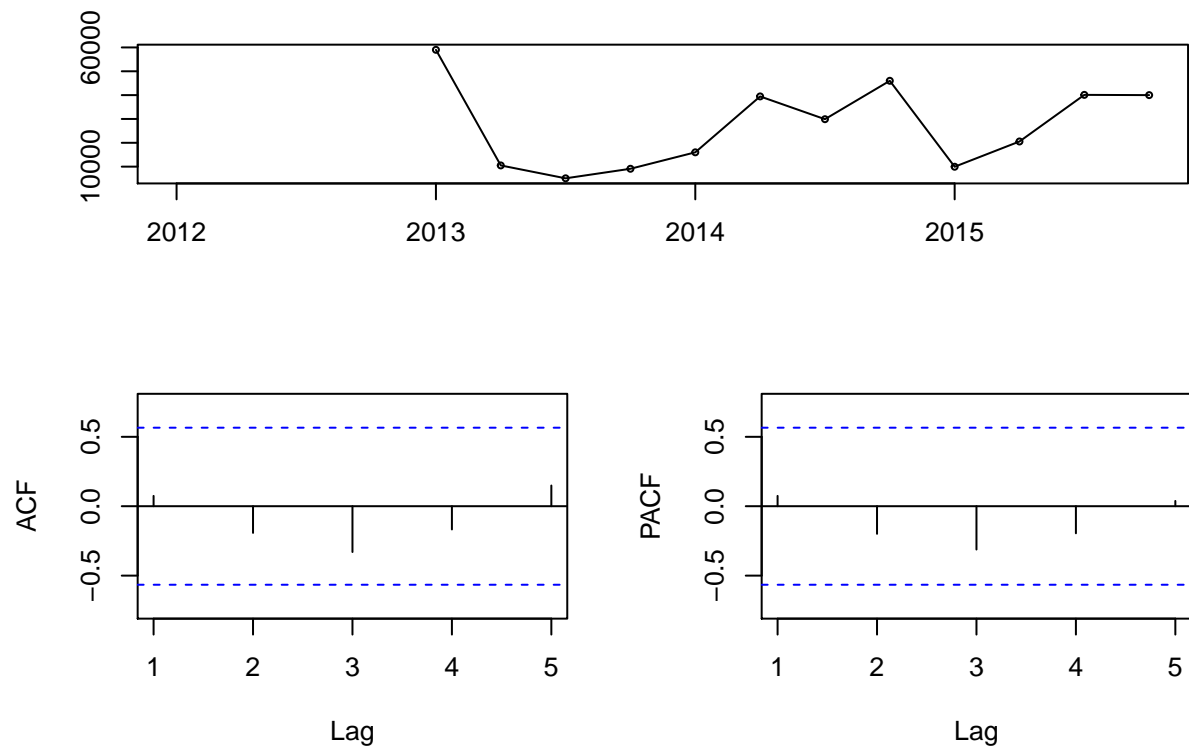
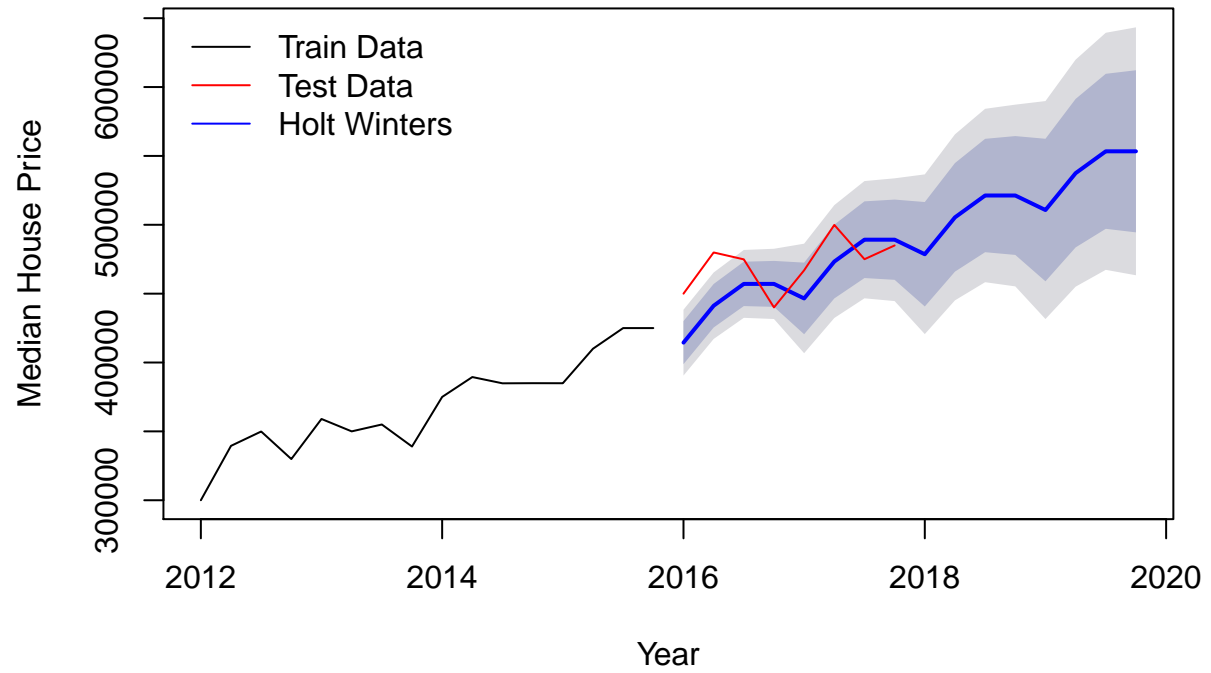# Portland, OR – Humboldt : Full TS Models Comparison

Portland, OR – Lair Hill
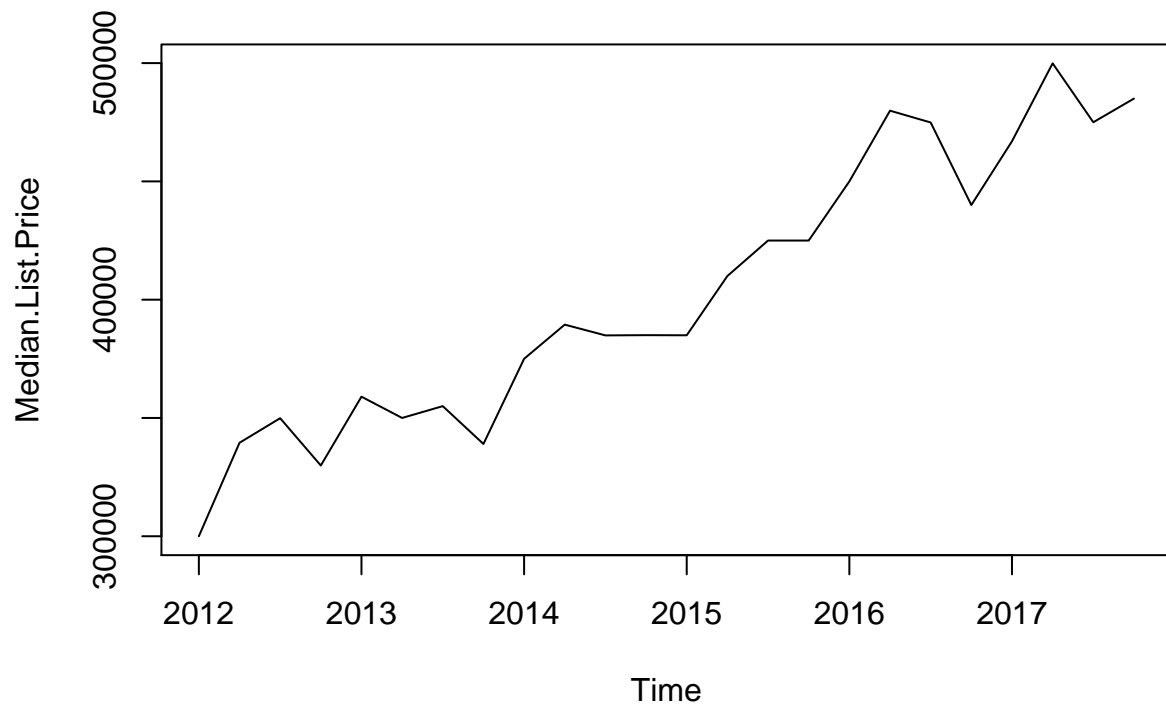
Portland, OR – Lair Hill : Naive Model Forecast

Legend:
- Train Data
- Test Data
- Seasonal Naive
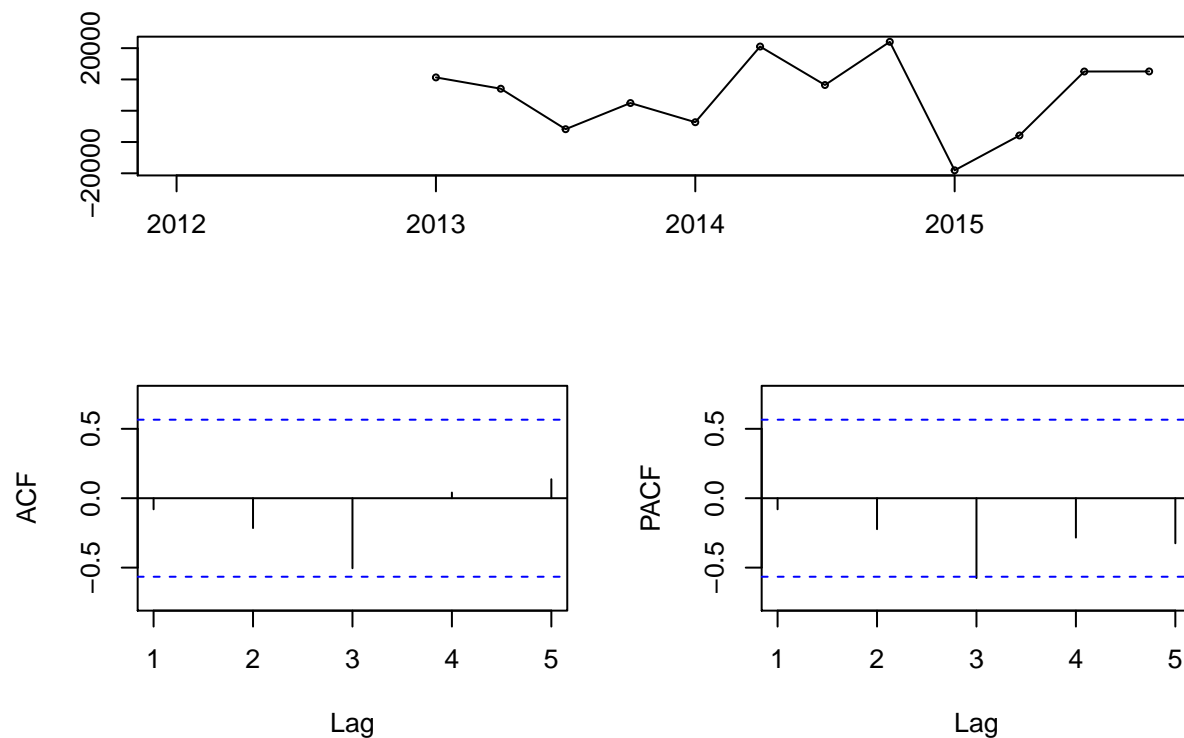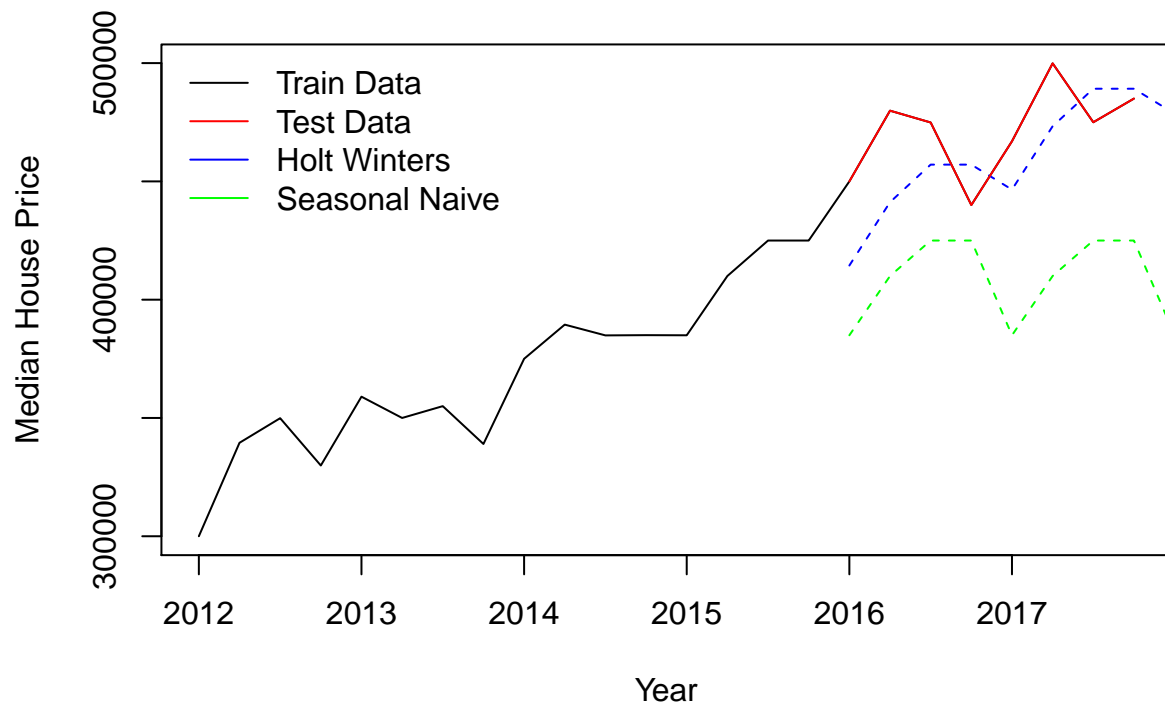
Y-axis: Median House Price
X-axis: Year
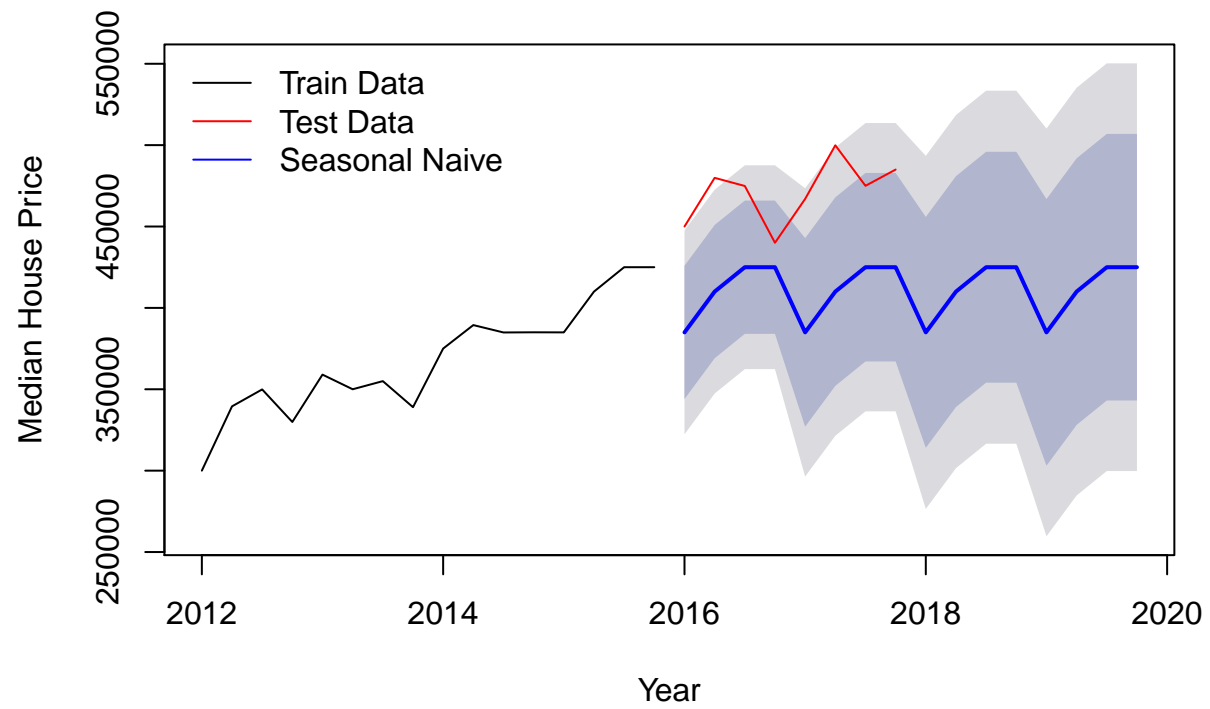
Portland, OR – Lair Hill : Naive Model Forecast Residuals

Portland, OR – Lair Hill : Holt Winters Model Forecast

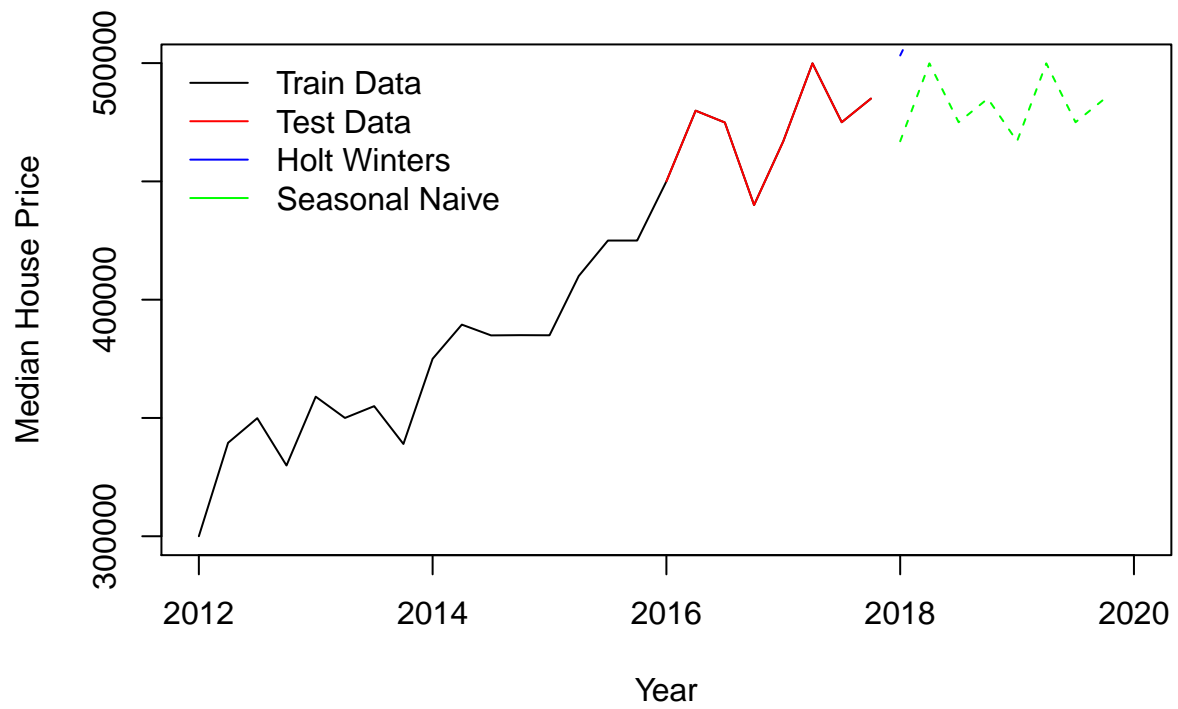**Portland, OR – Lair Hill : Holt Winters Model Forecast Residuals**


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Lair Hill"
##                   ME      RMSE      MAE      MPE      MAPE     MASE
## Training set 27137.50 31952.70 27137.50  7.009348  7.009348 1.000000
## Test set     60218.75 63971.22 60218.75 12.672434 12.672434 2.219023
##                   ACF1 Theil's U
## Training set  0.07447470       NA
## Test set     -0.06062551  2.489088
## [1] "Holt Winters Accuracy for  Portland, OR - Lair Hill"
##                   ME      RMSE      MAE      MPE      MAPE      MASE
## Training set  4958.017 12685.85 11044.14 1.268259 2.854145 0.4069698
## Test set     12953.835 24270.31 21812.73 2.709722 4.641760 0.8037857
##                  ACF1 Theil's U
## Training set -0.0798477       NA
## Test set      0.1580840 0.8701521
```

Portland, OR – Lair Hill : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Median House Price

Year

Portland, OR – Lair Hill : Full TS Models Comparison
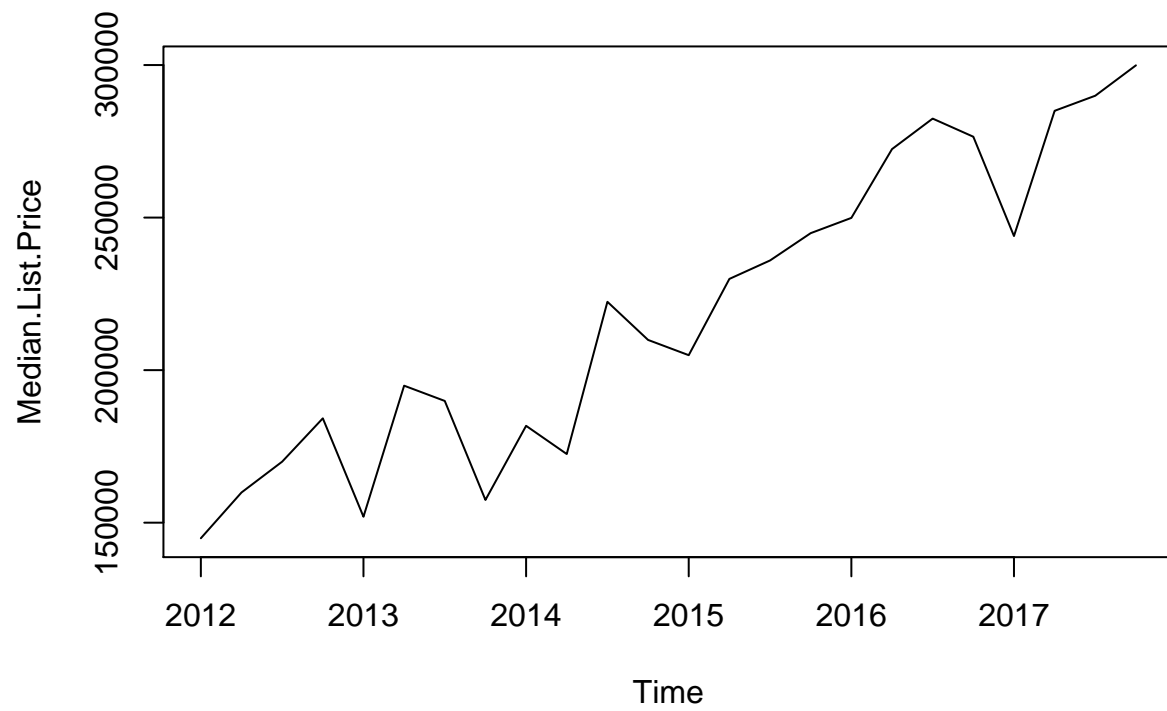
Legend:
- Train Data
- Test Data
- Holt Winters
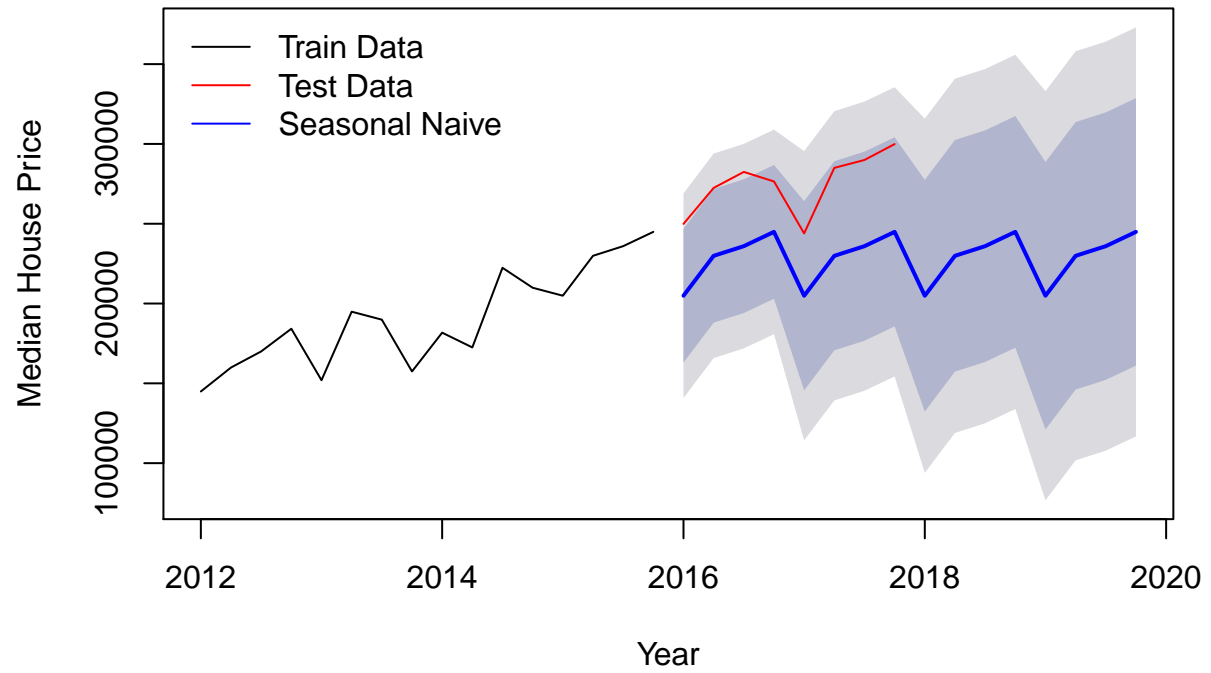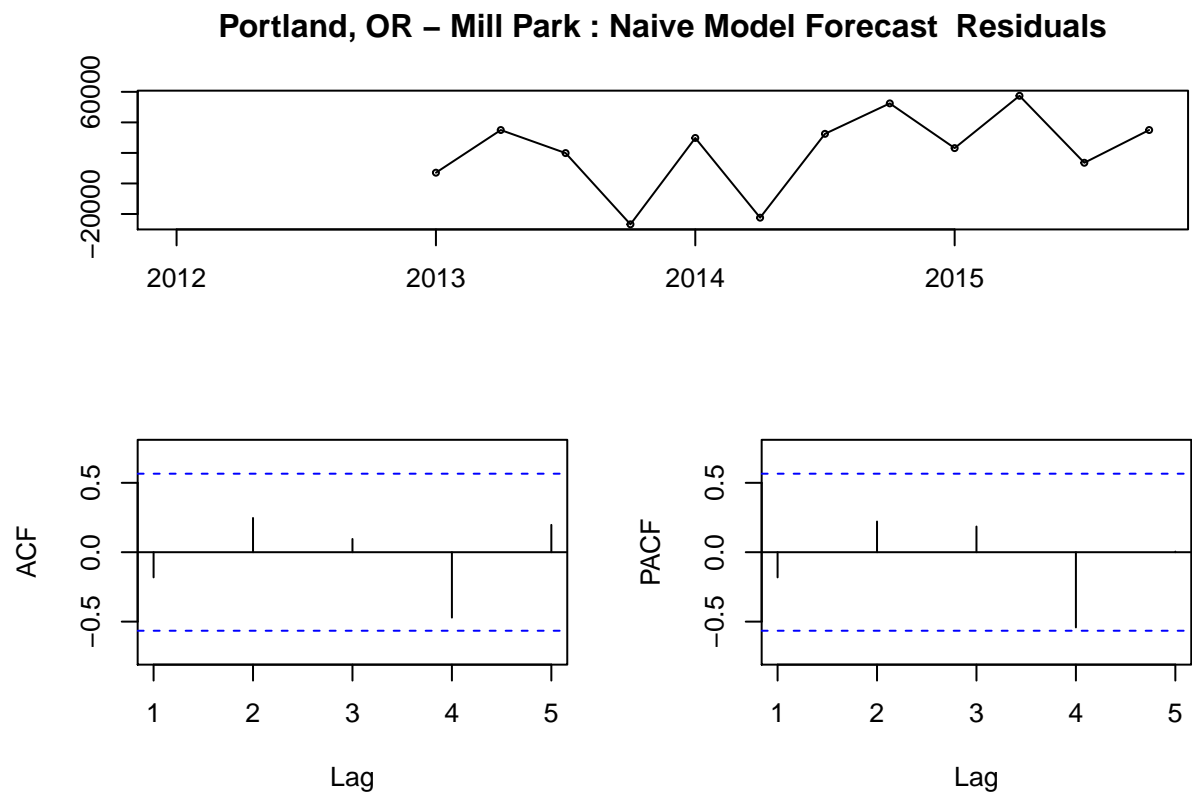- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

Portland, OR – Mill Park
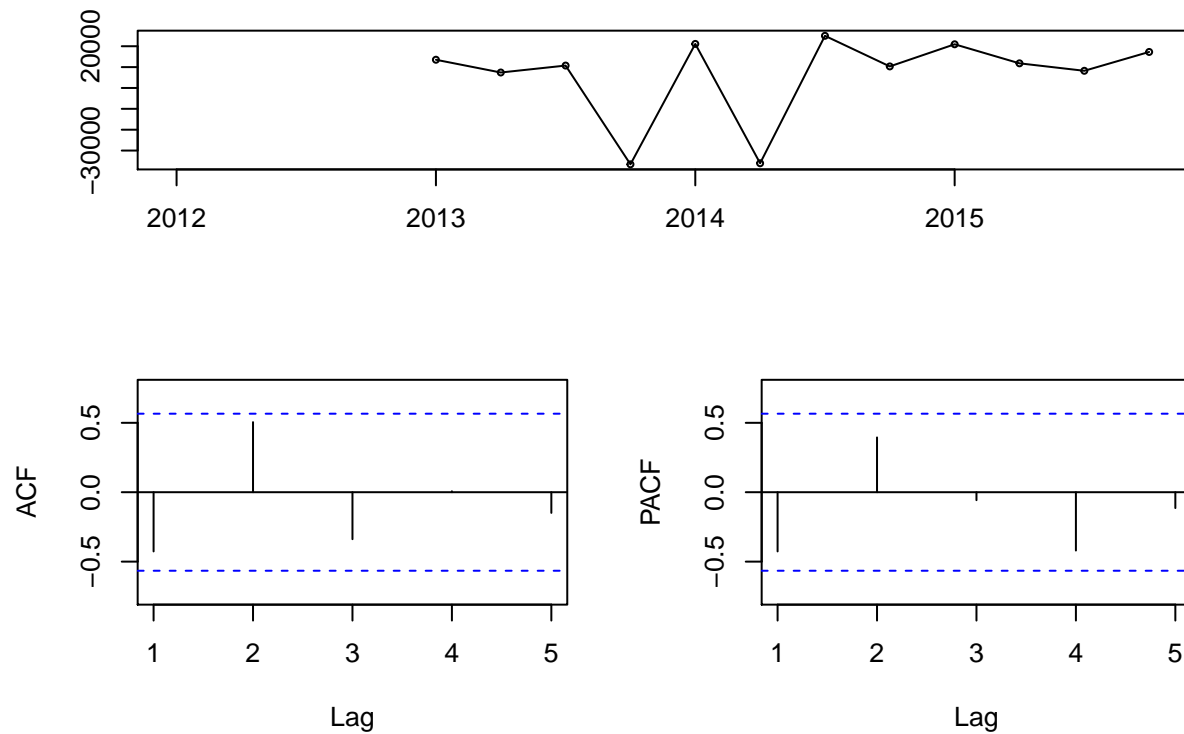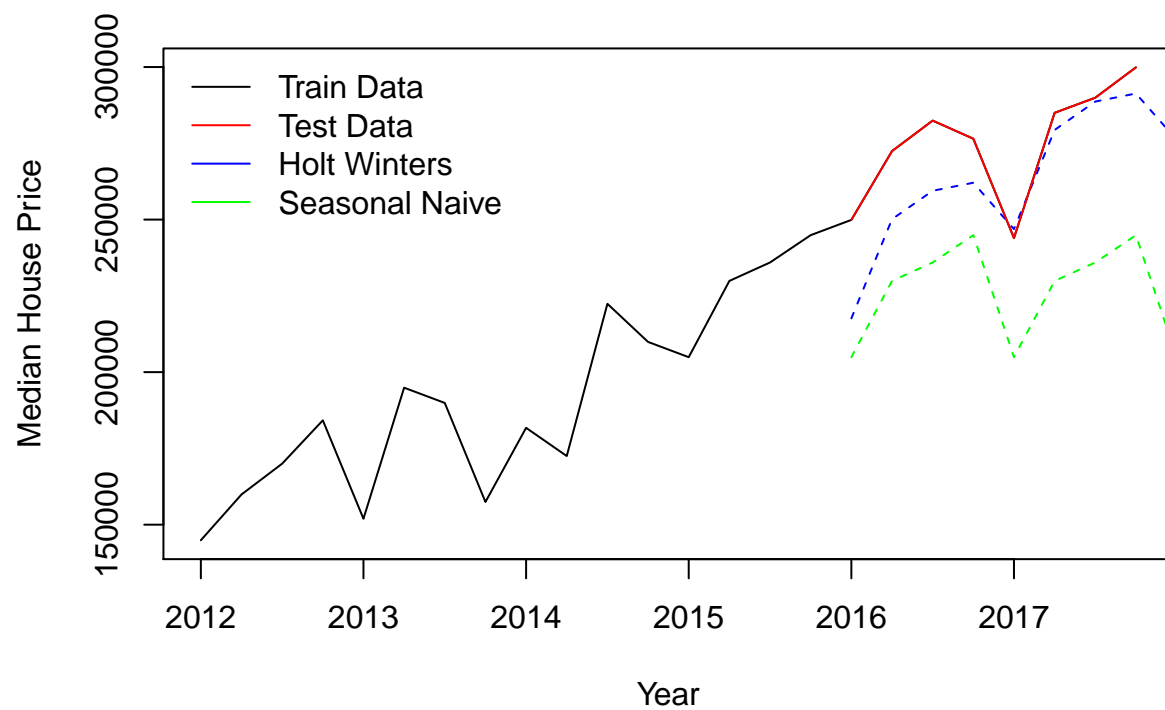
Portland, OR – Mill Park : Naive Model Forecast

Portland, OR – Mill Park : Naive Model Forecast Residuals

Portland, OR – Mill Park : Holt Winters Model Forecast
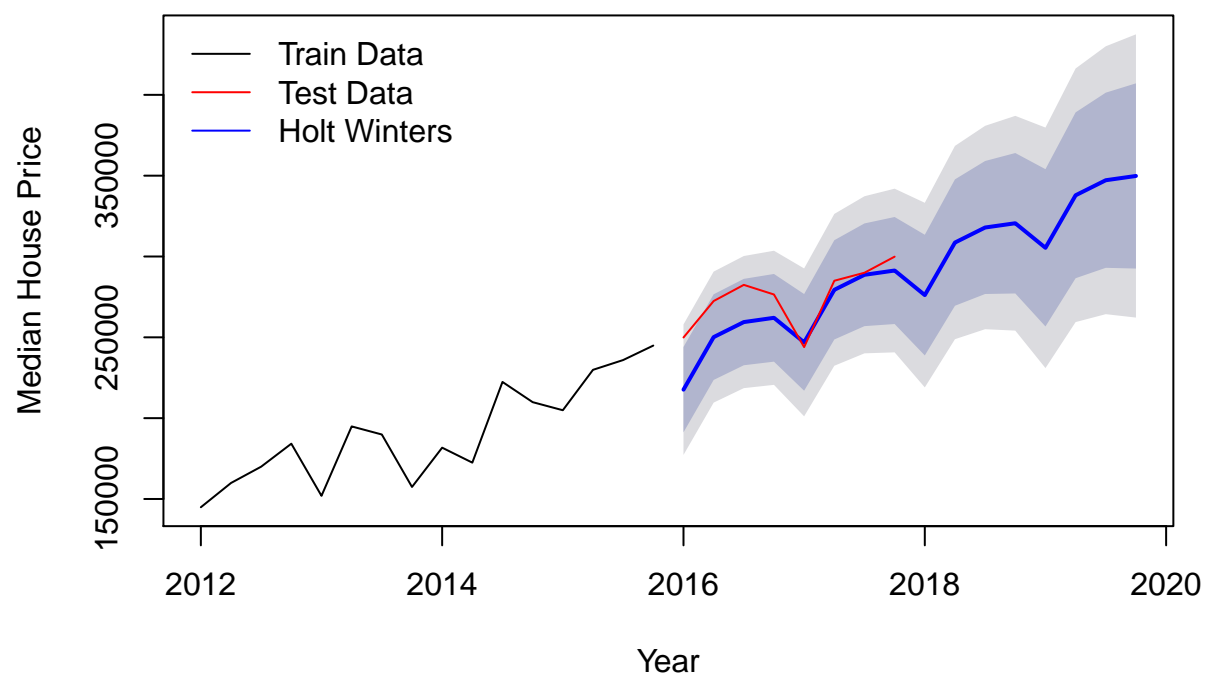
Portland, OR – Mill Park : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Mill Park"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 21387.5 32689.21 29579.58  9.616553 14.61266 1.000000
## Test set     46100.0 46768.35 46100.00 16.727559 16.72756 1.558507
##                   ACF1 Theil's U
## Training set -0.1812565        NA
## Test set      0.3562014  1.995955
## [1] "Holt Winters Accuracy for  Portland, OR - Mill Park"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set  6139.965 20645.99 18252.84 2.322491 9.682419 0.6170758
## Test set     13067.245 17290.75 13799.45 4.816177 5.116321 0.4665193
##                   ACF1 Theil's U
## Training set -0.4266353        NA
## Test set      0.5083674 0.5993603
```

Portland, OR – Mill Park : TS Training Model Comparison

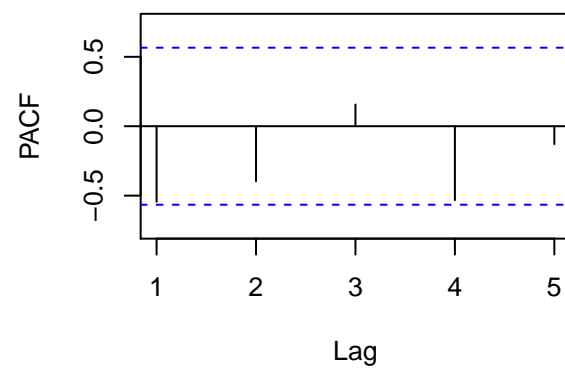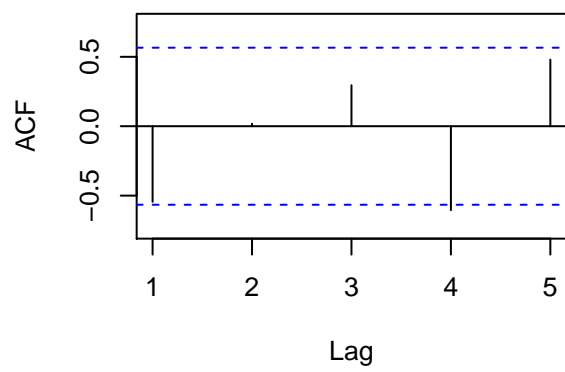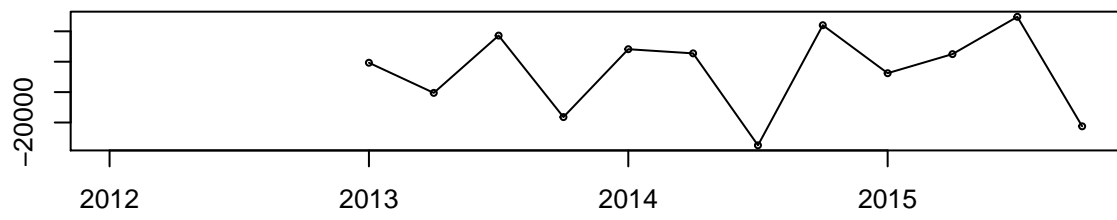Portland, OR – Mill Park : Full TS Models Comparison
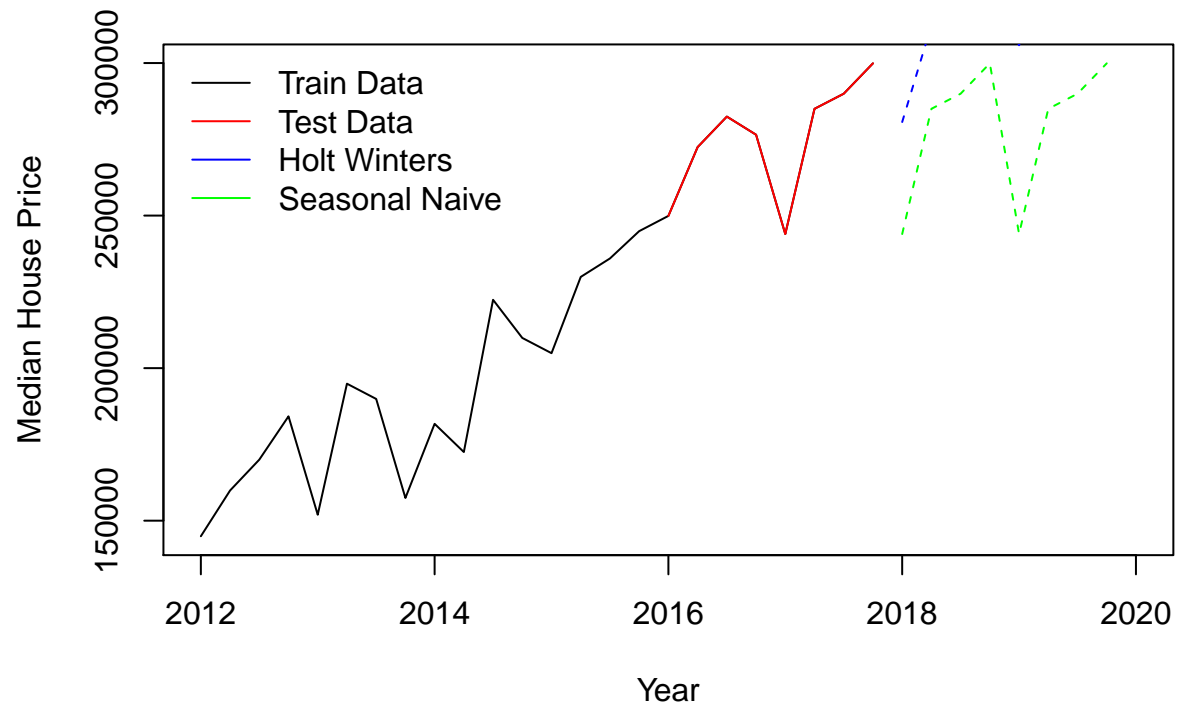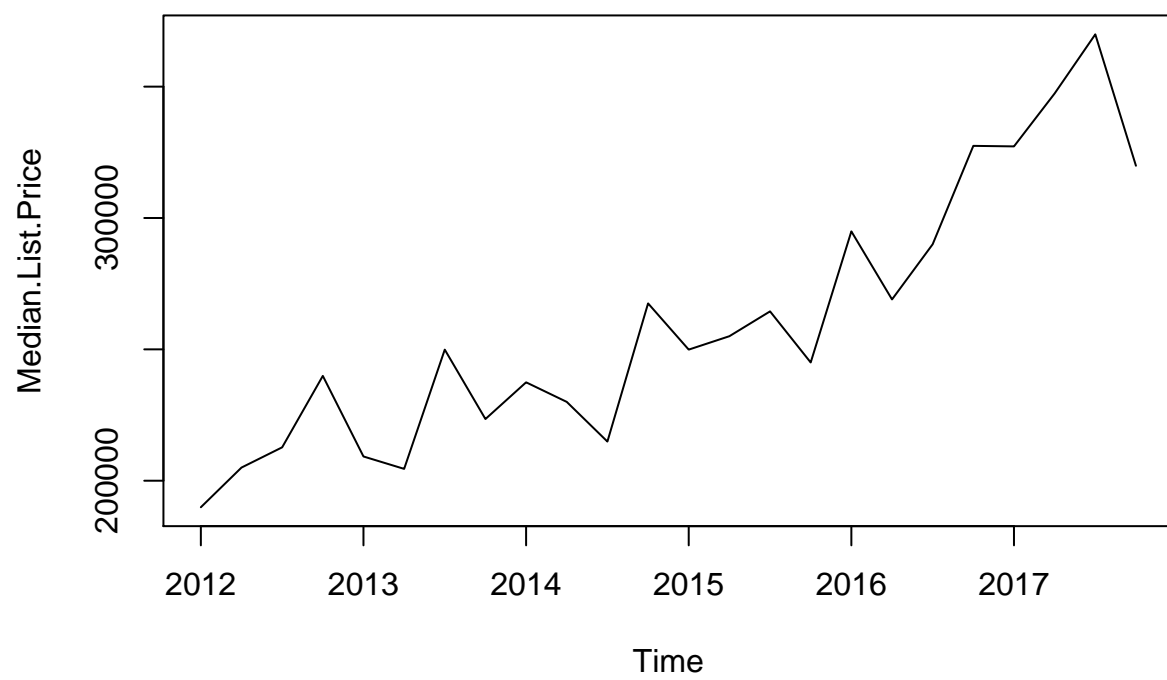
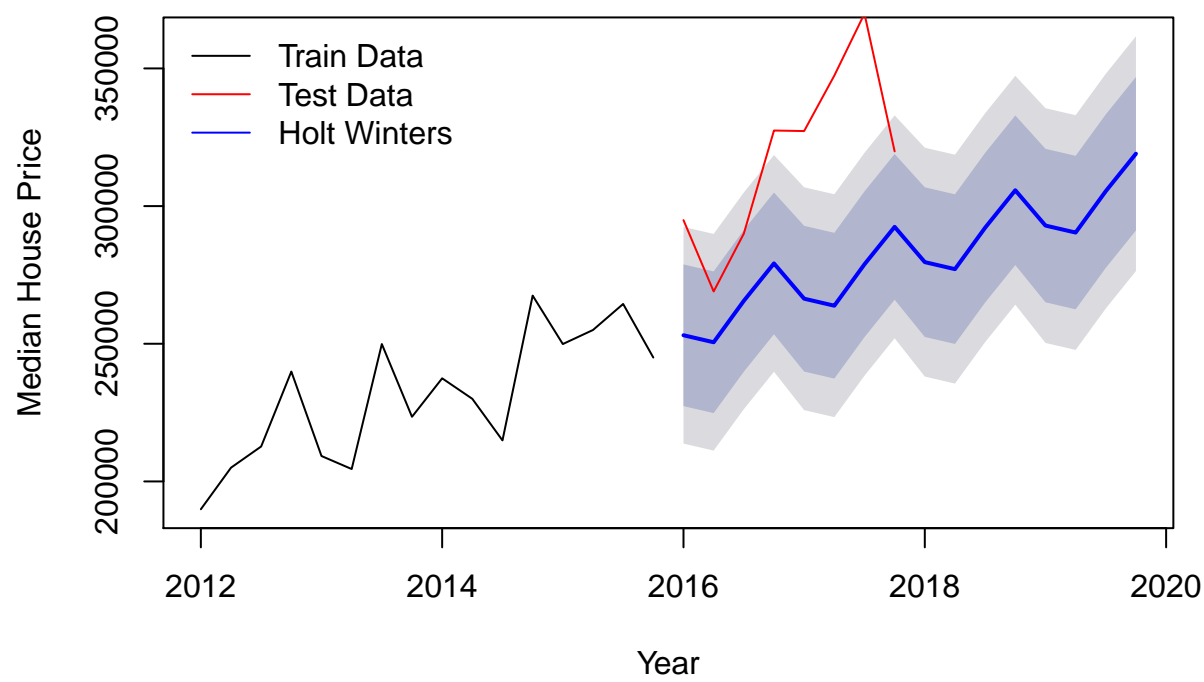# Portland, OR – Russell

Portland, OR – Russell : Naive Model Forecast
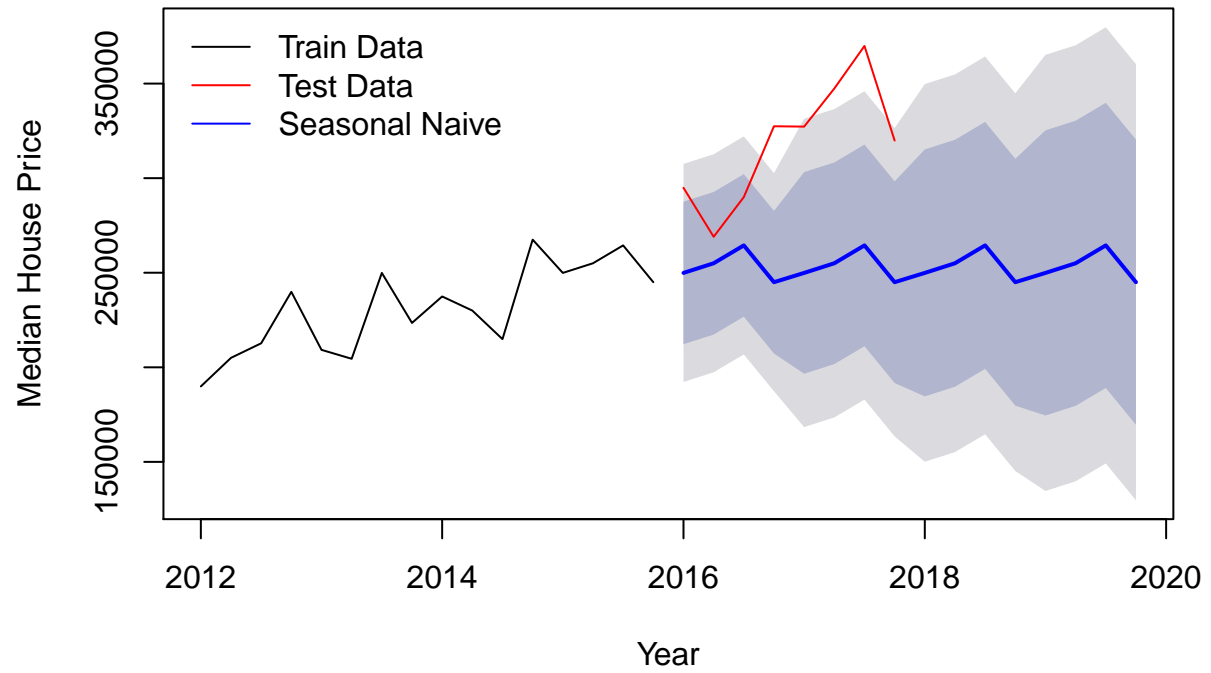
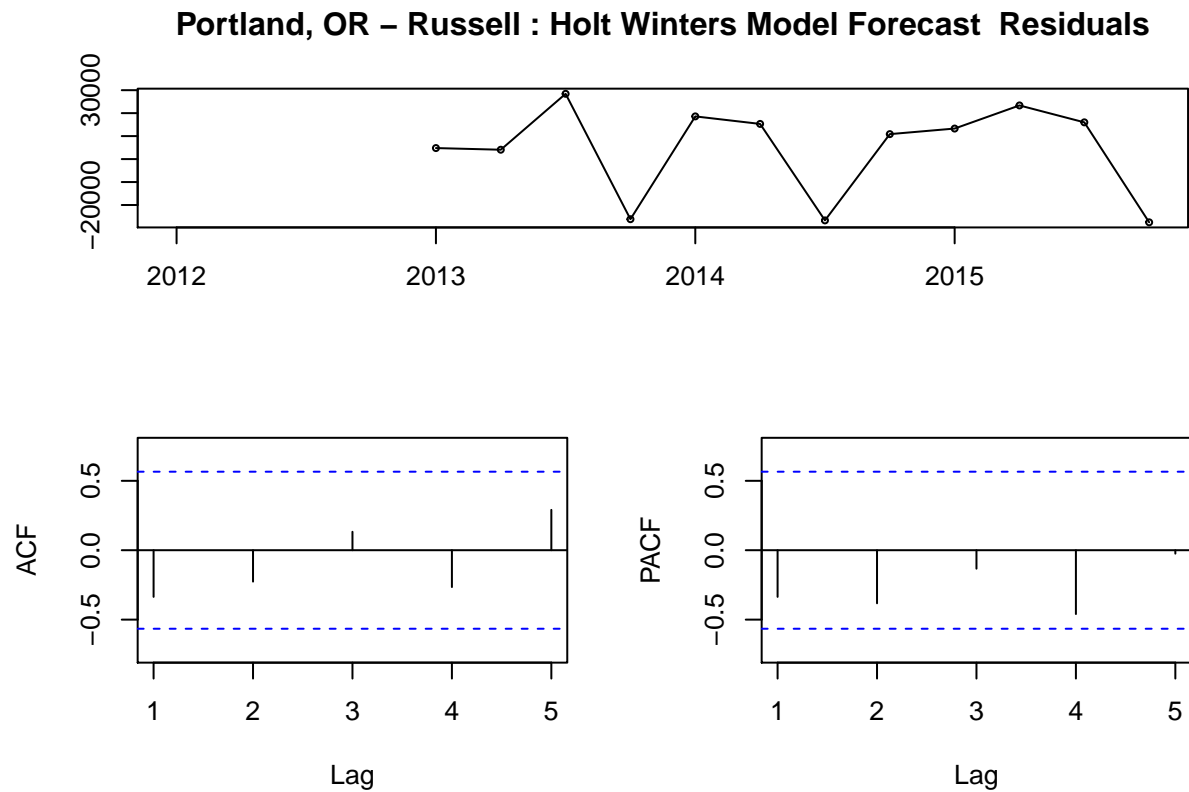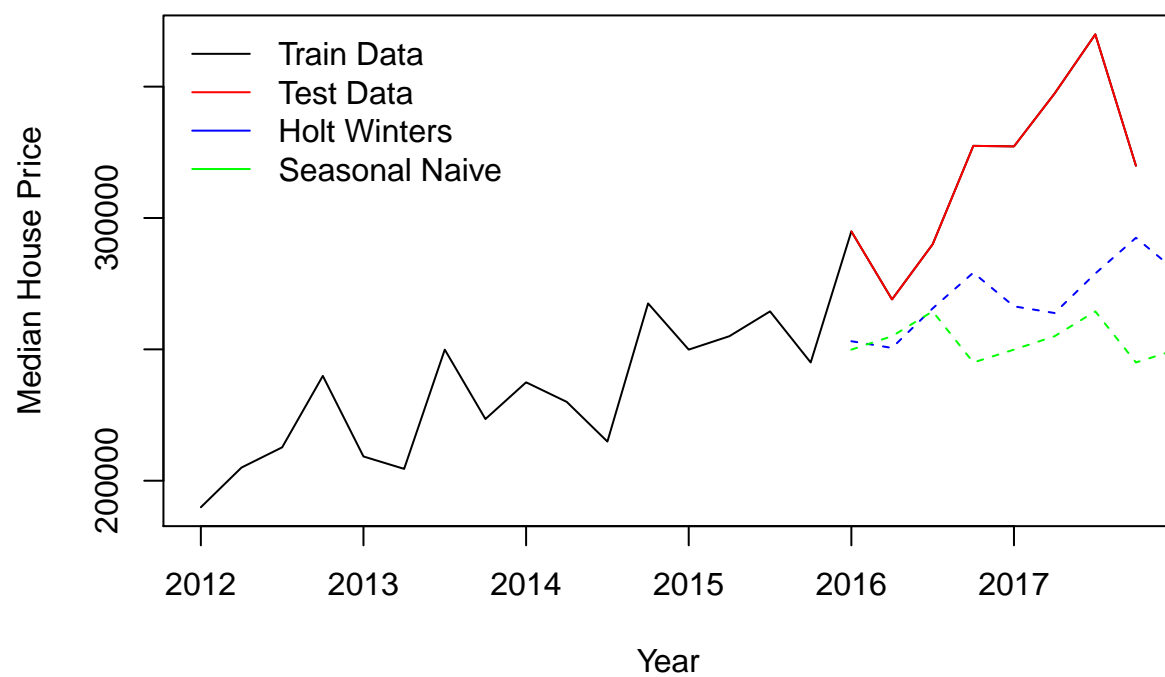**Portland, OR – Russell : Naive Model Forecast Residuals**

Portland, OR – Russell : Holt Winters Model Forecast

Portland, OR – Russell : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Russell"
##                    ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 13904.17 29408.83 26307.92  5.33438 10.84498 1.000000
## Test set     64635.00 71518.62 64635.00 19.57551 19.57551 2.456865
##                    ACF1 Theil's U
## Training set -0.5448111        NA
## Test set      0.5878915  2.521108
## [1] "Holt Winters Accuracy for  Portland, OR - Russell"
##                    ME      RMSE      MAE      MPE      MAPE      MASE
## Training set  4522.405 19744.92 17923.20  1.612276  7.507908 0.6812853
## Test set     49480.713 55614.80 49480.71 15.004678 15.004678 1.8808298
##                    ACF1 Theil's U
## Training set -0.3361938        NA
## Test set      0.3724179  1.940859
```
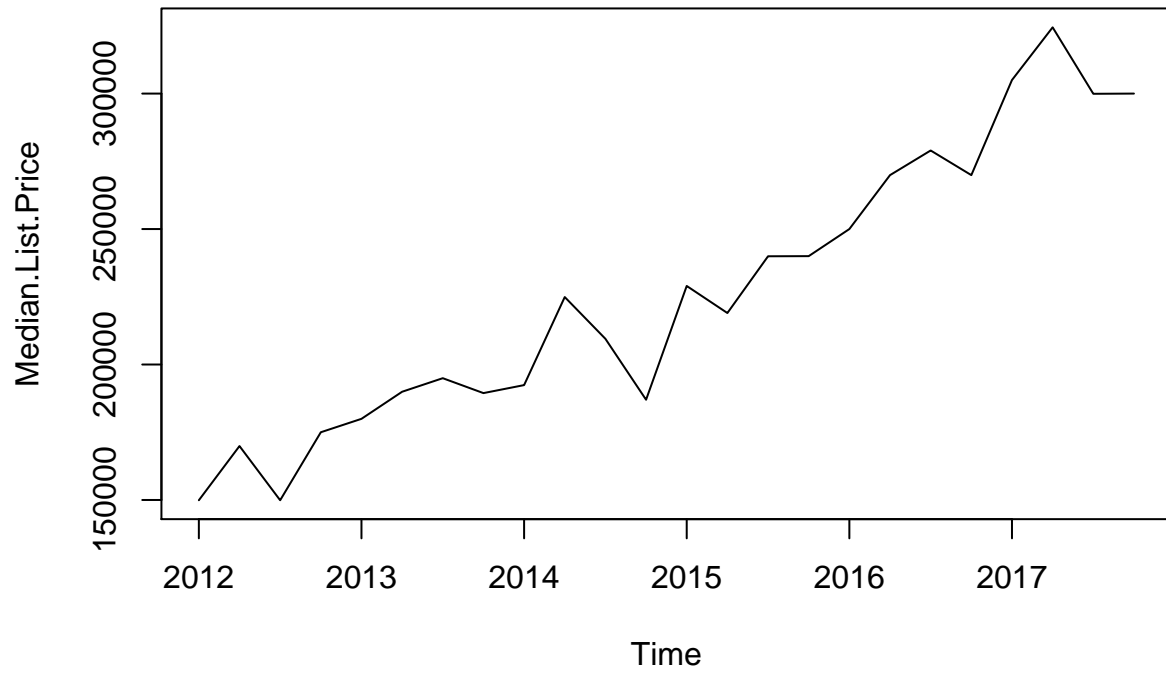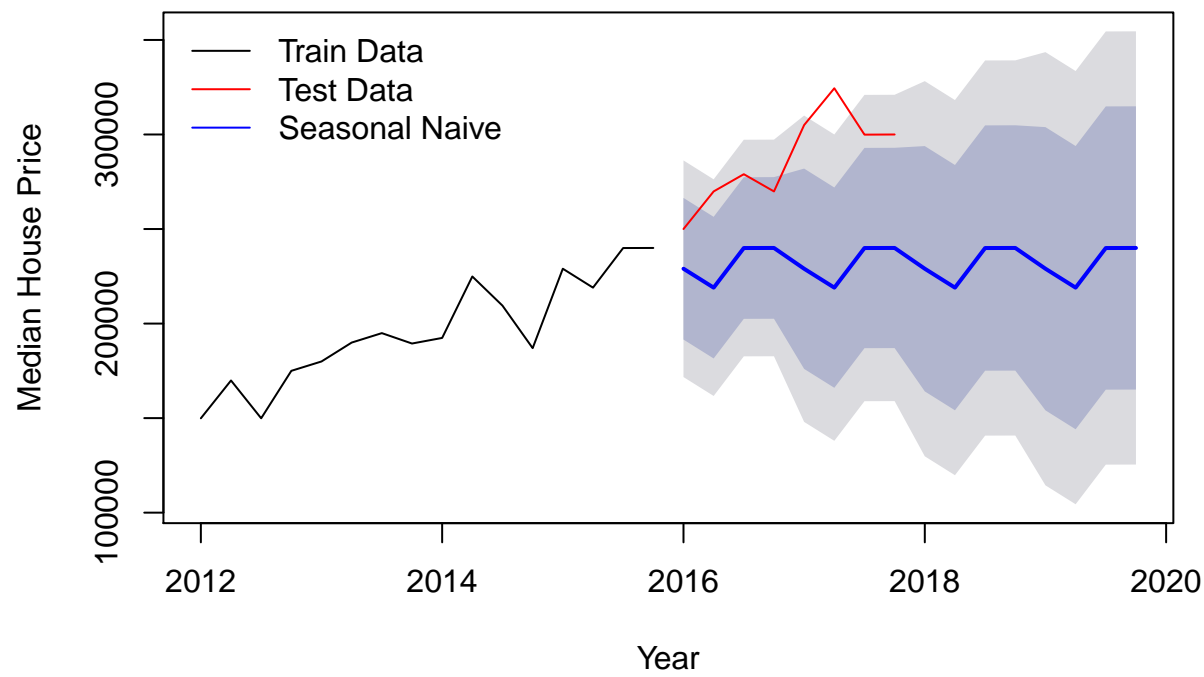
Portland, OR – Russell : TS Training Model Comparison
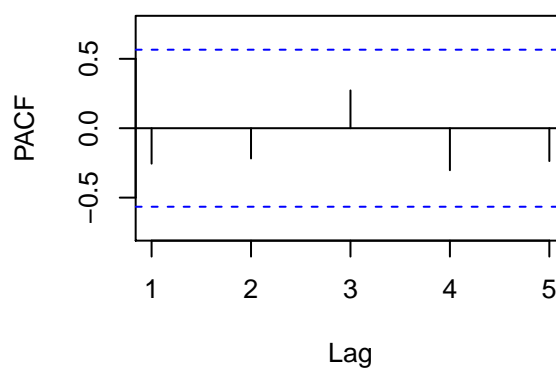
Portland, OR – Russell : Full TS Models Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
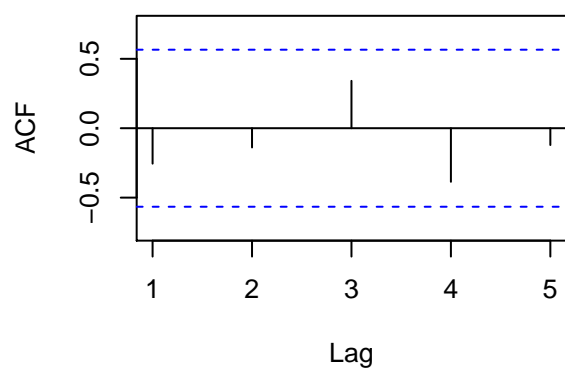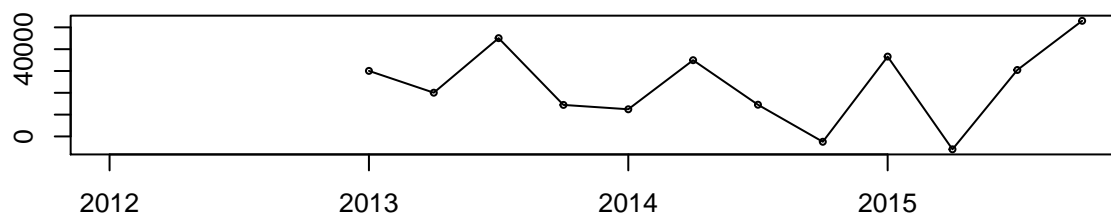- Seasonal Naive

Y-axis: Median House Price
X-axis: Year

Portland, OR – Hazelwood
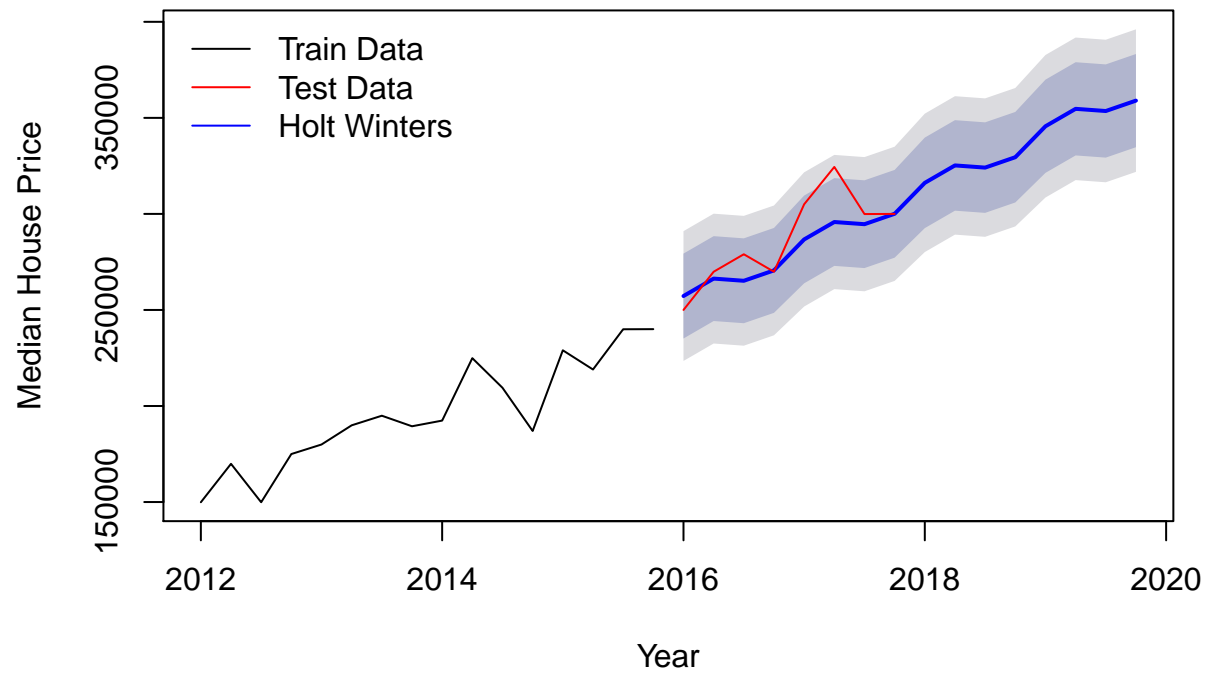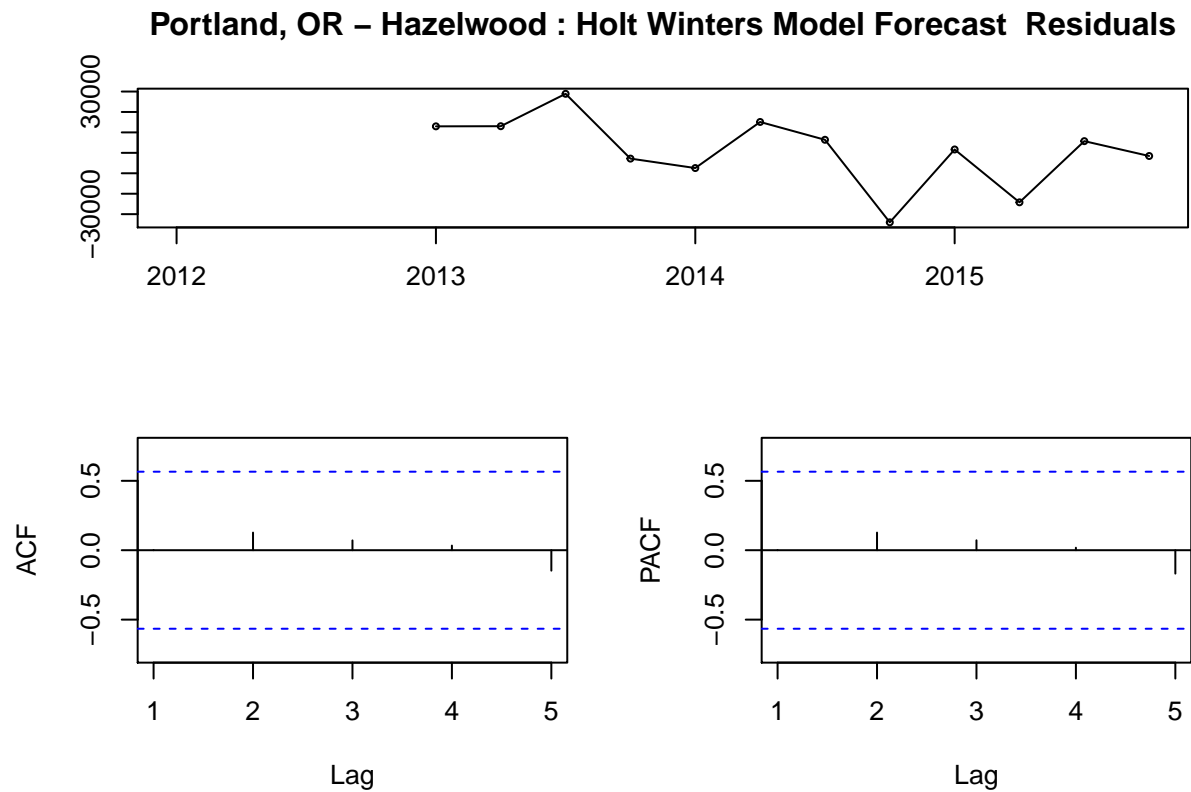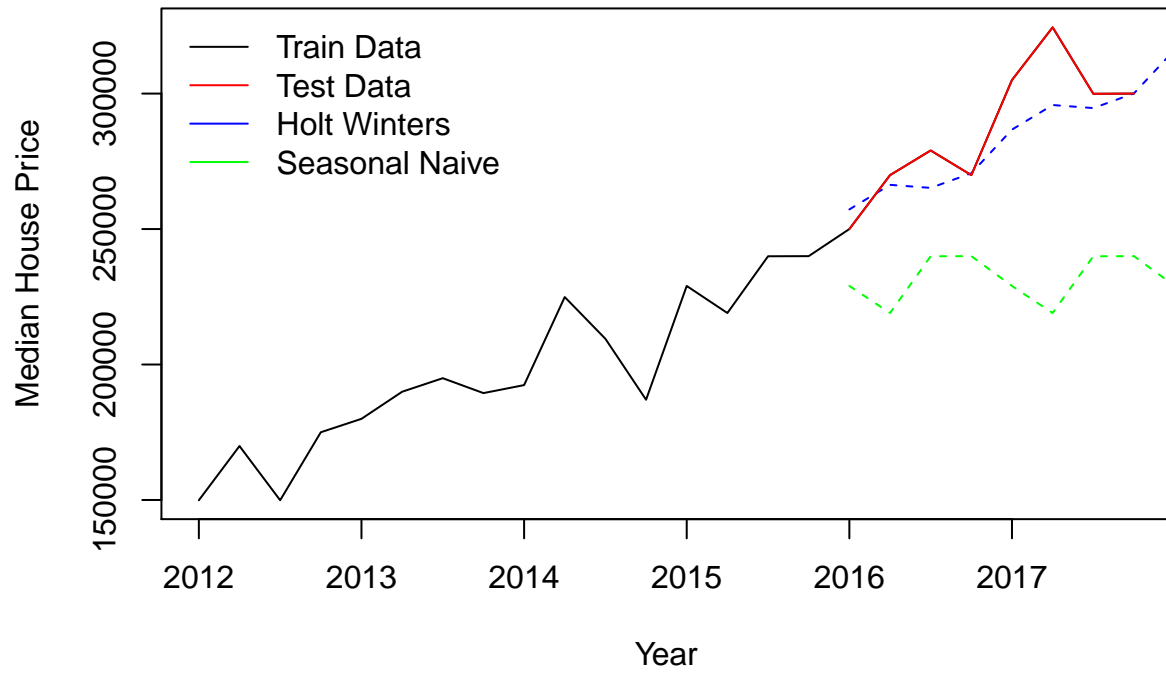
Portland, OR – Hazelwood : Naive Model Forecast

Legend:
- Train Data
- Test Data
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

Portland, OR – Hazelwood : Naive Model Forecast Residuals

Portland, OR – Hazelwood : Holt Winters Model Forecast

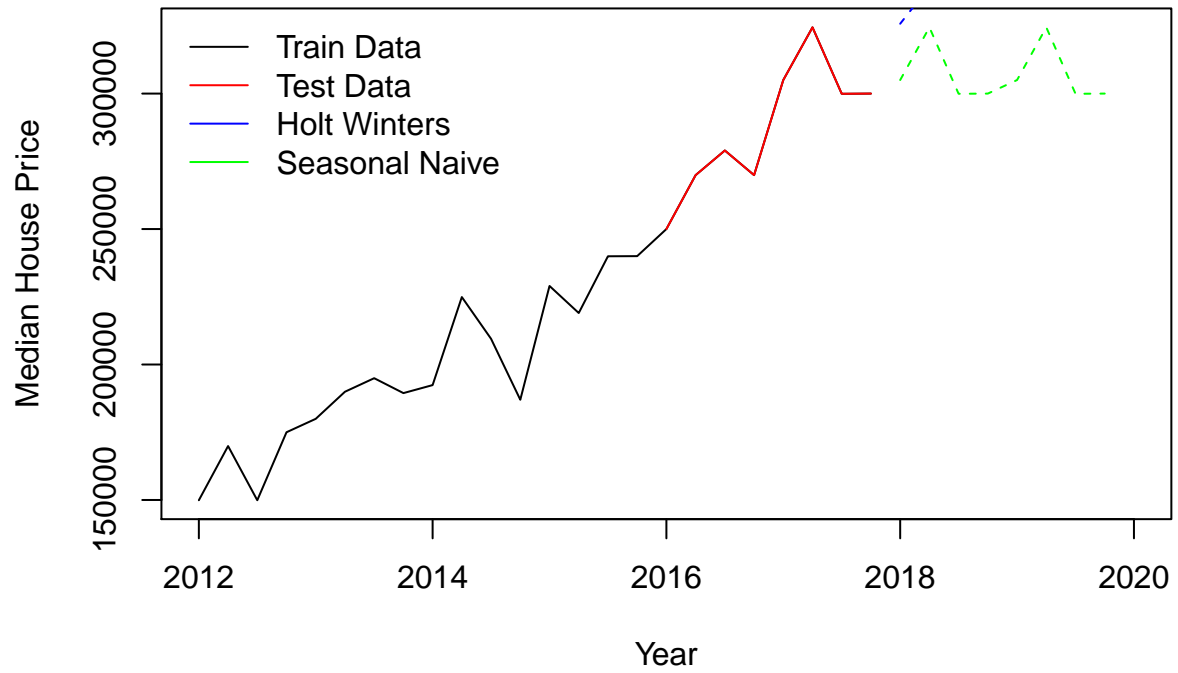## Portland, OR – Hazelwood : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Hazelwood"
##                   ME     RMSE      MAE      MPE     MAPE     MASE
## Training set 23604.12 29223.79 24995.79 11.14149 11.80886 1.000000
## Test set     55284.50 60769.56 55284.50 18.71870 18.71870 2.211752
##                  ACF1 Theil's U
## Training set -0.2552567        NA
## Test set      0.2757737    3.1379
## [1] "Holt Winters Accuracy for  Portland, OR - Hazelwood"
##                   ME     RMSE      MAE      MPE     MAPE      MASE
## Training set 1147.793 16543.37 12813.851 0.544829 6.415880 0.5126403
## Test set     7703.344 13420.26  9703.192 2.461657 3.255483 0.3881930
##                   ACF1 Theil's U
## Training set 0.001479583        NA
## Test set     0.089216233  0.684837
```
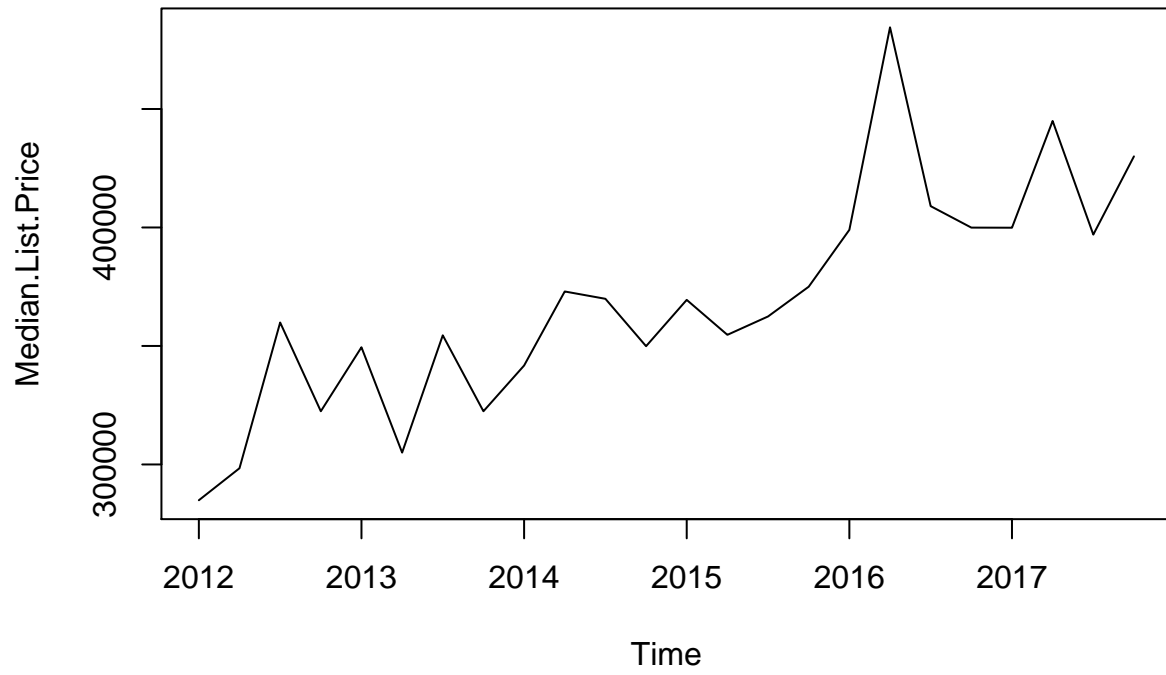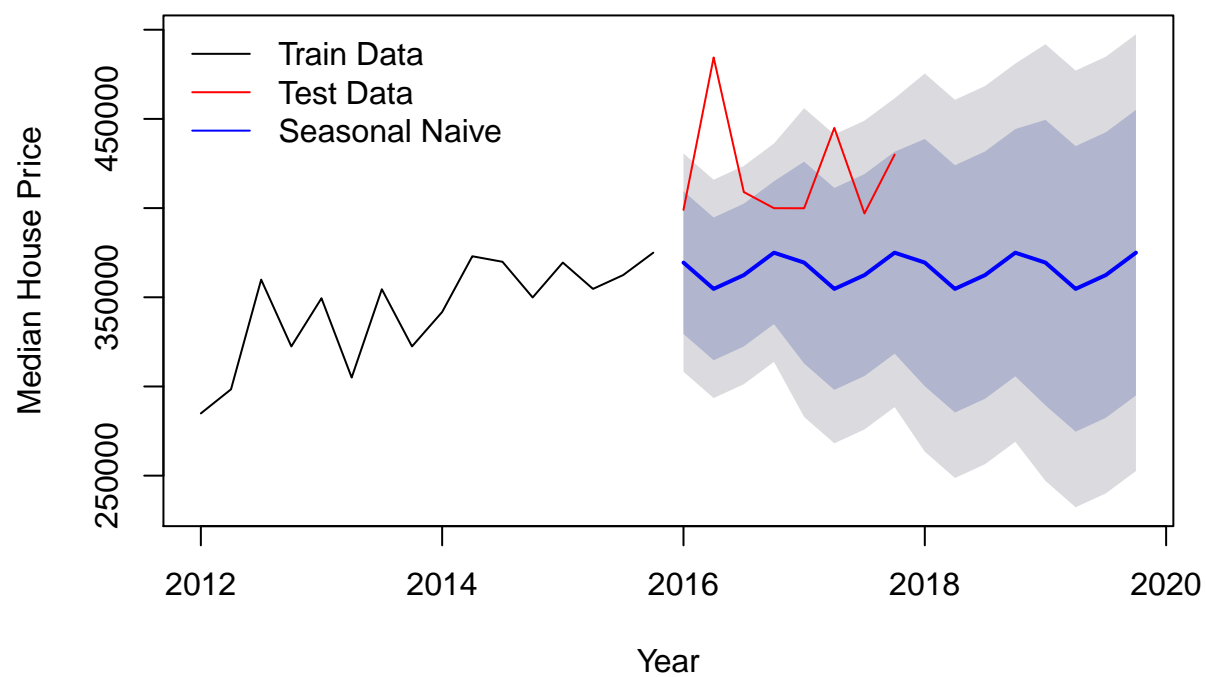
Portland, OR – Hazelwood : TS Training Model Comparison

Median House Price vs Year. Legend: Train Data (black), Test Data (red), Holt Winters (blue), Seasonal Naive (green).

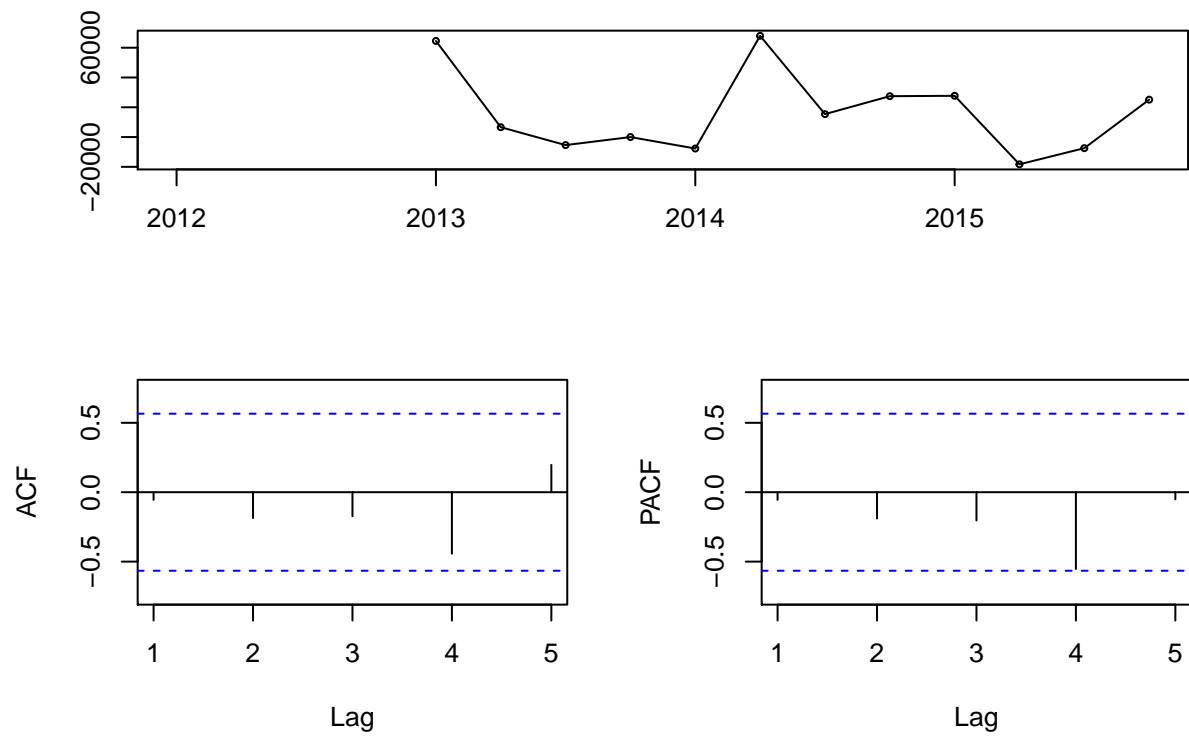# Portland, OR – Hazelwood : Full TS Models Comparison
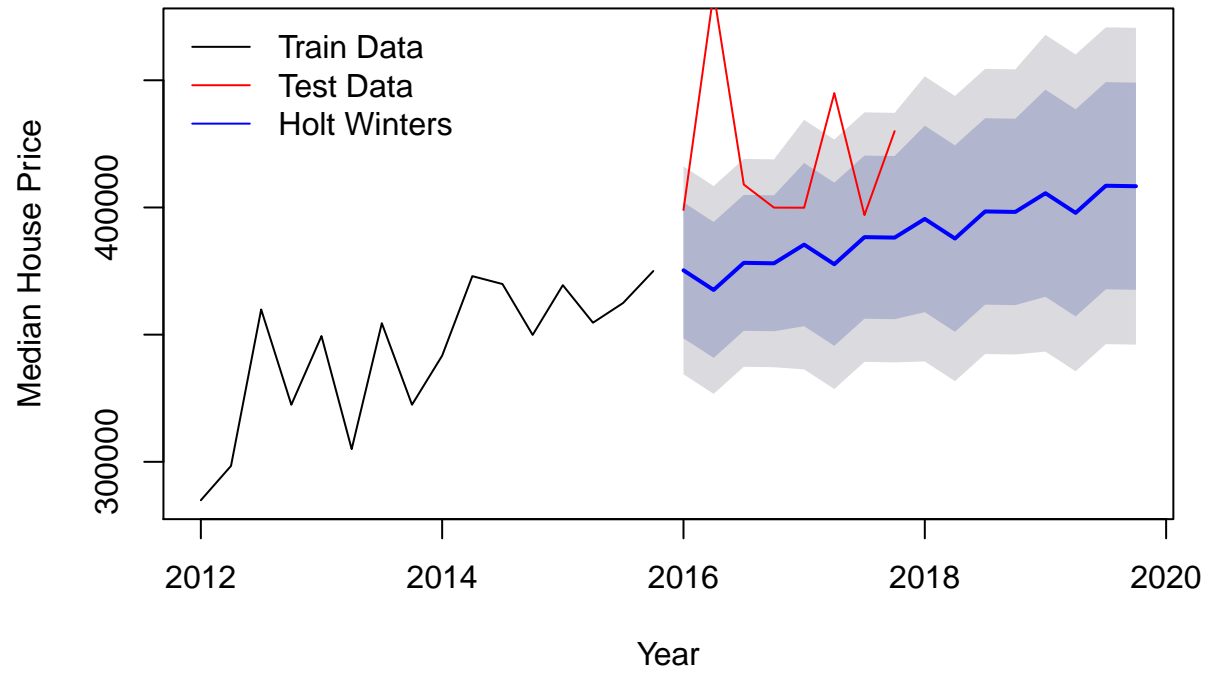
Portland, OR – Markham

Portland, OR – Markham : Naive Model Forecast

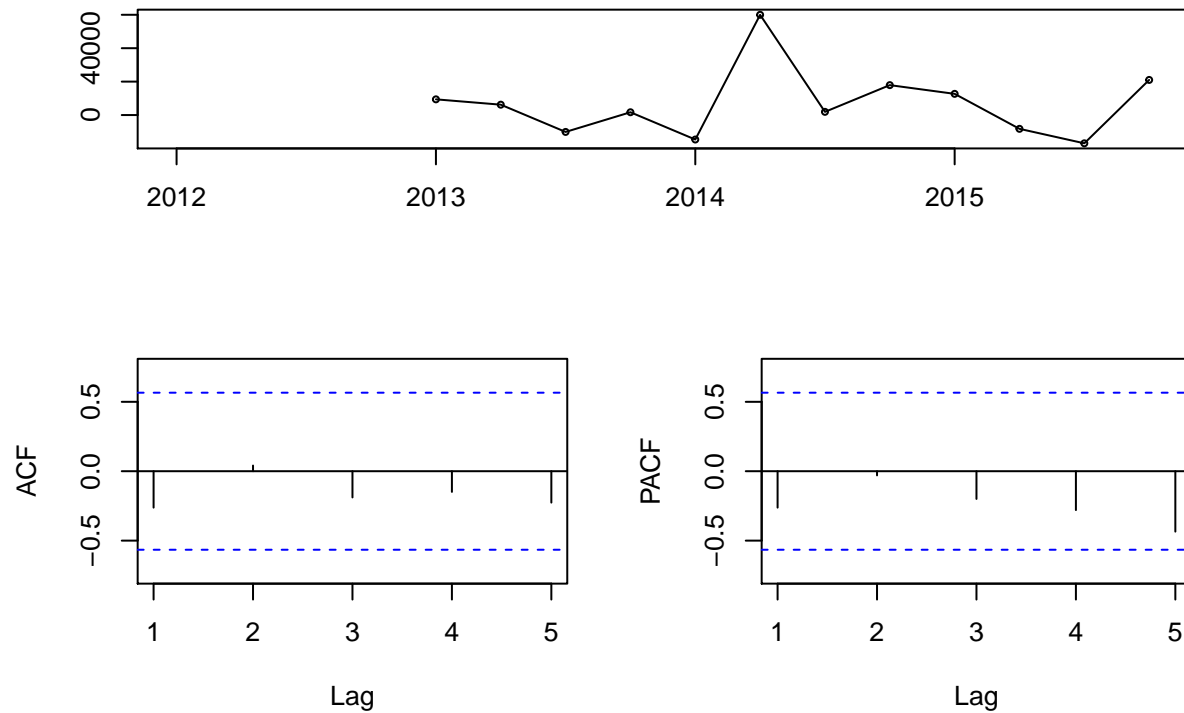# Portland, OR – Markham : Naive Model Forecast Residuals

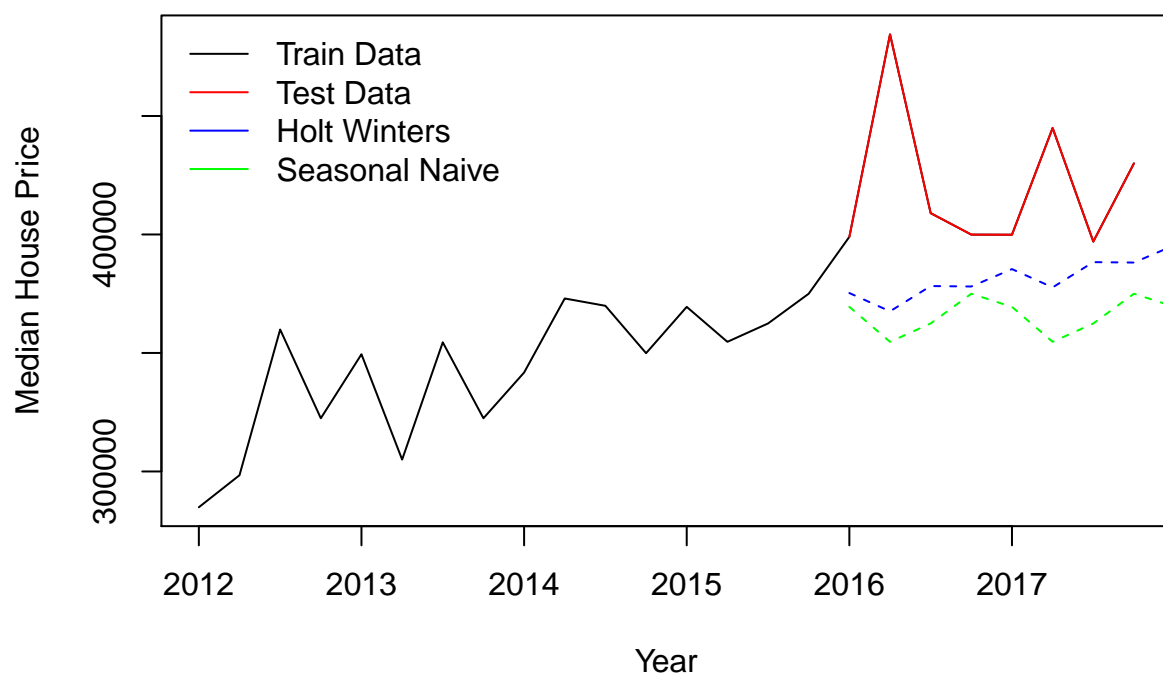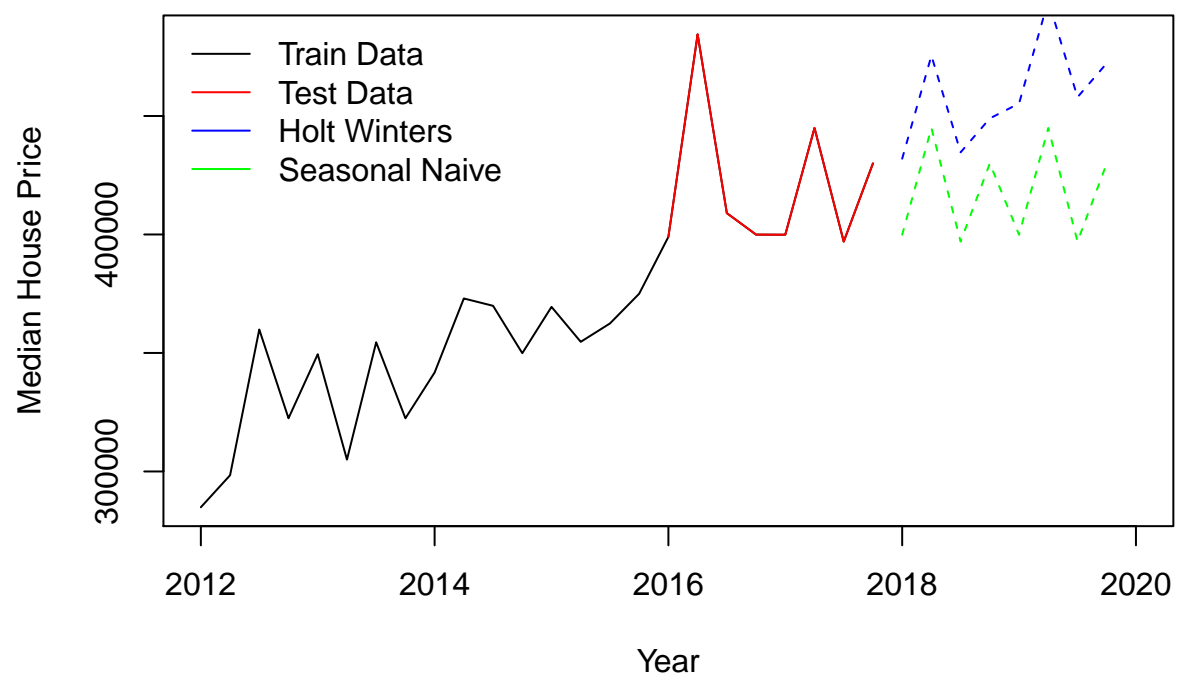# Portland, OR – Markham : Holt Winters Model Forecast

Legend:
- Train Data
- Test Data
- Holt Winters

Y-axis: Median House Price

X-axis: Year

Portland, OR – Markham : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Markham"
##                   ME     RMSE      MAE      MPE      MAPE     MASE
## Training set 16329.17 31226.41 22804.17  4.506217  6.338072 1.000000
## Test set     55131.25 64989.07 55131.25 12.649964 12.649964 2.417595
##                  ACF1 Theil's U
## Training set -0.05445208        NA
## Test set     -0.33063659  1.403775
## [1] "Holt Winters Accuracy for  Portland, OR - Markham"
##                   ME     RMSE      MAE      MPE     MAPE      MASE
## Training set  6736.682 21063.95 15055.11 1.821734 4.176288 0.6601912
## Test set     40693.262 52691.00 40693.26 9.215956 9.215956 1.7844661
##                 ACF1 Theil's U
## Training set -0.2623946        NA
## Test set     -0.3298312  1.146357
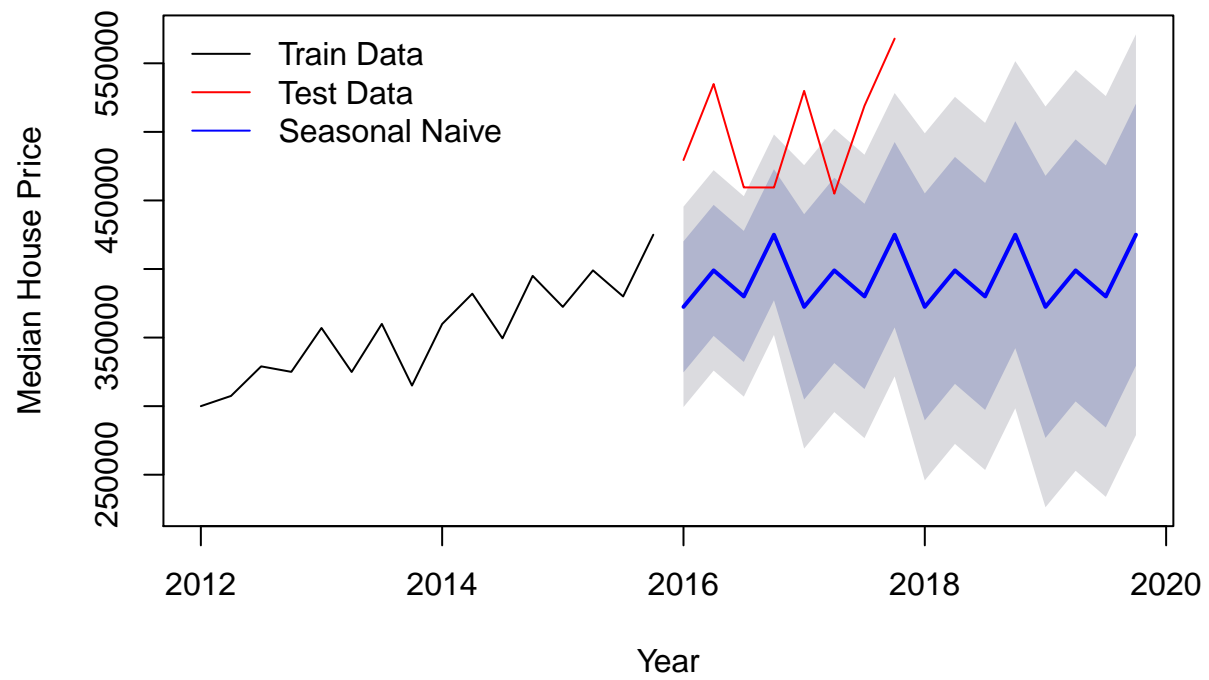```

# Portland, OR – Markham : TS Training Model Comparison

# Portland, OR – Markham : Full TS Models Comparison
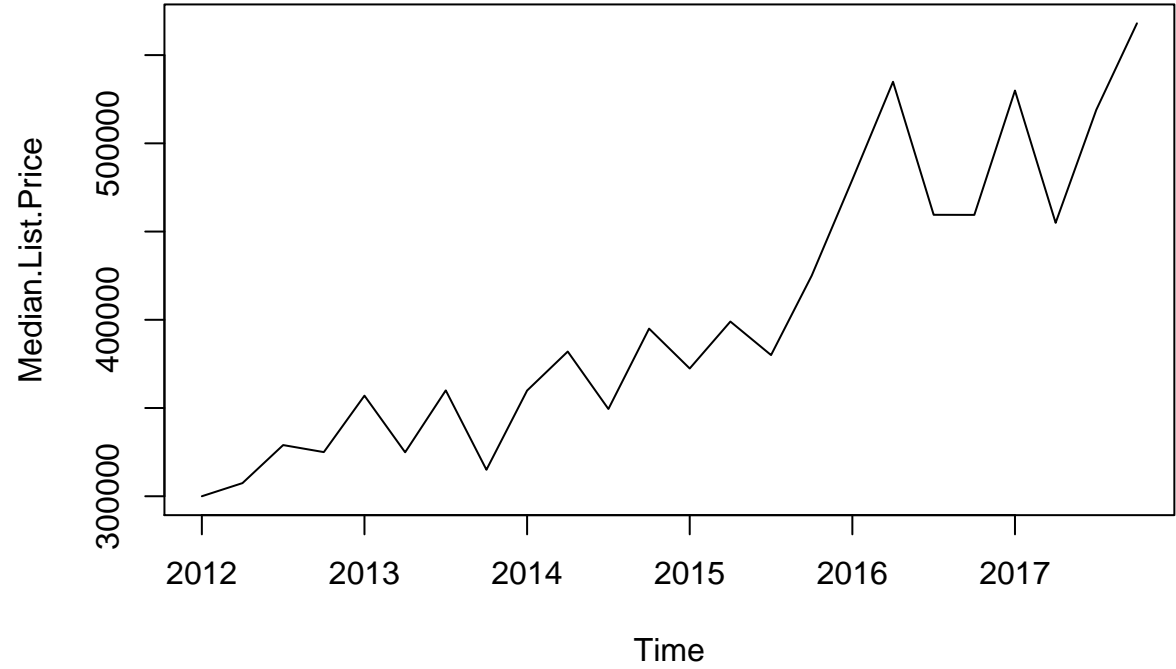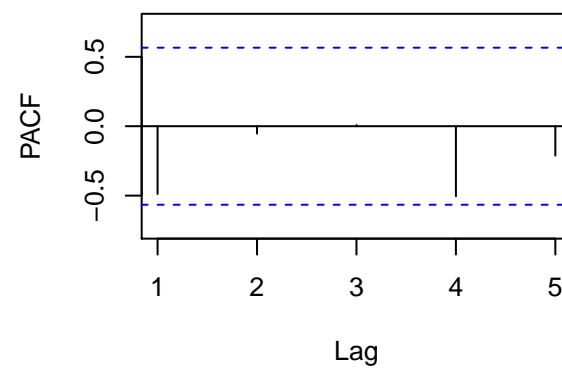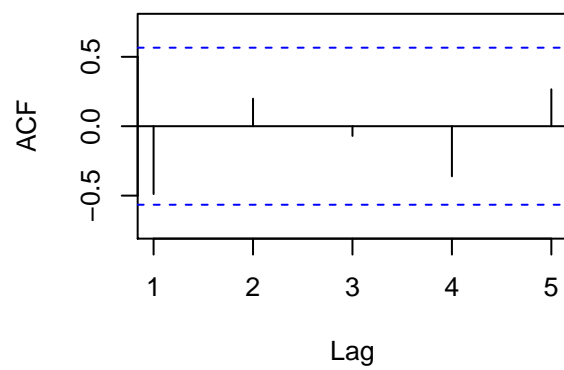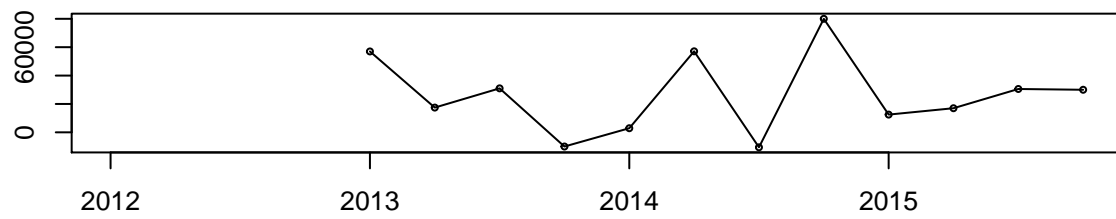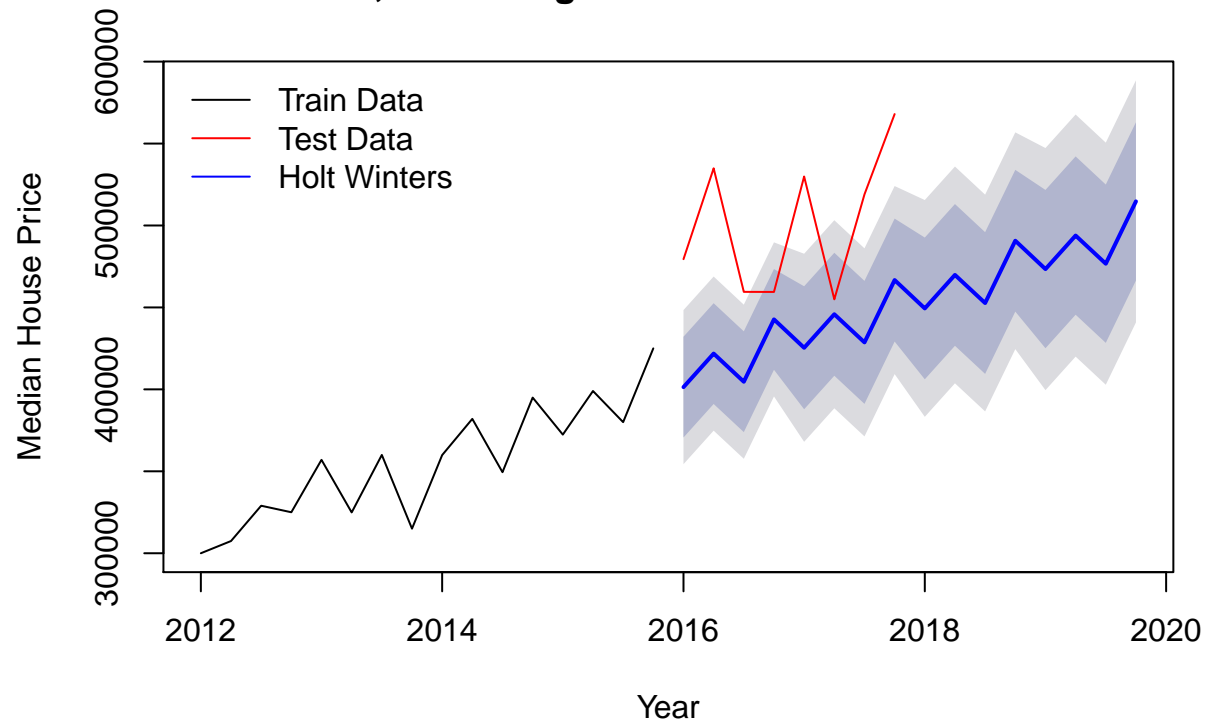


Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

**Portland, OR – King**

**Portland, OR – King : Naive Model Forecast**

Legend:
- Train Data
- Test Data
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year

# Portland, OR – King : Naive Model Forecast  Residuals

Portland, OR – King : Holt Winters Model Forecast

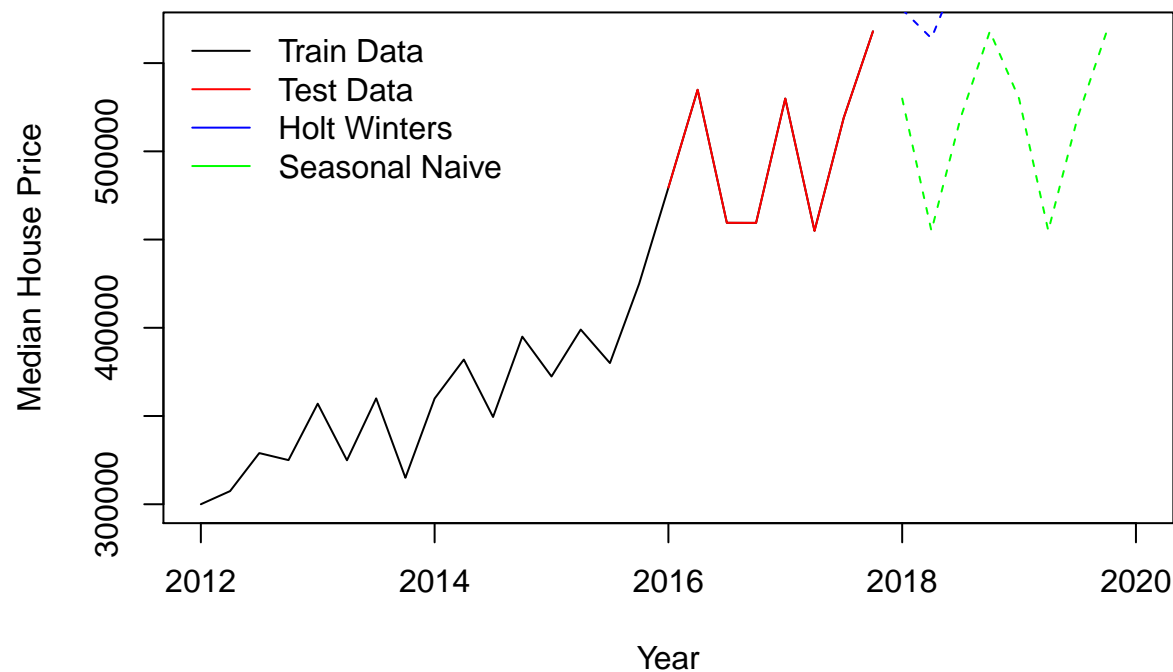**Portland, OR – King : Holt Winters Model Forecast  Residuals**
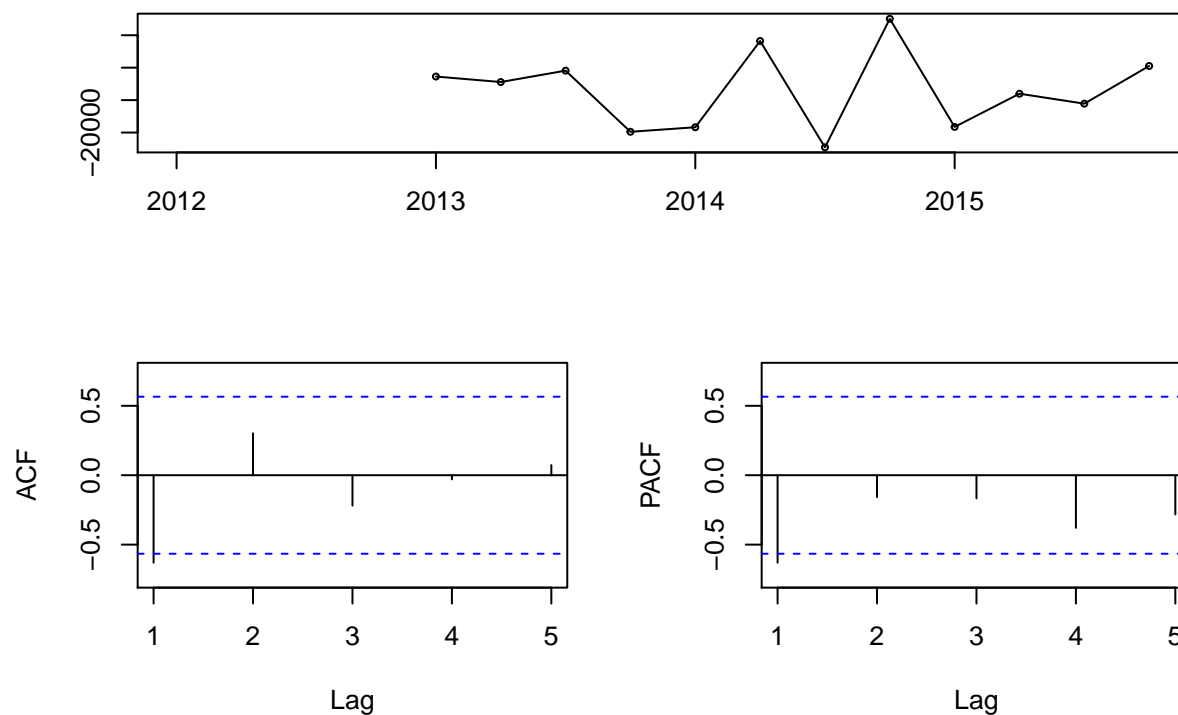


```
[1] "Seasonal Naive Accuracy for Portland, OR - King"
ME   RMSE   MAE   MPE   MAPE   MASE
Training set 26245.83 37275.08 29670.83 6.873074 7.905346 1.000000
Test set   106543.75 114641.95 106543.75 20.814096 20.814096 3.590858
ACF1 Theil's U
Training set -0.4885715   NA
Test set   -0.3866040 1.961695
[1] "Holt Winters Accuracy for Portland, OR - King"
ME   RMSE   MAE   MPE   MAPE   MASE
Training set   5938.045 23719.33 19958.26 1.375725 5.409491 0.6726559
Test set   71001.520 80310.36 71001.52 13.746594 13.746594 2.3929736
ACF1 Theil's U
Training set -0.6303503   NA
Test set   -0.3556917 1.366595
```
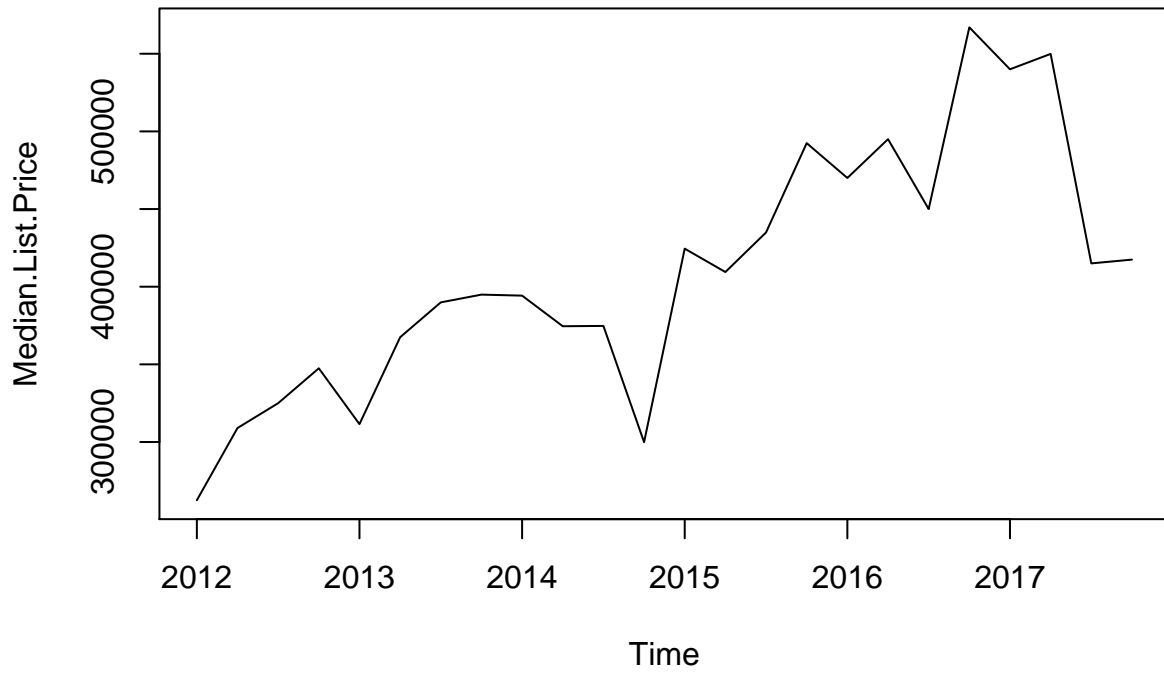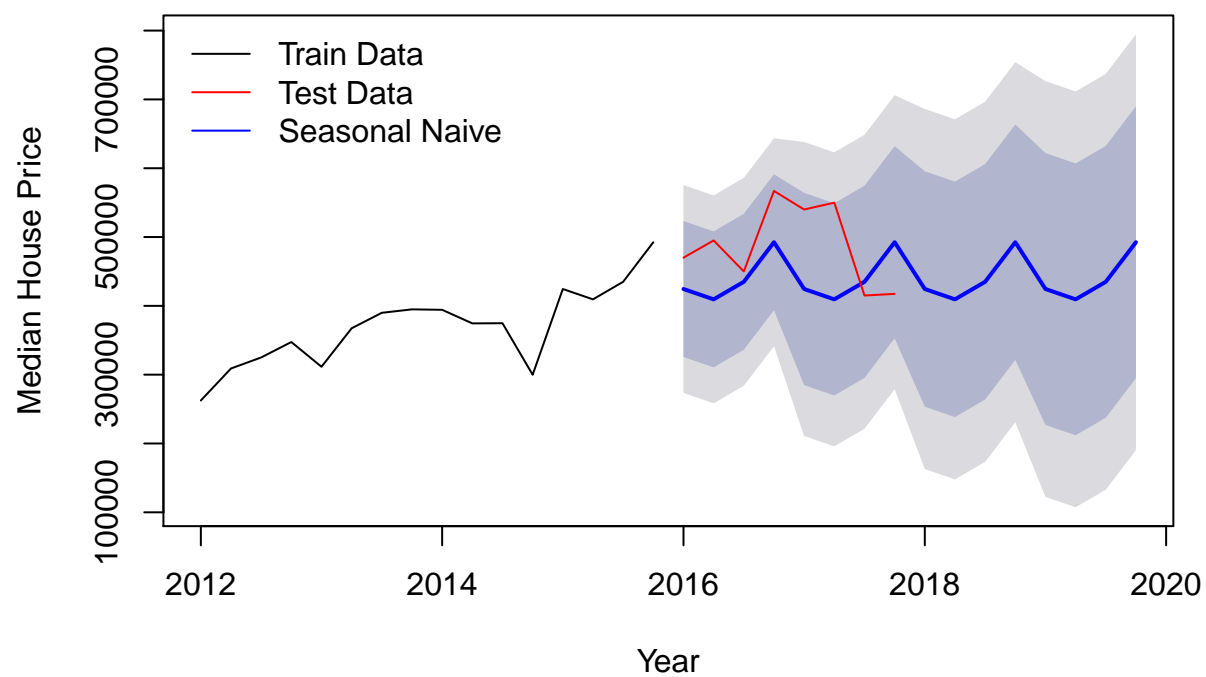
**Portland, OR – King : TS Training Model Comparison**
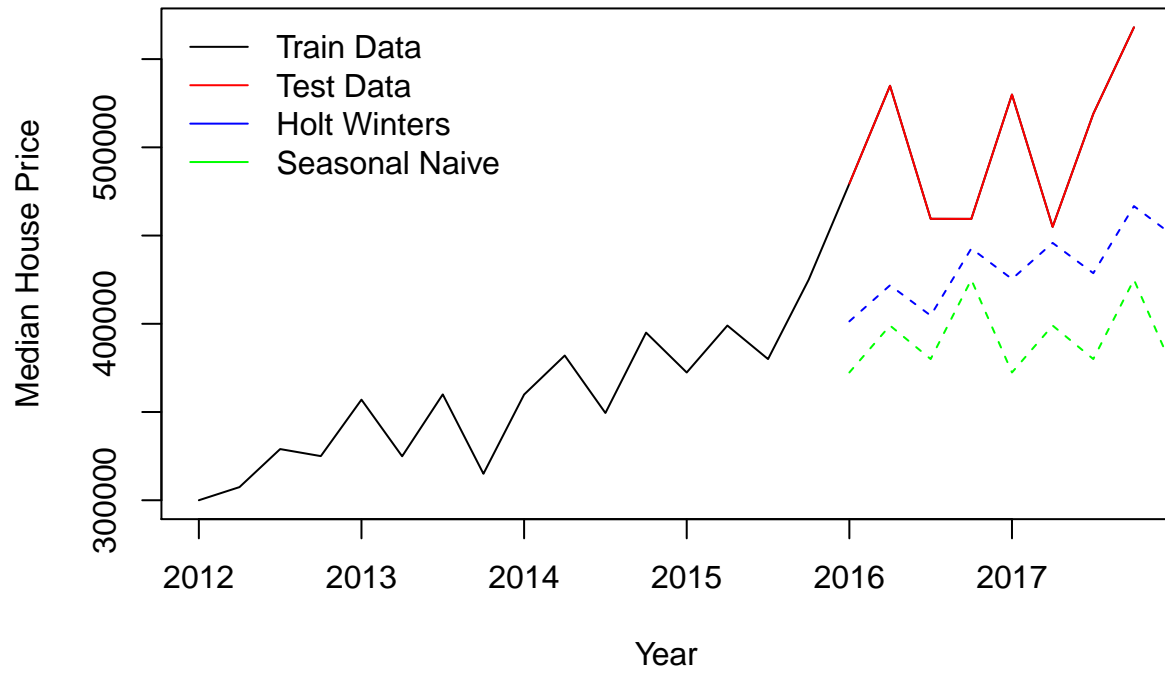
# Portland, OR – King : Full TS Models Comparison
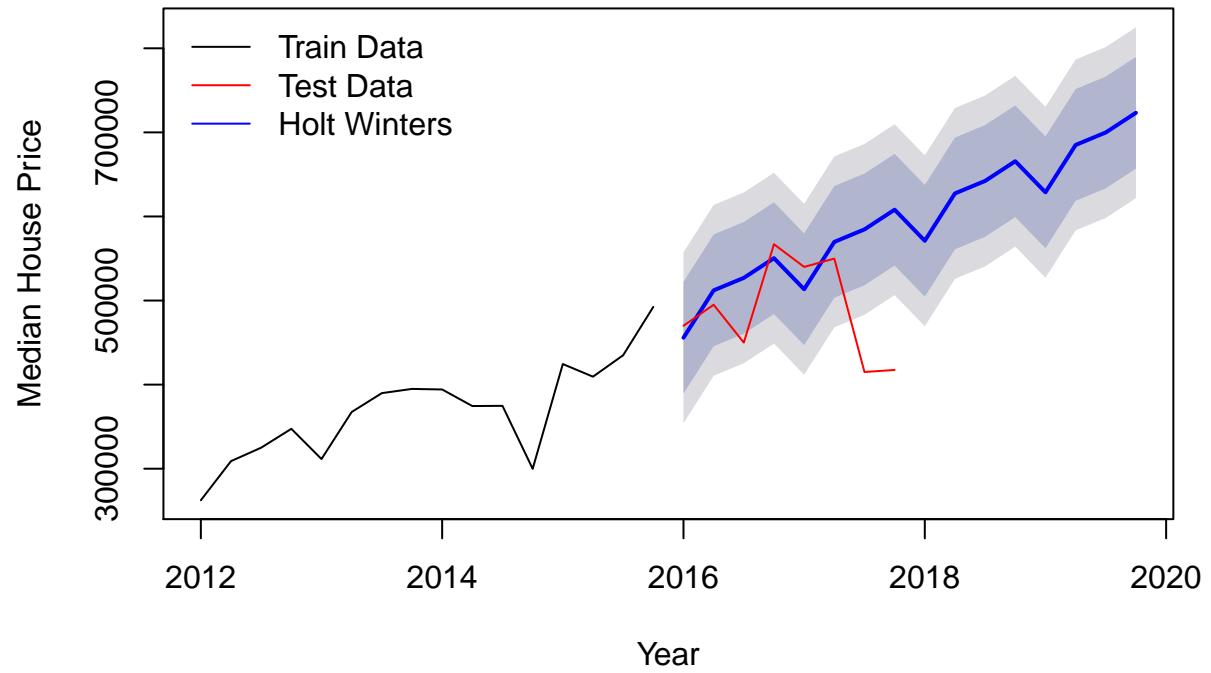
# Portland, OR – Kerns

# Portland, OR – Kerns : Naive Model Forecast

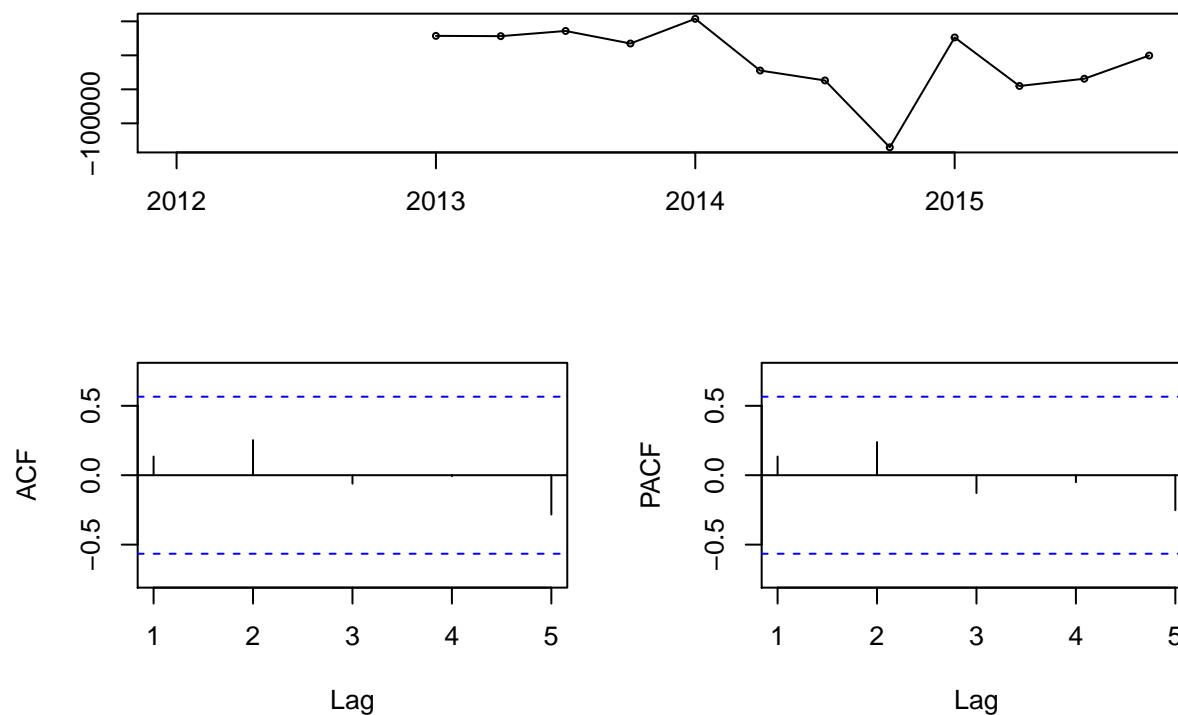# Portland, OR – Kerns : Naive Model Forecast  Residuals

# Portland, OR – Kerns : Holt Winters Model Forecast
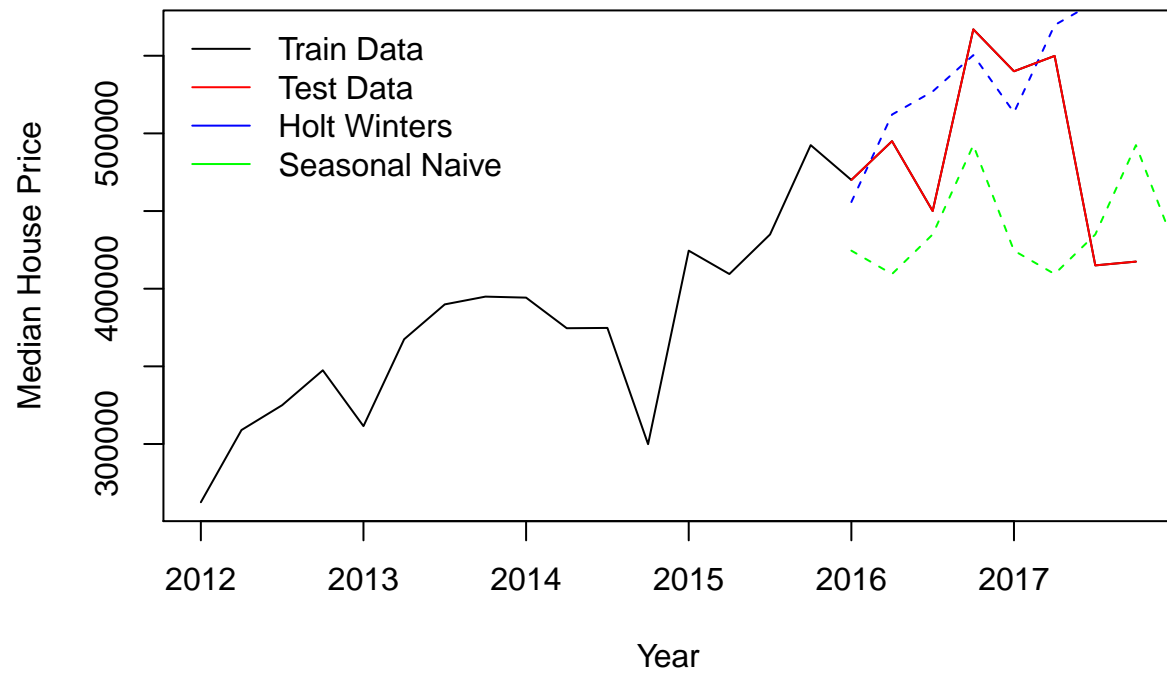
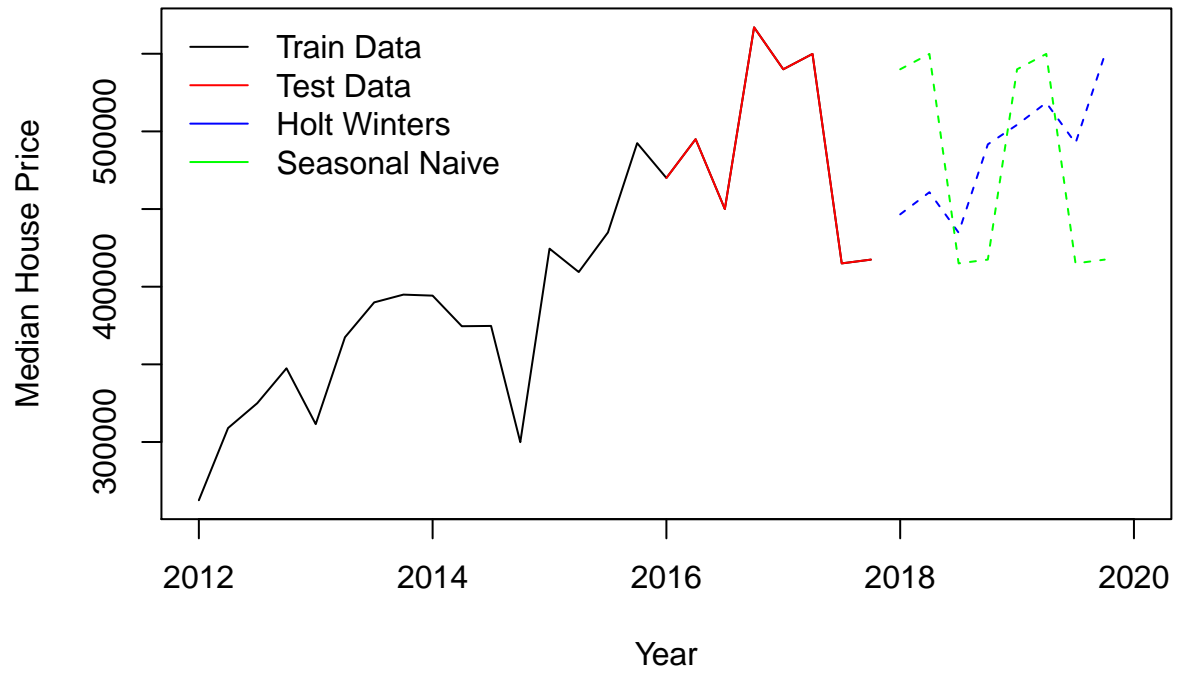## Portland, OR – Kerns : Holt Winters Model Forecast  Residuals



```
[1] "Seasonal Naive Accuracy for Portland, OR - Kerns"
ME   RMSE   MAE   MPE   MAPE   MASE
Training set 43116.67 77063.84 61475.00 9.671159 15.62448 1.000000
Test set   47706.25 82357.99 71443.75 8.451589 14.14495 1.162159
ACF1 Theil's U
Training set 0.2799235   NA
Test set   0.2201735   1.20248
[1] "Holt Winters Accuracy for Portland, OR - Kerns"
ME   RMSE   MAE   MPE   MAPE   MASE
Training set -7000.417 50118.56 38697.92 -2.463192 10.84795 0.6294903
Test set   -52102.500 95452.92 66439.06 -12.479888 15.19610 1.0807493
ACF1 Theil's U
Training set 0.1346555   NA
Test set   0.3940729 1.541982
```
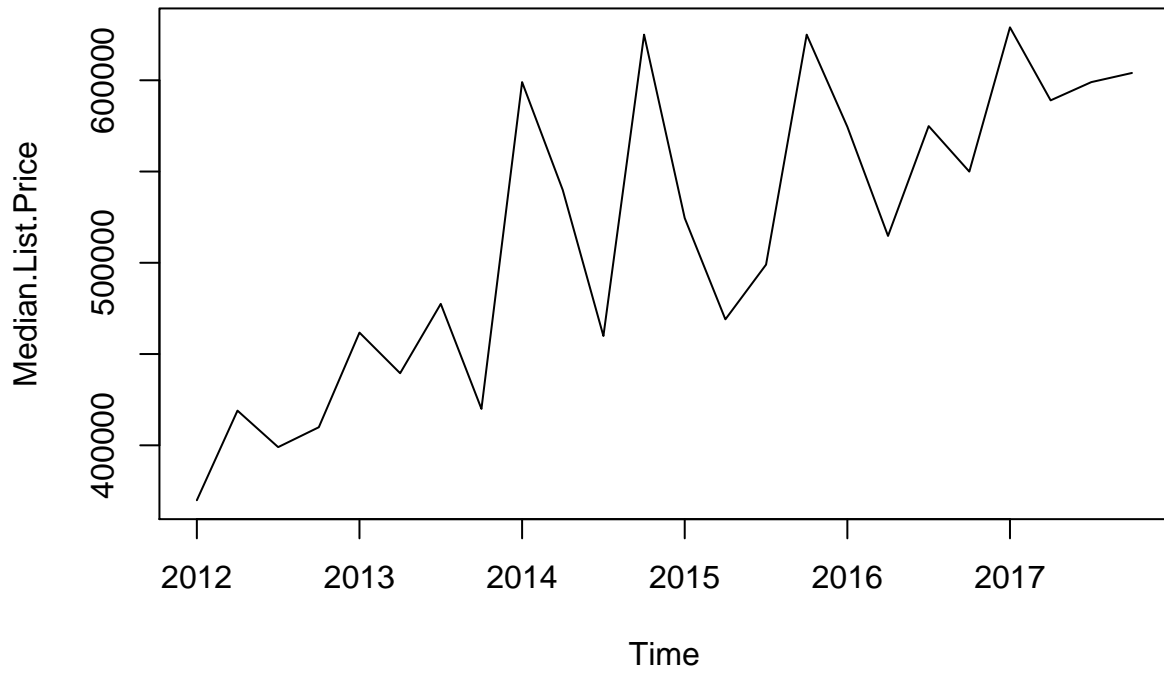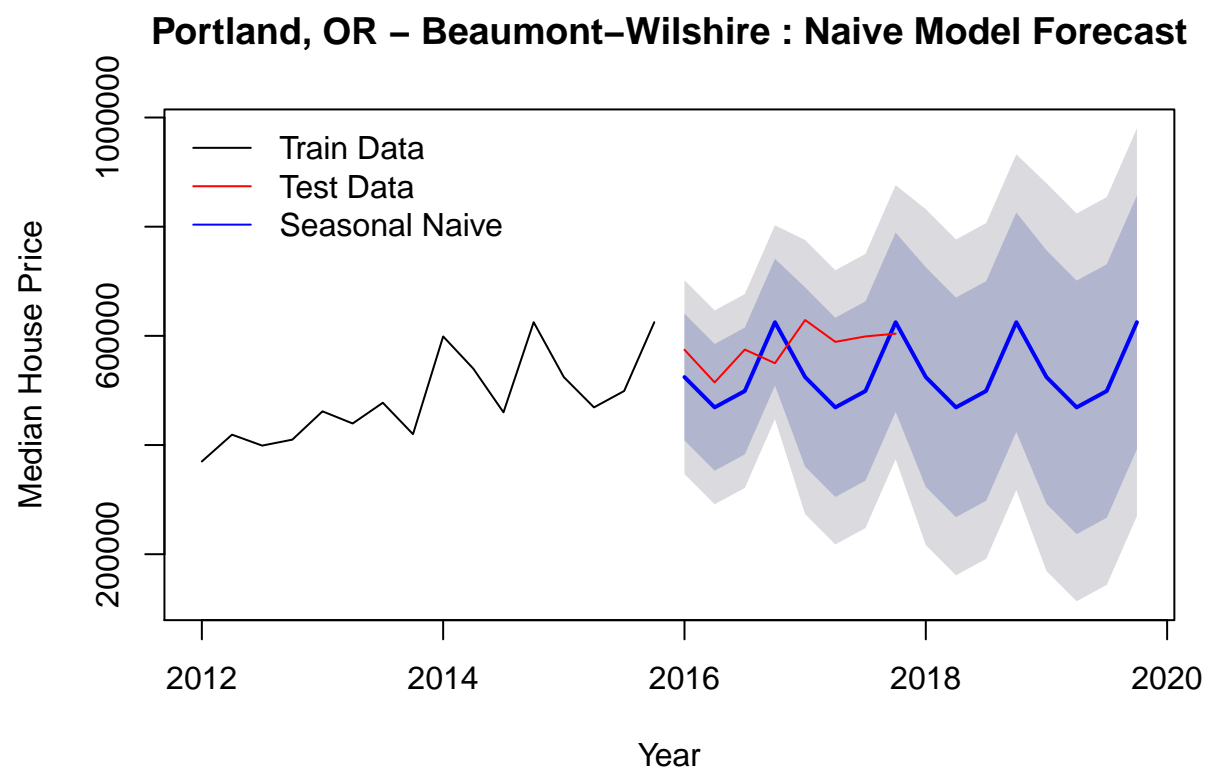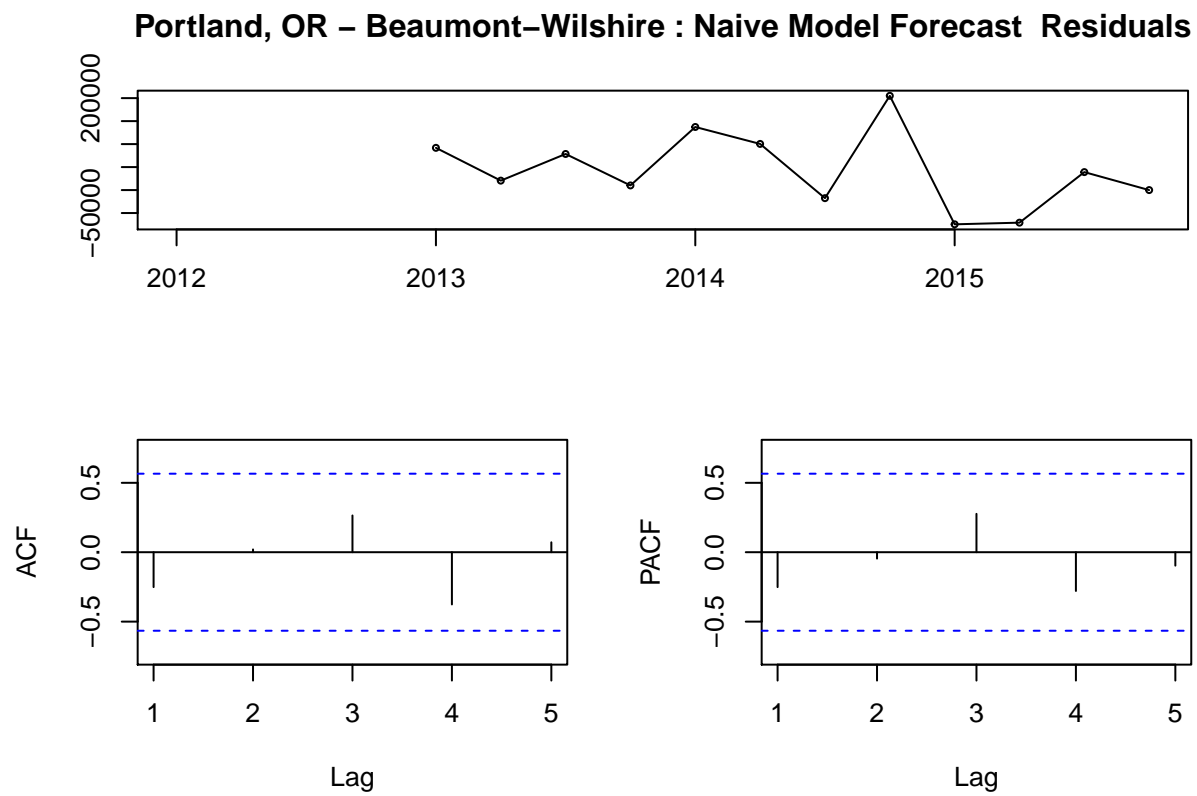
# Portland, OR – Kerns : TS Training Model Comparison
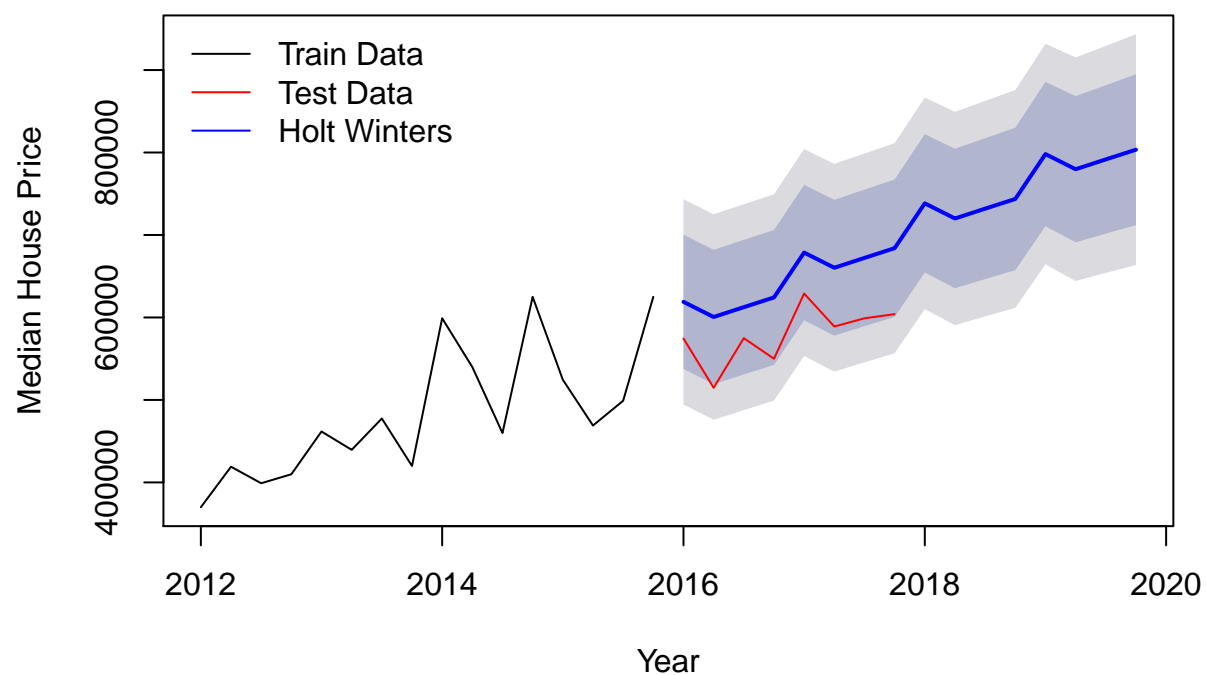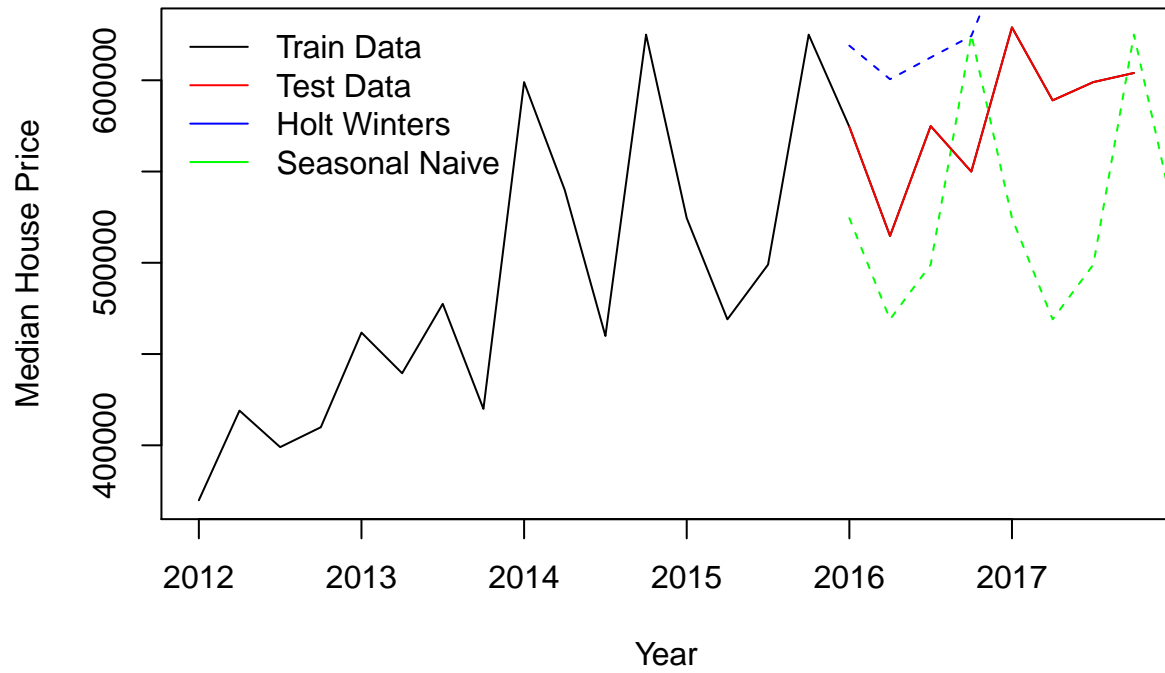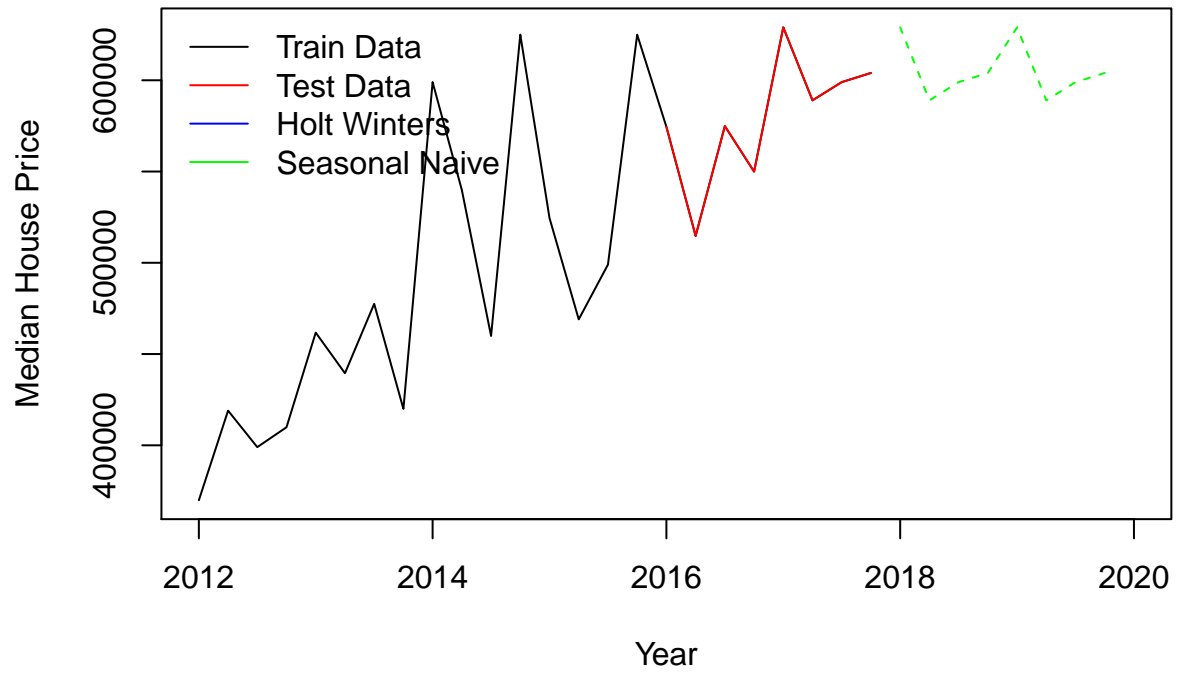
**Portland, OR – Kerns : Full TS Models Comparison**

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

X-axis: Year
Y-axis: Median House Price

# Portland, OR – Beaumont–Wilshire

**Portland, OR – Beaumont–Wilshire : Naive Model Forecast**

Legend:
- Train Data
- Test Data
- Seasonal Naive

Median House Price

Year

**Portland, OR – Beaumont–Wilshire : Naive Model Forecast  Residuals**

# Portland, OR – Beaumont–Wilshire : Holt Winters Model Forecast

**Portland, OR – Beaumont–Wilshire : Holt Winters Model Forecast  Residuals**
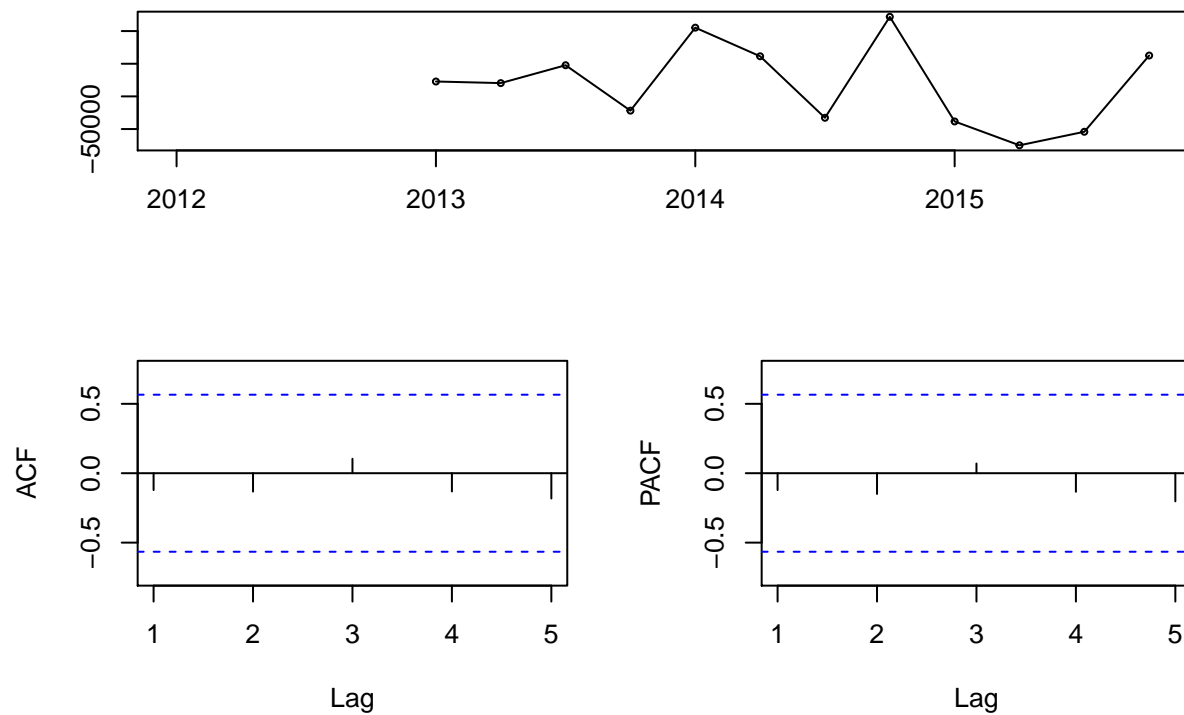


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Beaumont-Wilshire"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 43308.33 90599.73 70475.00 7.699463 13.22416 1.000000
## Test set     50009.38 80424.92 74021.88 8.418383 12.69926 1.050328
##                  ACF1 Theil's U
## Training set -0.2514371        NA
## Test set     -0.2016649  1.694368
## [1] "Holt Winters Accuracy for  Portland, OR - Beaumont-Wilshire"
##                   ME      RMSE      MAE       MPE     MAPE     MASE
## Training set  18315.54 63500.92 55330.52   2.626853 10.37281 0.7851085
## Test set     -64546.63 66698.26 64546.63 -11.241803 11.24180 0.9158798
##                  ACF1 Theil's U
## Training set -0.1213010        NA
## Test set     -0.5837963   1.38488
```

Portland, OR – Beaumont–Wilshire : TS Training Model Comparison

Median House Price vs Year

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Portland, OR – Beaumont–Wilshire : Full TS Models Comparison
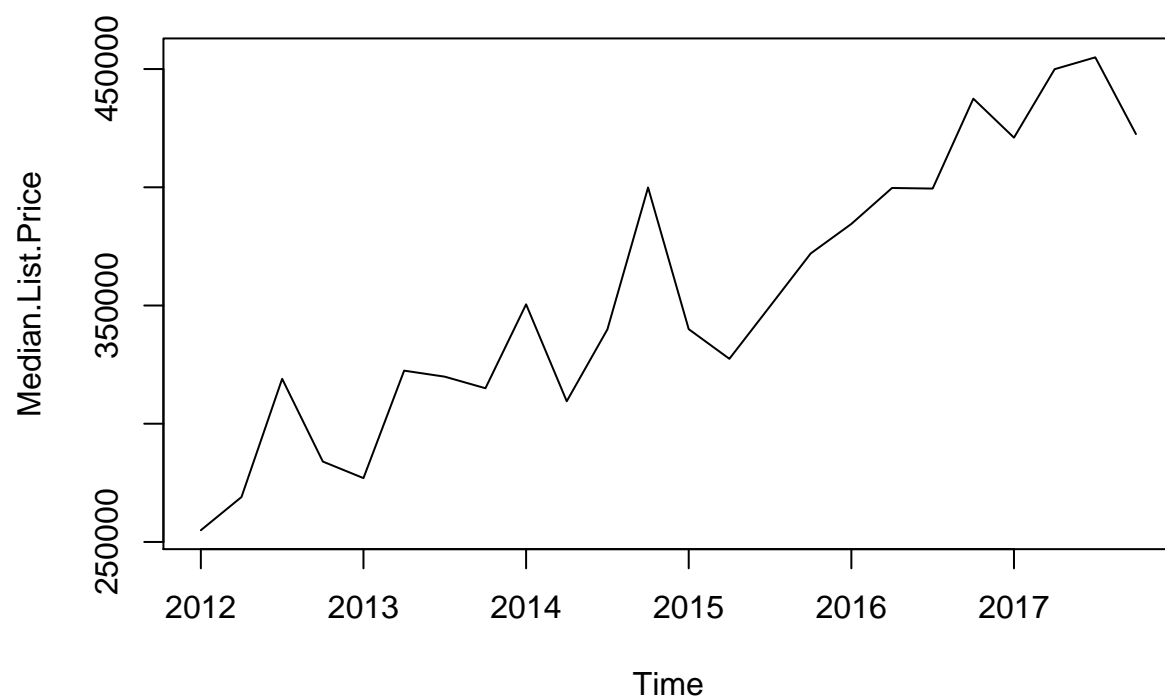
Legend:
- Train Data
- Test Data
- Holt Winters
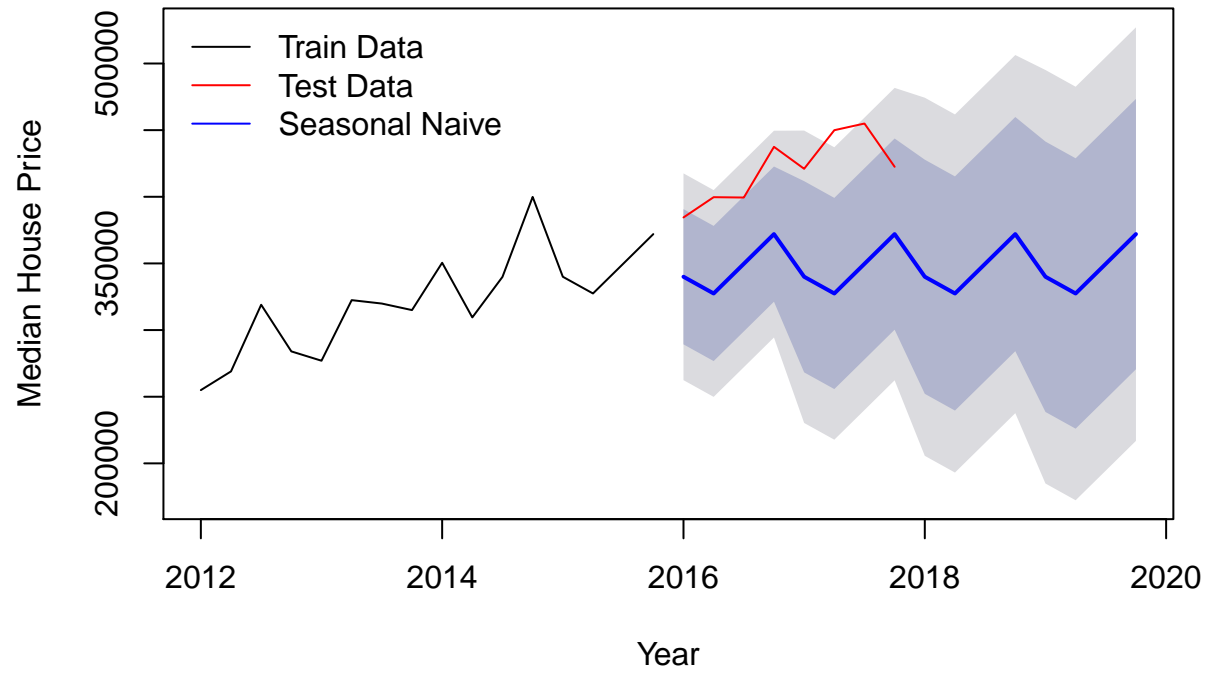- Seasonal Naive

X-axis: Year
Y-axis: Median House Price

Portland, OR – Multnomah Village

Portland, OR – Multnomah Village : Naive Model Forecast

Median House Price

Year

Train Data
Test Data
Seasonal Naive

Portland, OR – Multnomah Village : Naive Model Forecast Residuals
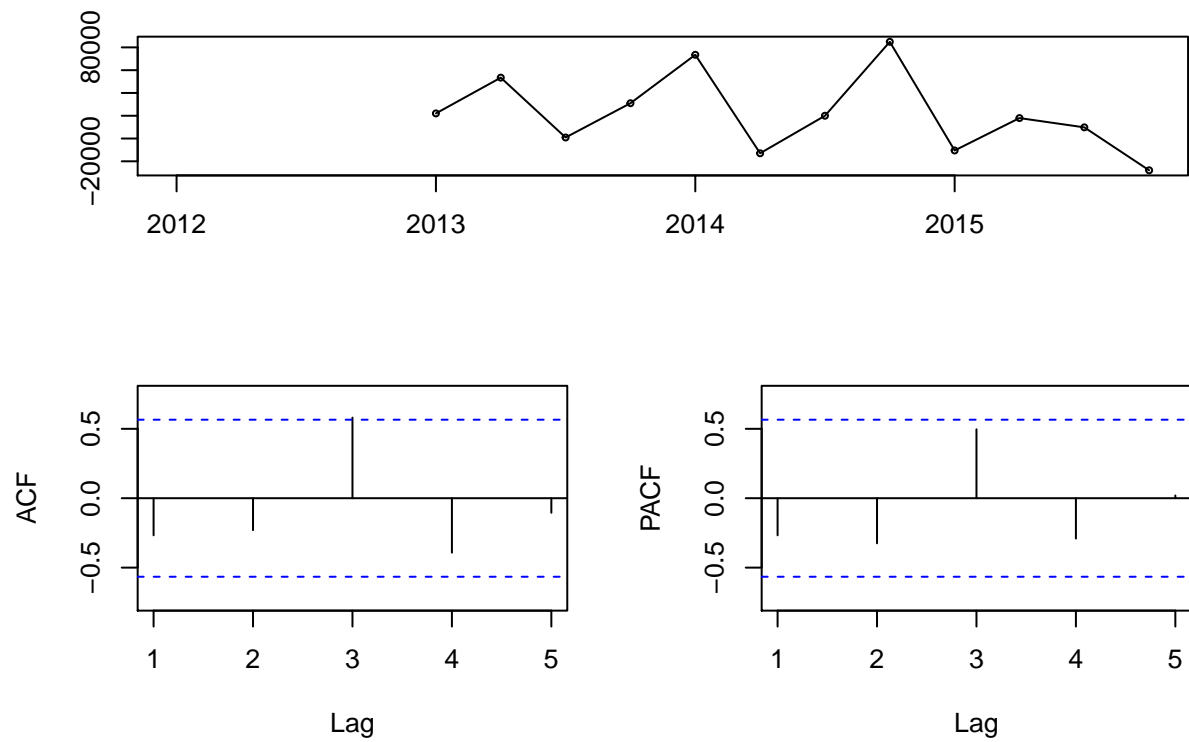
Portland, OR – Multnomah Village : Holt Winters Model Forecast
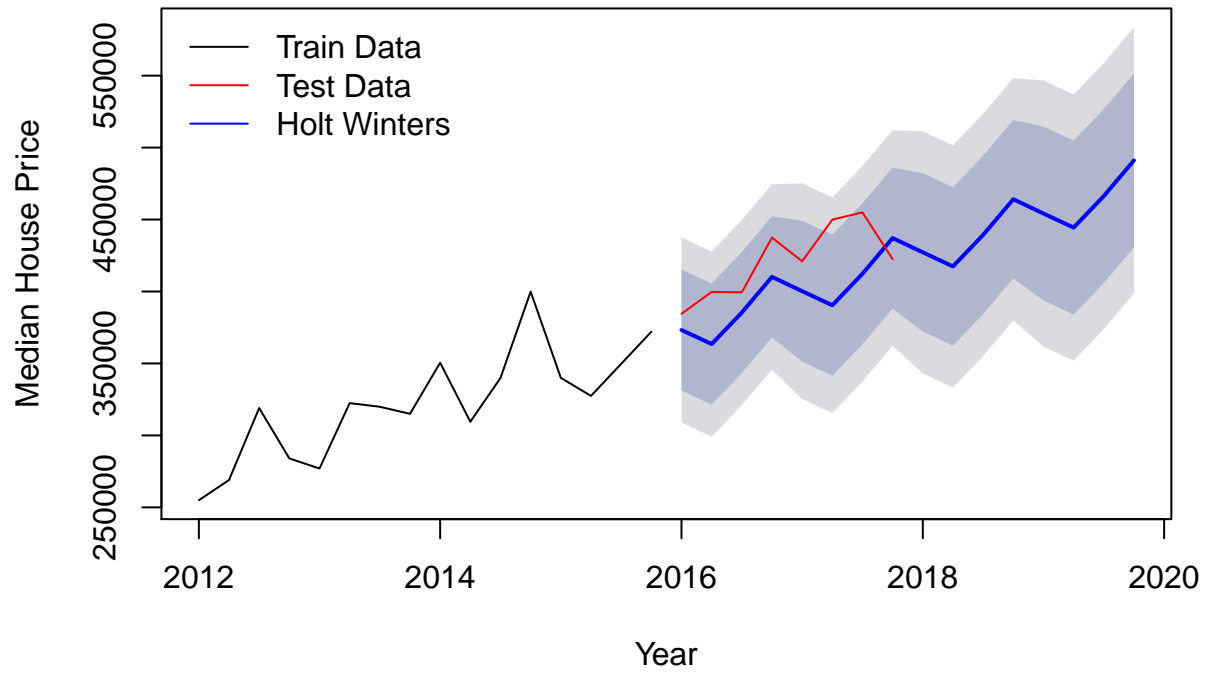
Portland, OR – Multnomah Village : Holt Winters Model Forecast Residuals
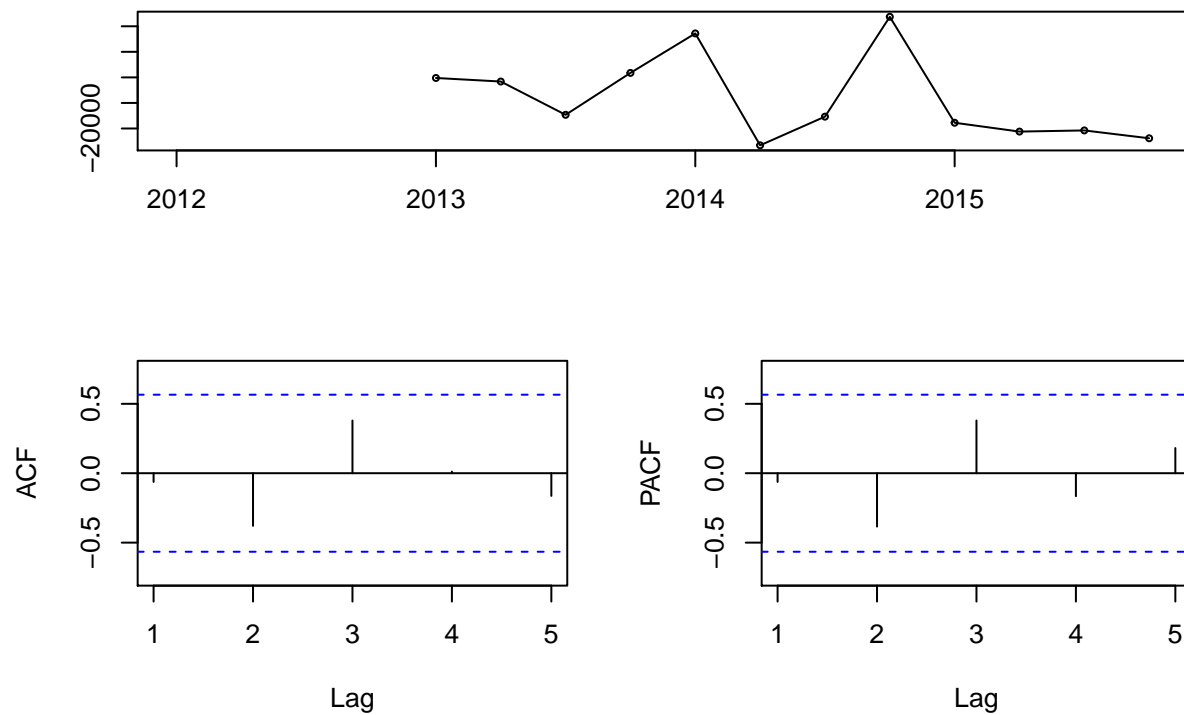

```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Multnomah Village"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 21850.00 39570.31 30408.25  6.354611  8.816651 1.000000
## Test set     73903.12 78387.99 73903.12 17.327869 17.327869 2.430364
##                   ACF1 Theil's U
## Training set -0.2673270        NA
## Test set      0.2501664  3.463188
## [1] "Holt Winters Accuracy for  Portland, OR - Multnomah Village"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set  3441.674 31609.92 26824.37 0.8591412 7.821608 0.8821412
## Test set     24639.969 32370.52 28297.22 5.7272667 6.592889 0.9305772
##                    ACF1 Theil's U
## Training set -0.06268974        NA
## Test set     -0.15030456  1.462412
```

Portland, OR – Multnomah Village : TS Training Model Comparison
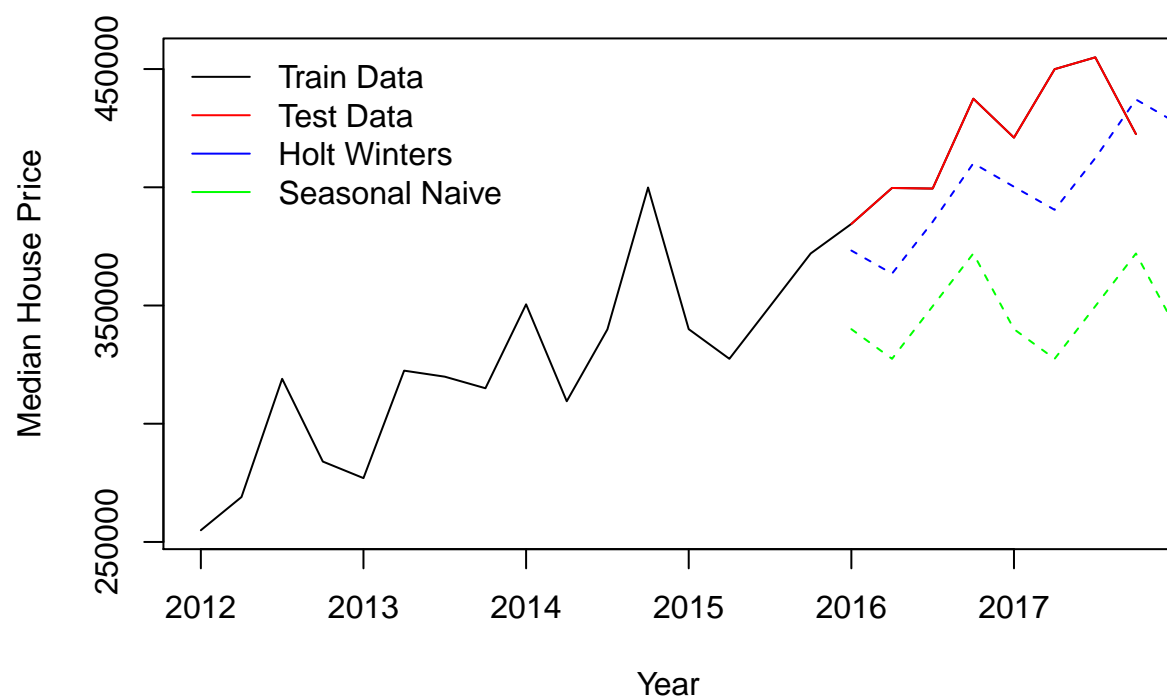
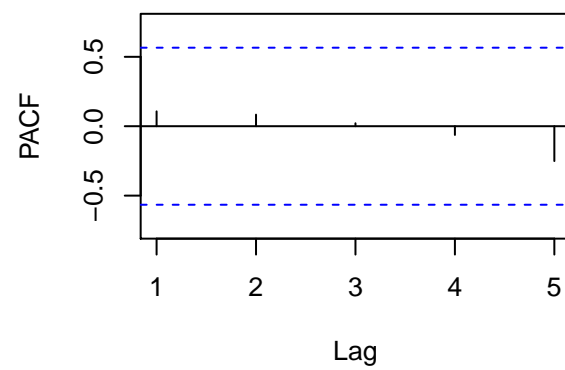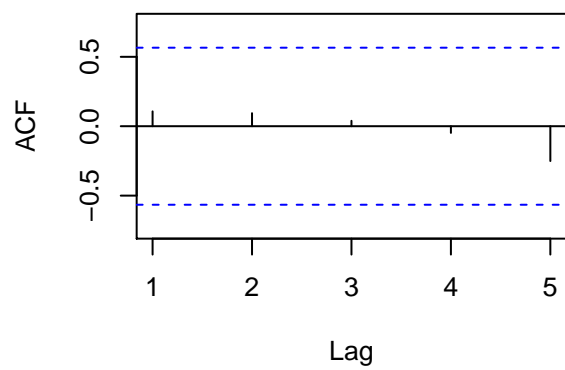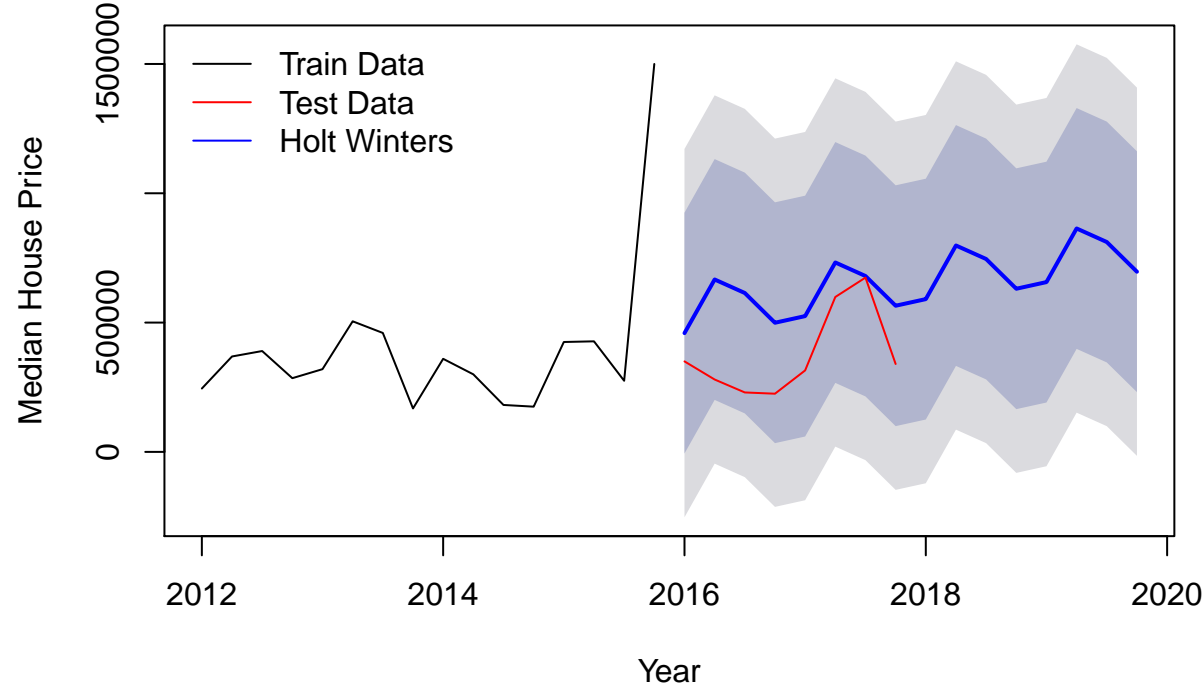# Portland, OR – Multnomah Village : Full TS Models Comparison
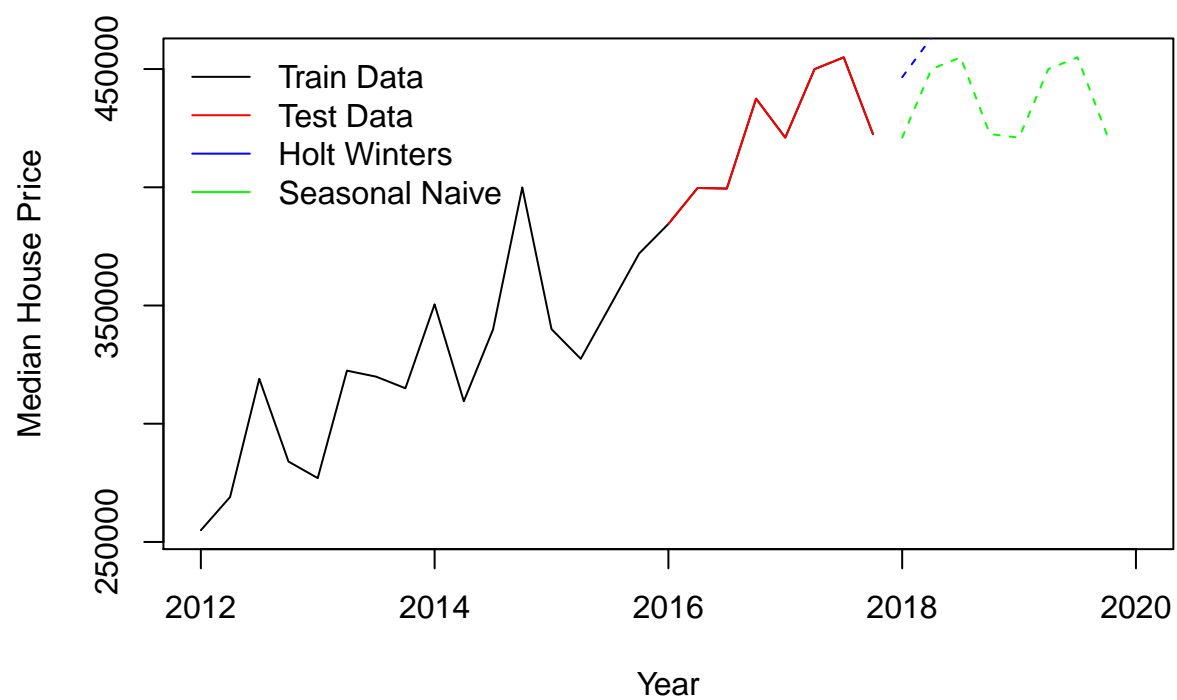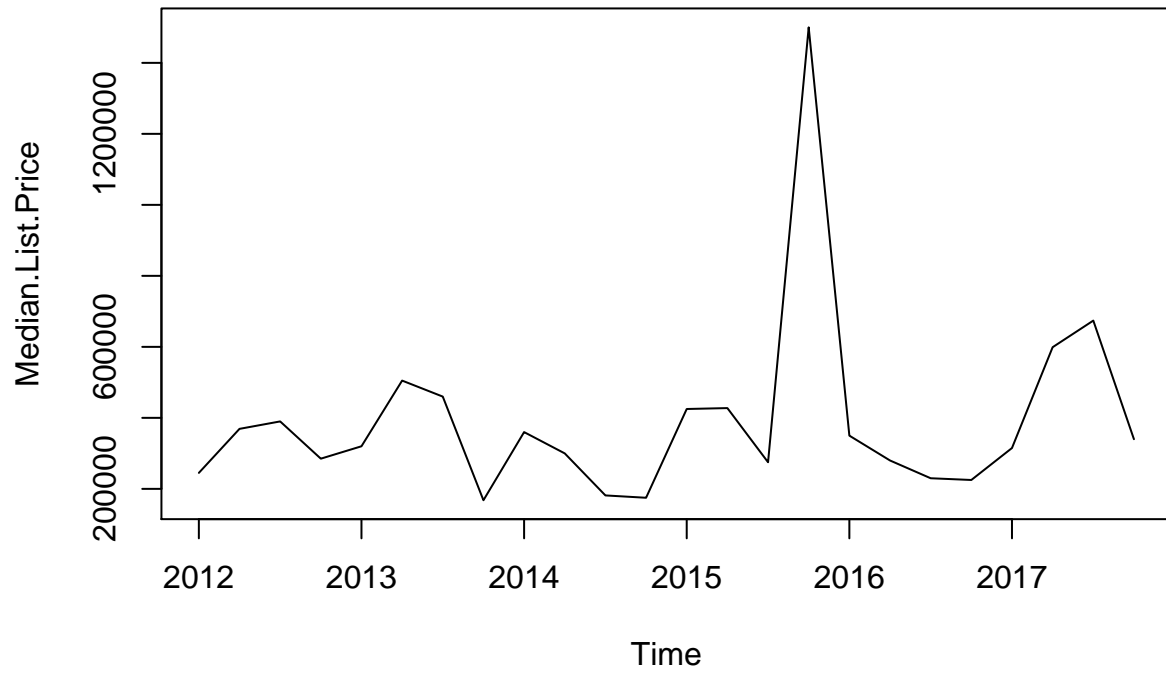
Portland, OR – Homestead
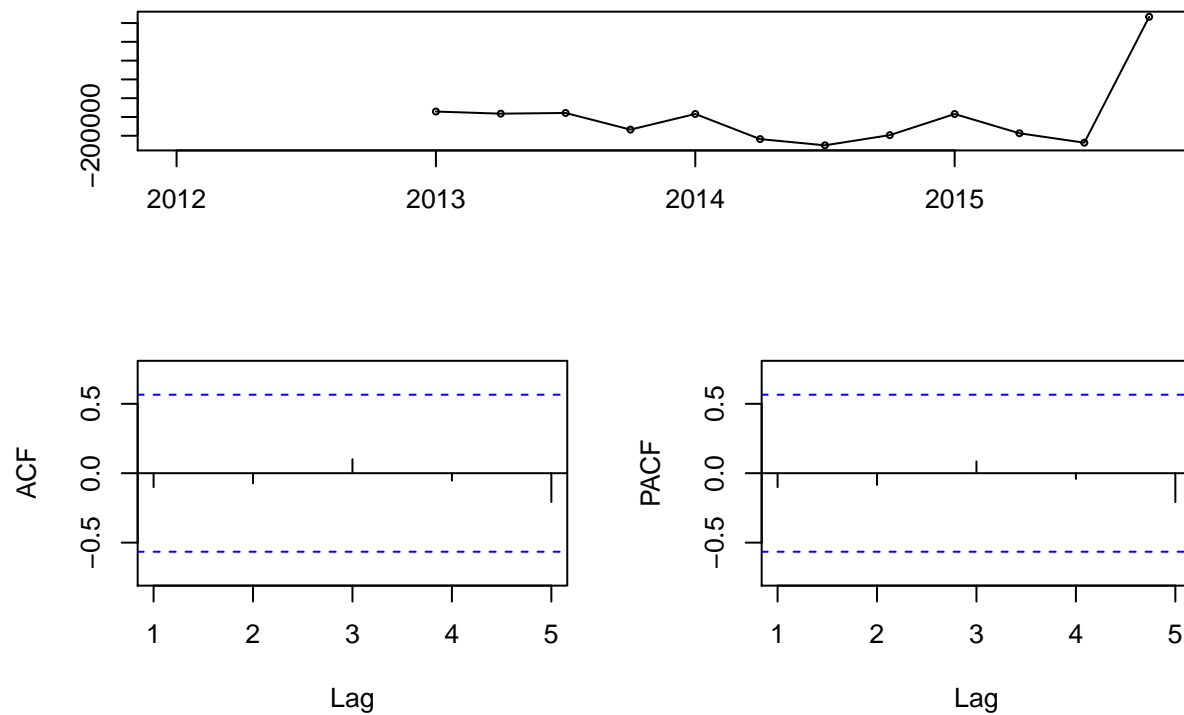
Portland, OR – Homestead : Naive Model Forecast
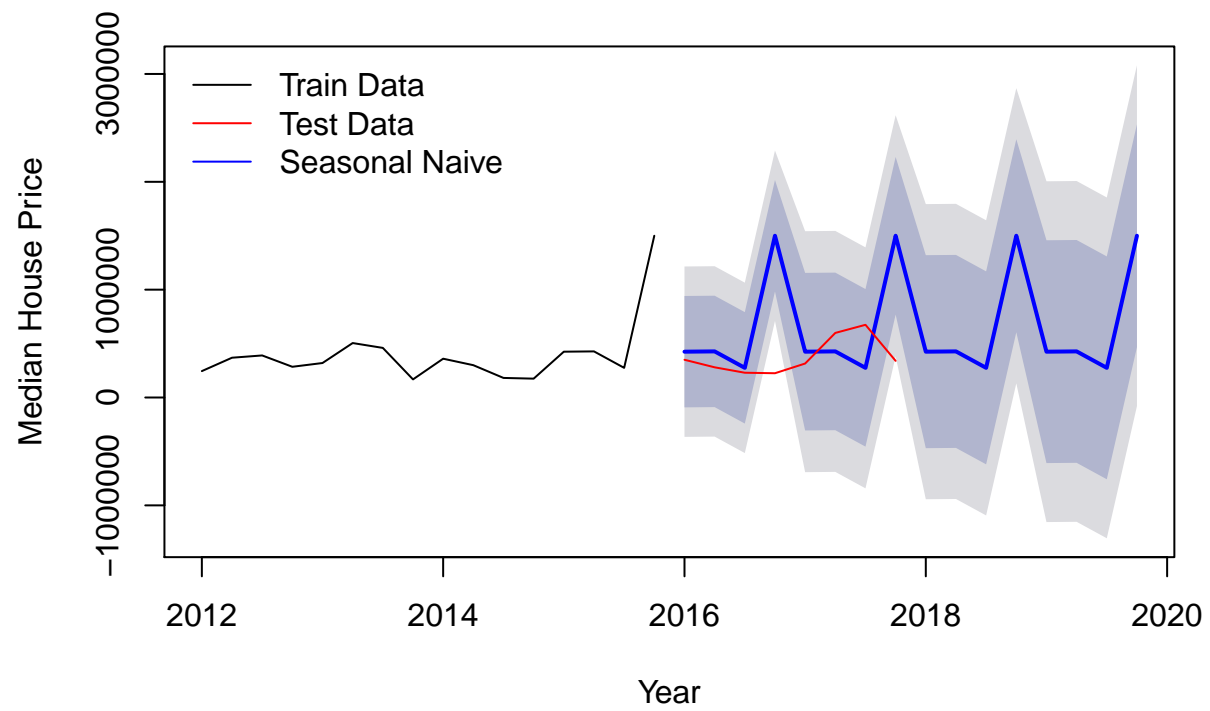
Portland, OR – Homestead : Naive Model Forecast Residuals

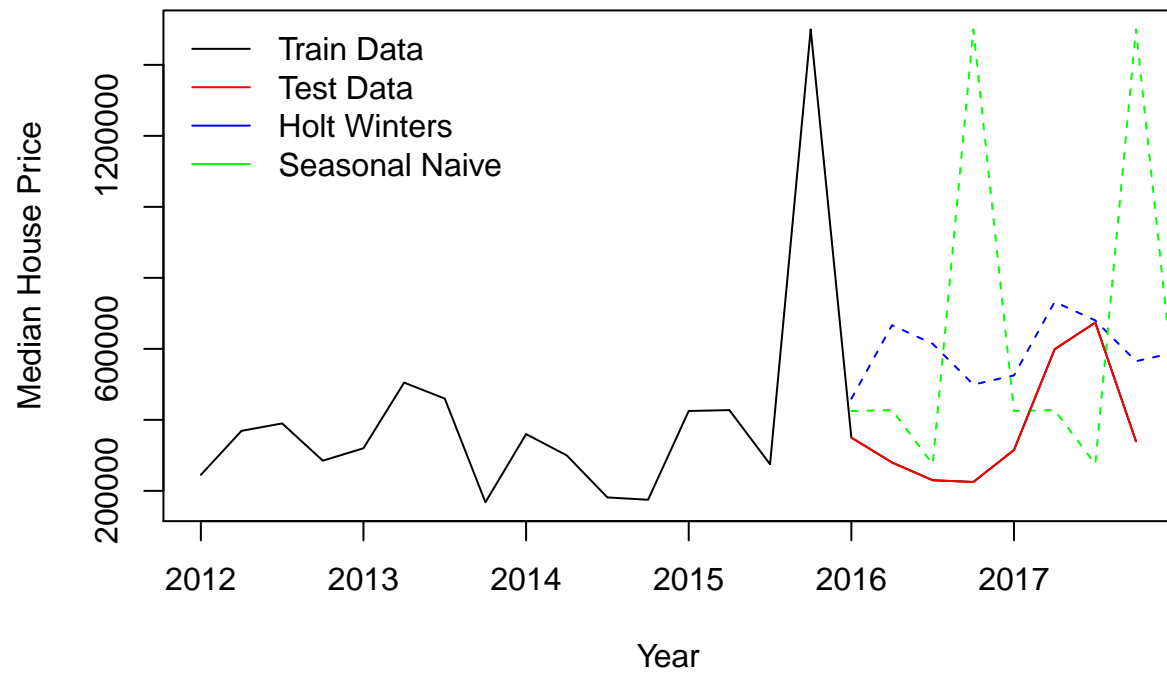**Portland, OR – Homestead : Holt Winters Model Forecast**

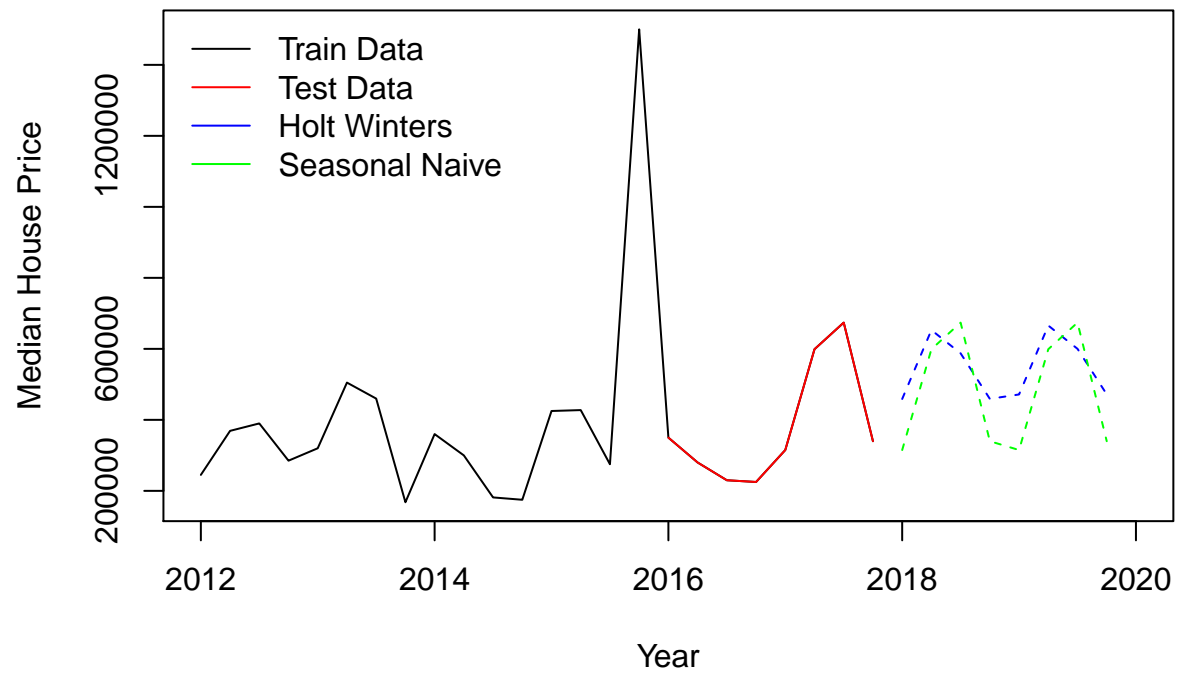## Portland, OR – Homestead : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Homestead"
##                      ME      RMSE      MAE        MPE       MAPE      MASE
## Training set   111541.7  403013.0  211625.0   -3.610505   44.96526  1.000000
## Test set      -280293.8  632615.9  422918.8 -118.607496  140.56496  1.998435
##                    ACF1 Theil's U
## Training set  0.1071213        NA
## Test set     -0.2171330  5.168237
## [1] "Holt Winters Accuracy for  Portland, OR - Homestead"
##                      ME      RMSE      MAE        MPE      MAPE      MASE
## Training set    -3804.01  347840.4  214738.9  -37.77193  58.06019  1.014714
## Test set      -216246.72  249357.4  216246.7  -76.85066  76.85066  1.021839
##                     ACF1 Theil's U
## Training set -0.09998965        NA
## Test set      0.29122662   2.08793
```
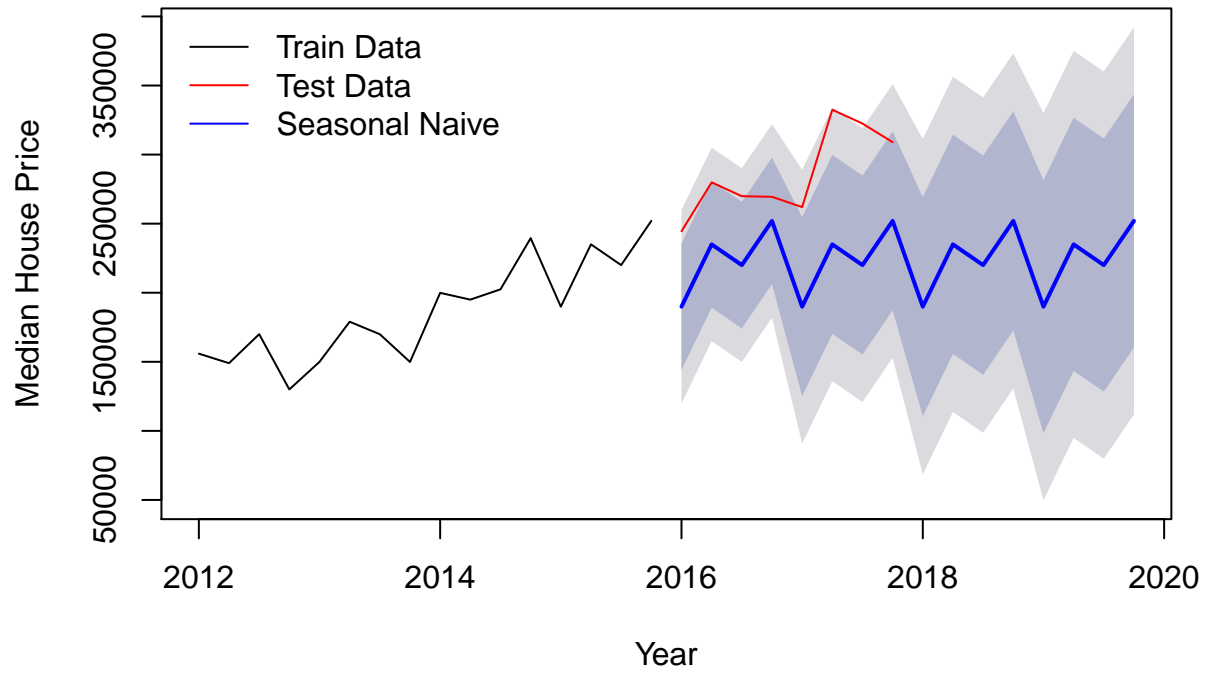
Portland, OR – Homestead : TS Training Model Comparison

Portland, OR – Homestead : Full TS Models Comparison
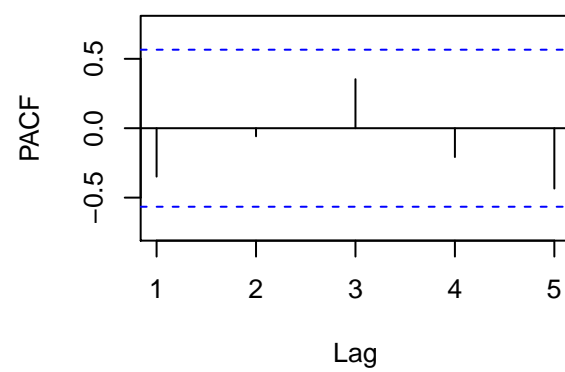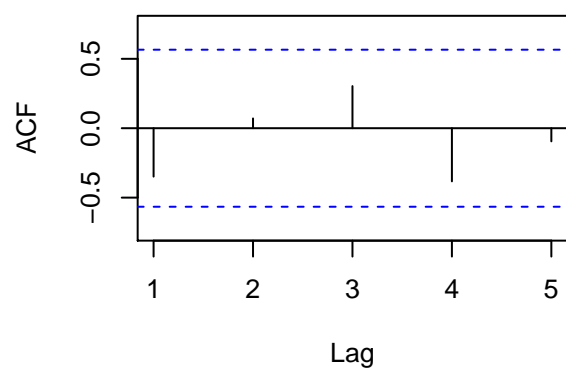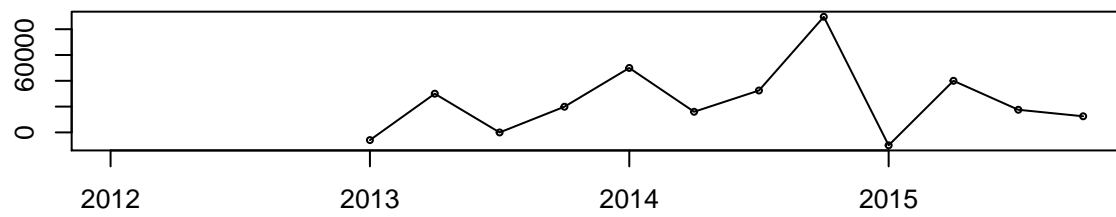
Portland, OR – Sumner
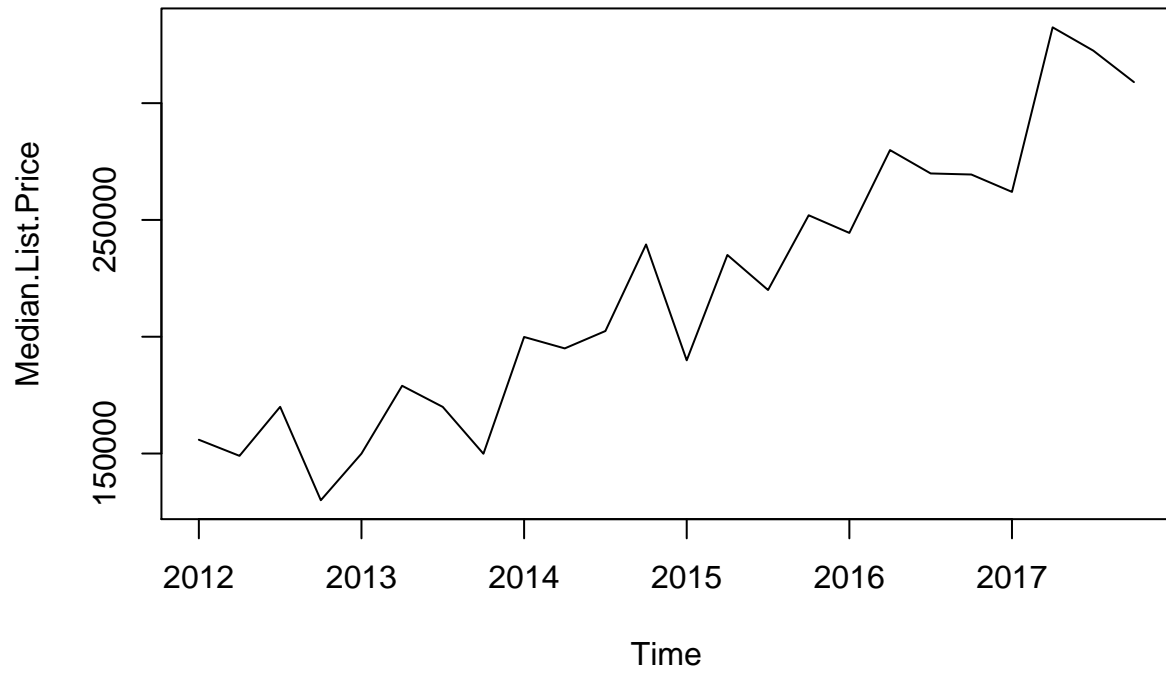
Portland, OR – Sumner : Naive Model Forecast
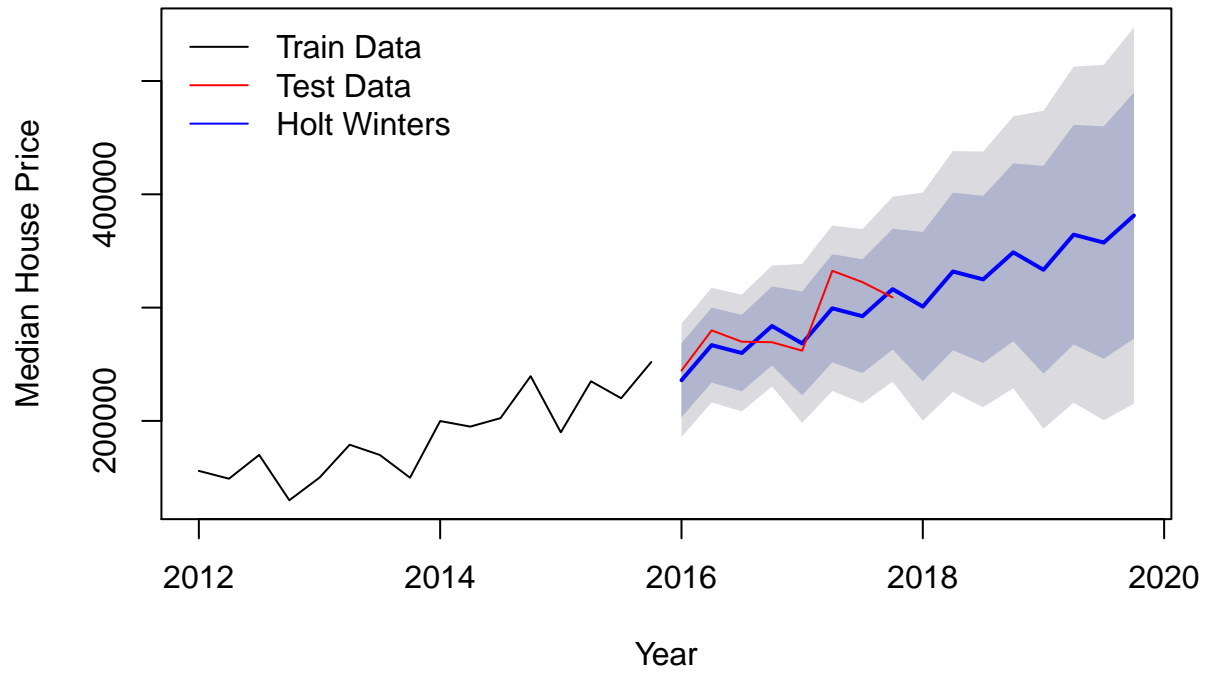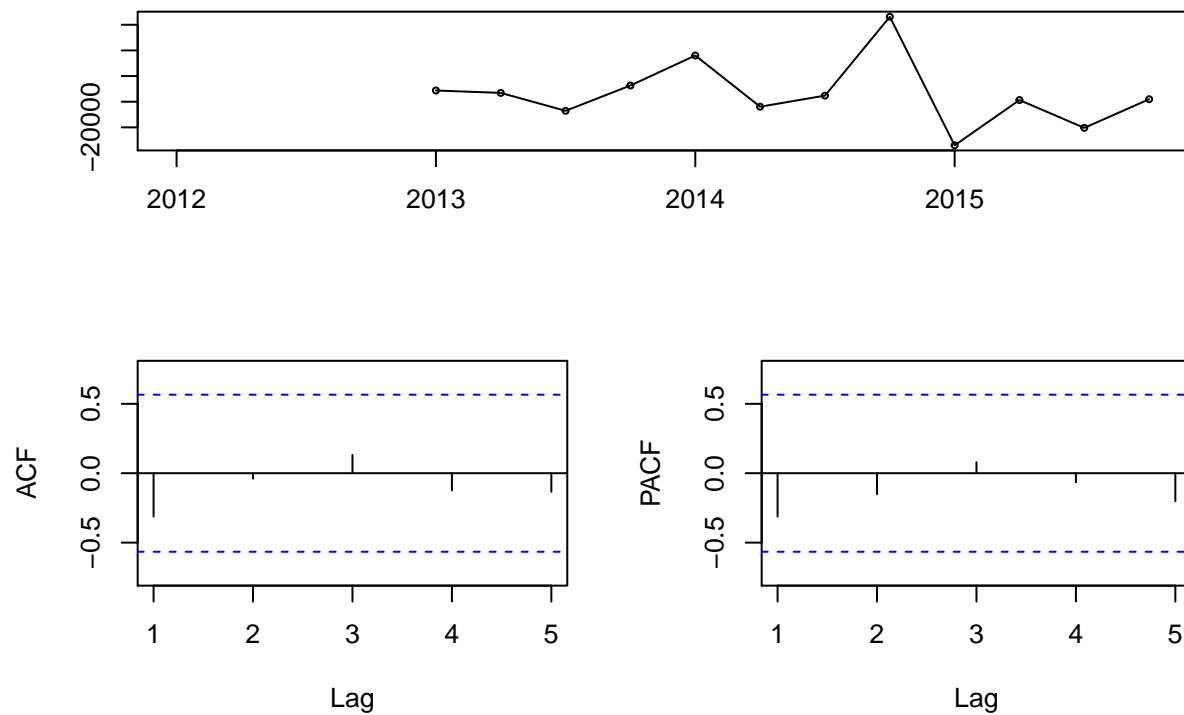
Portland, OR – Sumner : Naive Model Forecast Residuals
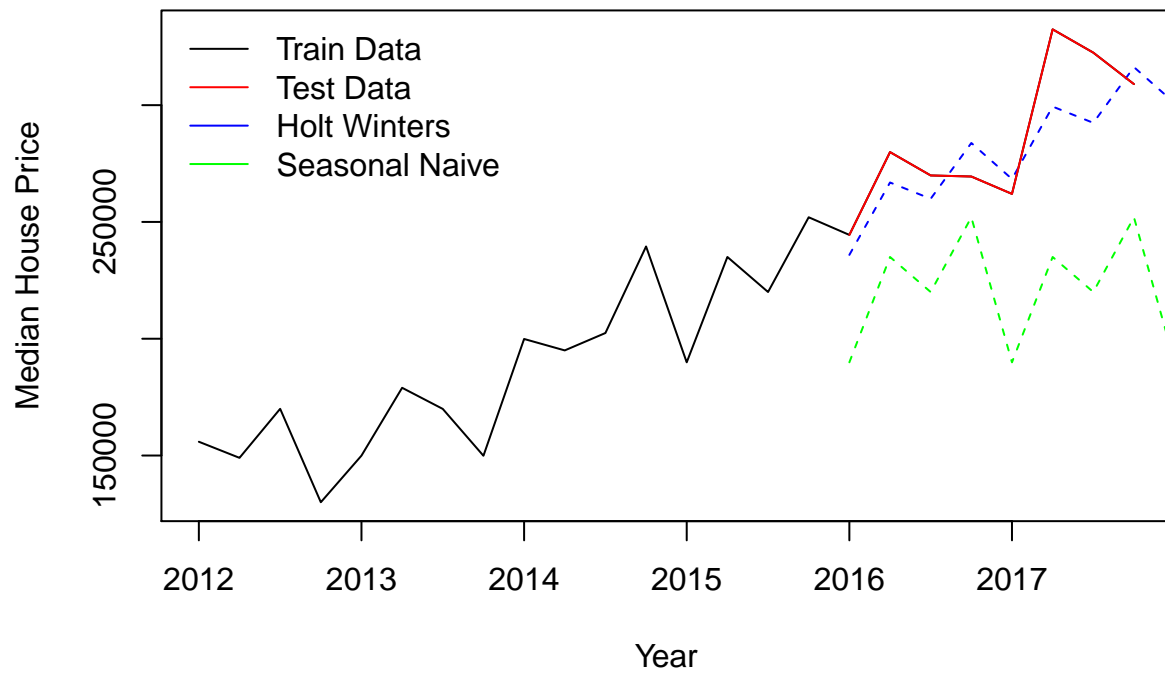
Portland, OR – Sumner : Holt Winters Model Forecast

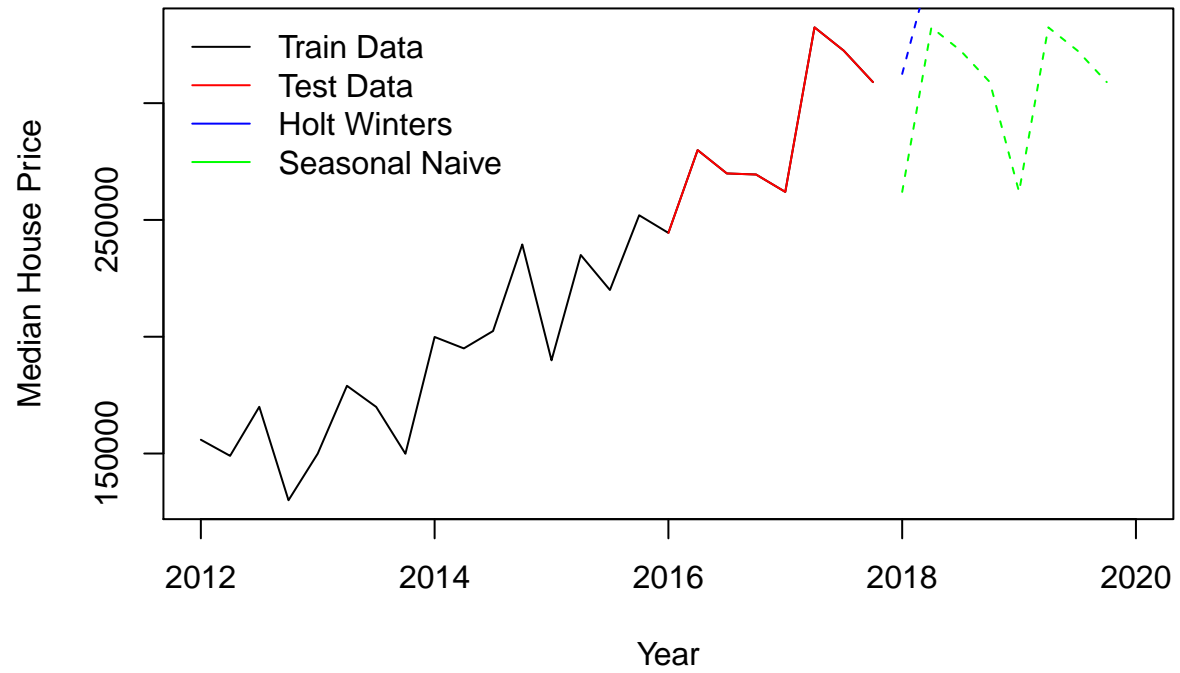**Portland, OR – Sumner : Holt Winters Model Forecast Residuals**


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Sumner"
##                   ME     RMSE      MAE      MPE     MAPE     MASE
## Training set 24333.33 35743.39 27000.00 11.44901 12.99290 1.000000
## Test set     61978.12 67297.16 61978.12 21.29717 21.29717 2.295486
##                   ACF1 Theil's U
## Training set -0.3487192        NA
## Test set      0.3661510  2.034903
## [1] "Holt Winters Accuracy for  Portland, OR - Sumner"
##                   ME     RMSE      MAE      MPE     MAPE      MASE
## Training set 6090.531 25207.02 16979.33 2.840700 8.393886 0.6288641
## Test set     8332.119 18160.36 15335.83 2.624475 5.154042 0.5679938
##                    ACF1 Theil's U
## Training set -0.31242619        NA
## Test set      0.06675253 0.5722341
```
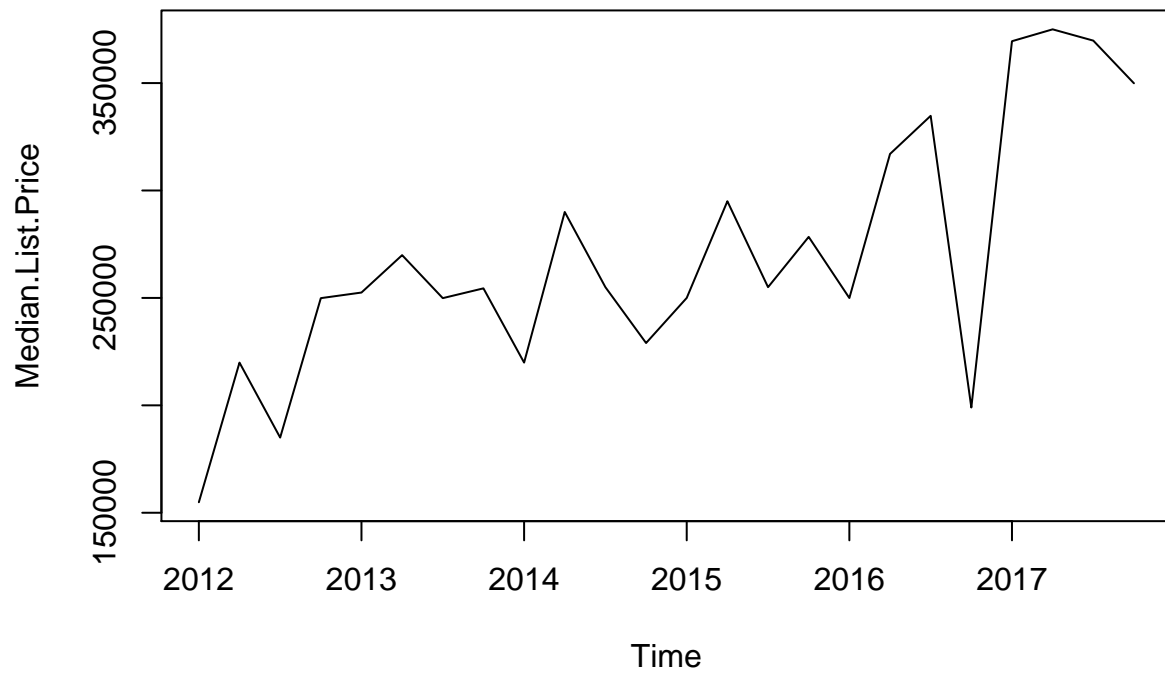
Portland, OR – Sumner : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
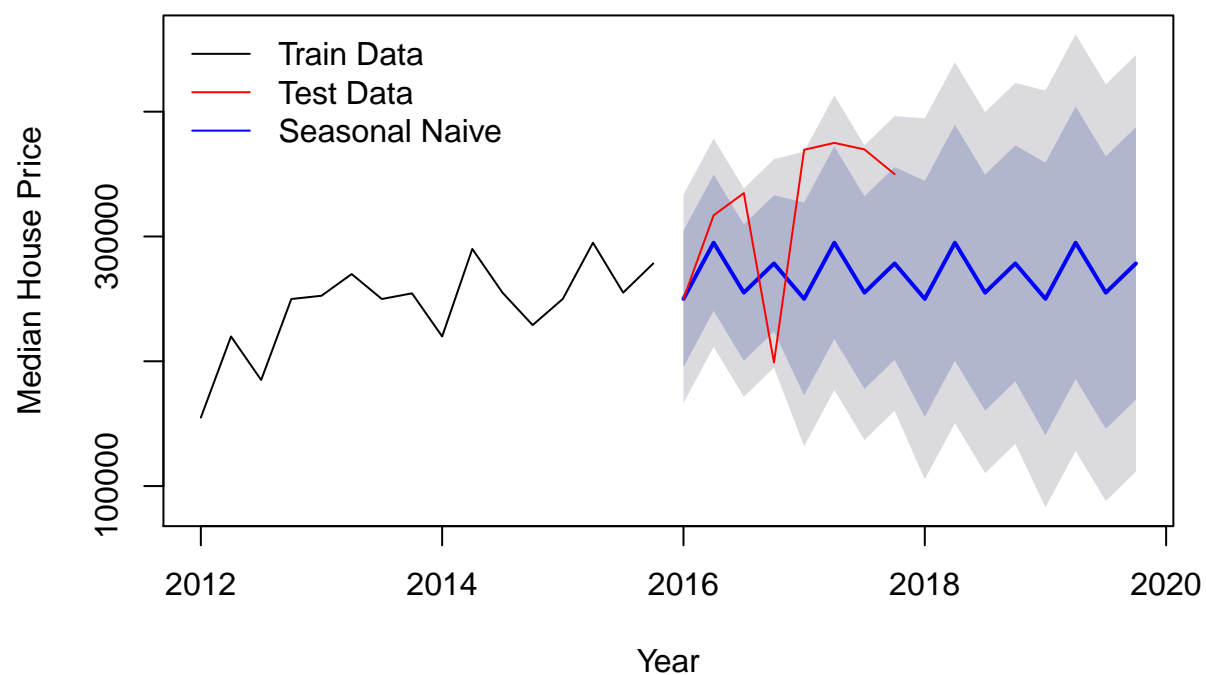- Seasonal Naive

Y-axis: Median House Price
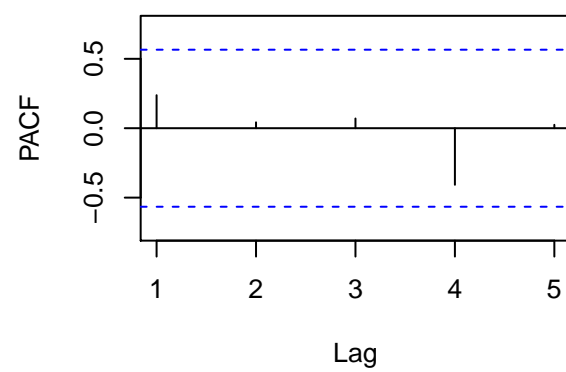X-axis: Year
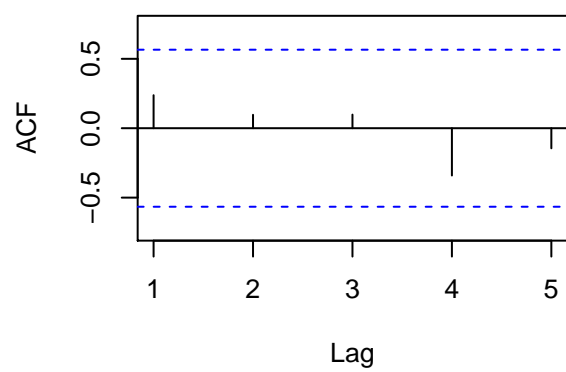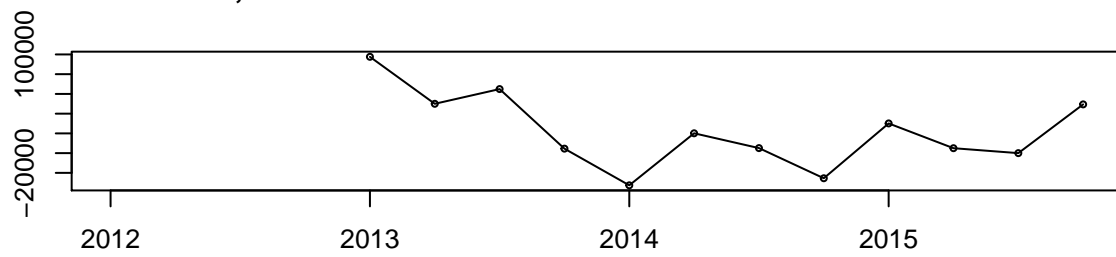
Portland, OR – Sumner : Full TS Models Comparison

Portland, OR – Cathedral Park
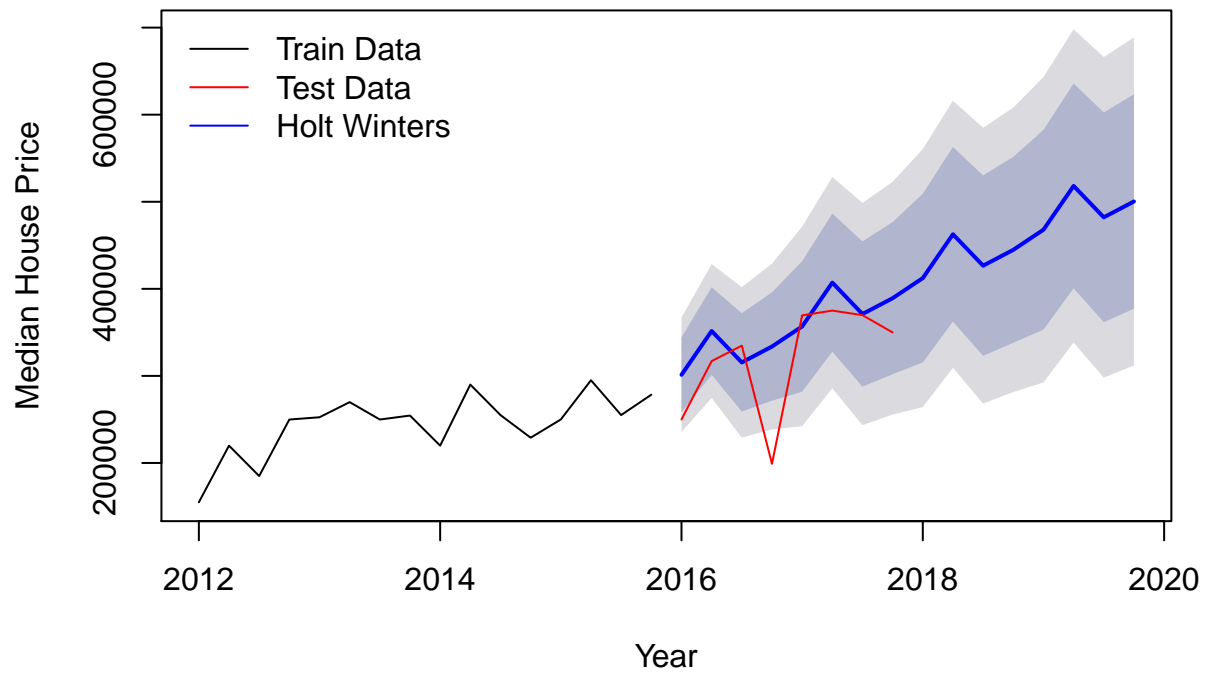
Portland, OR – Cathedral Park : Naive Model Forecast

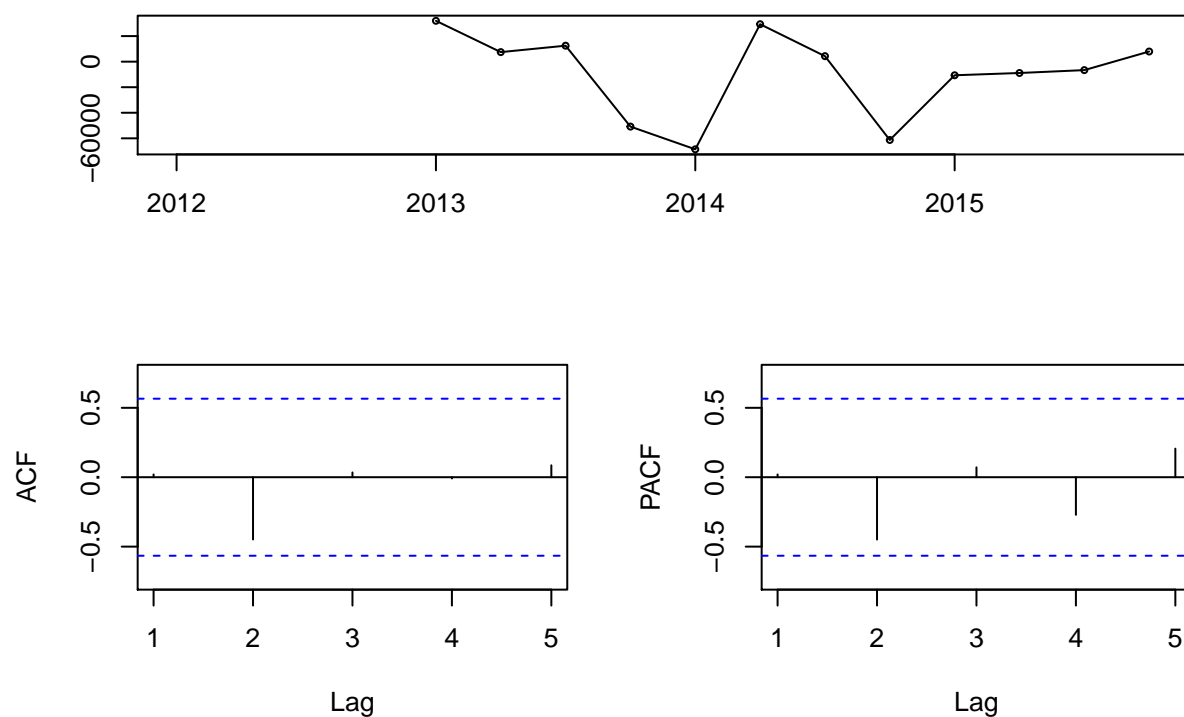**Portland, OR – Cathedral Park : Naive Model Forecast Residuals**

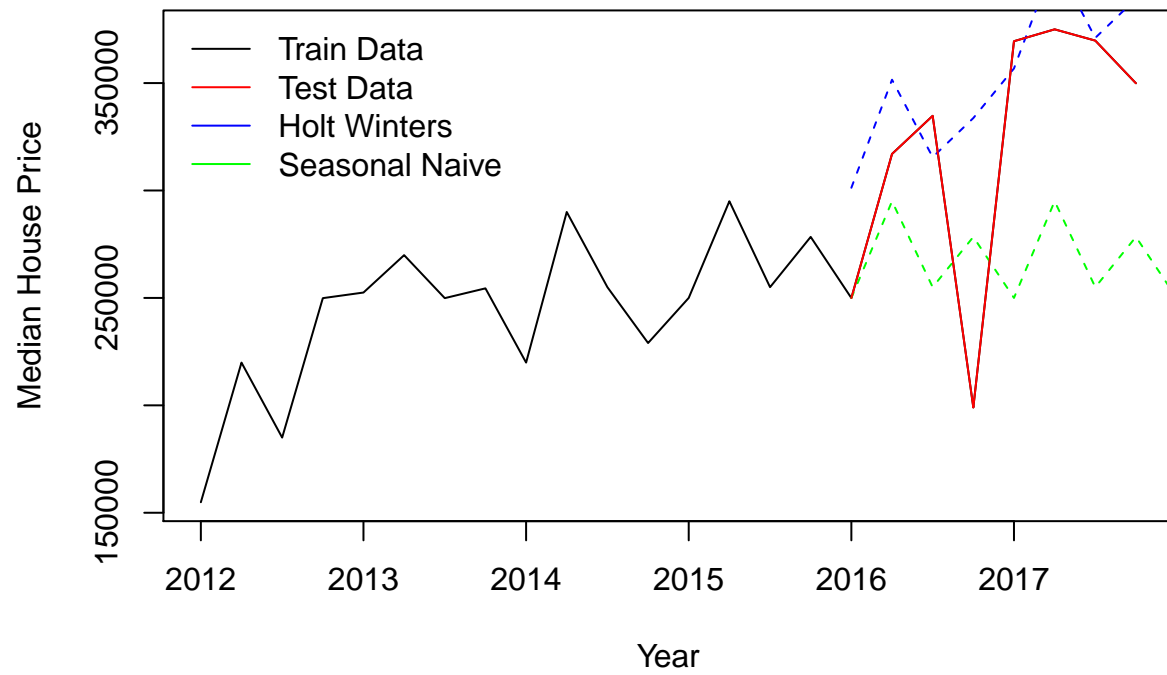## Portland, OR – Cathedral Park : Holt Winters Model Forecast

Portland, OR – Cathedral Park : Holt Winters Model Forecast Residuals
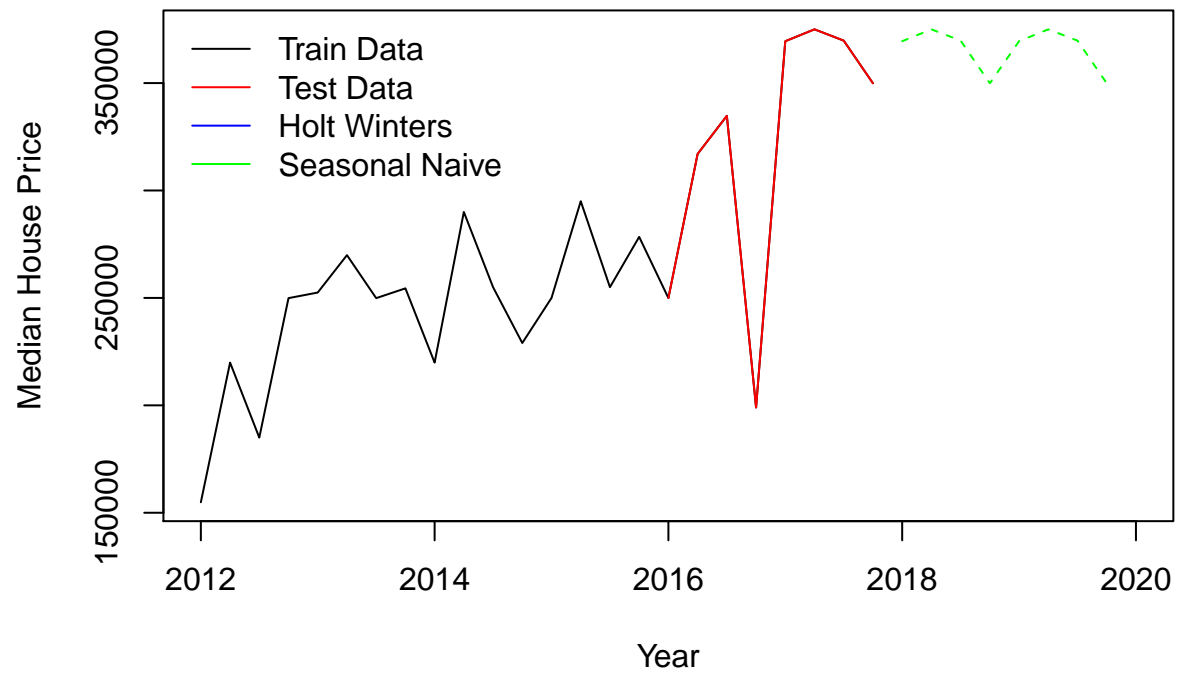


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Cathedral Park"
##                    ME      RMSE      MAE       MPE     MAPE     MASE
## Training set 22391.67 42593.35 32066.67  8.284096 12.60717 1.000000
## Test set     51003.12 80702.01 70865.62 11.997870 21.97775 2.209947
##                   ACF1 Theil's U
## Training set  0.2378759        NA
## Test set     -0.2201887 0.8255507
## [1] "Holt Winters Accuracy for  Portland, OR - Cathedral Park"
##                    ME      RMSE      MAE       MPE     MAPE      MASE
## Training set  -9453.806 33490.07 25029.97  -4.39613 10.24000 0.7805604
## Test set     -32679.557 56000.30 40658.60 -13.76389 16.05852 1.2679396
##                    ACF1 Theil's U
## Training set  0.02027662        NA
## Test set     -0.61372803  0.461156
```
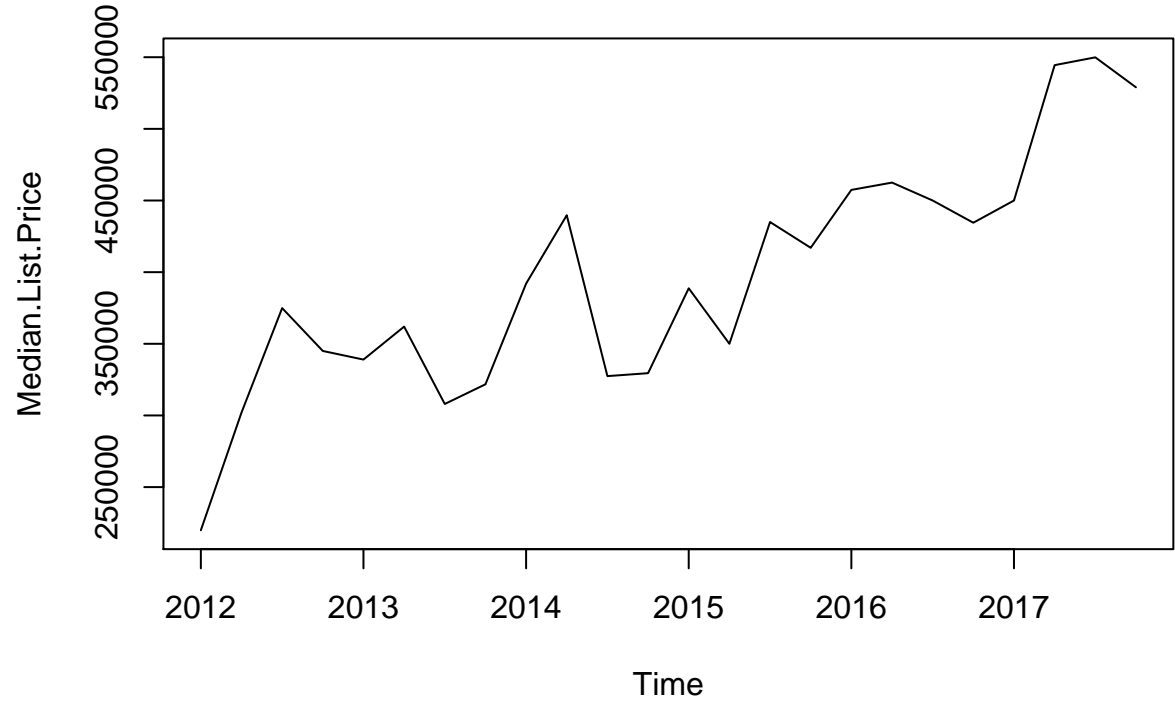
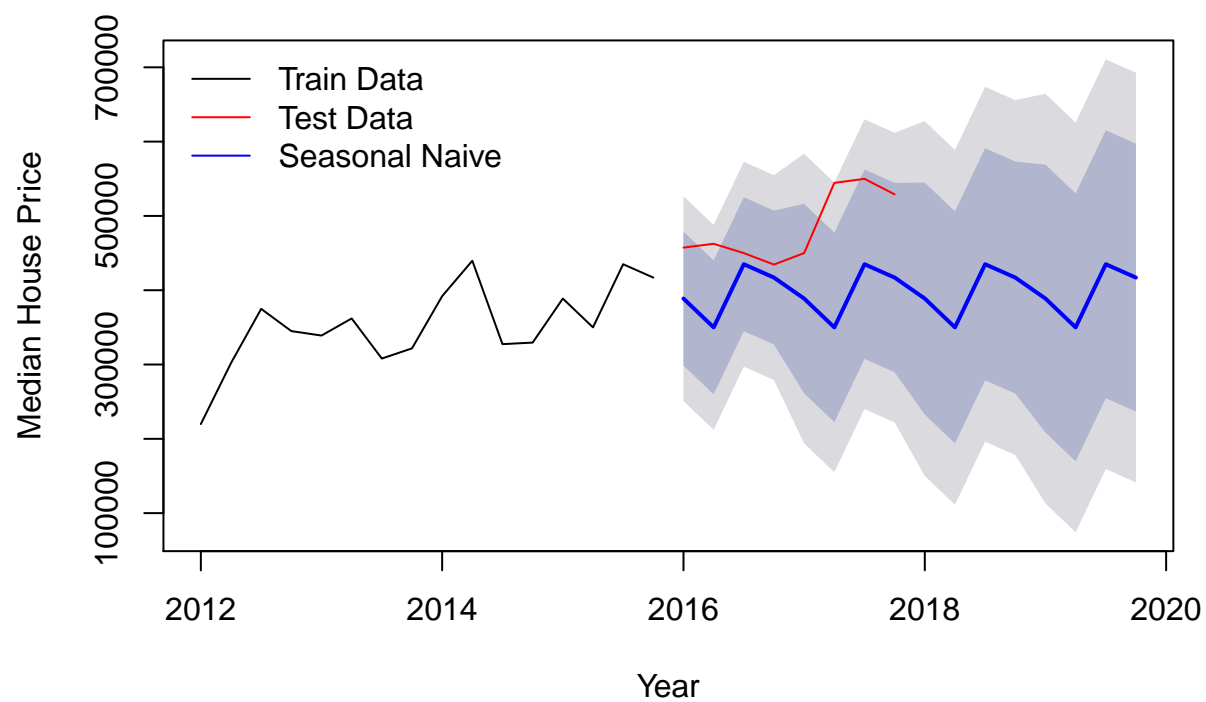# Portland, OR – Cathedral Park : TS Training Model Comparison

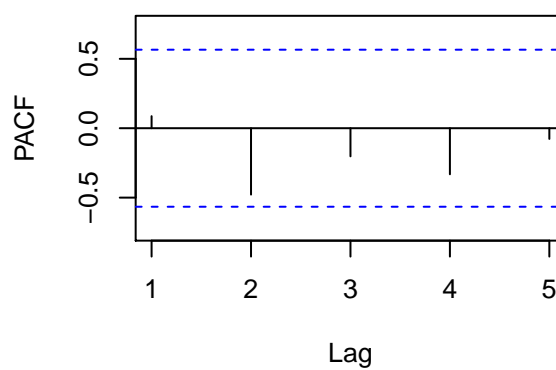# Portland, OR – Cathedral Park : Full TS Models Comparison

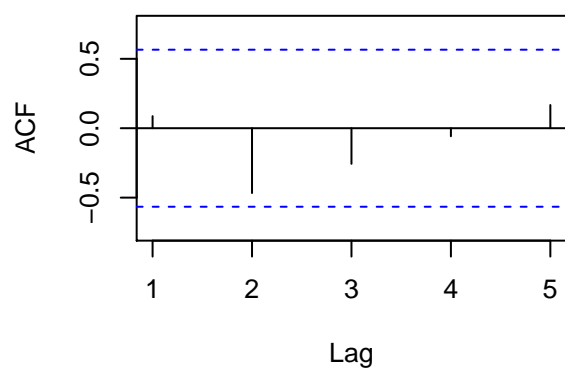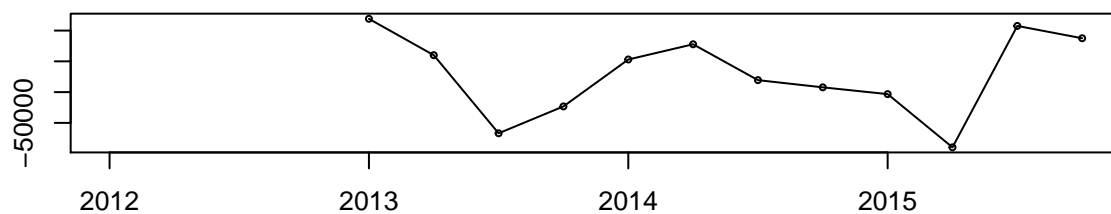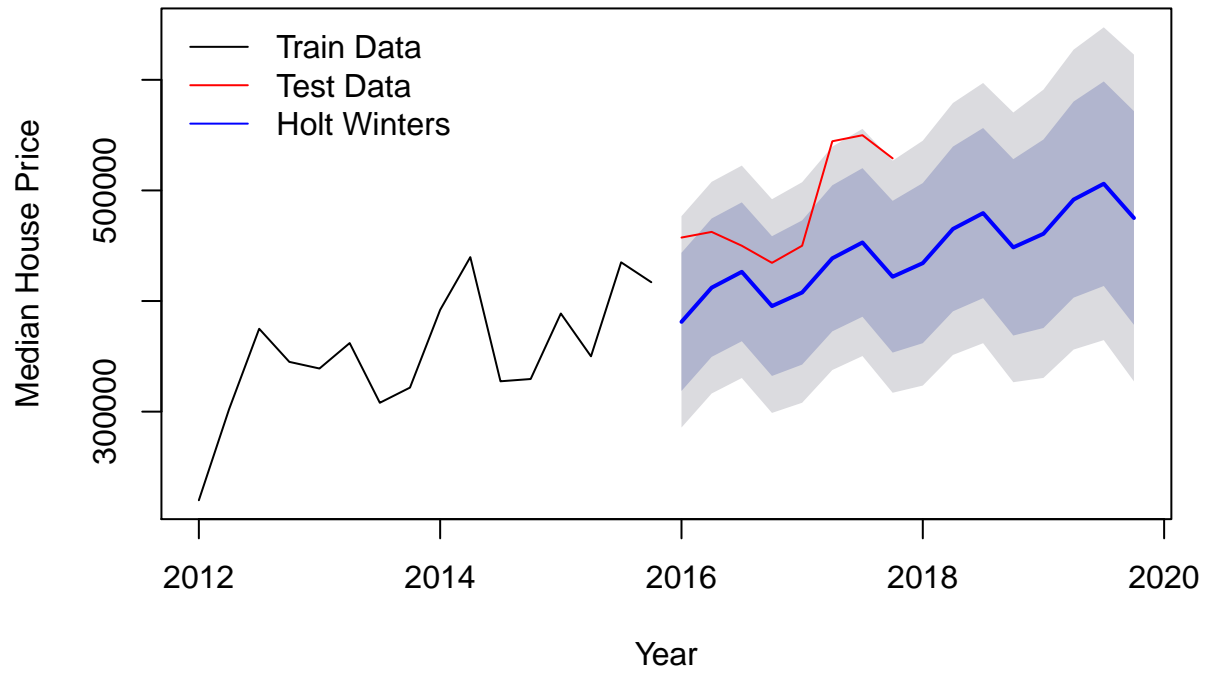# Portland, OR – Collins View

Portland, OR – Collins View : Naive Model Forecast

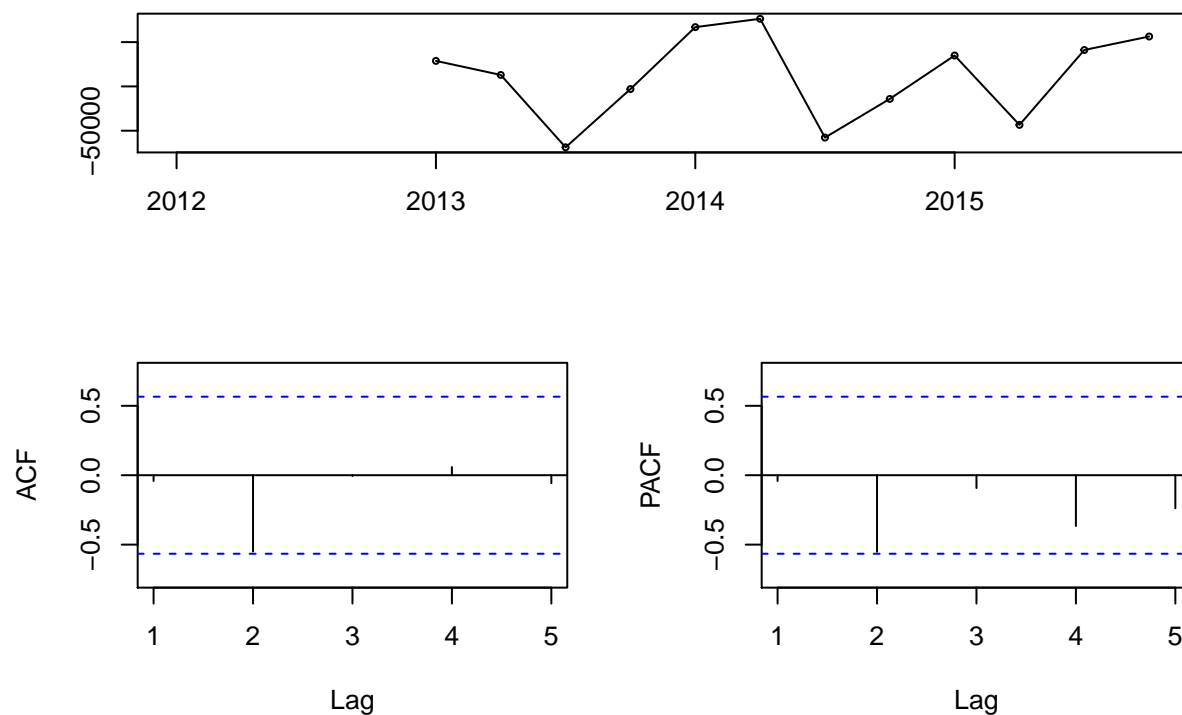**Portland, OR – Collins View : Naive Model Forecast Residuals**

Portland, OR – Collins View : Holt Winters Model Forecast
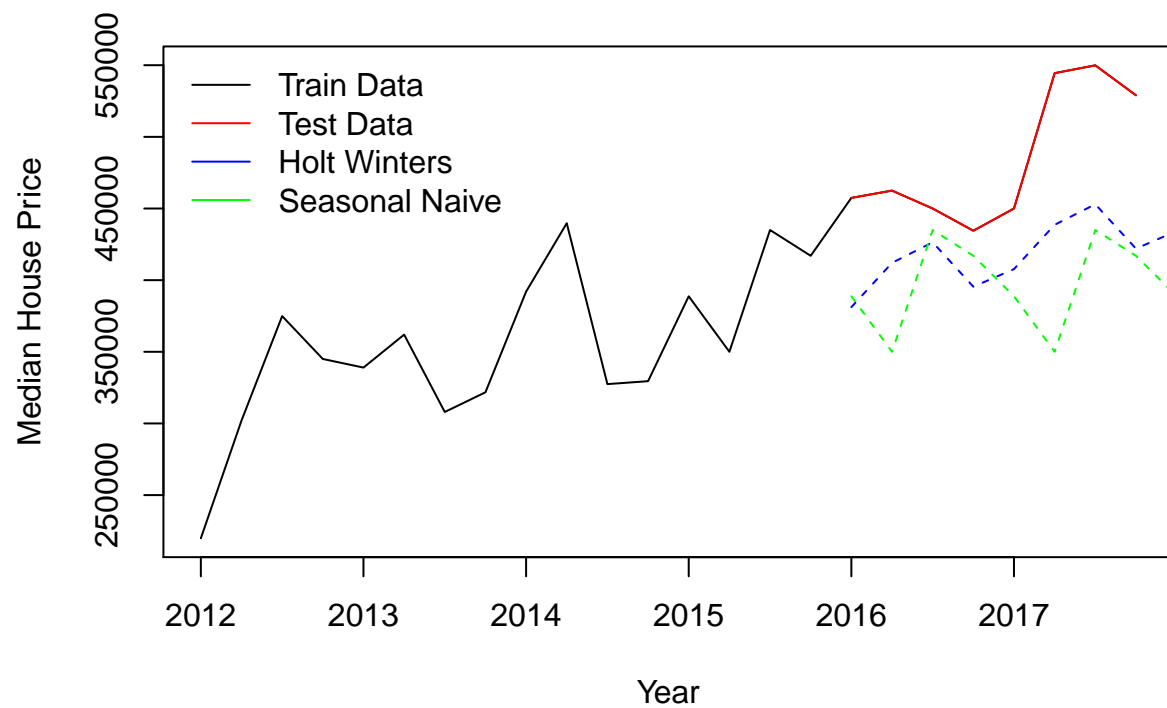
Portland, OR – Collins View : Holt Winters Model Forecast Residuals
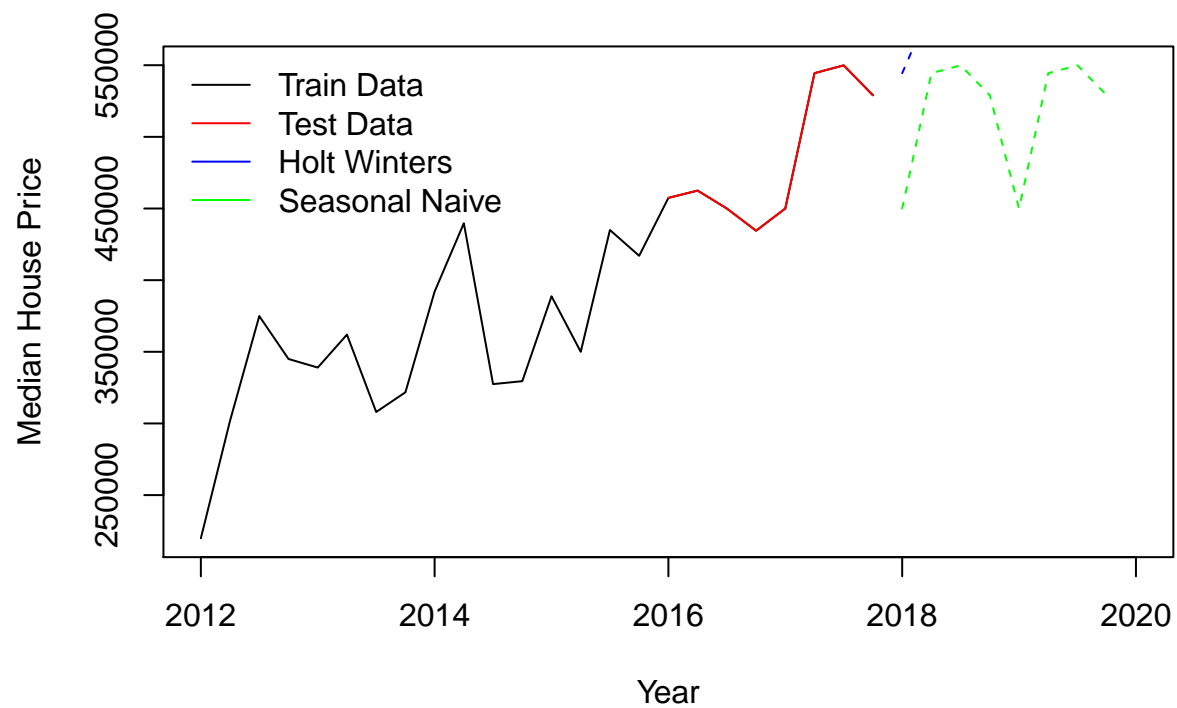


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Collins View"
##                    ME      RMSE      MAE       MPE     MAPE     MASE
## Training set 29077.08  70337.81 59597.92  6.789877 16.02648 1.000000
## Test set     87030.00 103203.92 87030.00 17.260582 17.26058 1.460286
##                   ACF1 Theil's U
## Training set 0.08695527        NA
## Test set     0.22014748  2.696604
## [1] "Holt Winters Accuracy for  Portland, OR - Collins View"
##                    ME      RMSE      MAE       MPE     MAPE      MASE
## Training set 10860.53  47908.90 42033.82  1.738864 11.33564 0.7052901
## Test set     67668.61  74390.27 67668.61 13.560997 13.56100 1.1354191
##                    ACF1 Theil's U
## Training set -0.04158258        NA
## Test set      0.51058667   1.78953
```
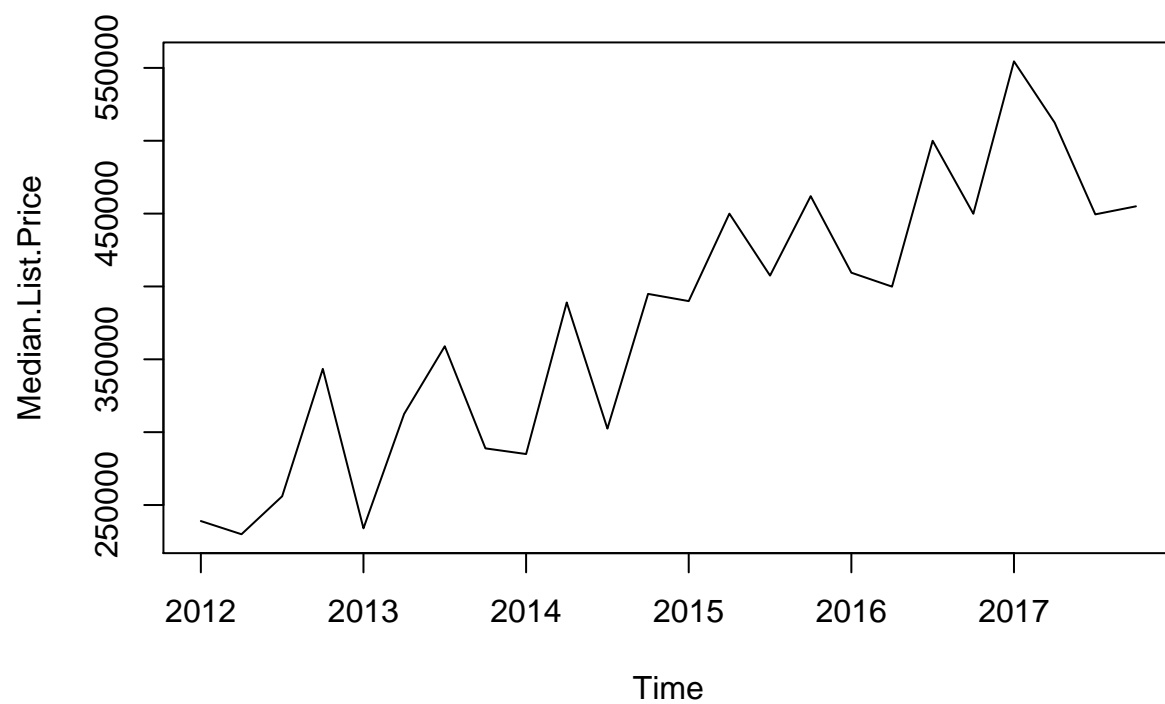
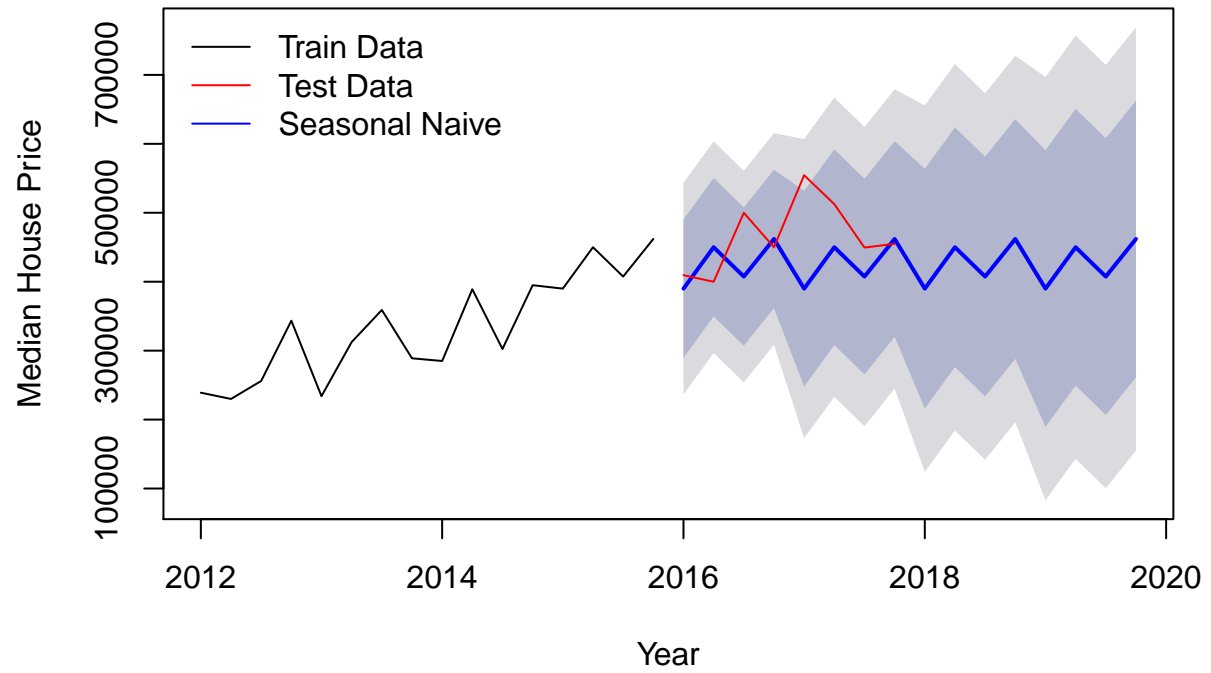**Portland, OR – Collins View : TS Training Model Comparison**
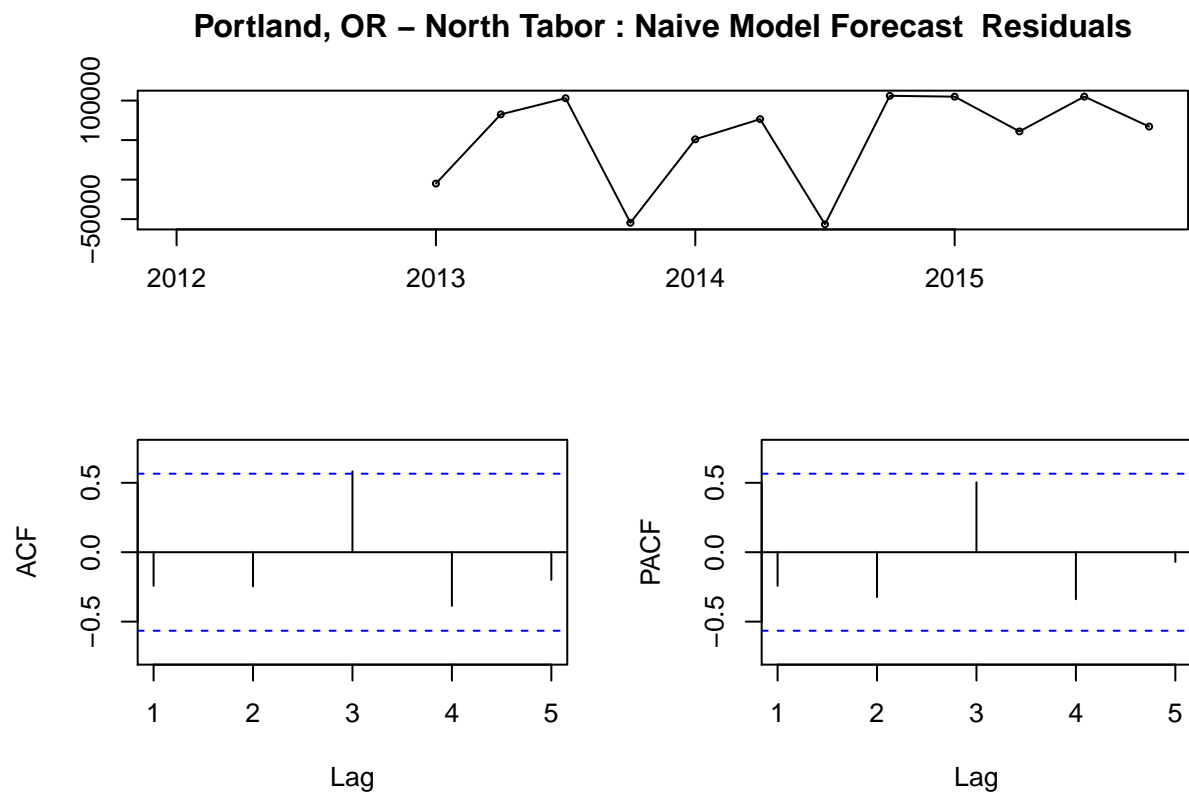
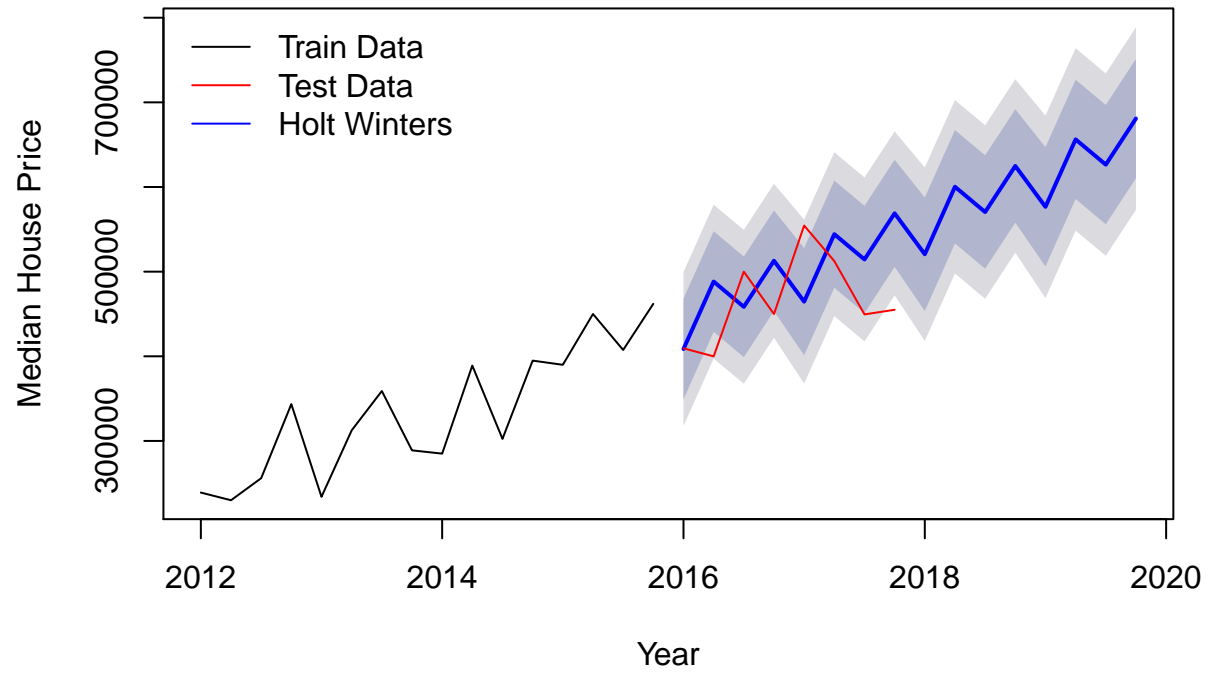# Portland, OR – Collins View : Full TS Models Comparison

Portland, OR – North Tabor

Portland, OR – North Tabor : Naive Model Forecast

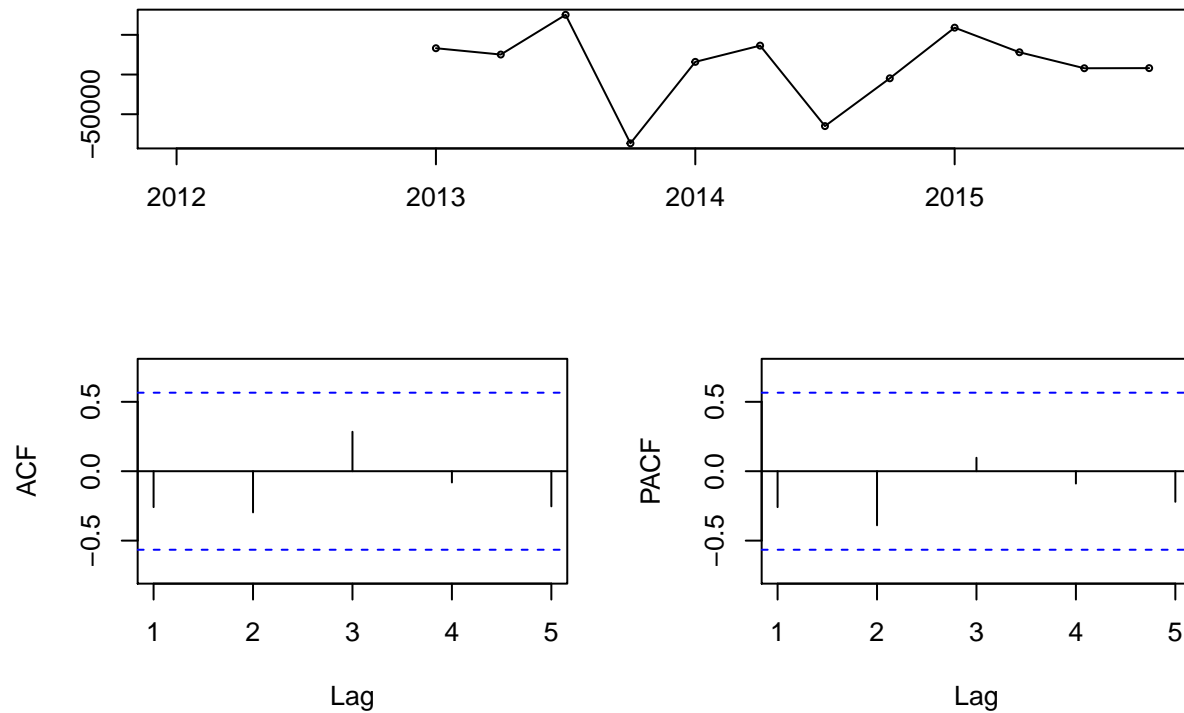**Portland, OR – North Tabor : Naive Model Forecast Residuals**

Portland, OR – North Tabor : Holt Winters Model Forecast
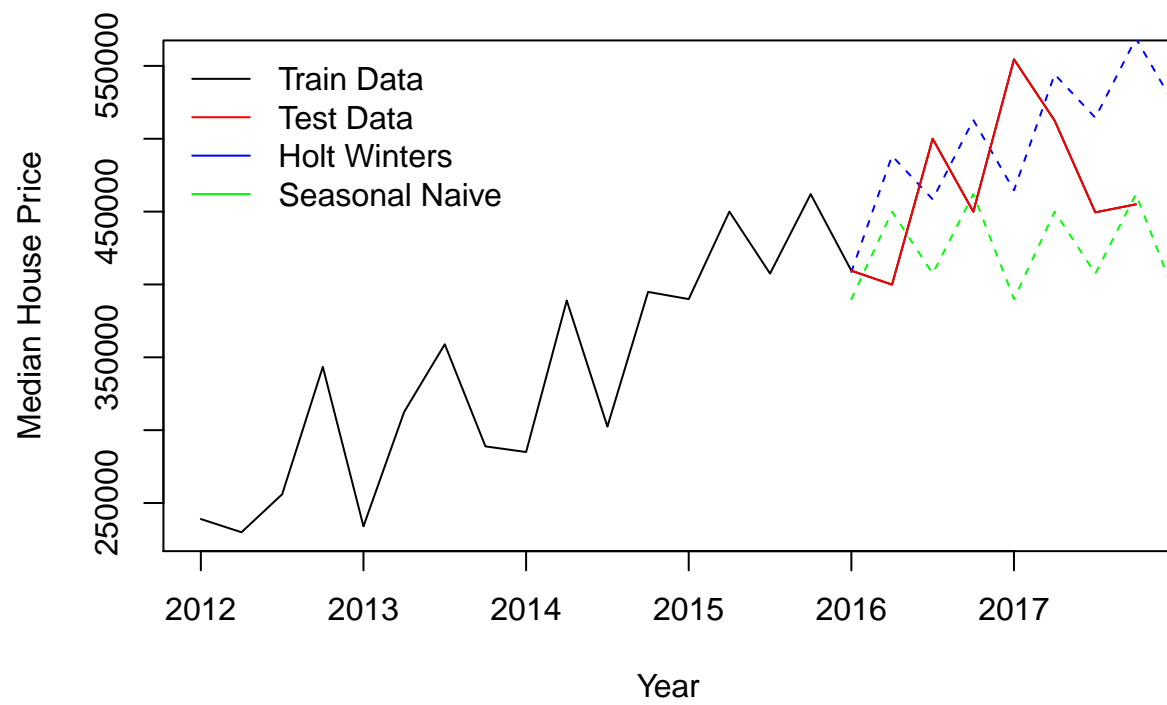
Portland, OR – North Tabor : Holt Winters Model Forecast Residuals
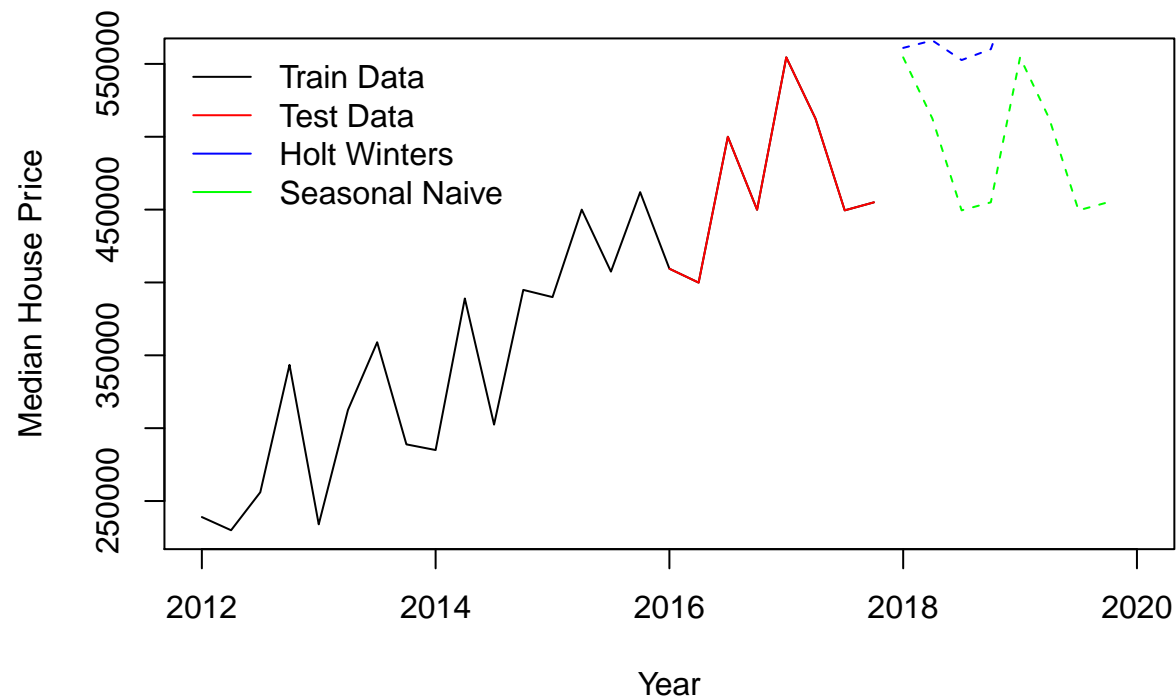


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - North Tabor"
##                    ME      RMSE      MAE       MPE     MAPE      MASE
## Training set 53416.62 78301.88 72766.62 13.379662 19.99934 1.0000000
## Test set     38987.50 74494.99 56287.50  7.216654 11.40567 0.7735346
##                   ACF1 Theil's U
## Training set -0.2422235       NA
## Test set     -0.2887973  1.225086
## [1] "Holt Winters Accuracy for  Portland, OR - North Tabor"
##                    ME      RMSE      MAE       MPE     MAPE      MASE
## Training set  11062.33 45753.25 37116.06  2.546252 11.32352 0.5100699
## Test set     -28706.33 70514.45 61781.84 -7.130384 13.31302 0.8490409
##                   ACF1 Theil's U
## Training set -0.2586917       NA
## Test set     -0.2892384  1.151709
```
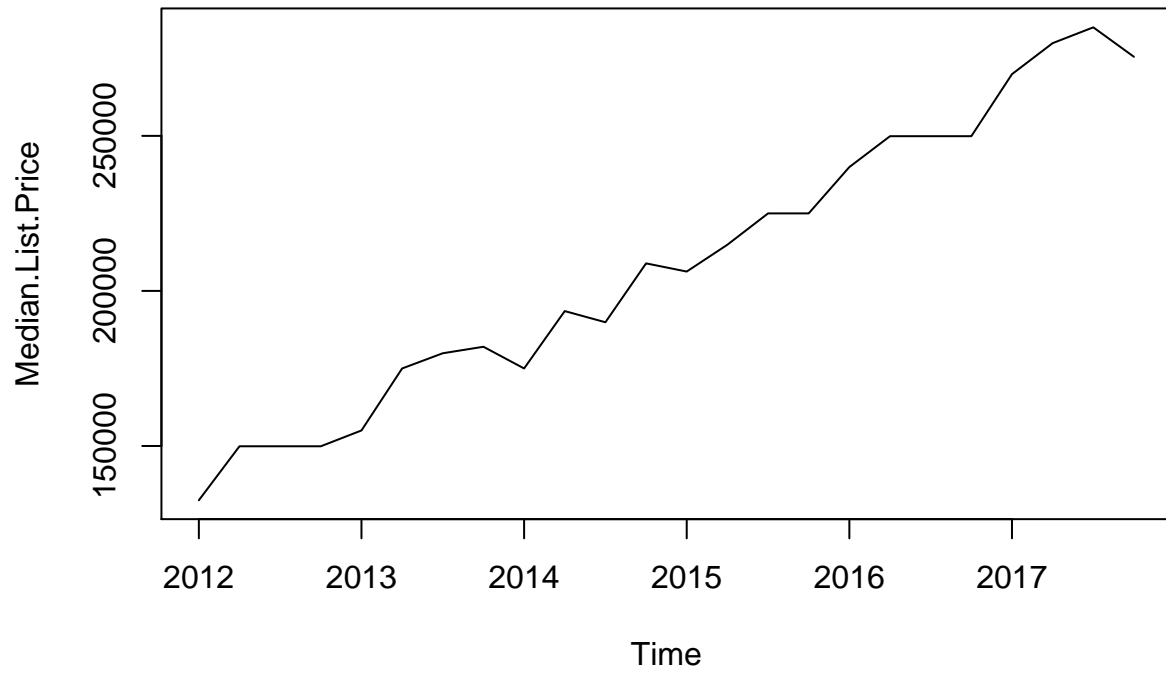
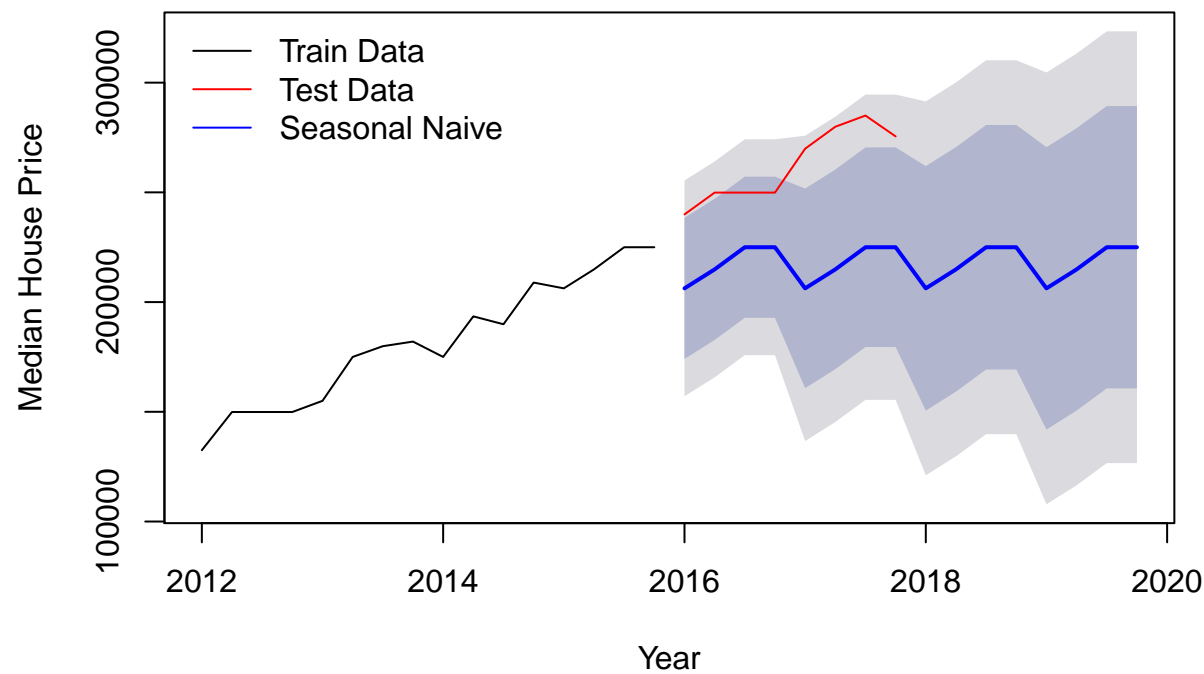**Portland, OR – North Tabor : TS Training Model Comparison**

Portland, OR – North Tabor : Full TS Models Comparison

Median House Price

Year

Legend:
- Train Data
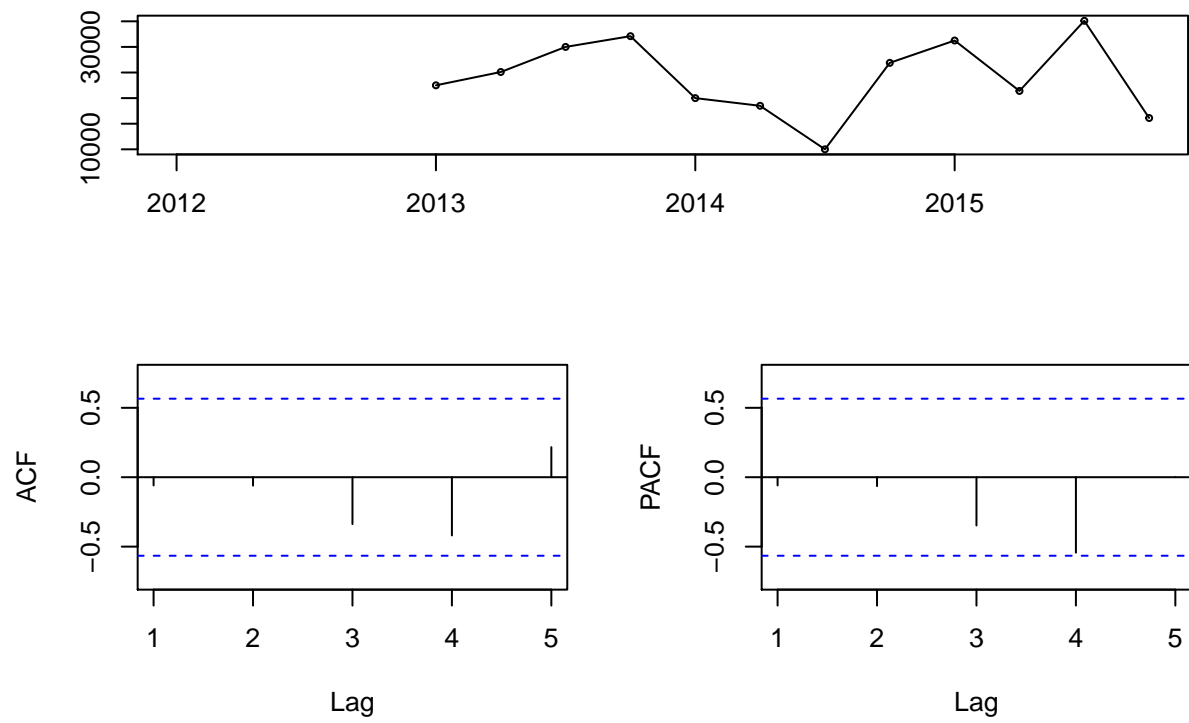- Test Data
- Holt Winters
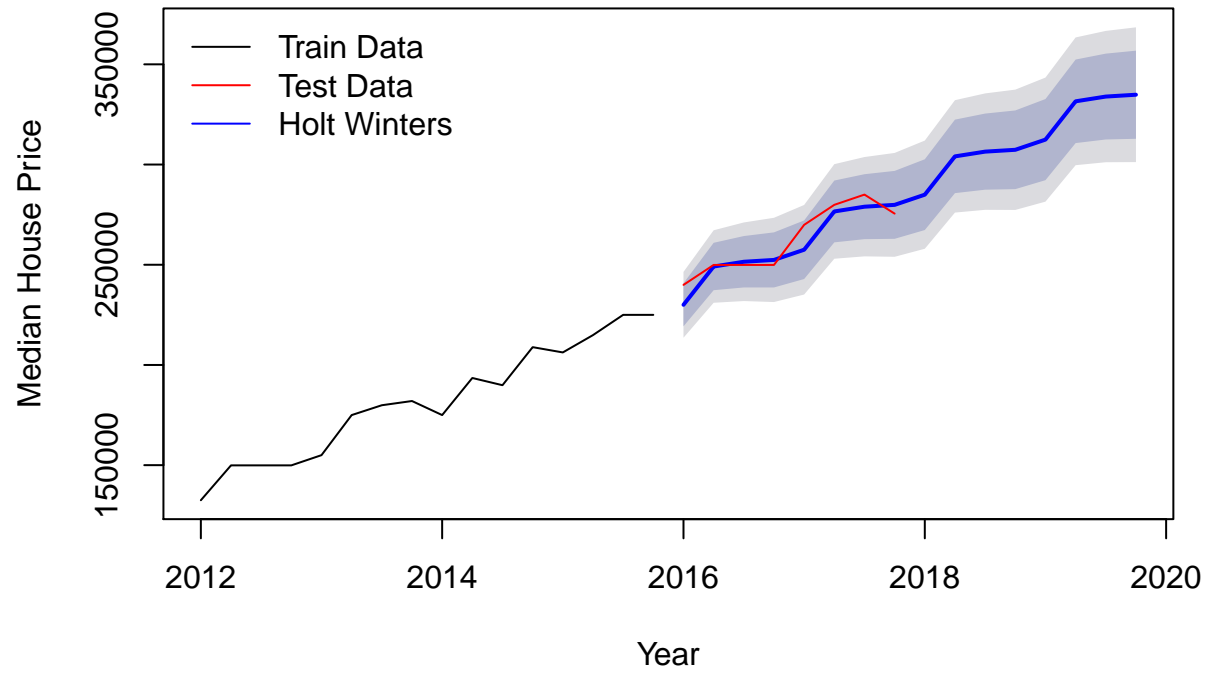- Seasonal Naive

Portland, OR – Centennial
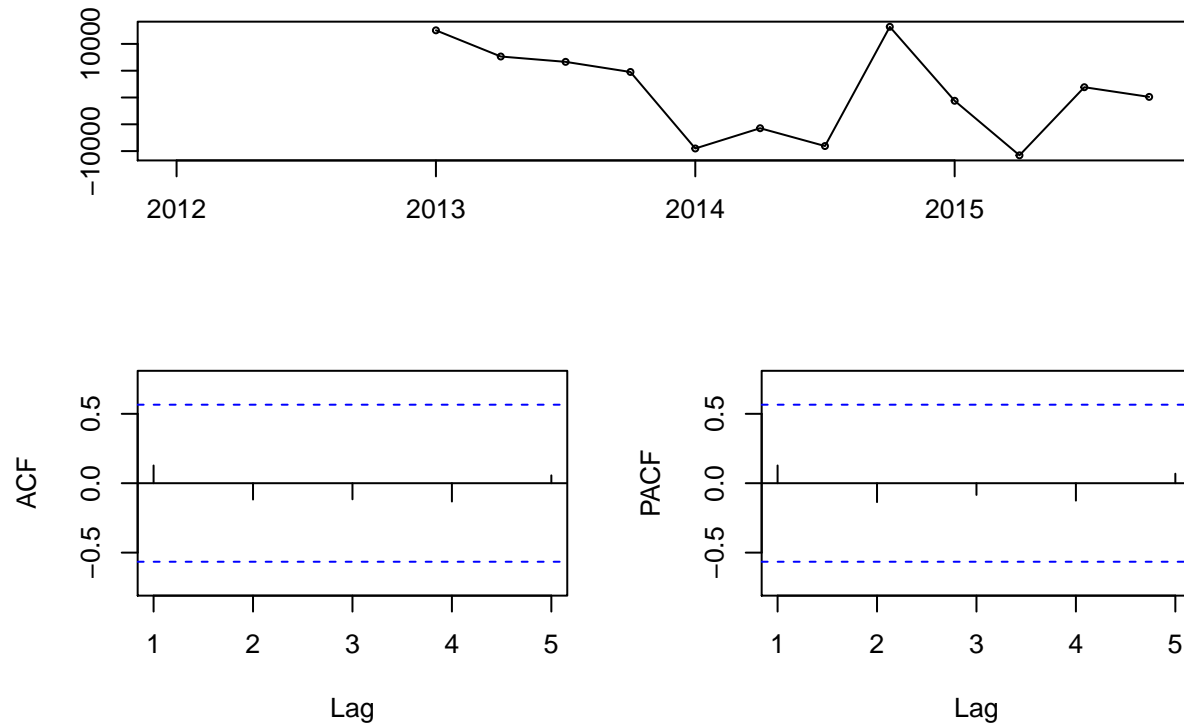
Portland, OR – Centennial : Naive Model Forecast

Portland, OR – Centennial : Naive Model Forecast Residuals

Portland, OR – Centennial : Holt Winters Model Forecast
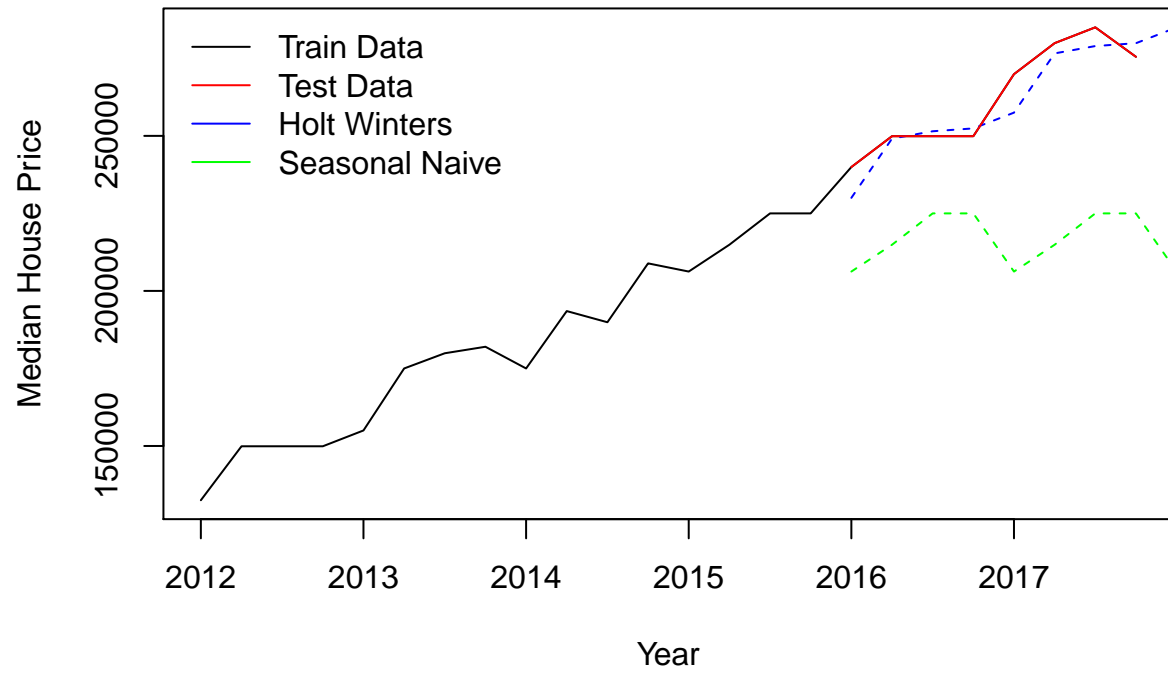
Portland, OR – Centennial : Holt Winters Model Forecast Residuals
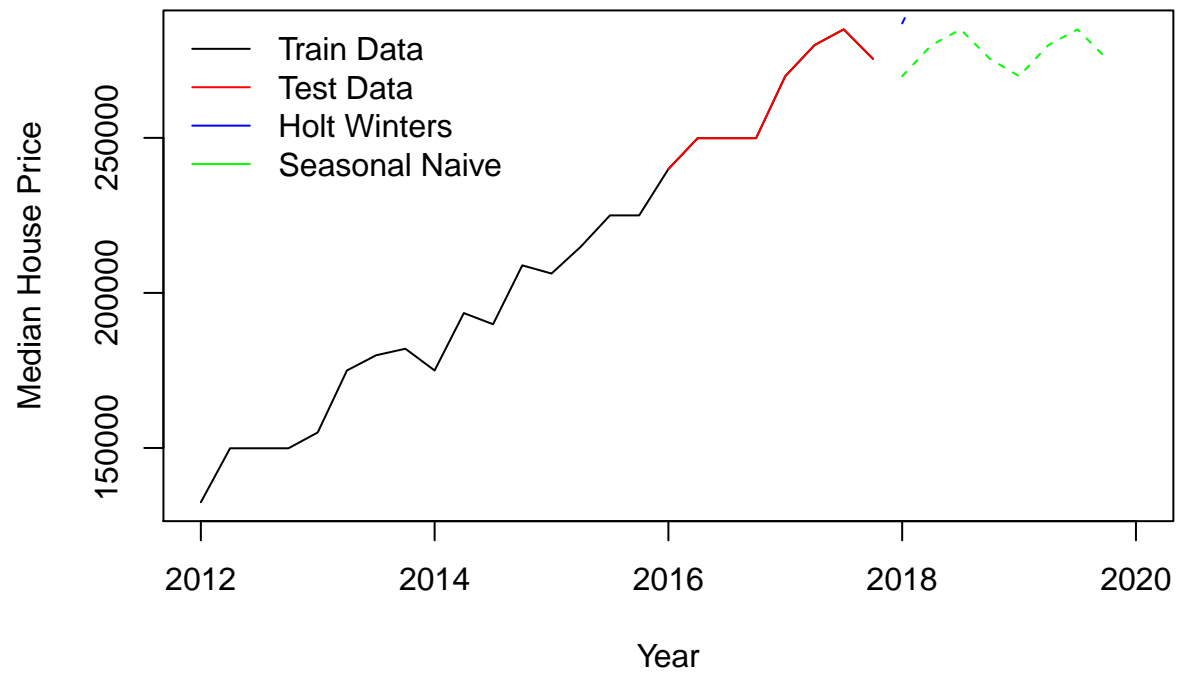


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Centennial"
##                    ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 24079.08 25096.39 24079.08 12.51414 12.51414 1.000000
## Test set     44706.50 47470.32 44706.50 16.77091 16.77091 1.856653
##                    ACF1 Theil's U
## Training set -0.05900897        NA
## Test set      0.53951058  4.696885
## [1] "Holt Winters Accuracy for  Portland, OR - Centennial"
##                   ME     RMSE      MAE       MPE     MAPE      MASE
## Training set  926.3939 8074.240 6877.031 0.6253252 3.706229 0.2856019
## Test set     2993.8519 6408.189 5117.213 1.1381791 1.947079 0.2125169
##                   ACF1 Theil's U
## Training set  0.1277728        NA
## Test set     -0.1962100 0.5629876
```
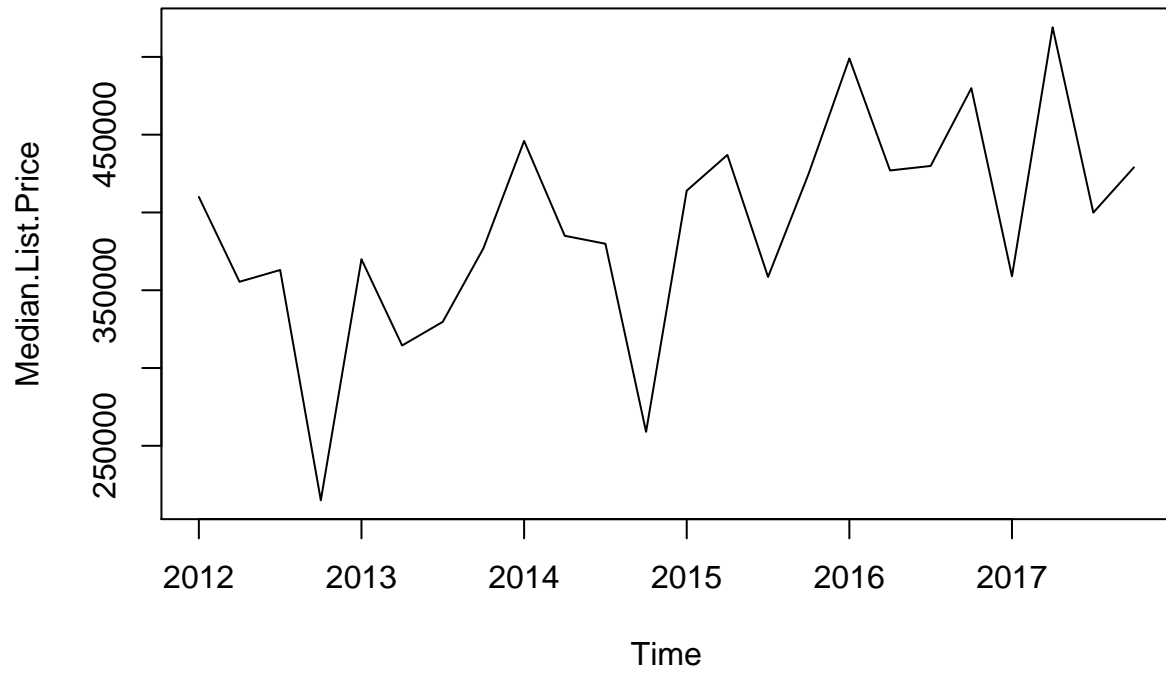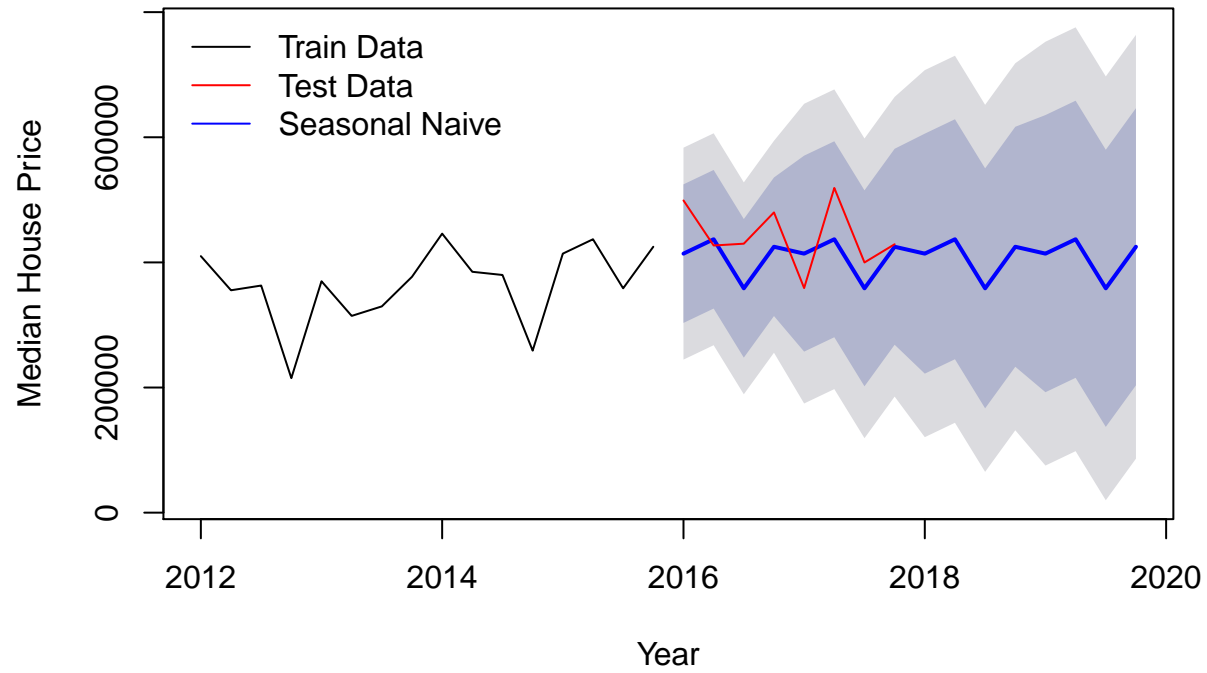
Portland, OR – Centennial : TS Training Model Comparison

Portland, OR – Centennial : Full TS Models Comparison
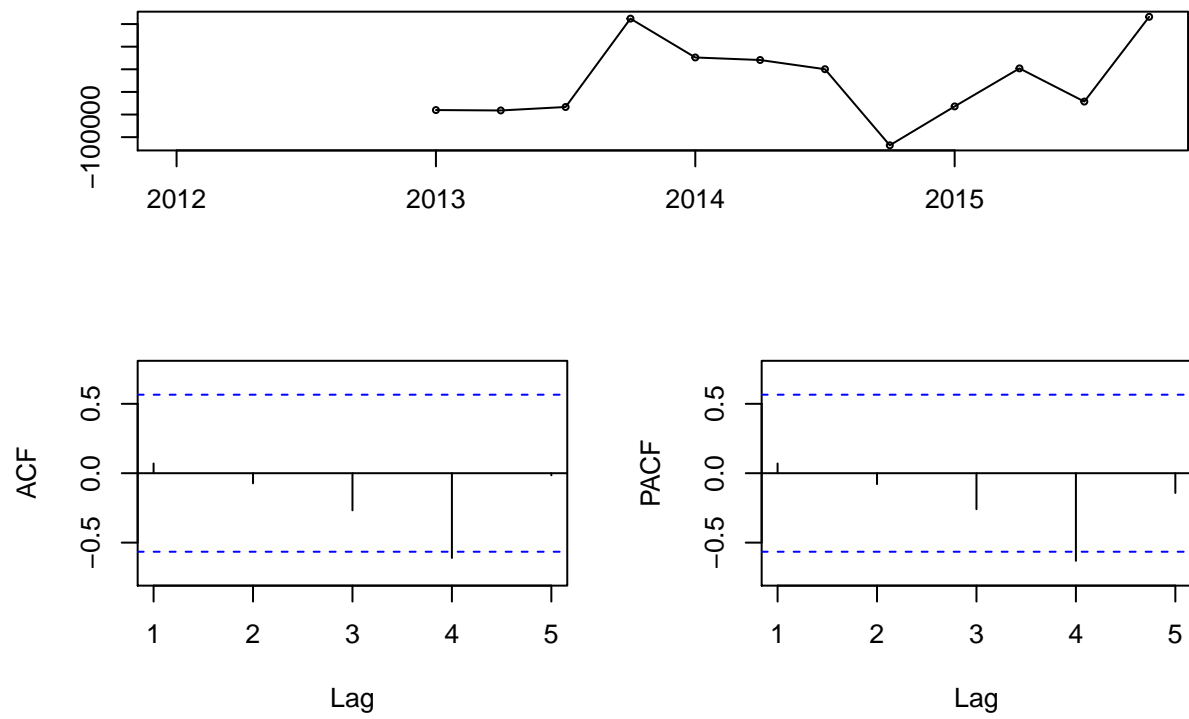
Portland, OR – Far Southwest
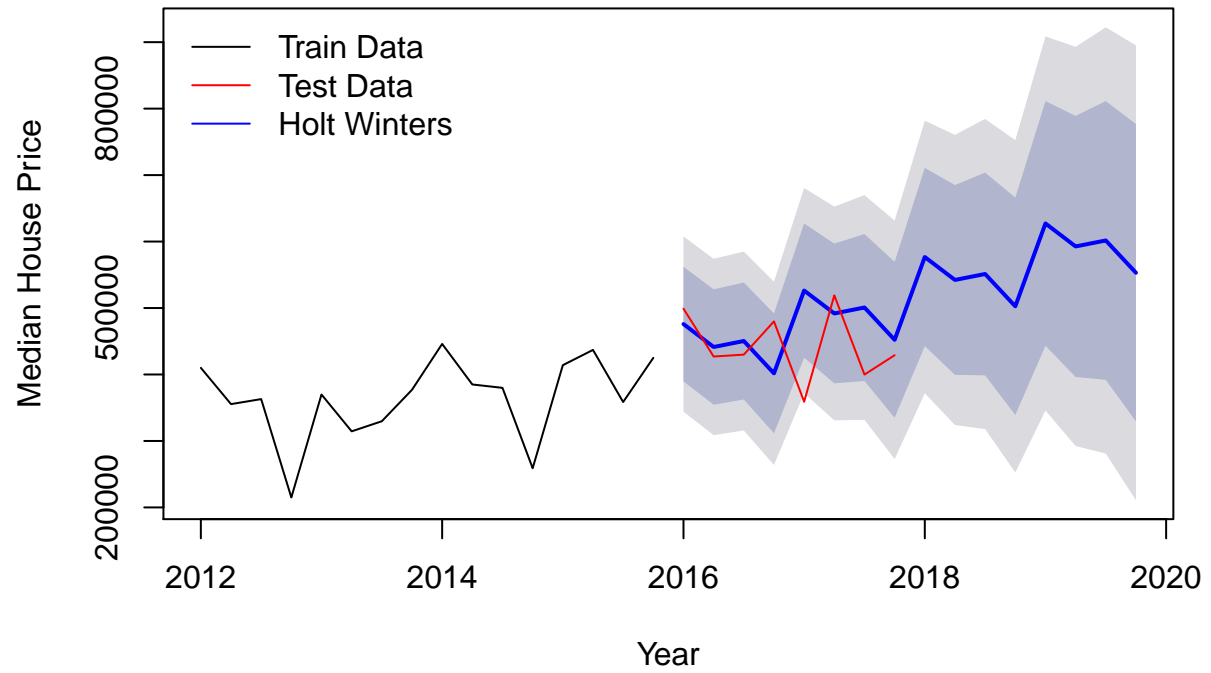
Portland, OR – Far Southwest : Naive Model Forecast


```
## Warning in HoltWinters(trainingData): optimization difficulties: ERROR:
## ABNORMAL_TERMINATION_IN_LNSRCH
```
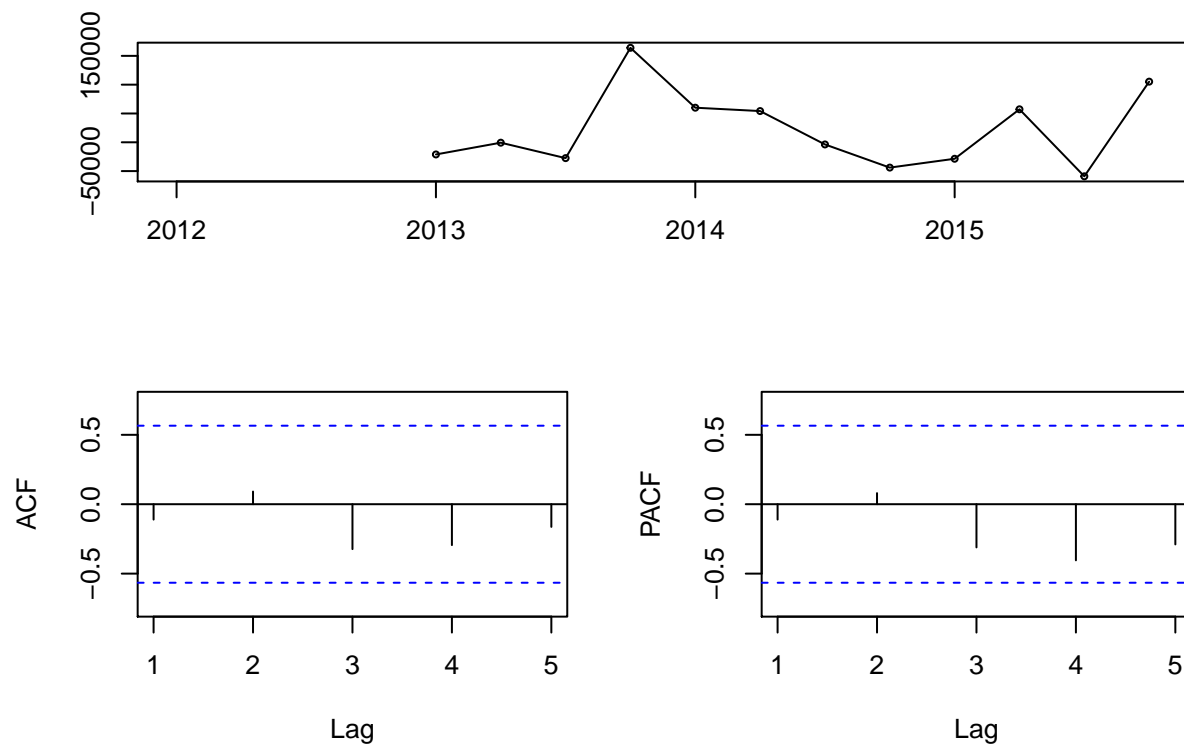
Portland, OR – Far Southwest : Naive Model Forecast Residuals

Portland, OR – Far Southwest : Holt Winters Model Forecast
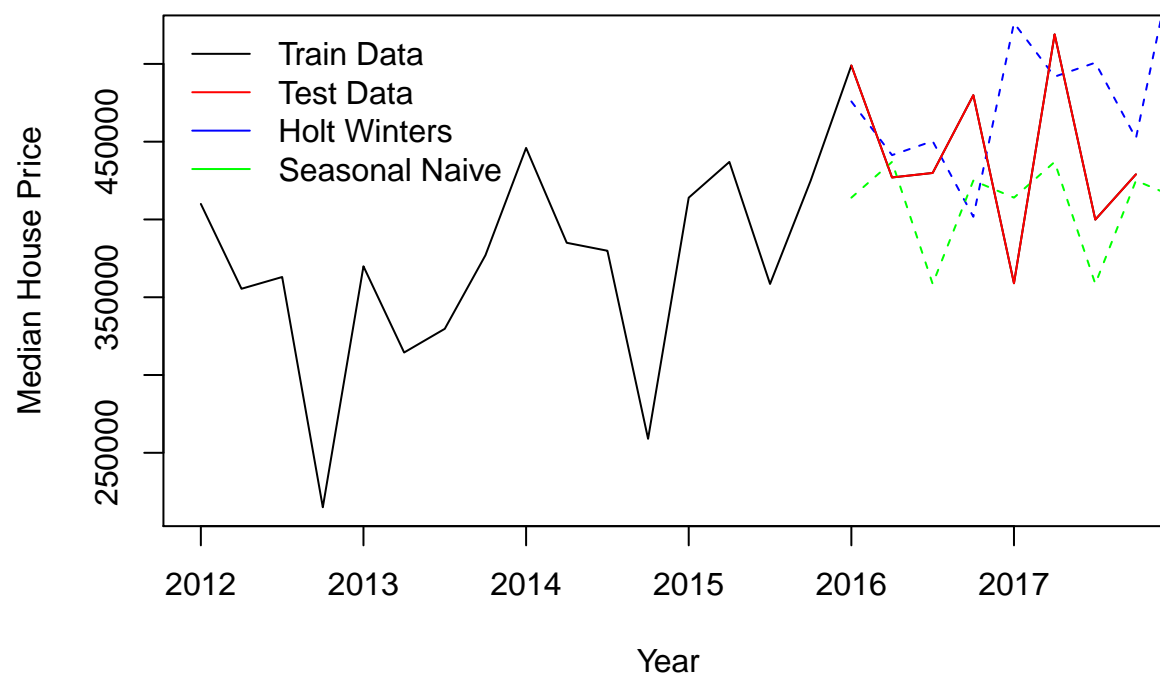
Portland, OR – Far Southwest : Holt Winters Model Forecast Residuals
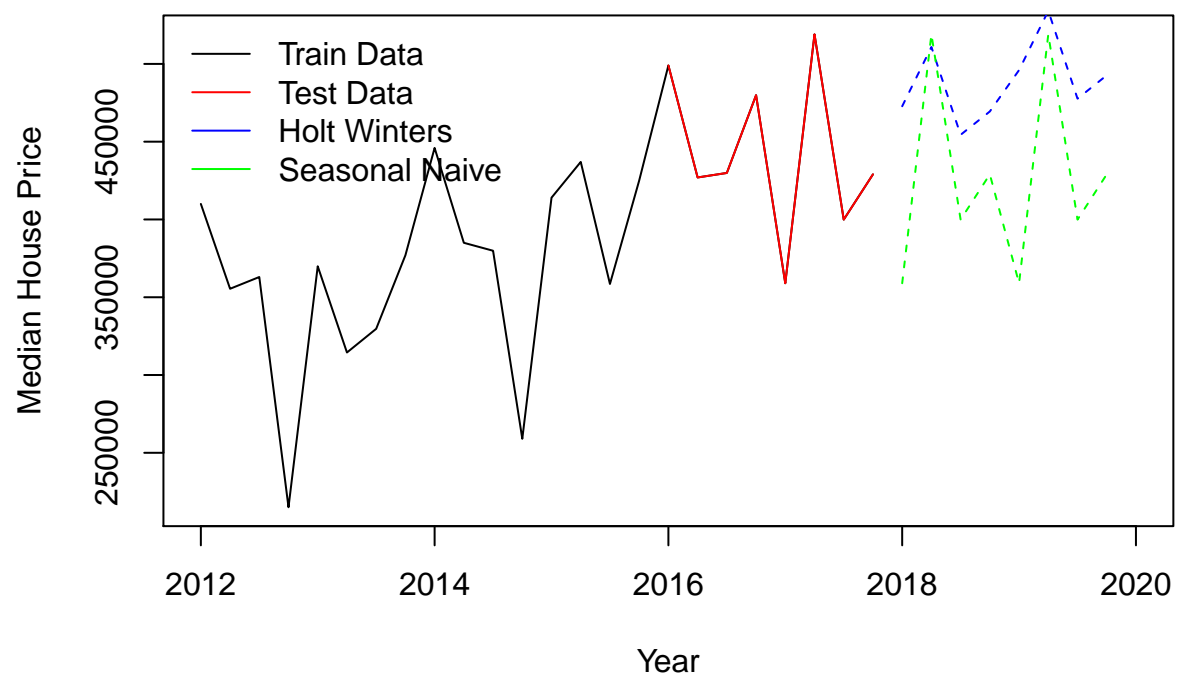


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Far Southwest"
##                    ME      RMSE      MAE      MPE     MAPE      MASE
## Training set 24258.33 86404.43 71879.17 4.109130 19.64486 1.0000000
## Test set     34200.00 57992.08 50450.00 6.810085 11.22565 0.7018724
##                   ACF1 Theil's U
## Training set  0.07011793        NA
## Test set     -0.51874779 0.5730243
## [1] "Holt Winters Accuracy for  Portland, OR - Far Southwest"
##                    ME      RMSE      MAE      MPE     MAPE      MASE
## Training set  21341.88 67844.49 52110.73  4.442712 13.70728 0.7249769
## Test set     -24712.74 76419.08 56834.96 -7.399271 13.93995 0.7907014
##                  ACF1 Theil's U
## Training set -0.1107914        NA
## Test set     -0.6015799 0.7597984
```

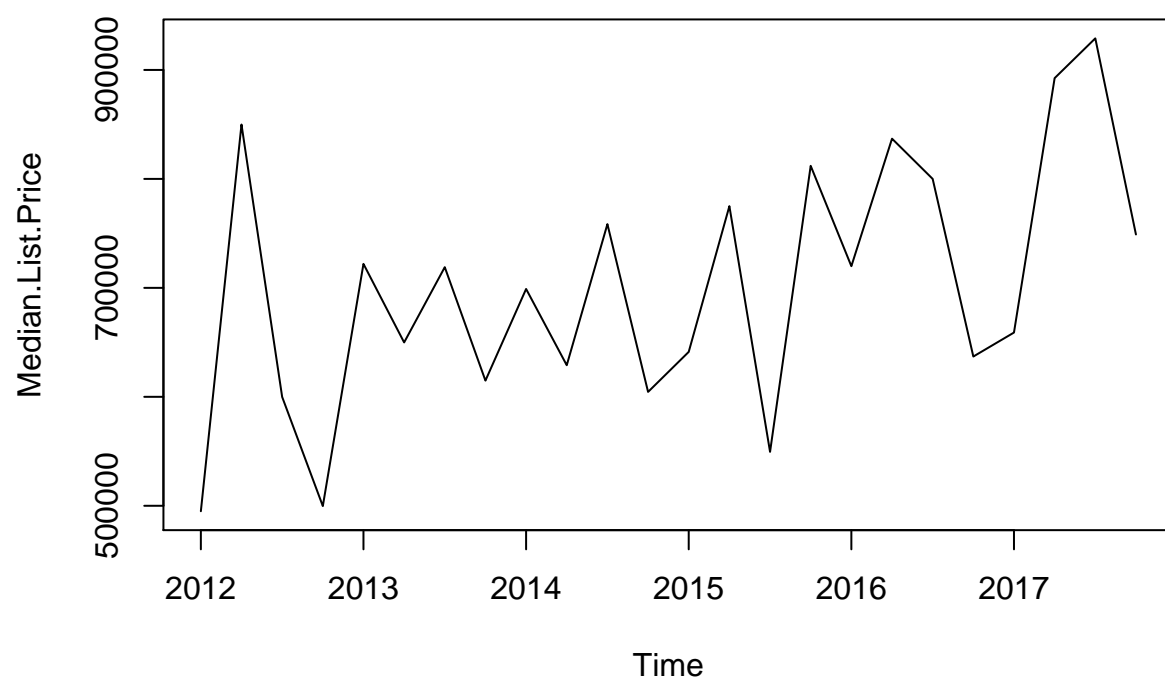**Portland, OR – Far Southwest : TS Training Model Comparison**

Median House Price

Year

Train Data
Test Data
Holt Winters
Seasonal Naive

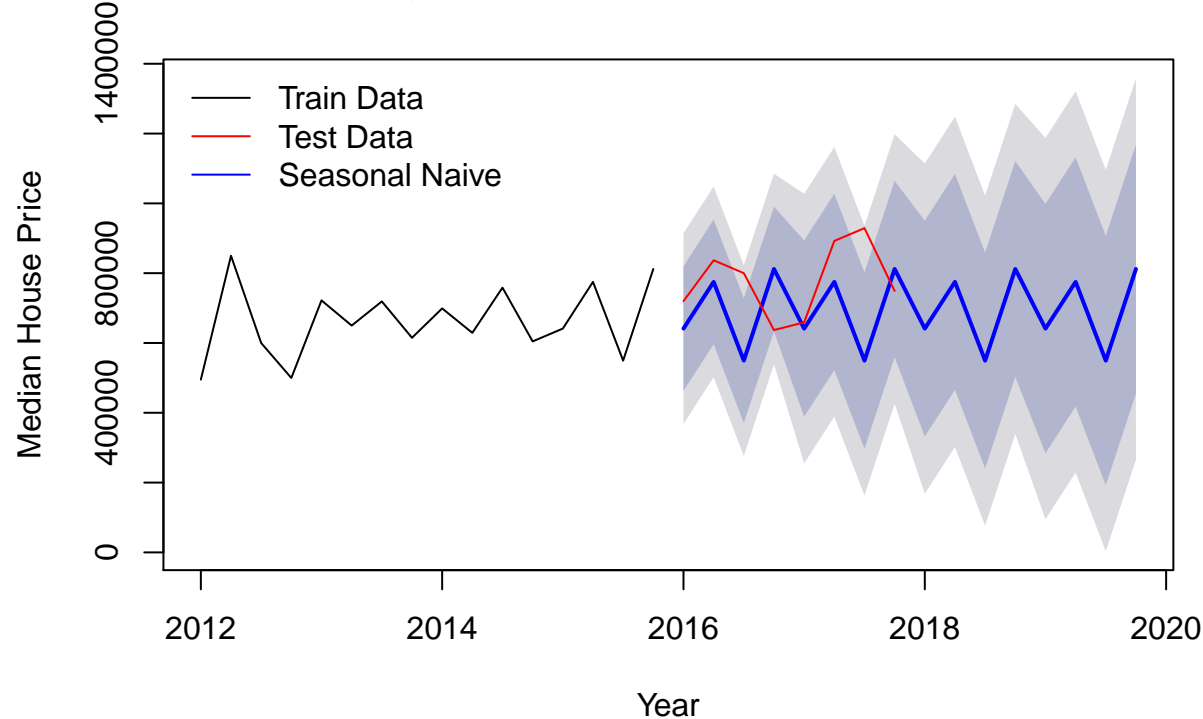# Portland, OR – Far Southwest : Full TS Models Comparison
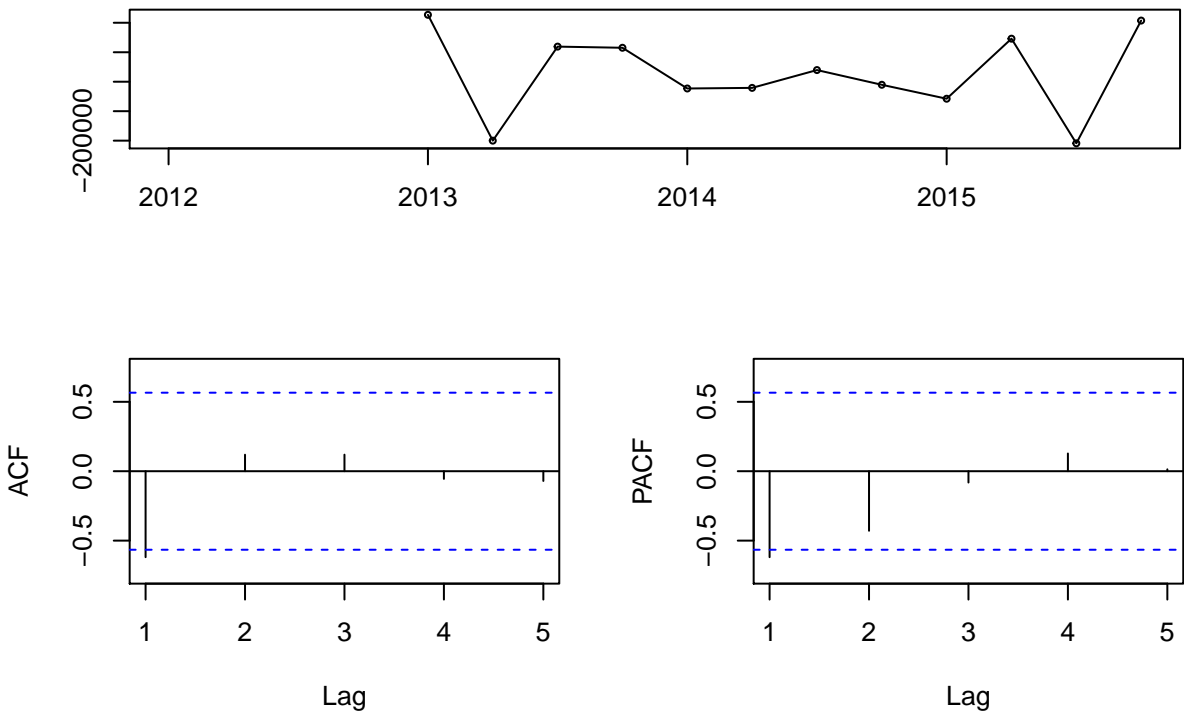

Year

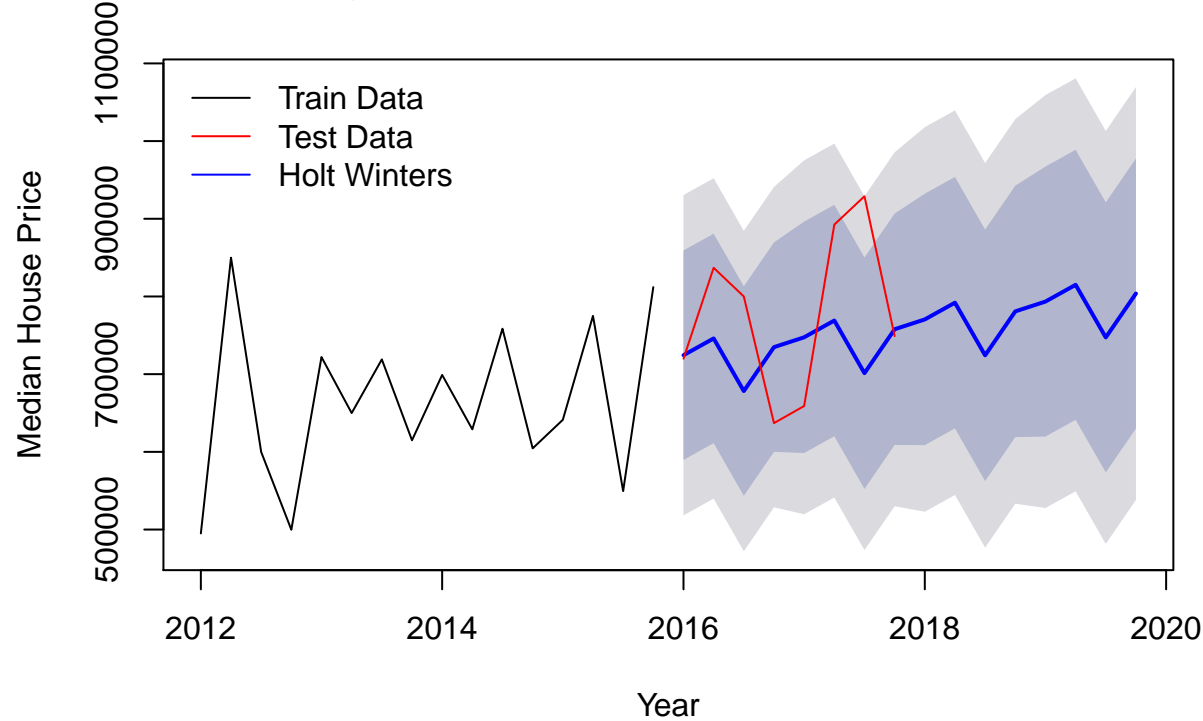Median House Price

Portland, OR – Hillside
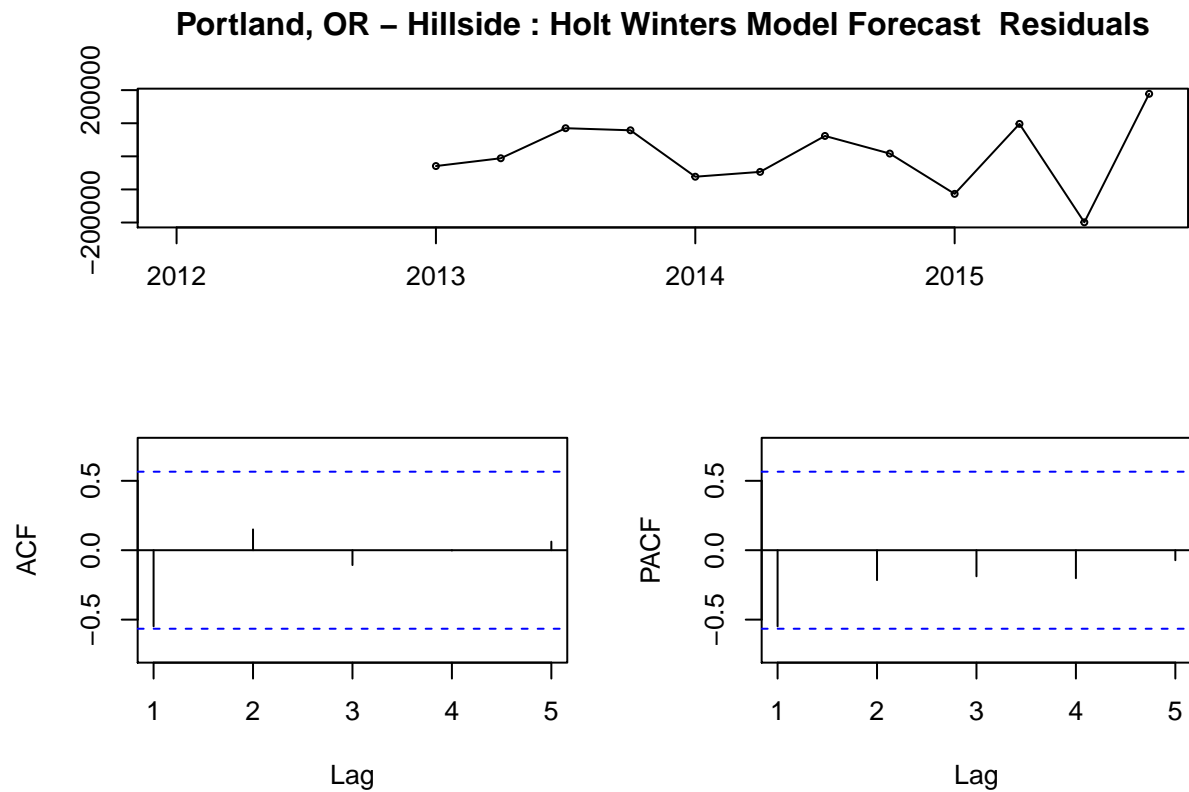
Portland, OR – Hillside : Naive Model Forecast

Portland, OR – Hillside : Naive Model Forecast Residuals

Portland, OR – Hillside : Holt Winters Model Forecast
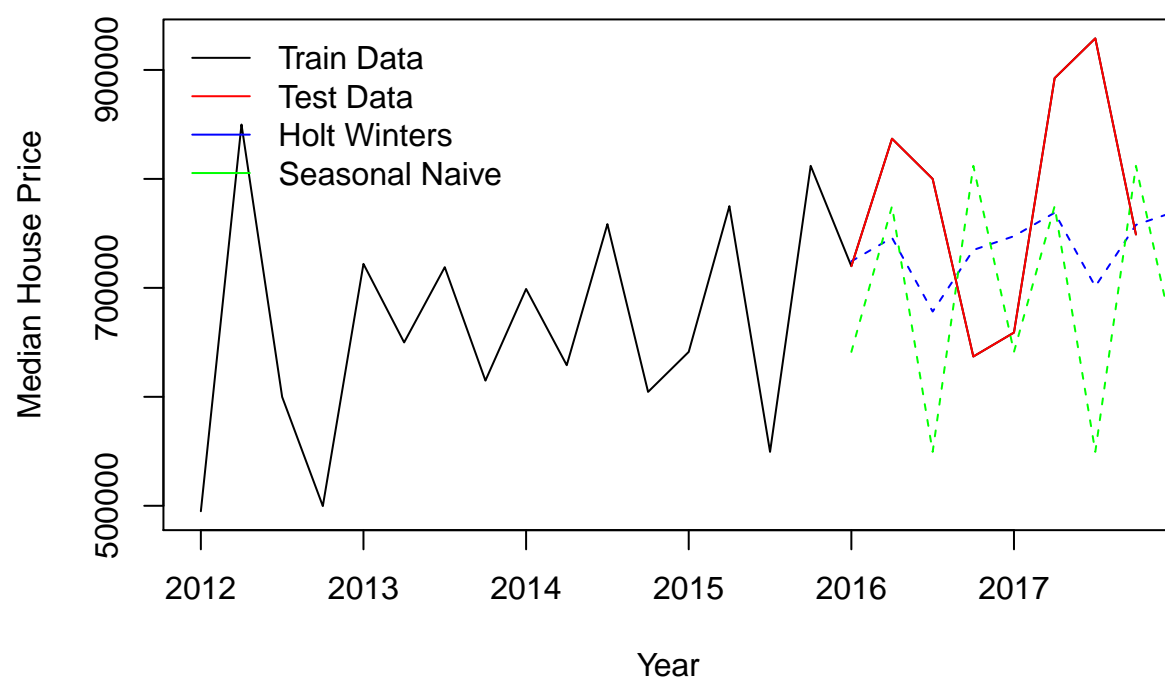
Portland, OR – Hillside : Holt Winters Model Forecast Residuals
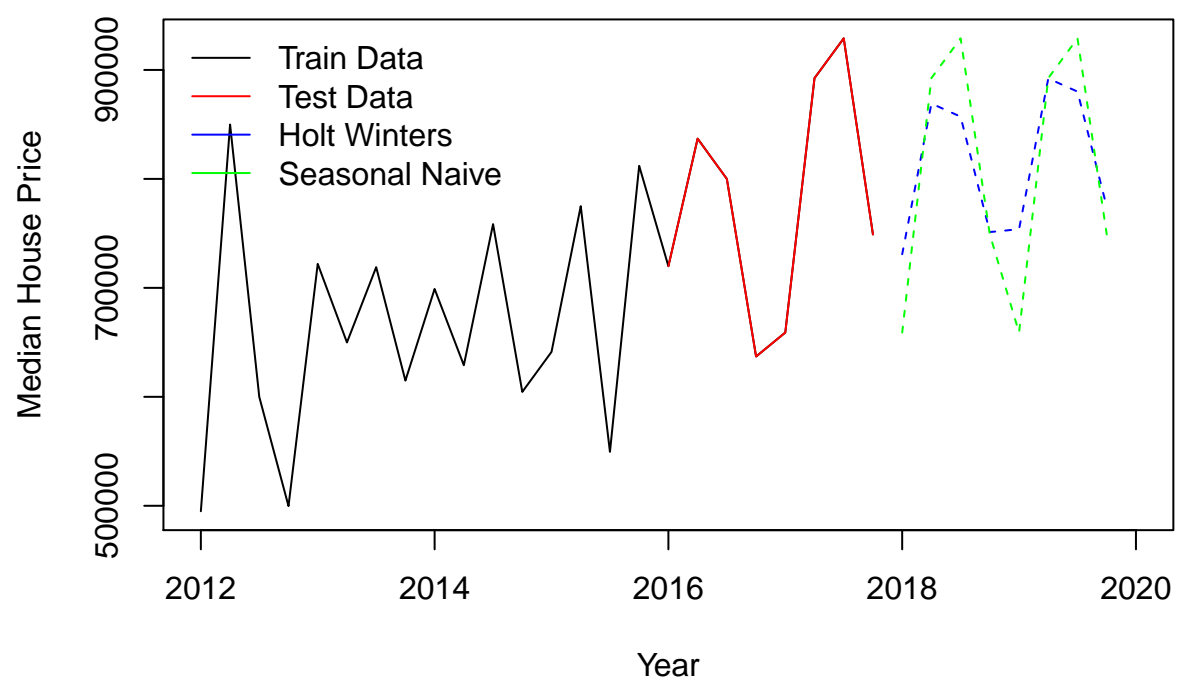


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Hillside"
##                    ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 27766.67 139342.5 114608.3 2.515359 16.87335 1.000000
## Test set     83480.00 182177.2 142980.0 8.807972 17.77891 1.247553
##                    ACF1 Theil's U
## Training set -0.6193701        NA
## Test set     -0.3108434   1.24029
## [1] "Holt Winters Accuracy for  Portland, OR - Hillside"
##                    ME      RMSE      MAE       MPE     MAPE      MASE
## Training set  5347.772 100860.6 81417.74 -0.4297091 12.10244 0.7103999
## Test set     45550.996 116026.0 95437.21  4.2331608 11.87665 0.8327249
##                     ACF1 Theil's U
## Training set -0.54840214        NA
## Test set      0.03650642 0.8531545
```
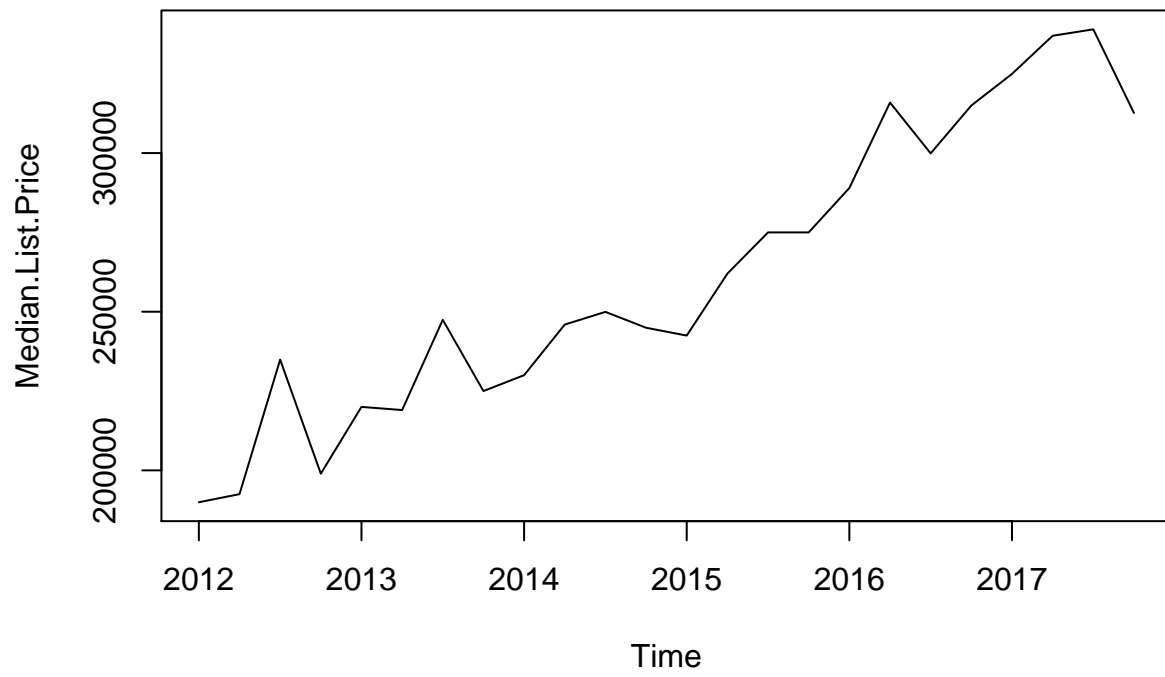
Portland, OR – Hillside : TS Training Model Comparison

Median House Price vs Year. Legend: Train Data (black), Test Data (red), Holt Winters (blue), Seasonal Naive (green).
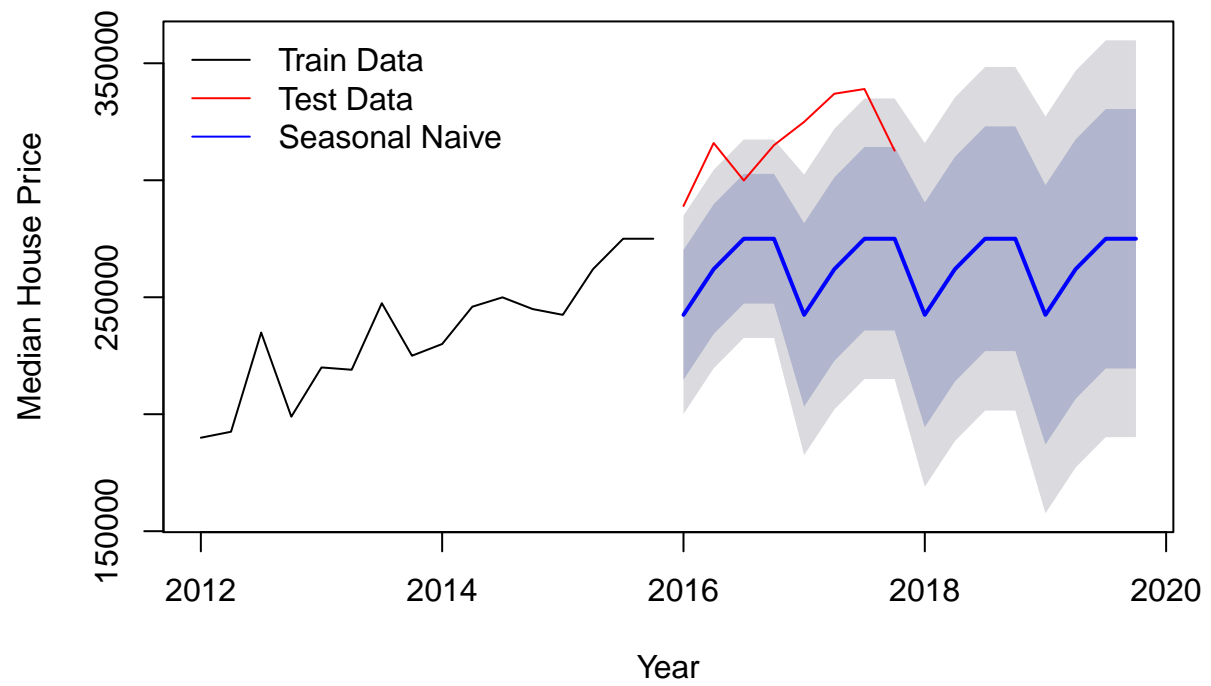
Portland, OR – Hillside : Full TS Models Comparison

Portland, OR – Wilkes
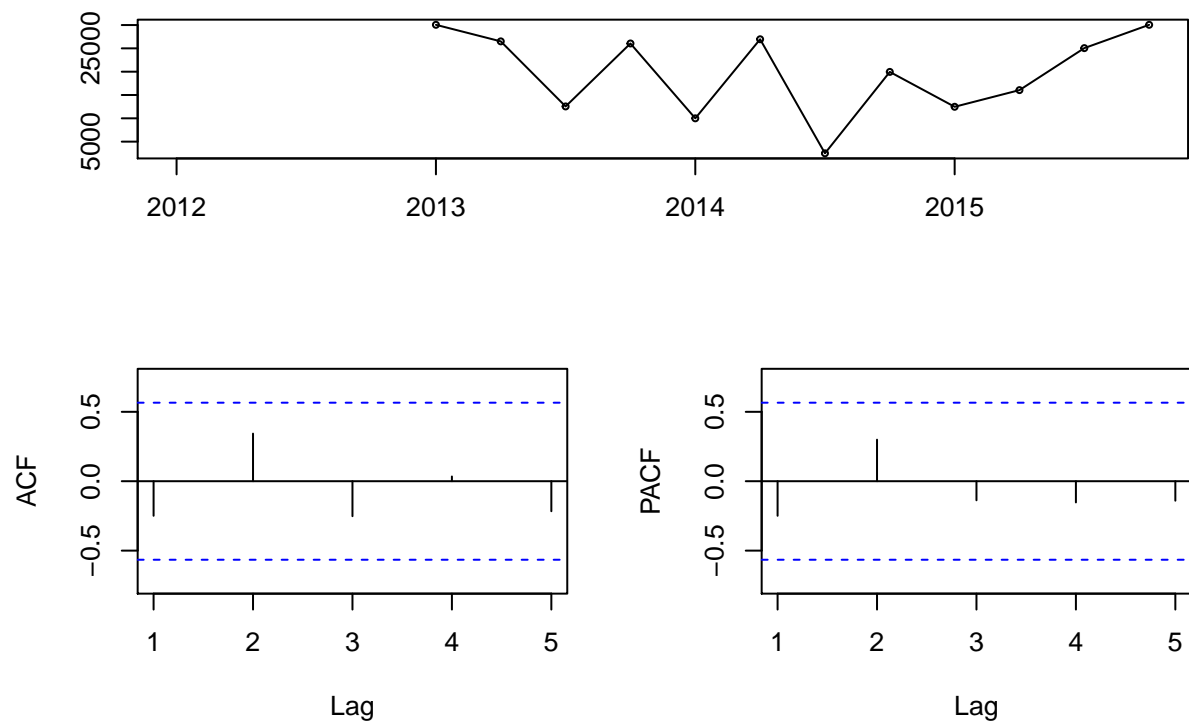
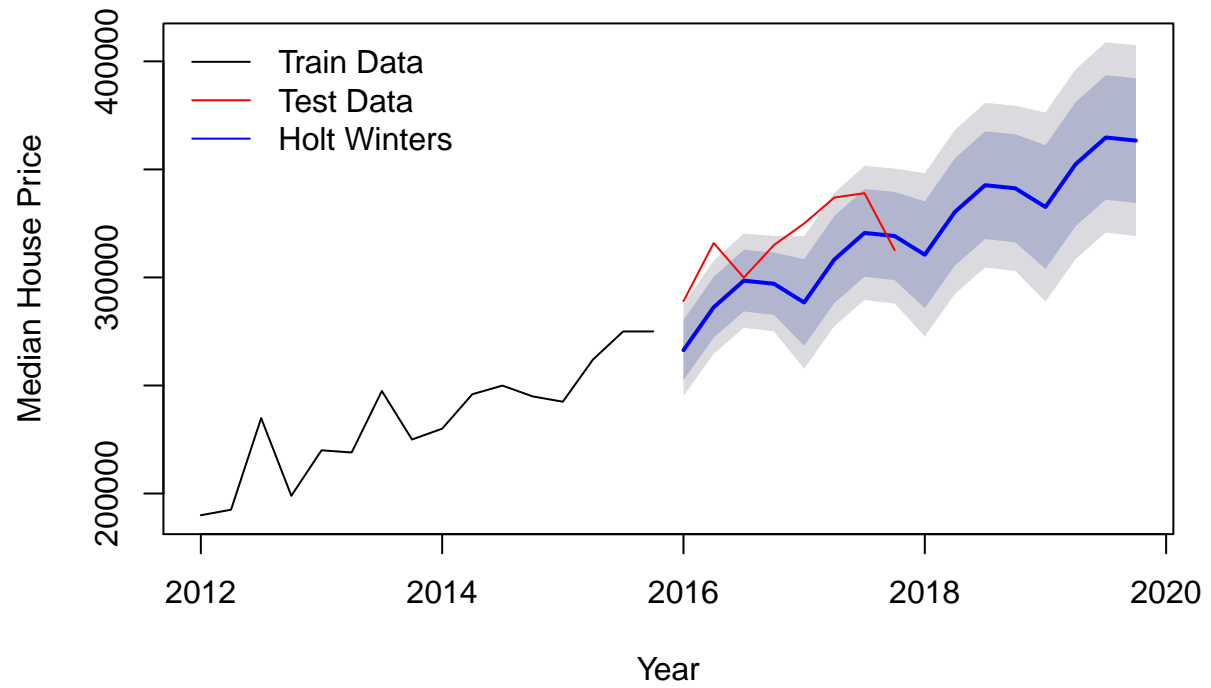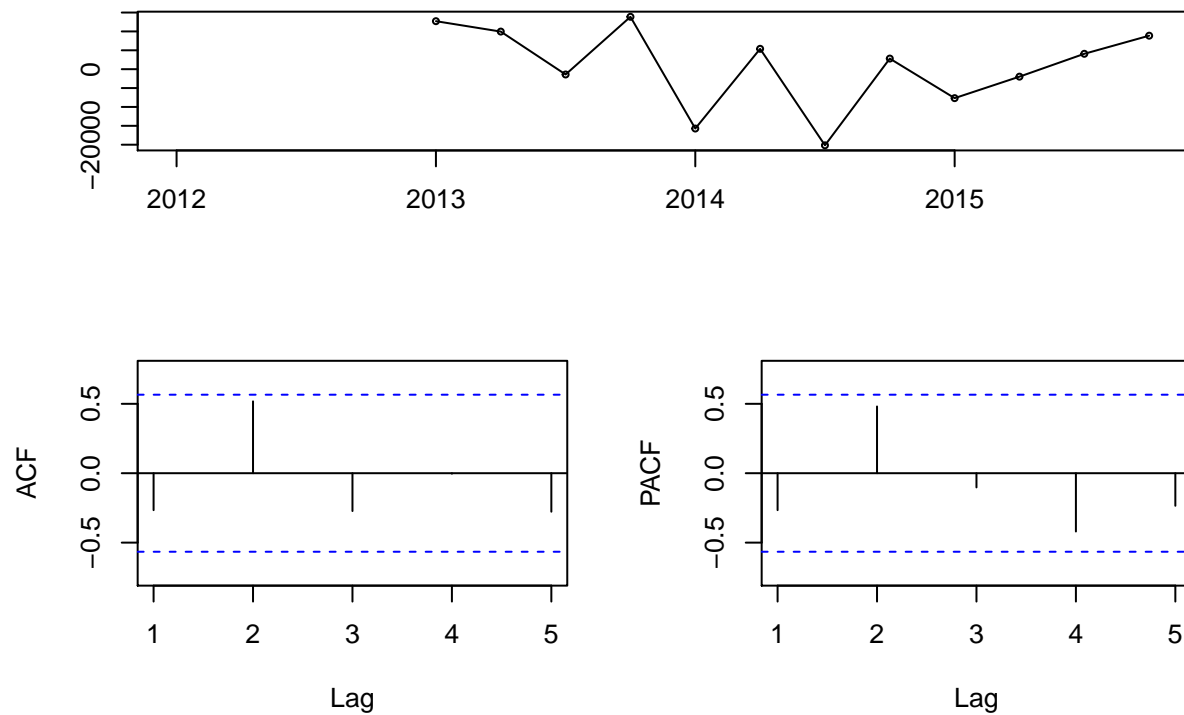# Portland, OR – Wilkes : Naive Model Forecast

Portland, OR – Wilkes : Naive Model Forecast Residuals

Portland, OR – Wilkes : Holt Winters Model Forecast
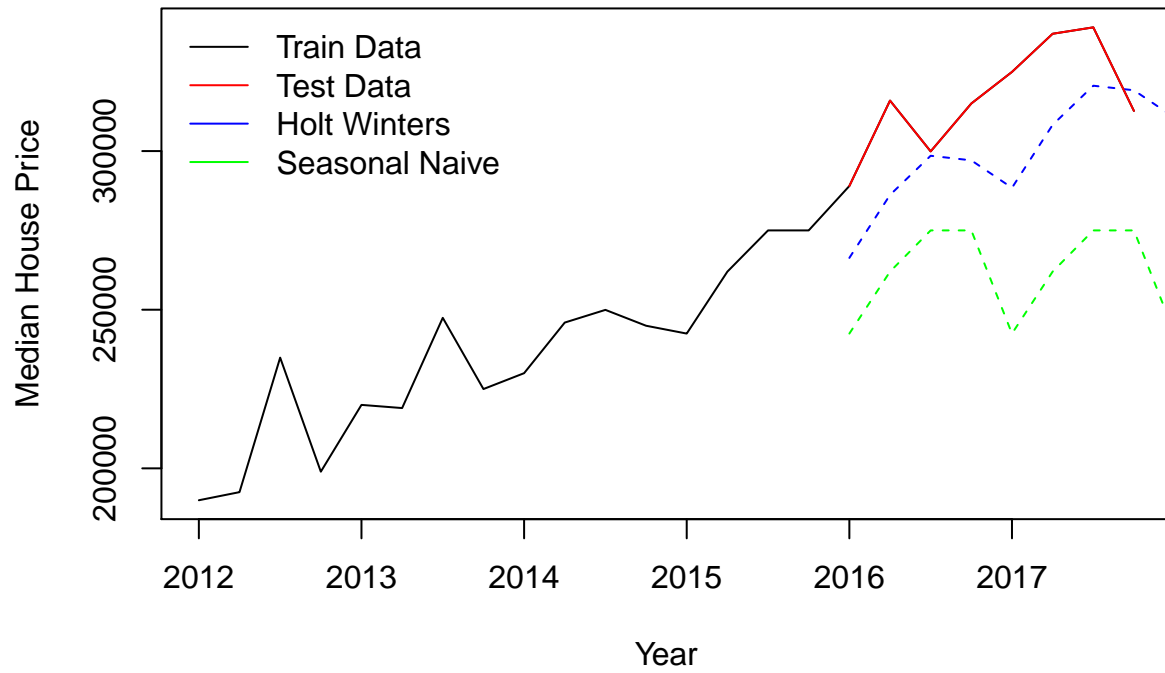
Portland, OR – Wilkes : Holt Winters Model Forecast Residuals
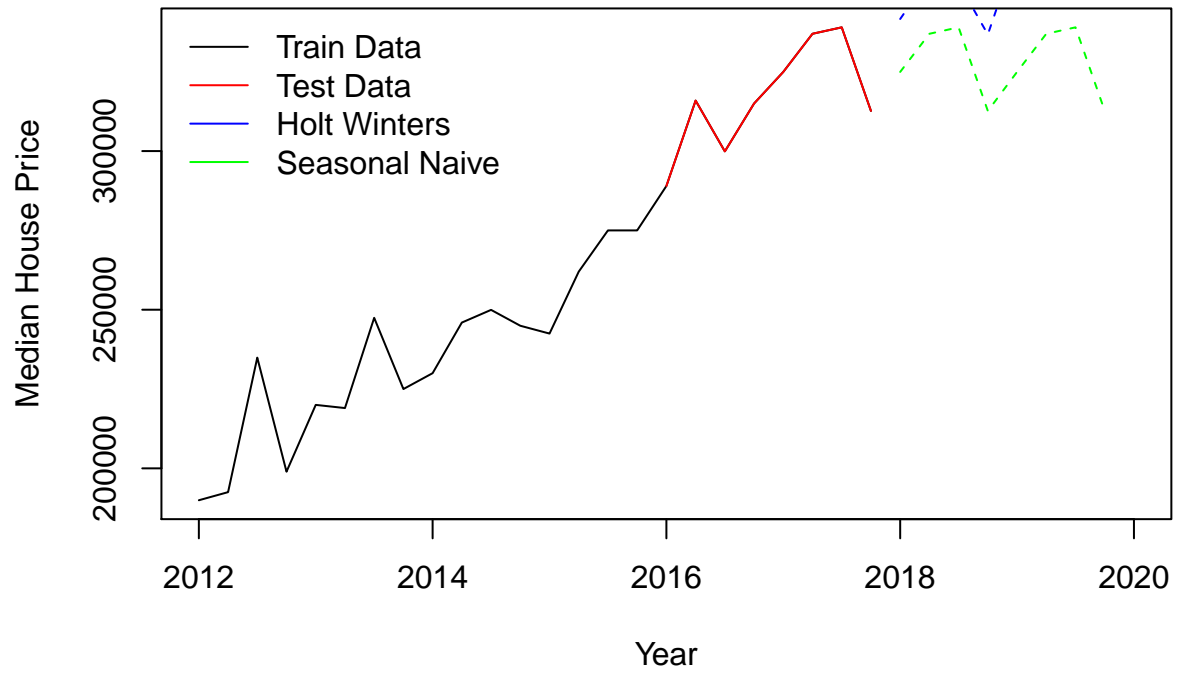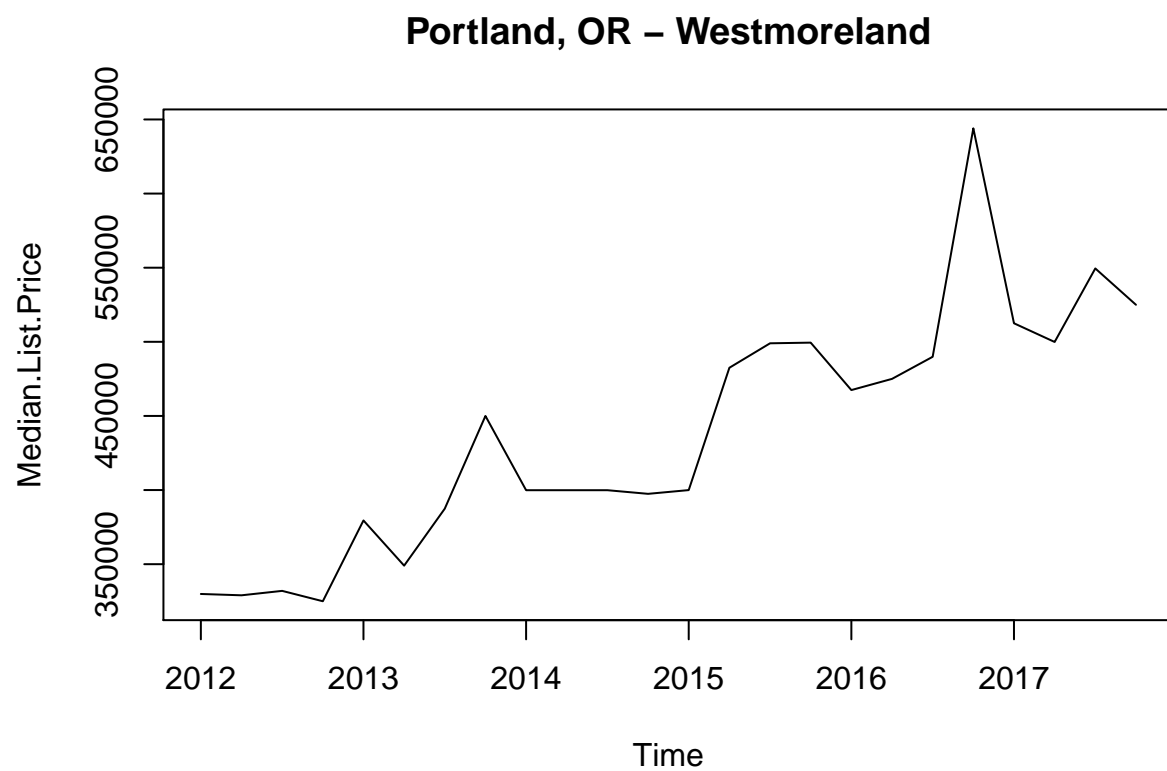


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Wilkes"
##                     ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 19847.92 21632.65 19847.92  8.180524  8.180524 1.000000
## Test set     53056.25 56157.58 53056.25 16.590031 16.590031 2.673139
##                   ACF1 Theil's U
## Training set -0.2491990        NA
## Test set      0.2470694  3.209447
## [1] "Holt Winters Accuracy for  Portland, OR - Wilkes"
##                     ME      RMSE      MAE      MPE      MAPE       MASE
## Training set   897.7884 10423.18  8718.565 0.4298426 3.660346 0.4392685
## Test set     18603.6177 23078.73 20232.293 5.8138071 6.334733 1.0193661
##                   ACF1 Theil's U
## Training set -0.2661881        NA
## Test set      0.0249140   1.32082
```
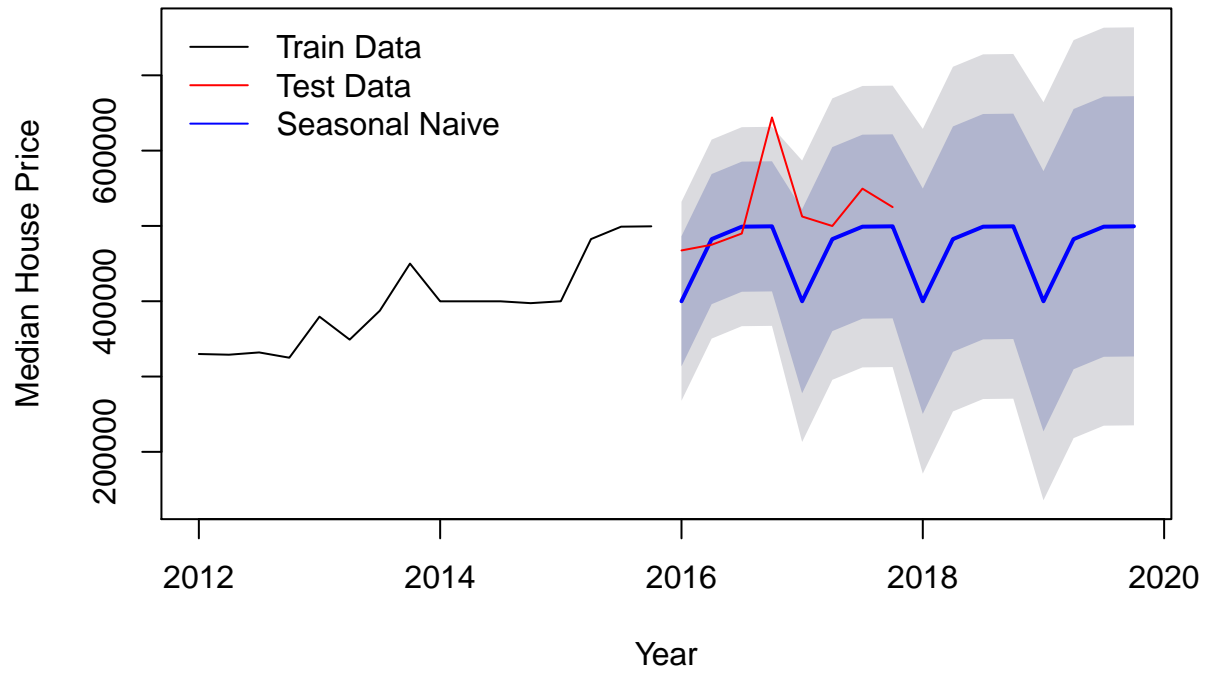
Portland, OR – Wilkes : TS Training Model Comparison
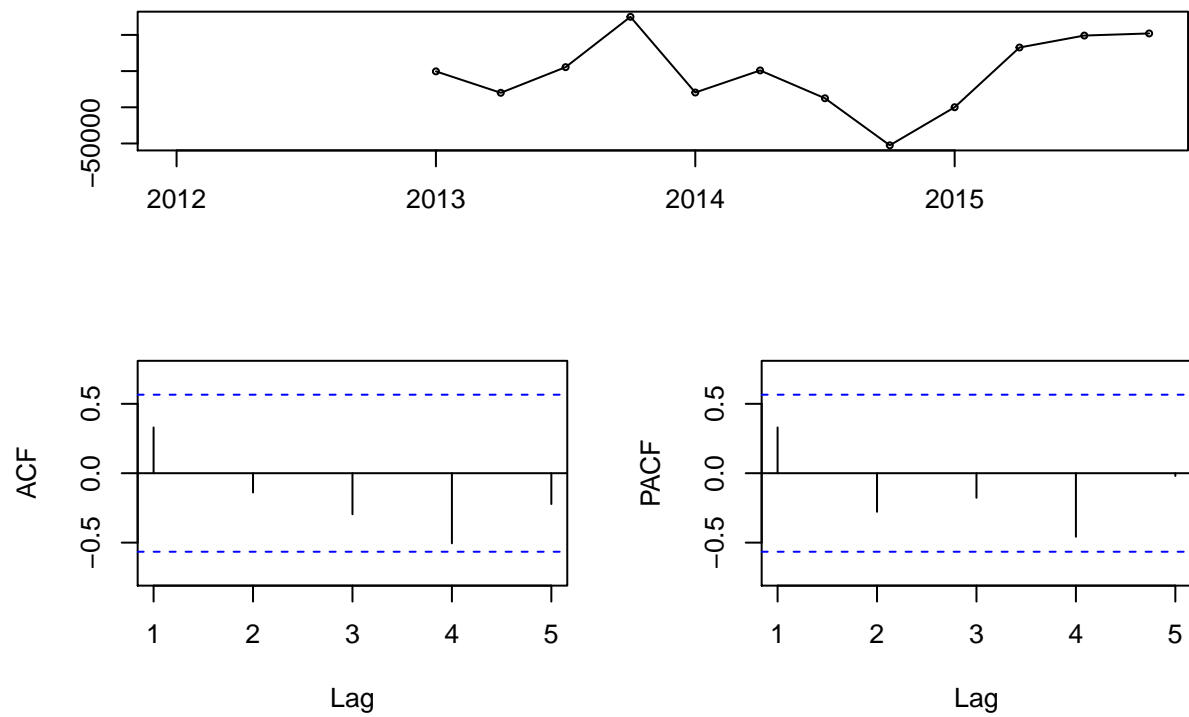
Portland, OR – Wilkes : Full TS Models Comparison

Median House Price

Year

- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Portland, OR – Westmoreland
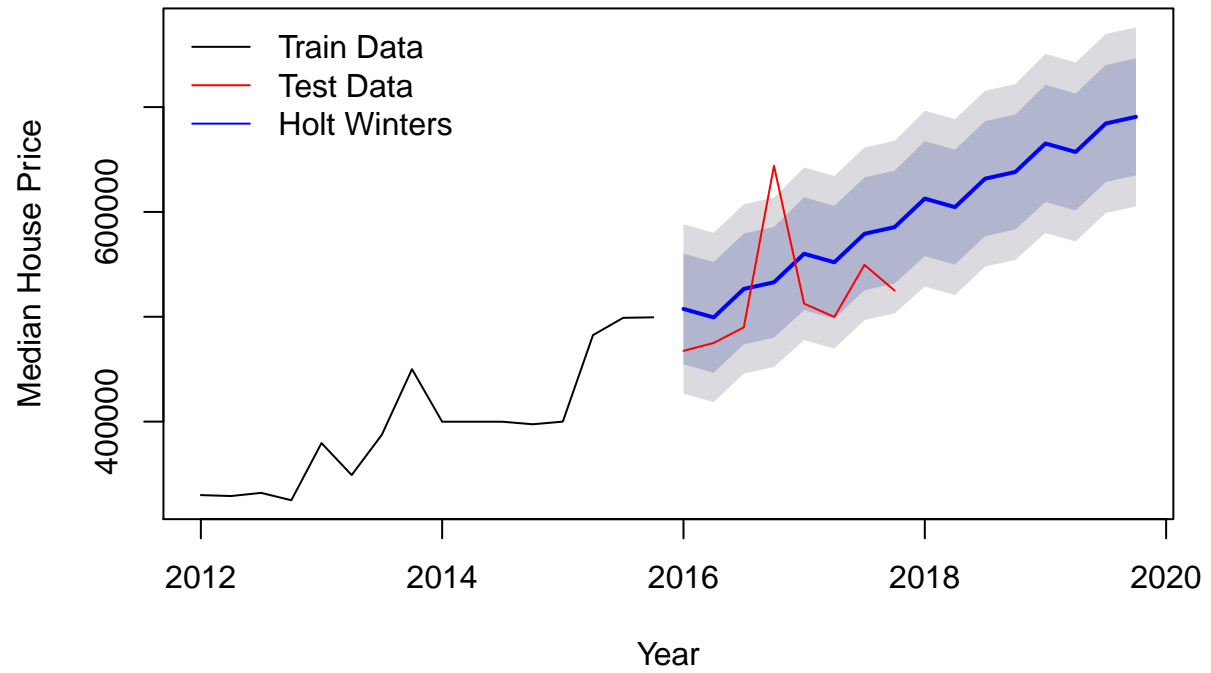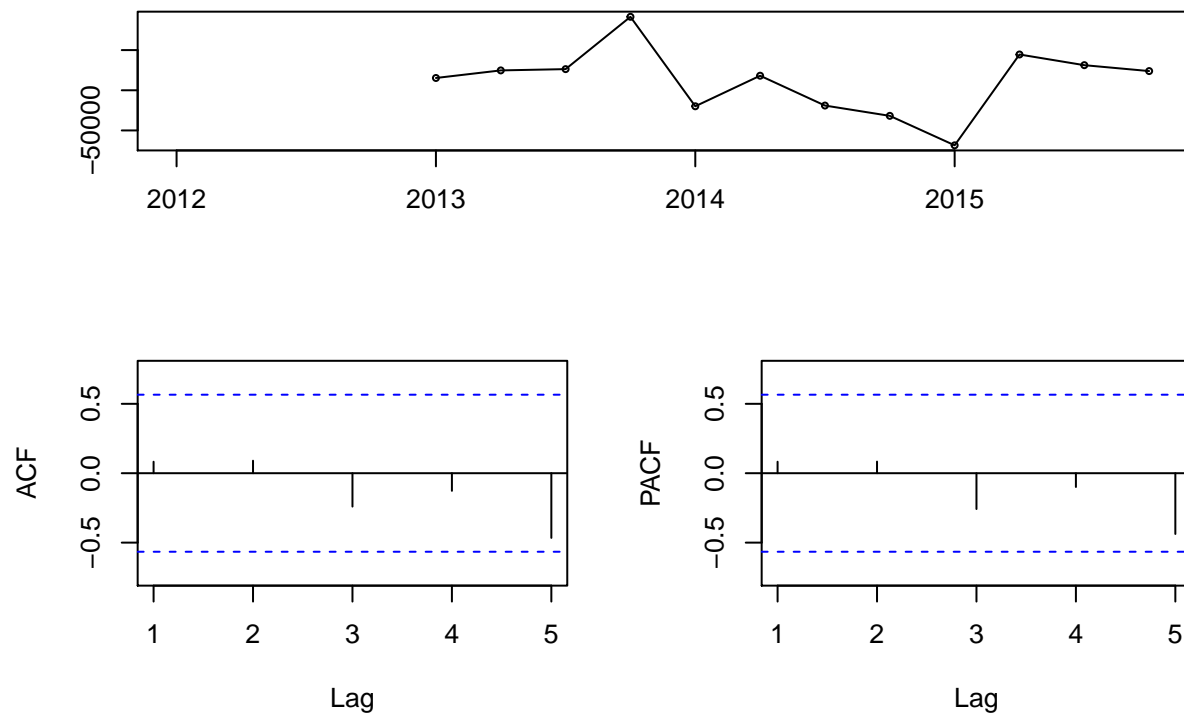
Portland, OR – Westmoreland : Naive Model Forecast

Portland, OR – Westmoreland : Naive Model Forecast Residuals

Portland, OR – Westmoreland : Holt Winters Model Forecast
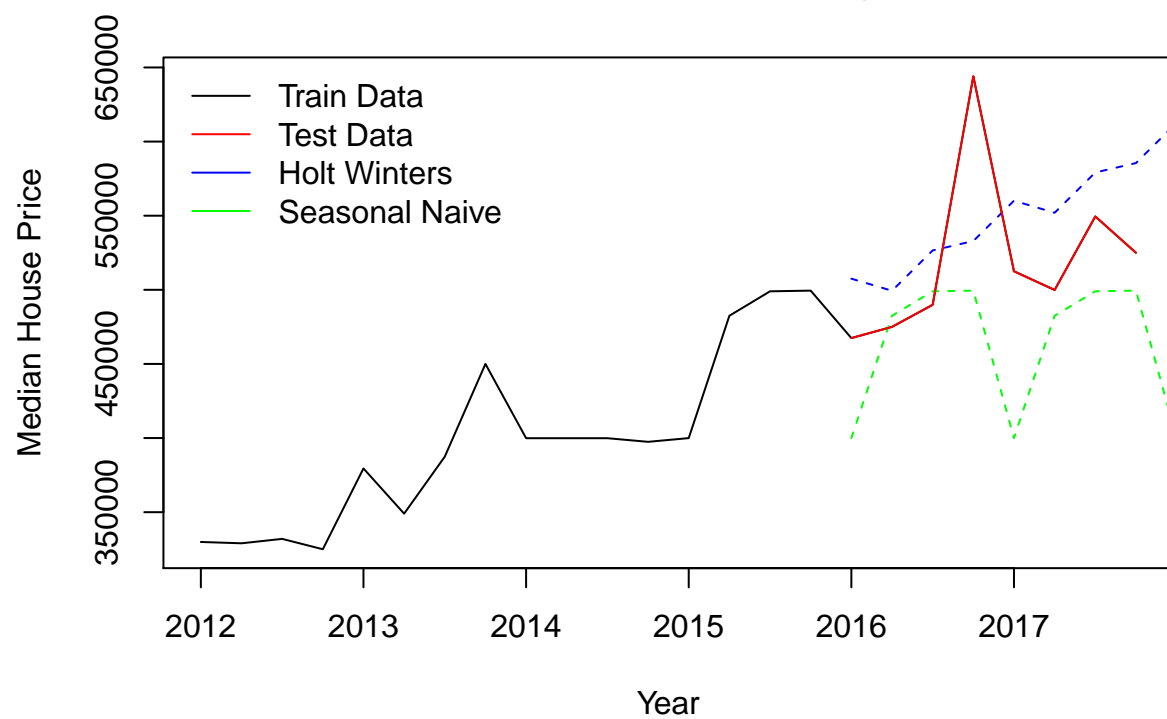
Portland, OR – Westmoreland : Holt Winters Model Forecast Residuals
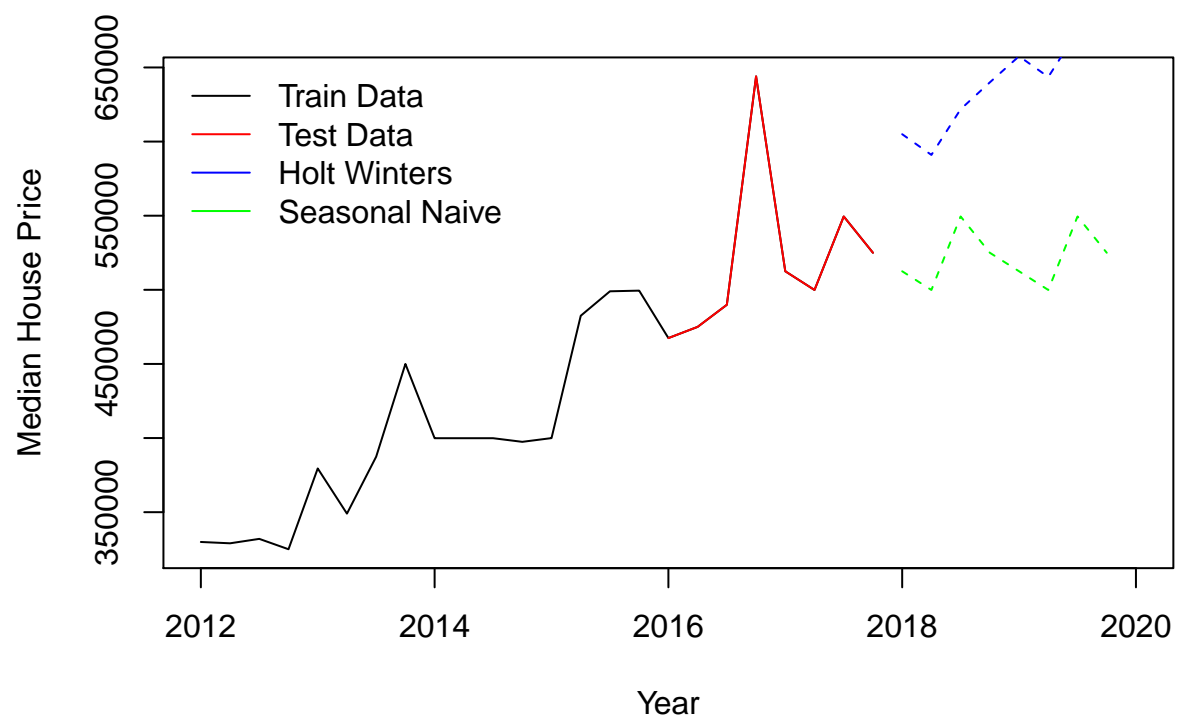


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Westmoreland"
##                    ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 47085.42 67411.00 55843.75 10.502570 12.706202 1.0000000
## Test set     50175.00 72244.66 54325.00  9.117189  9.976307 0.9728036
##                   ACF1 Theil's U
## Training set 0.32989685        NA
## Test set     0.03002371  0.923928
## [1] "Holt Winters Accuracy for  Portland, OR - Westmoreland"
##                    ME     RMSE      MAE       MPE     MAPE      MASE
## Training set  11347.26 41044.96 34565.86  2.344187 8.157930 0.6189745
## Test set     -22480.34 56352.16 50254.98 -5.070274 9.383106 0.8999214
##                    ACF1 Theil's U
## Training set  0.08295743        NA
## Test set     -0.18541308 0.7701642
```
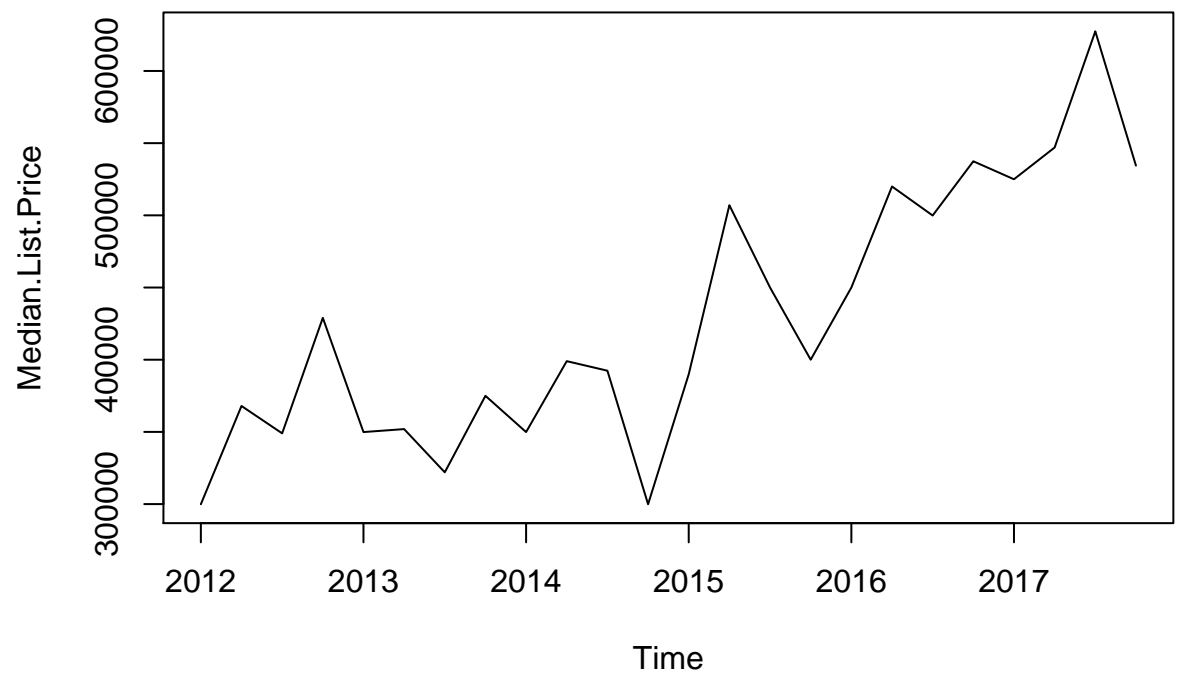
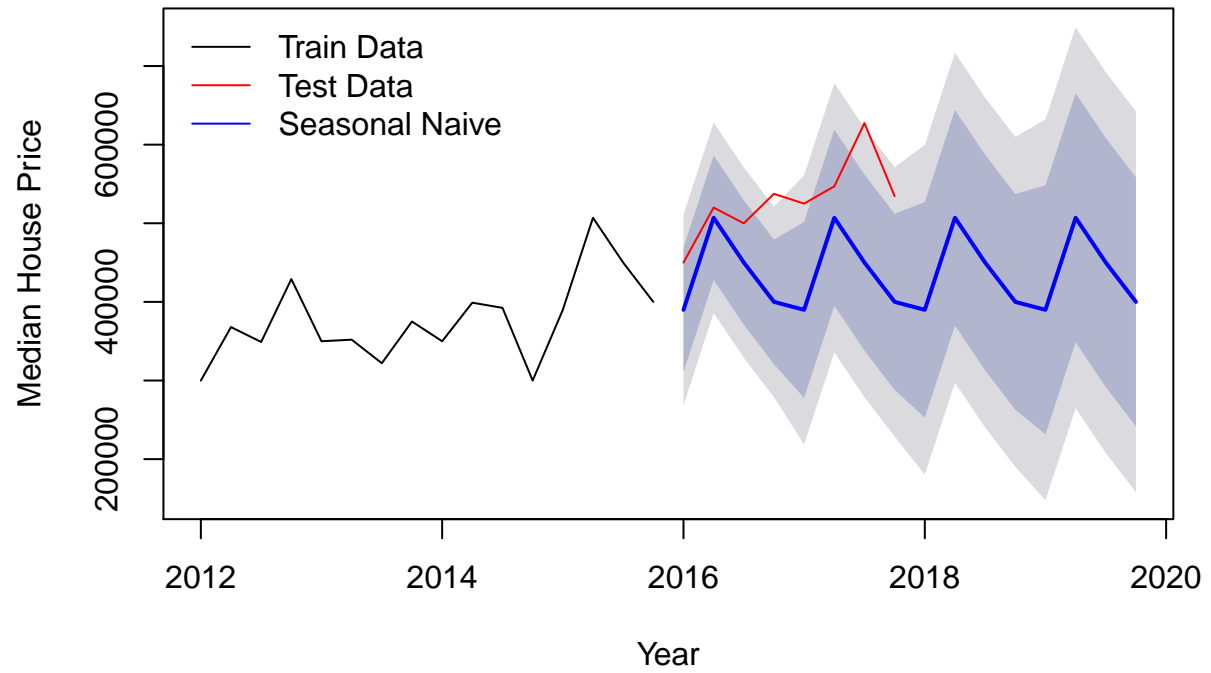# Portland, OR – Westmoreland : TS Training Model Comparison

Portland, OR – Westmoreland : Full TS Models Comparison

Median House Price
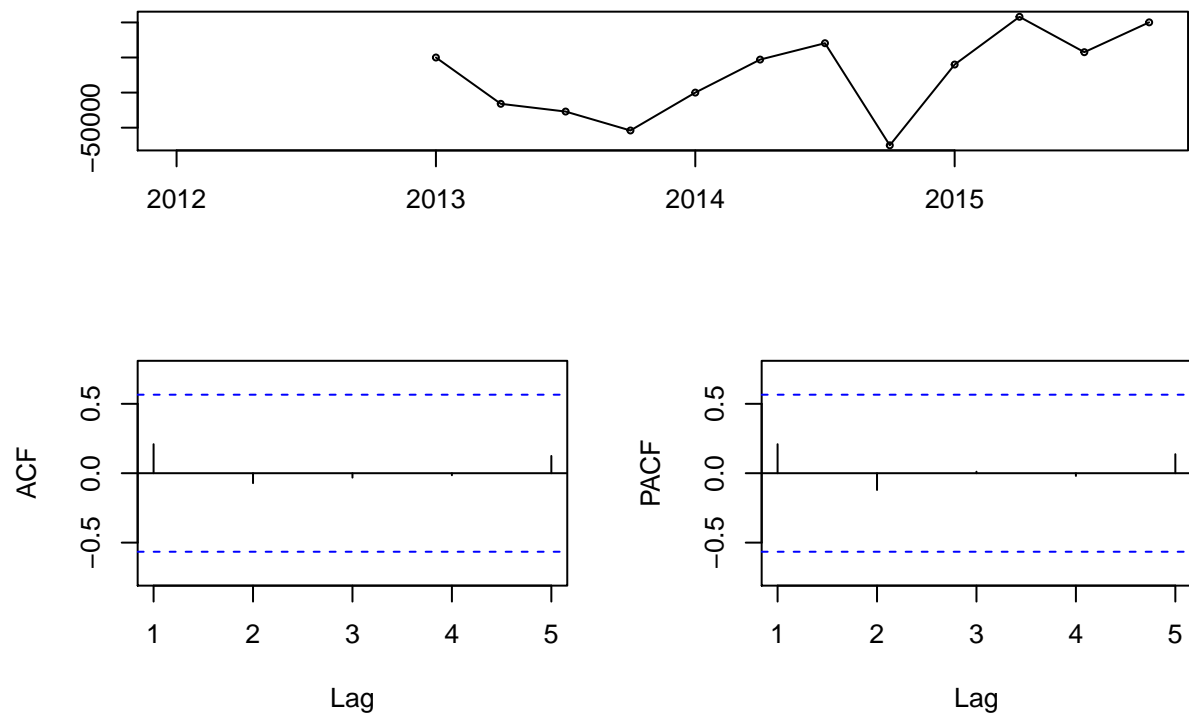
Year

Train Data
Test Data
Holt Winters
Seasonal Naive

Portland, OR – Eliot

Portland, OR – Eliot : Naive Model Forecast
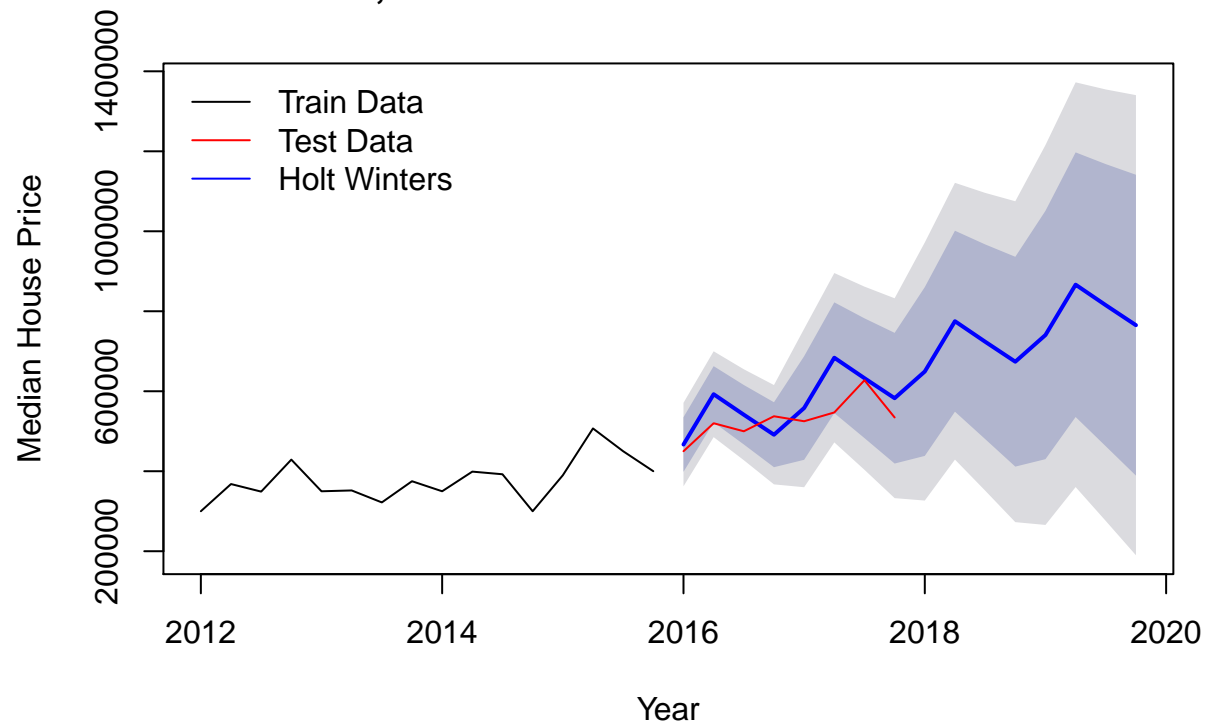
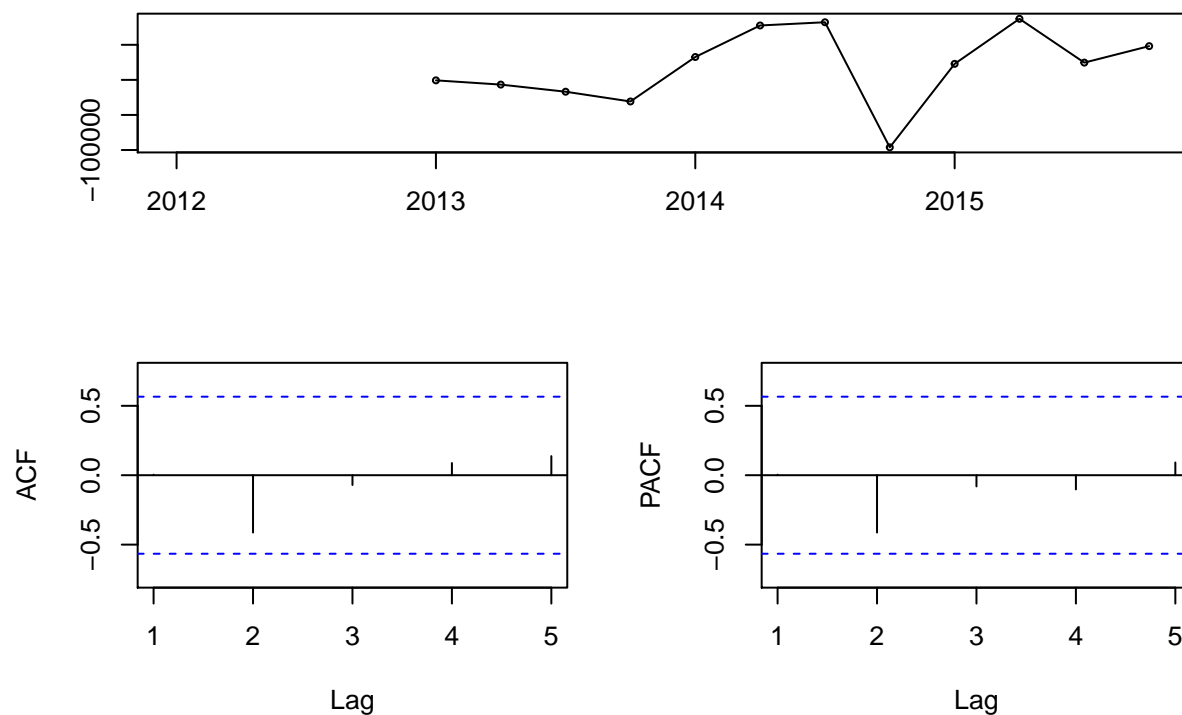# Portland, OR – Eliot : Naive Model Forecast Residuals
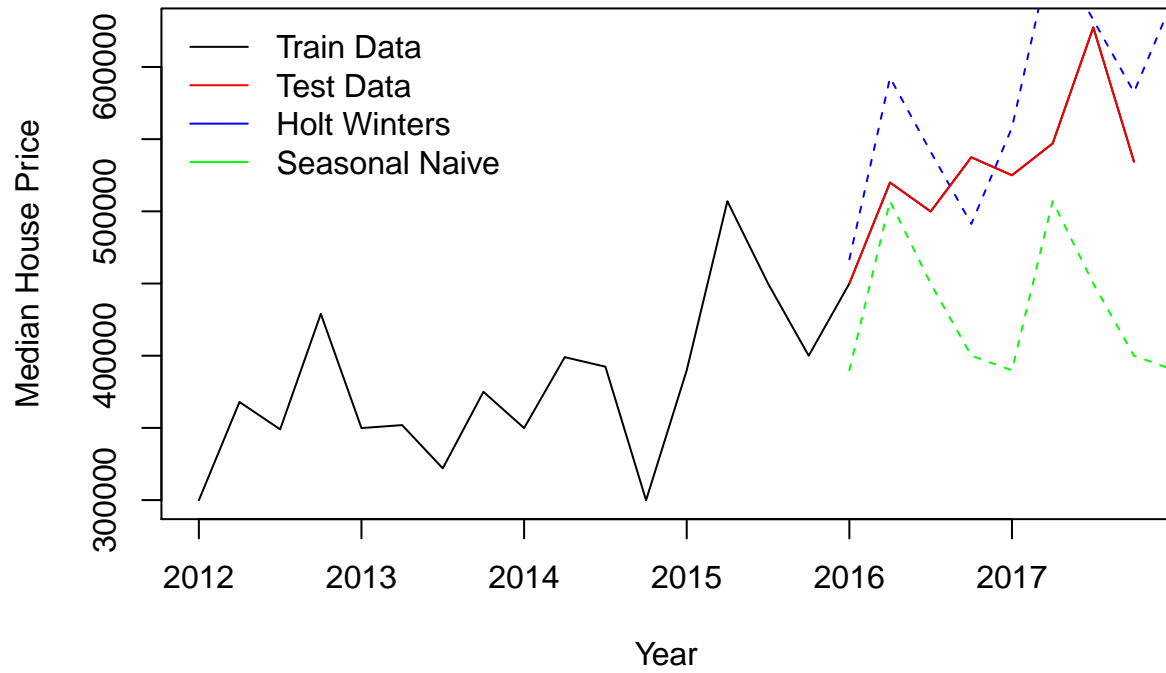
Portland, OR – Eliot : Holt Winters Model Forecast

Portland, OR – Eliot : Holt Winters Model Forecast Residuals
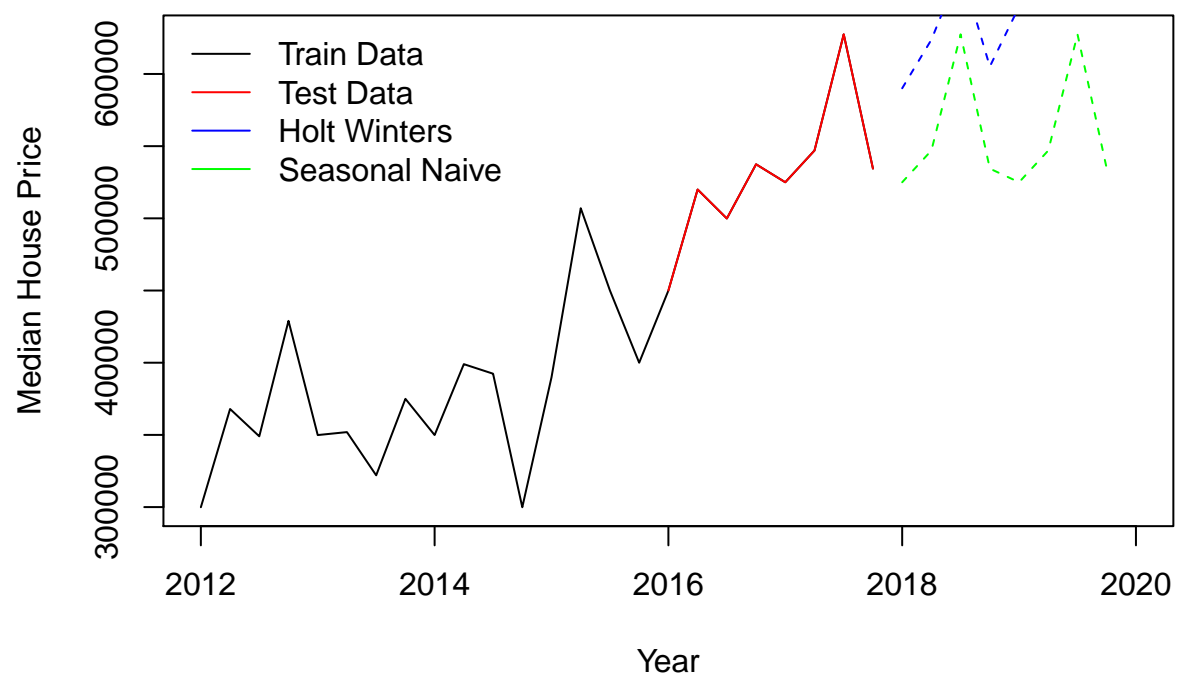


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Eliot"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 25087.50   61787.7 53770.83  5.08630 13.81511 1.000000
## Test set     93431.25 108731.8 93431.25 17.23698 17.23698 1.737582
##                 ACF1 Theil's U
## Training set 0.2091346       NA
## Test set     0.1143985 1.989893
## [1] "Holt Winters Accuracy for  Portland, OR - Eliot"
##                  ME     RMSE      MAE      MPE      MAPE      MASE
## Training set 18639.7 54291.59 43846.10 3.549247 11.486342 0.8154254
## Test set    -38457.4 62793.79 49997.42 -7.312011  9.459192 0.9298242
##                   ACF1 Theil's U
## Training set  0.003847561       NA
## Test set     -0.231495662 1.238884
```
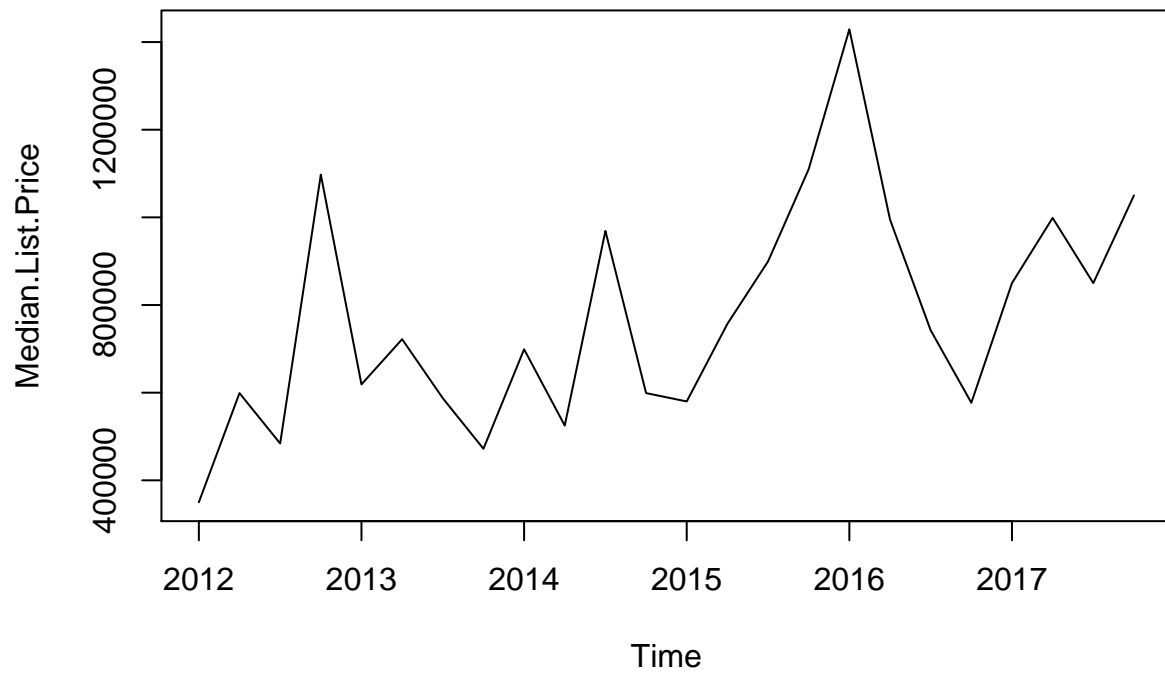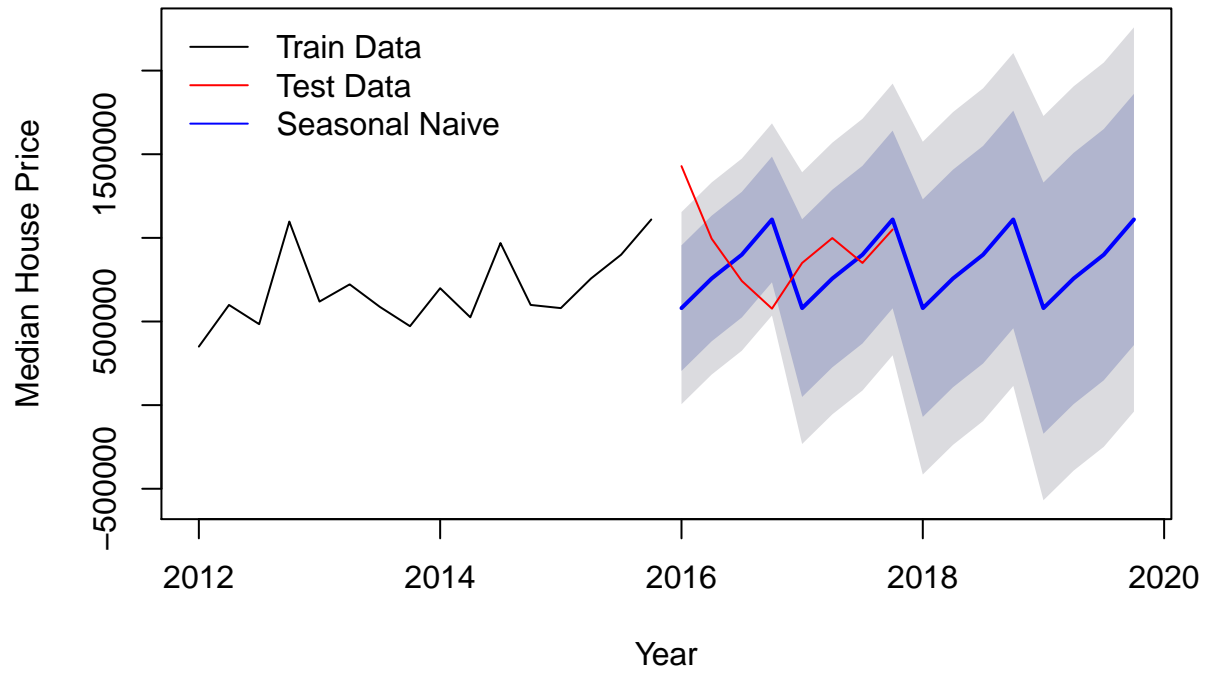
634

Portland, OR – Eliot : TS Training Model Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price
X-axis: Year

Portland, OR – Eliot : Full TS Models Comparison

Median House Price
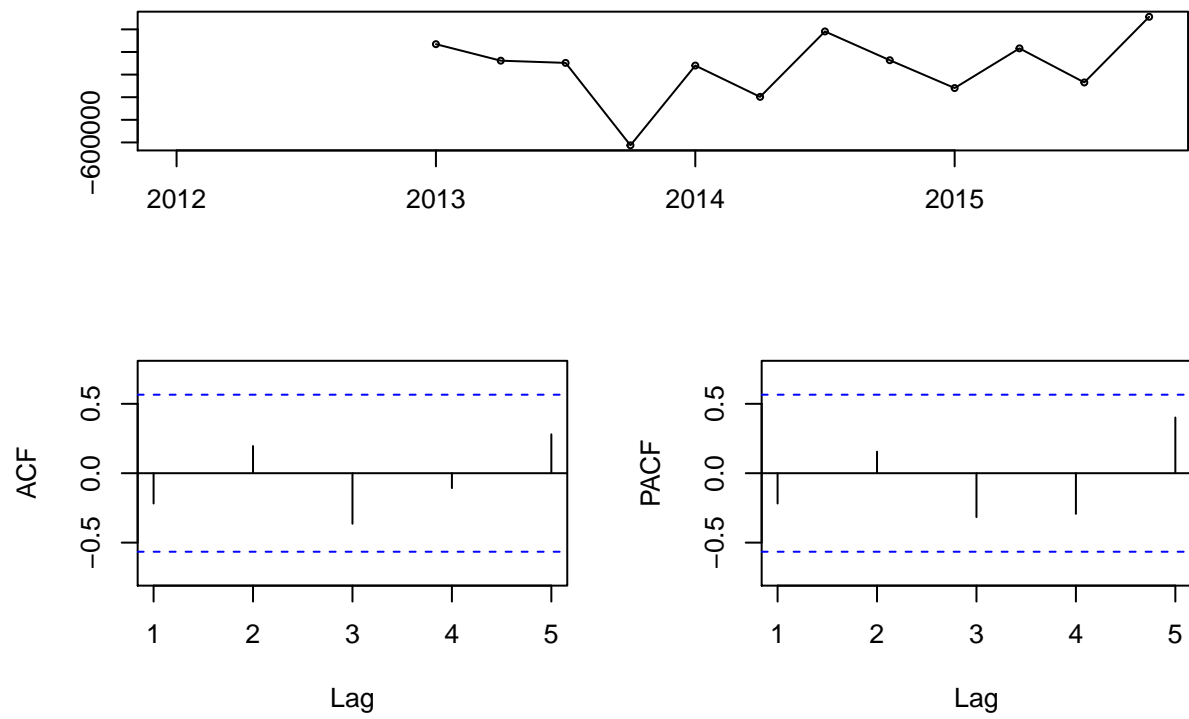
Year

Train Data
Test Data
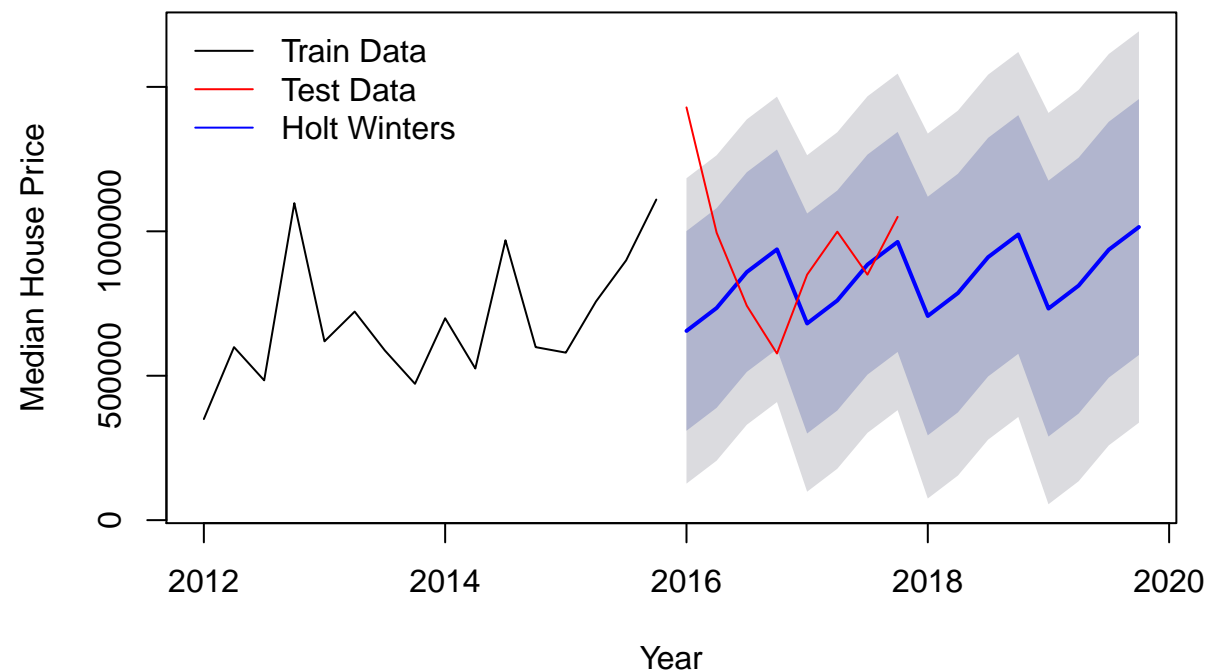Holt Winters
Seasonal Naive

Portland, OR – Forest Highlands

Portland, OR – Forest Highlands : Naive Model Forecast

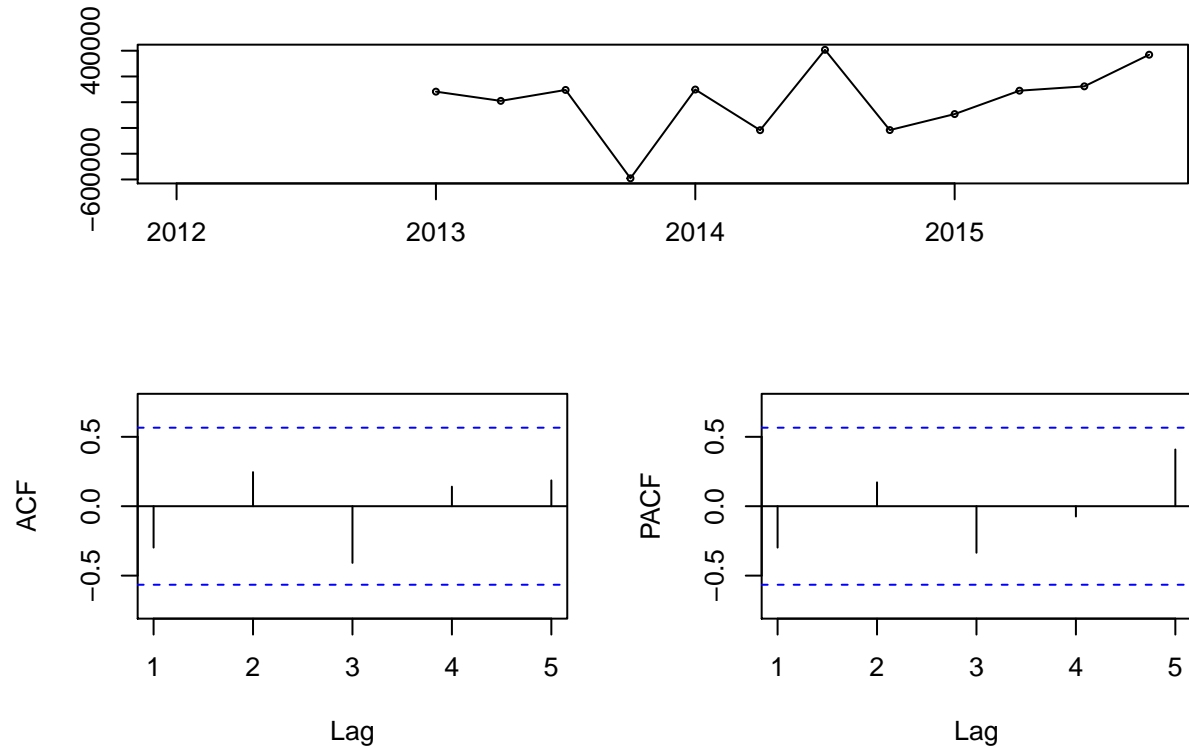# Portland, OR – Forest Highlands : Naive Model Forecast Residuals

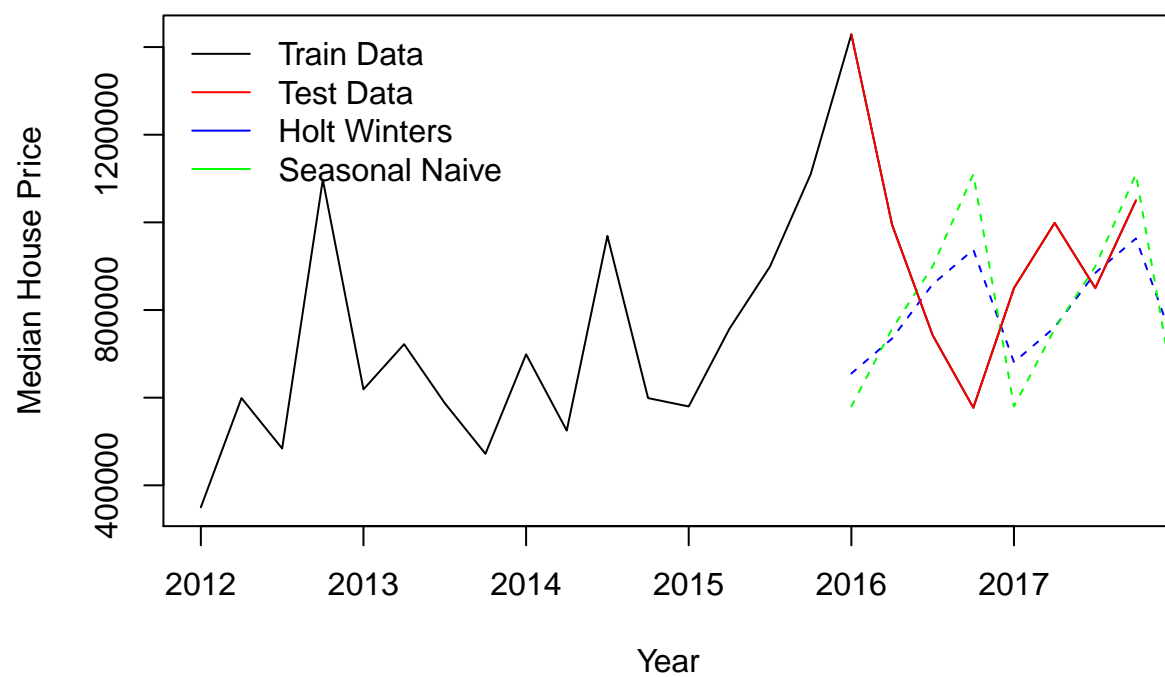# Portland, OR – Forest Highlands : Holt Winters Model Forecast

Portland, OR – Forest Highlands : Holt Winters Model Forecast Residuals
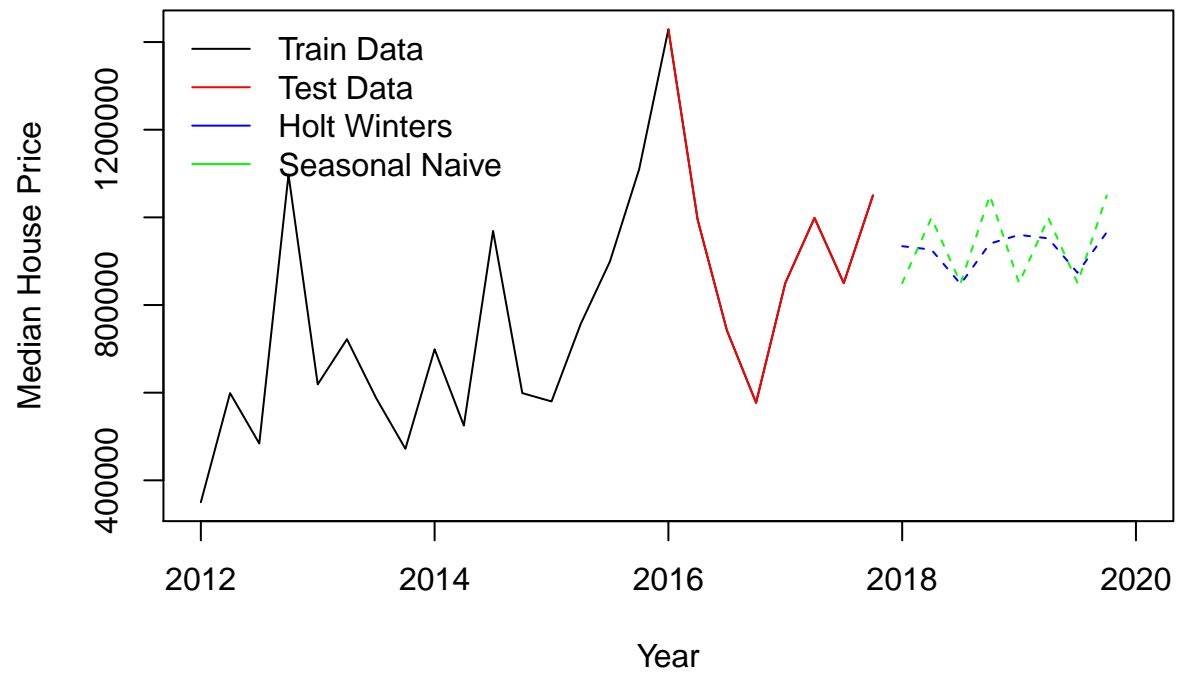


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Forest Highlands"
##                   ME      RMSE      MAE      MPE     MAPE     MASE
## Training set 67997.92 293014.1 236506.2 2.375785 35.42643 1.00000
## Test set     99925.00 391107.0 299800.0 1.782014 33.04671 1.26762
##                 ACF1 Theil's U
## Training set -0.2183621       NA
## Test set      0.1309136  1.275153
## [1] "Holt Winters Accuracy for  Portland, OR - Forest Highlands"
##                   ME      RMSE      MAE      MPE     MAPE      MASE
## Training set  13250.29 258576.9 199314.6 -6.058812 30.36472 0.8427457
## Test set     127060.50 336200.1 255000.4  6.257859 26.82285 1.0781973
##                 ACF1 Theil's U
## Training set -0.2980561       NA
## Test set      0.1873498 0.9230892
```
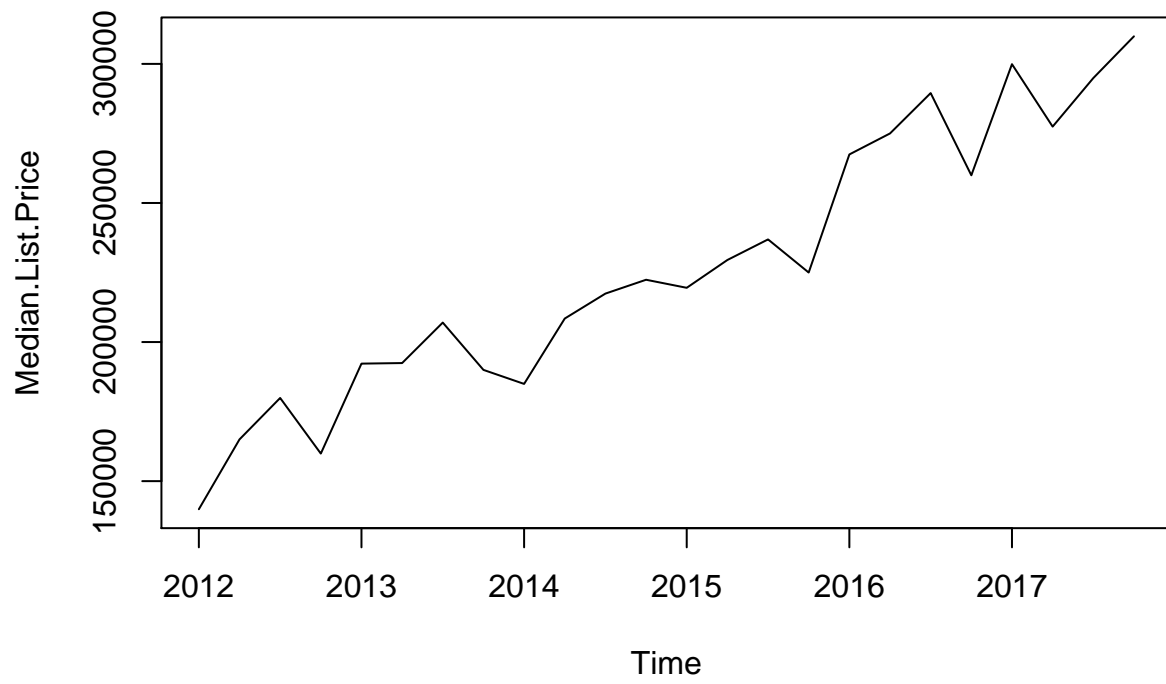
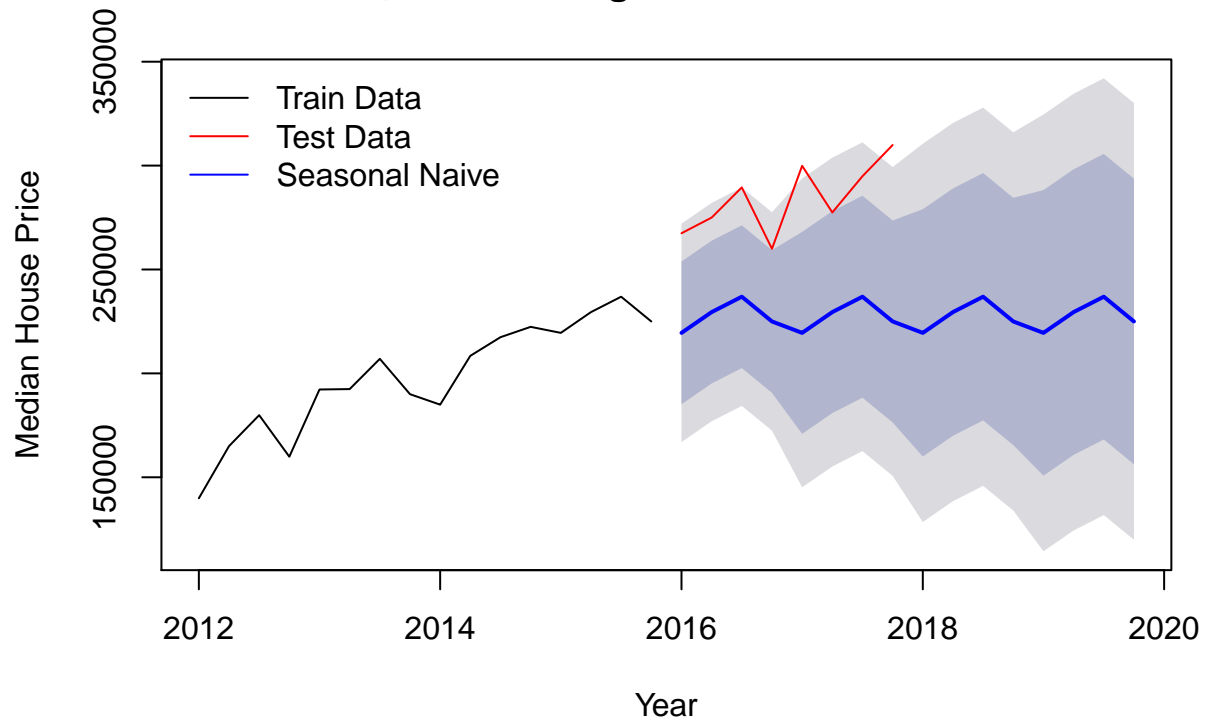# Portland, OR – Forest Highlands : TS Training Model Comparison

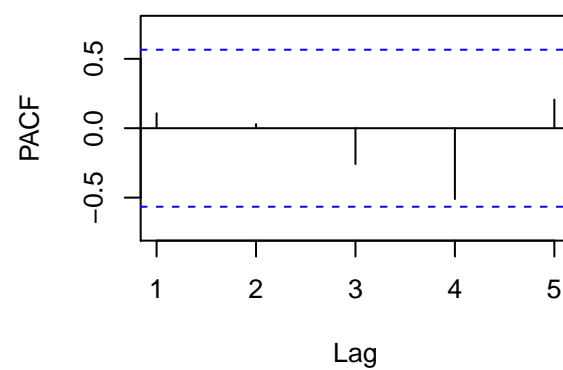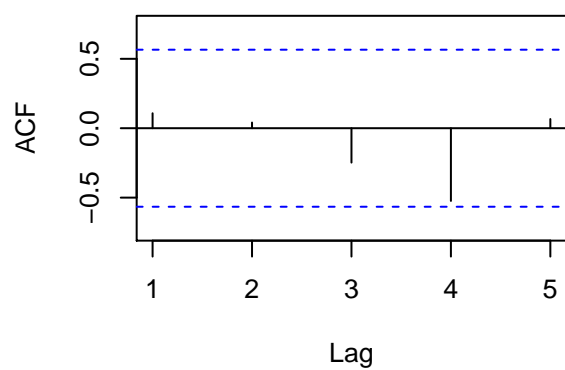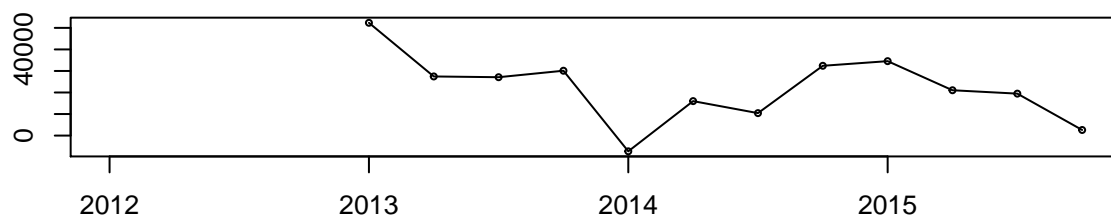# Portland, OR – Forest Highlands : Full TS Models Comparison
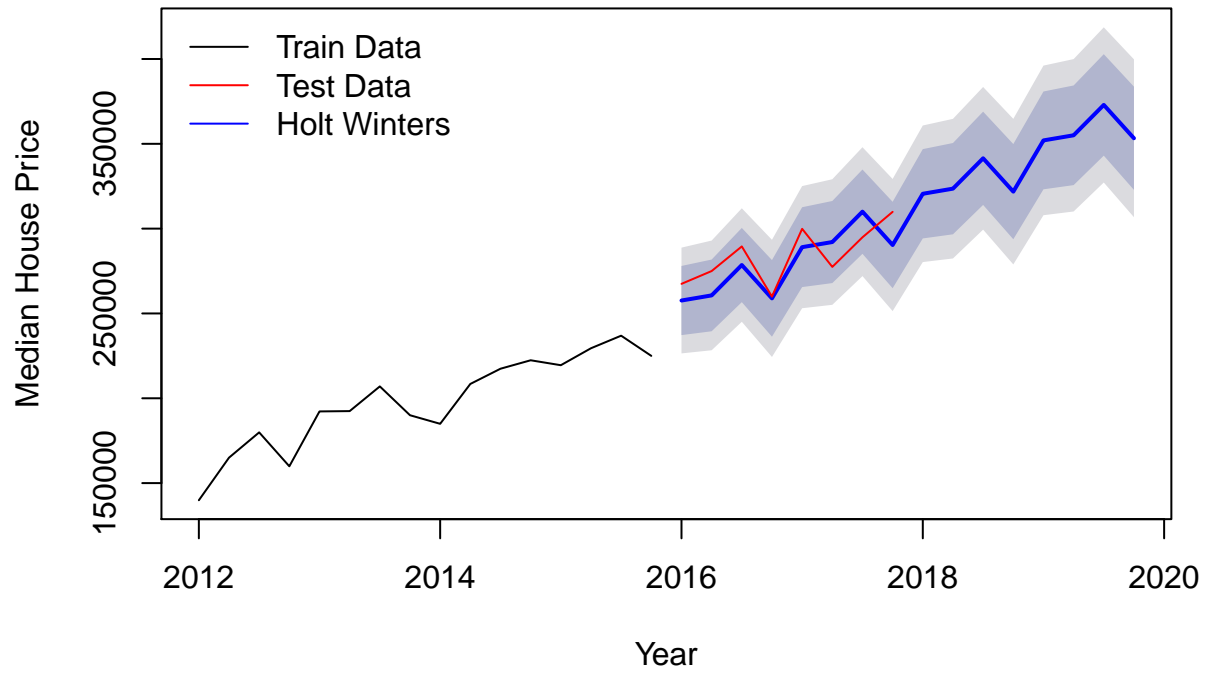
Portland, OR – Southgate
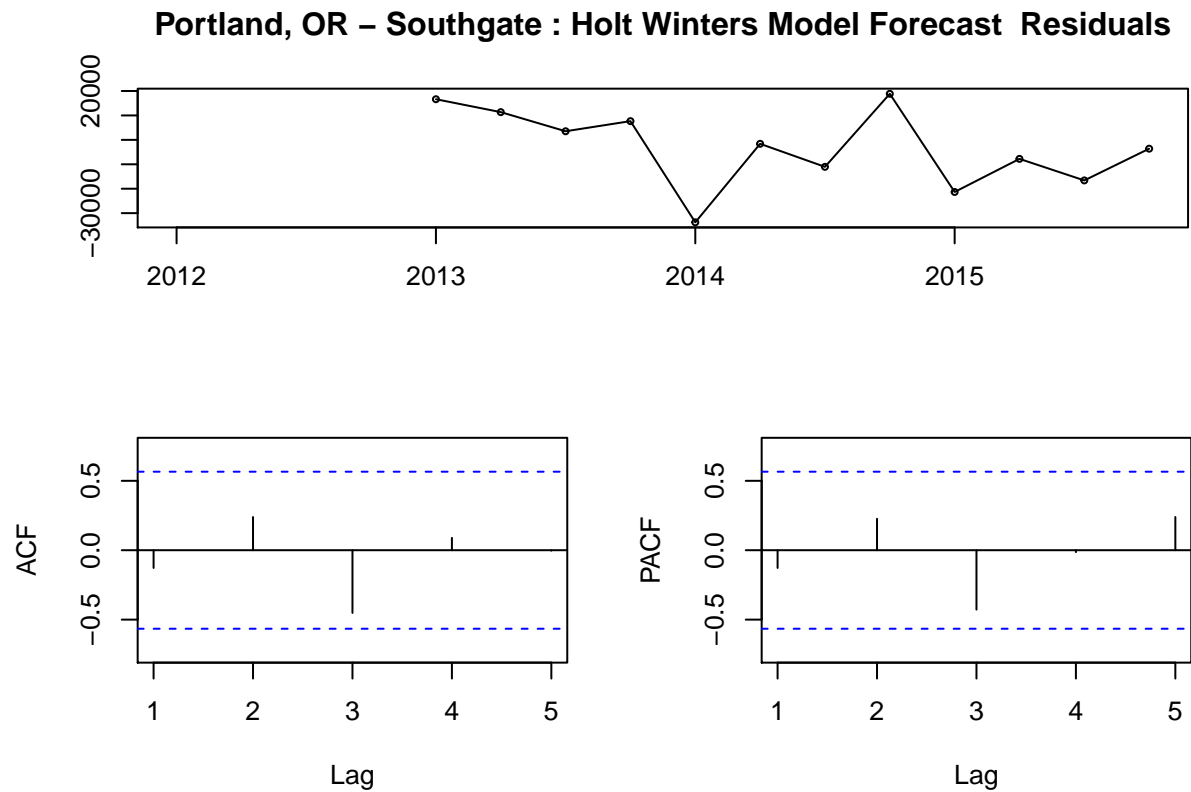
Portland, OR – Southgate : Naive Model Forecast

Portland, OR – Southgate : Naive Model Forecast Residuals

Portland, OR – Southgate : Holt Winters Model Forecast

Portland, OR – Southgate : Holt Winters Model Forecast Residuals
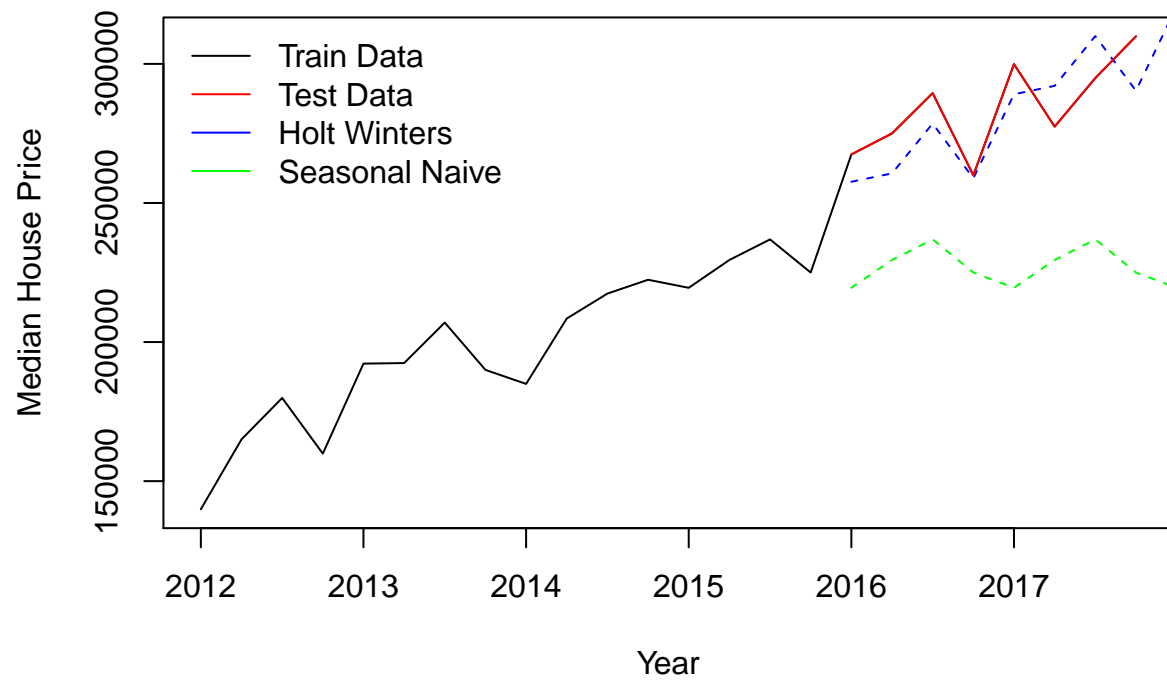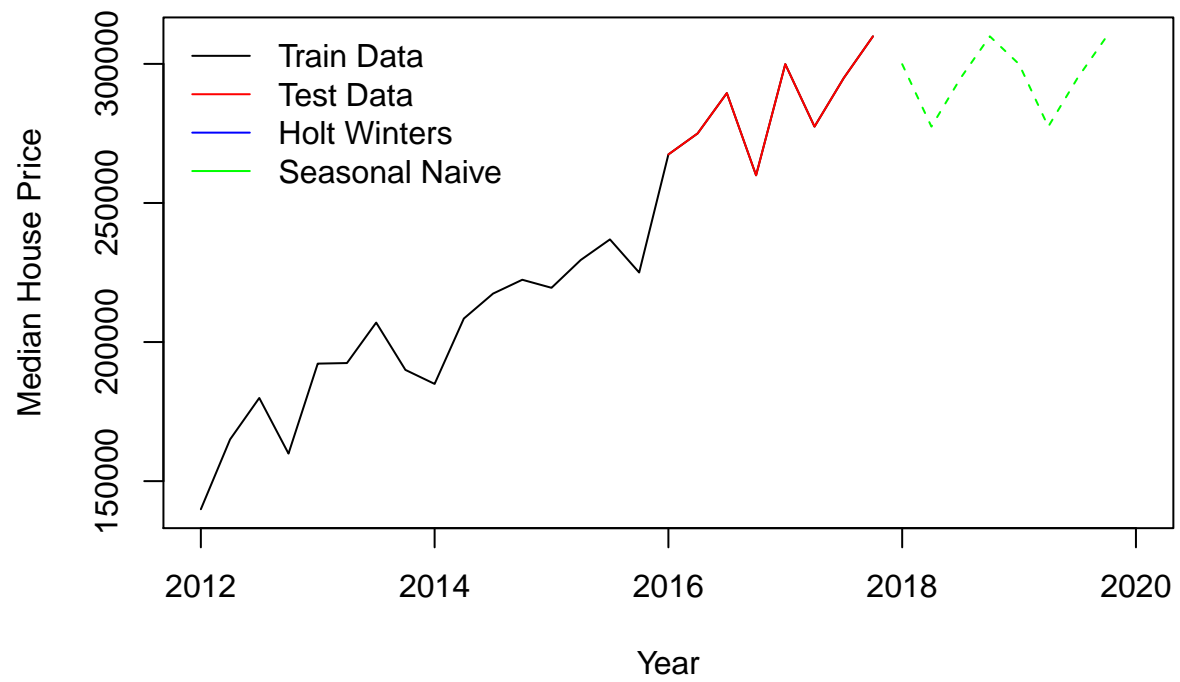


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Southgate"
##                   ME      RMSE      MAE      MPE     MAPE      MASE
## Training set 22182.88 26809.47 23399.54 10.65047 11.30831 1.000000
## Test set     56531.31 58836.08 56531.31 19.65547 19.65547 2.415915
##                   ACF1 Theil's U
## Training set  0.1079438        NA
## Test set     -0.2199474   2.56688
## [1] "Holt Winters Accuracy for  Portland, OR - Southgate"
##                   ME      RMSE      MAE       MPE     MAPE      MASE
## Training set -3141.945 15547.99 12815.22 -1.421492 6.216560 0.5476698
## Test set      4601.723 13066.88 12040.70  1.575108 4.175776 0.5145700
##                    ACF1 Theil's U
## Training set -0.12764617        NA
## Test set      0.02797653 0.5662981
```
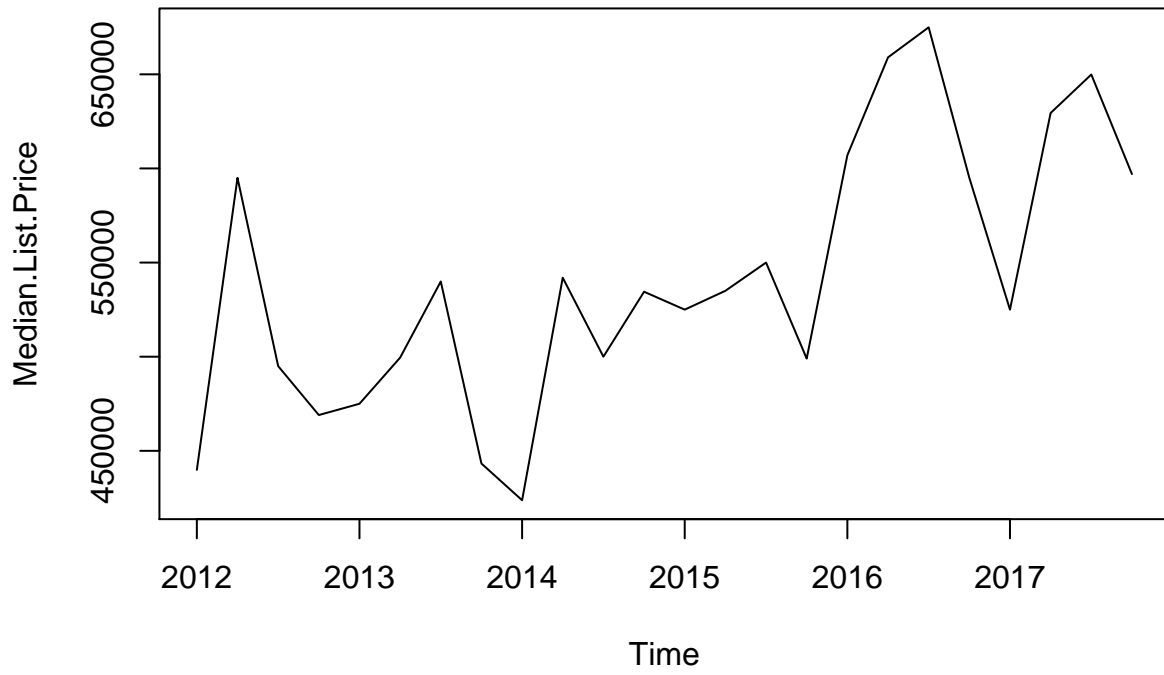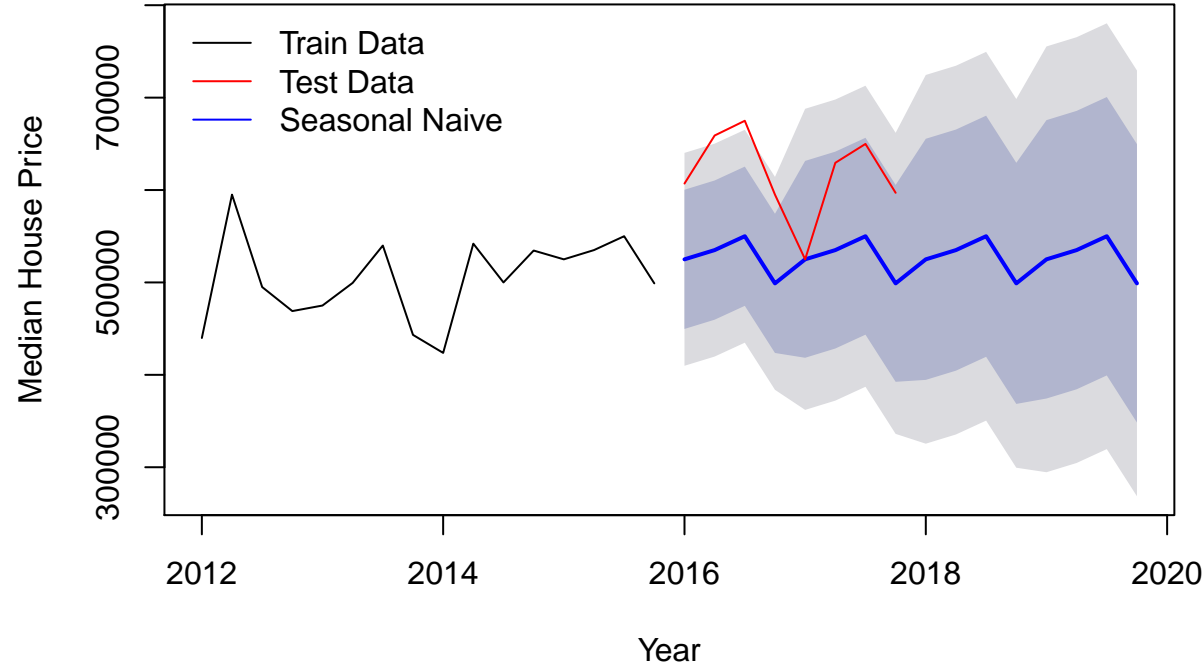
Portland, OR – Southgate : TS Training Model Comparison

Median House Price

Year

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Portland, OR – Southgate : Full TS Models Comparison

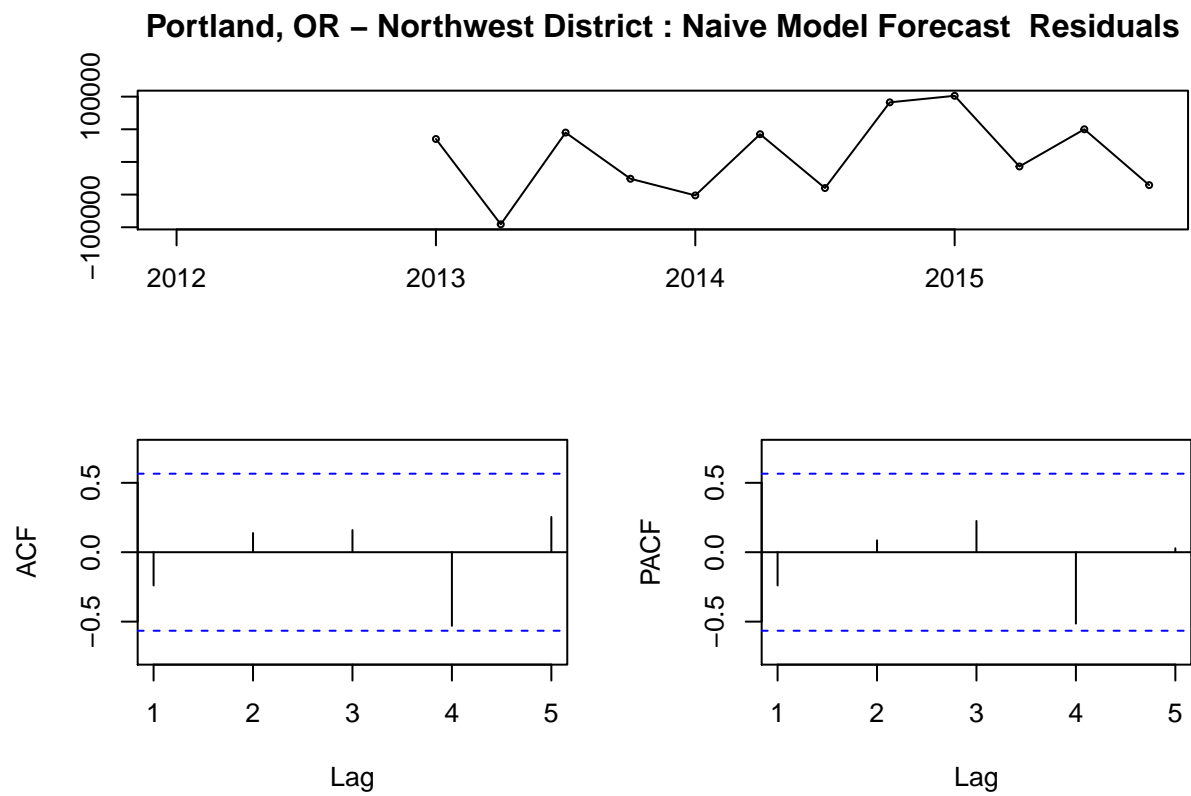# Portland, OR – Northwest District

Portland, OR – Northwest District : Naive Model Forecast
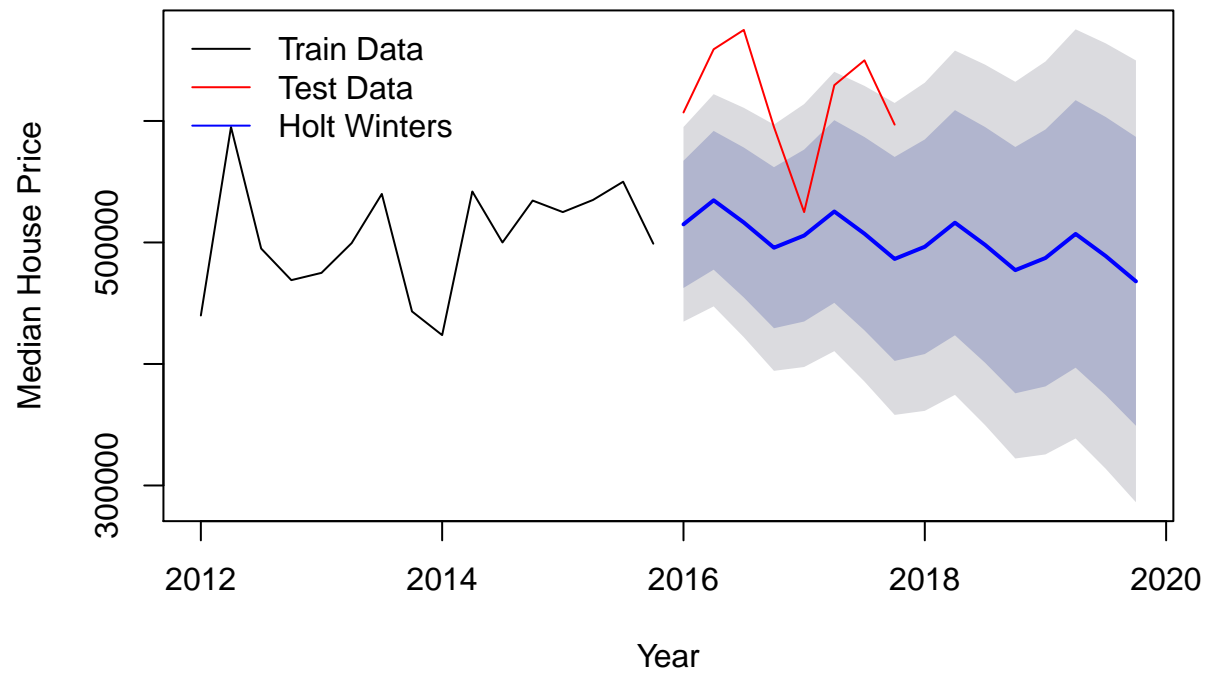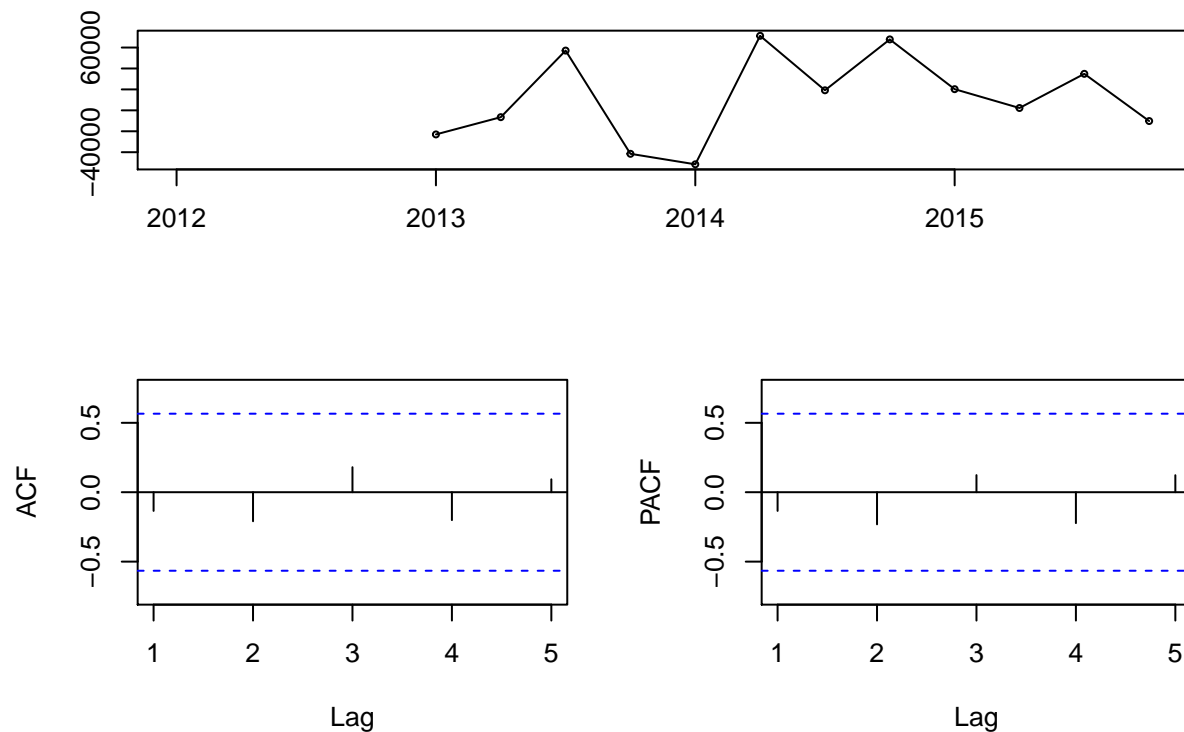
Portland, OR – Northwest District : Naive Model Forecast Residuals

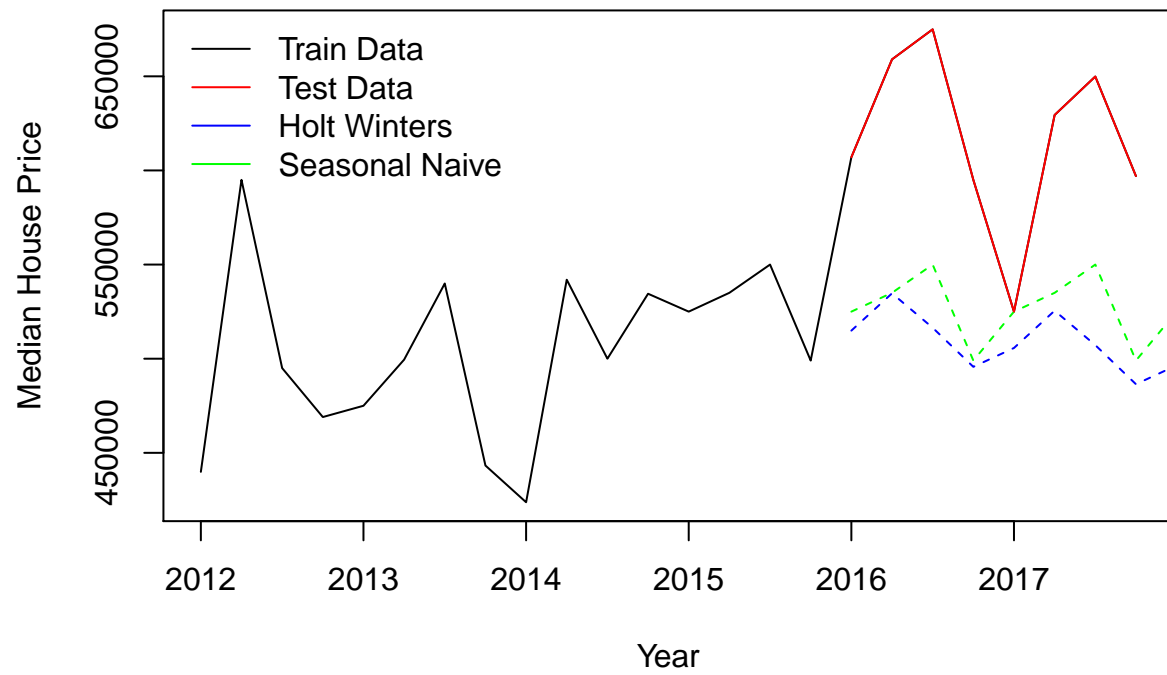# Portland, OR – Northwest District : Holt Winters Model Forecast

Portland, OR – Northwest District : Holt Winters Model Forecast Residuals

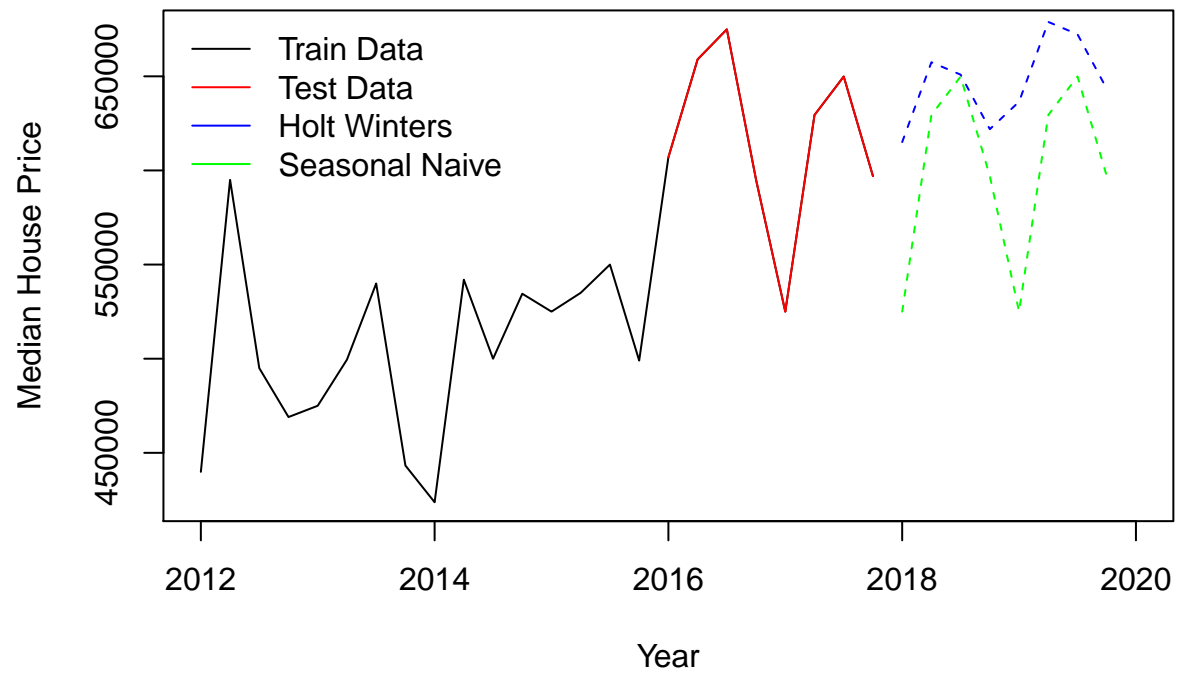
```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Northwest District"
##                     ME      RMSE     MAE      MPE     MAPE     MASE
## Training set   9175.0 58770.21 51658.5  1.297466 10.20186 1.000000
## Test set      89912.5 97103.88 89912.5 14.220569 14.22057 1.740517
##                    ACF1 Theil's U
## Training set -0.23950162        NA
## Test set      0.02869029  1.464754
## [1] "Holt Winters Accuracy for  Portland, OR - Northwest District"
##                      ME     RMSE       MAE      MPE     MAPE      MASE
## Training set   11640.55  40809.1  33790.04 1.757631  6.715441 0.6541043
## Test set      106336.65 113289.4 106336.65 16.858966 16.858966 2.0584541
##                    ACF1 Theil's U
## Training set -0.13466638        NA
## Test set      0.09811408  1.706976
```

Portland, OR – Northwest District : TS Training Model Comparison
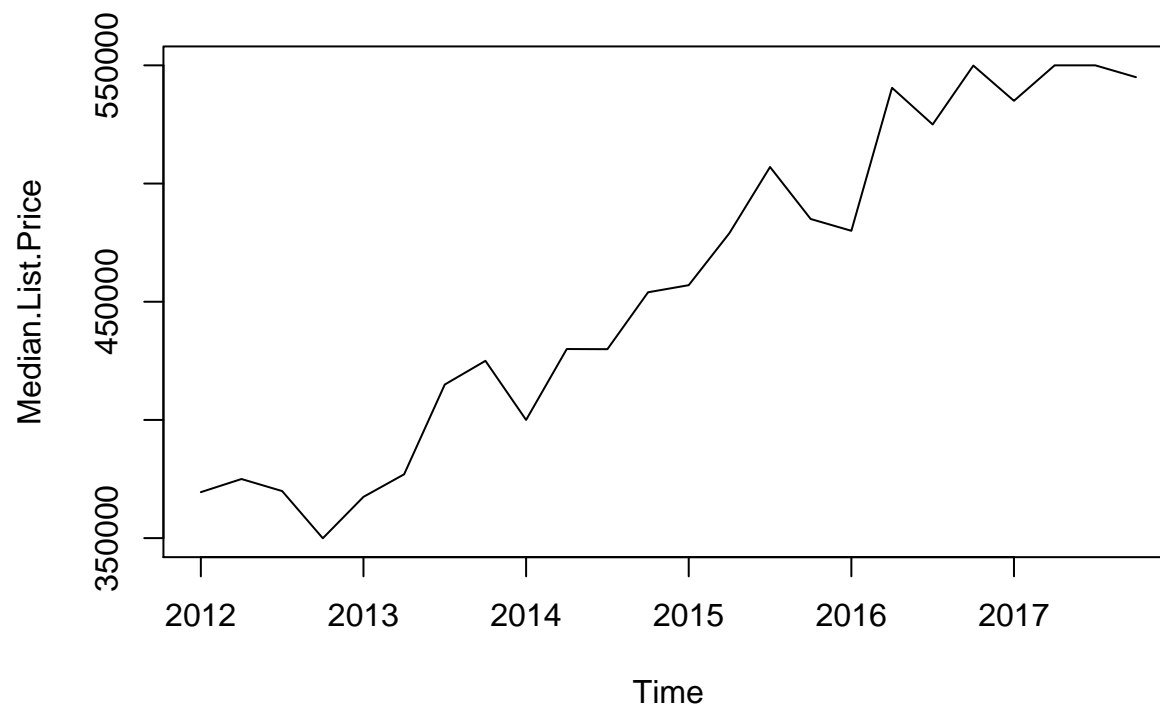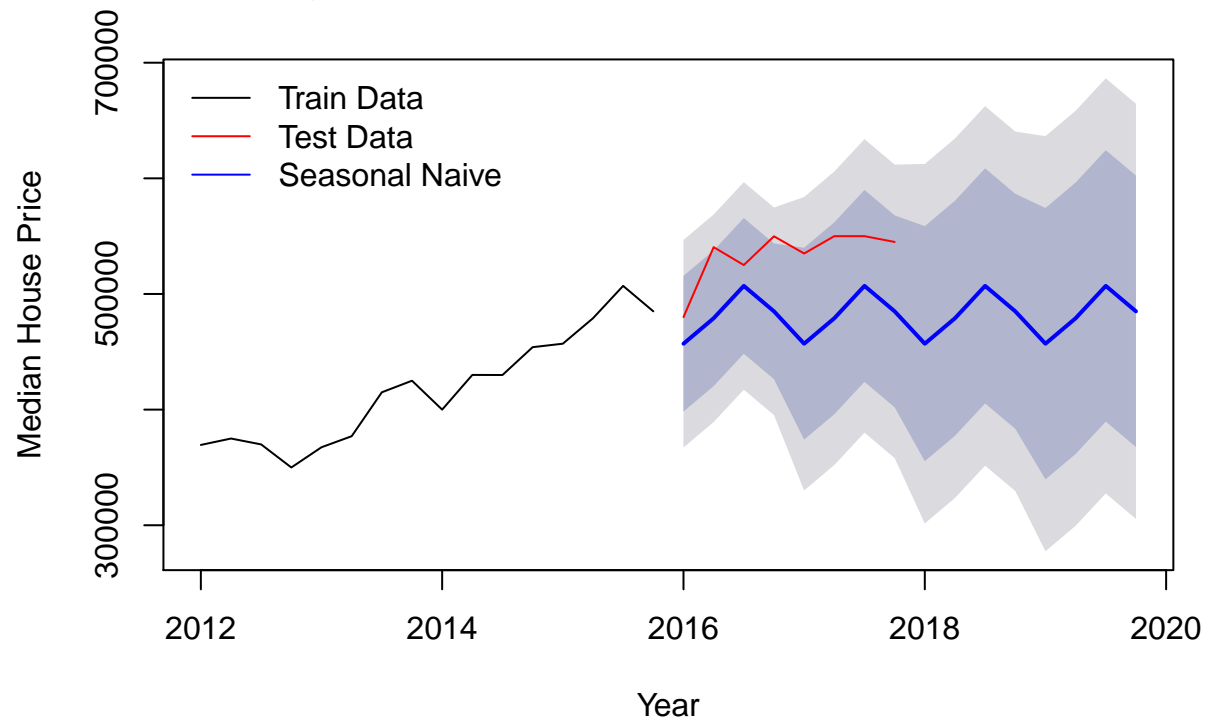
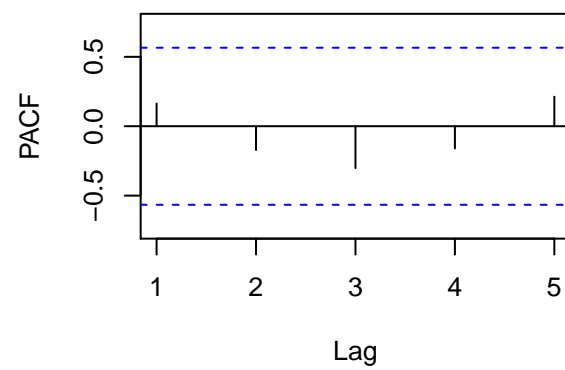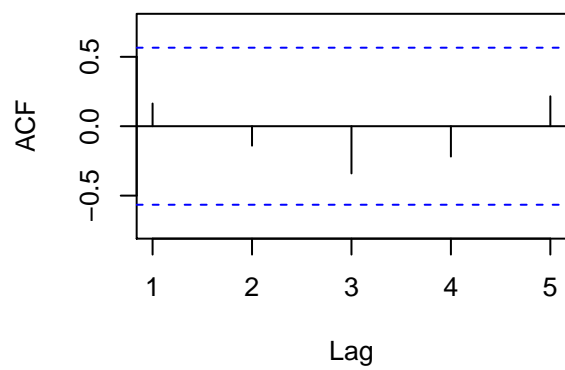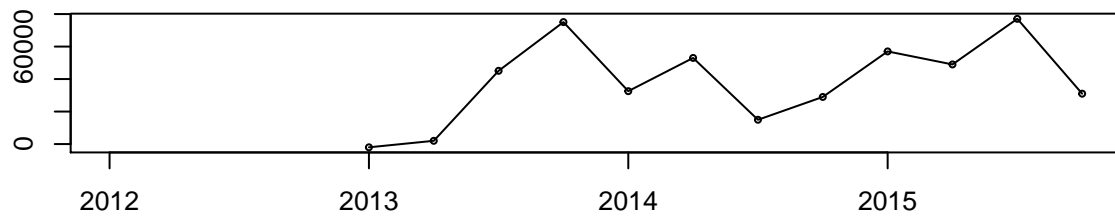# Portland, OR – Northwest District : Full TS Models Comparison
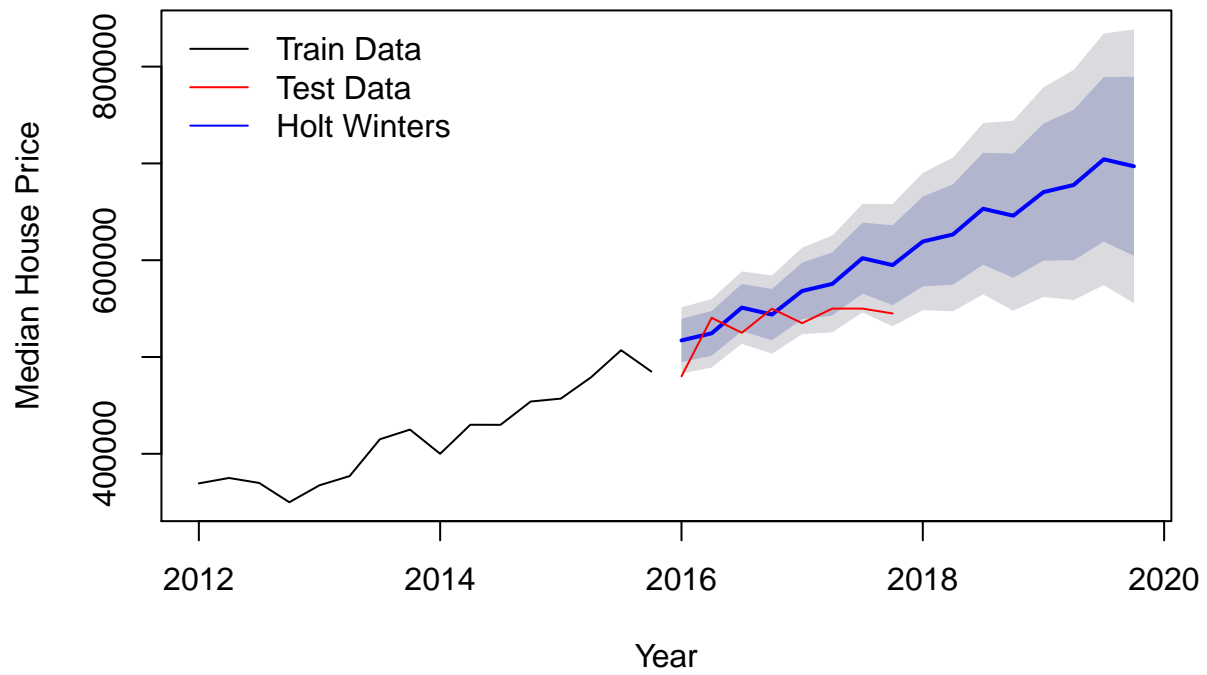
Portland, OR – Hawthorne District

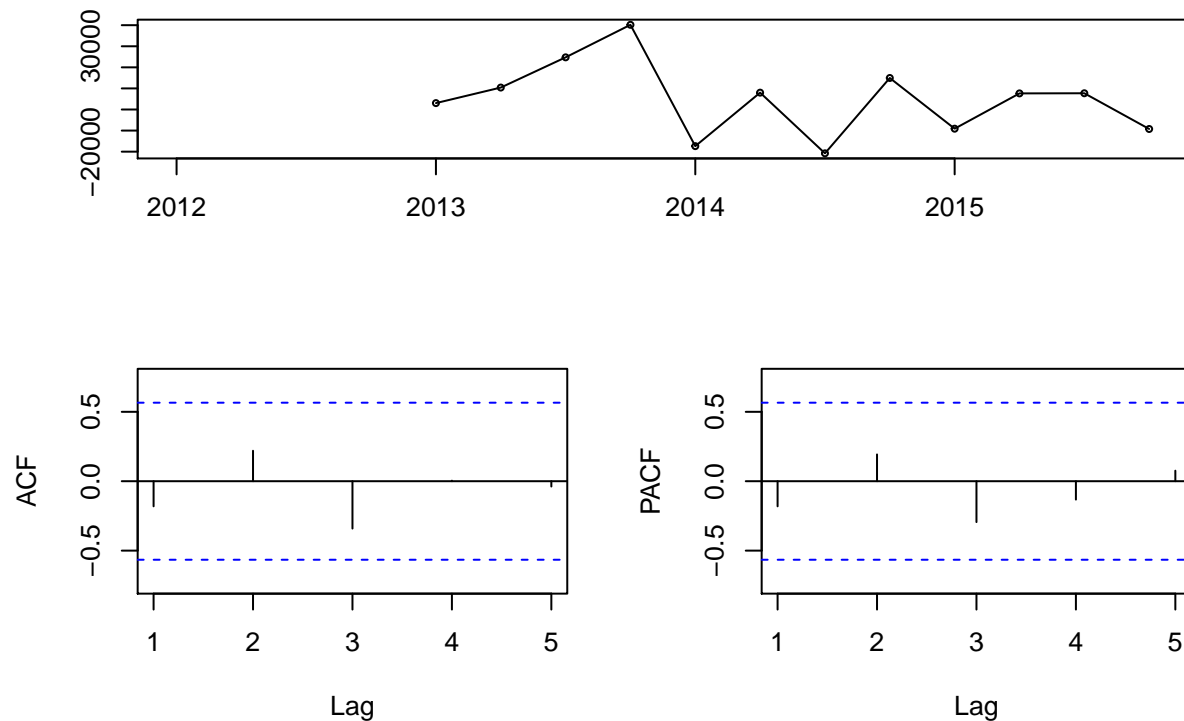Portland, OR – Hawthorne District : Naive Model Forecast

Portland, OR – Hawthorne District : Naive Model Forecast Residuals

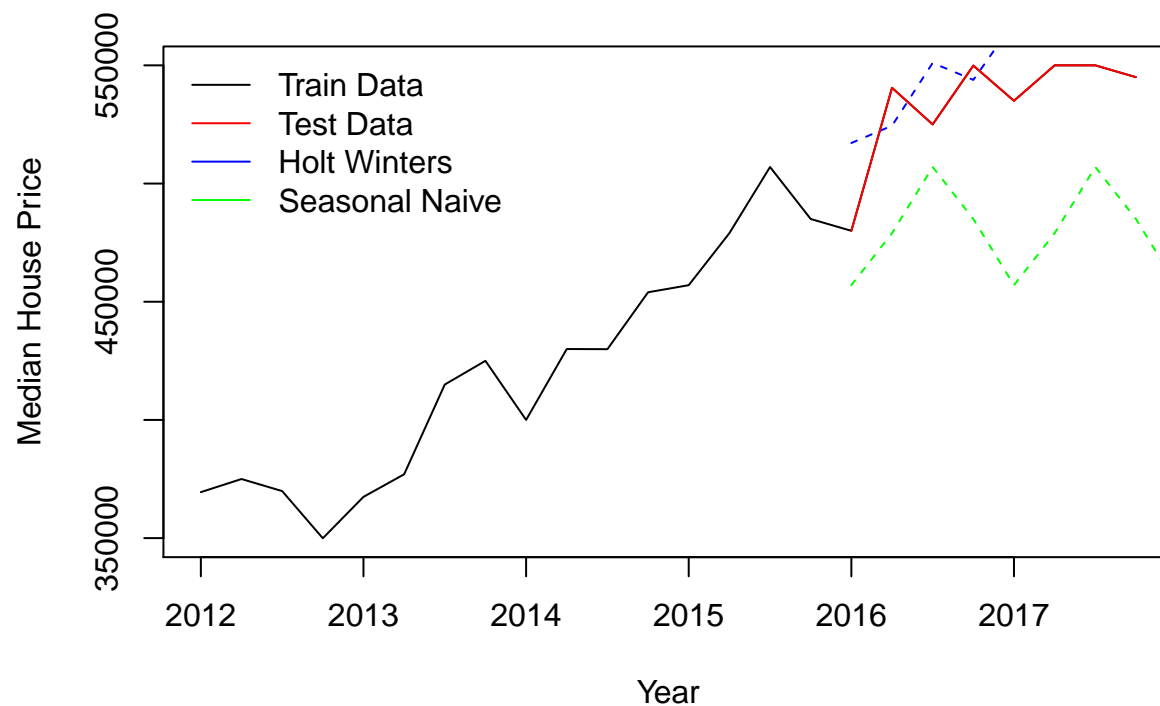# Portland, OR – Hawthorne District : Holt Winters Model Forecast

Portland, OR – Hawthorne District : Holt Winters Model Forecast Residuals

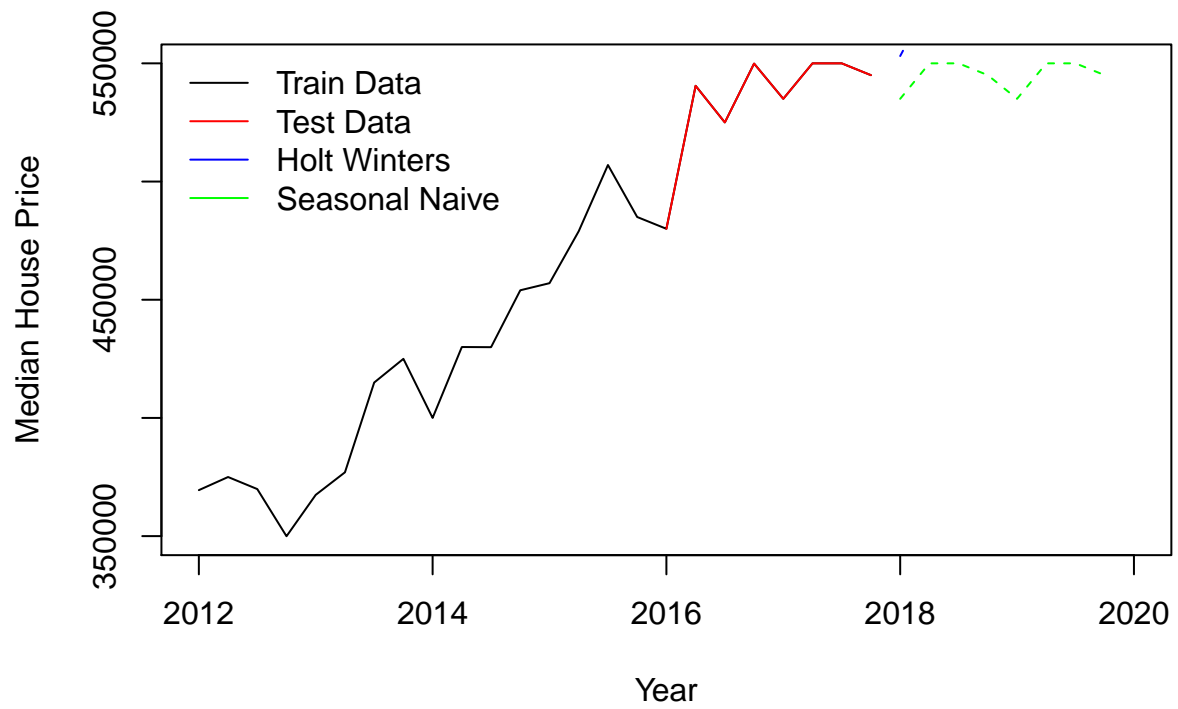
```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Hawthorne District"
##                   ME      RMSE    MAE      MPE      MAPE      MASE       ACF1
## Training set 38641.67 45786.48 38975 8.594287 8.685003 1.000000  0.1635997
## Test set     52425.00 56370.71 52425 9.714578 9.714578 1.345093 -0.1343104
##               Theil's U
## Training set        NA
## Test set      2.075264
## [1] "Holt Winters Accuracy for  Portland, OR - Hawthorne District"
##                   ME      RMSE      MAE       MPE      MAPE      MASE
## Training set   5011.352 17445.54 14431.33  1.182575 3.362453 0.3702715
## Test set     -25232.558 34120.36 30756.33 -4.764211 5.781398 0.7891297
##                    ACF1 Theil's U
## Training set -0.18100149        NA
## Test set     -0.02999711  1.139662
```

Portland, OR – Hawthorne District : TS Training Model Comparison
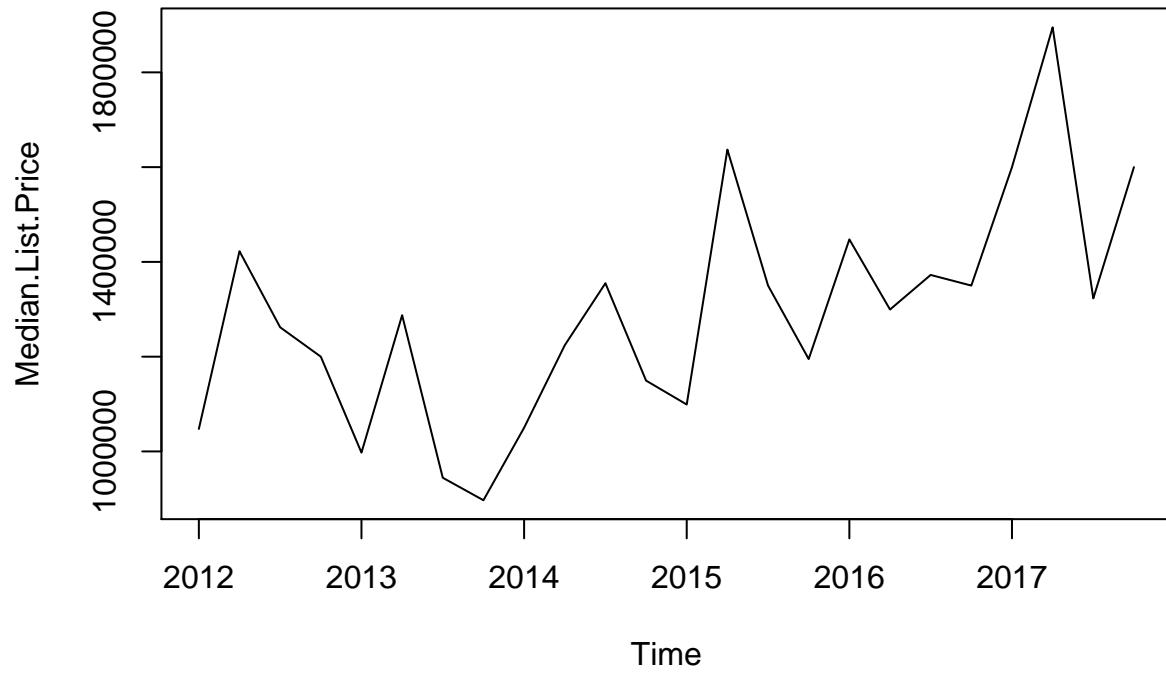
Portland, OR – Hawthorne District : Full TS Models Comparison
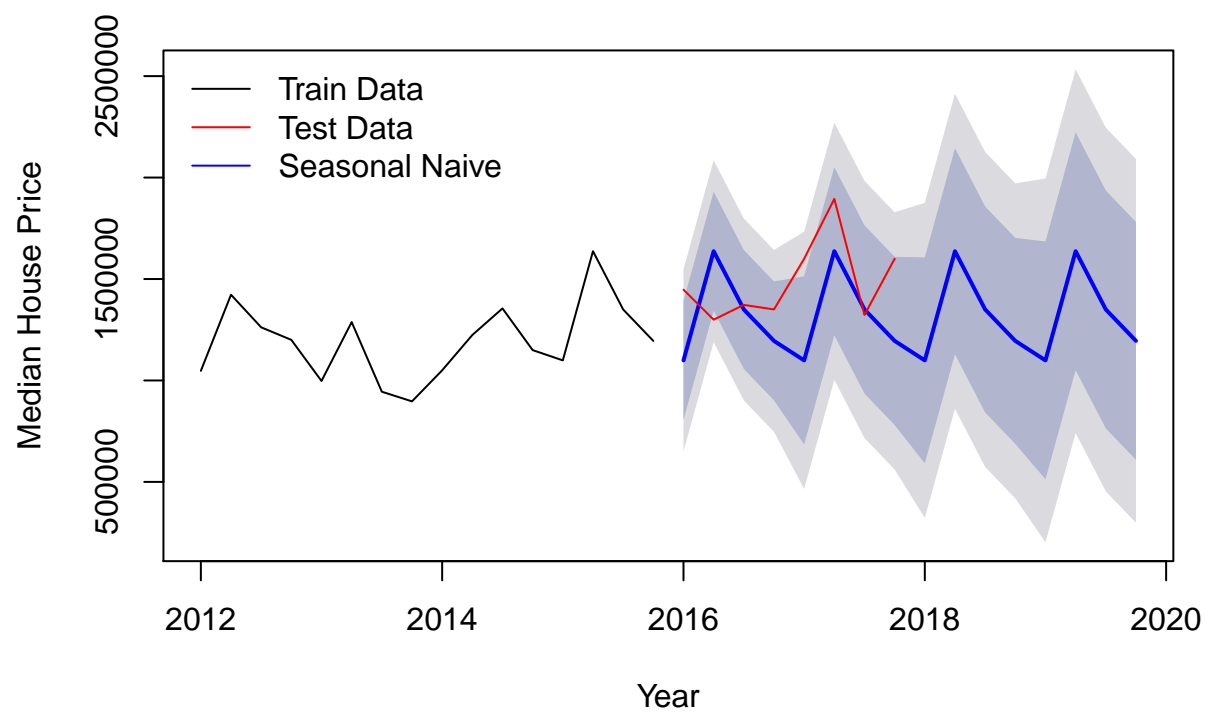
Legend:
- Train Data
- Test Data
- Holt Winters
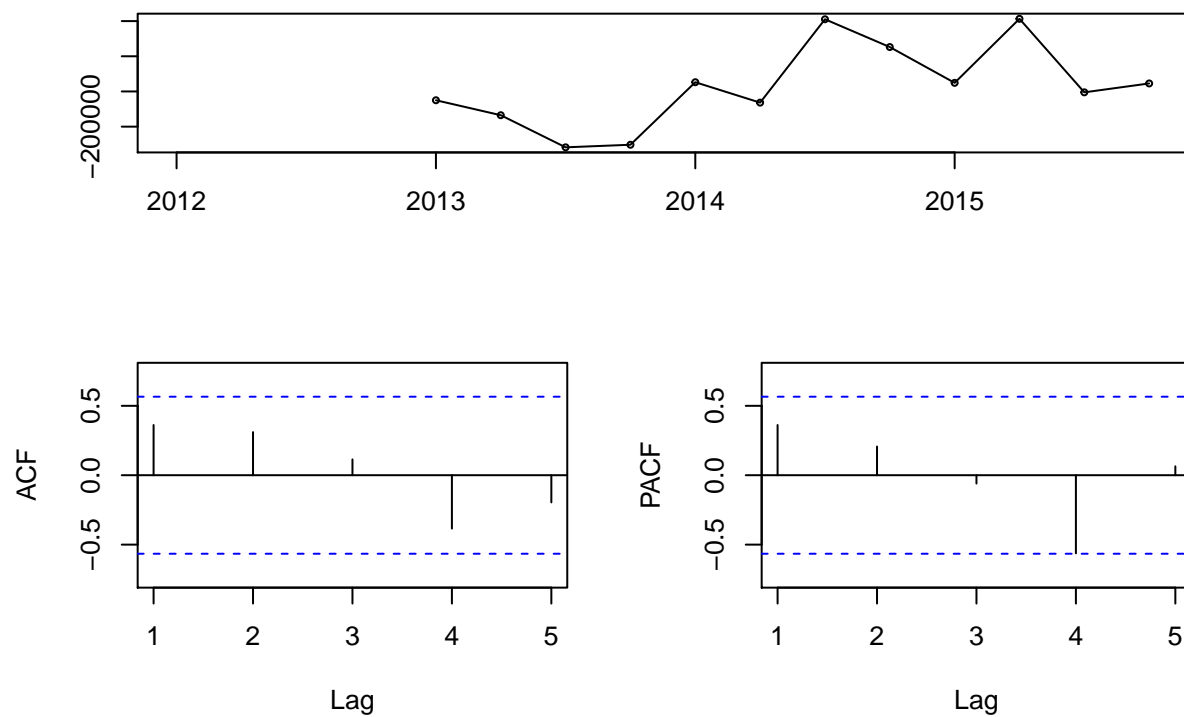- Seasonal Naive

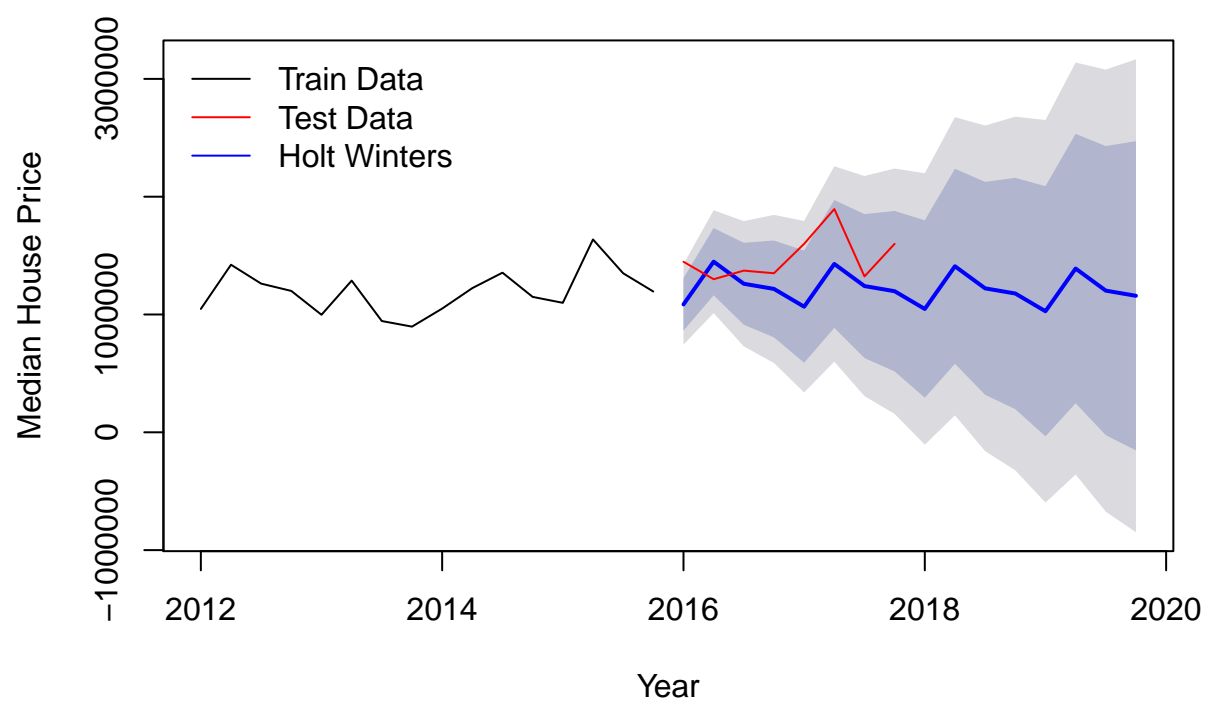Y-axis: Median House Price
X-axis: Year

Portland, OR – Dunthorpe
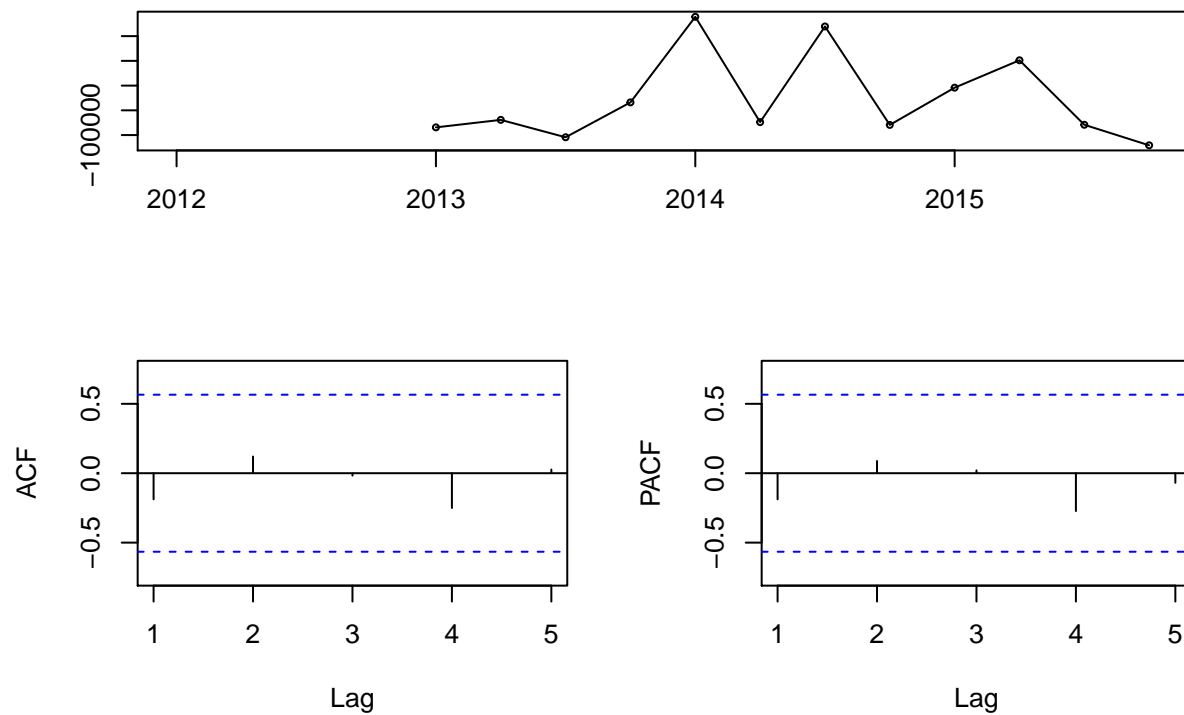
Portland, OR – Dunthorpe : Naive Model Forecast

Portland, OR – Dunthorpe : Naive Model Forecast Residuals

Portland, OR – Dunthorpe : Holt Winters Model Forecast
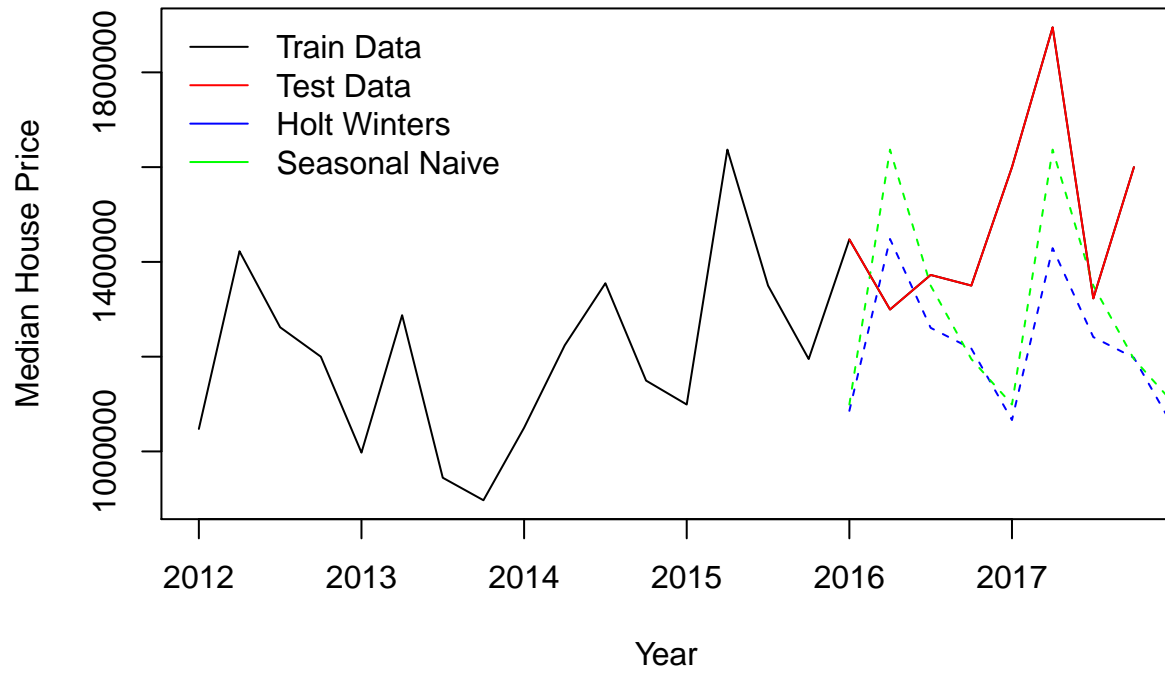
Portland, OR – Dunthorpe : Holt Winters Model Forecast Residuals


```
## [1] "Seasonal Naive Accuracy for  Portland, OR - Dunthorpe"
##                    ME      RMSE      MAE       MPE     MAPE     MASE
## Training set  29083.33 228666.5 174750.0 0.1921085 14.93397 1.000000
## Test set     165674.88 304571.0 256799.9 9.9274889 16.93057 1.469527
##                  ACF1 Theil's U
## Training set  0.3618090        NA
## Test set     -0.1051666   1.22349
## [1] "Holt Winters Accuracy for  Portland, OR - Dunthorpe"
##                    ME      RMSE      MAE       MPE     MAPE      MASE
## Training set  43399.39 172164.8 130533.5  3.227188 10.99628 0.7469727
## Test set     242645.63 326671.8 279873.1 15.098100 17.96286 1.6015631
##                  ACF1 Theil's U
## Training set -0.18814191        NA
## Test set     -0.02514386  1.292668
```

Portland, OR – Dunthorpe : TS Training Model Comparison

Portland, OR – Dunthorpe : Full TS Models Comparison

Legend:
- Train Data
- Test Data
- Holt Winters
- Seasonal Naive

Y-axis: Median House Price

X-axis: Year