

Portland Housing Price Prediction by Neighborhood

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

suppressWarnings(suppressMessages(library(dplyr)))
suppressWarnings(suppressMessages(library(fpp)))
suppressWarnings(suppressMessages(library(forecast)))
options(scipen=999)
#Set the neighborhood we want to use as our example throughout
neighborhood <- "Portland, OR - Lents"
```

Executive Summary

The City of Portland has experienced exceptional growth in the last 10 years [1]. This significant growth, along with the urban growth boundary [2] has led to average home prices in the city growing to all time highs and much faster than the national average. Our study looks to predict the future median home prices over the next coming years to see how this trend will impact affordability within the city and region.

This analysis defines affordability for the typical Portland household, then analyzes the each neighborhood's median sales price from 2012 through 2017. Evaluating the data shows significant variation in our dataset but three general trends are identified: the "flat but bouncy," most often correlated to high-priced neighborhoods; the "meeting price elasticity" found in the mid-market priced areas; and the "up-and-coming," appearing farther out from the city center. We then project median sales prices forward for <#> years and compare where affordability maps.

This information is valuable for several government and business purposes. Local and state legislators can identify and control for, or assist those affected by radical growth in housing prices and the impacts of gentrification. For business and construction, these trends can identify areas or neighborhoods that look to be show a balance between good value and likely ongoing growth in final sales prices. This would likely be housing developers or your single family home "flippers."

Ultimately, this data provides a simplified view into the complexities of real estate in one of the nation's hottest markets. It projects that trends remain hot and identifies that, over time, housing prices have continued to drive average home buyers further from the city center likely driving current residents in these highly sought after areas out.

Business problem

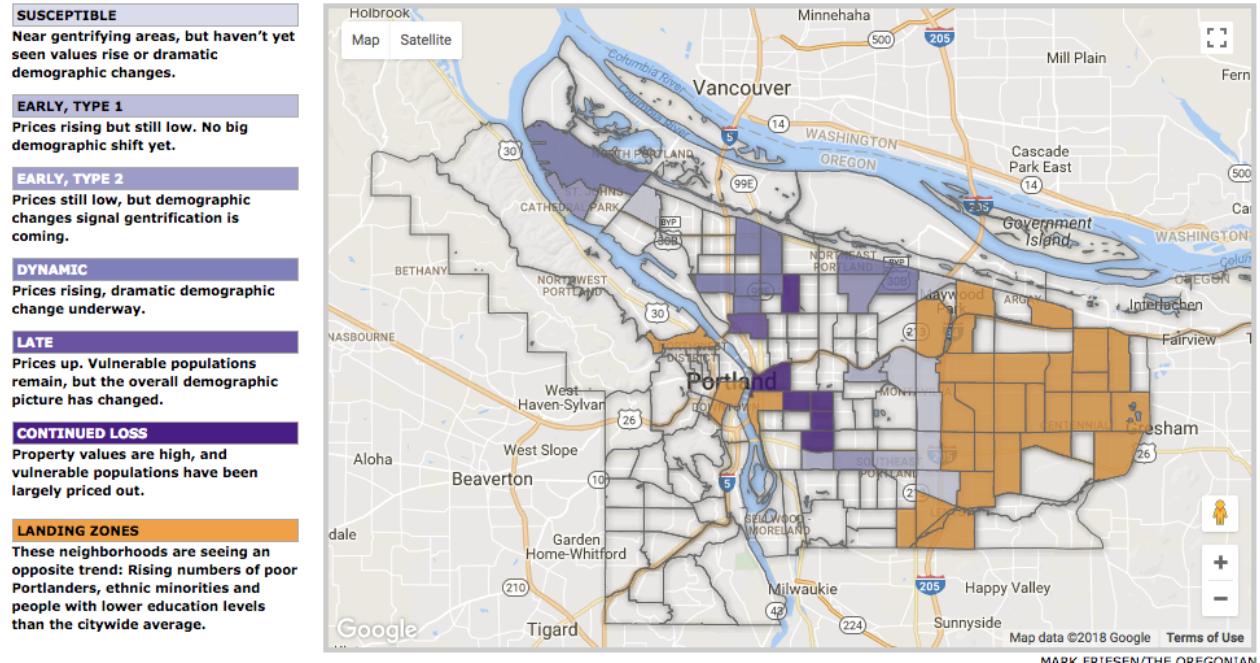
This is an analysis of real estate pricing information for Portland, Oregon. Our interest is to predict how quickly the median housing price will climb within the city and compare that against the average family income. While identification of the overall trend in Portland is interesting, our group has broken the city down by neighborhood in order to classify and identify variations and trends across the region.

If you are in real estate, then you should invest in areas with high growth in median sales prices predicted. If you are a city planner, you should focus your anti-gentrification policies and housing affordability efforts in these neighborhoods to reduce displacement in the resident populations.

Related Work

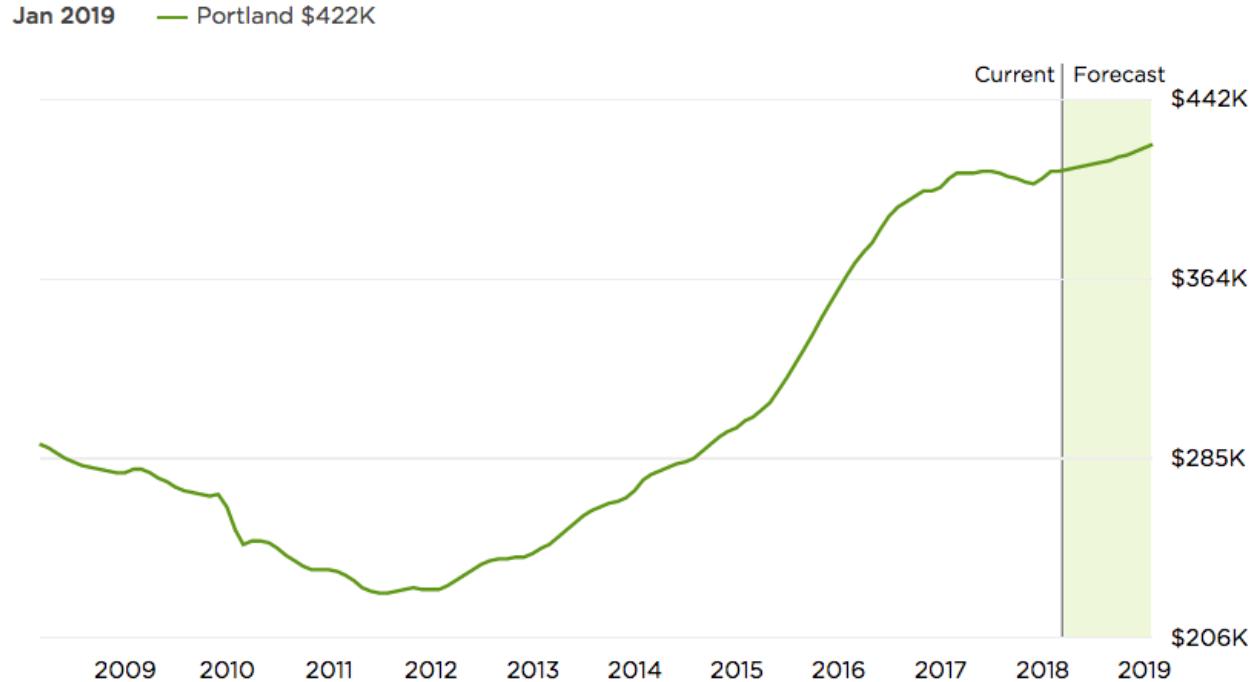
Portland's Bureau of Planning and Sustainability's R

The majority of our work has focused on the isolation of appropriate data from our initial dataset and preparation for time series analysis. To determine the relevance of this undertaking, we did a survey of the topic and found several interesting correlaries. Oregon Live is hosting an interactive map on this topic, showcasing a similar effort: to determine what neighborhoods are under pressure from gentrification and which are likely to be next. [3] “Map of Gentrification in Portland” This study was generated by city planners from Portland’s Bureau of Planning and Sustainability. [4]



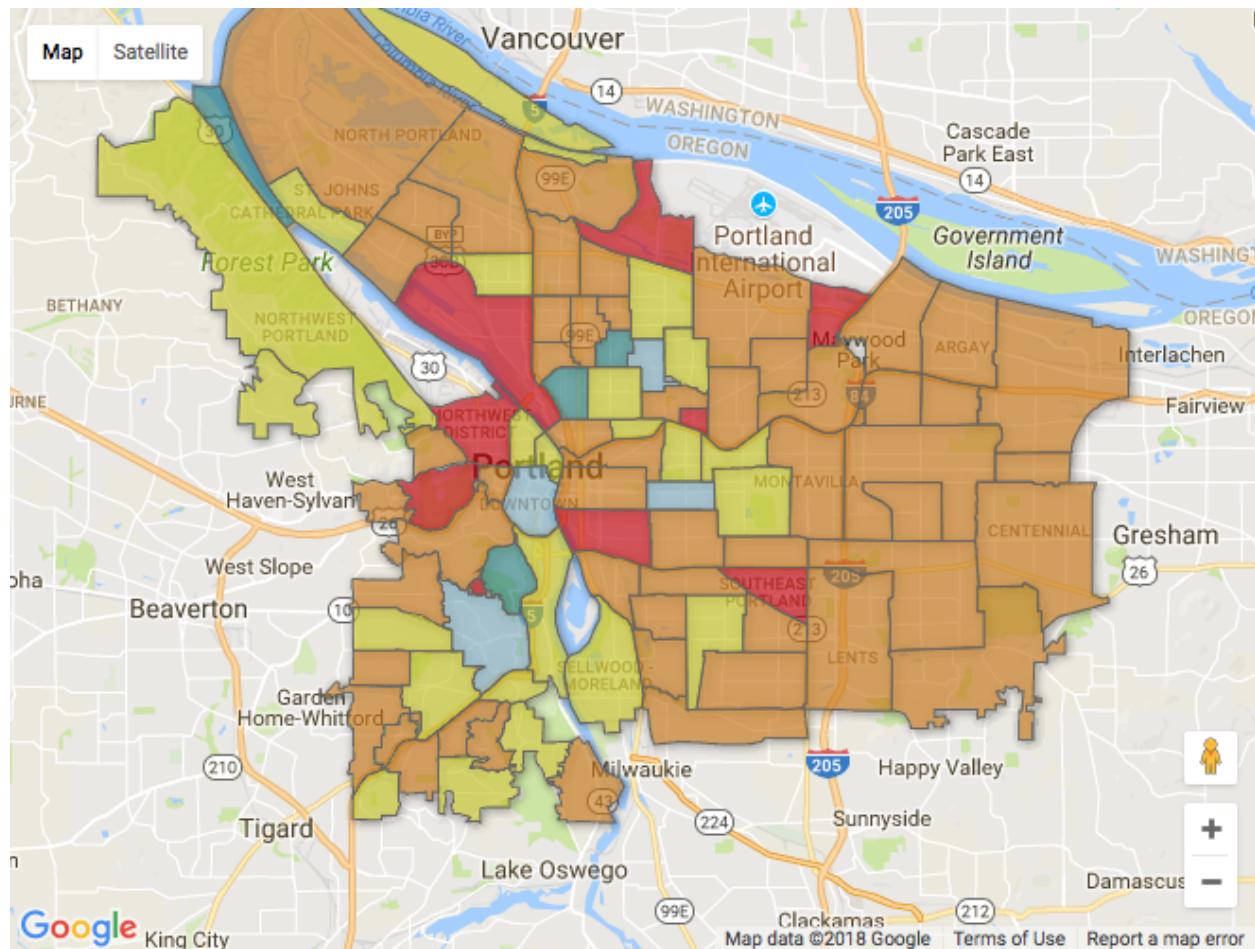
Zillow

Zillow has a wealth of information including their own proprietary “Zestimate”[5] of a single properties estimate market value. As we explored their blogs and sites, we also found have historical information for the median home prices for all of Portland with a forecast [6] that only goes out one year. They provide this information and a “market temperature” gauge to indicate if it’s a buyer or seller’s market.



Portland Monthly Magazine

Those two examples were helpful as each was trying to show an element of our project, the mapping of data to location and the forecasting of prices. Another report by Portland Monthly magazine [7] examined Portland's neighborhoods median change in price over one year, breaking the increases into blocks of price increases. This visual shows that some popular inner-city neighborhoods continue to show 20% or higher increases in median sale price, while the majority of the outer city area, particularly the eastside have growth rates between 10-19%. This reflected our expectations and was another data point to make comparisons.



Map Legend: Change in Median Home Price Over 1 Year

■	20% or more increase	■	10 - 19% increase
■	Less than 10% increase	■	Less than 5% decrease
■	5% - 9% decrease	■	10% or more decrease
■	Unreported		

S&P CoreLogic Case-Shiller Home Price Indices

We used a lot of resources in our research and evaluation but another important one to mention here is the S&P CoreLogic Case-Shiller Home Price Indices. [8] This is an industry-standard for measuring the housing market and has been another great piece of data to compare against as we worked through our project. While we did not design a methodology to compare directly against this index, its value as a cross-regional market data point could be used in future evaluations and comes up in many real estate research and evaluations as a key metric for market performance over time.

Data Source, Data Exploration, Descriptive Statistics, Variable Selection

Our project required two data explorations: 1) defining and projecting affordability, and 2) forecasting median sales price by neighborhood in the city of Portland.

Affordability

For the first, we gathered and simplified criteria to use a generic, but Portland-based housing affordability rating over time. Given the large number of variables involved in purchasing a home, securing a mortgage, etc., we had to make a number of assumptions, detailed later on. Our goal was to create a synthetic but representative value showing a average homeowner's purchasing power within this market. Our key datapoints and their sources were:

1. **Average Mortgage Rate** - Freddie Mac: 30-Year Fixed-Rate Mortgages Since 1971
 2. **Portland Median Family Income** - Department of Numbers: Portland-Vancouver-Hillsboro Oregon Household Income
 3. **Average monthly Mortgage Payment** - [The Motely Fool: This Is the Average American Homebuyer In] 2017](<https://www.fool.com/mortgages/2017/02/27/this-is-the-average-american-homebuyer-in-2017.aspx>)
 4. **Average down payment** - 14% Sammamish Mortgage: Average Monthly Mortgage Payment in Portland, Oregon: 2017
 5. **Average Homebuyer Mortgage** - The Present Value of the time-specific mortgage rate, the periods (360), and the monthly mortgage payment.
-

Past and Projected Housing Affordability for Portland Median Family

Year	Average Mortgage Rate	Portland Median Family Income	Average Monthly Mortgage	Average Homebuyer Purchase Price
2022	4.15%	\$94,918	\$1,819	\$426,648
2021	4.15%	\$92,585	\$1,775	\$416,162
2020	4.15%	\$90,252	\$1,730	\$405,675
2019	4.15%	\$87,919	\$1,685	\$395,189
2018	4.15%	\$85,586	\$1,640	\$384,703
2017	3.99%	\$83,253	\$1,596	\$381,487
2016	3.65%	\$82,734	\$1,586	\$395,169
2015	3.85%	\$78,183	\$1,499	\$364,392
2014	4.17%	\$73,419	\$1,407	\$329,225
2013	3.98%	\$73,550	\$1,410	\$337,433
2012	3.66%	\$73,386	\$1,407	\$350,088

Assumptions

1. Average Mortgage Rate was the annual average for 30-year fixed rate mortgages as reported by Freddie Mac.

- We used a naive forecast for future annual mortgage rates, pegged to the current rate.
2. Median Family income was for Portland and was inflation adjusted.
 - Median family income was projected until 2022 using a simple line of best fit calculation.
 3. Average monthly mortgage was calculated by multiplying the annual median family income by the front-end debt-to-income ratio, divided by 12 months.
 - The front-end debt-to-income ratio is the buyer's new mortgage payment as a percentage of their pre-tax income
 4. Average down payment is for 2017 and applied to all years.
 5. No other household debts were taken into account.
 - As a comparison, the back-end debt-to-income ratio was 35%.
-

Forecasting Median Sales Price

Data Source

The data for our analysis was sourced from the Redfin Data Center. The first things we had to do was convert a Tableau workbook file into a CSV. This compressed source file resulted in a 1.4GB CSV file with 3.9 million observations. The data provided 47 variables. Since we were focused on Portland, our first pass was to filter to only Oregon and drop any observations with missing data. Then we begin reviewing the data. At this point, we were unsure if we would focus on the city alone, or the metro area. This left us with 65,765 observations.

Our first real dive into the data we found replication in a few areas. There were a lot of overlapping observations as the data provided "Region Types" which broken down sales info for city, zip, place, and neighborhood. As we were only interested in the City of Portland, we sorted this dataset down to the "neighborhood" type.

Summarizing and Exploring

Next we went into removing unnecessary variables and after coming up with three major categories: Home Data, Time Data, and Location Data that would prove useful for our dataset, we dug into summarizing and visualizing. This segmentation of our dataset consisted of 6,836 observations and 13 variables. Median Sales Price being our predictor.

Once we had limited the scope of our variables selected, we started summarizing to explore the data a bit further.

Data Cleaning Processing

#Load and Filter Data

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

```
#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")
```

Type of Variable	Variable Name	Action/Filter	Description
Home Data	Avg Sale To List		Avg sale to list difference in \$
	Homes Sold		# of homes sold in region
	Inventory		Current housing inventory
	Median Sale Price	PREDICTOR	Median Sale Price
	Months Of Supply		Months of Supply
	New Listings		# of new listings on the market
	Property Type	"All Residential"	Property type : filtered
Time Data	Period Begin		Period beginning date
	Period End		Period end date
	Period Duration		days in period of observation
Location Data	Region		Name of the Region
	Region Type		Zip, place, neighborhood, county
	State Code	"Oregon"	State: Filtered for Oregon

Figure 1: Final Variables for Prediction

```

## [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
##

```

#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"
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

```

#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"
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
```

Filter to final dataset

```
#Select only the final variables
selected.var <- c(2, 6, 9, 24, 30, 33, 34, 35, 40)

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

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

This led us to realize that several of our selected variables were unnecessary or useless. Months.Of.Supply had an NA value for all observations and Property.Type was all the same value. With the data sorted, we no longer needed the Region.Type or State as they were the same value for all observations as well. None of these would be helpful in building a predictive model, thus they were eliminated.

Exploring at this stage is where we determined that our data set was based on 90 day time slices that overlapped. There were 95 neighborhoods and each had exactly 72 records, meaning there was one timeslice for each month over the period of 6 years, 2012 through 2017. The summary info showed that the data was also in aggregate, not individual sales. Each observation showed the numbers of homes sold, the inventory during that 90 day window, etc. as an average of all houses for that neighborhood. The mean homes sold and inventory were 53.8 and 32.7 respectively, so at least these averages were based on a decent amount of activity. There were minimum values of 1 for both homes sold and inventory, so obviously we would have some rough numbers sprinkled throughout. Later this was seen in some of the more expensive neighborhoods as “spiky” time series.

With the 90 day time slices, we decided to select periods of January-March, April-June, July-September, and October-December in order to avoid overlapping data. It appears that Redfin’s analysis of this data used each 90-day average to represent the month in which the period ended. This causes overlapping but also results in smoother data and more data points. We ultimately decided to keep the data to the four data points per year to keep the runtime and experimentation realistic for the time available for this group project. This also lead us to evaluate the data using seasonality-based models.

Timeseries Time

Now that we had all the pieces ready, it was time to build our first timeseries plots. We started by building a loop and iterating through all neighborhoods. This was the basis for all of our operations, though as we added multiple models and complexity, it took a long time to run. Below is an example of one of our timeseries plots. The full listing of plots is available in Appendix A: A Whole Bunch Of Plots.

```
# create the timeseries
oneNeighborhood.df <- neighborhoods.df [neighborhoods.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|18|19|11|12|", oneNeighborhood.df$Period.Begin)]
# somehow they are out of order, now to sort the period.begin
oneNeighborhood.df <- oneNeighborhood.df [order(as.Date(oneNeighborhood.df$Period.Begin, format="%m/%d"))

# select the median price column for the timeseries
```

```

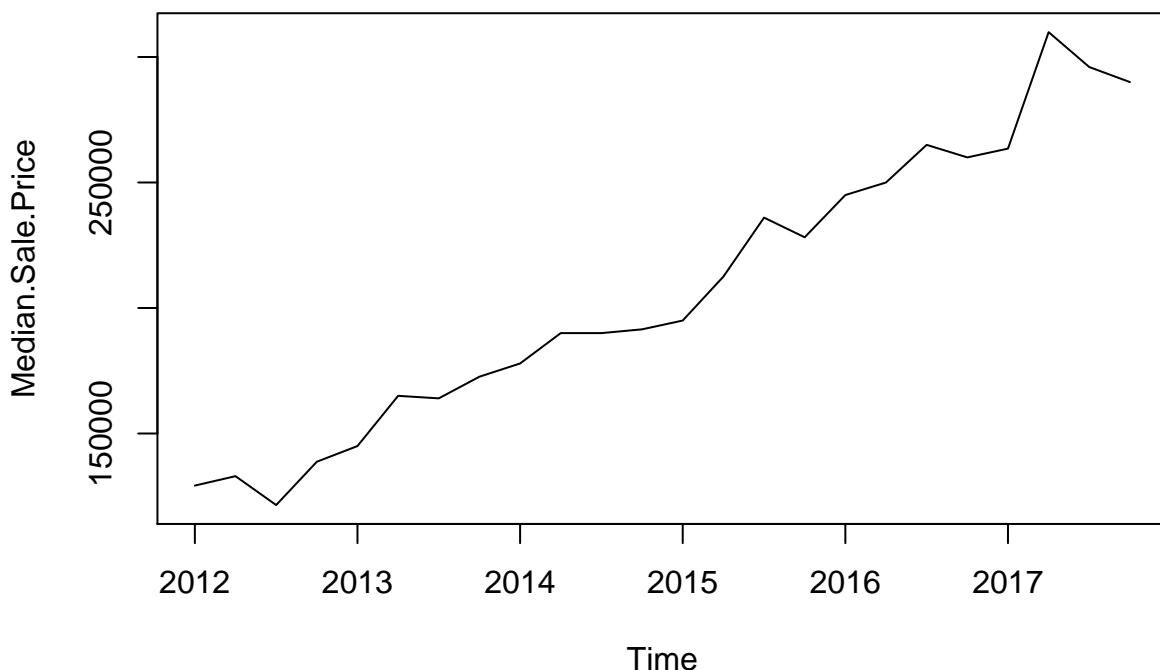
oneNeighborhood.df <- oneNeighborhood.df[c(4)]

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

#Plot timeseries
plotTitle <- paste(neighborhood, ": Timeseries")
plot(oneNeighborhood.timeseries, main=plotTitle)

```

Portland, OR – Lents : Timeseries



Methodologies Considered

Now that we had a working timeseries broken into seasonal segments, and a loop structure that can iterate through all 95 neighborhood objects, it was time to try and test various forecasting methods and check for accuracy. Below are graphs of the four models that we ran against the full timeseries data prior to splitting or doing training and test data runs.

```

#set plot options once

#select a neighborhood into a dataframe
oneNeighborhood.df <- neighborhoods.df[neighborhoods.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.BeginMonth)]

```

```

# somehow they are out of order, now to sort the period.begin
oneNeighborhood.df <- oneNeighborhood.df[order(as.Date(oneNeighborhood.df$Period.Begin, format="%m/%d/%Y"), oneNeighborhood.df$Period.Begin),]

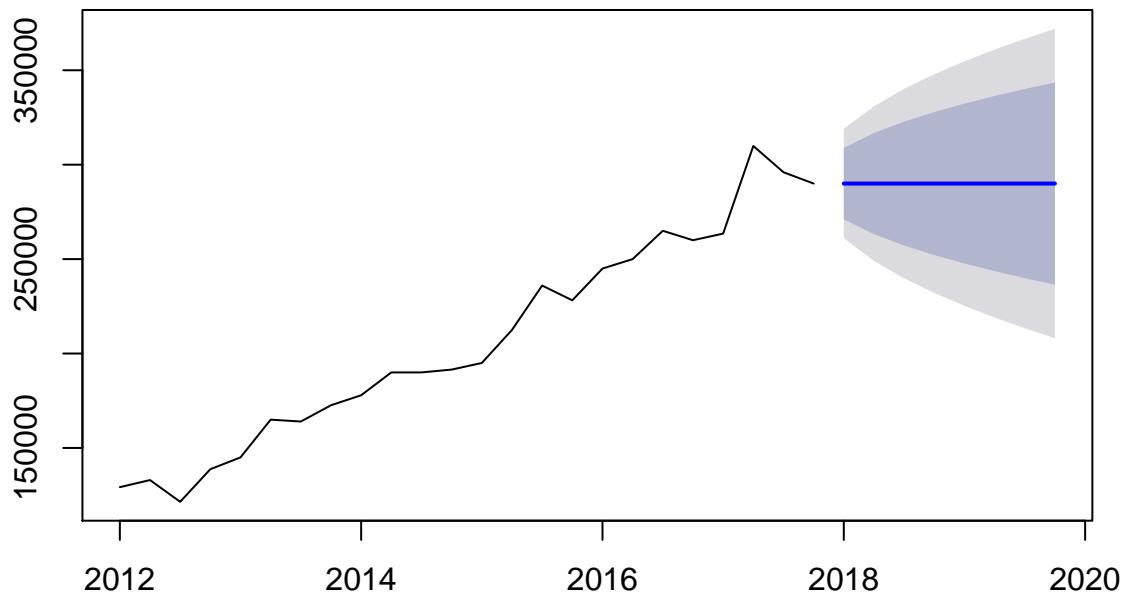
# select the median price column for the timeseries
oneNeighborhood.df <- oneNeighborhood.df[c(4)]

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

# Naive Approach
# H = Number of periods for forecasting
plotTitle <- paste(neighborhood, ": Naive Model")
plot(naive(oneNeighborhood.timeseries, h = 8), main=plotTitle)

```

Portland, OR – Lents : Naive Model

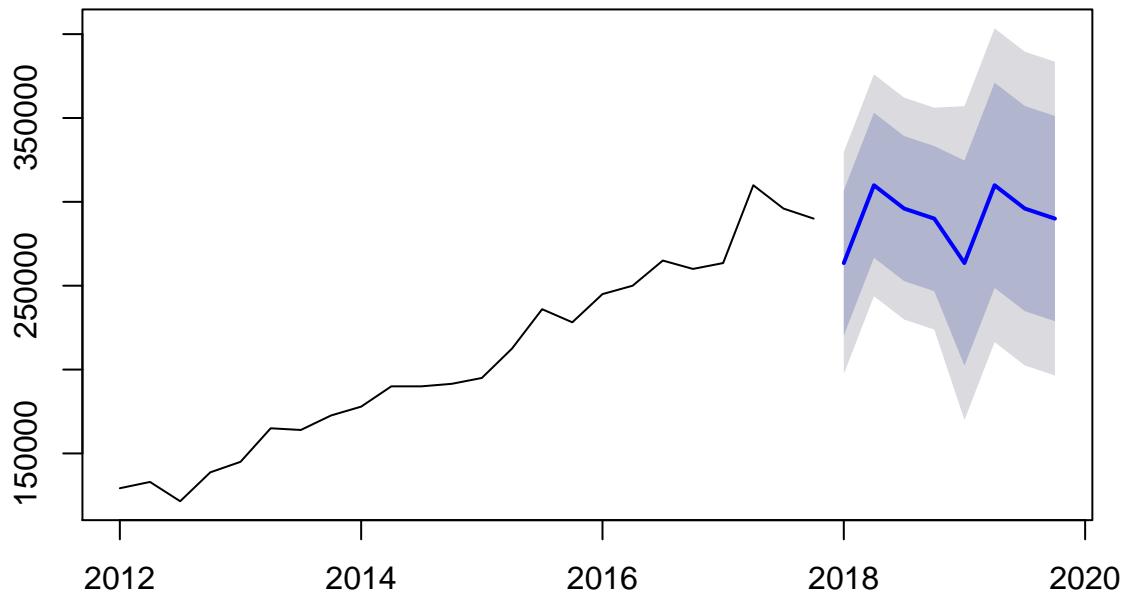


```

# Seasonal Naive Method
plotTitle <- paste(neighborhood, ": Seasonal Naive Model")
plot(snaive(oneNeighborhood.timeseries, h = 8), main=plotTitle)

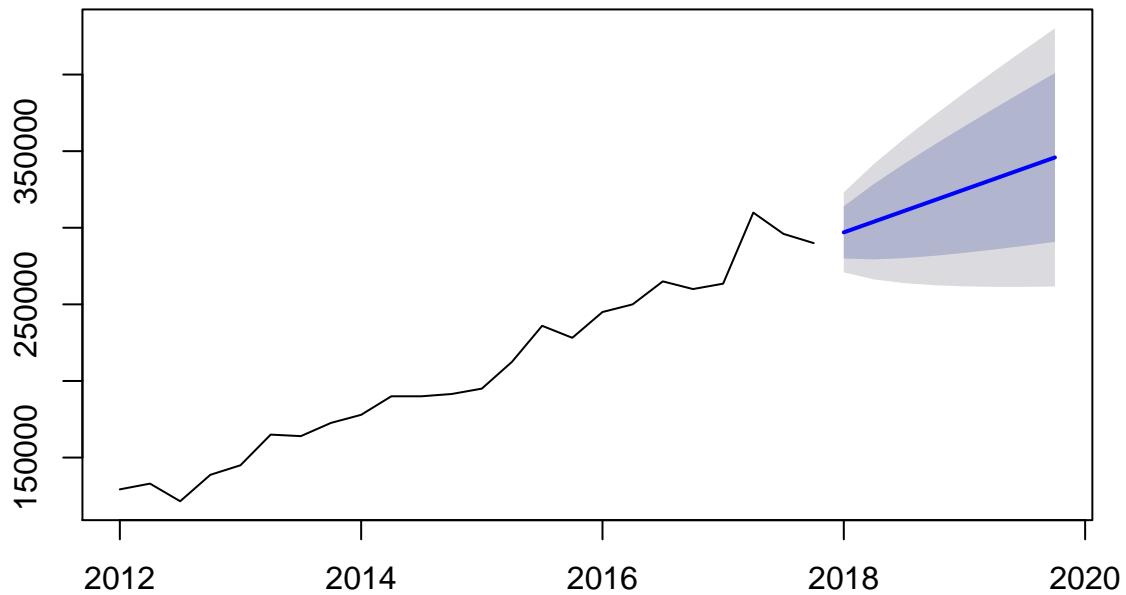
```

Portland, OR – Lents : Seasonal Naive Model



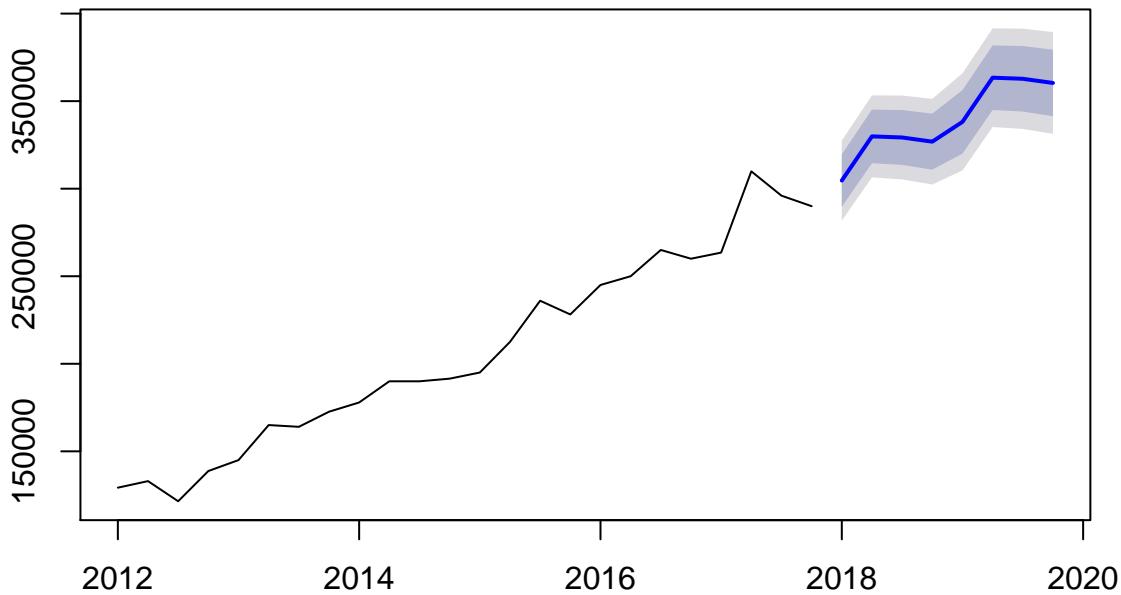
```
# Drift Method Method
plotTitle <- paste(neighborhood, ": Drift Model")
plot(rwf(oneNeighborhood.timeseries, h = 8, drift = T), main=plotTitle)
```

Portland, OR – Lents : Drift Model



```
# Holt Winters Method
plotTitle <- paste(neighborhood, ": Holt Winters Model")
plot(forecast(HoltWinters(oneNeighborhood.timeseries), h = 8), main=plotTitle)
```

Portland, OR – Lents : Holt Winters Model



As you can see, there is quite a bit of variety in these models. To provide more context, these models were:

1. Naive - All forecasts are simply set to be the value of the last observation
2. Seasonal Naive - Useful for highly seasonal data. Set each forecast to be equal to the last observed value from the same season of the year
3. Drift - A naive variation that increases or decreases over time-called the drift-that is the average change seen in the historical data
4. Holt Winters - A seasonal method that comprises the forecast equation and layers on three smoothing equations

When plotting all this within the entire loop, we found that the Holt Winters and Drift seemed to track the best with existing trends, while the naive and seasonal naive simply repeated the past as their models are meant to do. To determine if these were better or worse we had to plot and verify by testing the accuracy of each model on training and validation/test data.

Accuracy Evaluation

Accuracy Methodology

For this evaluation example, we will use one of the neighborhoods: Lents. The neighborhood will be selected and each of the models will be trained against the Lents training set and tested for accuracy against the Lents test set.

Mean Absolute Error (MAE) and Root mean squared error (RMSE) are popular to use with forecasting on a single data set, in this case: Lents. MAE and RMSE are scale-dependent, so would be appropriate to compare the models within a single neighborhood. However if we want to compare across neighborhoods, then we would use a metric based on percentage which is more appropriate for the different median house price scales of different neighborhoods.

```

#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$Period.Begin)
# somehow they are out of order, now to sort the period.begin
oneNeighborhood.df <- oneNeighborhood.df[order(as.Date(oneNeighborhood.df$Period.Begin, format="%m/%d/%Y"), oneNeighborhood.df$Period.Begin),]

# select the median price column for the timeseries
oneNeighborhood.df <- oneNeighborhood.df[c(4)]

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

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

```

For this project we looked at the following types of models: naive, seasonal naive, drift and Holt Winters. We run each of these models against the training set for the neighborhood.

```

#Run Models on training data
#Seasonal Naive
naive.forecast <- naive(trainingData, h = 8)
snaive.forecast <- snaive(trainingData, h = 8 )
drift.forecast <- rwf(trainingData, h = 8, drift = T)
hwinters.forecast <- forecast(HoltWinters(trainingData), h = 8)

```

Next we calculate the accuracy for each of the forecasts of the above models against the test data which was held back from the training set.

```

#Calculate accuracy
naive.accuracy <- accuracy(naive.forecast, testData)
snaive.accuracy <- accuracy(snaive.forecast, testData)
drift.accuracy <- accuracy(drift.forecast, testData)
hwinters.accuracy <- accuracy(hwinters.forecast, testData)

```

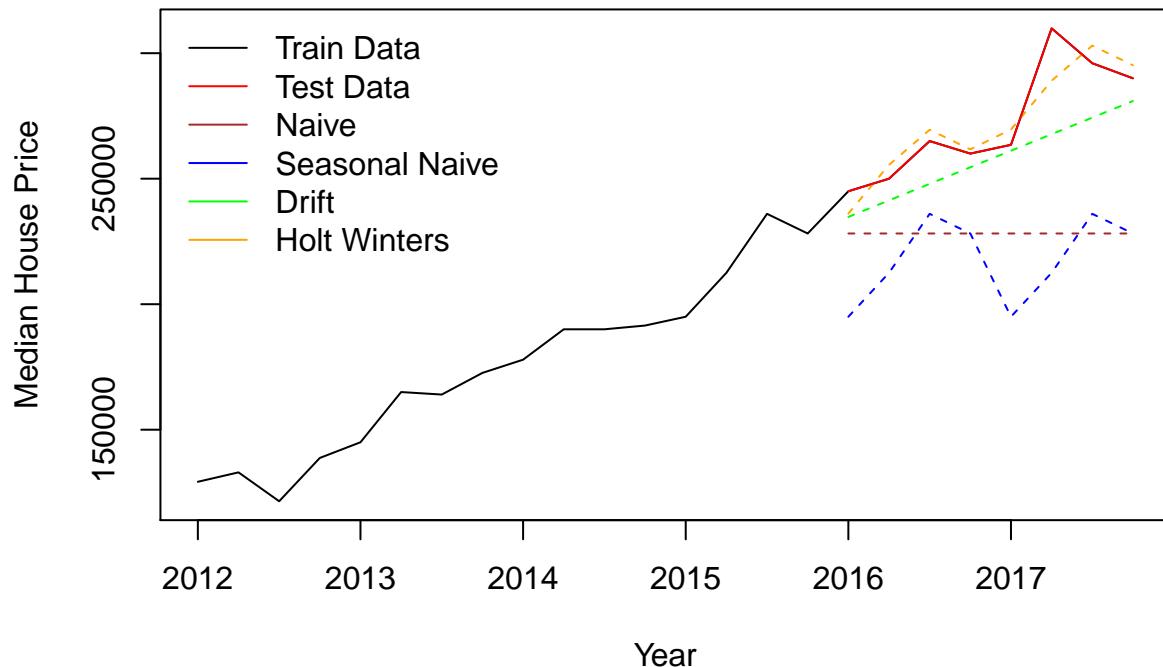
An easy way to visually determine which of the models matches the test data the closest, is to compare the model forecast against the test data in a graph.

```

# Forecast plot for Combined models -----
plotTitle <- paste(neighborhood, ": Training Model Comparison")
# plots both the train data, test data and both predictions
plot(oneNeighborhood.timeseries, main=plotTitle, ylab = "Median House Price", xlab = "Year")
lines(naive.forecast$mean,col="brown", lty="dashed")
lines(snaive.forecast$mean,col="blue", lty="dashed")
lines(drift.forecast$mean,col="green", lty="dashed")
lines(hwinters.forecast$mean, col="orange", 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", "brown", "blue", "green", "orange"),c("Train Data", "Test Data"))

```

Portland, OR – Lents : Training Model Comparison



We can see in this graph, that the dotted orange line, for Holt Winters most closely follows the red solid line representing the test data. The Naive line is useless as it is simply the last value in the Training data. The green line for Drift seems to follow our test data as a trend line rather well. The Seasonal Naive line is somewhat better than pure naive, as it generally follows the seasonality of the test data, if not the scale.

Now let's look at the actual accuracy for each of the models for this neighborhood.

Seasonal Naive

We can see that seasonal naive has a RMSE of 30584 for the training set and 58482 for the test set.

The ACF is 0.3094 for training and 0.4584 for the test set.

```
# Seasonal Naive
print(paste("Seasonal Naive Accuracy for ", neighborhood))

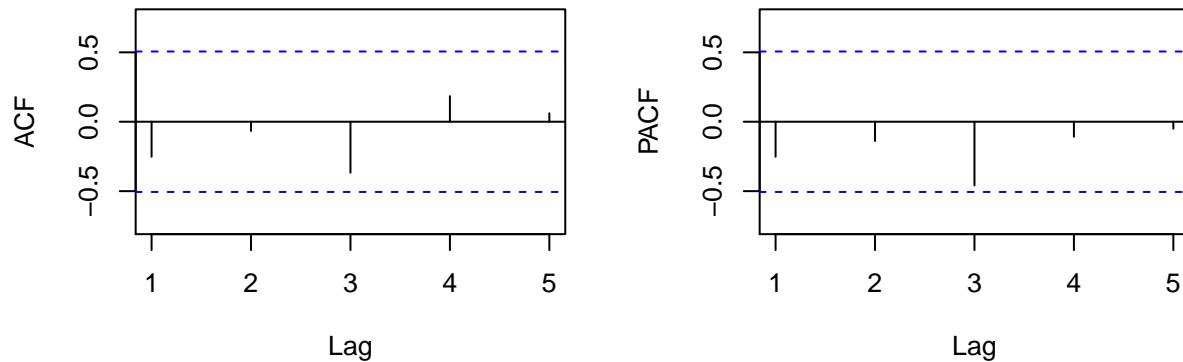
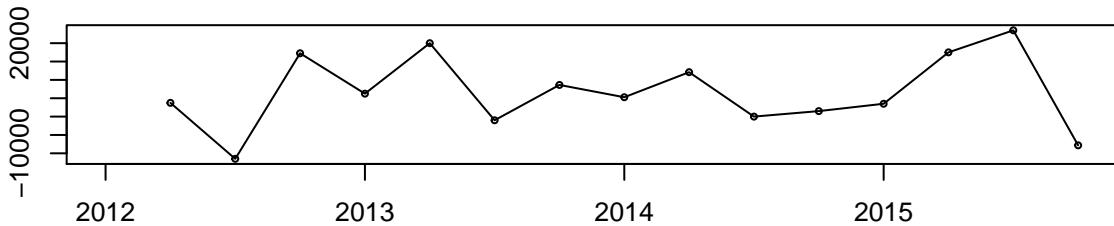
## [1] "Seasonal Naive Accuracy for Portland, OR - Lents"
print(snaive.accuracy)

##               ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 29097.67 30584.75 29097.67 15.49219 15.49219 1.000000
## Test set     54506.25 58482.28 54506.25 19.70086 19.70086 1.873217
##             ACF1 Theil's U
## Training set 0.3093653      NA
## Test set     0.4584392  2.985056

plotTitle <- paste(neighborhood, ": Seasonal Naive Model Residuals")
options(scipen=999)
```

```
tsdisplay(residuals(naive.forecast), main = paste(plotTitle, " Residuals"))
```

Portland, OR – Lents : Seasonal Naive Model Residuals Residuals



Naive

Naive has a RMSE of 11738.18 for the training set and 49342.8 for the test set.

The ACF is -0.2522954 for training and 0.5108548 for the test set.

```
# Naive
print(paste("Naive Accuracy for ", neighborhood))
```

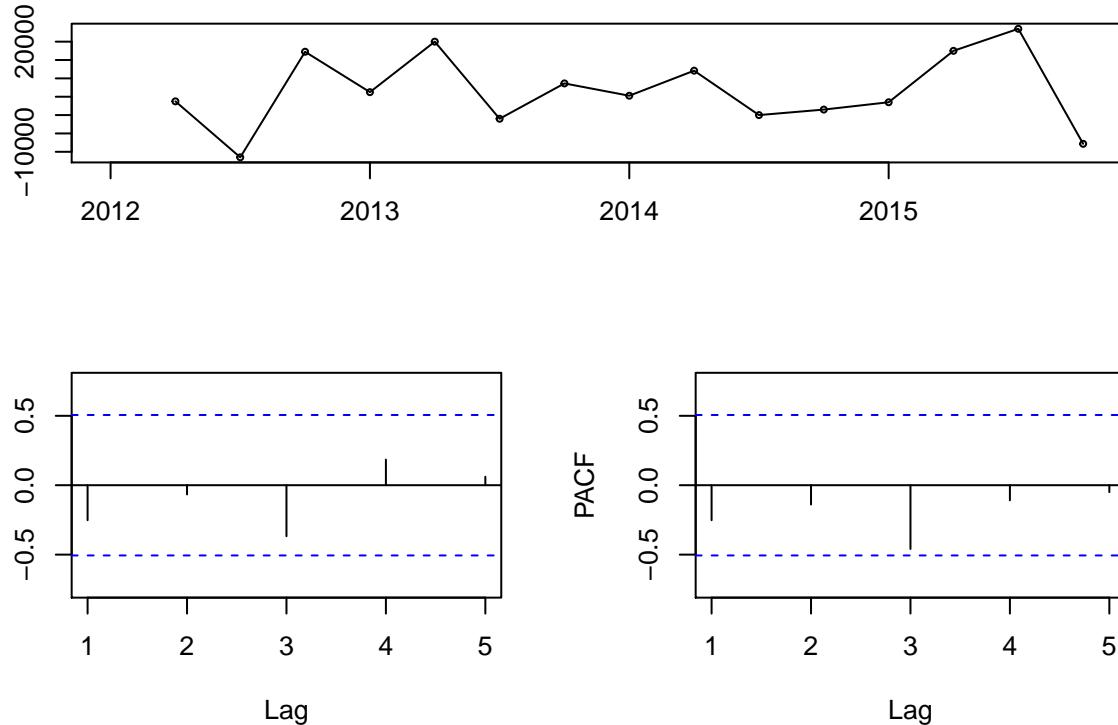
```
## [1] "Naive Accuracy for Portland, OR – Lents"
```

```
print(naive.accuracy)
```

	ME	RMSE	MAE	MPE	MAPE	MASE
## Training set	6594.8	11738.18	9304.8	3.551877	5.352432	0.3197782
## Test set	44250.0	49342.82	44250.0	15.718032	15.718032	1.5207405
## ACF1 Theil's U	-0.2522954	NA				
## Training set	-0.2522954	NA				
## Test set	0.5108548	2.566676				

```
plotTitle <- paste(neighborhood, ": Naive Model Residuals")
options(scipen=999)
tsdisplay(residuals(naive.forecast), main = paste(plotTitle, " Residuals"))
```

Portland, OR – Lents : Naive Model Residuals



Holt Winters

Holt Winters has a RMSE of 10710.34 for the training set and 9232.58 for the test set.

The ACF is 0.2502565 for training and -0.357791 for the test set.

This is much better than seasonal Naive or Naive.

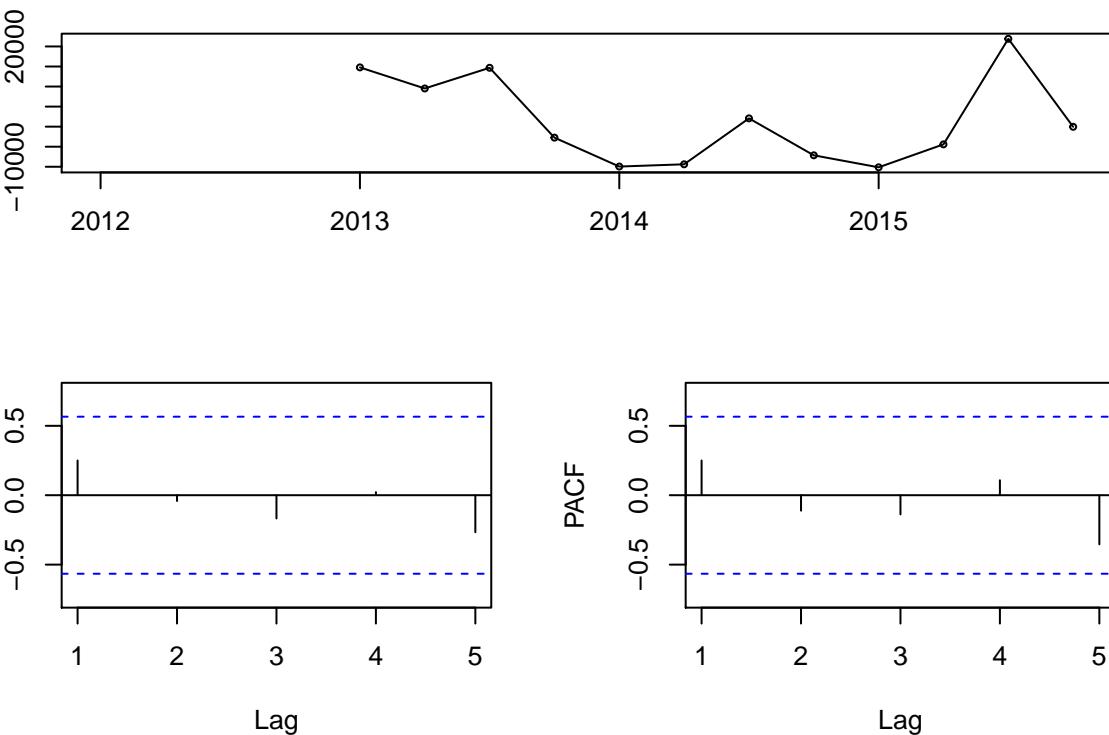
```
# Holt Winters
print(paste("Holt Winters Accuracy for ", neighborhood))

## [1] "Holt Winters Accuracy for Portland, OR - Lents"
print(hwinters.accuracy)

##               ME      RMSE      MAE       MPE      MAPE      MASE
## Training set 1596.91395 10710.346 8896.498  1.01265917 4.868772 0.3057461
## Test set     -37.61688  9232.584 7478.073 -0.08544842 2.676521 0.2569990
##             ACF1 Theil's U
## Training set  0.2502565      NA
## Test set      -0.3577911 0.4735659

plotTitle <- paste(neighborhood, ": Holt Winters Model Residuals")
options(scipen=999)
tsdisplay(residuals(hwinters.forecast), main = paste(plotTitle, " Residuals"))
```

Portland, OR – Lents : Holt Winters Model Residuals Residuals



Drift Drift has a RMSE of 9710.479 for the training set and 18819.398 for the test set.

The ACF is -0.25229542 for training and -0.0709451 for the test set.

This is much better than seasonal Naive or Naive.

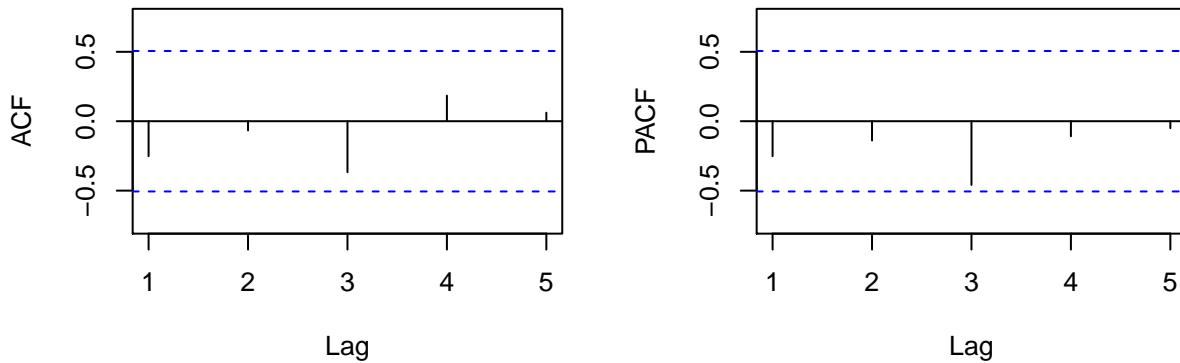
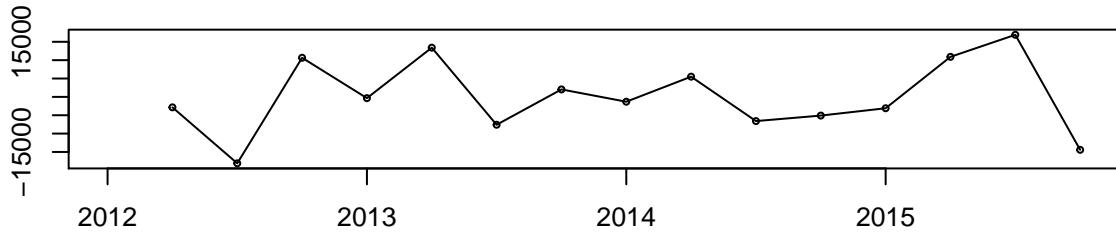
```
# Drift
print(paste("Drift Accuracy for ", neighborhood))

## [1] "Drift Accuracy for Portland, OR - Lents"
print(drift.accuracy)

##               ME      RMSE      MAE      MPE
## Training set 0.0000000001067152 9710.479 7920.827 -0.3006927
## Test set    14573.4000000001236913 18819.398 14573.400  5.1368178
##          MAPE      MASE      ACF1 Theil's U
## Training set 4.590348 0.2722152 -0.25229542      NA
## Test set     5.136818 0.5008443 -0.07094514 0.9977252

plotTitle <- paste(neighborhood, ": Drift Model Residuals")
options(scipen=999)
tsdisplay(residuals(drift.forecast), main = paste(plotTitle, " Residuals"))
```

Portland, OR – Lents : Drift Model Residuals Residuals



Lents Neighborhood accuracy metrics:

Model	Training RMSE	Test set RMSE	Training ACF	Test ACF
Naive	11738.18	49342.8	-0.2522954	0.5108548
Seasonal Naive	30584	58482	0.3094	0.4584
Drift	9710.479	18819.398	-0.25229542	-0.0709451
Holt Winters	10710.34	9232.58	0.2502565	-0.357791

For accurate forecasting, we have chosen Holt Winters as the most accurate model, for this neighborhood as well as a random sampling of others in the set of neighborhoods. The test set RMSE was the best for this model.

For this paper, we have chosen to compare Holt Winters, our most accurate model, against Seasonal Naive. Seasonal Naive is the most accurate of the two naive models. Drift is a useful trend line but doesn't give the detail that holt winters provides for seasonal dips and peaks.

Results, Conclusions, Recommendations

- Run time series model on training and validation sets
- Try various time series models and compare accuracy
 - Trend and seasonality
 - Linear, and polynomial
 - Naive

- Compare accuracy between these models
- Create comparison array to evaluate neighborhood predictions
- Continue building report and narrative
- Investigate possibility of visualizing with a mapping tool
- Beautify graphs/visualizations

References

References

[1] <https://www.forbes.com/pictures/mhj45mhl/10-portland-or/#2887f4ca560b> [2] <https://www.oregonmetro.gov/urban-growth-boundary> [3] <https://projects.oregonlive.com/maps/gentrification/> [4] <https://www.portlandoregon.gov/bps/article/454027> [5] <https://www.zillow.com/zestimate/#acc> [6] <https://www.zillow.com/portland-or/home-values/> [7] <https://www.pdxmonthly.com/articles/2017/3/22/portland-neighborhoods-by-the-numbers-2017-the-city> [8] <https://us.spindices.com/indices/real-estate/sp-corelogic-case-shiller-portland-home-price-nsa-index> [9] [10] [11][12] Redfin Data Center: Downloadable Housing Market Data From Redfin

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

Appendix

```
# Create a storage array for our results
neighborhoodsSummary.array <- array()

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

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

# For loop
#loop through all the neighborhoods and for each create a timeseries and print the plot
#DEBUG use if just want to look at one neighborhood: for (neighborhood in c("Portland, OR - Rose City P
for (neighborhood in neighborhoods.array){
  #set plot options once
  options(scipen=999)

  #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$Period.Begin,
  # somehow they are out of order, now to sort the period.begin
  oneNeighborhood.df <- oneNeighborhood.df[order(as.Date(oneNeighborhood.df$Period.Begin, format="%m/%d

  #DEBUGSaving data for debugging prior to removing columns
  #dat1 <- oneNeighborhood.df

  #DEBUG 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(4)]

# 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 years)
testData = window(oneNeighborhood.timeseries, start=c(2016,1), end=c(2017,4), frequency=4) ### Test set (1 year)

# Generic plot of timeseries without any modeling -----
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 Naive Forecast"))

# 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 Winters Forecast"))

```

```

# 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)

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

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

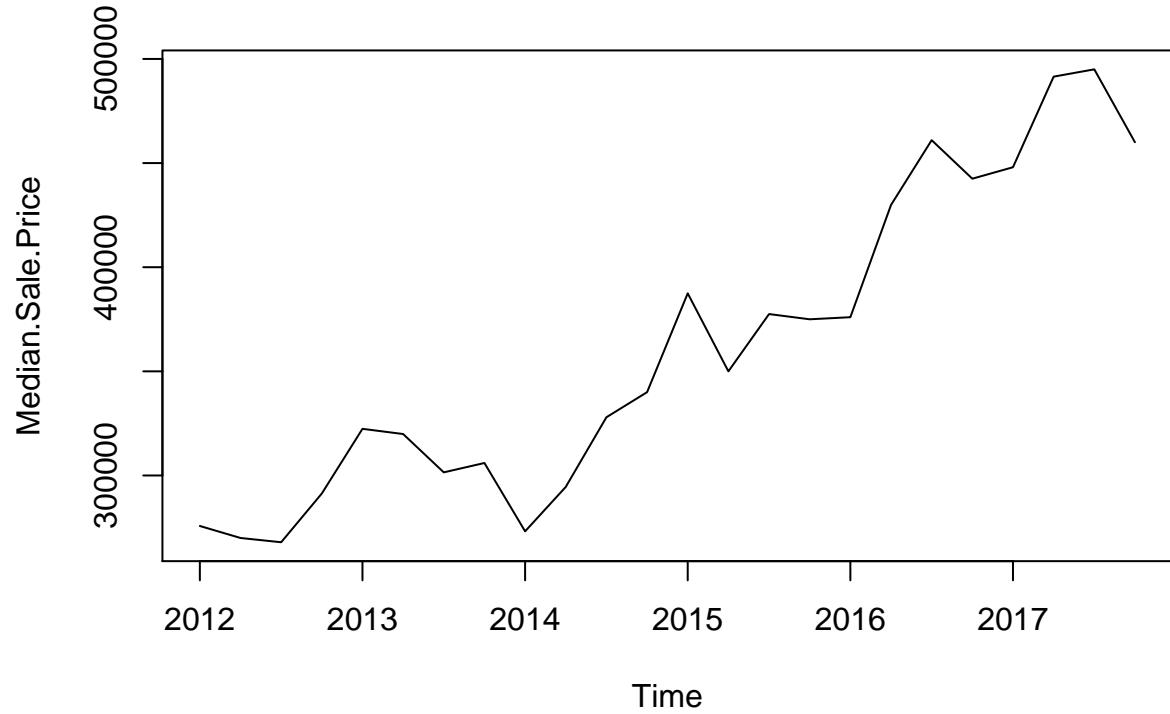
# Forecast plot for Combined models -----
plotTitle <- paste(neighborhood, ": TS Training Model Comparison")
options(scipen=999)
# plots both the train data, test data and both predictions
plot(oneNeighborhood.timeseries, main=plotTitle, ylab = "Median House Price", xlab = "Year")
lines(hwinters.forecast$mean,col="blue", lty="dashed")
lines(snaive.forecast$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", "Holt Winters"))

# This needs work *****
# 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(2000,2010))
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", "Holt Winters"))

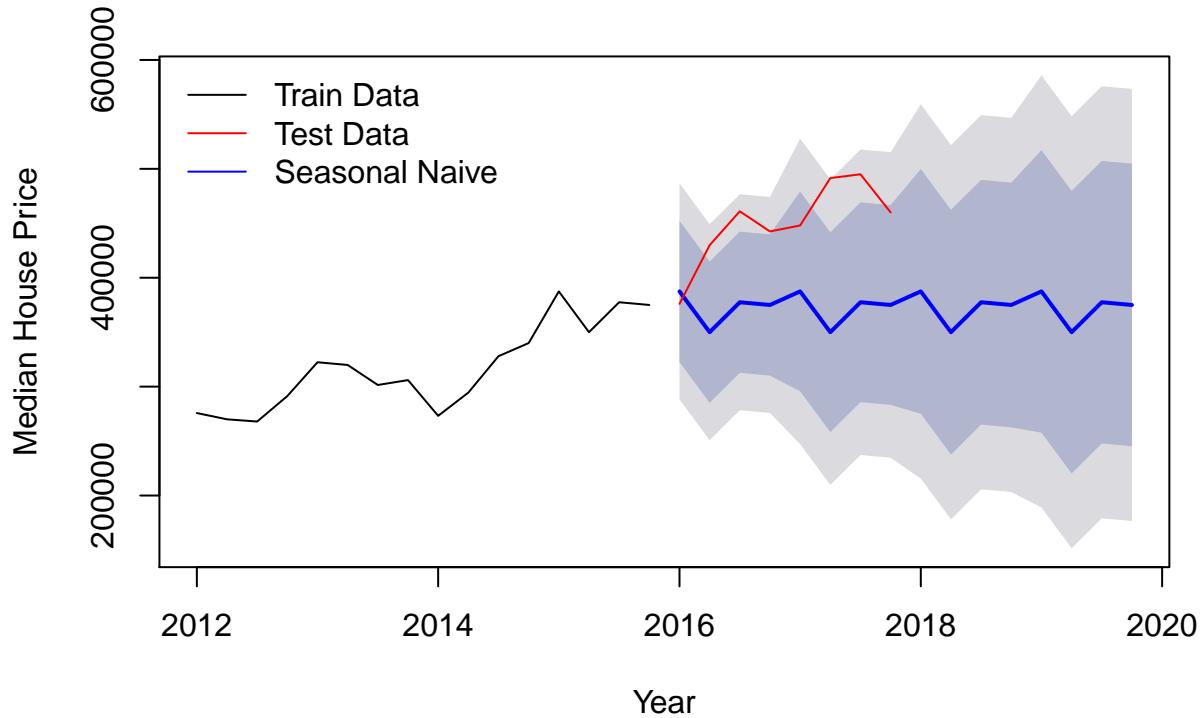
}

```

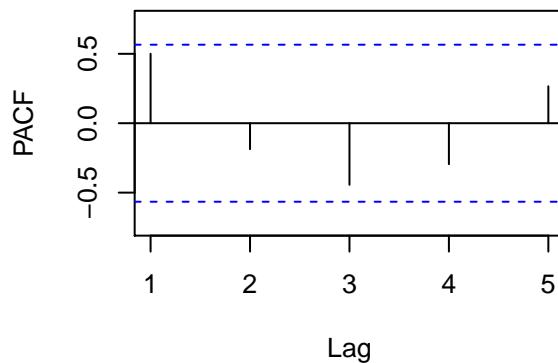
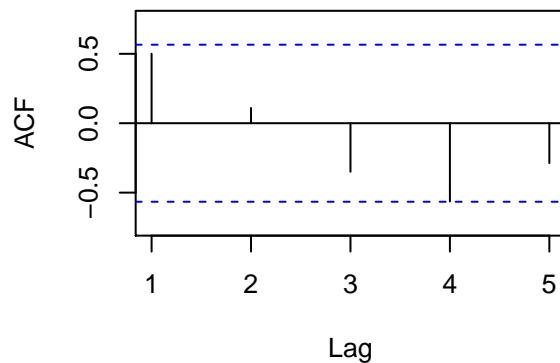
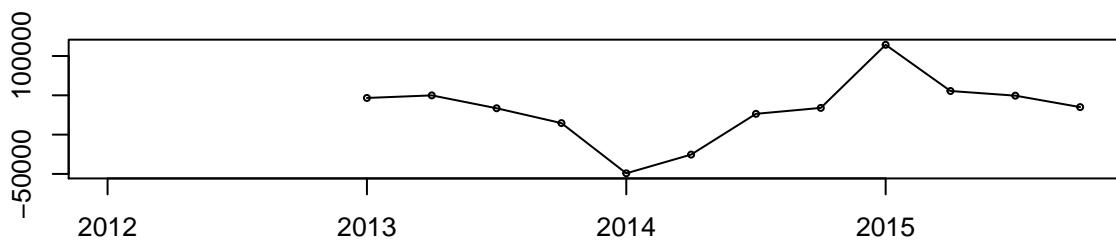
Portland, OR – University Park



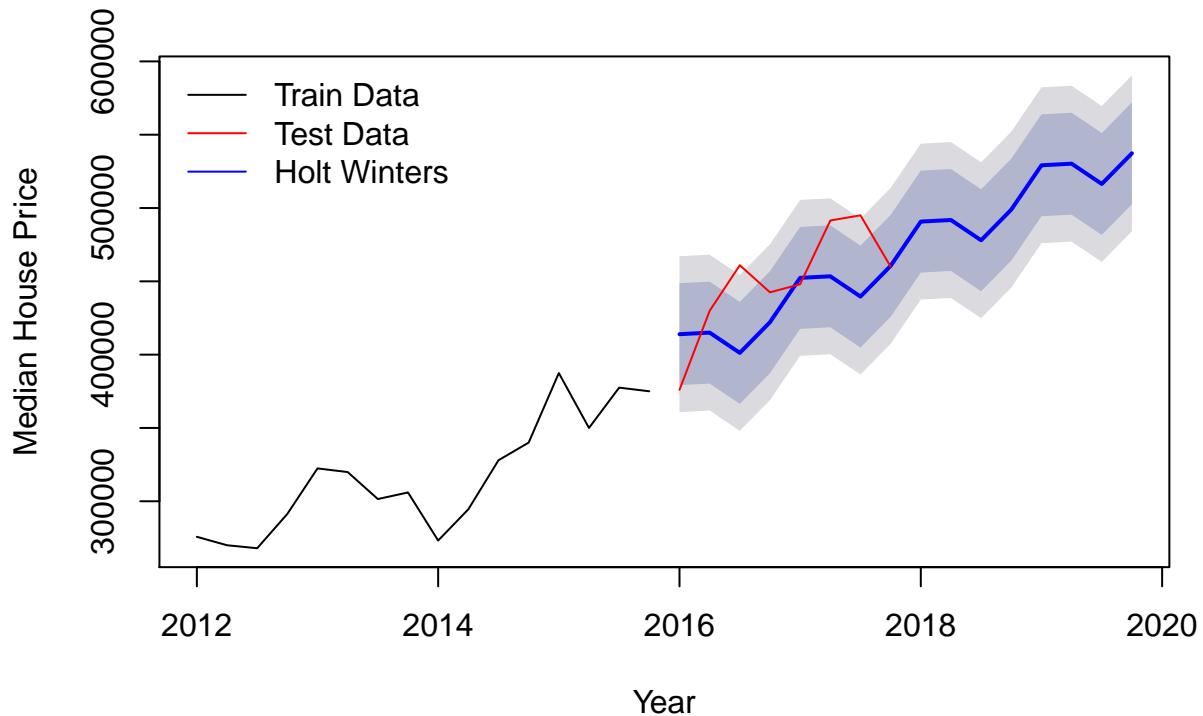
Portland, OR – University Park : Naive Model Forecast



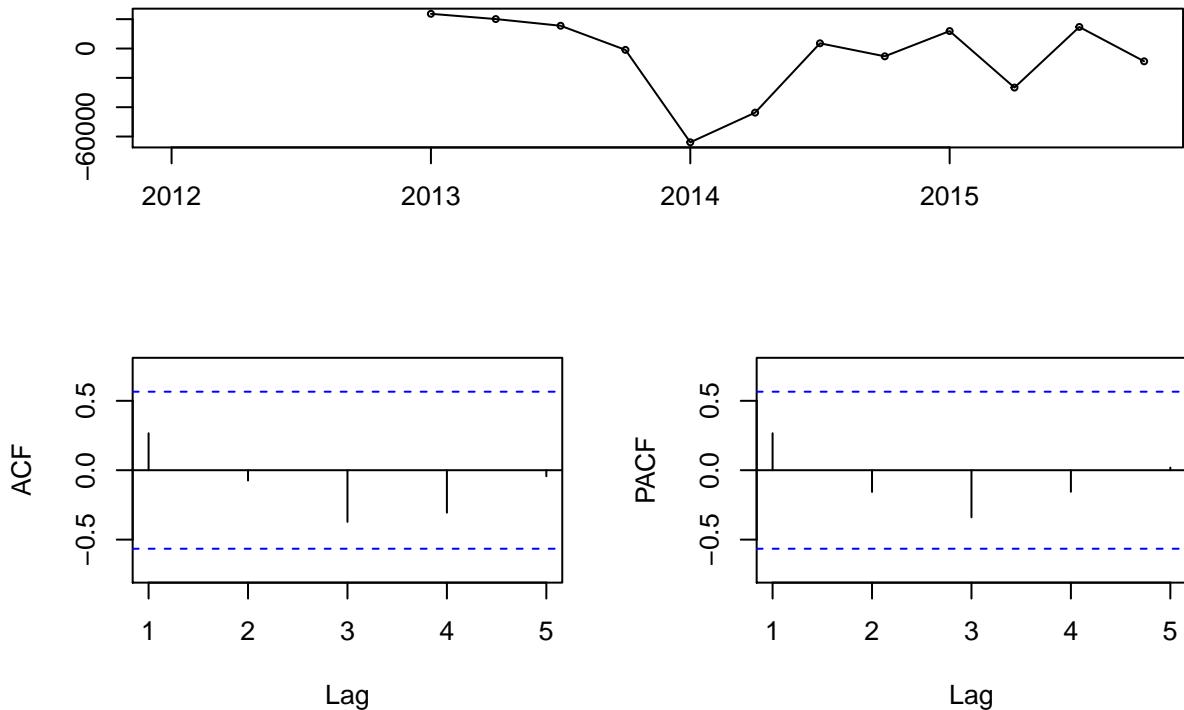
Portland, OR – University Park : Naive Model Forecast Residuals



Portland, OR – University Park : Holt Winters Model Forecast



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

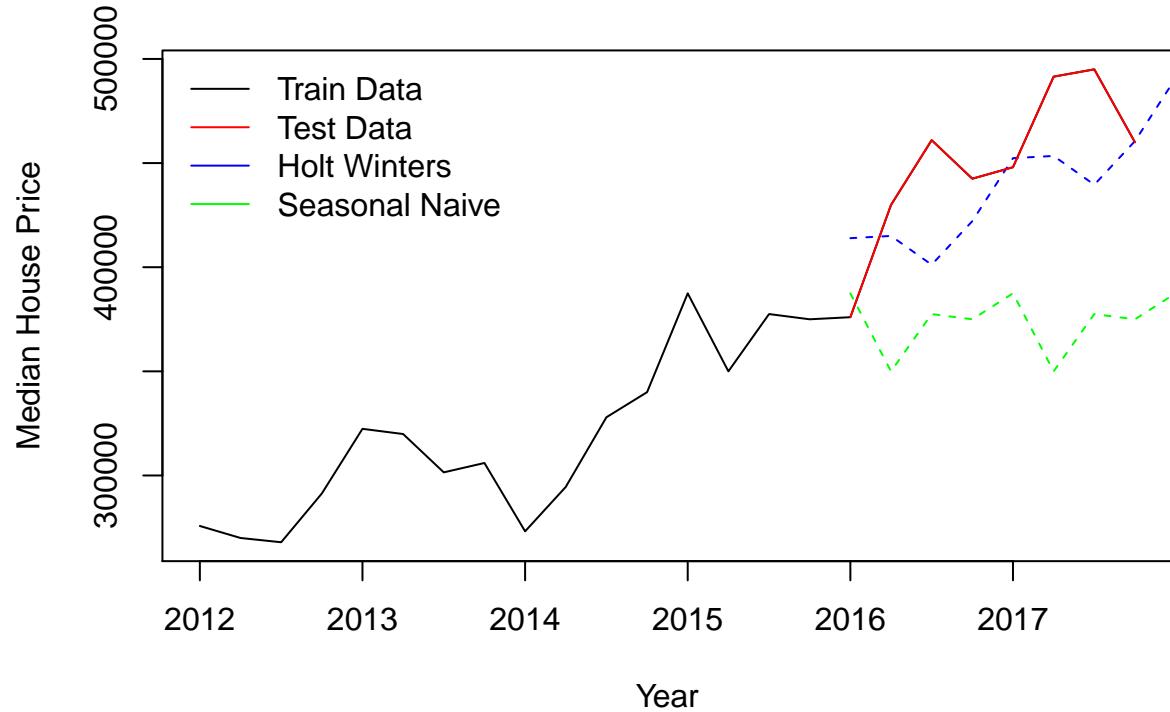


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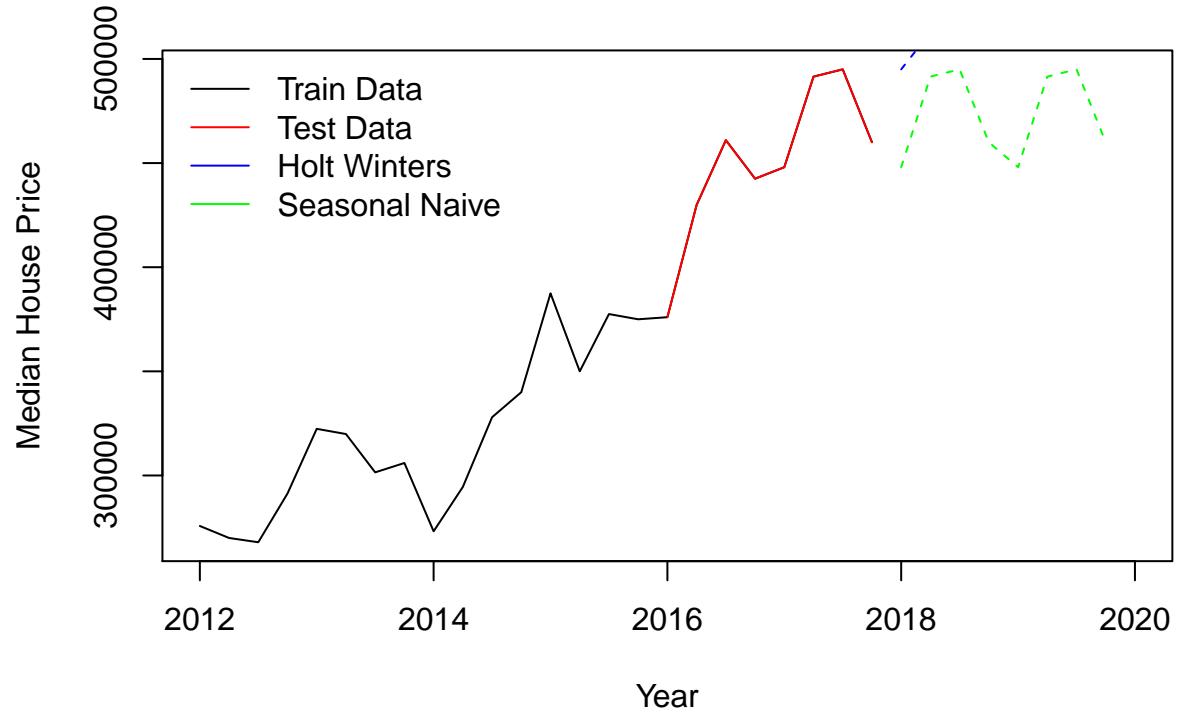
## [1] "Seasonal Naive Accuracy for Portland, OR - University Park"
##          ME      RMSE      MAE      MPE      MAPE      MASE      ACF1
## Training set 32075 50614.04 44508.33 8.768264 13.20719 1.000000 0.5003318
## Test set     78000 88574.41 80862.50 16.678528 17.43983 1.816795 0.1165706
##          Theil's U
## Training set     NA
## Test set       2.713508
## [1] "Holt Winters Accuracy for Portland, OR - University Park"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -4986.354 26438.94 19889.69 -1.936432 6.405355 0.4468756
## Test set      18211.562 35690.36 28918.98  3.599420 6.394189 0.6497431
##          ACF1 Theil's U
## Training set  0.2663360      NA
## Test set      -0.0420438  1.010268

```

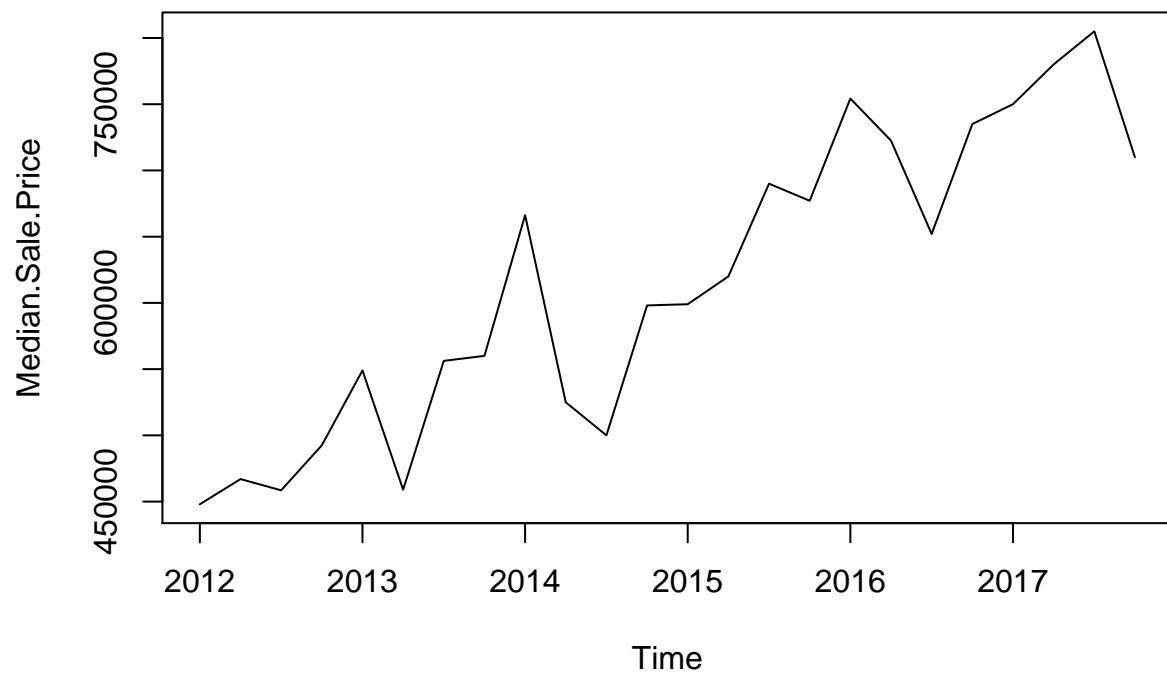
Portland, OR – University Park : TS Training Model Comparison



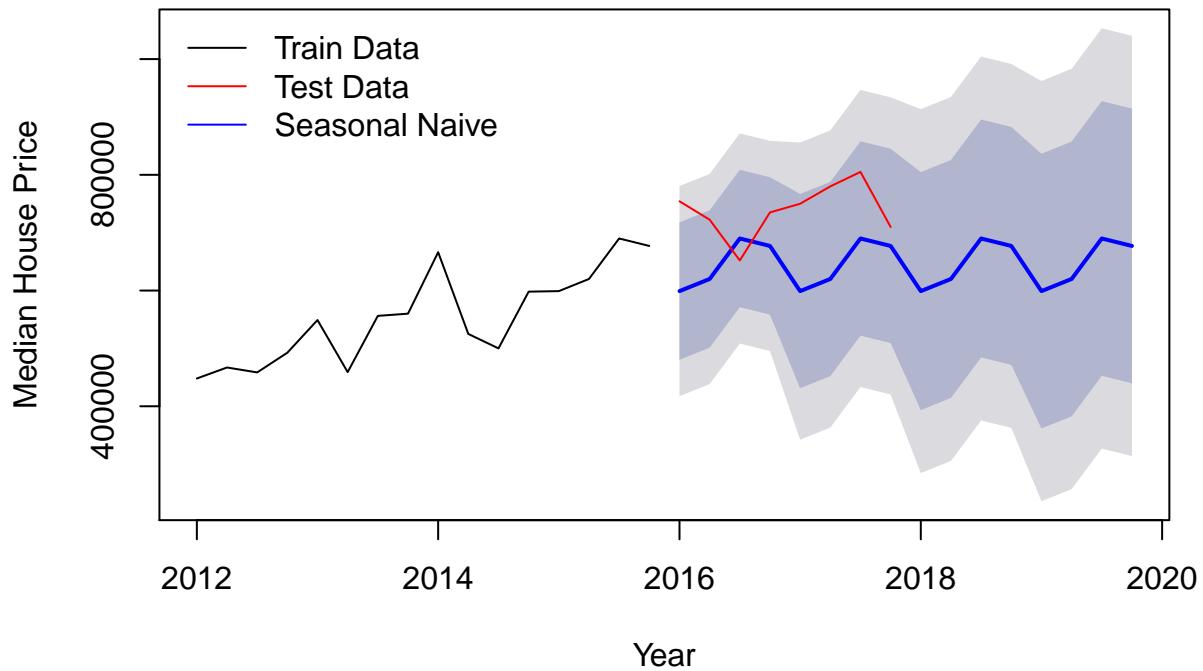
Portland, OR – University Park : Full TS Models Comparison



Portland, OR – Laurelhurst

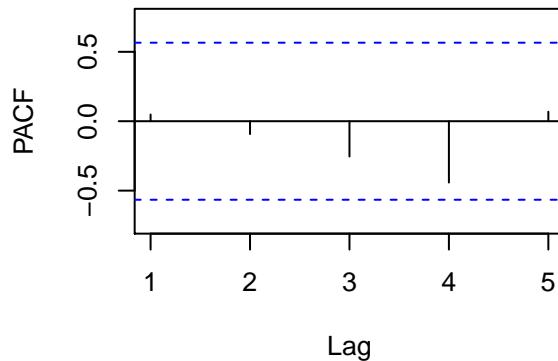
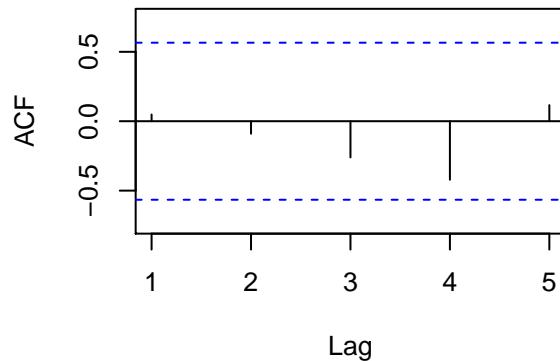
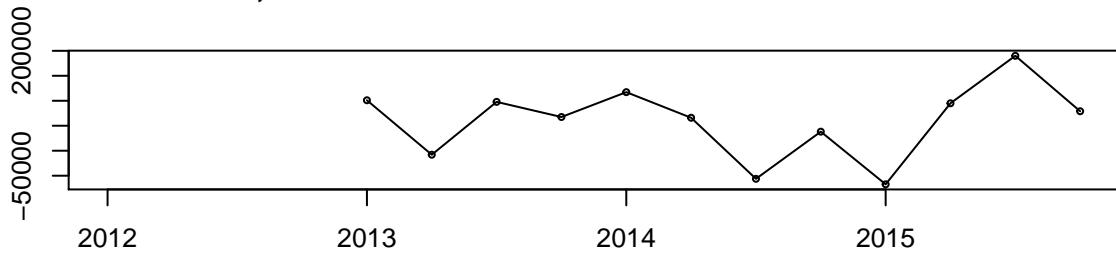


Portland, OR – Laurelhurst : Naive Model Forecast

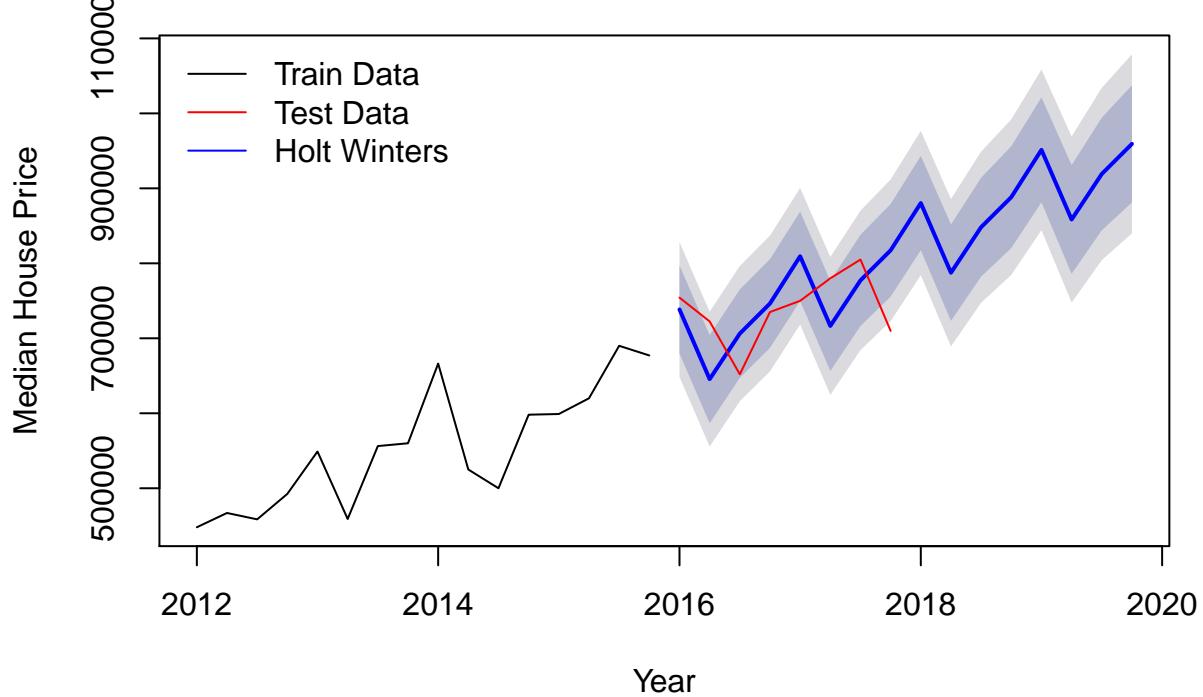


```
## Warning in HoltWinters(oneNeighborhood.timeseries): optimization  
## difficulties: ERROR: ABNORMAL_TERMINATION_IN_LNSRCH
```

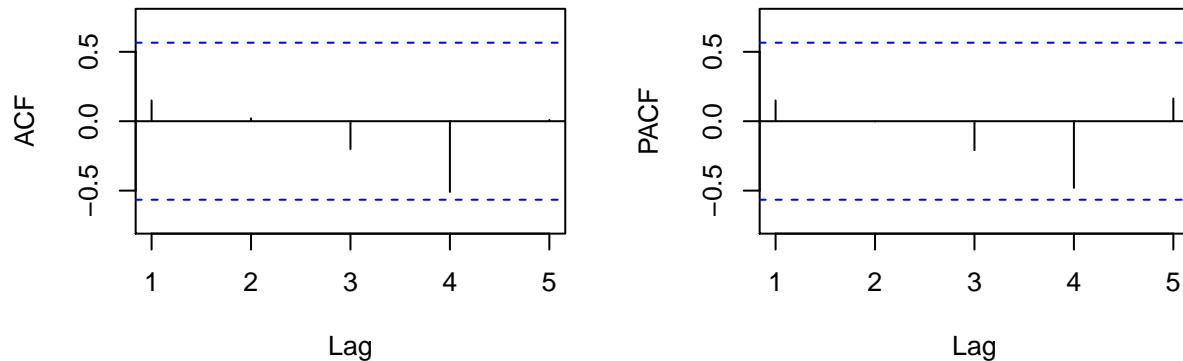
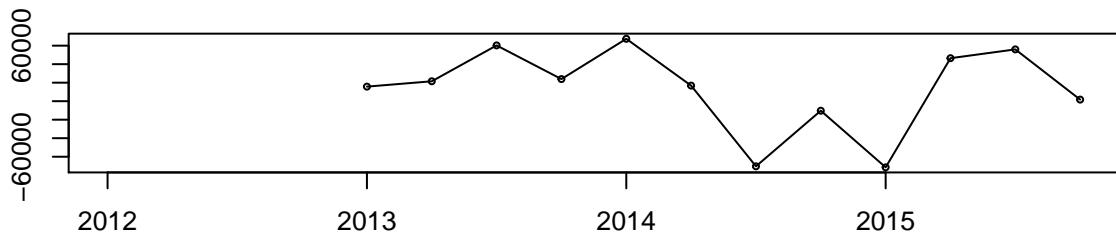
Portland, OR – Laurelhurst : Naive Model Forecast Residuals



Portland, OR – Laurelhurst : Holt Winters Model Forecast

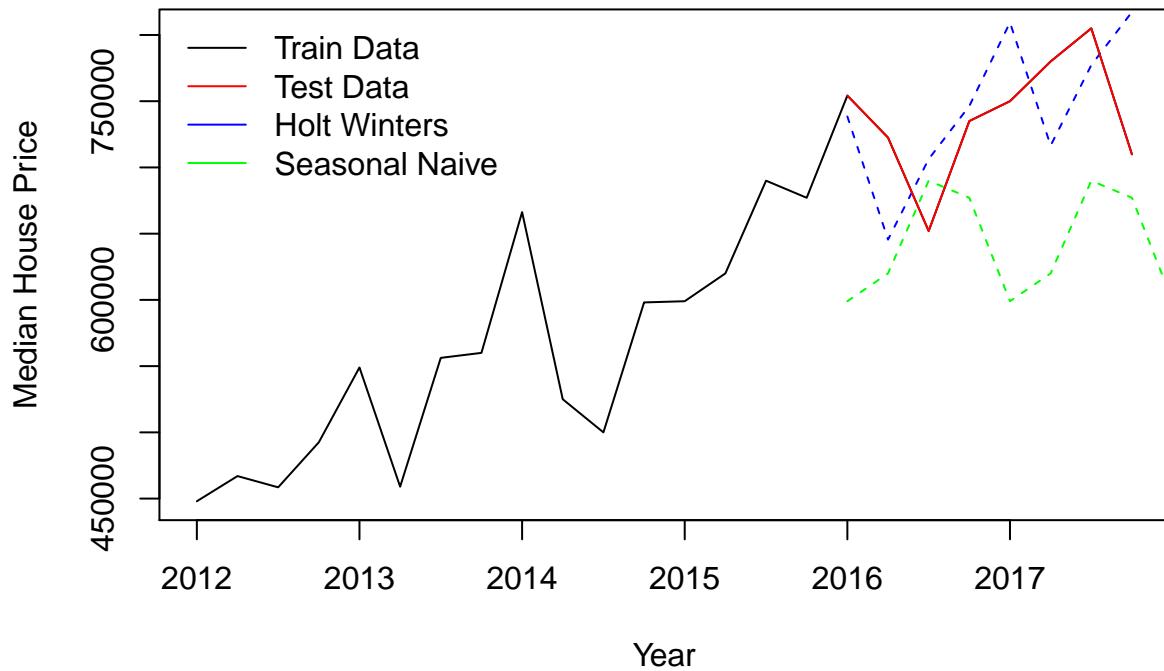


Portland, OR – Laurelhurst : Holt Winters Model Forecast Residuals

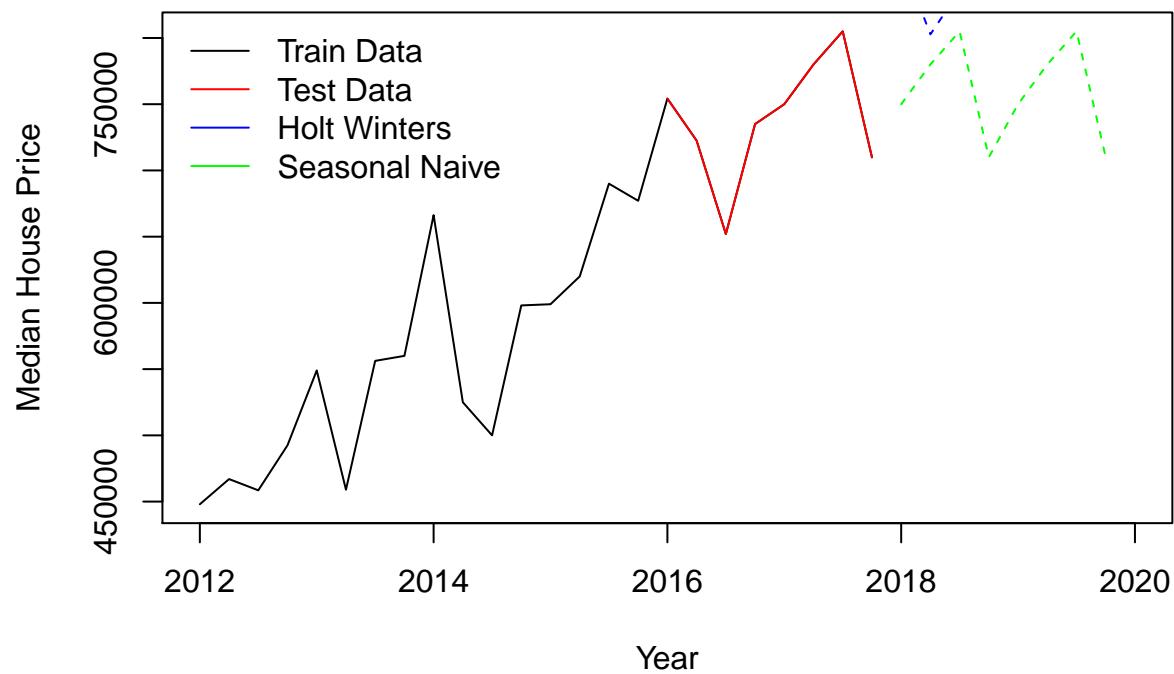


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Laurelhurst"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 60008.33 92639.13 81925.0 9.572504 13.60916 1.000000
## Test set     92056.25 112975.14 101556.2 12.046472 13.50353 1.239625
##          ACF1 Theil's U
## Training set 0.04856611      NA
## Test set     0.17296524 1.775228
## [1] "Holt Winters Accuracy for Portland, OR - Laurelhurst"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 13136.73 45819.90 38489.47 2.008897 6.629565 0.4698135
## Test set     -6062.60 60341.69 52070.72 -1.074323 7.158788 0.6355901
##          ACF1 Theil's U
## Training set 0.1495260      NA
## Test set     -0.2231411 1.050957
```

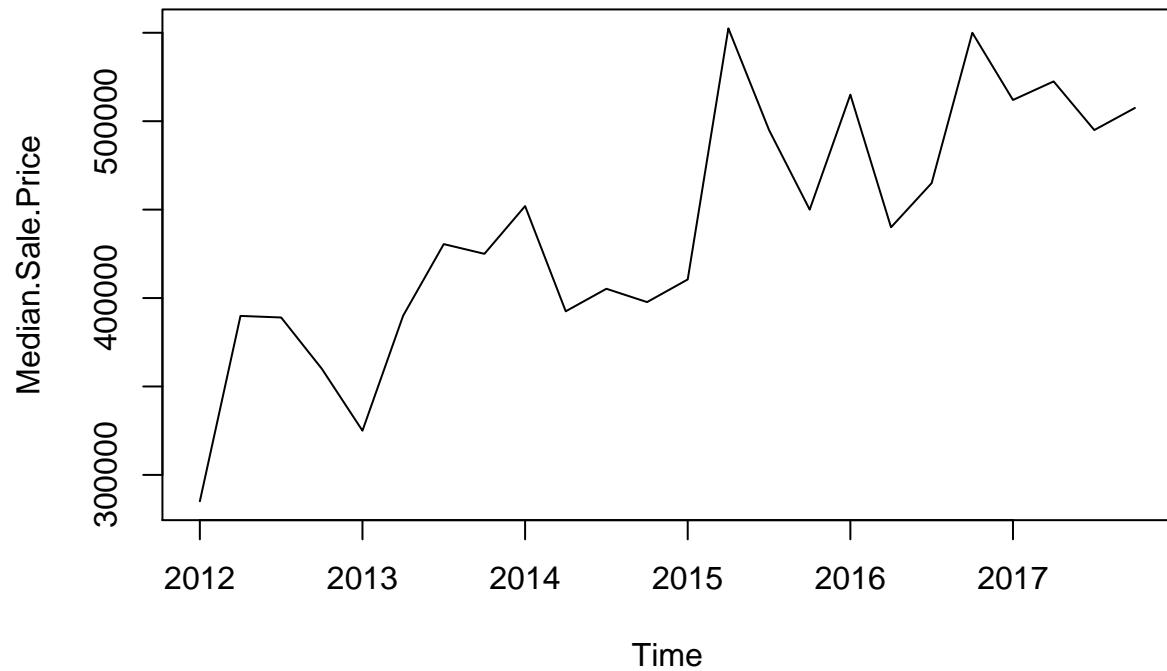
Portland, OR – Laurelhurst : TS Training Model Comparison



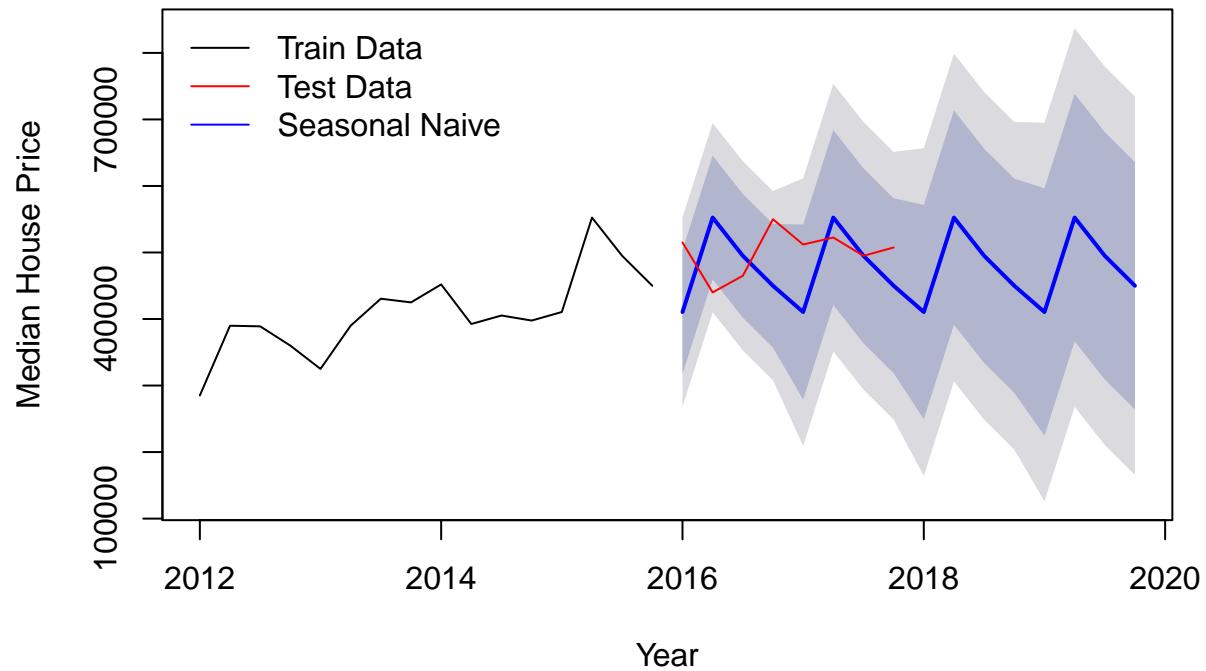
Portland, OR – Laurelhurst : Full TS Models Comparison



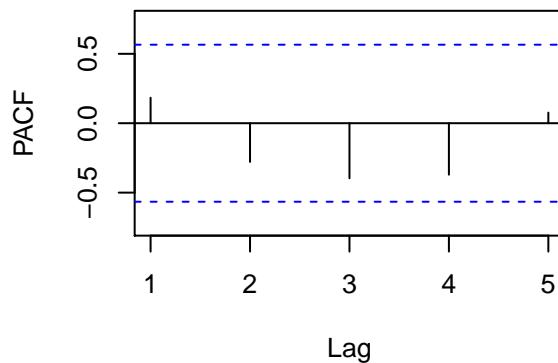
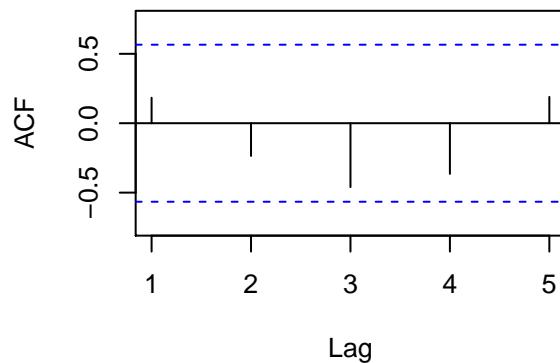
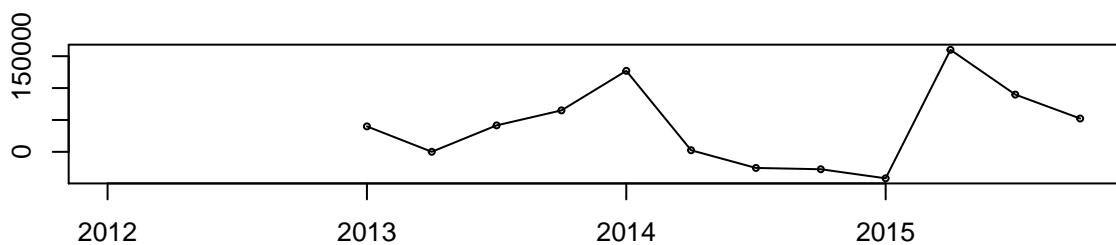
Portland, OR – Hillsdale



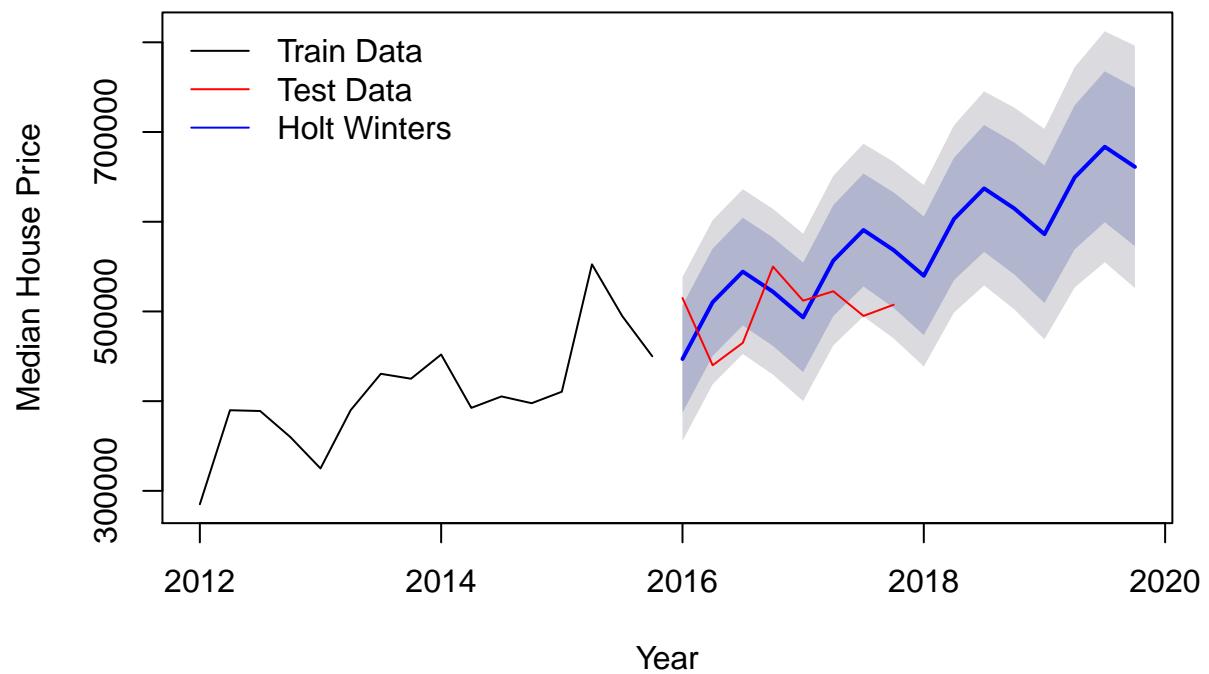
Portland, OR – Hillsdale : Naive Model Forecast



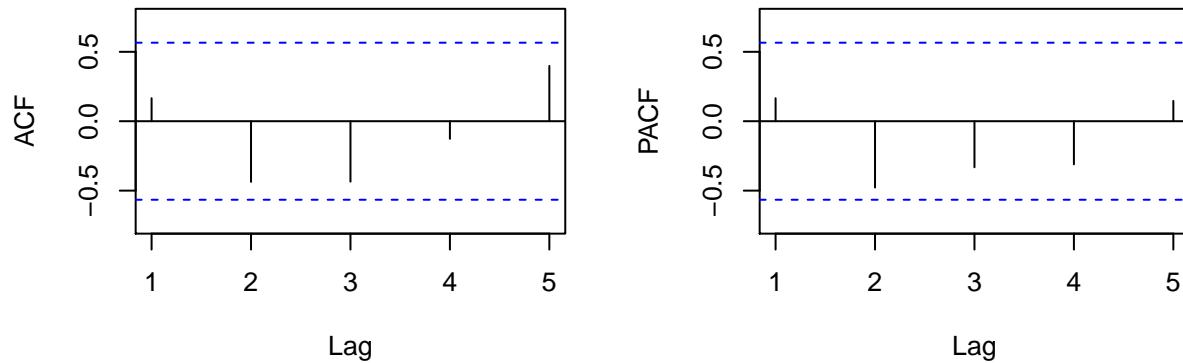
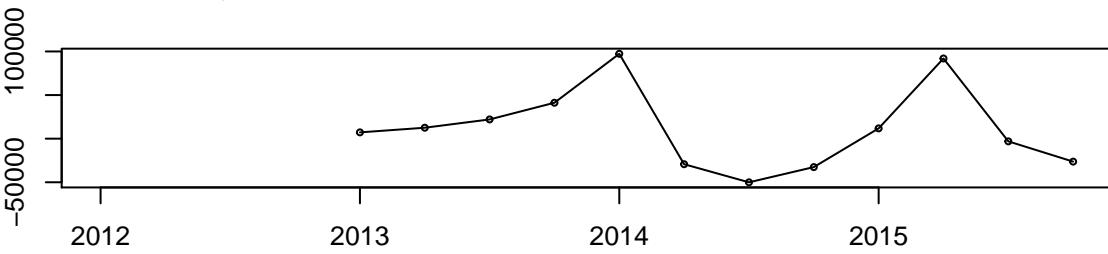
Portland, OR – Hillsdale : Naive Model Forecast Residuals



Portland, OR – Hillsdale : Holt Winters Model Forecast

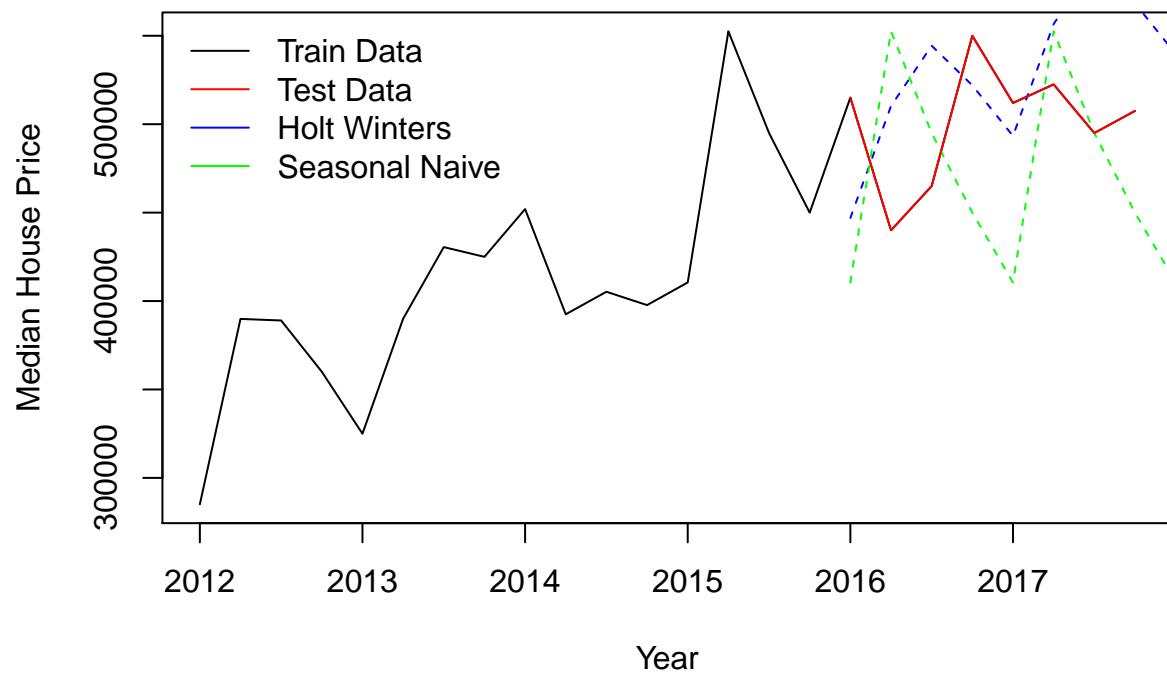


Portland, OR – Hillsdale : Holt Winters Model Forecast Residuals

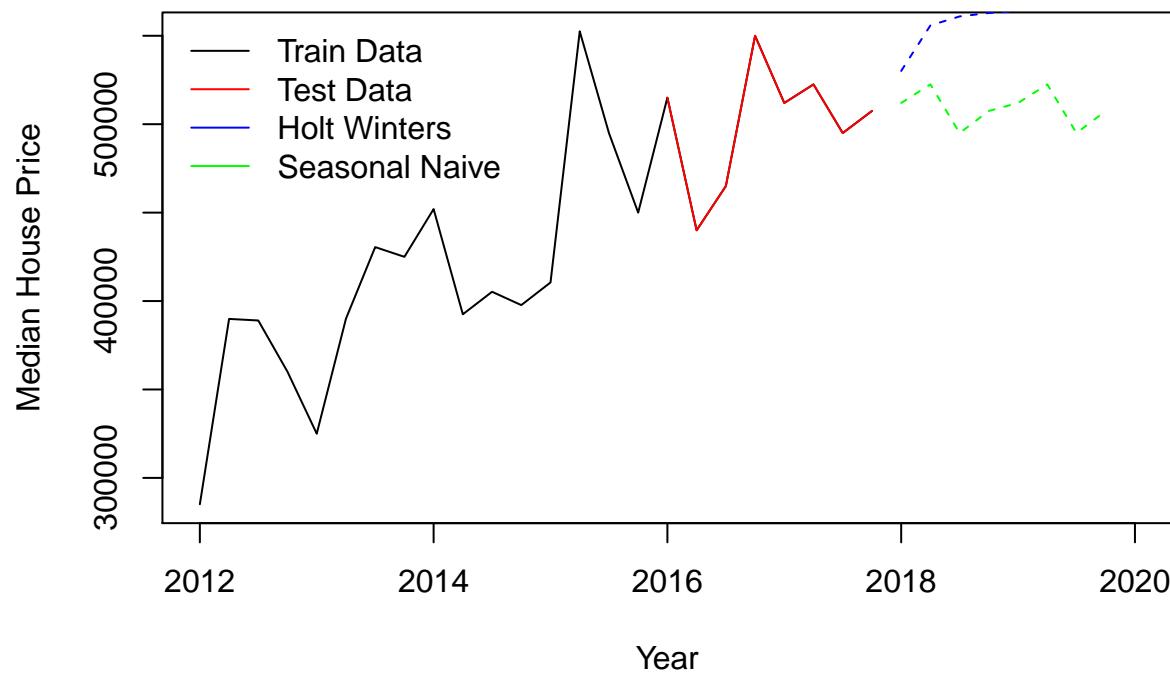


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Hillsdale"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 40333.33 72554.56 56008.33 8.456577 12.32405 1.000000
## Test set     23875.00 78250.40 67000.00 3.983241 13.42360 1.196251
##          ACF1 Theil's U
## Training set 0.1837821      NA
## Test set     -0.1246743 1.500404
## [1] "Holt Winters Accuracy for Portland, OR – Hillsdale"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 11892.07 46172.79 35451.01 2.234306 7.981699 0.6329596
## Test set     -28219.33 62288.18 56887.18 -6.121846 11.607142 1.0156913
##          ACF1 Theil's U
## Training set 0.165934937      NA
## Test set     0.007694517 1.281319
```

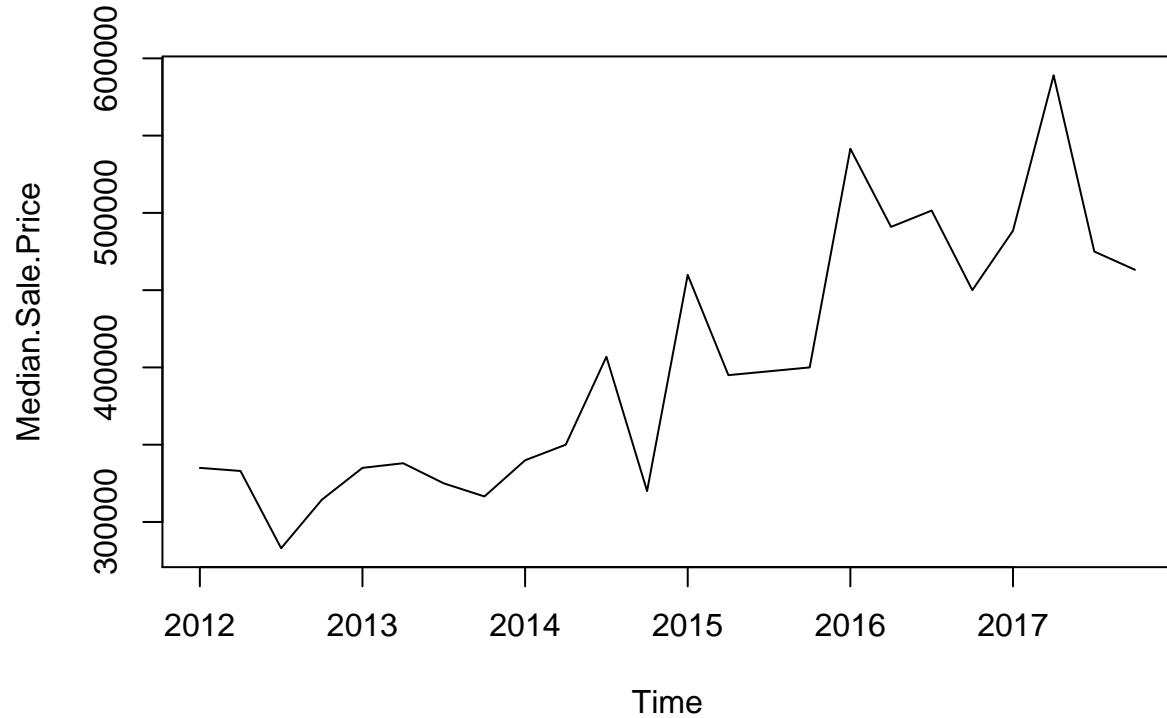
Portland, OR – Hillsdale : TS Training Model Comparison



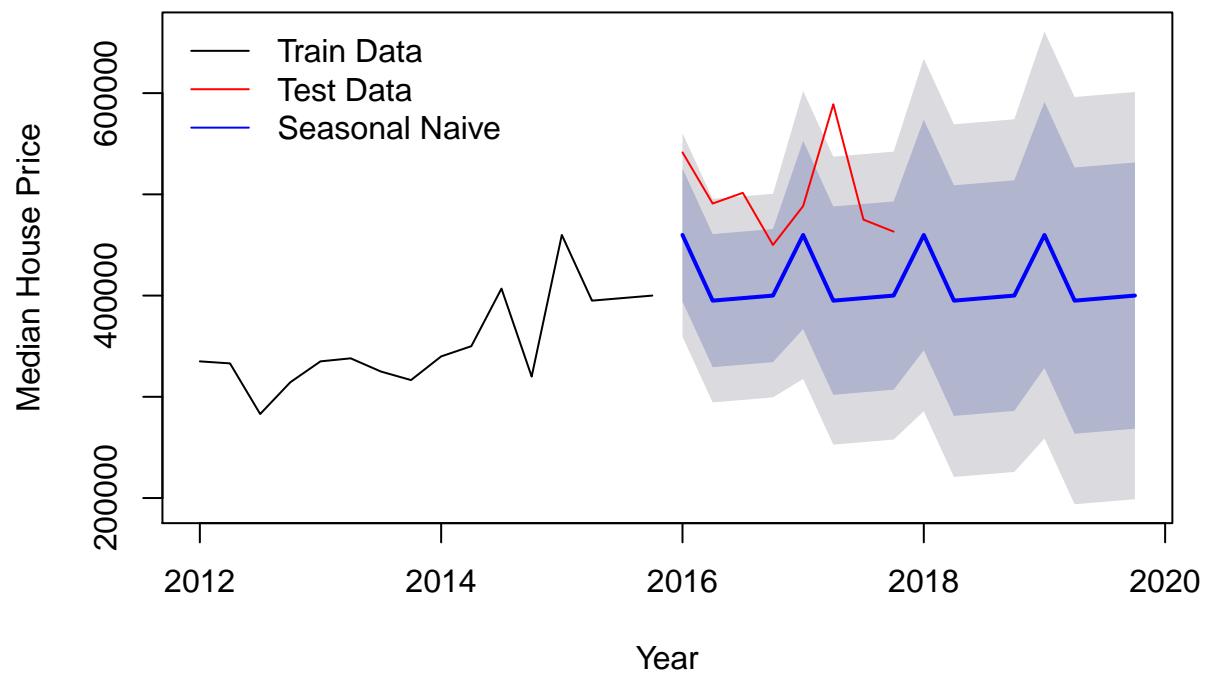
Portland, OR – Hillsdale : Full TS Models Comparison



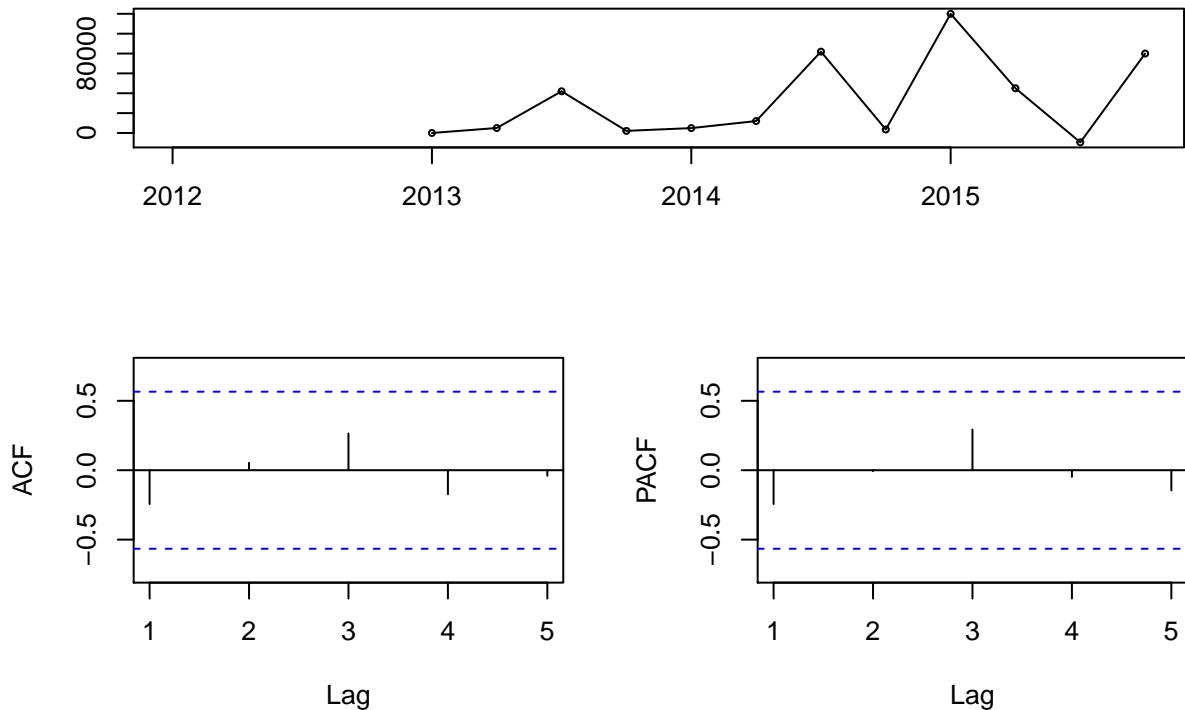
Portland, OR – Reed



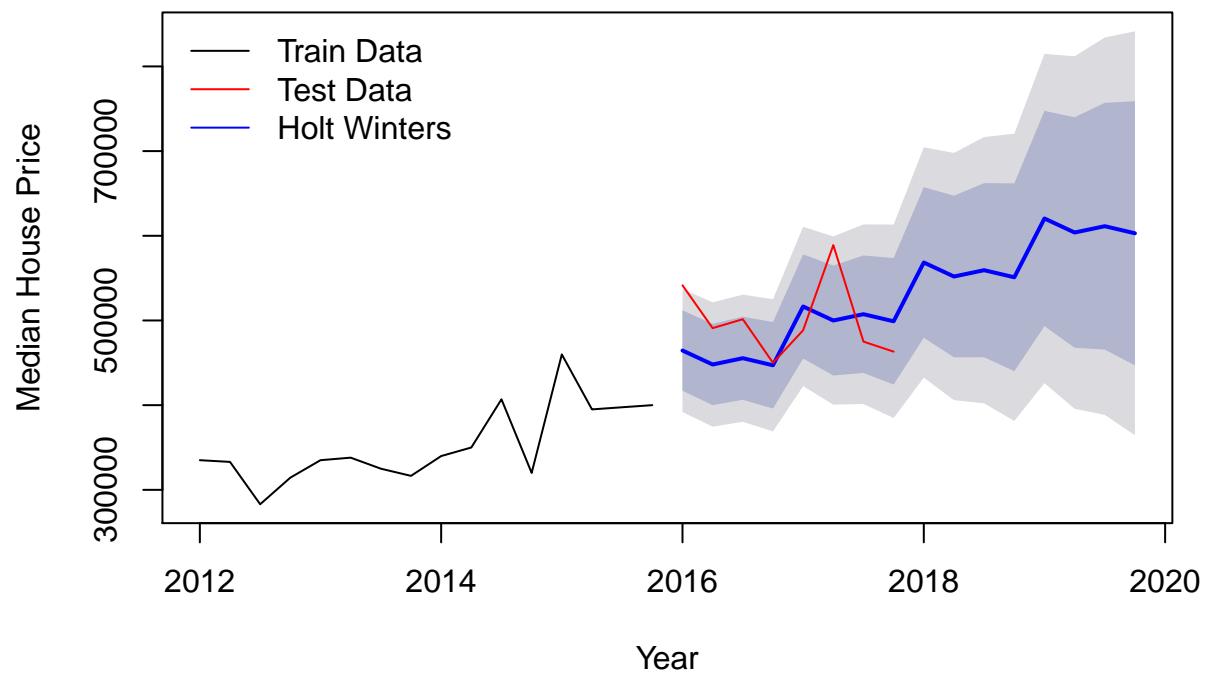
Portland, OR – Reed : Naive Model Forecast



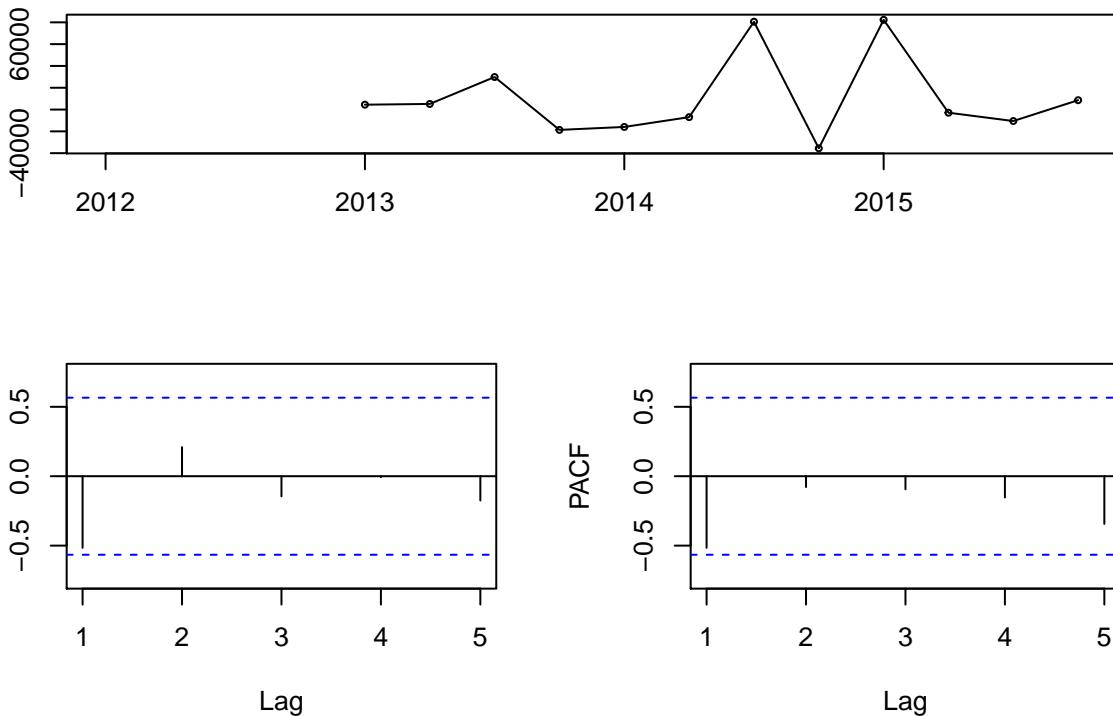
Portland, OR – Reed : Naive Model Forecast Residuals



Portland, OR – Reed : Holt Winters Model Forecast



Portland, OR – Reed : Holt Winters Model Forecast Residuals

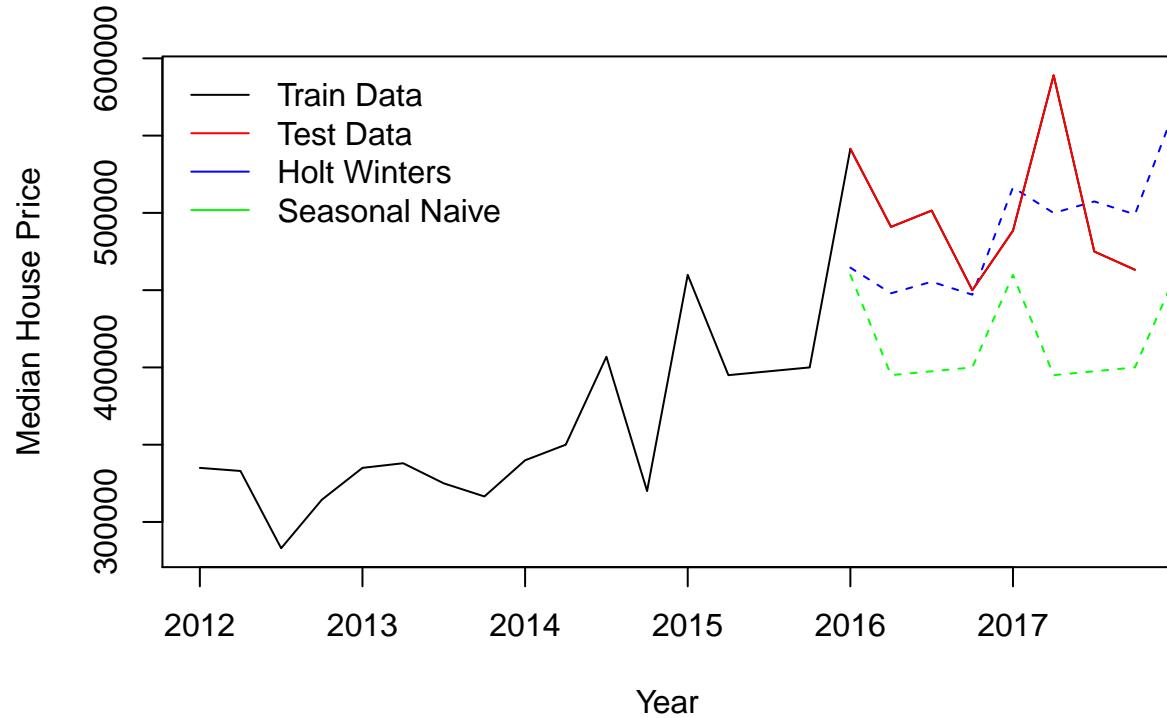


```

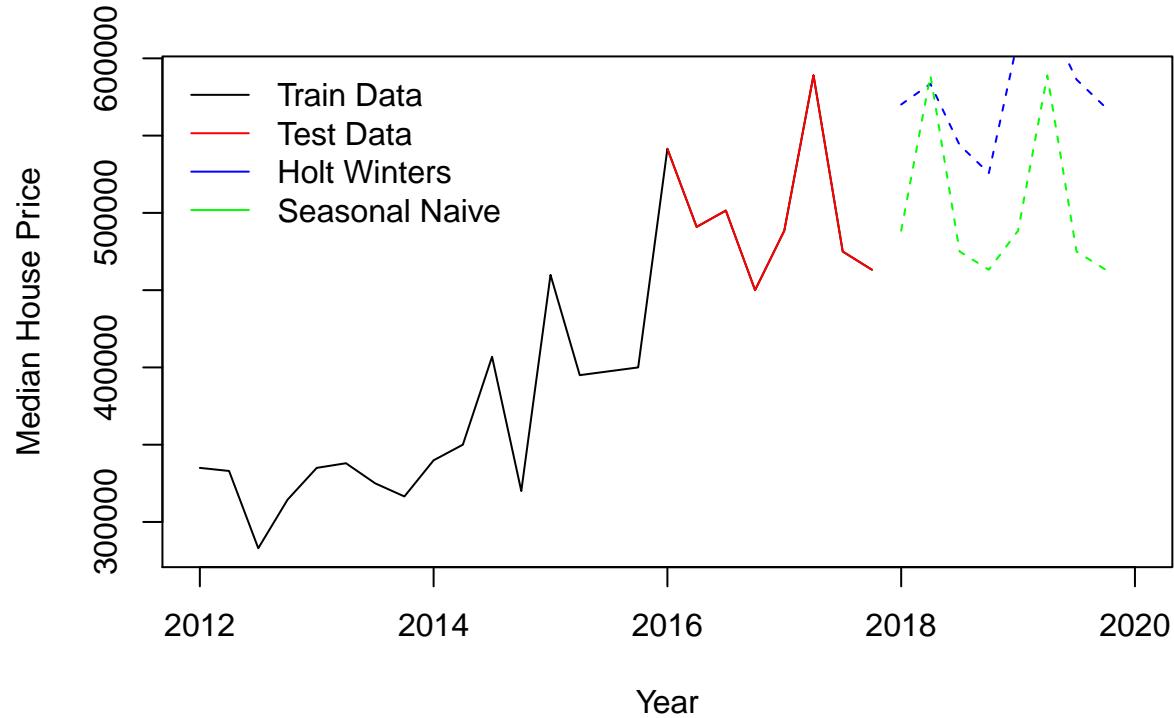
## [1] "Seasonal Naive Accuracy for Portland, OR - Reed"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 32252.08 51311.75 33818.75 8.023812 8.417942 1.000000
## Test set     86850.00 98509.23 86850.00 16.900512 16.900512 2.568102
##          ACF1 Theil's U
## Training set -0.2437938      NA
## Test set     -0.3125020 1.622689
## [1] "Holt Winters Accuracy for Portland, OR - Reed"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 10031.19 36863.37 25119.33 2.067942 6.578528 0.7427635
## Test set     20208.88 51174.68 44283.09 3.452006 8.527624 1.3094241
##          ACF1 Theil's U
## Training set -0.51630232      NA
## Test set     -0.09789275 0.7533028

```

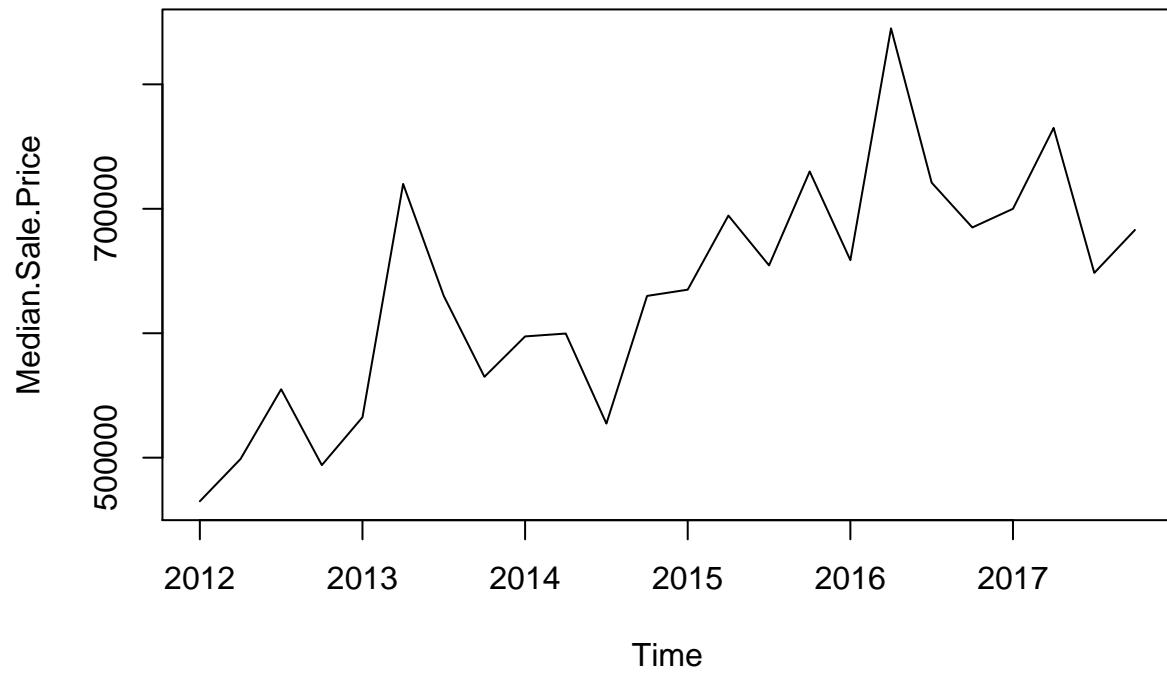
Portland, OR – Reed : TS Training Model Comparison



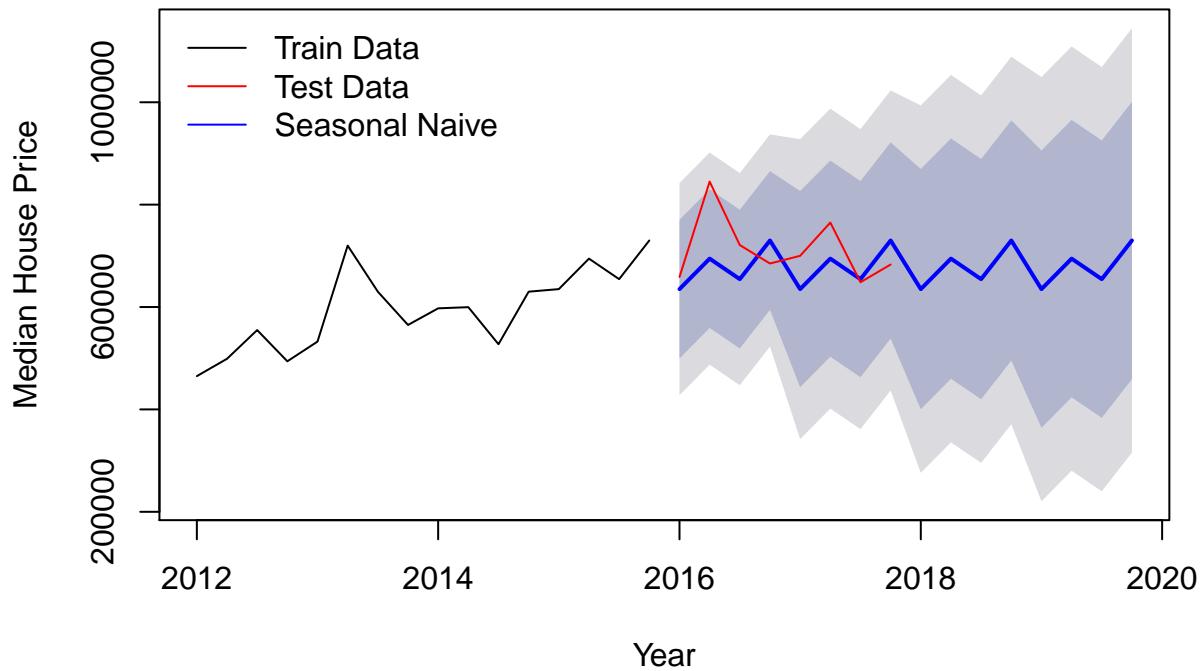
Portland, OR – Reed : Full TS Models Comparison



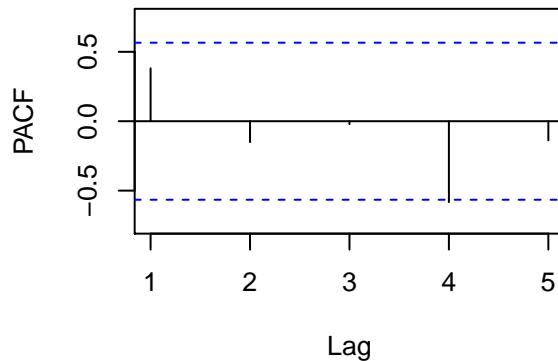
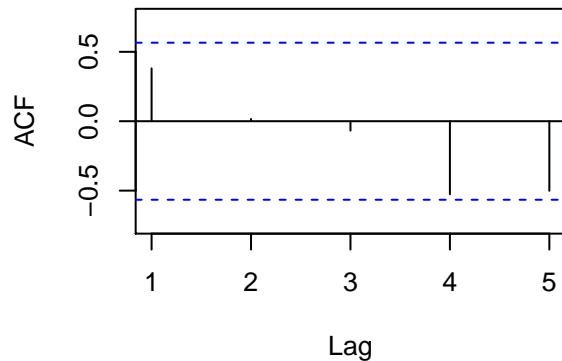
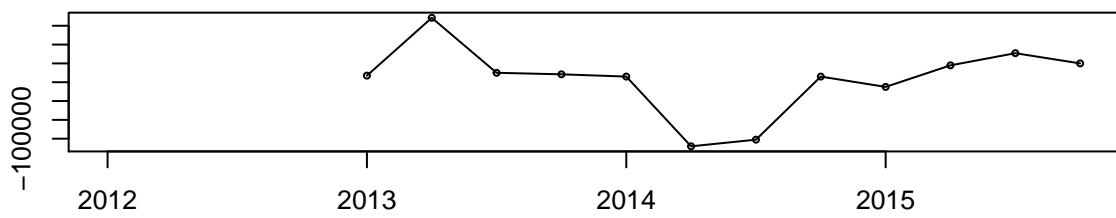
Portland, OR – Irvington



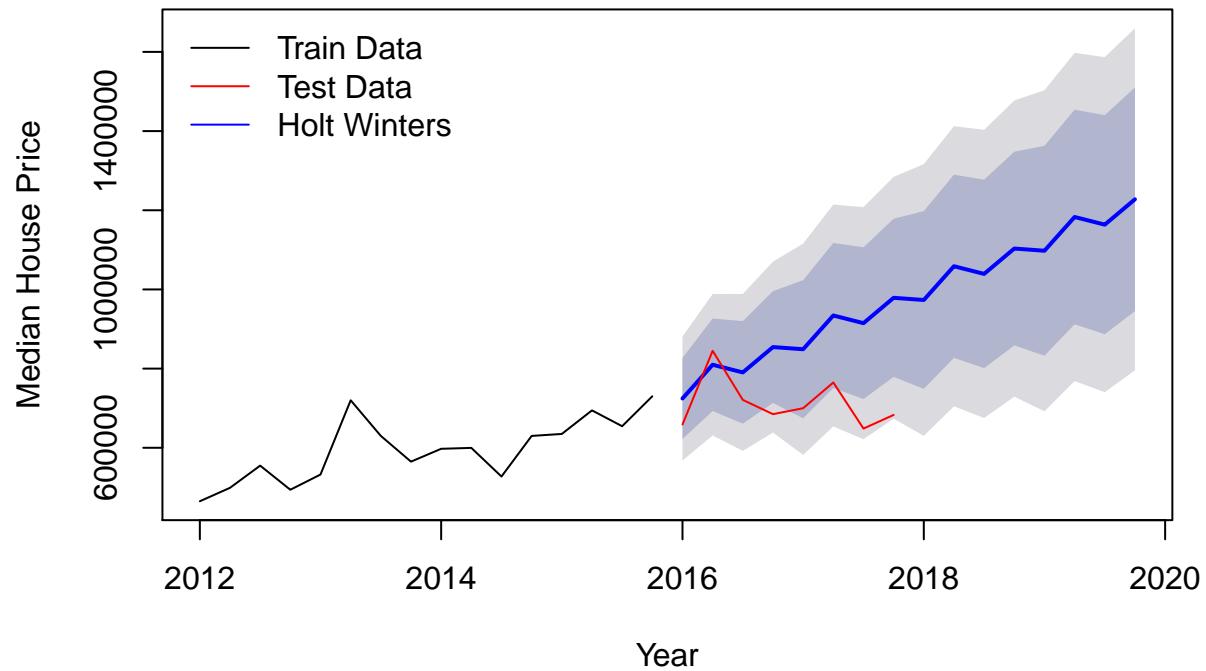
Portland, OR – Irvington : Naive Model Forecast



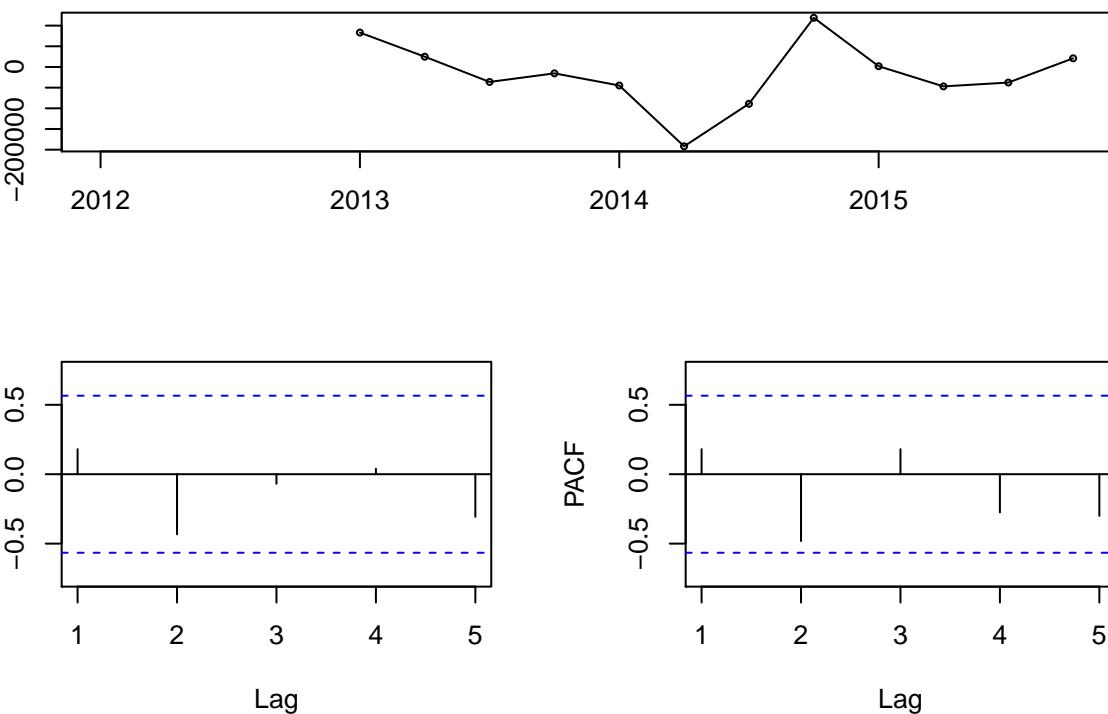
Portland, OR – Irvington : Naive Model Forecast Residuals



Portland, OR – Irvington : Holt Winters Model Forecast



Portland, OR – Irvington : Holt Winters Model Forecast Residuals

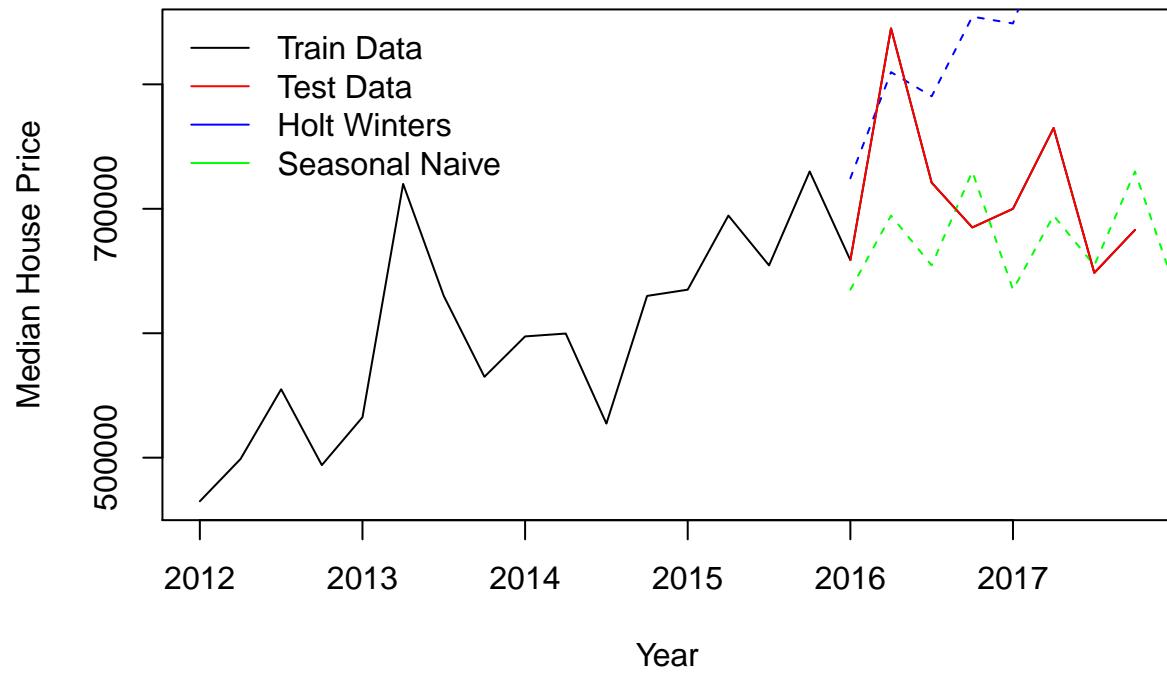


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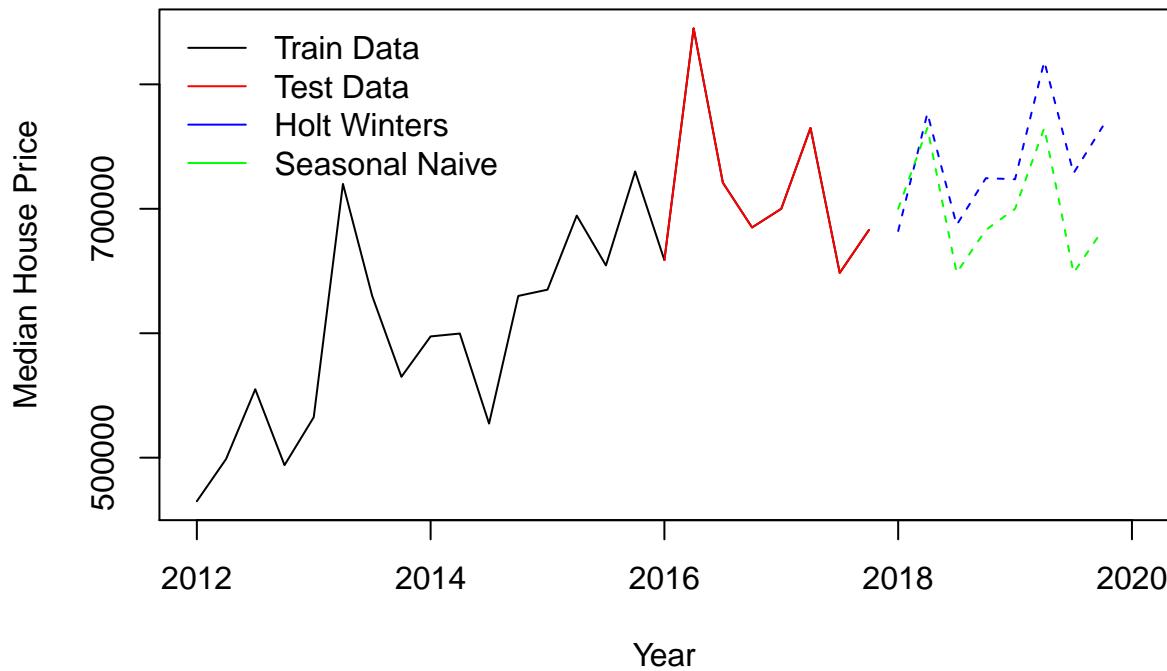
## [1] "Seasonal Naive Accuracy for Portland, OR - Irvington"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 58428.75 105706.76 95570.42 8.518341 15.102332 1.0000000
## Test set     34768.75 71658.67 59268.75 4.344031 7.938022 0.6201579
##          ACF1 Theil's U
## Training set 0.38086706      NA
## Test set     0.01308536 0.7895066
## [1] "Holt Winters Accuracy for Portland, OR - Irvington"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -17687.86 78545.39 59301.5 -3.021528 9.871579 0.6205006
## Test set     -143699.14 176176.69 152500.0 -20.992397 22.033913 1.5956816
##          ACF1 Theil's U
## Training set 0.1806708      NA
## Test set     0.5699679 1.895527

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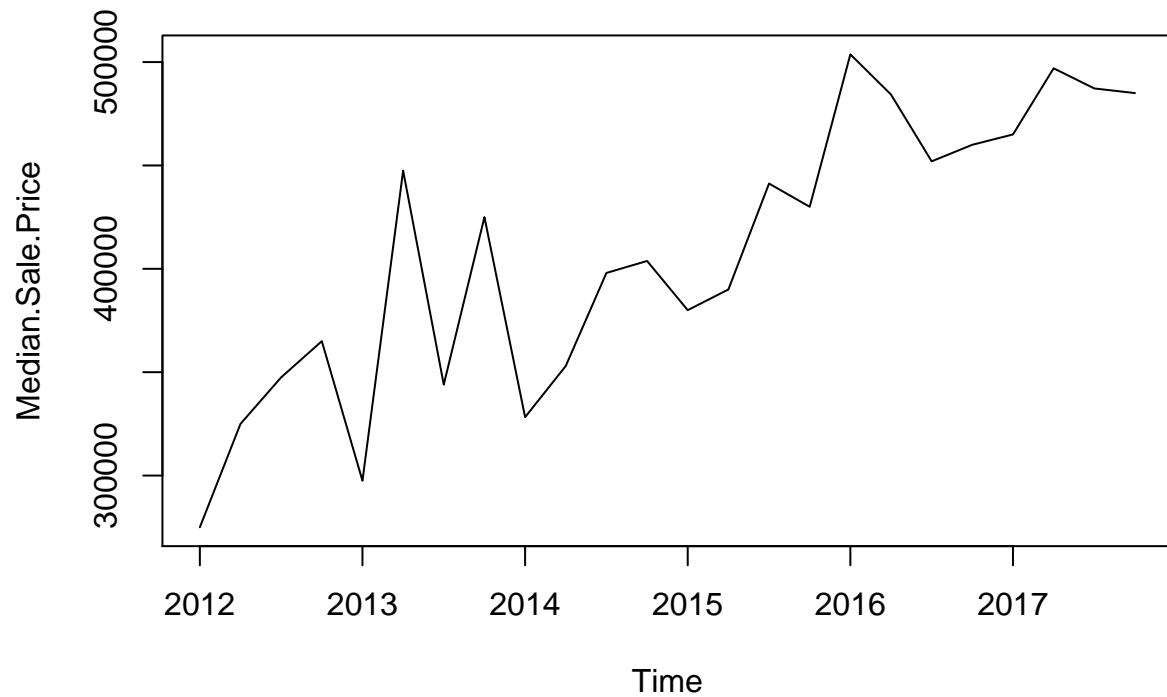
Portland, OR – Irvington : TS Training Model Comparison



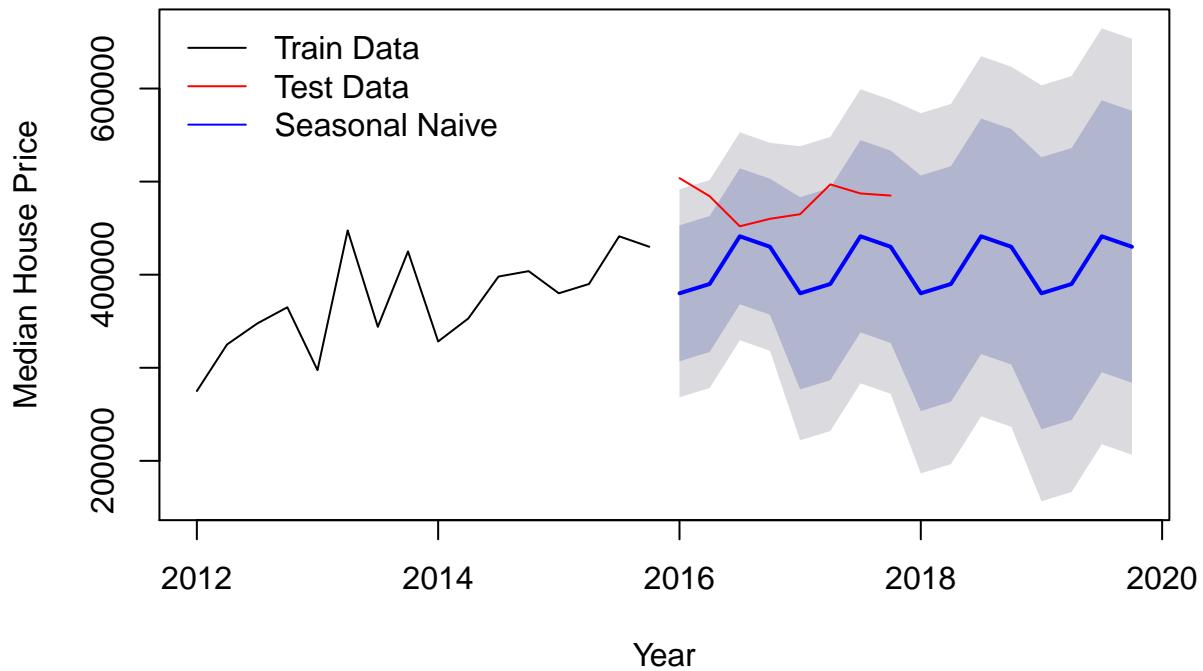
Portland, OR – Irvington : Full TS Models Comparison



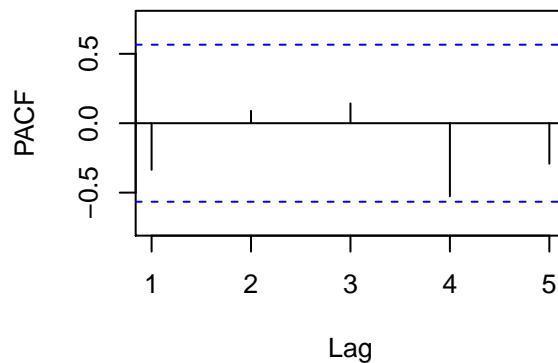
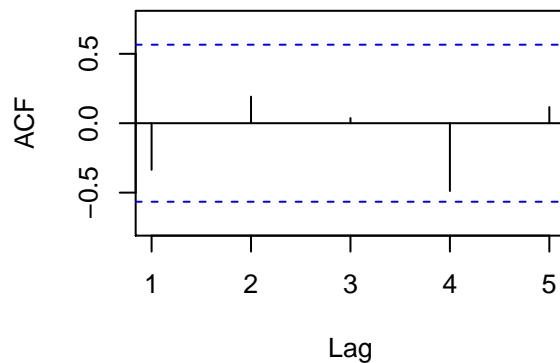
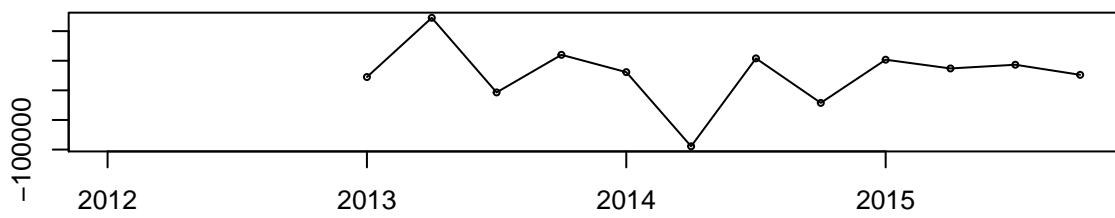
Portland, OR – South Burlingame



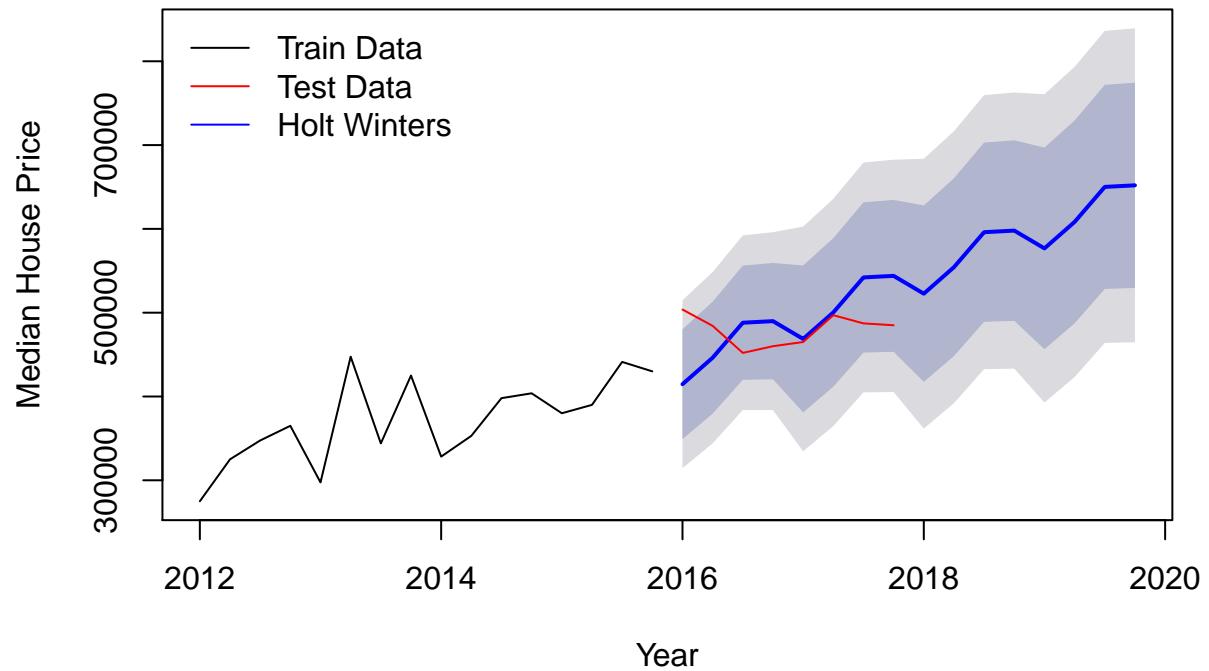
Portland, OR – South Burlingame : Naive Model Forecast



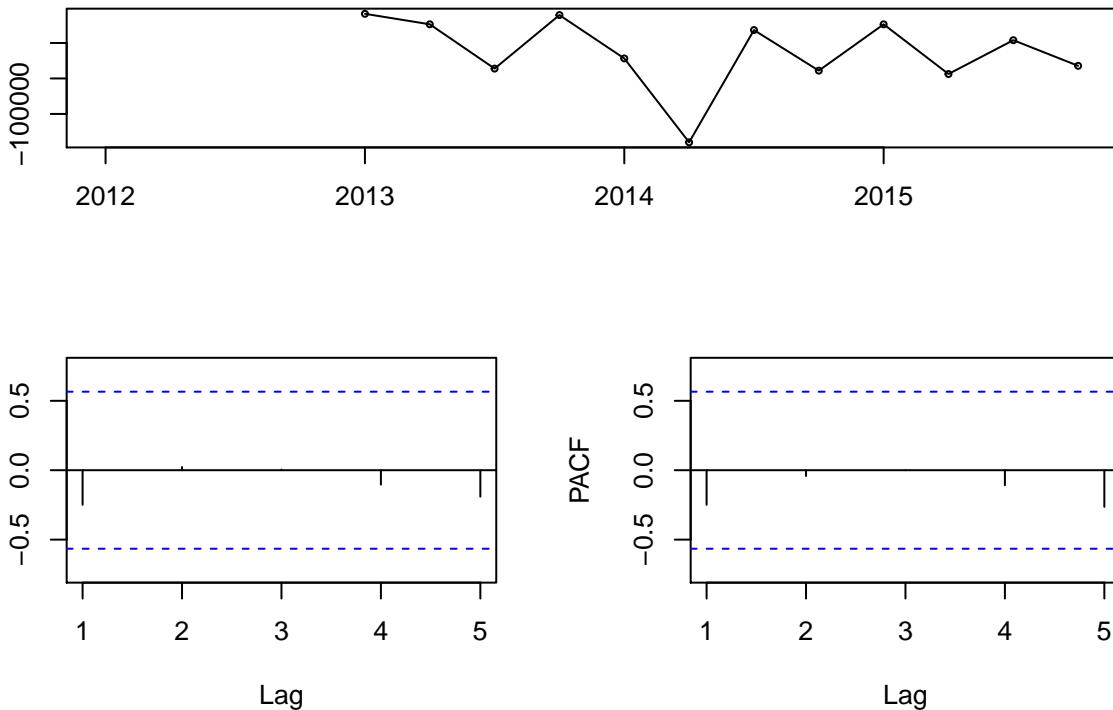
Portland, OR – South Burlingame : Naive Model Forecast Residuals



Portland, OR – South Burlingame : Holt Winters Model Forecast



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

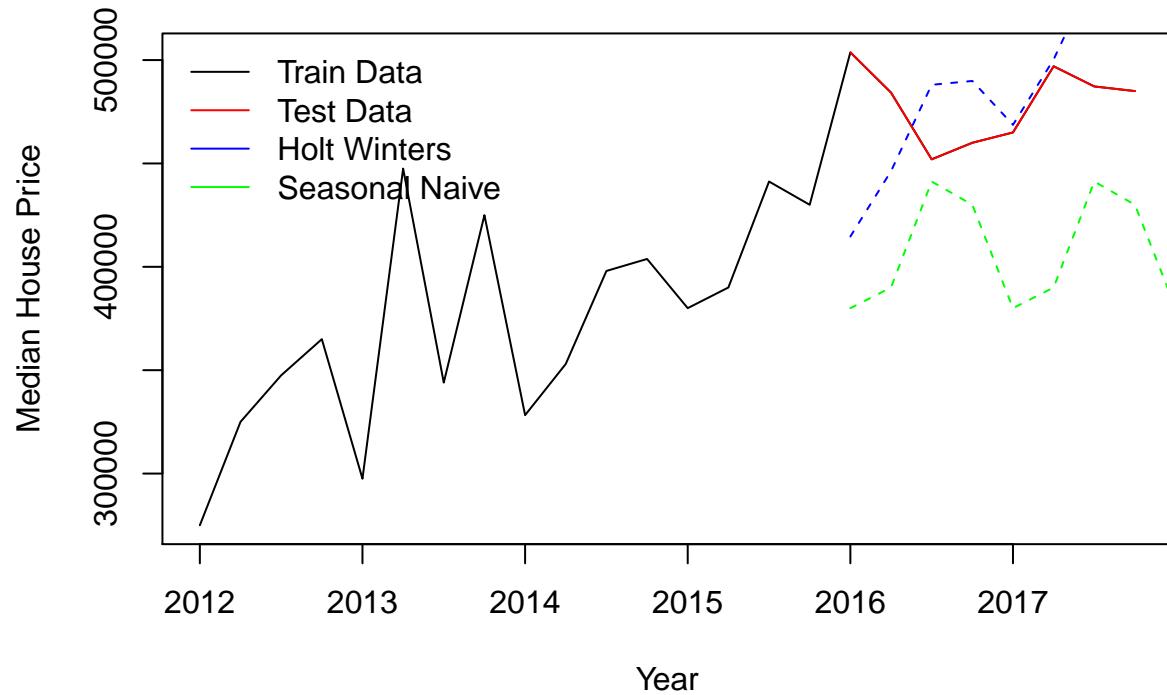


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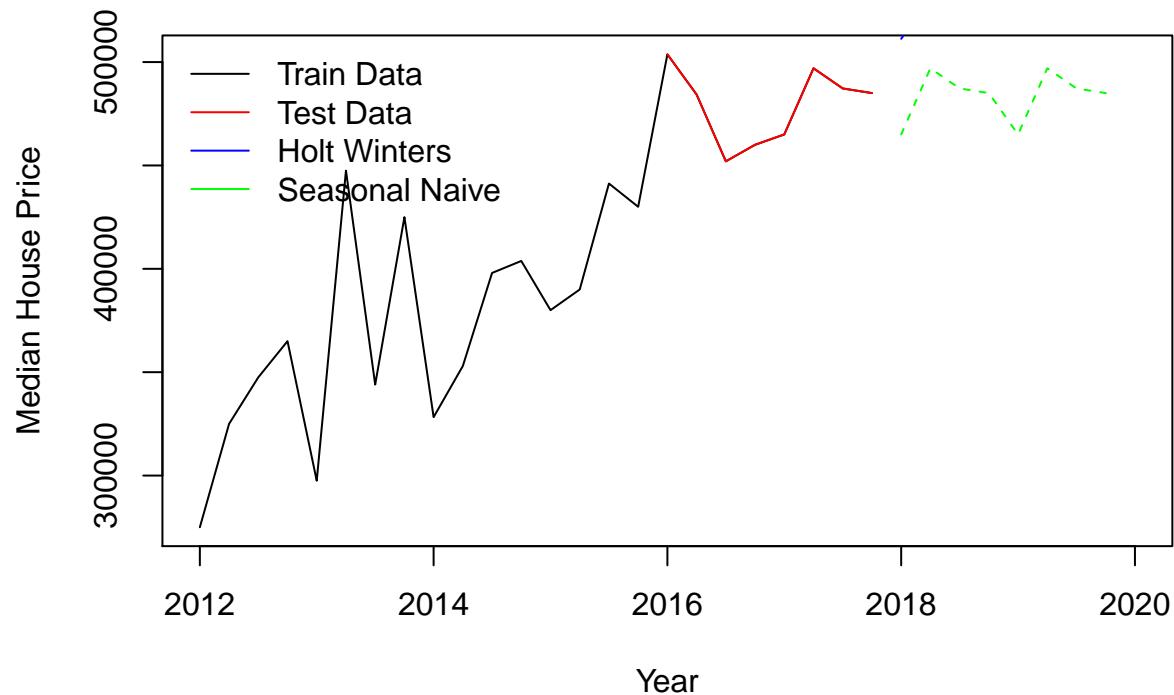
## [1] "Seasonal Naive Accuracy for Portland, OR - South Burlingame"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 27395.83 56986.89 47262.50 6.496074 12.00243 1.00000
## Test set     68970.62 78286.27 68970.62 14.190156 14.19016 1.45931
##          ACF1 Theil's U
## Training set -0.3358352      NA
## Test set     0.1470548  3.590076
## [1] "Holt Winters Accuracy for Portland, OR - South Burlingame"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -13122.311 50665.02 38993.58 -3.647560 10.538578 0.8250426
## Test set     -7446.764 47532.00 39217.47 -1.724549  8.107298 0.8297798
##          ACF1 Theil's U
## Training set -0.2497848      NA
## Test set     0.3348135  1.921817

```

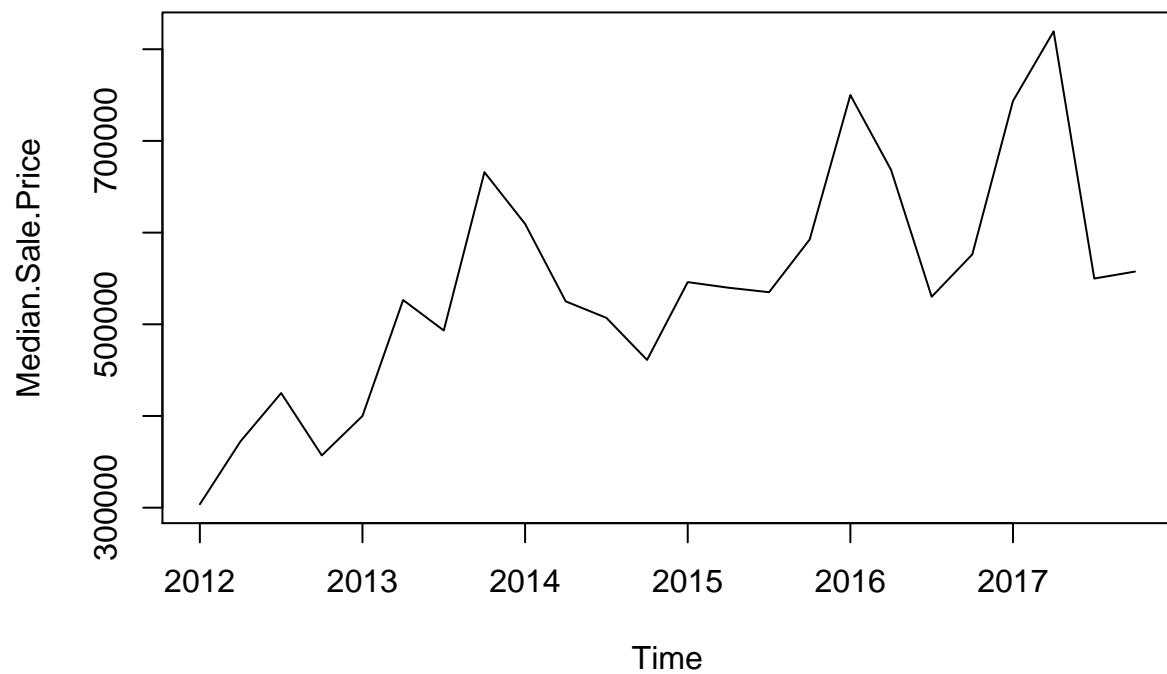
Portland, OR – South Burlingame : TS Training Model Comparison



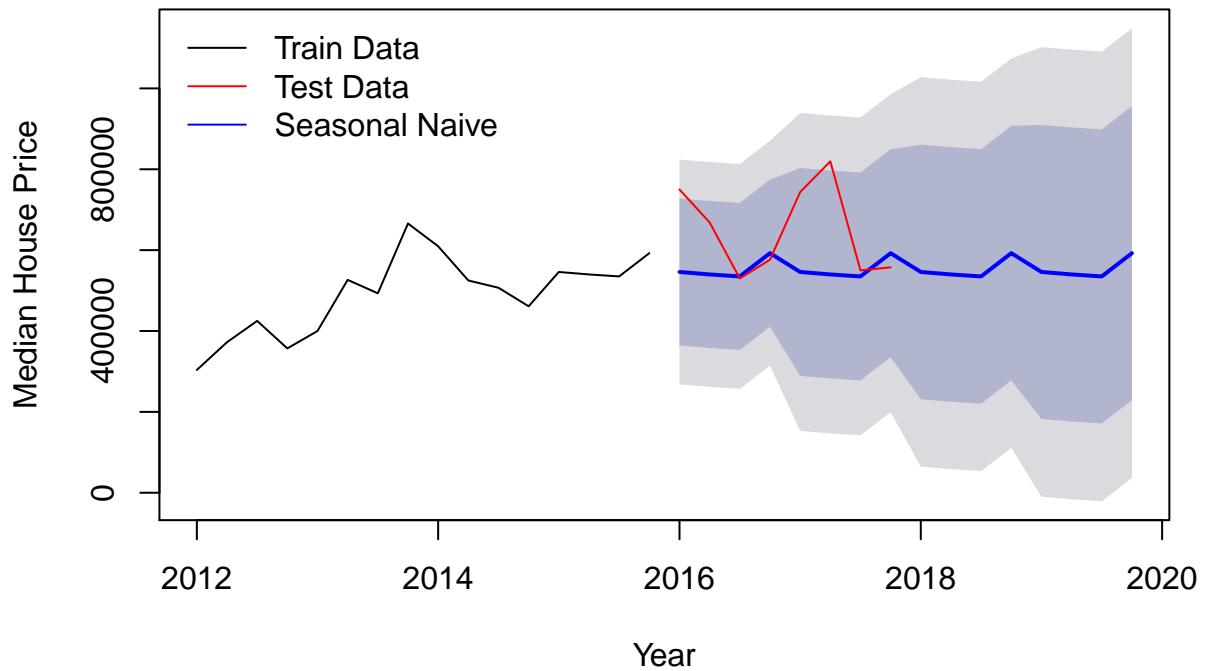
Portland, OR – South Burlingame : Full TS Models Comparison



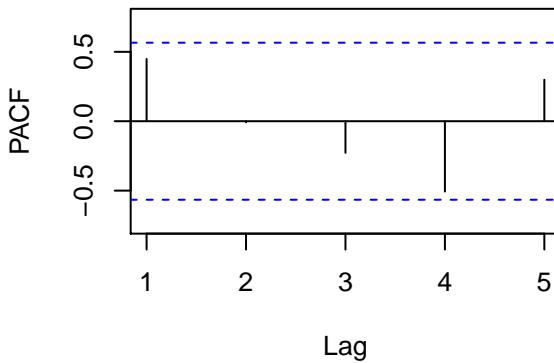
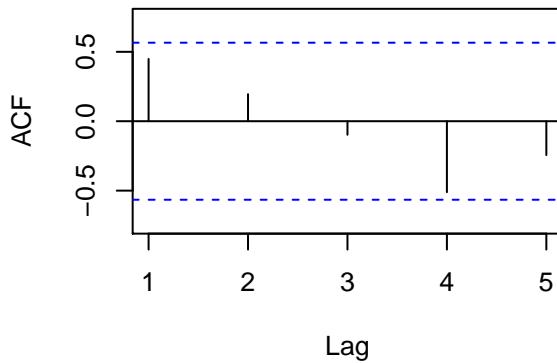
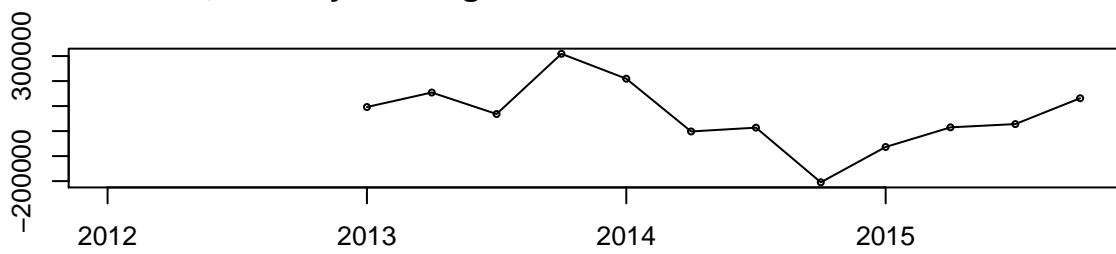
Portland, OR – Sylvan-Highlands



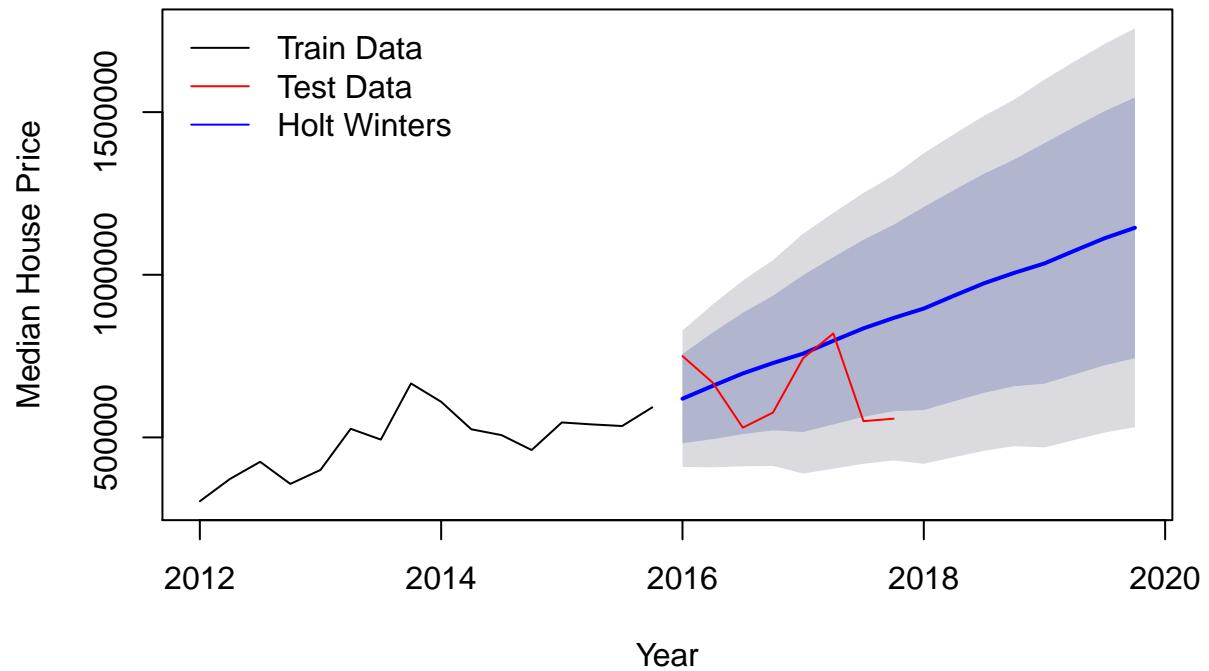
Portland, OR – Sylvan–Highlands : Naive Model Forecast



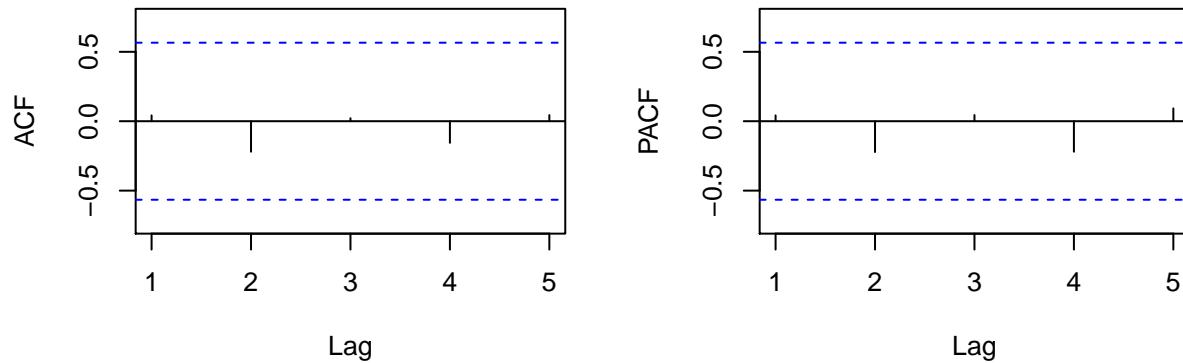
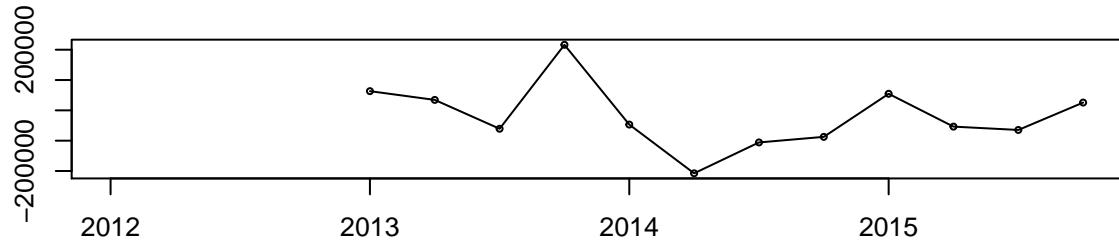
Portland, OR – Sylvan–Highlands : Naive Model Forecast Residuals



Portland, OR – Sylvan-Highlands : Holt Winters Model Forecast

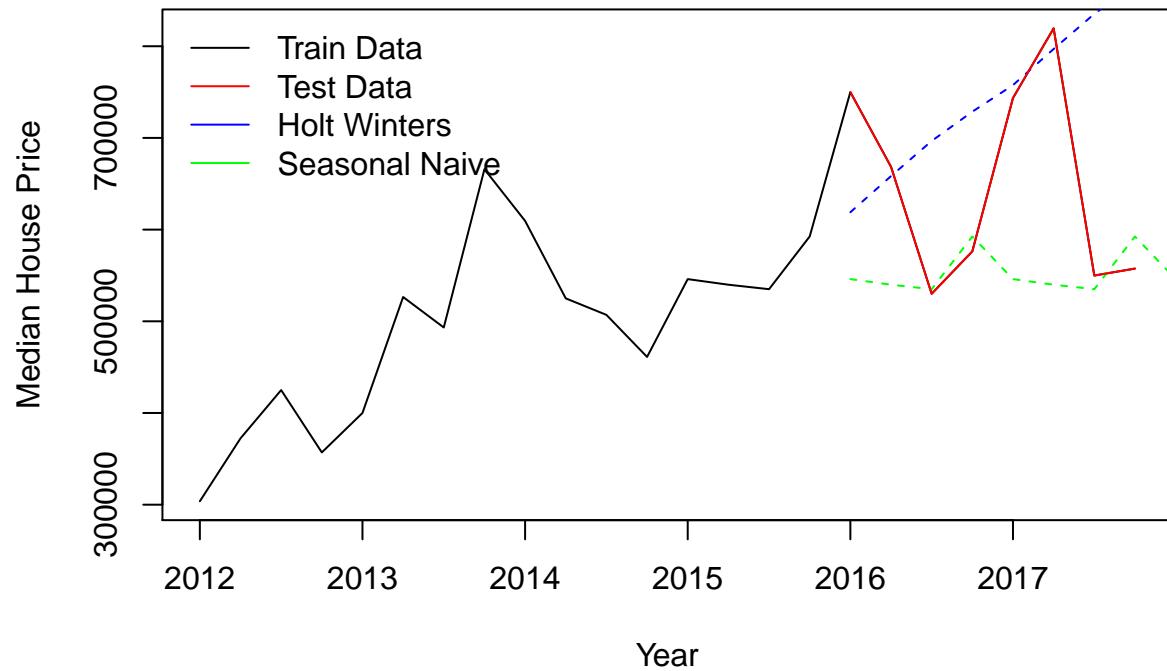


Portland, OR – Sylvan-Highlands : Holt Winters Model Forecast Residuals

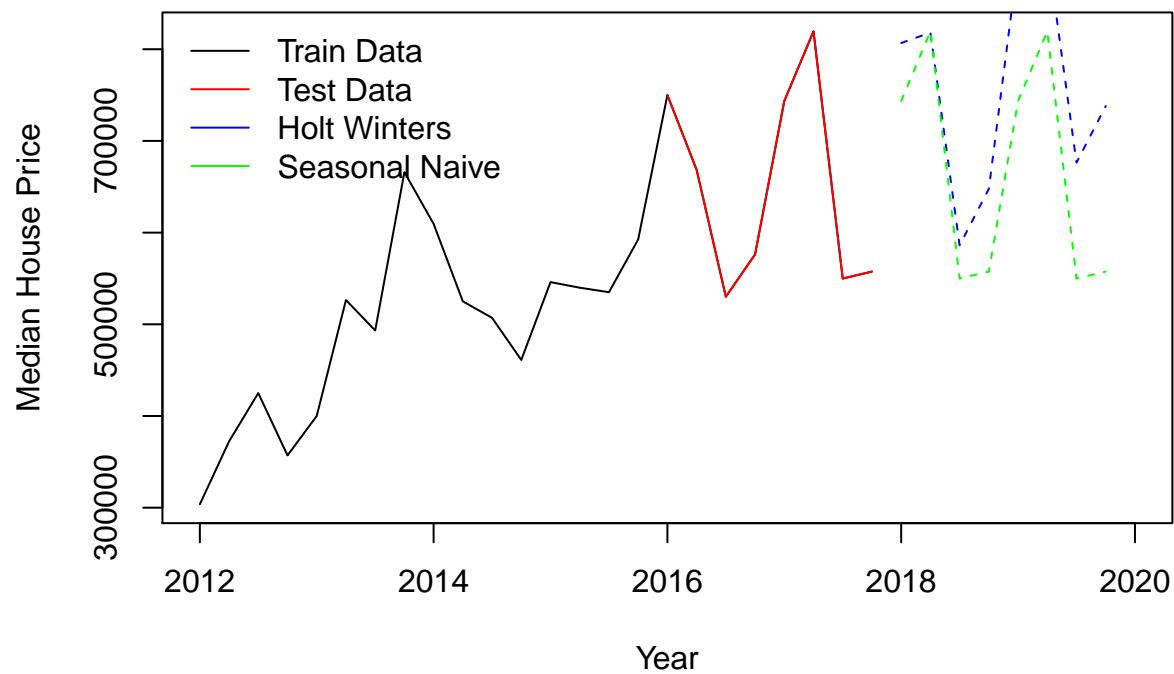


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Sylvan-Highlands"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 62943.75 141835.1 107902.1 10.37514 19.76108 1.000000
## Test set     96046.88 148774.8 110103.1 12.47396 14.98319 1.020399
##          ACF1 Theil's U
## Training set 0.4486670      NA
## Test set     0.1407989 1.051821
## [1] "Holt Winters Accuracy for Portland, OR – Sylvan-Highlands"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -19349.61 104262.4 85077.65 -4.346771 15.87979 0.7884709
## Test set     -95559.68 175479.9 136489.86 -18.186239 23.62116 1.2649419
##          ACF1 Theil's U
## Training set 0.04213783      NA
## Test set     0.25223989 1.484591
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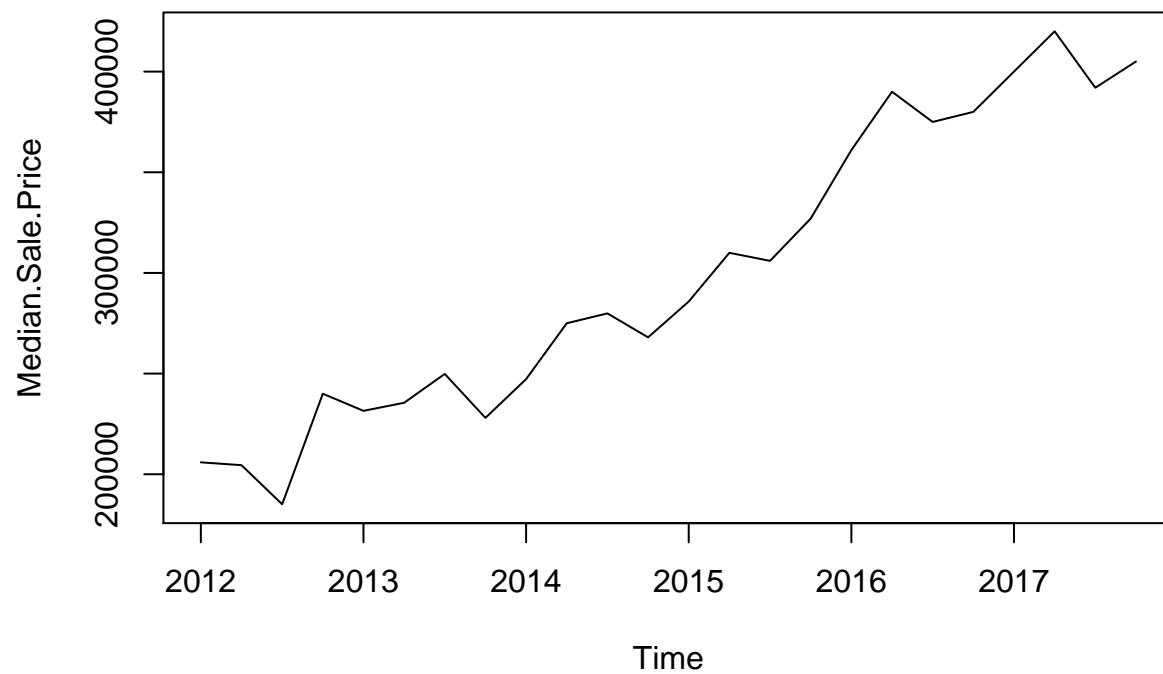
Portland, OR – Sylvan–Highlands : TS Training Model Comparison



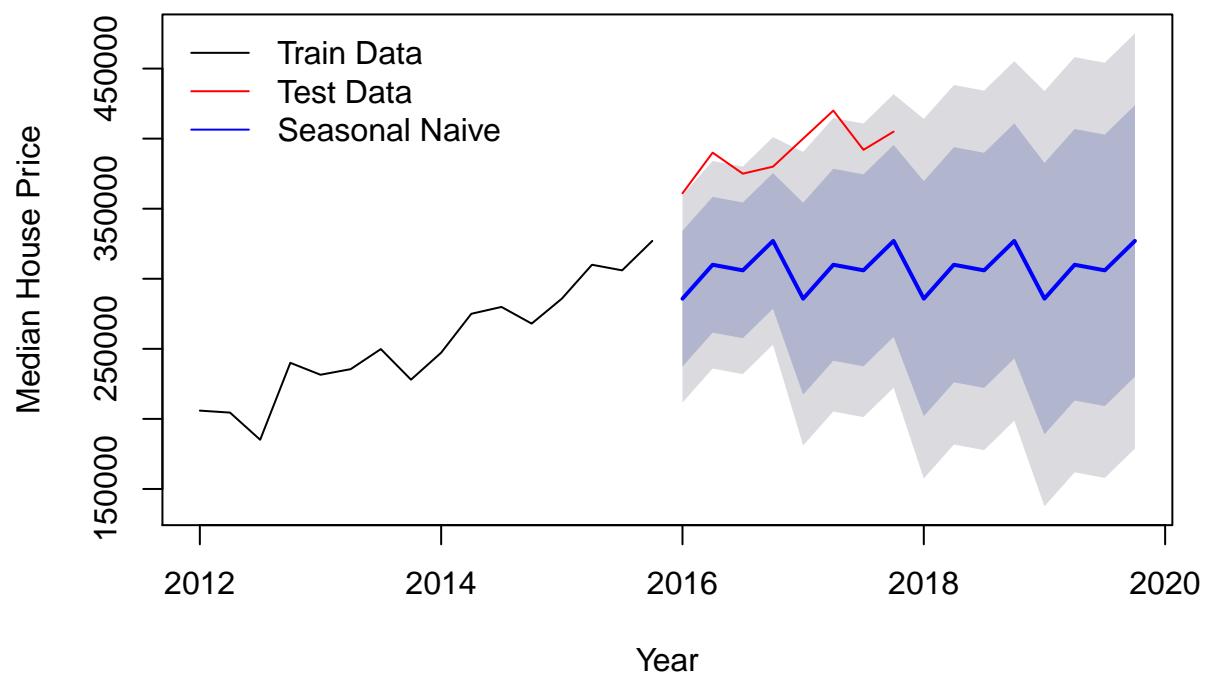
Portland, OR – Sylvan–Highlands : Full TS Models Comparison



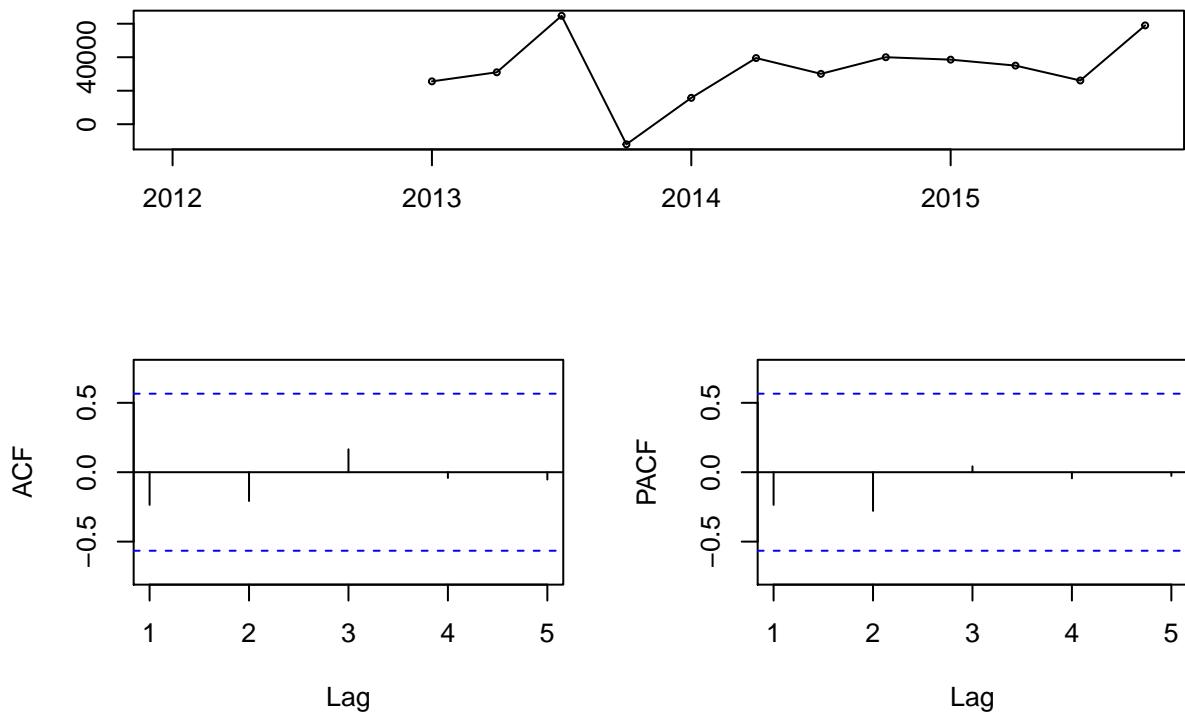
Portland, OR – Kenton



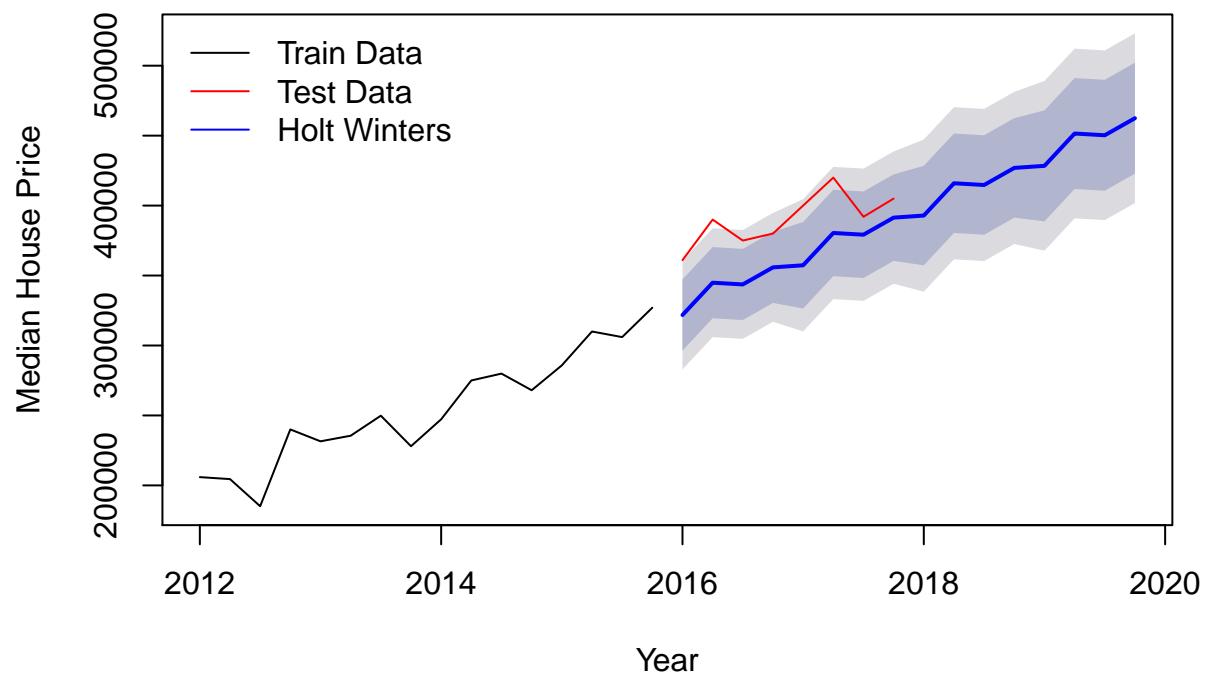
Portland, OR – Kenton : Naive Model Forecast



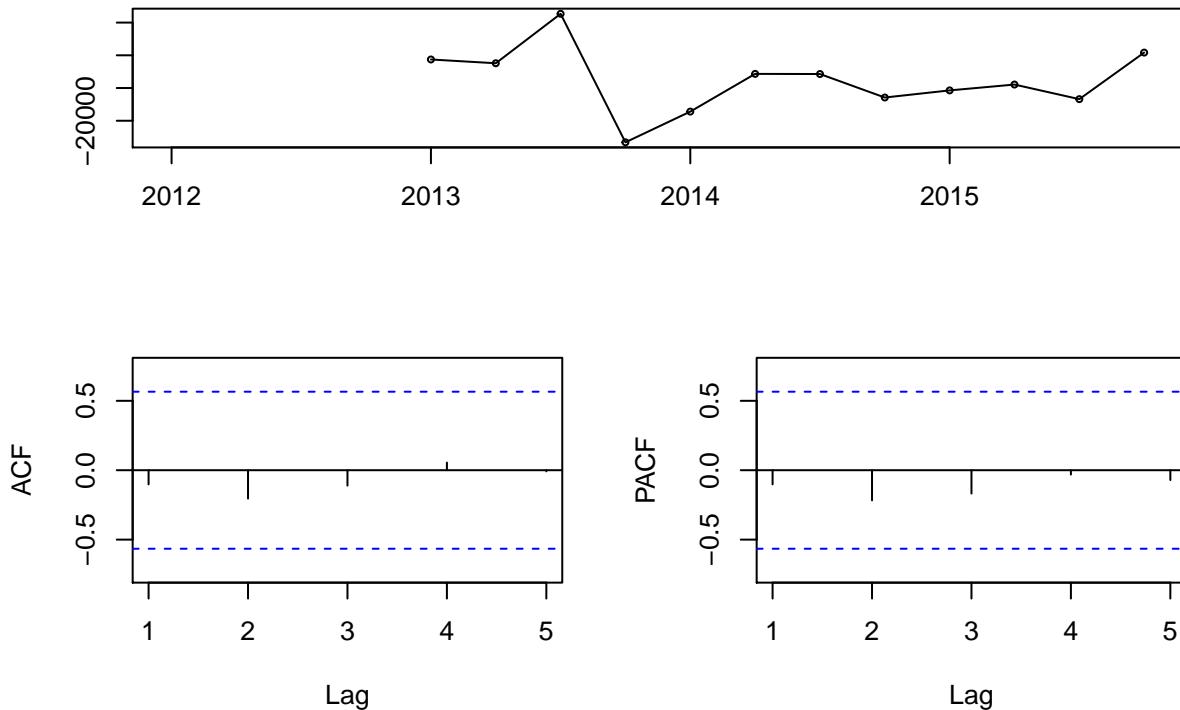
Portland, OR – Kenton : Naive Model Forecast Residuals



Portland, OR – Kenton : Holt Winters Model Forecast



Portland, OR – Kenton : Holt Winters Model Forecast Residuals

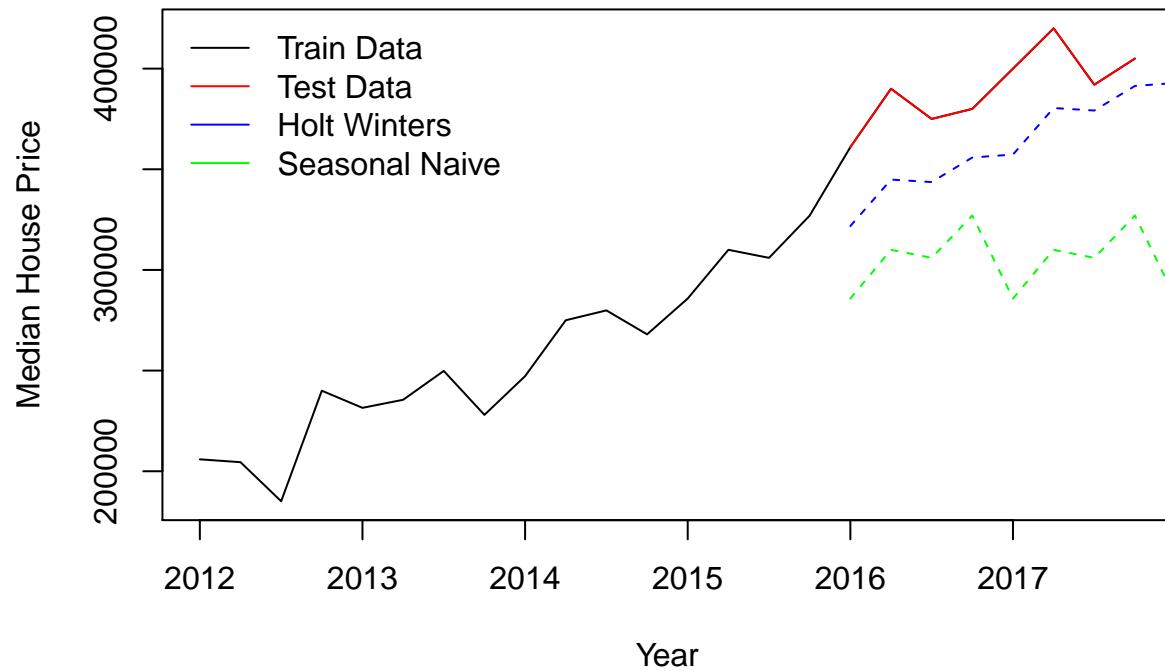


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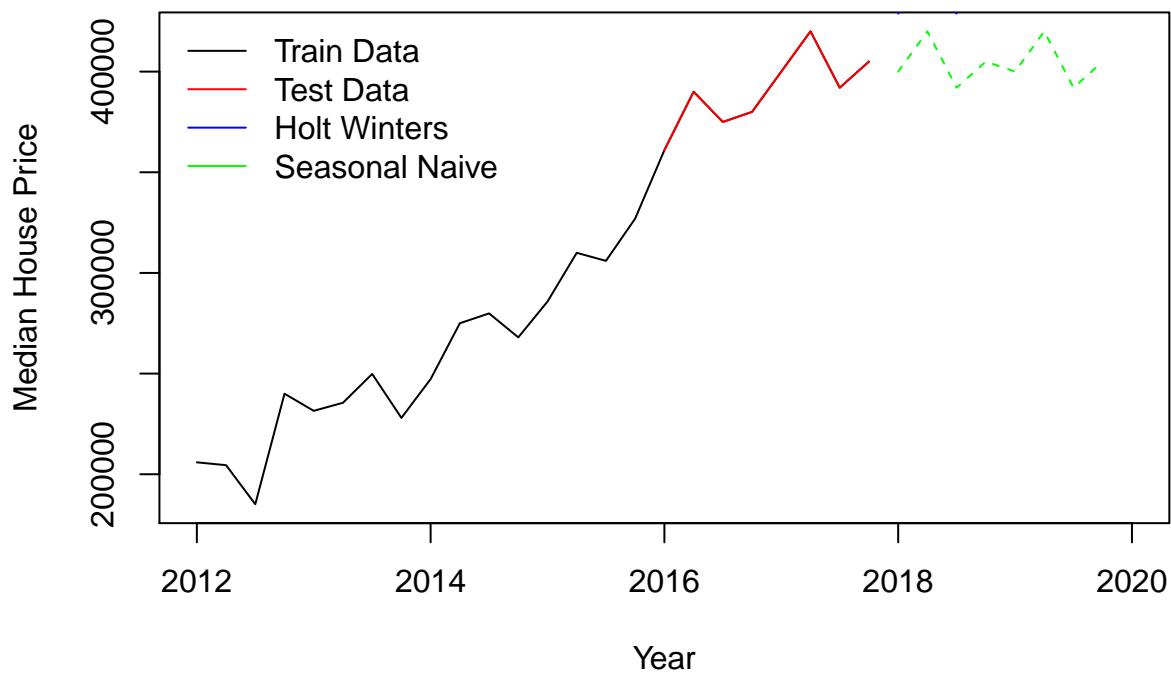
## [1] "Seasonal Naive Accuracy for Portland, OR - Kenton"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 32773.75 37787.84 34773.75 11.88461 12.76180 1.00000
## Test set     83175.00 85327.81 83175.00 21.20372 21.20372 2.39189
##          ACF1 Theil's U
## Training set -0.2354725      NA
## Test set      0.1568845 4.287264
## [1] "Holt Winters Accuracy for Portland, OR - Kenton"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 4777.355 19585.55 15046.22 1.697541 5.908251 0.4326889
## Test set     31064.553 33310.00 31064.55 7.983760 7.983760 0.8933334
##          ACF1 Theil's U
## Training set -0.1021270      NA
## Test set      0.2579833 1.637875

```

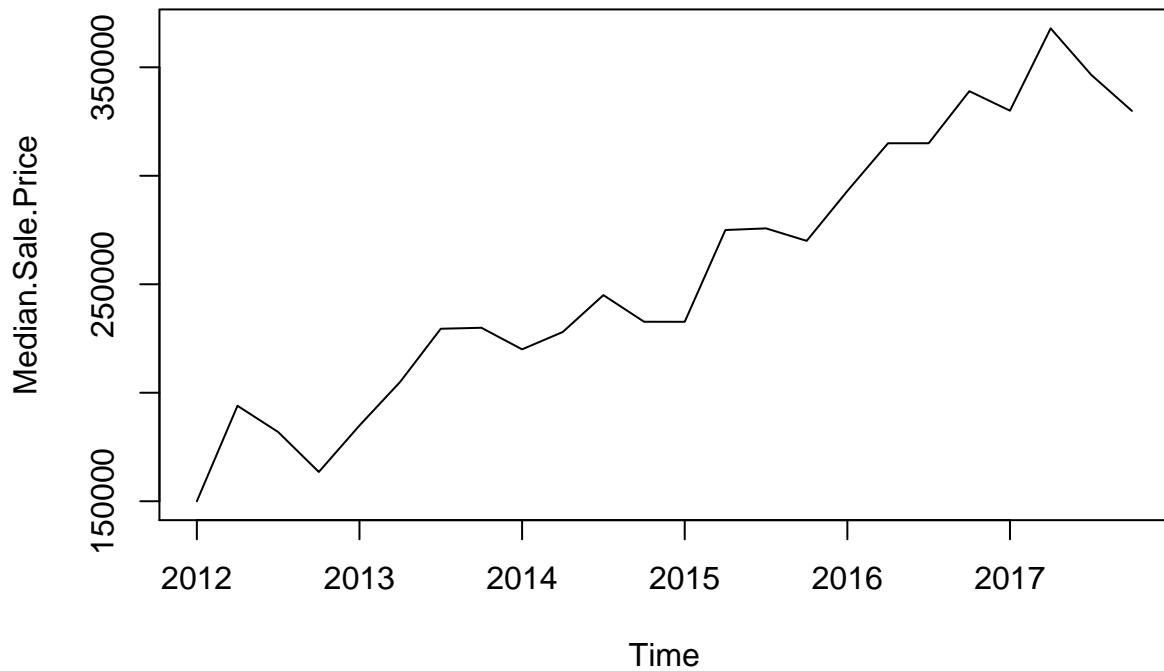
Portland, OR – Kenton : TS Training Model Comparison



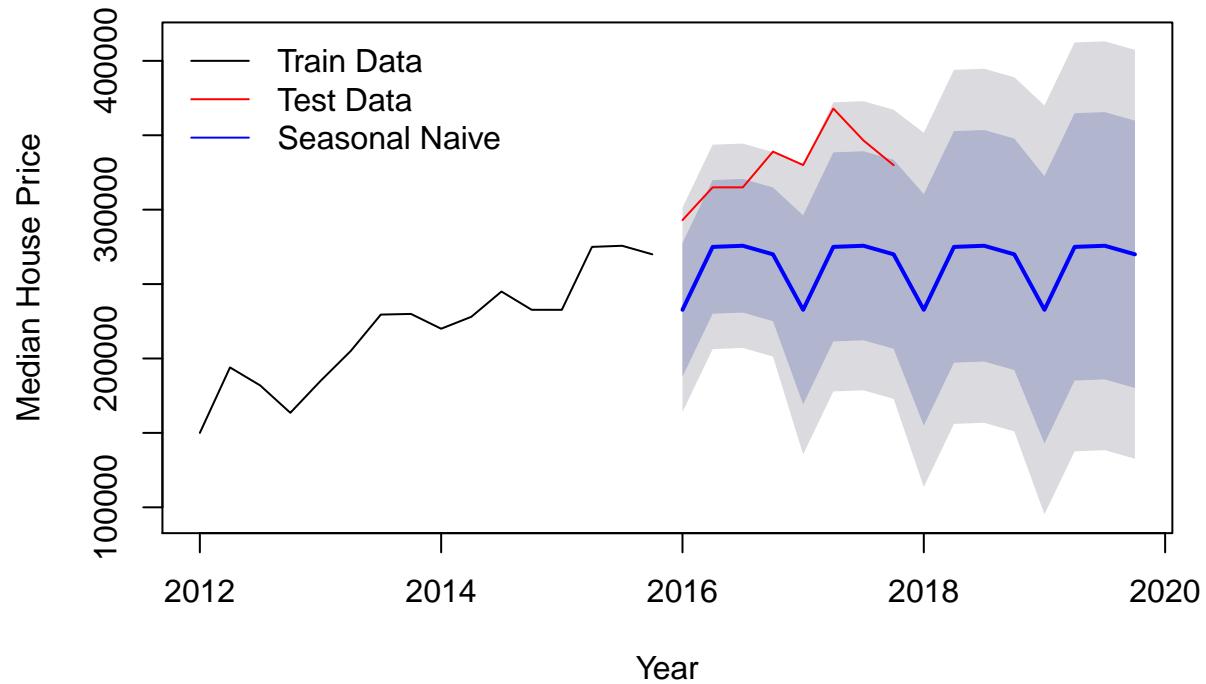
Portland, OR – Kenton : Full TS Models Comparison



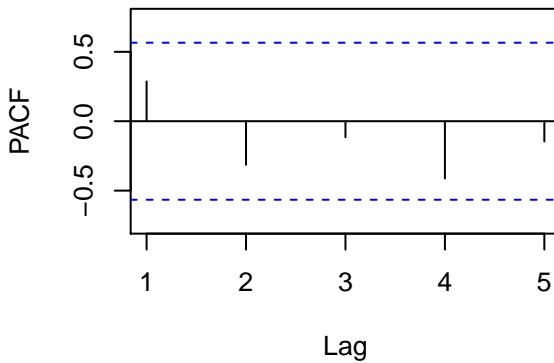
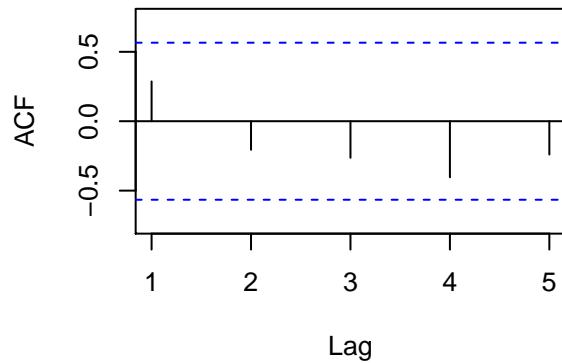
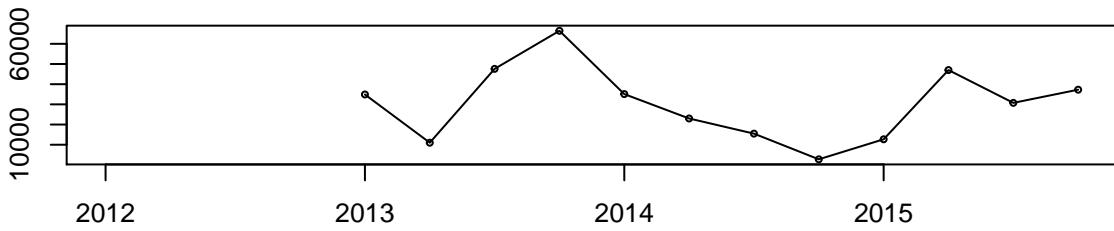
Portland, OR – St. Johns



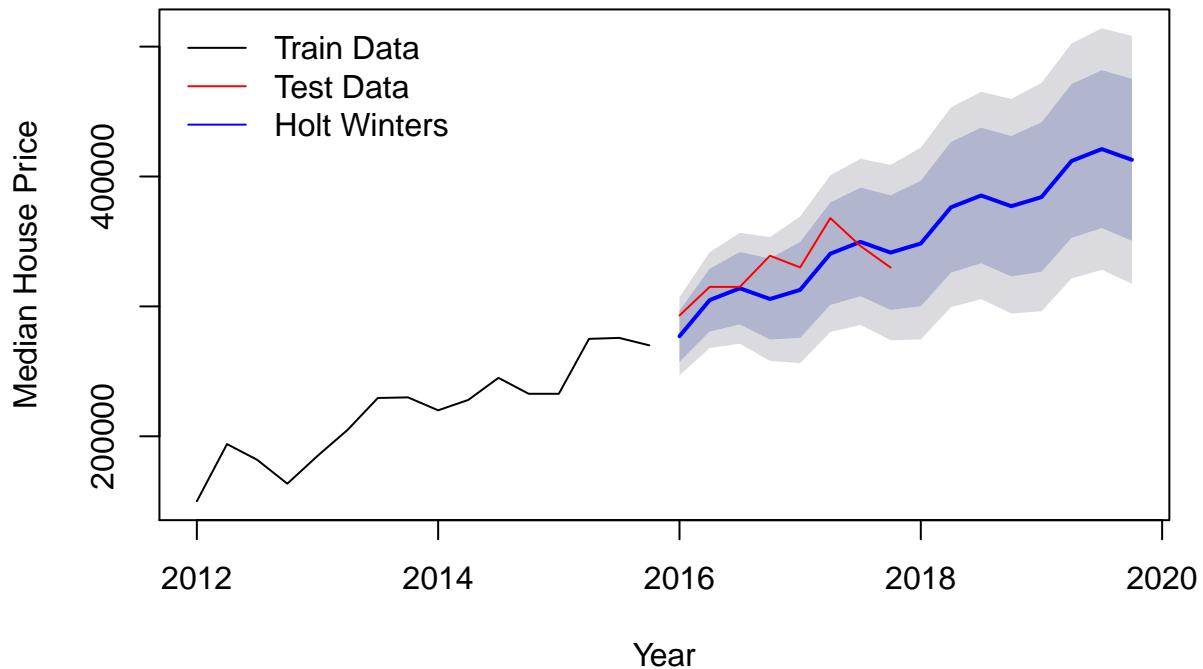
Portland, OR – St. Johns : Naive Model Forecast



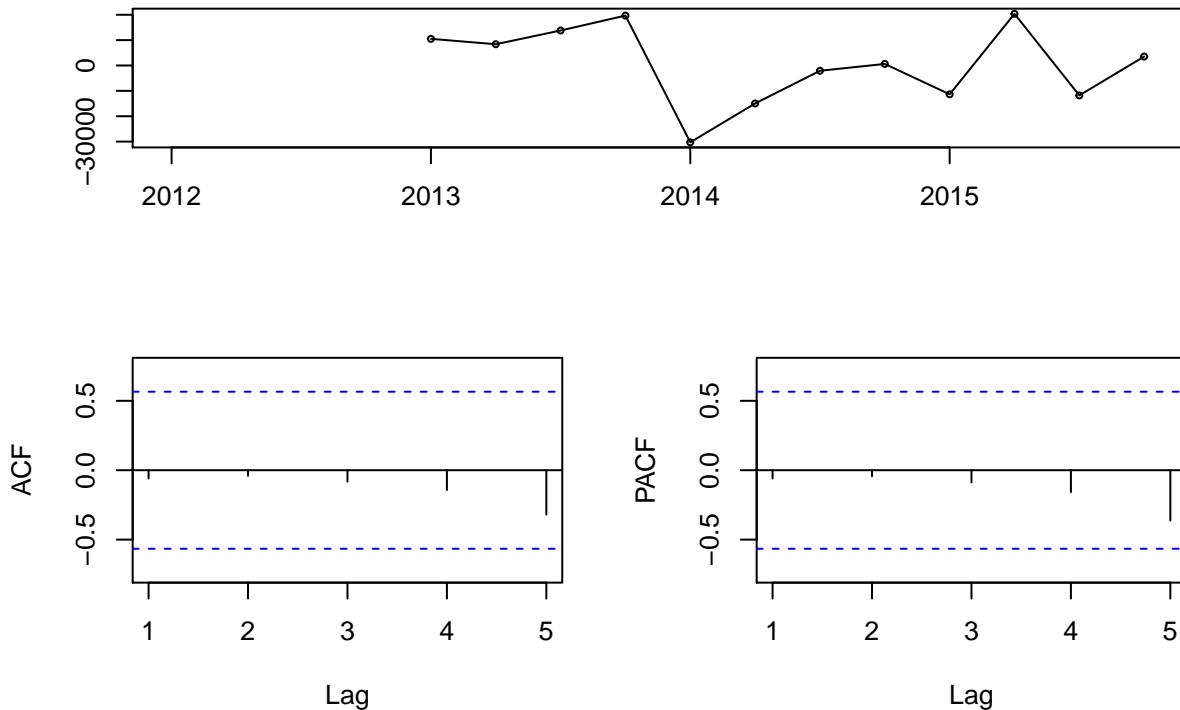
Portland, OR – St. Johns : Naive Model Forecast Residuals



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

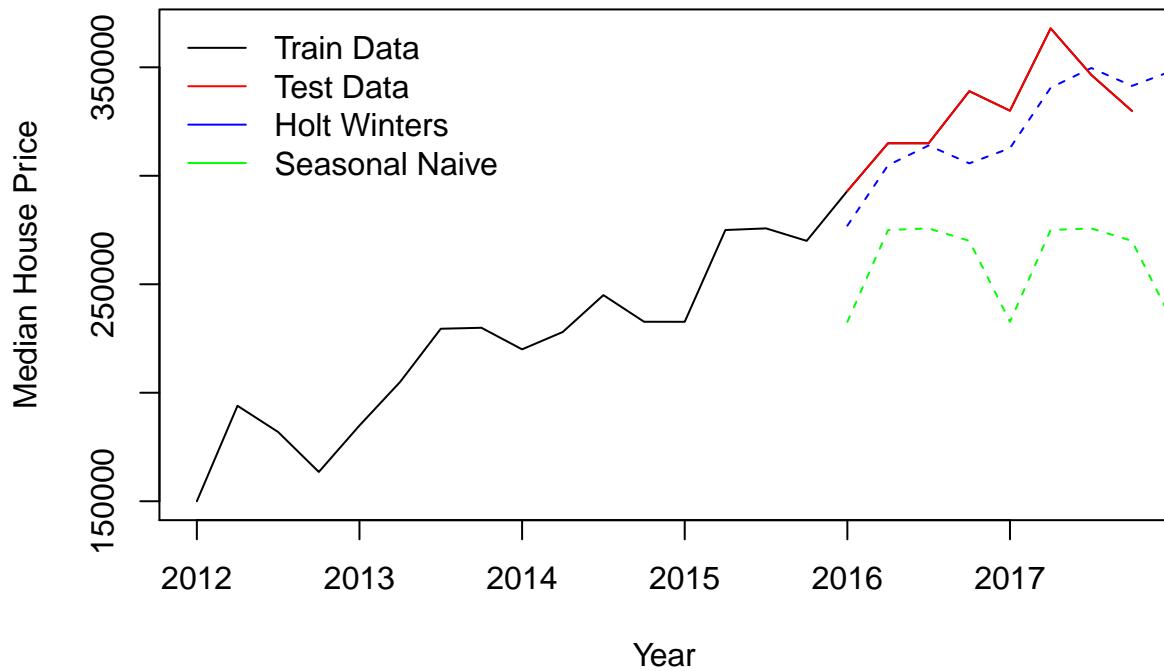


Portland, OR – St. Johns : Holt Winters Model Forecast Residuals

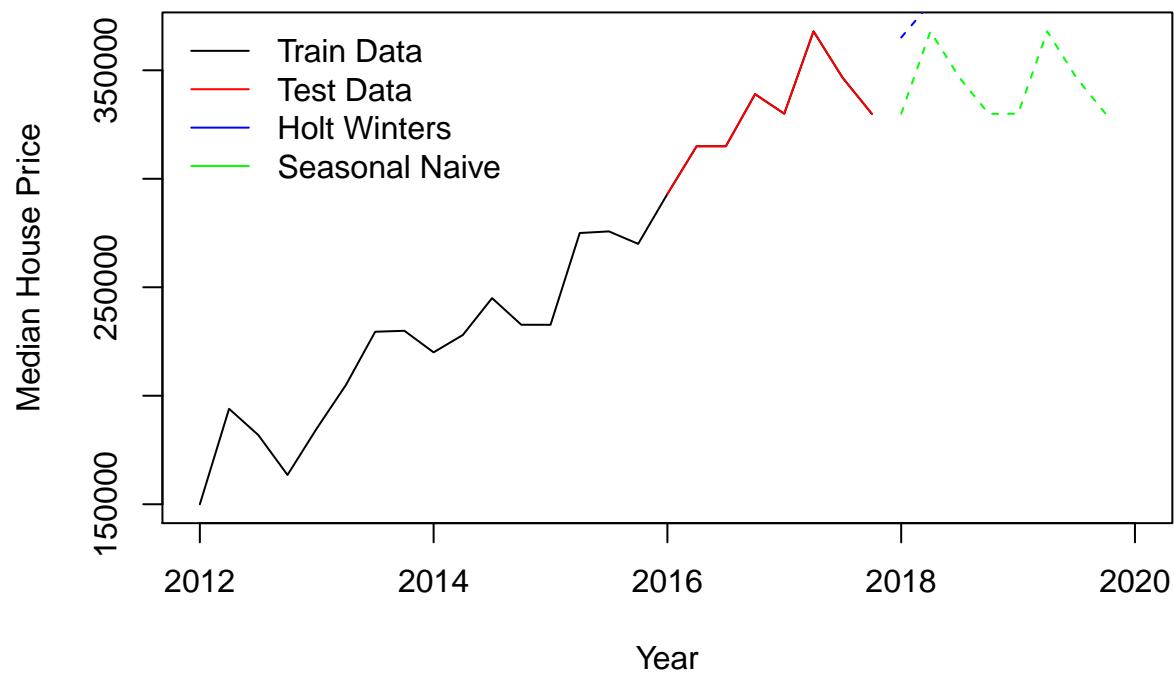


```
## [1] "Seasonal Naive Accuracy for Portland, OR – St. Johns"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 30337.46 35041.16 30337.46 12.91215 12.91215 1.000000
## Test set     66181.38 69136.08 66181.38 19.92690 19.92690 2.181507
##          ACF1 Theil's U
## Training set 0.2867573      NA
## Test set     0.5619645 3.162572
## [1] "Holt Winters Accuracy for Portland, OR – St. Johns"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 533.531 14719.89 12281.77 0.2487293 5.305391 0.4048386
## Test set     11303.245 18232.27 14978.89 3.3870597 4.489694 0.4937425
##          ACF1 Theil's U
## Training set -0.05937071      NA
## Test set     0.06482319 0.8612148
```

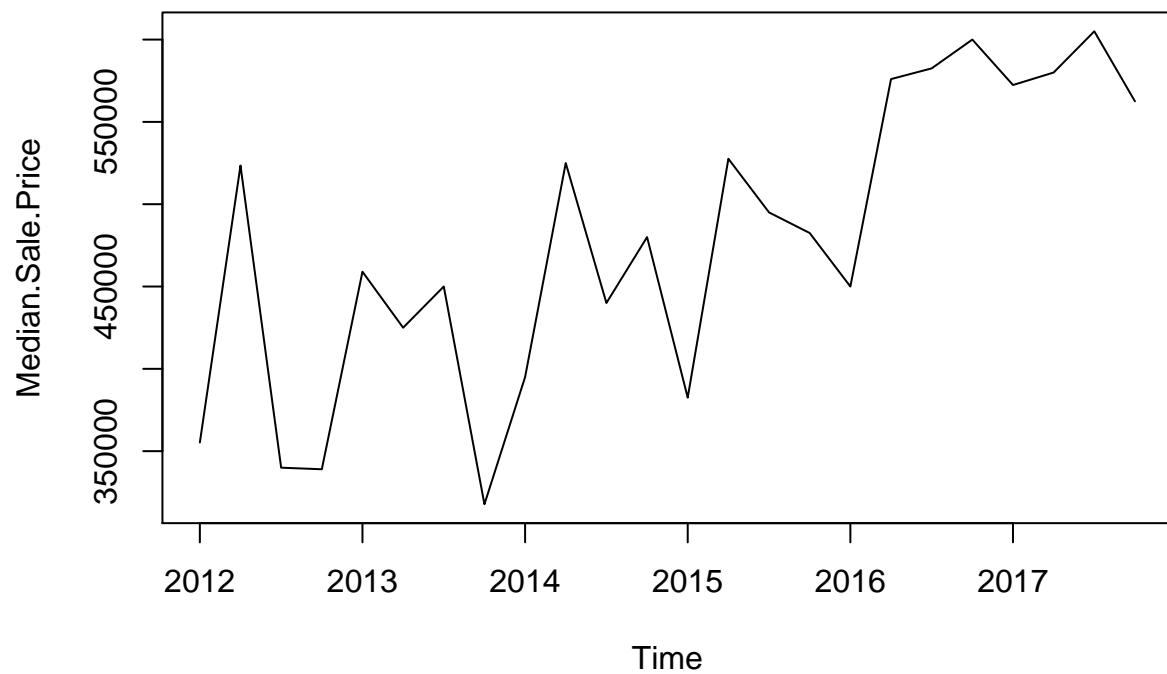
Portland, OR – St. Johns : TS Training Model Comparison



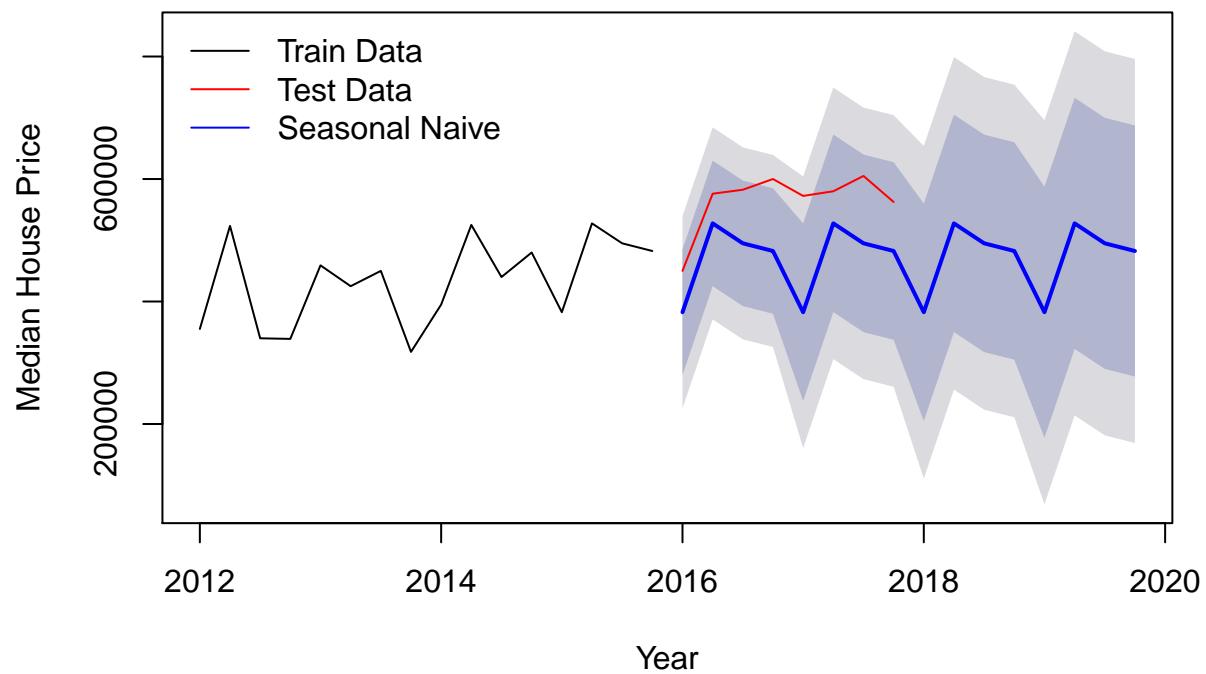
Portland, OR – St. Johns : Full TS Models Comparison



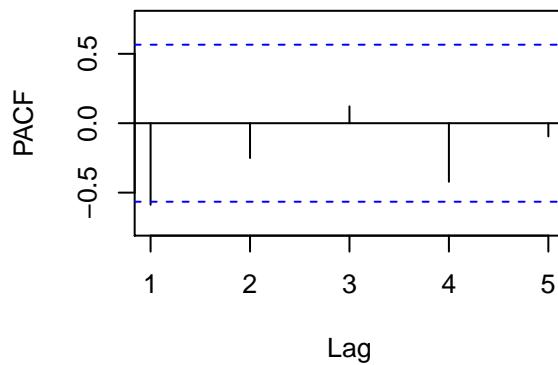
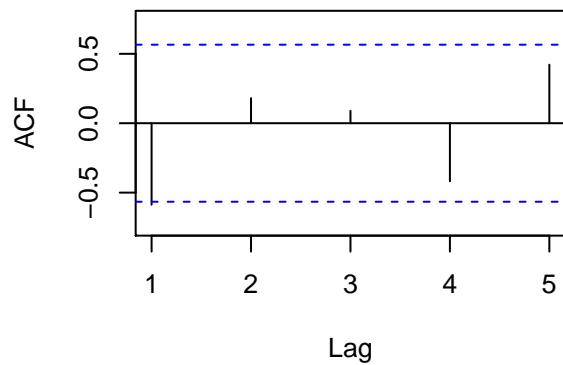
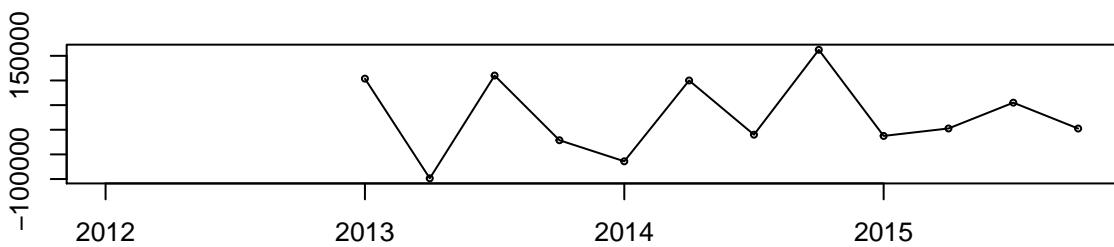
Portland, OR – Bridlemile



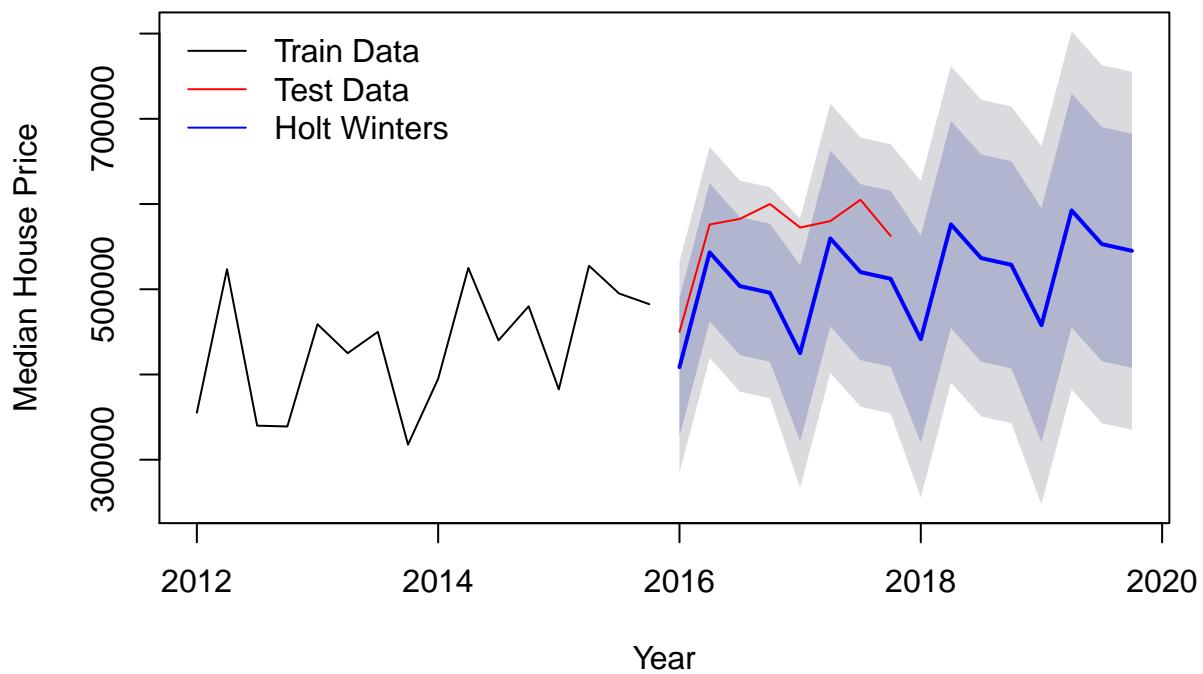
Portland, OR – Bridlemile : Naive Model Forecast



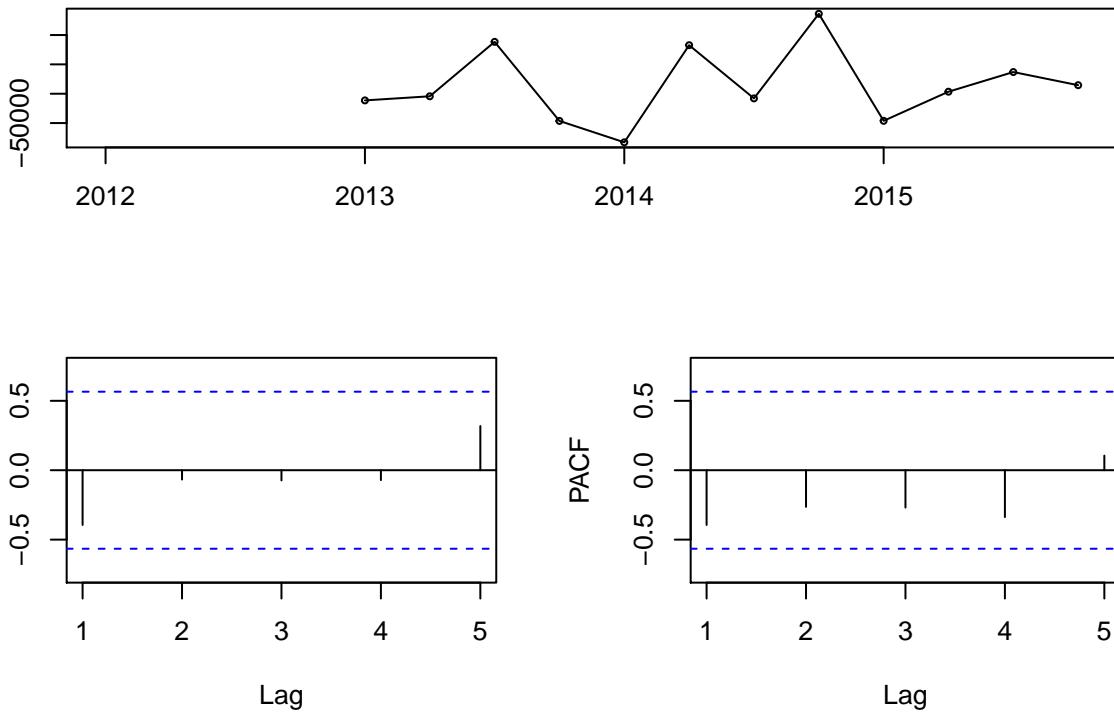
Portland, OR – Bridlemile : Naive Model Forecast Residuals



Portland, OR – Bridlemile : Holt Winters Model Forecast

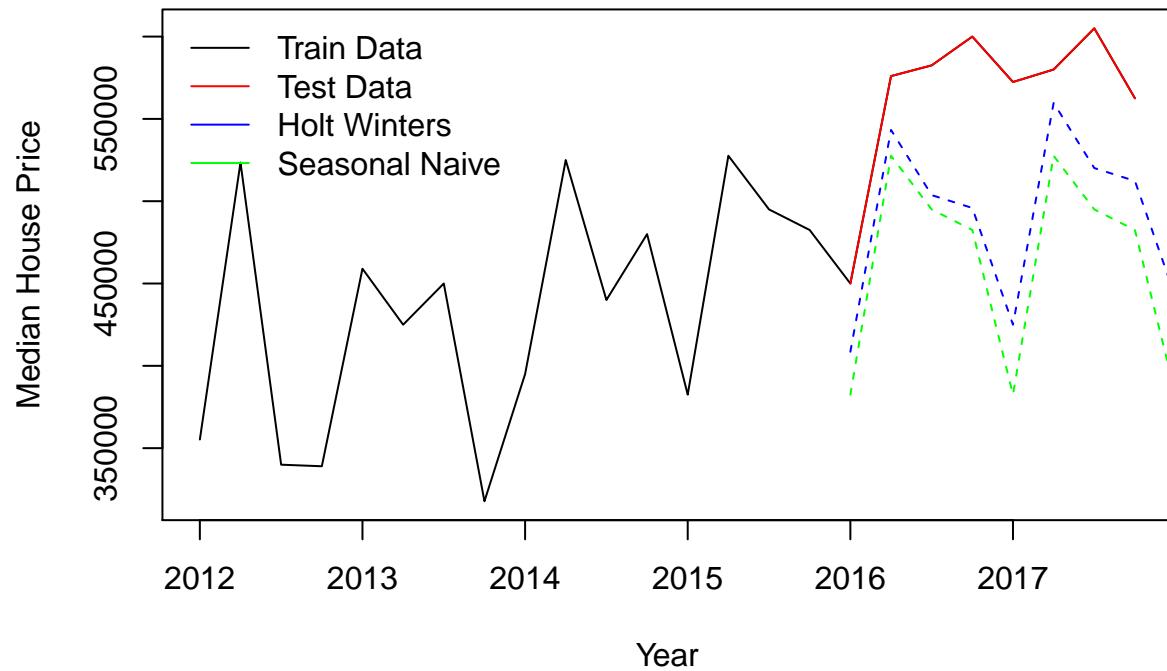


Portland, OR – Bridlemile : Holt Winters Model Forecast Residuals

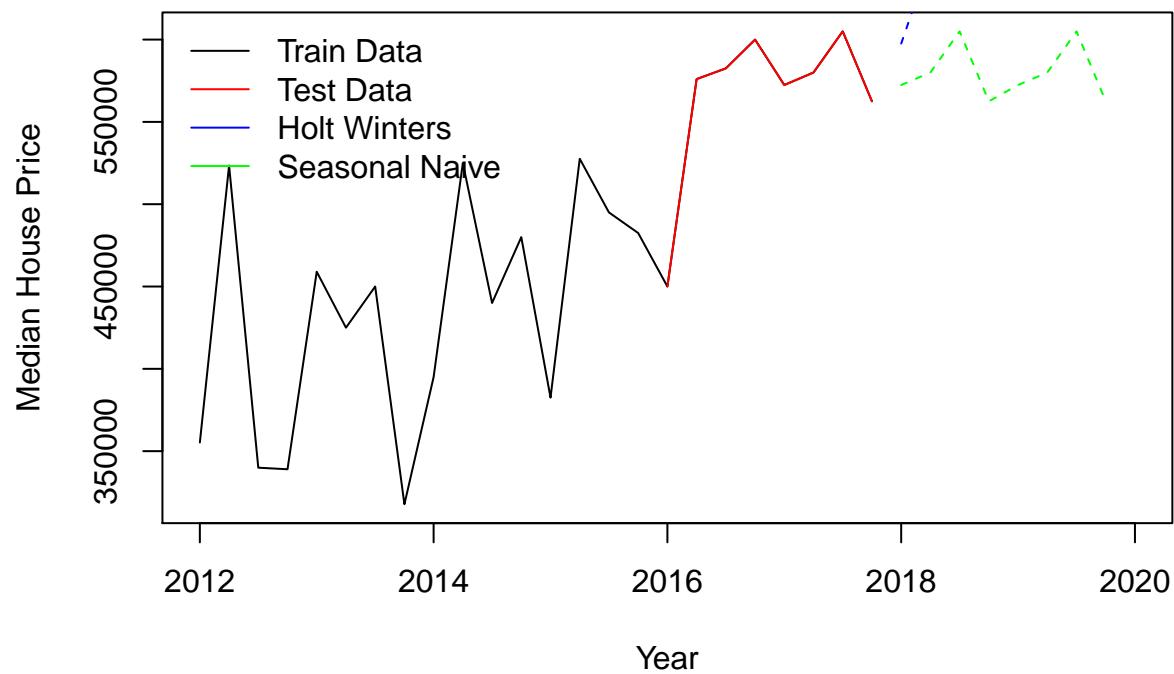


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Bridlemile"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 27491.67 79970.93 61866.67 5.035286 13.63651 1.000000
## Test set     94150.00 103482.53 94150.00 16.577774 16.57777 1.521821
##          ACF1 Theil's U
## Training set -0.58729172    NA
## Test set     -0.08672257 1.637489
## [1] "Holt Winters Accuracy for Portland, OR – Bridlemile"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 13578.62 61992.47 46763.61 1.825567 10.65199 0.7558773
## Test set     69976.35 80389.75 69976.35 12.245923 12.24592 1.1310832
##          ACF1 Theil's U
## Training set -0.39459678    NA
## Test set     -0.09606679 1.28368
```

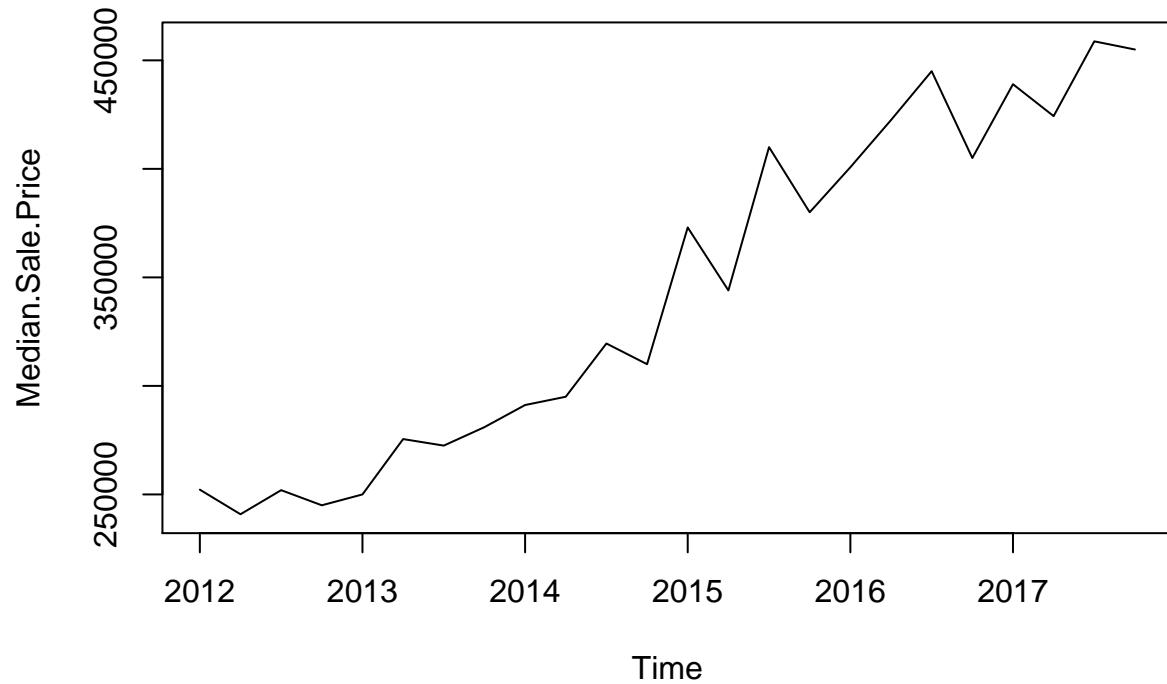
Portland, OR – Bridlemile : TS Training Model Comparison



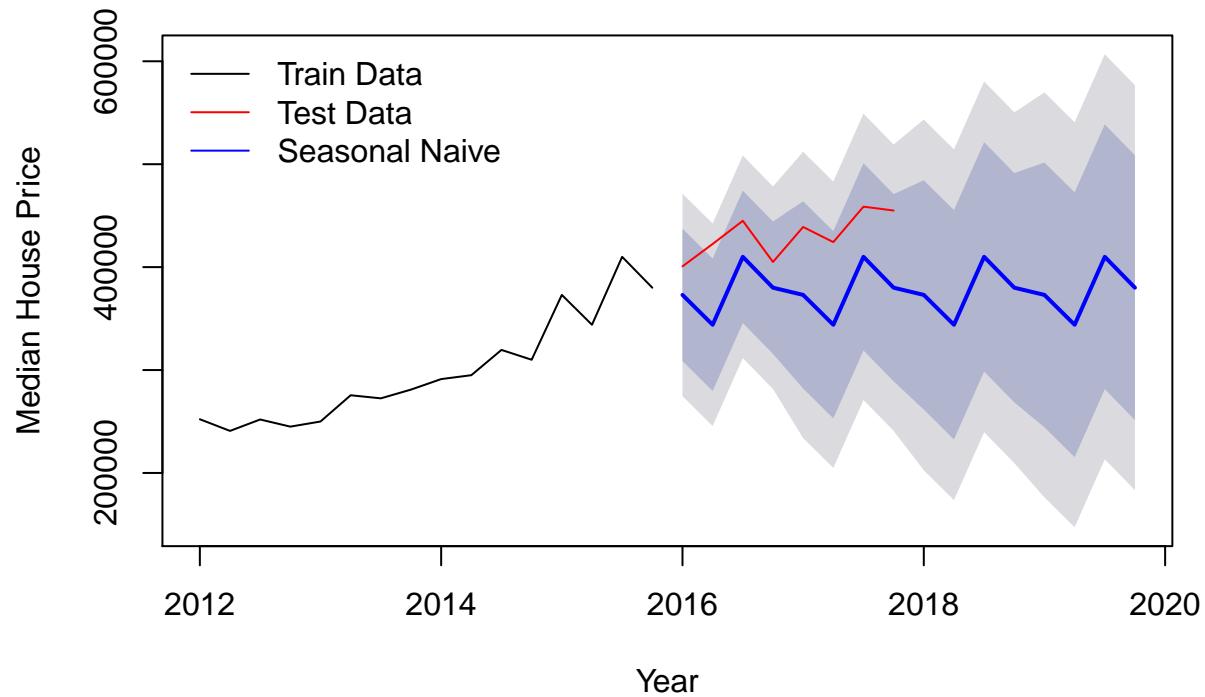
Portland, OR – Bridlemile : Full TS Models Comparison



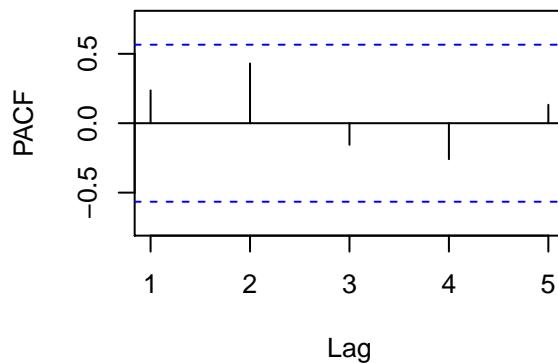
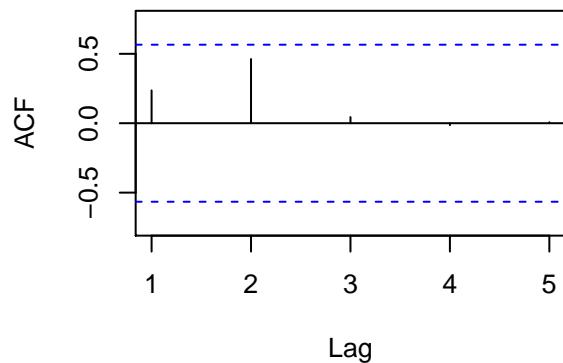
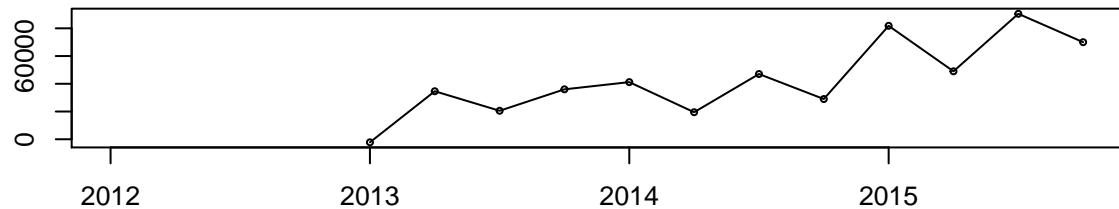
Portland, OR – Woodlawn



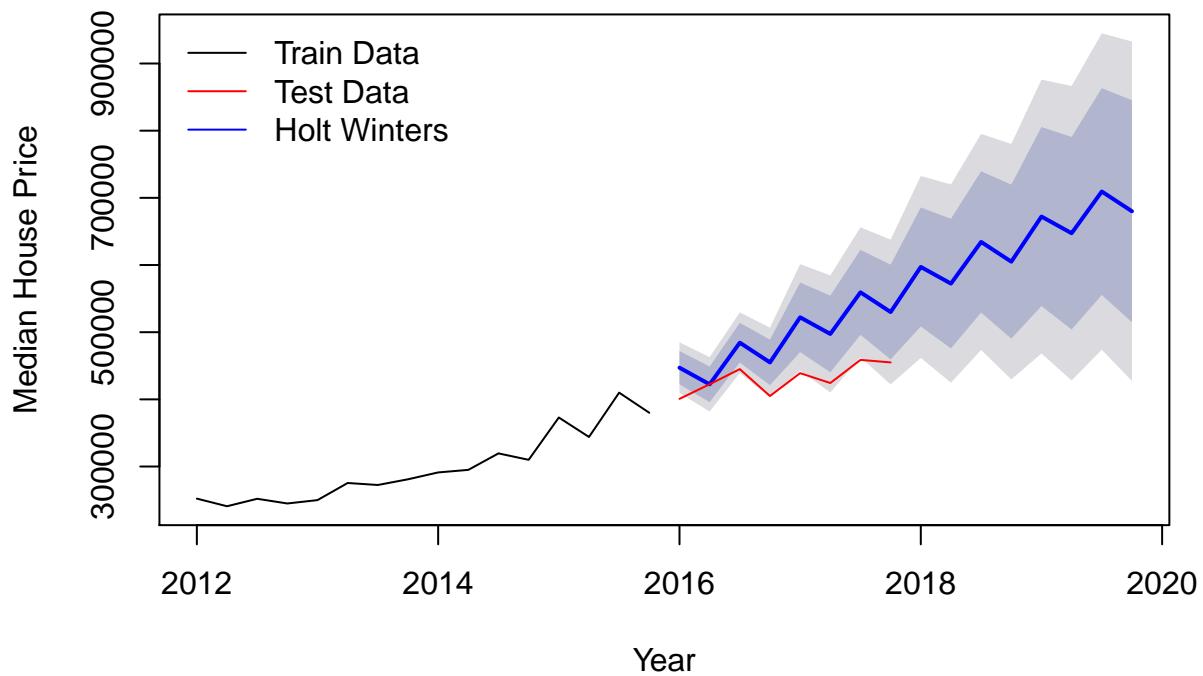
Portland, OR – Woodlawn : Naive Model Forecast



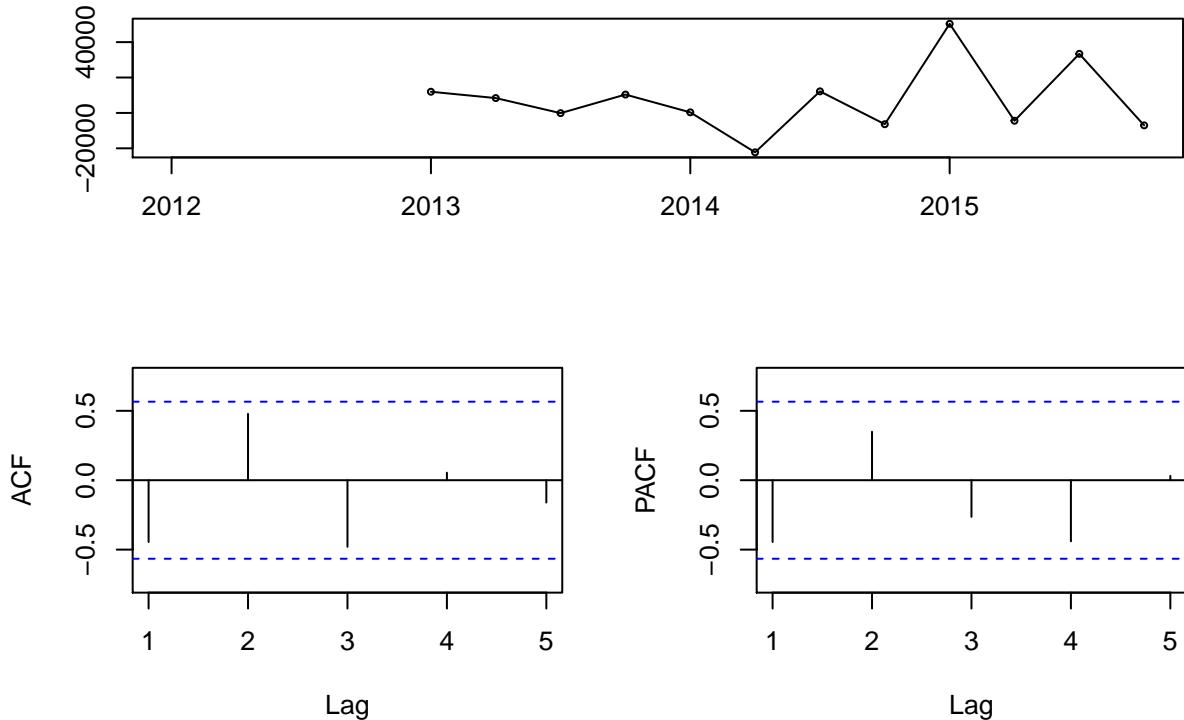
Portland, OR – Woodlawn : Naive Model Forecast Residuals



Portland, OR – Woodlawn : Holt Winters Model Forecast



Portland, OR – Woodlawn : Holt Winters Model Forecast Residuals

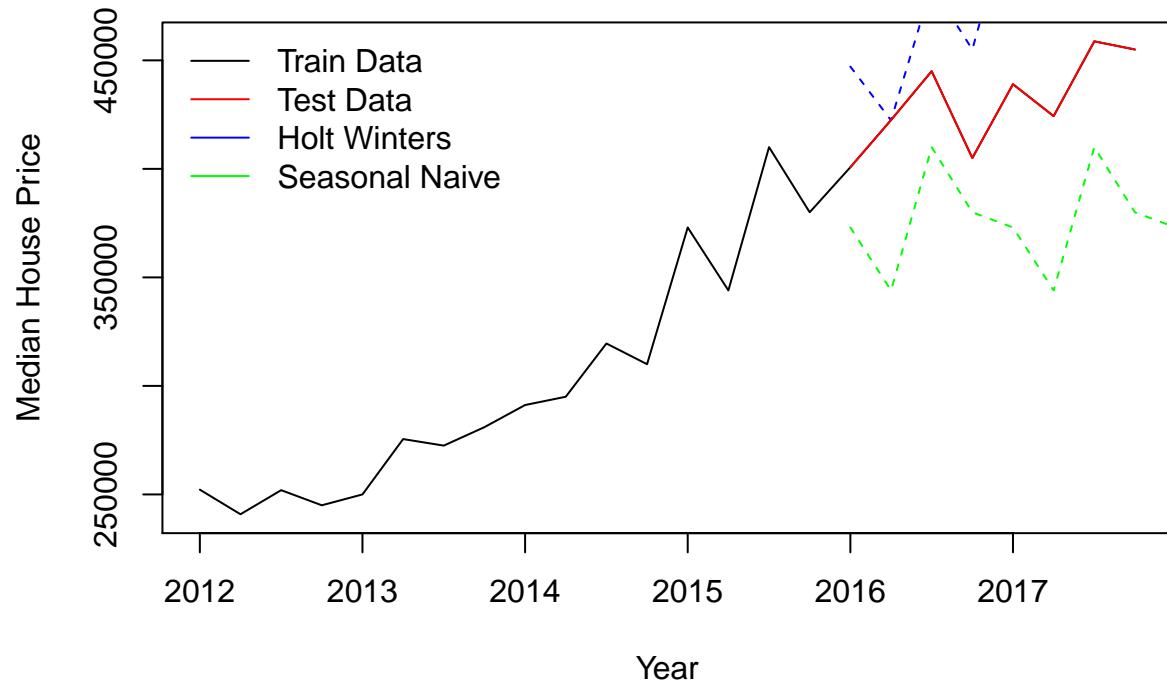


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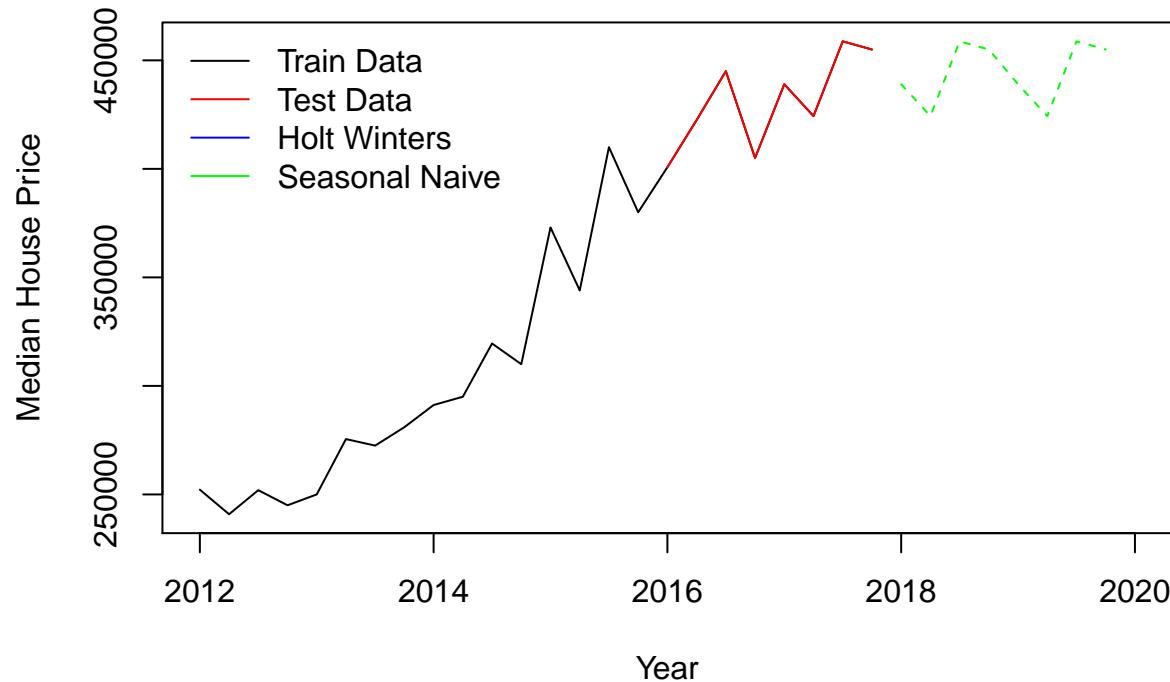
## [1] "Seasonal Naive Accuracy for Portland, OR – Woodlawn"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 43080.21 50189.46 43446.88 12.79414 12.94081 1.000000
## Test set     54537.50 58723.89 54537.50 12.57651 12.57651 1.255269
##          ACF1 Theil's U
## Training set 0.2364220      NA
## Test set     -0.2224402  2.273829
## [1] "Holt Winters Accuracy for Portland, OR – Woodlawn"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 7227.577 19840.13 13931.11  2.024768 4.155688 0.3206471
## Test set     -58433.396 65388.52 58467.47 -13.414487 13.422552 1.3457233
##          ACF1 Theil's U
## Training set -0.4454179      NA
## Test set     0.5011657  2.463677

```

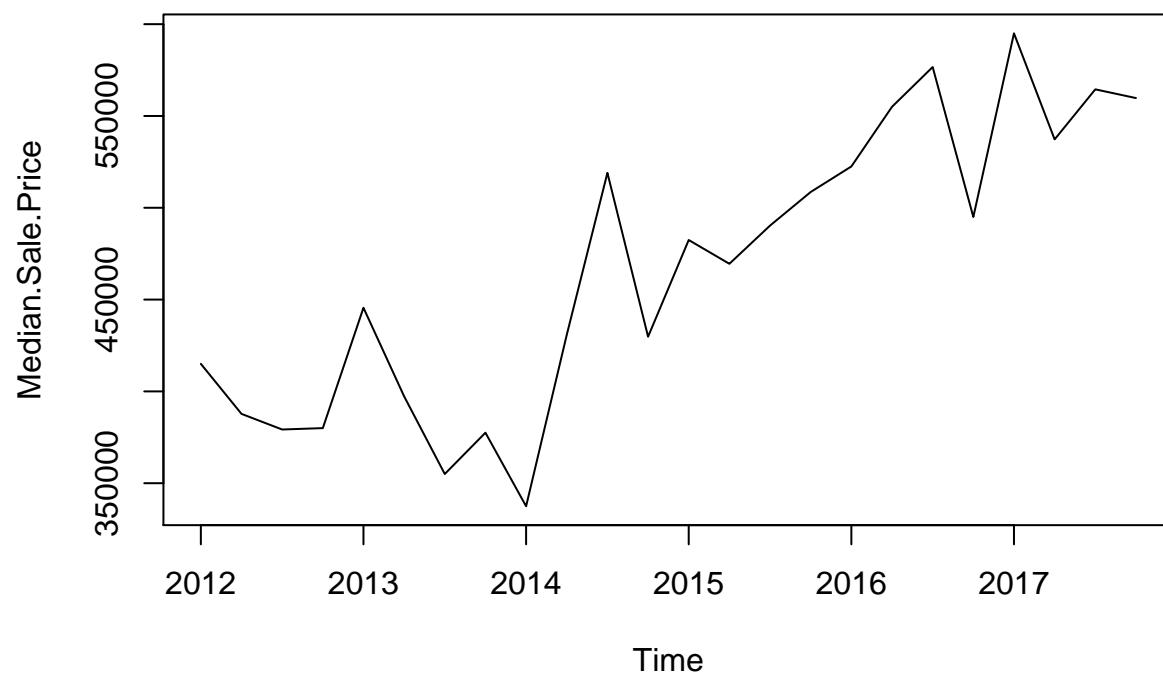
Portland, OR – Woodlawn : TS Training Model Comparison



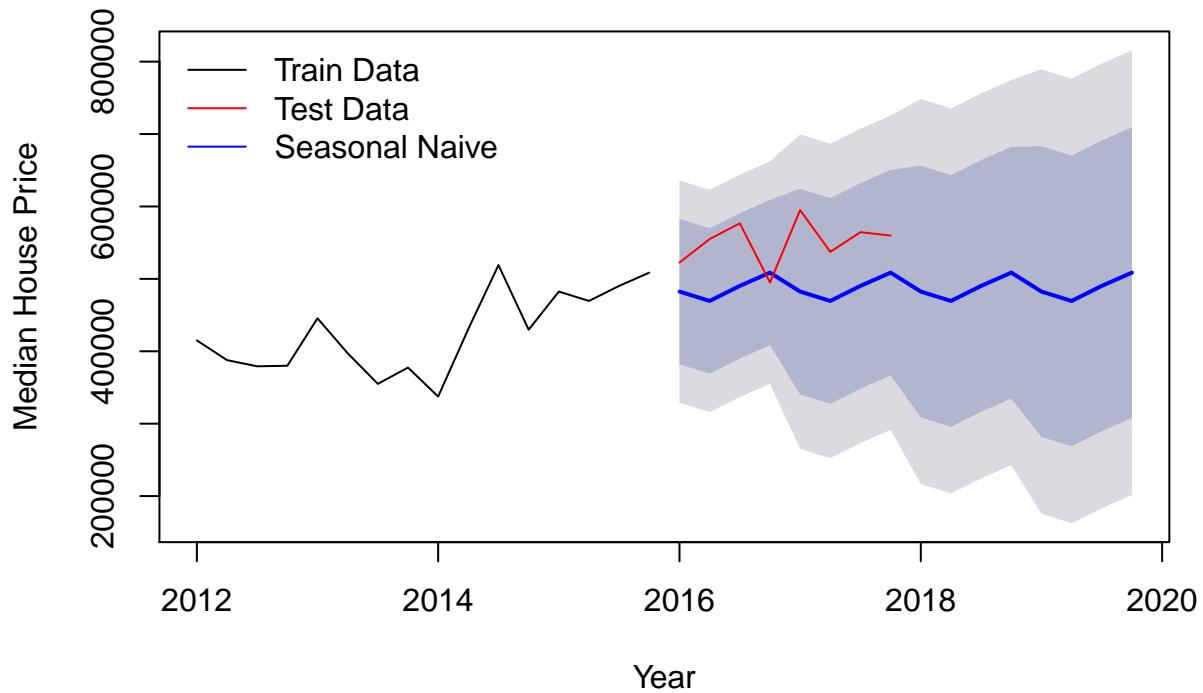
Portland, OR – Woodlawn : Full TS Models Comparison



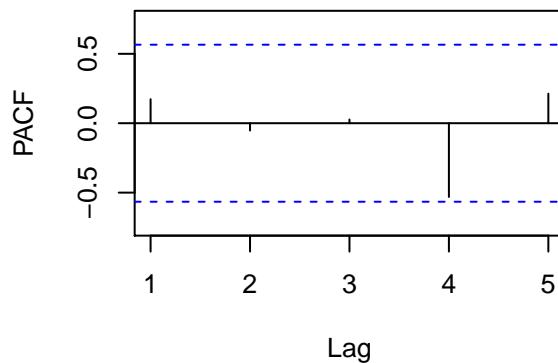
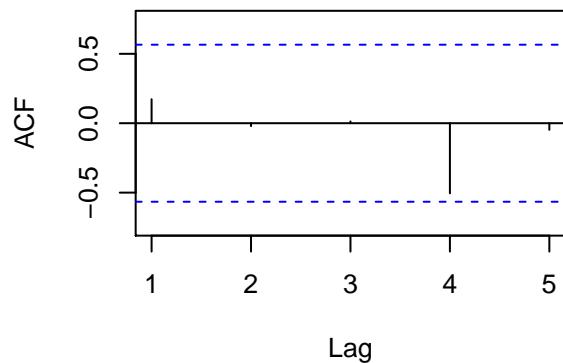
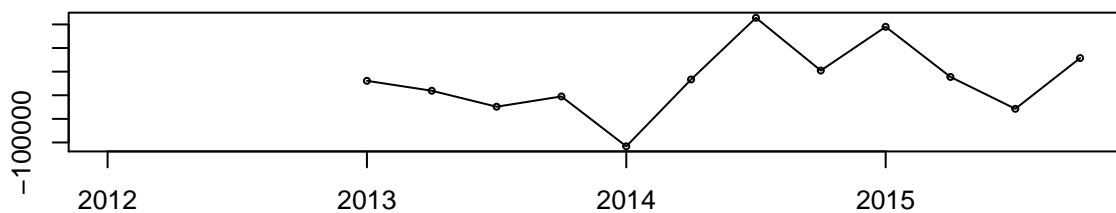
Portland, OR – Arnold Creek



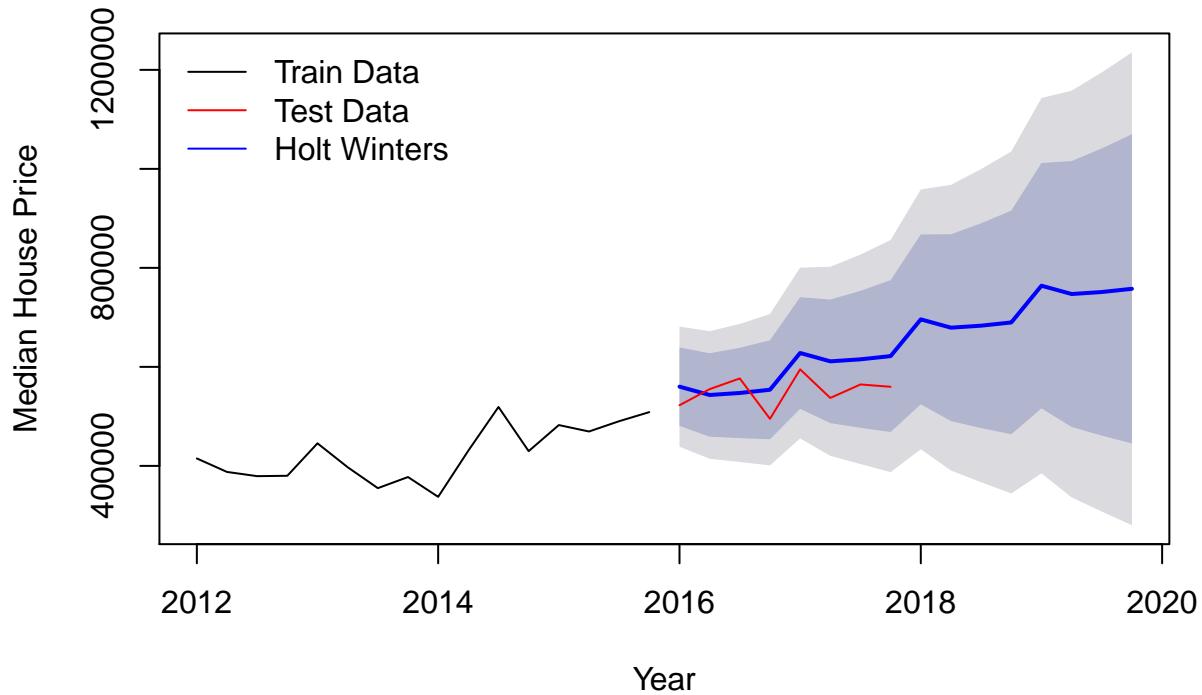
Portland, OR – Arnold Creek : Naive Model Forecast



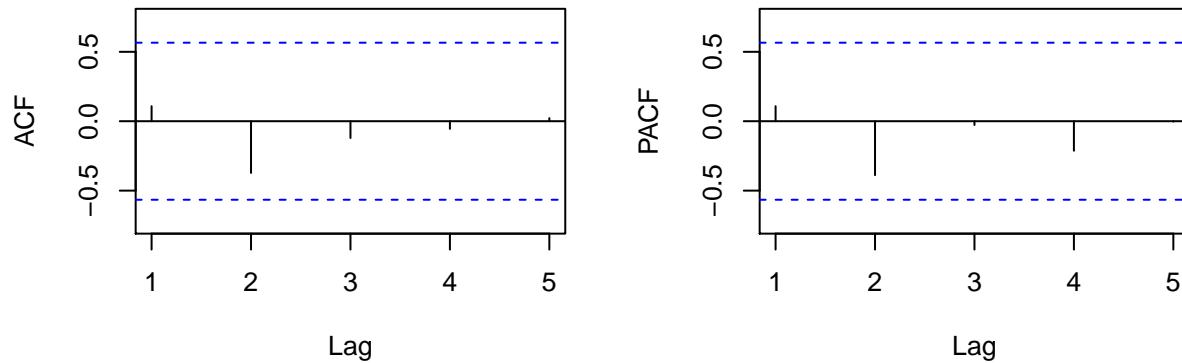
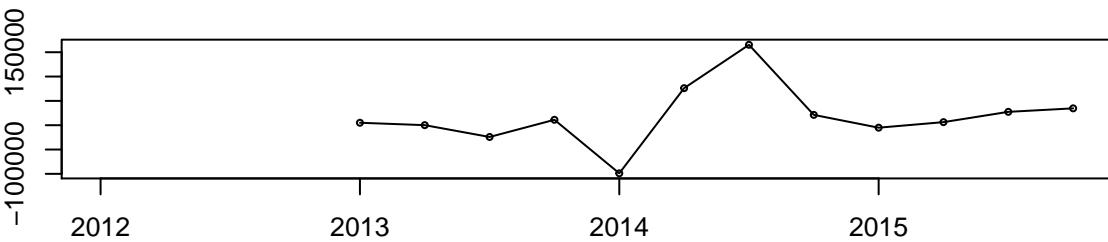
Portland, OR – Arnold Creek : Naive Model Forecast Residuals



Portland, OR – Arnold Creek : Holt Winters Model Forecast

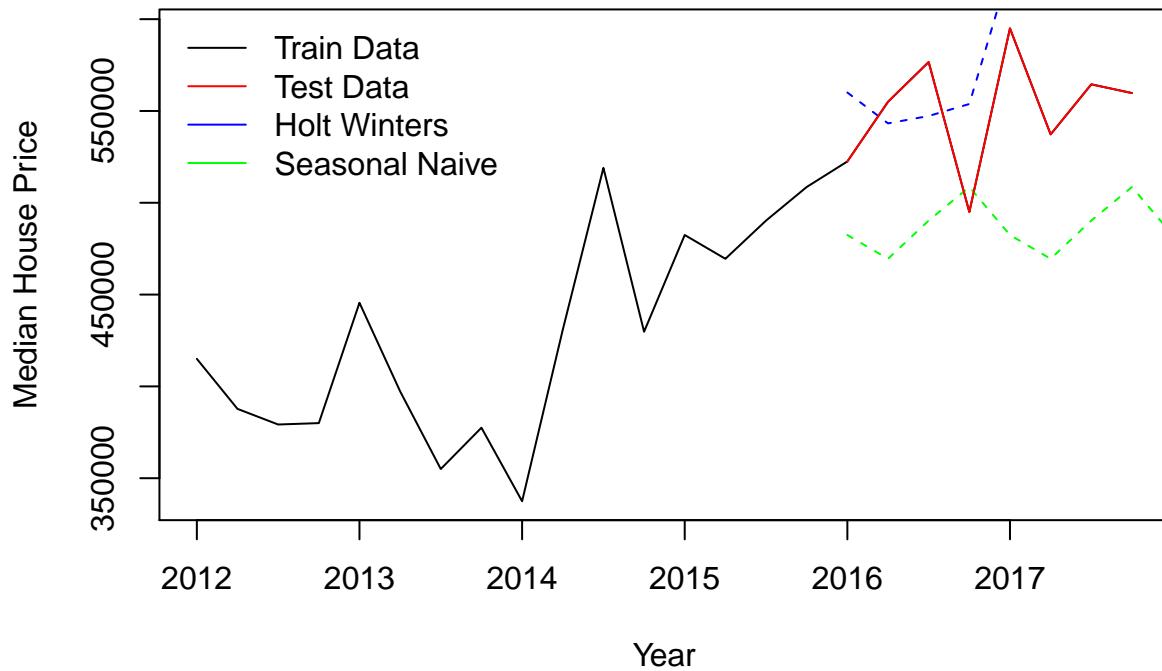


Portland, OR – Arnold Creek : Holt Winters Model Forecast Residuals

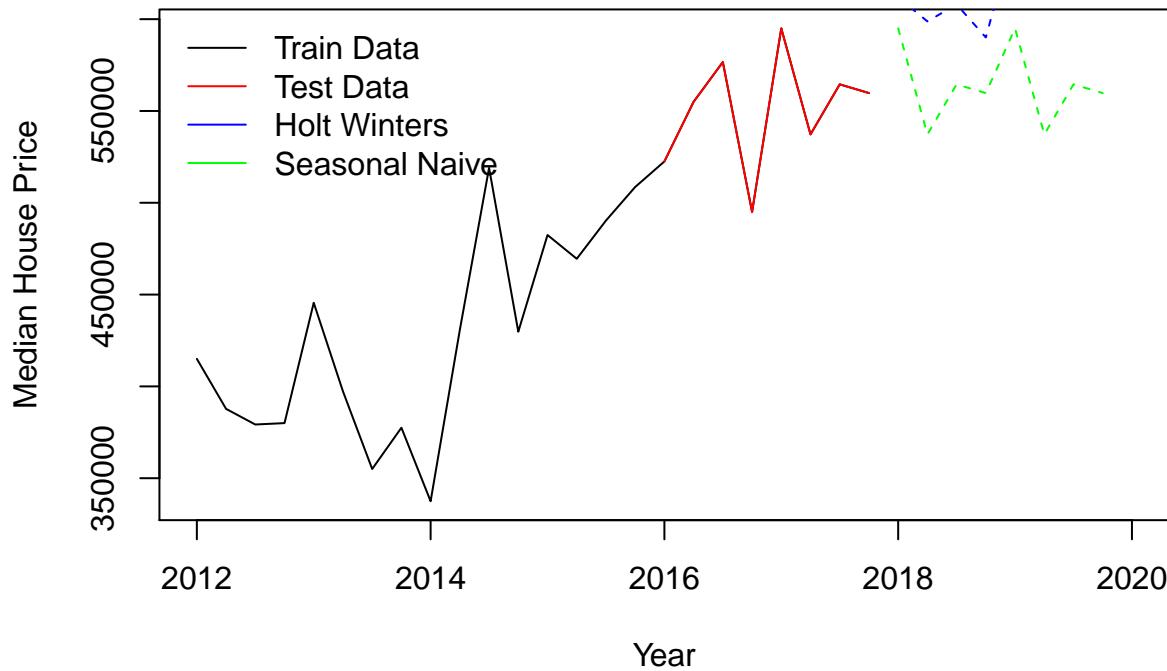


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Arnold Creek"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 32403.75 78323.11 59662.08 5.767786 13.33131 1.00000
## Test set     62995.00 72401.17 66393.75 11.138524 11.82514 1.11283
##          ACF1 Theil's U
## Training set 0.1729792      NA
## Test set     -0.5318462 1.353591
## [1] "Holt Winters Accuracy for Portland, OR – Arnold Creek"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 18261.52 61976.01 39620.84 2.928573 9.123656 0.6640875
## Test set     -34377.80 48549.18 44661.39 -6.406114 8.209331 0.7485724
##          ACF1 Theil's U
## Training set 0.1083750      NA
## Test set     0.2395819 0.8350741
```

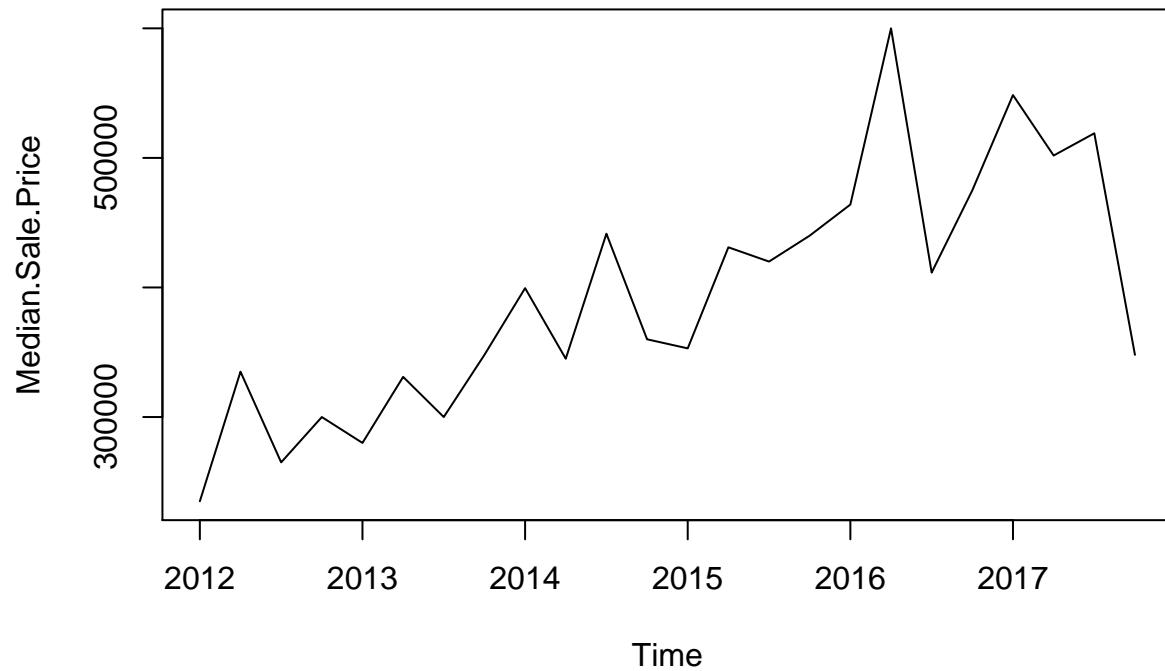
Portland, OR – Arnold Creek : TS Training Model Comparison



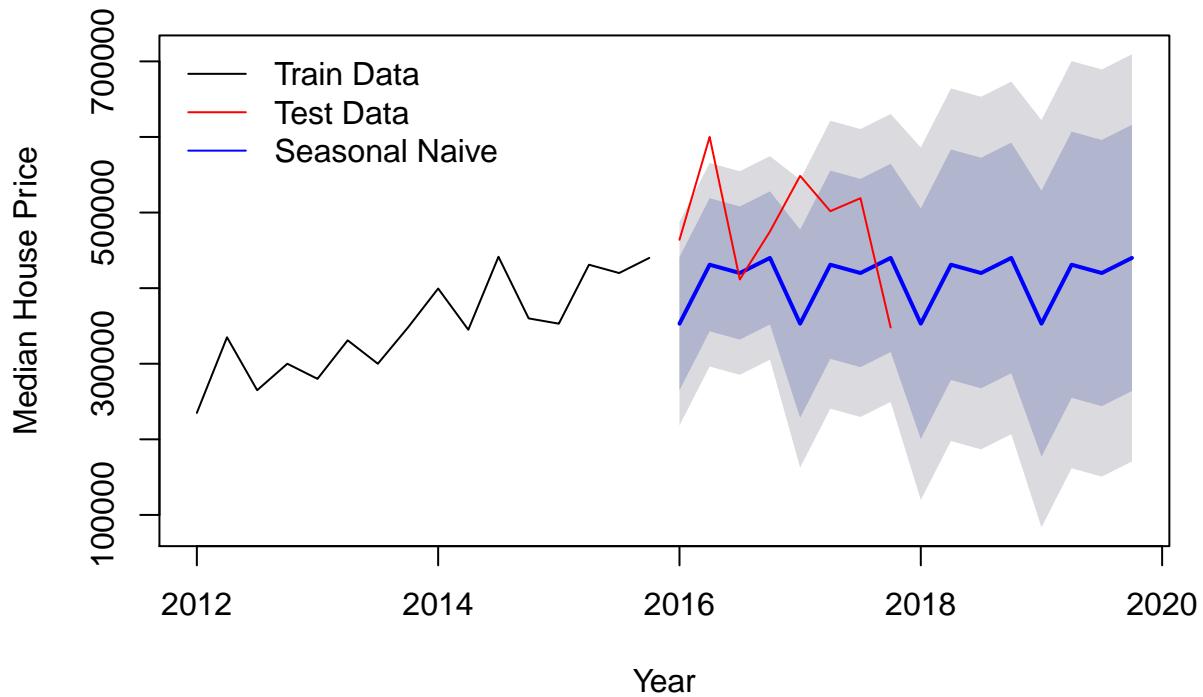
Portland, OR – Arnold Creek : Full TS Models Comparison



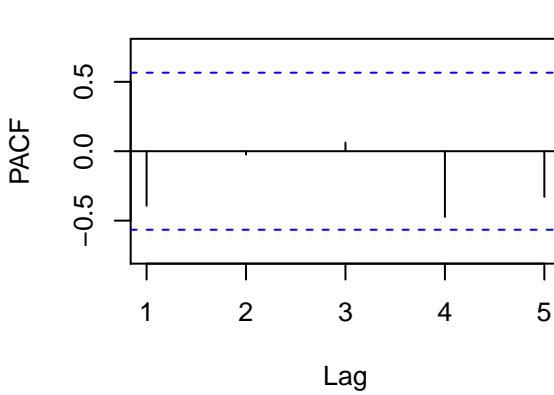
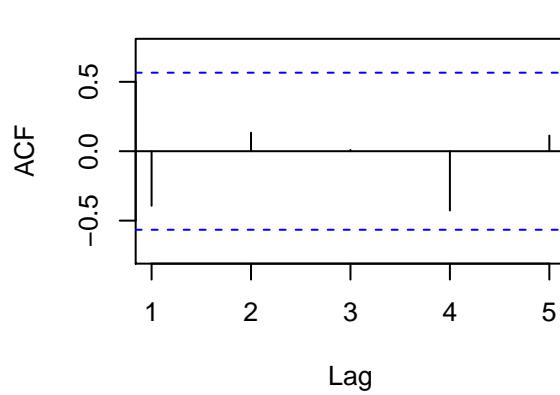
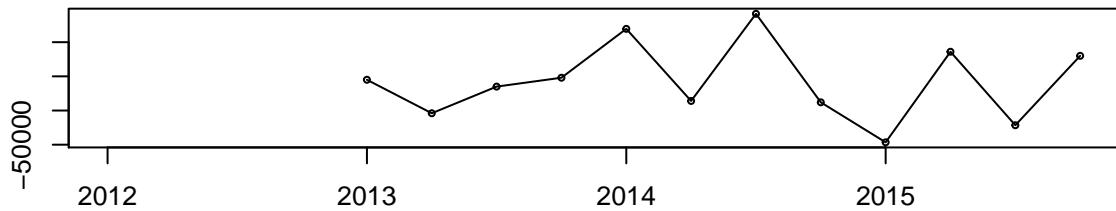
Portland, OR – Maplewood



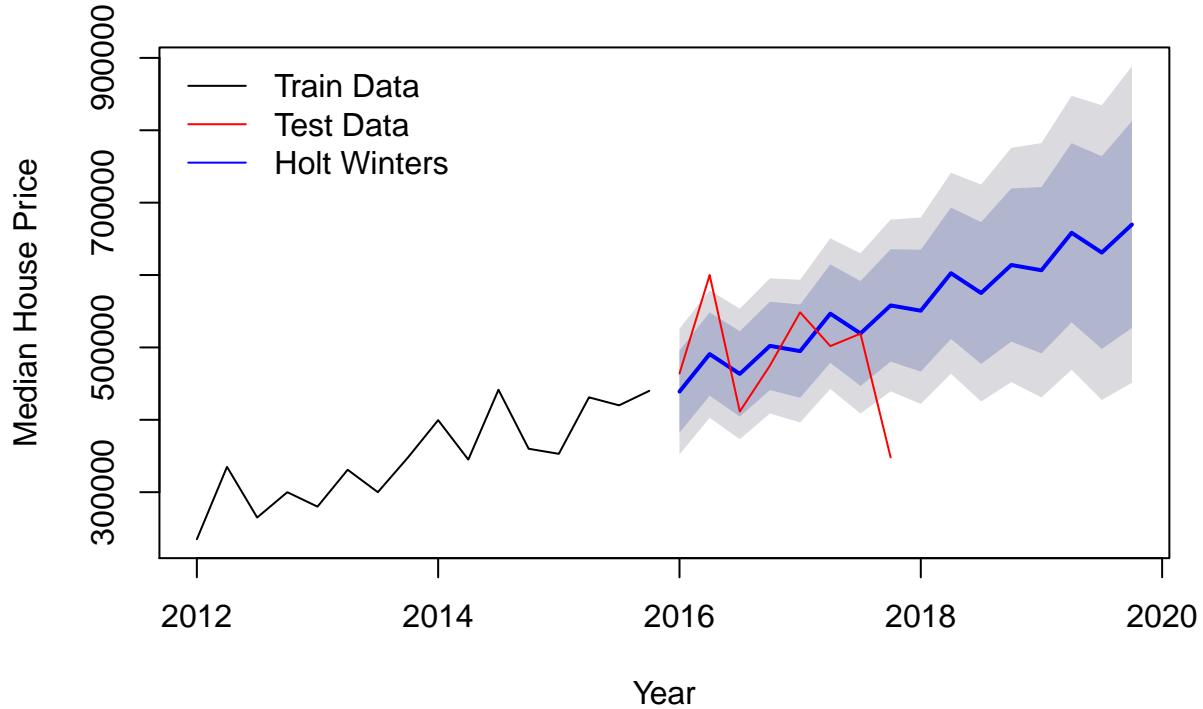
Portland, OR – Maplewood : Naive Model Forecast



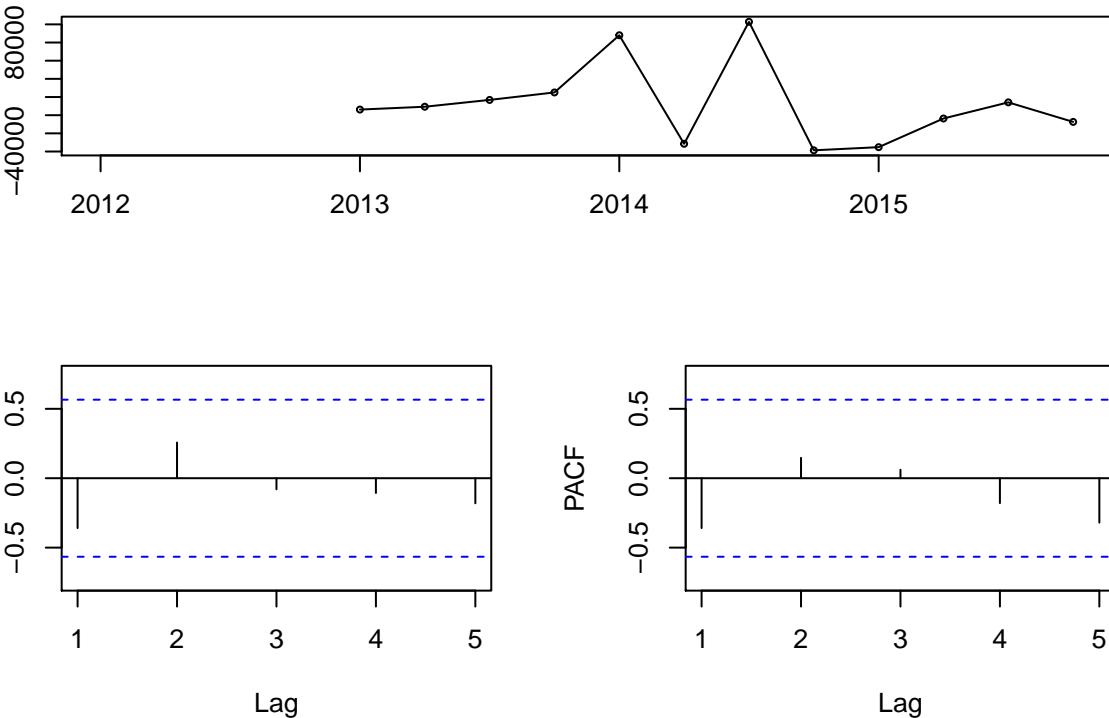
Portland, OR – Maplewood : Naive Model Forecast Residuals



Portland, OR – Maplewood : Holt Winters Model Forecast

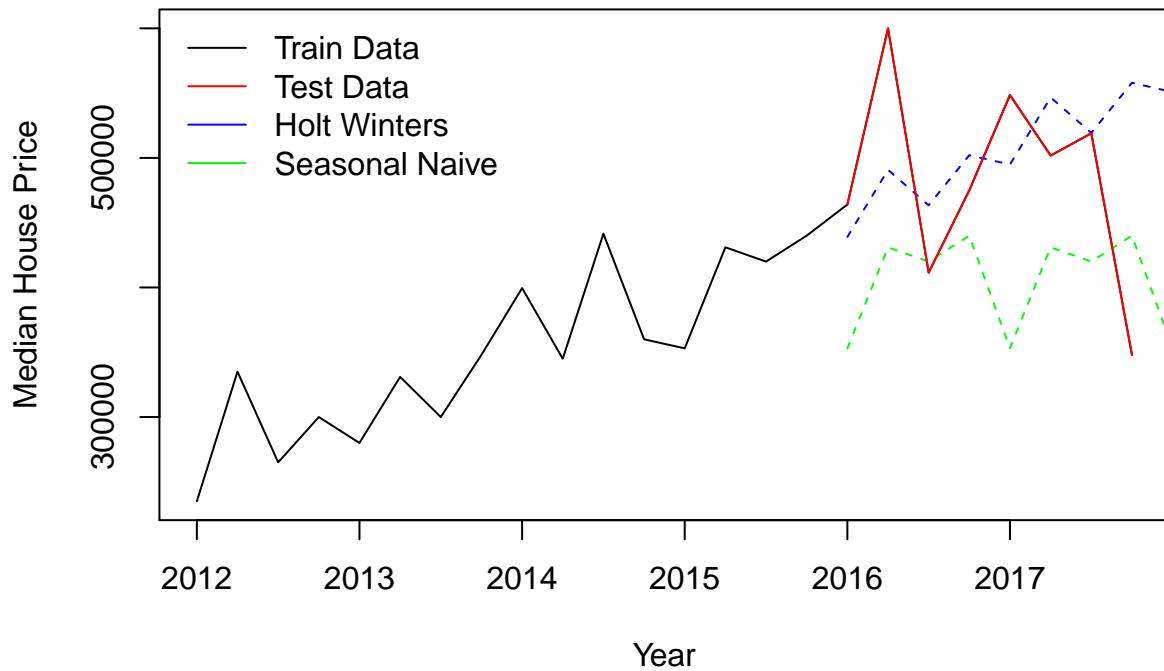


Portland, OR – Maplewood : Holt Winters Model Forecast Residuals

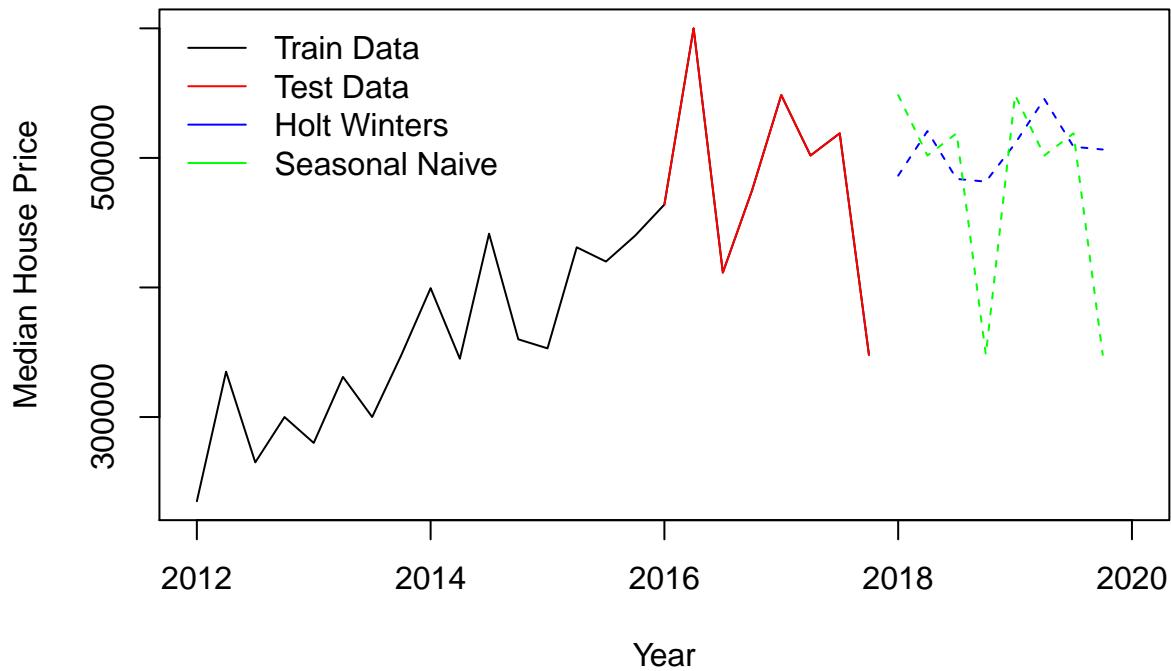


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Maplewood"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 42416.67 68698.01 54416.67 10.79332 14.04337 1.000000
## Test set     72478.12 113842.37 97603.12 12.47330 19.59890 1.793626
##          ACF1 Theil's U
## Training set -0.3928090      NA
## Test set     -0.1667827  1.065377
## [1] "Holt Winters Accuracy for Portland, OR – Maplewood"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 12150.91 44105.06 31554.58  2.842450  8.238082 0.5798698
## Test set     -18296.15 90120.07 65250.78 -6.788026 15.128817 1.1990954
##          ACF1 Theil's U
## Training set -0.35931139      NA
## Test set     -0.07941146  0.8466252
```

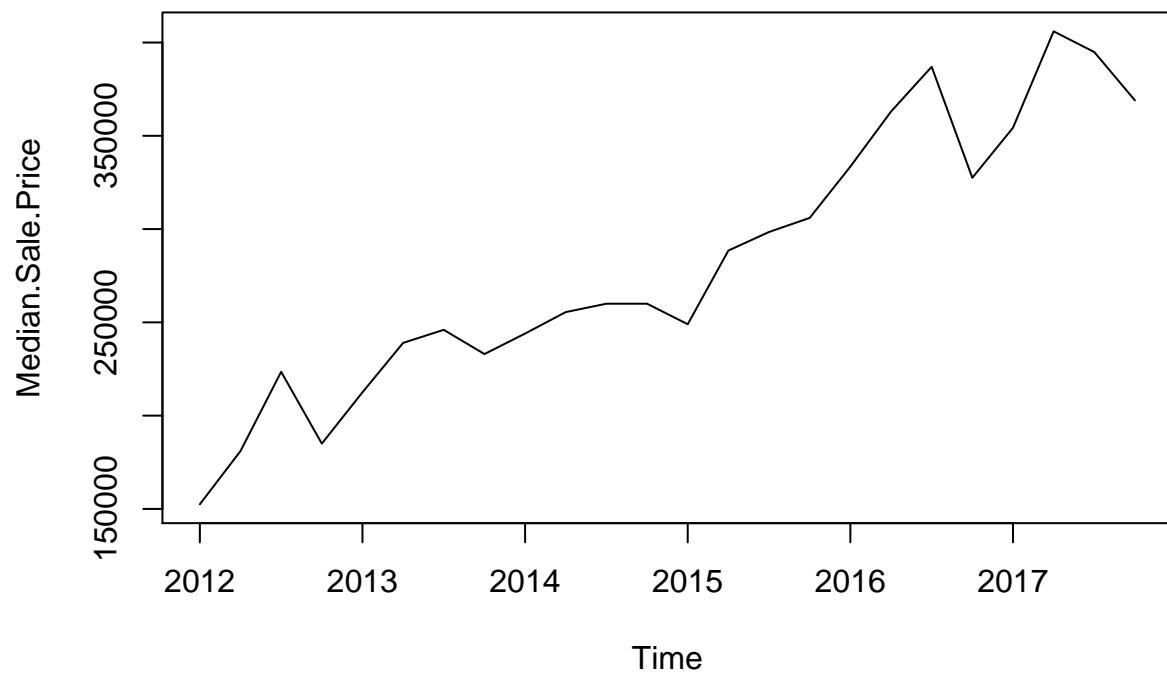
Portland, OR – Maplewood : TS Training Model Comparison



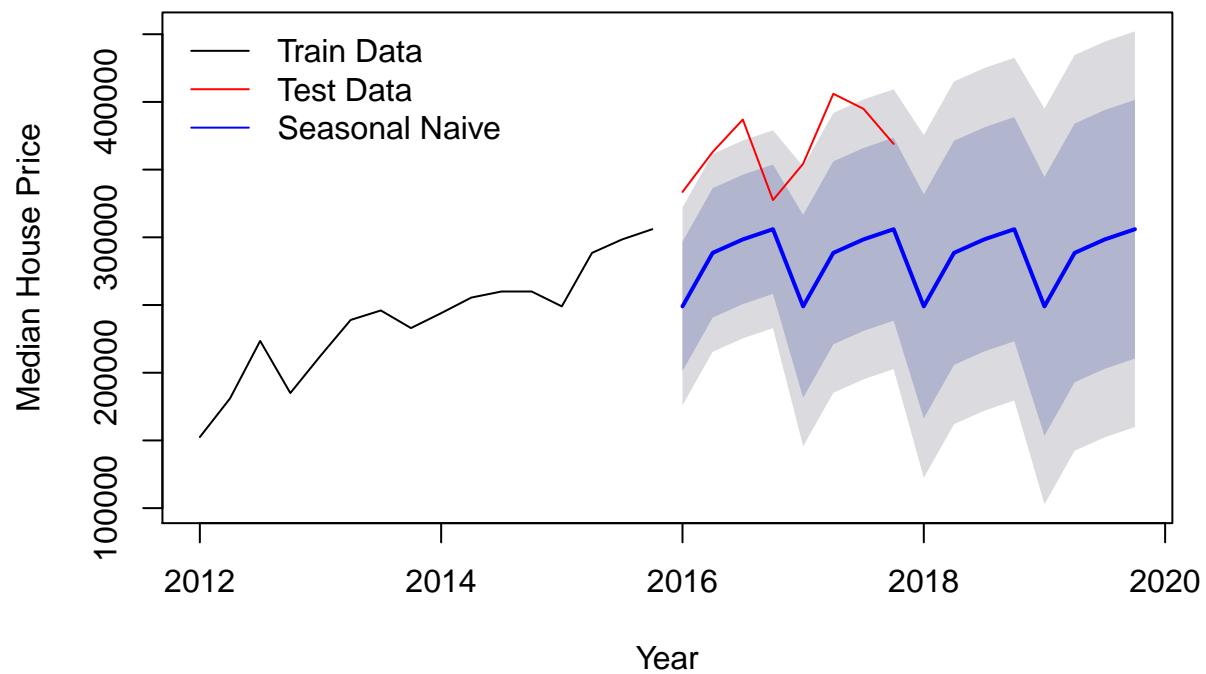
Portland, OR – Maplewood : Full TS Models Comparison



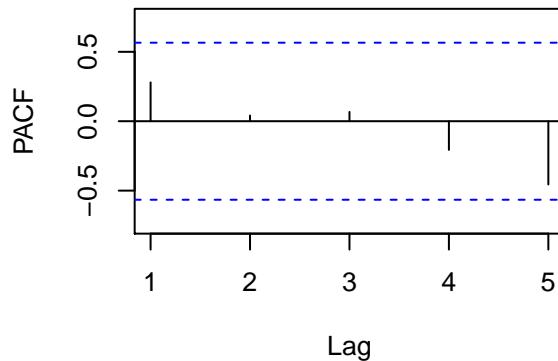
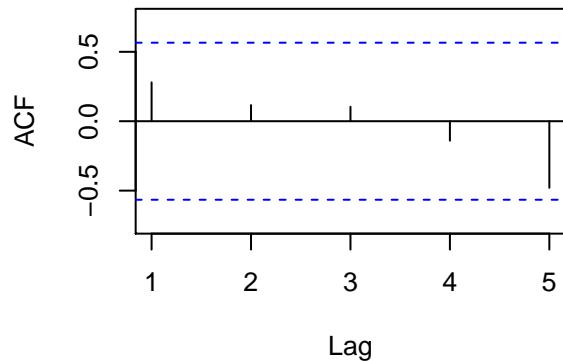
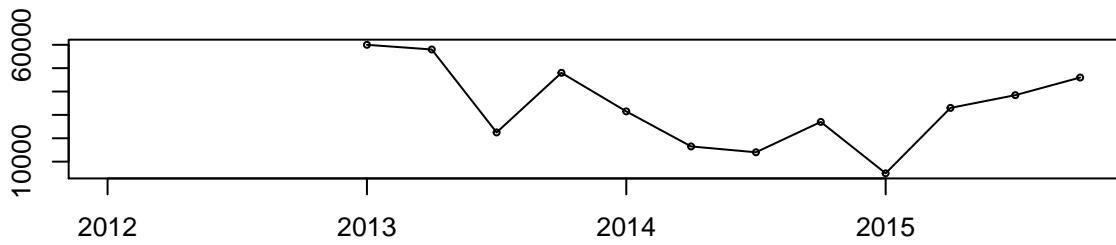
Portland, OR – Foster–Powell



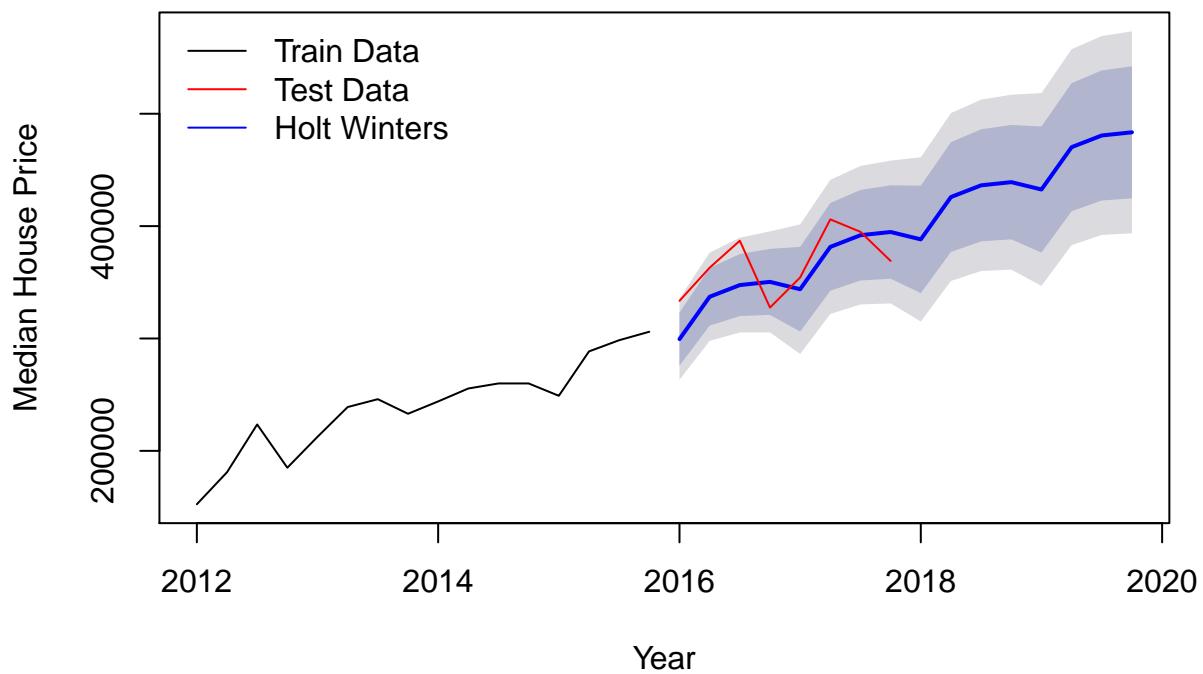
Portland, OR – Foster–Powell : Naive Model Forecast



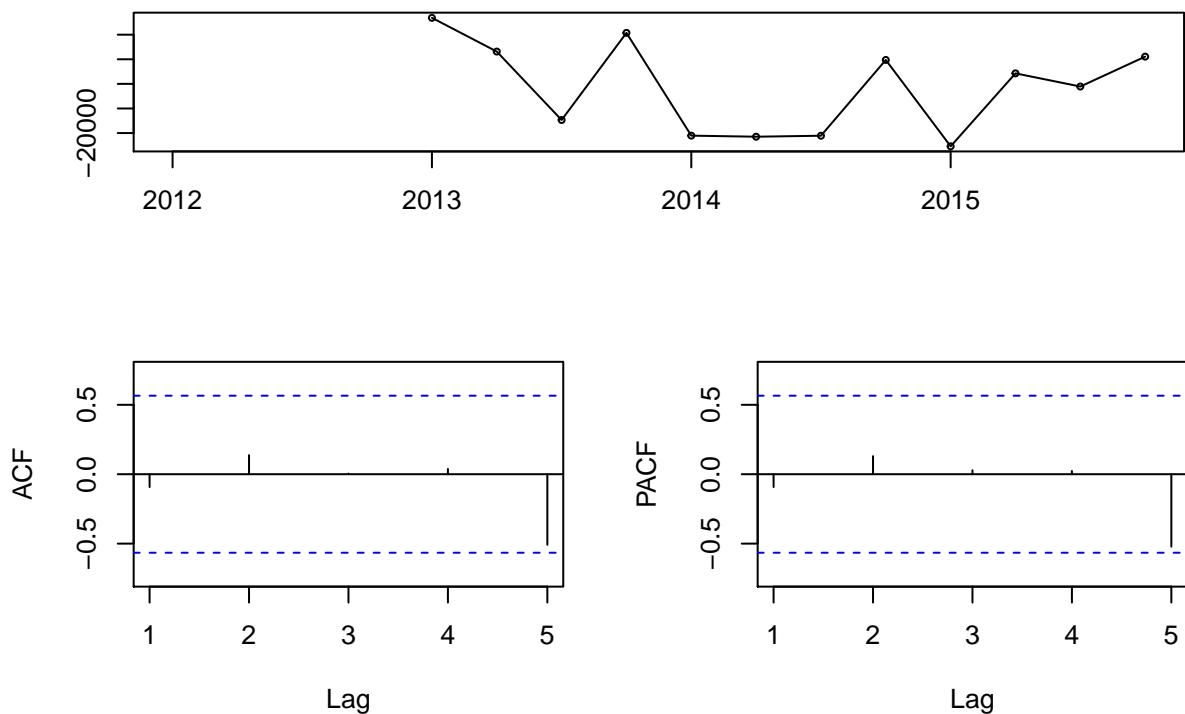
Portland, OR – Foster–Powell : Naive Model Forecast Residuals



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

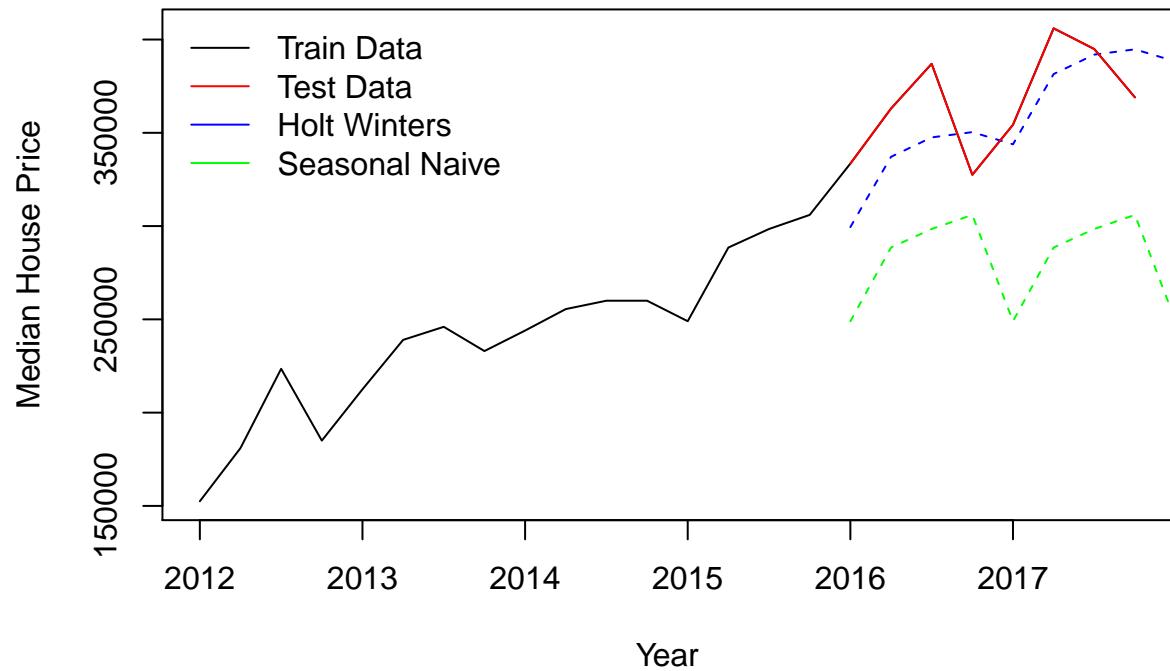


Portland, OR – Foster–Powell : Holt Winters Model Forecast Residuals

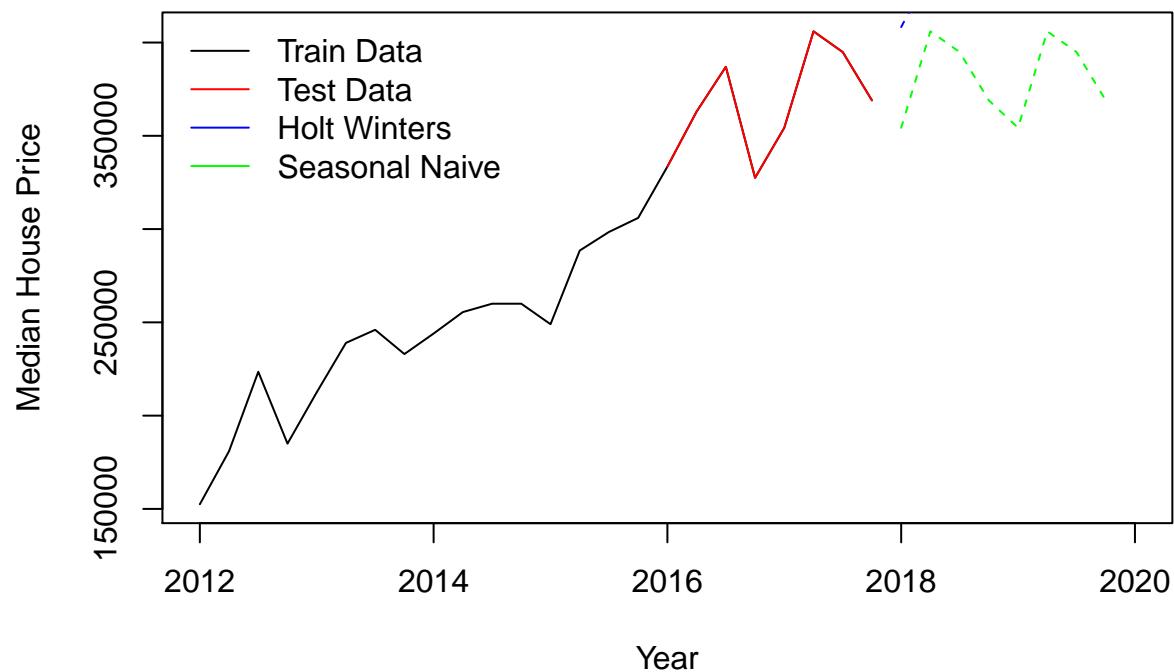


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Foster-Powell"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 33329.17 37273.93 33329.17 13.22914 13.22914 1.00000
## Test set     81412.50 85994.04 81412.50 21.93316 21.93316 2.44268
##          ACF1 Theil's U
## Training set  0.2798670      NA
## Test set      -0.1306485  2.43317
## [1] "Holt Winters Accuracy for Portland, OR - Foster-Powell"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set -1579.366 17723.83 15880.86 -0.4825761 6.462160 0.4764854
## Test set     11084.735 25712.97 23240.99  2.9133561 6.404119 0.6973167
##          ACF1 Theil's U
## Training set -0.0922767377      NA
## Test set      -0.0005230127 0.6755232
```

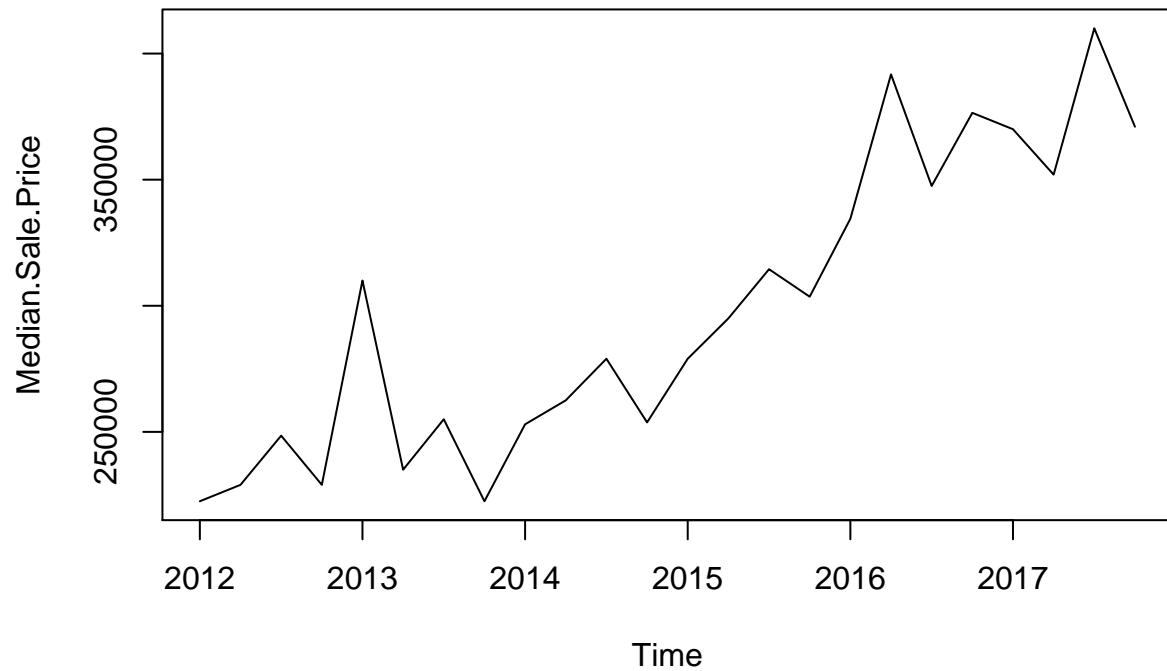
Portland, OR – Foster–Powell : TS Training Model Comparison



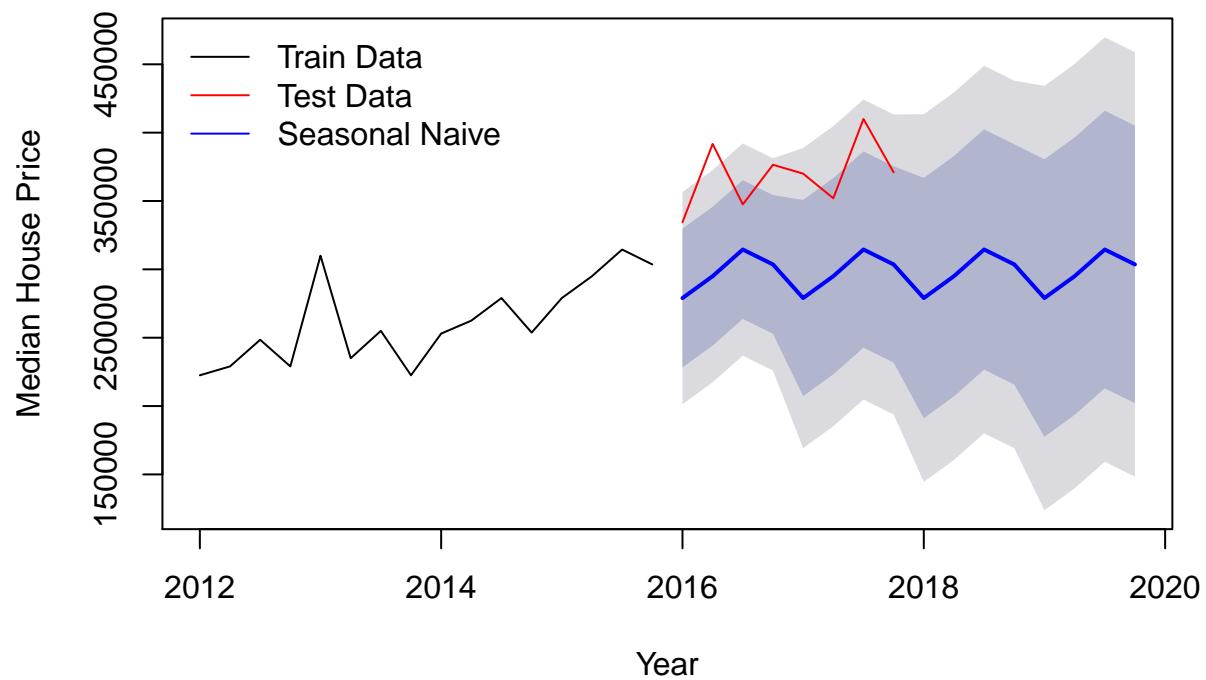
Portland, OR – Foster–Powell : Full TS Models Comparison



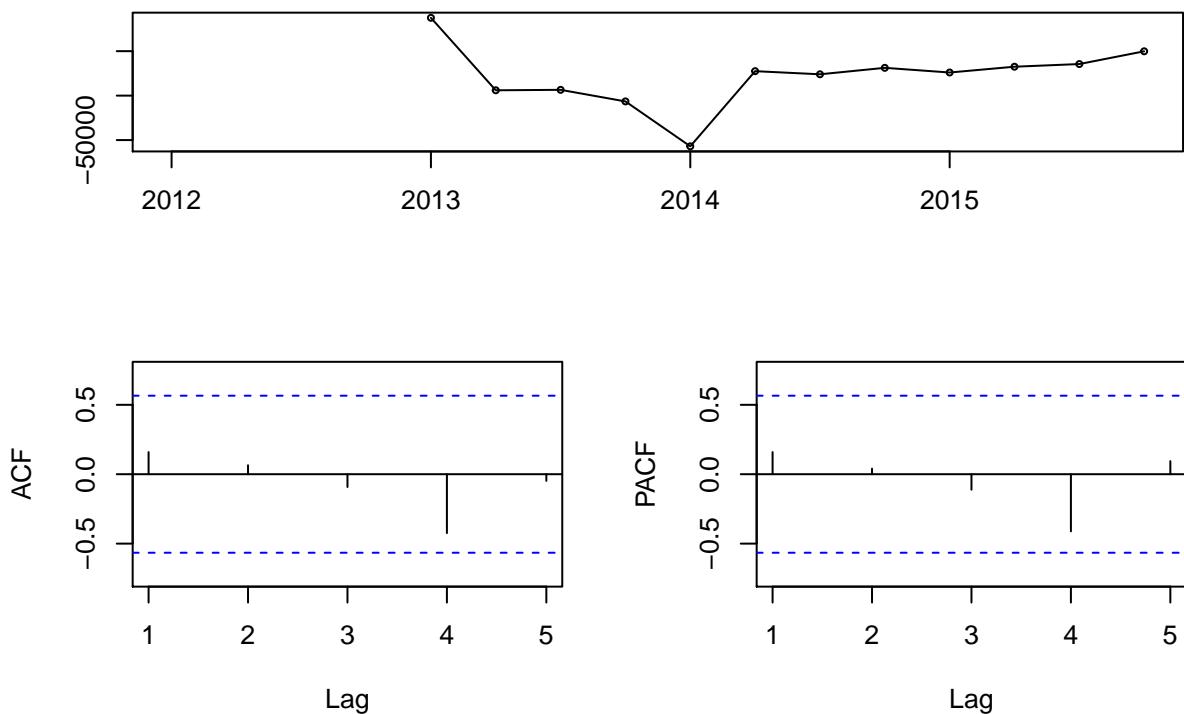
Portland, OR – Goose Hollow



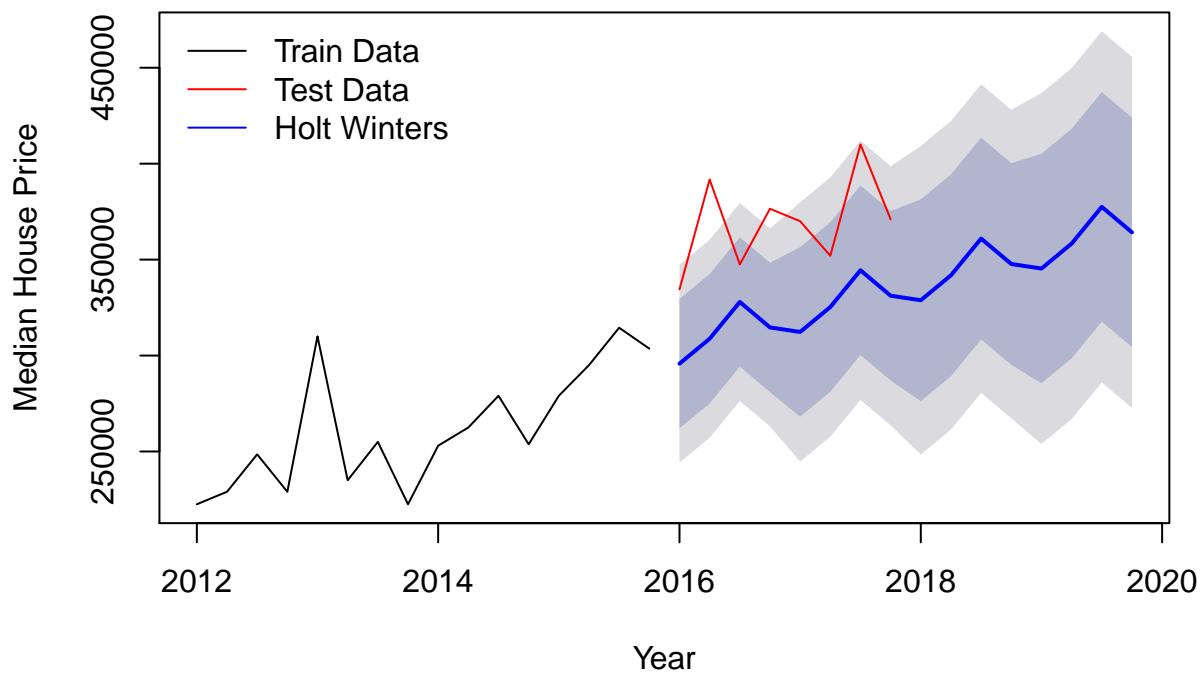
Portland, OR – Goose Hollow : Naive Model Forecast



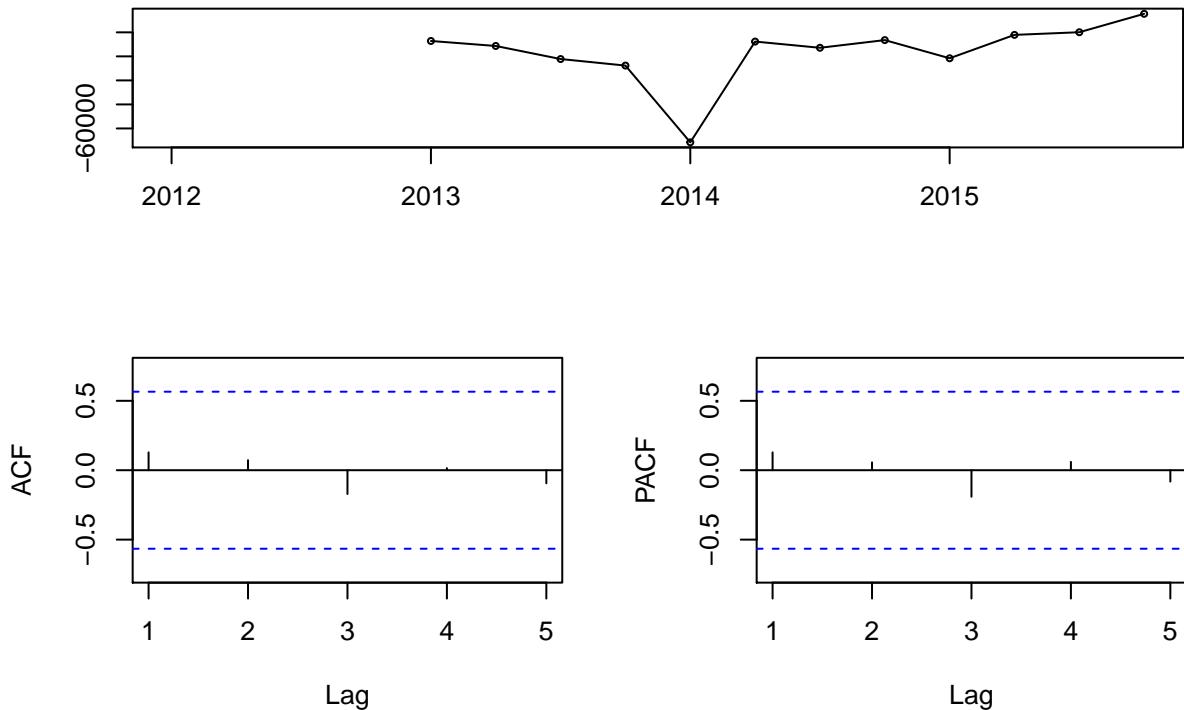
Portland, OR – Goose Hollow : Naive Model Forecast Residuals



Portland, OR – Goose Hollow : Holt Winters Model Forecast

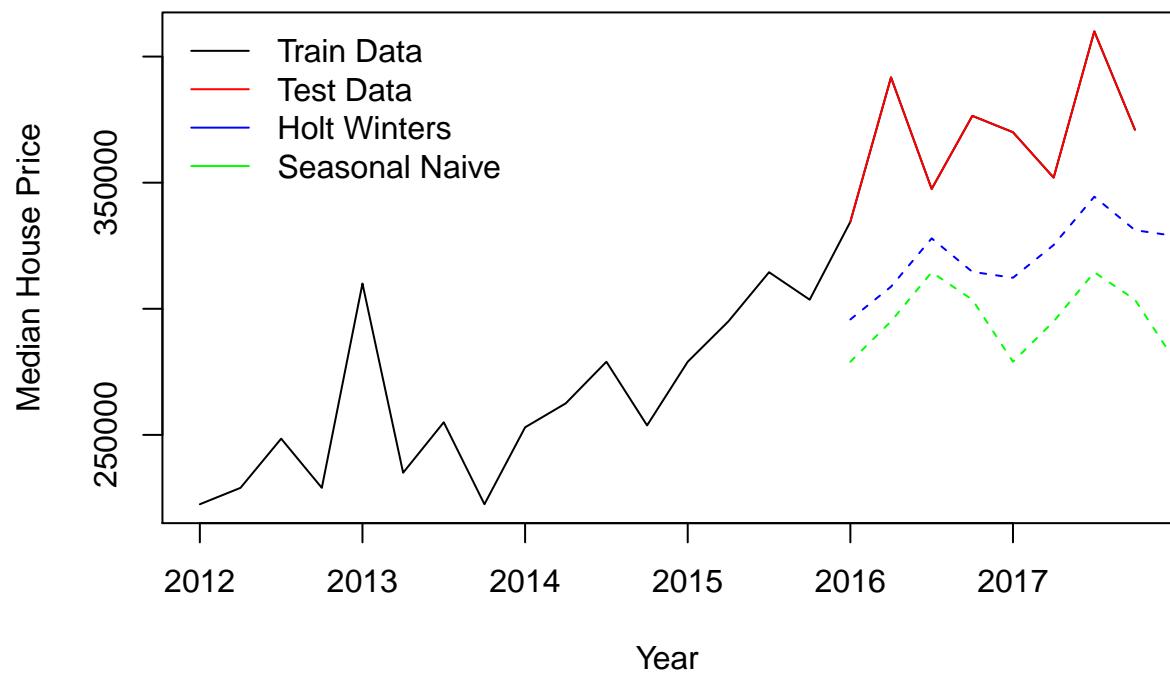


Portland, OR – Goose Hollow : Holt Winters Model Forecast Residuals

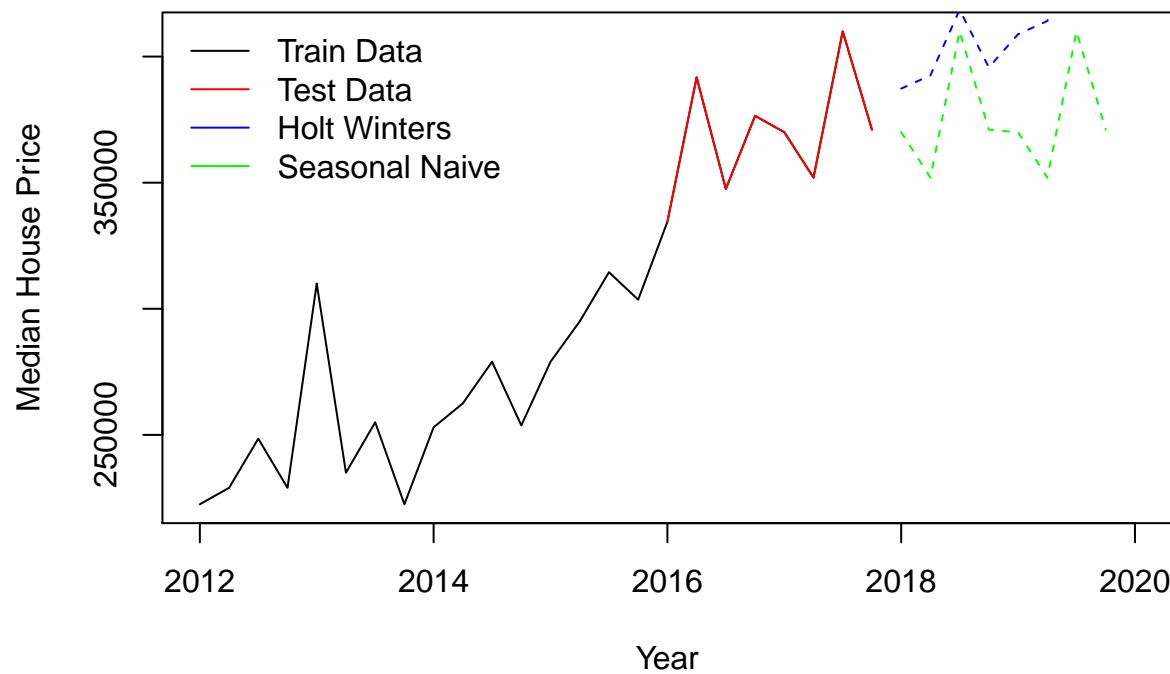


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Goose Hollow"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 21925.00 39593.86 32508.33 7.276164 11.51800 1.000000
## Test set     71131.25 74193.36 71131.25 19.049416 19.04942 2.188093
##          ACF1 Theil's U
## Training set  0.159304      NA
## Test set     -0.597104  1.900911
## [1] "Holt Winters Accuracy for Portland, OR – Goose Hollow"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 3732.428 25473.64 17569.00 0.9449982 6.472351 0.5404462
## Test set     49117.822 53059.49 49117.82 13.0915048 13.091505 1.5109302
##          ACF1 Theil's U
## Training set  0.1285473     NA
## Test set     -0.7239237  1.384905
```

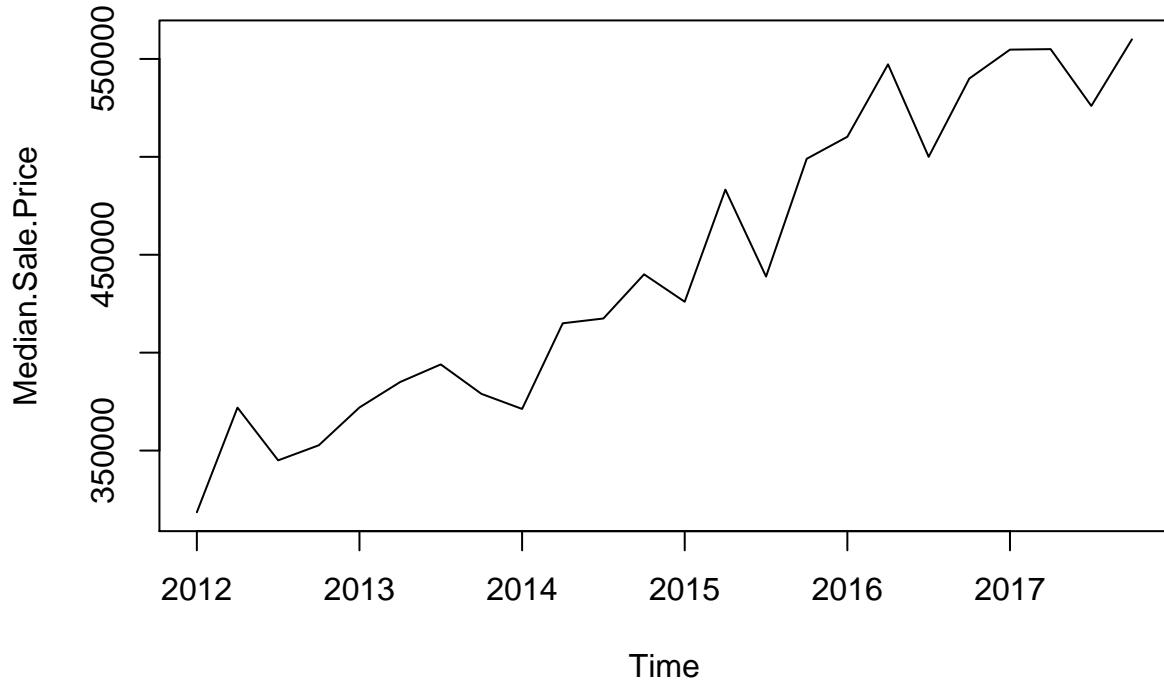
Portland, OR – Goose Hollow : TS Training Model Comparison



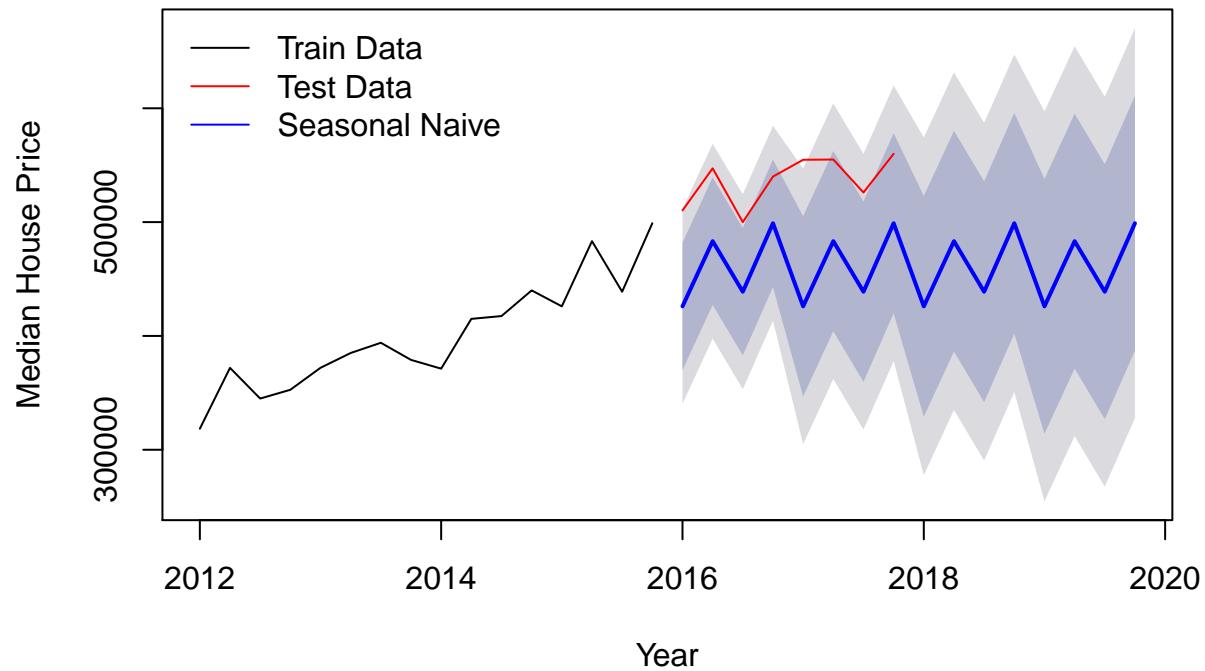
Portland, OR – Goose Hollow : Full TS Models Comparison



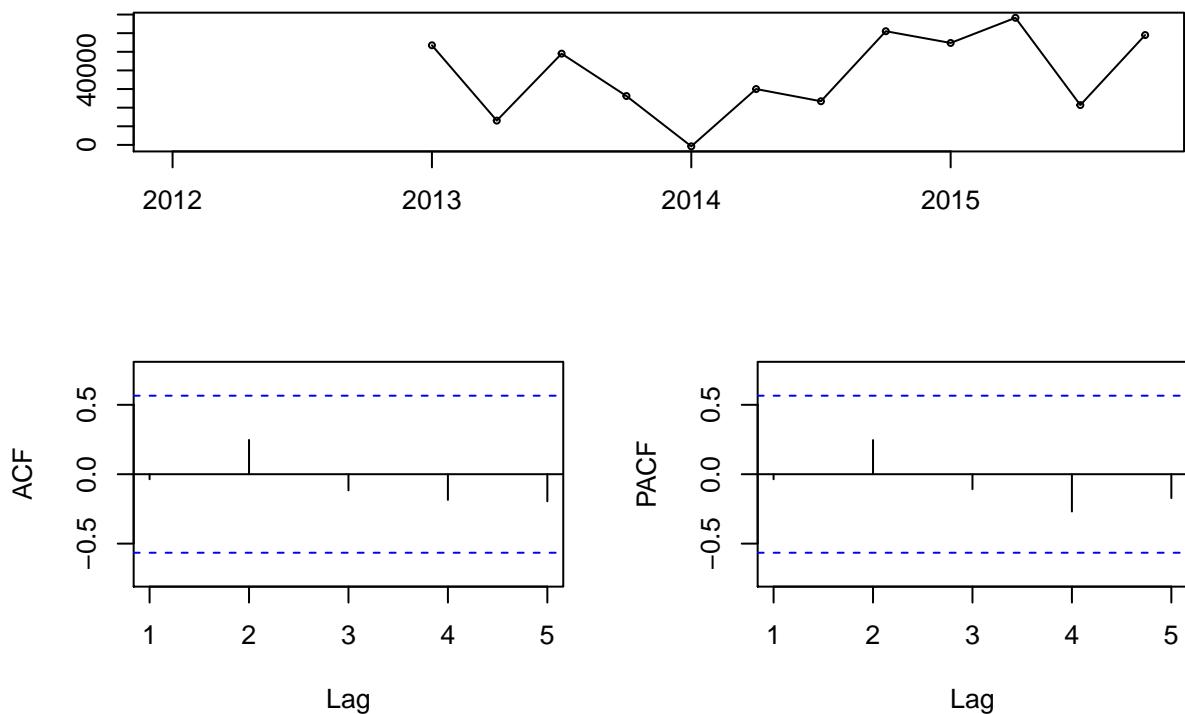
Portland, OR – Rose City Park



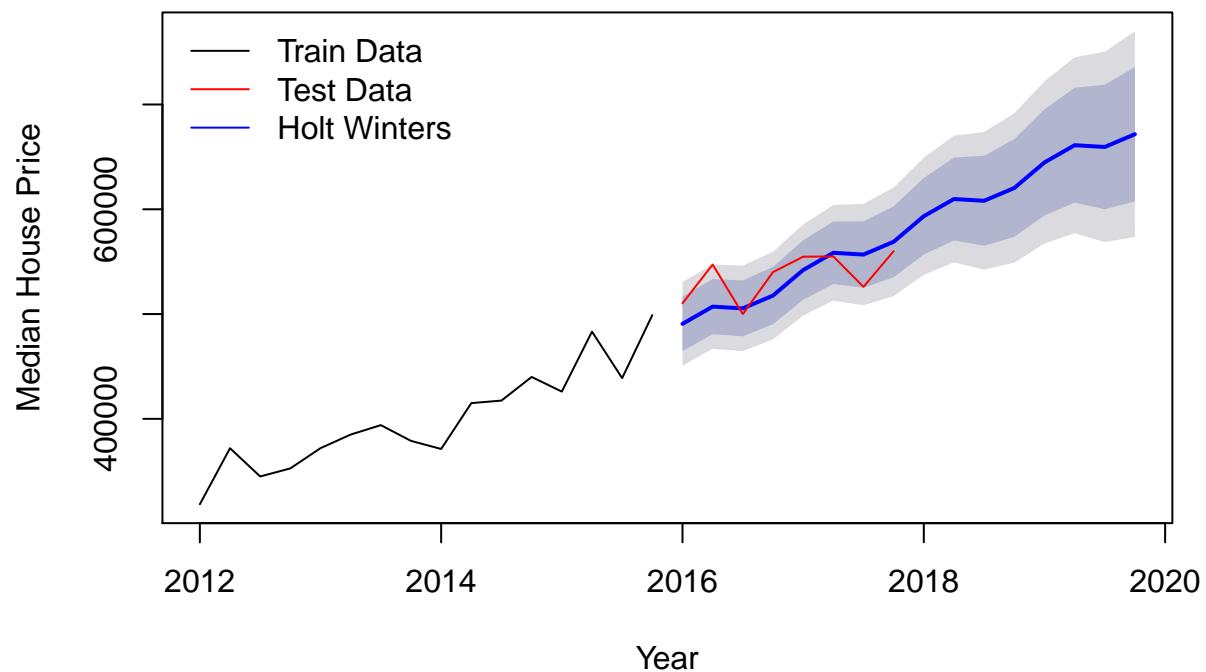
Portland, OR – Rose City Park : Naive Model Forecast



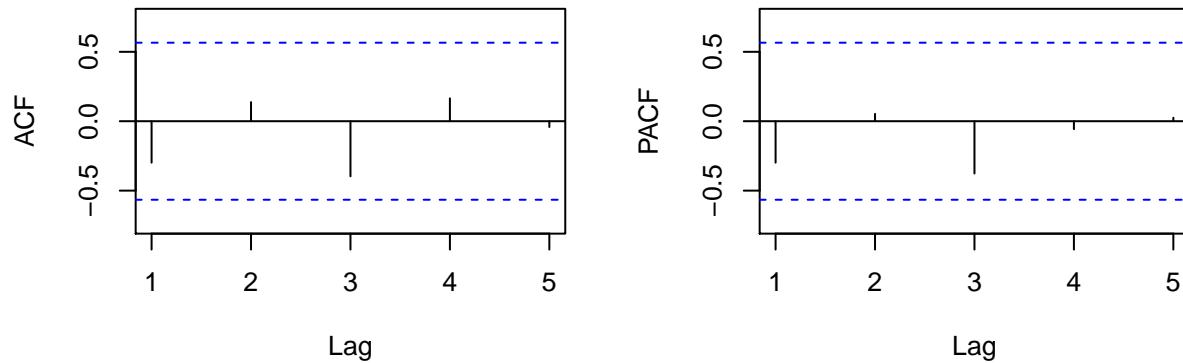
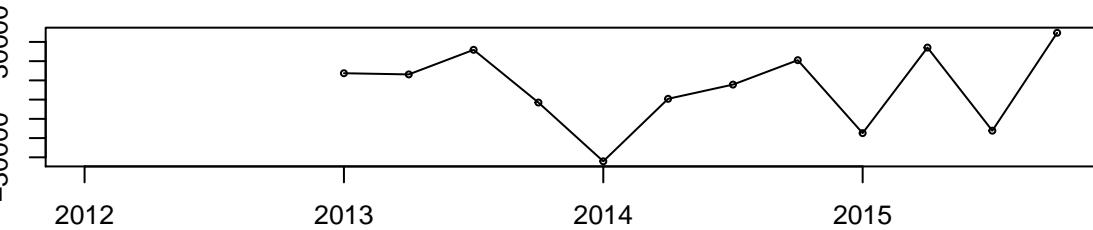
Portland, OR – Rose City Park : Naive Model Forecast Residuals



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

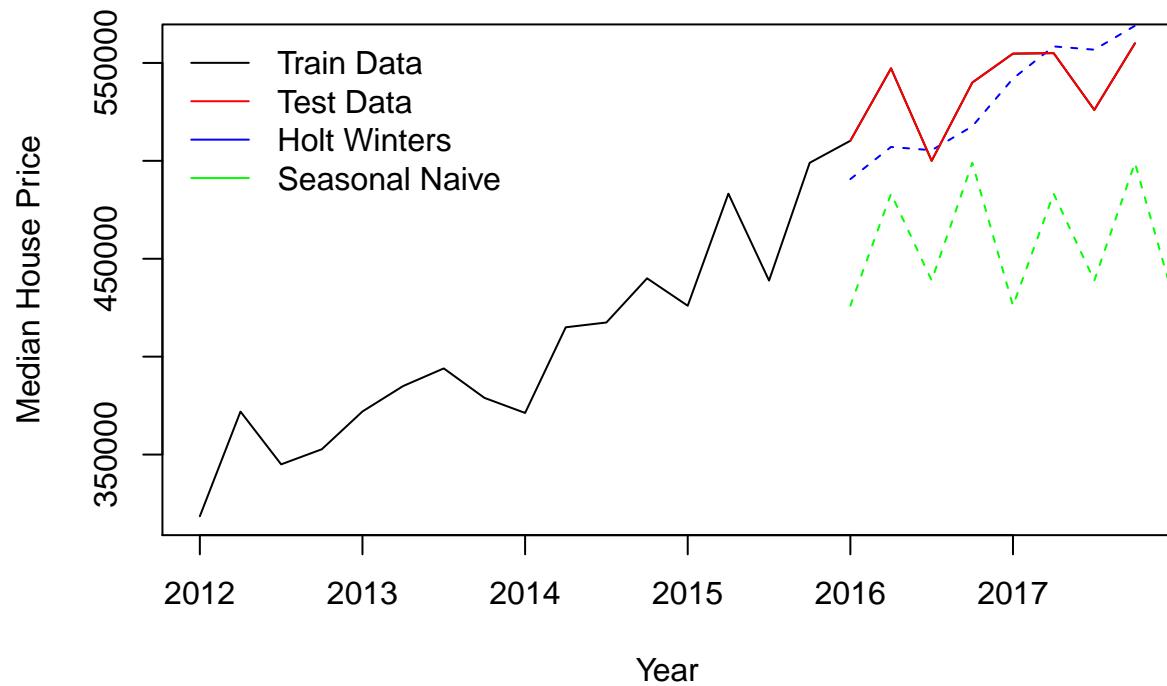


Portland, OR – Rose City Park : Holt Winters Model Forecast Residuals

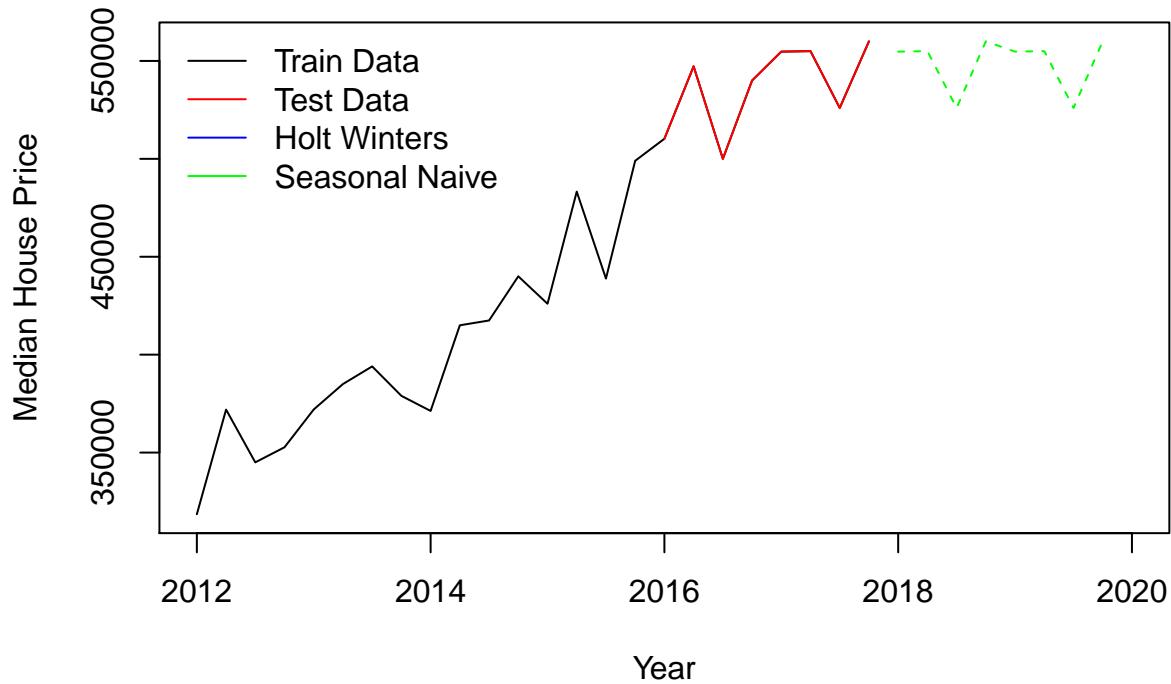


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Rose City Park"
##          ME      RMSE       MAE       MPE       MAPE       MASE
## Training set 38245.83 43679.48 38370.83 8.944126 8.977796 1.000000
## Test set     74881.25 78783.83 74881.25 13.953353 13.953353 1.951515
##          ACF1 Theil's U
## Training set -0.03629417      NA
## Test set     -0.35223156  2.340436
## [1] "Holt Winters Accuracy for Portland, OR – Rose City Park"
##          ME      RMSE       MAE       MPE       MAPE       MASE
## Training set 6340.000 20506.91 17534.82 1.337140 4.138993 0.4569830
## Test set     5780.391 21583.95 17931.43 1.057328 3.346313 0.4673191
##          ACF1 Theil's U
## Training set -0.2987186      NA
## Test set     0.2404844  0.6765333
```

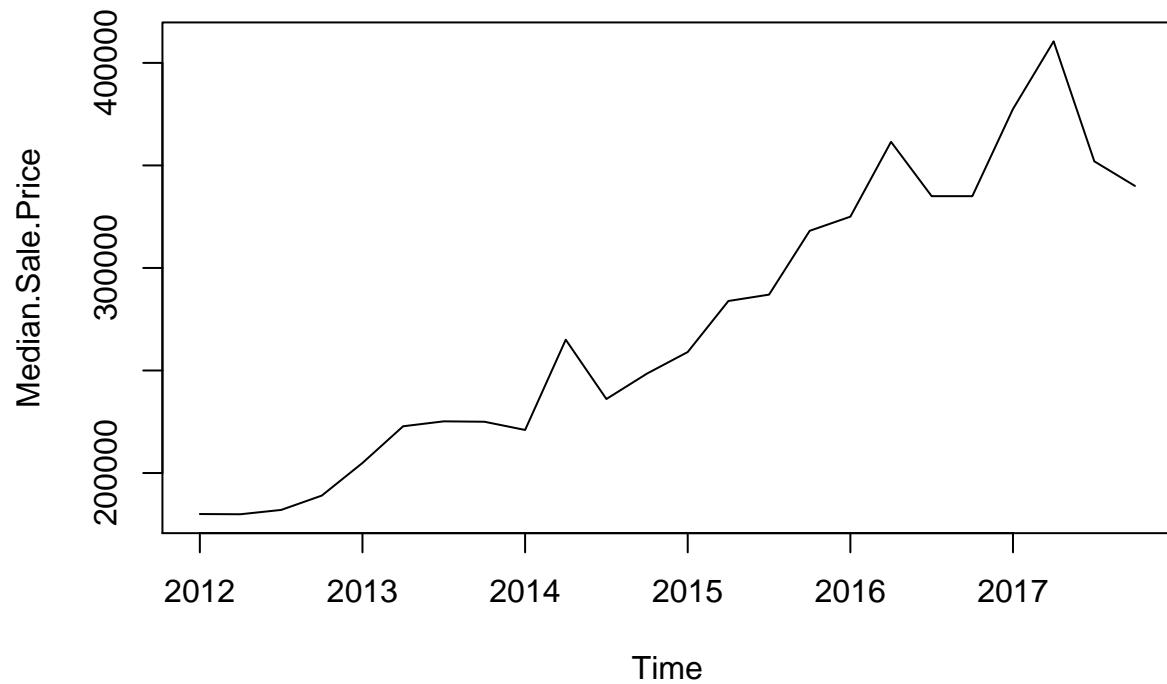
Portland, OR – Rose City Park : TS Training Model Comparison



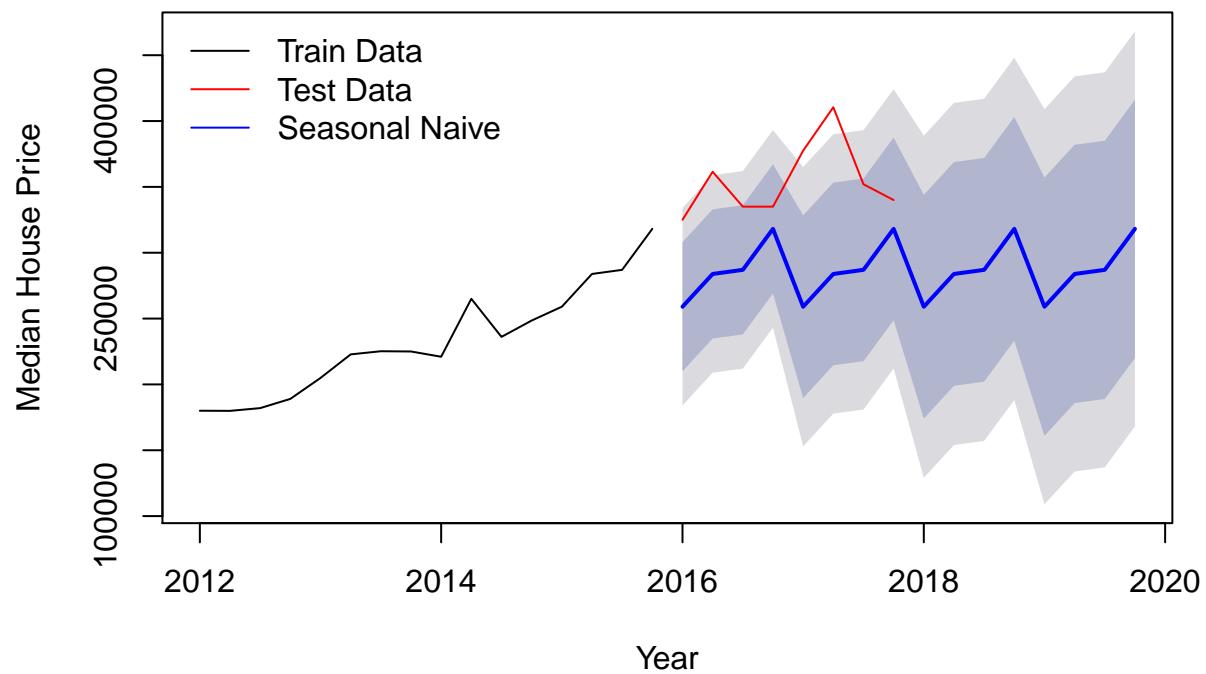
Portland, OR – Rose City Park : Full TS Models Comparison



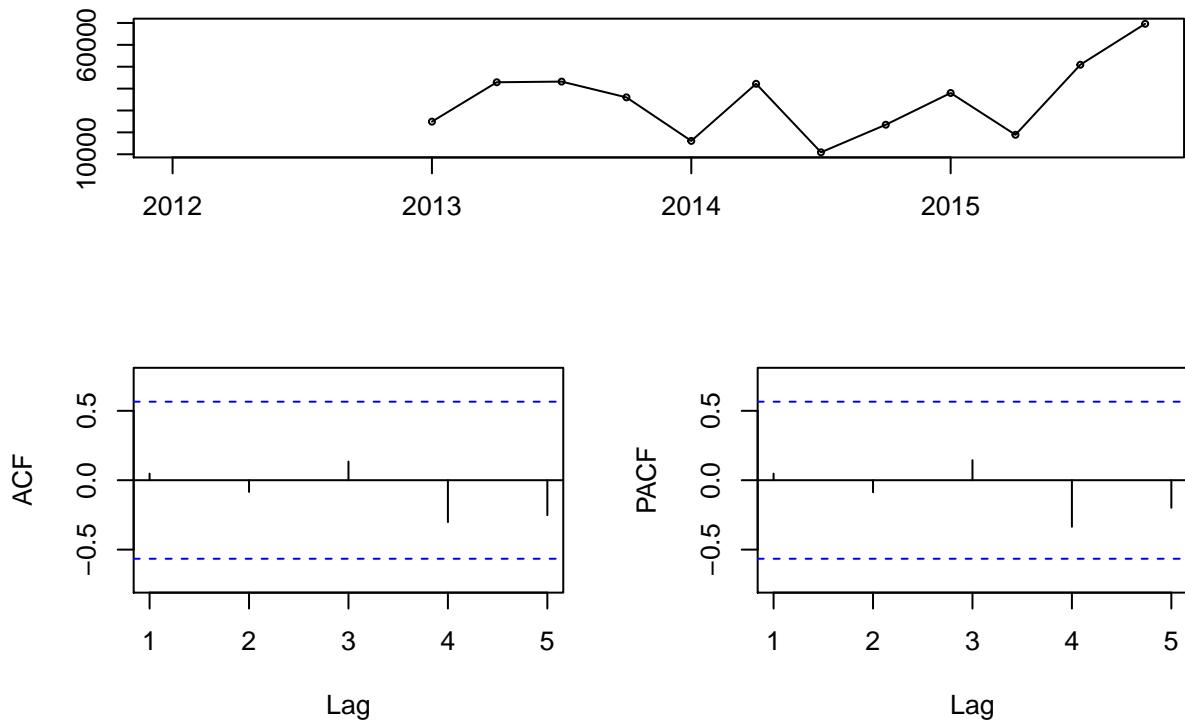
Portland, OR – Mount Scott–Arleta



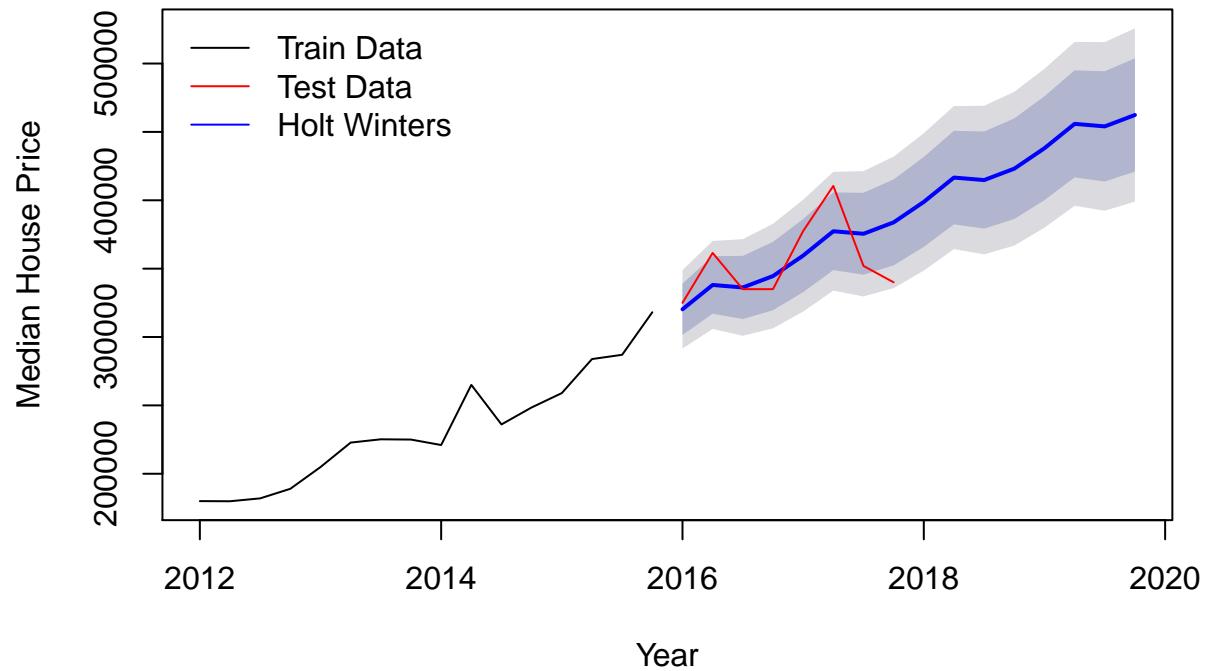
Portland, OR – Mount Scott–Arleta : Naive Model Forecast



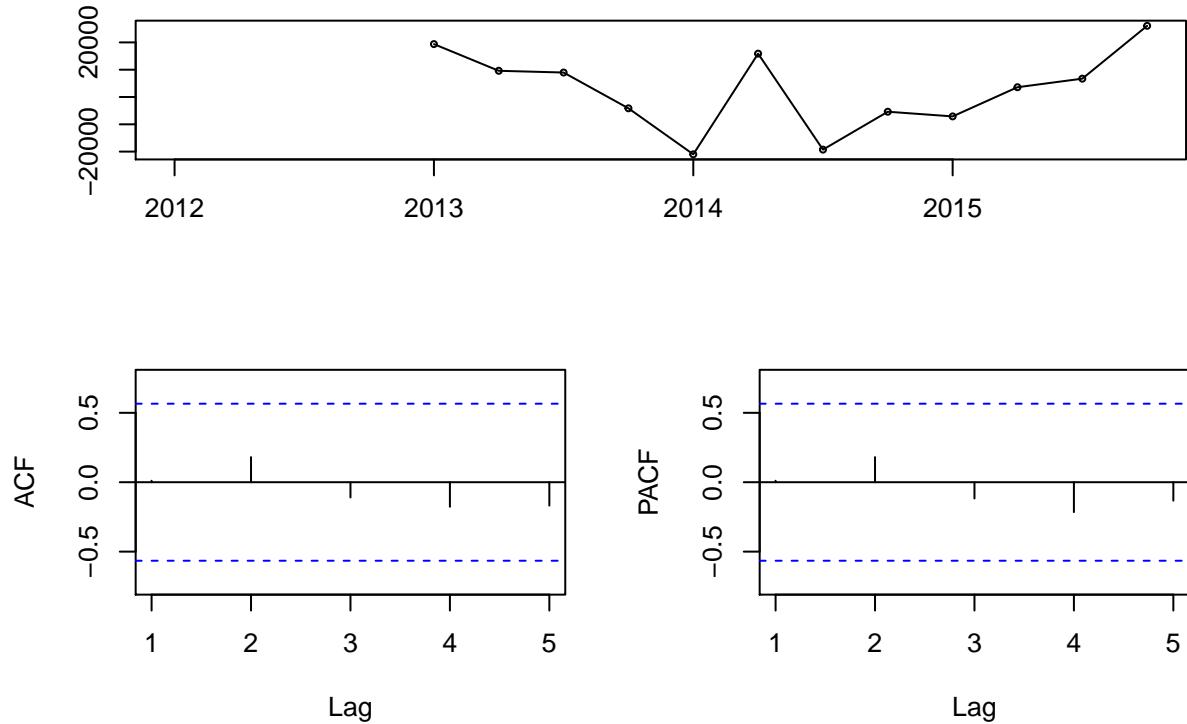
Portland, OR – Mount Scott–Arleta : Naive Model Forecast Residuals



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

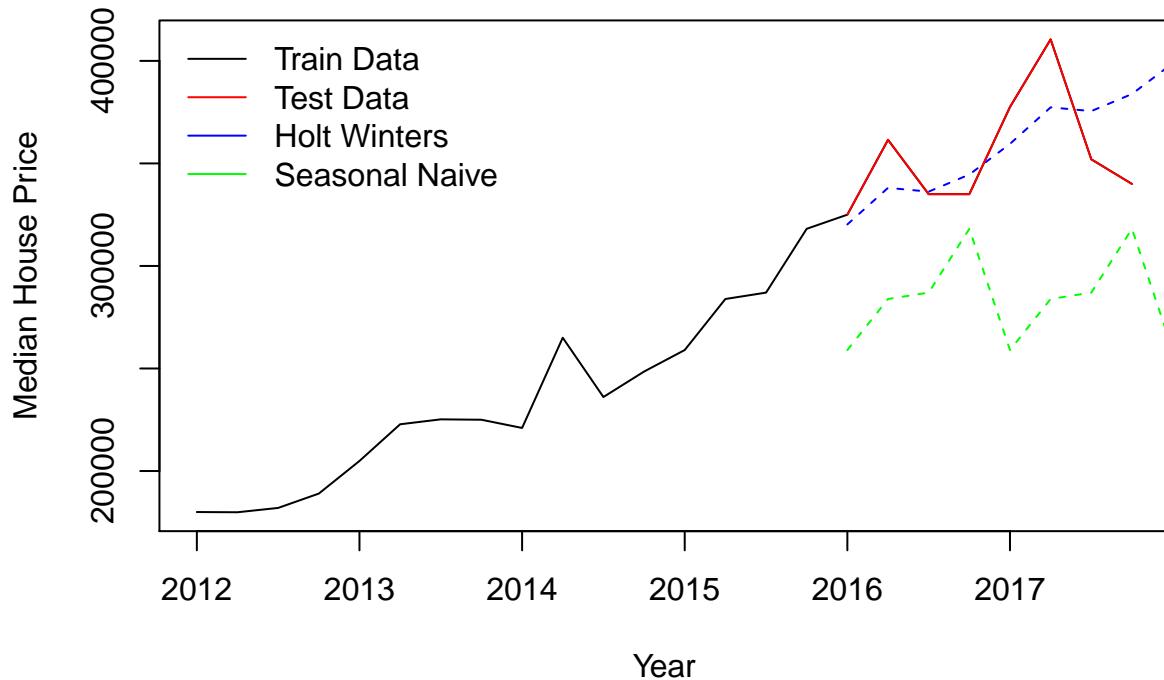


Portland, OR – Mount Scott–Arleta : Holt Winters Model Forecast Residuals

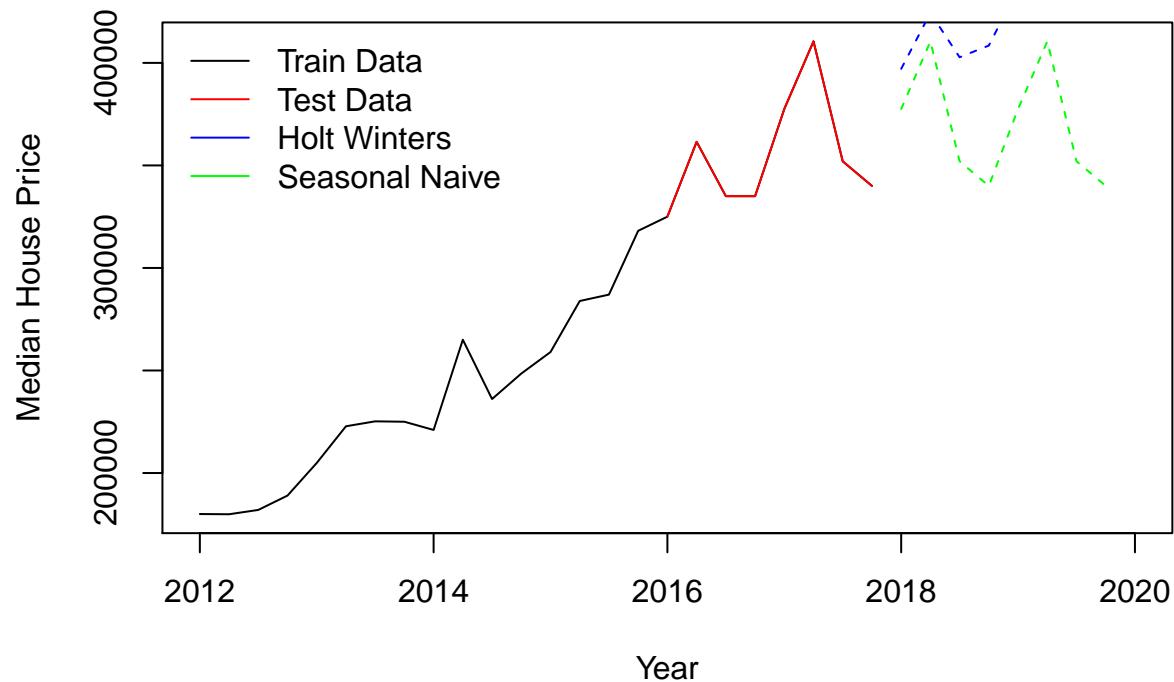


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Mount Scott–Arleta"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 34758.62 38267.31 34758.62 13.73471 13.73471 1.000000
## Test set     67561.62 77253.90 67561.62 18.53529 18.53529 1.943737
##          ACF1 Theil's U
## Training set 0.04775519      NA
## Test set     0.10431213 2.332294
## [1] "Holt Winters Accuracy for Portland, OR – Mount Scott–Arleta"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 2772.9082 14277.40 12256.64 0.9263043 4.995502 0.3526215
## Test set     138.3093 23877.38 19680.00 -0.2538897 5.446613 0.5661904
##          ACF1 Theil's U
## Training set 0.01058989      NA
## Test set     0.16734497 0.7485064
```

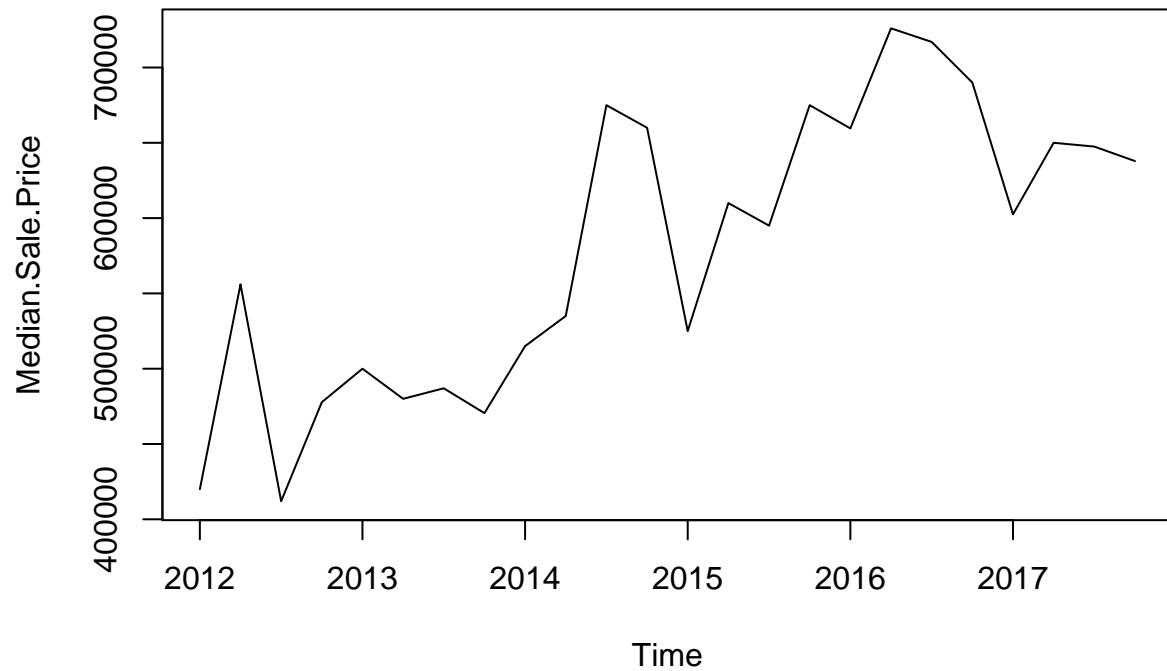
Portland, OR – Mount Scott–Arleta : TS Training Model Comparisor



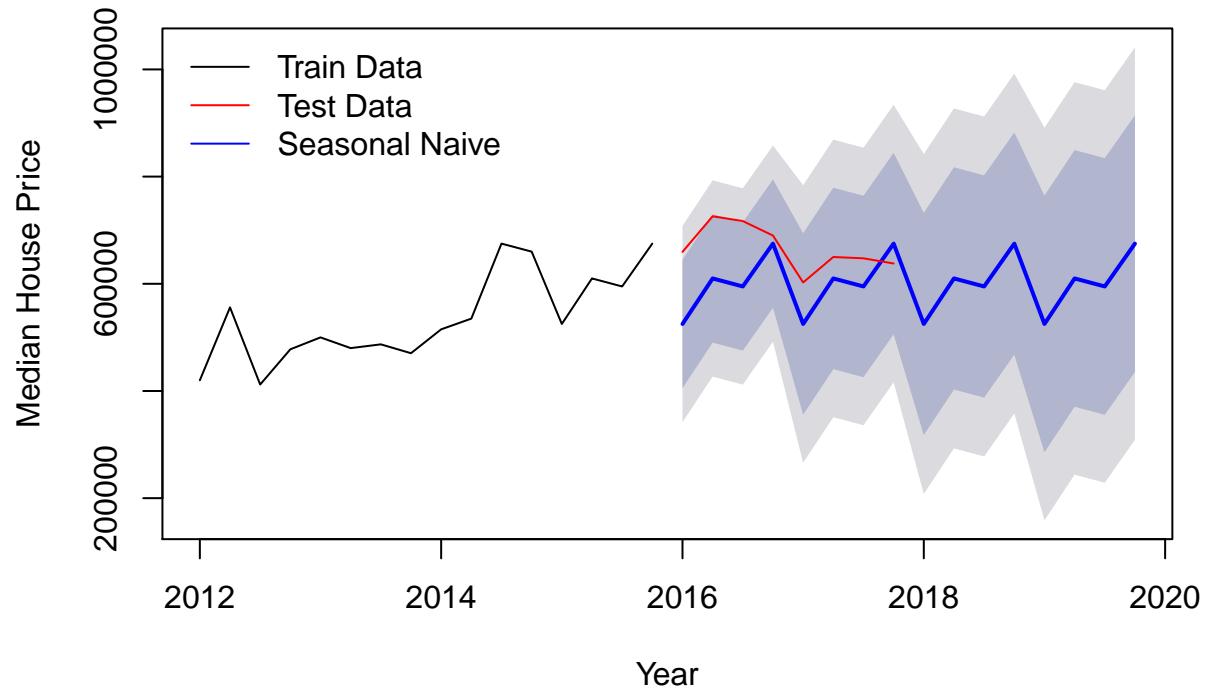
Portland, OR – Mount Scott–Arleta : Full TS Models Comparison



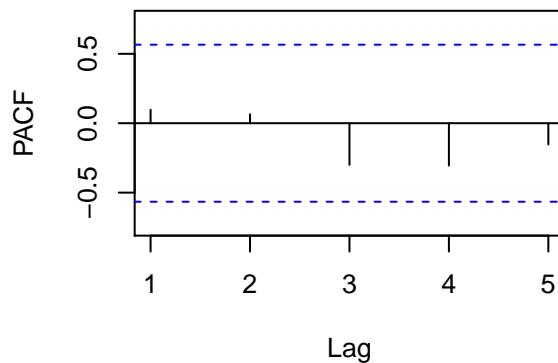
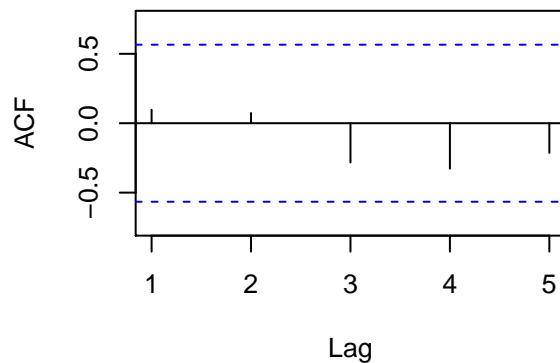
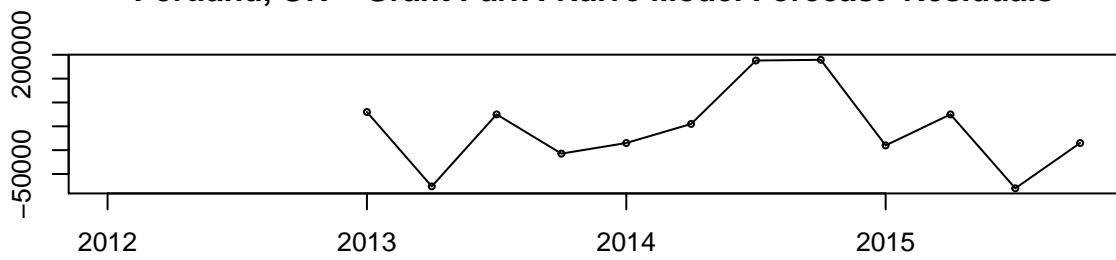
Portland, OR – Grant Park



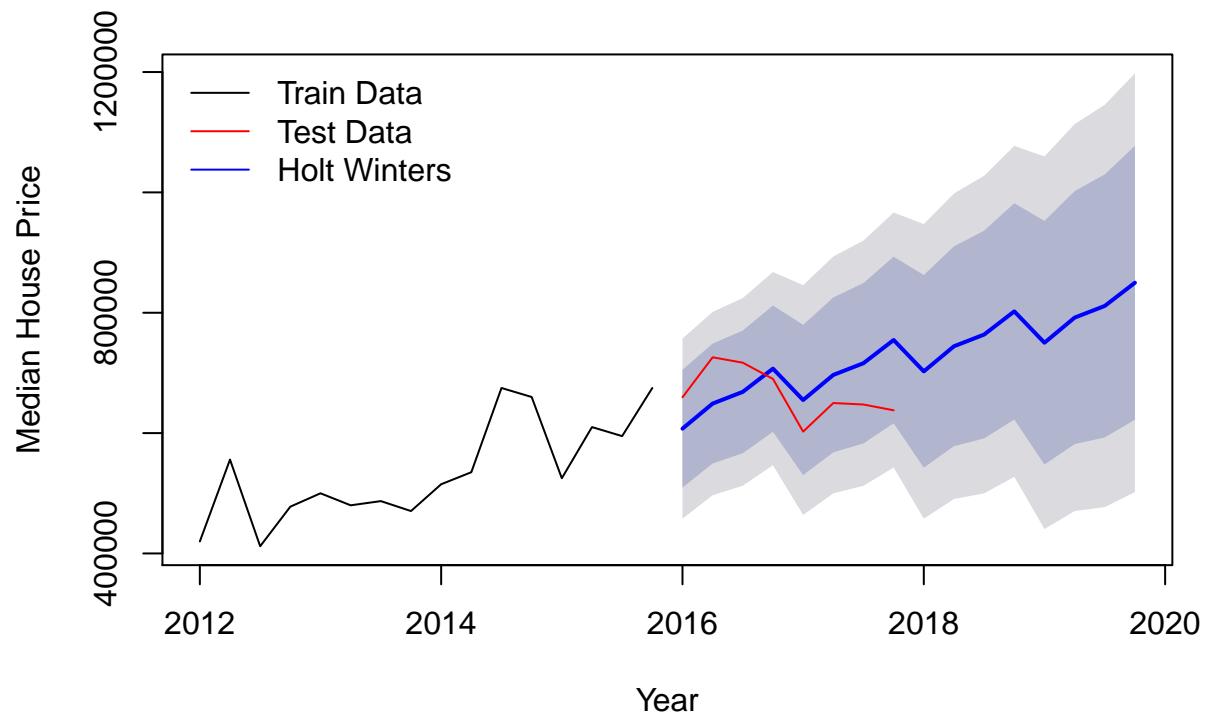
Portland, OR – Grant Park : Naive Model Forecast



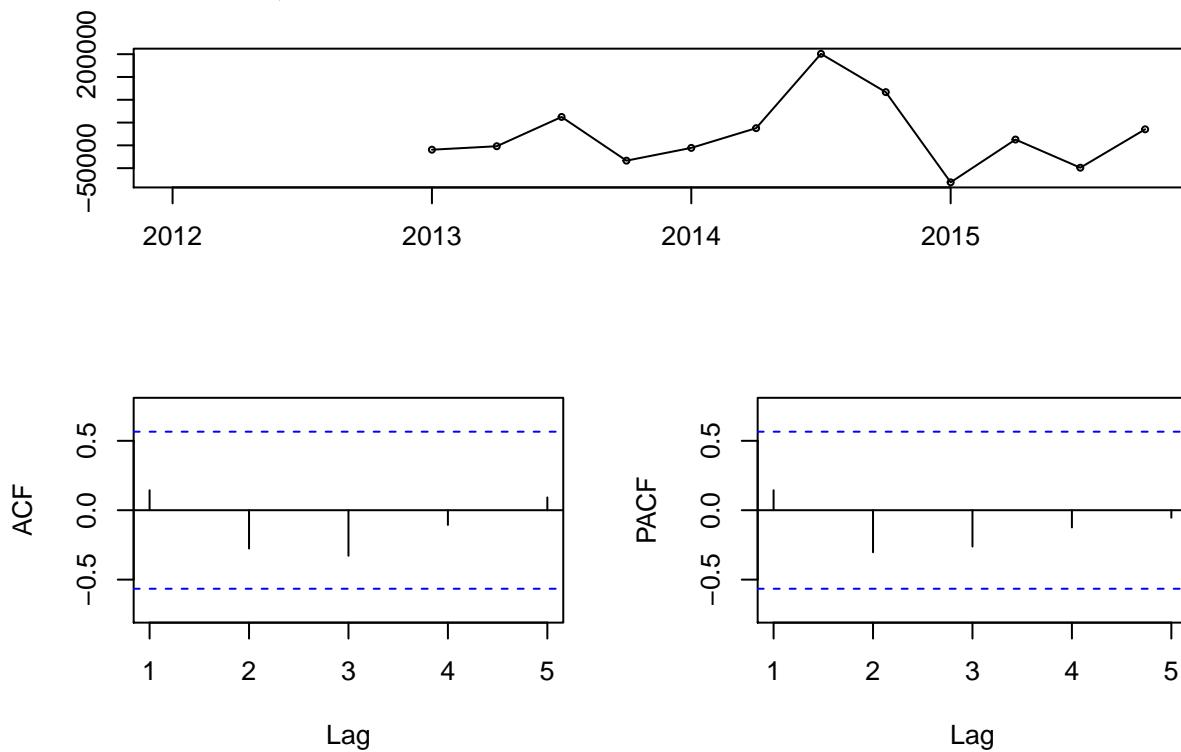
Portland, OR – Grant Park : Naive Model Forecast Residuals



Portland, OR – Grant Park : Holt Winters Model Forecast



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

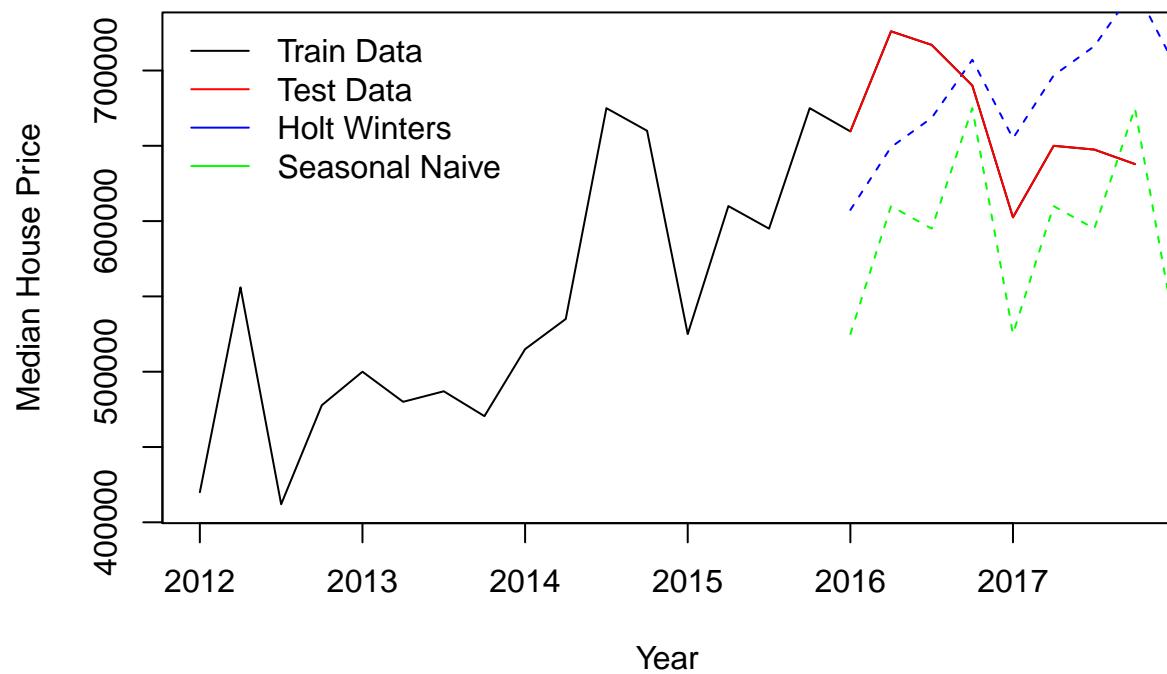


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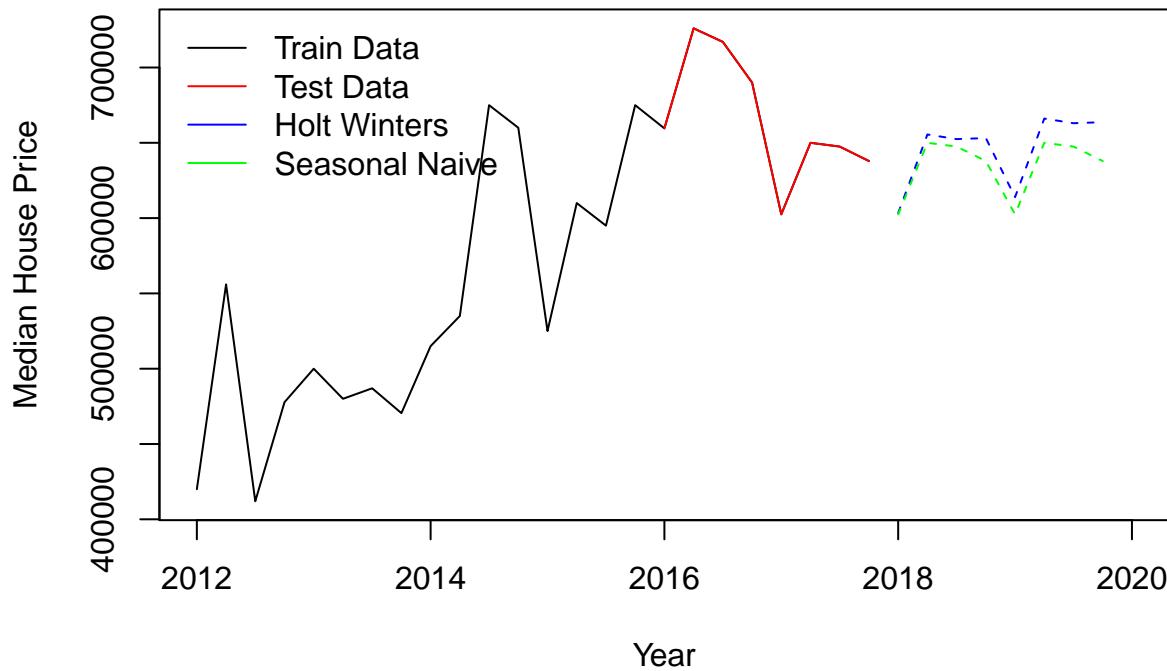
## [1] "Seasonal Naive Accuracy for Portland, OR - Grant Park"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 44937.50 93411.19 72145.83 7.229985 12.36659 1.00000
## Test set     65057.12 85450.29 74338.38 9.609579 11.06461 1.03039
##          ACF1 Theil's U
## Training set 0.09718063      NA
## Test set     0.17331471 1.58859
## [1] "Holt Winters Accuracy for Portland, OR - Grant Park"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 23754.20 76860.96 53843.68 3.368414 9.064245 0.7463172
## Test set     -15526.43 65739.52 59911.67 -2.753402 9.069025 0.8304246
##          ACF1 Theil's U
## Training set 0.1440601      NA
## Test set     0.6223428 1.470988

```

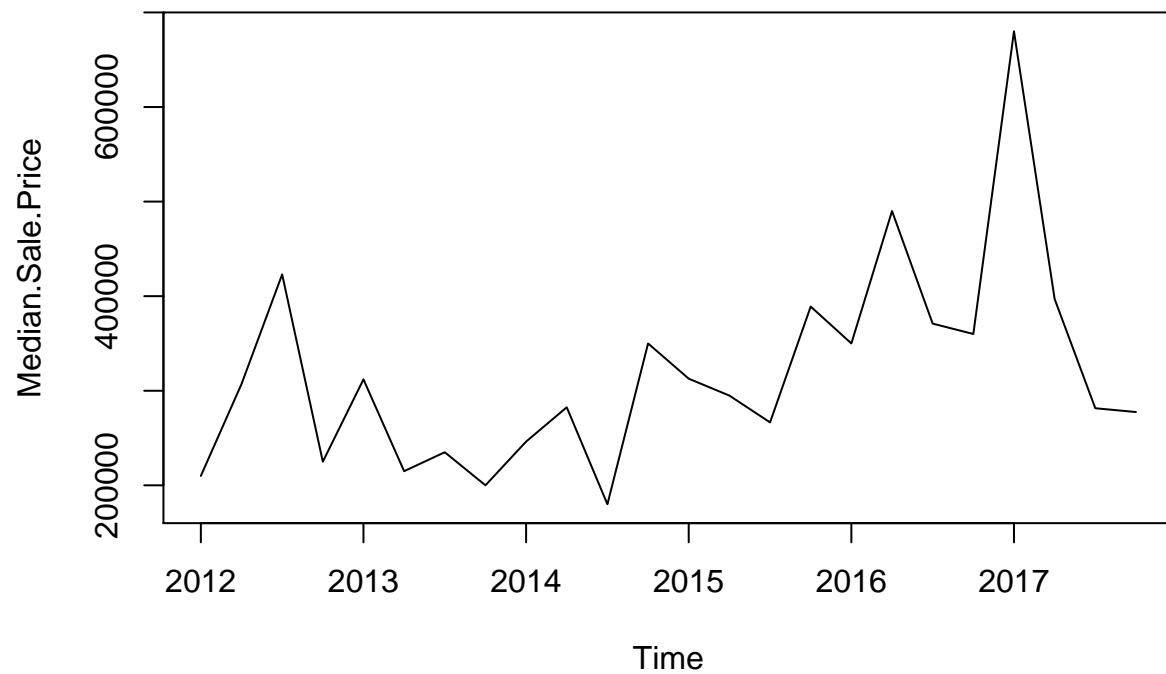
Portland, OR – Grant Park : TS Training Model Comparison



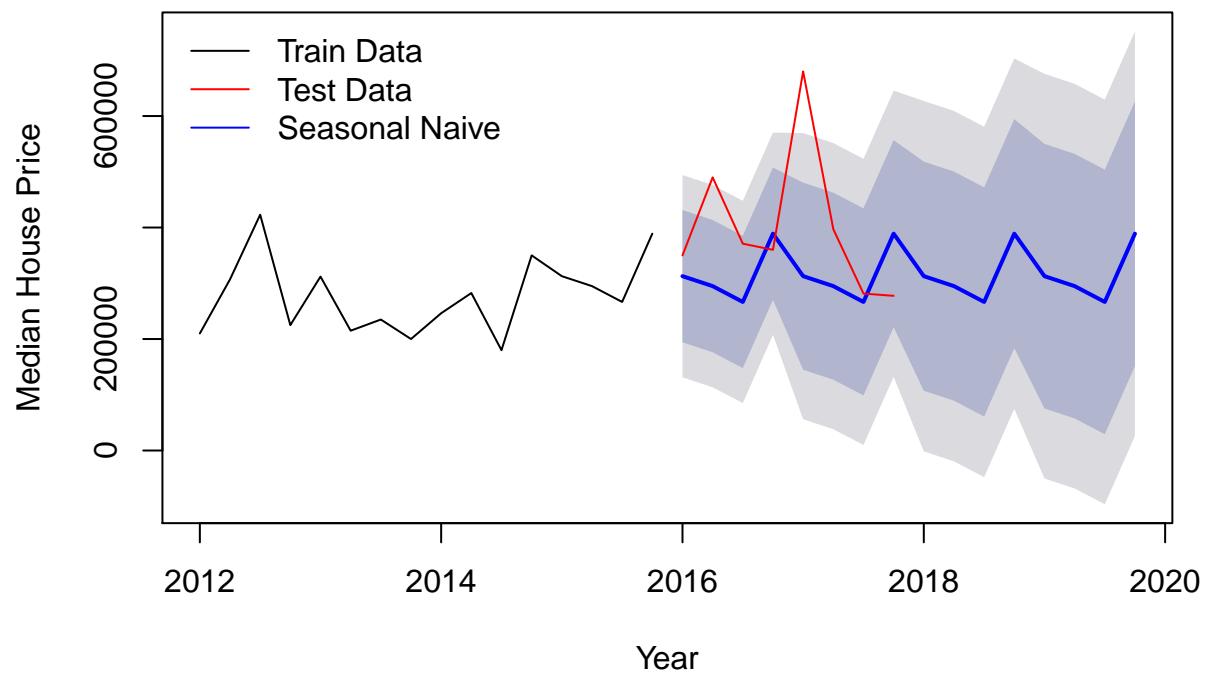
Portland, OR – Grant Park : Full TS Models Comparison



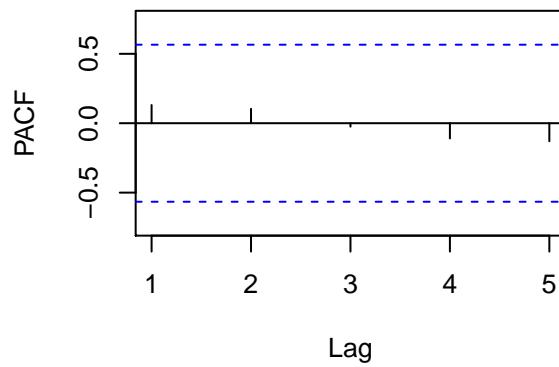
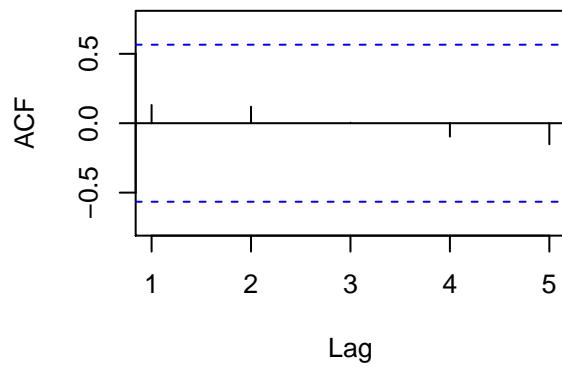
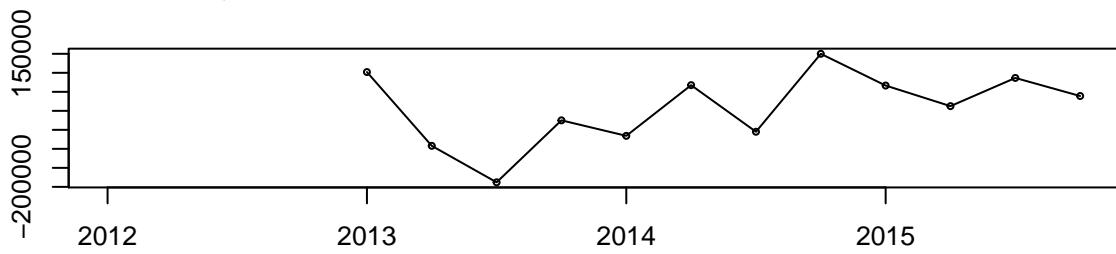
Portland, OR – Sullivan's Gulch



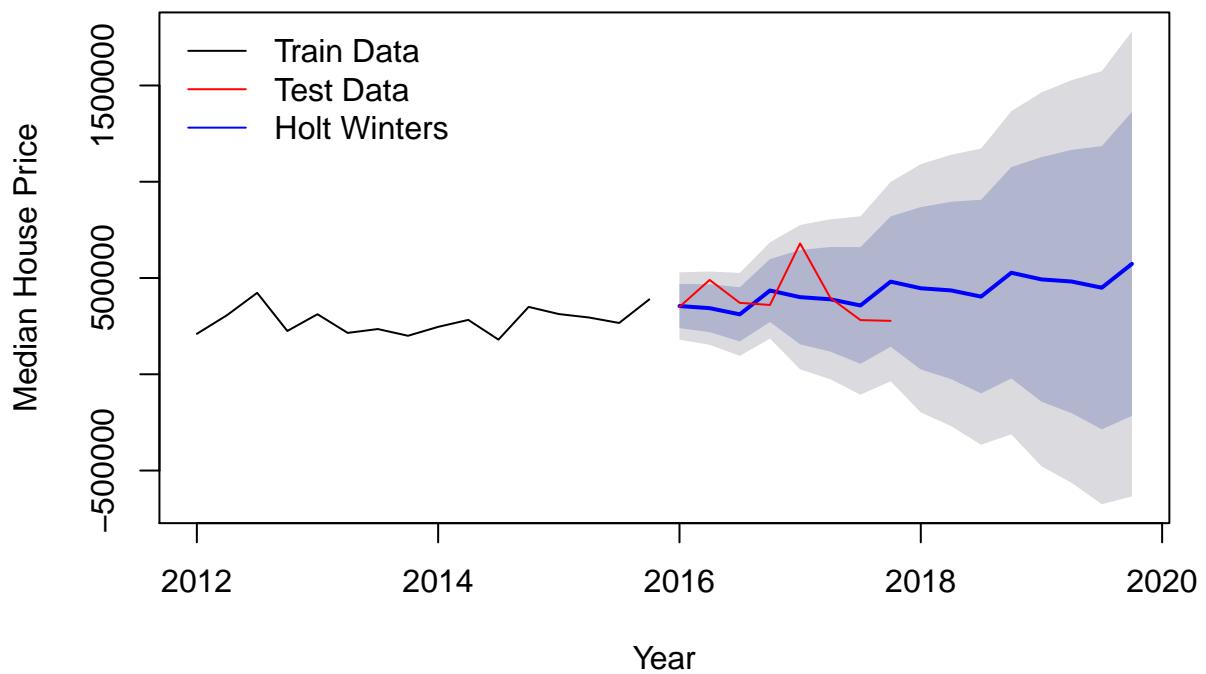
Portland, OR – Sullivan's Gulch : Naive Model Forecast



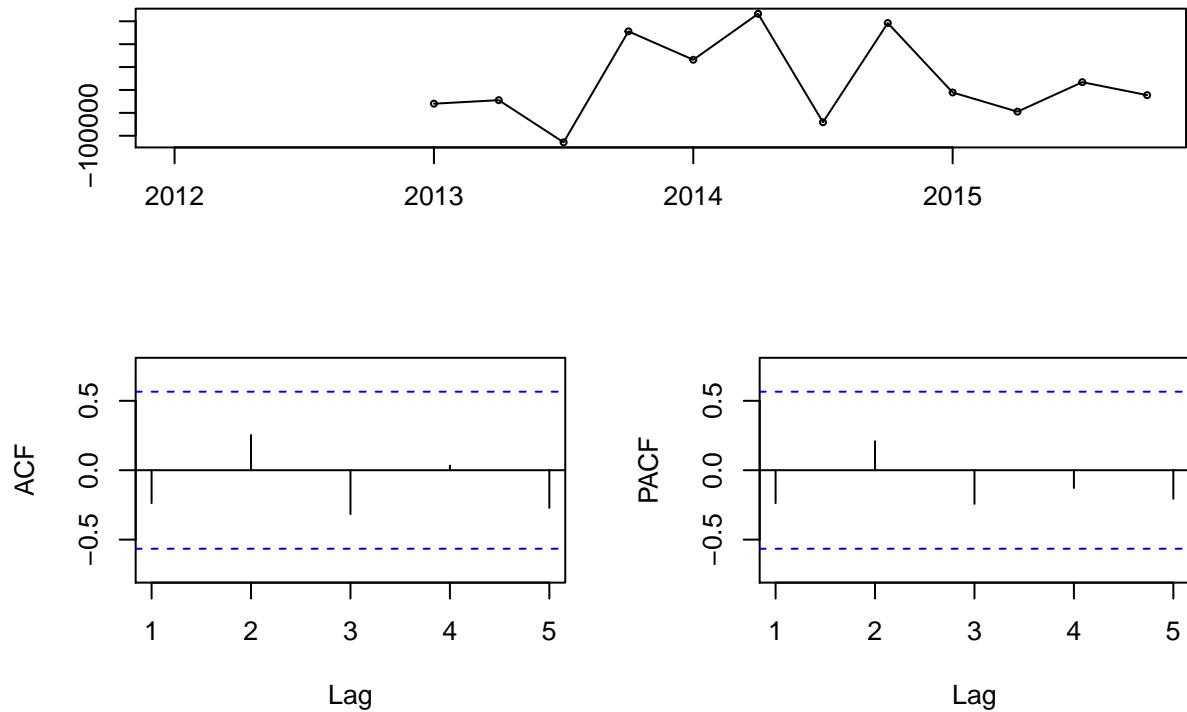
Portland, OR – Sullivan's Gulch : Naive Model Forecast Residuals



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

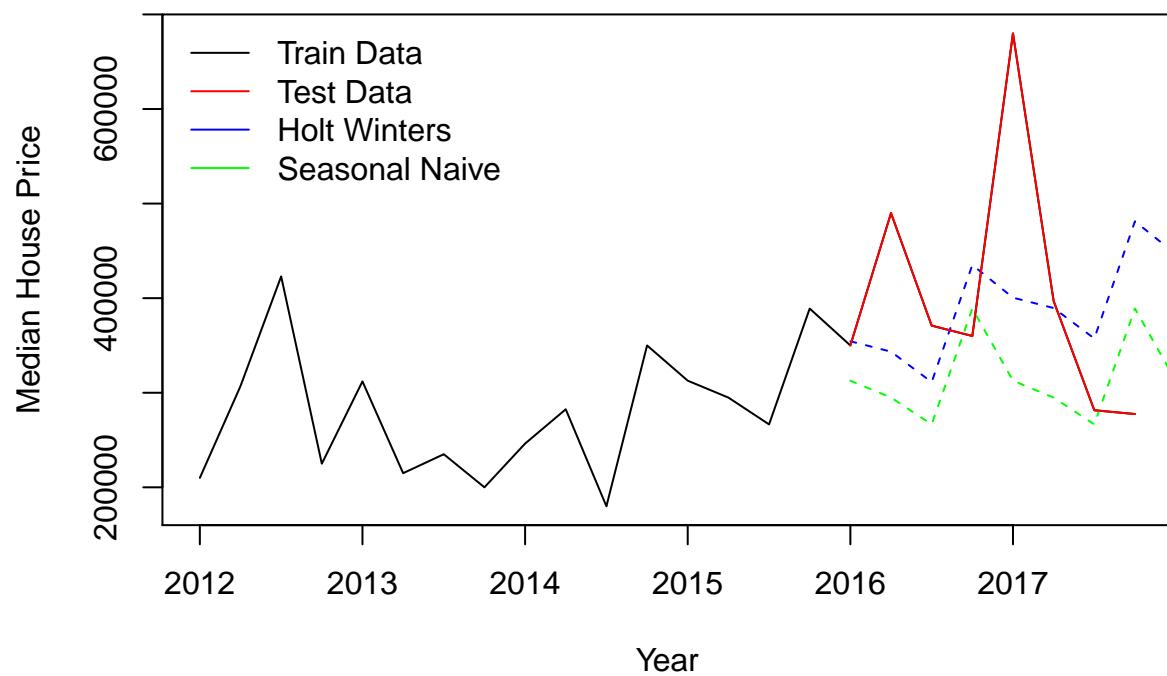


Portland, OR – Sullivan's Gulch : Holt Winters Model Forecast Residuals

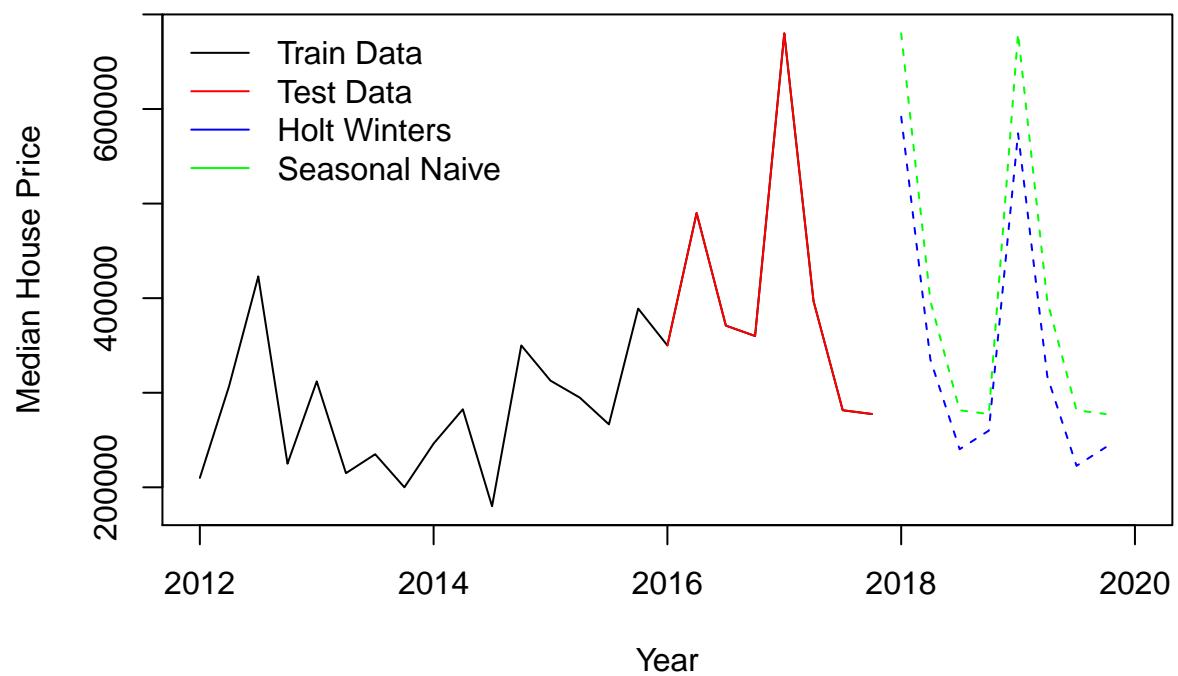


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Sullivan's Gulch"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 8183.333 92576.63 79150 -2.096254 30.00041 1.000000
## Test set     85075.000 161692.26 120200 14.426645 26.48558 1.518636
##          ACF1 Theil's U
## Training set 0.1311714      NA
## Test set     -0.1331183 1.117602
## [1] "Holt Winters Accuracy for Portland, OR – Sullivan's Gulch"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 18516.4 87494.23 68711.39 5.774390 27.1876 0.8681161
## Test set     16758.7 139704.65 106547.54 -4.189116 26.4367 1.3461471
##          ACF1 Theil's U
## Training set -0.23707350      NA
## Test set     -0.04169914 1.048637
```

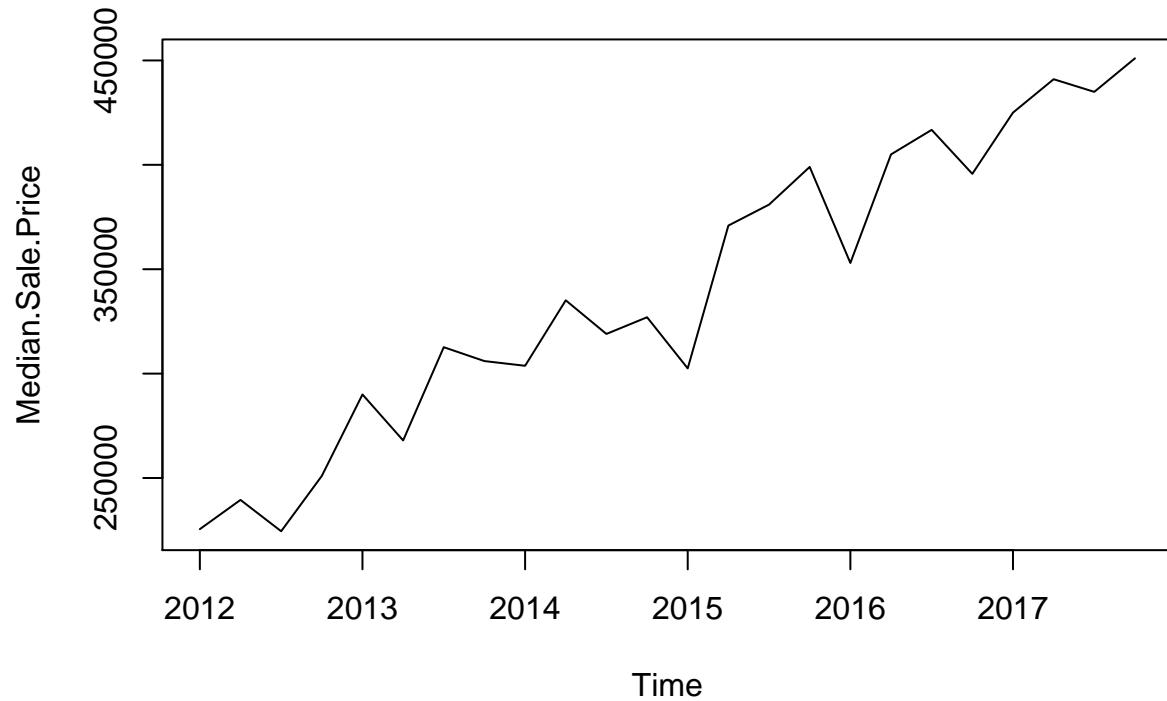
Portland, OR – Sullivan's Gulch : TS Training Model Comparison



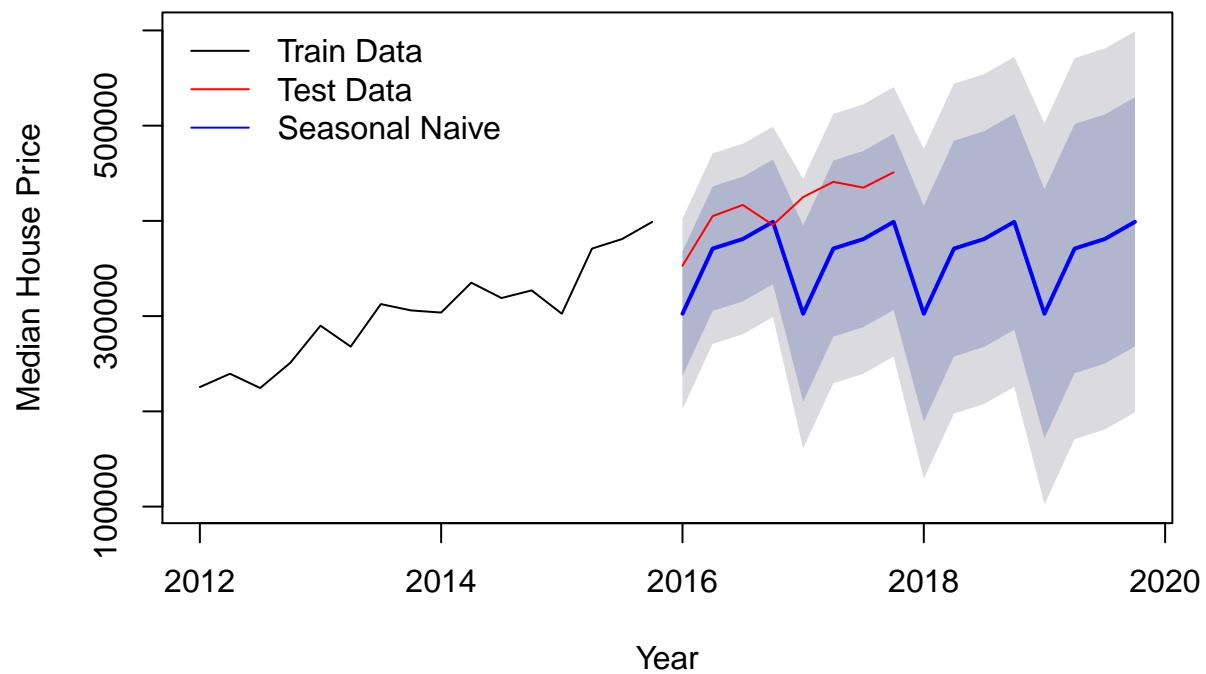
Portland, OR – Sullivan's Gulch : Full TS Models Comparison



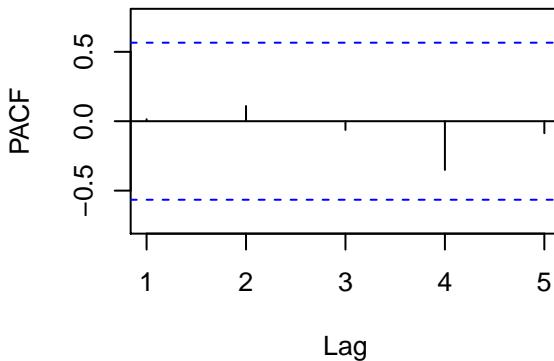
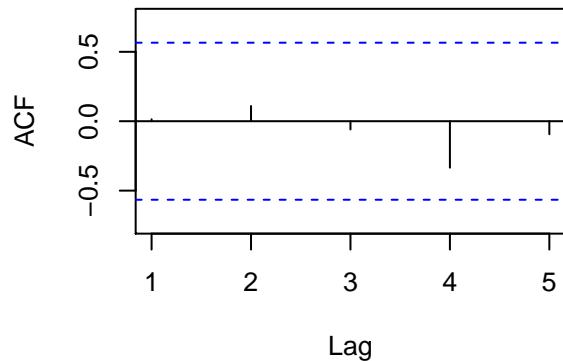
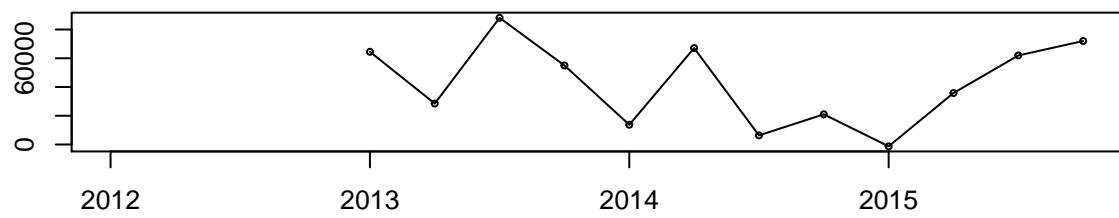
Portland, OR – Piedmont



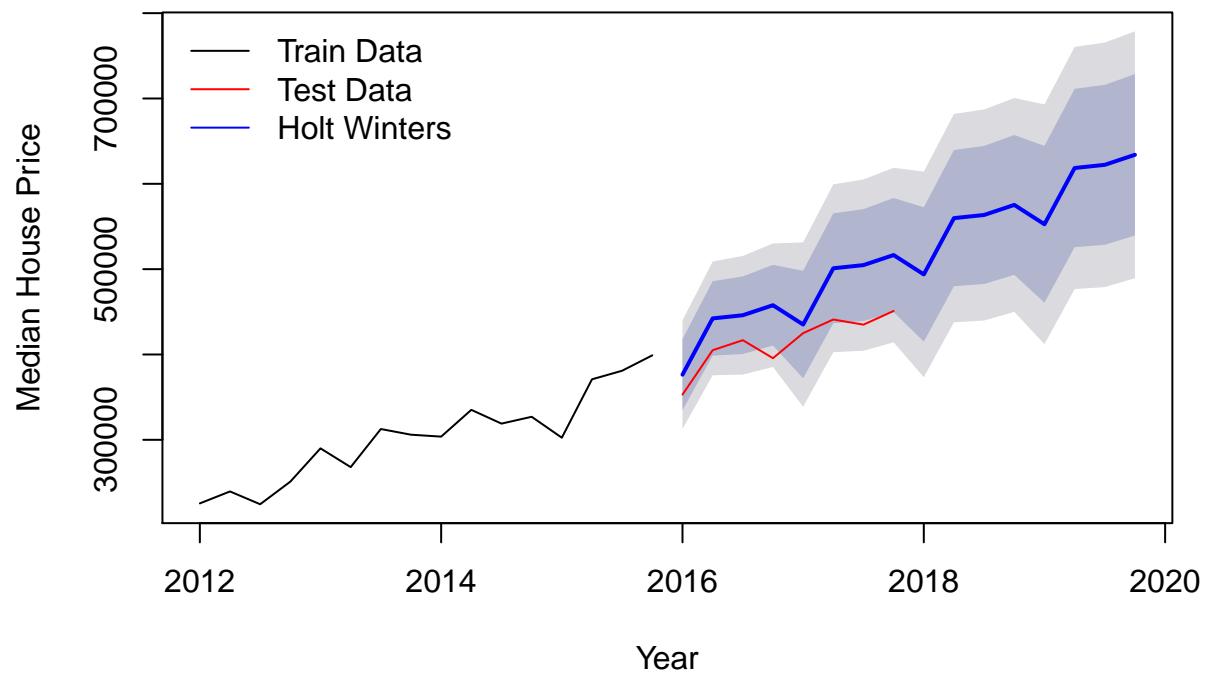
Portland, OR – Piedmont : Naive Model Forecast



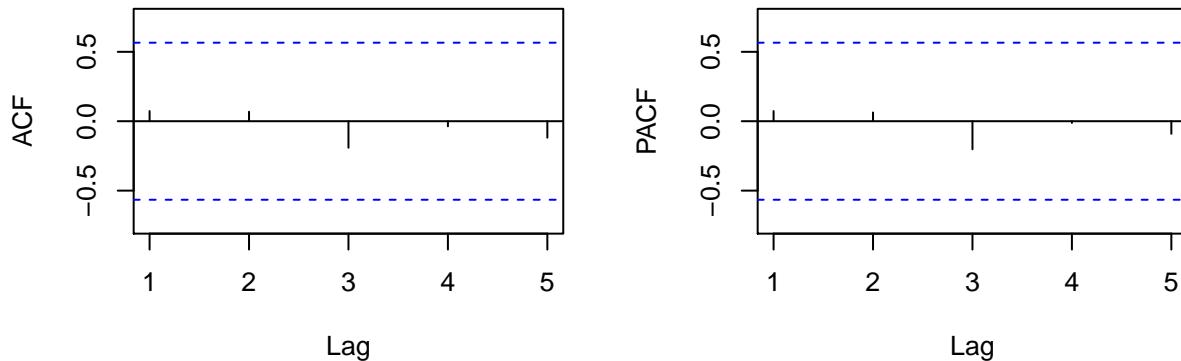
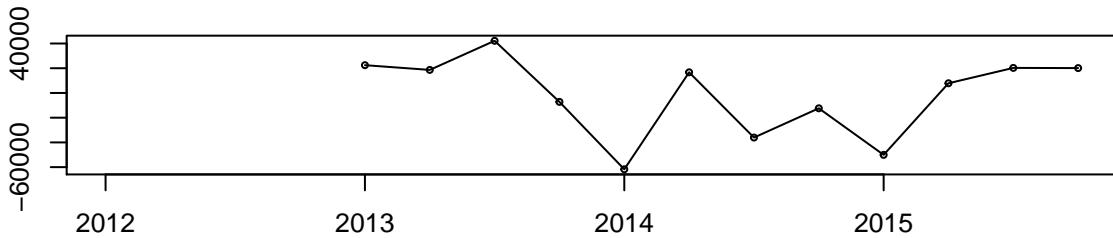
Portland, OR – Piedmont : Naive Model Forecast Residuals



Portland, OR – Piedmont : Holt Winters Model Forecast

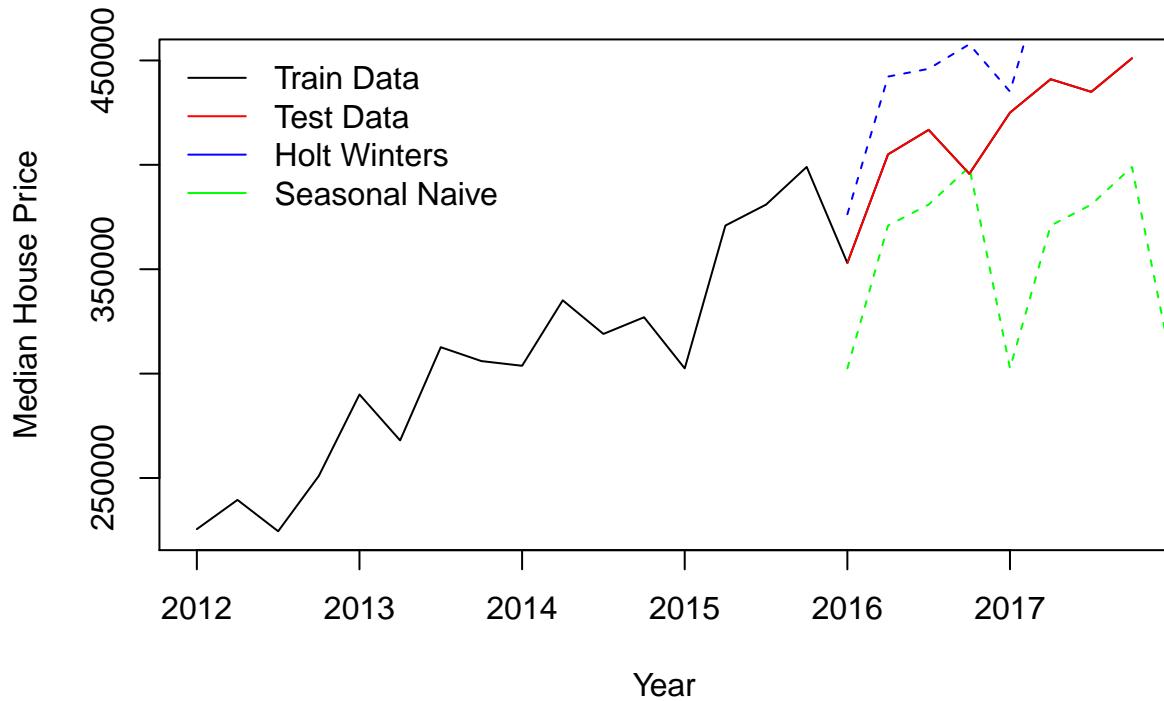


Portland, OR – Piedmont : Holt Winters Model Forecast Residuals

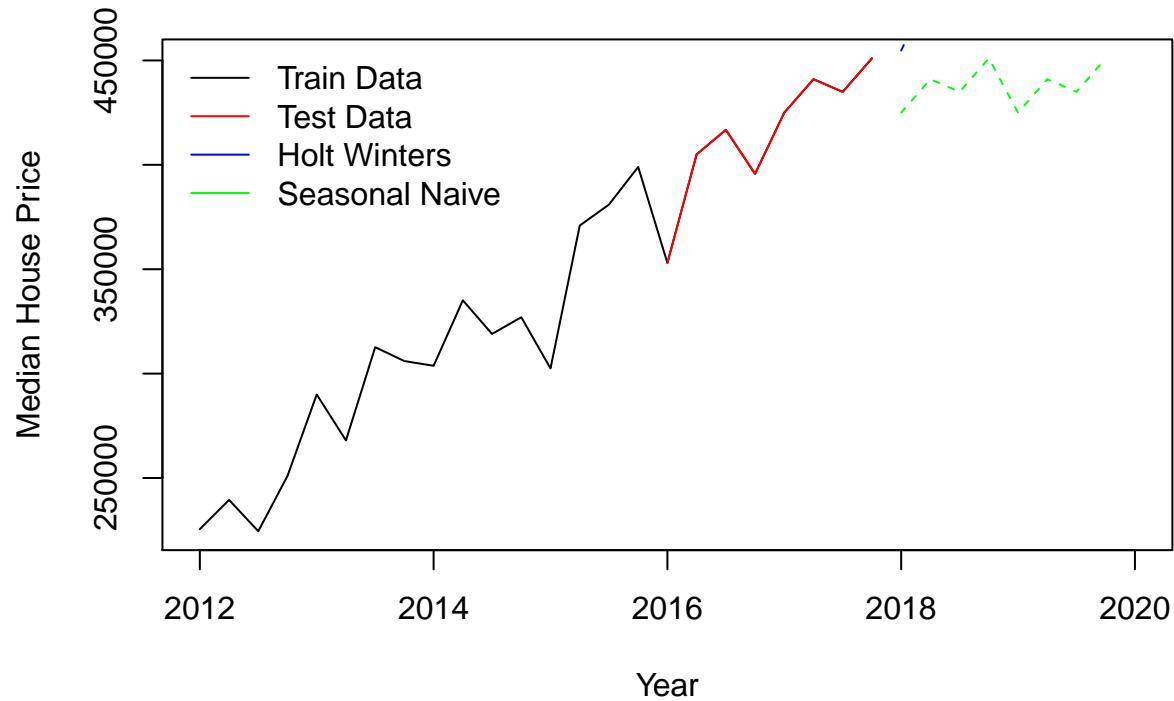


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Piedmont"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 42737.92 51027.84 42946.25 12.96288 13.03175 1.000000
## Test set     51960.00 61790.85 52787.50 12.39268 12.60181 1.229153
##          ACF1 Theil's U
## Training set 0.01430577      NA
## Test set     -0.15363958 2.247975
## [1] "Holt Winters Accuracy for Portland, OR – Piedmont"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set -1607.725 31113.84 26313.46 -0.7237608 8.33381 0.6127067
## Test set     -44660.952 49378.28 44660.95 -10.6326573 10.63266 1.0399267
##          ACF1 Theil's U
## Training set 0.07350622      NA
## Test set     -0.06207807 1.784695
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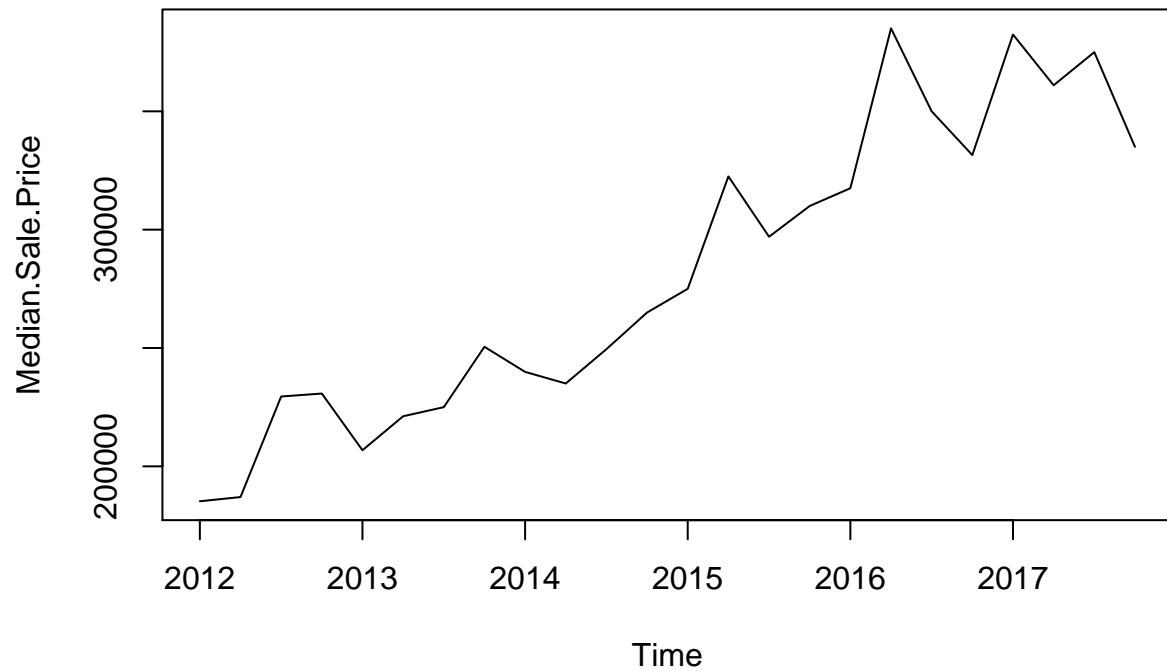
Portland, OR – Piedmont : TS Training Model Comparison



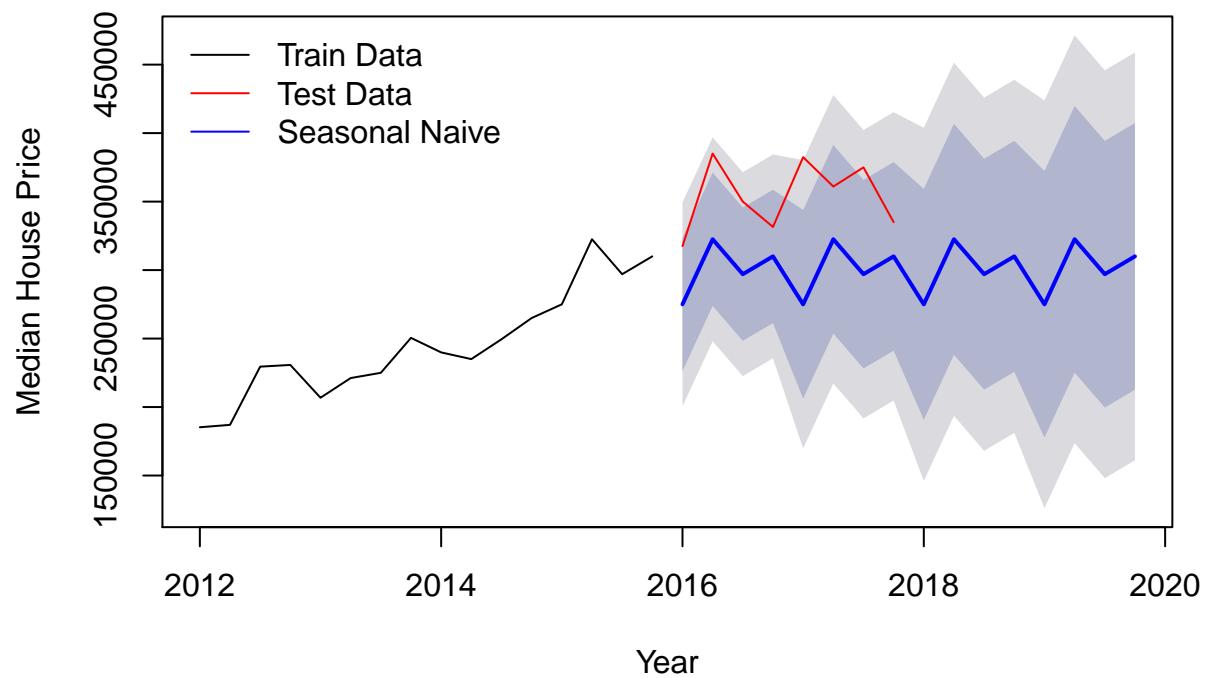
Portland, OR – Piedmont : Full TS Models Comparison



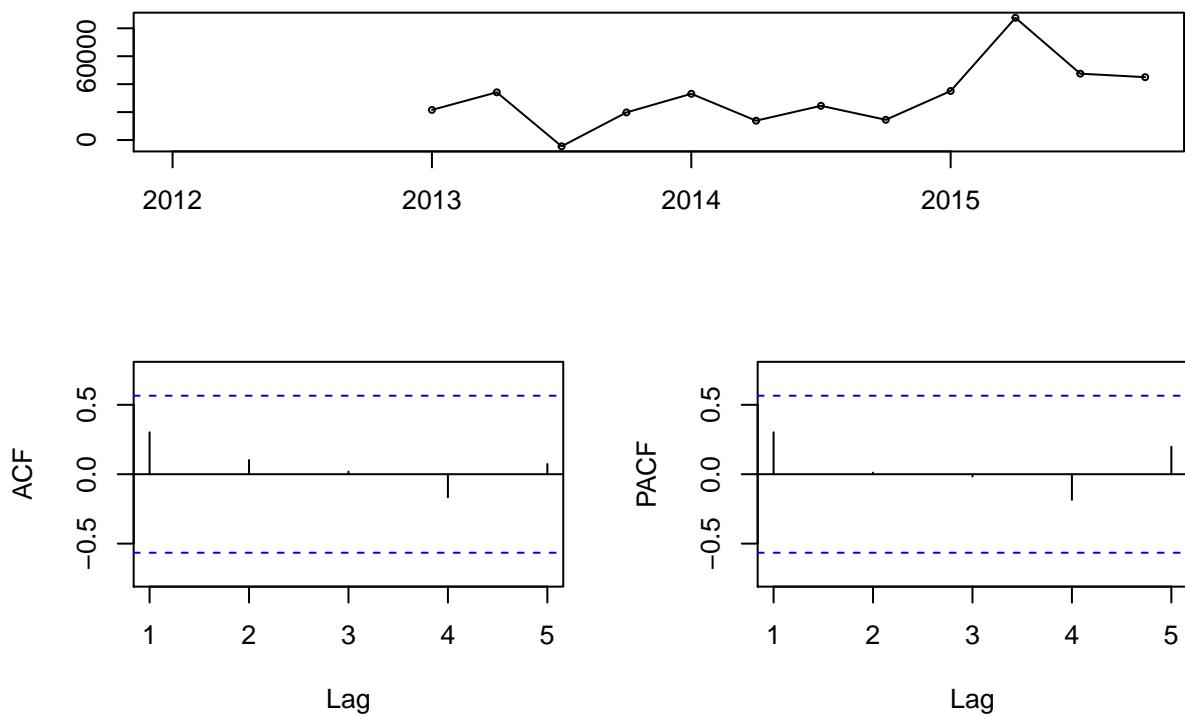
Portland, OR – Cully



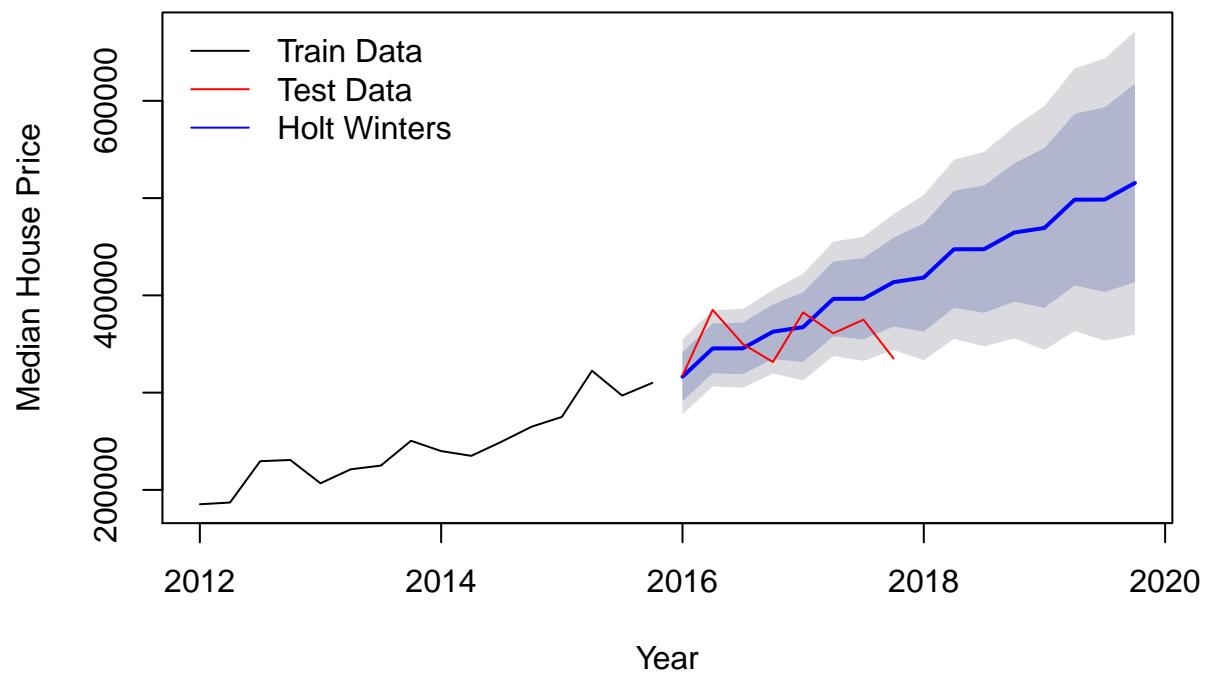
Portland, OR – Cully : Naive Model Forecast



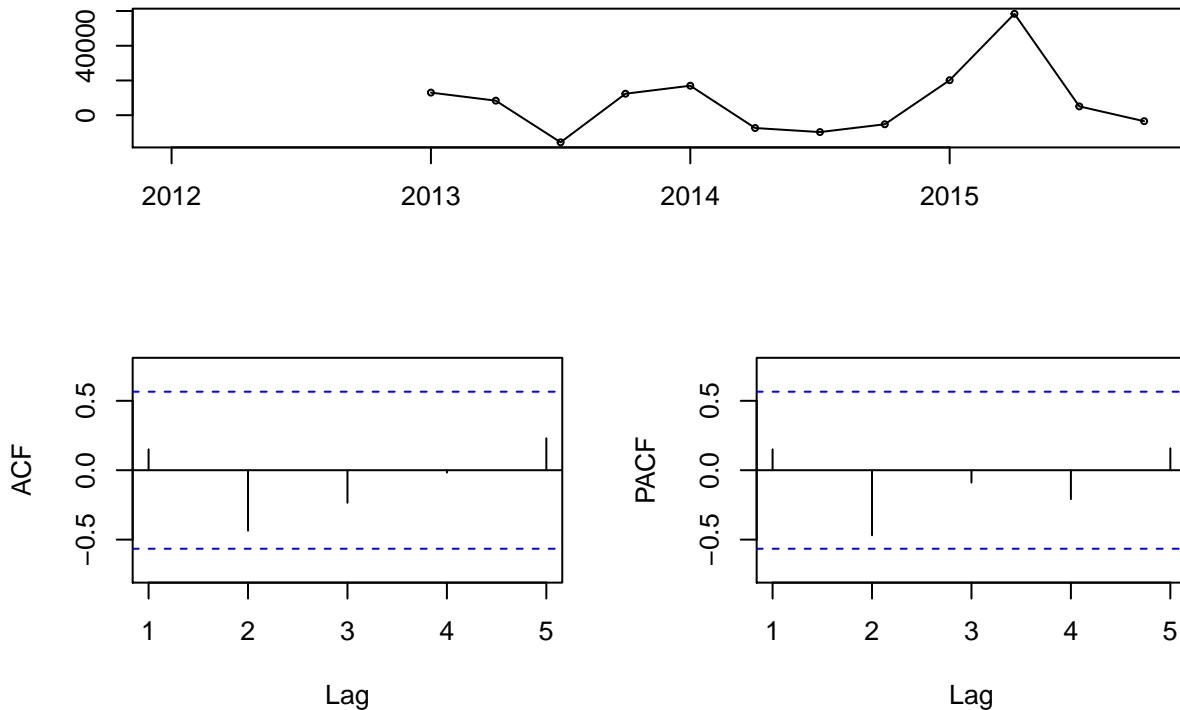
Portland, OR – Cully : Naive Model Forecast Residuals



Portland, OR – Cully : Holt Winters Model Forecast



Portland, OR – Cully : Holt Winters Model Forecast Residuals

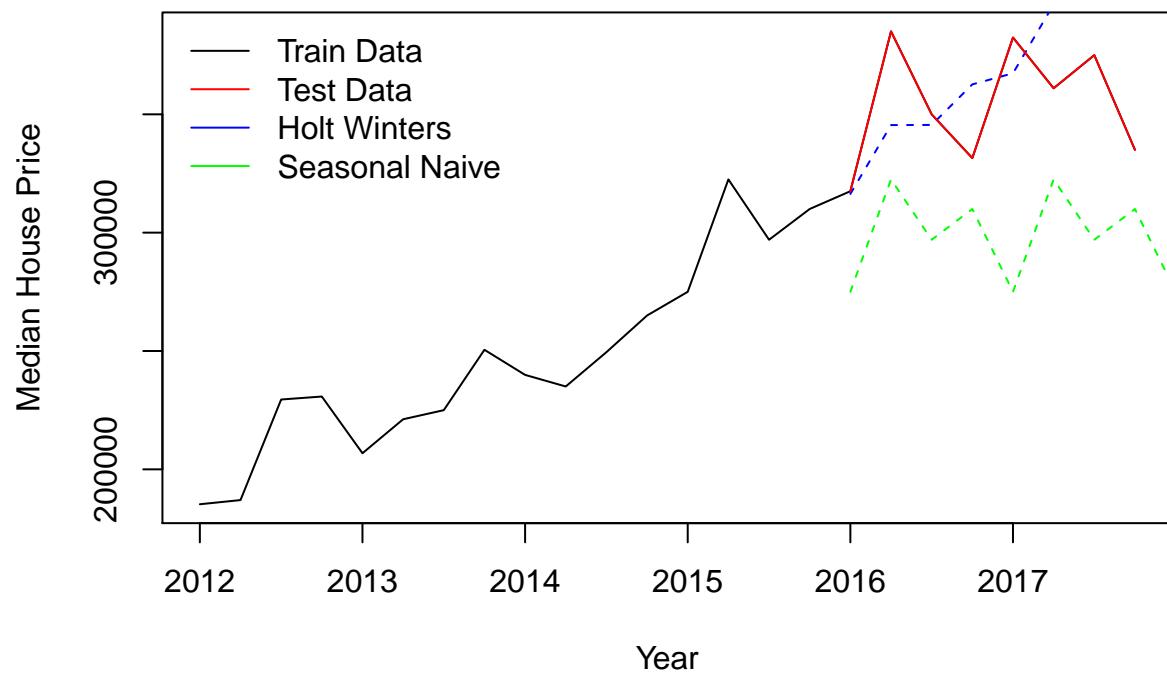


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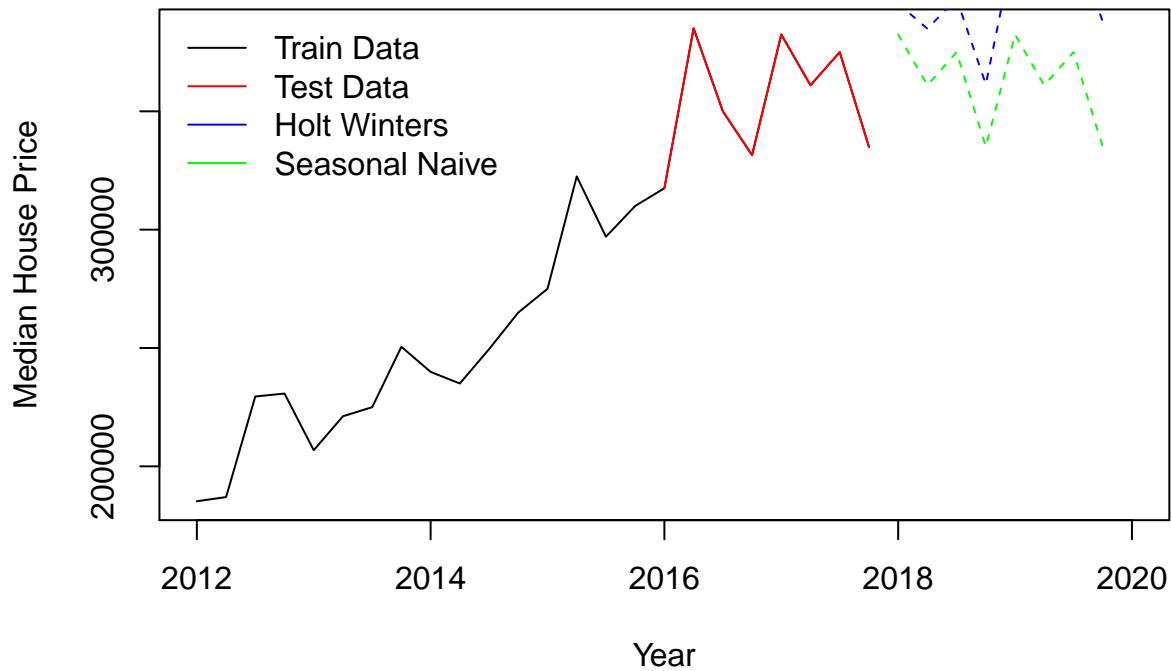
## [1] "Seasonal Naive Accuracy for Portland, OR - Cully"
##          ME      RMSE     MAE      MPE      MAPE      MASE      ACF1
## Training set 31000 37978.86 31750 11.42781 11.76114 1.000000  0.3018648
## Test set     53563 59924.18 53563 14.78532 14.78532 1.687024 -0.6392825
##          Theil's U
## Training set     NA
## Test set       1.540621
## [1] "Holt Winters Accuracy for Portland, OR - Cully"
##          ME      RMSE     MAE      MPE      MAPE      MASE
## Training set   7748.349 20316.68 14642.98  2.681883 5.523858 0.4611962
## Test set      -13296.661 36552.77 28380.73 -4.067529 8.036500 0.8938813
##          ACF1 Theil's U
## Training set 0.1503862        NA
## Test set     0.1043452 0.9230123

```

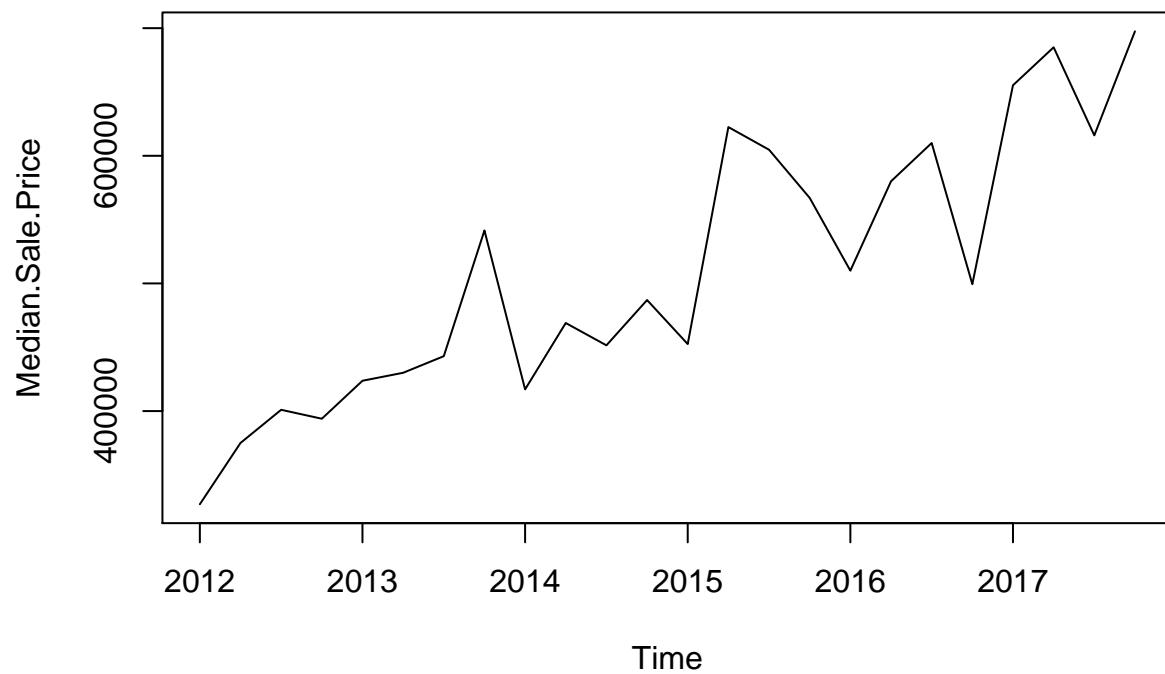
Portland, OR – Cully : TS Training Model Comparison



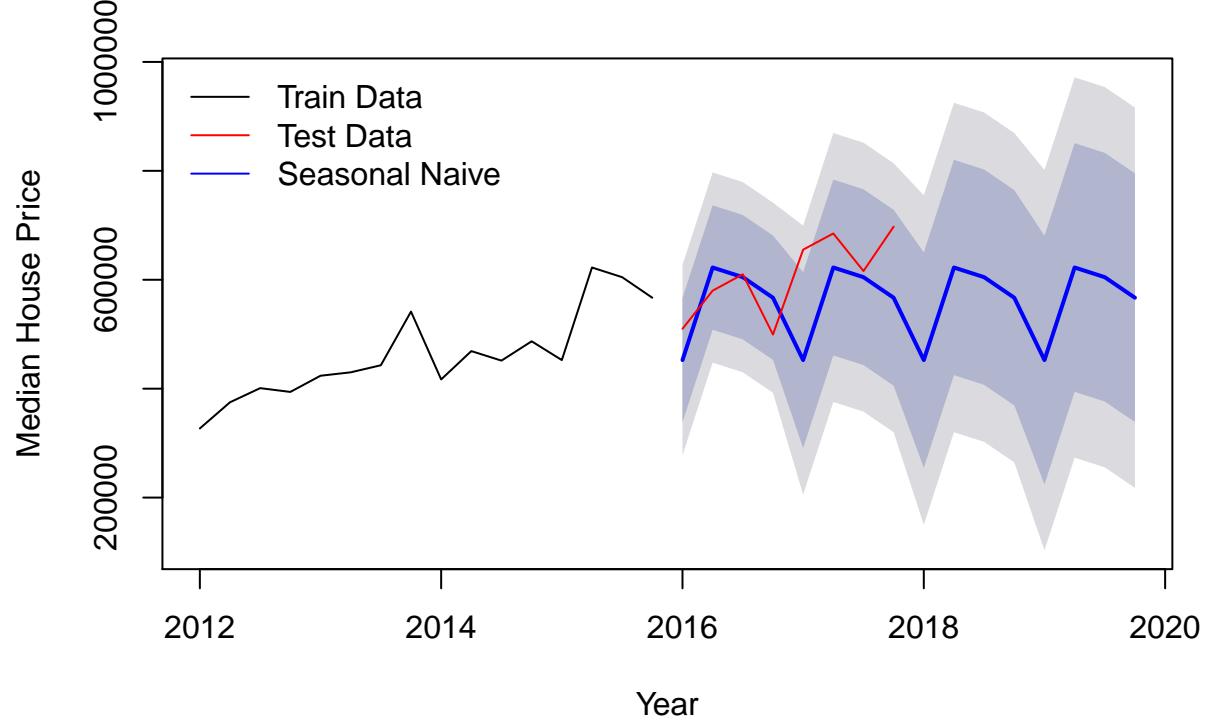
Portland, OR – Cully : Full TS Models Comparison



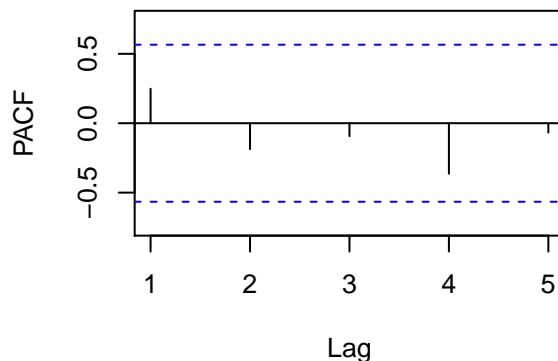
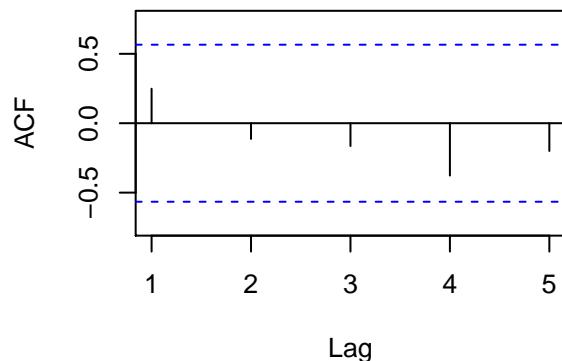
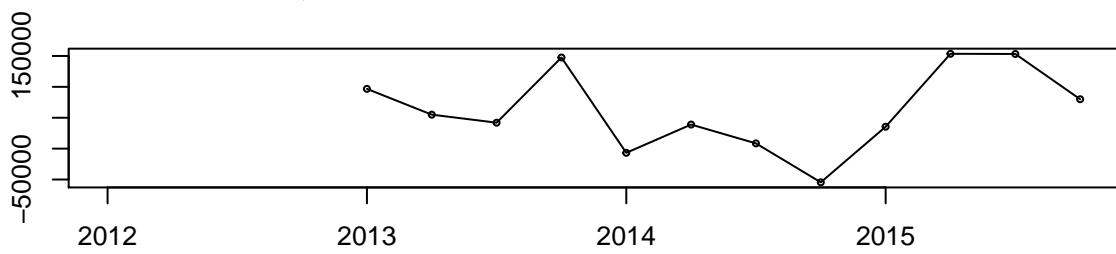
Portland, OR – Sabin



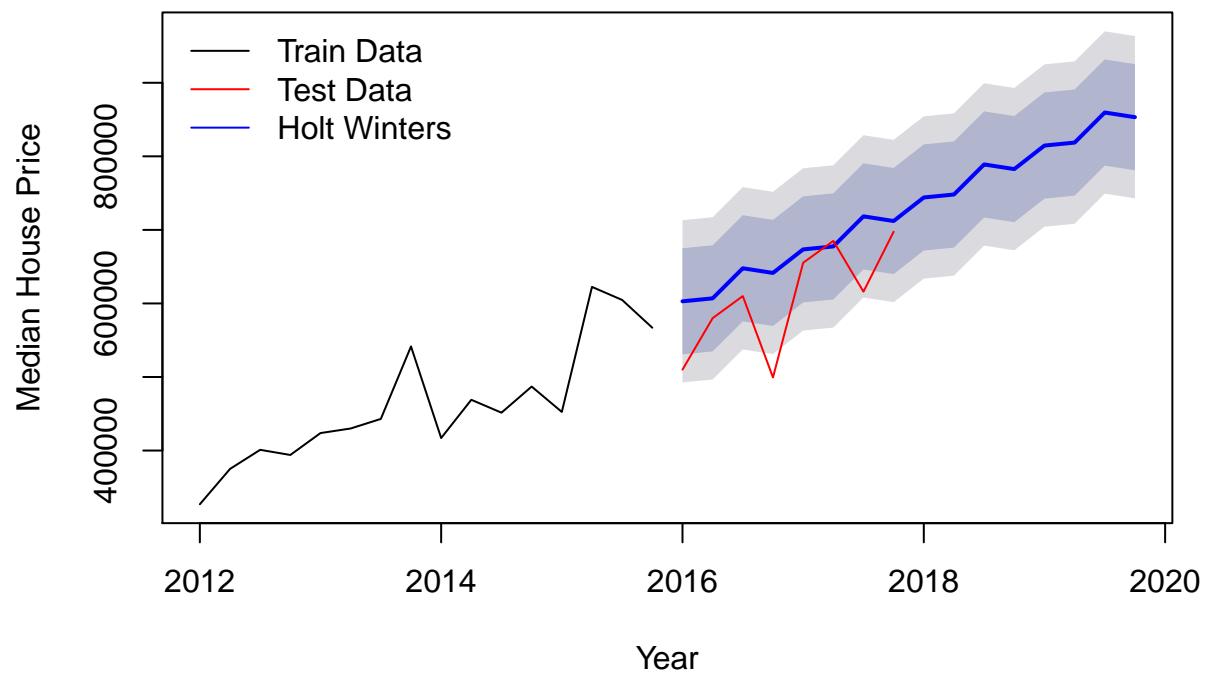
Portland, OR – Sabin : Naive Model Forecast



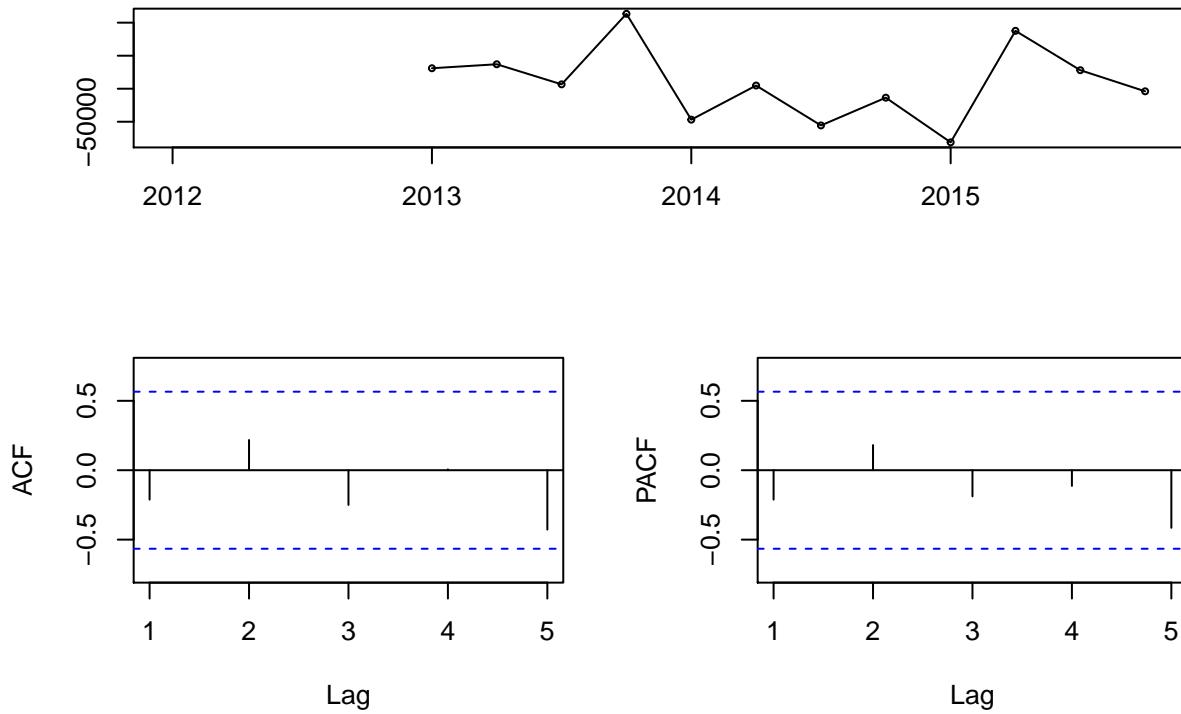
Portland, OR – Sabin : Naive Model Forecast Residuals



Portland, OR – Sabin : Holt Winters Model Forecast



Portland, OR – Sabin : Holt Winters Model Forecast Residuals

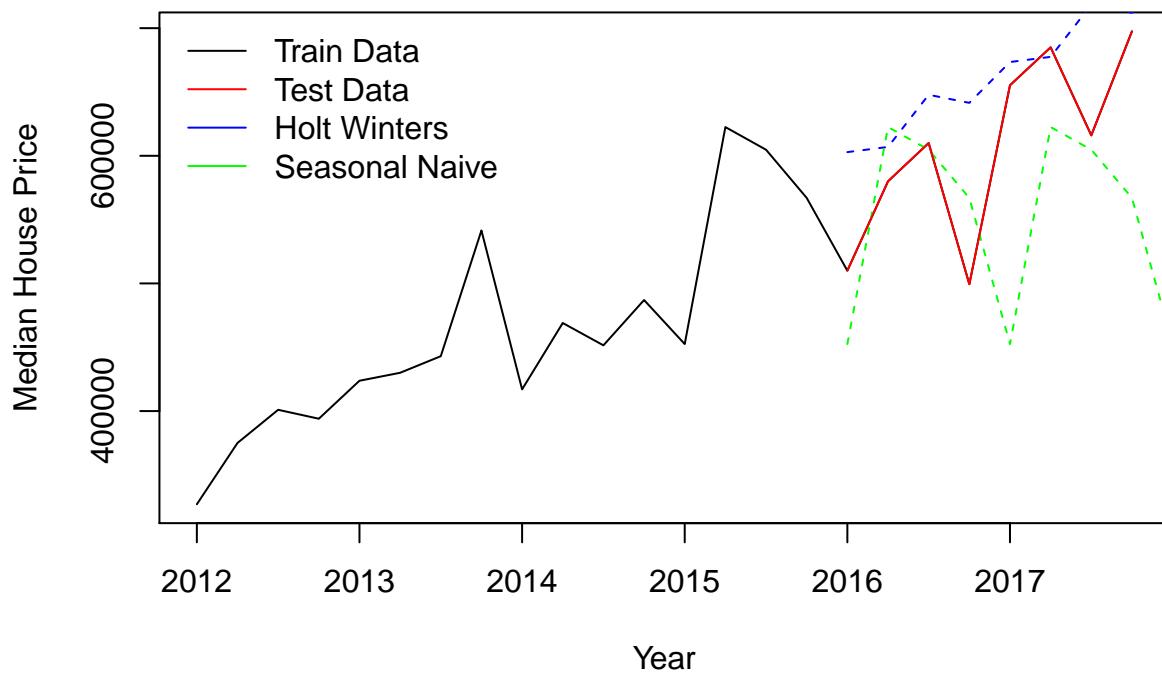


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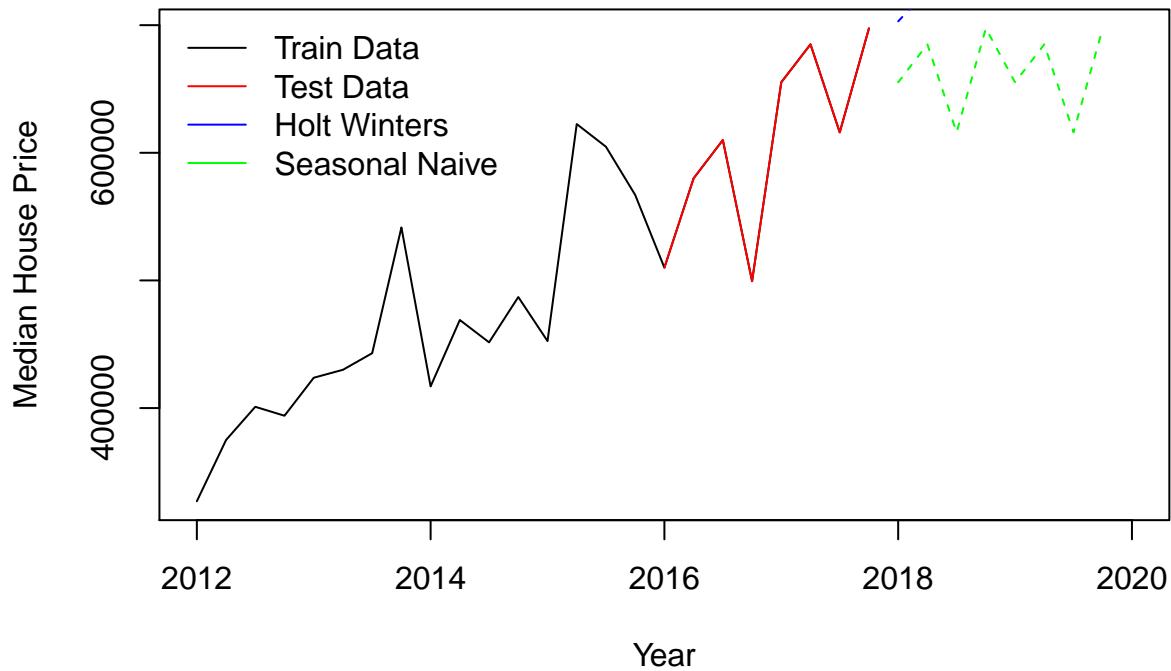
## [1] "Seasonal Naive Accuracy for Portland, OR - Sabin"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 62479.17 89079.99 72687.50 11.807114 13.94206 1.0000000
## Test set     44956.25 94789.53 72481.25  6.484223 11.70018 0.9971625
##          ACF1 Theil's U
## Training set 0.2486564      NA
## Test set     -0.2086152 1.146063
## [1] "Holt Winters Accuracy for Portland, OR - Sabin"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 8942.206 54623.74 42472.67 1.092780 8.58954 0.5843188
## Test set     -53421.776 72499.49 55292.39 -9.737297 10.01038 0.7606864
##          ACF1 Theil's U
## Training set -0.2117657      NA
## Test set     -0.4099504 0.6869396

```

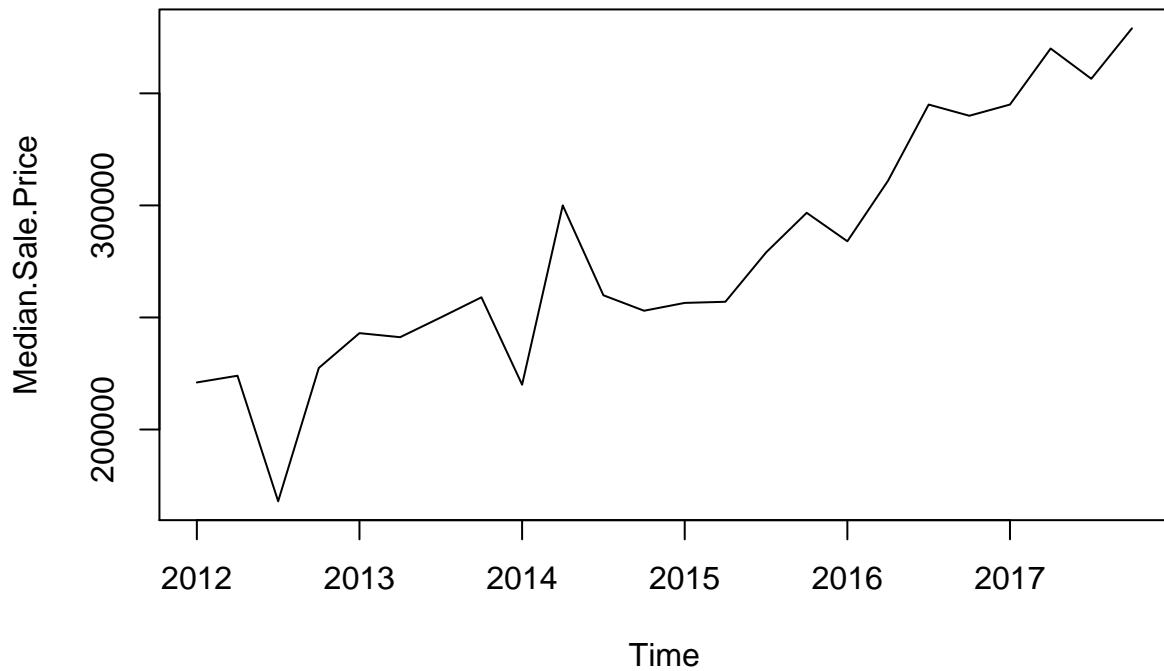
Portland, OR – Sabin : TS Training Model Comparison



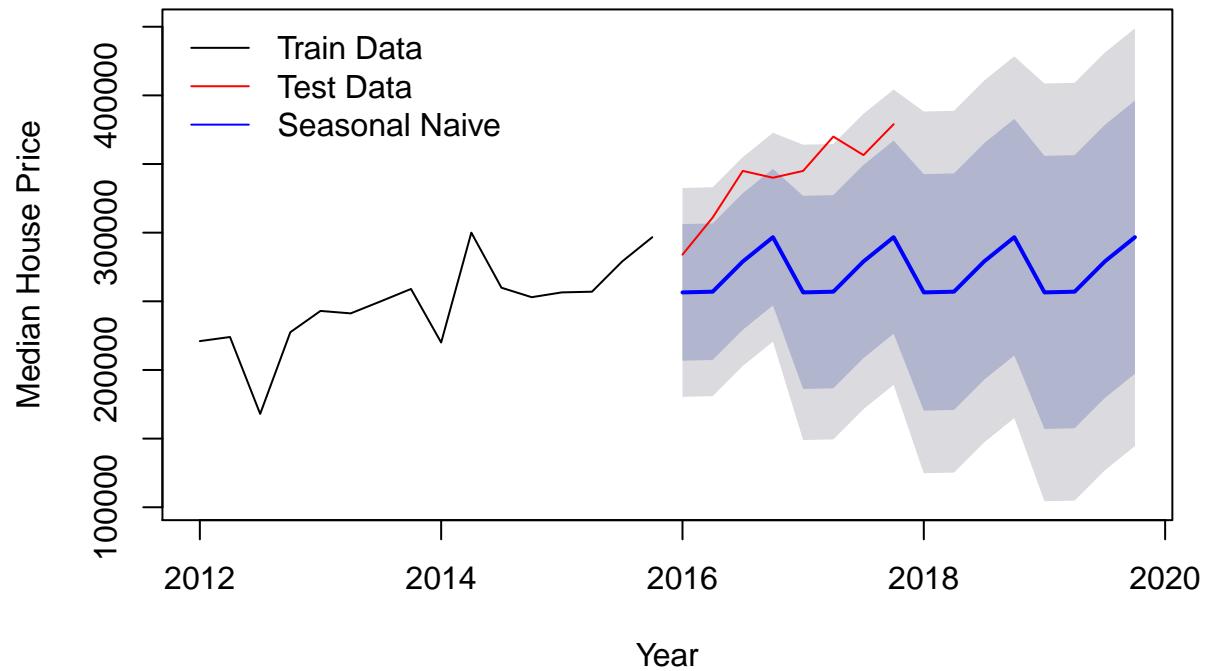
Portland, OR – Sabin : Full TS Models Comparison



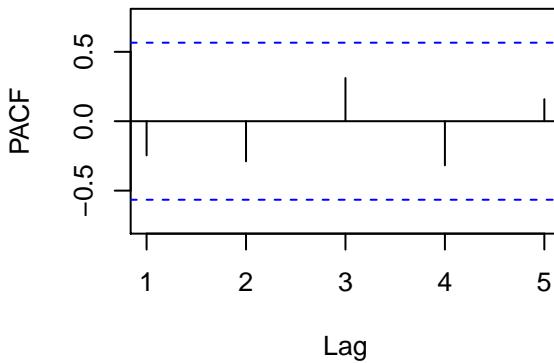
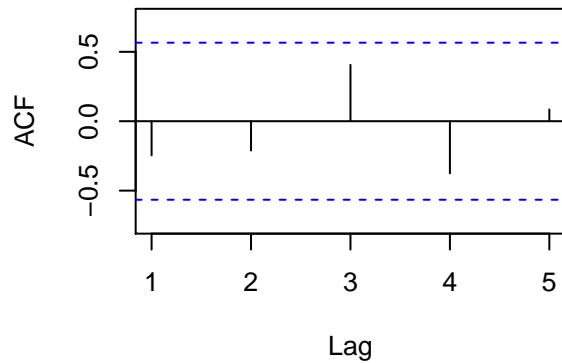
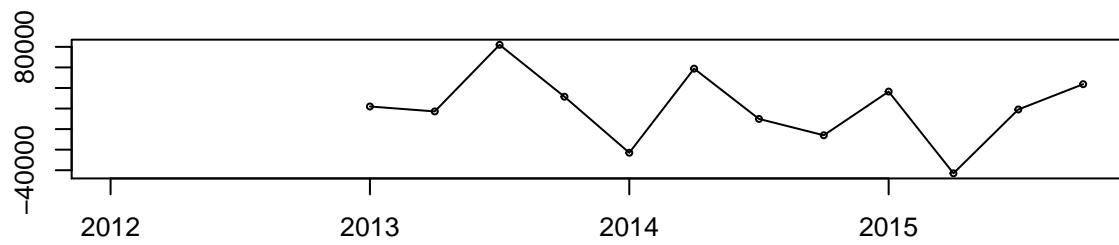
Portland, OR – Argay



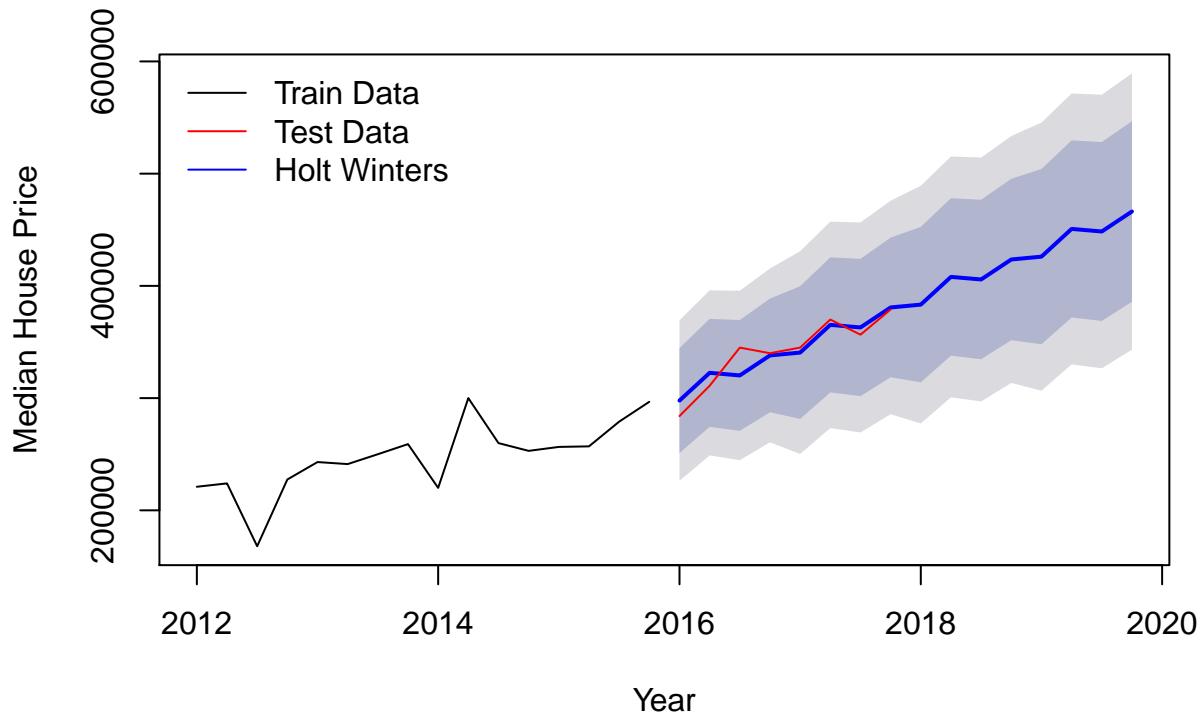
Portland, OR – Argay : Naive Model Forecast



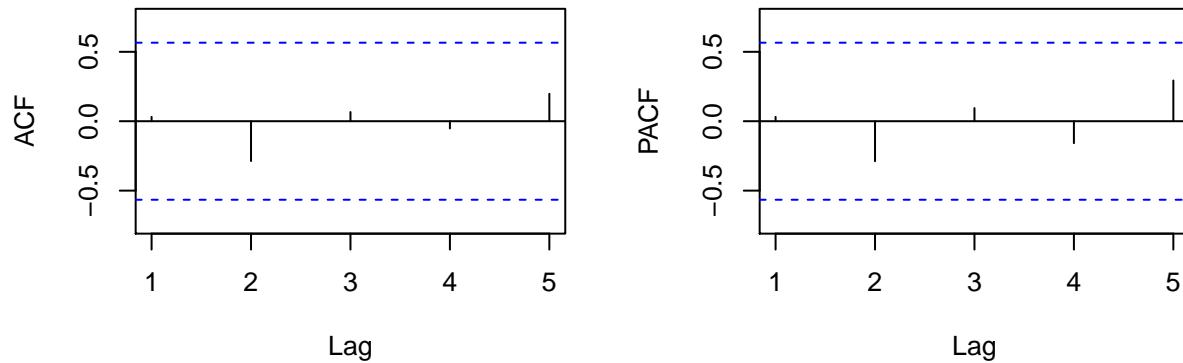
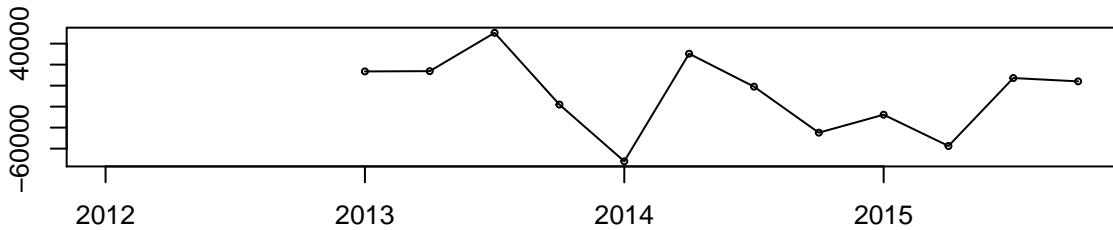
Portland, OR – Argay : Naive Model Forecast Residuals



Portland, OR – Argay : Holt Winters Model Forecast

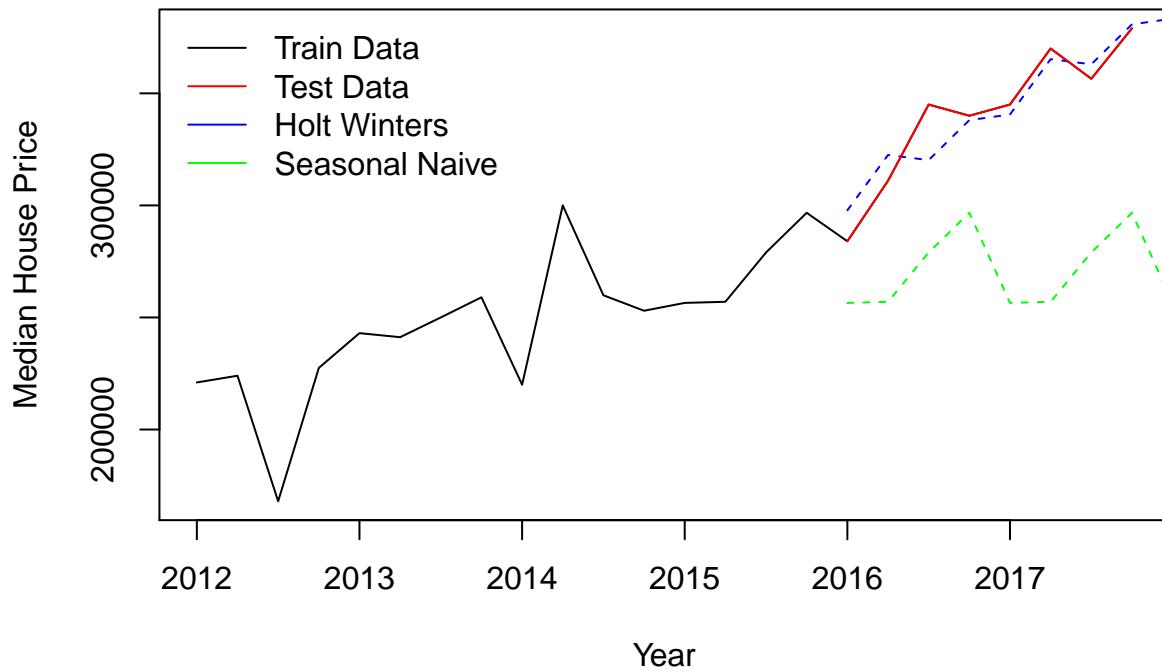


Portland, OR – Argay : Holt Winters Model Forecast Residuals

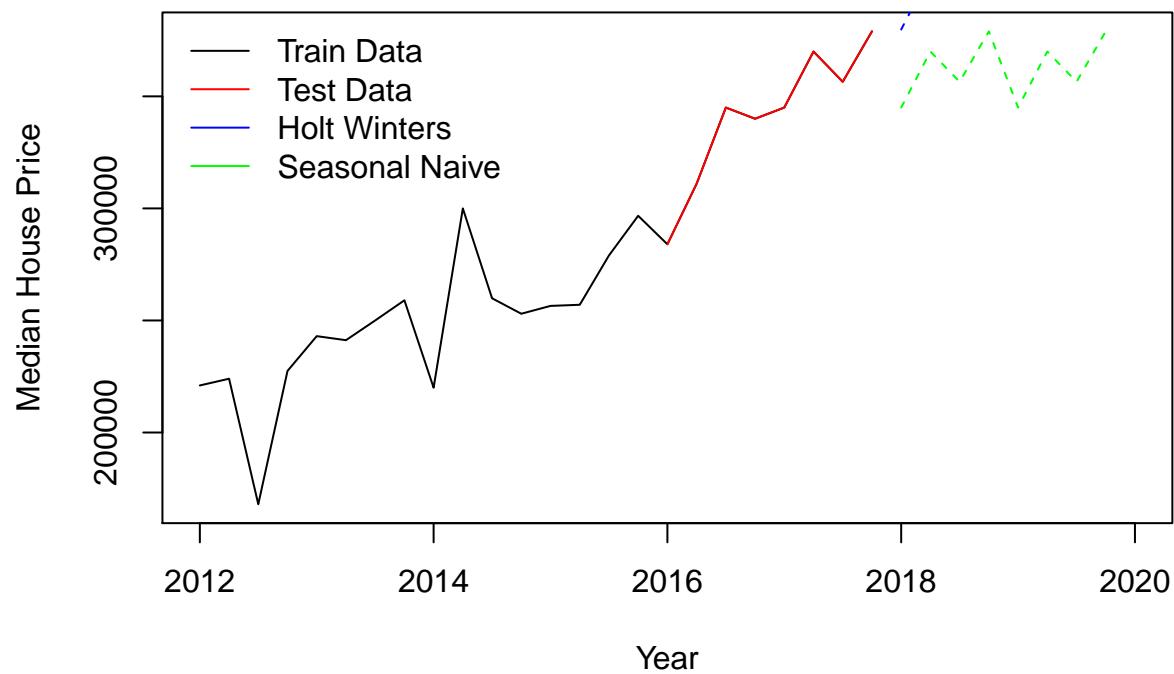


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Argay"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 20727.08 38809.22 32727.08 7.567705 12.49397 1.000000
## Test set     69012.50 73556.04 69012.50 19.819882 19.81988 2.108727
##          ACF1 Theil's U
## Training set -0.2460979      NA
## Test set      0.3064660 3.397373
## [1] "Holt Winters Accuracy for Portland, OR - Argay"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -8481.6944 35940.72 28368.09 -3.79040328 11.373948 0.8668078
## Test set      299.3892 11341.01  8687.50 -0.06349478  2.647251 0.2654529
##          ACF1 Theil's U
## Training set  0.03126357      NA
## Test set      -0.07053527 0.5221819
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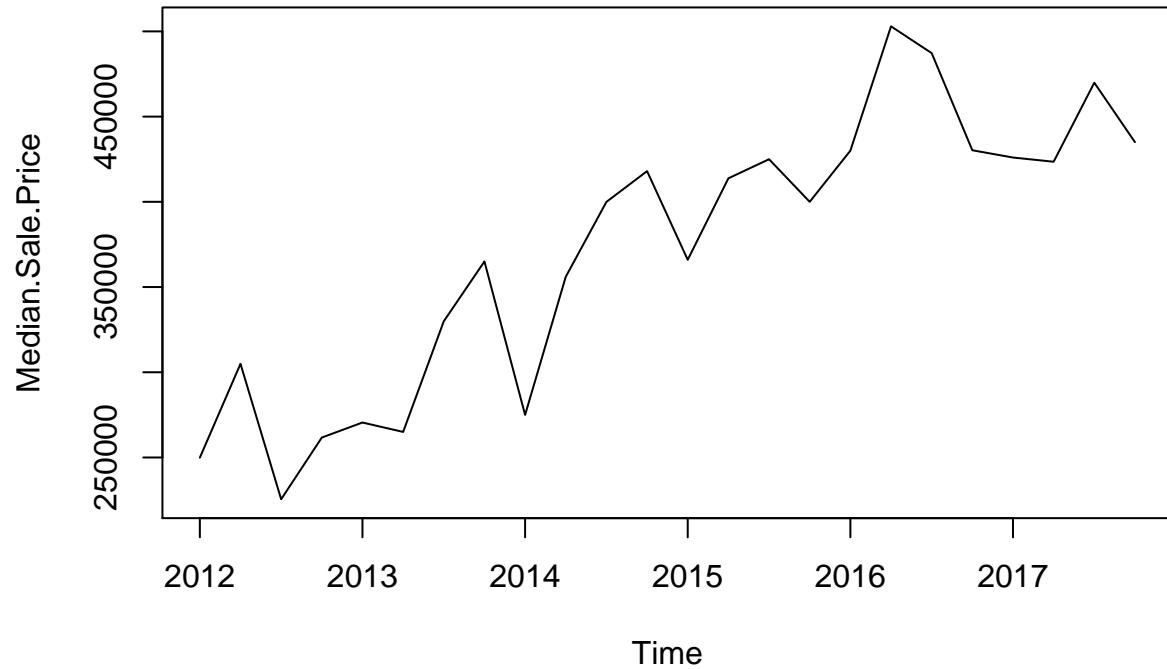
Portland, OR – Argay : TS Training Model Comparison



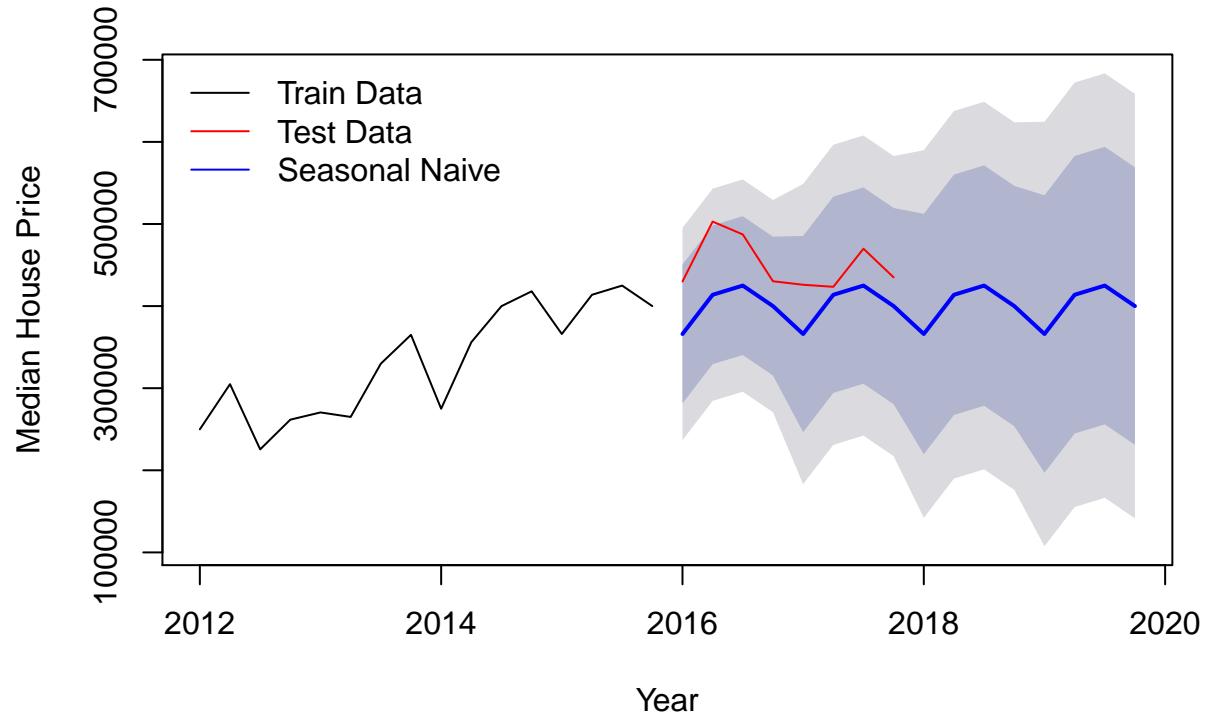
Portland, OR – Argay : Full TS Models Comparison



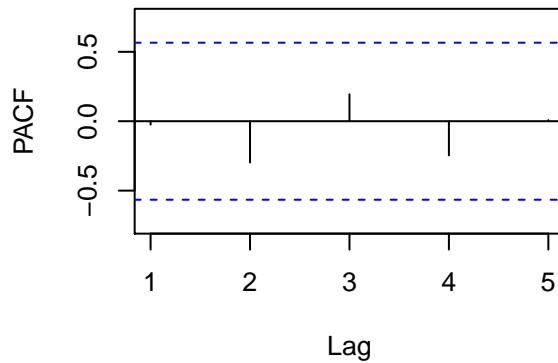
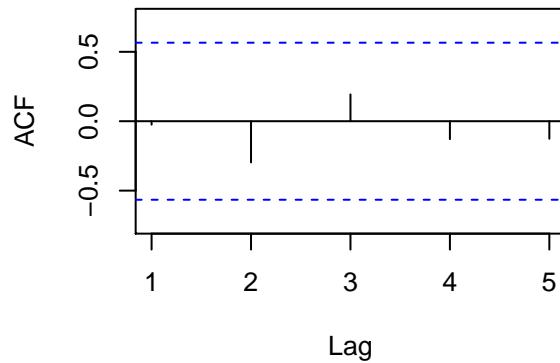
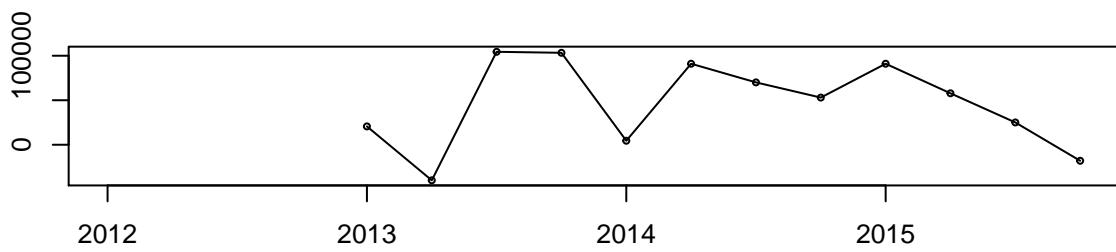
Portland, OR – Brooklyn



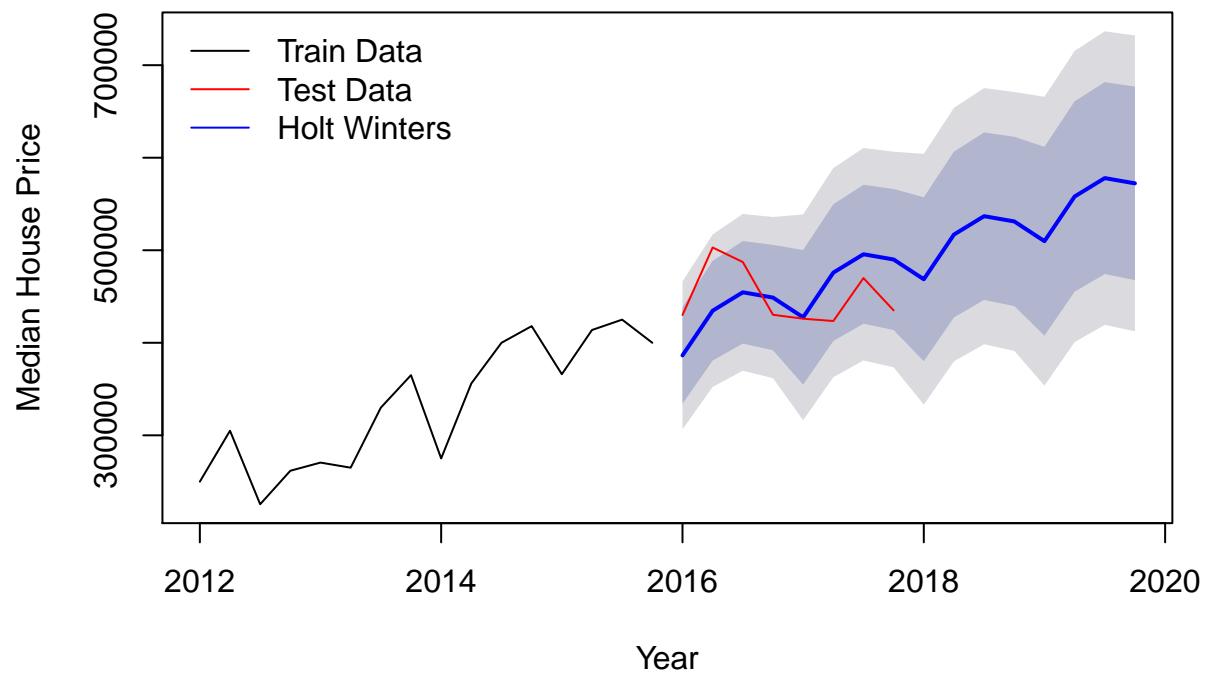
Portland, OR – Brooklyn : Naive Model Forecast



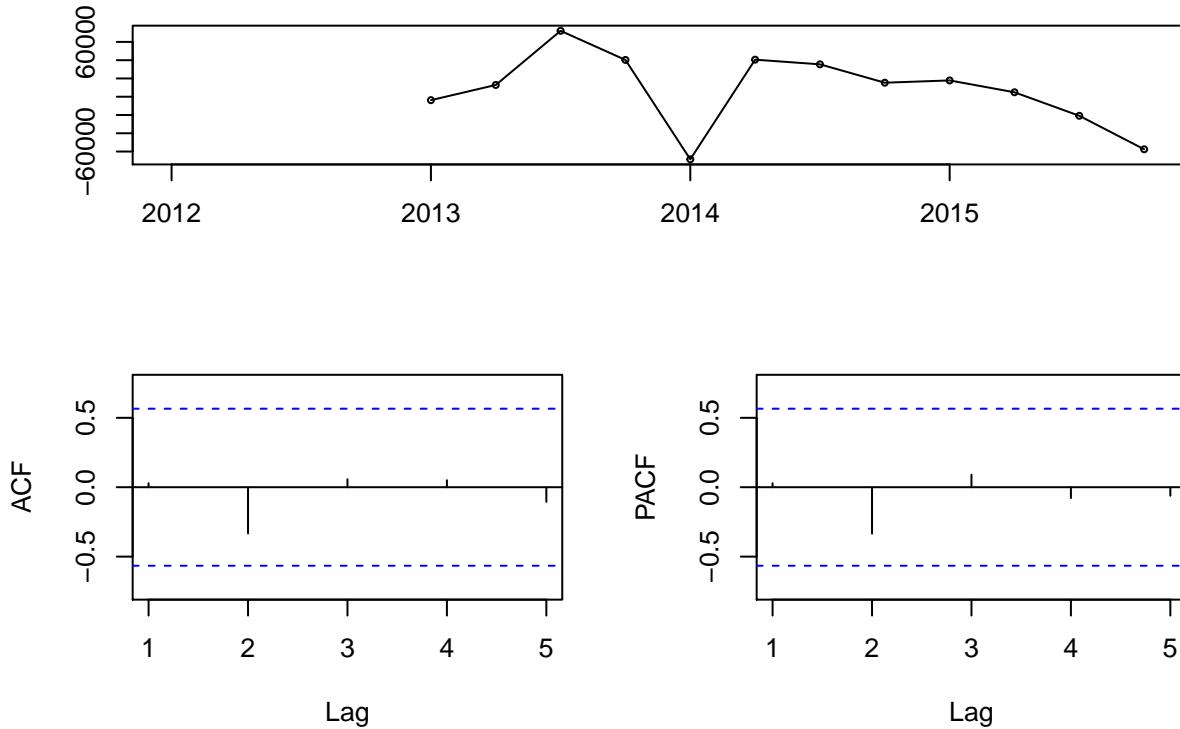
Portland, OR – Brooklyn : Naive Model Forecast Residuals



Portland, OR – Brooklyn : Holt Winters Model Forecast

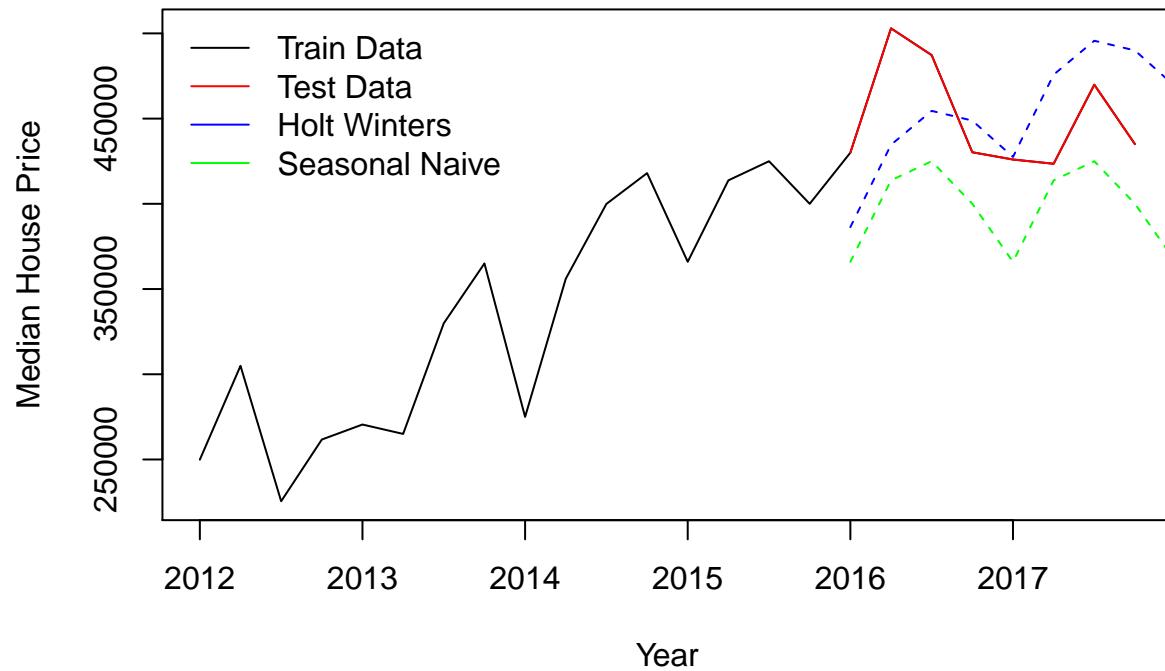


Portland, OR – Brooklyn : Holt Winters Model Forecast Residuals

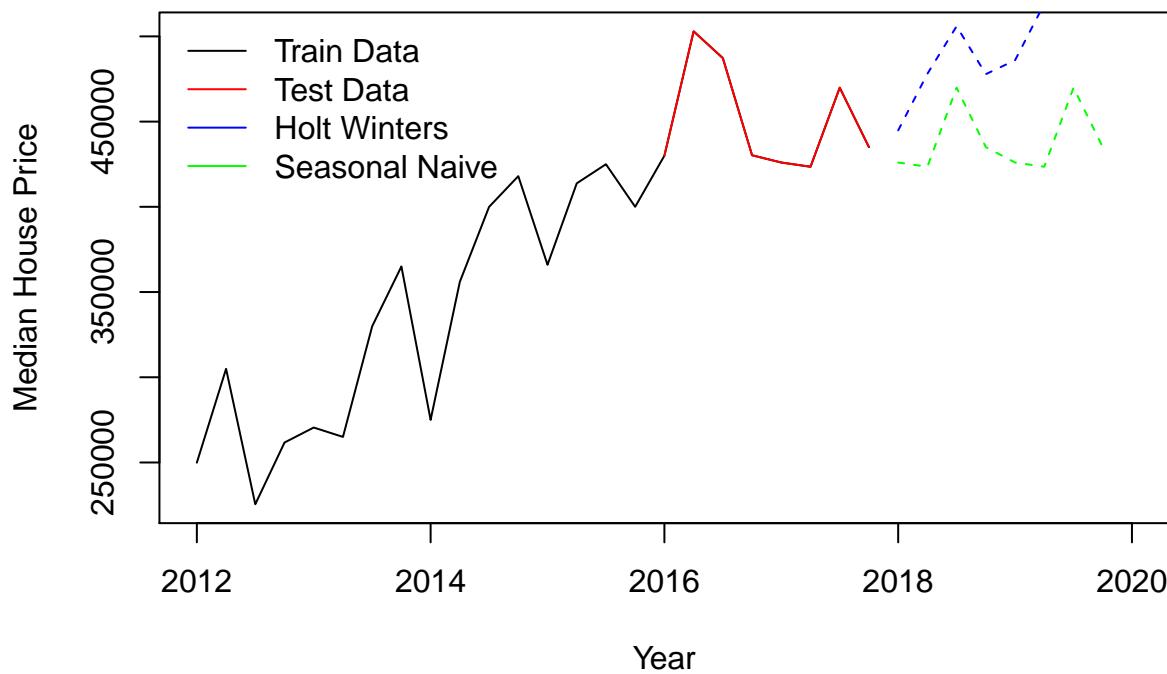


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Brooklyn"
##          ME      RMSE       MAE       MPE       MAPE       MASE
## Training set 46894.17 65941.2 56552.50 12.50843 15.77100 1.0000000
## Test set     49411.25 54512.5 49411.25 10.80007 10.80007 0.8737235
##          ACF1 Theil's U
## Training set -0.0246646      NA
## Test set     0.1097283 1.272546
## [1] "Holt Winters Accuracy for Portland, OR - Brooklyn"
##          ME      RMSE       MAE       MPE       MAPE       MASE
## Training set 7393.020 39719.67 32508.24 1.8459255 9.446022 0.5748330
## Test set     -1053.809 42441.04 37223.76 -0.5862926 8.198339 0.6582159
##          ACF1 Theil's U
## Training set 0.02881536      NA
## Test set     0.51946203 1.018626
```

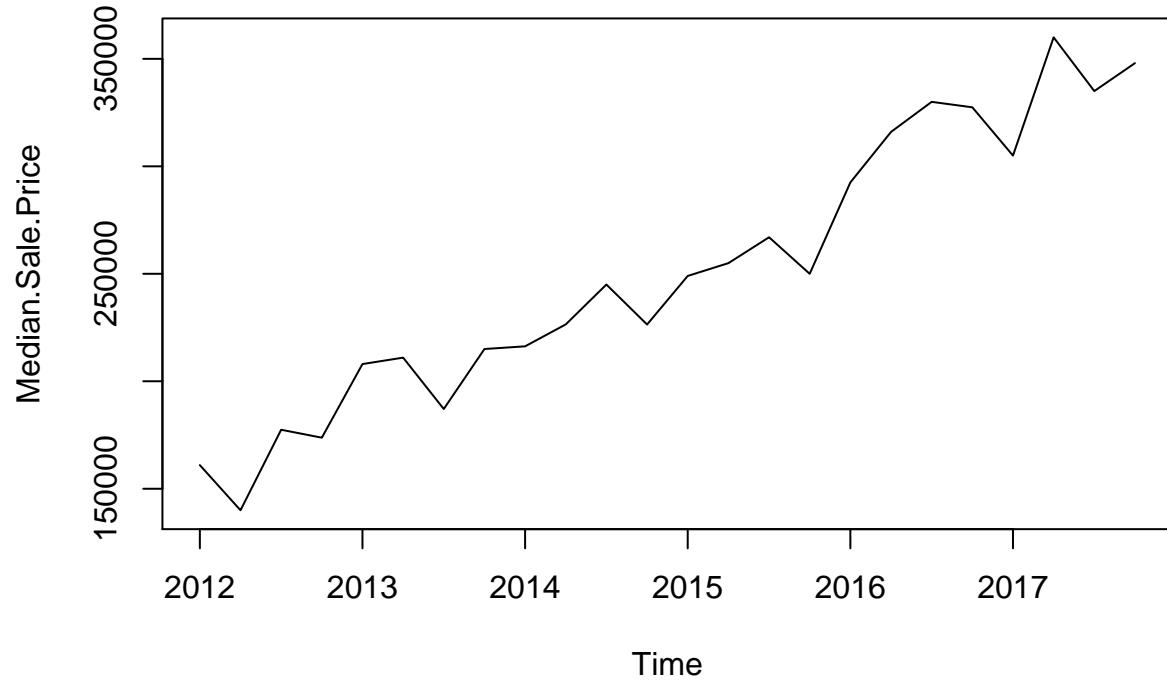
Portland, OR – Brooklyn : TS Training Model Comparison



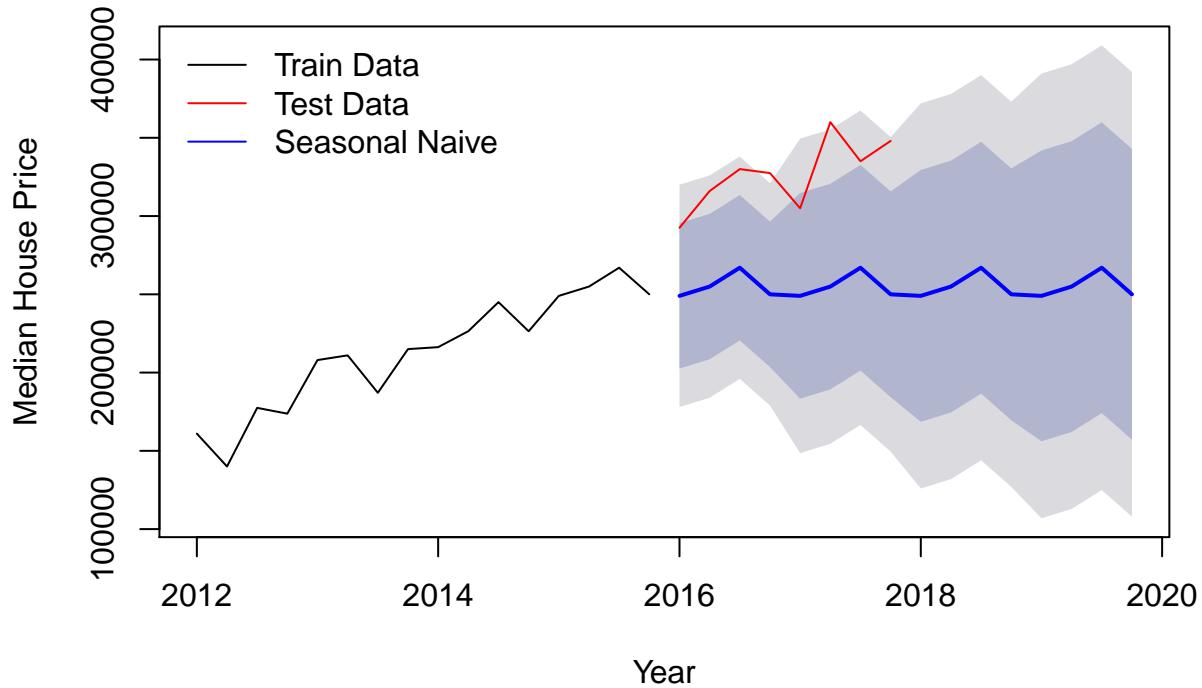
Portland, OR – Brooklyn : Full TS Models Comparison



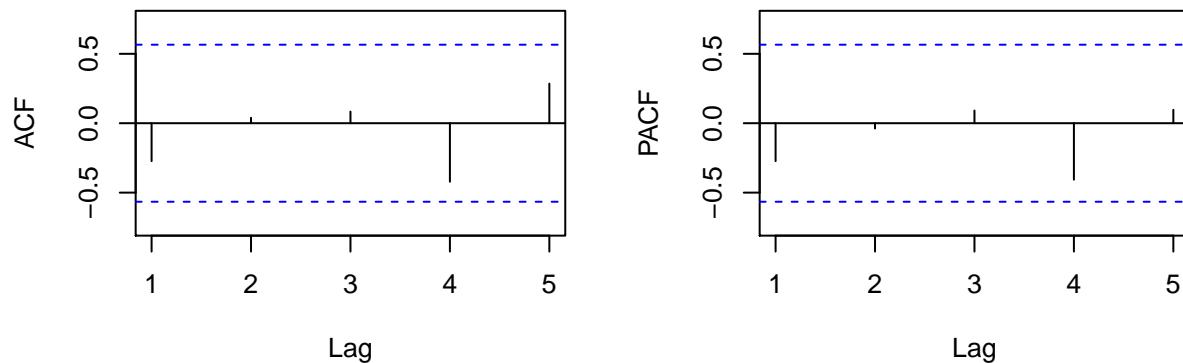
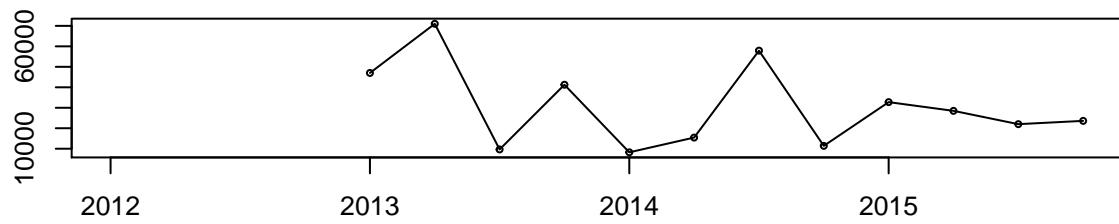
Portland, OR – Madison South



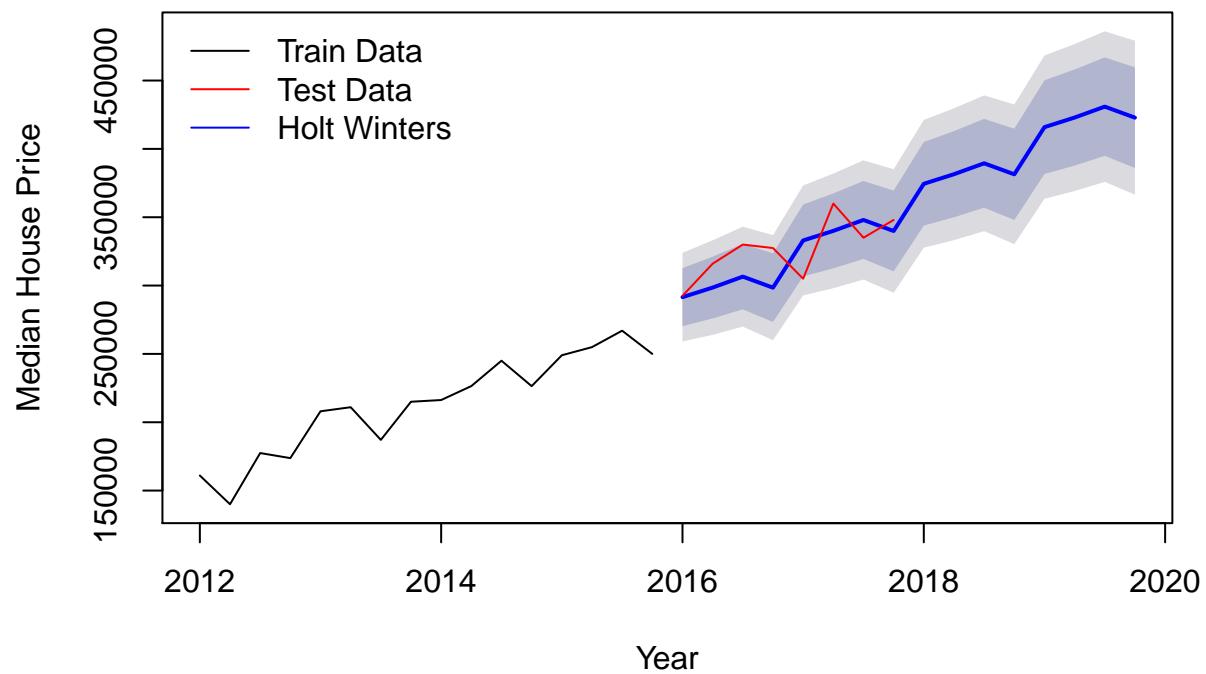
Portland, OR – Madison South : Naive Model Forecast



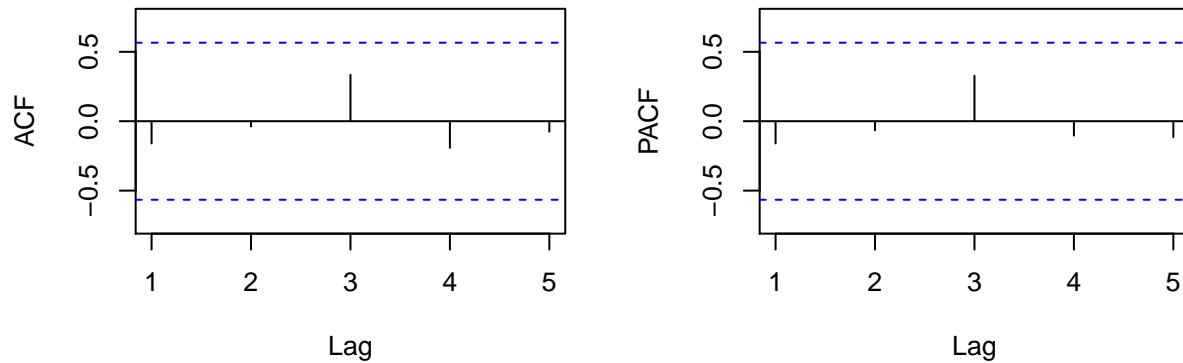
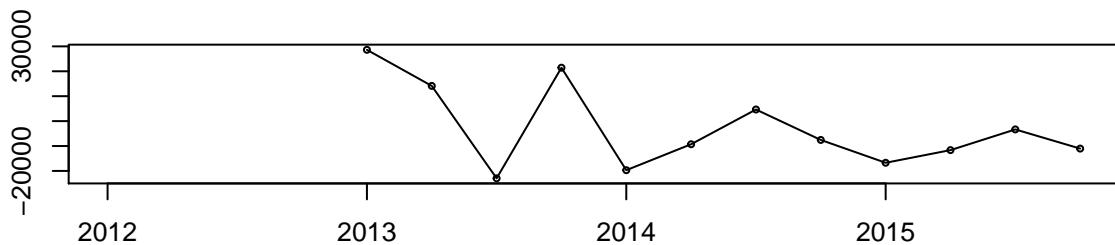
Portland, OR – Madison South : Naive Model Forecast Residuals



Portland, OR – Madison South : Holt Winters Model Forecast

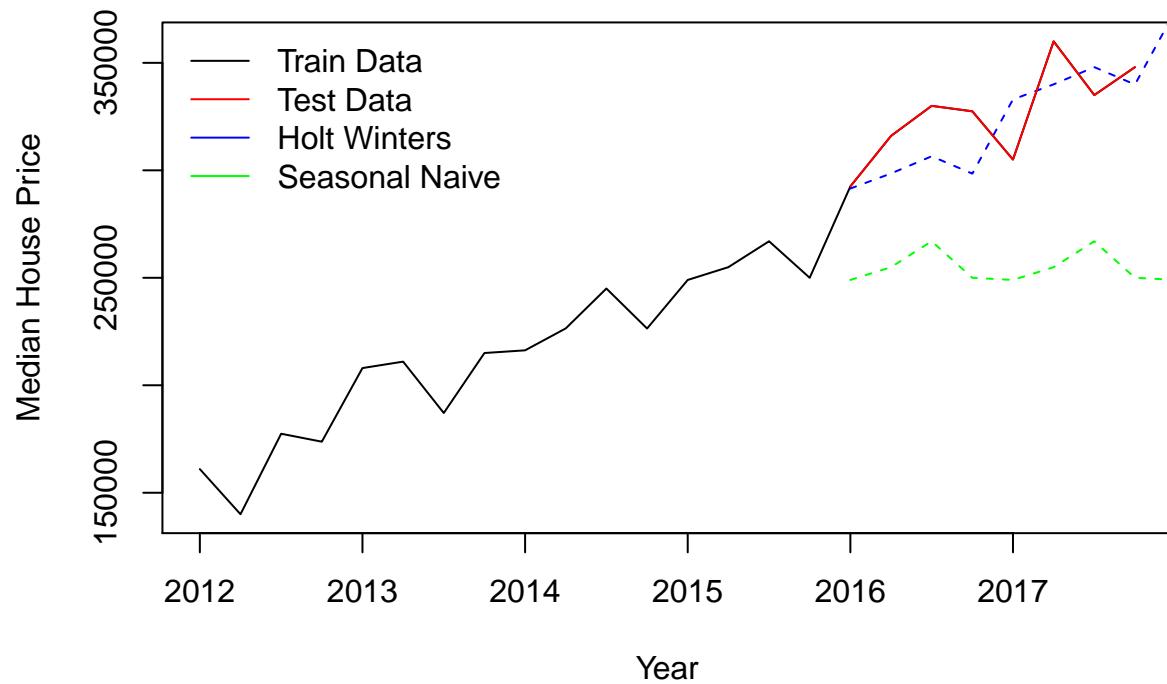


Portland, OR – Madison South : Holt Winters Model Forecast Residuals

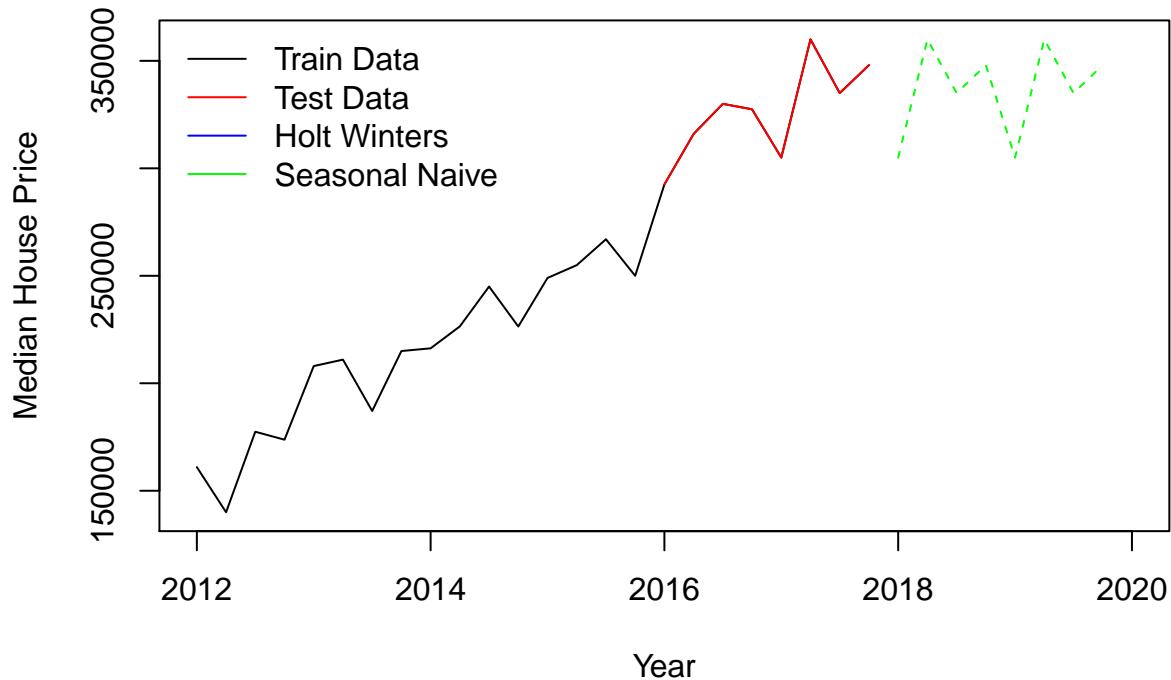


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Madison South"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 30729.17 36239.47 30729.17 13.49215 13.49215 1.000000
## Test set     71506.25 74150.49 71506.25 21.61693 21.61693 2.326983
##          ACF1 Theil's U
## Training set -0.2733959      NA
## Test set     -0.1595429  2.798817
## [1] "Holt Winters Accuracy for Portland, OR - Madison South"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set -2785.929 16091.44 14259.04 -1.121134 6.508674 0.4640229
## Test set     7250.511 19734.30 17498.38  2.081203 5.345716 0.5694388
##          ACF1 Theil's U
## Training set -0.1602294      NA
## Test set     -0.3847590  0.7631282
```

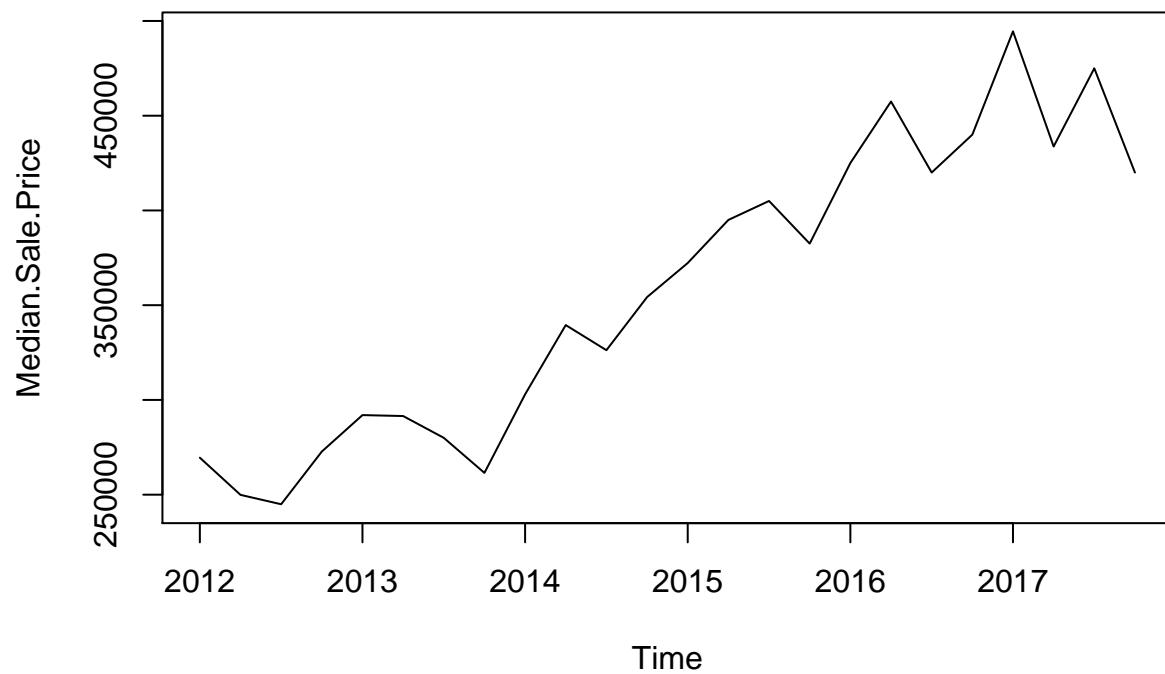
Portland, OR – Madison South : TS Training Model Comparison



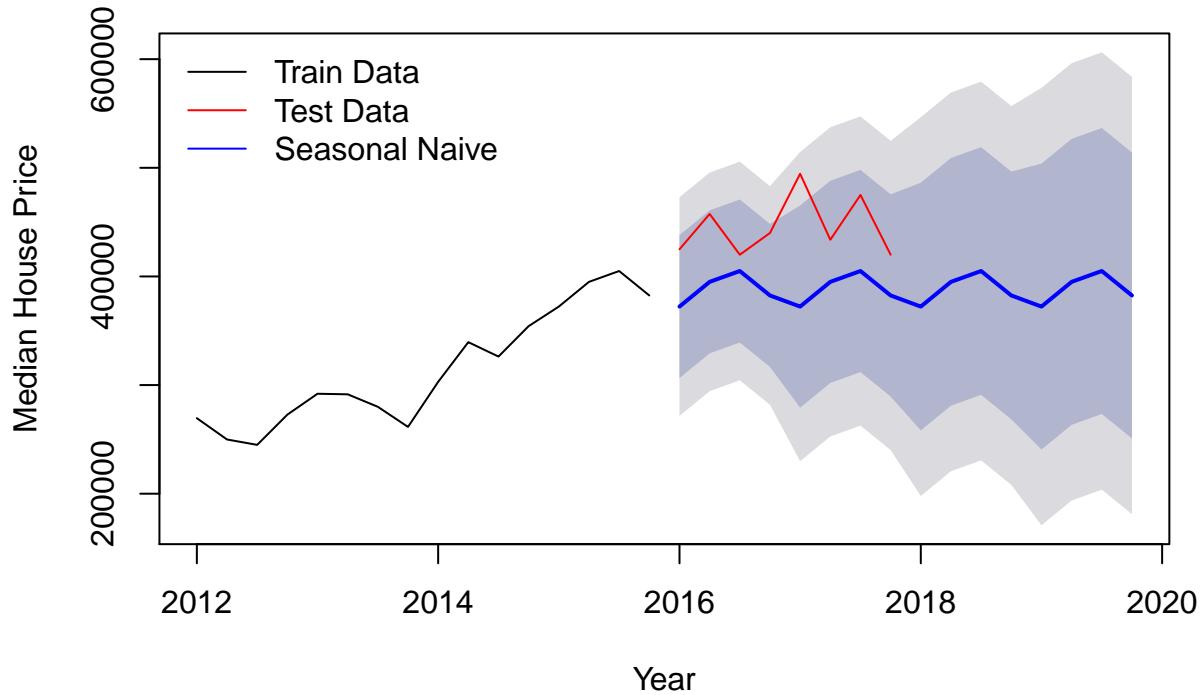
Portland, OR – Madison South : Full TS Models Comparison



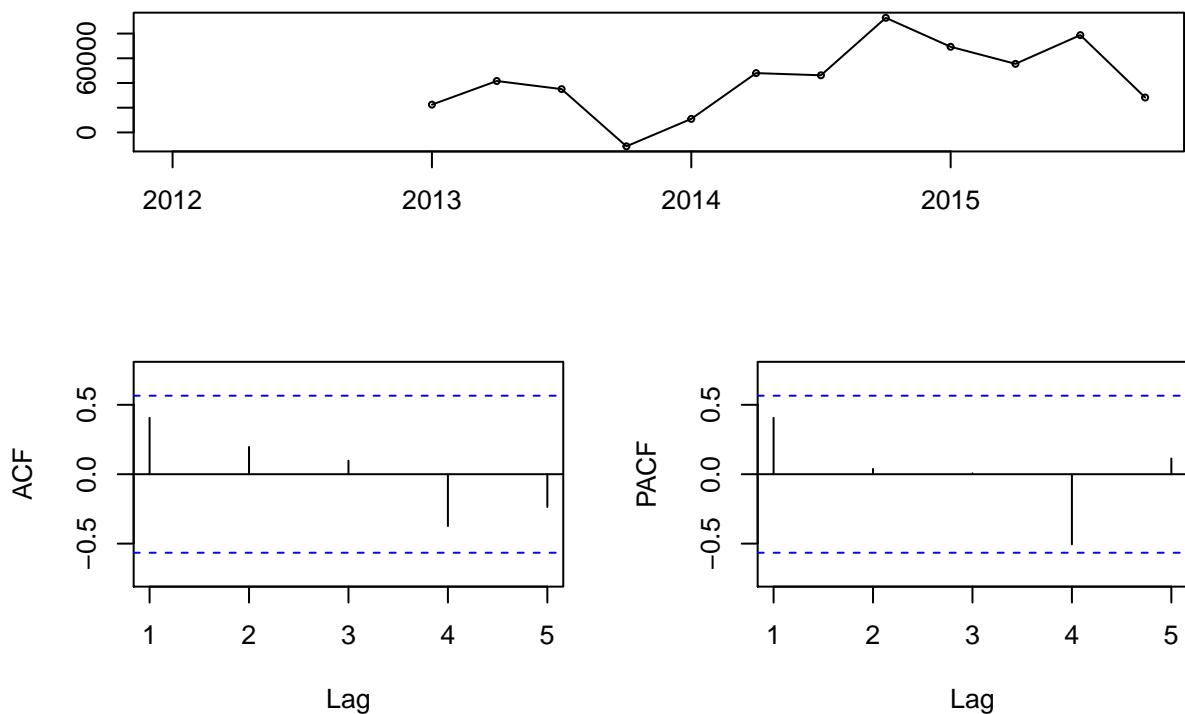
Portland, OR – Woodstock



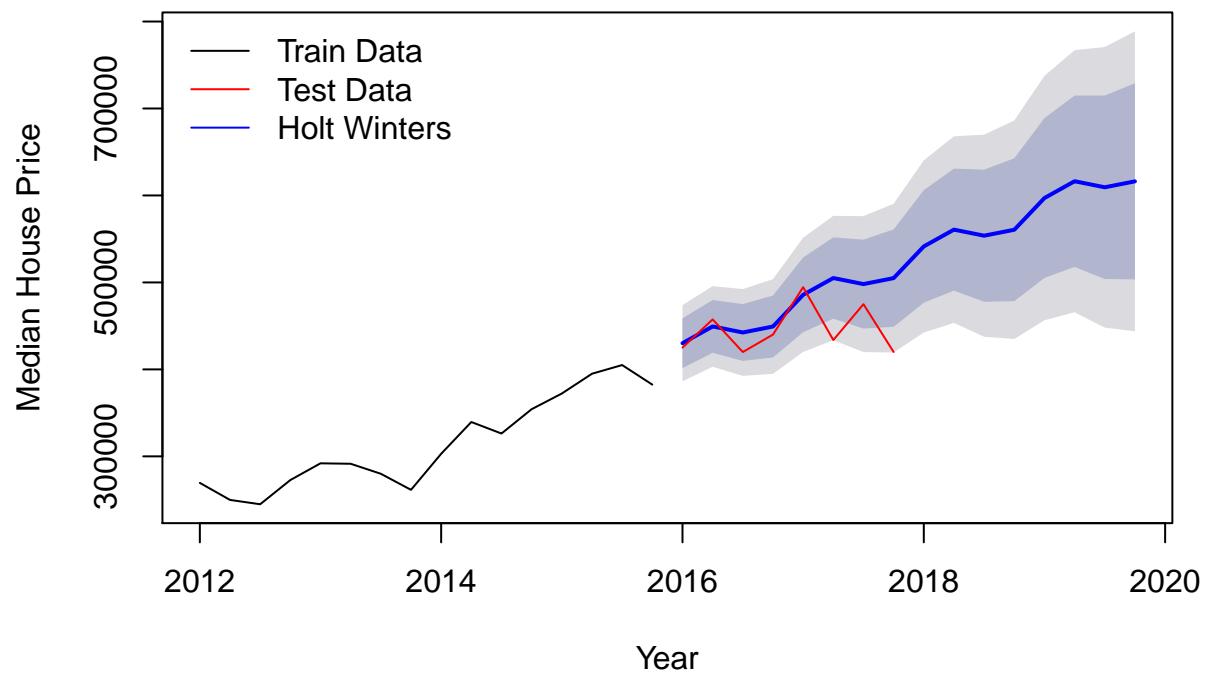
Portland, OR – Woodstock : Naive Model Forecast



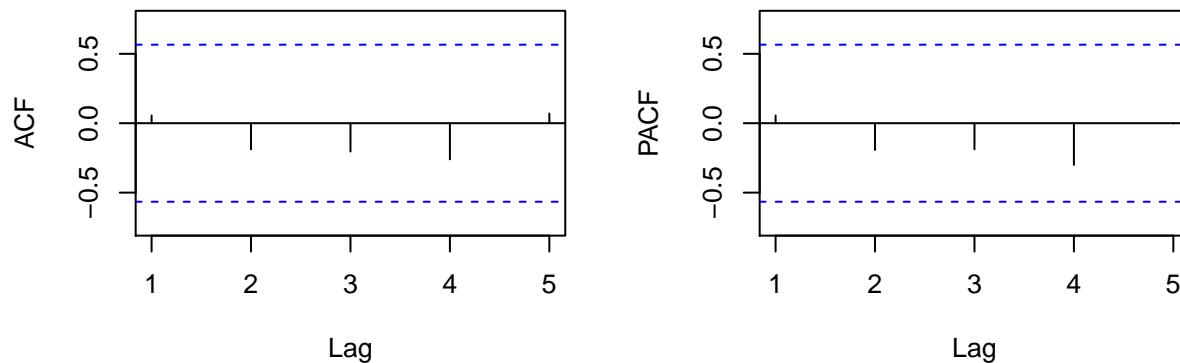
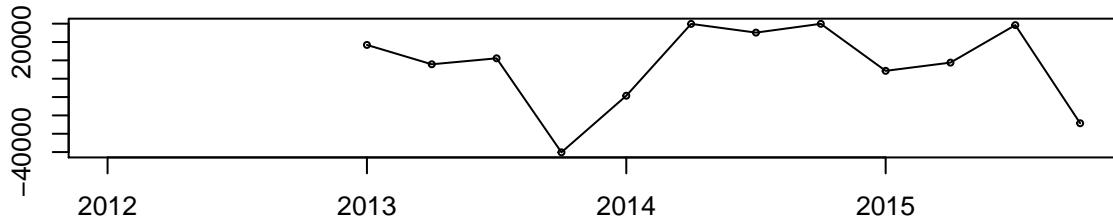
Portland, OR – Woodstock : Naive Model Forecast Residuals



Portland, OR – Woodstock : Holt Winters Model Forecast

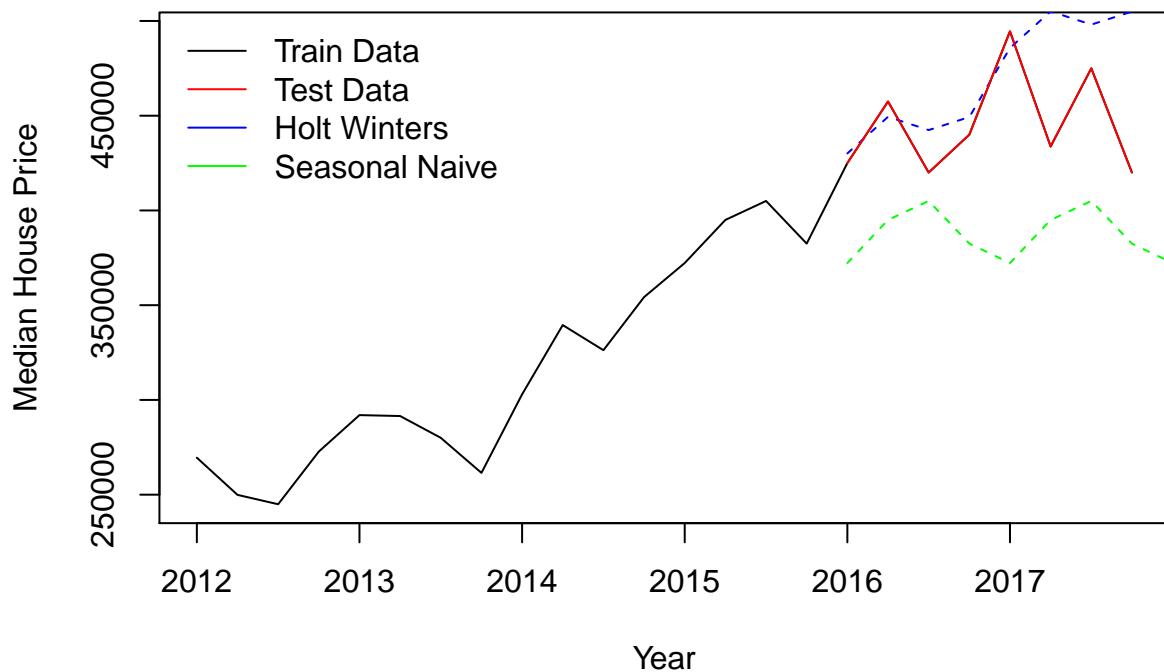


Portland, OR – Woodstock : Holt Winters Model Forecast Residuals

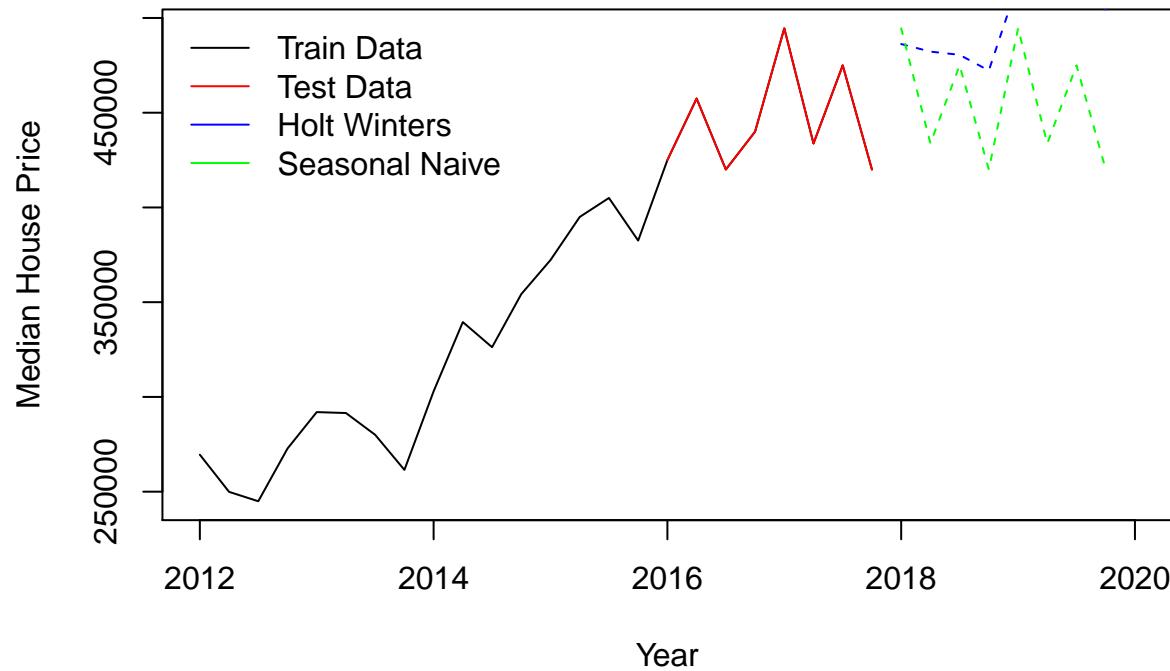


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Woodstock"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 43136.25 51349.06 45011.25 12.31624 13.03326 1.000000
## Test set     57035.31 64205.87 57035.31 12.50491 12.50491 1.267135
##          ACF1 Theil's U
## Training set 0.4058422      NA
## Test set     -0.2768465 1.522843
## [1] "Holt Winters Accuracy for Portland, OR - Woodstock"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 7578.859 22692.30 19858.24 1.980344 6.105630 0.4411839
## Test set     -24909.198 41218.36 29126.09 -5.828691 6.714498 0.6470847
##          ACF1 Theil's U
## Training set 0.05572856      NA
## Test set     -0.05295982 0.9353594
```

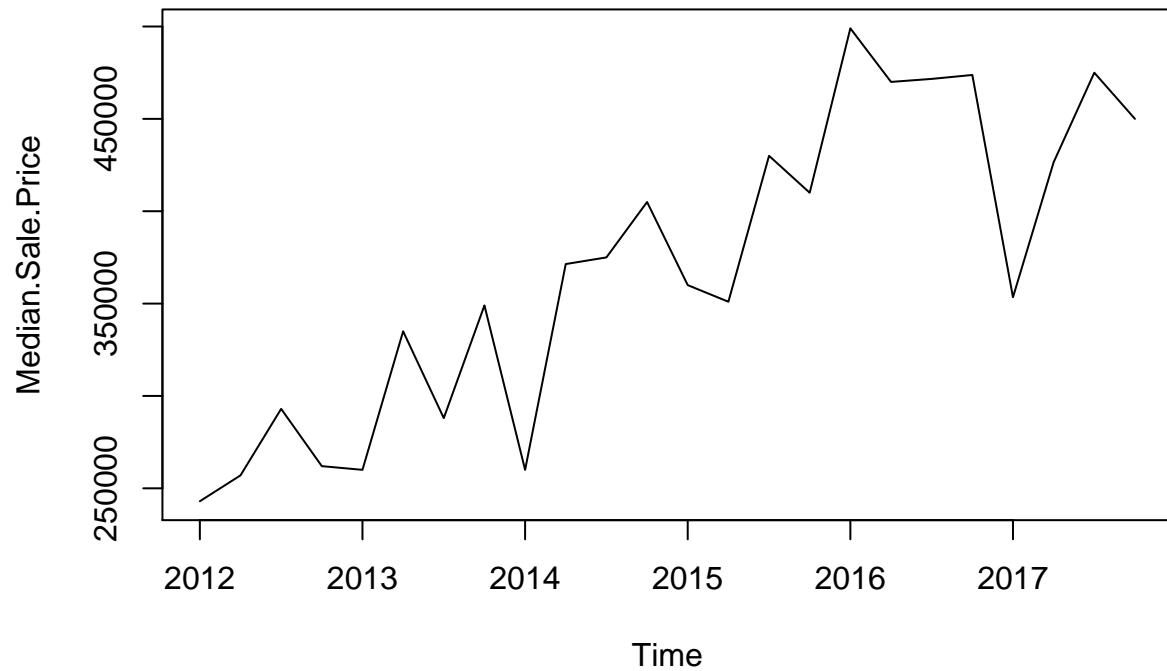
Portland, OR – Woodstock : TS Training Model Comparison



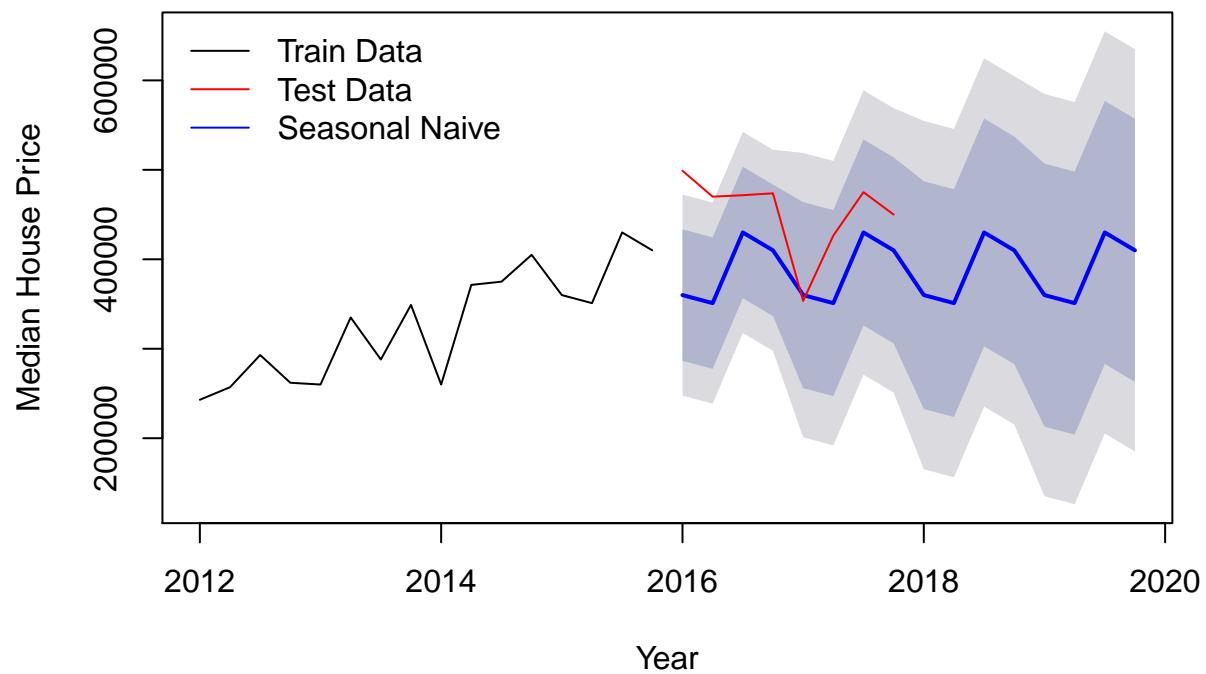
Portland, OR – Woodstock : Full TS Models Comparison



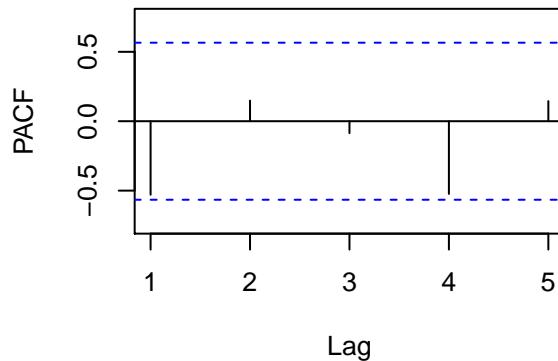
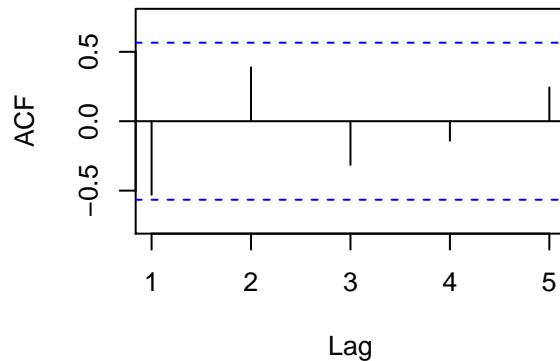
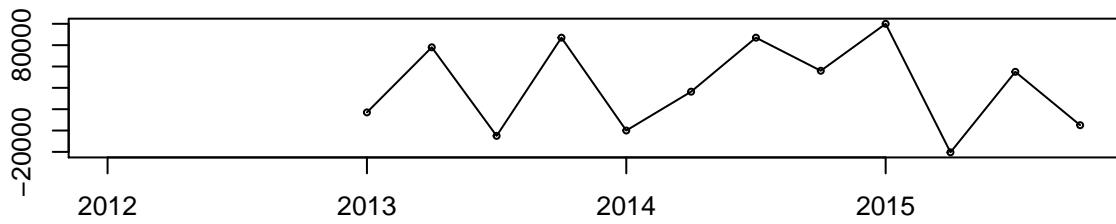
Portland, OR – Overlook



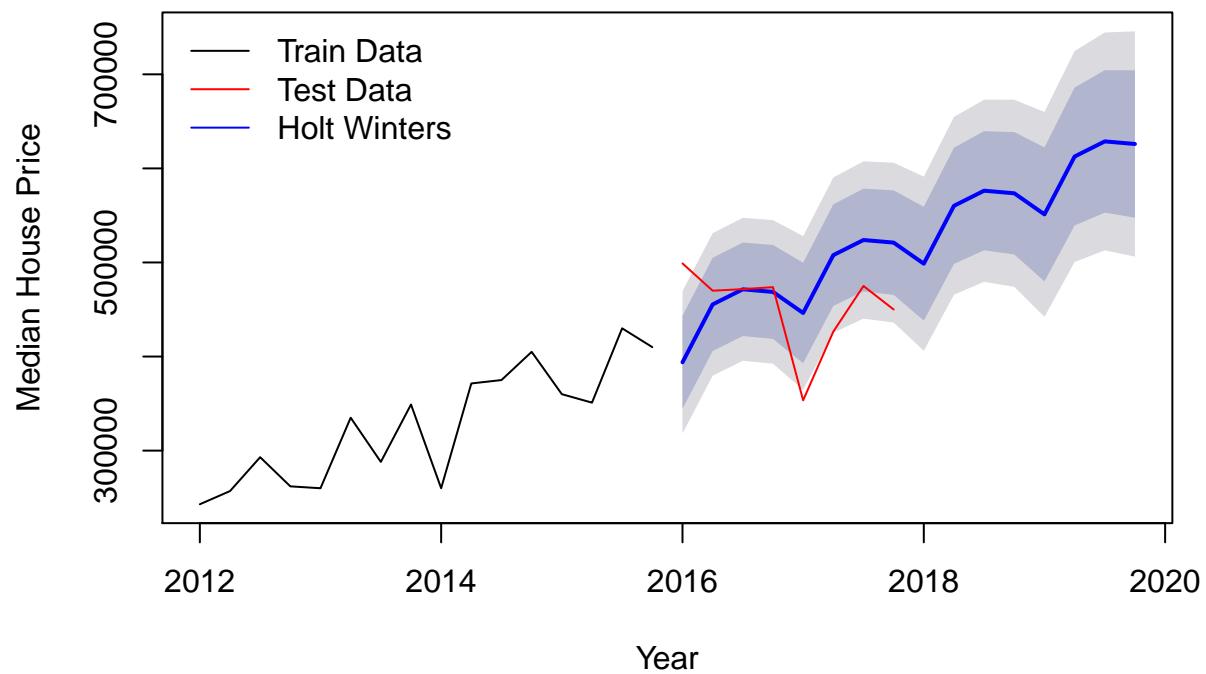
Portland, OR – Overlook : Naive Model Forecast



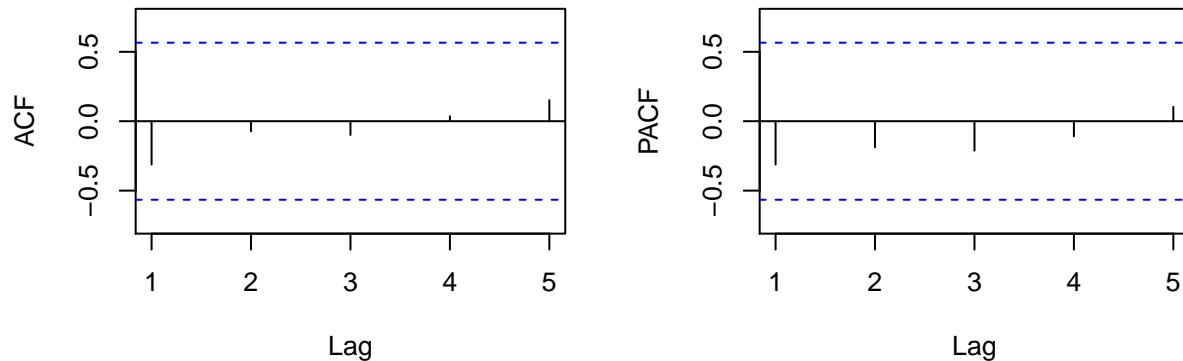
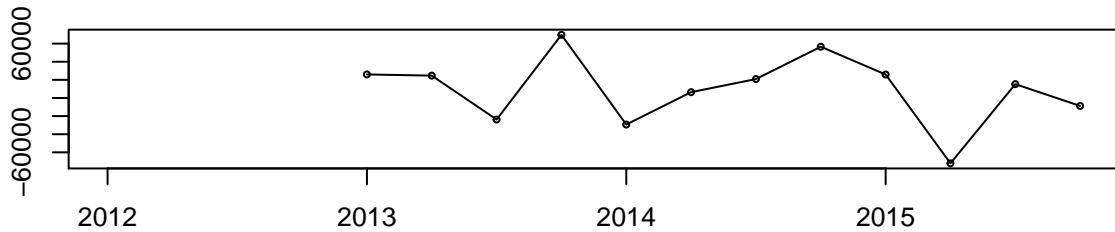
Portland, OR – Overlook : Naive Model Forecast Residuals



Portland, OR – Overlook : Holt Winters Model Forecast

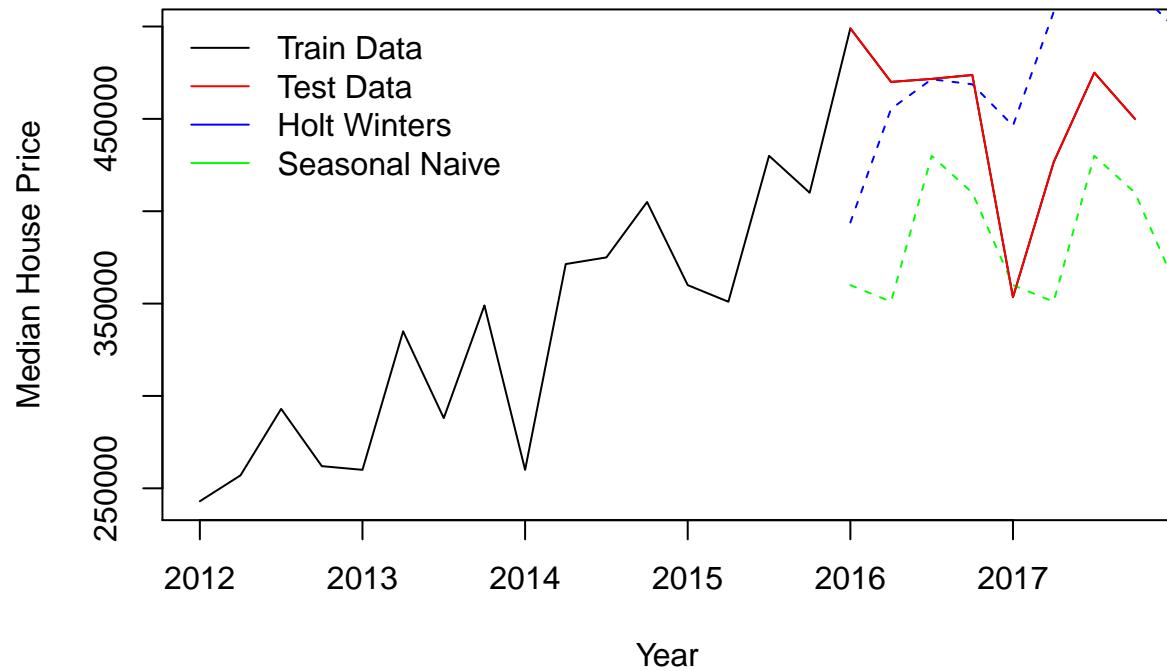


Portland, OR – Overlook : Holt Winters Model Forecast Residuals

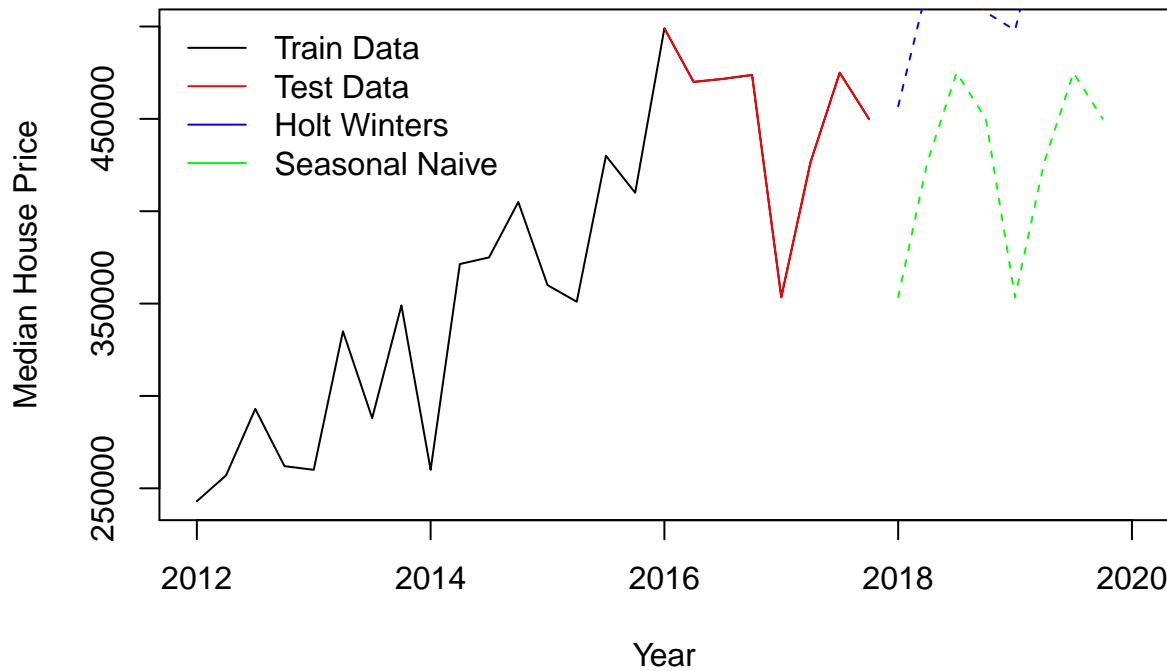


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Overlook"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 41333.33 57346.26 45566.67 11.31819 12.57620 1.000000
## Test set     64666.25 77980.18 66303.75 13.70872 14.17202 1.455093
##          ACF1 Theil's U
## Training set -0.5298891      NA
## Test set      0.1562538  1.078921
## [1] "Holt Winters Accuracy for Portland, OR - Overlook"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set  9281.052 38105.52 31614.34  2.259147  9.296718 0.693804
## Test set      -21150.616 65160.10 52385.84 -5.768845 12.087523 1.149653
##          ACF1 Theil's U
## Training set -0.3122785      NA
## Test set      0.3726541  1.006064
```

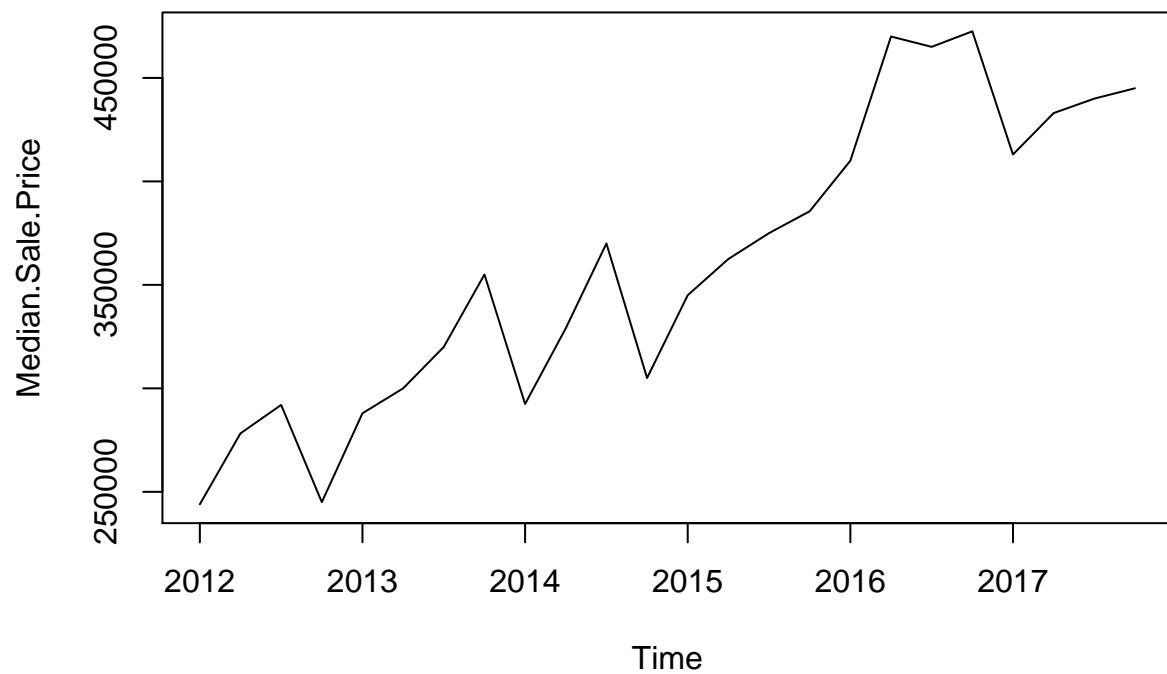
Portland, OR – Overlook : TS Training Model Comparison



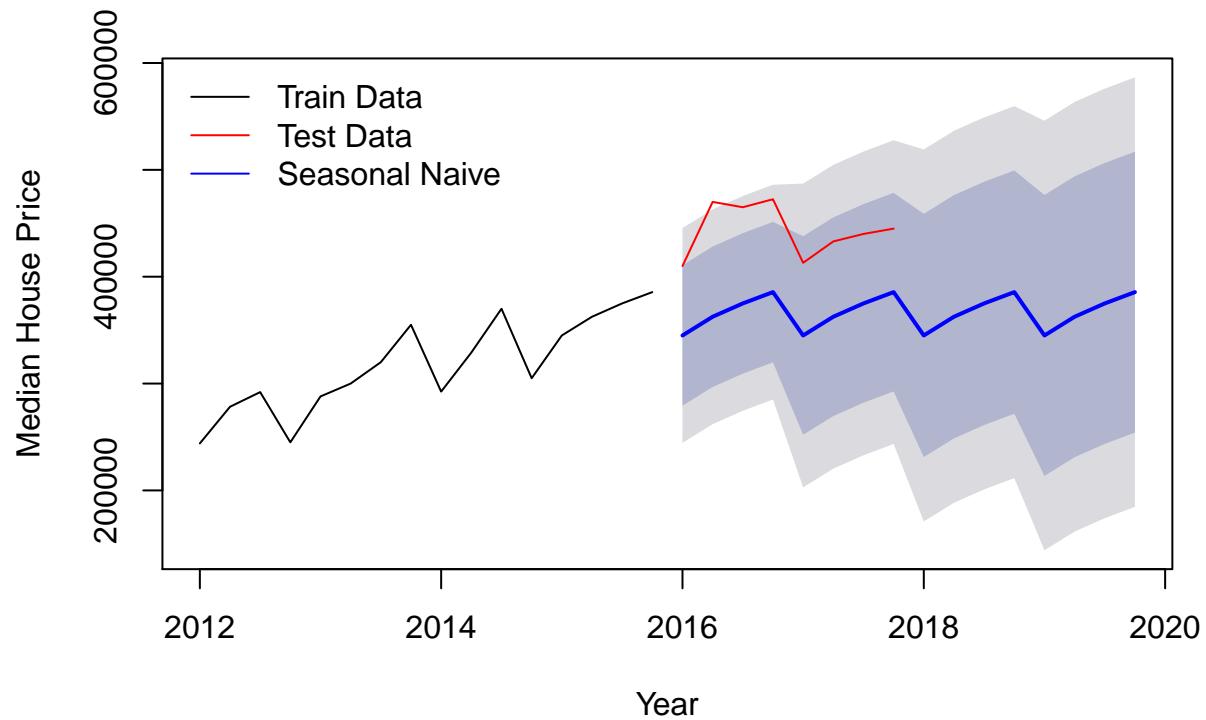
Portland, OR – Overlook : Full TS Models Comparison



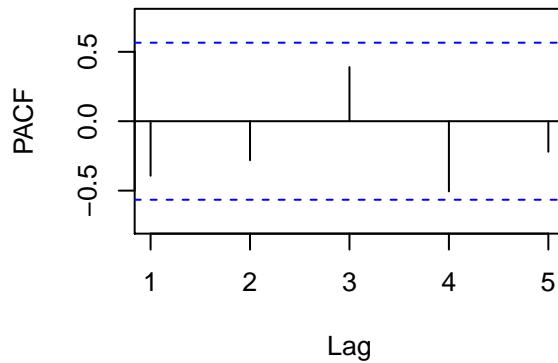
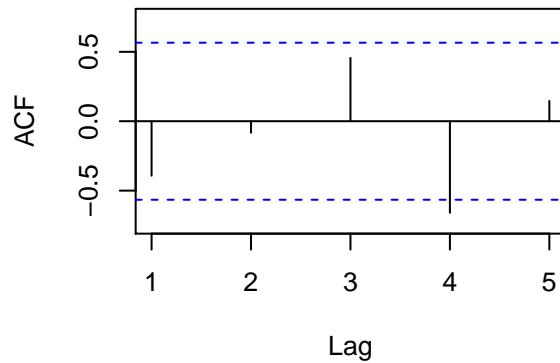
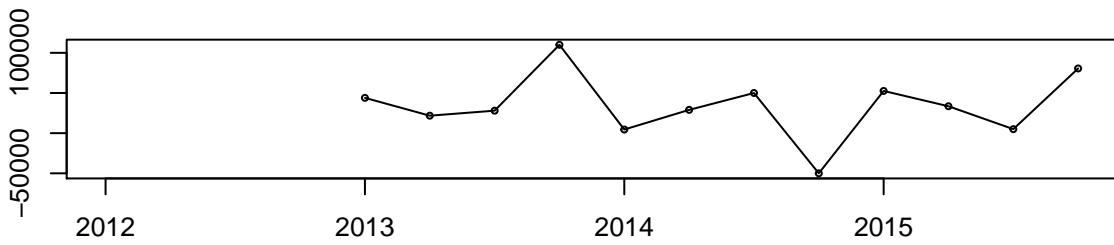
Portland, OR – Ashcreek



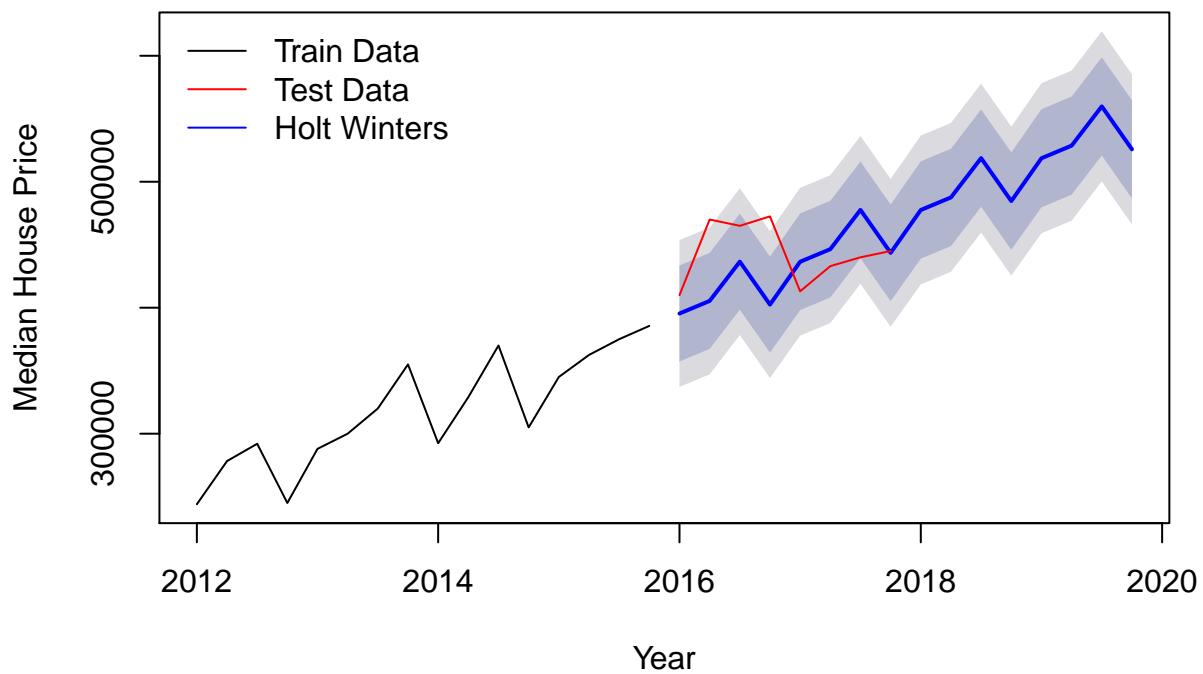
Portland, OR – Ashcreek : Naive Model Forecast



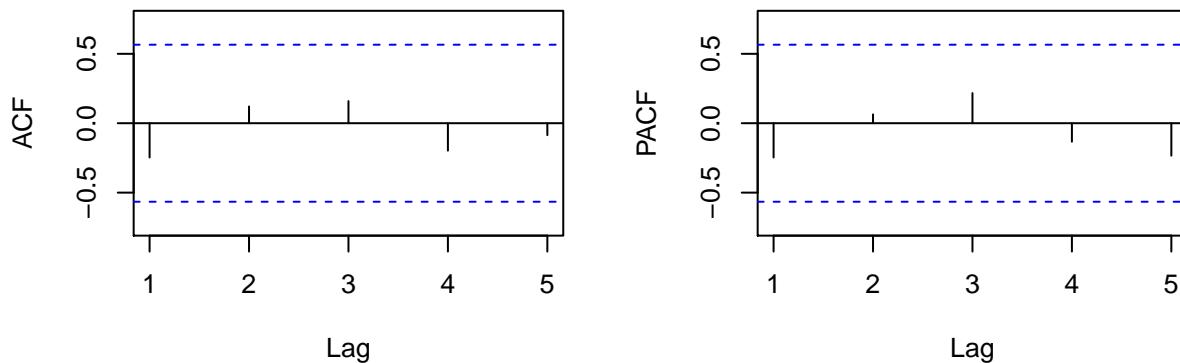
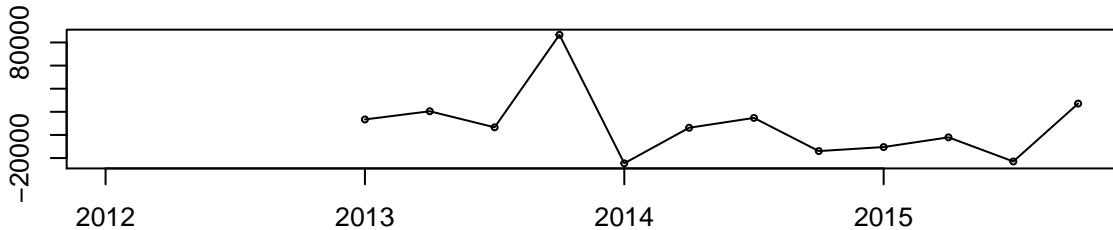
Portland, OR – Ashcreek : Naive Model Forecast Residuals



Portland, OR – Ashcreek : Holt Winters Model Forecast

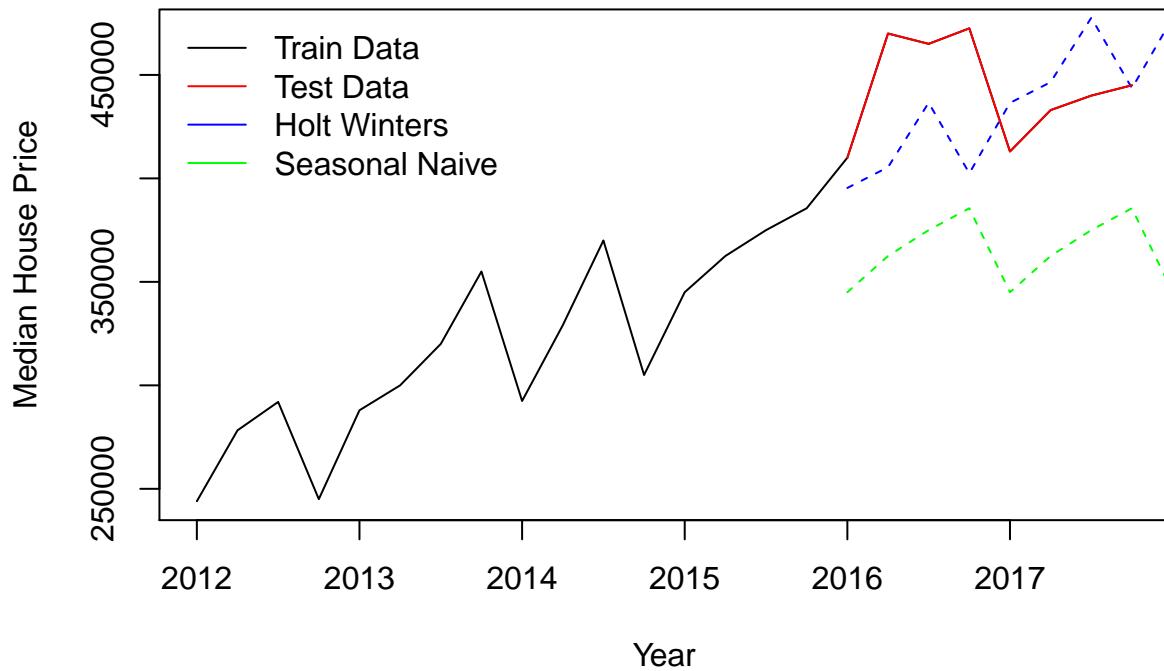


Portland, OR – Ashcreek : Holt Winters Model Forecast Residuals

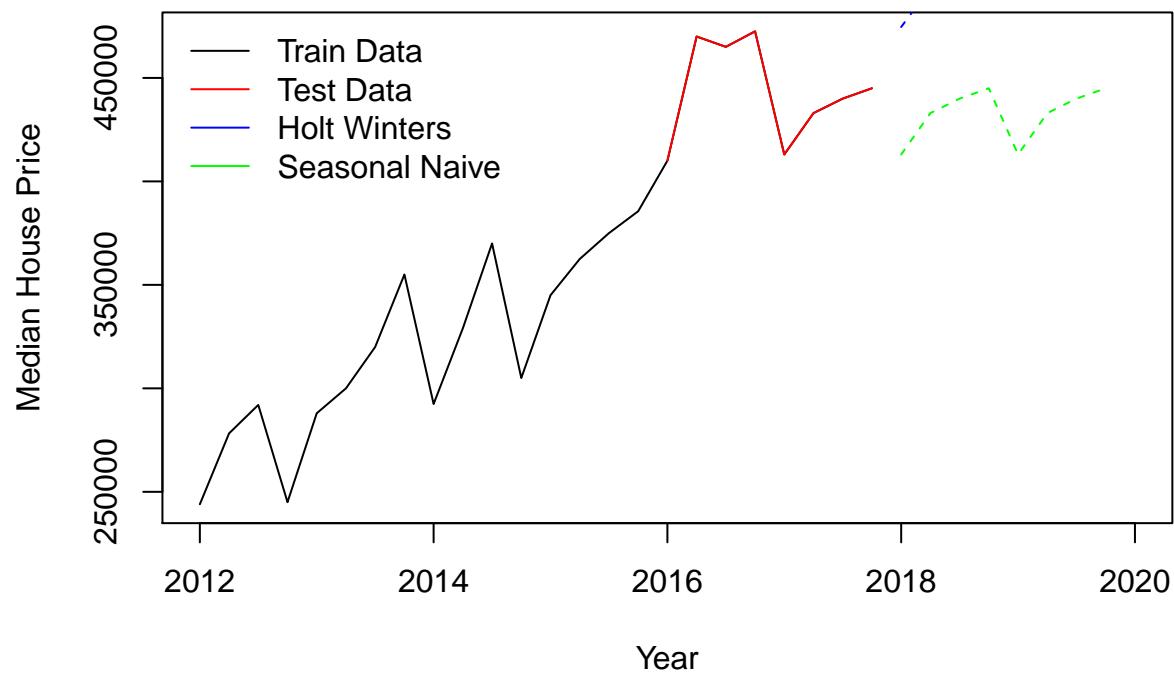


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Ashcreek"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 34067.71 51274.57 42401.04  9.70198 12.43422 1.000000
## Test set     76546.88 78095.65 76546.88 17.16955 17.16955 1.805306
##          ACF1 Theil's U
## Training set -0.3928348      NA
## Test set     0.2239227  2.391743
## [1] "Holt Winters Accuracy for Portland, OR – Ashcreek"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 8423.957 29681.67 20762.00 2.343902 6.128022 0.4896577
## Test set     13063.455 39131.68 31715.76 2.651681 6.990430 0.7479949
##          ACF1 Theil's U
## Training set -0.2469044      NA
## Test set     0.2364872  1.241709
```

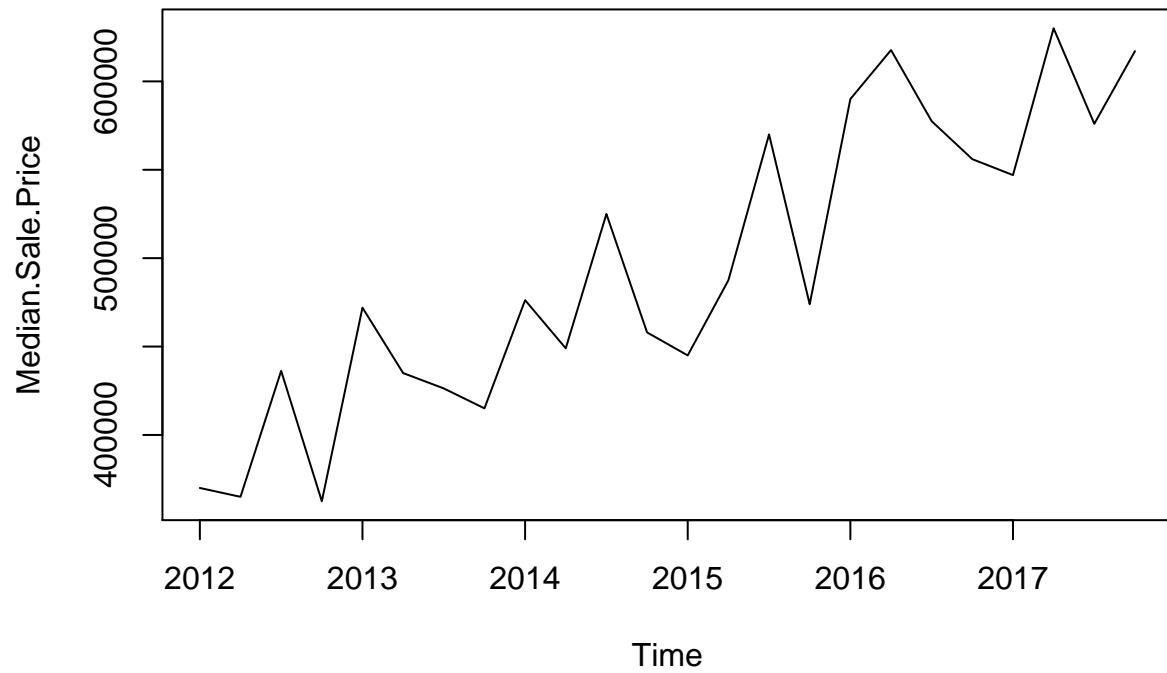
Portland, OR – Ashcreek : TS Training Model Comparison



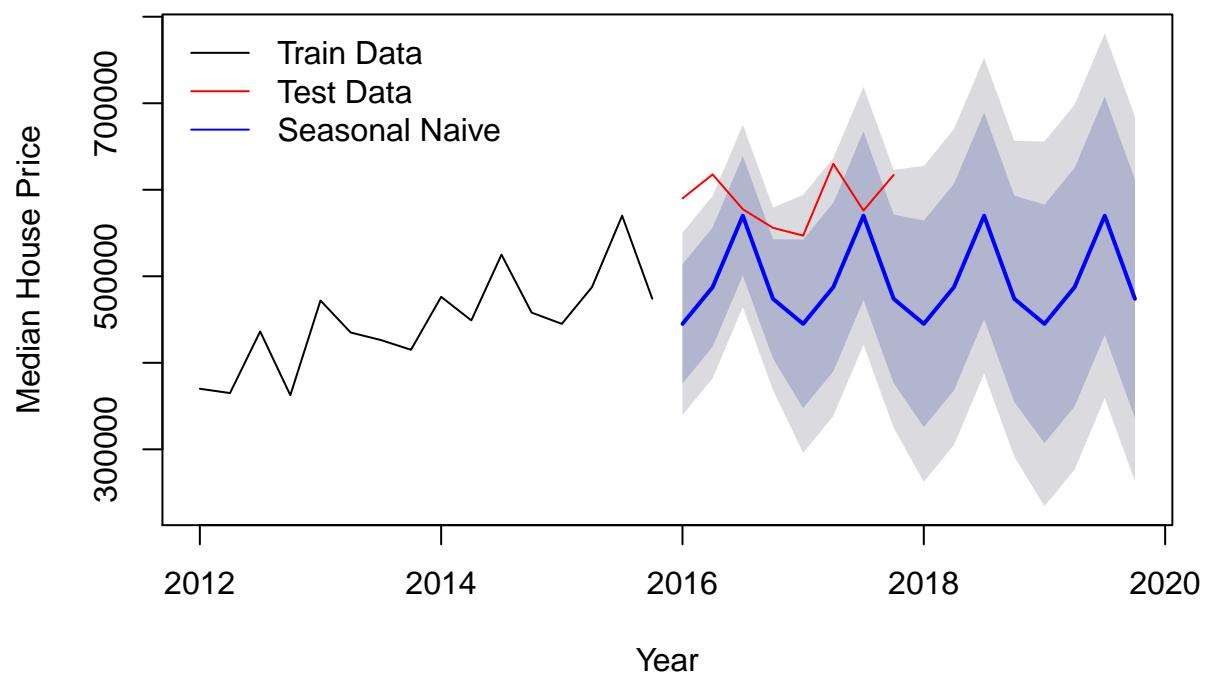
Portland, OR – Ashcreek : Full TS Models Comparison



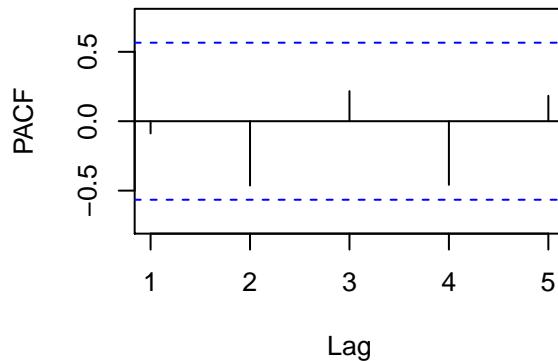
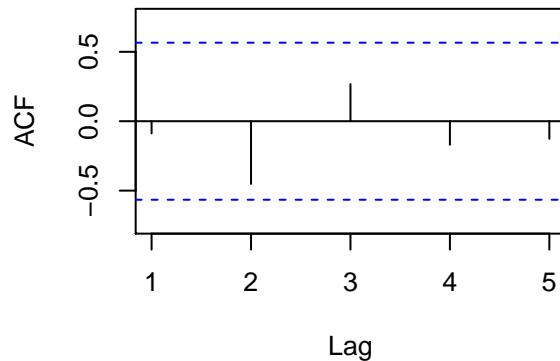
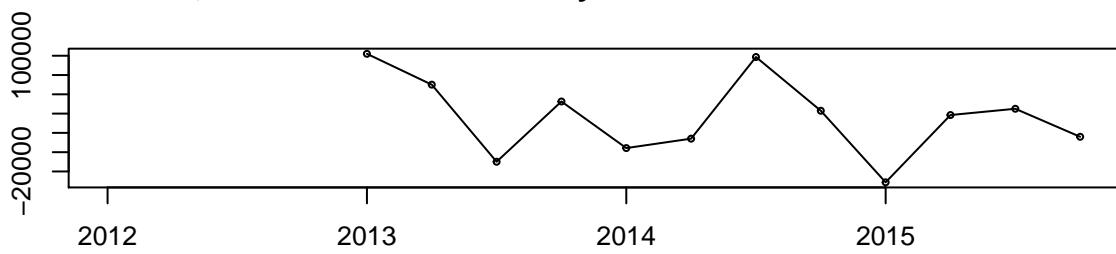
Portland, OR – Hosford–Abernethy



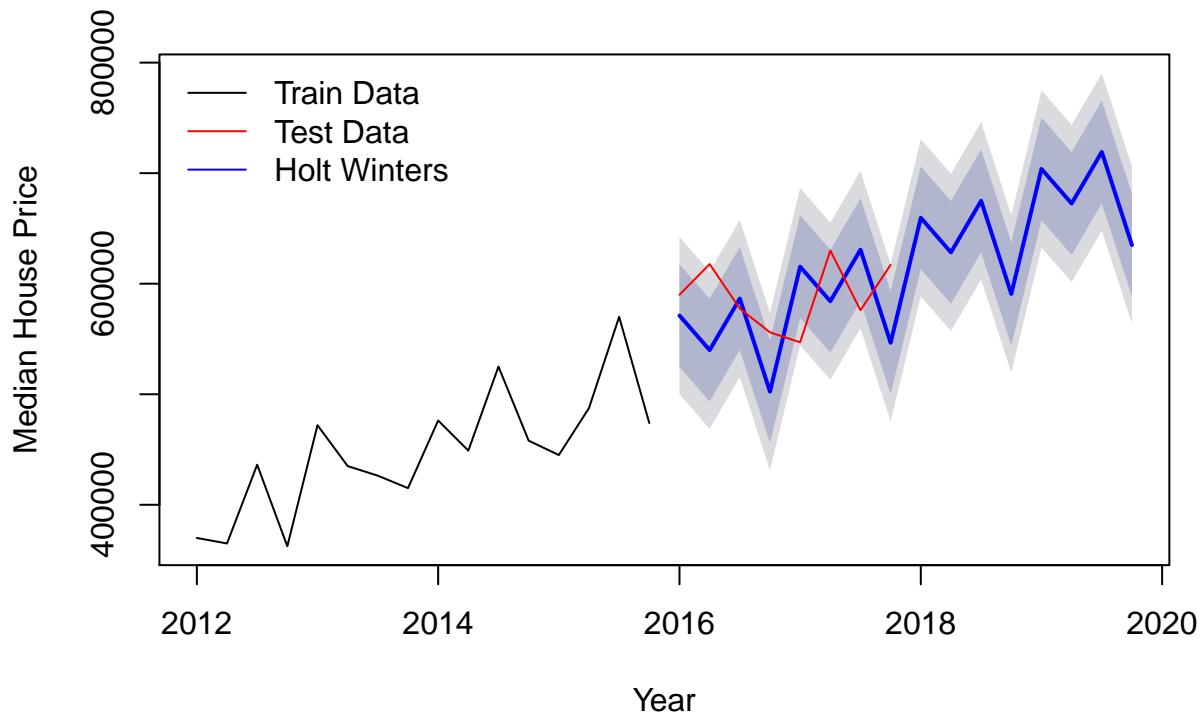
Portland, OR – Hosford–Abernethy : Naive Model Forecast



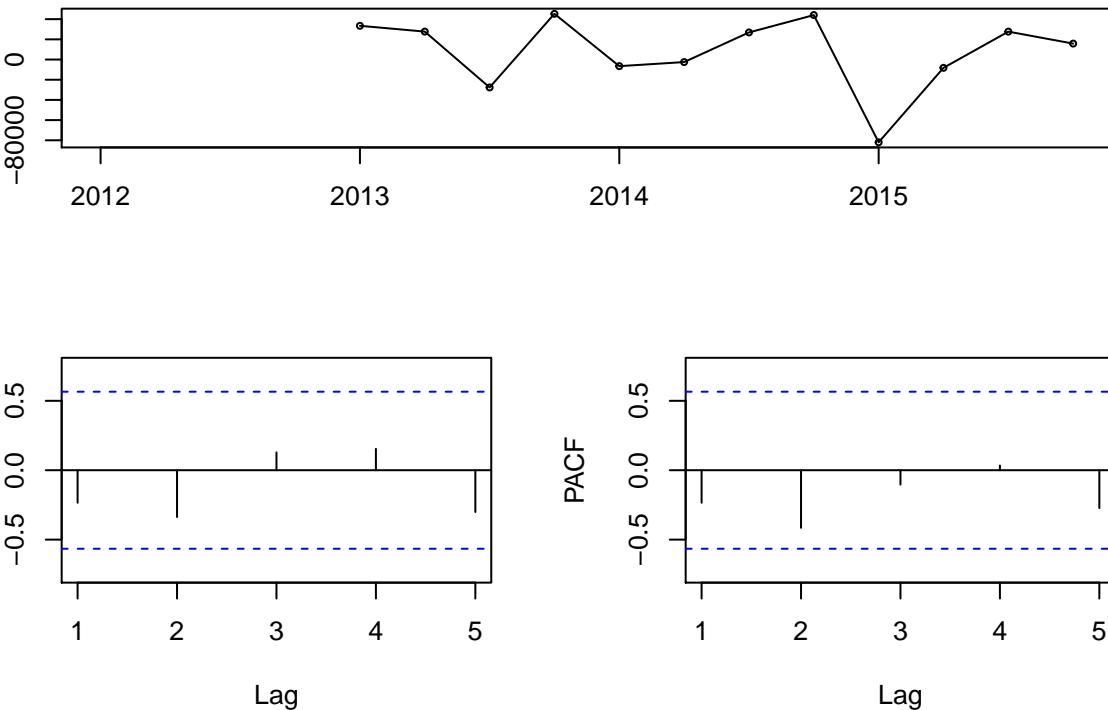
Portland, OR – Hosford–Abernethy : Naive Model Forecast Residuals



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

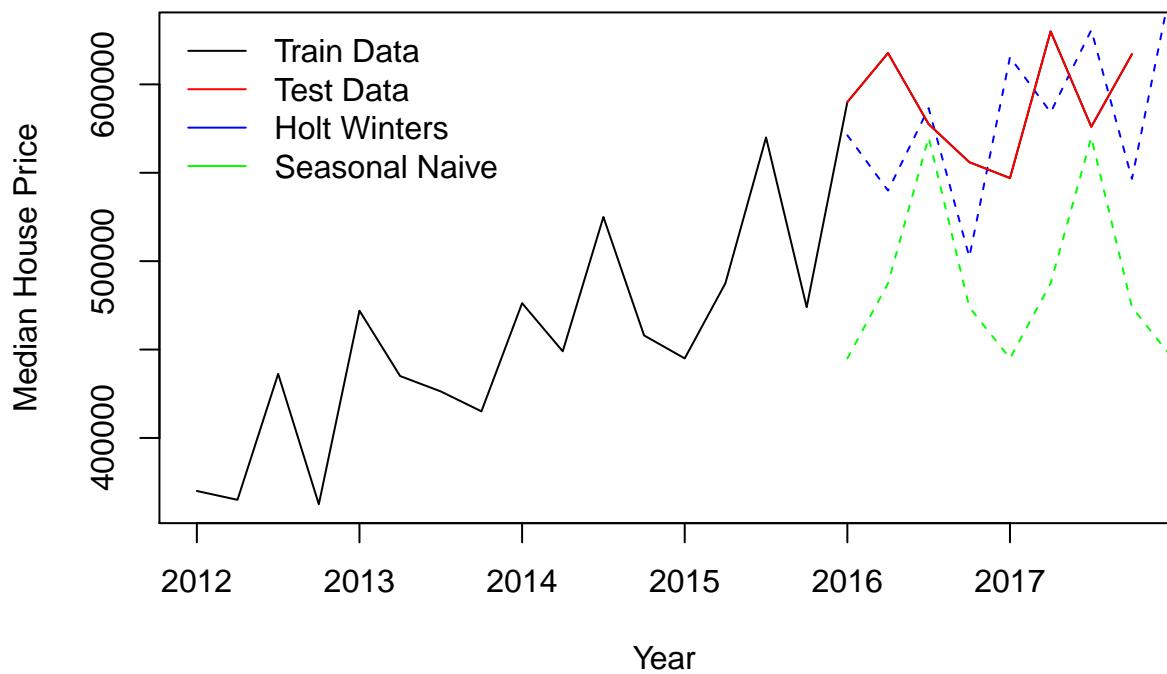


Portland, OR – Hosford–Abernethy : Holt Winters Model Forecast Residuals

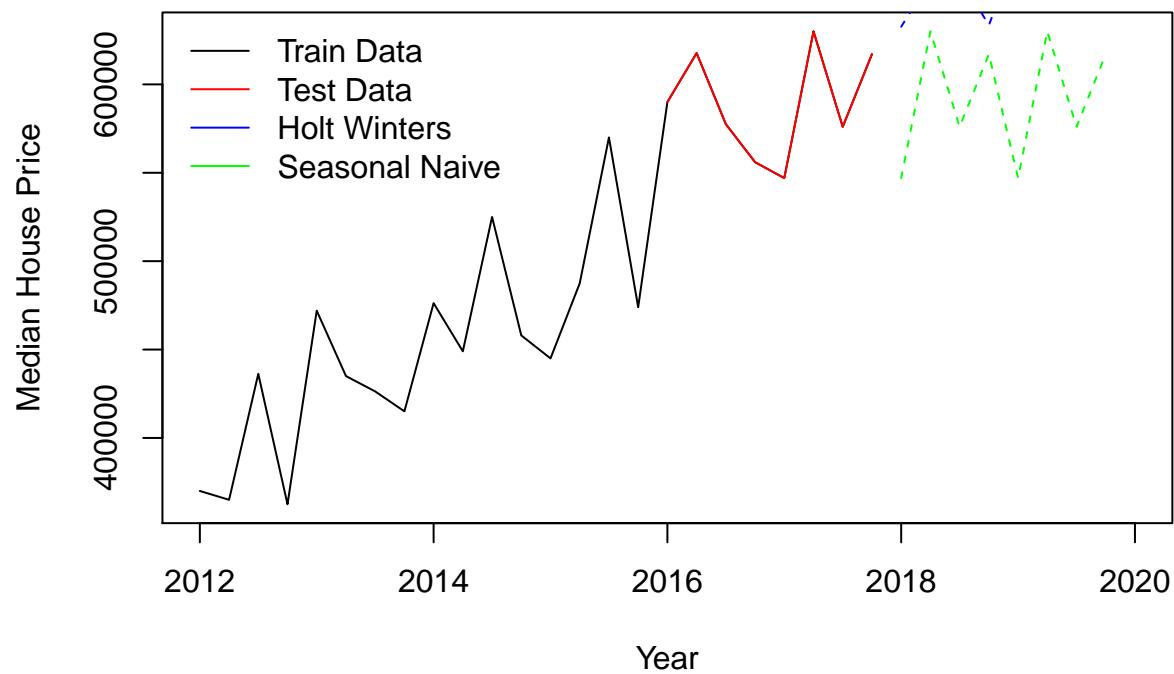


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Hosford–Abernethy"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 36891.67 53774.58 43756.25 7.696085 9.255003 1.000000
## Test set     94801.25 109548.09 94801.25 15.902091 15.902091 2.166576
##          ACF1 Theil's U
## Training set -0.08772489      NA
## Test set     -0.35167140  2.310048
## [1] "Holt Winters Accuracy for Portland, OR – Hosford–Abernethy"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 7819.453 35606.33 28970.46 1.562094 6.316744 0.6620873
## Test set     16800.391 54910.01 49857.40 2.569478 8.464923 1.1394350
##          ACF1 Theil's U
## Training set -0.2344678      NA
## Test set     -0.6380465  1.276282
```

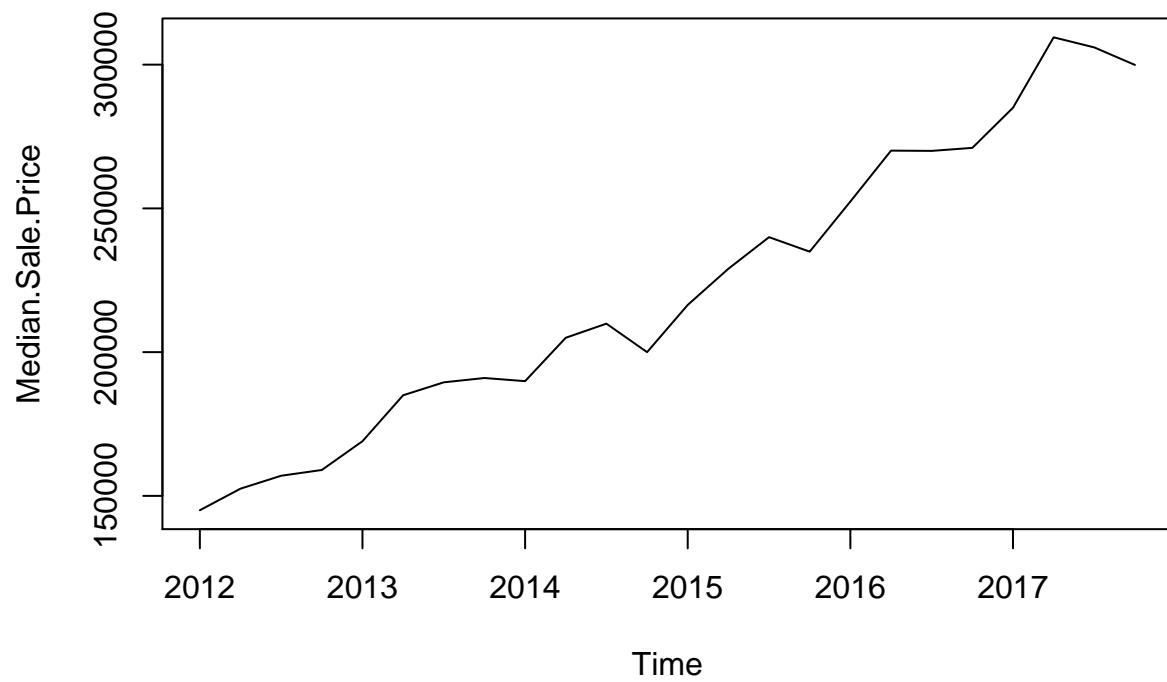
Portland, OR – Hosford–Abernethy : TS Training Model Comparison



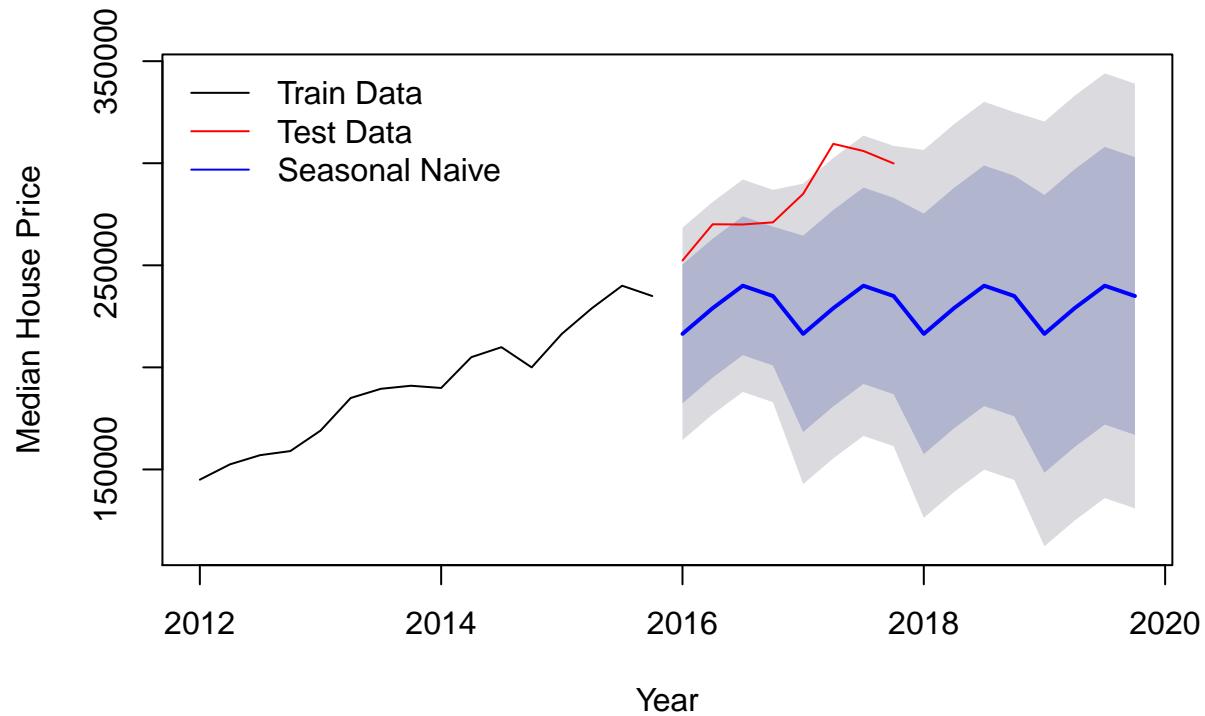
Portland, OR – Hosford–Abernethy : Full TS Models Comparison



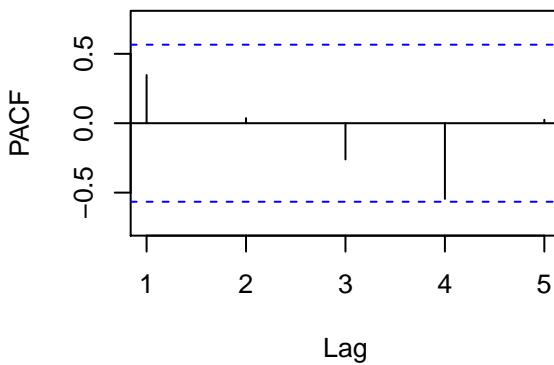
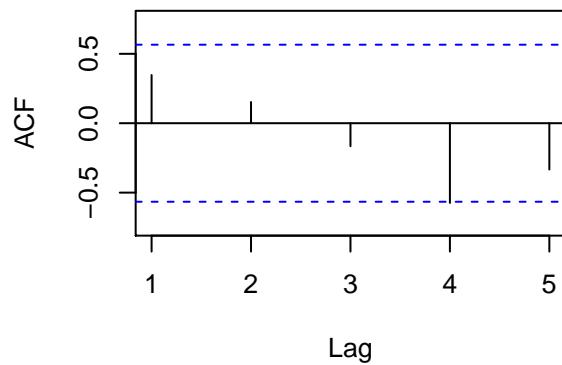
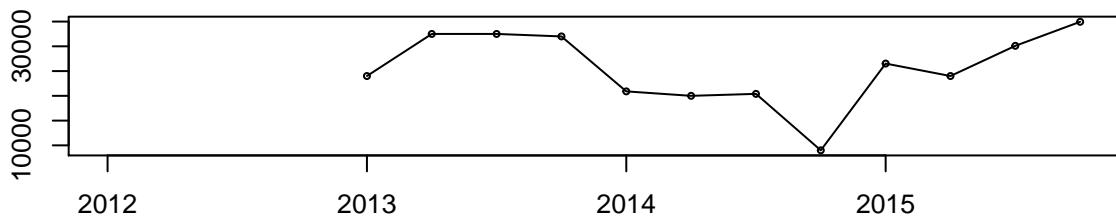
Portland, OR – East Portland



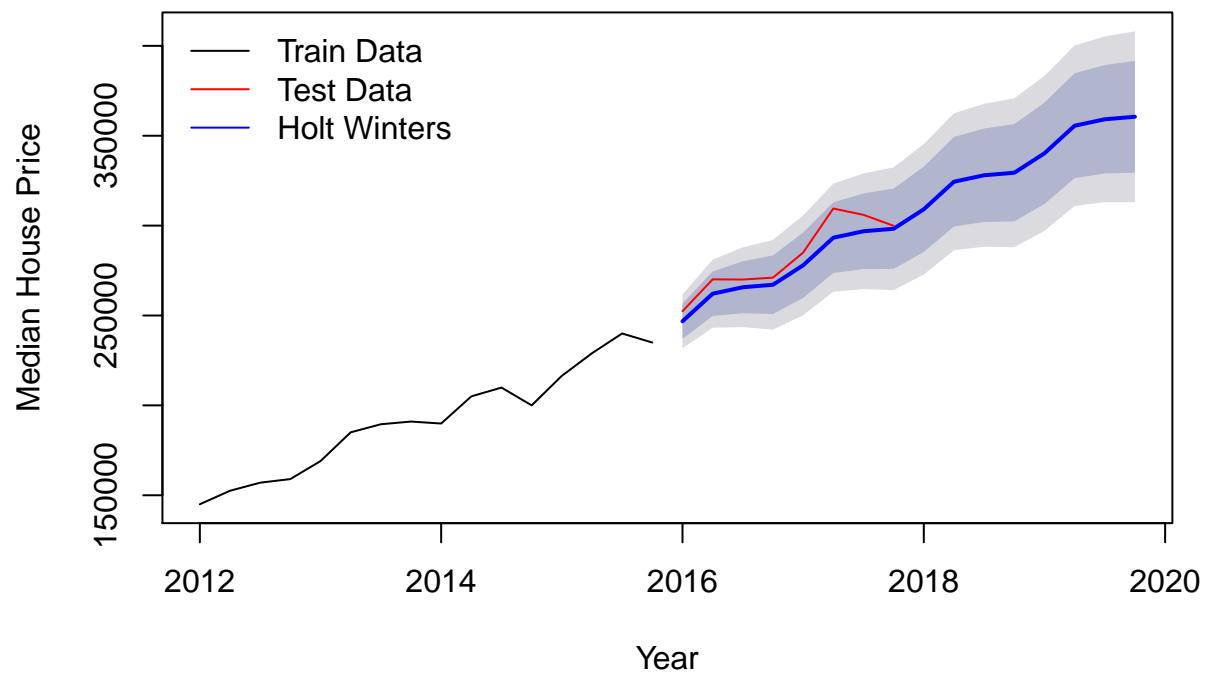
Portland, OR – East Portland : Naive Model Forecast



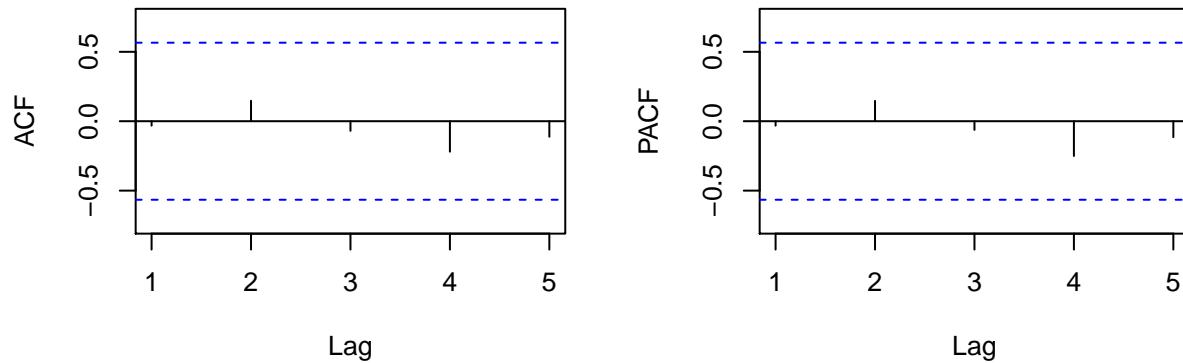
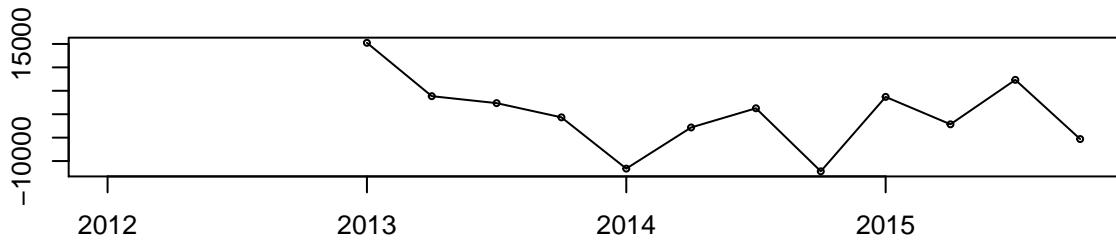
Portland, OR – East Portland : Naive Model Forecast Residuals



Portland, OR – East Portland : Holt Winters Model Forecast



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

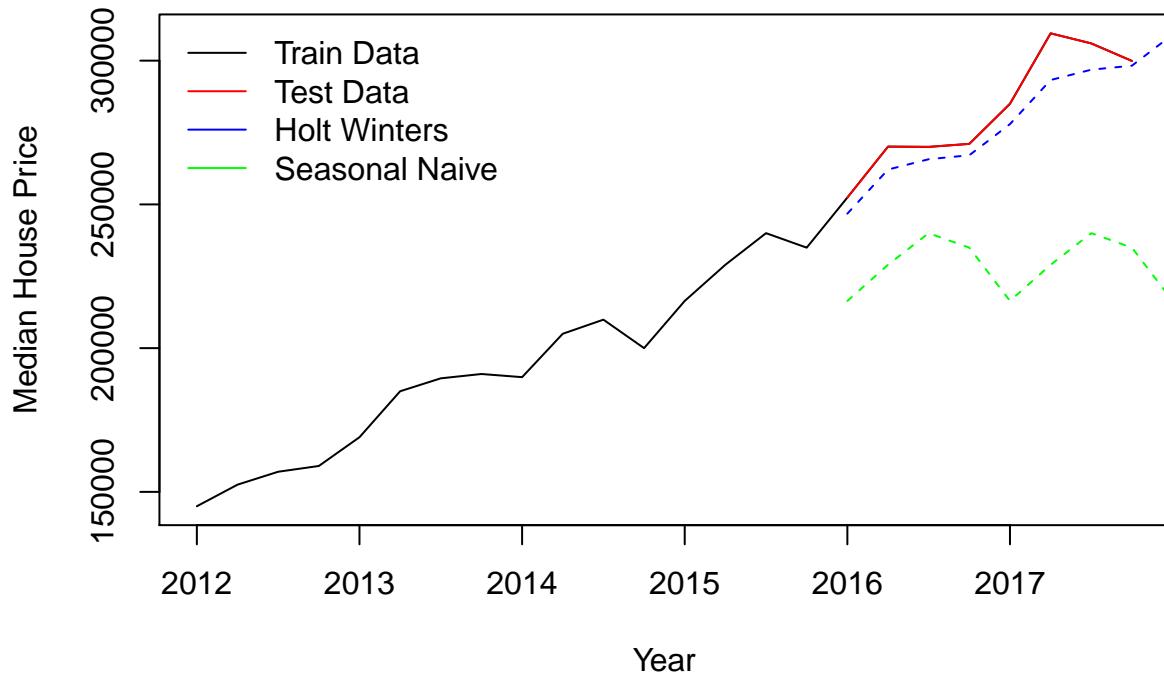


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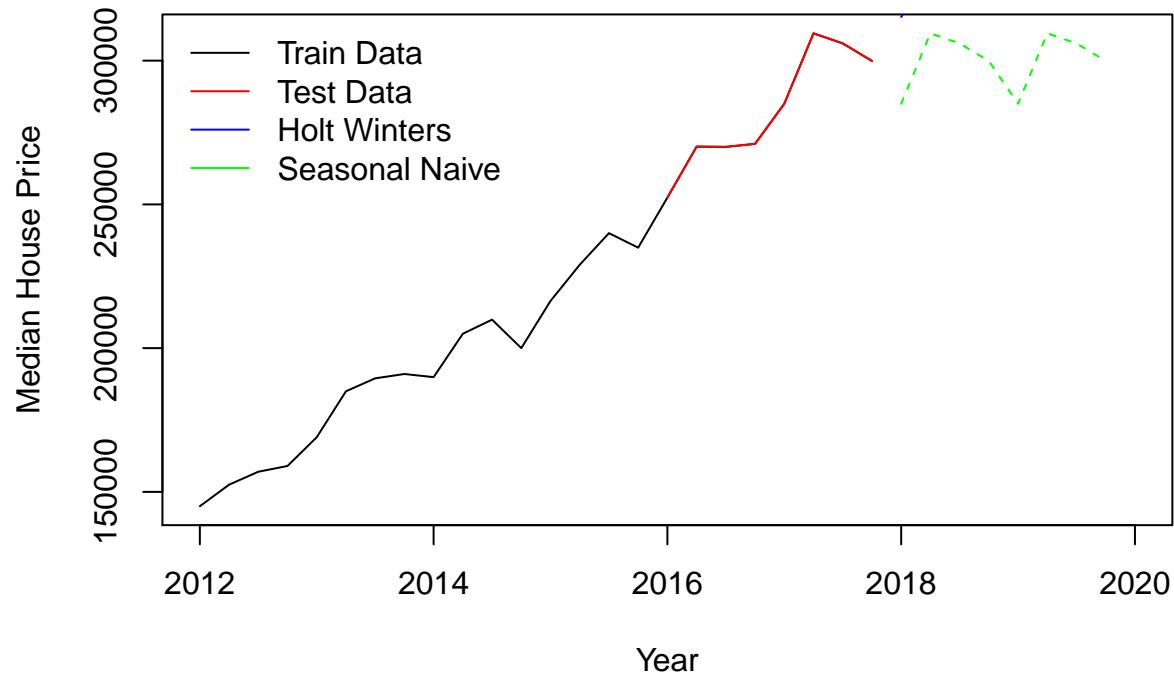
## [1] "Seasonal Naive Accuracy for Portland, OR - East Portland"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 25572.29 26541.10 25572.29 12.56703 12.56703 1.000000
## Test set     52898.69 55838.65 52898.69 18.39917 18.39917 2.068594
##          ACF1 Theil's U
## Training set 0.3472147      NA
## Test set     0.6035881 4.3317
## [1] "Holt Winters Accuracy for Portland, OR - East Portland"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -83.07344 7340.707 5710.515 0.04837631 2.905072 0.2233087
## Test set     6989.79152 8131.261 6989.792 2.43550909 2.435509 0.2733346
##          ACF1 Theil's U
## Training set -0.03204822      NA
## Test set     0.09455473 0.6369825

```

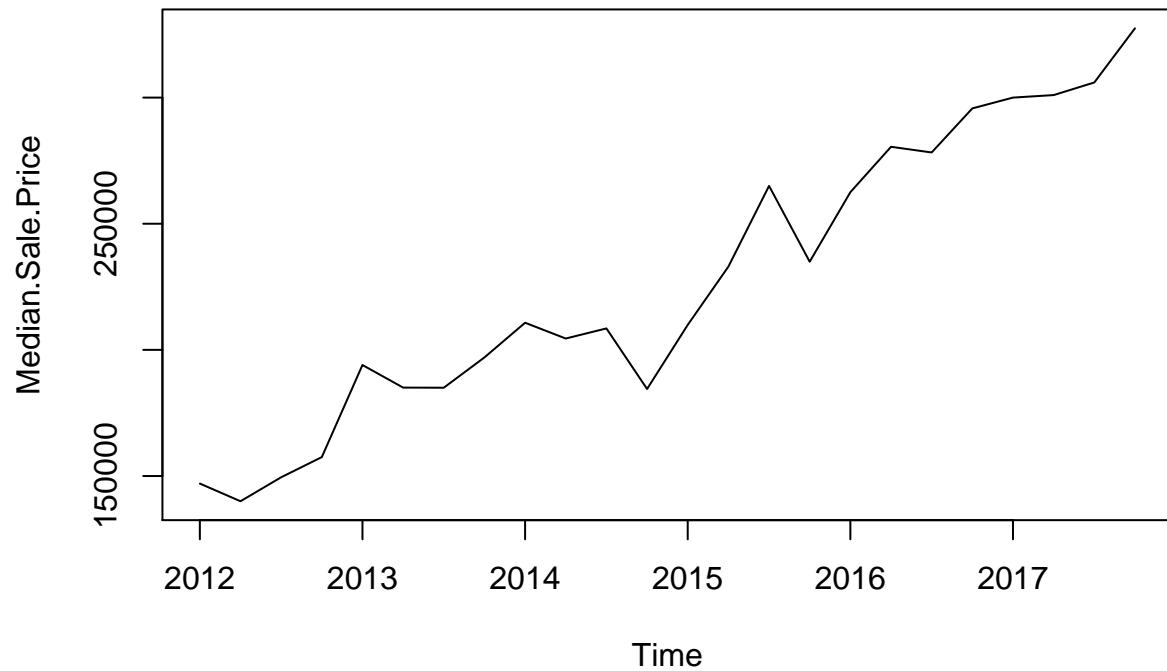
Portland, OR – East Portland : TS Training Model Comparison



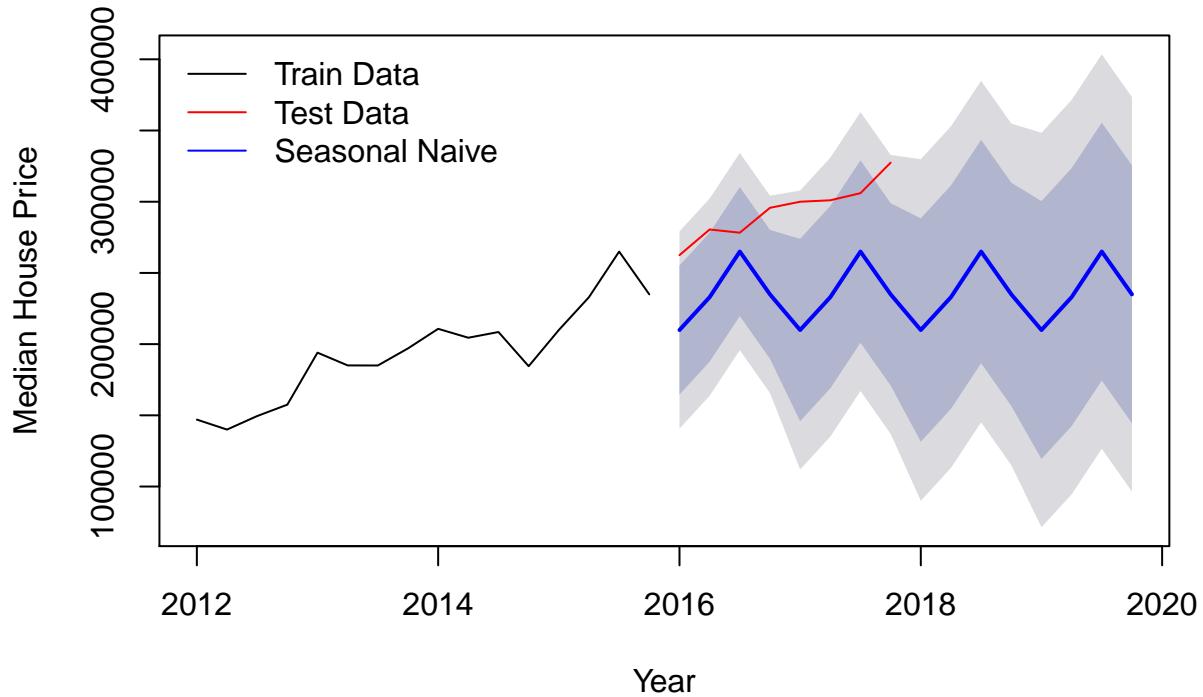
Portland, OR – East Portland : Full TS Models Comparison



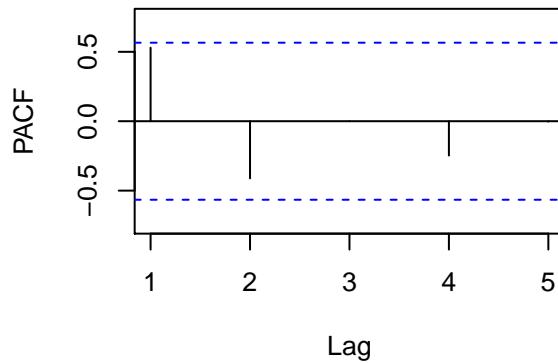
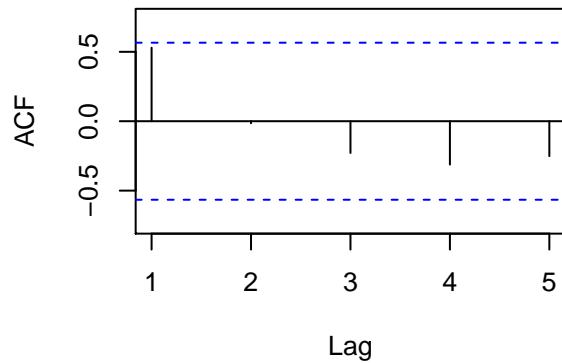
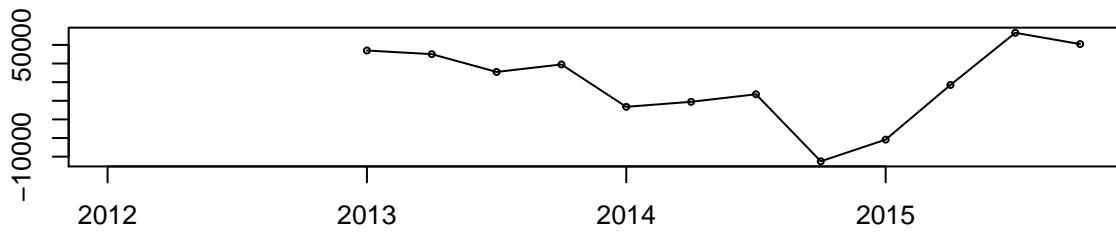
Portland, OR – Parkrose Heights



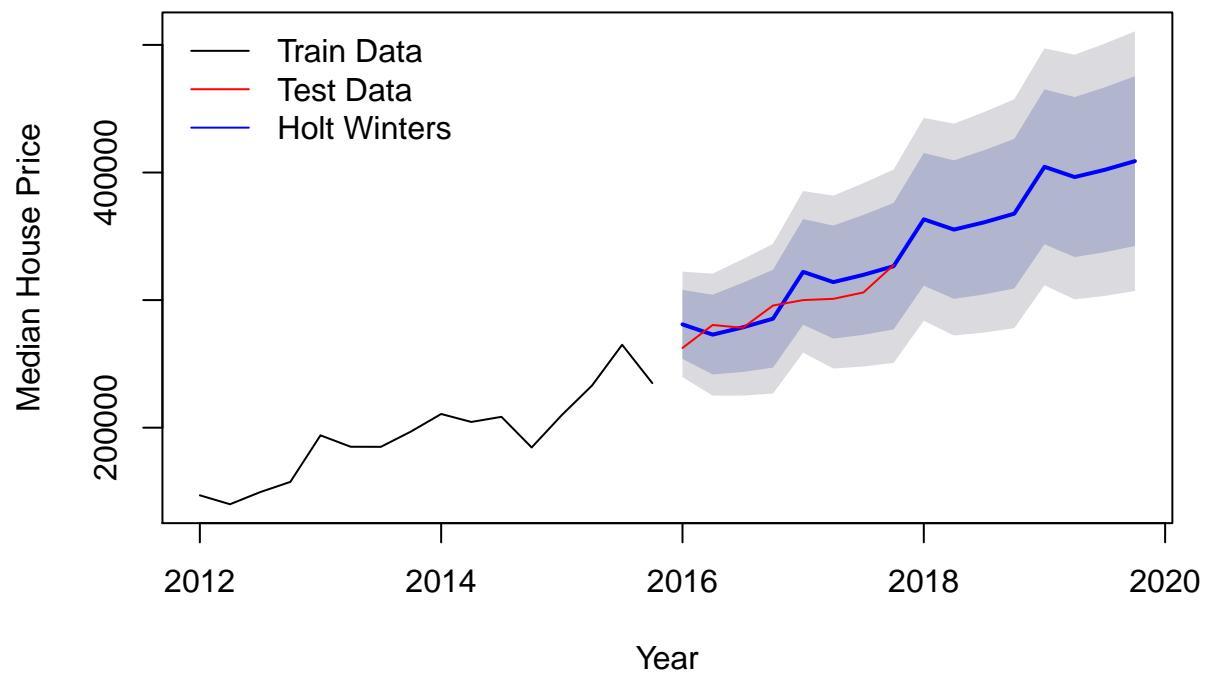
Portland, OR – Parkrose Heights : Naive Model Forecast



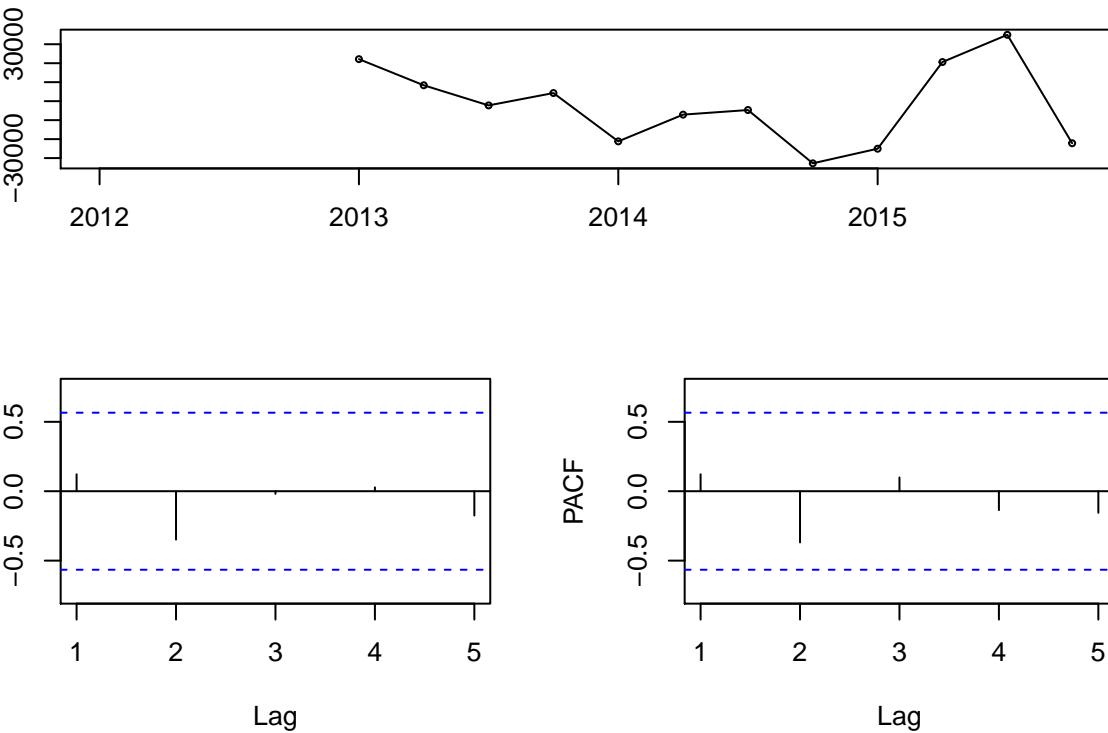
Portland, OR – Parkrose Heights : Naive Model Forecast Residuals



Portland, OR – Parkrose Heights : Holt Winters Model Forecast



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

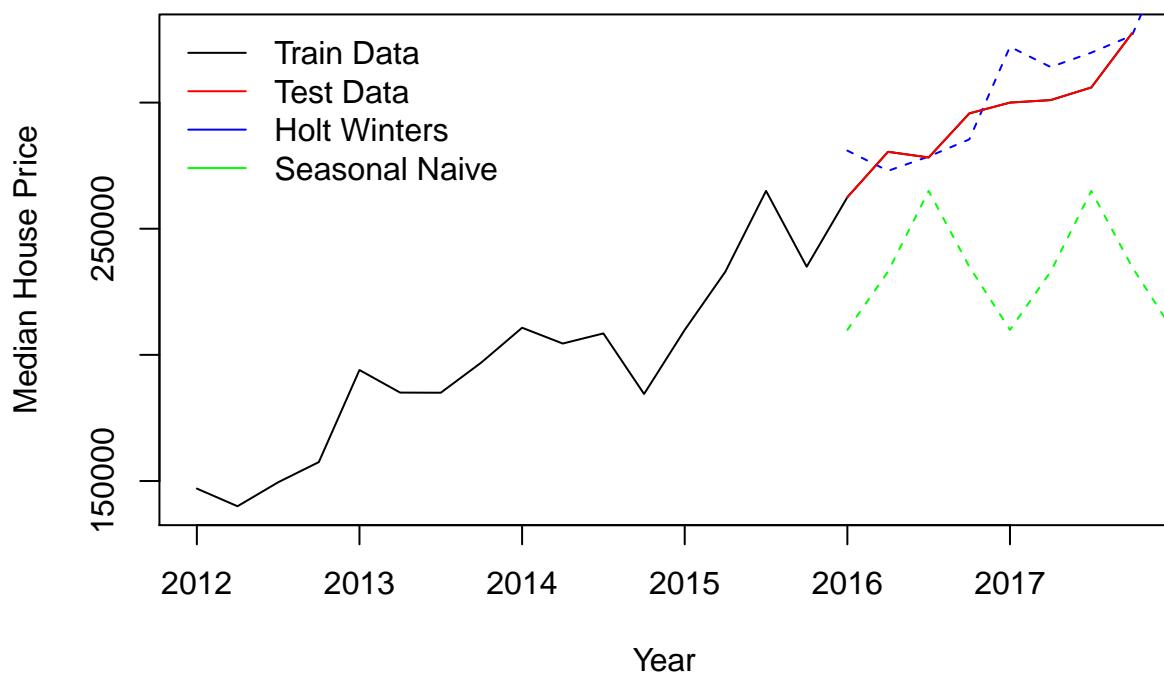


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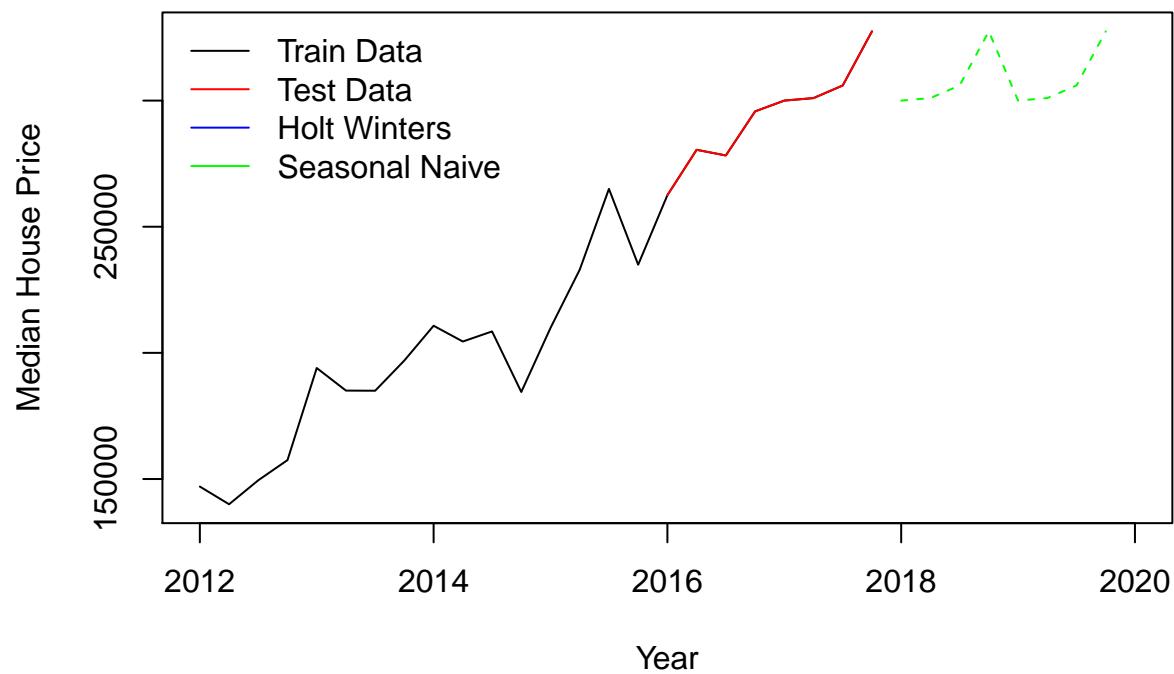
## [1] "Seasonal Naive Accuracy for Portland, OR - Parkrose Heights"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 29070.83 35327.98 31295.83 13.69887 14.89554 1.00000
## Test set     58215.56 63118.28 58215.56 19.56964 19.56964 1.86017
##          ACF1 Theil's U
## Training set 0.53008014      NA
## Test set     0.01299333 4.884018
## [1] "Holt Winters Accuracy for Portland, OR - Parkrose Heights"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set -2066.025 20295.91 17126.35 -1.328634 8.019610 0.5472406
## Test set     -6146.007 13028.59 10829.24 -2.121694 3.732945 0.3460281
##          ACF1 Theil's U
## Training set 0.1219903      NA
## Test set     -0.1395258 0.9152204

```

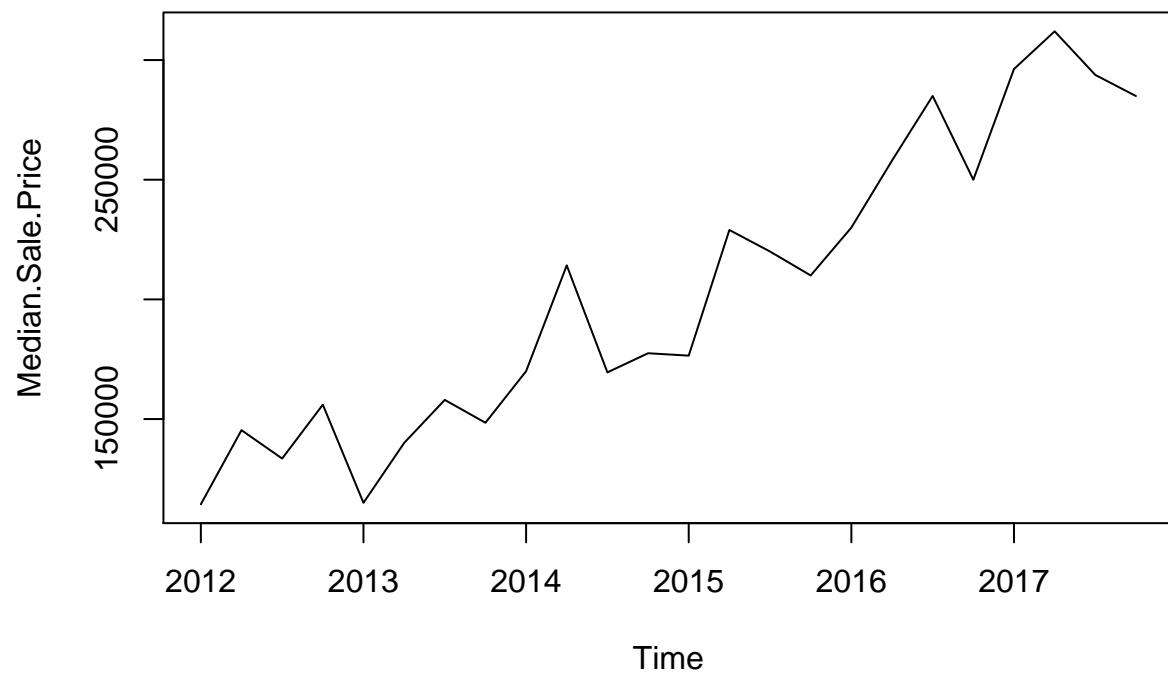
Portland, OR – Parkrose Heights : TS Training Model Comparison



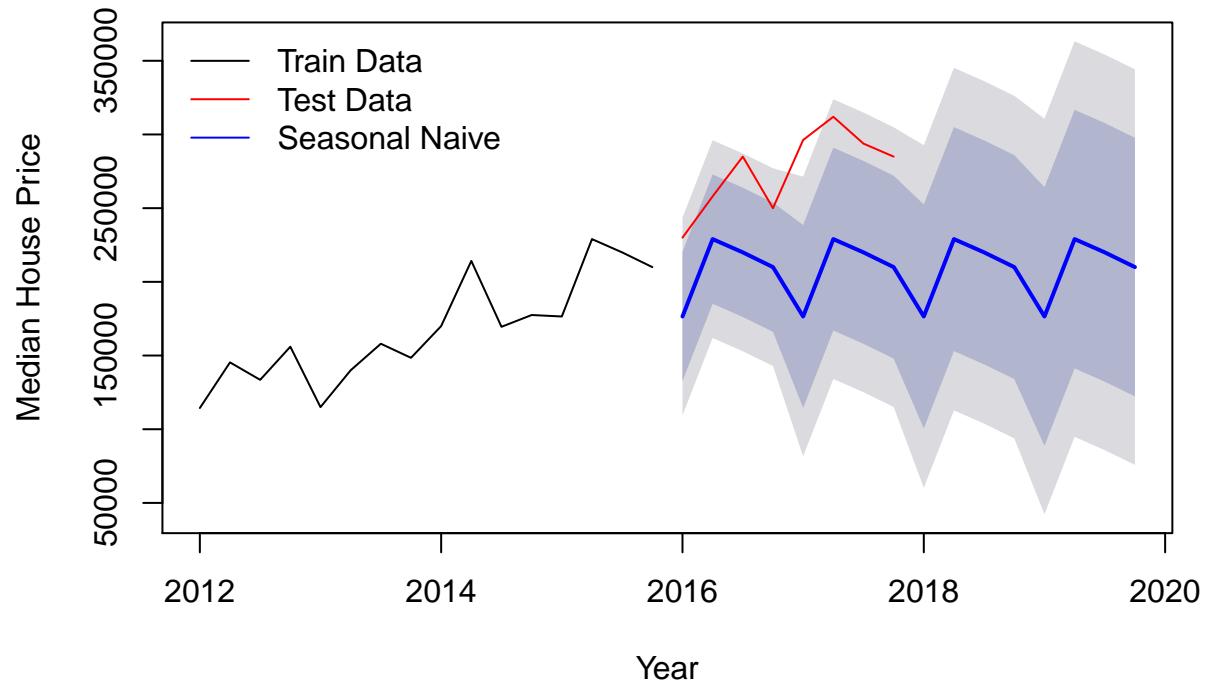
Portland, OR – Parkrose Heights : Full TS Models Comparison



Portland, OR – Lents–Powellhurst–Gilbert

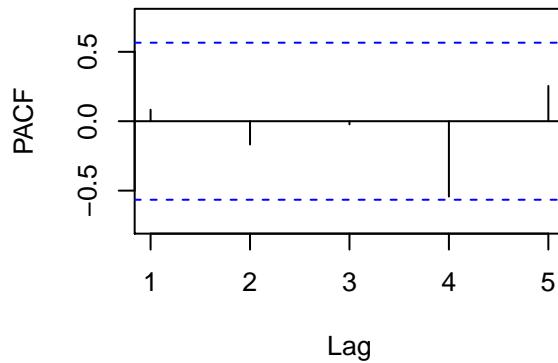
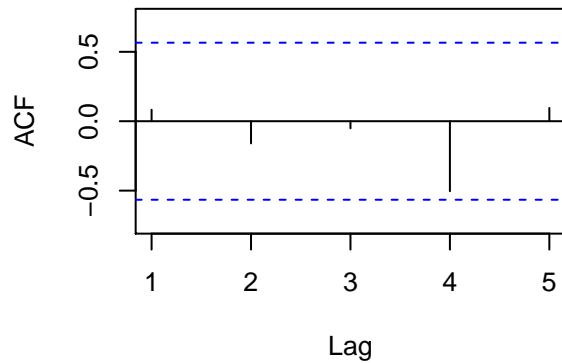
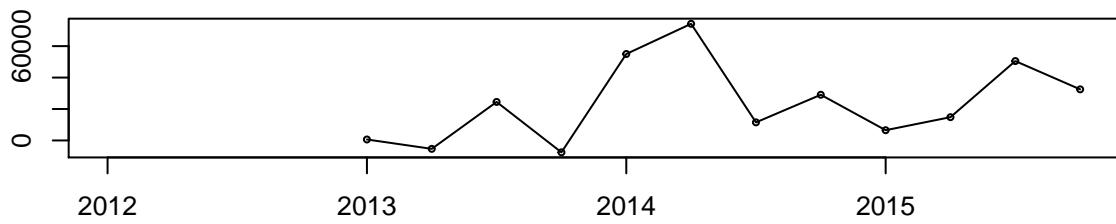


Portland, OR – Lents–Powellhurst–Gilbert : Naive Model Forecast

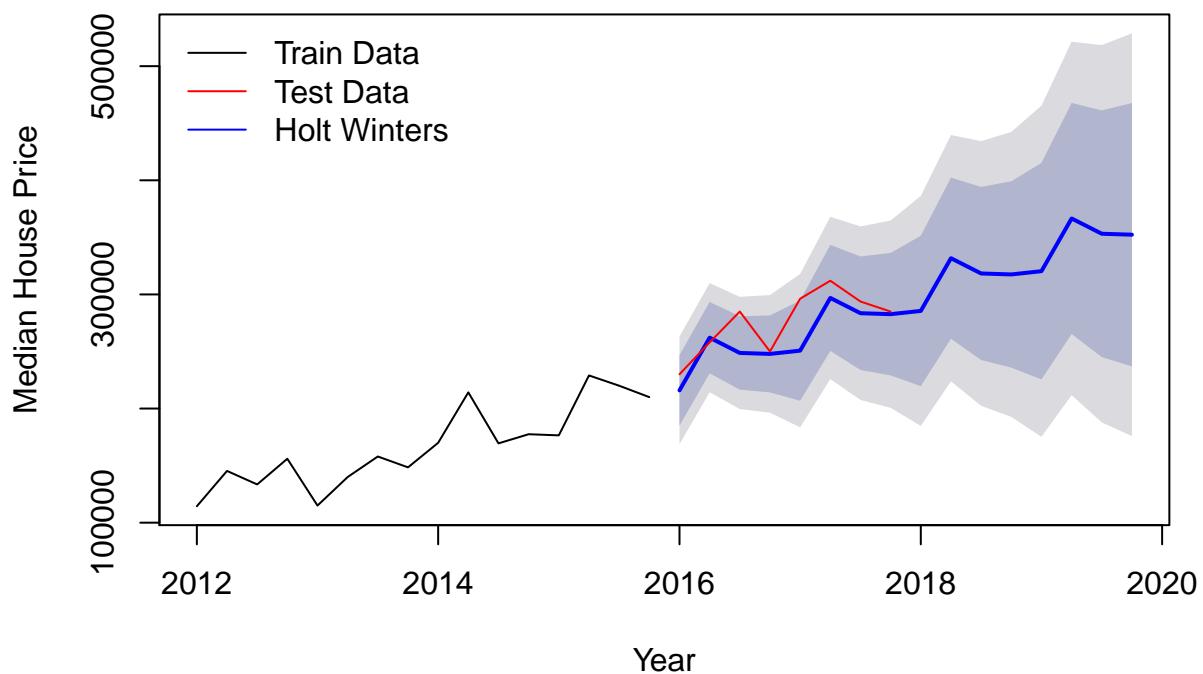


```
## Warning in HoltWinters(trainingData): optimization difficulties: ERROR:  
## ABNORMAL_TERMINATION_IN_LNSRCH  
  
## Warning in HoltWinters(trainingData): optimization difficulties: ERROR:  
## ABNORMAL_TERMINATION_IN_LNSRCH
```

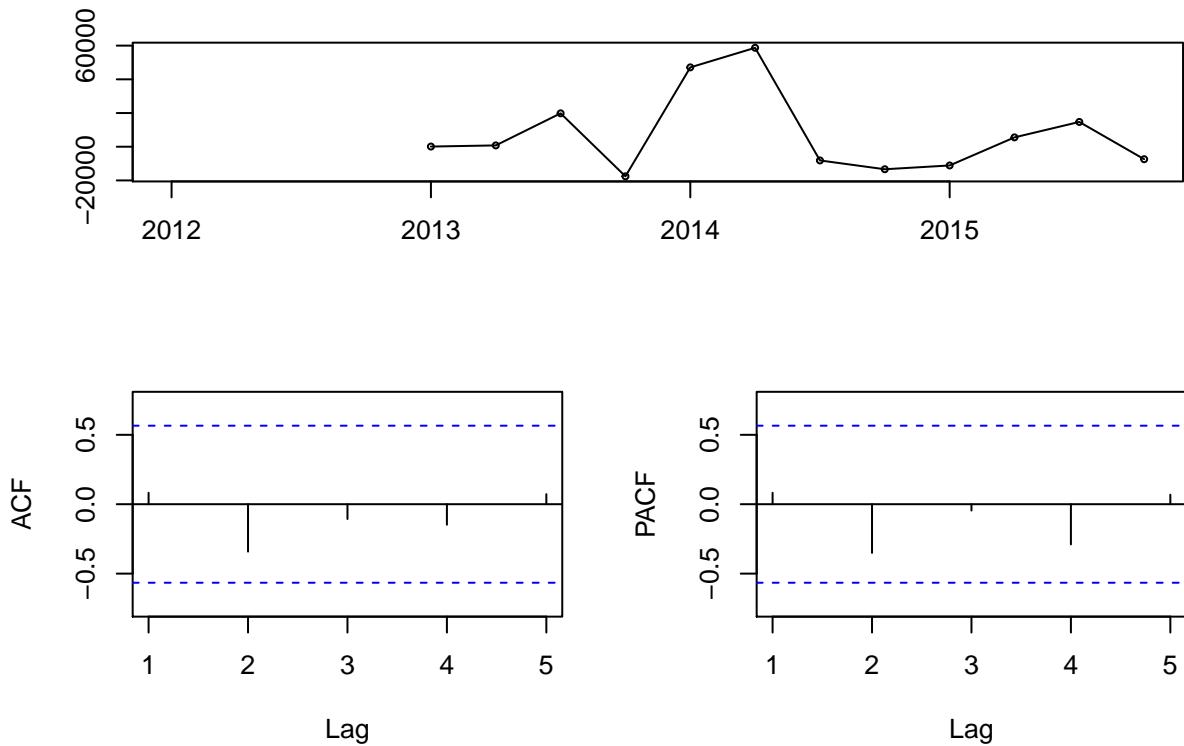
Portland, OR – Lents–Powellhurst–Gilbert : Naive Model Forecast Residuals



Portland, OR – Lents–Powellhurst–Gilbert : Holt Winters Model Forec

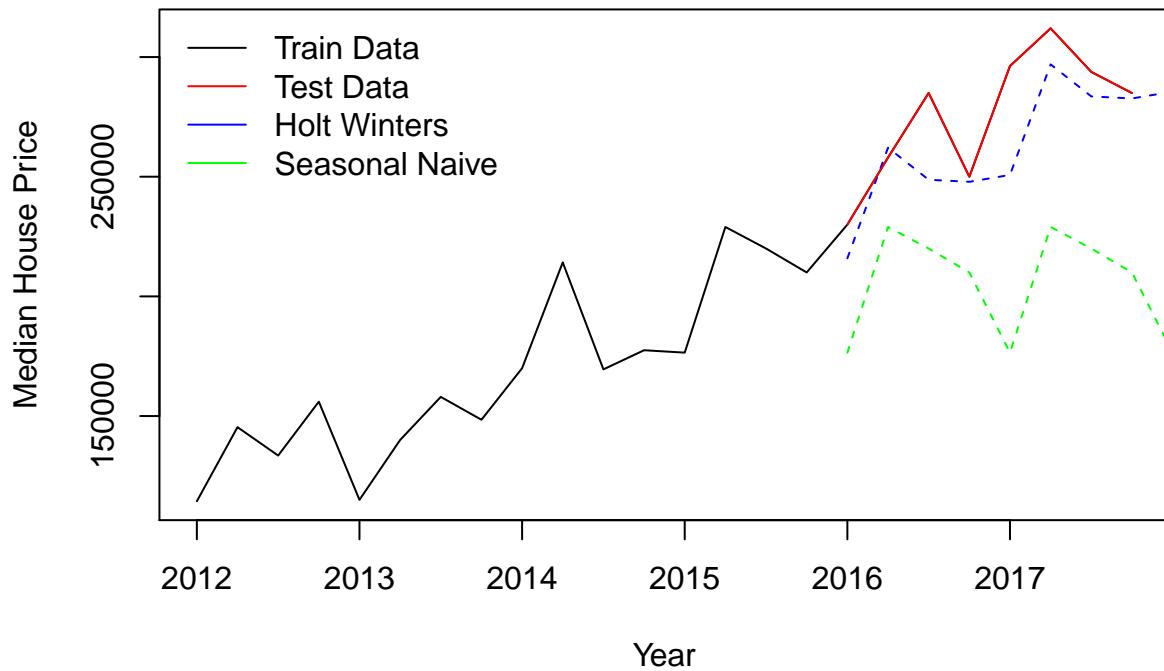


Portland, OR – Lents-Powellhurst-Gilbert : Holt Winters Model Forecast Residuals

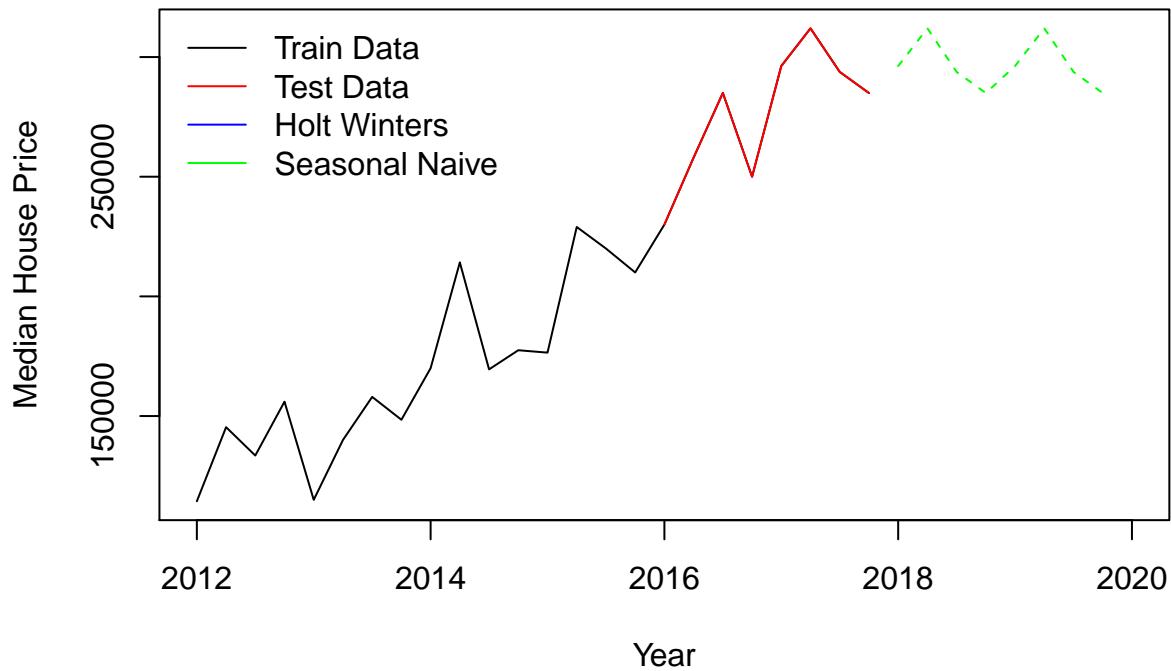


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Lents-Powellhurst-Gilbert"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 23854.17 34229.61 26004.17 12.15357 13.63812 1.000000
## Test set     67378.12 72305.78 67378.12 23.97014 23.97014 2.591051
##          ACF1 Theil's U
## Training set 0.08291819      NA
## Test set     0.04038930  2.53446
## [1] "Holt Winters Accuracy for Portland, OR – Lents-Powellhurst-Gilbert"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 7428.413 24213.41 17028.09 3.617312 9.282528 0.6548218
## Test set     15179.669 22201.06 16211.28 5.321509 5.721358 0.6234108
##          ACF1 Theil's U
## Training set 0.0822369      NA
## Test set     -0.4746537  0.83266
```

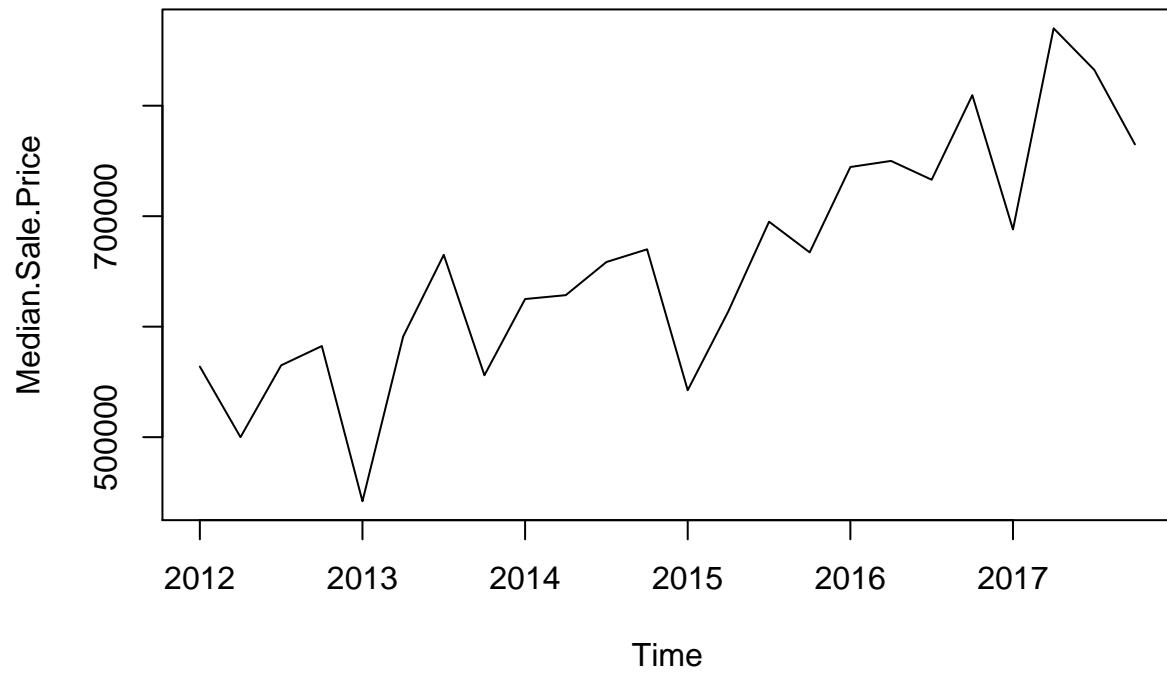
Portland, OR – Lents–Powellhurst–Gilbert : TS Training Model Compar



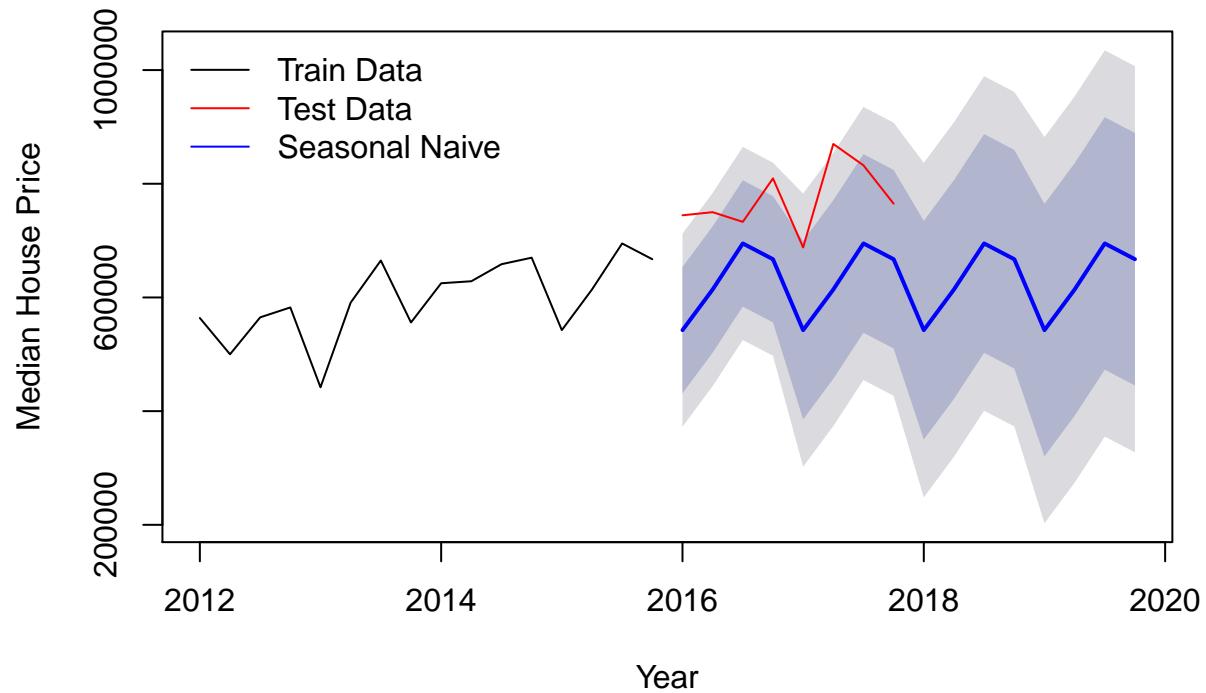
Portland, OR – Lents–Powellhurst–Gilbert : Full TS Models Comparis



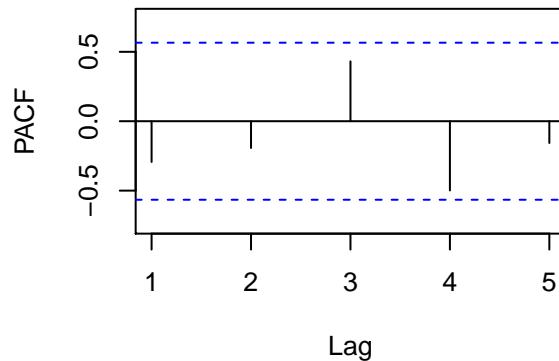
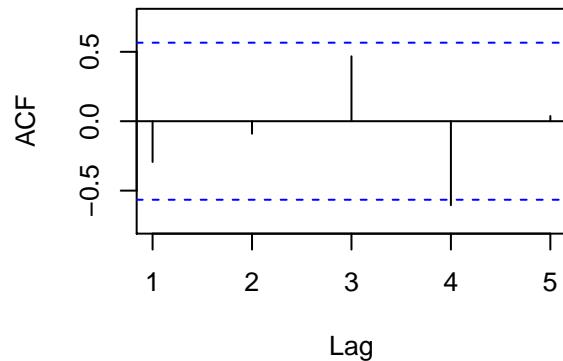
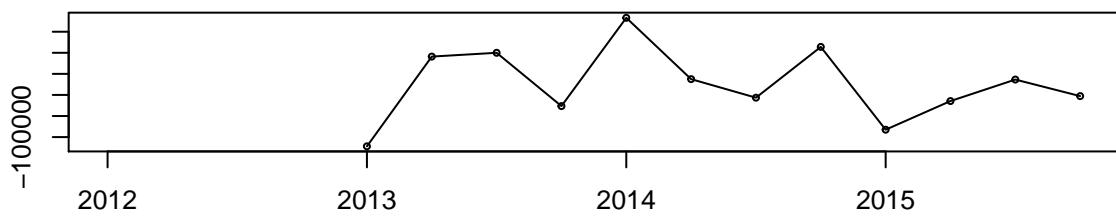
Portland, OR – Southwest Hills



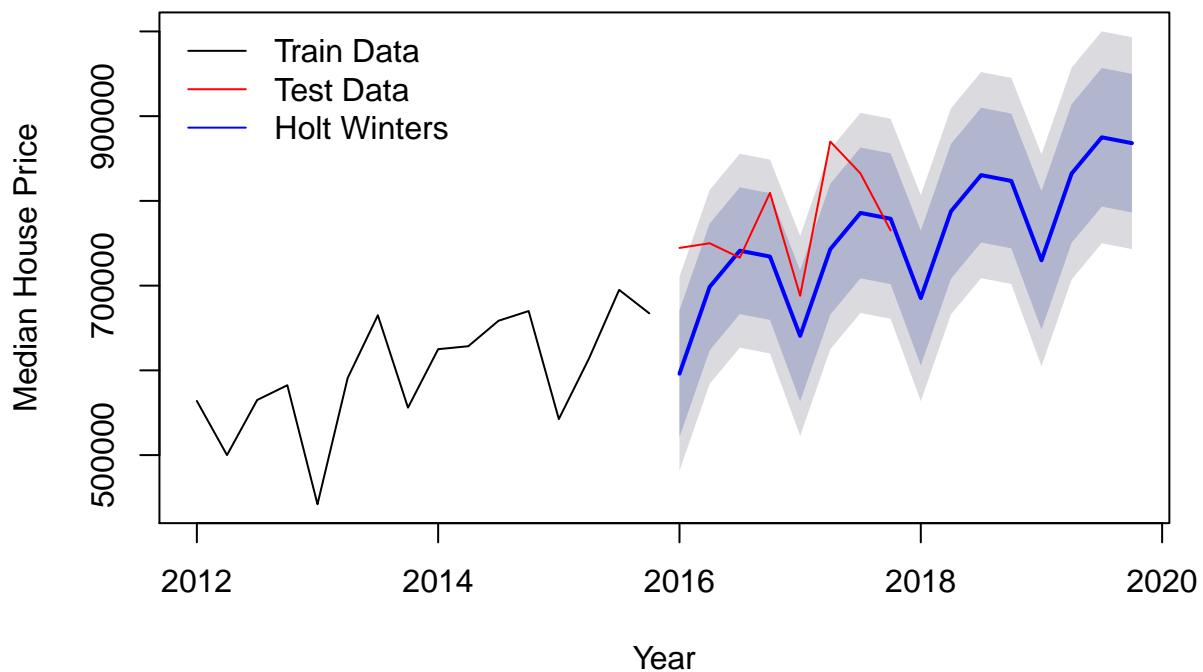
Portland, OR – Southwest Hills : Naive Model Forecast



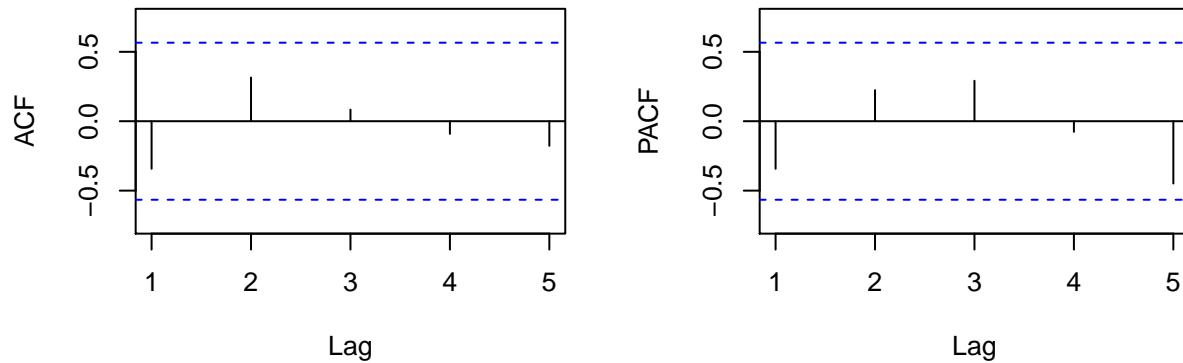
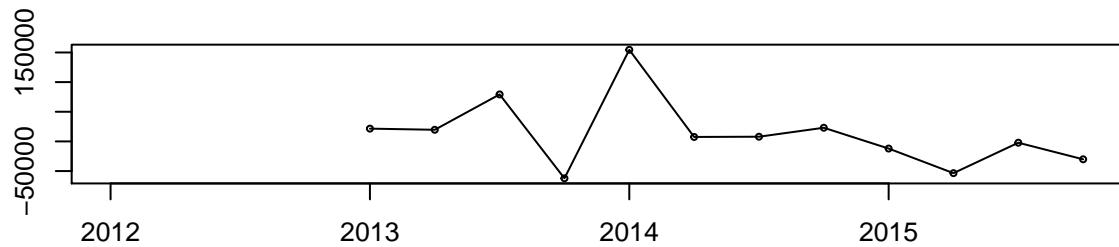
Portland, OR – Southwest Hills : Naive Model Forecast Residuals



Portland, OR – Southwest Hills : Holt Winters Model Forecast



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

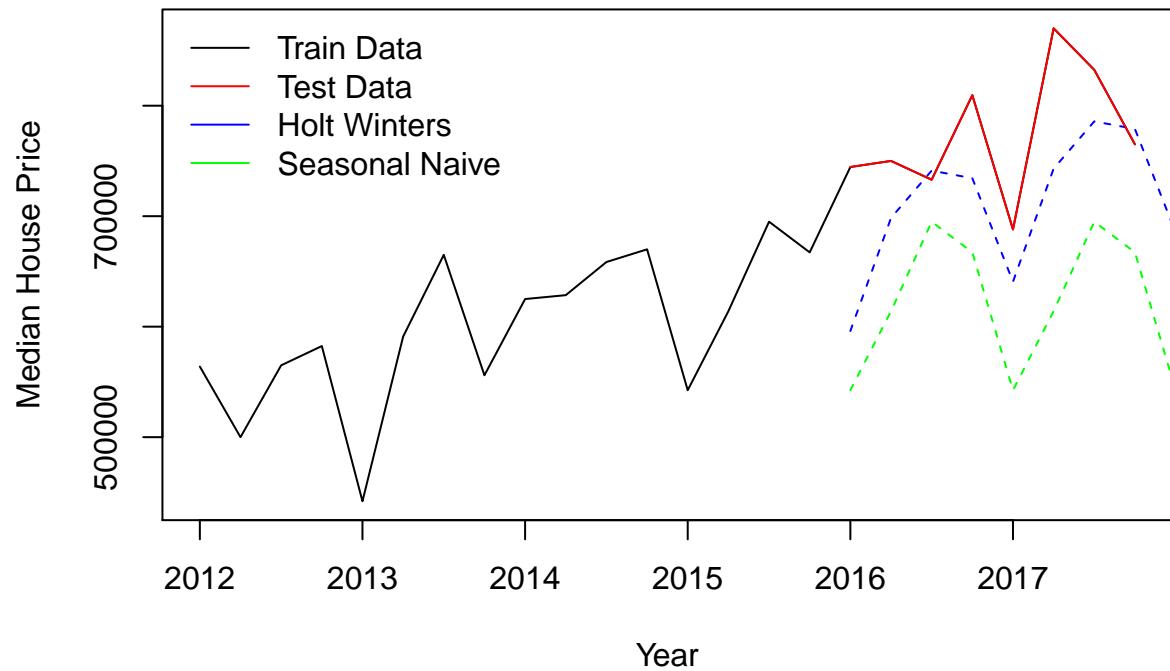


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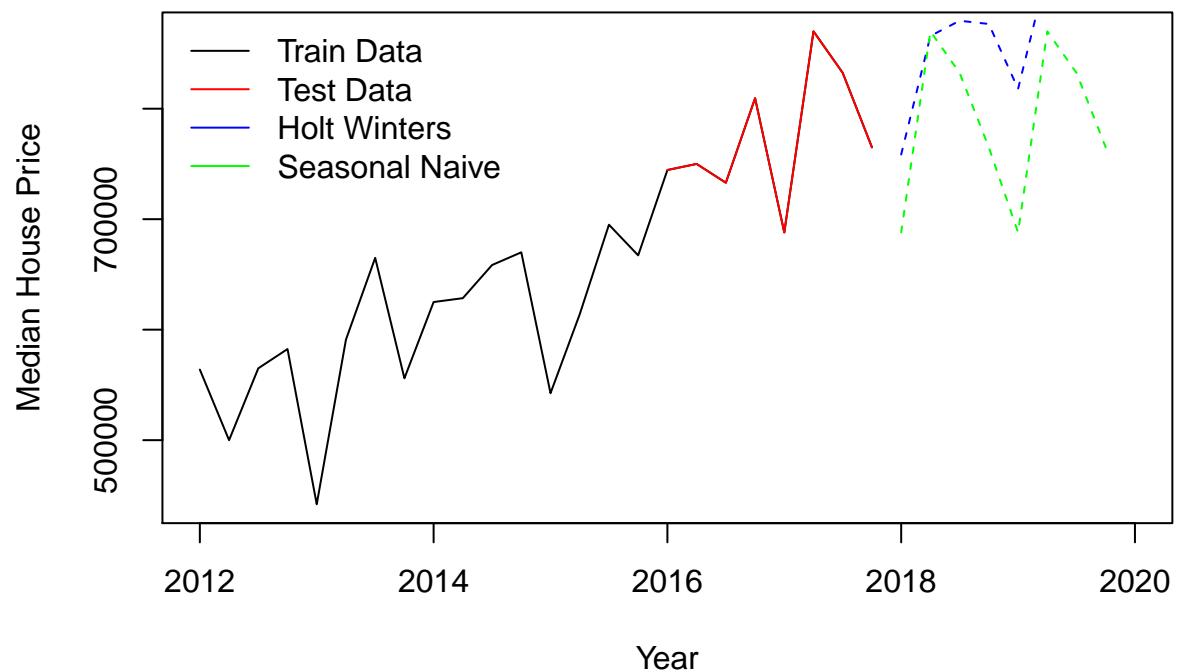
## [1] "Seasonal Naive Accuracy for Portland, OR - Southwest Hills"
##                               ME      RMSE      MAE      MPE      MAPE      MASE
## Training set  25618.54  86662.44  68048.12  3.05409 11.6040 1.00000
## Test set     144360.00 156571.71 144360.00 18.48470 18.4847 2.12144
##                               ACF1 Theil's U
## Training set -0.29376260      NA
## Test set     0.01034668  1.587016
## [1] "Holt Winters Accuracy for Portland, OR - Southwest Hills"
##                               ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 12781.16 57326.59 39459.07 1.977302 6.469092 0.5798700
## Test set     59230.18 79945.26 64774.11 7.527376 8.263841 0.9518867
##                               ACF1 Theil's U
## Training set -0.34268085      NA
## Test set     -0.09397678  0.7060907

```

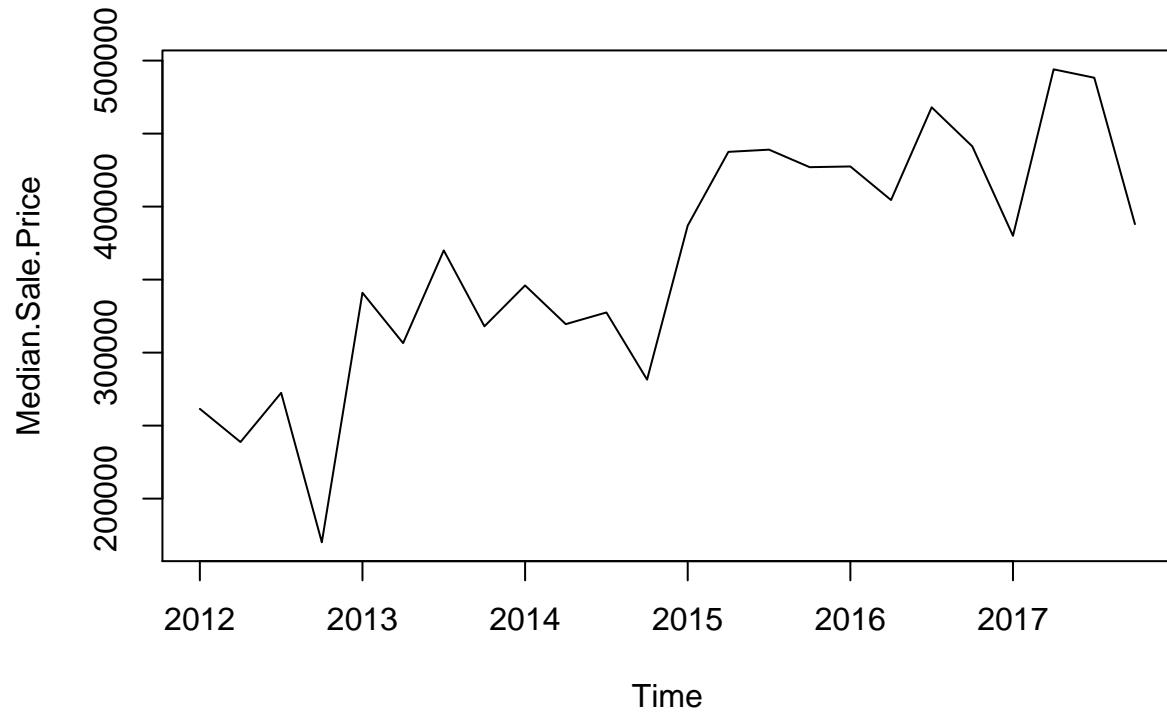
Portland, OR – Southwest Hills : TS Training Model Comparison



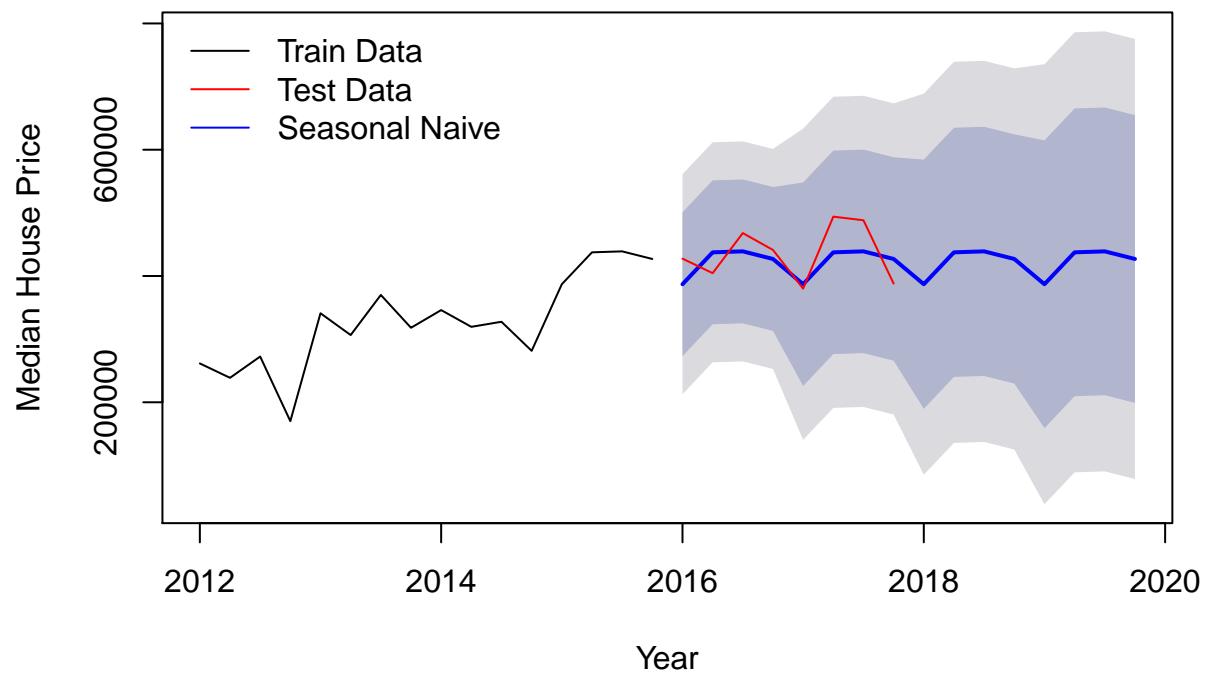
Portland, OR – Southwest Hills : Full TS Models Comparison



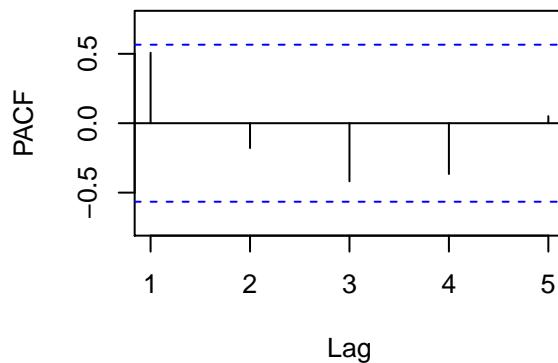
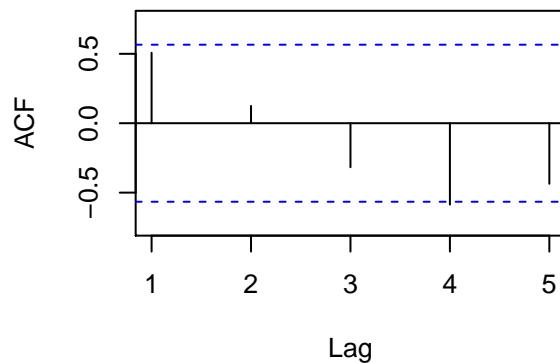
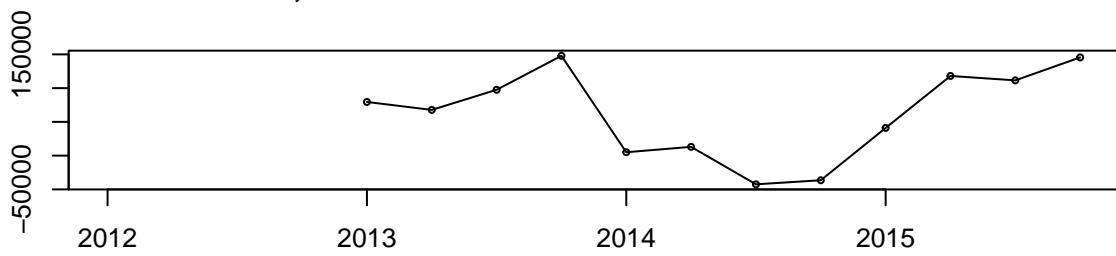
Portland, OR – Center



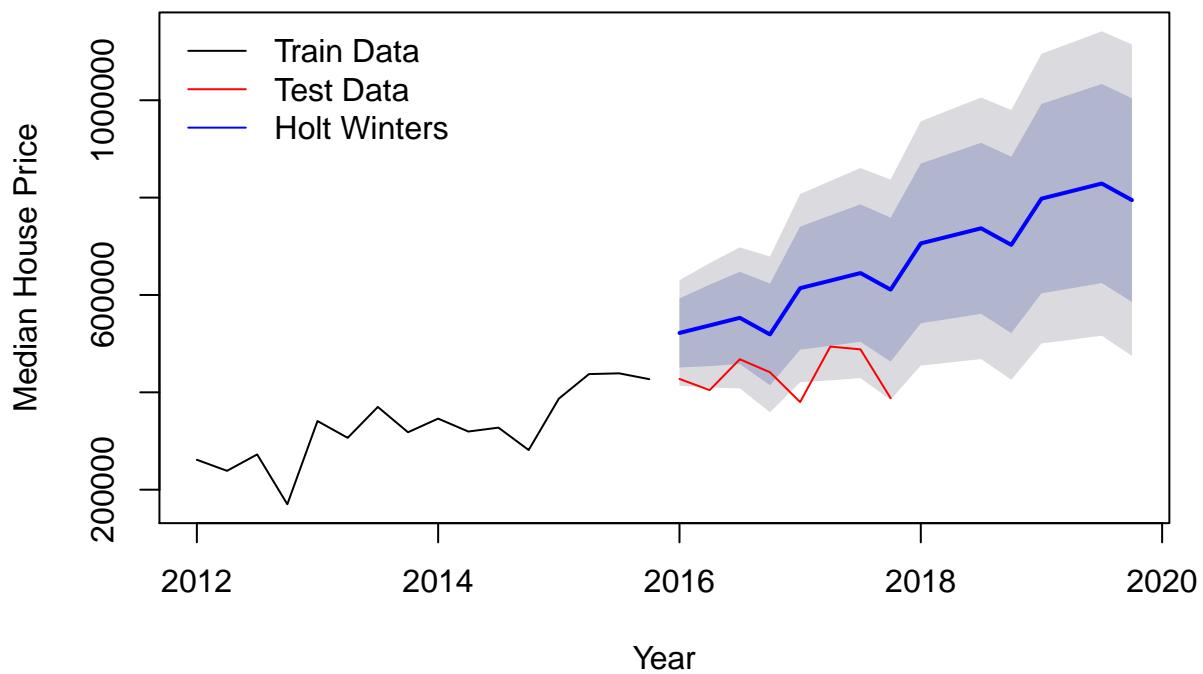
Portland, OR – Center : Naive Model Forecast



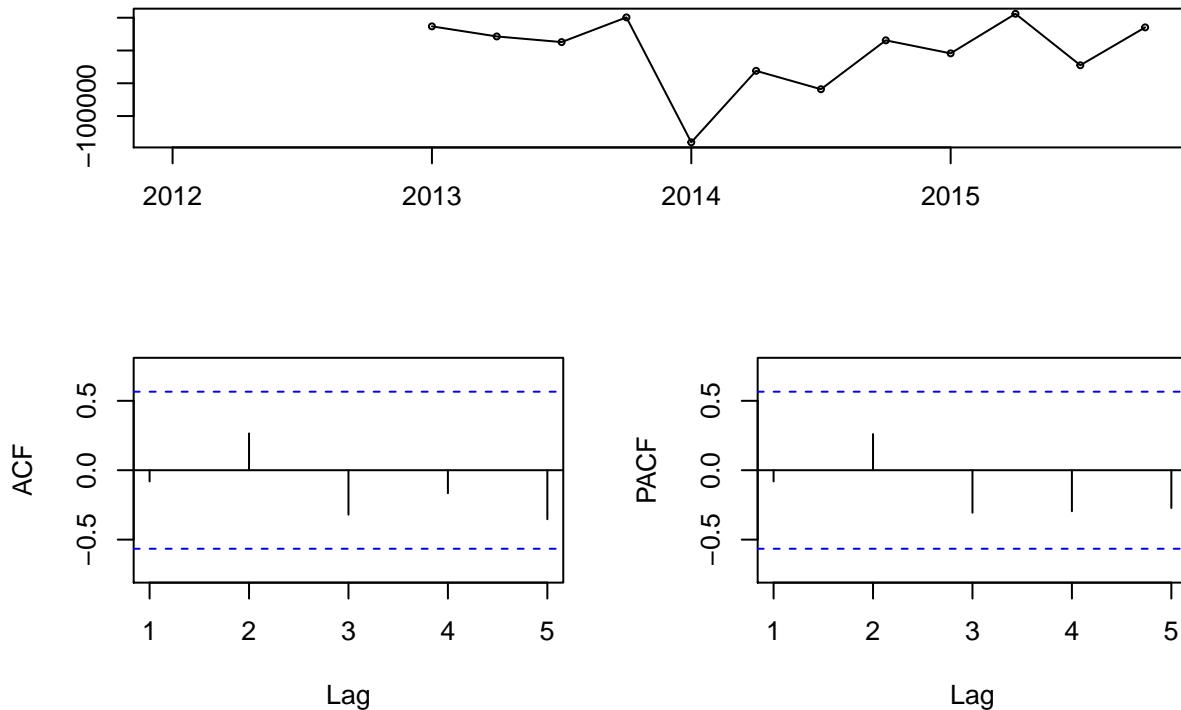
Portland, OR – Center : Naive Model Forecast Residuals



Portland, OR – Center : Holt Winters Model Forecast



Portland, OR – Center : Holt Winters Model Forecast Residuals

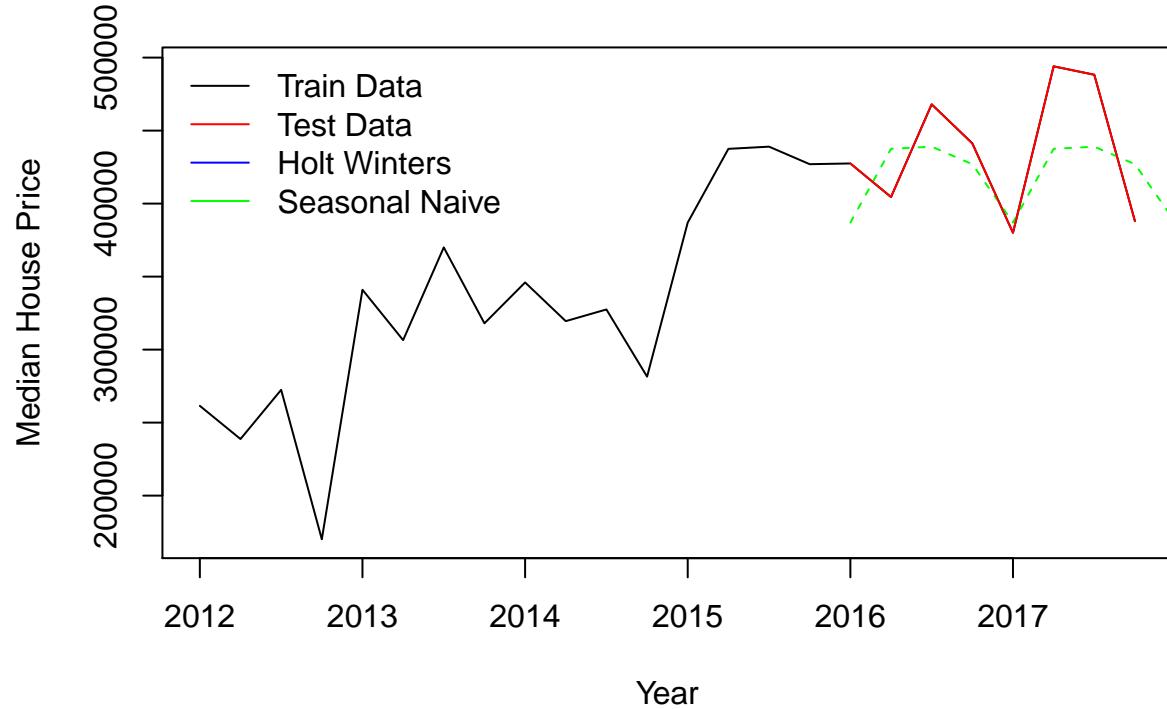


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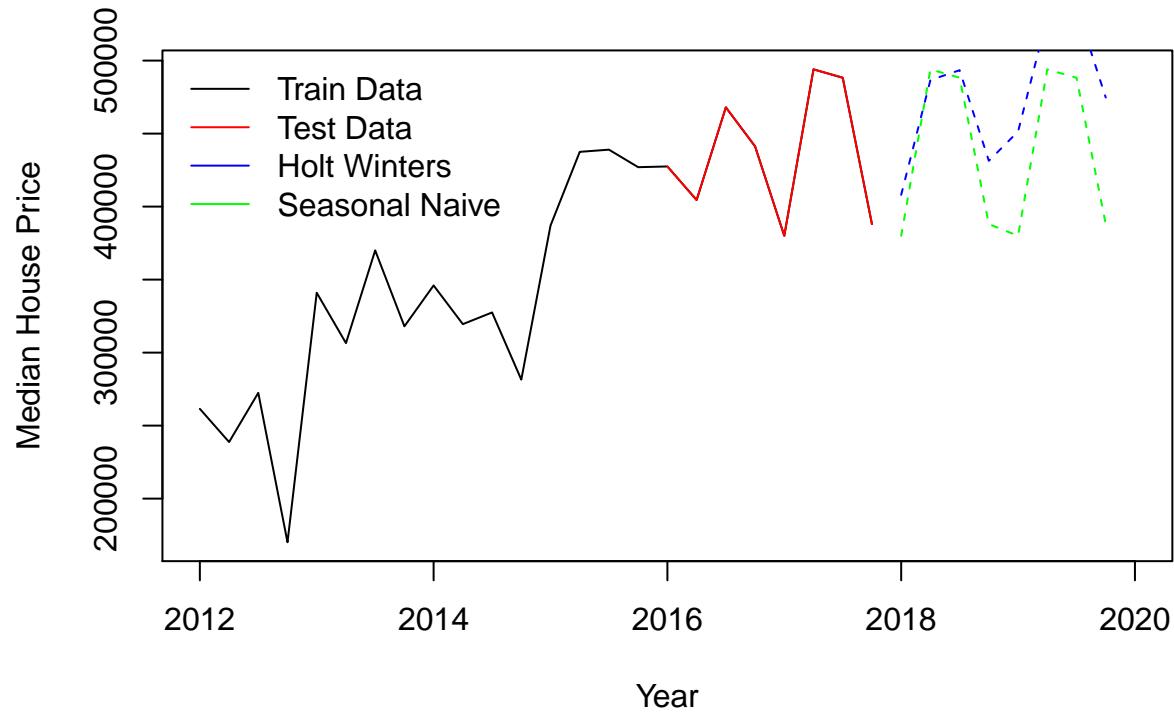
## [1] "Seasonal Naive Accuracy for Portland, OR – Center"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 62305.83 88896.87 75472.5 16.241080 20.564972 1.0000000
## Test set     13812.50 37015.41 33562.5  2.546519  7.559486 0.4446984
##          ACF1 Theil's U
## Training set 0.5077408      NA
## Test set     -0.3402253 0.5272881
## [1] "Holt Winters Accuracy for Portland, OR – Center"
##          ME      RMSE      MAE      MPE      MAPE
## Training set -2370.486 53031.14 40452.14 -0.8923235 11.51688
## Test set     -142412.626 152982.96 142412.63 -33.6632960 33.66330
##          MASE      ACF1 Theil's U
## Training set 0.5359852 -0.08076055      NA
## Test set     1.8869473 -0.03212064  2.203949

```

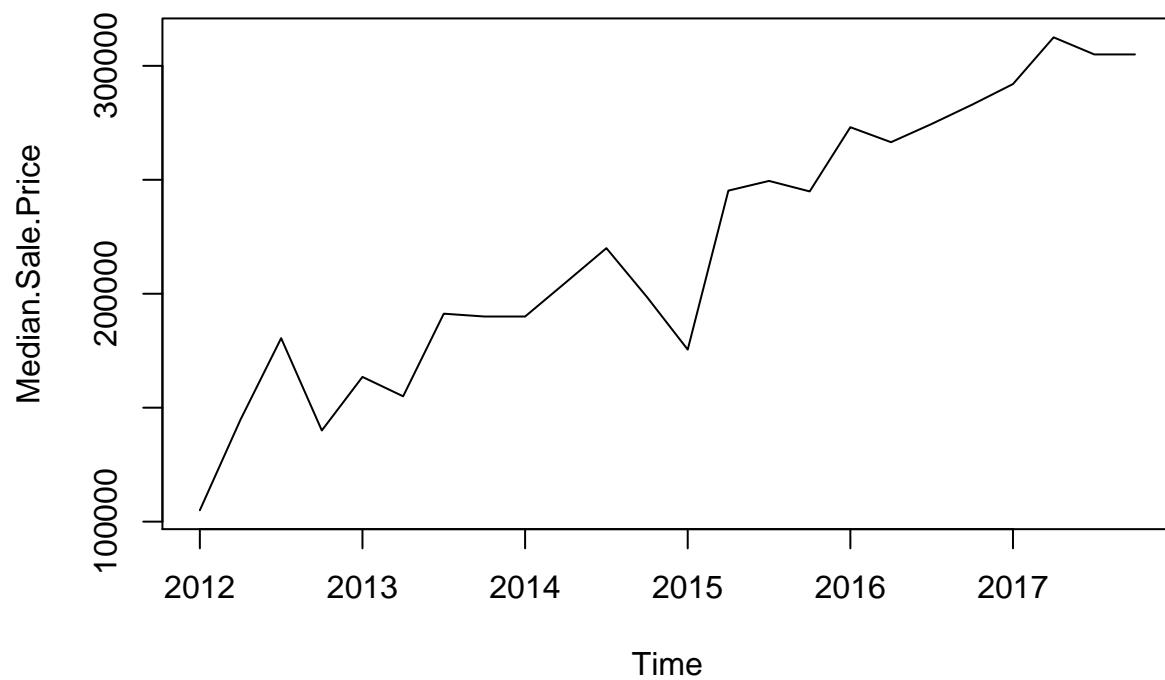
Portland, OR – Center : TS Training Model Comparison



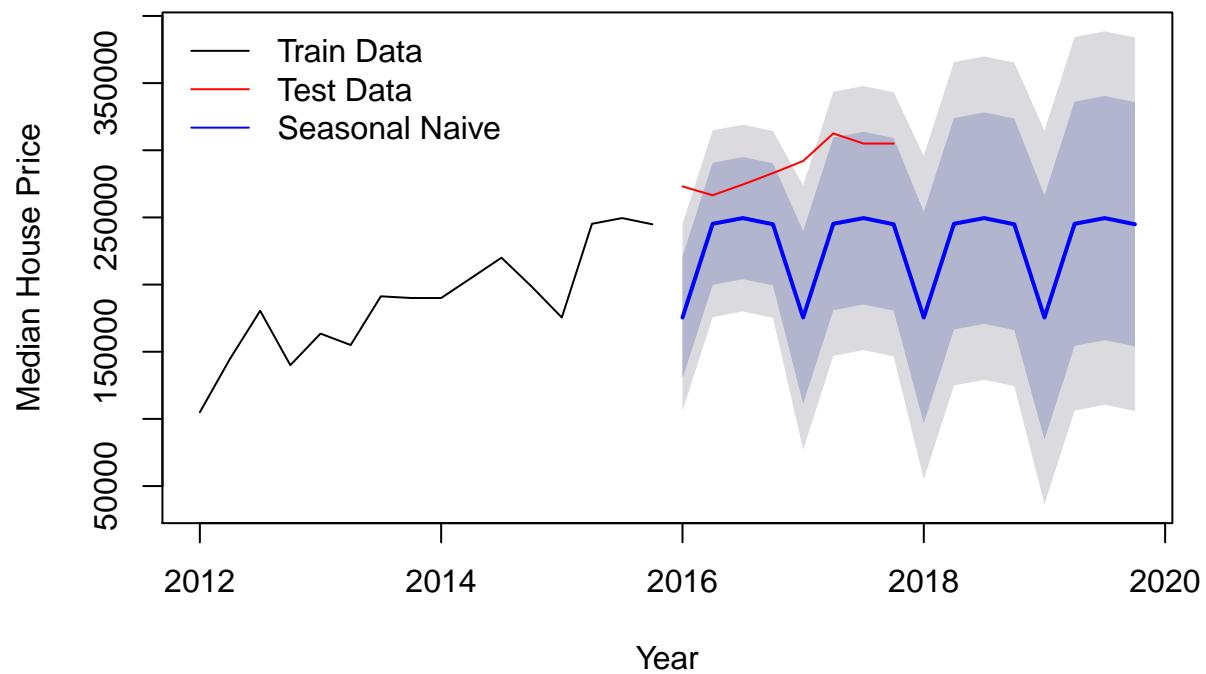
Portland, OR – Center : Full TS Models Comparison



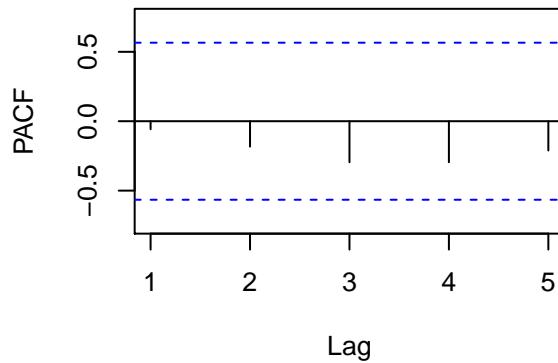
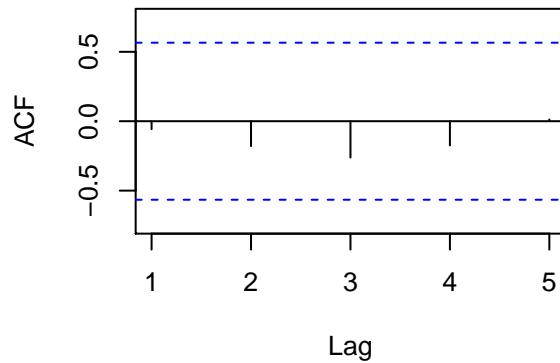
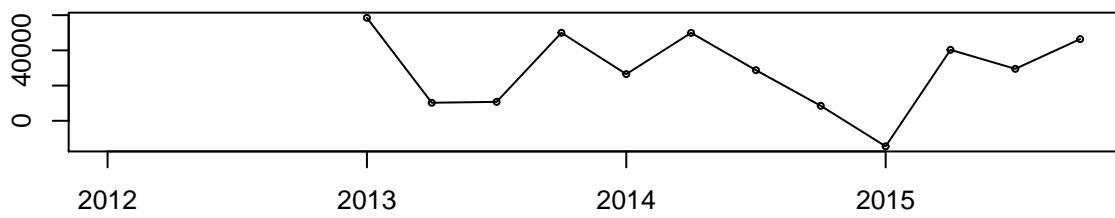
Portland, OR – Parkrose



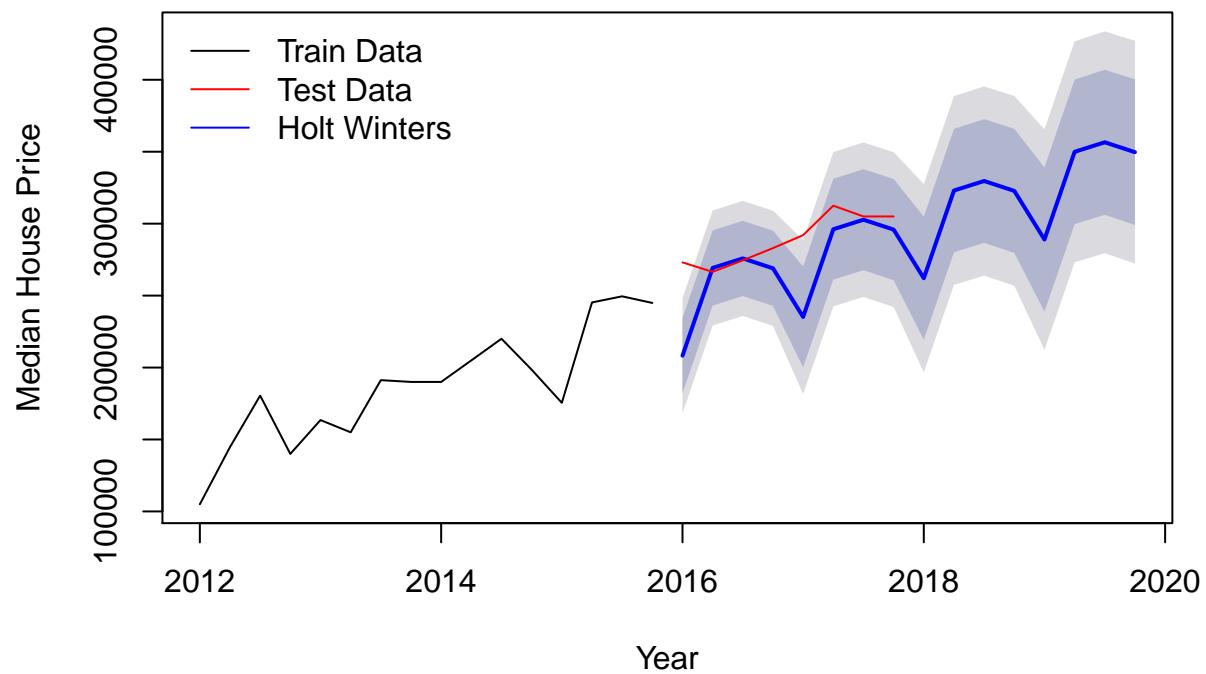
Portland, OR – Parkrose : Naive Model Forecast



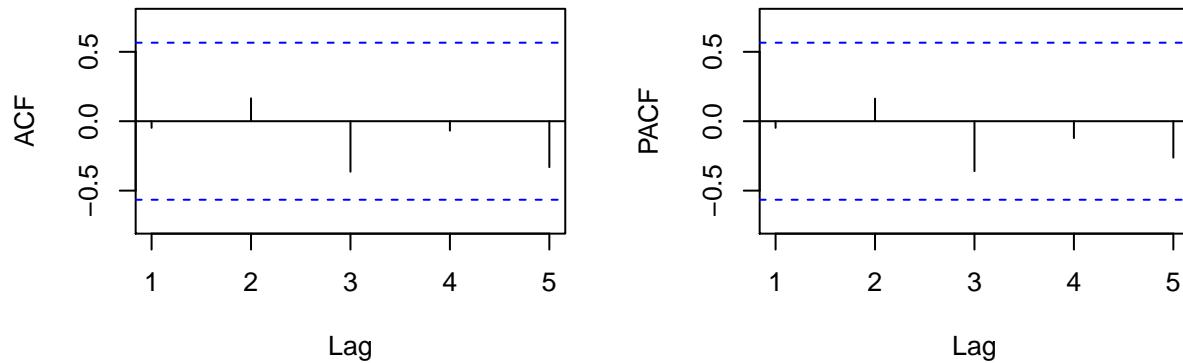
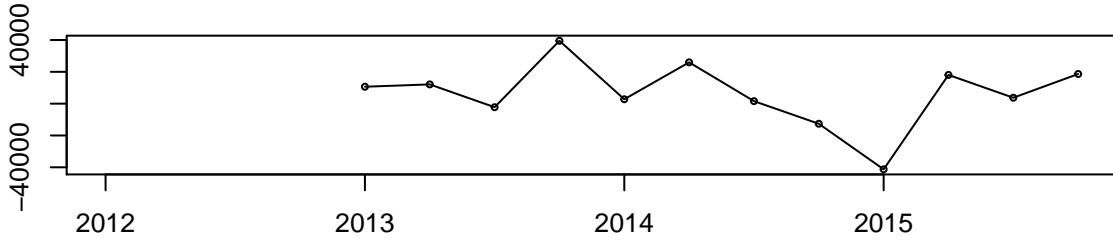
Portland, OR – Parkrose : Naive Model Forecast Residuals



Portland, OR – Parkrose : Holt Winters Model Forecast

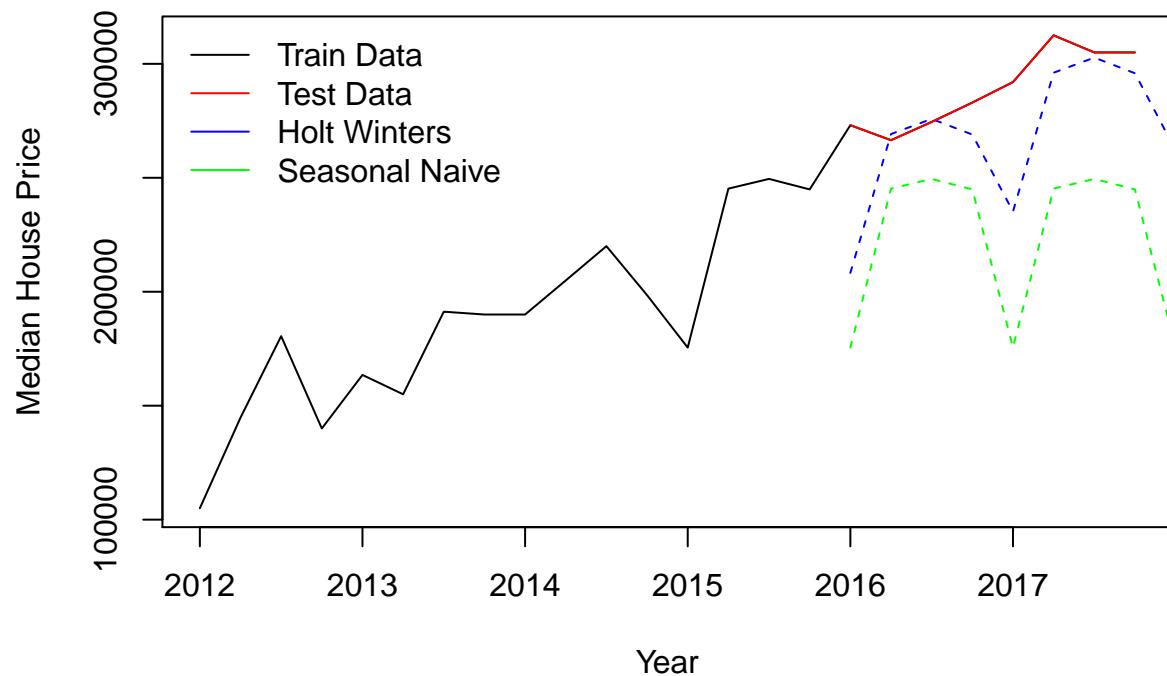


Portland, OR – Parkrose : Holt Winters Model Forecast Residuals

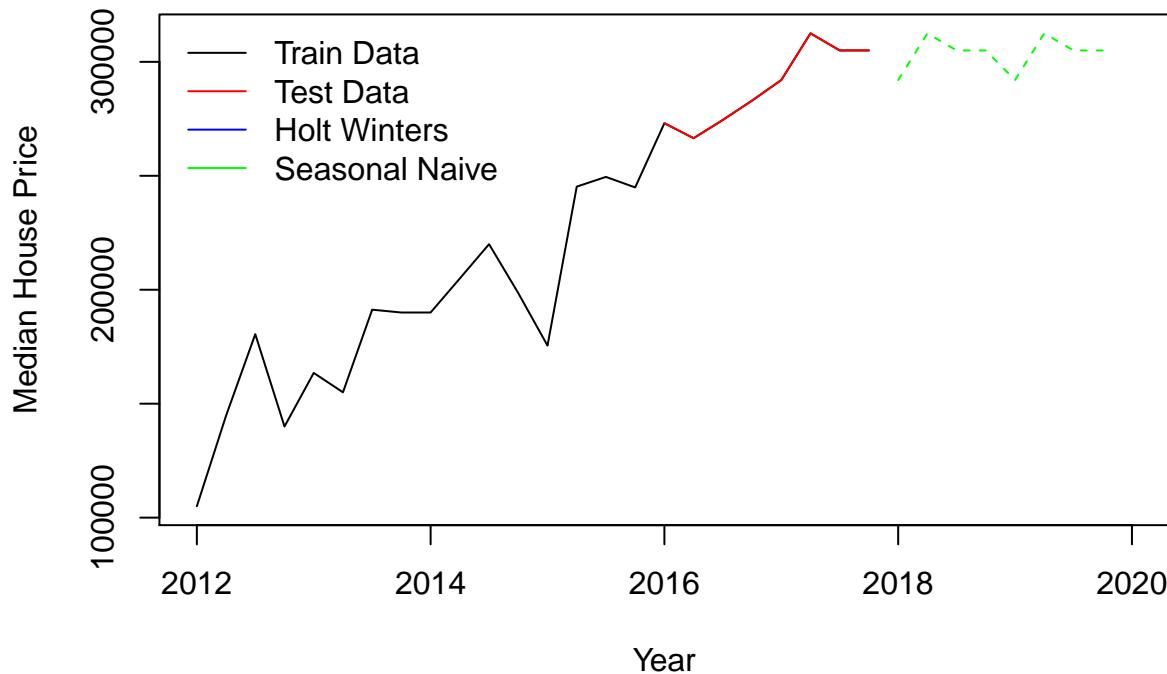


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Parkrose"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 28741.67 35468.87 31158.33 14.07826 15.45528 1.000000
## Test set     60159.38 67856.58 60159.38 20.69937 20.69937 1.930764
##          ACF1 Theil's U
## Training set -0.05741469      NA
## Test set     -0.02388777  6.04251
## [1] "Holt Winters Accuracy for Portland, OR – Parkrose"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 6401.863 20536.08 15761.94 2.946404 8.123111 0.5058659
## Test set     19927.765 31610.11 20937.19 6.954440 7.329557 0.6719610
##          ACF1 Theil's U
## Training set -0.04758655      NA
## Test set     -0.10460560  2.294847
```

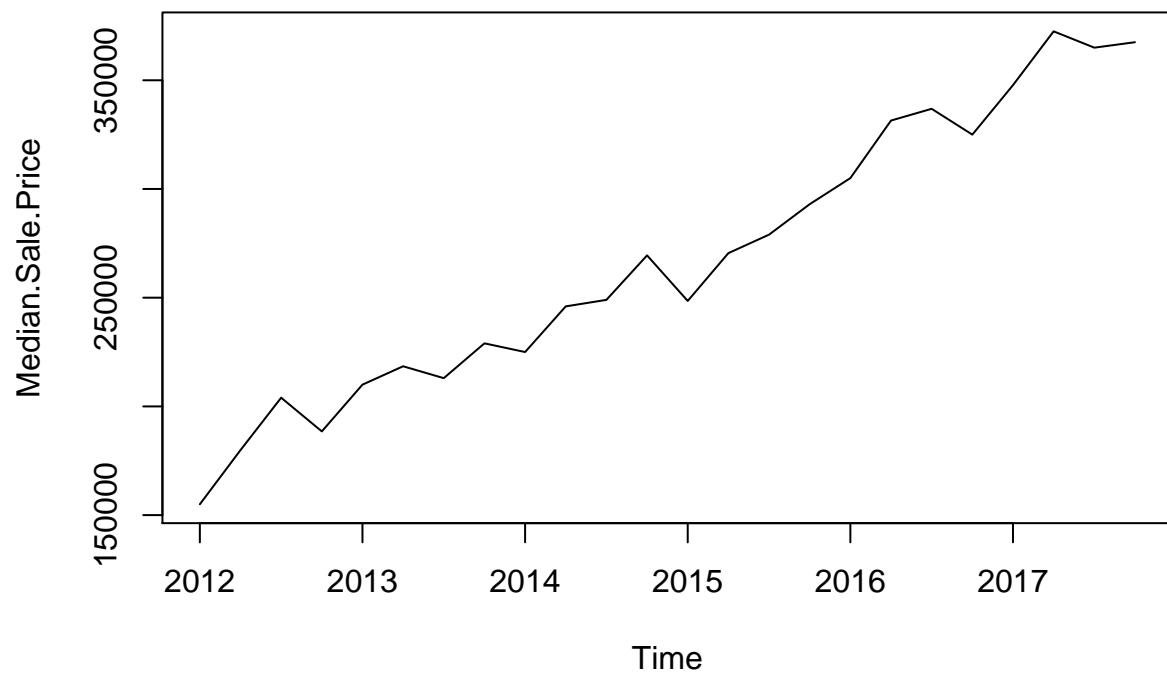
Portland, OR – Parkrose : TS Training Model Comparison



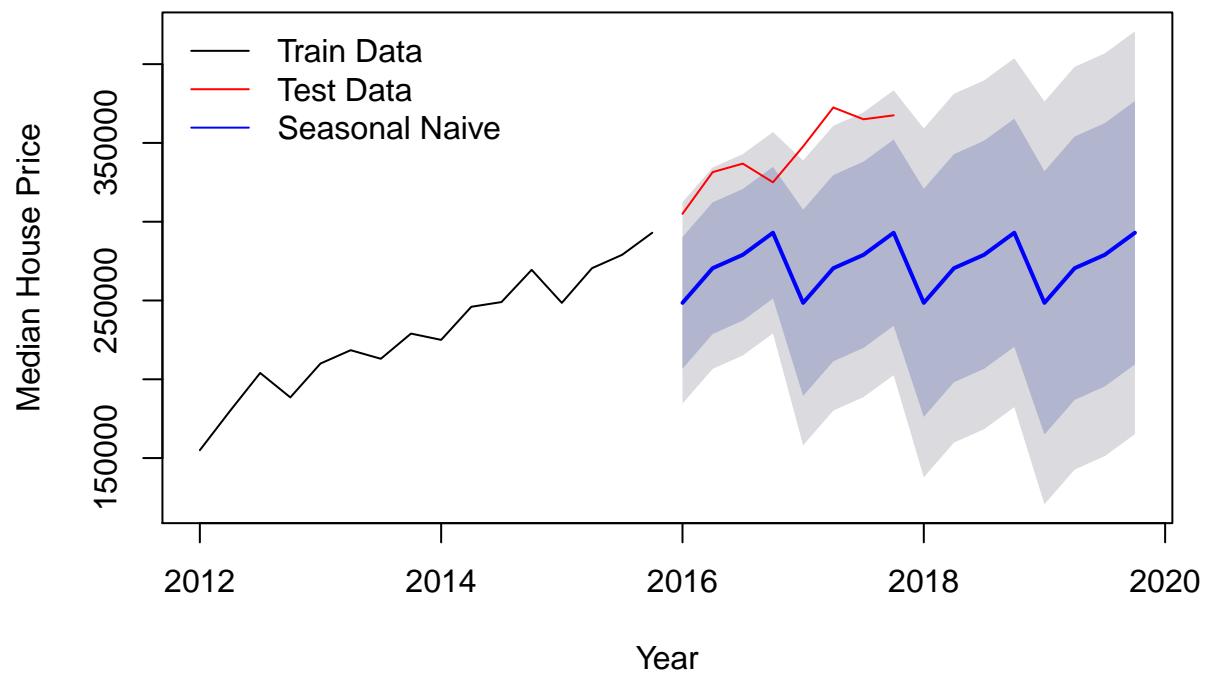
Portland, OR – Parkrose : Full TS Models Comparison



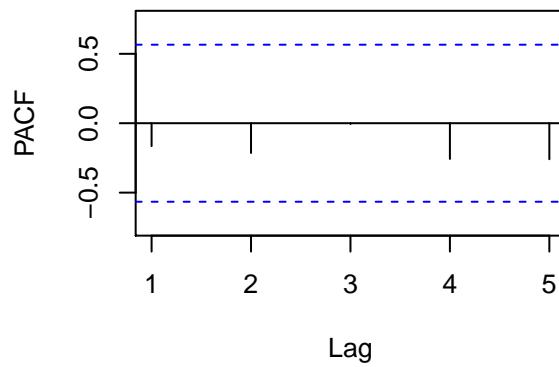
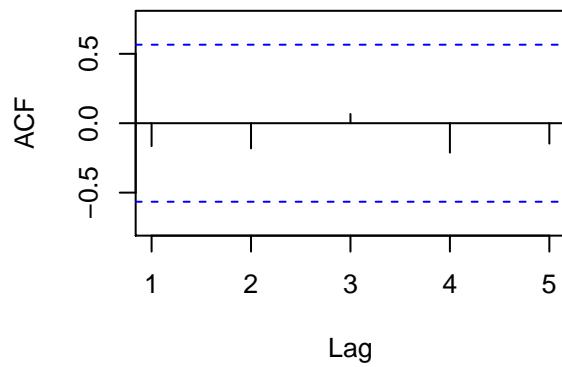
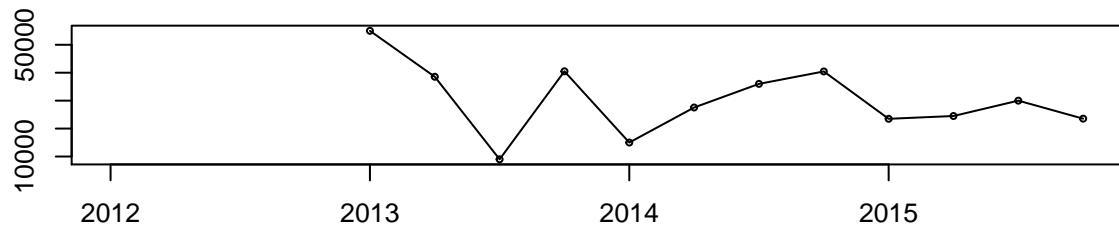
Portland, OR – Montavilla



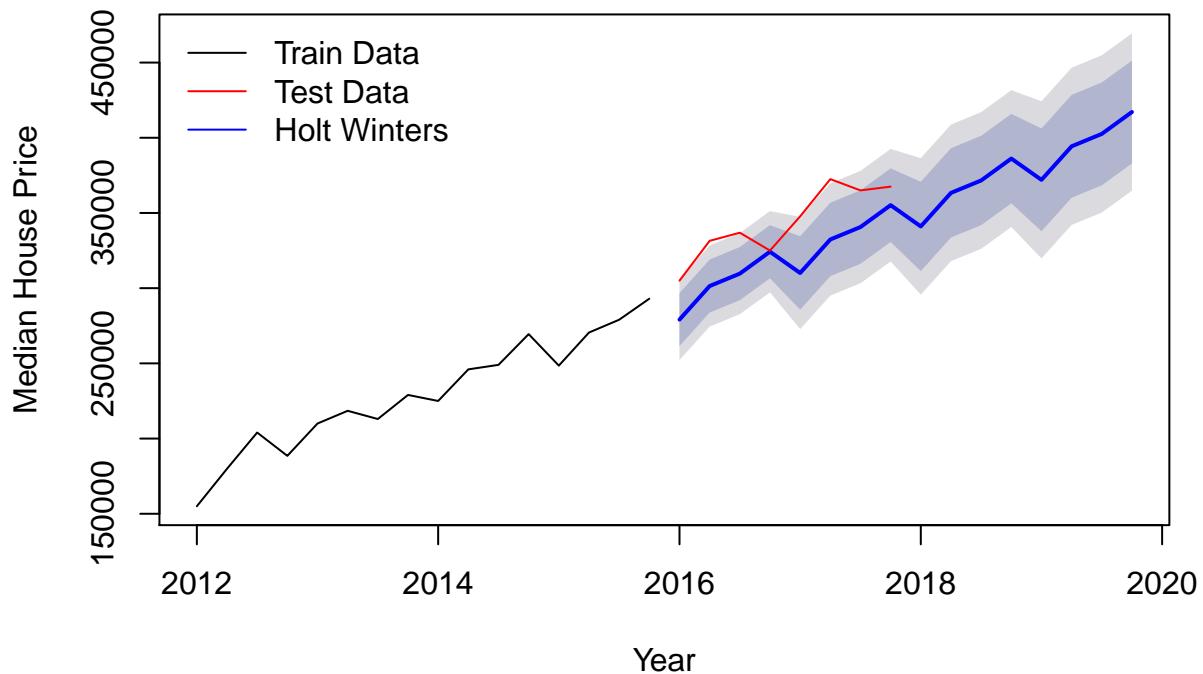
Portland, OR – Montavilla : Naive Model Forecast



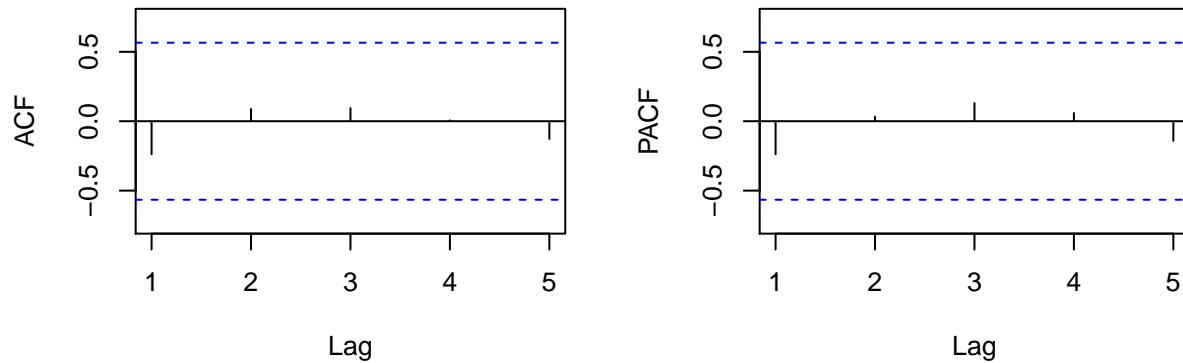
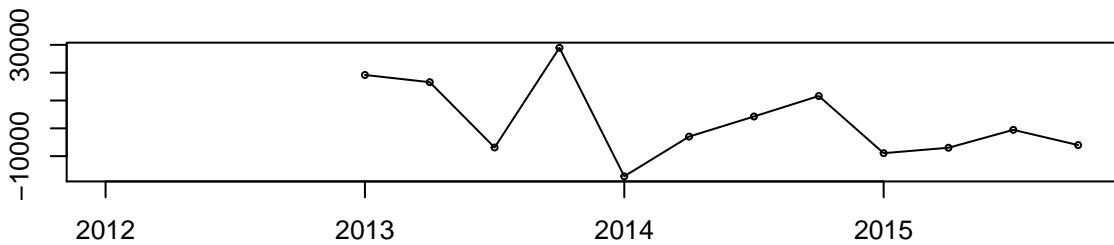
Portland, OR – Montavilla : Naive Model Forecast Residuals



Portland, OR – Montavilla : Holt Winters Model Forecast



Portland, OR – Montavilla : Holt Winters Model Forecast Residuals

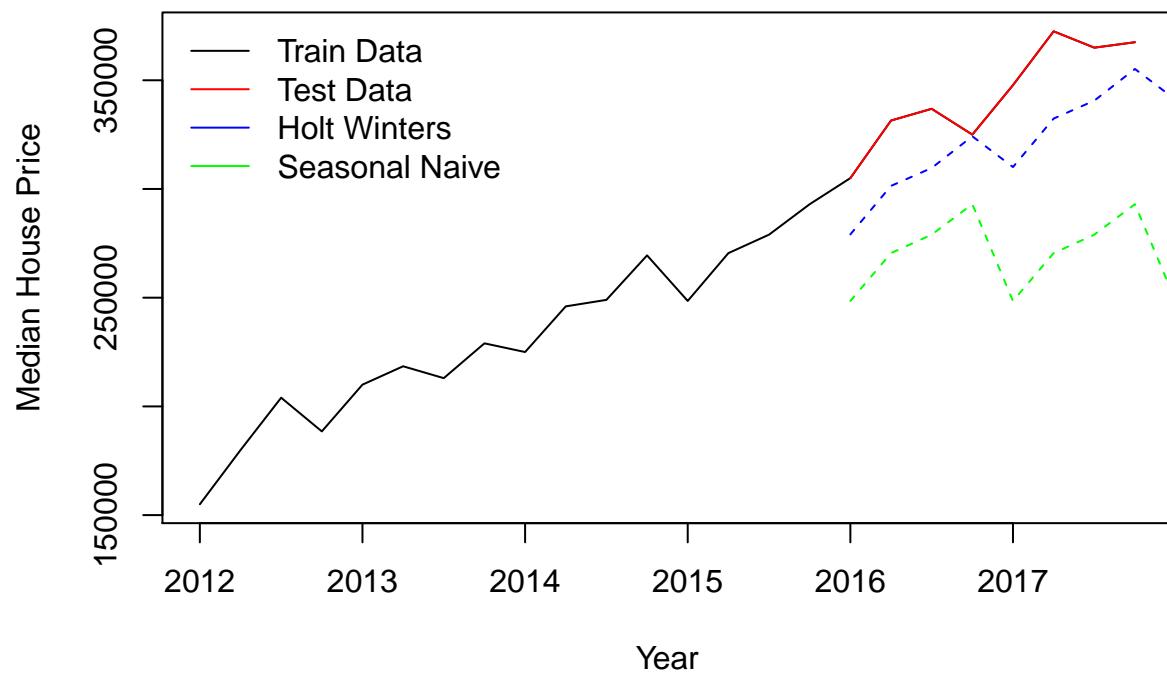


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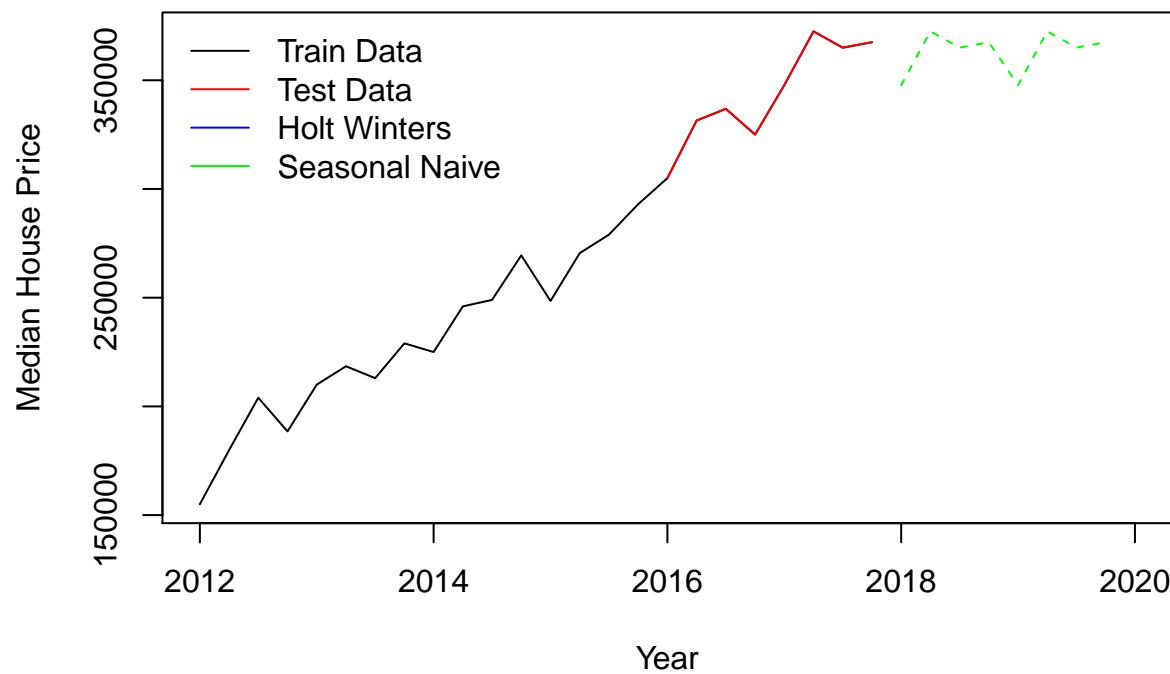
## [1] "Seasonal Naive Accuracy for Portland, OR - Montavilla"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 30300.0 32603.25 30300.0 12.53237 12.53237 1.000000
## Test set     71137.5 74569.20 71137.5 20.46284 20.46284 2.347772
##          ACF1 Theil's U
## Training set -0.1649795      NA
## Test set     0.2696463 4.263431
## [1] "Holt Winters Accuracy for Portland, OR - Montavilla"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 2585.541 13390.56 10843.60 1.238784 4.658369 0.3578747
## Test set     24798.490 27587.07 24798.49 7.187121 7.187121 0.8184320
##          ACF1 Theil's U
## Training set -0.2382659      NA
## Test set     -0.1307519 1.580596

```

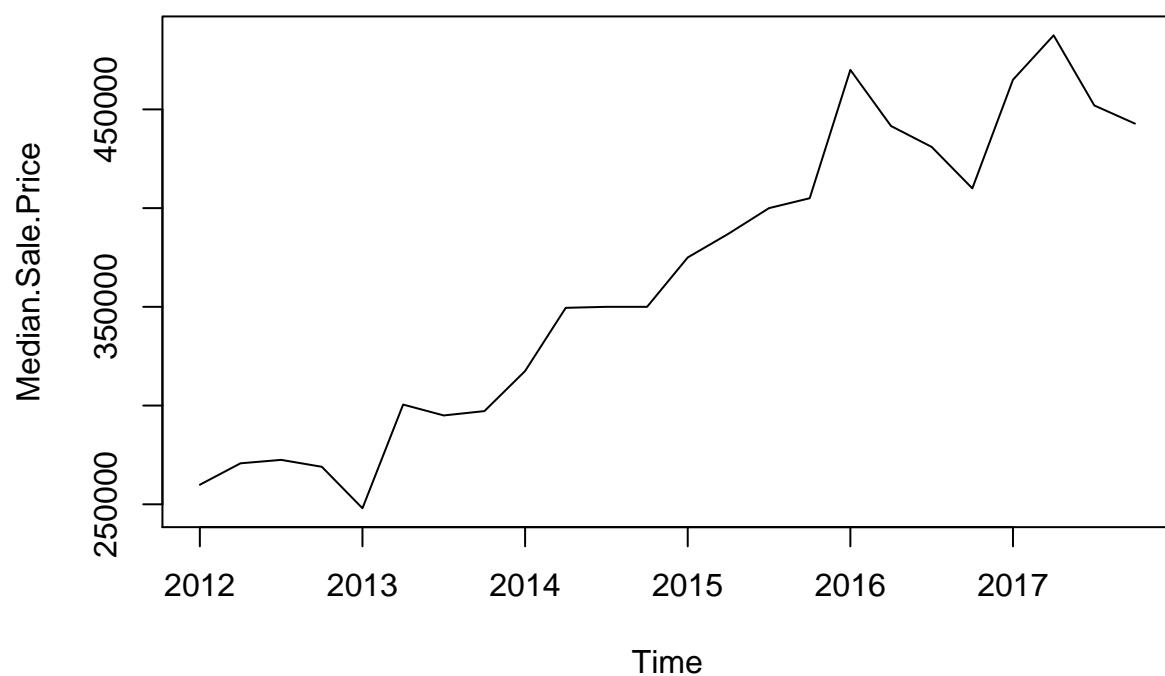
Portland, OR – Montavilla : TS Training Model Comparison



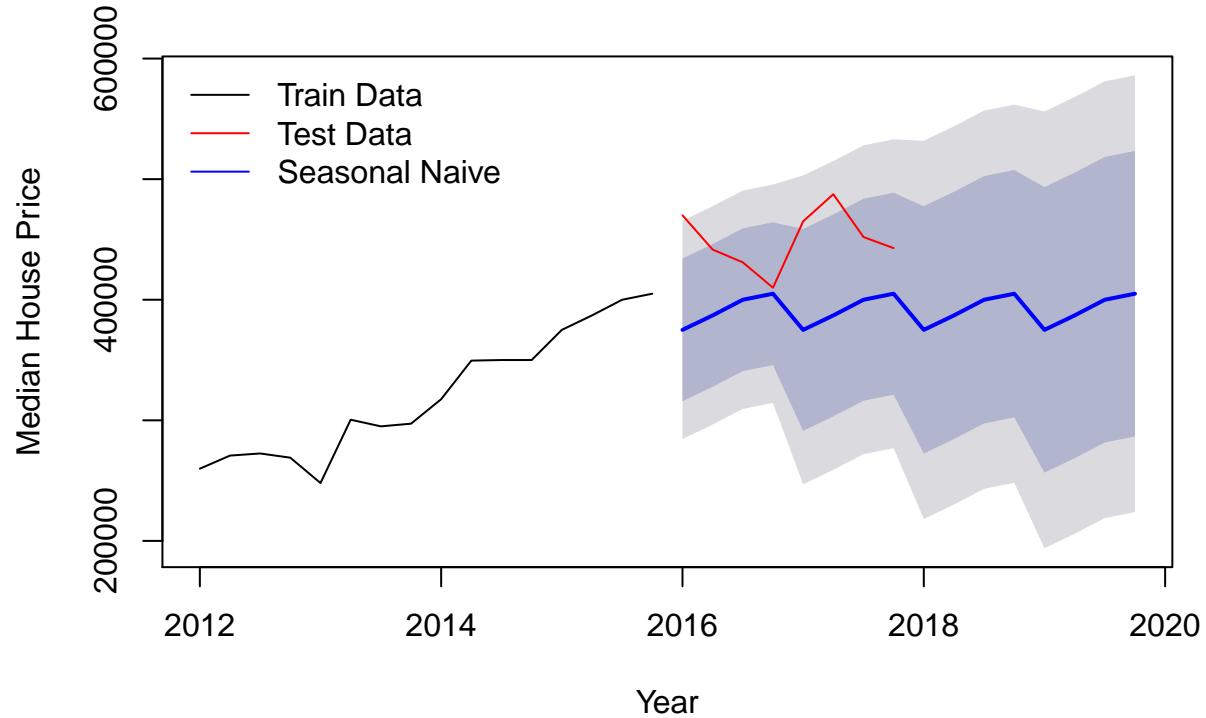
Portland, OR – Montavilla : Full TS Models Comparison



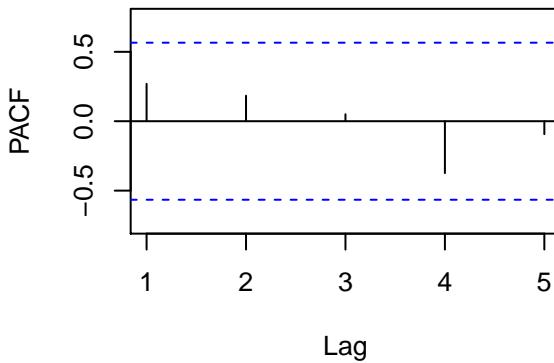
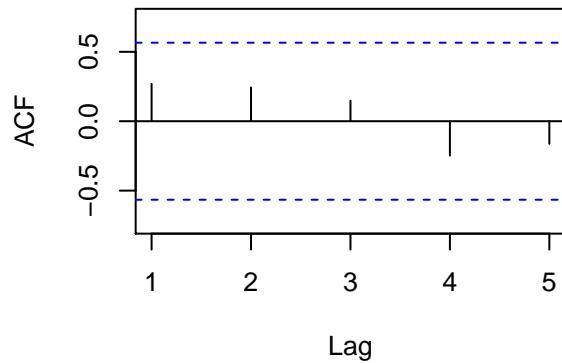
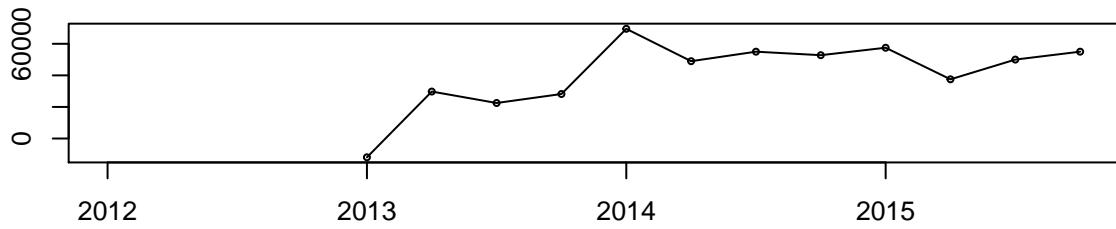
Portland, OR – Arbor Lodge



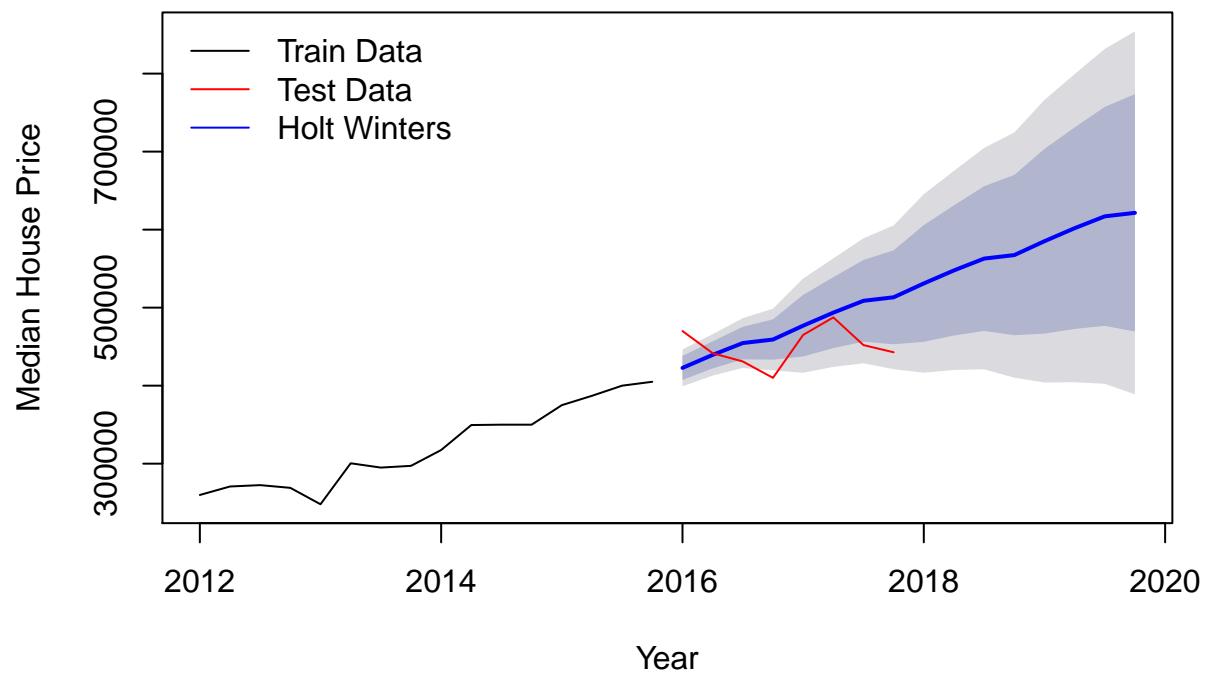
Portland, OR – Arbor Lodge : Naive Model Forecast



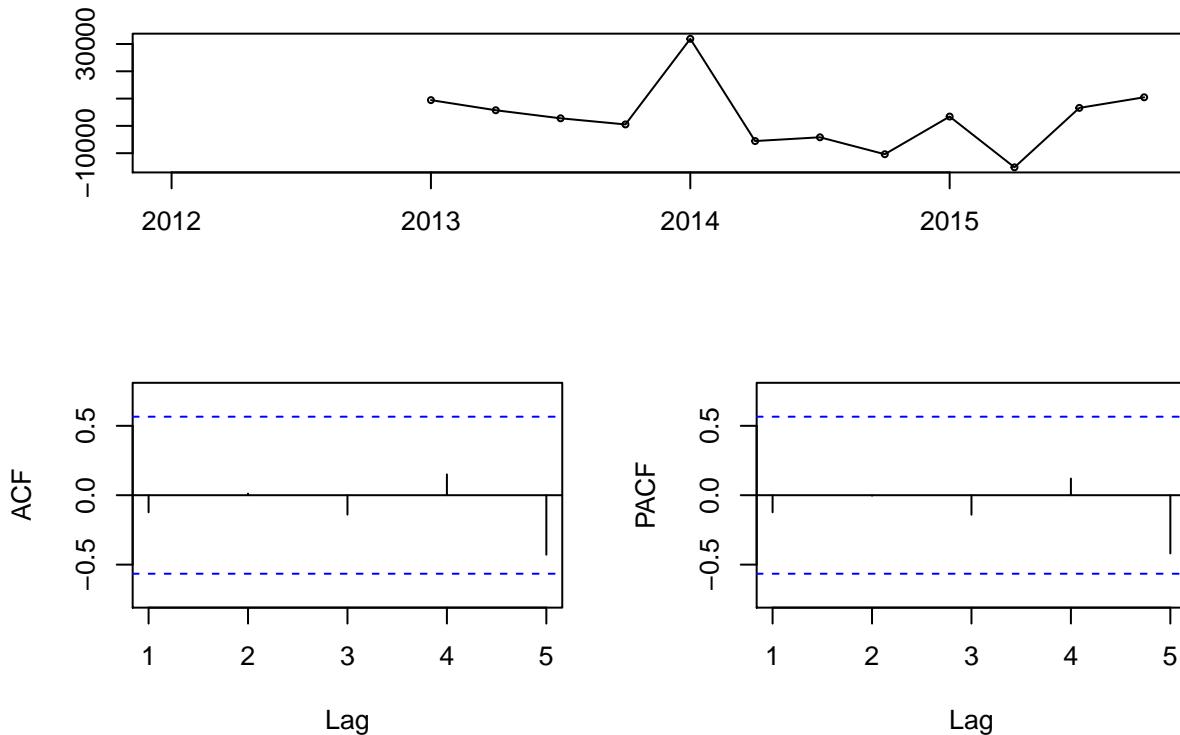
Portland, OR – Arbor Lodge : Naive Model Forecast Residuals



Portland, OR – Arbor Lodge : Holt Winters Model Forecast

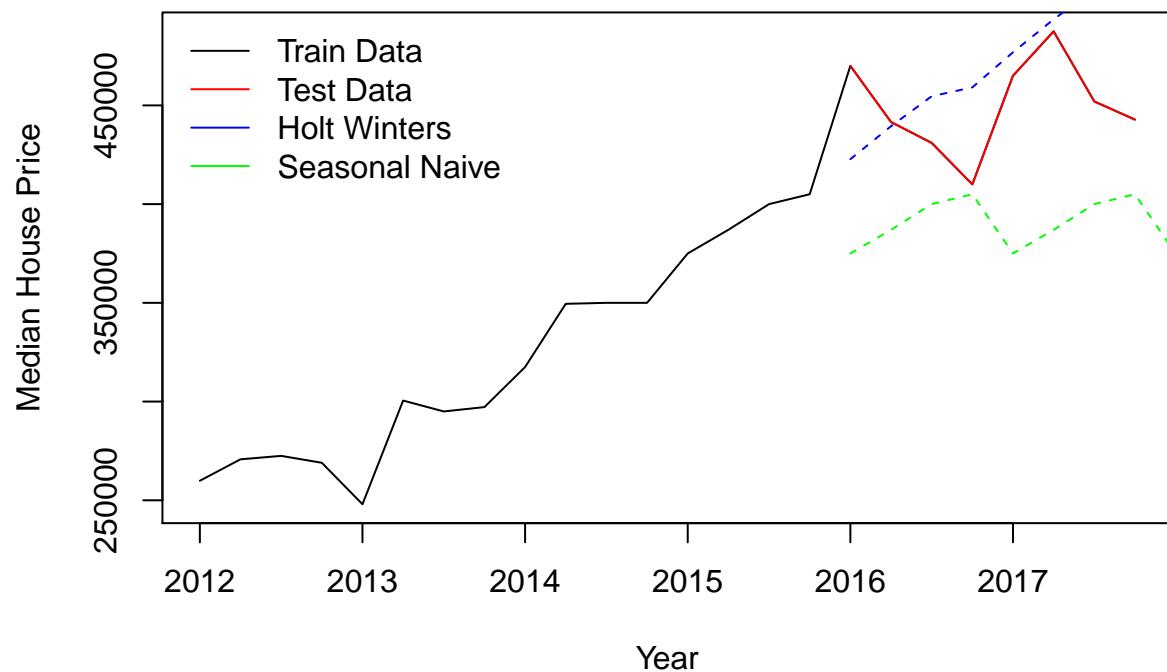


Portland, OR – Arbor Lodge : Holt Winters Model Forecast Residuals

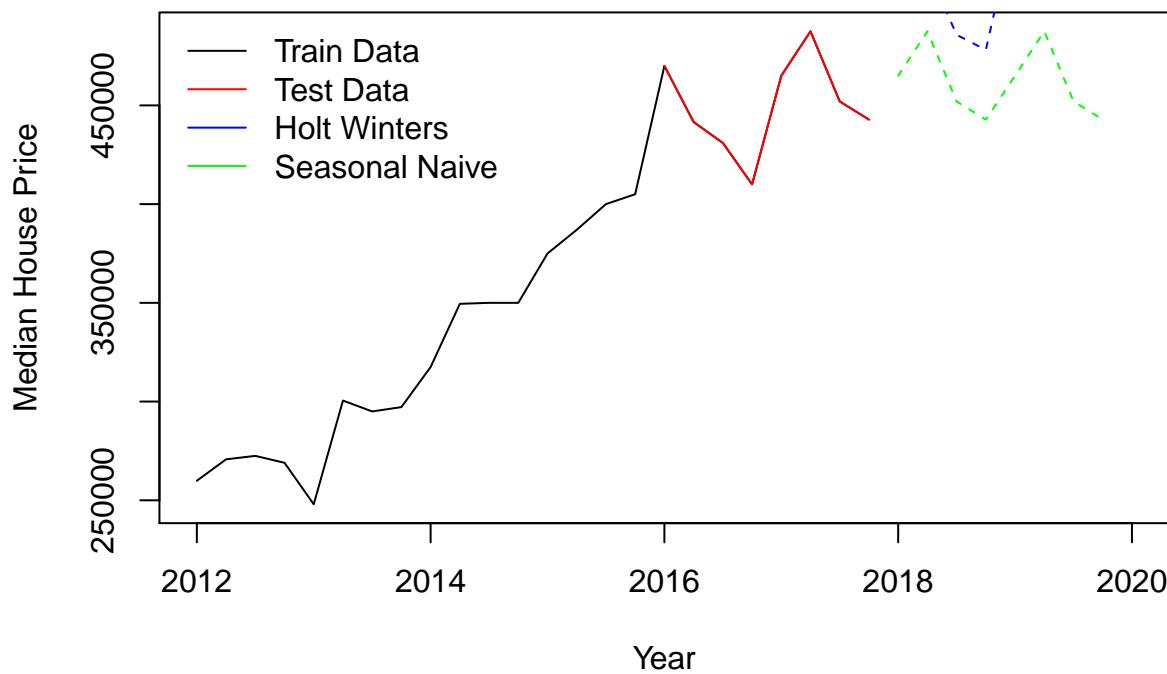


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Arbor Lodge"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 41237.50 46196.82 43220.83 11.66923 12.46896 1.000000
## Test set     58236.06 66449.13 58236.06 12.62474 12.62474 1.347407
##          ACF1 Theil's U
## Training set 0.2694266      NA
## Test set     0.1135814 2.009112
## [1] "Holt Winters Accuracy for Portland, OR – Arbor Lodge"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 2963.56 11899.48 8847.211 1.029403 2.641726 0.2046978
## Test set     -21068.34 41187.41 33412.245 -4.899816 7.533463 0.7730588
##          ACF1 Theil's U
## Training set -0.1229619      NA
## Test set     0.2699149 1.294628
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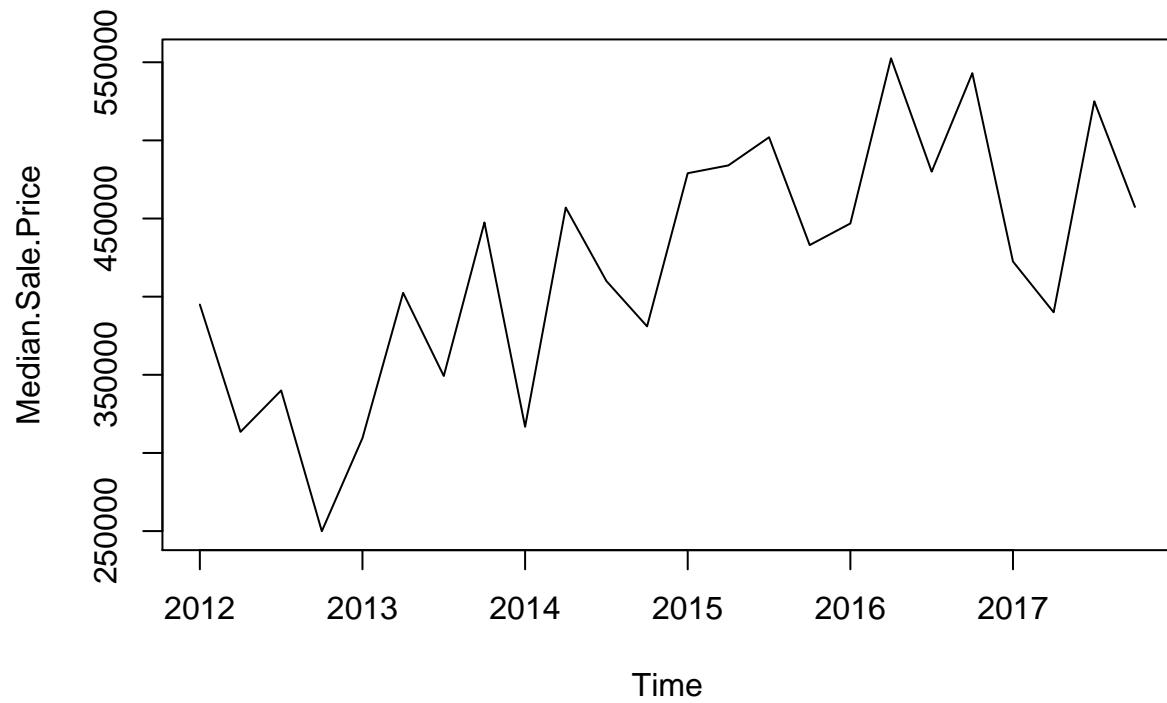
Portland, OR – Arbor Lodge : TS Training Model Comparison



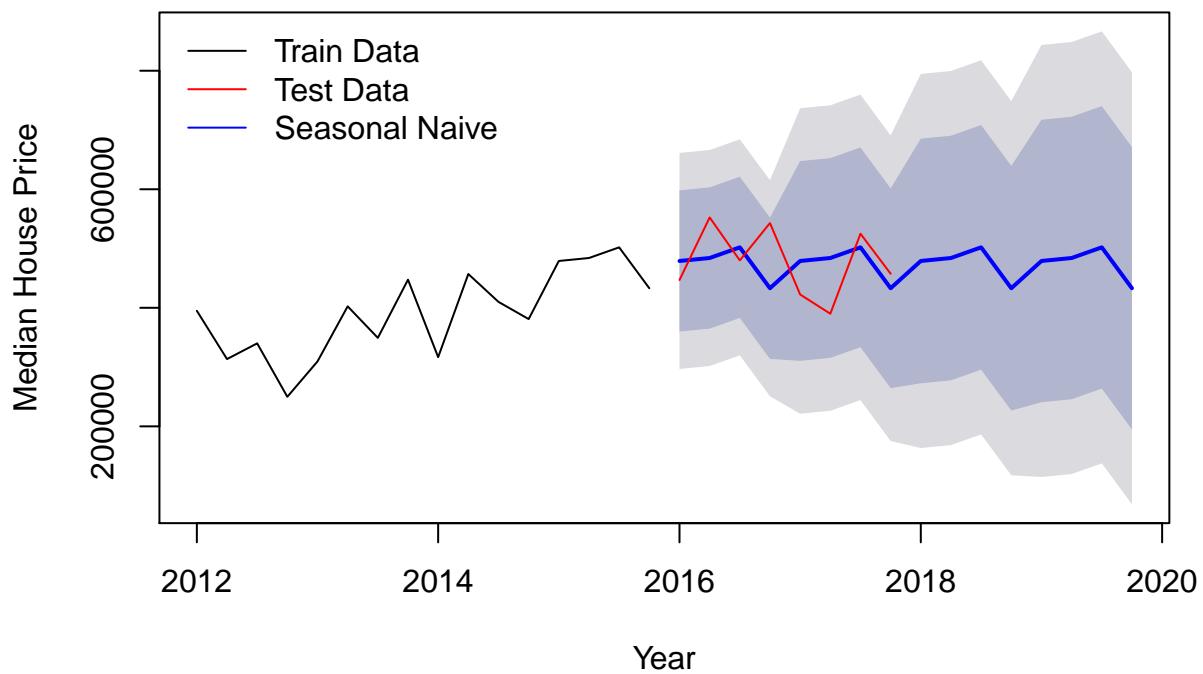
Portland, OR – Arbor Lodge : Full TS Models Comparison



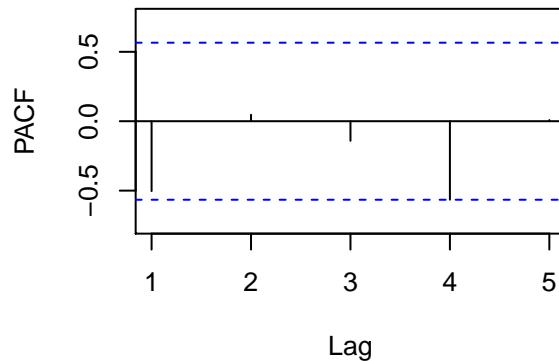
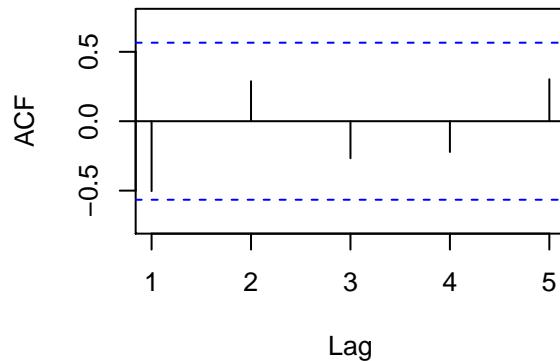
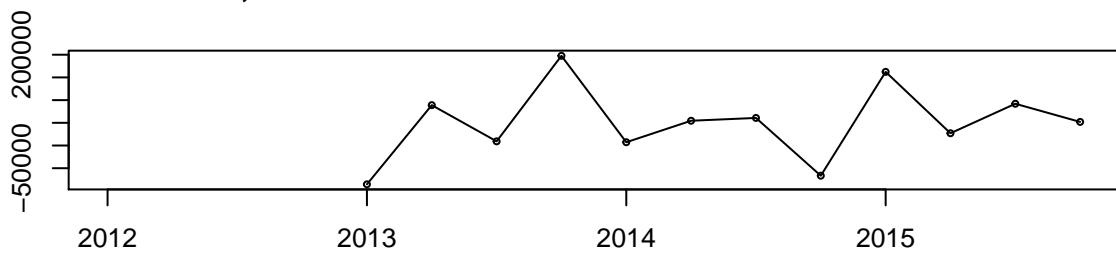
Portland, OR – Marshall Park



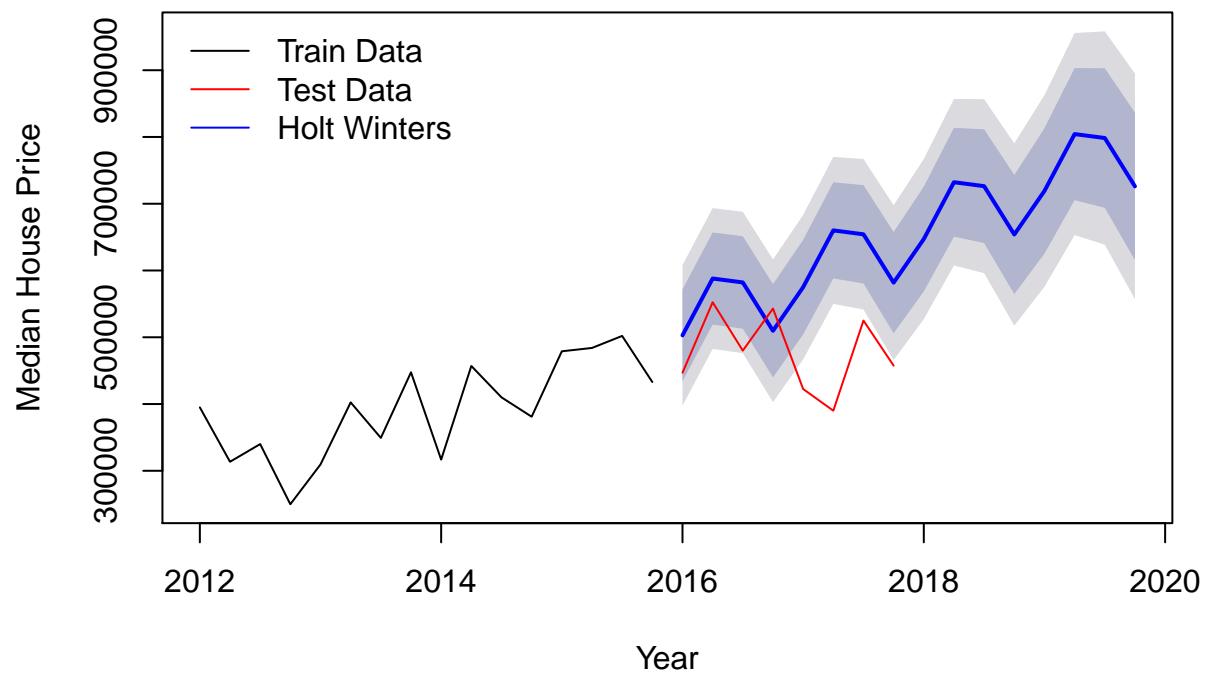
Portland, OR – Marshall Park : Naive Model Forecast



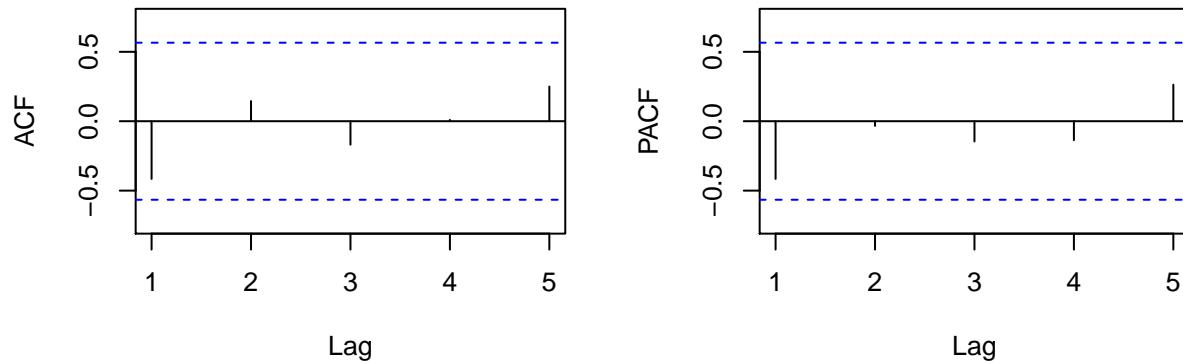
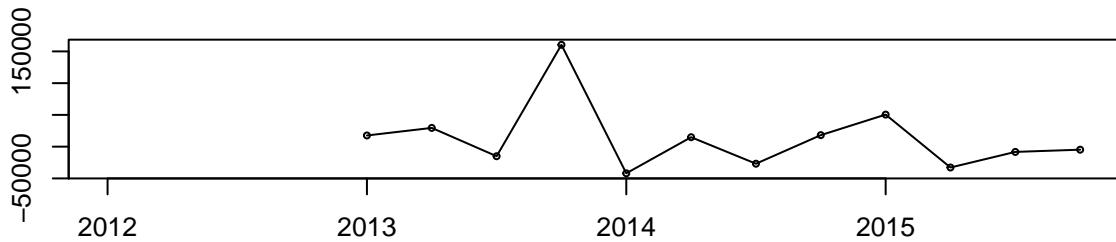
Portland, OR – Marshall Park : Naive Model Forecast Residuals



Portland, OR – Marshall Park : Holt Winters Model Forecast

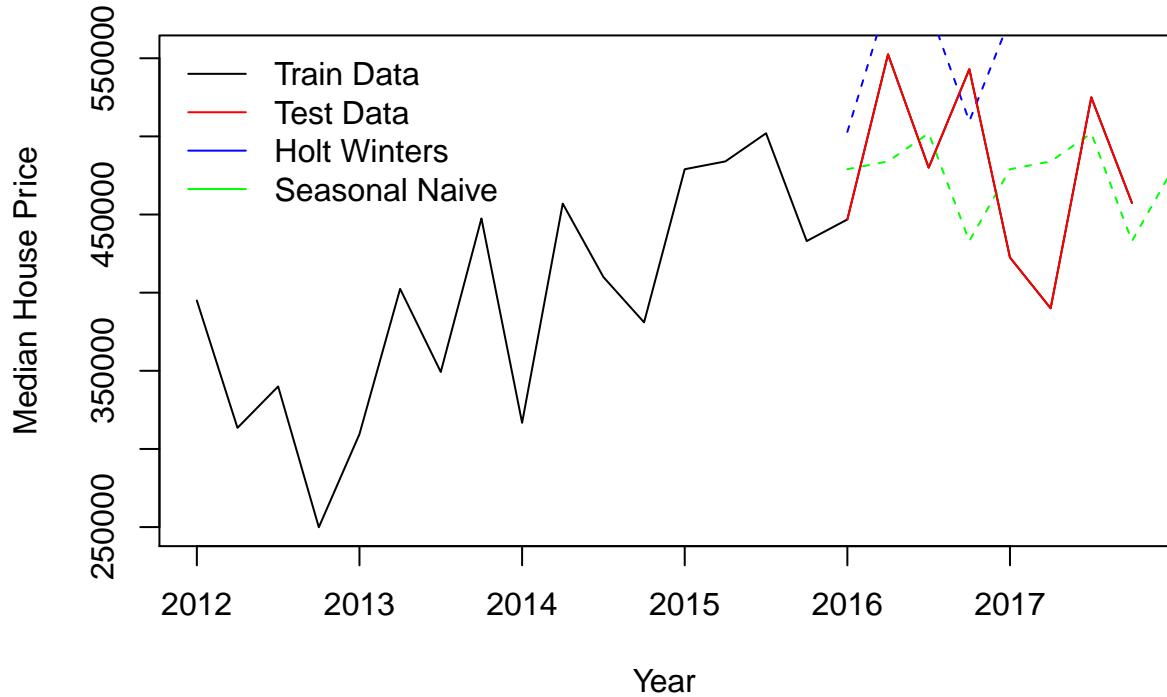


Portland, OR – Marshall Park : Holt Winters Model Forecast Residuals

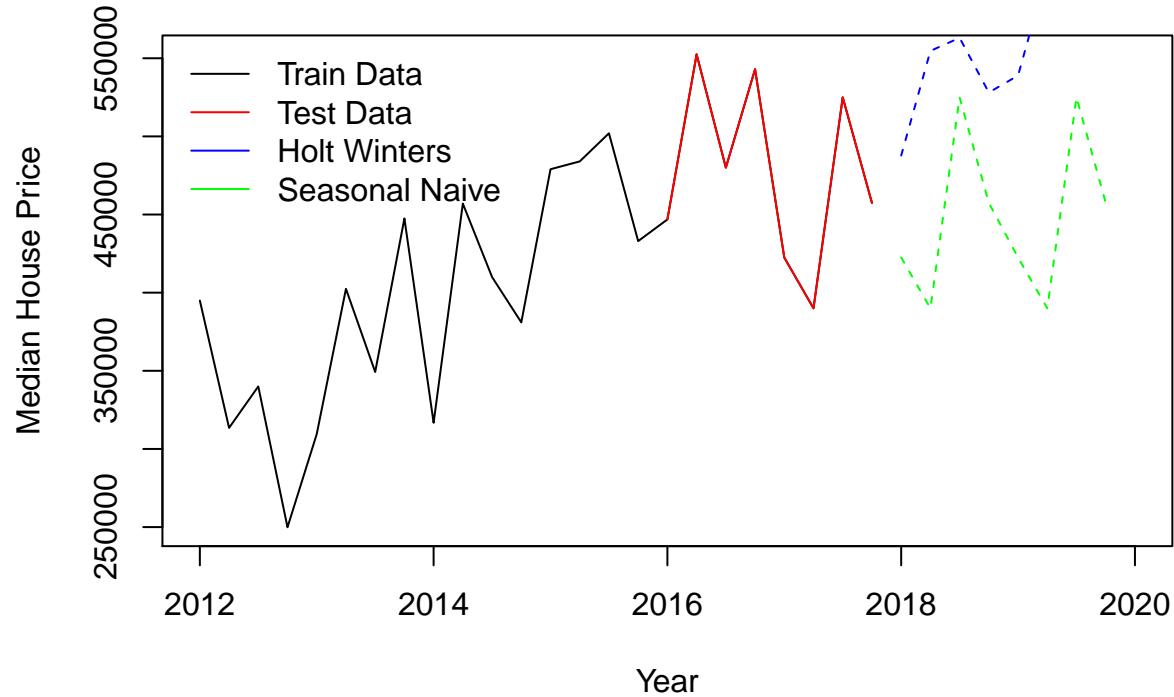


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Marshall Park"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 49970.83 92964.27 75295.83 10.2227957 17.73331 1.000000
## Test set     2662.50 62714.56 53825.00 -0.8589589 11.45441 0.714847
##          ACF1 Theil's U
## Training set -0.5034028      NA
## Test set      -0.2775461 0.7136785
## [1] "Holt Winters Accuracy for Portland, OR - Marshall Park"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 13428.68 53129.18 35064.16  2.812471  8.422292 0.4656853
## Test set     -104574.45 134313.16 112893.71 -23.908782 25.440874 1.4993354
##          ACF1 Theil's U
## Training set -0.4158533      NA
## Test set      0.1716544  1.574474
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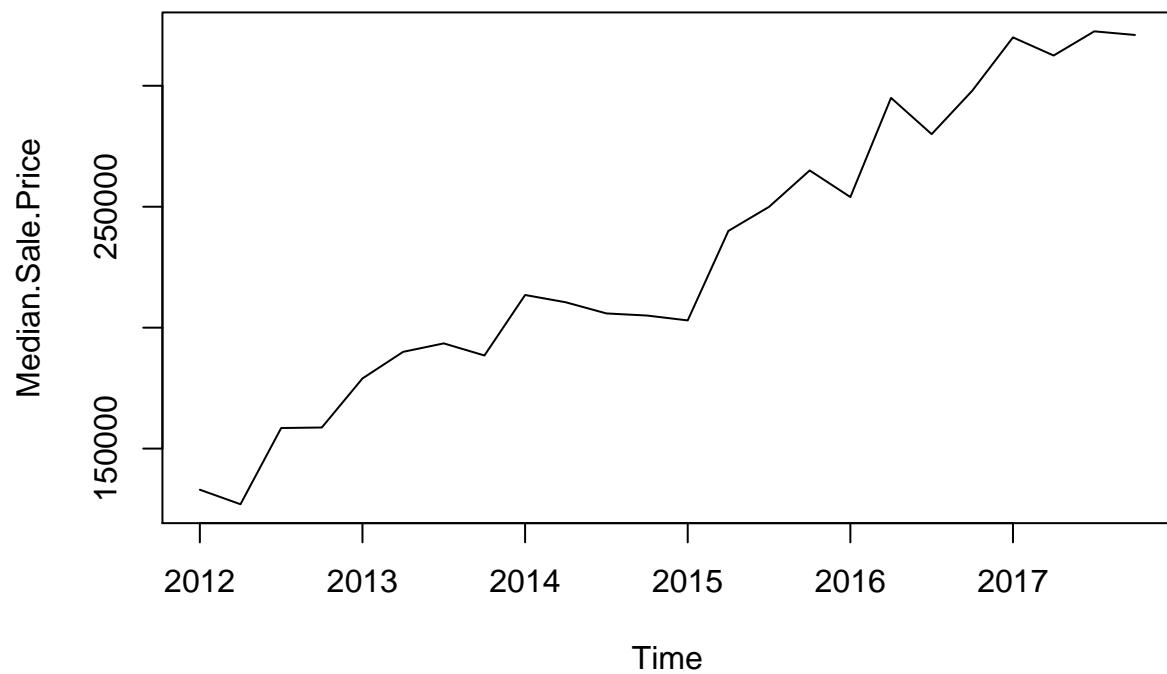
Portland, OR – Marshall Park : TS Training Model Comparison



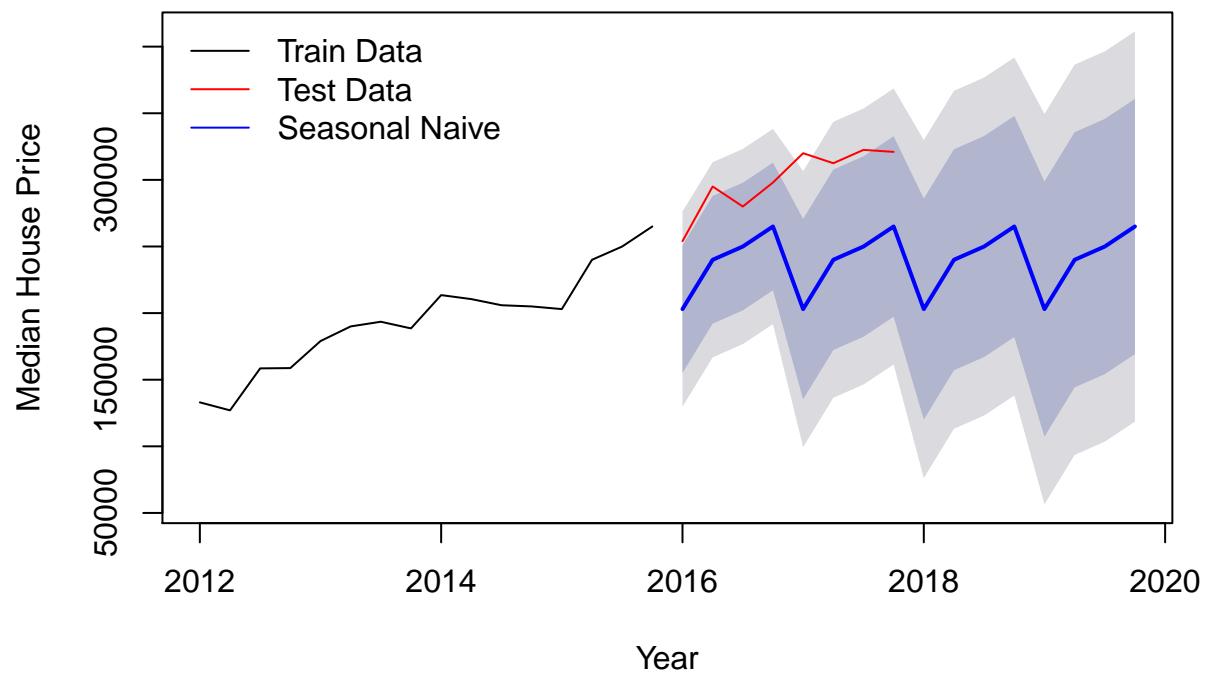
Portland, OR – Marshall Park : Full TS Models Comparison



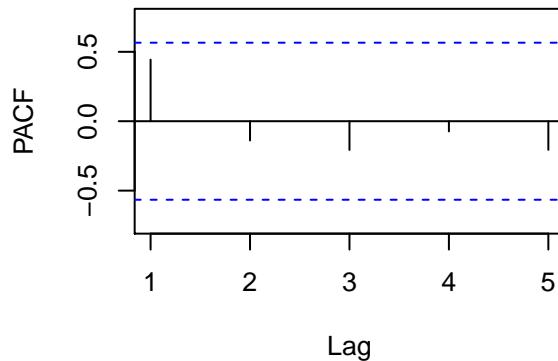
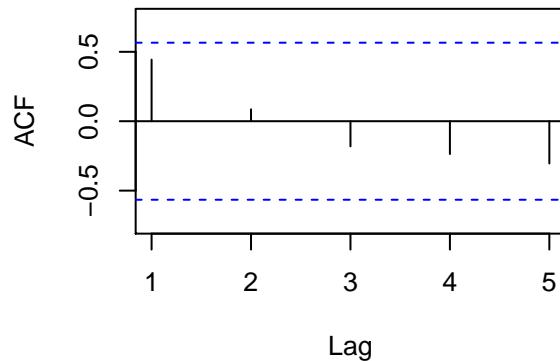
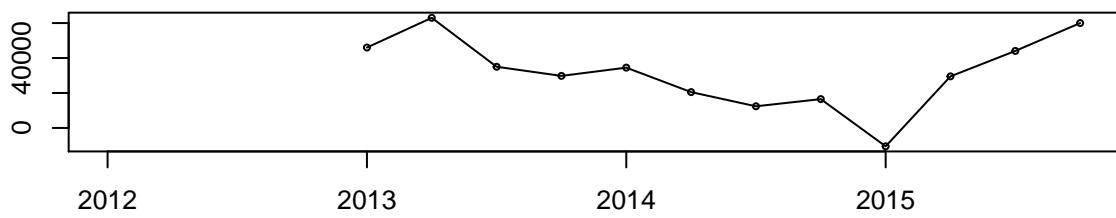
Portland, OR – Brentwood



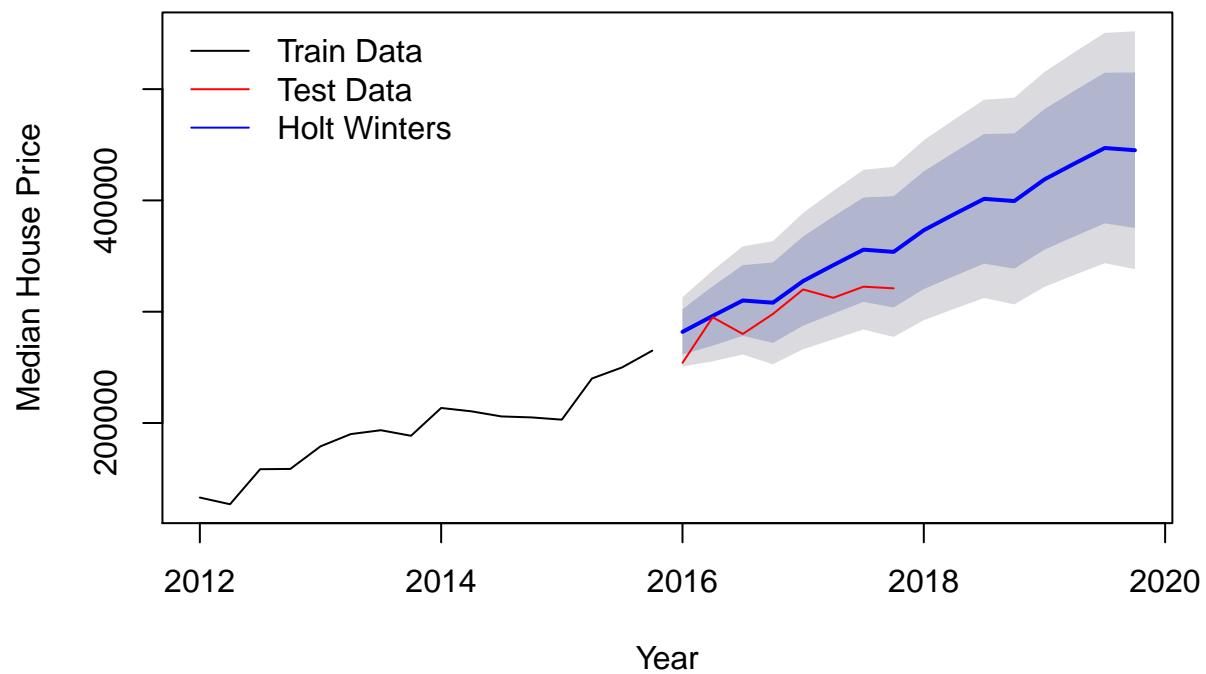
Portland, OR – Brentwood : Naive Model Forecast



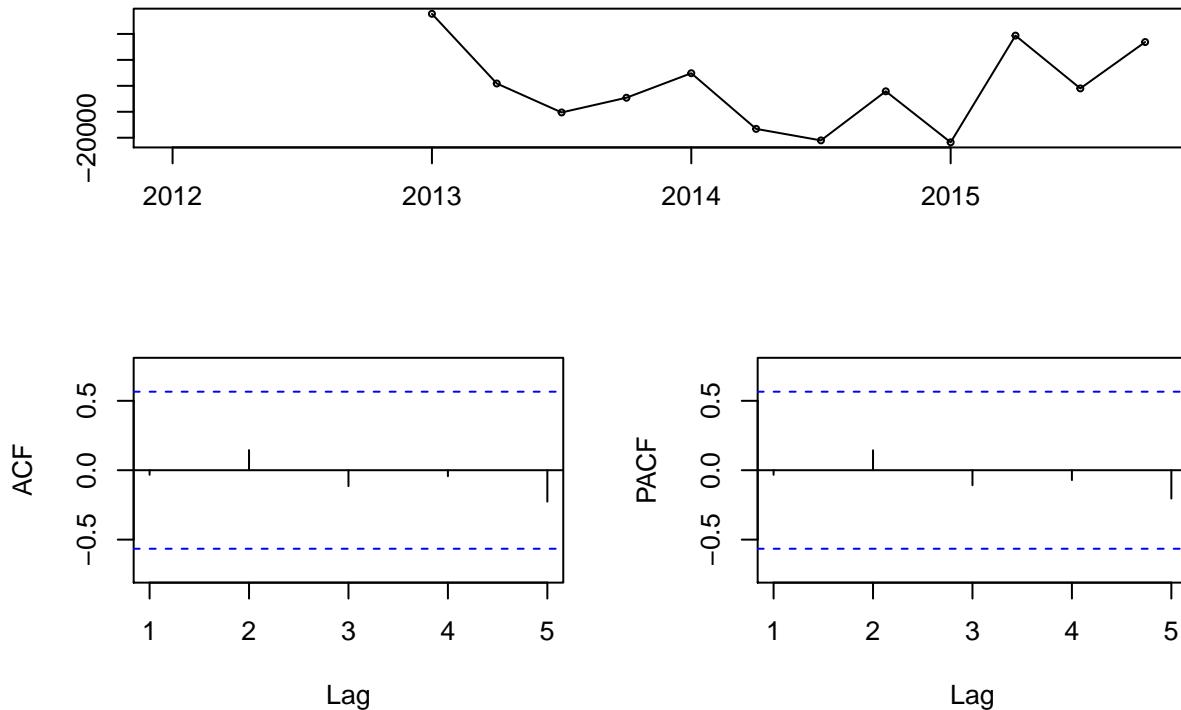
Portland, OR – Brentwood : Naive Model Forecast Residuals



Portland, OR – Brentwood : Holt Winters Model Forecast



Portland, OR – Brentwood : Holt Winters Model Forecast Residuals

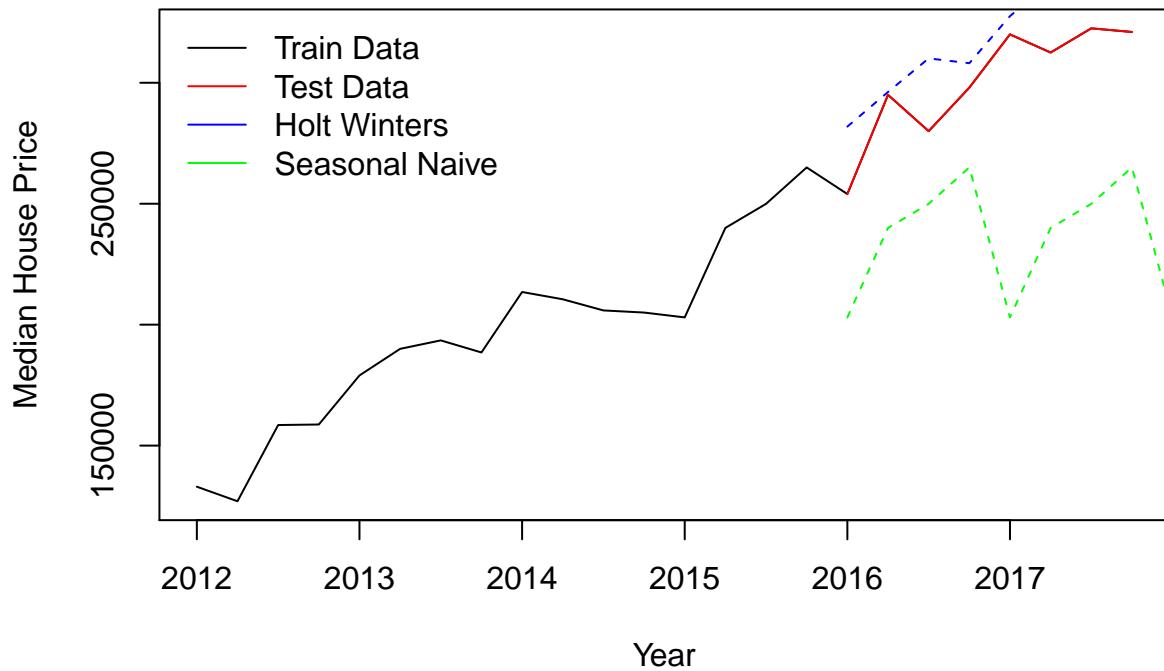


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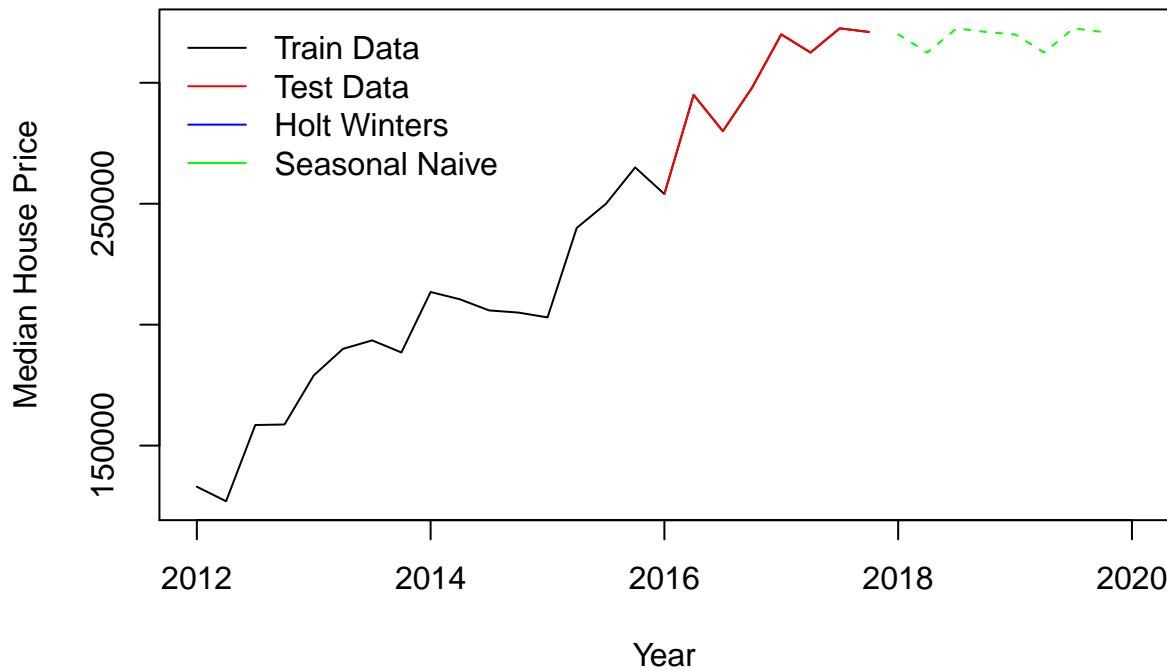
## [1] "Seasonal Naive Accuracy for Portland, OR - Brentwood"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 31727.08 37365.98 33477.08 15.00772 15.86979 1.000000
## Test set     60887.50 66108.58 60887.50 20.02911 20.02911 1.818782
##          ACF1 Theil's U
## Training set 0.44394597      NA
## Test set     0.04994833 3.009671
## [1] "Holt Winters Accuracy for Portland, OR - Brentwood"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -625.251 15213.13 12255.67 -0.4374576 5.888336 0.3660912
## Test set     -21519.501 24705.52 21519.50 -7.2221640 7.222164 0.6428129
##          ACF1 Theil's U
## Training set -0.03319707      NA
## Test set     -0.10785596 1.032136

```

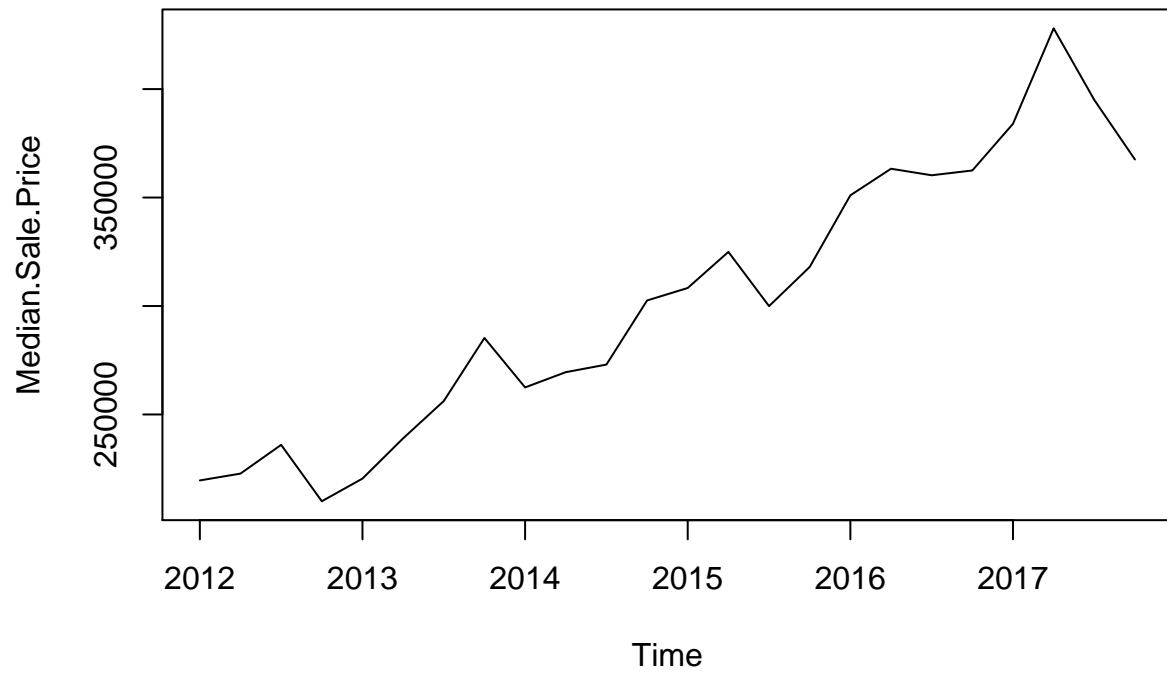
Portland, OR – Brentwood : TS Training Model Comparison



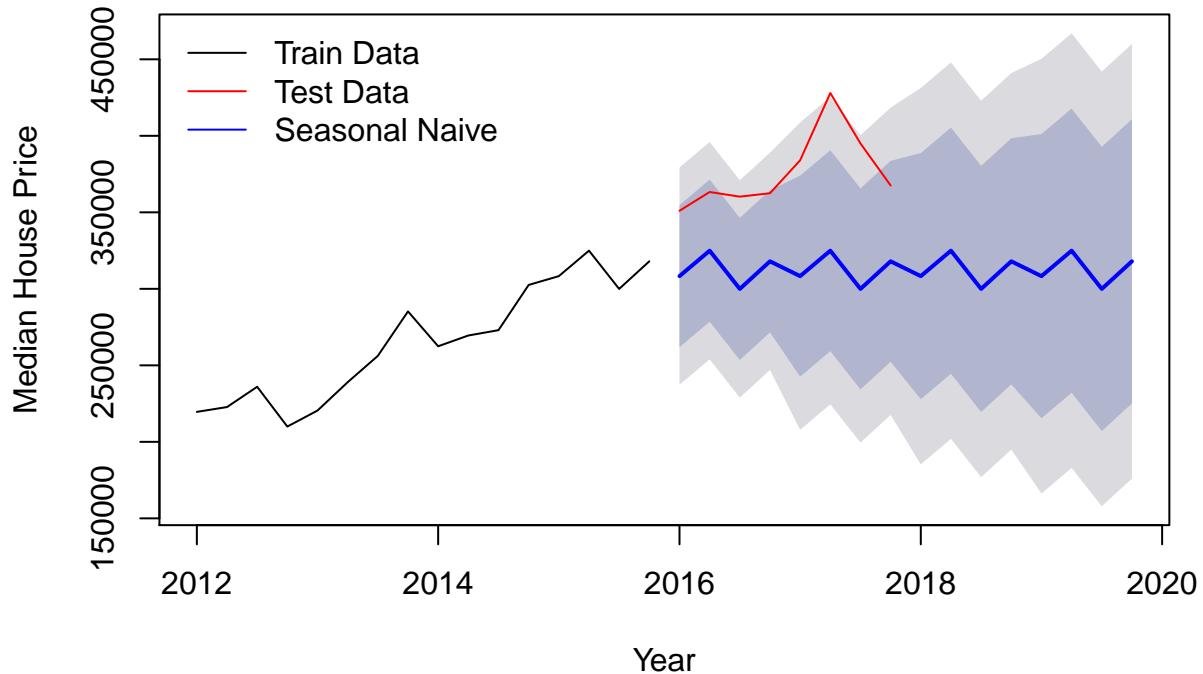
Portland, OR – Brentwood : Full TS Models Comparison



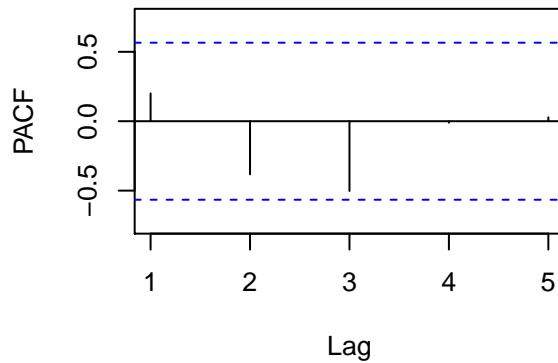
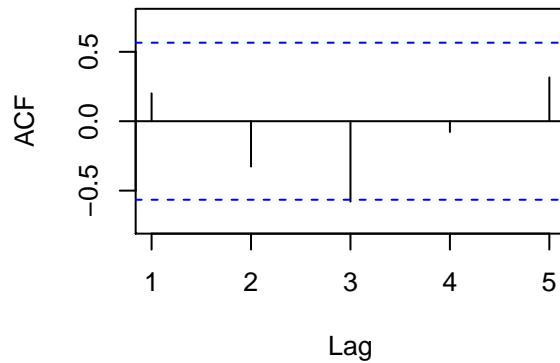
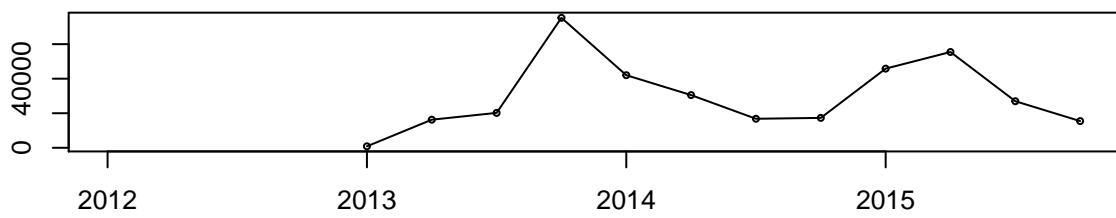
Portland, OR – Pleasant Valley



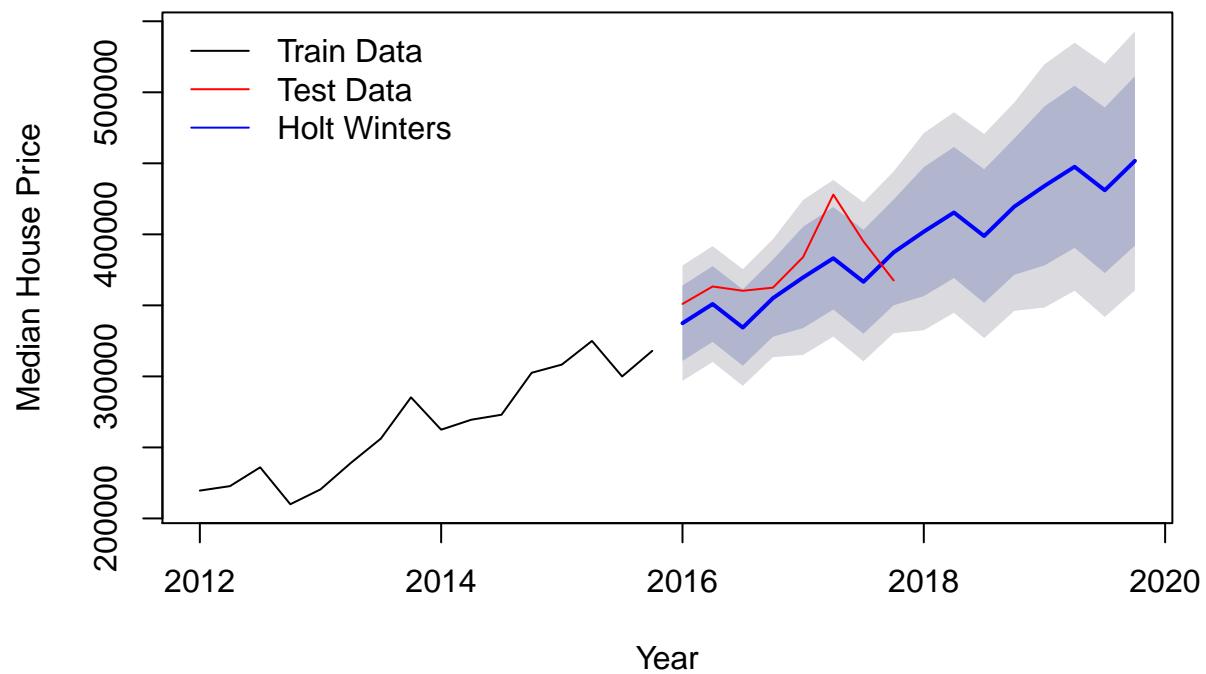
Portland, OR – Pleasant Valley : Naive Model Forecast



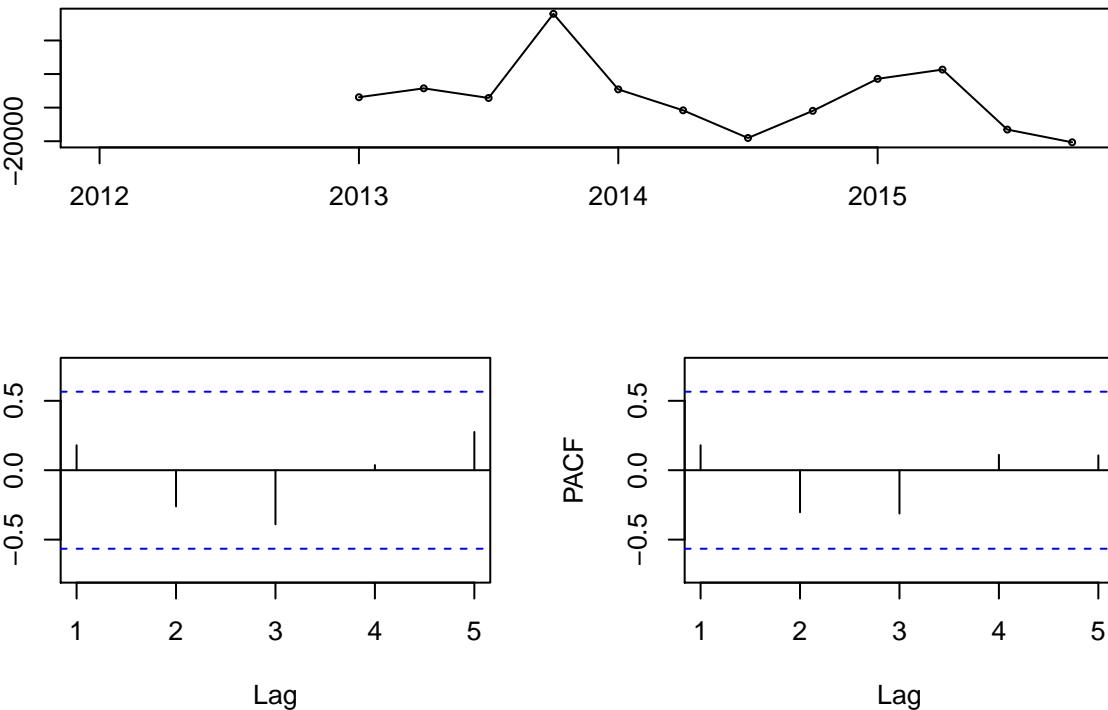
Portland, OR – Pleasant Valley : Naive Model Forecast Residuals



Portland, OR – Pleasant Valley : Holt Winters Model Forecast



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

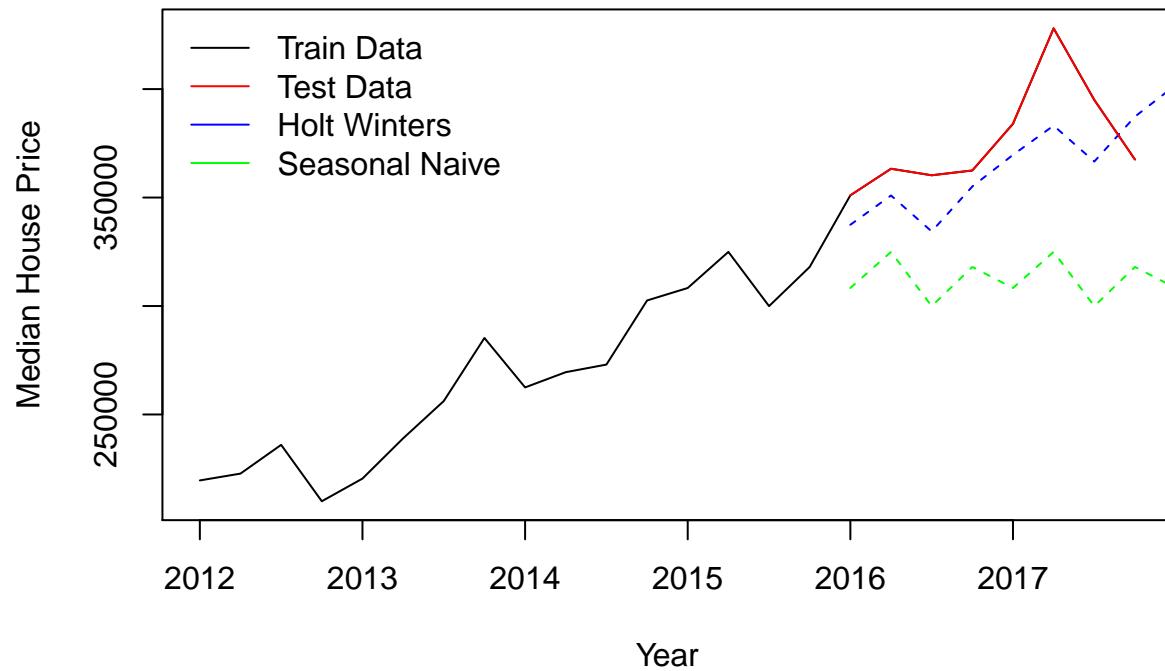


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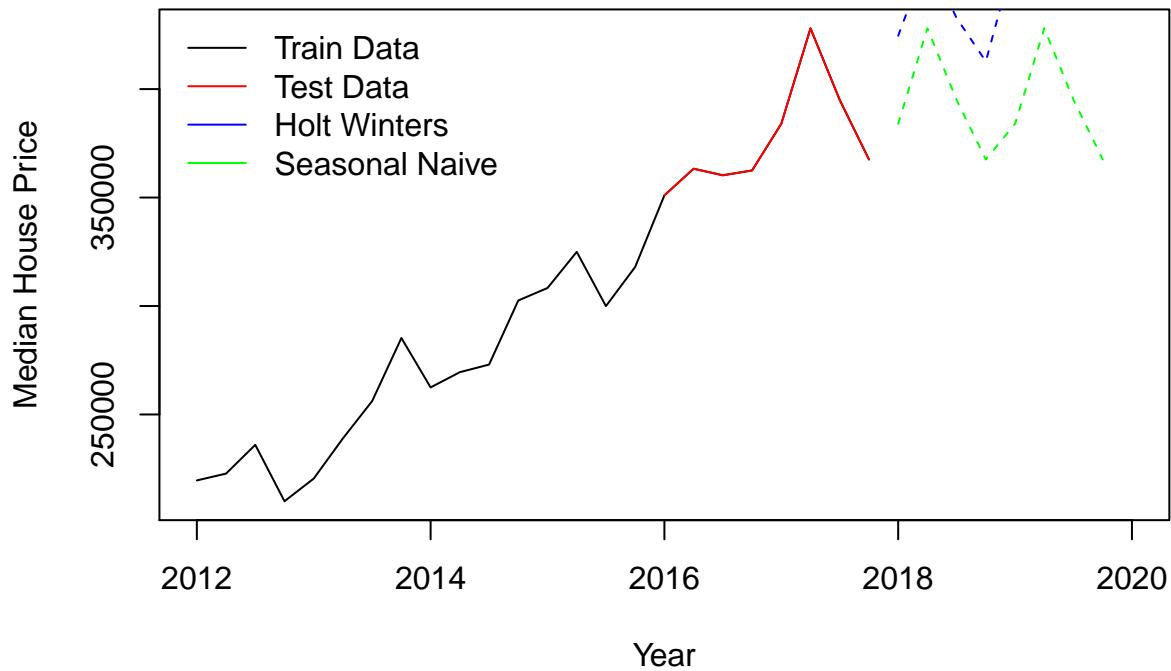
## [1] "Seasonal Naive Accuracy for Portland, OR - Pleasant Valley"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 30237.50 36231.78 30237.50 10.53509 10.53509 1.000000
## Test set     63649.81 67777.41 63649.81 16.63378 16.63378 2.104996
##          ACF1 Theil's U
## Training set 0.2009333      NA
## Test set     0.3955121 2.861259
## [1] "Holt Winters Accuracy for Portland, OR - Pleasant Valley"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 6223.395 20779.83 15444.21 2.285818 5.403210 0.5107635
## Test set     15874.060 23646.98 20812.05 4.063459 5.406949 0.6882862
##          ACF1 Theil's U
## Training set 0.17999167      NA
## Test set     -0.09245473 1.00135

```

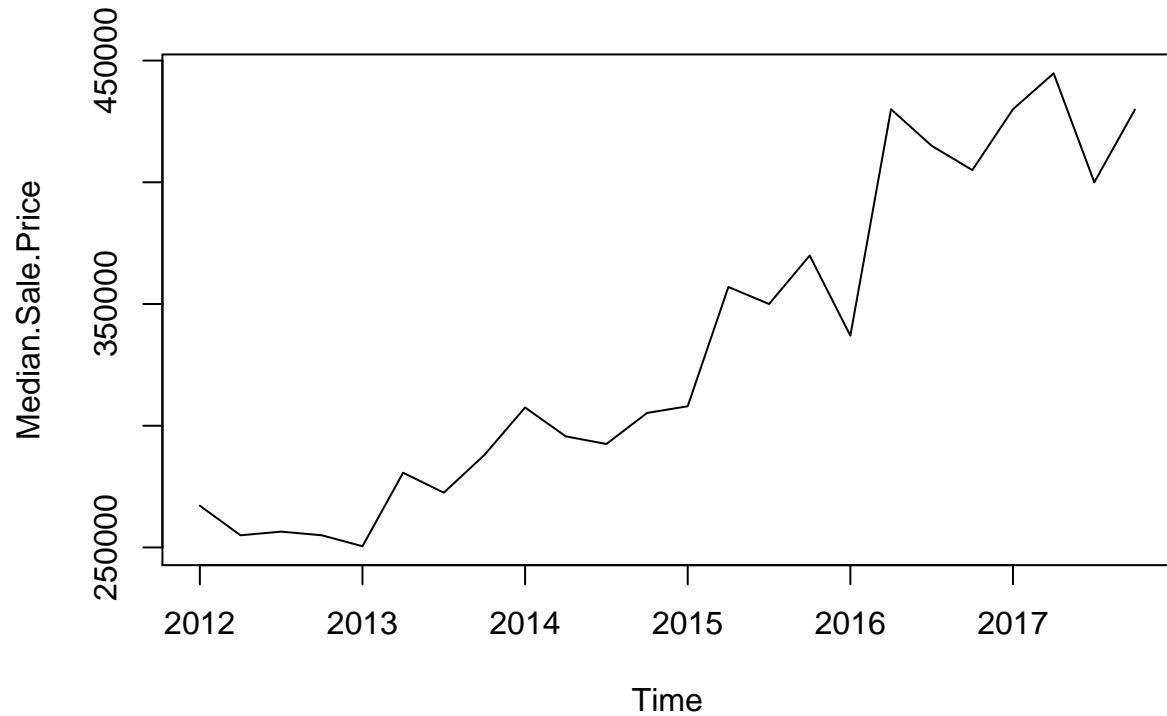
Portland, OR – Pleasant Valley : TS Training Model Comparison



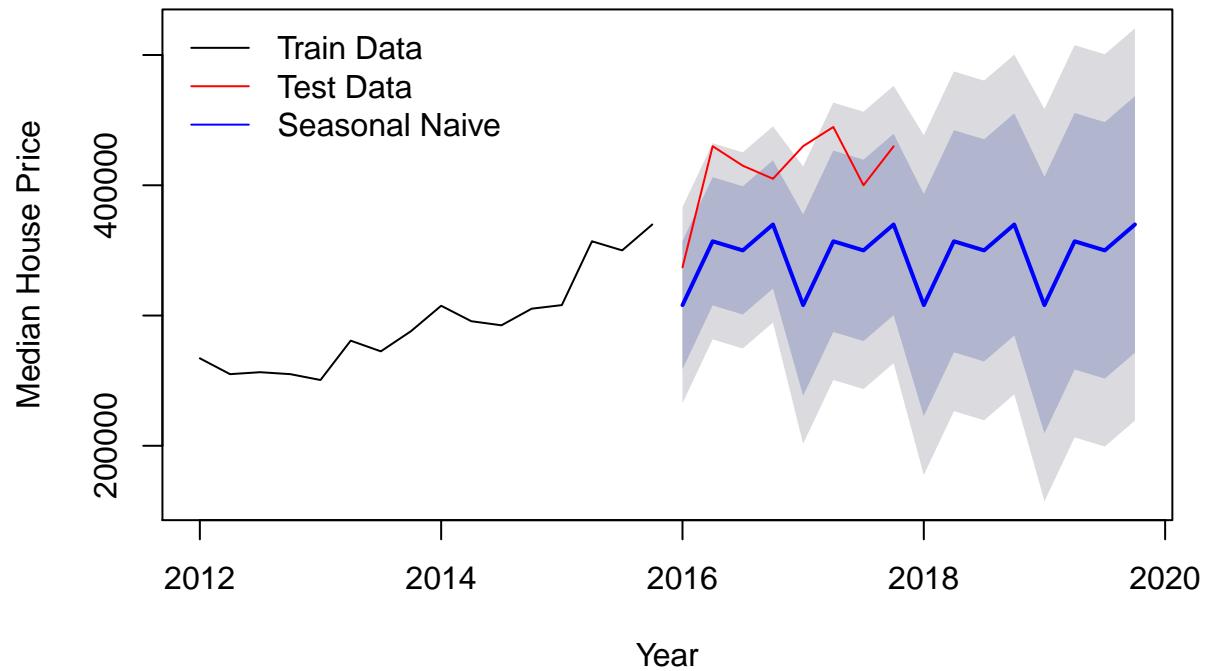
Portland, OR – Pleasant Valley : Full TS Models Comparison



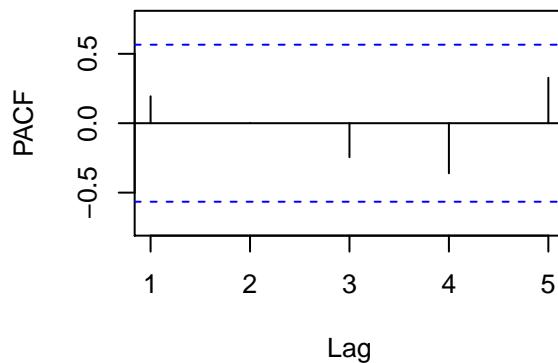
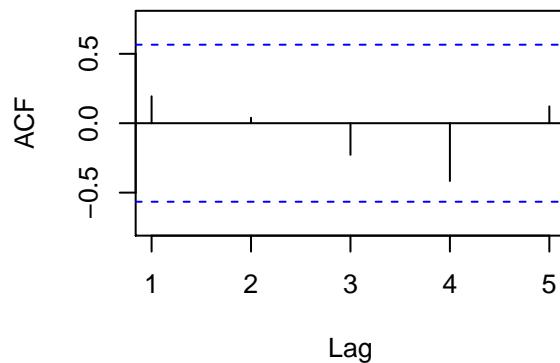
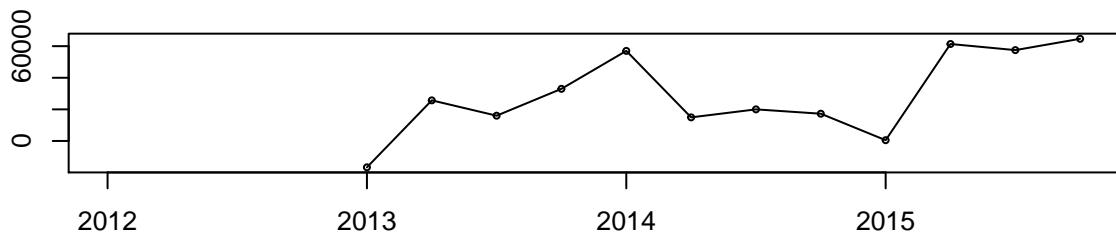
Portland, OR – Roseway



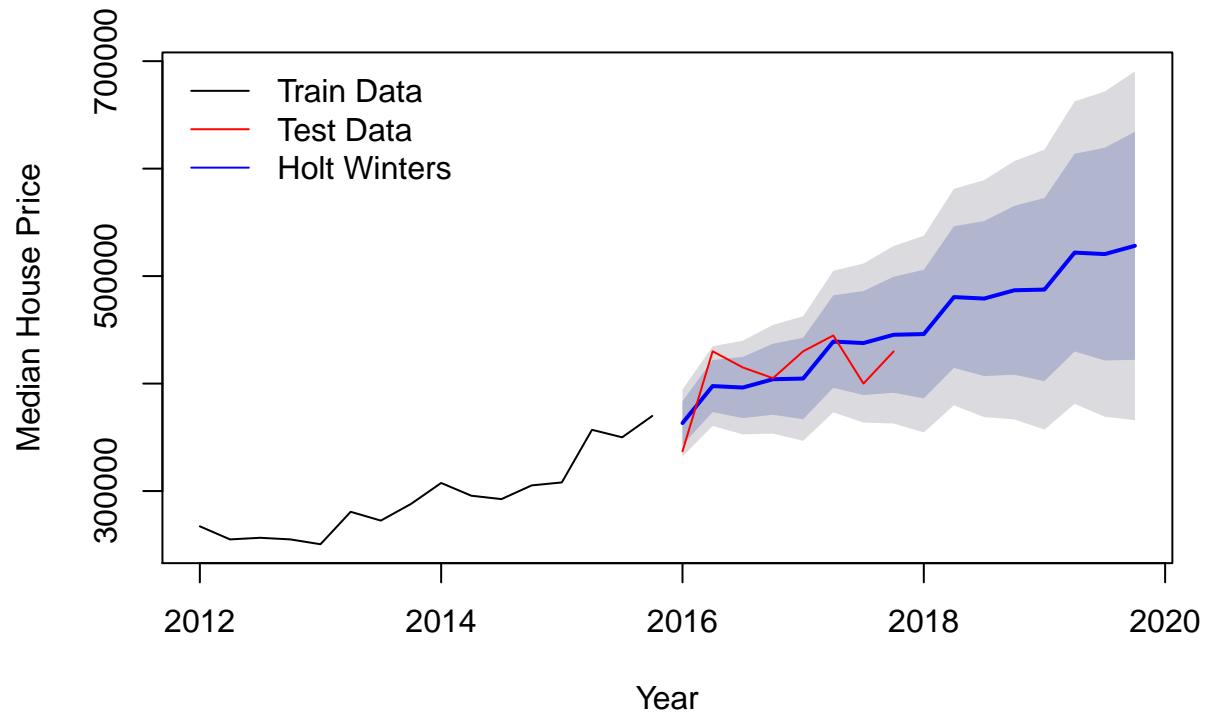
Portland, OR – Roseway : Naive Model Forecast



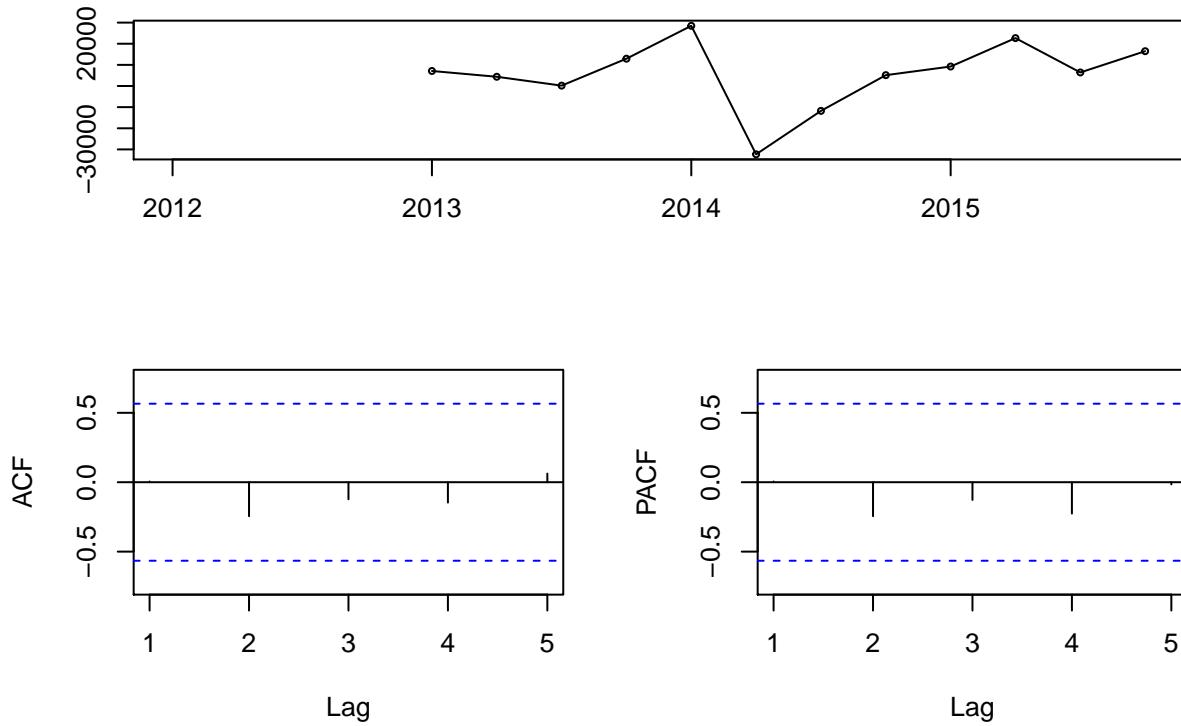
Portland, OR – Roseway : Naive Model Forecast Residuals



Portland, OR – Roseway : Holt Winters Model Forecast

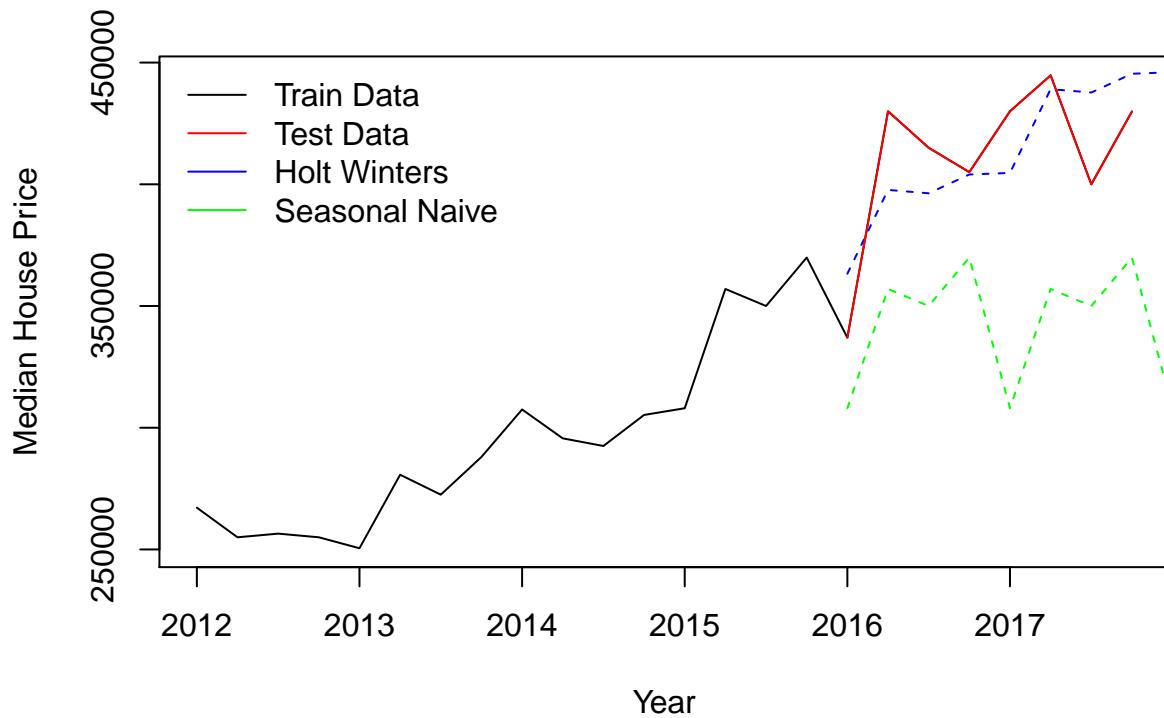


Portland, OR – Roseway : Holt Winters Model Forecast Residuals

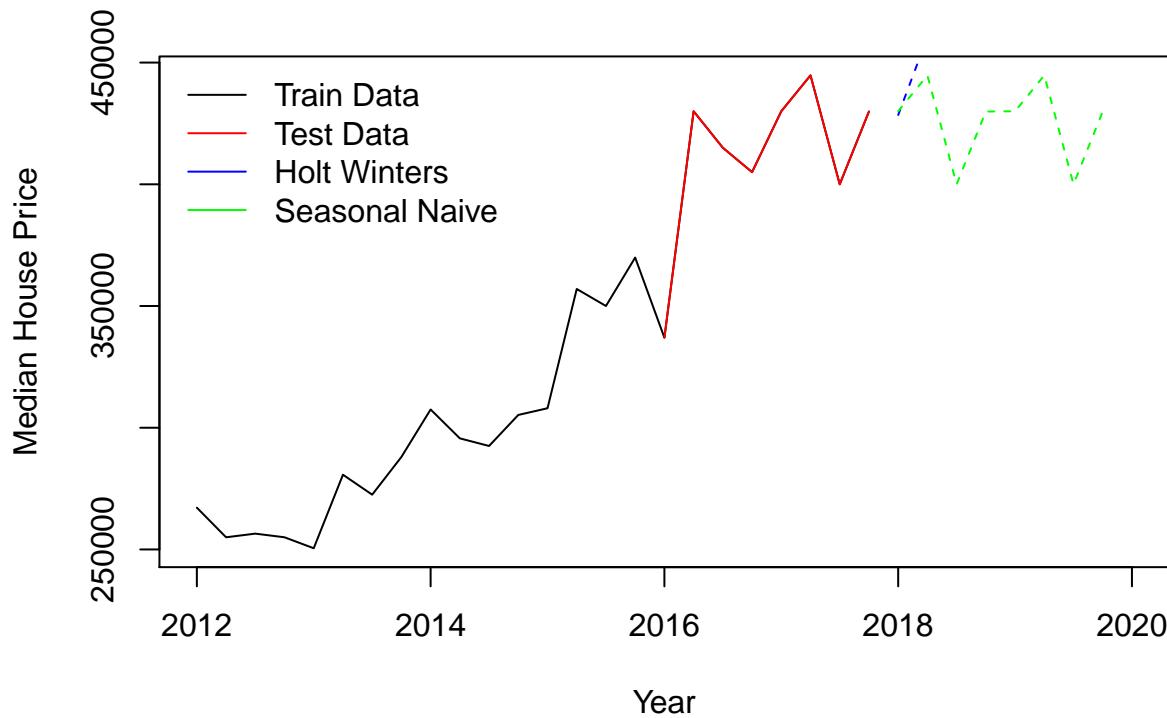


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Roseway"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 29269.58 38410.23 32047.08  8.930659 10.03944 1.000000
## Test set     65231.25 70985.10 65231.25 15.558802 15.55880 2.035482
##          ACF1 Theil's U
## Training set 0.1939019      NA
## Test set     -0.1549825 1.574139
## [1] "Holt Winters Accuracy for Portland, OR – Roseway"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 5740.3809 16247.86 13086.97  1.7138659 4.205963 0.4083670
## Test set     437.6205 23506.28 20308.30 -0.1753301 5.031819 0.6337021
##          ACF1 Theil's U
## Training set 0.005690448      NA
## Test set     0.066322242 0.4918337
```

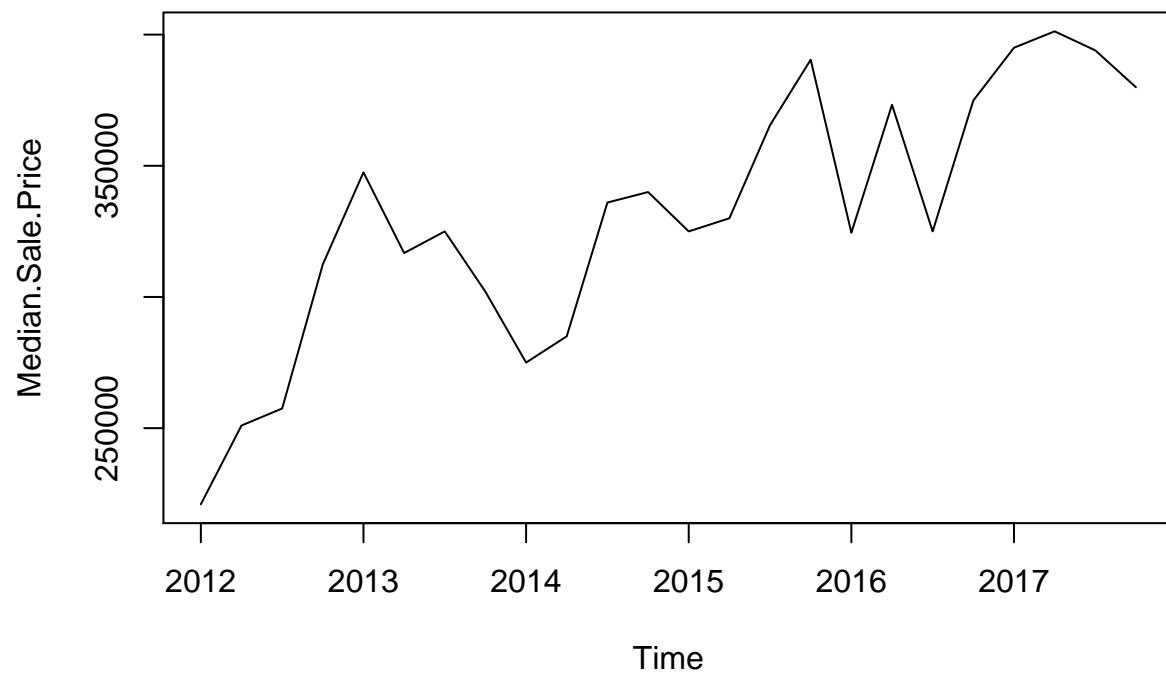
Portland, OR – Roseway : TS Training Model Comparison



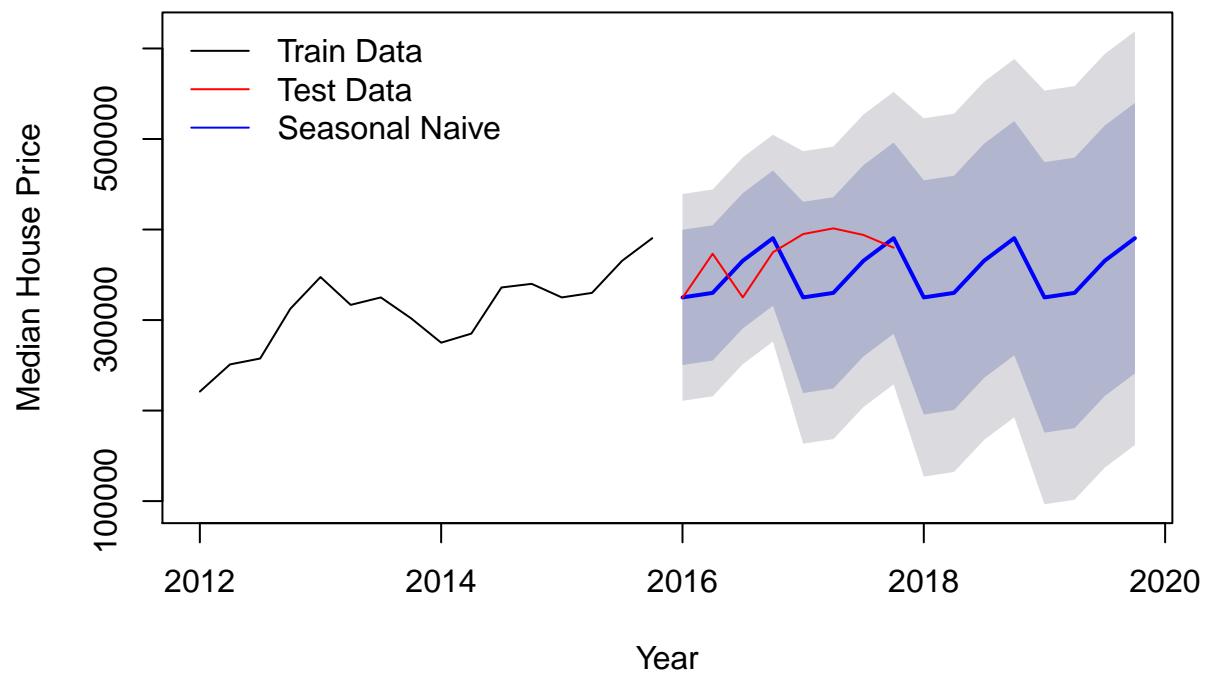
Portland, OR – Roseway : Full TS Models Comparison



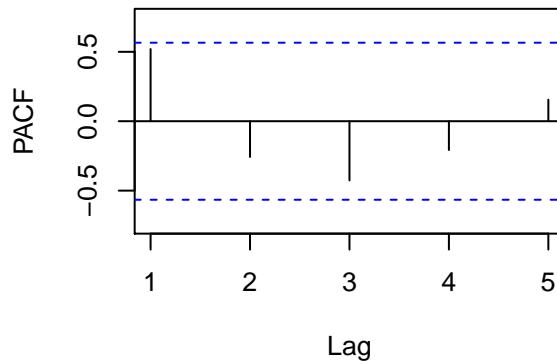
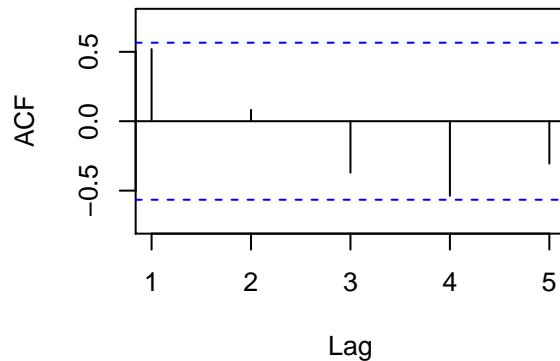
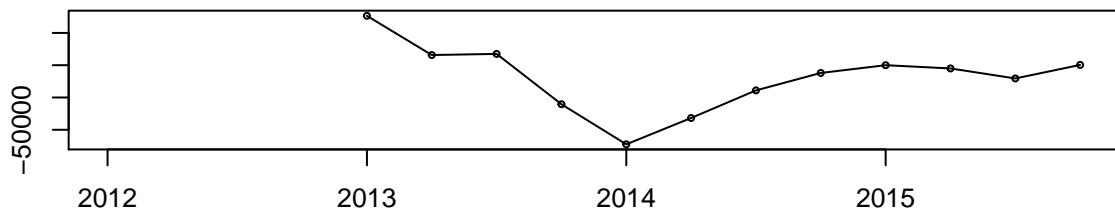
Portland, OR – Downtown Portland



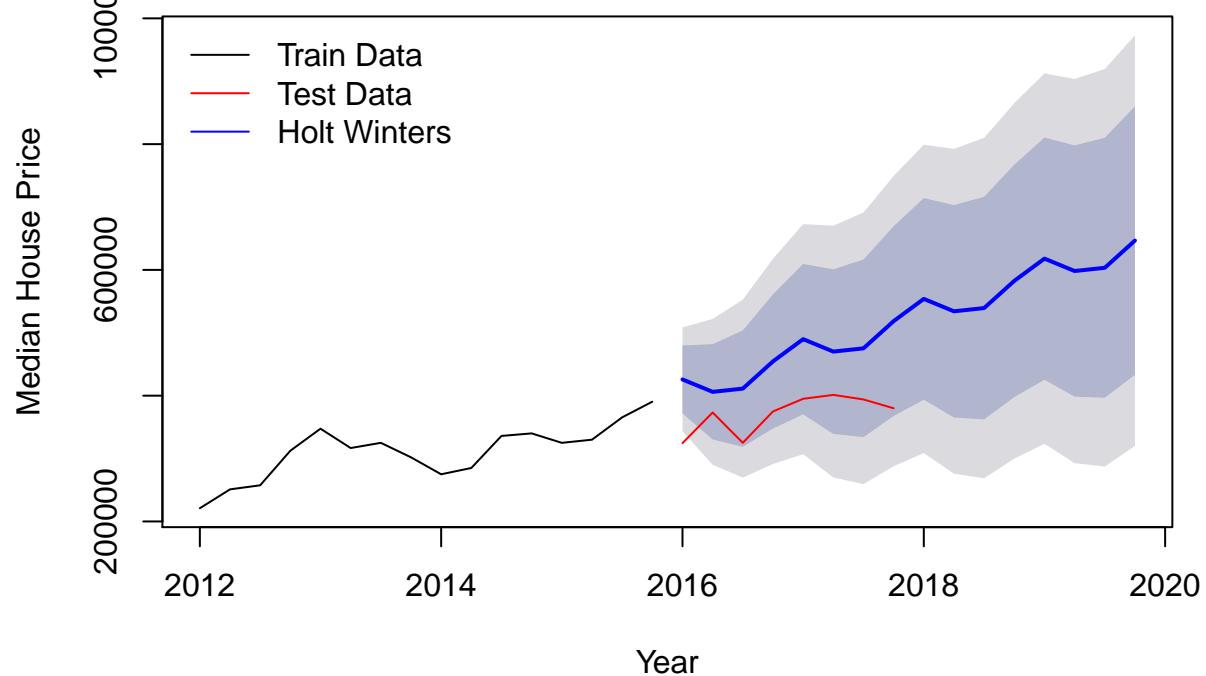
Portland, OR – Downtown Portland : Naive Model Forecast



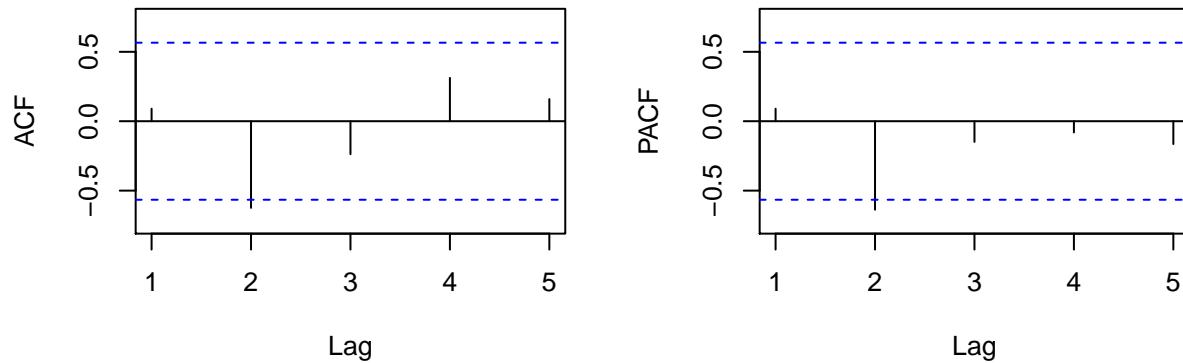
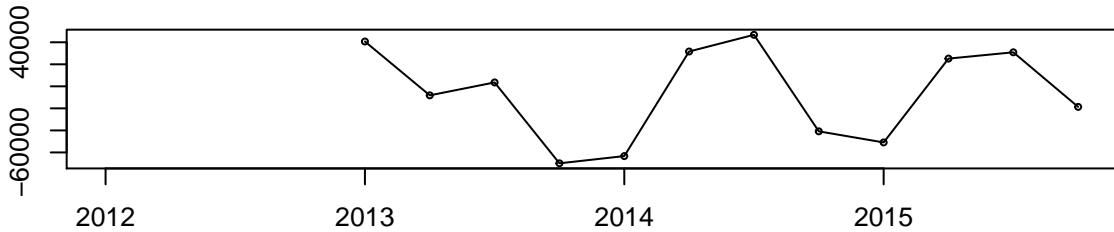
Portland, OR – Downtown Portland : Naive Model Forecast Residuals



Portland, OR – Downtown Portland : Holt Winters Model Forecast

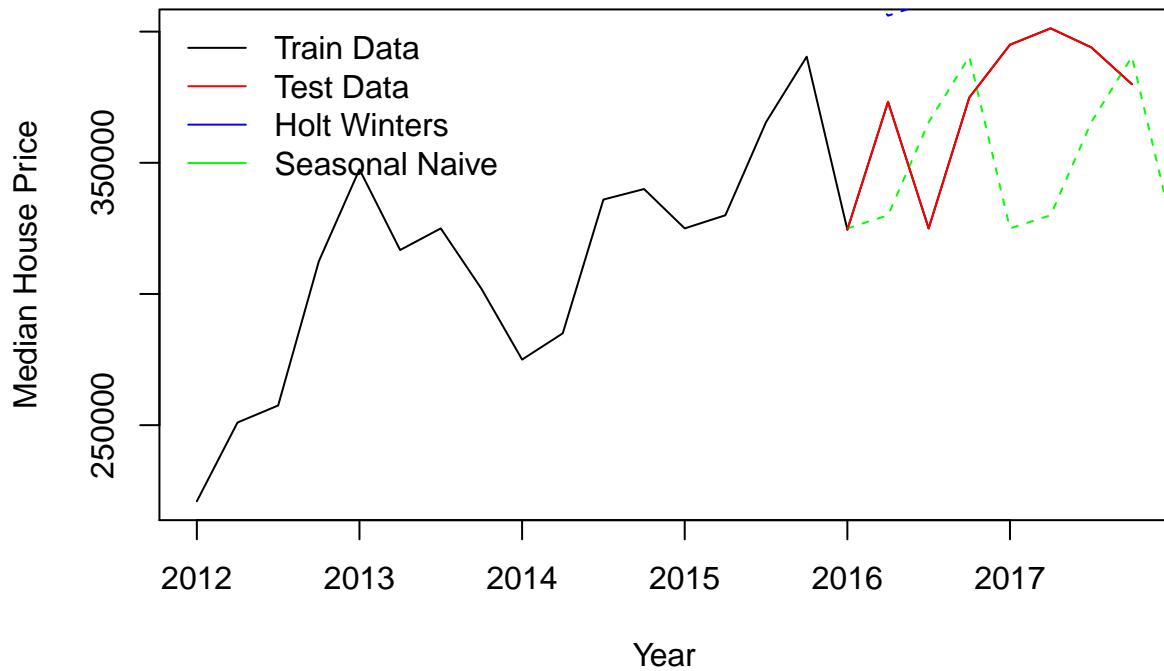


Portland, OR – Downtown Portland : Holt Winters Model Forecast Residuals

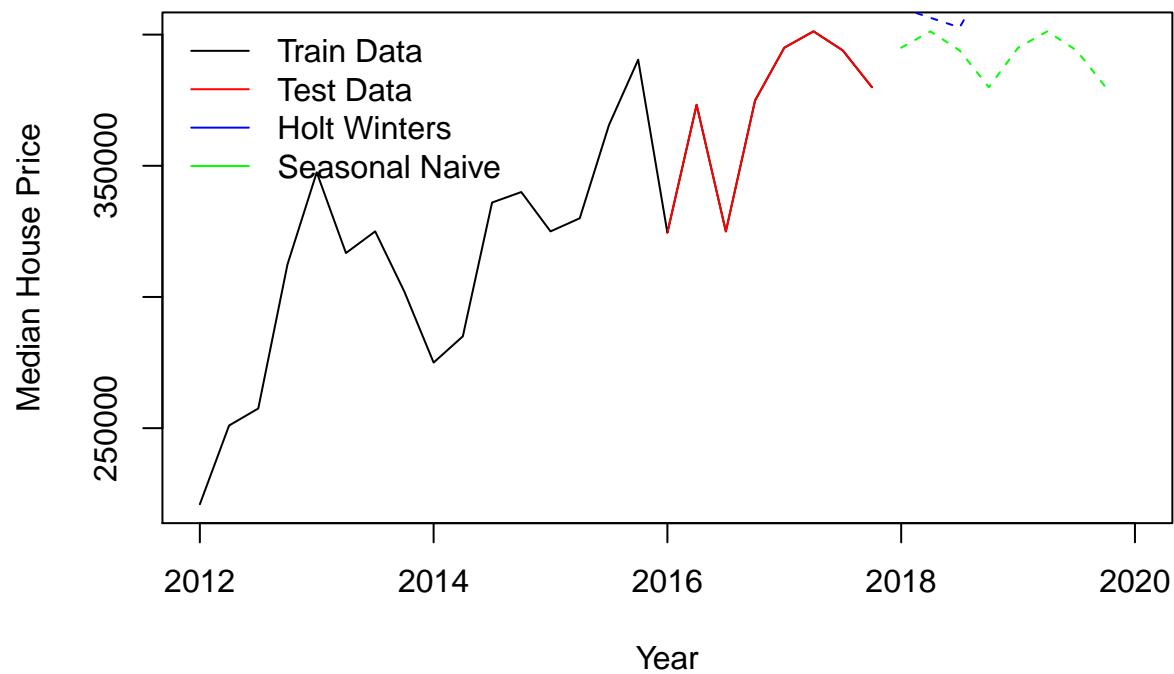


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Downtown Portland"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 30750.00 58281.31 49866.67 8.452411 15.279787 1.000000
## Test set     18243.75 42795.92 35006.25 4.346565 9.228294 0.701997
##          ACF1 Theil's U
## Training set 0.5199281      NA
## Test set     0.1076555 1.246401
## [1] "Holt Winters Accuracy for Portland, OR – Downtown Portland"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -6093.254 40836.90 35872.84 -2.276144 11.25796 0.7193751
## Test set     -85442.453 89906.19 85442.45 -23.257134 23.25713 1.7134182
##          ACF1 Theil's U
## Training set 0.09021015      NA
## Test set     -0.19884681 2.379856
```

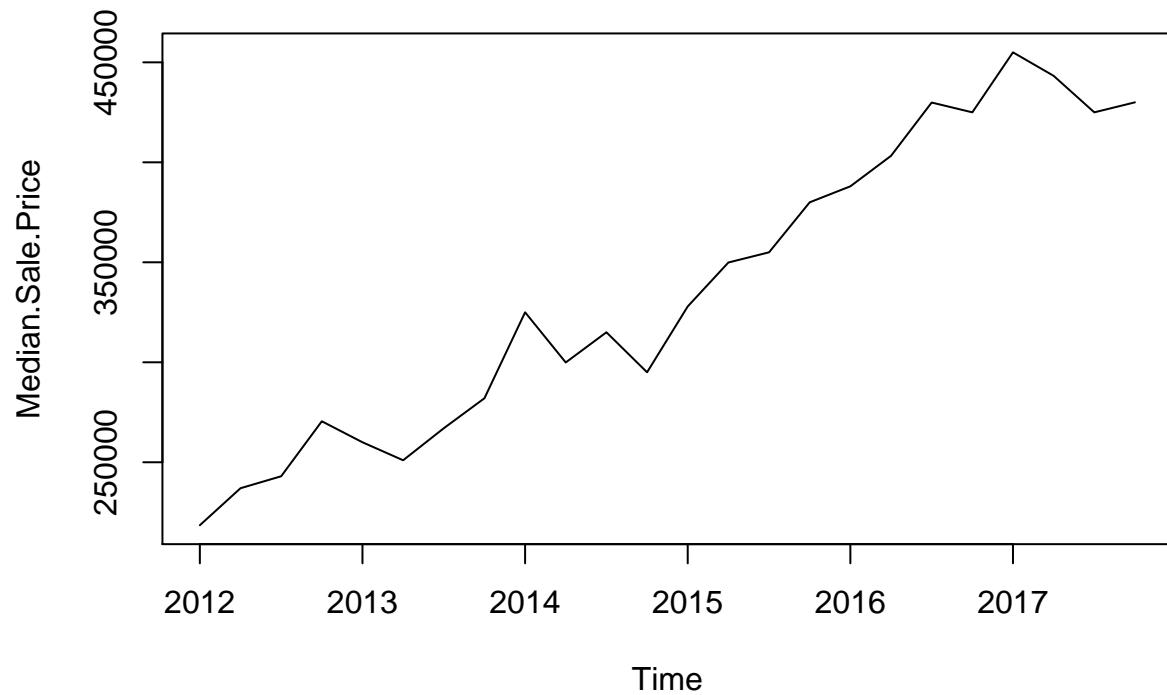
Portland, OR – Downtown Portland : TS Training Model Comparison



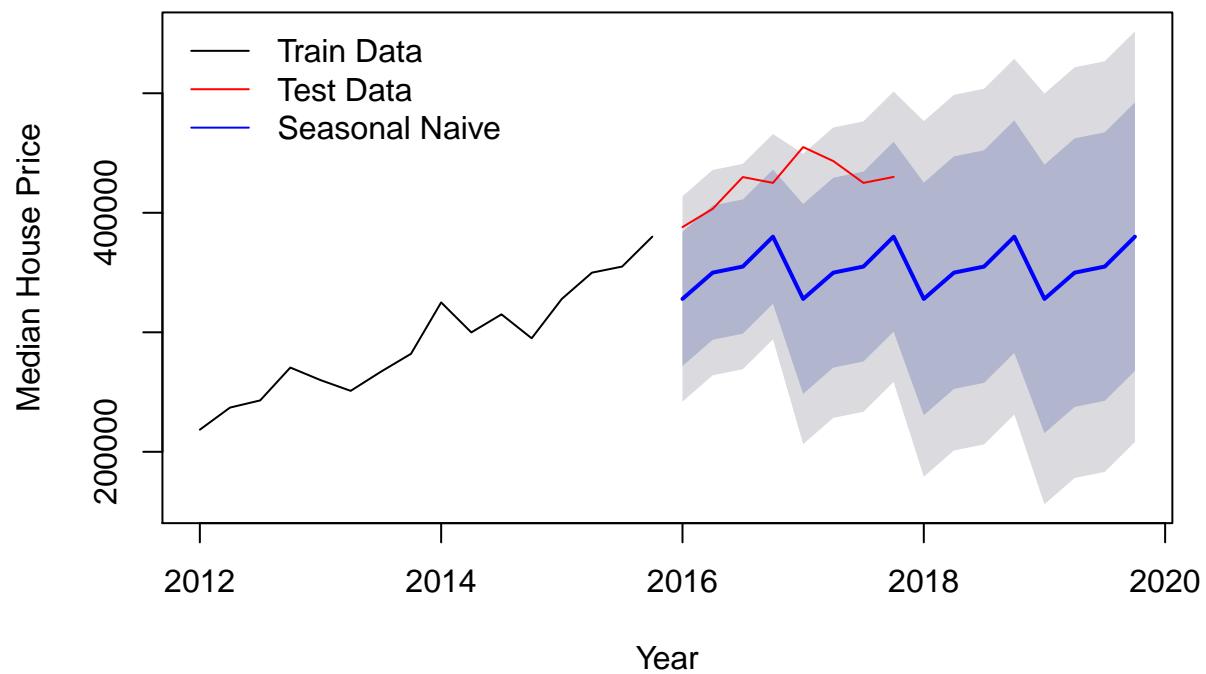
Portland, OR – Downtown Portland : Full TS Models Comparison



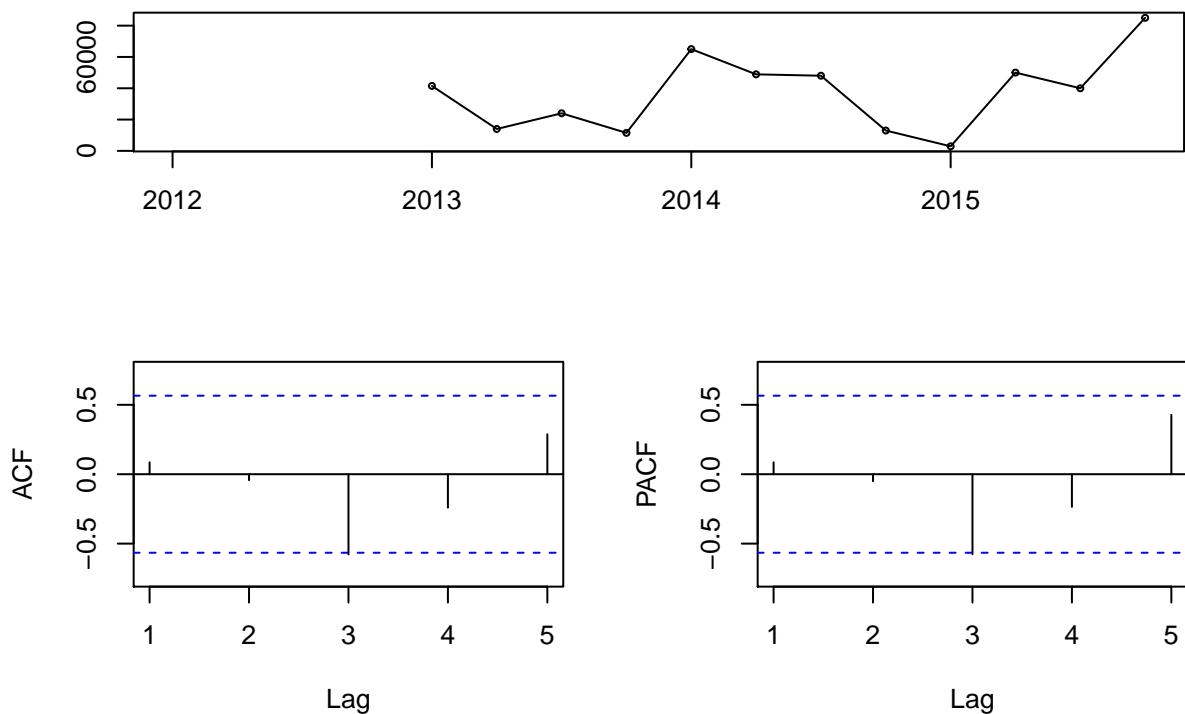
Portland, OR – South Tabor



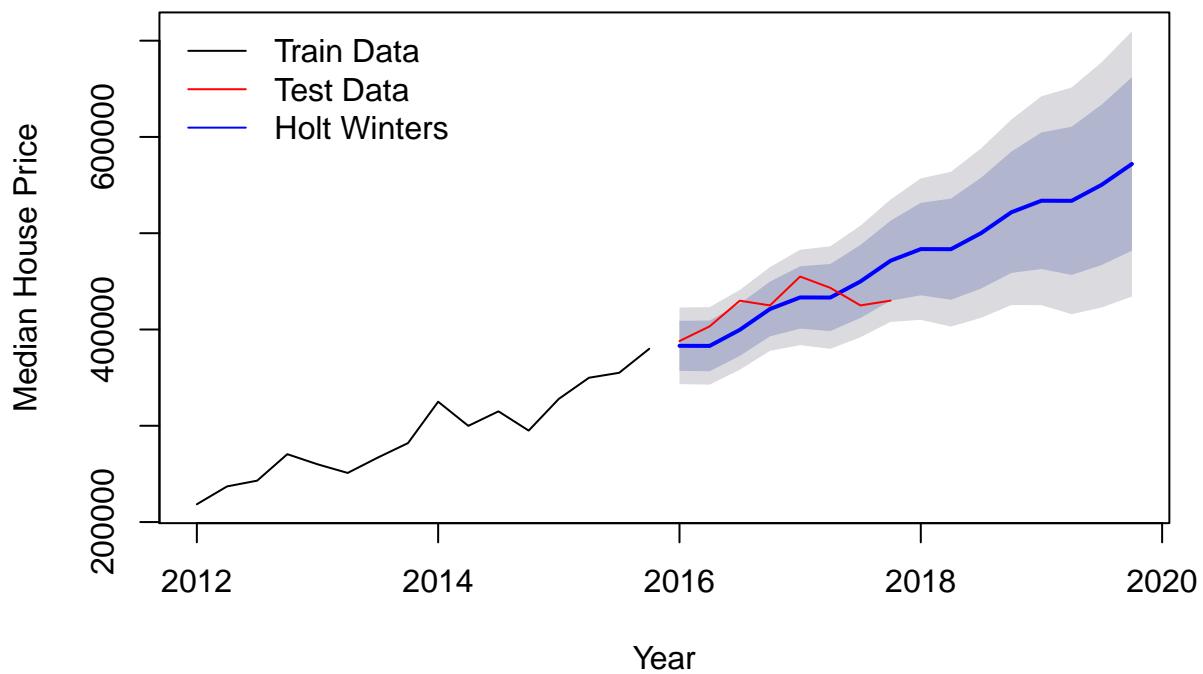
Portland, OR – South Tabor : Naive Model Forecast



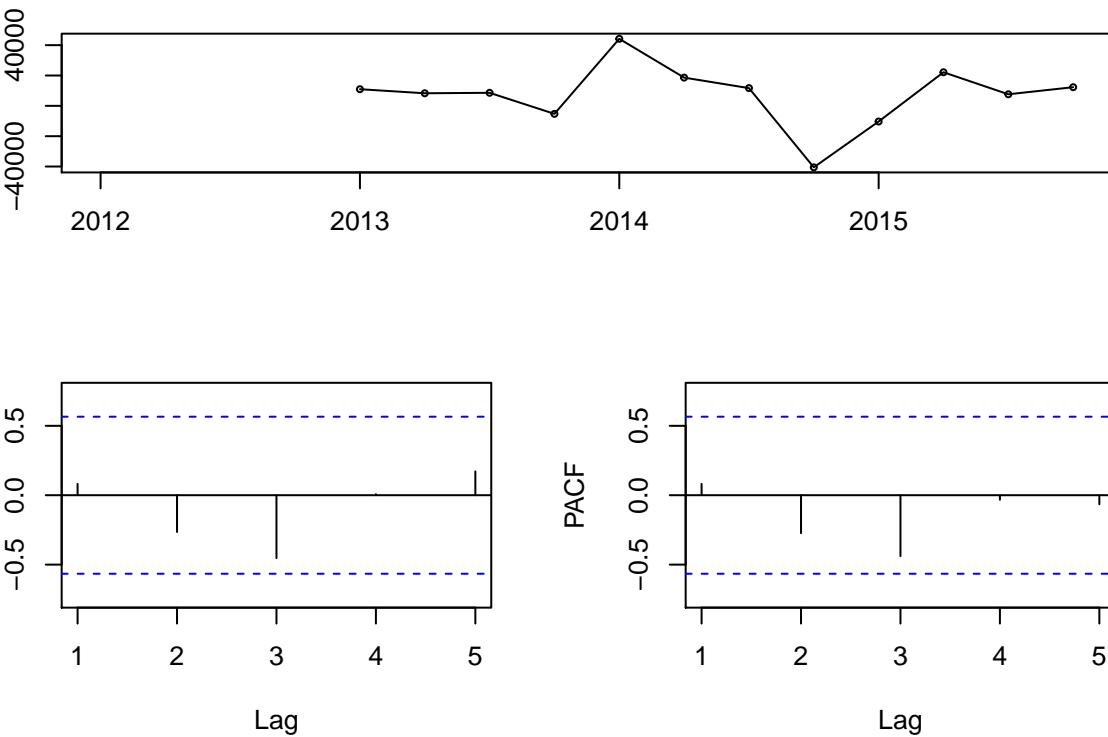
Portland, OR – South Tabor : Naive Model Forecast Residuals



Portland, OR – South Tabor : Holt Winters Model Forecast

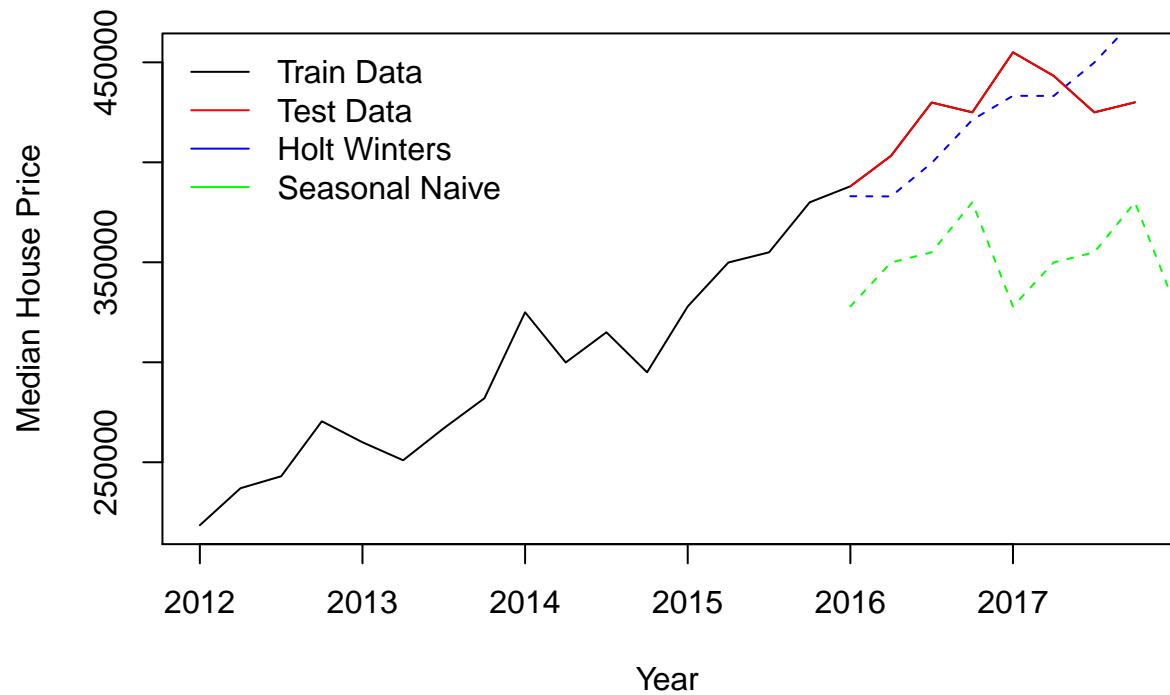


Portland, OR – South Tabor : Holt Winters Model Forecast Residuals

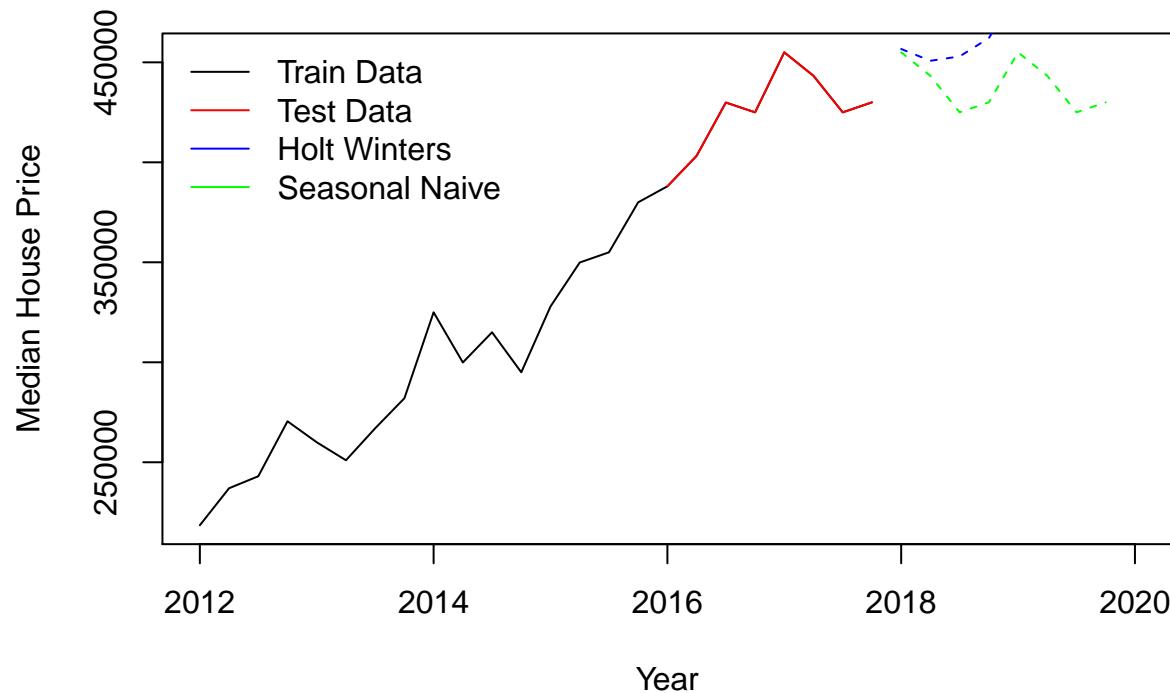


```
## [1] "Seasonal Naive Accuracy for Portland, OR – South Tabor"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 36985.42 43826.61 36985.42 11.61451 11.61451 1.000000
## Test set     71718.75 76118.75 71718.75 16.72645 16.72645 1.939109
##          ACF1 Theil's U
## Training set  0.08594186    NA
## Test set     -0.04055202 4.165055
## [1] "Holt Winters Accuracy for Portland, OR – South Tabor"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 7356.638 20762.71 16707.17 2.2674593 5.392350 0.4517233
## Test set     3080.766 23127.12 19675.78 0.7207138 4.597047 0.5319875
##          ACF1 Theil's U
## Training set 0.08174171    NA
## Test set     0.40726882 1.338159
```

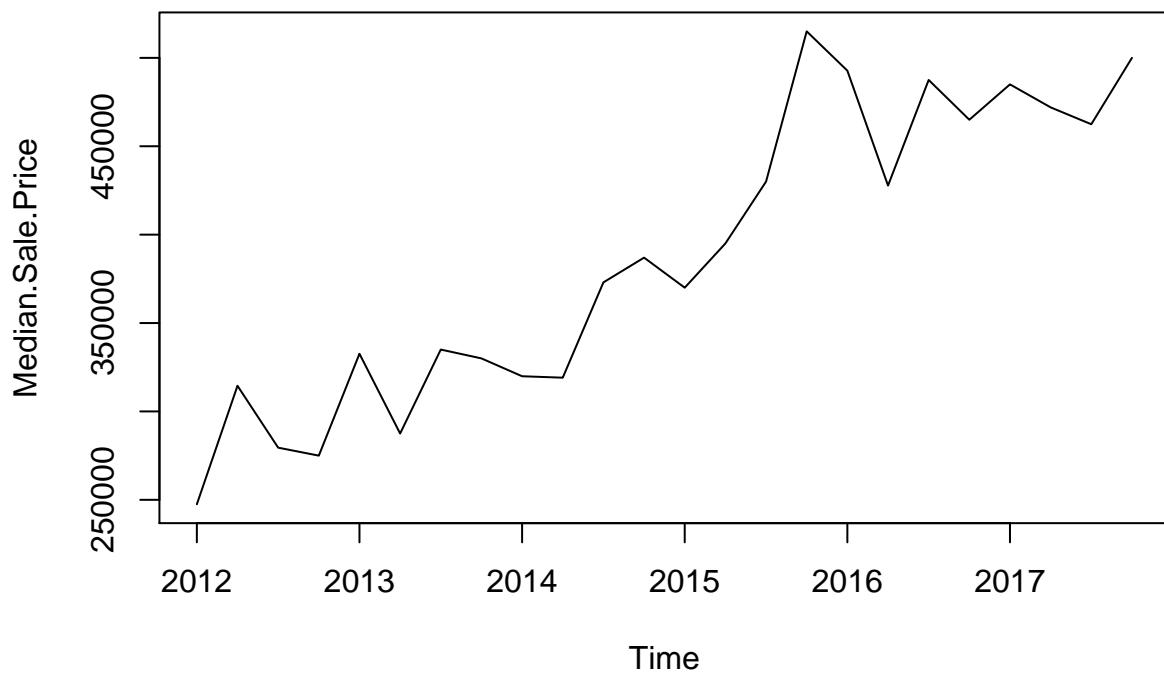
Portland, OR – South Tabor : TS Training Model Comparison



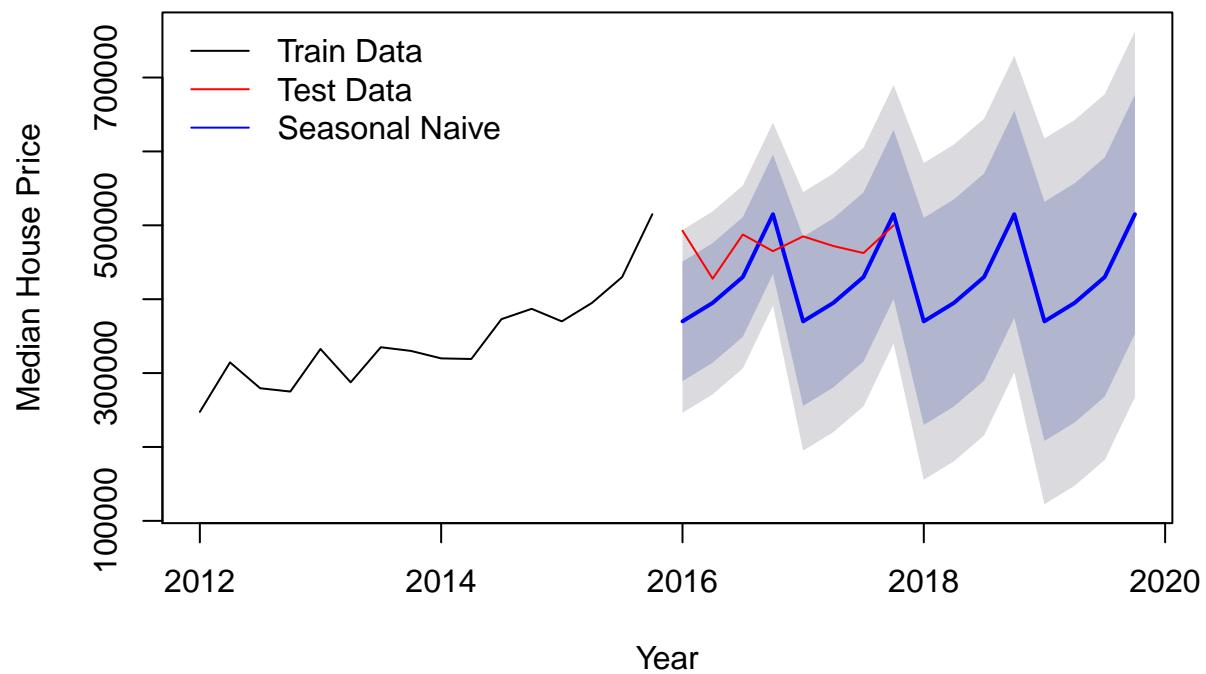
Portland, OR – South Tabor : Full TS Models Comparison



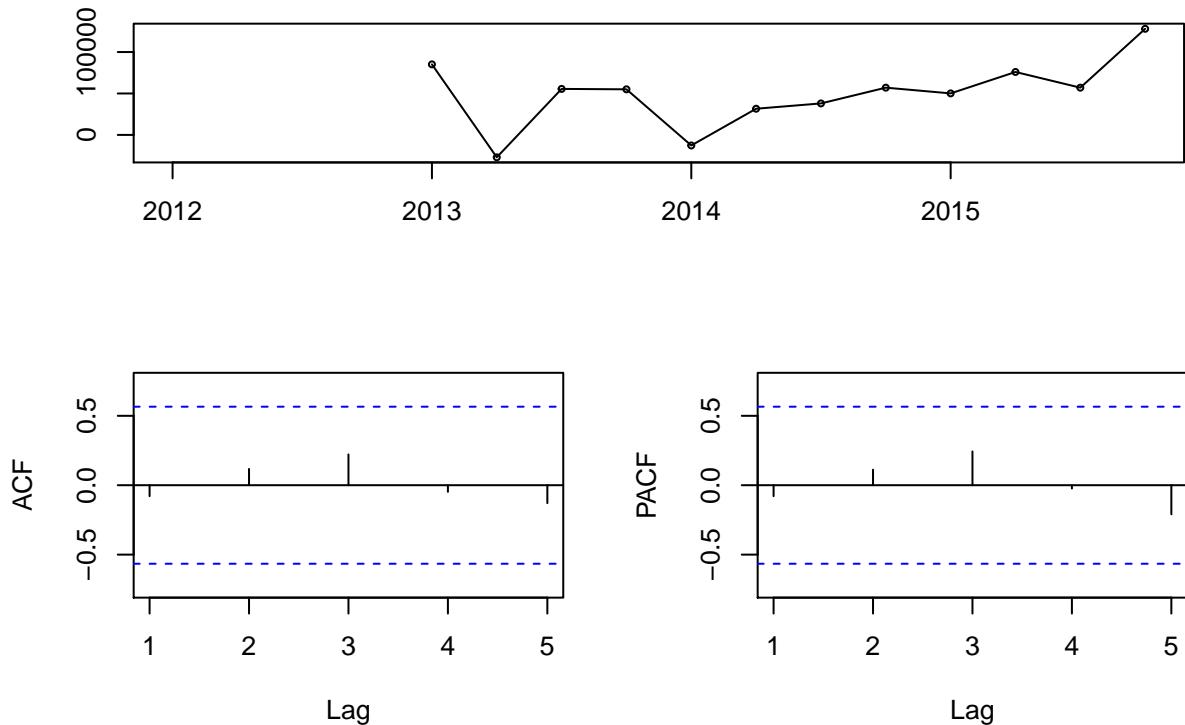
Portland, OR – Hayhurst



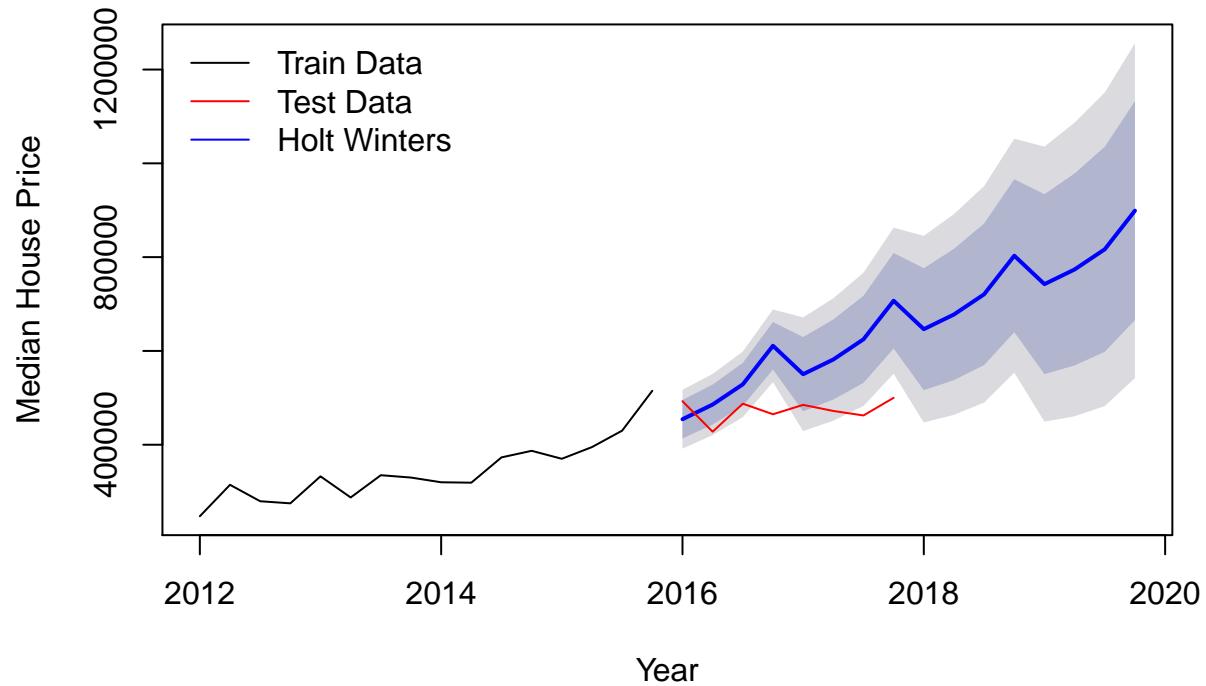
Portland, OR – Hayhurst : Naive Model Forecast



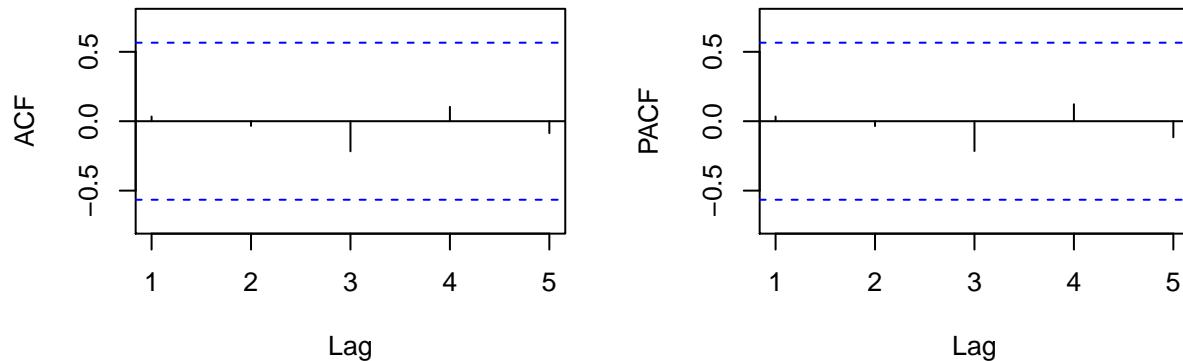
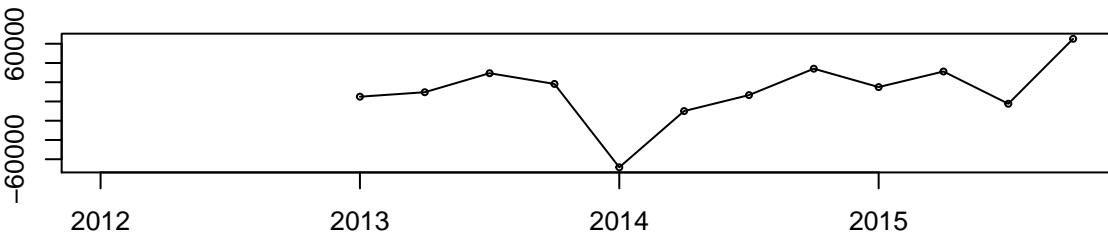
Portland, OR – Hayhurst : Naive Model Forecast Residuals



Portland, OR – Hayhurst : Holt Winters Model Forecast



Portland, OR – Hayhurst : Holt Winters Model Forecast Residuals

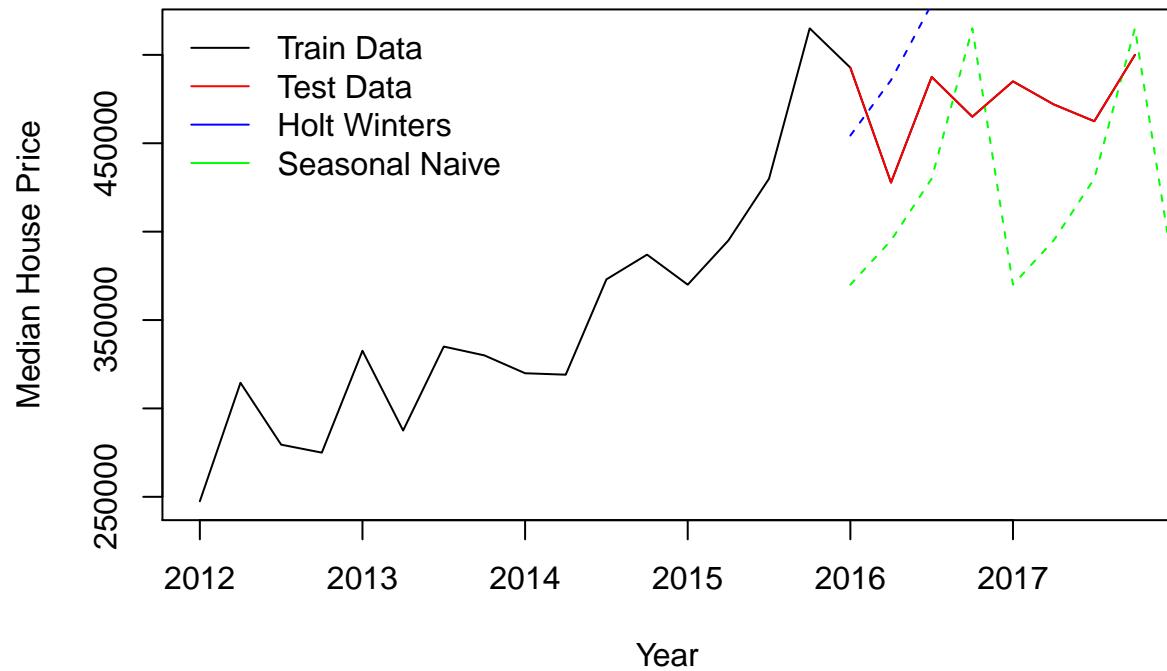


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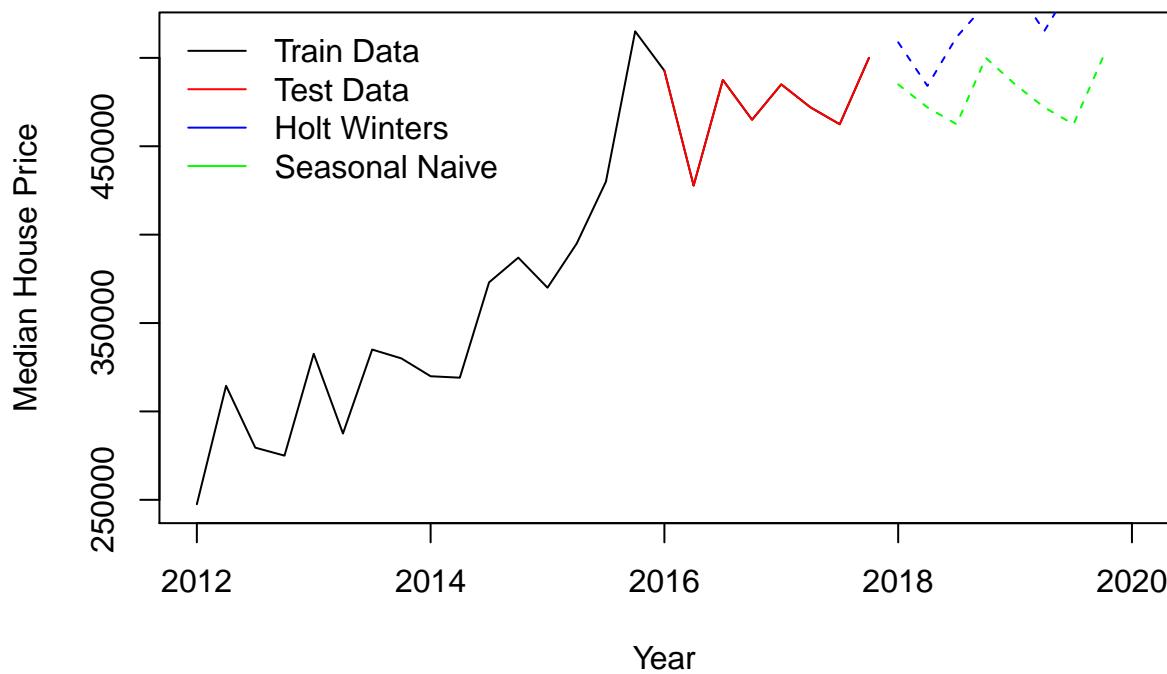
## [1] "Seasonal Naive Accuracy for Portland, OR - Hayhurst"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 49458.33 63138.07 56077.50 12.595185 14.82288 1.00000
## Test set     46556.25 72782.53 62806.25  9.706451 13.14462 1.11999
##          ACF1 Theil's U
## Training set -0.07877683      NA
## Test set     -0.25344313 1.604512
## [1] "Holt Winters Accuracy for Portland, OR - Hayhurst"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 11116.93 32573.15 24569.02  2.436404 6.611341 0.4381261
## Test set     -93902.58 119041.03 103501.27 -19.855012 21.802997 1.8456828
##          ACF1 Theil's U
## Training set 0.03397177      NA
## Test set     0.25186642 3.214817

```

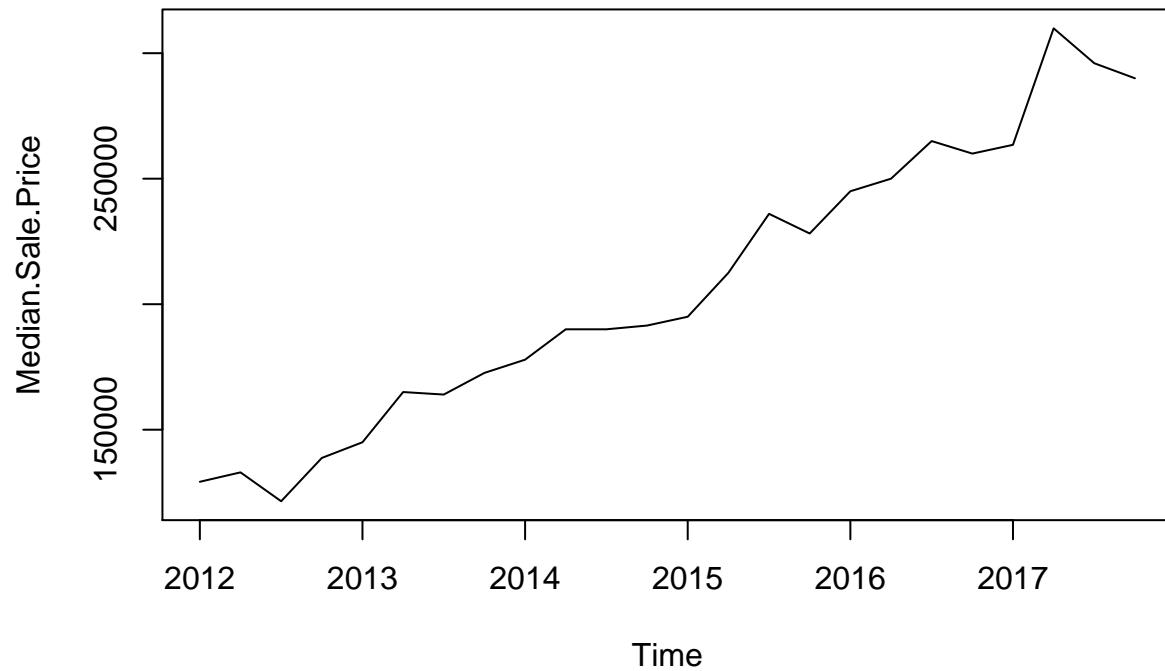
Portland, OR – Hayhurst : TS Training Model Comparison



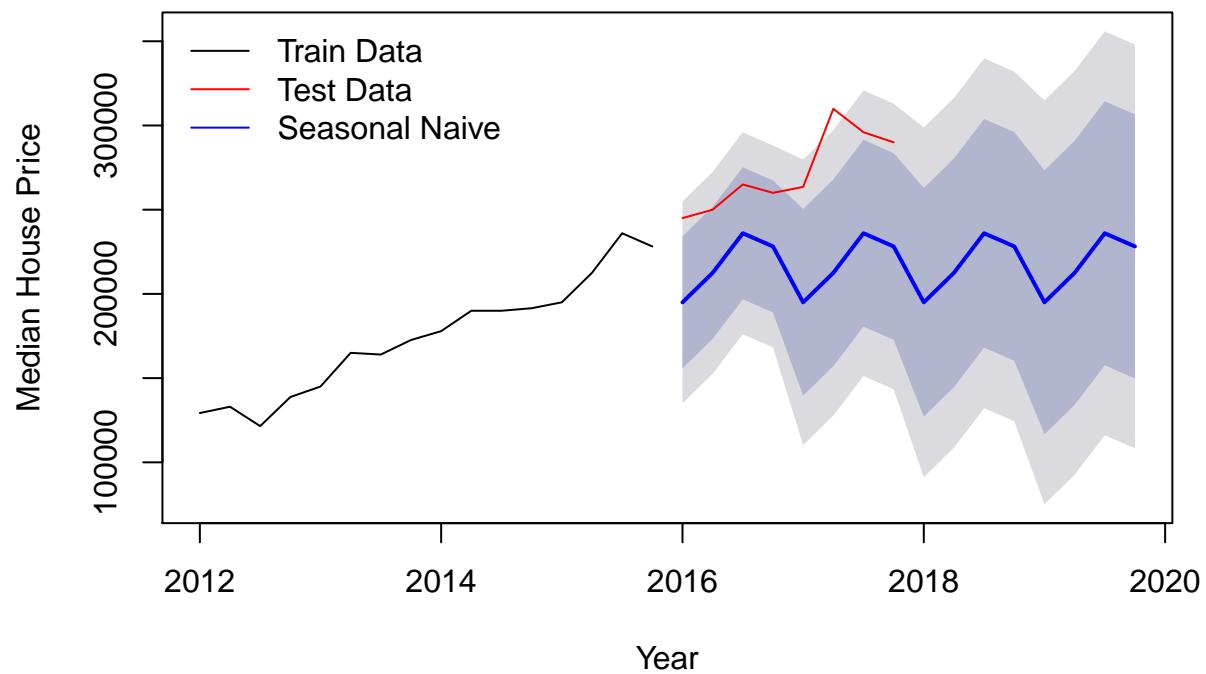
Portland, OR – Hayhurst : Full TS Models Comparison



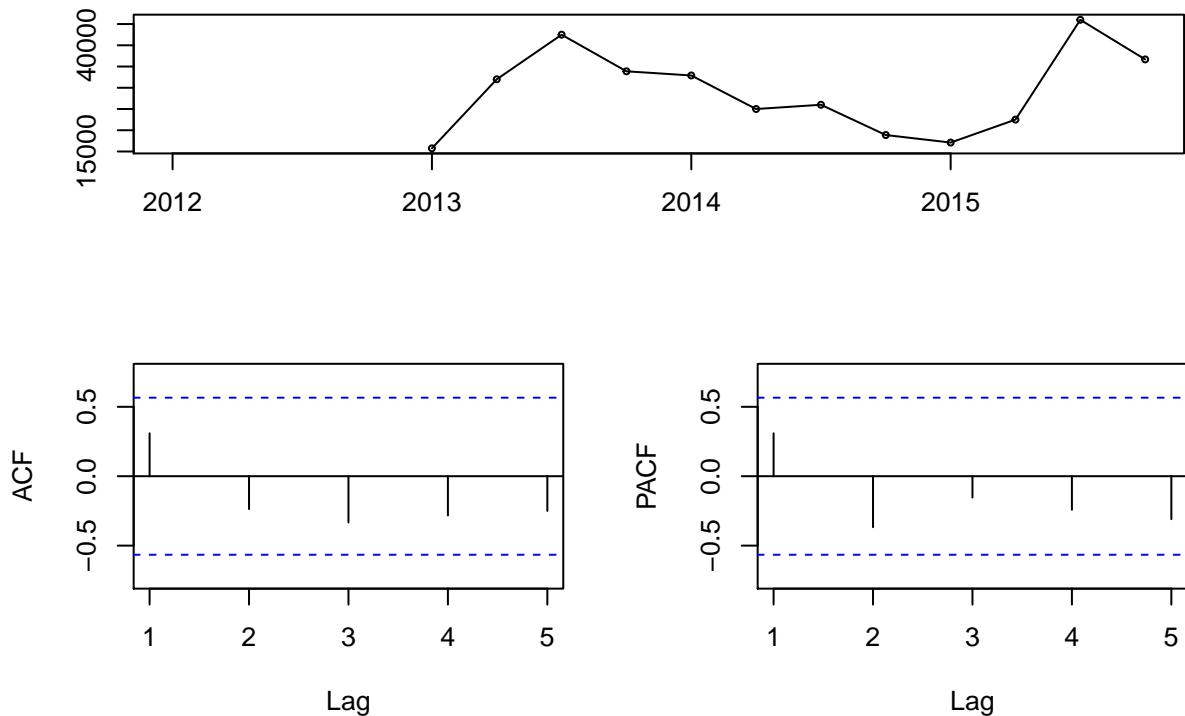
Portland, OR – Lents



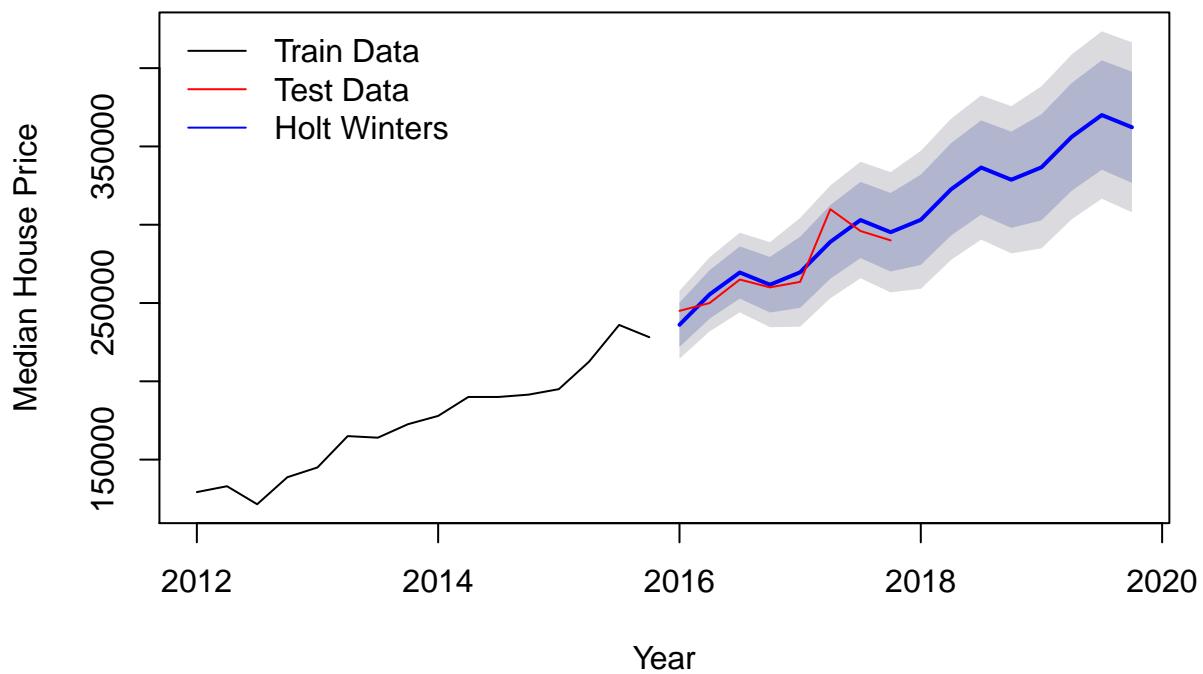
Portland, OR – Lents : Naive Model Forecast



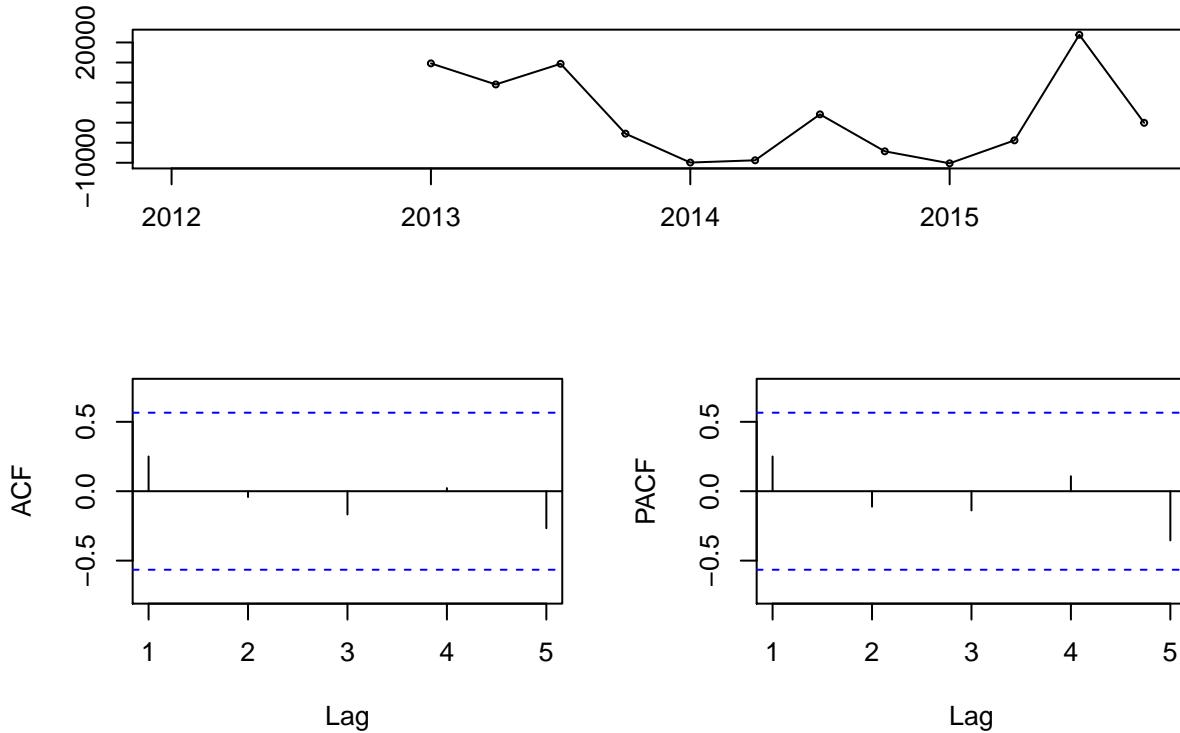
Portland, OR – Lents : Naive Model Forecast Residuals



Portland, OR – Lents : Holt Winters Model Forecast



Portland, OR – Lents : Holt Winters Model Forecast Residuals

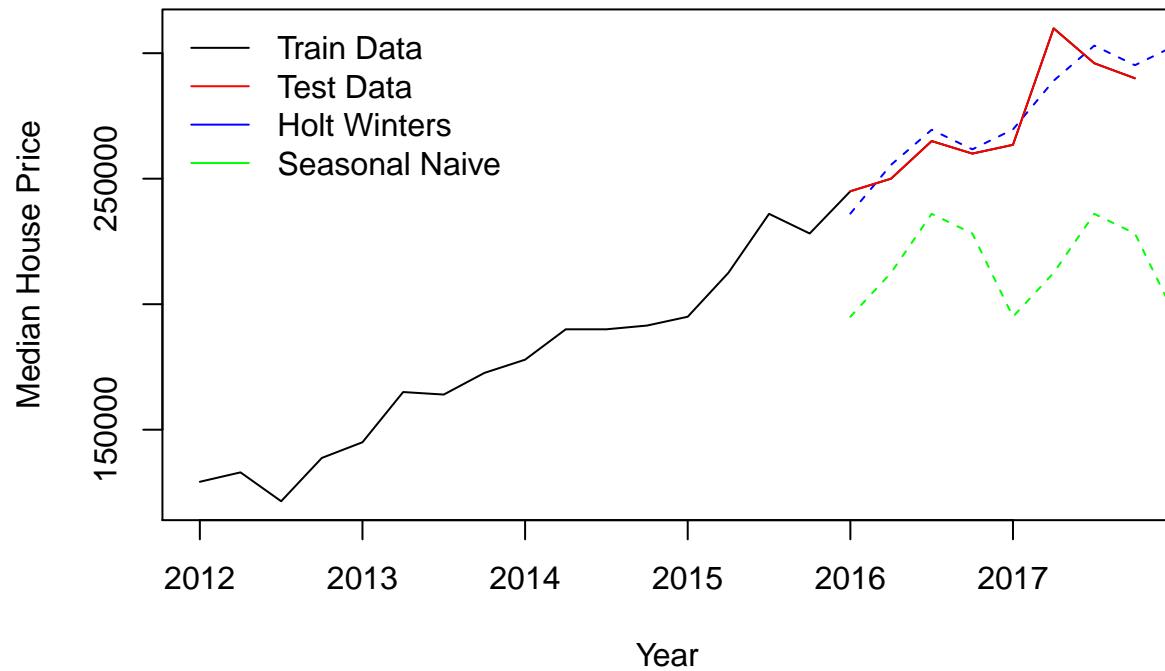


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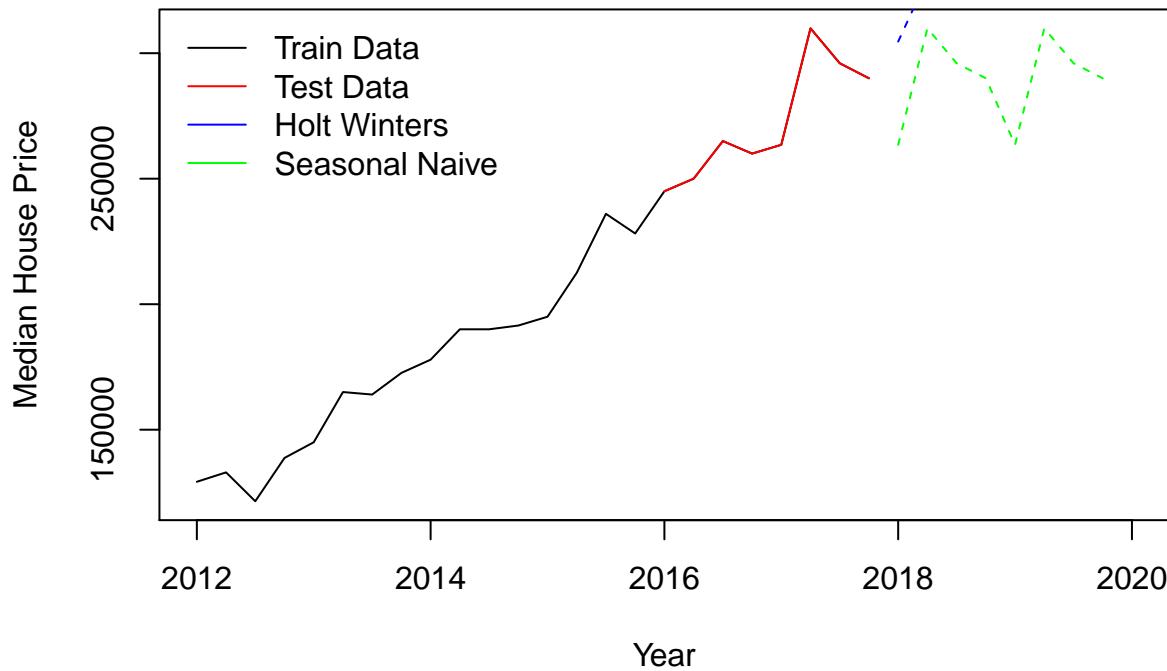
## [1] "Seasonal Naive Accuracy for Portland, OR – Lents"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 29097.67 30584.75 29097.67 15.49219 15.49219 1.000000
## Test set     54506.25 58482.28 54506.25 19.70086 19.70086 1.873217
##          ACF1 Theil's U
## Training set 0.3093653      NA
## Test set     0.4584392 2.985056
## [1] "Holt Winters Accuracy for Portland, OR – Lents"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 1596.91395 10710.346 8896.498 1.01265917 4.868772 0.3057461
## Test set     -37.61688  9232.584 7478.073 -0.08544842 2.676521 0.2569990
##          ACF1 Theil's U
## Training set 0.2502565      NA
## Test set     -0.3577911 0.4735659

```

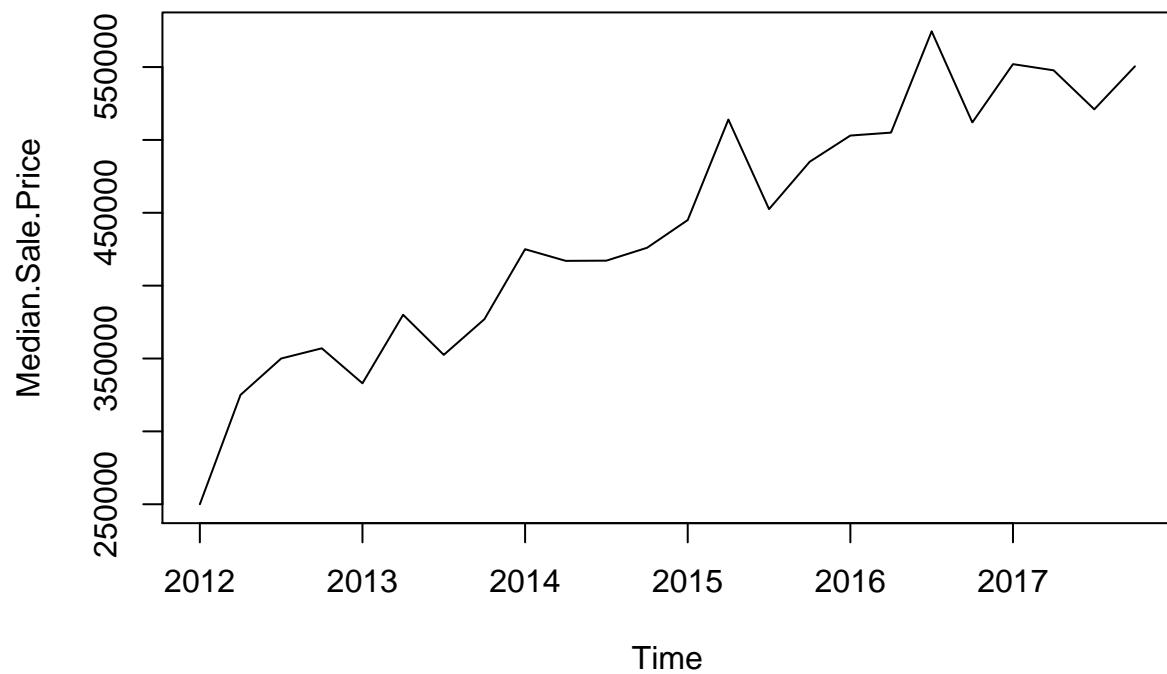
Portland, OR – Lents : TS Training Model Comparison



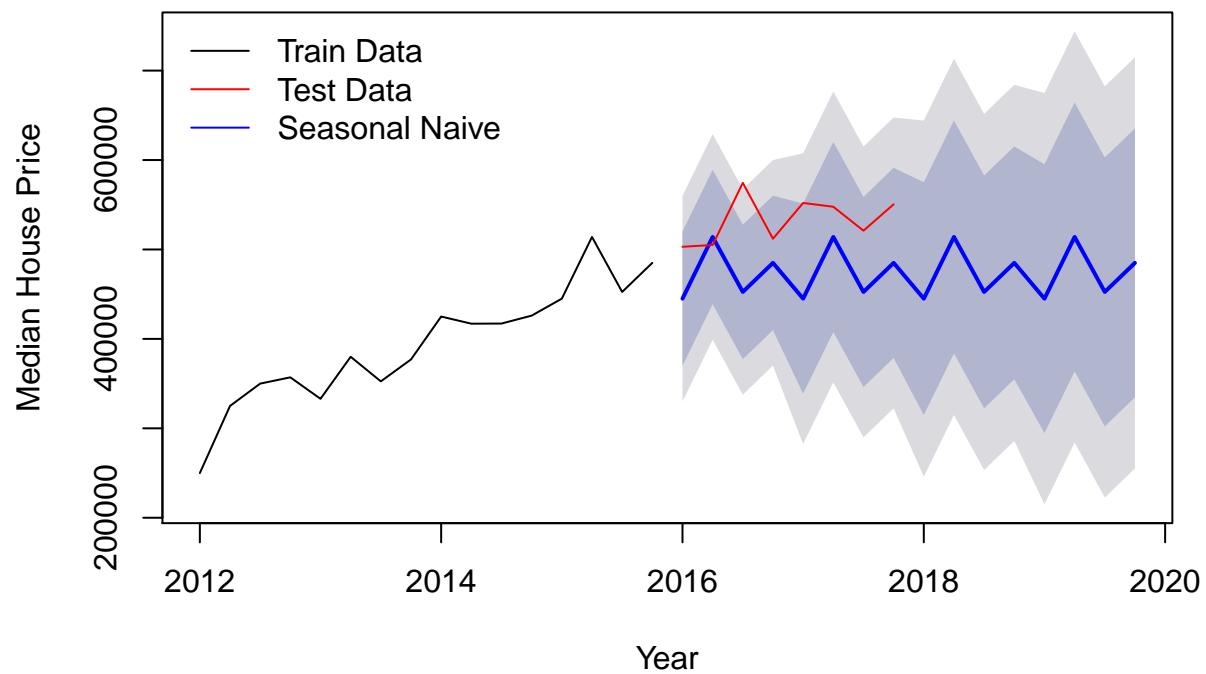
Portland, OR – Lents : Full TS Models Comparison



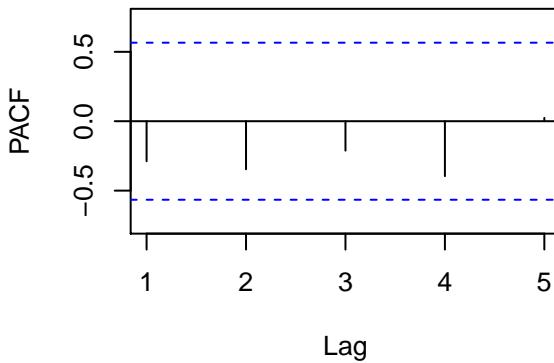
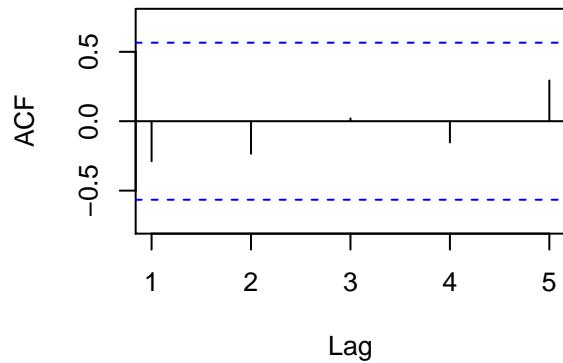
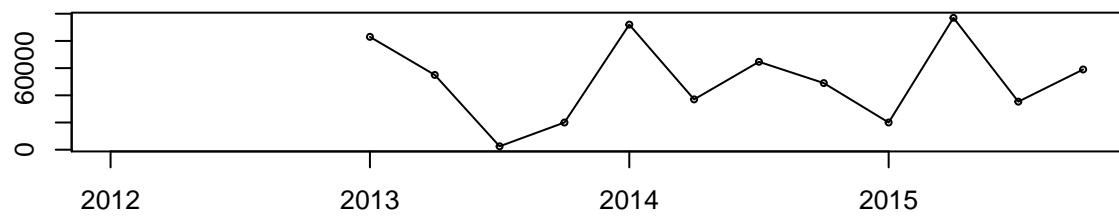
Portland, OR – Richmond



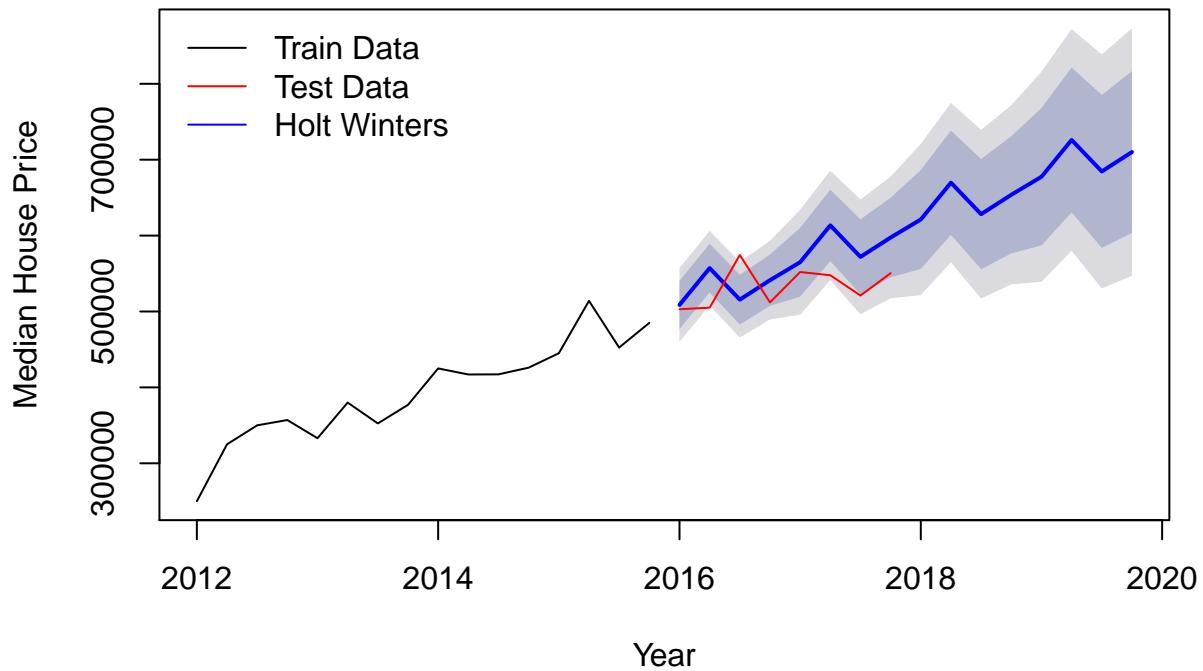
Portland, OR – Richmond : Naive Model Forecast



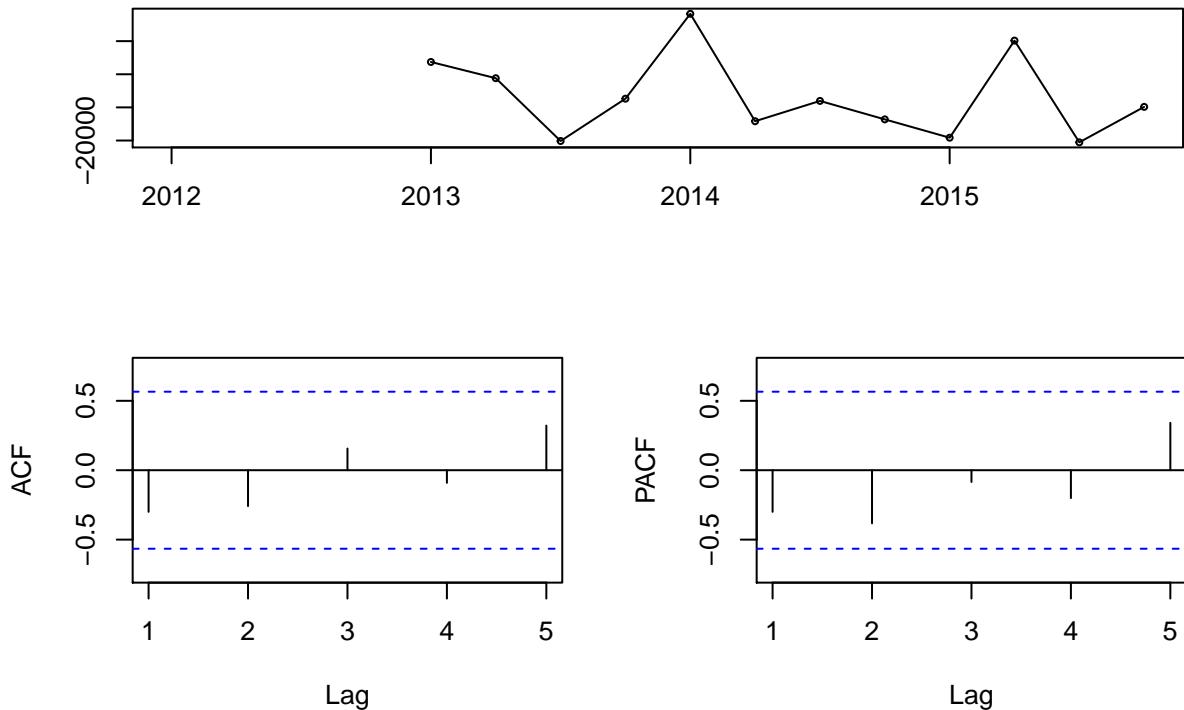
Portland, OR – Richmond : Naive Model Forecast Residuals



Portland, OR – Richmond : Holt Winters Model Forecast



Portland, OR – Richmond : Holt Winters Model Forecast Residuals

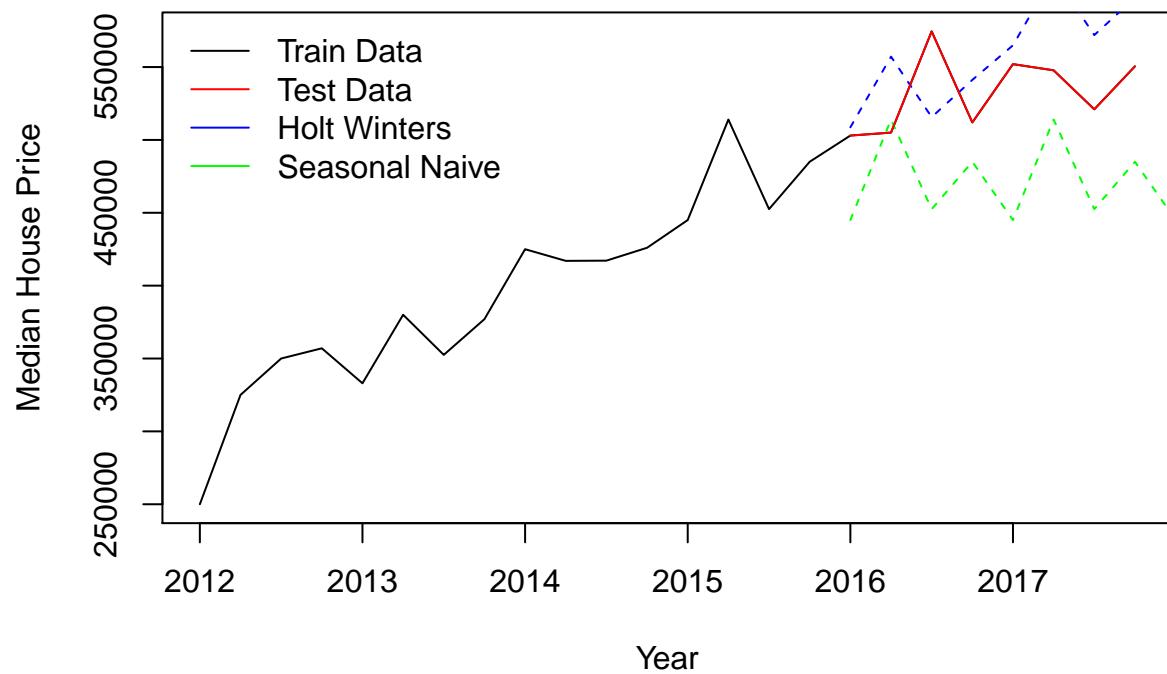


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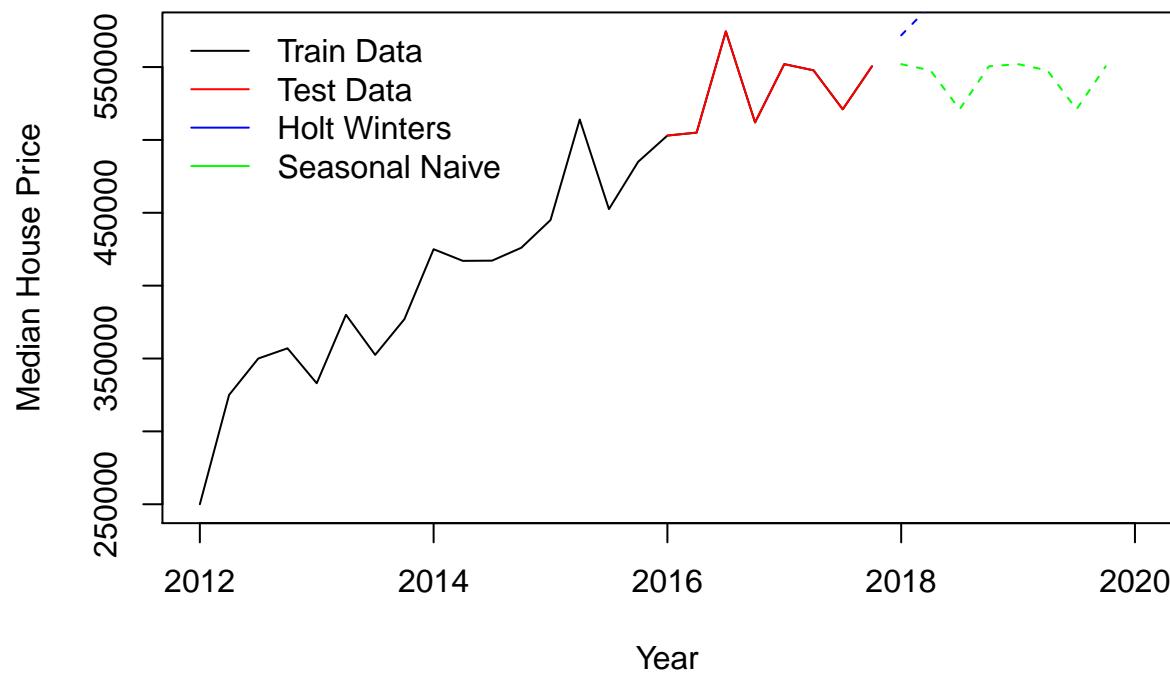
## [1] "Seasonal Naive Accuracy for Portland, OR – Richmond"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 51208.33 58646.89 51208.33 12.18969 12.18969 1.000000
## Test set     59093.75 71264.09 61343.75 10.85620 11.30175 1.197925
##          ACF1 Theil's U
## Training set -0.2883172      NA
## Test set     -0.7215328  1.81238
## [1] "Holt Winters Accuracy for Portland, OR – Richmond"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set  6342.505 24561.30 18886.60  1.515376 4.553704 0.3688189
## Test set     -25584.767 45213.17 40298.02 -4.944190 7.505244 0.7869427
##          ACF1 Theil's U
## Training set -0.2998165      NA
## Test set     -0.1863968  1.172611

```

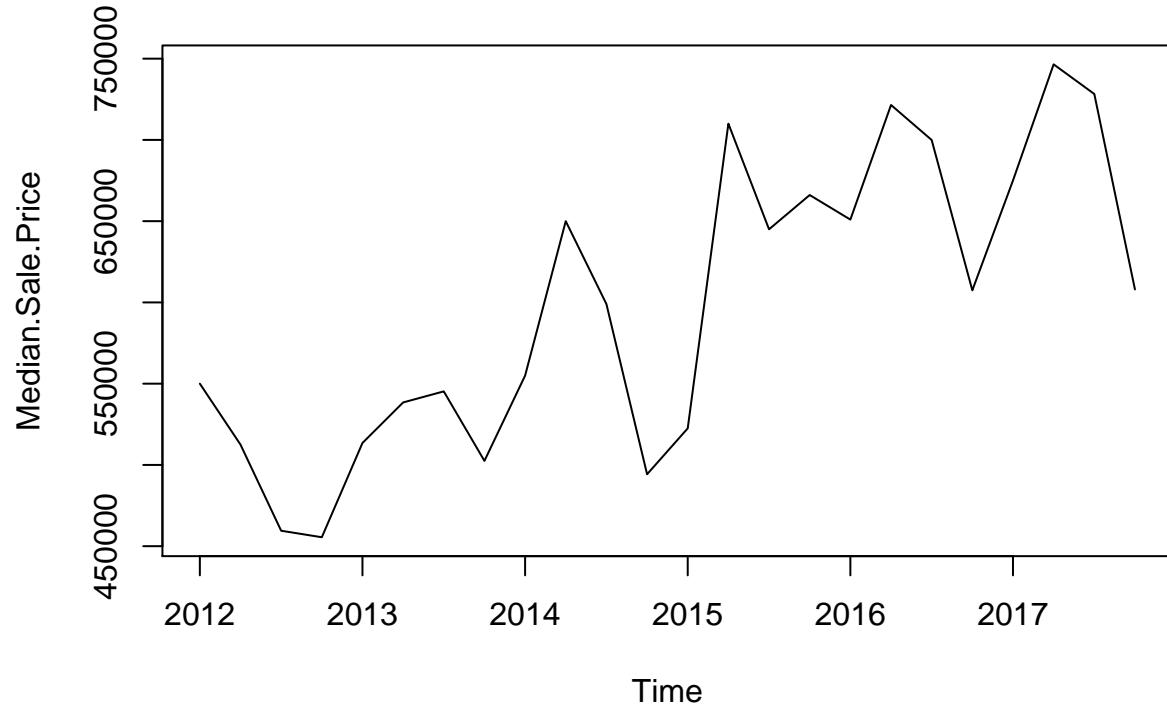
Portland, OR – Richmond : TS Training Model Comparison



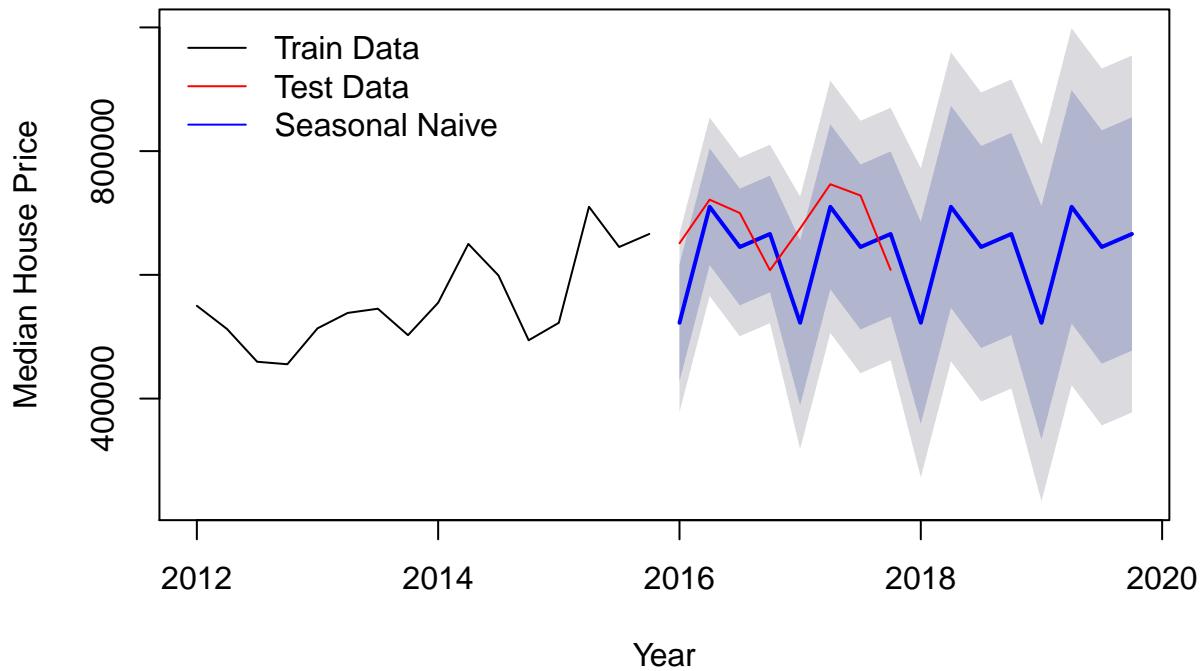
Portland, OR – Richmond : Full TS Models Comparison



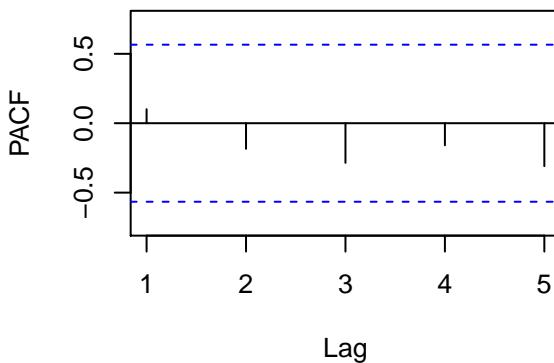
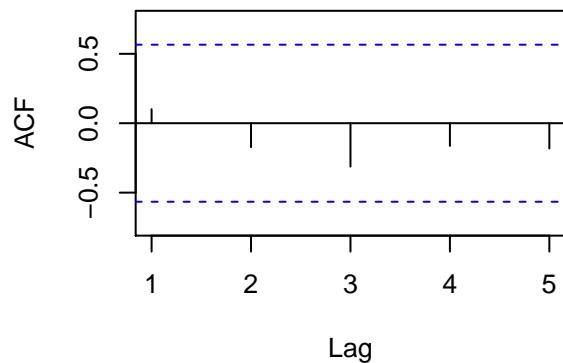
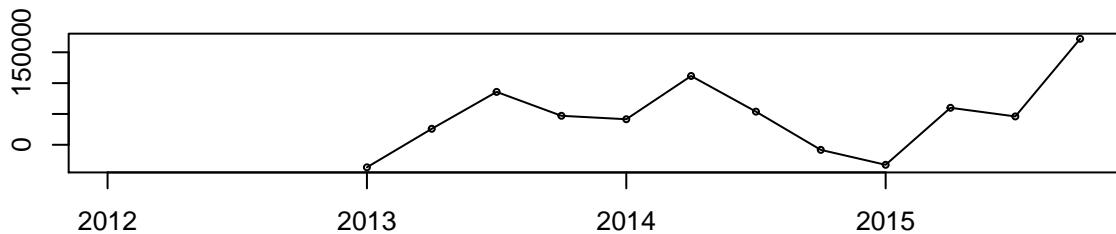
Portland, OR – Alameda



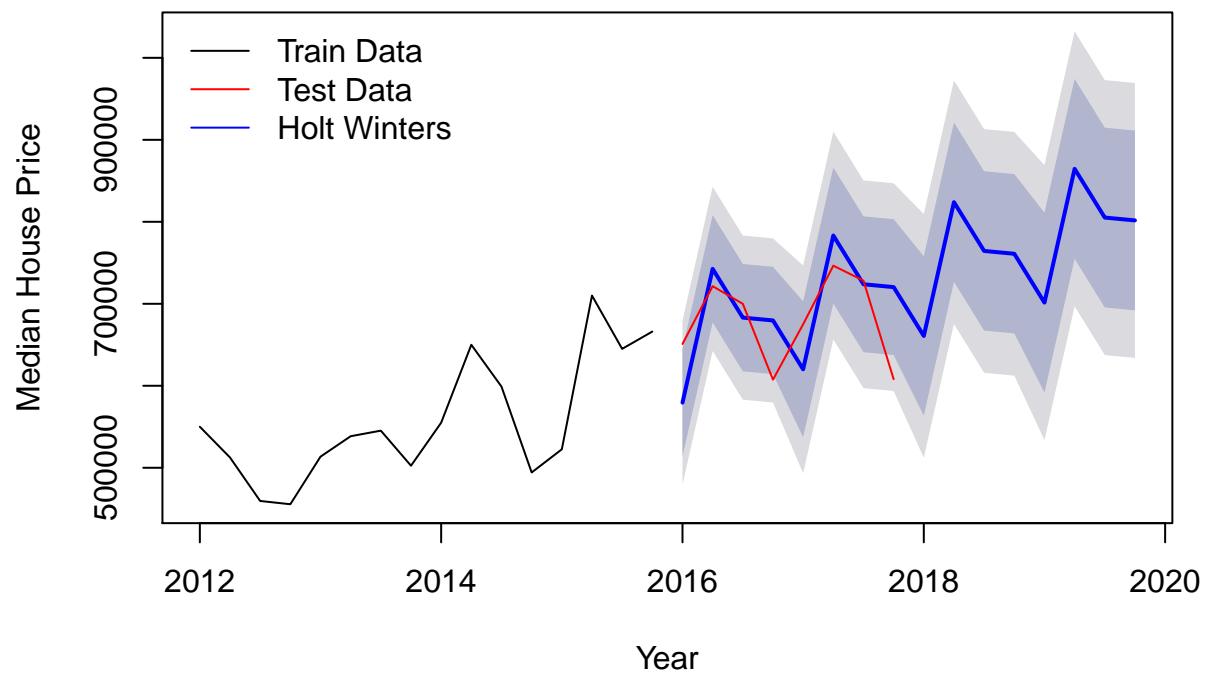
Portland, OR – Alameda : Naive Model Forecast



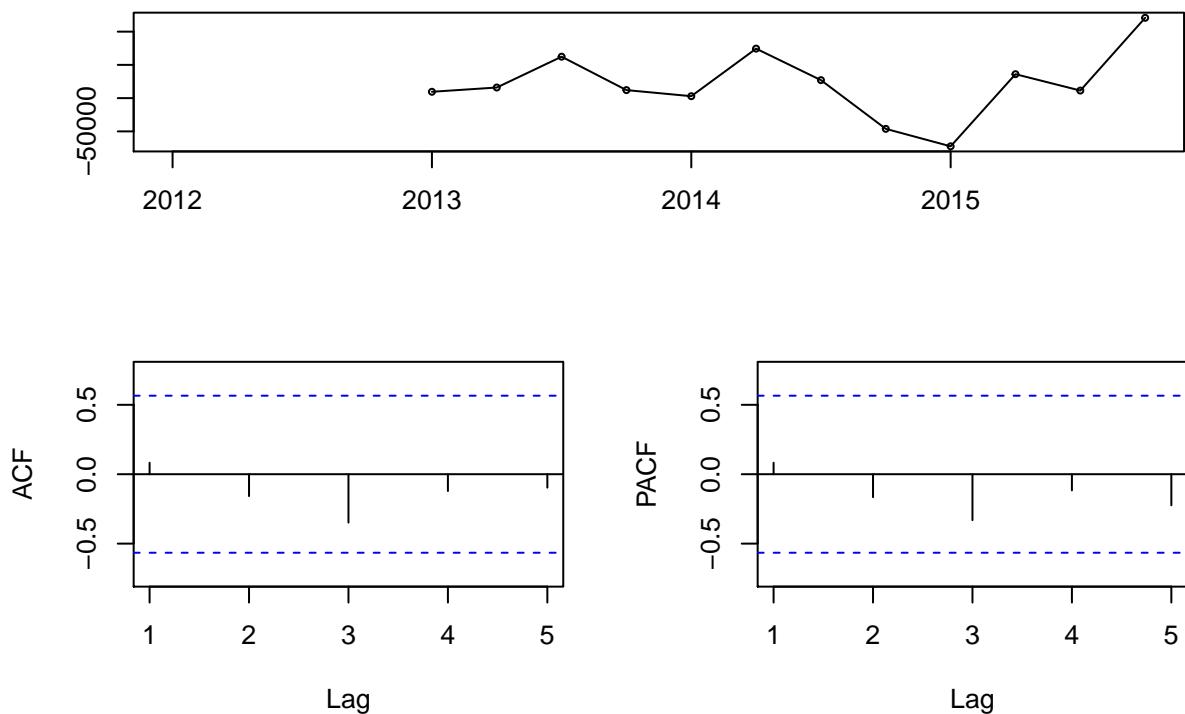
Portland, OR – Alameda : Naive Model Forecast Residuals



Portland, OR – Alameda : Holt Winters Model Forecast

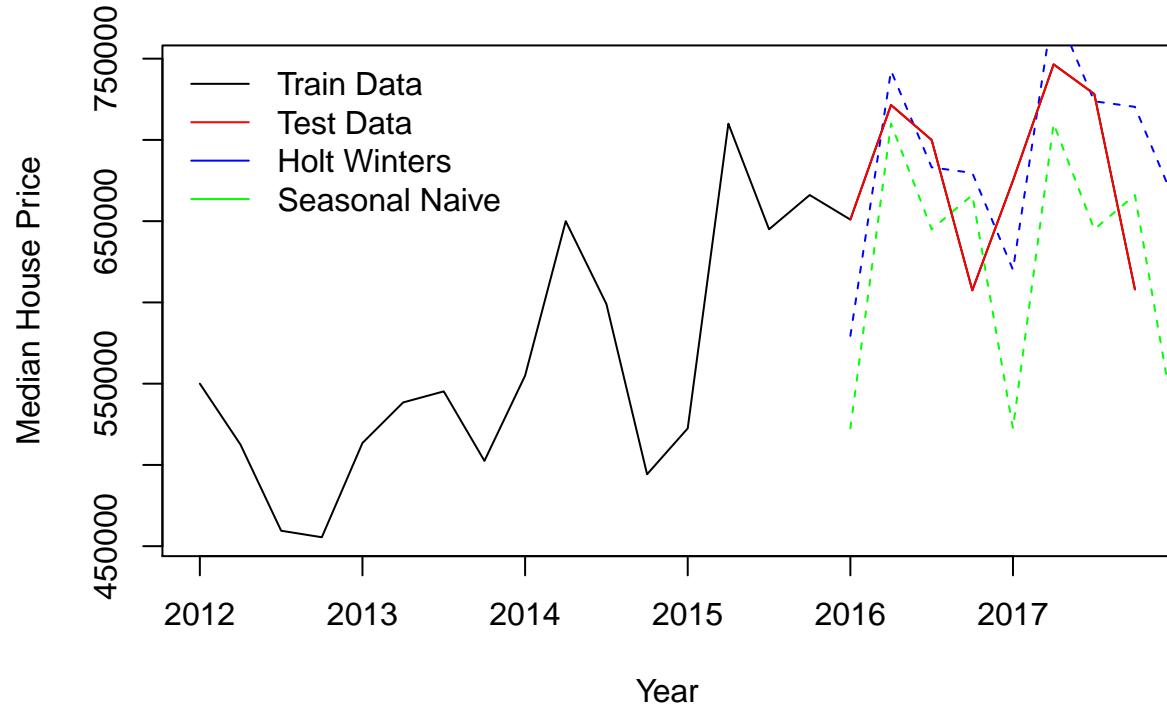


Portland, OR – Alameda : Holt Winters Model Forecast Residuals

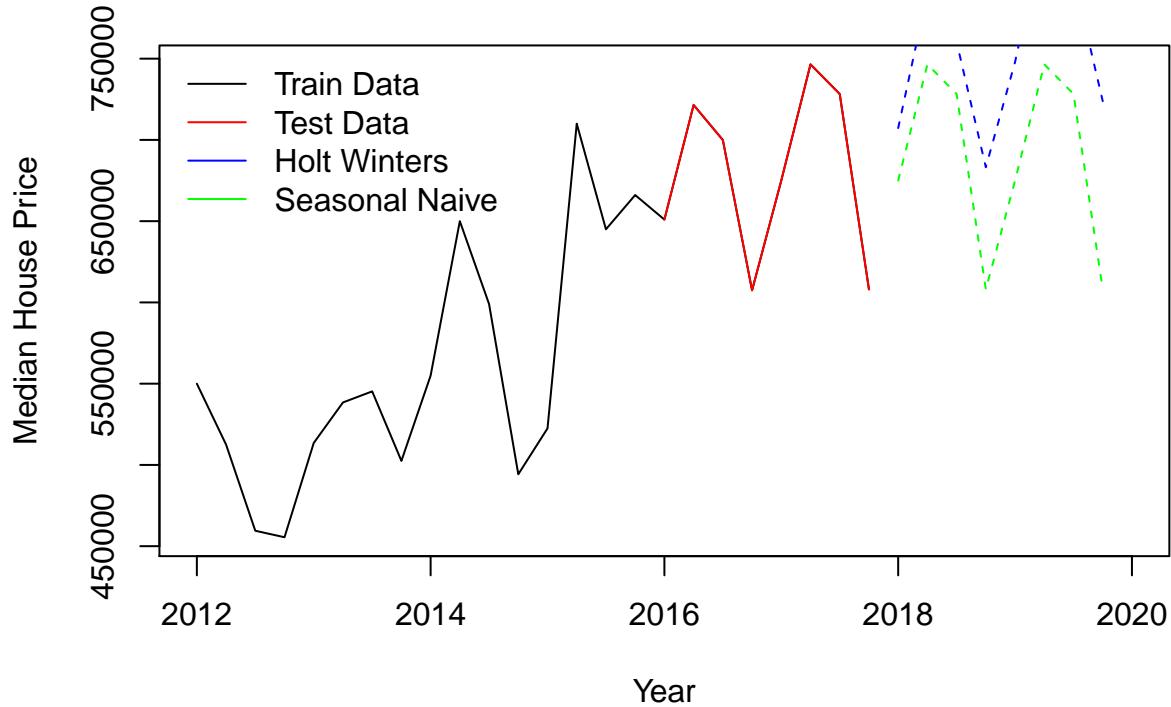


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Alameda"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 47173.54 73587.68 60040.21 7.49129 9.989258 1.000000
## Test set     43807.50 85138.11 72986.25 6.11107 10.912389 1.215623
##          ACF1 Theil's U
## Training set 0.1011614      NA
## Test set     -0.4801799  1.095591
## [1] "Holt Winters Accuracy for Portland, OR - Alameda"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 21154.15 53280.76 40934.04 3.075535 6.945417 0.6817772
## Test set     -11831.53 59238.73 48775.16 -2.008666 7.545299 0.8123750
##          ACF1 Theil's U
## Training set 0.08297257      NA
## Test set     -0.38987514  0.7609275
```

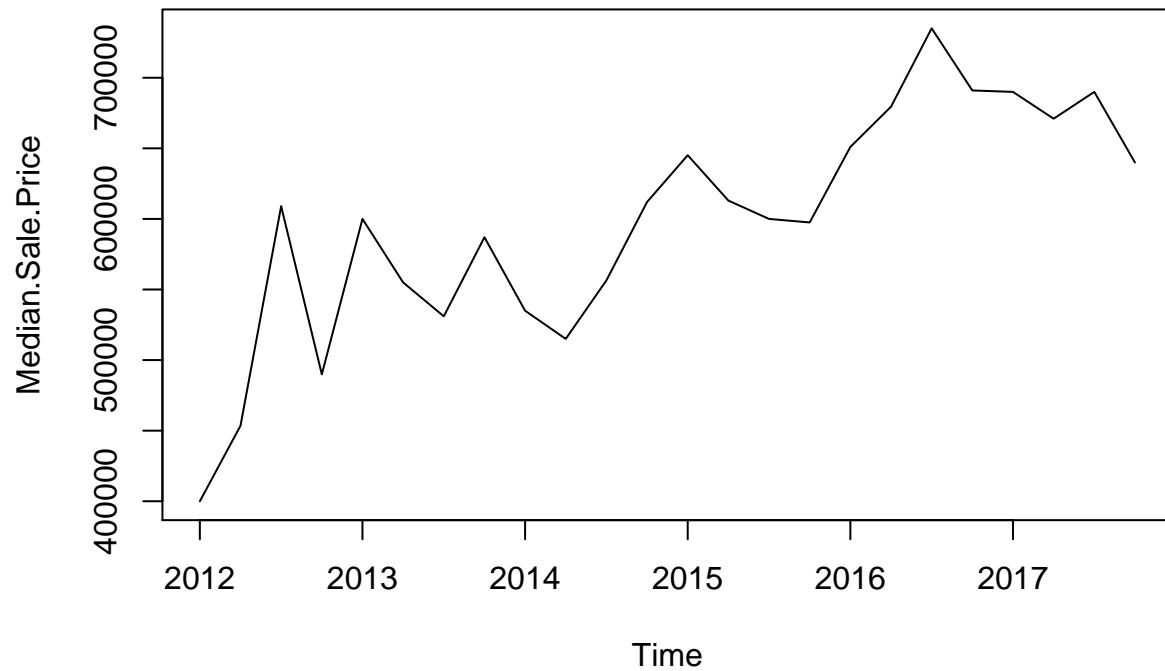
Portland, OR – Alameda : TS Training Model Comparison



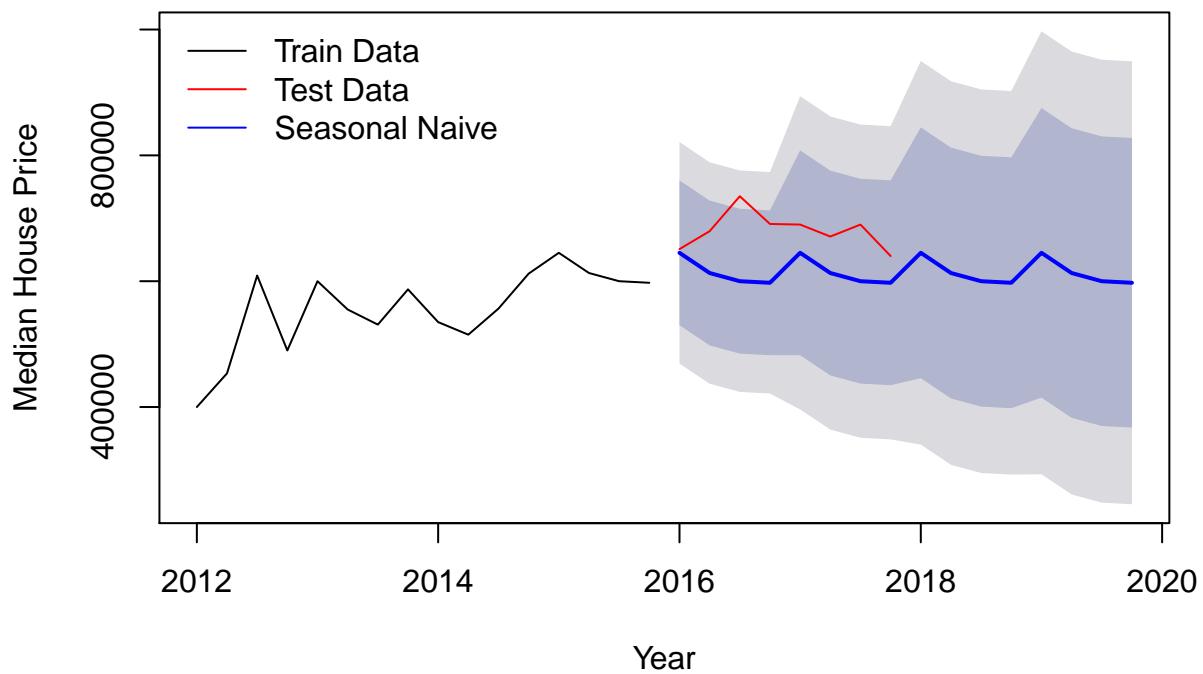
Portland, OR – Alameda : Full TS Models Comparison



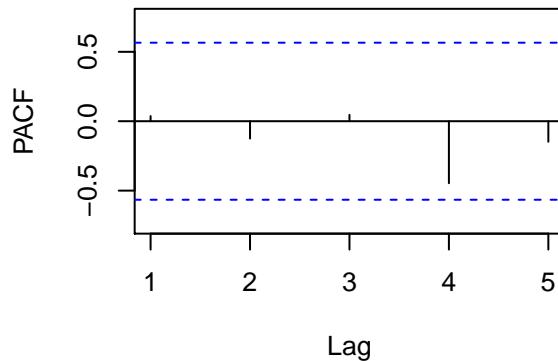
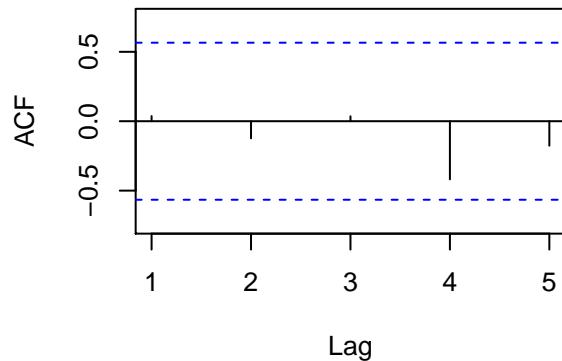
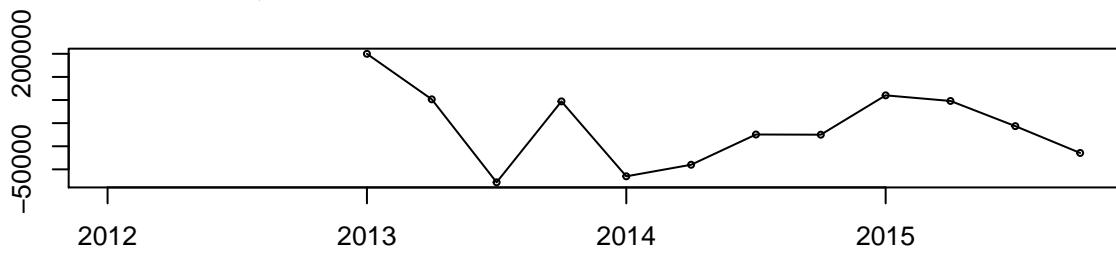
Portland, OR – Forest Park



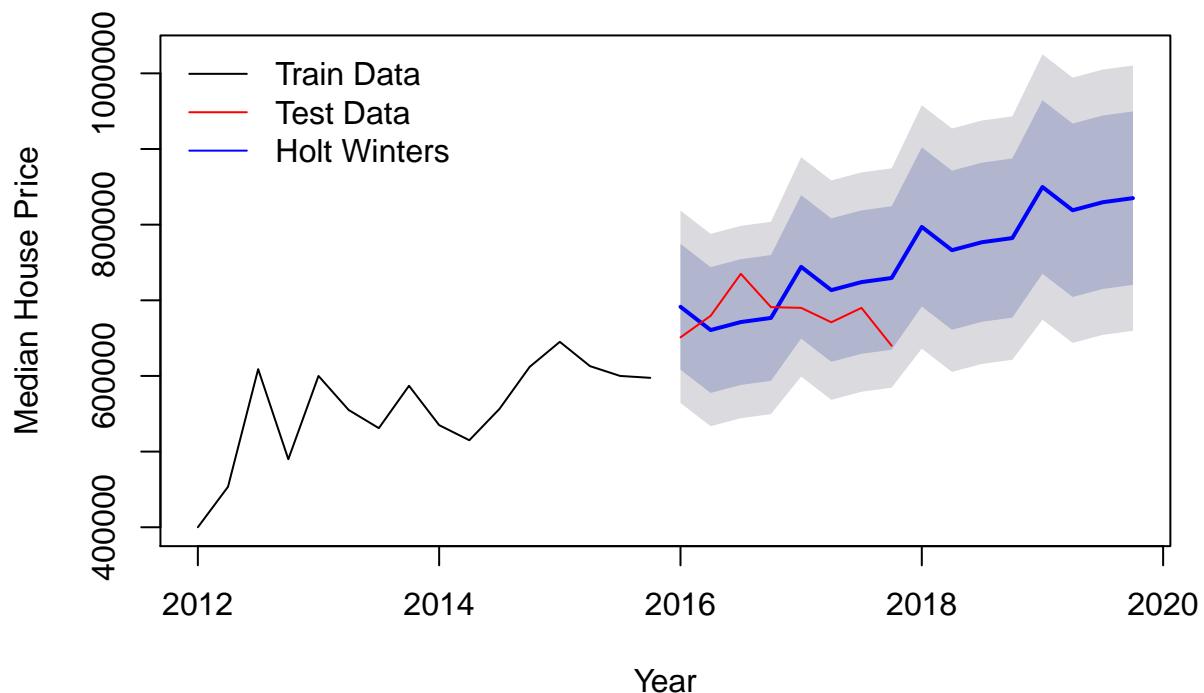
Portland, OR – Forest Park : Naive Model Forecast



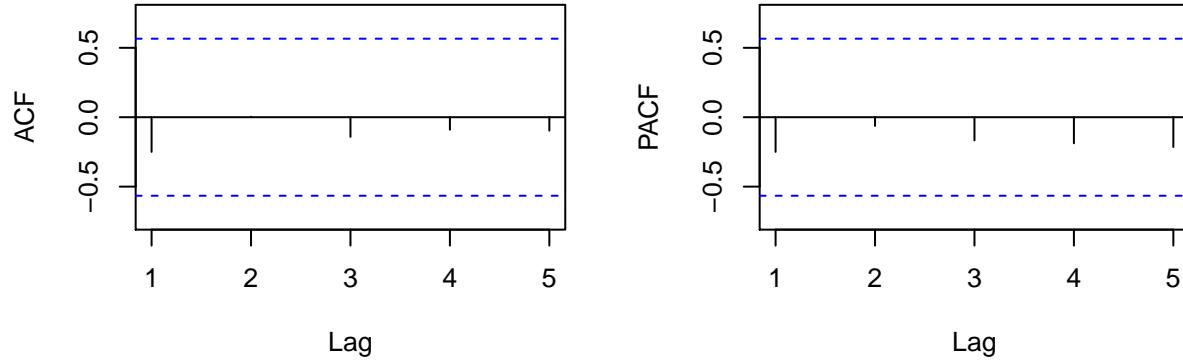
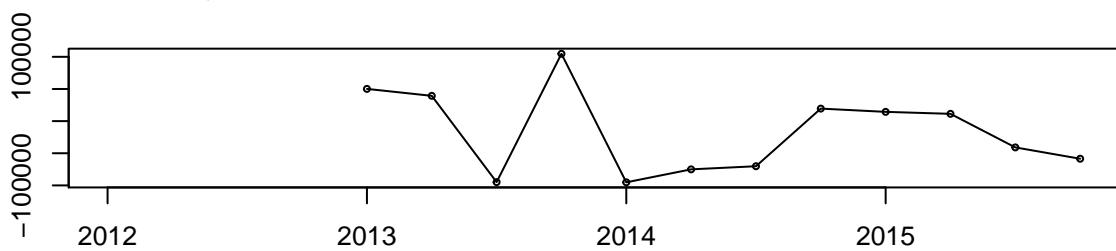
Portland, OR – Forest Park : Naive Model Forecast Residuals



Portland, OR – Forest Park : Holt Winters Model Forecast

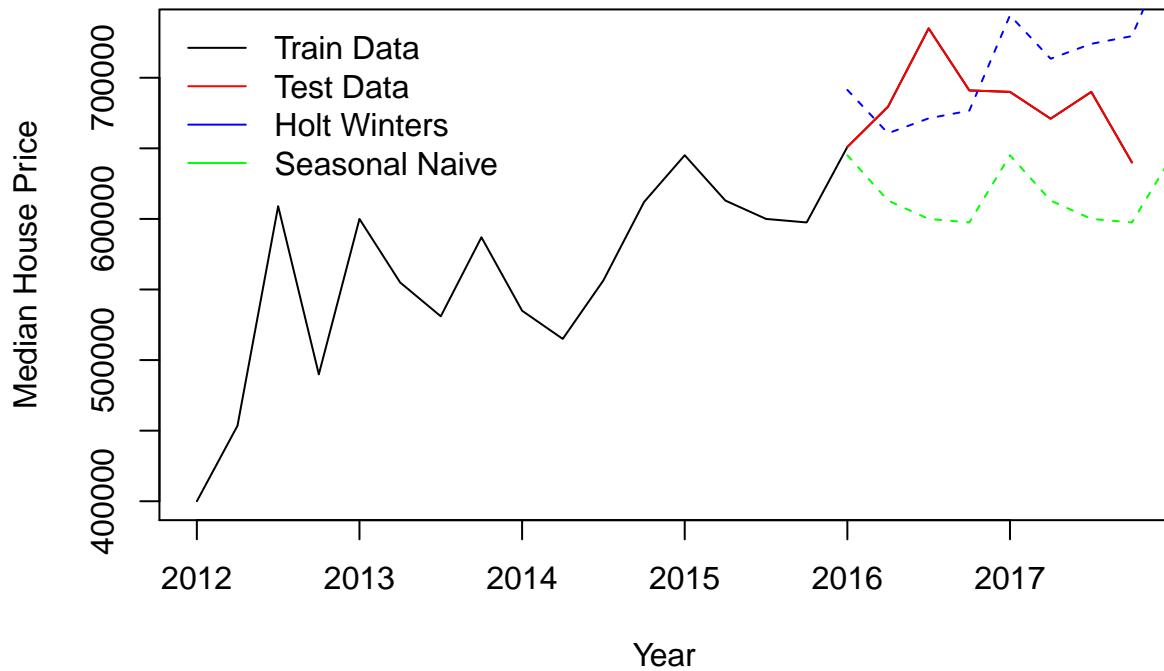


Portland, OR – Forest Park : Holt Winters Model Forecast Residuals

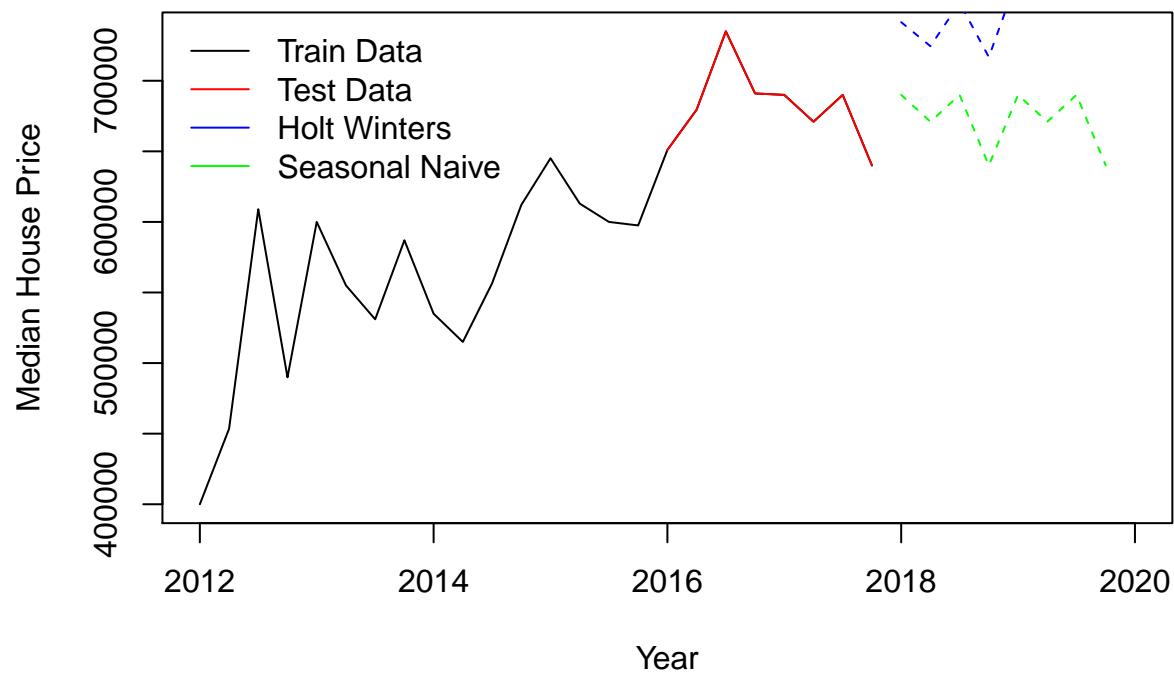


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Forest Park"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 41933.33 89794.52 74855.83 6.674997 12.848251 1.0000000
## Test set     67031.88 76409.44 67031.88 9.677554 9.677554 0.8954796
##          ACF1 Theil's U
## Training set 0.03722635      NA
## Test set     0.05938621 2.285235
## [1] "Holt Winters Accuracy for Portland, OR – Forest Park"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -16279.75 64195.95 56171.57 -3.243067 9.999462 0.7503967
## Test set     -20470.29 50208.10 44690.75 -3.224886 6.603489 0.5970243
##          ACF1 Theil's U
## Training set -0.2497092      NA
## Test set     0.3723460 1.439754
```

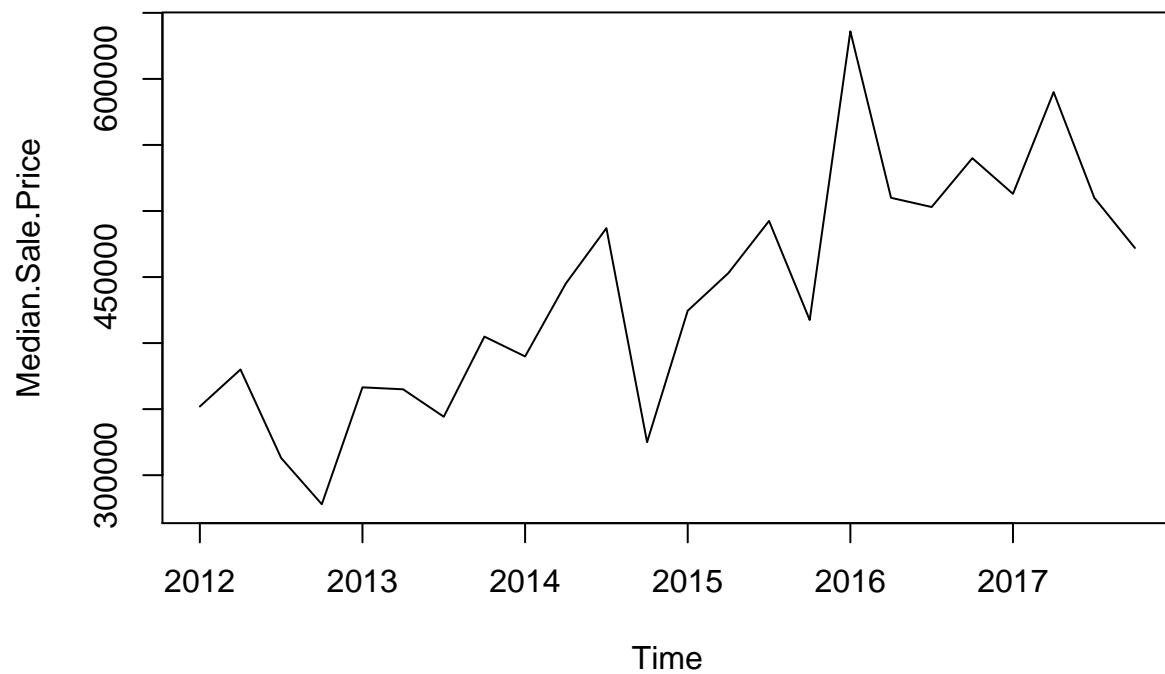
Portland, OR – Forest Park : TS Training Model Comparison



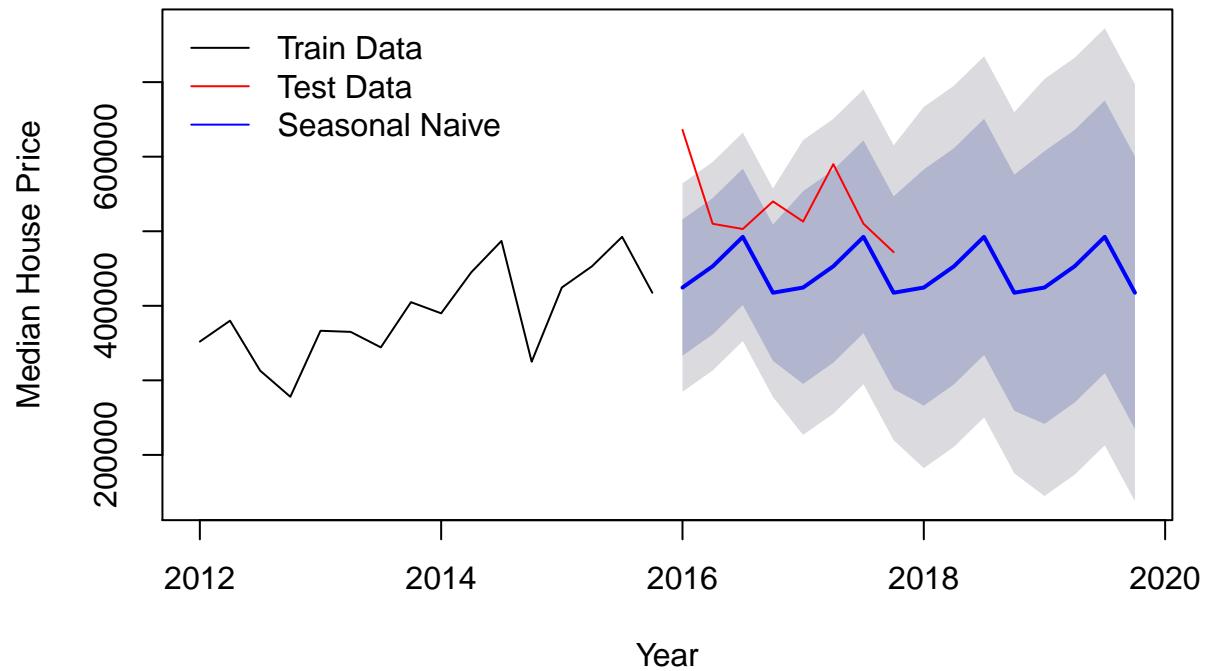
Portland, OR – Forest Park : Full TS Models Comparison



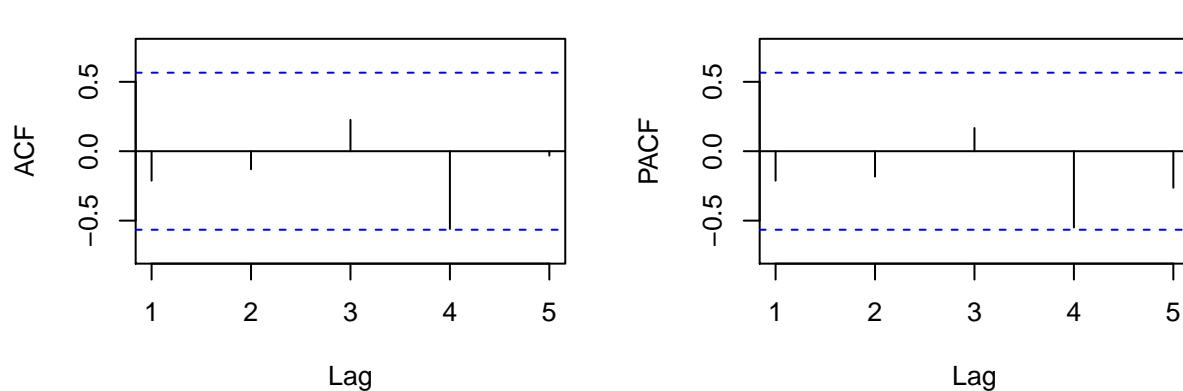
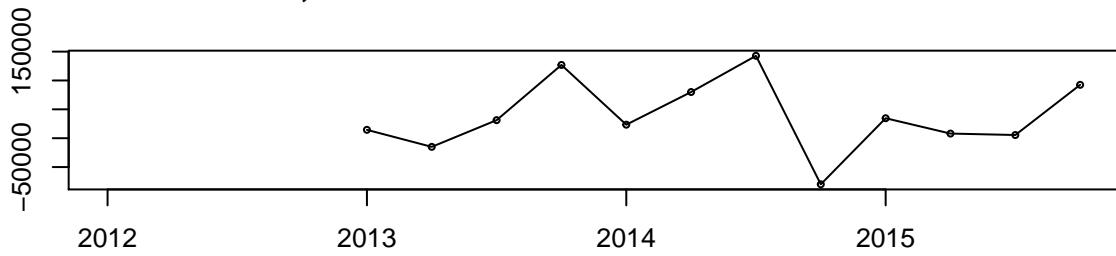
Portland, OR – Boise



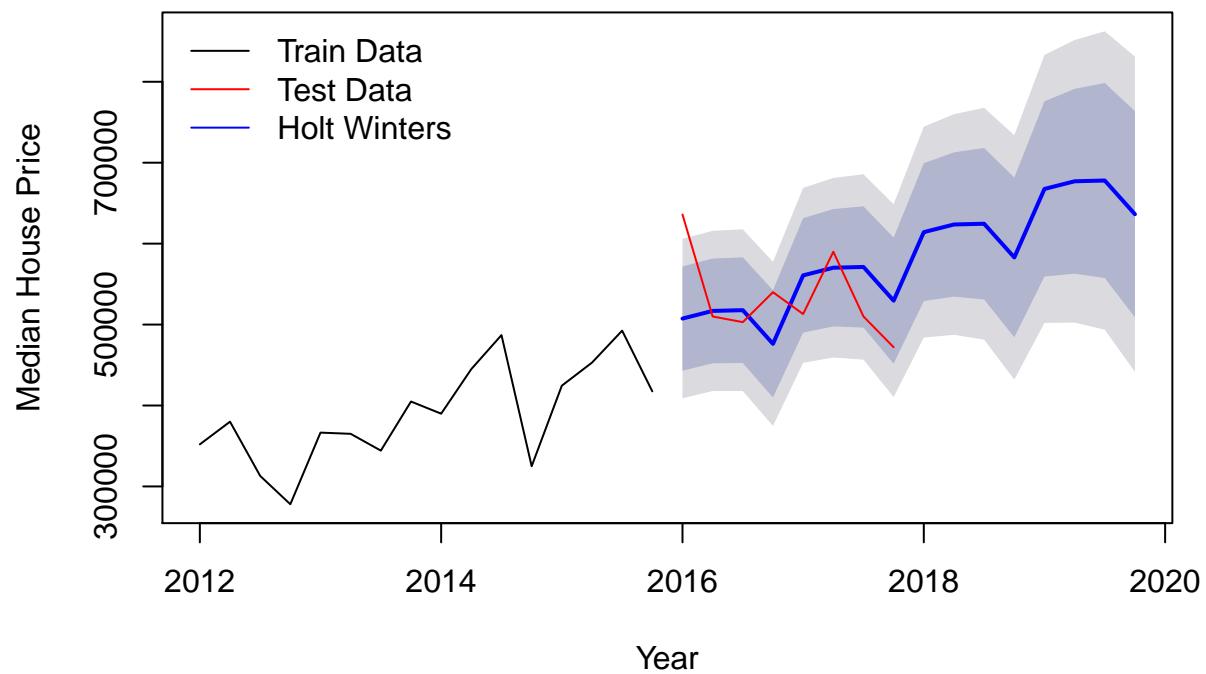
Portland, OR – Boise : Naive Model Forecast



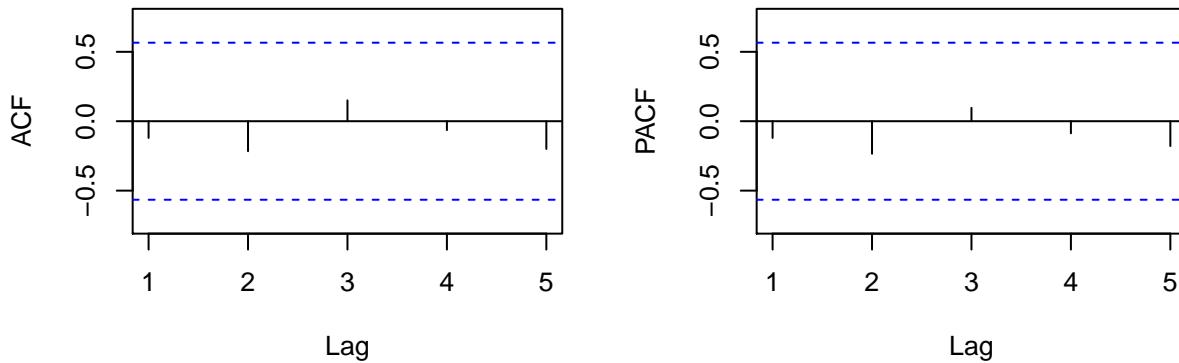
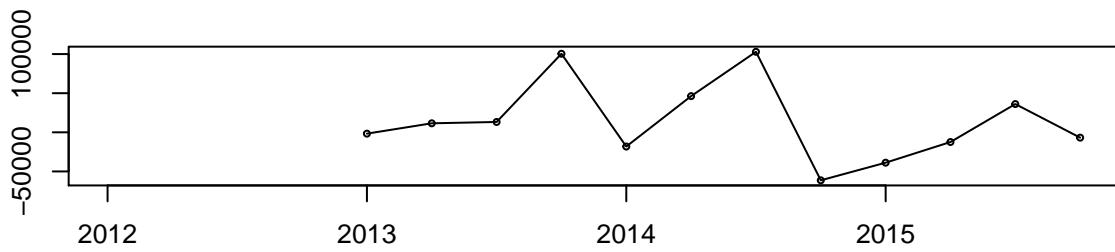
Portland, OR – Boise : Naive Model Forecast Residuals



Portland, OR – Boise : Holt Winters Model Forecast

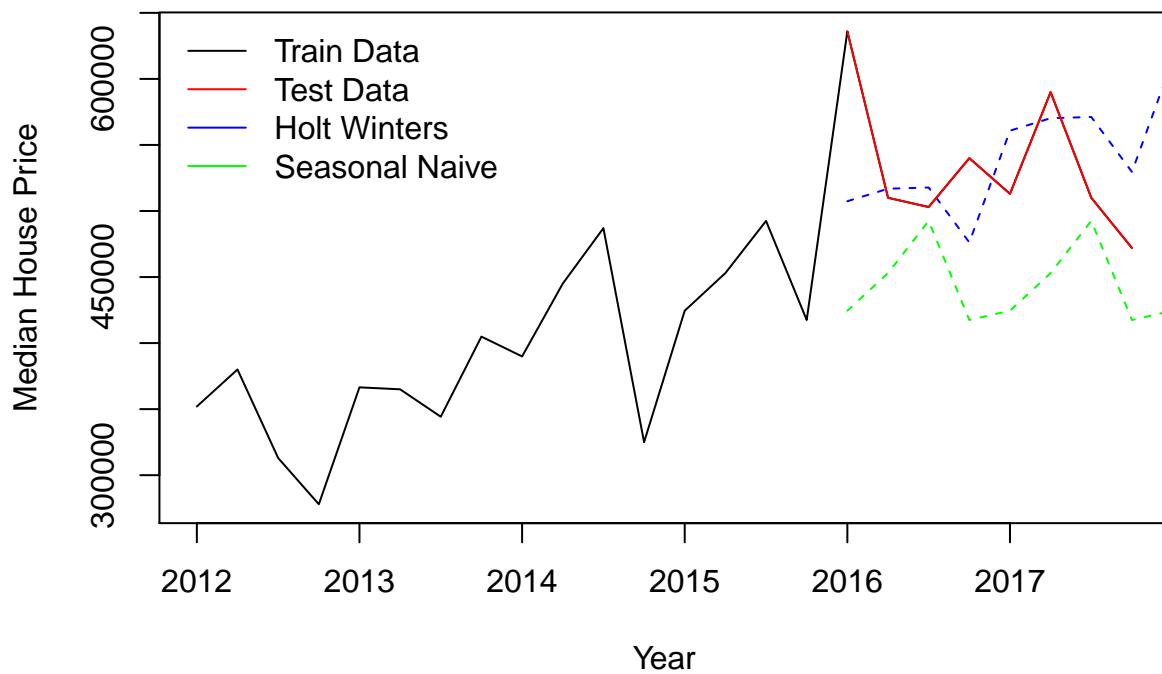


Portland, OR – Boise : Holt Winters Model Forecast Residuals

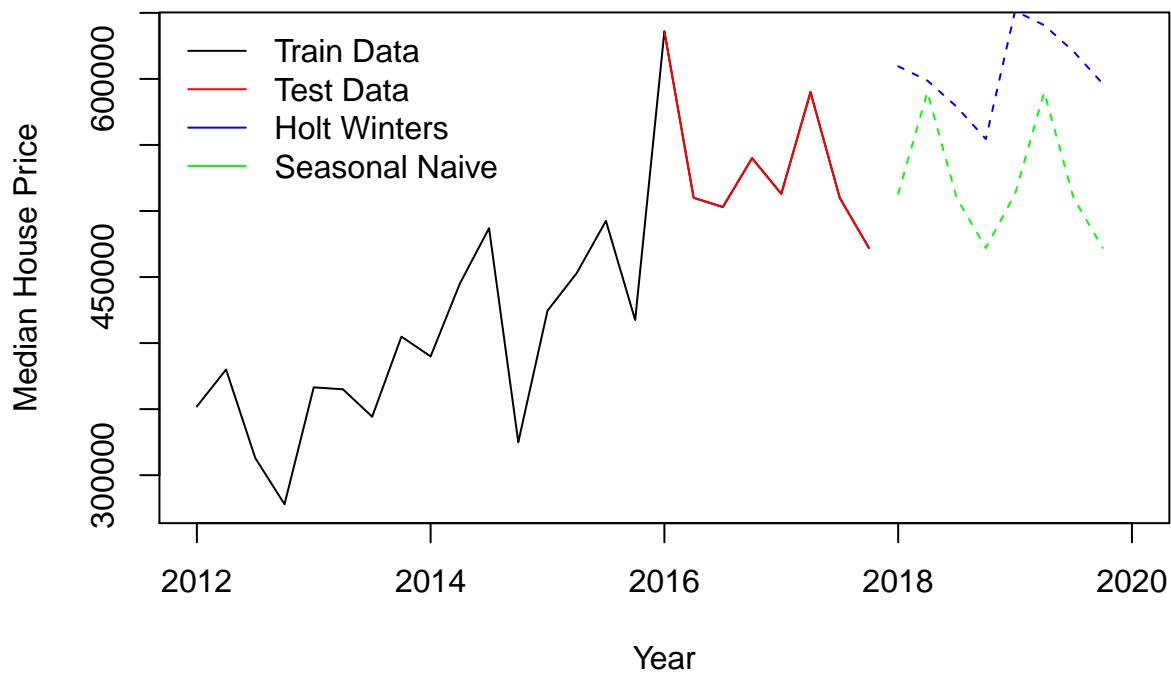


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Boise"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 38708.33 71339.69 54525 8.513442 13.29581 1.000000
## Test set     87375.00 107805.09 87375 15.581704 15.58170 1.602476
##          ACF1 Theil's U
## Training set -0.2120209      NA
## Test set     -0.1633371 1.378396
## [1] "Holt Winters Accuracy for Portland, OR - Boise"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 14265.342 50193.11 37477.84 2.7617351 9.015116 0.6873516
## Test set     2990.599 61855.52 50048.13 -0.3023072 9.148252 0.9178932
##          ACF1 Theil's U
## Training set -0.1208106      NA
## Test set     -0.1072017 0.7291568
```

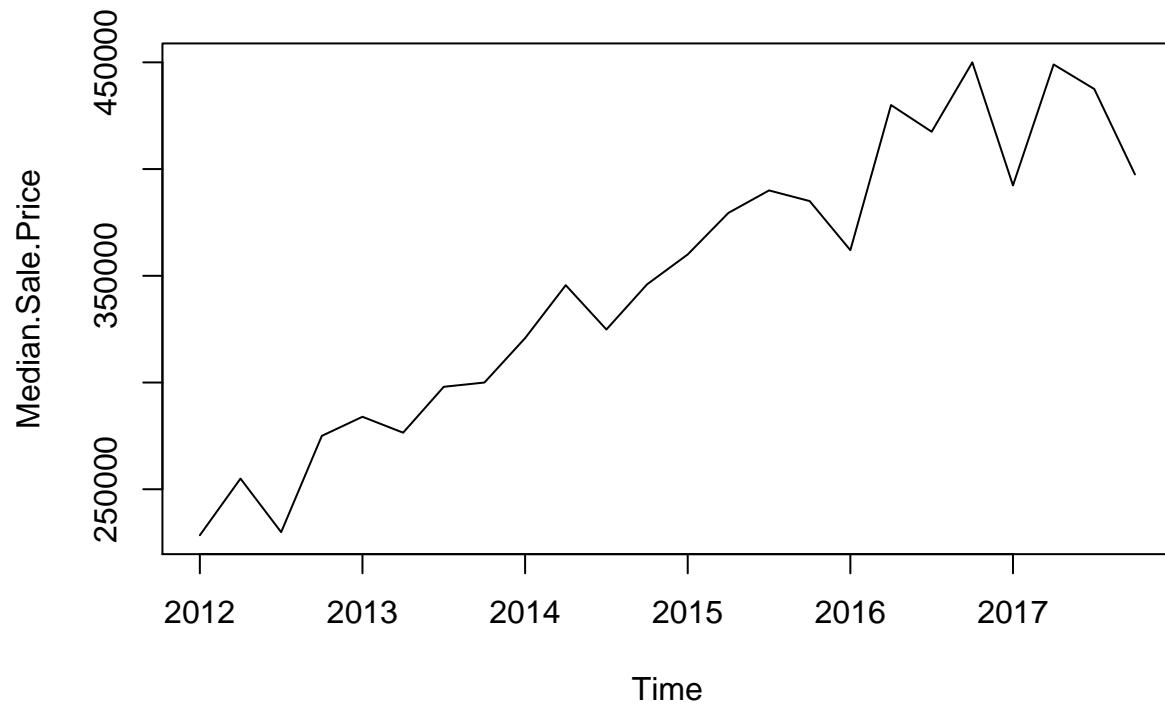
Portland, OR – Boise : TS Training Model Comparison



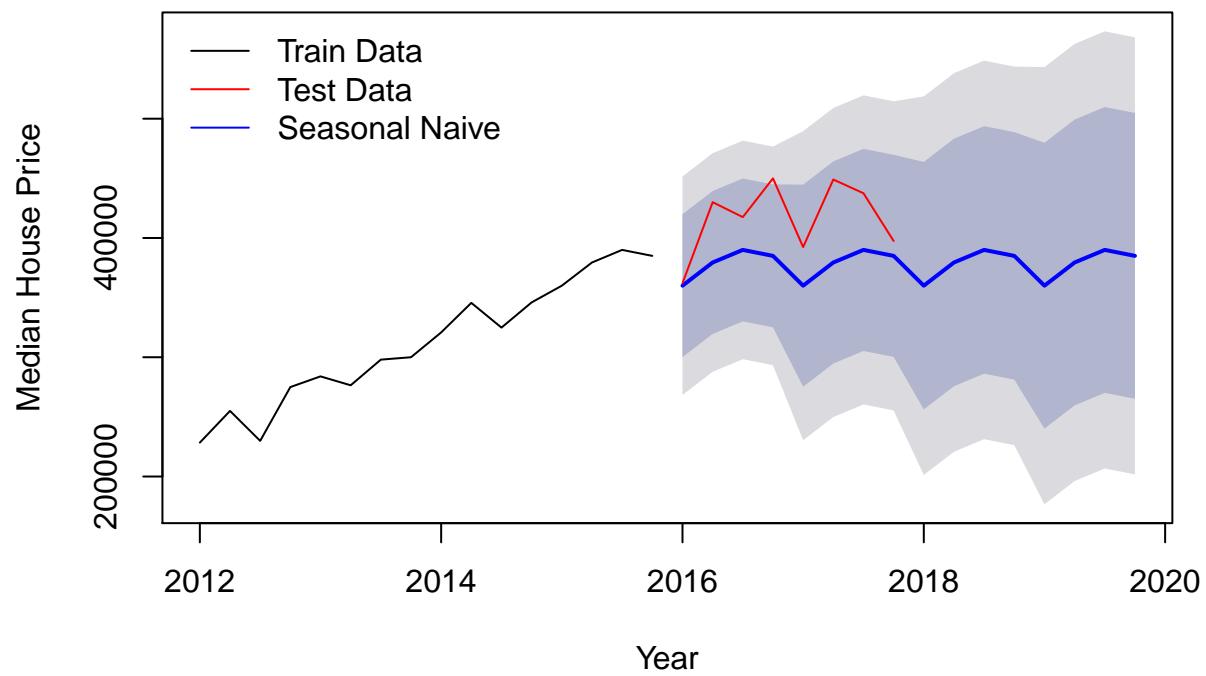
Portland, OR – Boise : Full TS Models Comparison



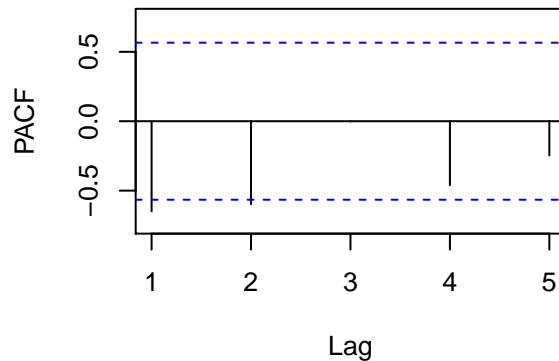
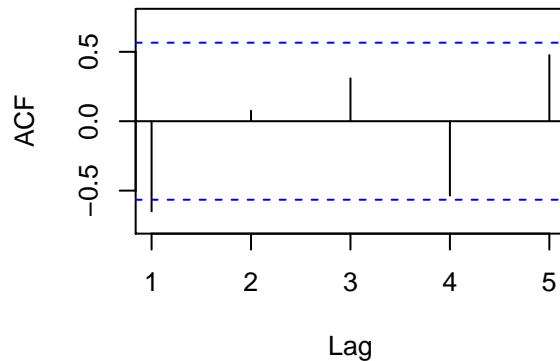
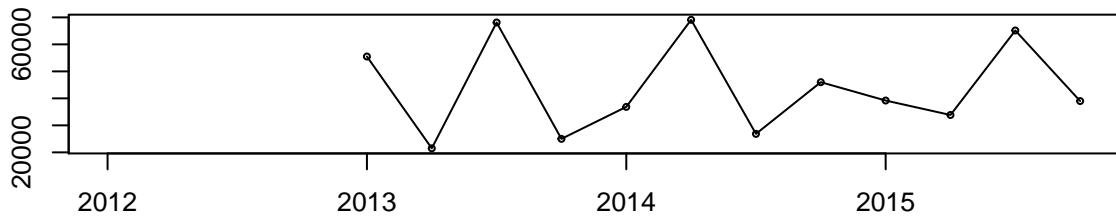
Portland, OR – Creston–Kenilworth



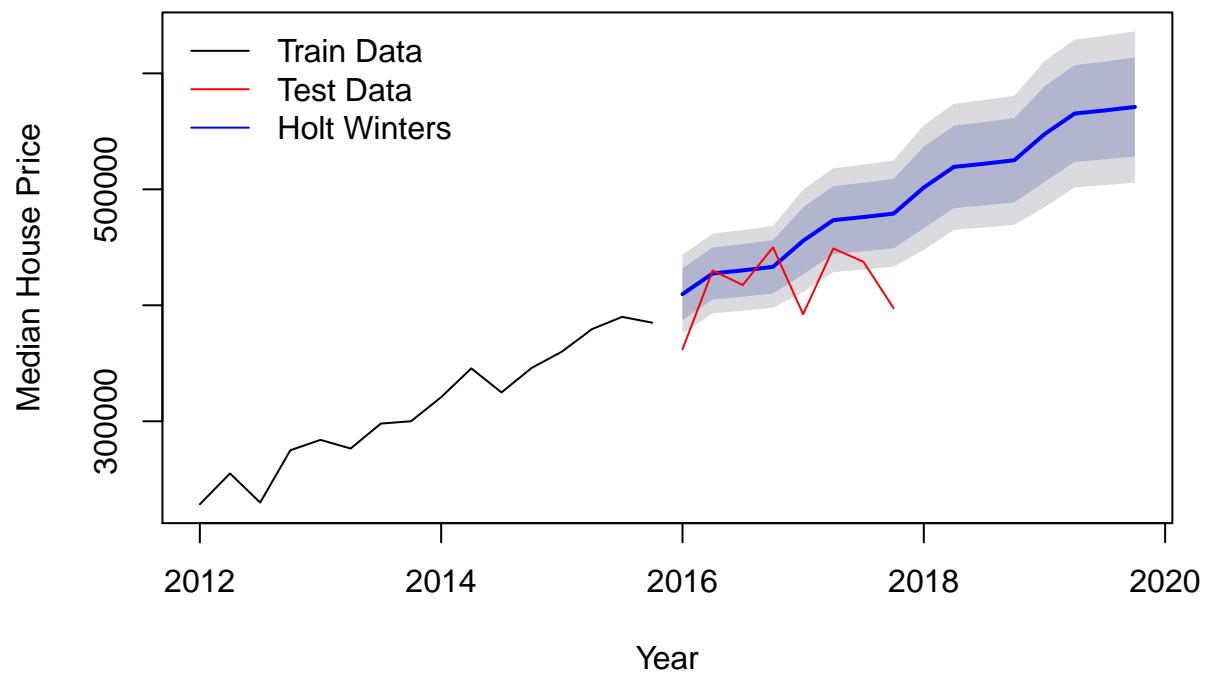
Portland, OR – Creston–Kenilworth : Naive Model Forecast



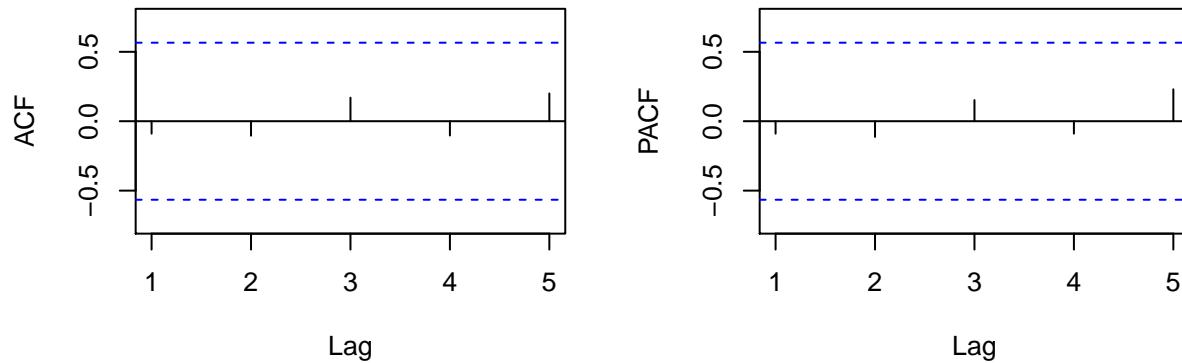
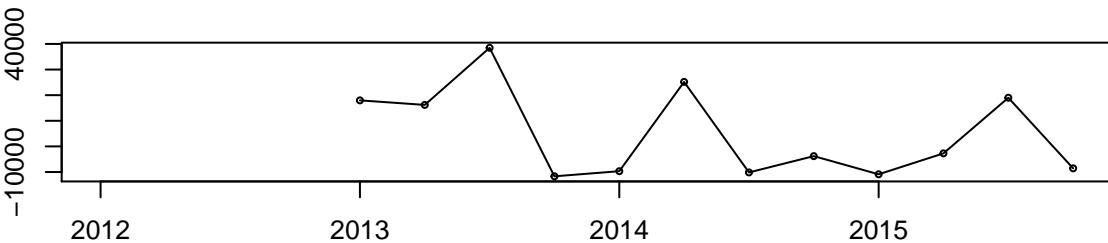
Portland, OR – Creston-Kenilworth : Naive Model Forecast Residuals



Portland, OR – Creston–Kenilworth : Holt Winters Model Forecast

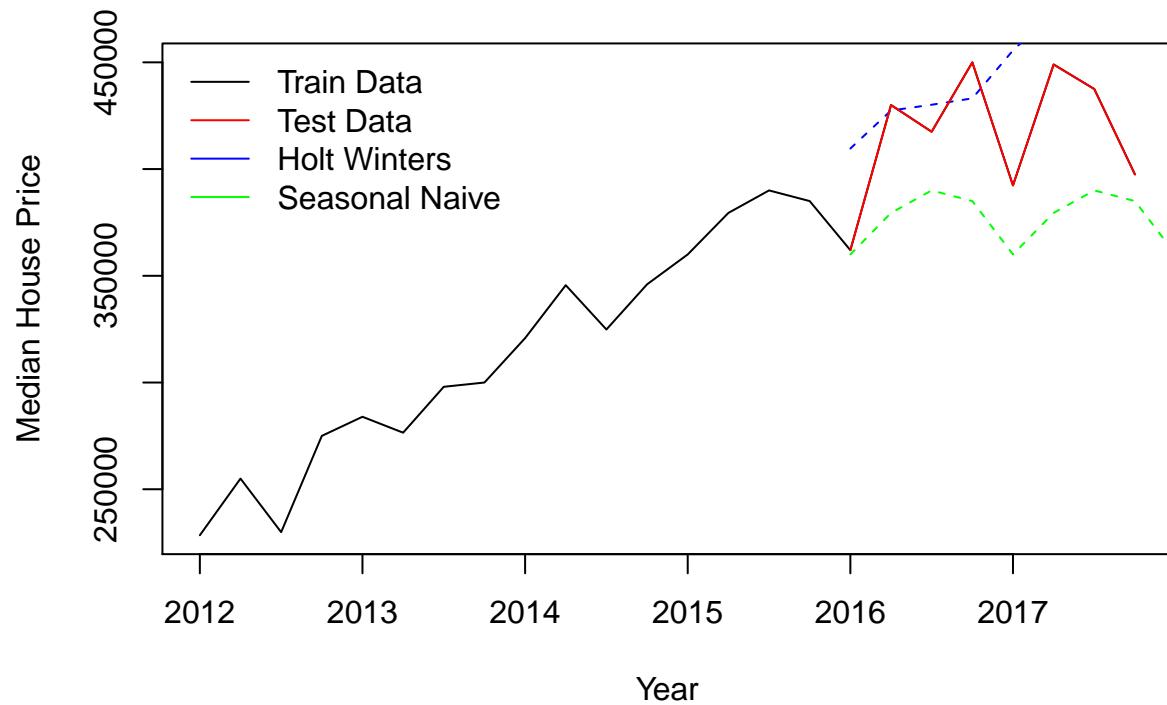


Portland, OR – Creston-Kenilworth : Holt Winters Model Forecast Residuals

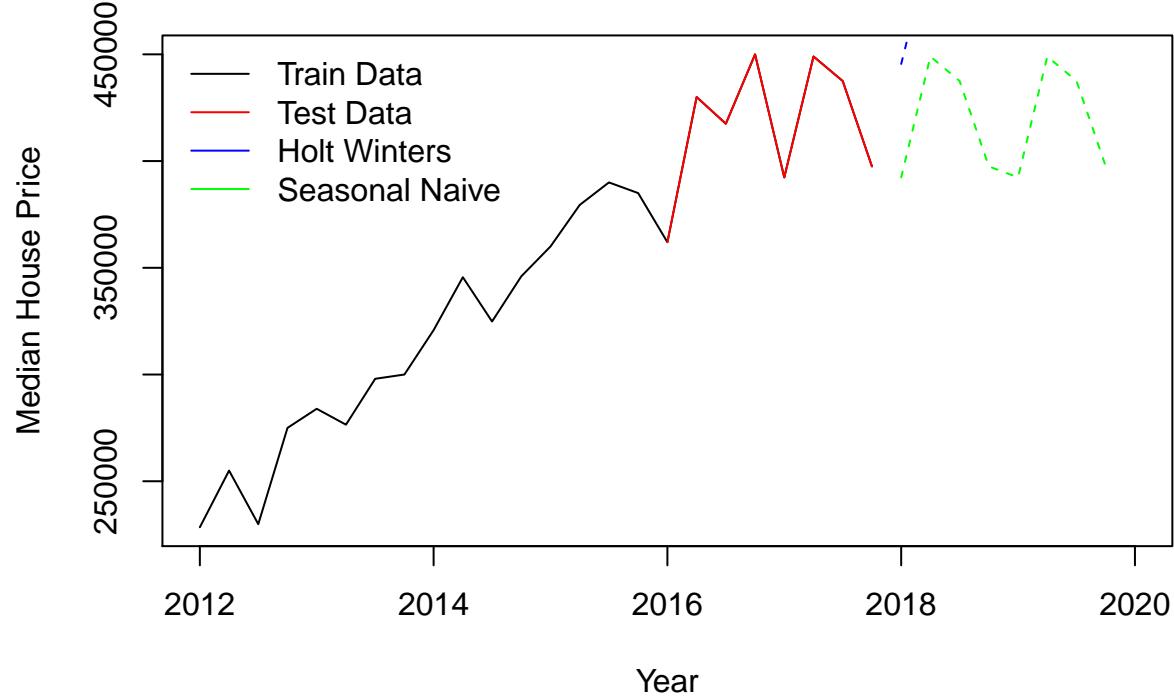


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Creston-Kenilworth"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 43841.67 46746.43 43841.67 13.182759 13.182759 1.0000000
## Test set     38368.75 44492.66 38368.75  8.884567  8.884567 0.8751663
##          ACF1 Theil's U
## Training set -0.6491974      NA
## Test set     -0.2868118  1.04403
## [1] "Holt Winters Accuracy for Portland, OR - Creston-Kenilworth"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 4946.537 17337.77 14522.56  1.680162 4.528820 0.3312502
## Test set     -31082.314 43959.39 35939.91 -7.842325 8.928389 0.8197660
##          ACF1 Theil's U
## Training set -0.08972457      NA
## Test set     -0.06185992 0.8788623
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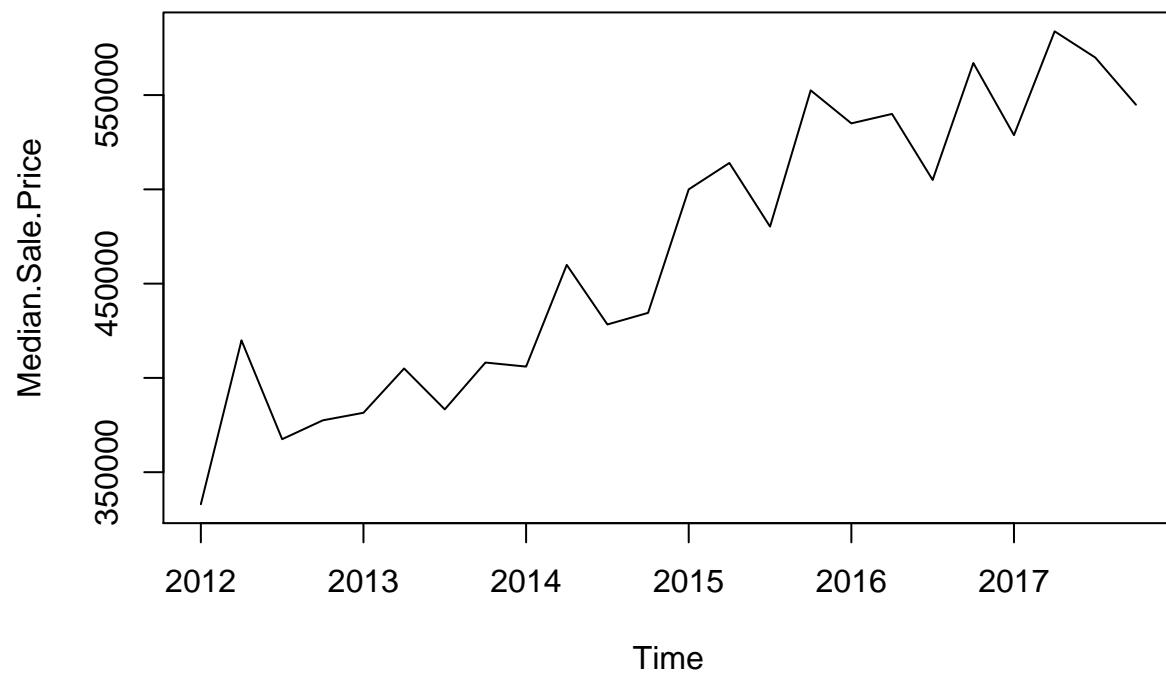
Portland, OR – Creston-Kenilworth : TS Training Model Comparison



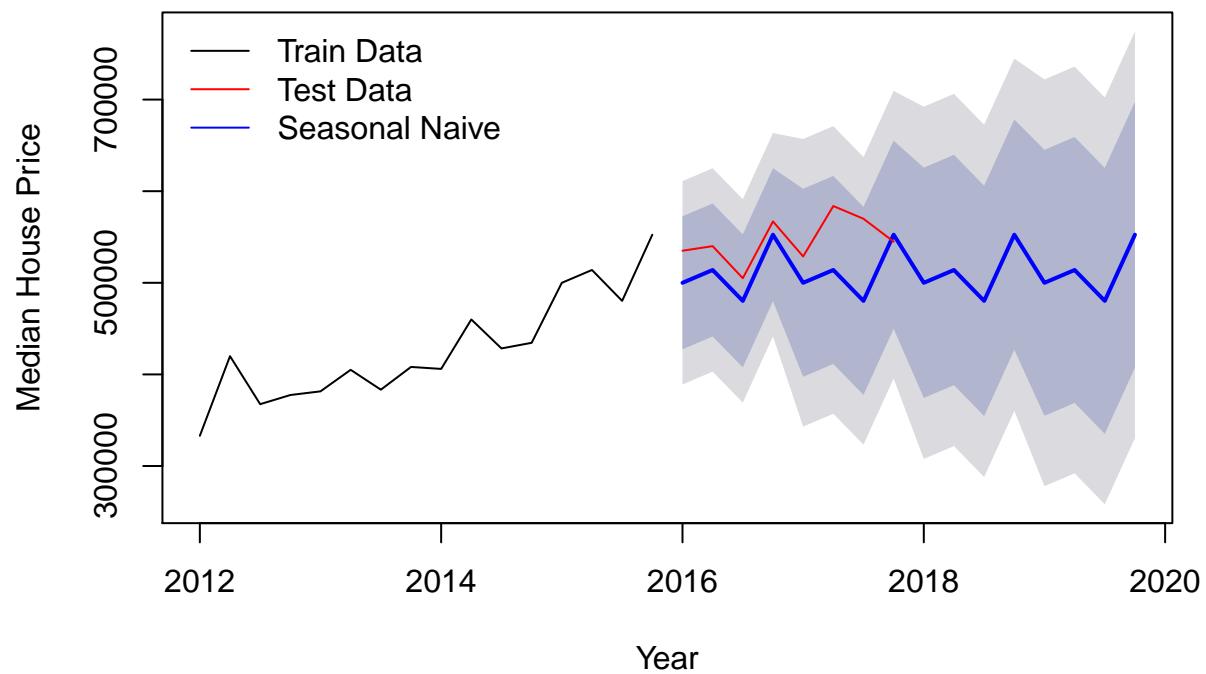
Portland, OR – Creston–Kenilworth : Full TS Models Comparison



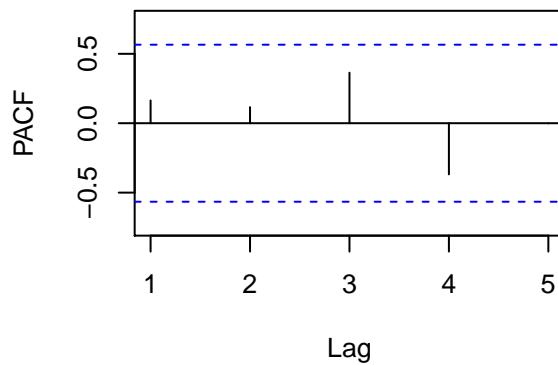
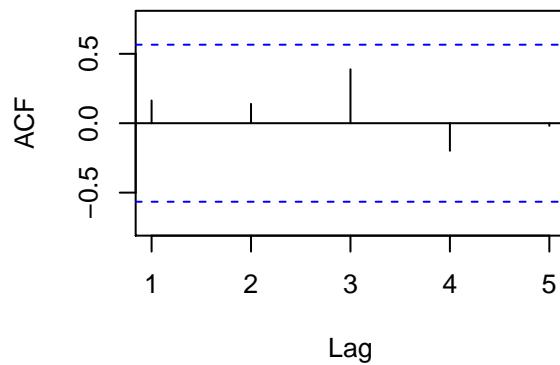
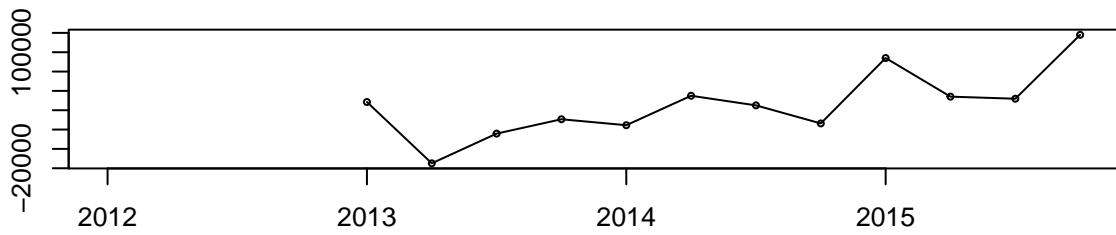
Portland, OR – Mount Tabor



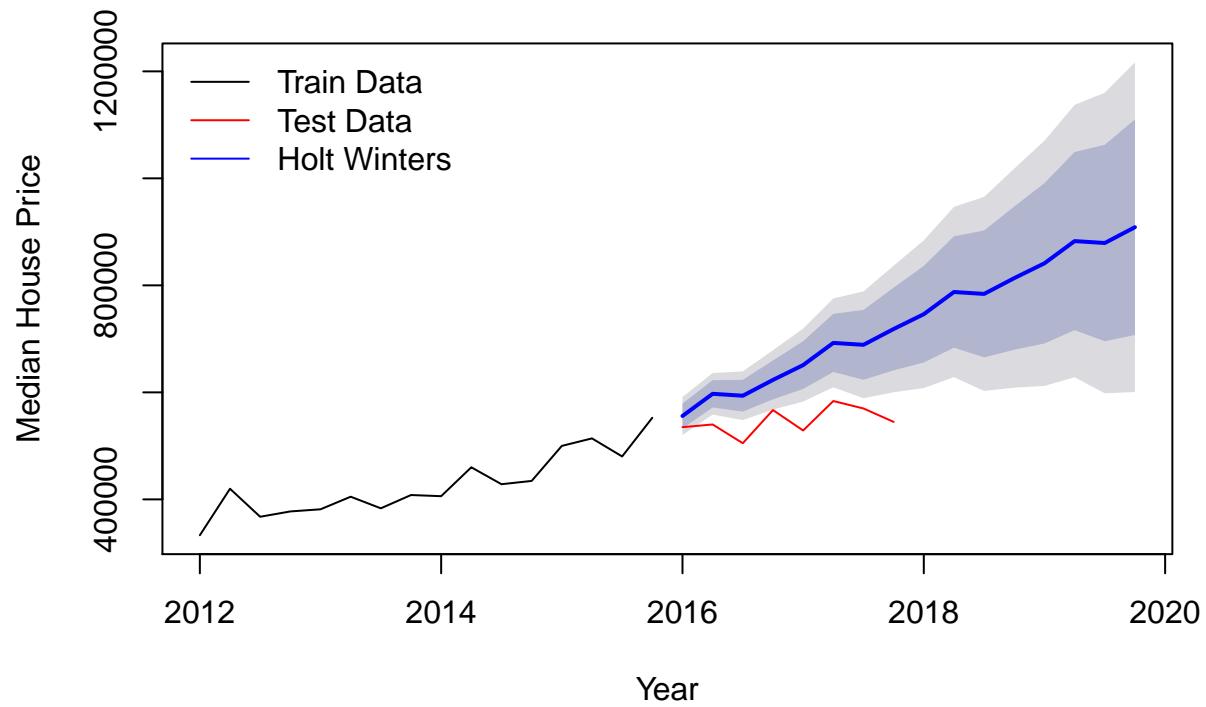
Portland, OR – Mount Tabor : Naive Model Forecast



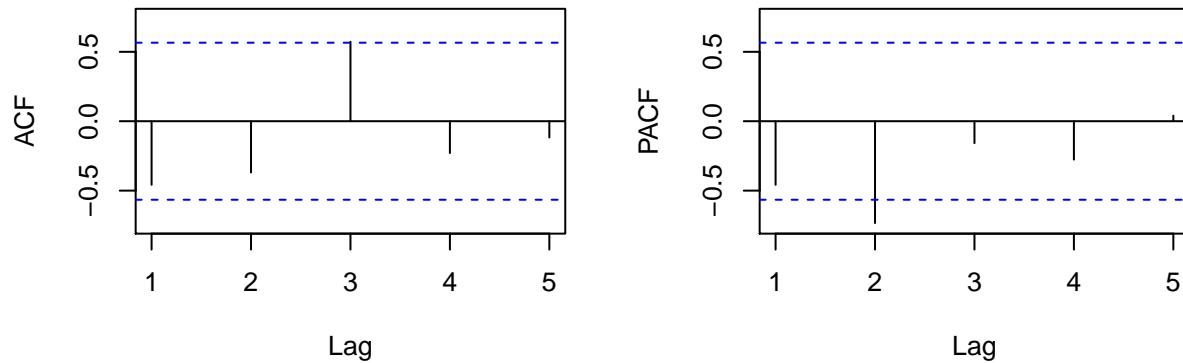
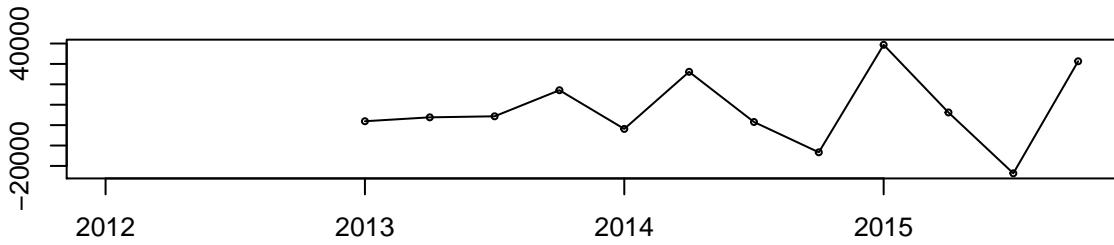
Portland, OR – Mount Tabor : Naive Model Forecast Residuals



Portland, OR – Mount Tabor : Holt Winters Model Forecast

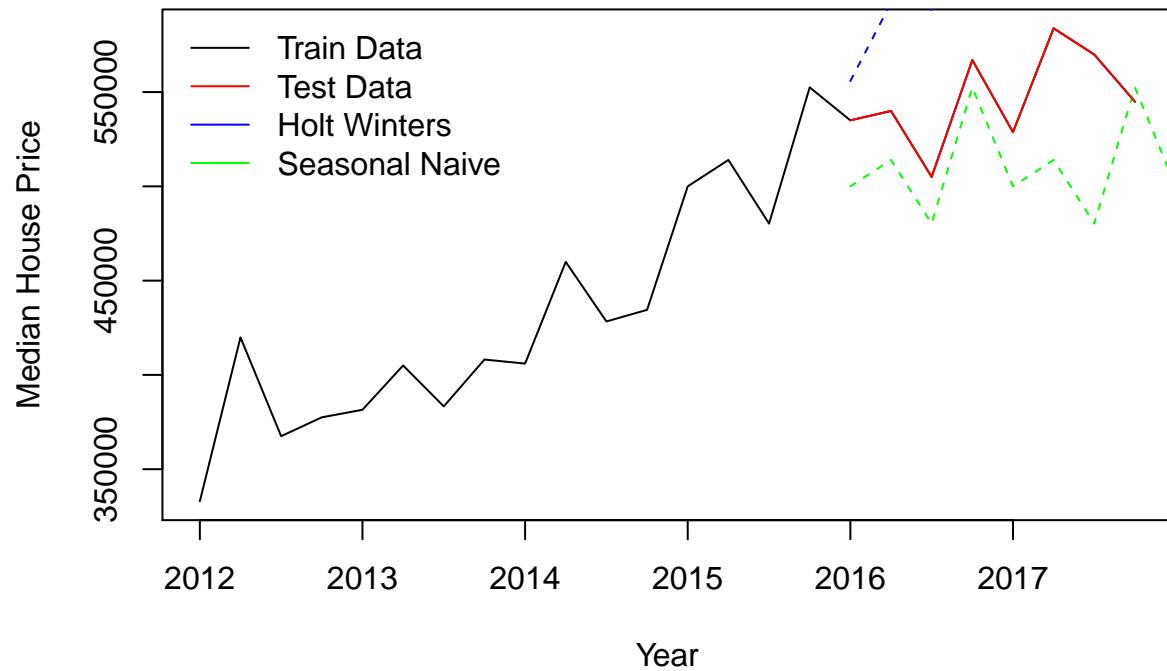


Portland, OR – Mount Tabor : Holt Winters Model Forecast Residuals

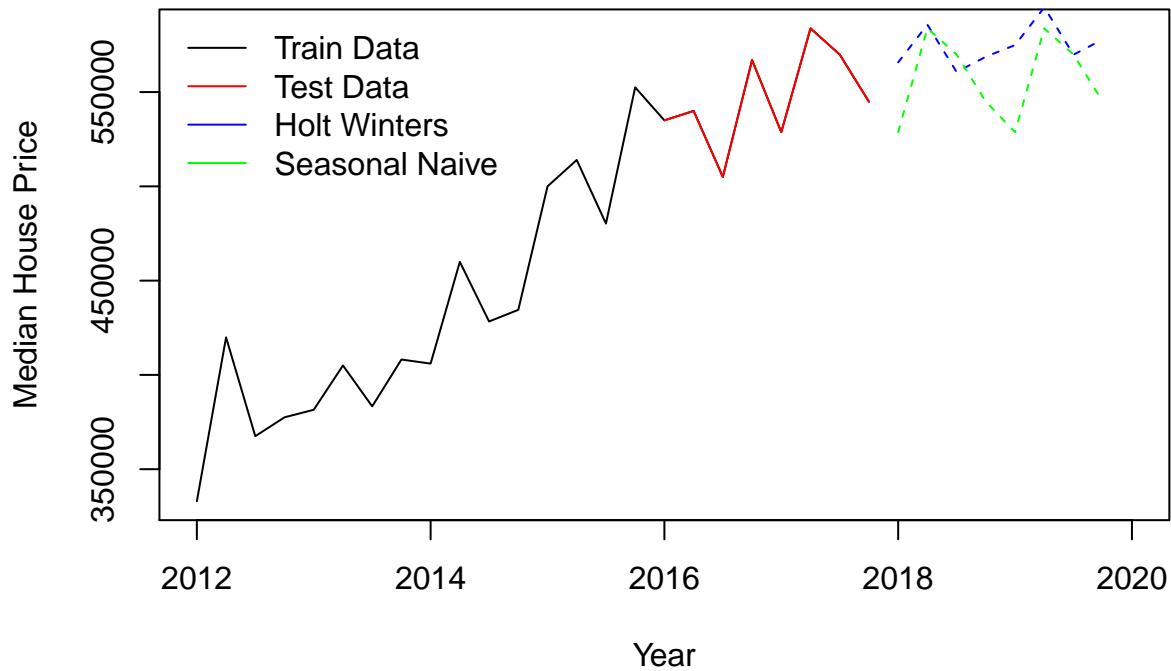


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Mount Tabor"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 45737.50 56628.29 48220.83 9.725721 10.338889 1.0000000
## Test set     35106.25 45438.55 37006.25 6.318095 6.666783 0.7674328
##          ACF1 Theil's U
## Training set 0.16388363      NA
## Test set     -0.03272866 1.147544
## [1] "Holt Winters Accuracy for Portland, OR – Mount Tabor"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 7743.378 18977.11 14208.46 1.592619 2.999243 0.294654
## Test set     -93332.585 103556.96 93332.59 -17.059474 17.059474 1.935524
##          ACF1 Theil's U
## Training set -0.4582675      NA
## Test set      0.2960973 2.711925
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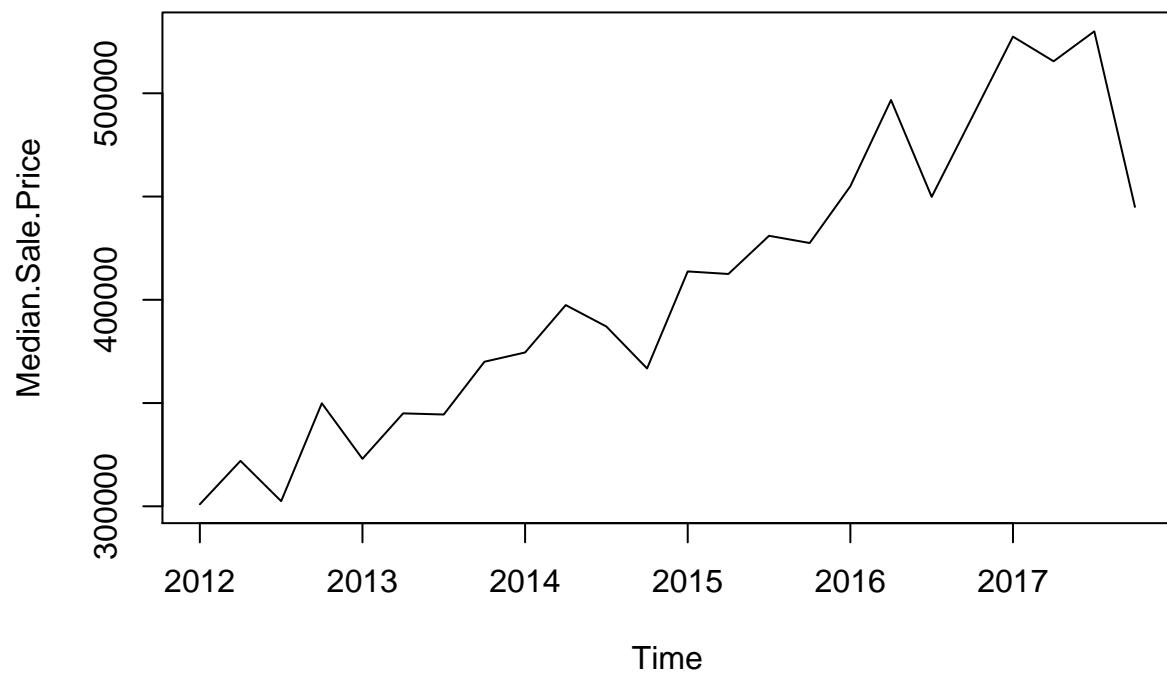
Portland, OR – Mount Tabor : TS Training Model Comparison



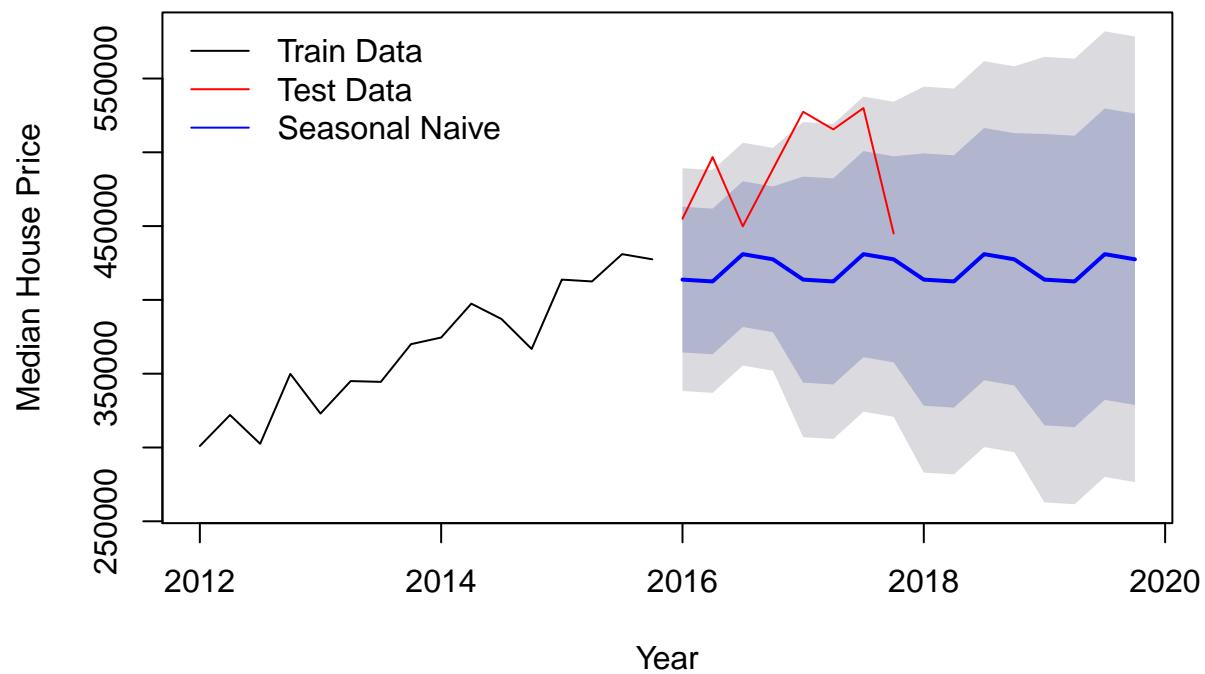
Portland, OR – Mount Tabor : Full TS Models Comparison



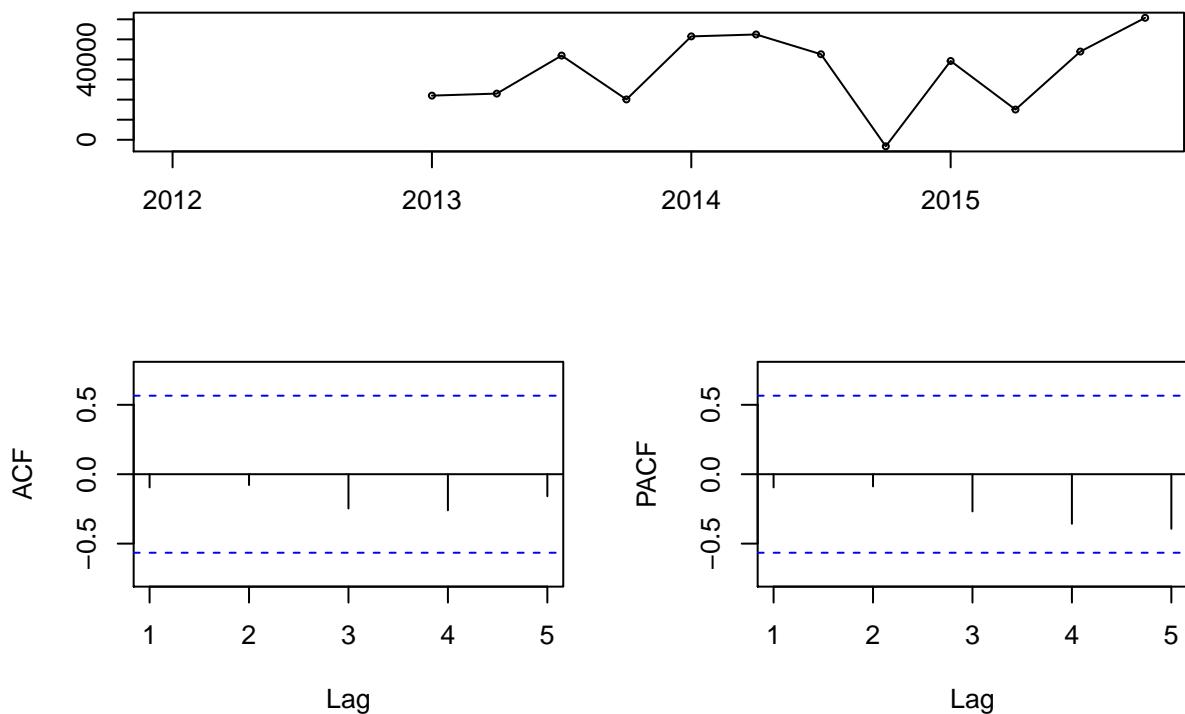
Portland, OR – Concordia



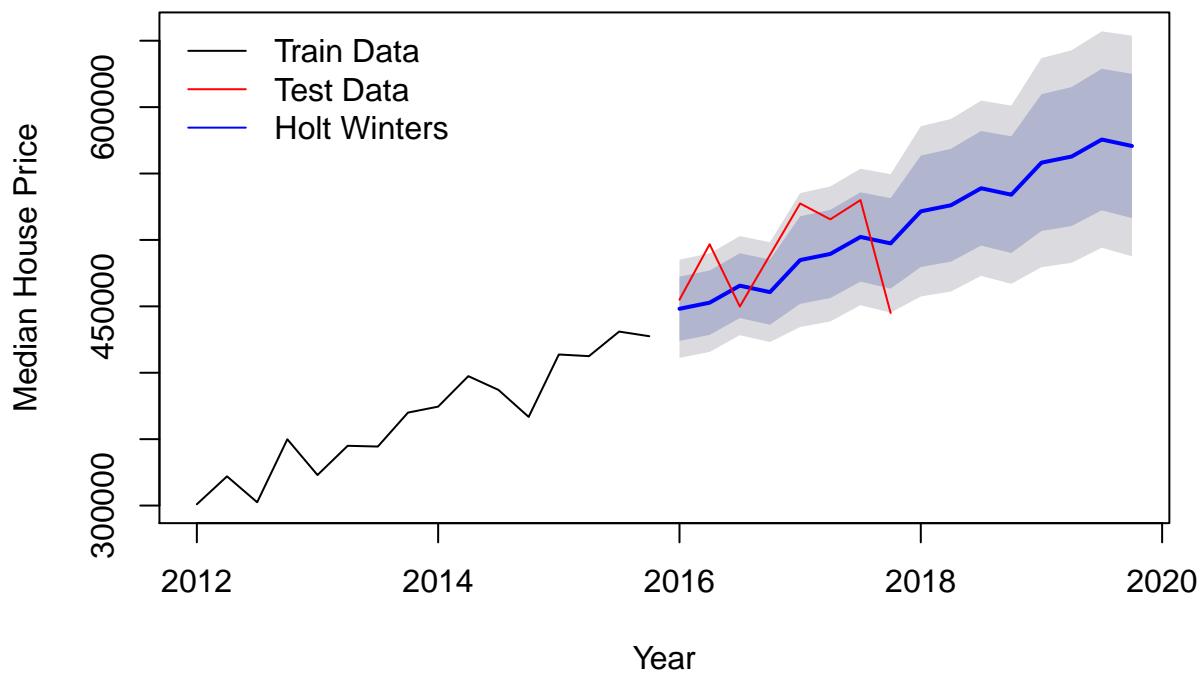
Portland, OR – Concordia : Naive Model Forecast



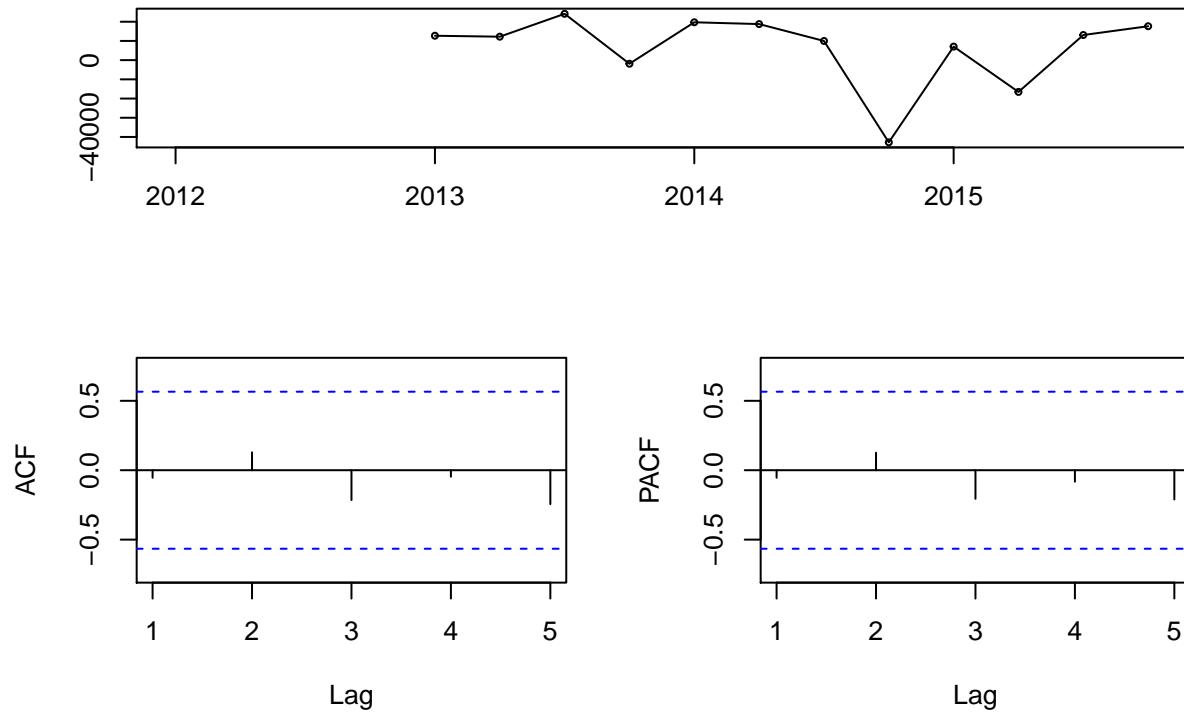
Portland, OR – Concordia : Naive Model Forecast Residuals



Portland, OR – Concordia : Holt Winters Model Forecast



Portland, OR – Concordia : Holt Winters Model Forecast Residuals

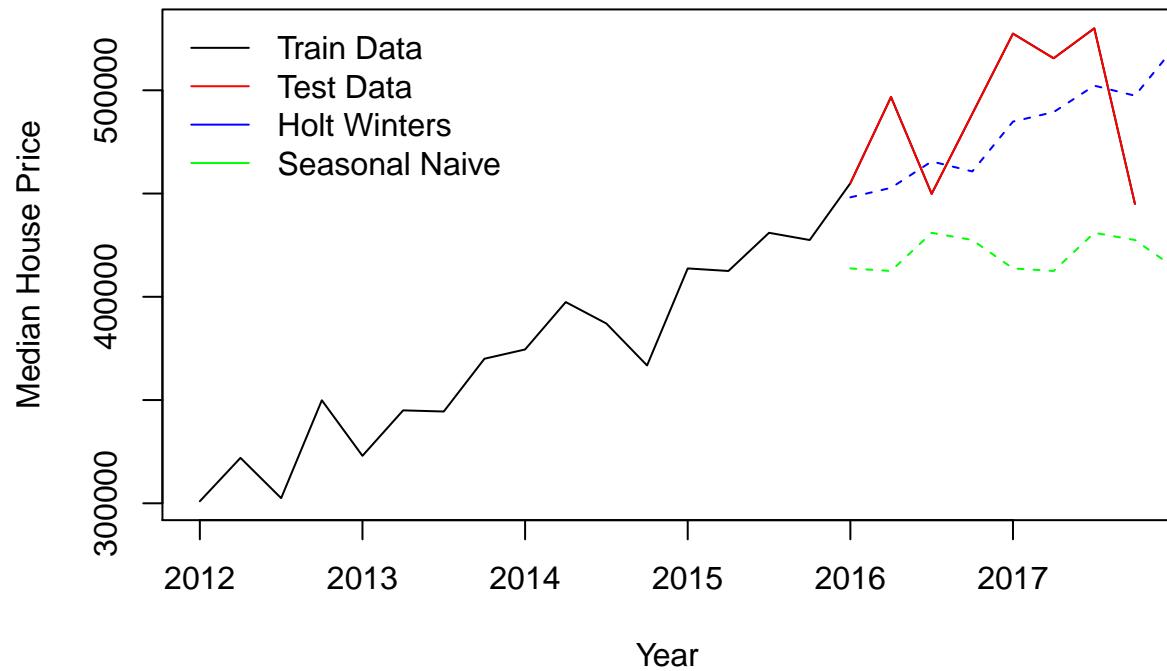


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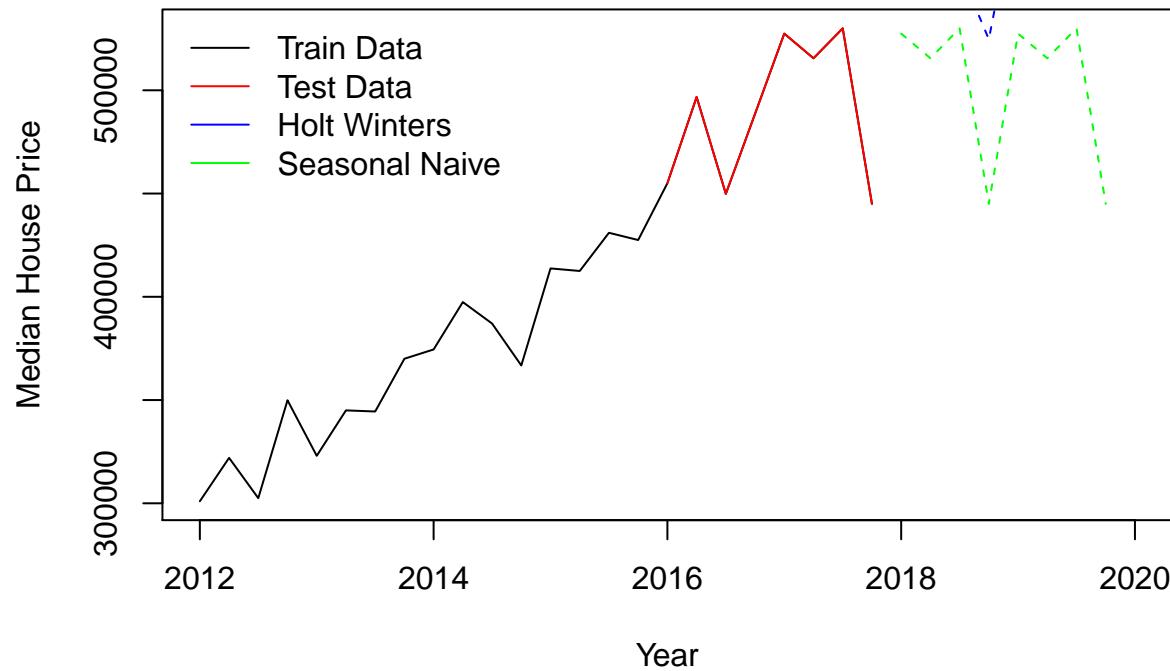
## [1] "Seasonal Naive Accuracy for Portland, OR – Concordia"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 34112.5 38508.22 34654.17 8.808347 8.956041 1.000000
## Test set     67337.5 76271.07 67337.50 13.359938 13.359938 1.943129
##          ACF1 Theil's U
## Training set -0.095063523      NA
## Test set     -0.004239737 1.781729
## [1] "Holt Winters Accuracy for Portland, OR – Concordia"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 6174.896 19091.39 16376.36 1.644129 4.341577 0.4725653
## Test set     13380.657 33572.98 30408.36 2.396452 6.213379 0.8774806
##          ACF1 Theil's U
## Training set -0.05470876      NA
## Test set     -0.19538025 0.7970454

```

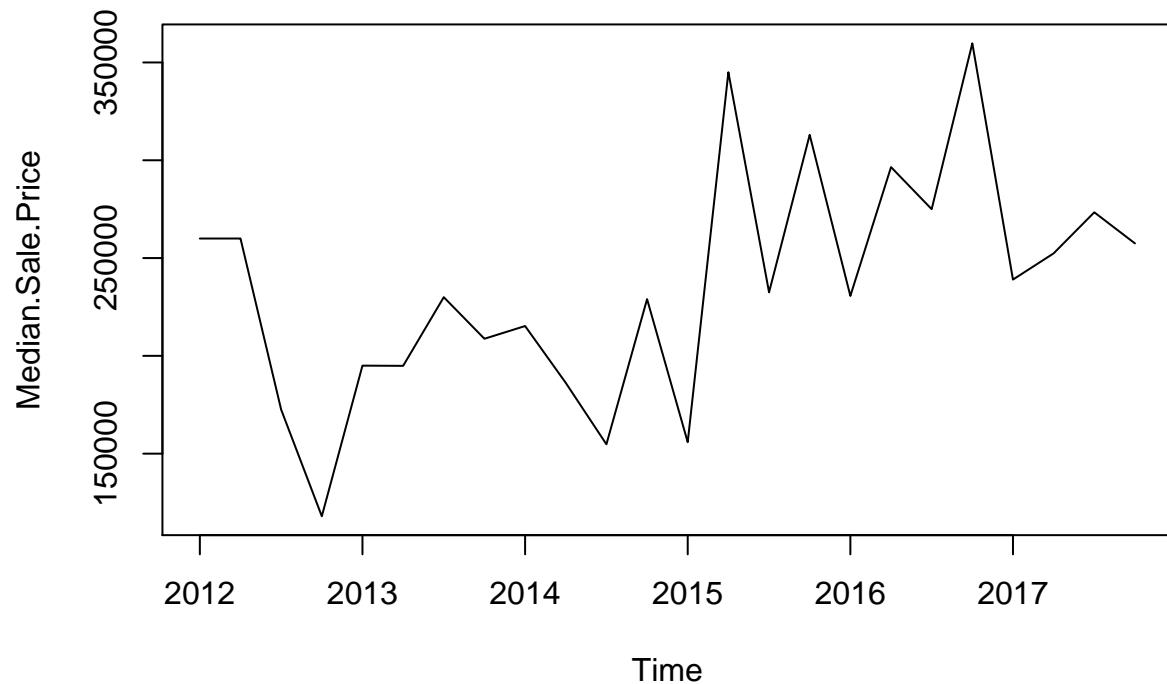
Portland, OR – Concordia : TS Training Model Comparison



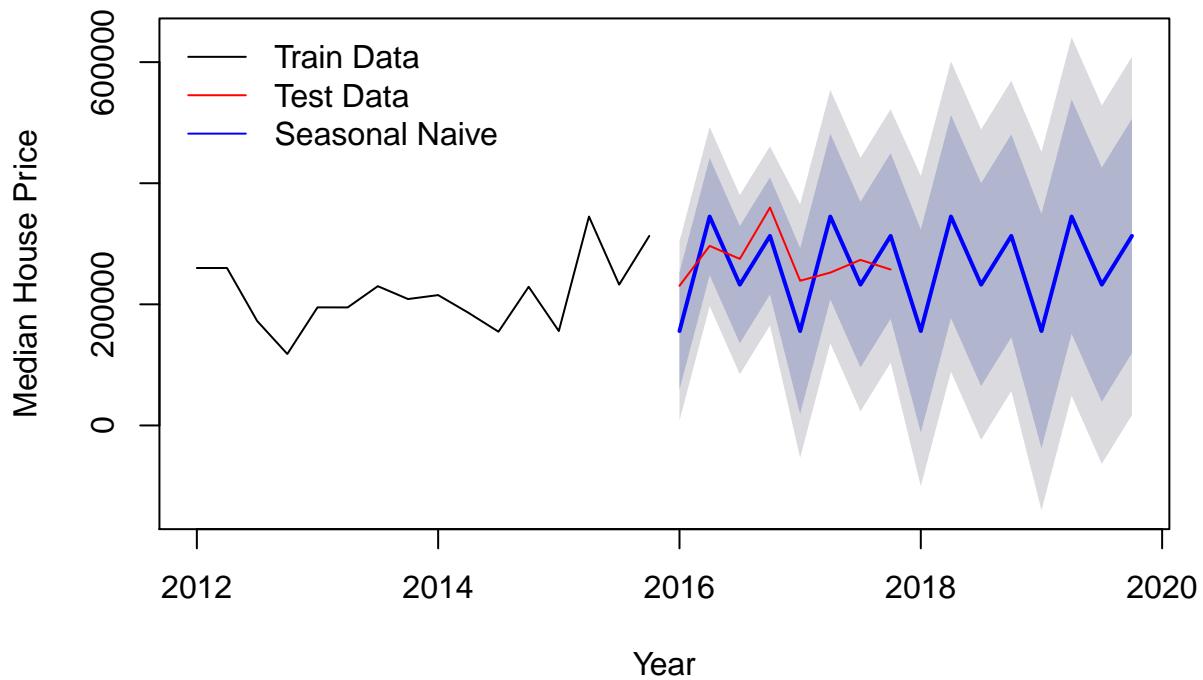
Portland, OR – Concordia : Full TS Models Comparison



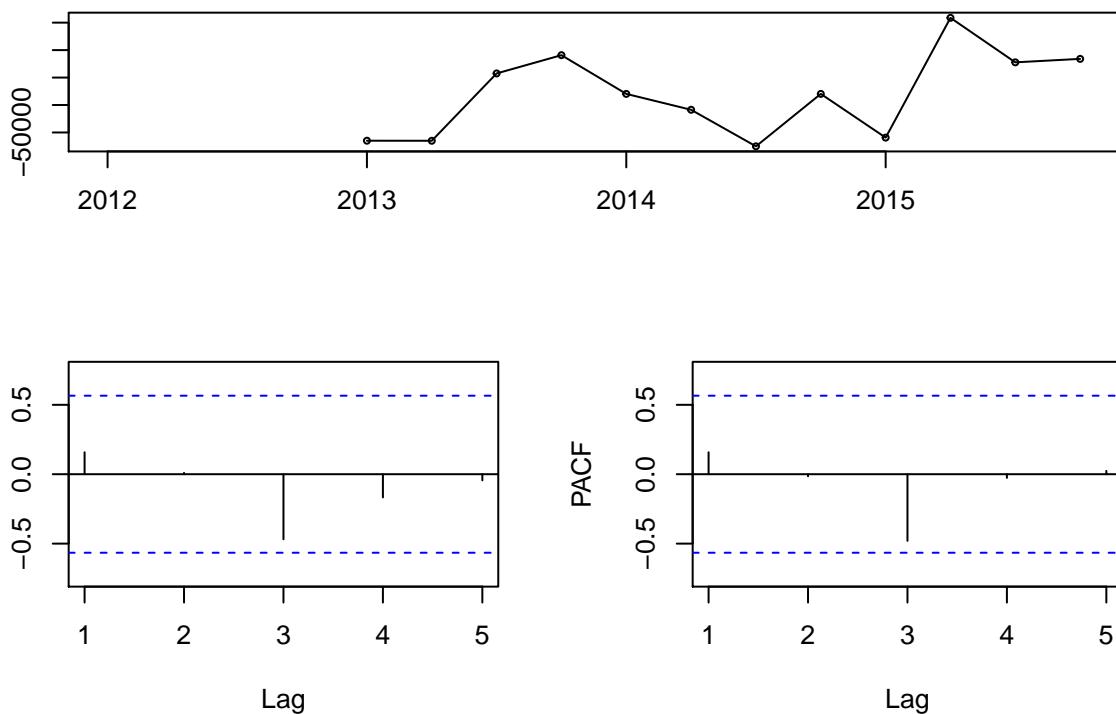
Portland, OR – Hayden Island



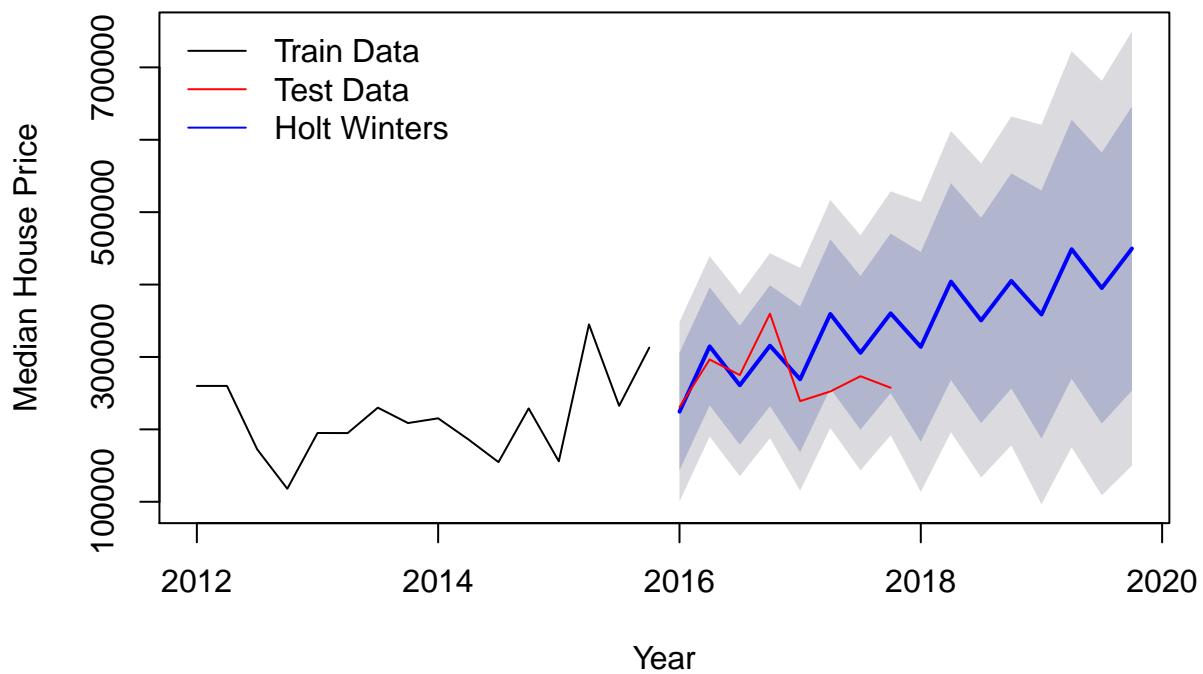
Portland, OR – Hayden Island : Naive Model Forecast



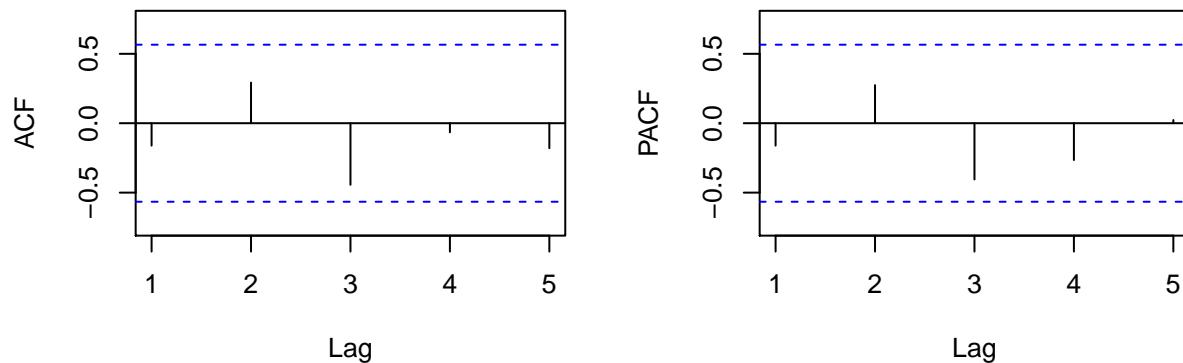
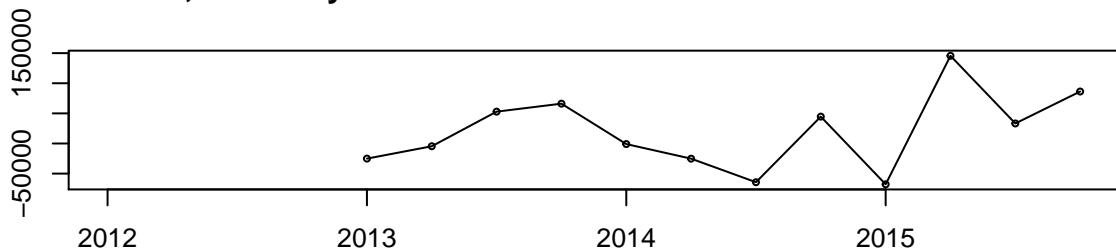
Portland, OR – Hayden Island : Naive Model Forecast Residuals



Portland, OR – Hayden Island : Holt Winters Model Forecast

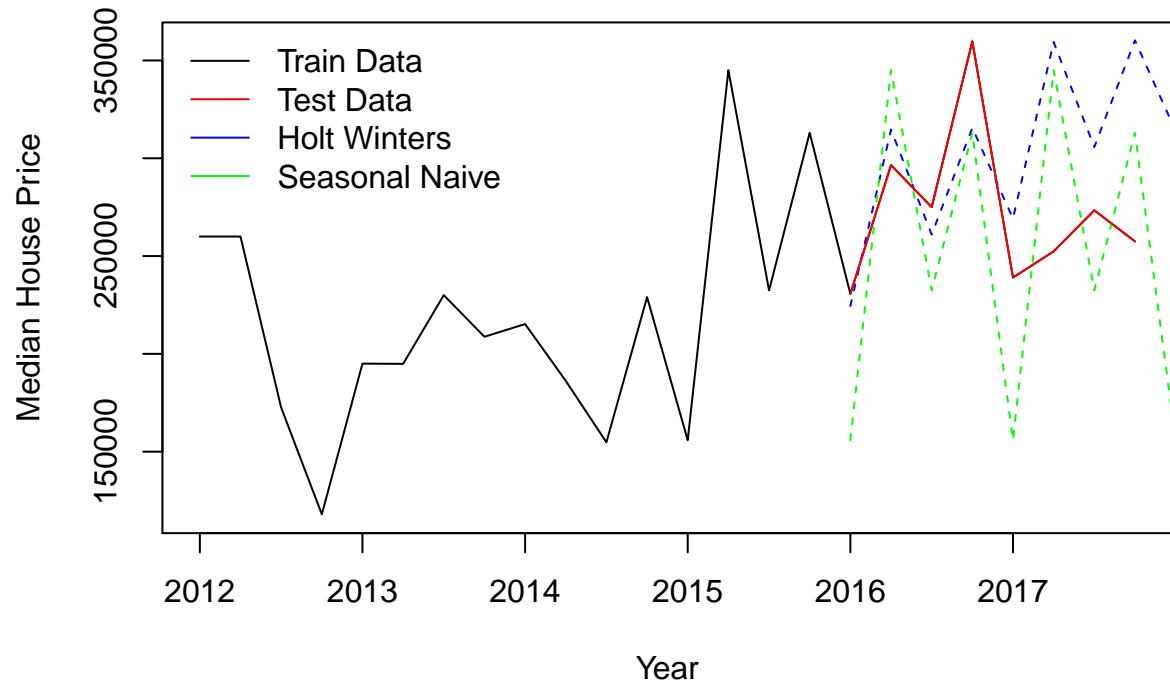


Portland, OR – Hayden Island : Holt Winters Model Forecast Residuals

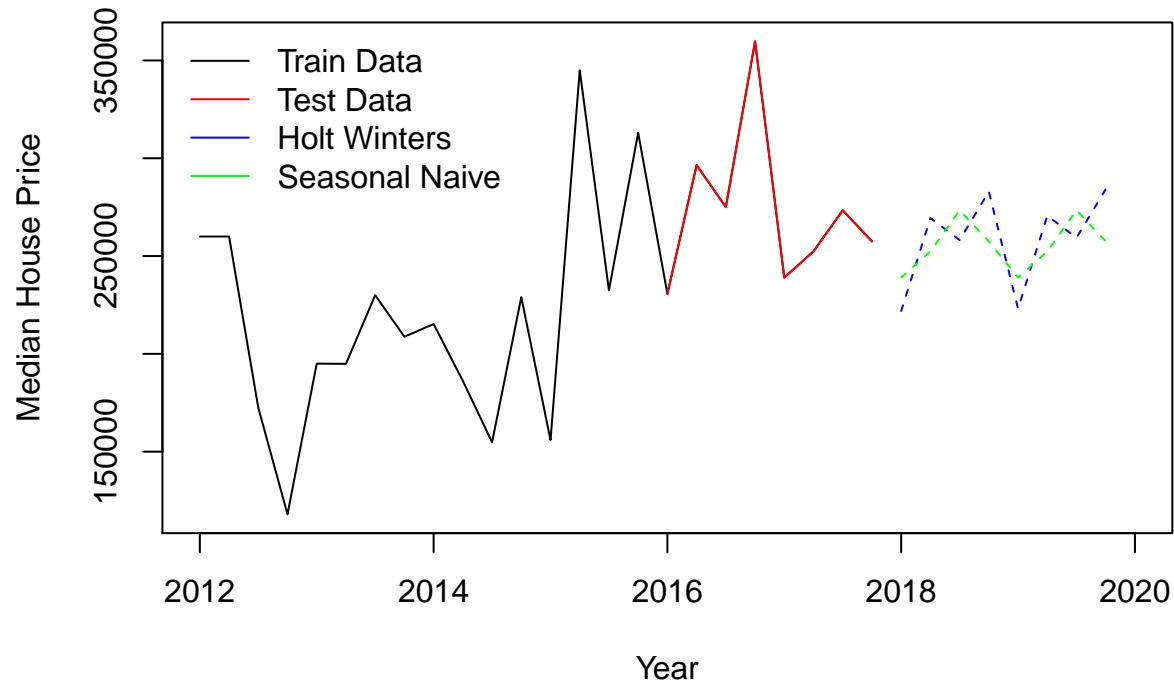


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Hayden Island"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 19656.46 75494.43 65218.62 2.910959 29.25723 1.000000
## Test set     11432.69 63416.40 60582.69 4.501473 23.15115 0.928917
##          ACF1 Theil's U
## Training set 0.1581676      NA
## Test set     -0.4665185 1.088134
## [1] "Holt Winters Accuracy for Portland, OR – Hayden Island"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 20061.05 63841.59 51383.95 3.66325 22.70140 0.7878724
## Test set     -28257.09 57547.57 44362.96 -11.60318 16.62101 0.6802192
##          ACF1 Theil's U
## Training set -0.1613604      NA
## Test set     0.2224630 1.13902
```

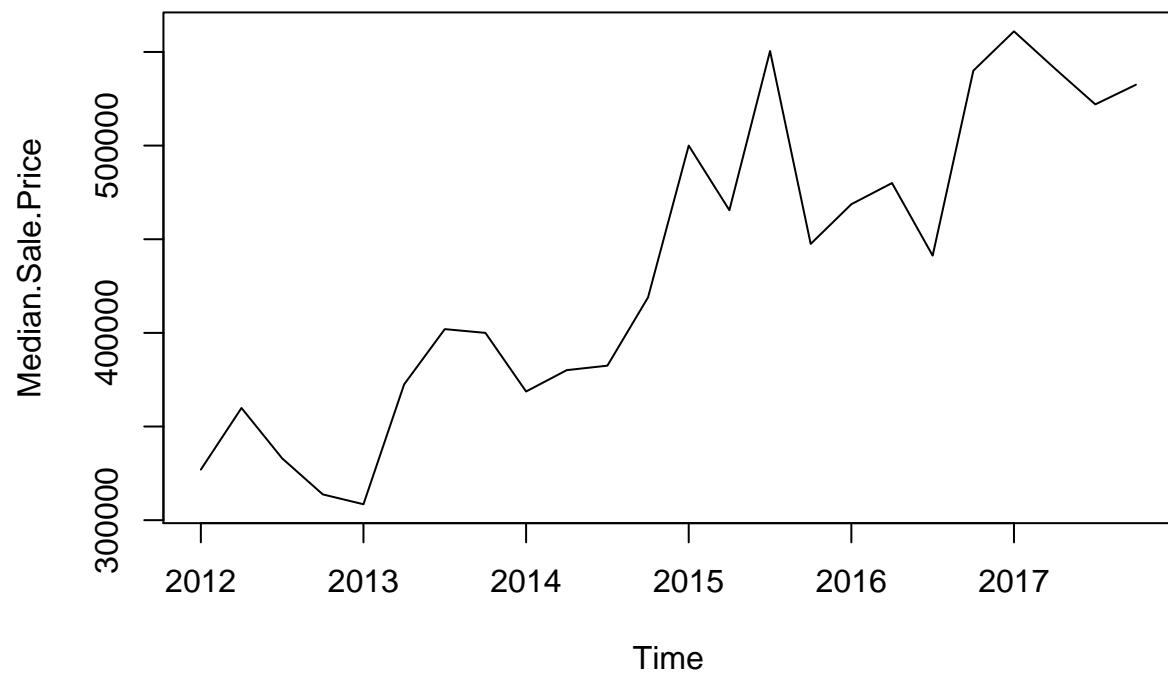
Portland, OR – Hayden Island : TS Training Model Comparison



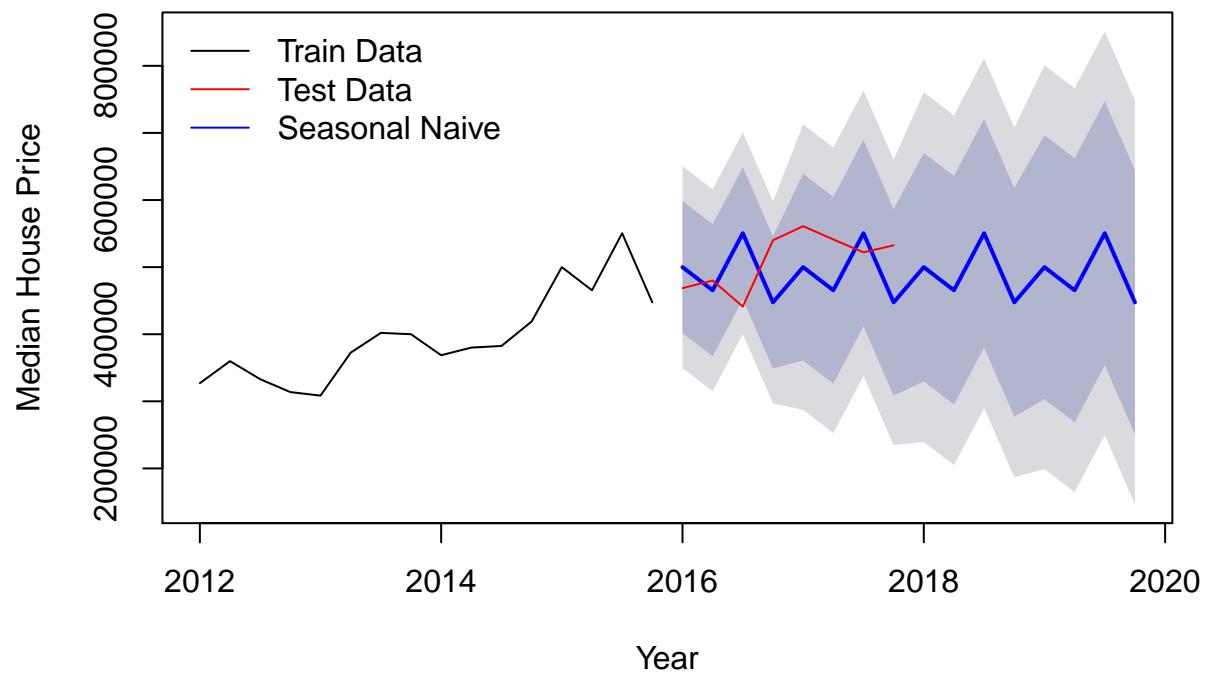
Portland, OR – Hayden Island : Full TS Models Comparison



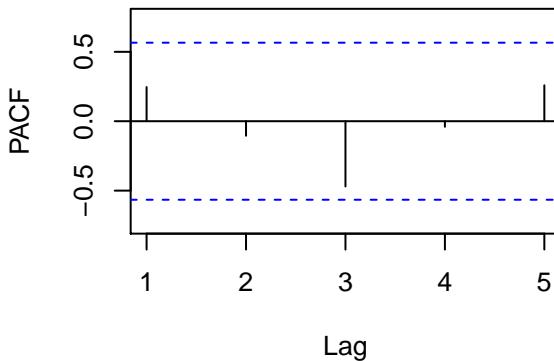
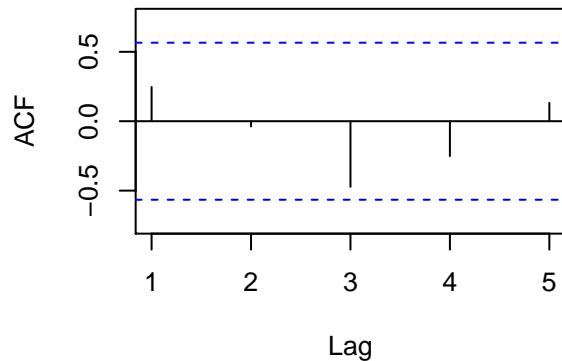
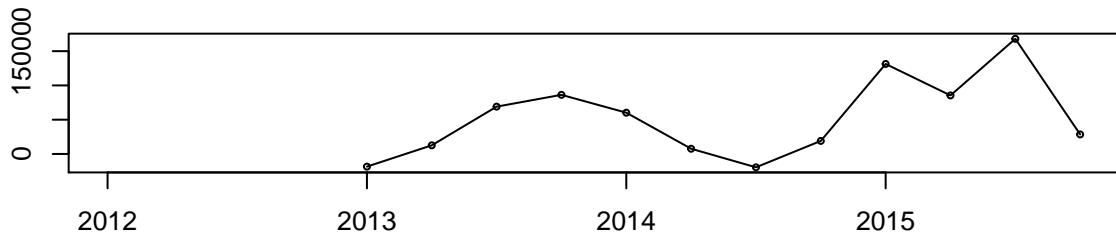
Portland, OR – Sunnyside



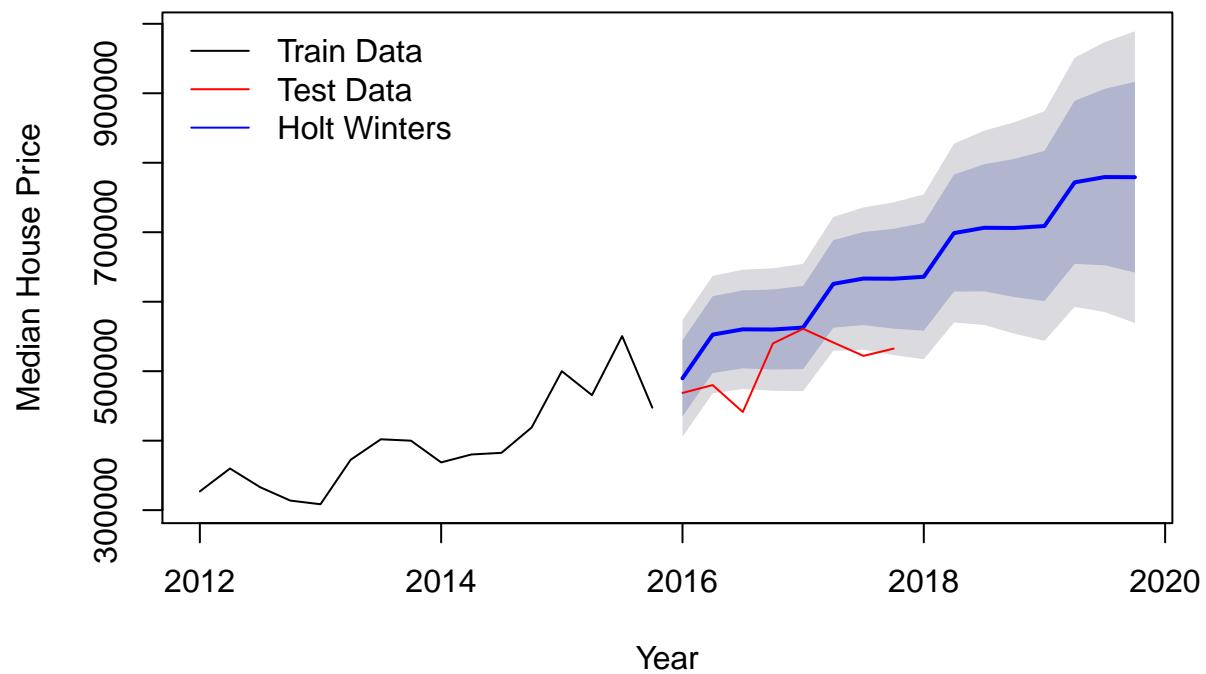
Portland, OR – Sunnyside : Naive Model Forecast



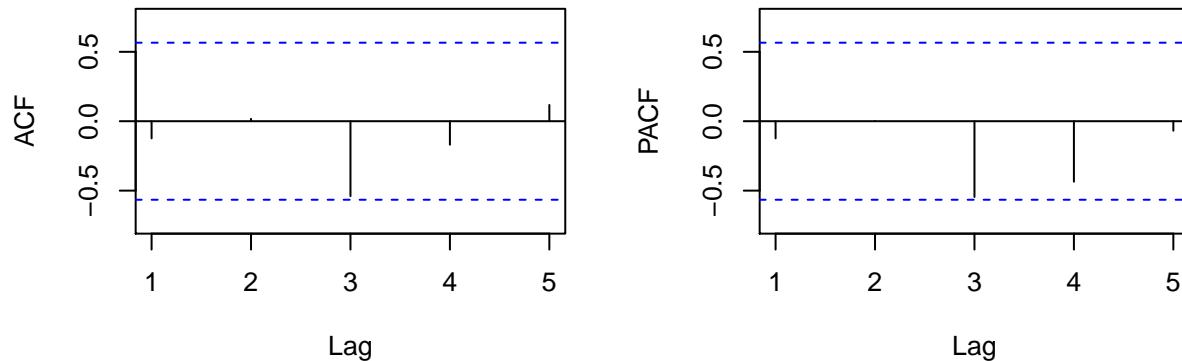
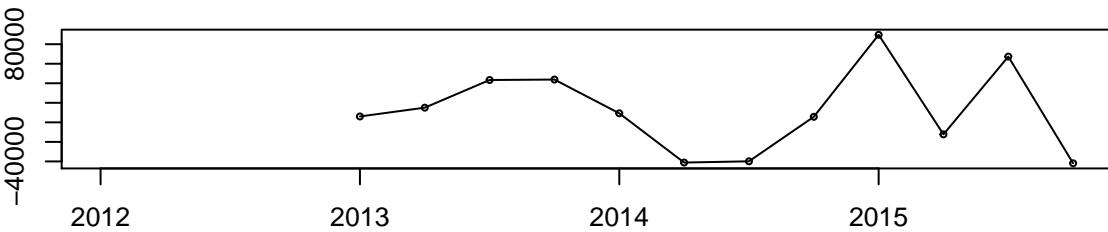
Portland, OR – Sunnyside : Naive Model Forecast Residuals



Portland, OR – Sunnyside : Holt Winters Model Forecast



Portland, OR – Sunnyside : Holt Winters Model Forecast Residuals

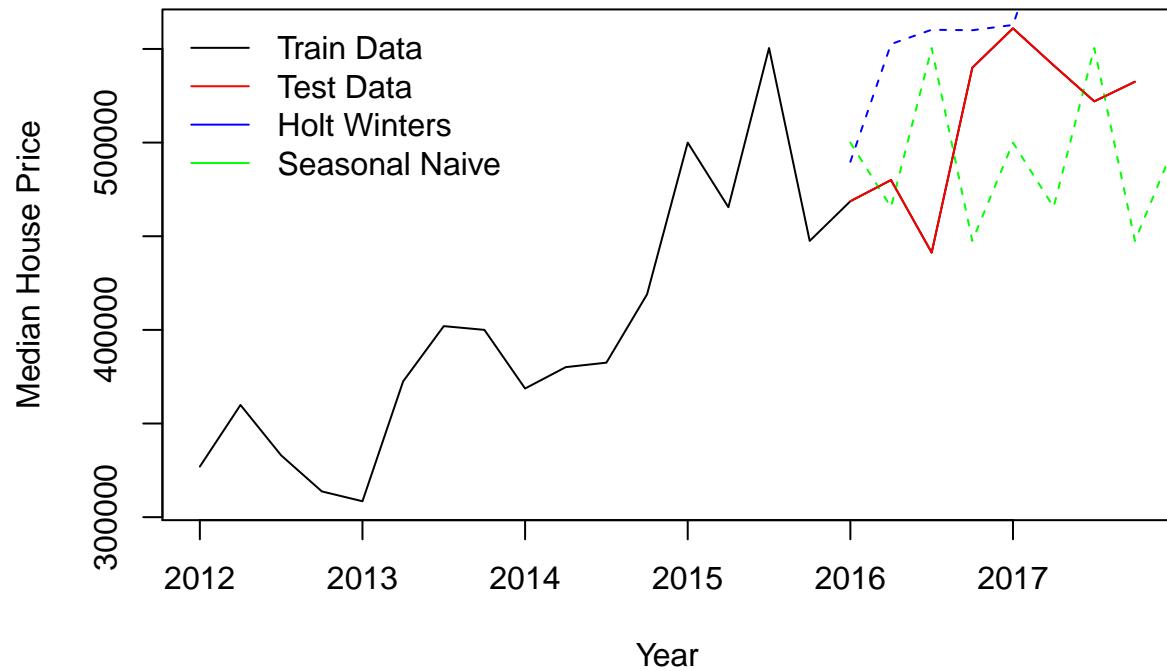


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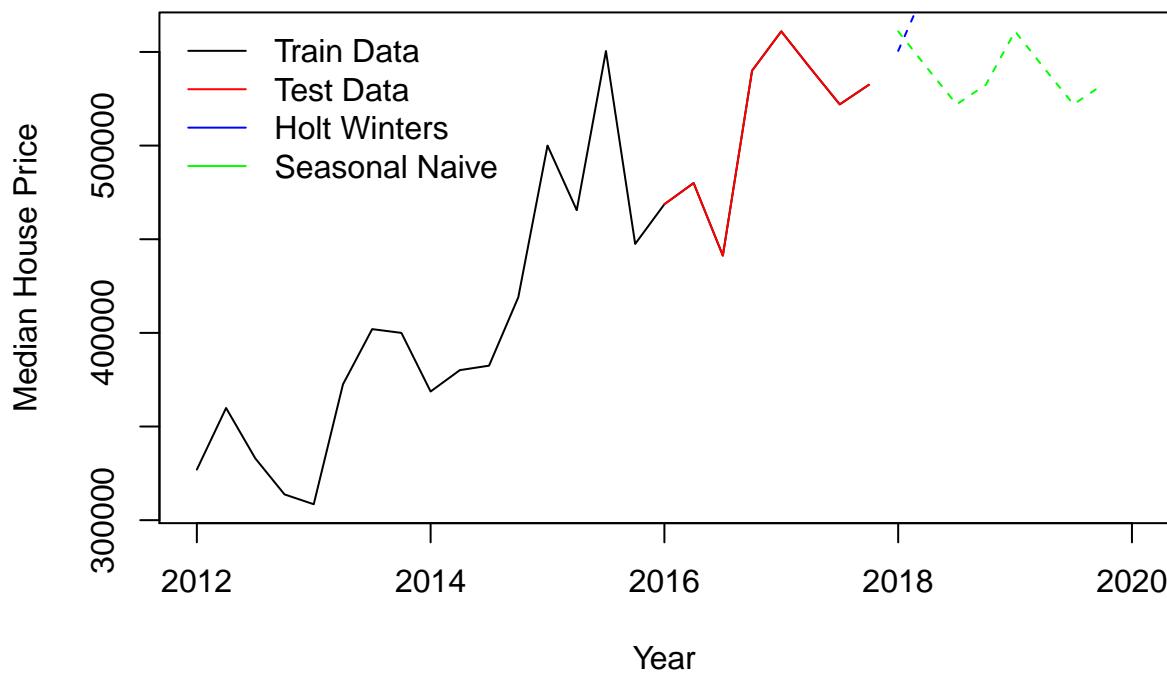
## [1] "Seasonal Naive Accuracy for Portland, OR – Sunnyside"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 52487.5 76752.84 58820.83 11.280732 13.12986 1.000000
## Test set     19962.5 69980.41 62225.00  3.010588 12.23484 1.057873
##          ACF1 Theil's U
## Training set  0.2463323      NA
## Test set      -0.2494092  1.596342
## [1] "Holt Winters Accuracy for Portland, OR – Sunnyside"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 12065.90 42744.08 34602.60  2.372564  7.914935 0.5882711
## Test set     -66343.71 78982.38 66343.71 -13.302101 13.302101 1.1278948
##          ACF1 Theil's U
## Training set -0.1234047      NA
## Test set      0.1212217  1.754181

```

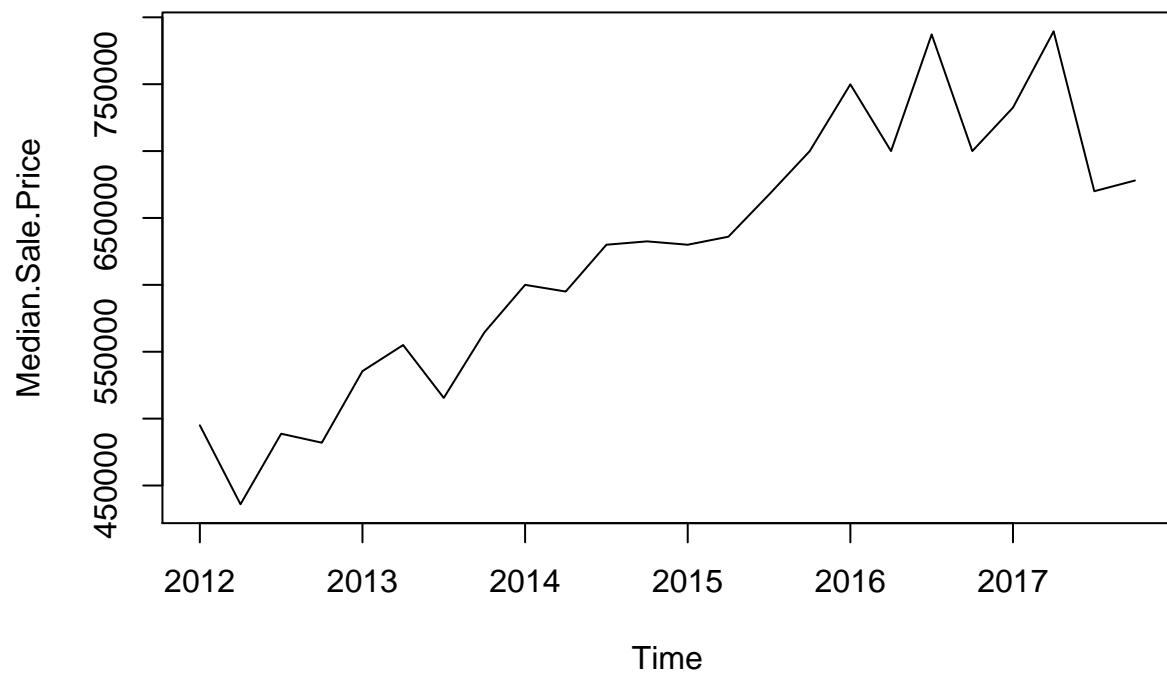
Portland, OR – Sunnyside : TS Training Model Comparison



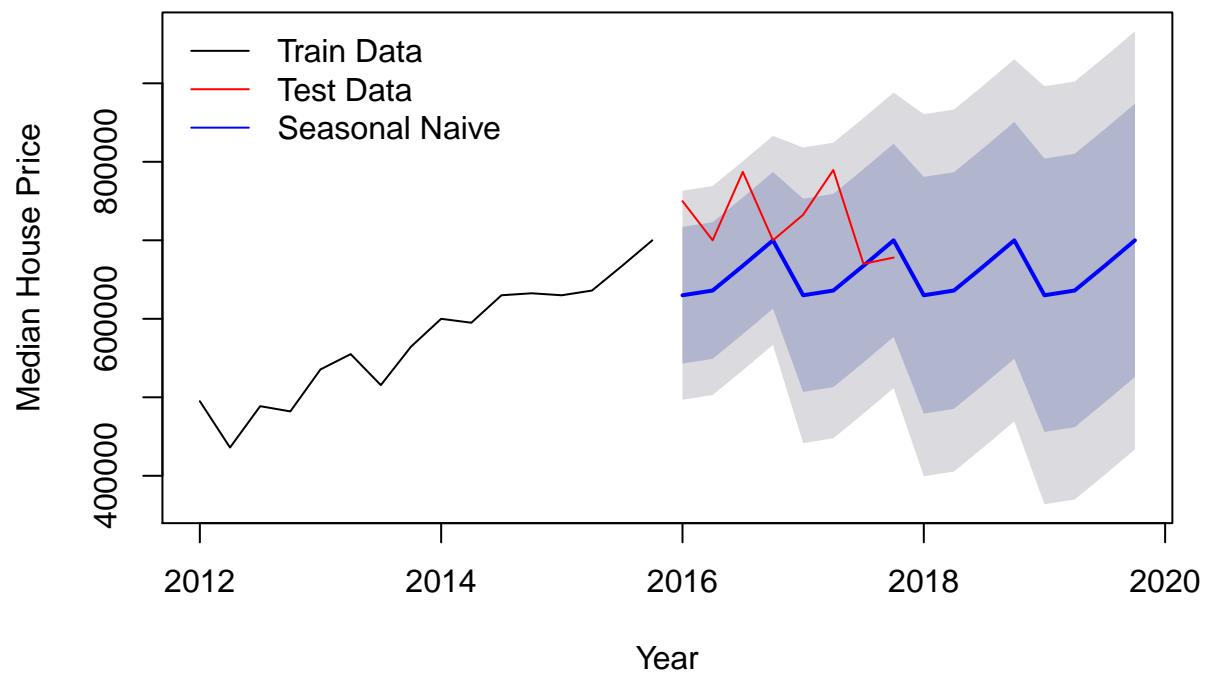
Portland, OR – Sunnyside : Full TS Models Comparison



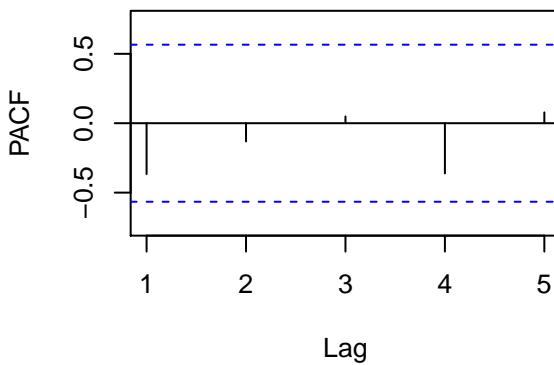
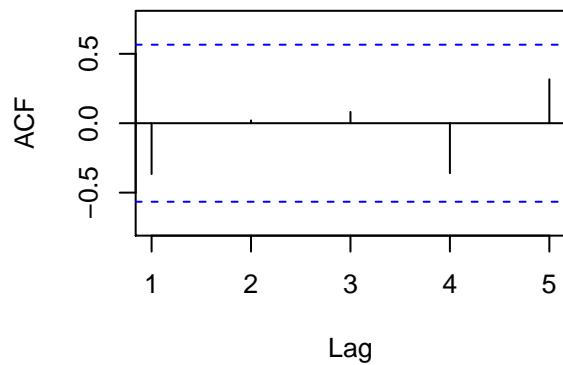
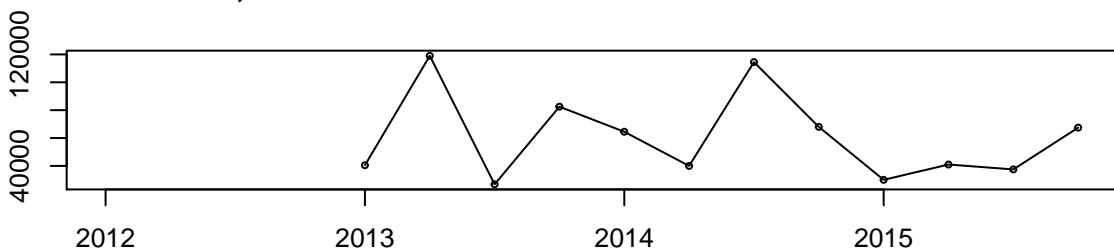
Portland, OR – Eastmoreland



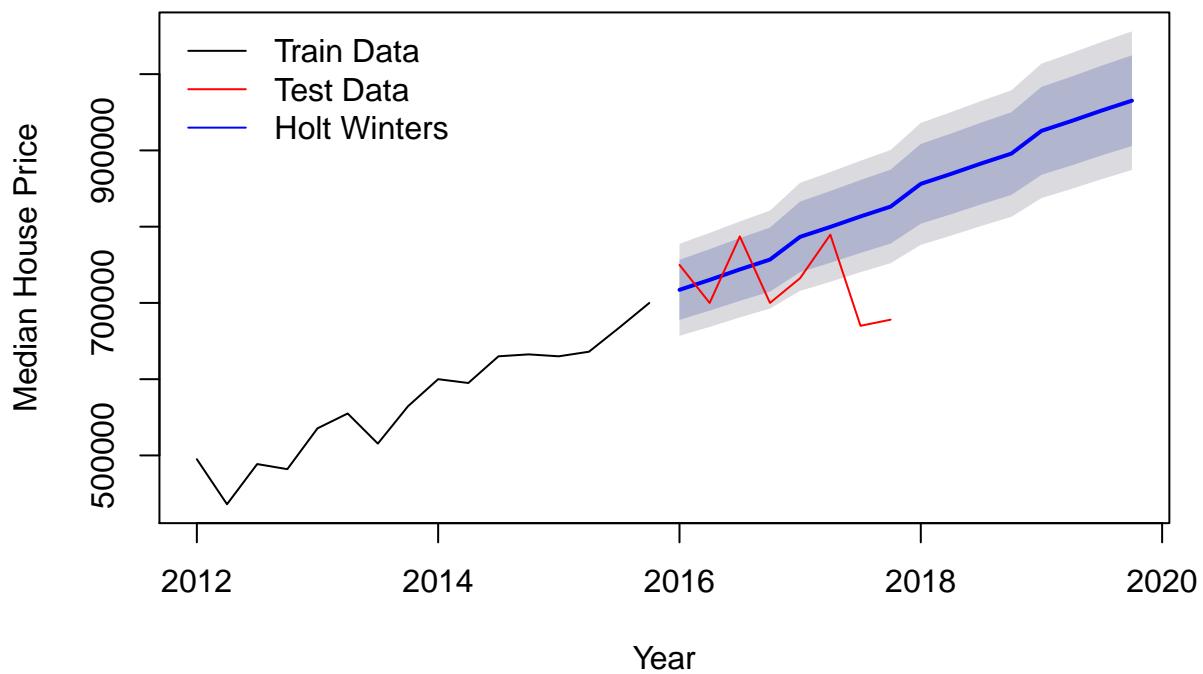
Portland, OR – Eastmoreland : Naive Model Forecast



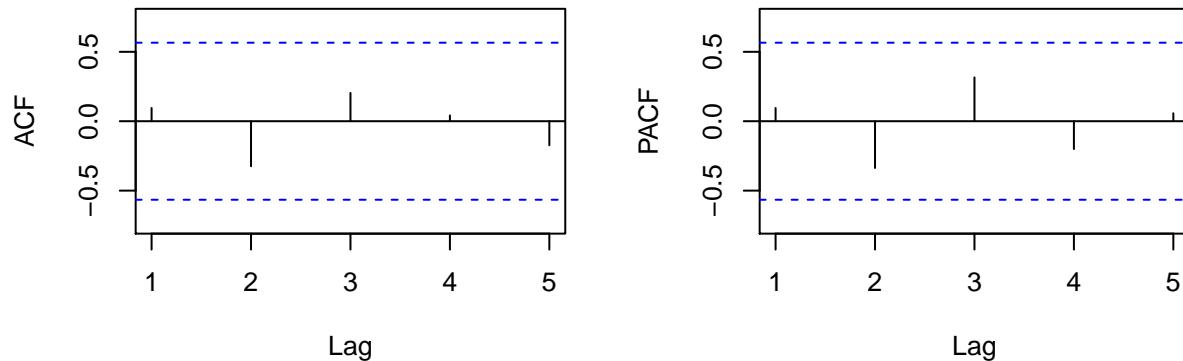
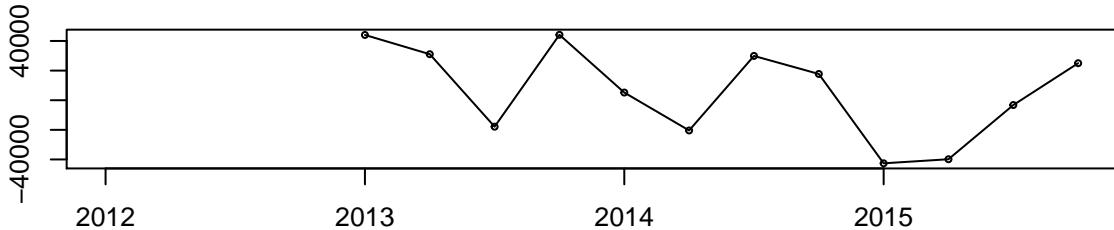
Portland, OR – Eastmoreland : Naive Model Forecast Residuals



Portland, OR – Eastmoreland : Holt Winters Model Forecast

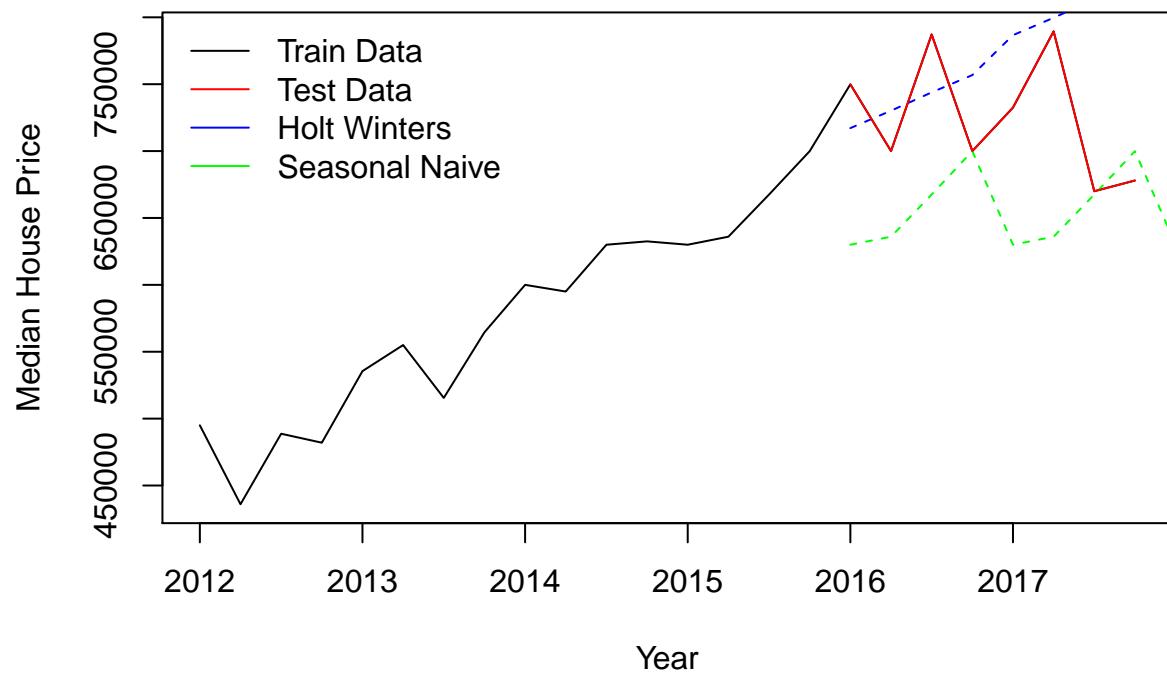


Portland, OR – Eastmoreland : Holt Winters Model Forecast Residuals

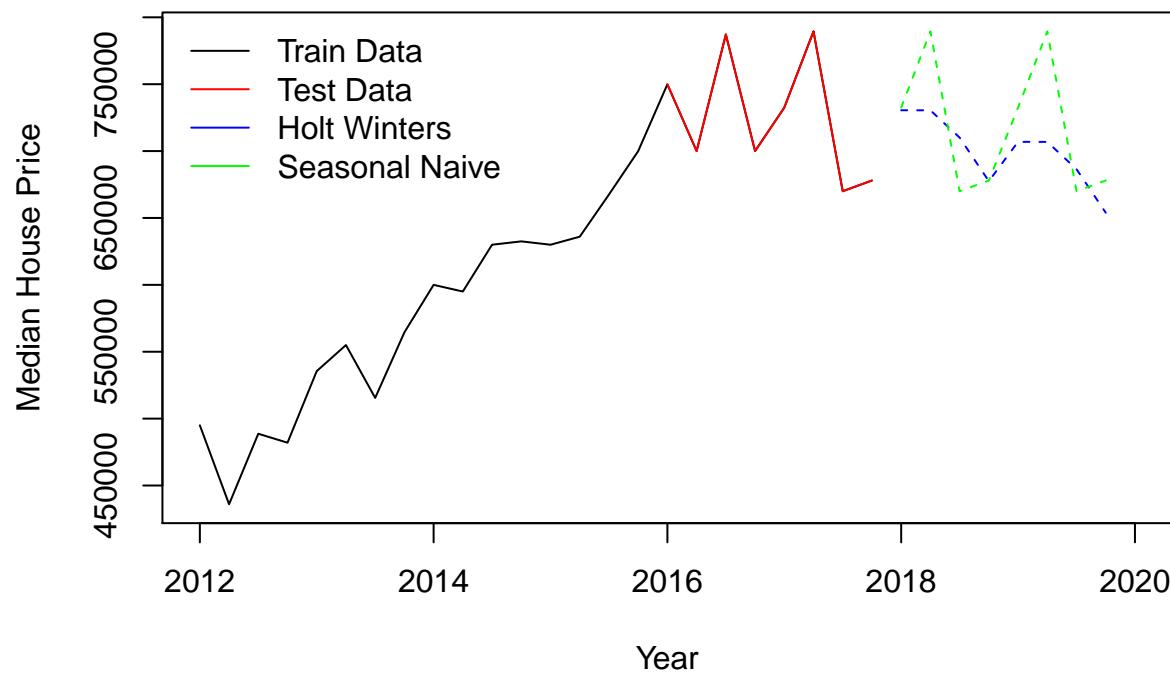


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Eastmoreland"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 60979.12 67919.64 60979.12 10.13992 10.139921 1.000000
## Test set     67524.62 91757.61 73012.00  8.86448  9.673827 1.197328
##          ACF1 Theil's U
## Training set -0.3663949      NA
## Test set     -0.0976102  1.273579
## [1] "Holt Winters Accuracy for Portland, OR – Eastmoreland"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 6091.89 30092.96 26756.81 1.101615 4.503795 0.4387863
## Test set     -45865.73 81137.78 64876.92 -6.813897 9.280646 1.0639201
##          ACF1 Theil's U
## Training set 0.09556016      NA
## Test set     0.22198362  1.247572
```

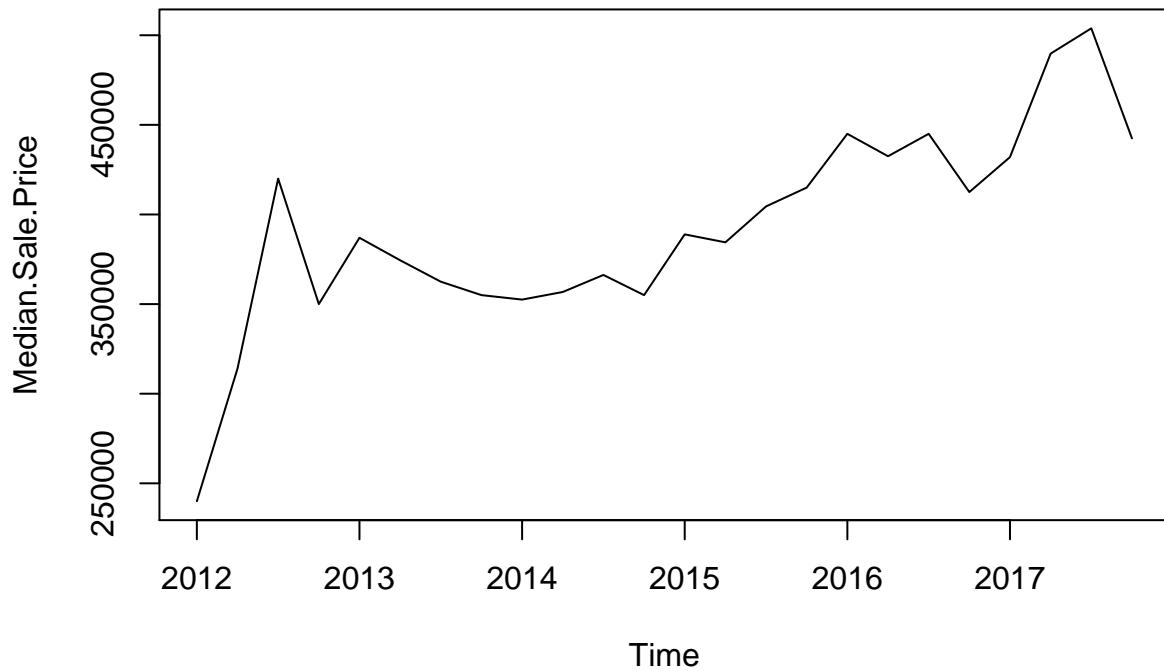
Portland, OR – Eastmoreland : TS Training Model Comparison



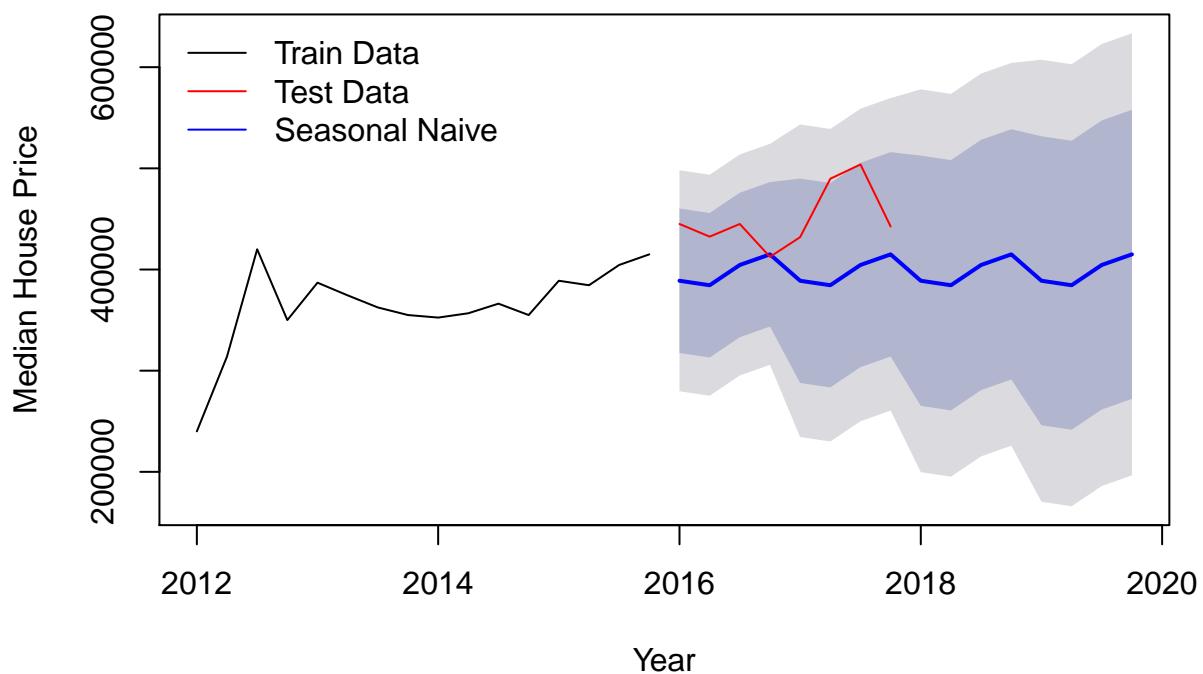
Portland, OR – Eastmoreland : Full TS Models Comparison



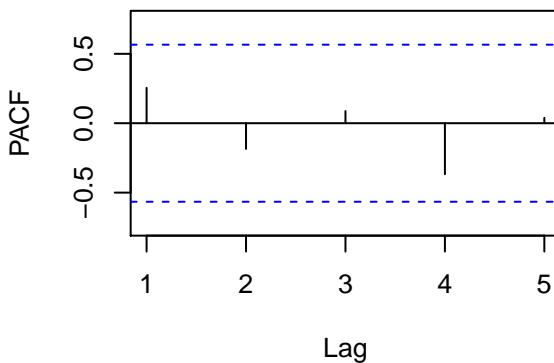
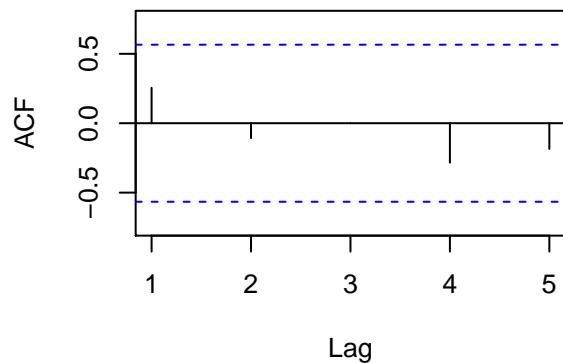
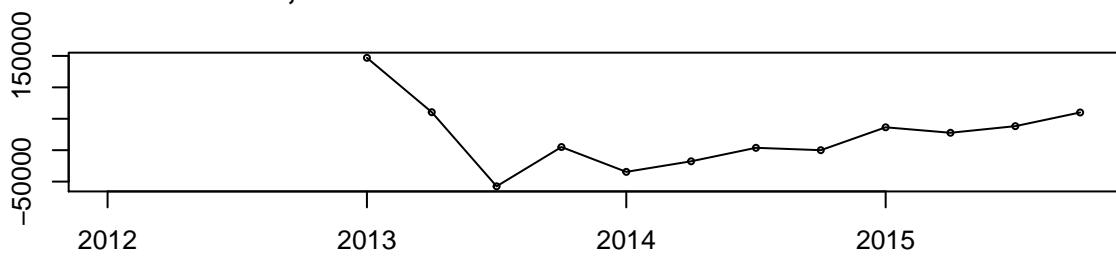
Portland, OR – Corbett



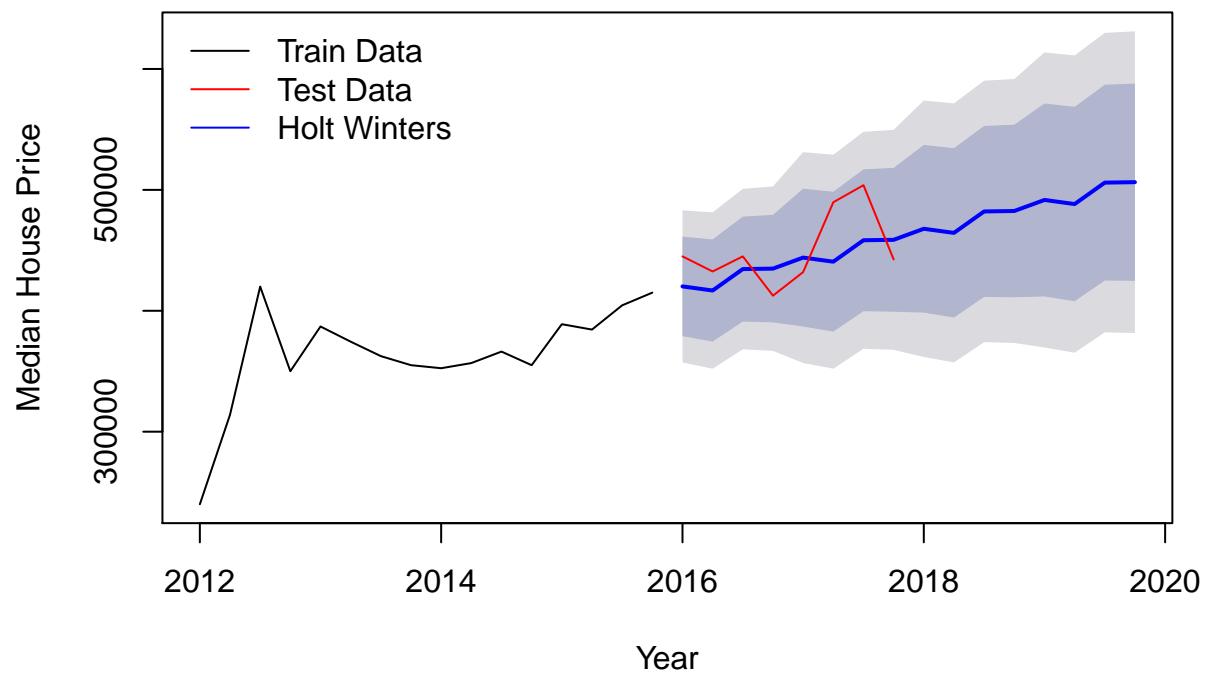
Portland, OR – Corbett : Naive Model Forecast



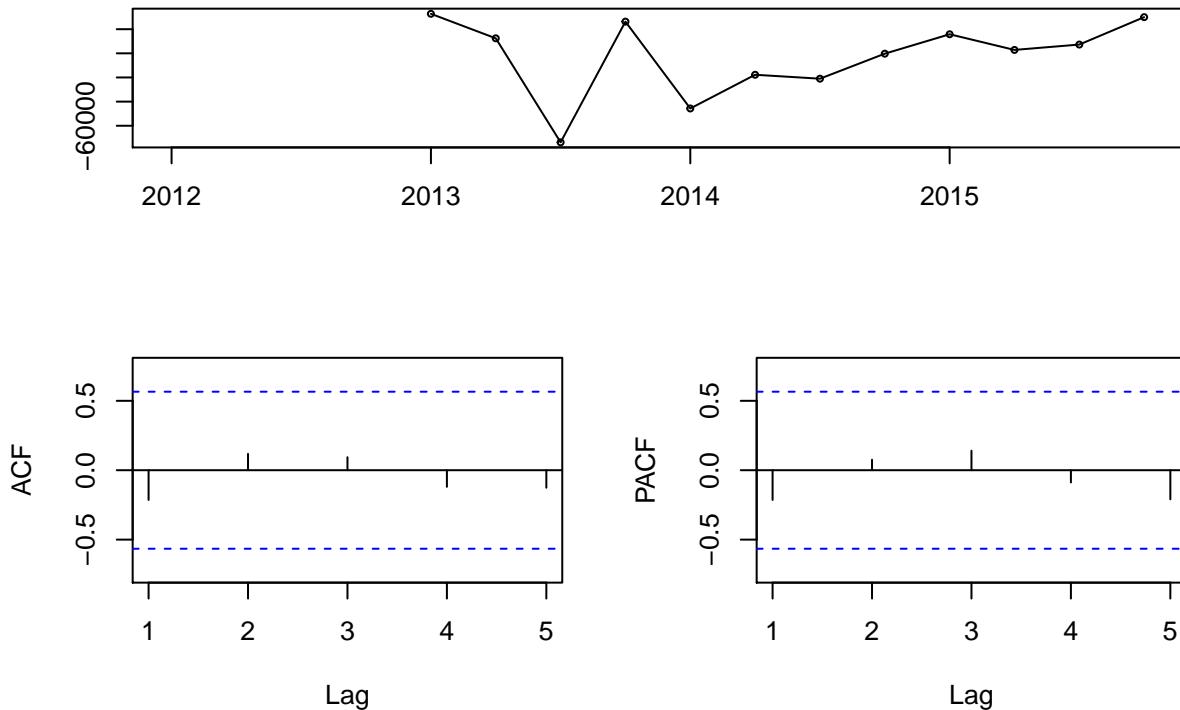
Portland, OR – Corbett : Naive Model Forecast Residuals



Portland, OR – Corbett : Holt Winters Model Forecast



Portland, OR – Corbett : Holt Winters Model Forecast Residuals

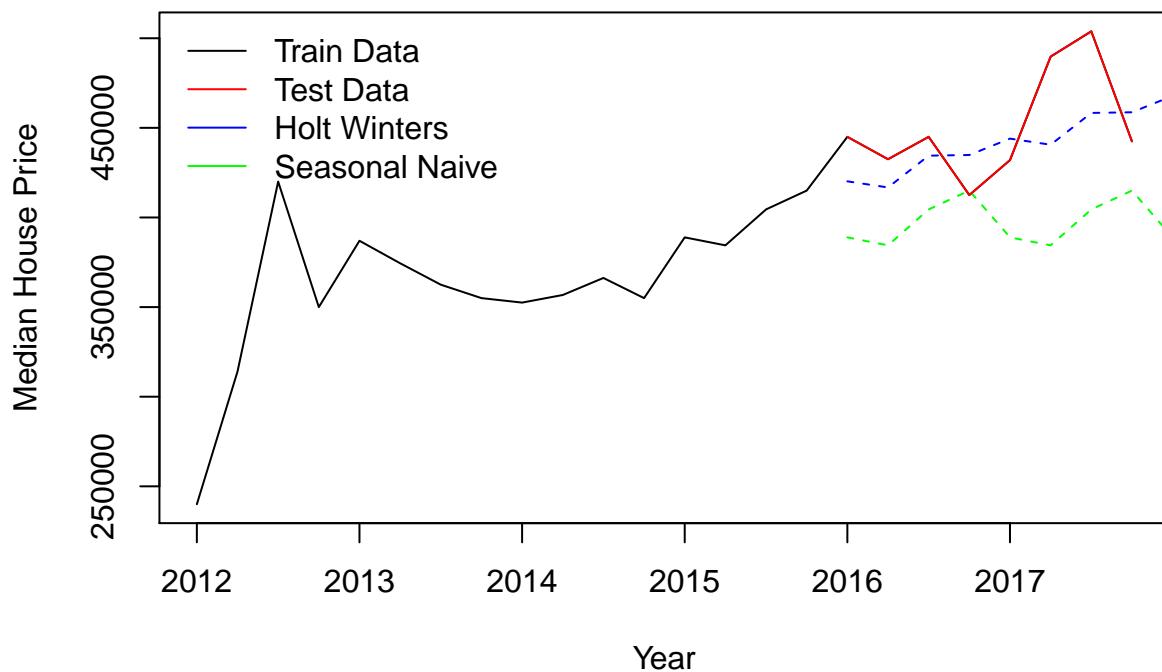


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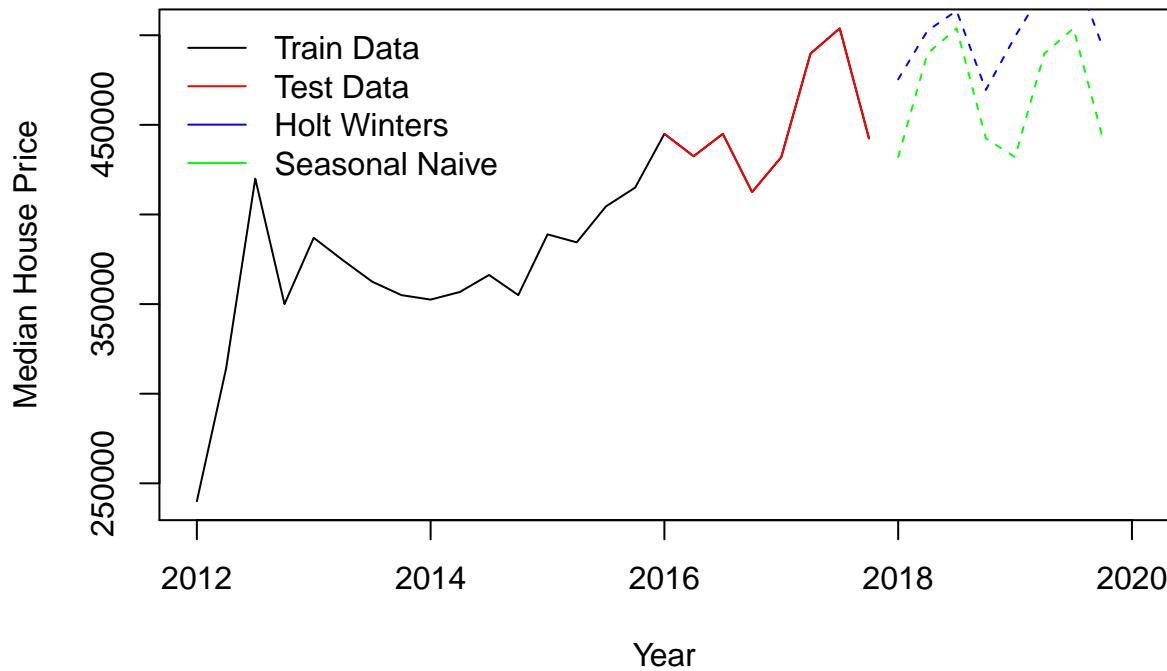
## [1] "Seasonal Naive Accuracy for Portland, OR – Corbett"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 22404.17 55728.04 40687.50  5.535711 10.63750 1.000000
## Test set     52174.69 61921.71 52799.69 11.202714 11.35423 1.297688
##          ACF1 Theil's U
## Training set 0.2550797      NA
## Test set     0.2277705 1.777199
## [1] "Holt Winters Accuracy for Portland, OR – Corbett"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set -2593.814 30826.70 23815.86 -0.9240284 6.424534 0.5853360
## Test set     11902.807 28218.94 24540.49  2.3498363 5.314164 0.6031457
##          ACF1 Theil's U
## Training set -0.21436708      NA
## Test set     0.06272014 0.8072264

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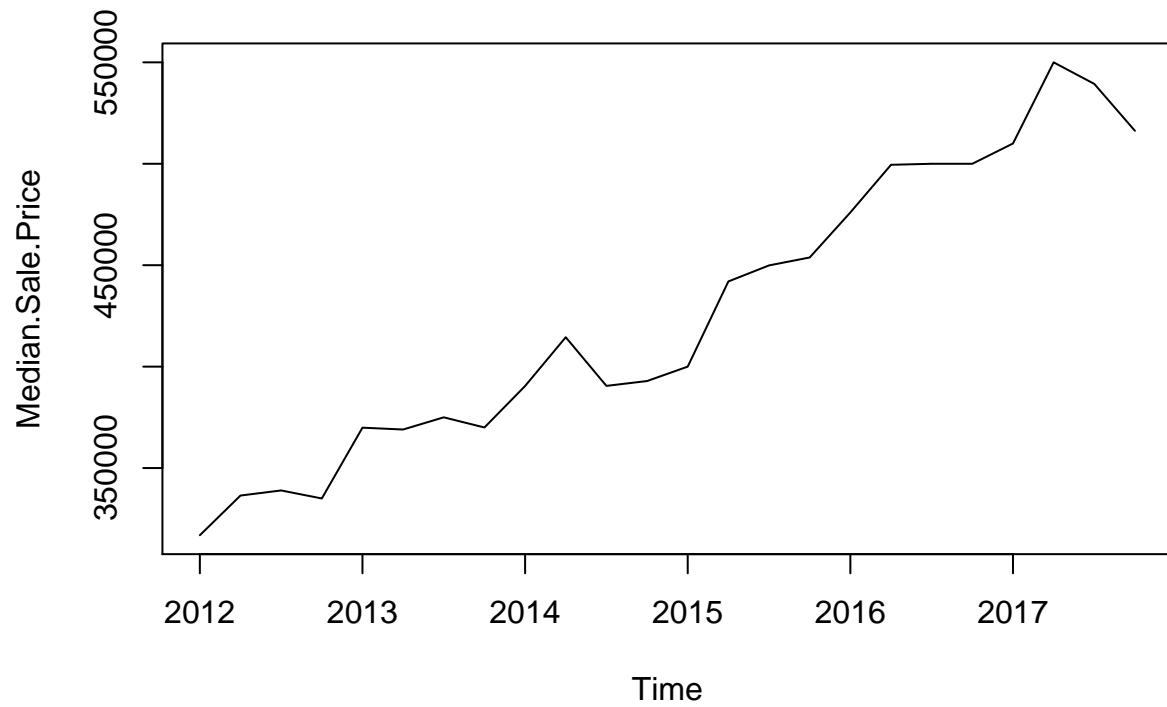
Portland, OR – Corbett : TS Training Model Comparison



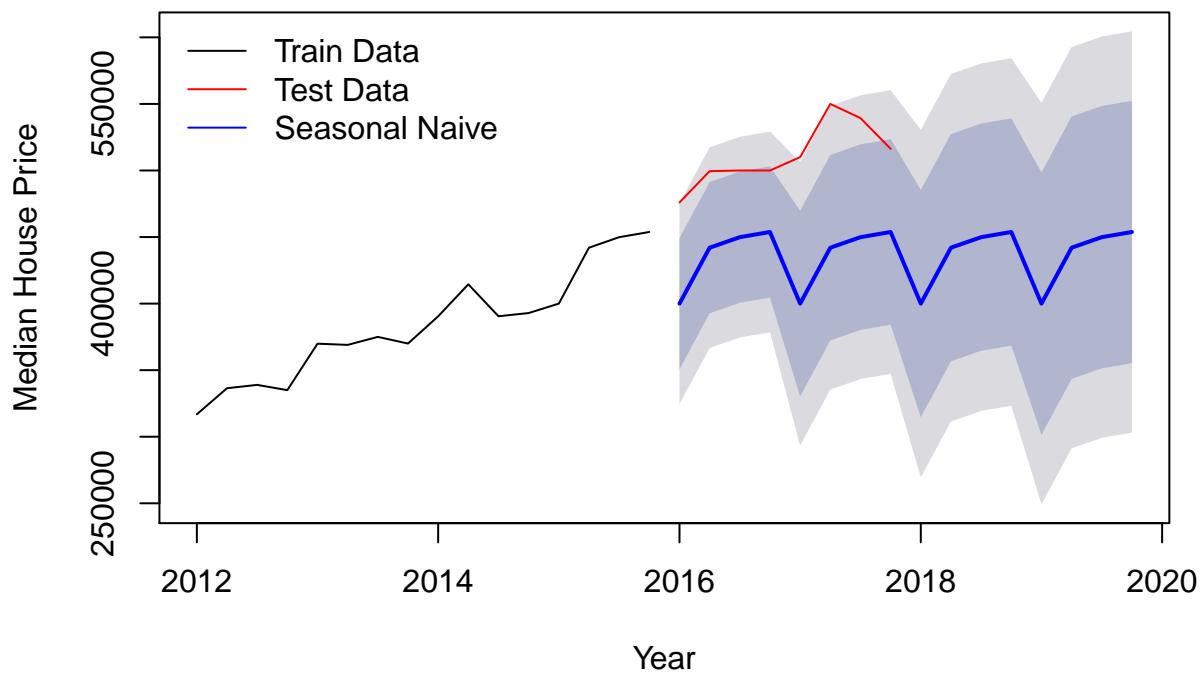
Portland, OR – Corbett : Full TS Models Comparison



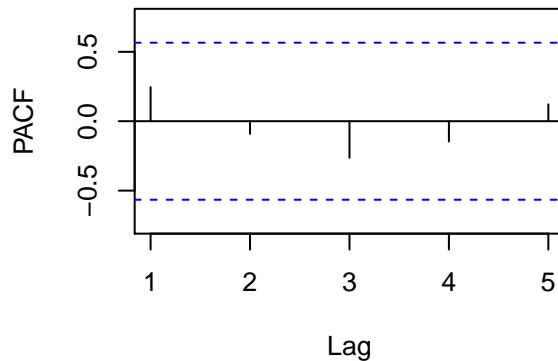
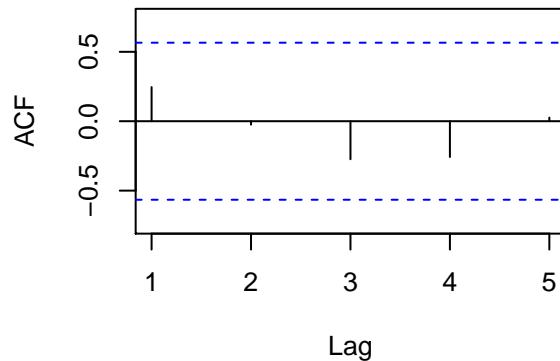
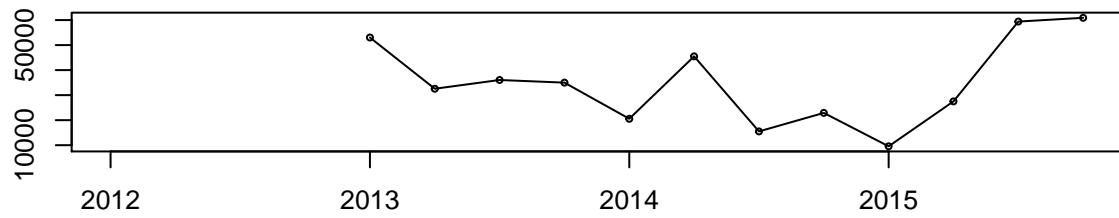
Portland, OR – Northeast Portland



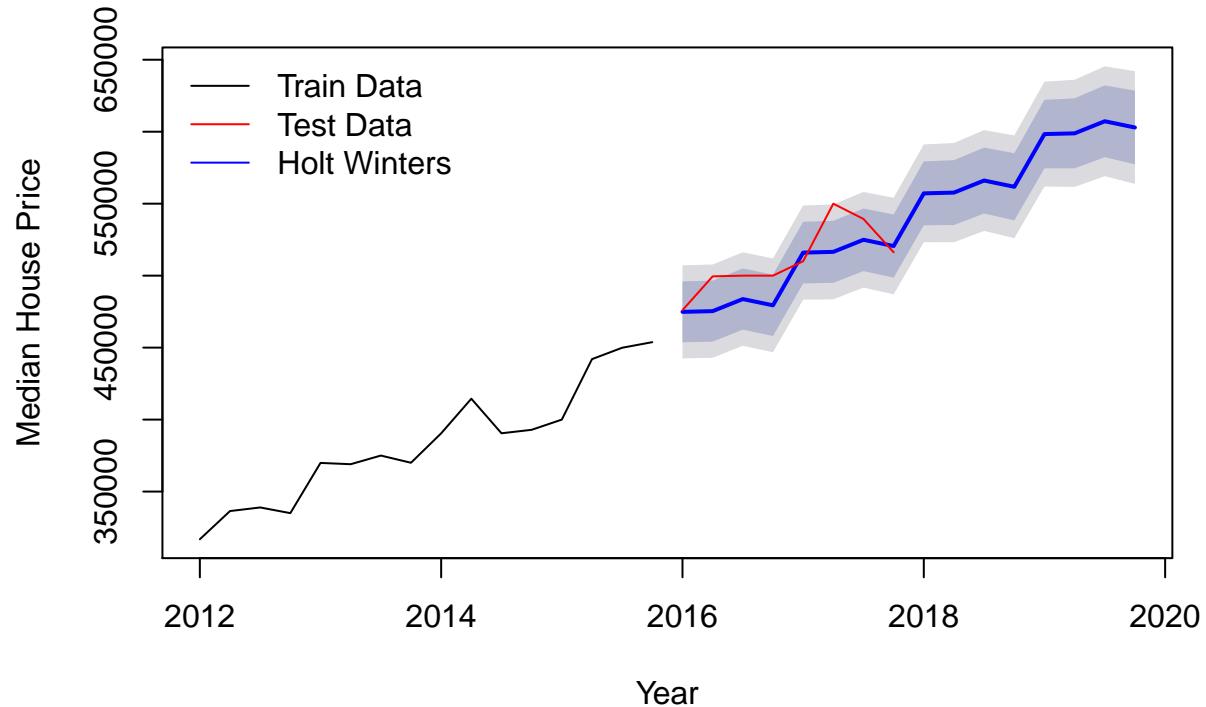
Portland, OR – Northeast Portland : Naive Model Forecast



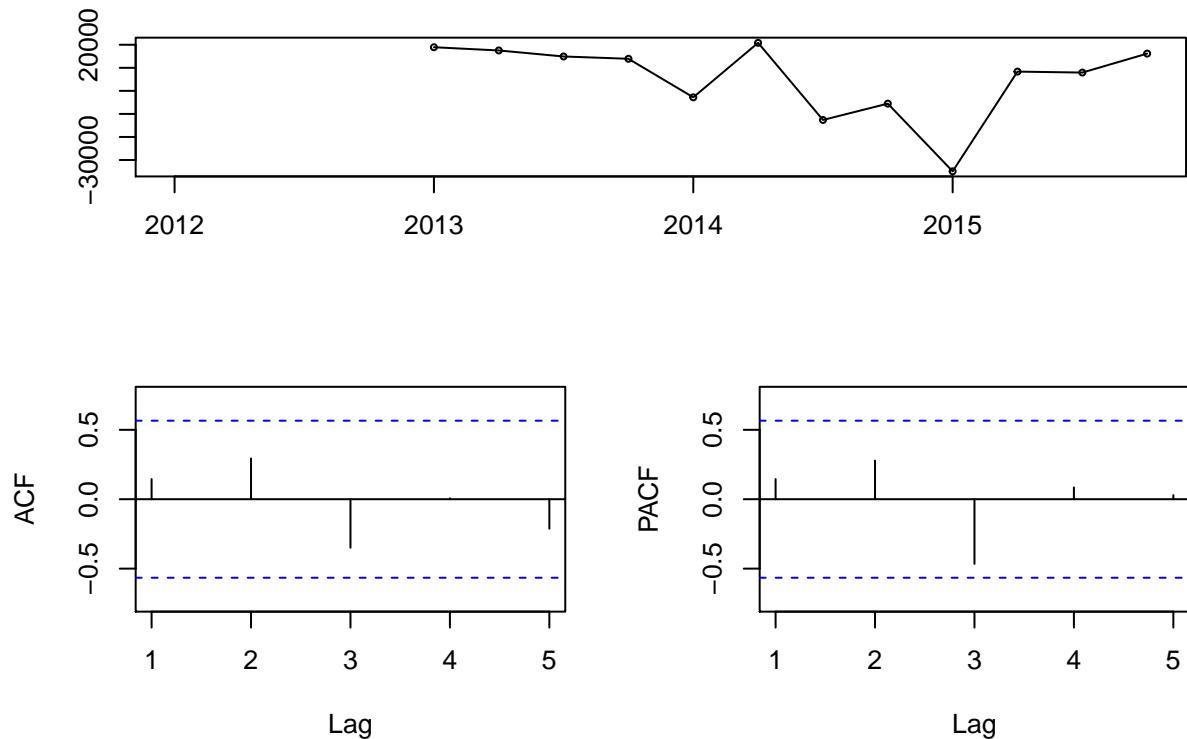
Portland, OR – Northeast Portland : Naive Model Forecast Residuals



Portland, OR – Northeast Portland : Holt Winters Model Forecast

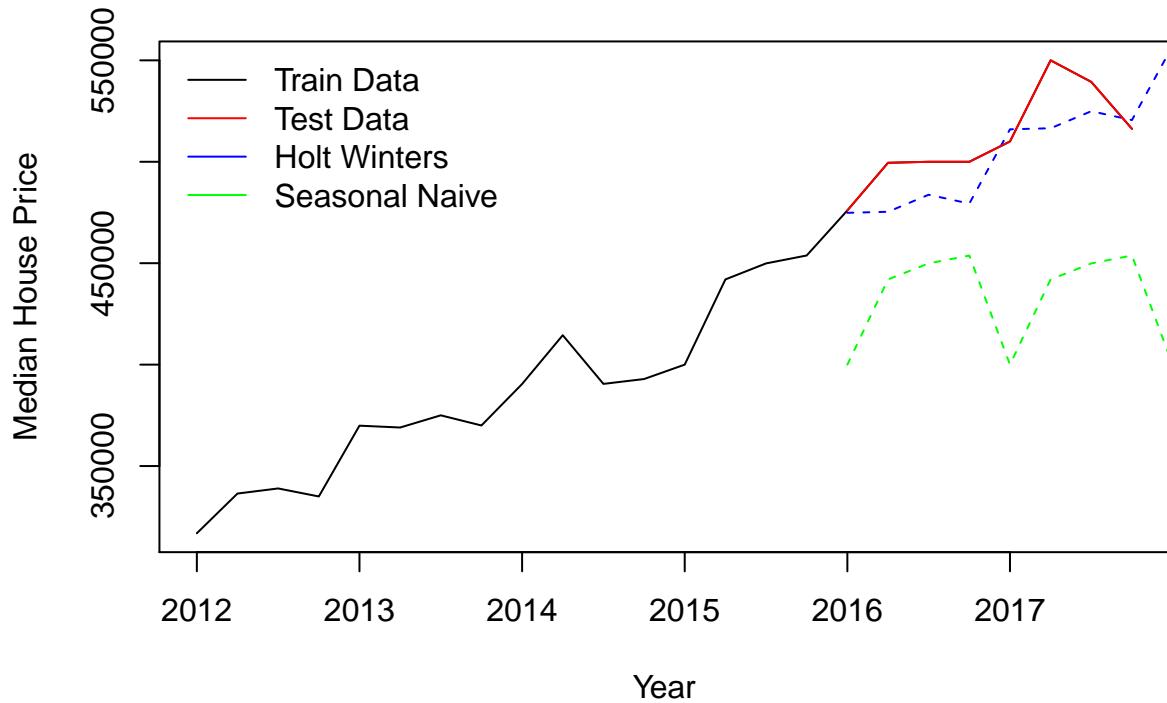


Portland, OR – Northeast Portland : Holt Winters Model Forecast Residuals

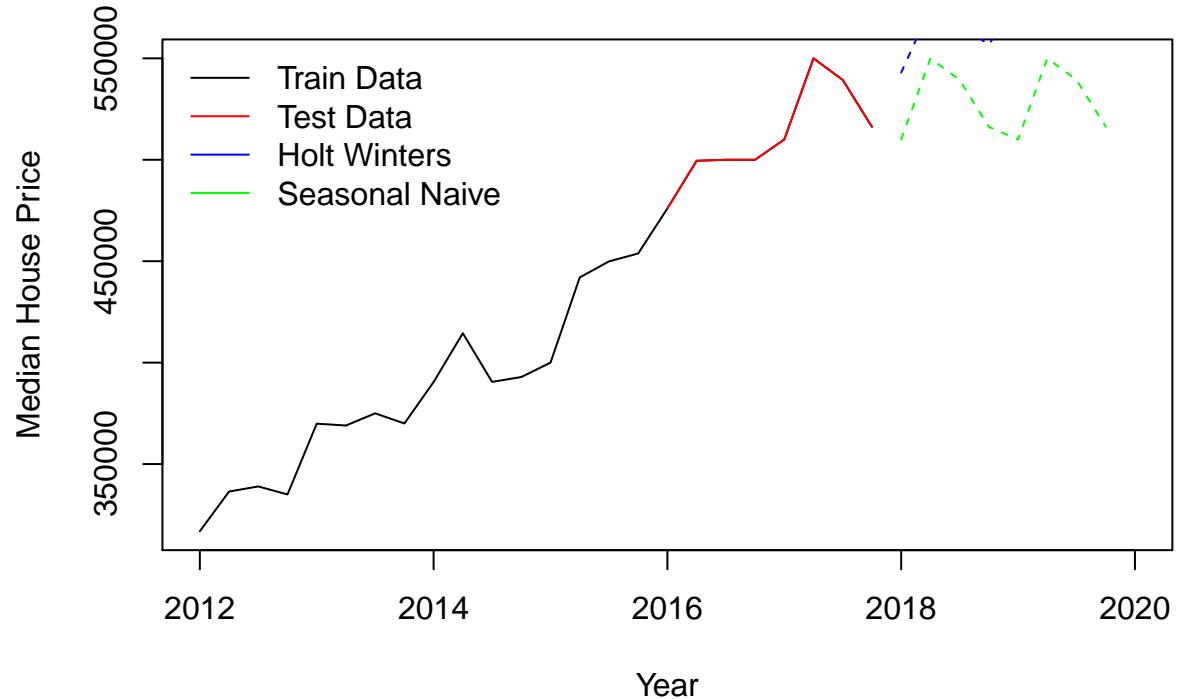


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Northeast Portland"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 34868.75 38446.49 34868.75 8.624918 8.624918 1.000000
## Test set     74965.62 78578.37 74965.62 14.578548 14.578548 2.149937
##          ACF1 Theil's U
## Training set 0.2460681      NA
## Test set     0.3557617 3.853193
## [1] "Holt Winters Accuracy for Portland, OR – Northeast Portland"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 5229.494 16649.31 14538.24 1.314459 3.661457 0.4169417
## Test set     12475.052 18229.03 15055.32 2.400944 2.904320 0.4317712
##          ACF1 Theil's U
## Training set 0.1451098      NA
## Test set     -0.4156021 0.9701171
```

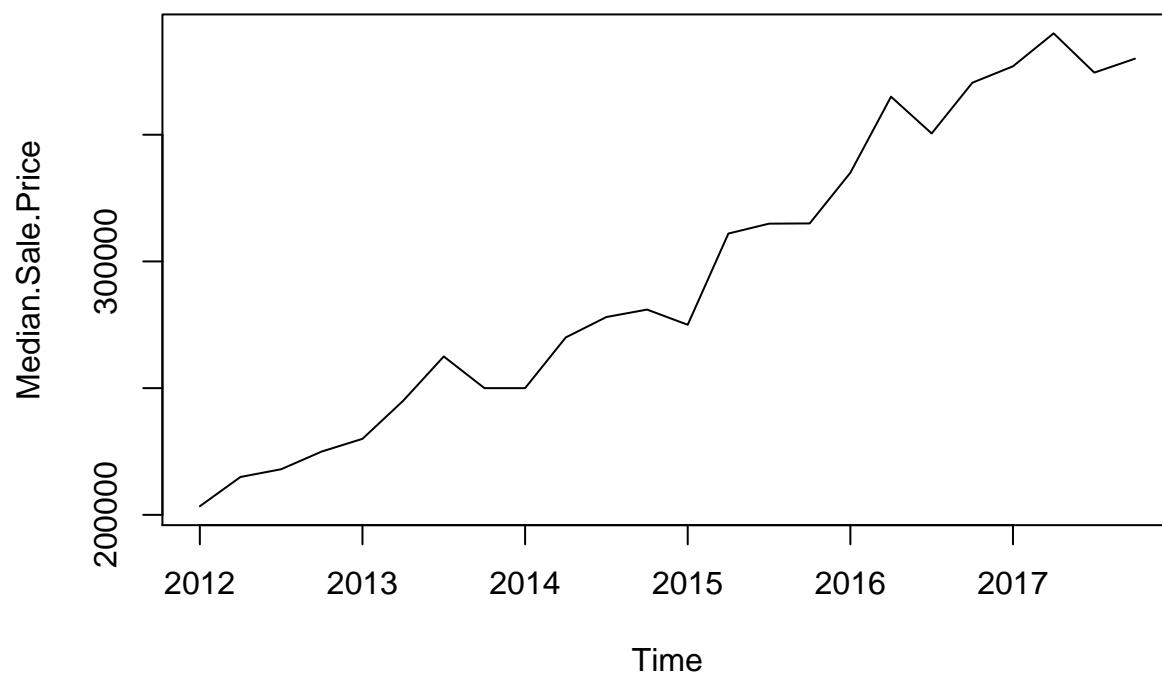
Portland, OR – Northeast Portland : TS Training Model Comparisor



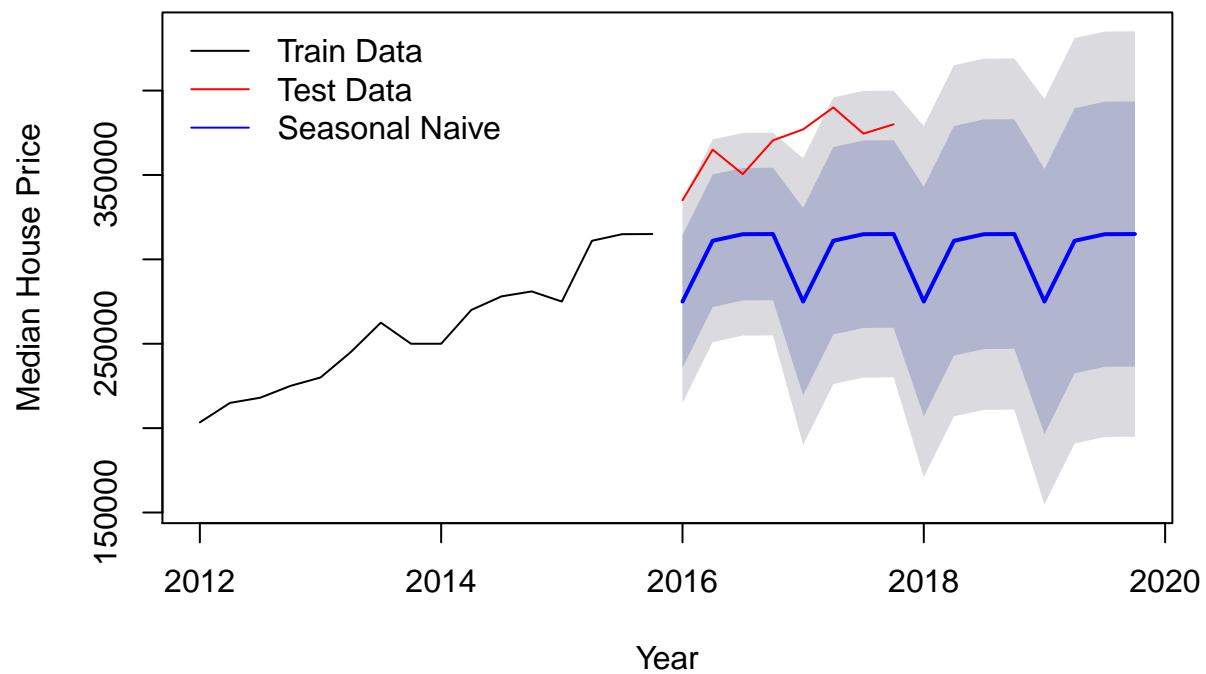
Portland, OR – Northeast Portland : Full TS Models Comparison



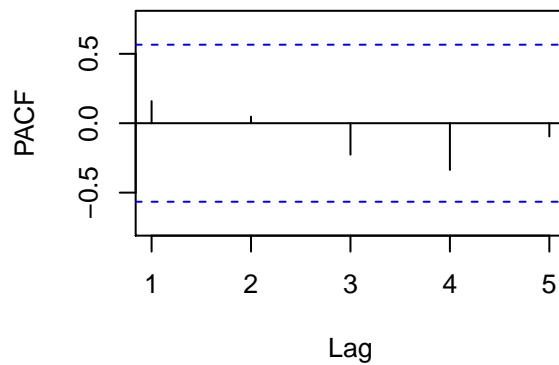
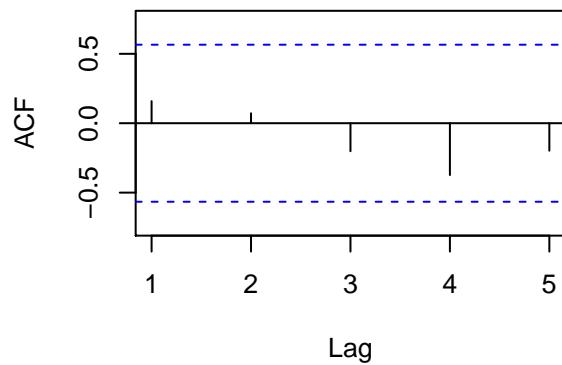
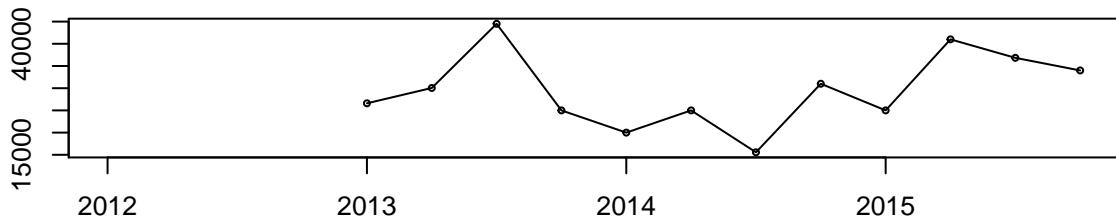
Portland, OR – North Portland



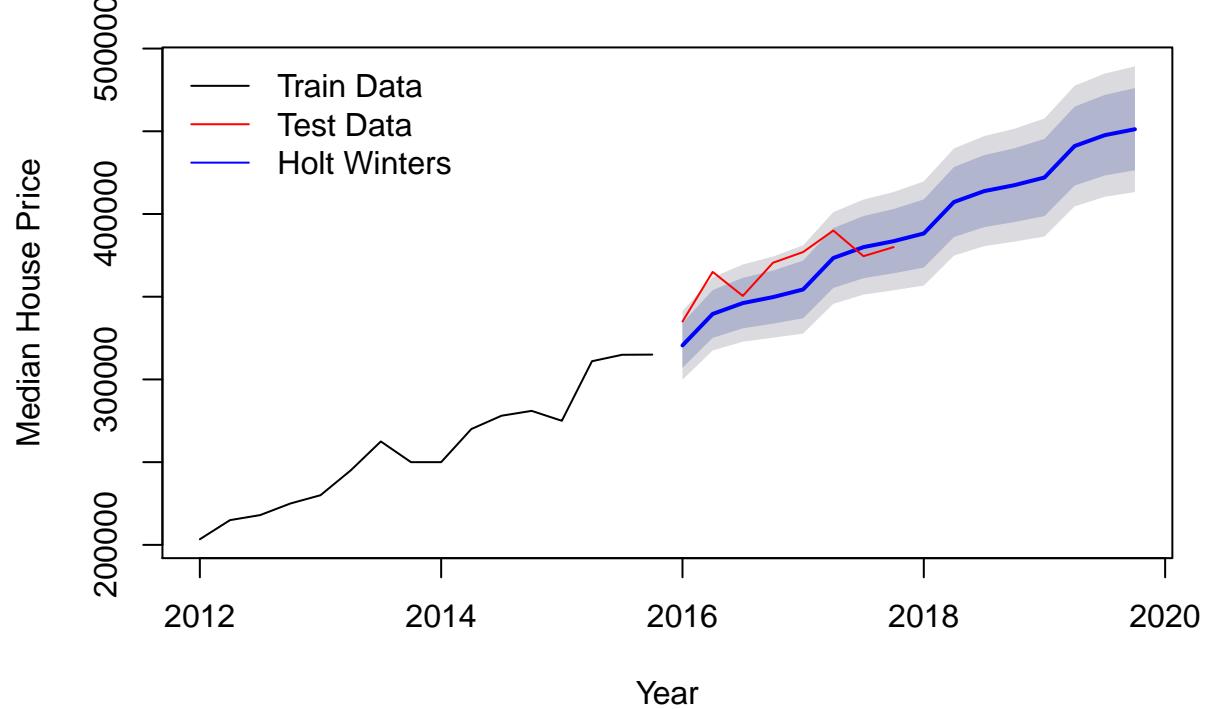
Portland, OR – North Portland : Naive Model Forecast



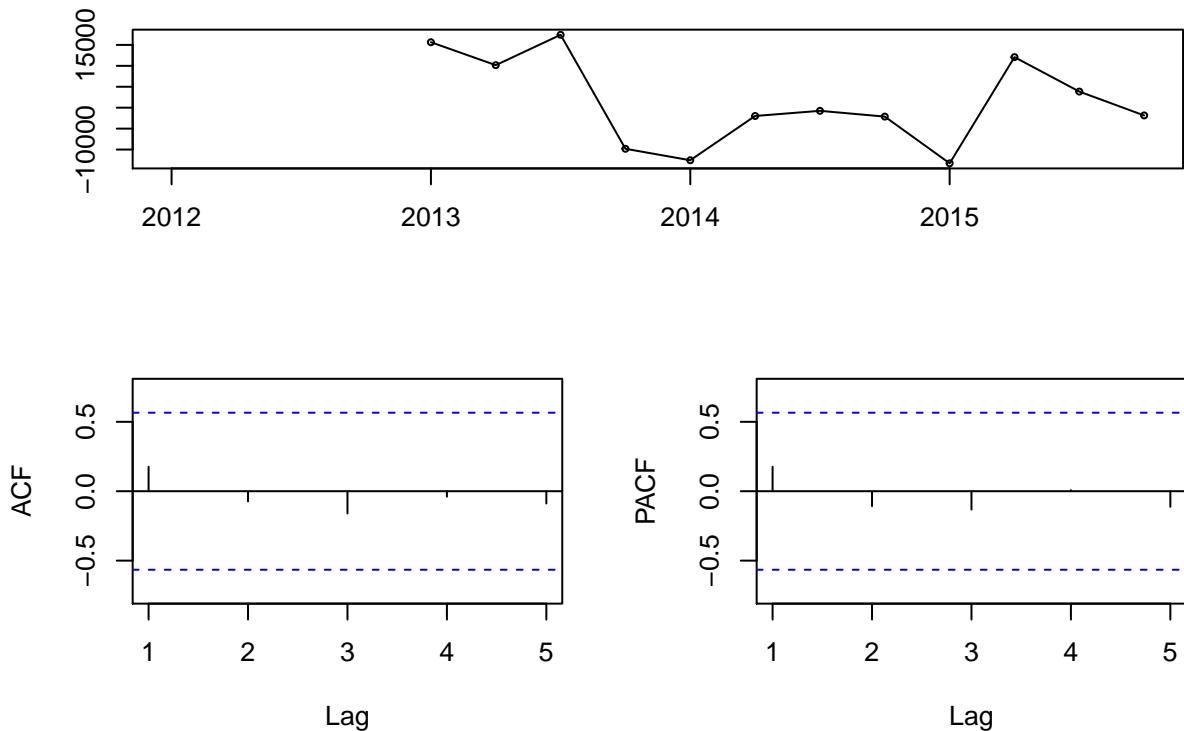
Portland, OR – North Portland : Naive Model Forecast Residuals



Portland, OR – North Portland : Holt Winters Model Forecast



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

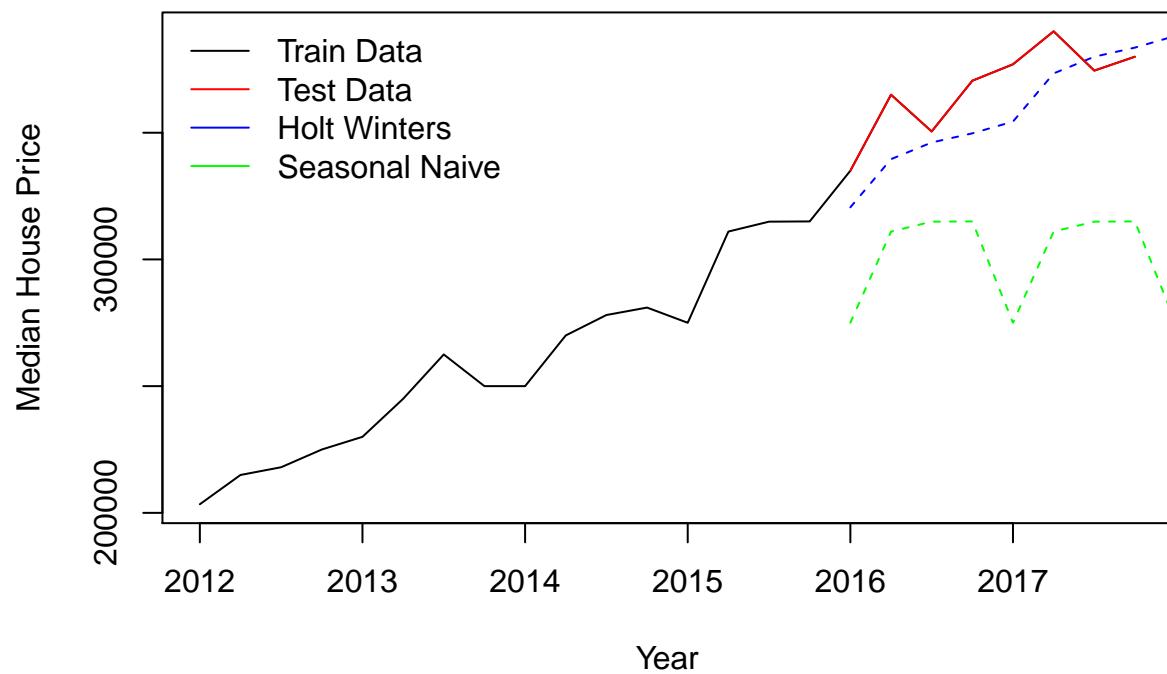


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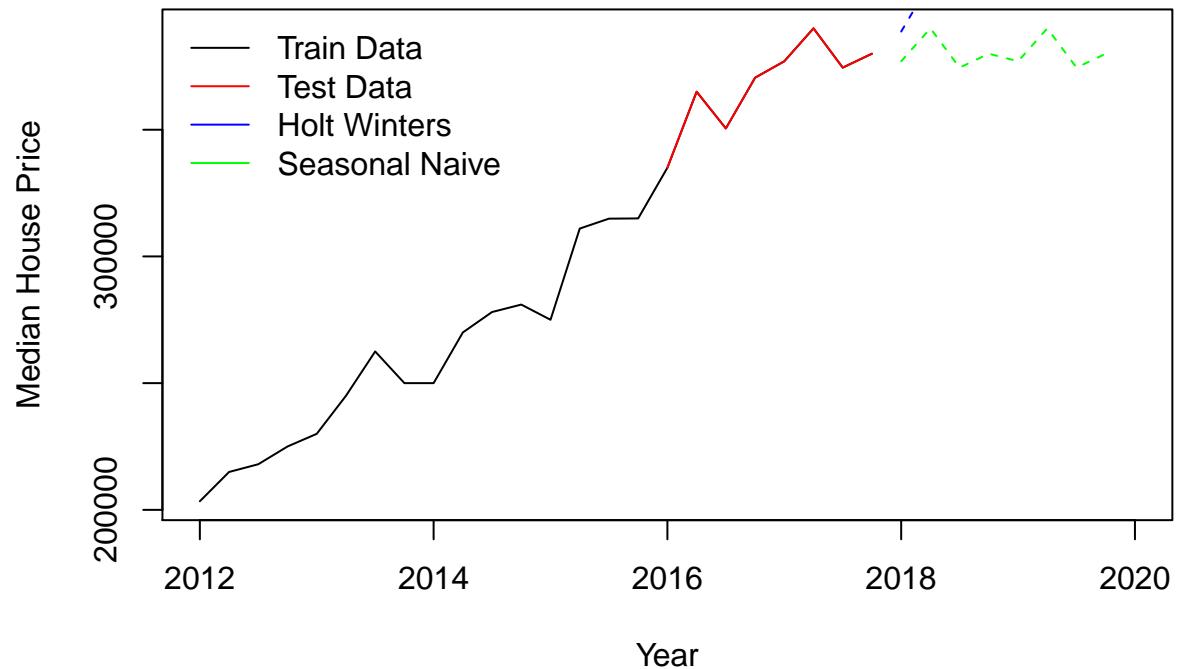
## [1] "Seasonal Naive Accuracy for Portland, OR - North Portland"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 29545.83 30636.31 29545.83 10.78641 10.78641 1.00000
## Test set     63839.38 66414.83 63839.38 17.27213 17.27213 2.16069
##          ACF1 Theil's U
## Training set 0.1592492      NA
## Test set     0.2766297 3.804585
## [1] "Holt Winters Accuracy for Portland, OR - North Portland"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 1398.328 10225.49 8459.052 0.5467598 3.234602 0.2863027
## Test set     11891.586 16336.41 14157.709 3.2463633 3.848008 0.4791779
##          ACF1 Theil's U
## Training set 0.1764338      NA
## Test set     0.1974272 0.975442

```

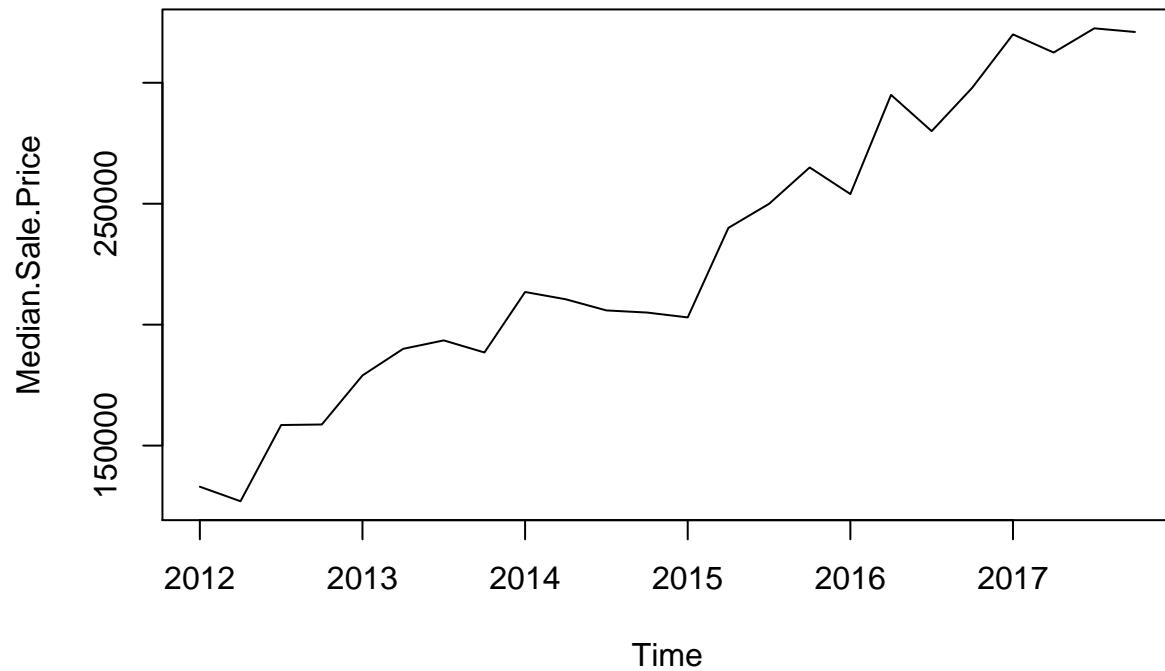
Portland, OR – North Portland : TS Training Model Comparison



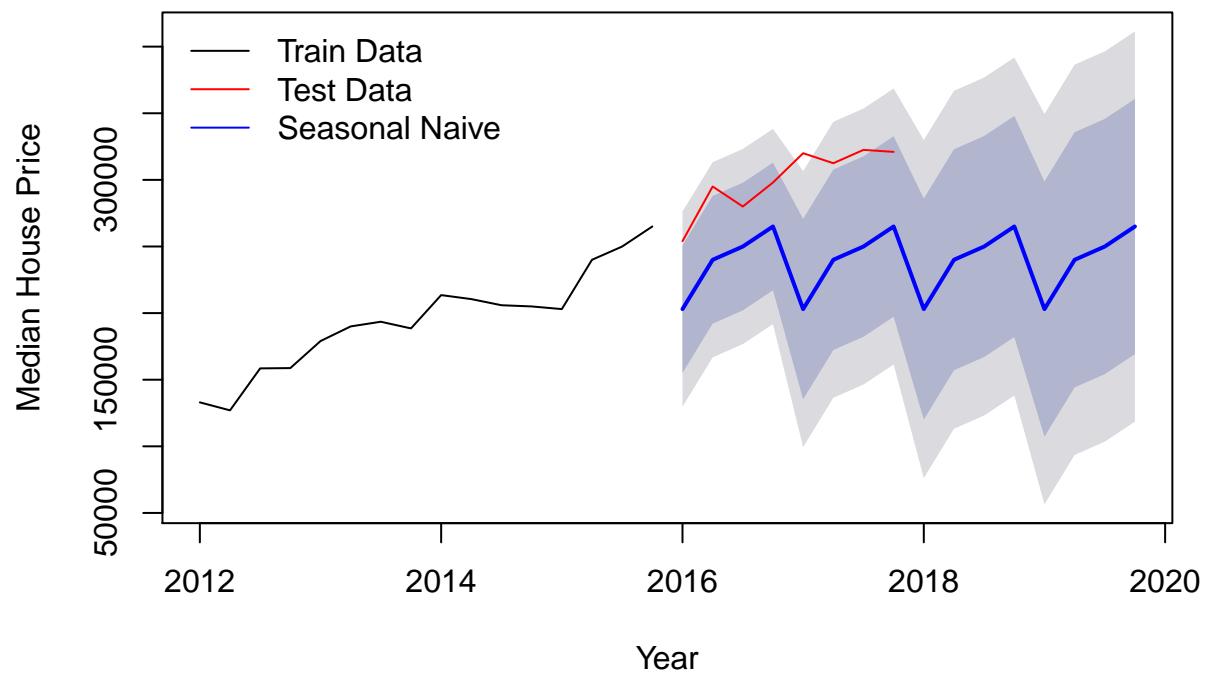
Portland, OR – North Portland : Full TS Models Comparison



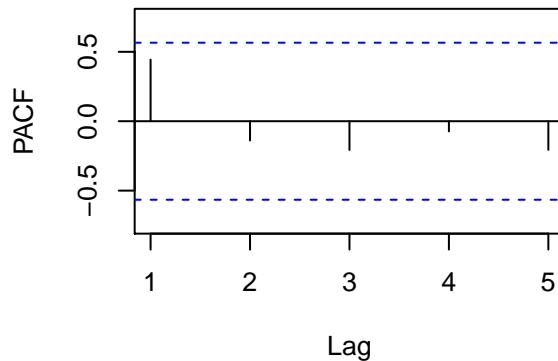
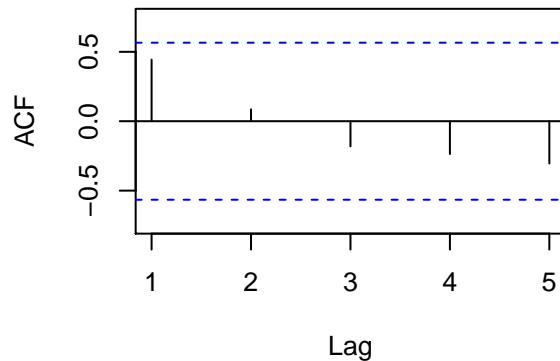
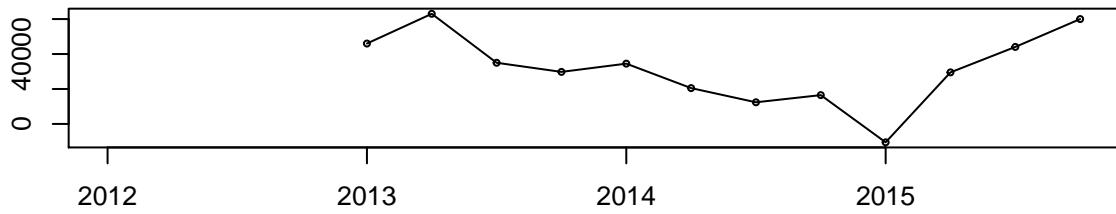
Portland, OR – Brentwood–Darlington



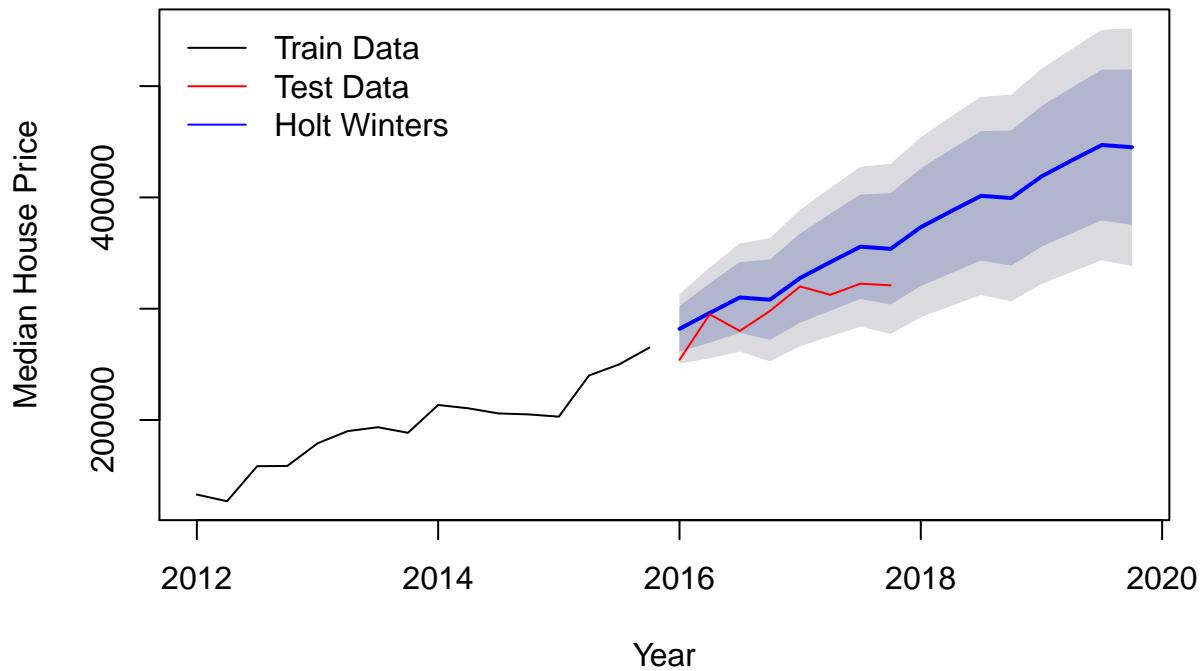
Portland, OR – Brentwood–Darlington : Naive Model Forecast



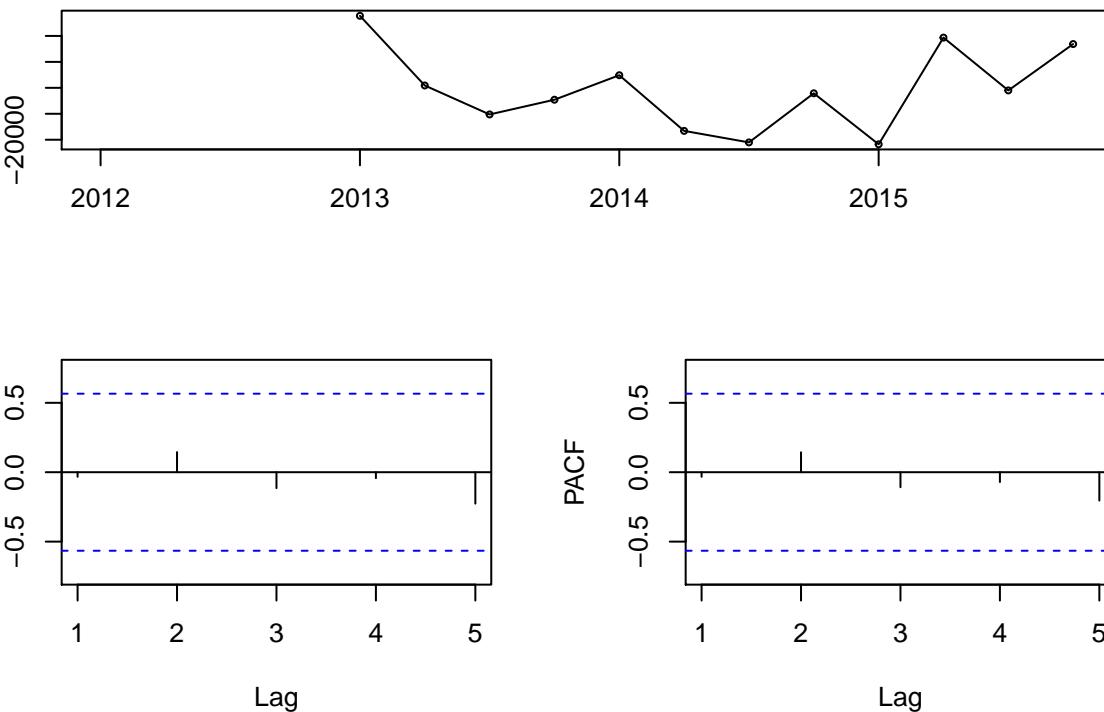
Portland, OR – Brentwood–Darlington : Naive Model Forecast Residuals



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

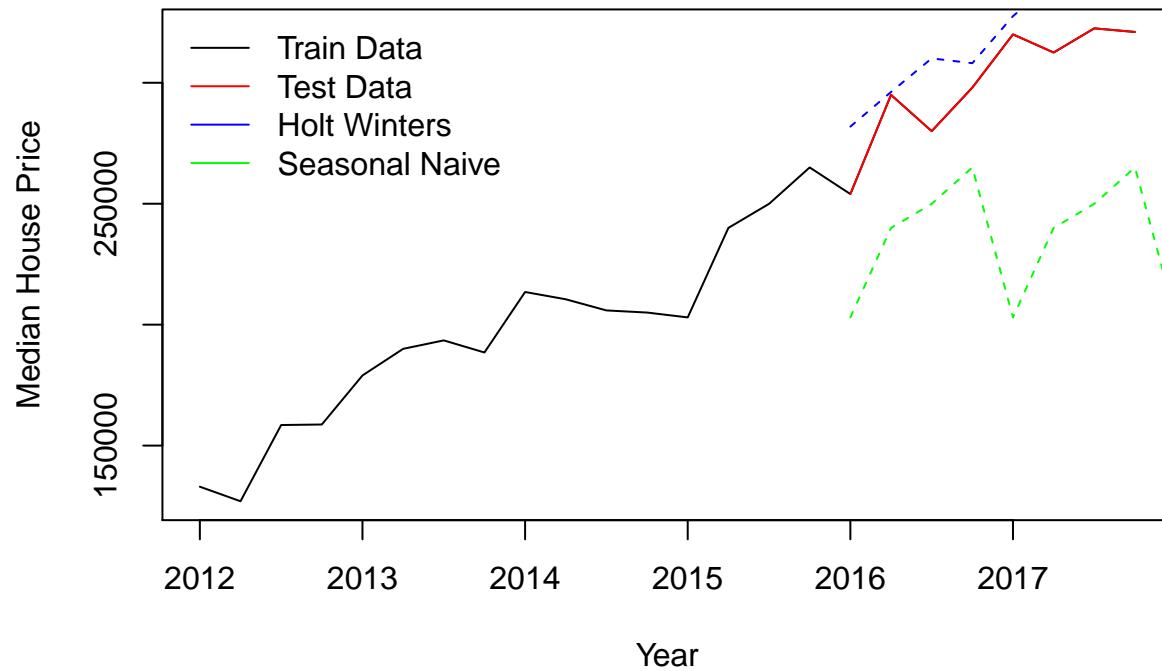


Portland, OR – Brentwood–Darlington : Holt Winters Model Forecast Residuals

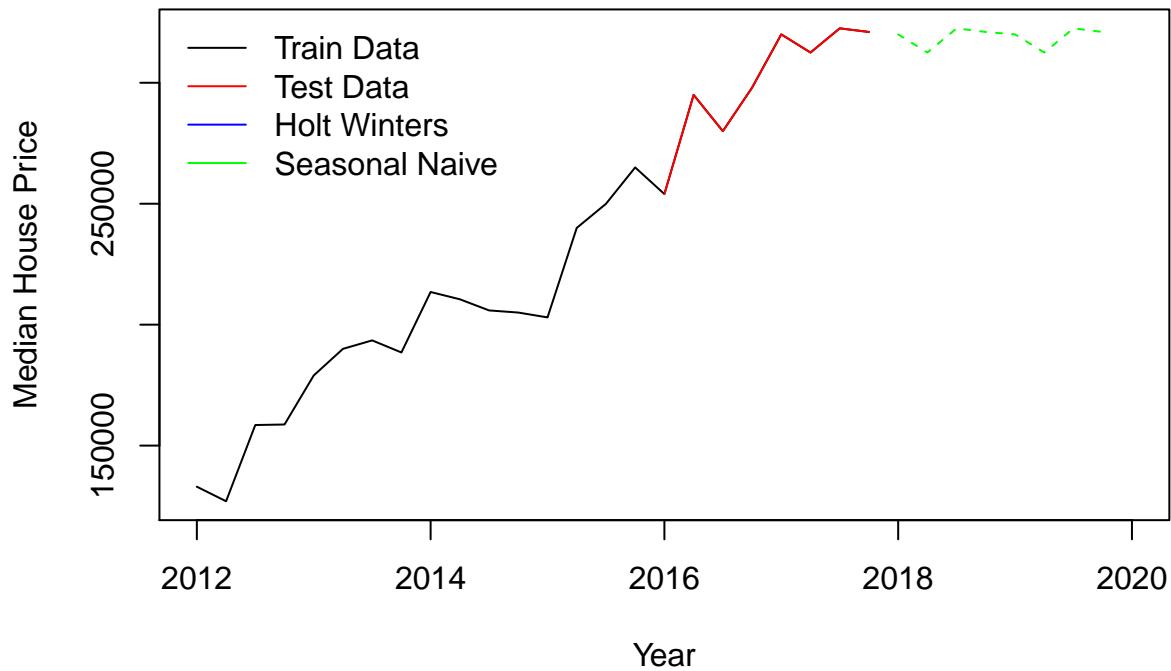


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Brentwood-Darlington"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 31727.08 37365.98 33477.08 15.00772 15.86979 1.000000
## Test set     60887.50 66108.58 60887.50 20.02911 20.02911 1.818782
##          ACF1 Theil's U
## Training set 0.44394597      NA
## Test set     0.04994833 3.009671
## [1] "Holt Winters Accuracy for Portland, OR - Brentwood-Darlington"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -625.251 15213.13 12255.67 -0.4374576 5.888336 0.3660912
## Test set     -21519.501 24705.52 21519.50 -7.2221640 7.222164 0.6428129
##          ACF1 Theil's U
## Training set -0.03319707      NA
## Test set     -0.10785596 1.032136
```

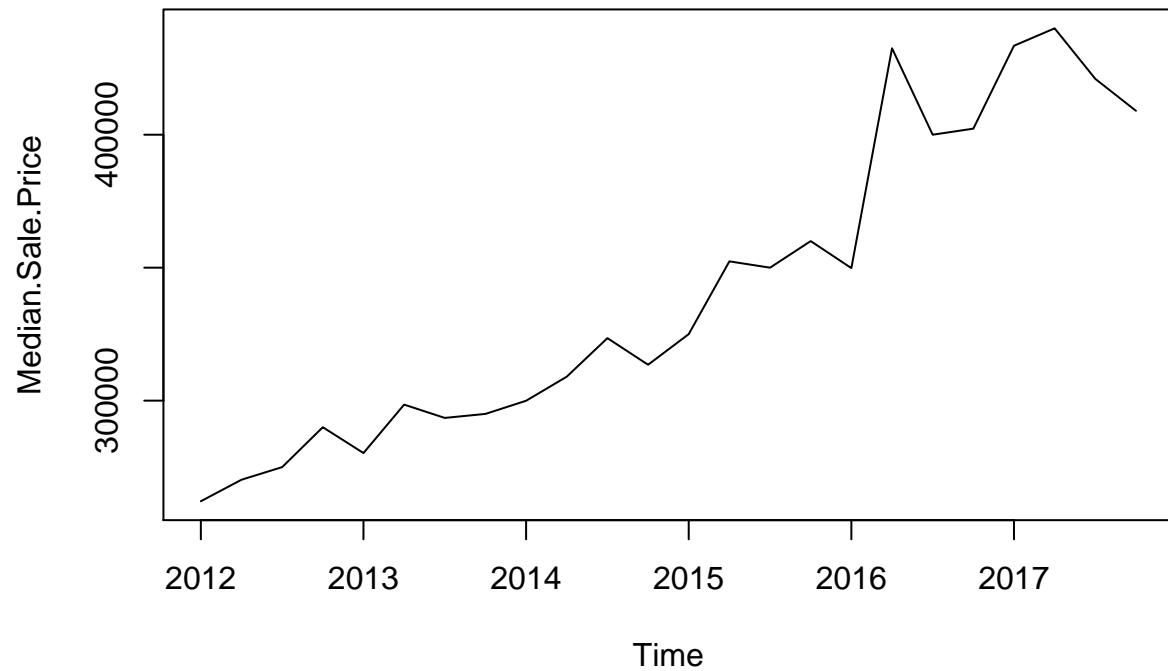
Portland, OR – Brentwood–Darlington : TS Training Model Comparison



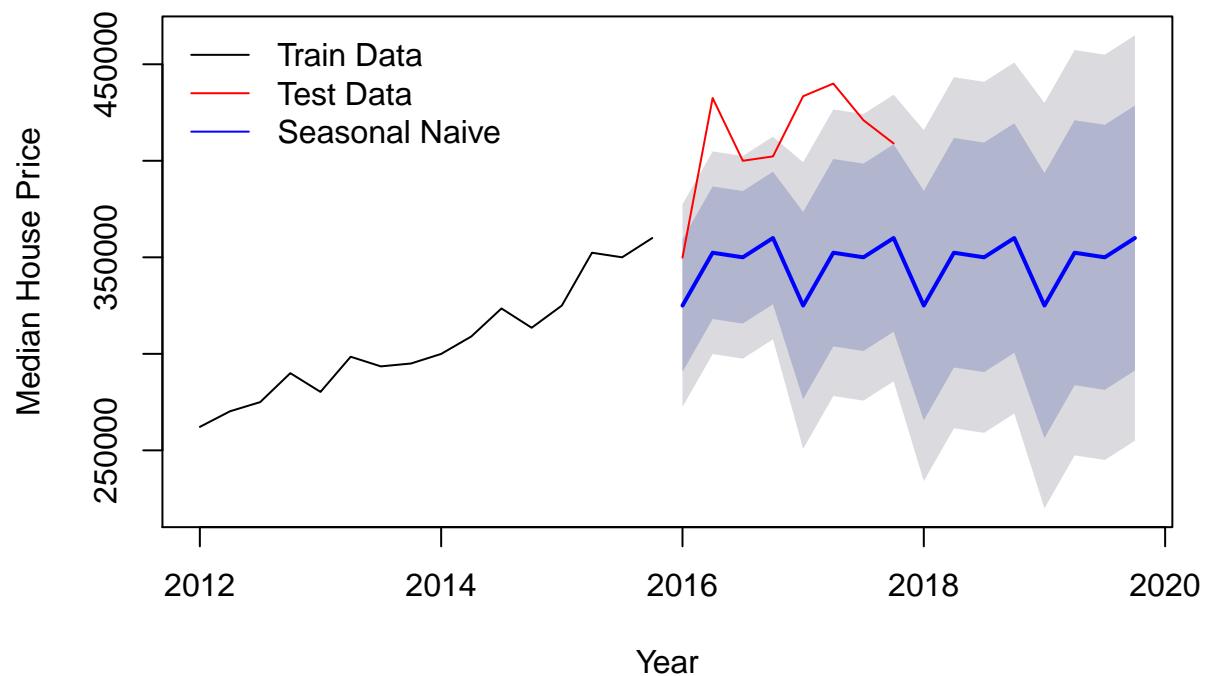
Portland, OR – Brentwood–Darlington : Full TS Models Comparisor



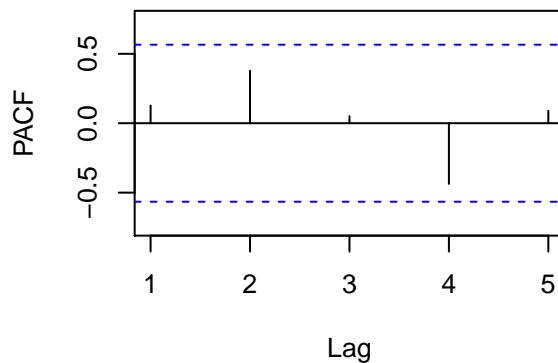
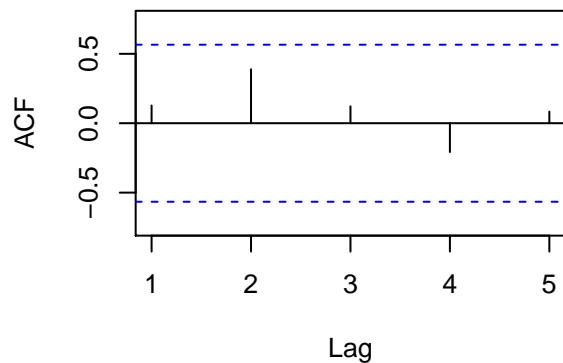
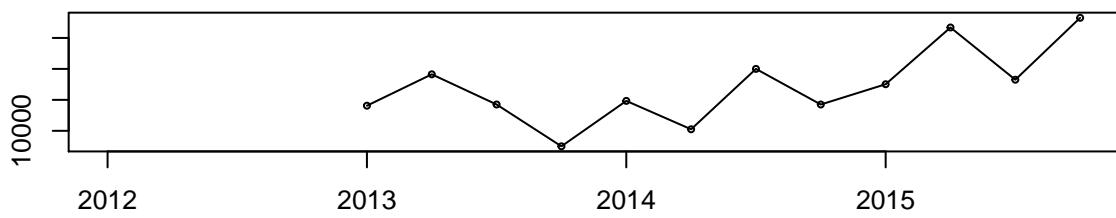
Portland, OR – Central Northeast Portland



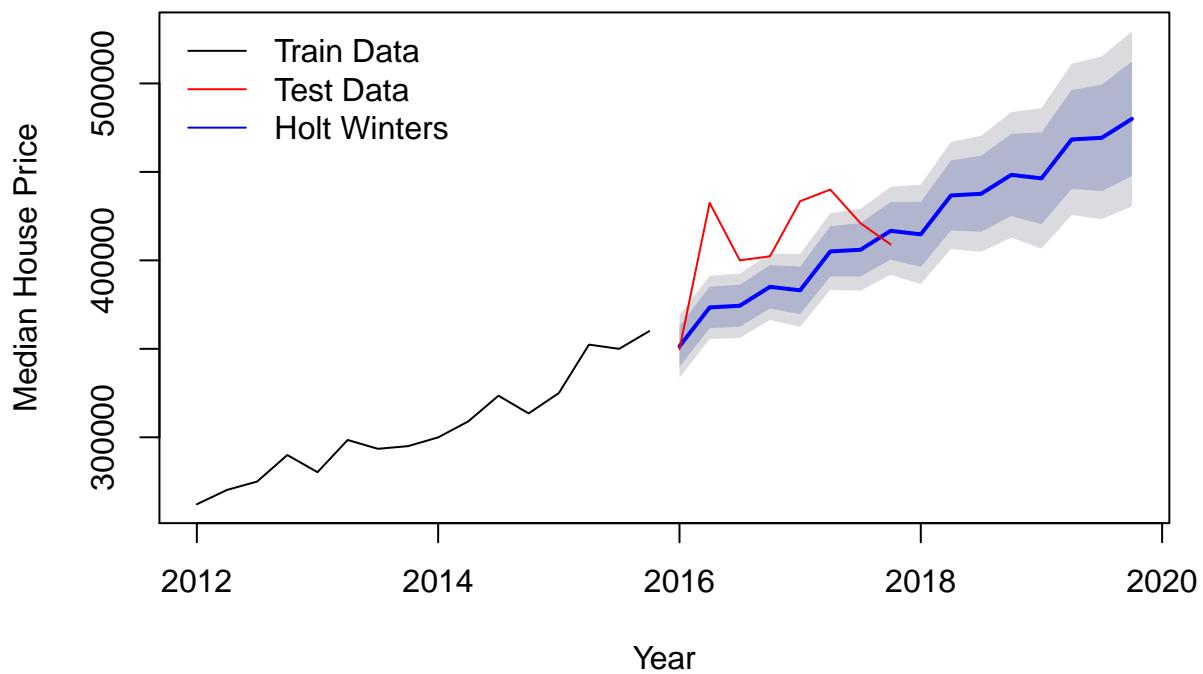
Portland, OR – Central Northeast Portland : Naive Model Forecast



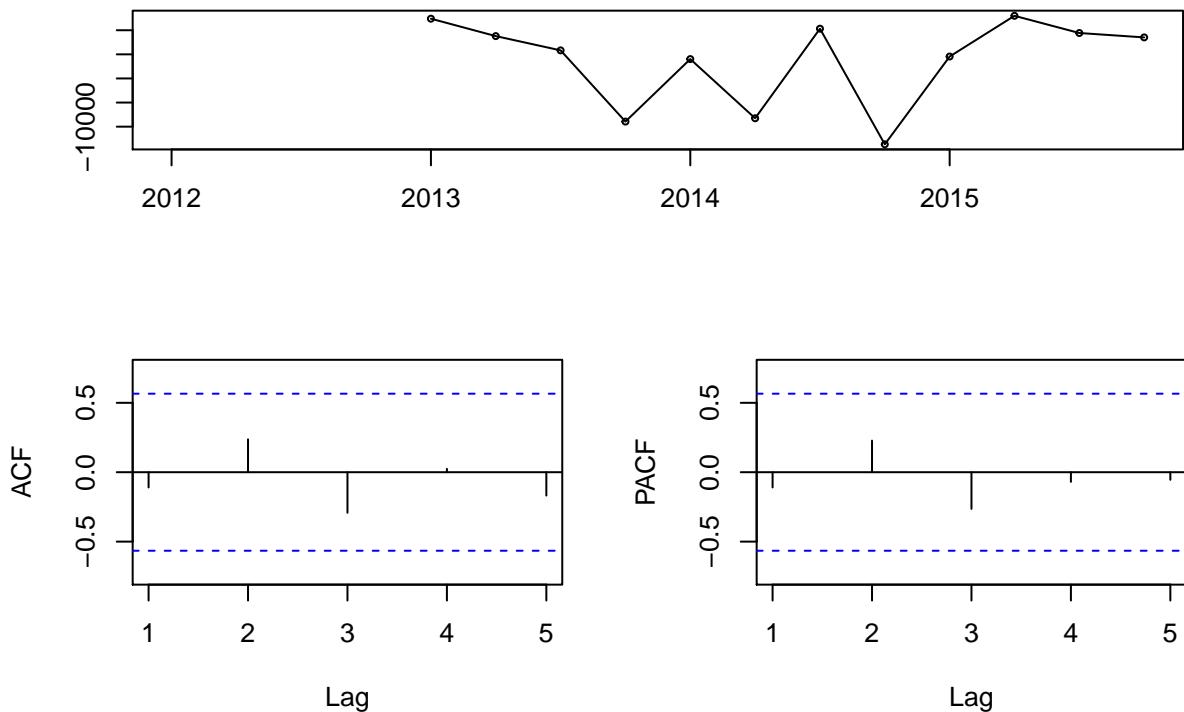
Portland, OR – Central Northeast Portland : Naive Model Forecast Residuals



Portland, OR – Central Northeast Portland : Holt Winters Model Forec



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

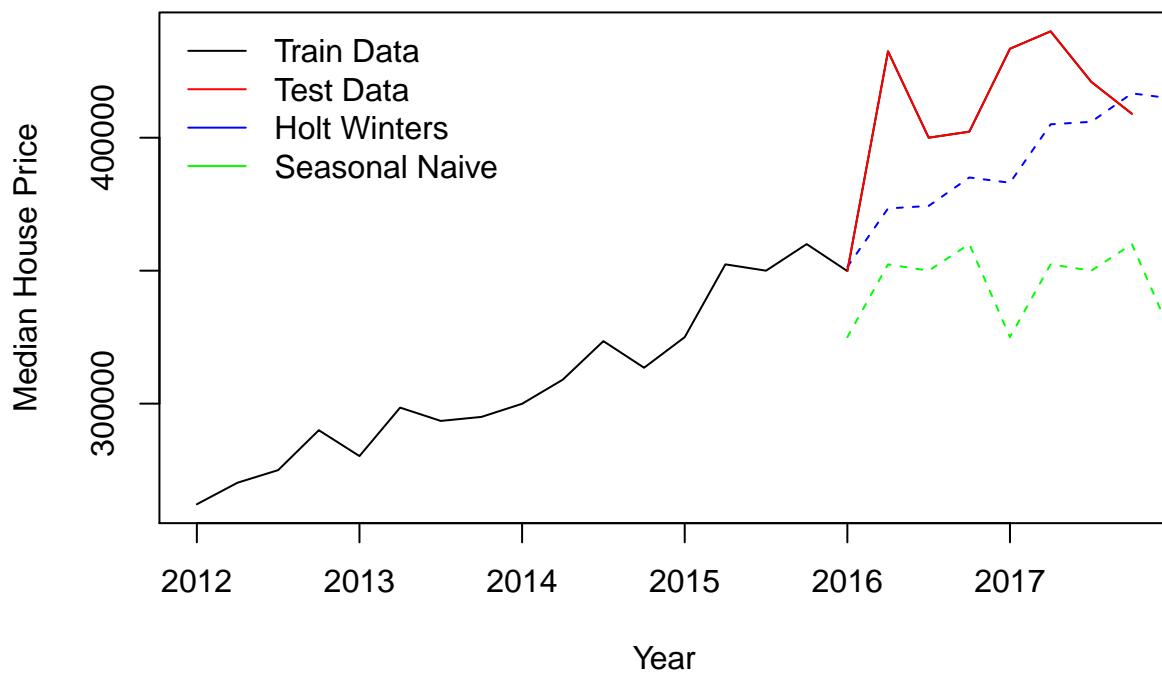


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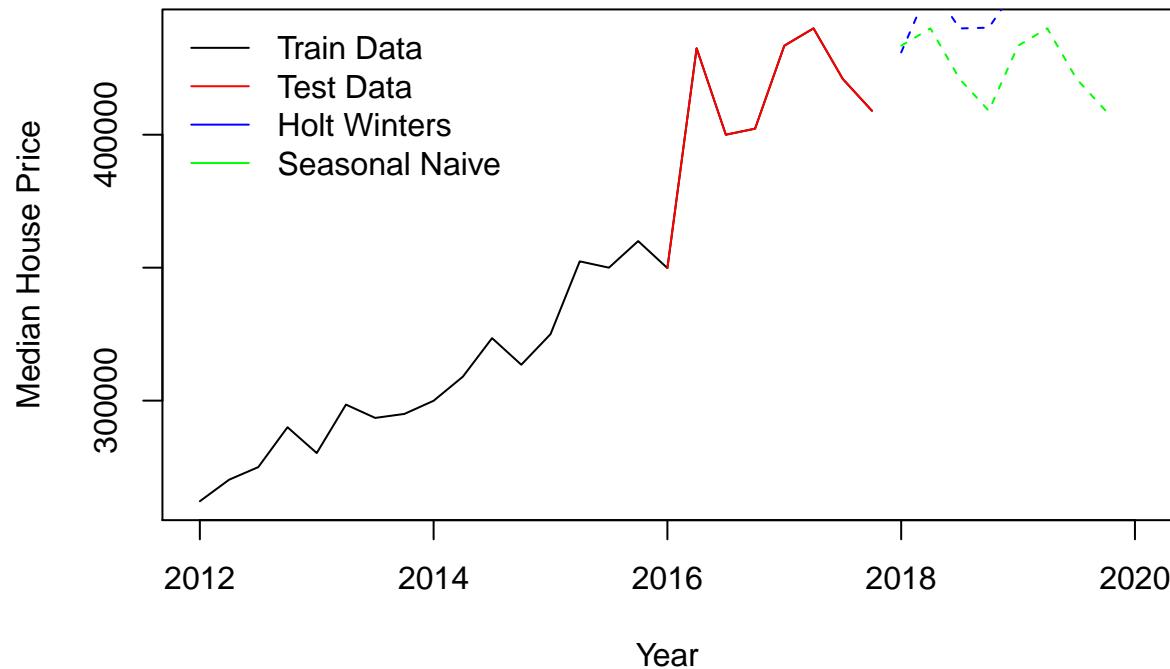
## [1] "Seasonal Naive Accuracy for Portland, OR - Central Northeast Portland"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 24163.33 26780.37 24163.33 7.463412 7.463412 1.000000
## Test set     64164.38 69106.58 64164.38 15.301924 15.301924 2.655444
##          ACF1 Theil's U
## Training set 0.12785761      NA
## Test set     -0.07920915 1.807746
## [1] "Holt Winters Accuracy for Portland, OR - Central Northeast Portland"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 3829.967 9457.779 8975.218 1.163495 2.840946 0.3714396
## Test set     24132.741 32585.535 26449.992 5.645362 6.228271 1.0946334
##          ACF1 Theil's U
## Training set -0.1097420      NA
## Test set     -0.1465218 0.9043749

```

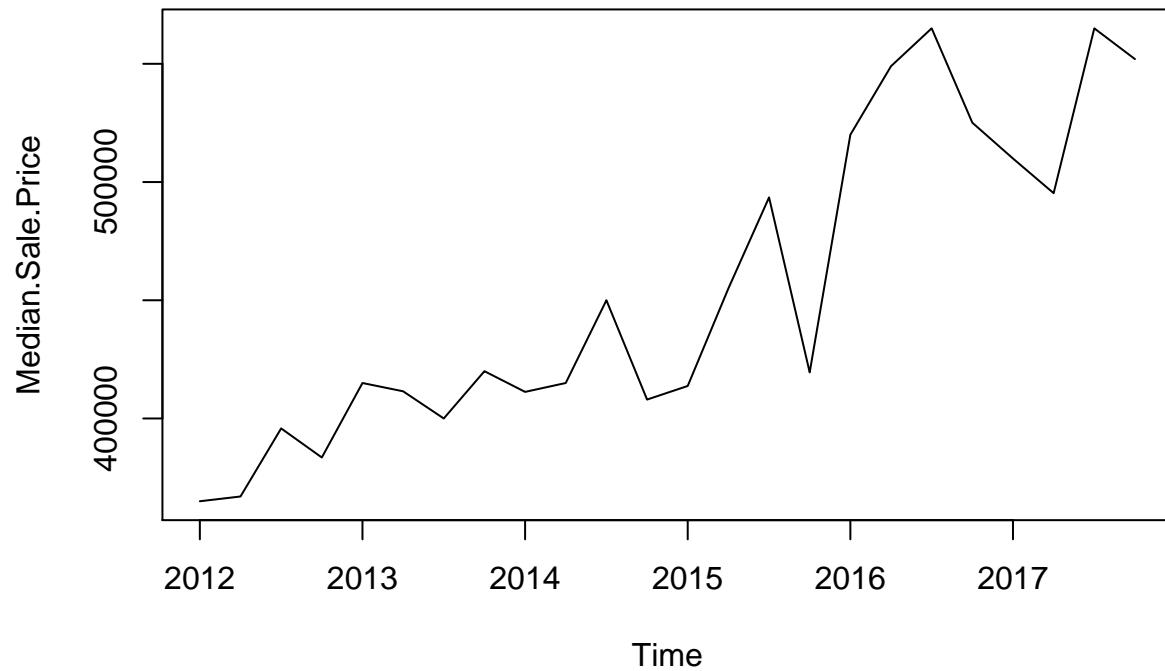
Portland, OR – Central Northeast Portland : TS Training Model Compar



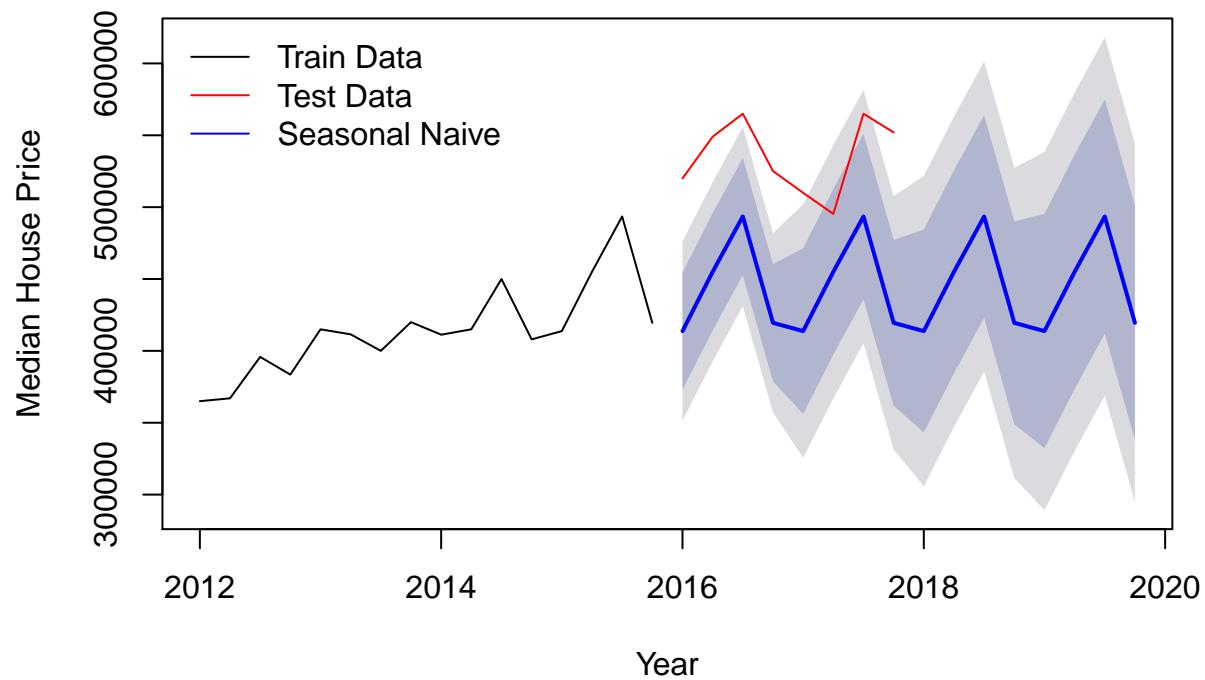
Portland, OR – Central Northeast Portland : Full TS Models Comparis



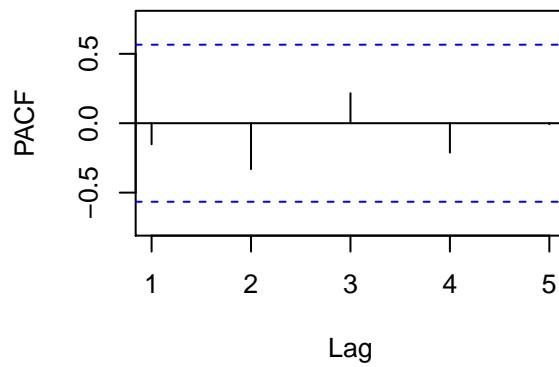
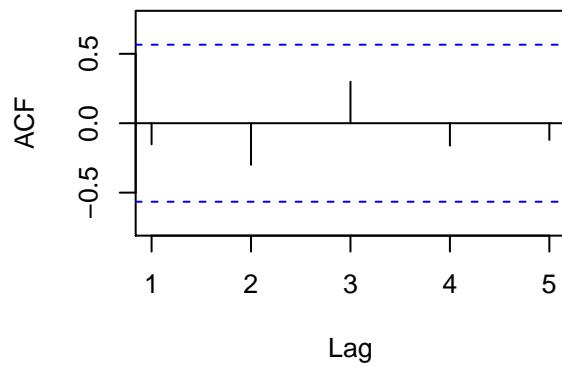
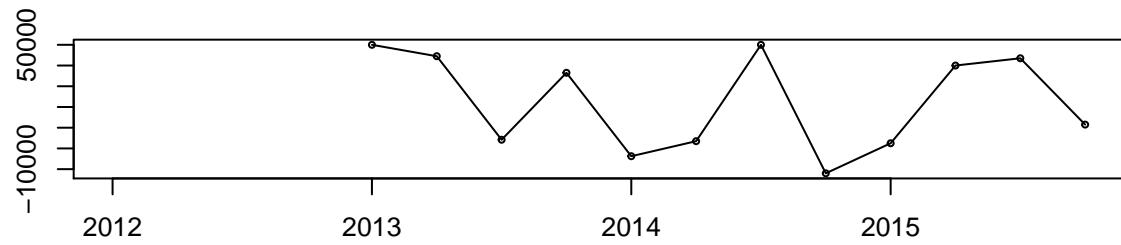
Portland, OR – Neighbors West–Northwest



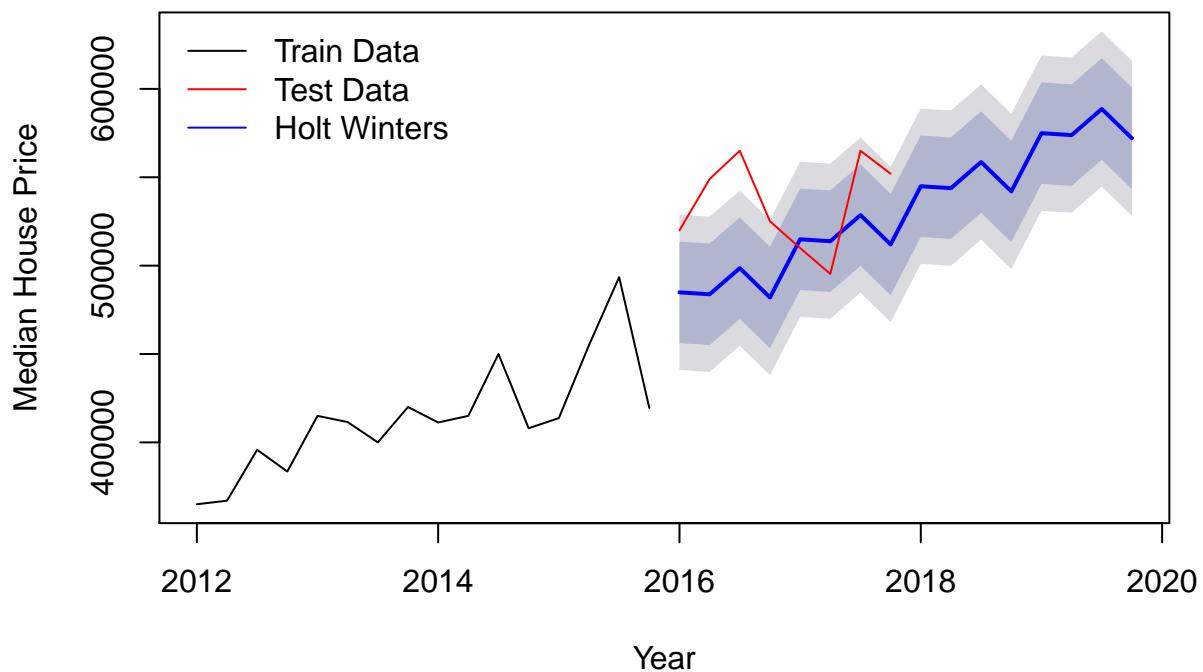
Portland, OR – Neighbors West–Northwest : Naive Model Forecast



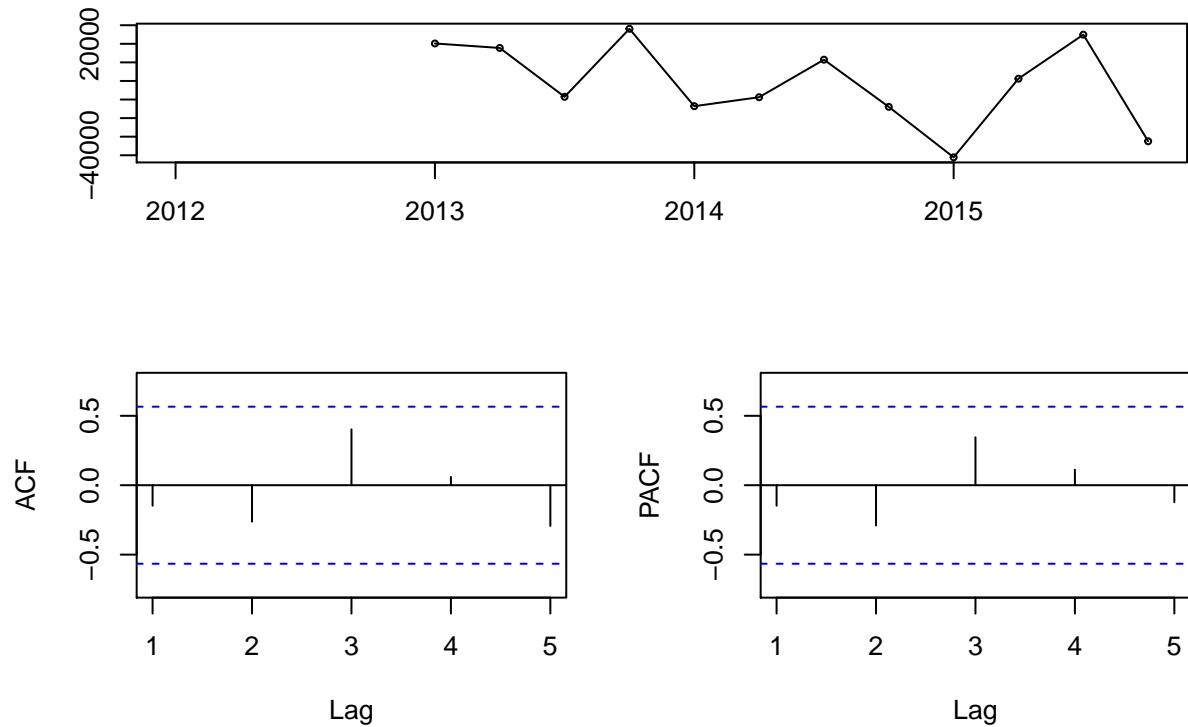
Portland, OR – Neighbors West–Northwest : Naive Model Forecast Residuals



Portland, OR – Neighbors West–Northwest : Holt Winters Model Forecast

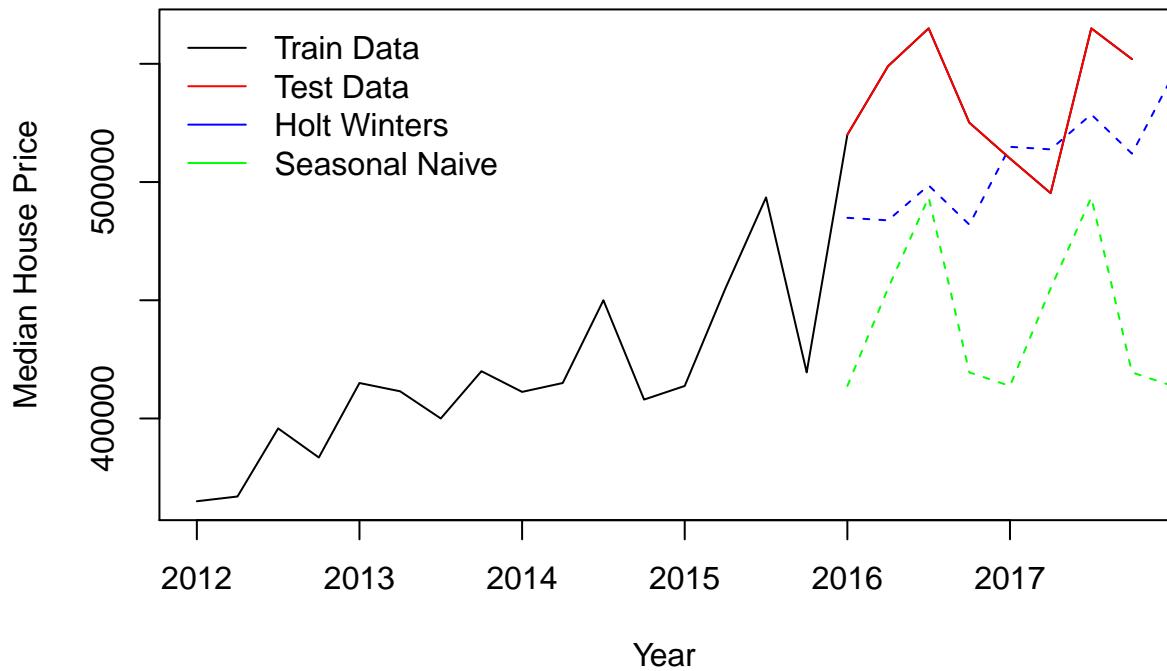


Portland, OR – Neighbors West–Northwest : Holt Winters Model Forecast Residu

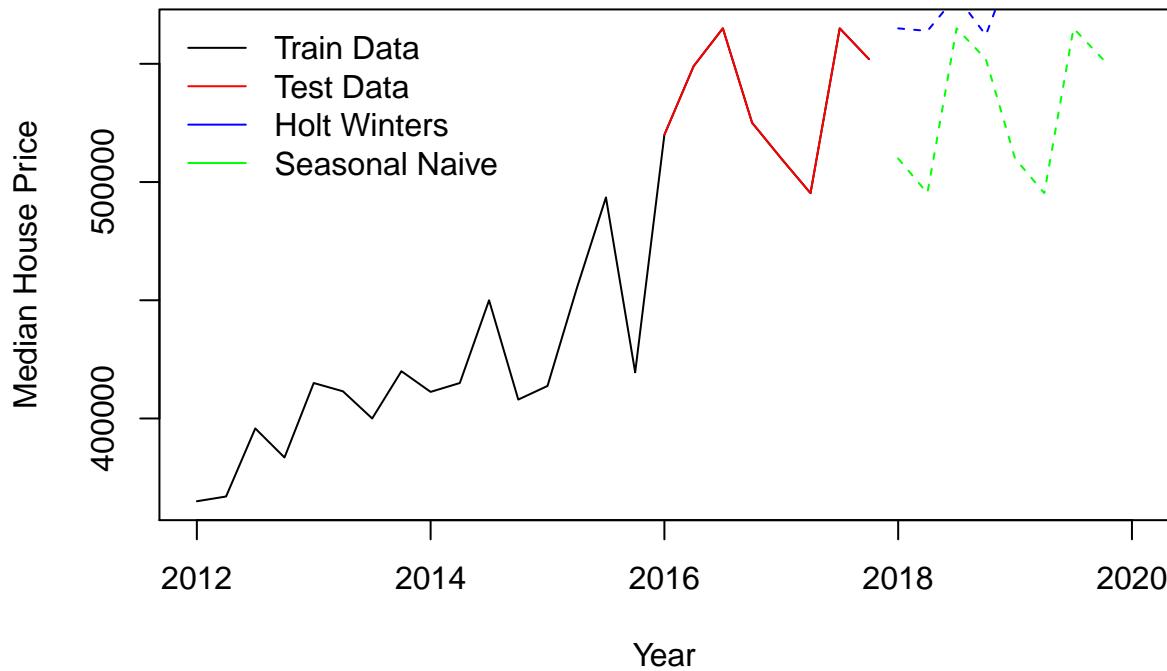


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Neighbors West-Northwest"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 22537.5 31795.18 25162.5 5.137967 5.780139 1.000000
## Test set     89731.0 93498.36 89731.0 16.747406 16.747406 3.566061
##          ACF1 Theil's U
## Training set -0.15187364    NA
## Test set     -0.07102997 2.543905
## [1] "Holt Winters Accuracy for Portland, OR - Neighbors West-Northwest"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -1228.333 21481.57 18501.25 -0.4085628 4.363981 0.7352707
## Test set     32848.500 43369.07 38714.62  5.9470433 7.124231 1.5385842
##          ACF1 Theil's U
## Training set -0.1477541    NA
## Test set     0.4522093 1.245585
```

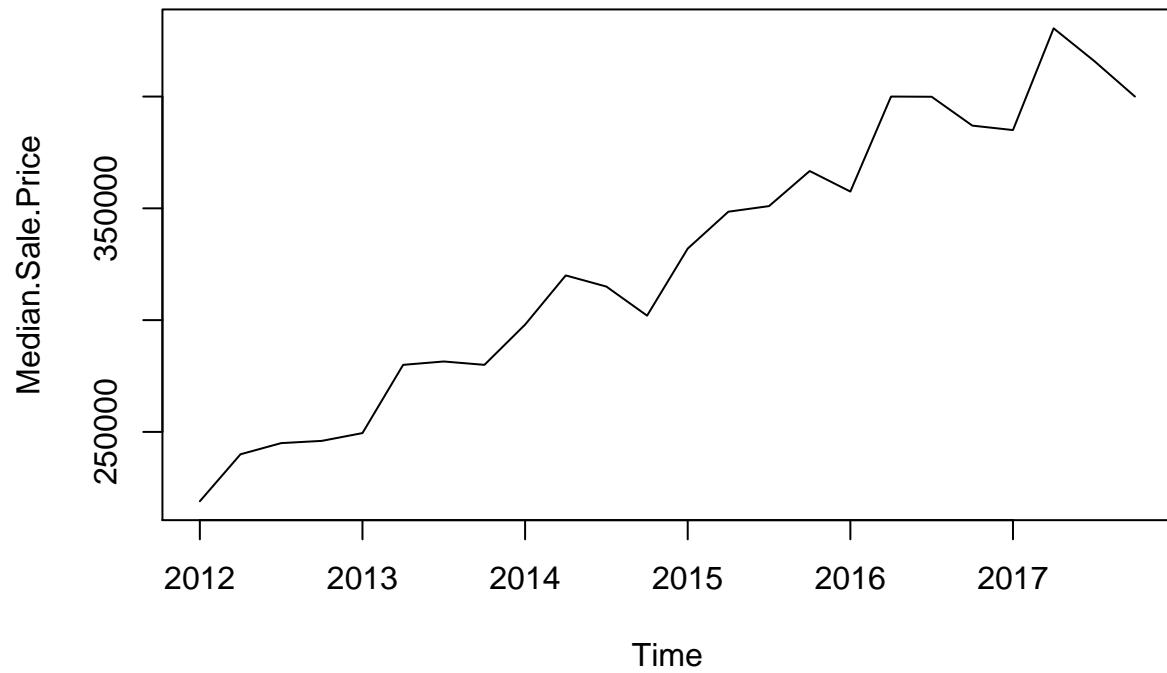
Portland, OR – Neighbors West–Northwest : TS Training Model Comparison



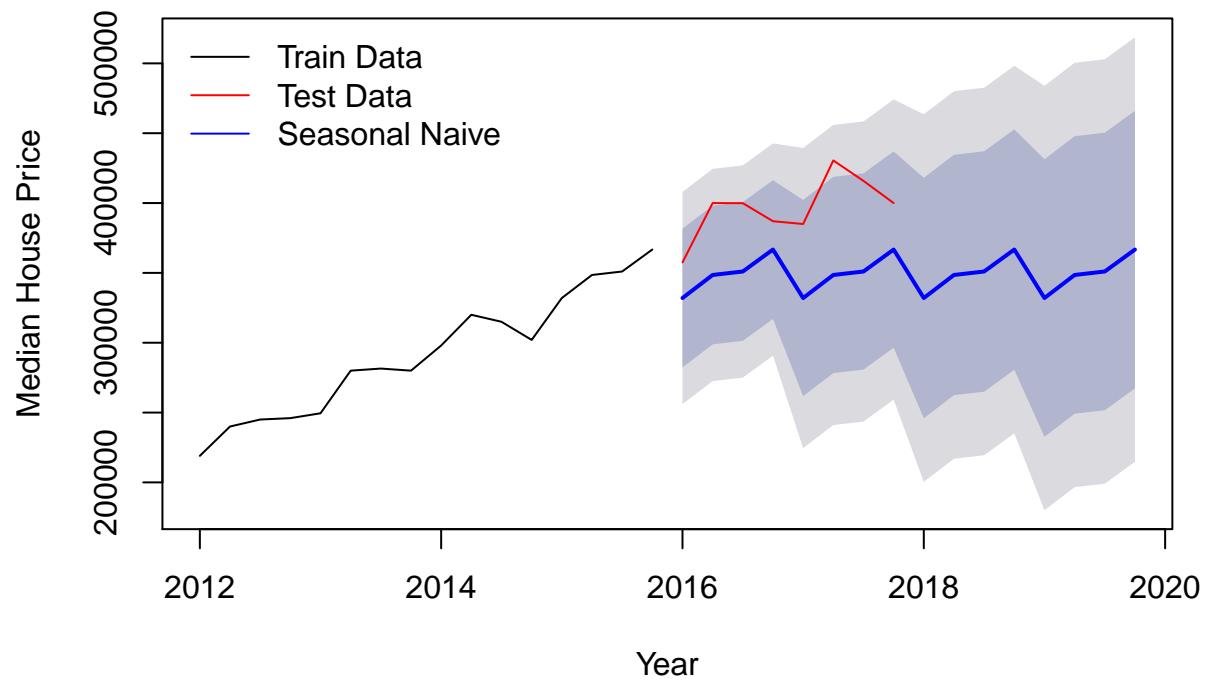
Portland, OR – Neighbors West–Northwest : Full TS Models Comparis



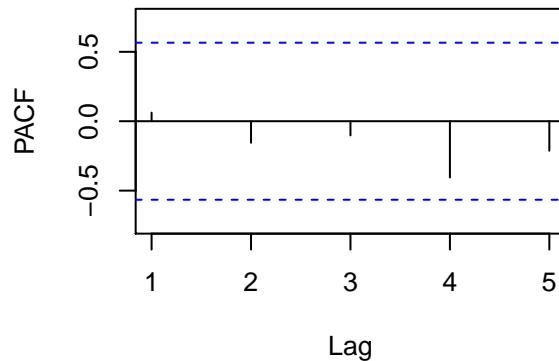
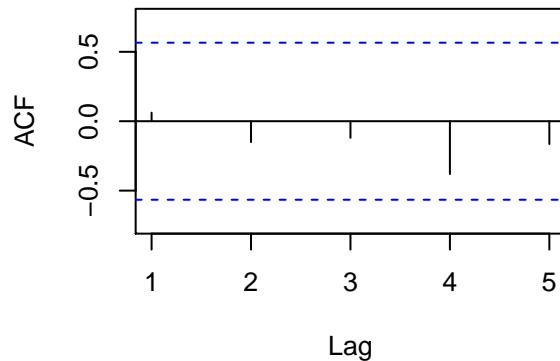
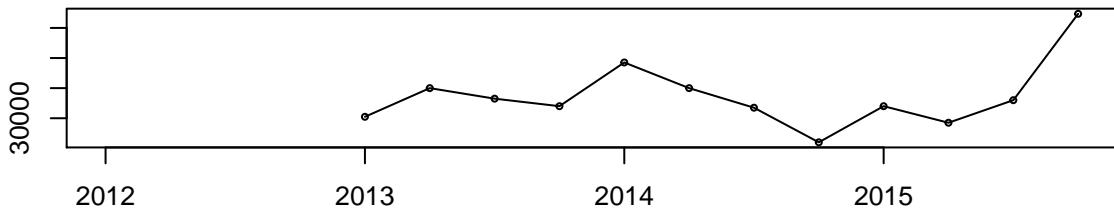
Portland, OR – Southeast Uplift



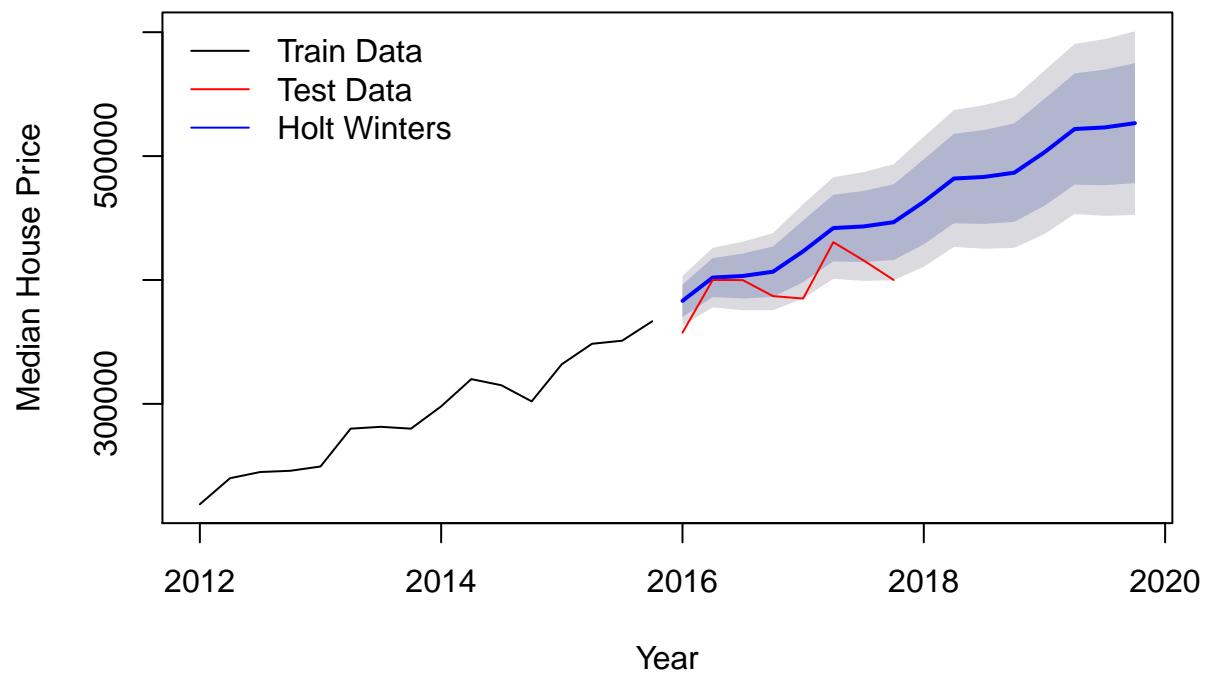
Portland, OR – Southeast Uplift : Naive Model Forecast



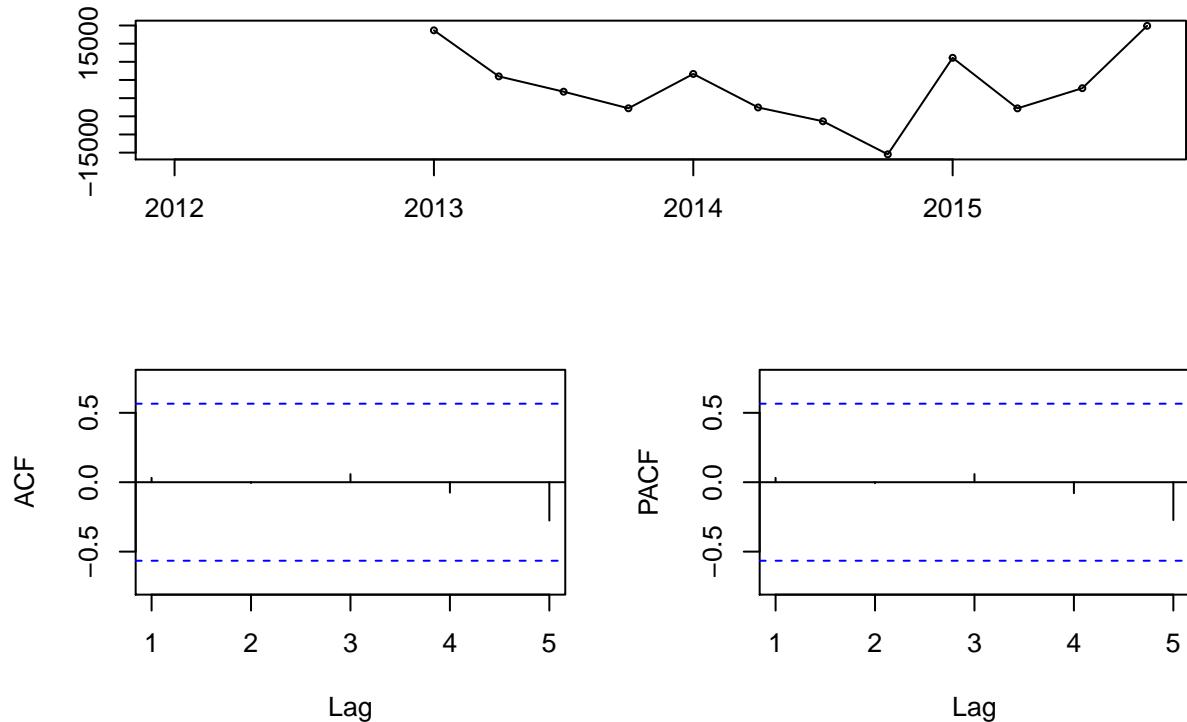
Portland, OR – Southeast Uplift : Naive Model Forecast Residuals



Portland, OR – Southeast Uplift : Holt Winters Model Forecast



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

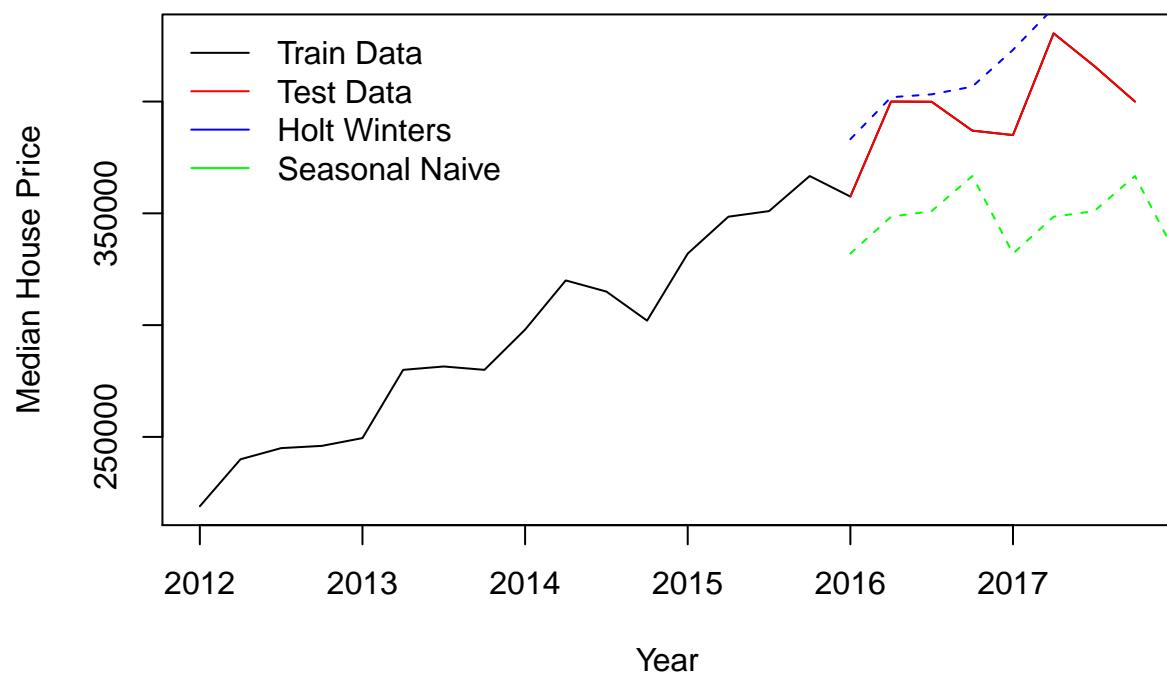


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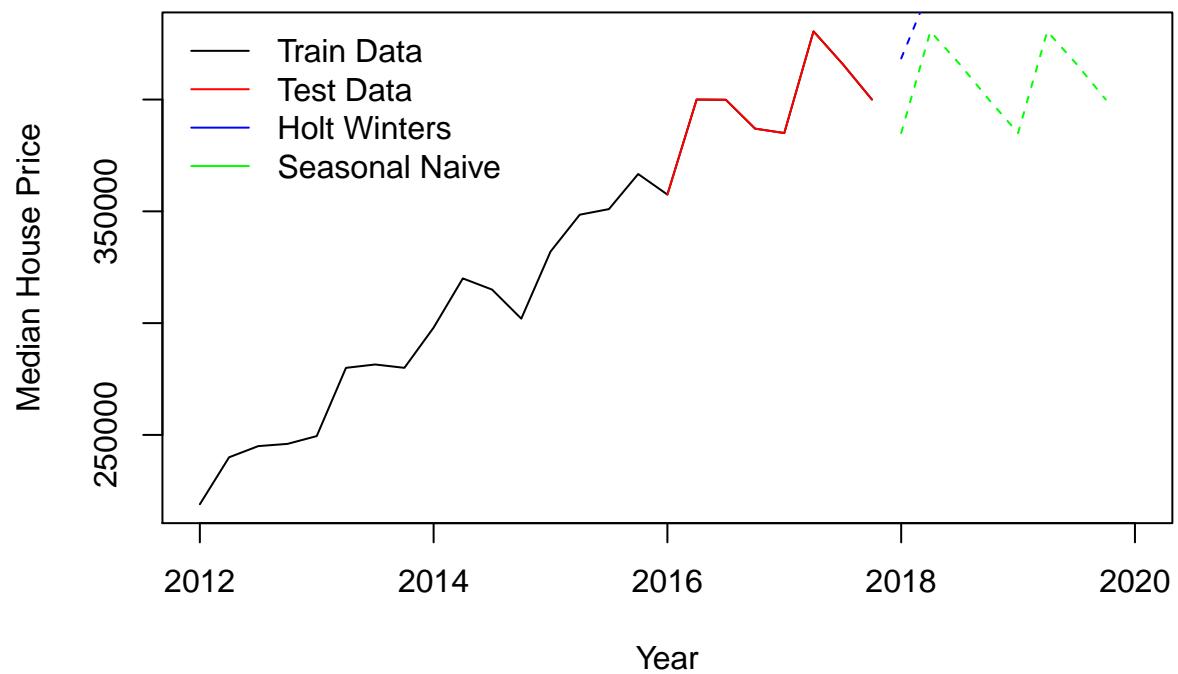
## [1] "Seasonal Naive Accuracy for Portland, OR - Southeast Uplift"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 37349.83 38759.93 37349.83 12.05270 12.05270 1.000000
## Test set     47421.12 51180.29 47421.12 11.77736 11.77736 1.269648
##          ACF1 Theil's U
## Training set 0.06176364      NA
## Test set     0.09274951 2.034293
## [1] "Holt Winters Accuracy for Portland, OR - Southeast Uplift"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 3070.835 10251.29 8071.56 1.024673 2.649446 0.2161070
## Test set     -21758.925 26376.28 21758.93 -5.544316 5.544316 0.5825709
##          ACF1 Theil's U
## Training set 0.03164607      NA
## Test set     0.11474354 0.9668875

```

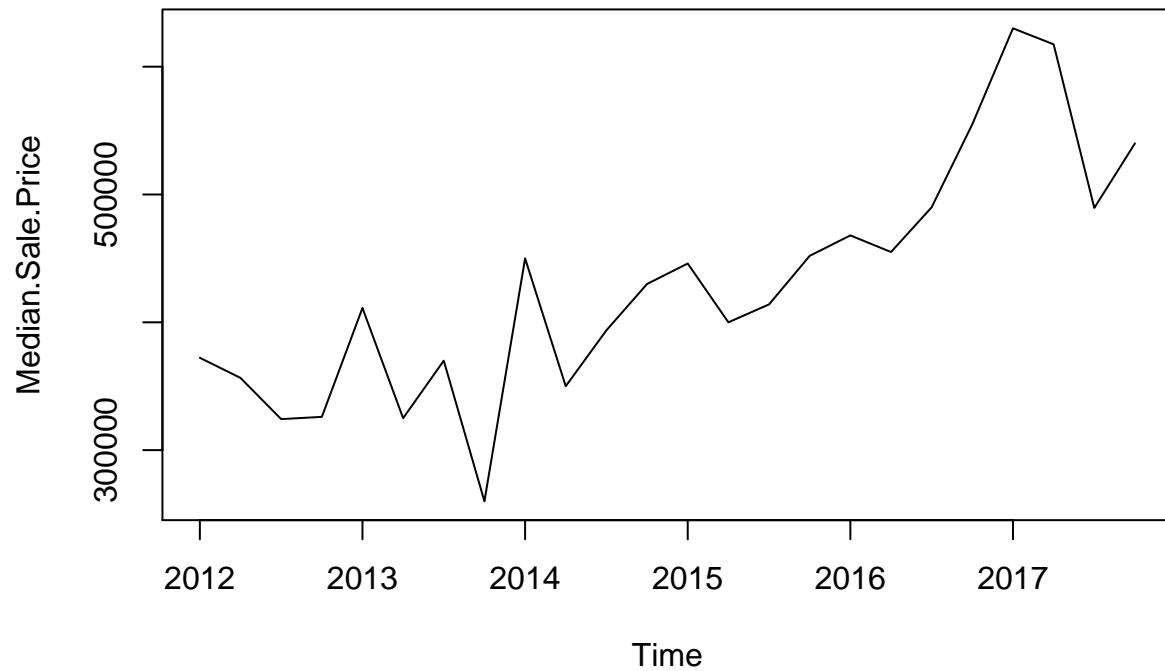
Portland, OR – Southeast Uplift : TS Training Model Comparison



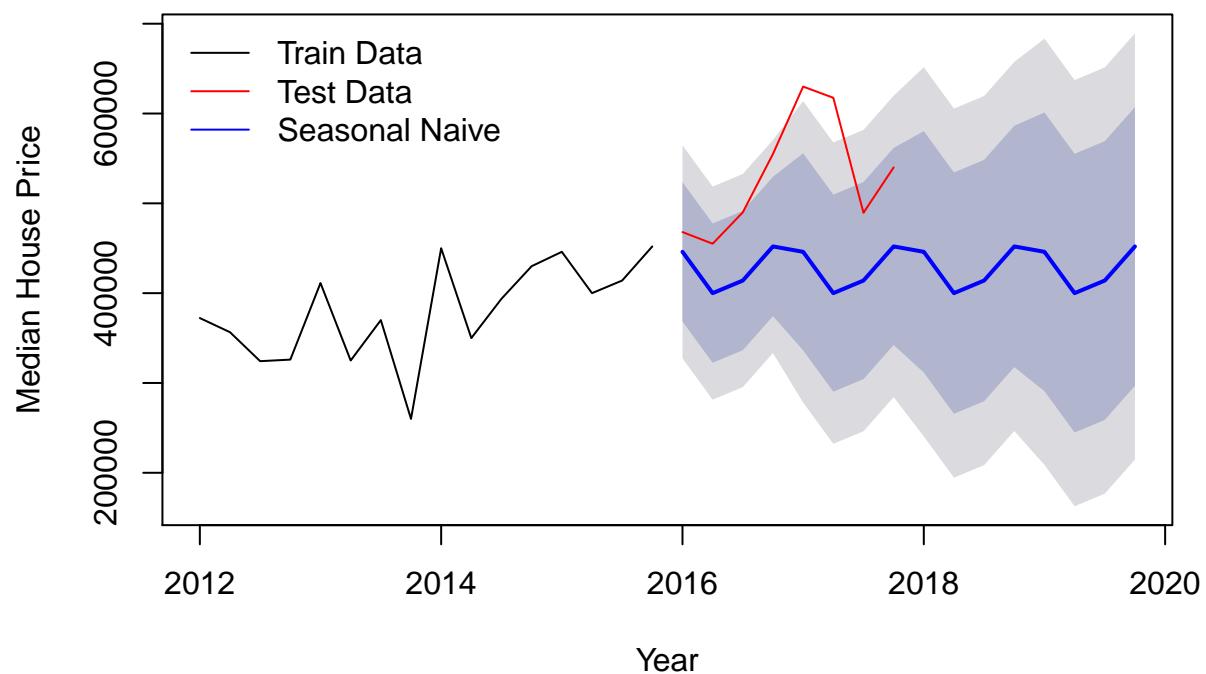
Portland, OR – Southeast Uplift : Full TS Models Comparison



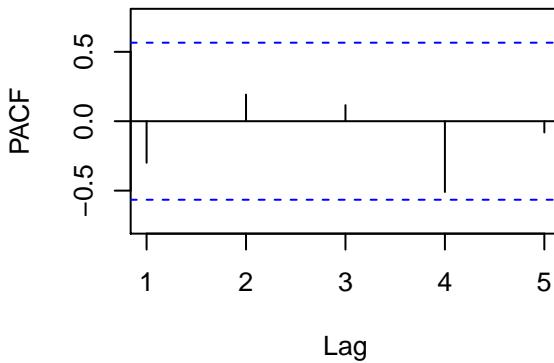
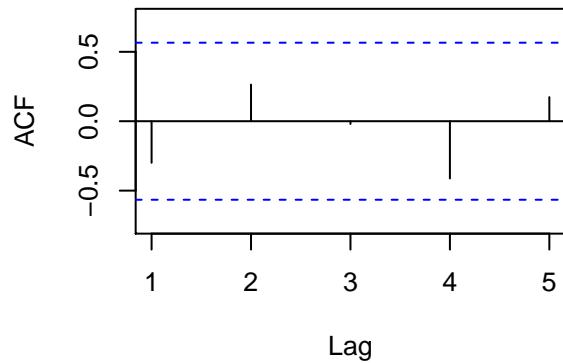
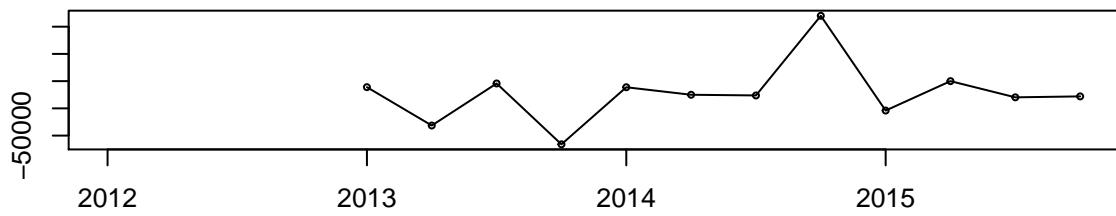
Portland, OR – Vernon



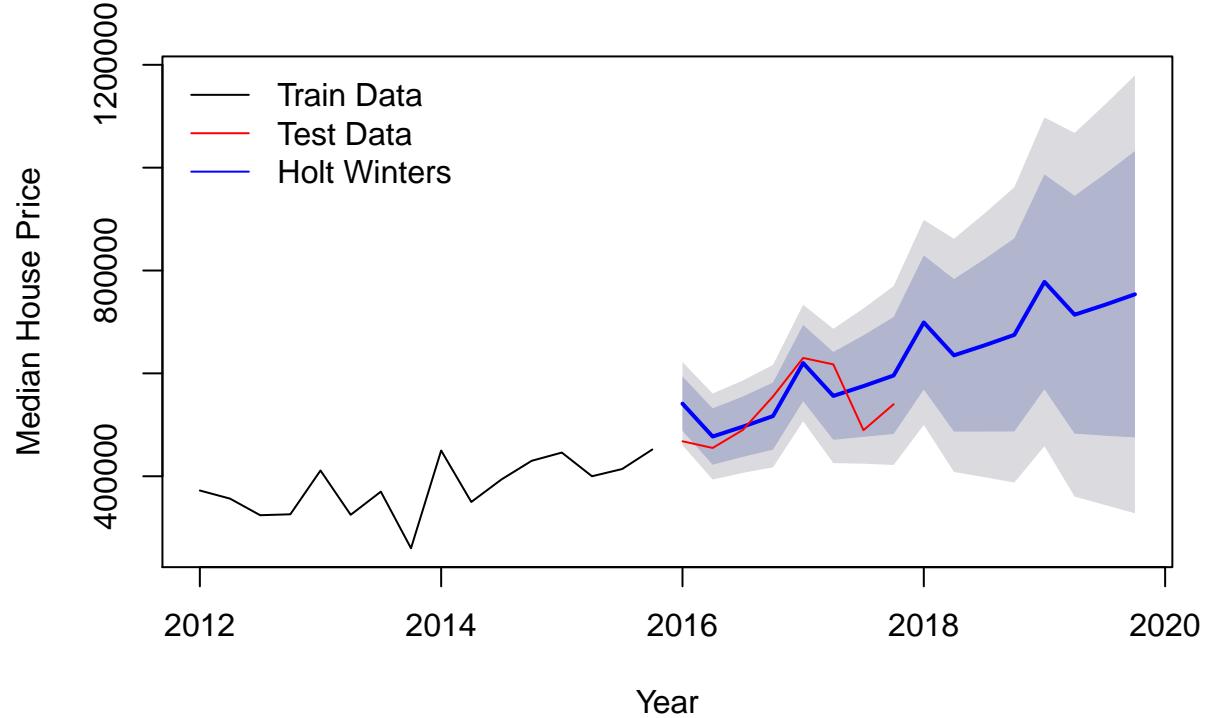
Portland, OR – Vernon : Naive Model Forecast



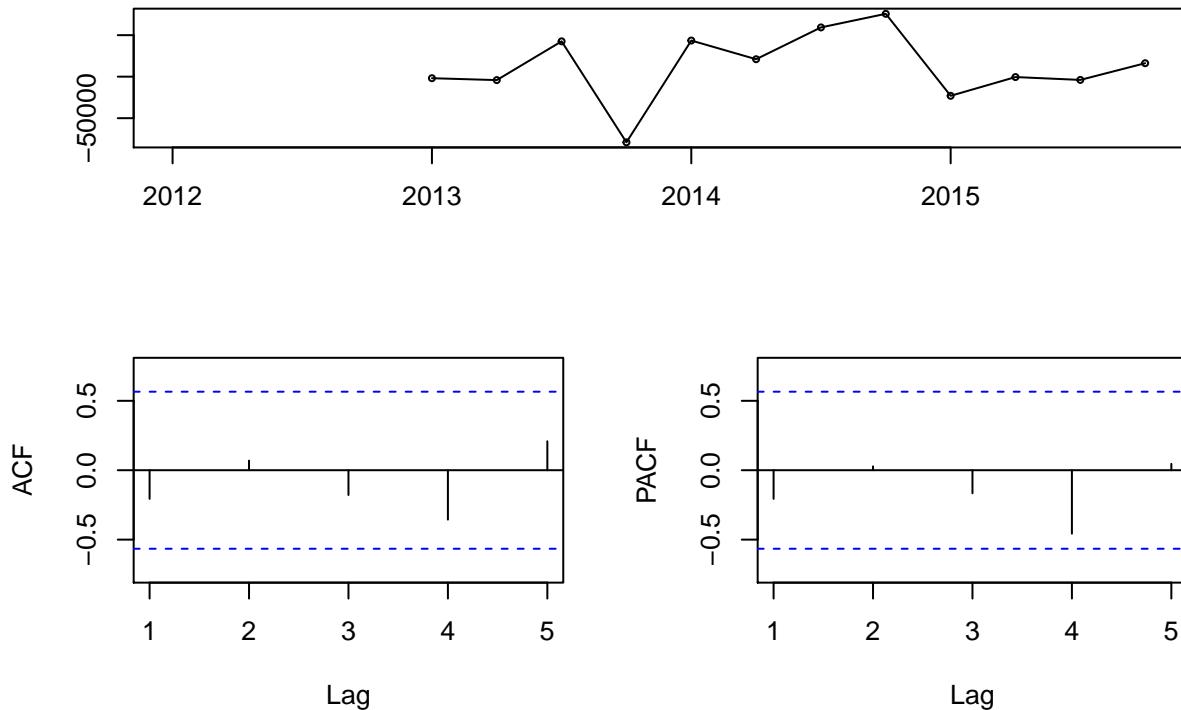
Portland, OR – Vernon : Naive Model Forecast Residuals



Portland, OR – Vernon : Holt Winters Model Forecast



Portland, OR – Vernon : Holt Winters Model Forecast Residuals

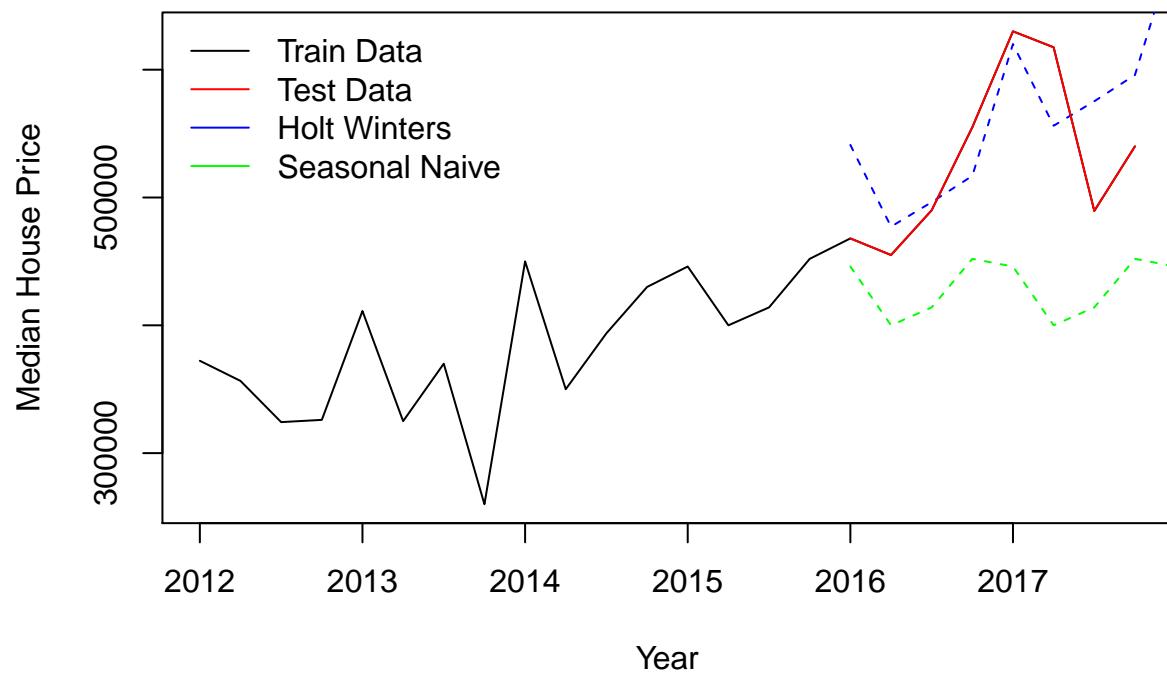


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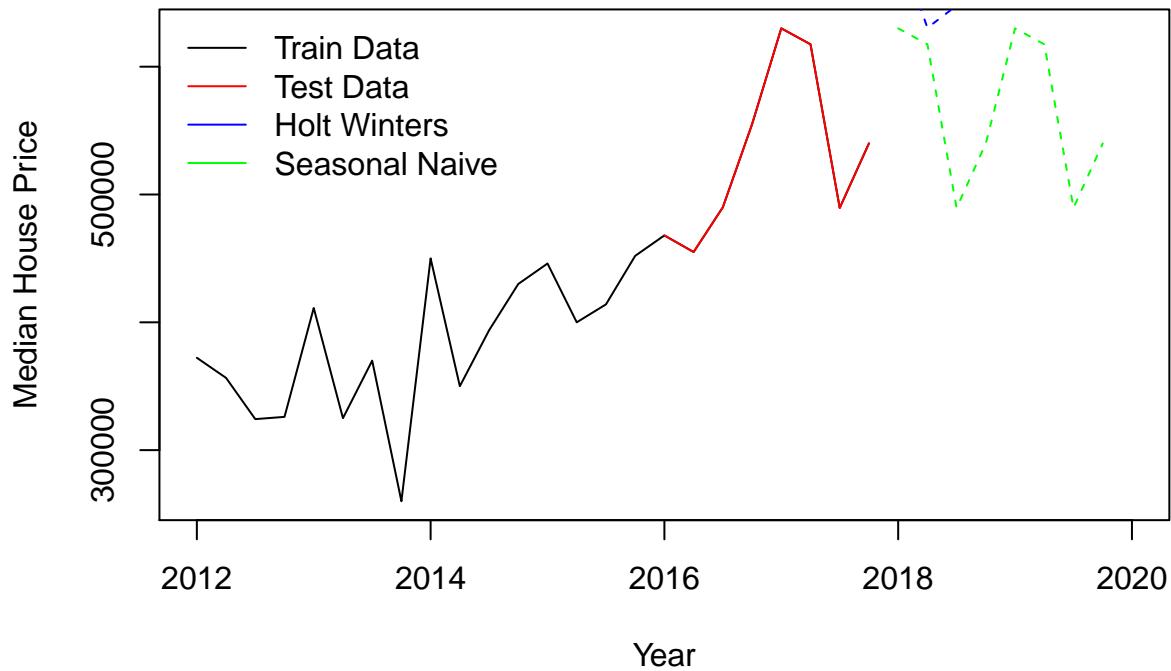
## [1] "Seasonal Naive Accuracy for Portland, OR – Vernon"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 27751.67 60528.03 44668.33 5.788188 11.78382 1.000000
## Test set     102620.00 119631.96 102620.00 18.374823 18.37482 2.297377
##          ACF1 Theil's U
## Training set -0.2992280      NA
## Test set      0.3886731 1.936959
## [1] "Holt Winters Accuracy for Portland, OR – Vernon"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 12154.47 41315.67 30904.17 2.089553 8.483936 0.6918585
## Test set     -16744.01 52054.16 44089.19 -3.911962 8.506001 0.9870347
##          ACF1 Theil's U
## Training set -0.20662903      NA
## Test set      0.08610705 0.7241014

```

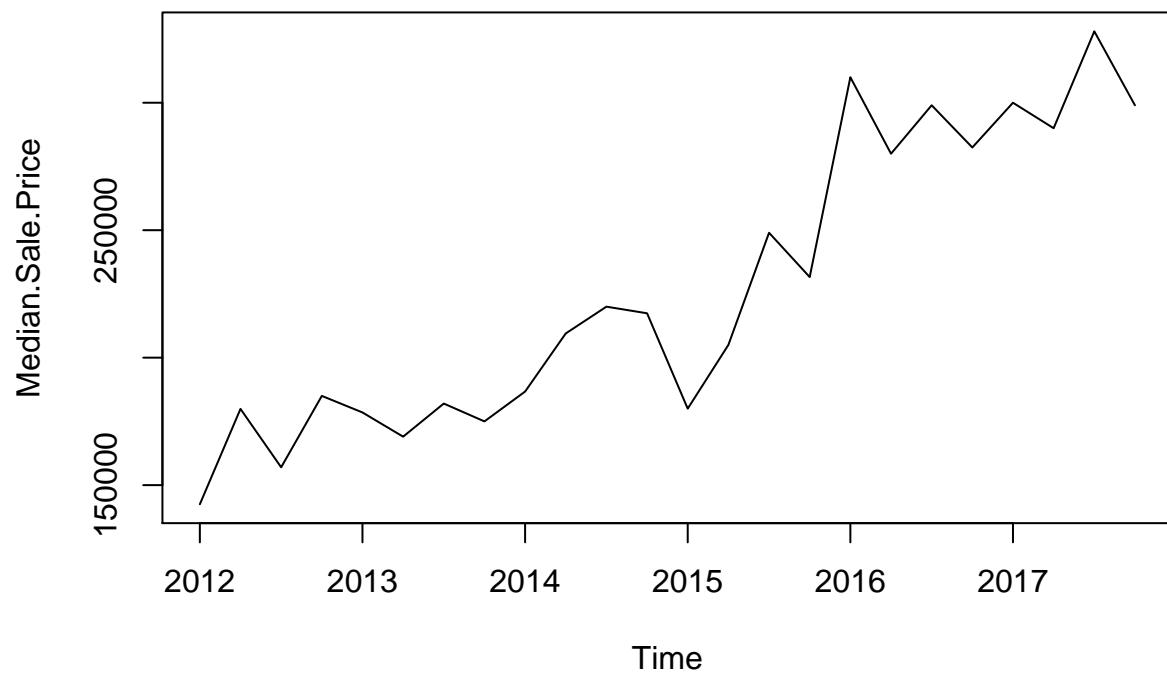
Portland, OR – Vernon : TS Training Model Comparison



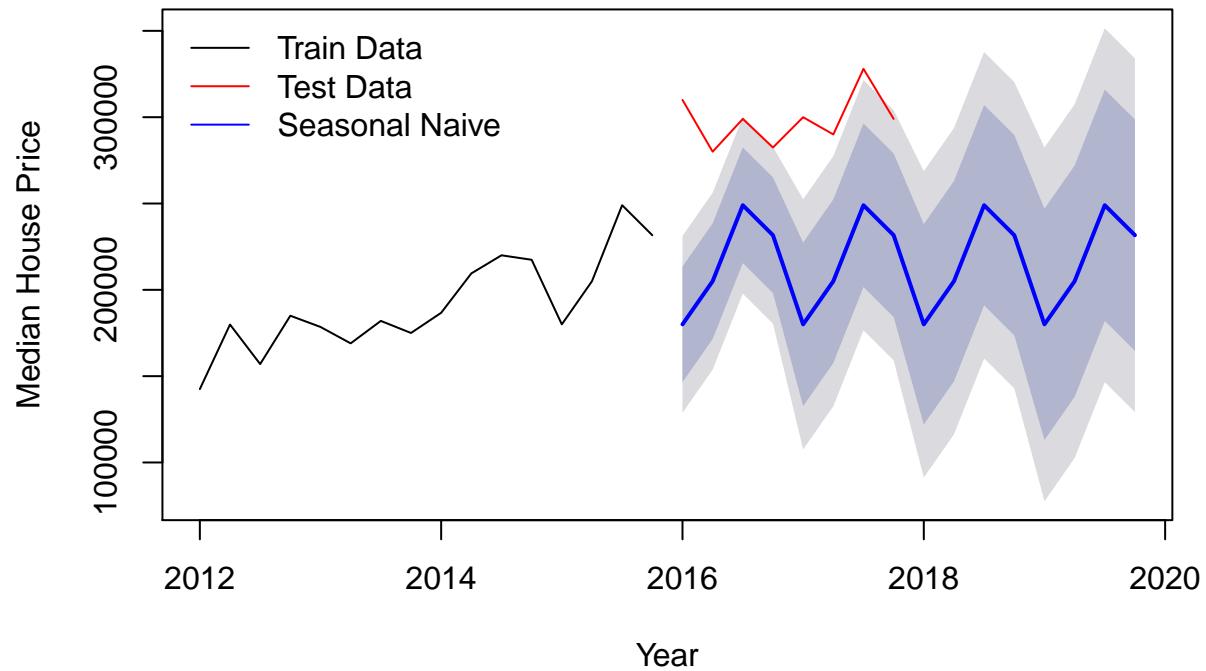
Portland, OR – Vernon : Full TS Models Comparison



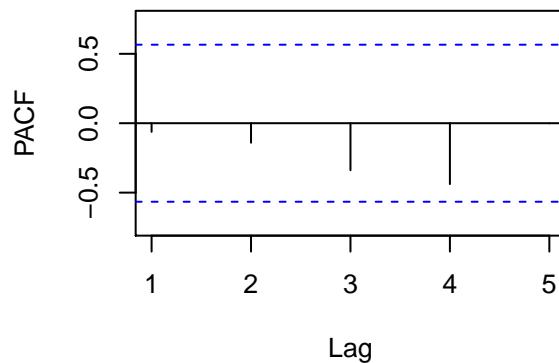
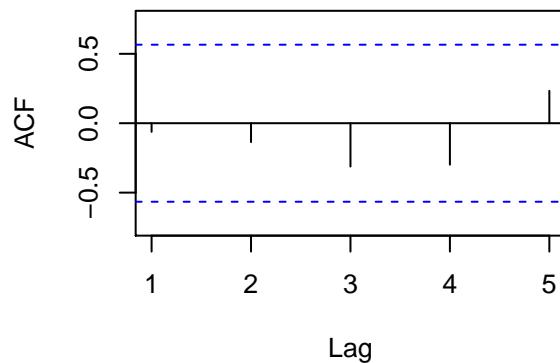
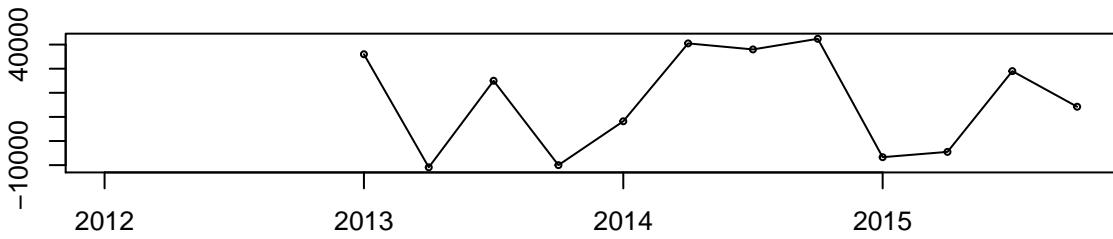
Portland, OR – Glenfair



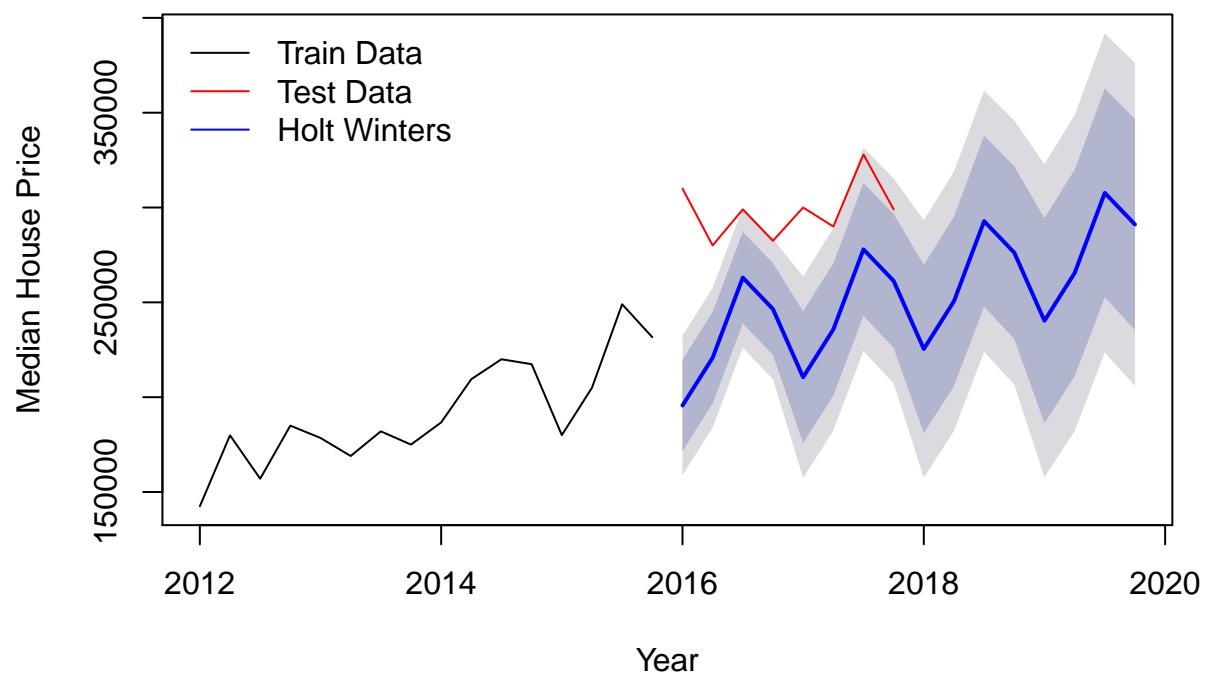
Portland, OR – Glenfair : Naive Model Forecast



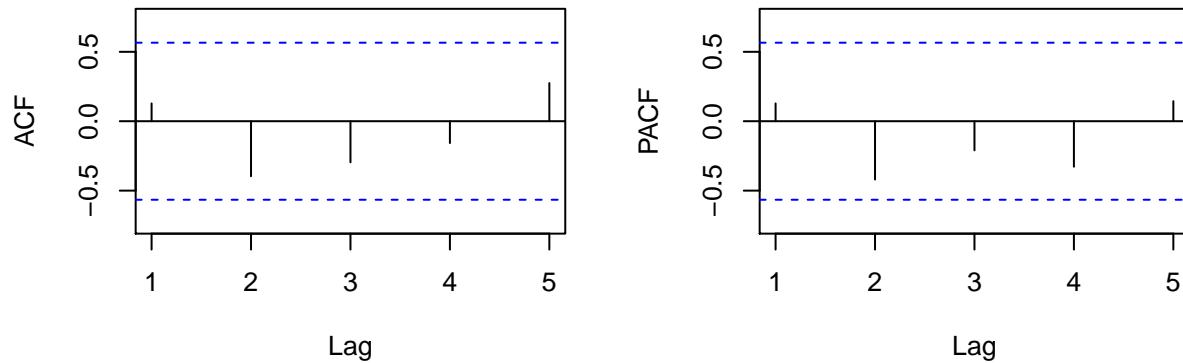
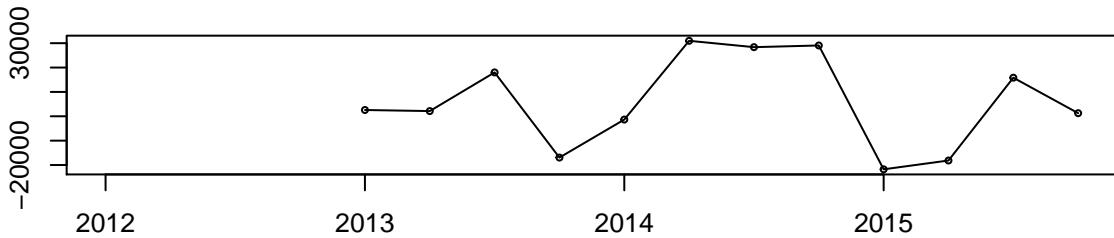
Portland, OR – Glenfair : Naive Model Forecast Residuals



Portland, OR – Glenfair : Holt Winters Model Forecast

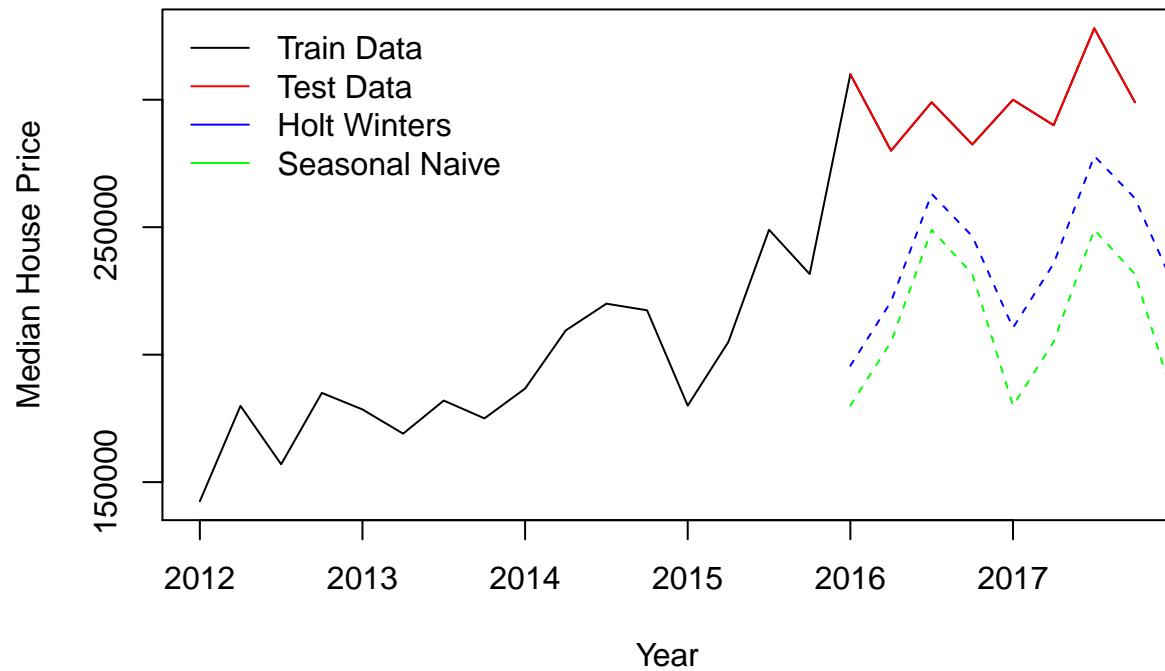


Portland, OR – Glenfair : Holt Winters Model Forecast Residuals

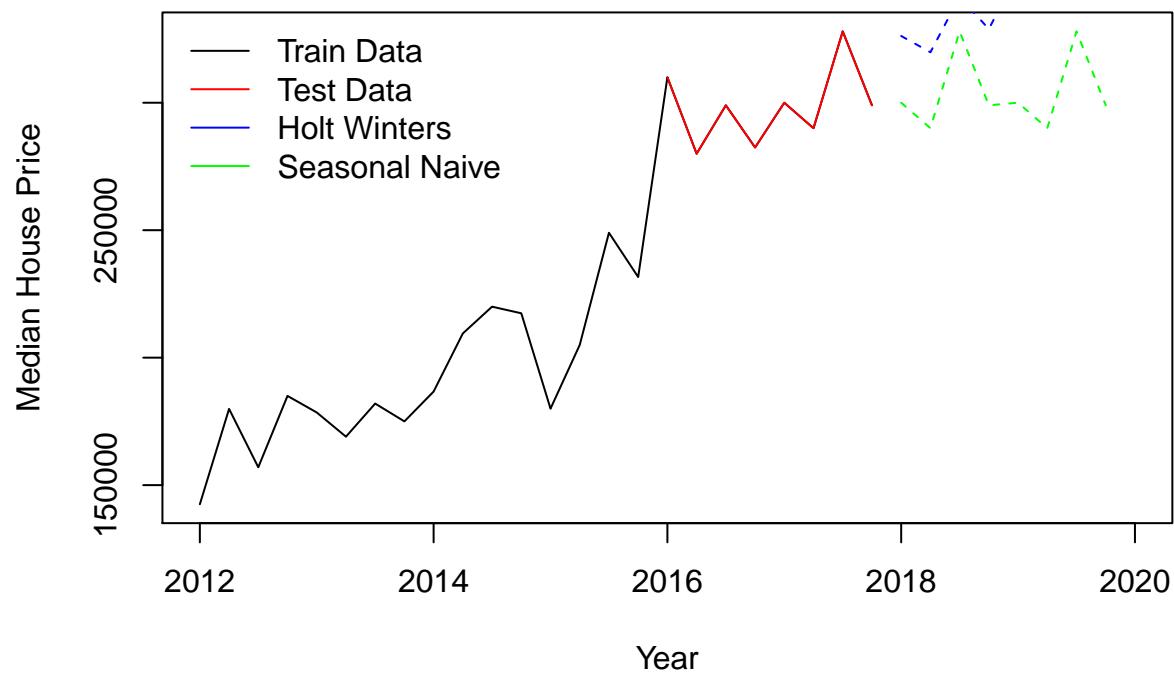


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Glenfair"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 16768.75 26136.74 22118.75 7.842561 10.85612 1.000000
## Test set     82150.00 86612.33 82150.00 27.420887 27.42089 3.714044
##          ACF1 Theil's U
## Training set -0.06215242      NA
## Test set      -0.02412965 3.250449
## [1] "Holt Winters Accuracy for Portland, OR - Glenfair"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set  5836.676 18902.56 15535.41 2.43470 7.658316 0.702364
## Test set      59629.242 65242.56 59629.24 19.90226 19.902259 2.695869
##          ACF1 Theil's U
## Training set  0.12837844      NA
## Test set      -0.01031227 2.276634
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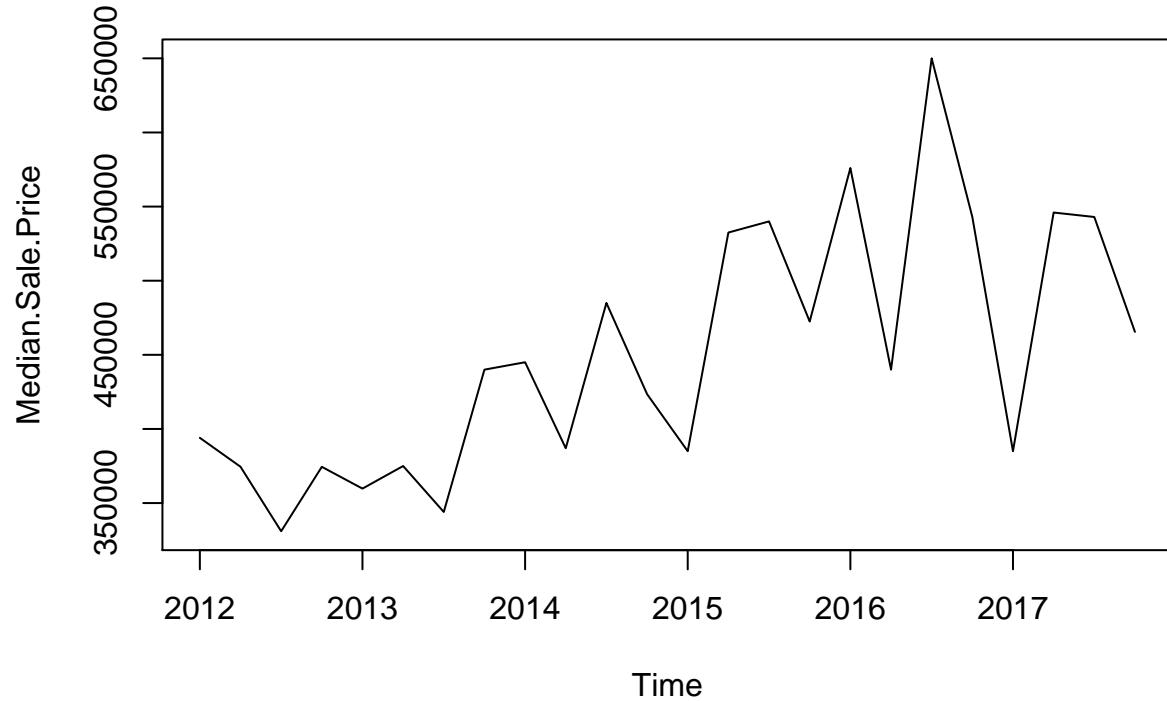
Portland, OR – Glenfair : TS Training Model Comparison



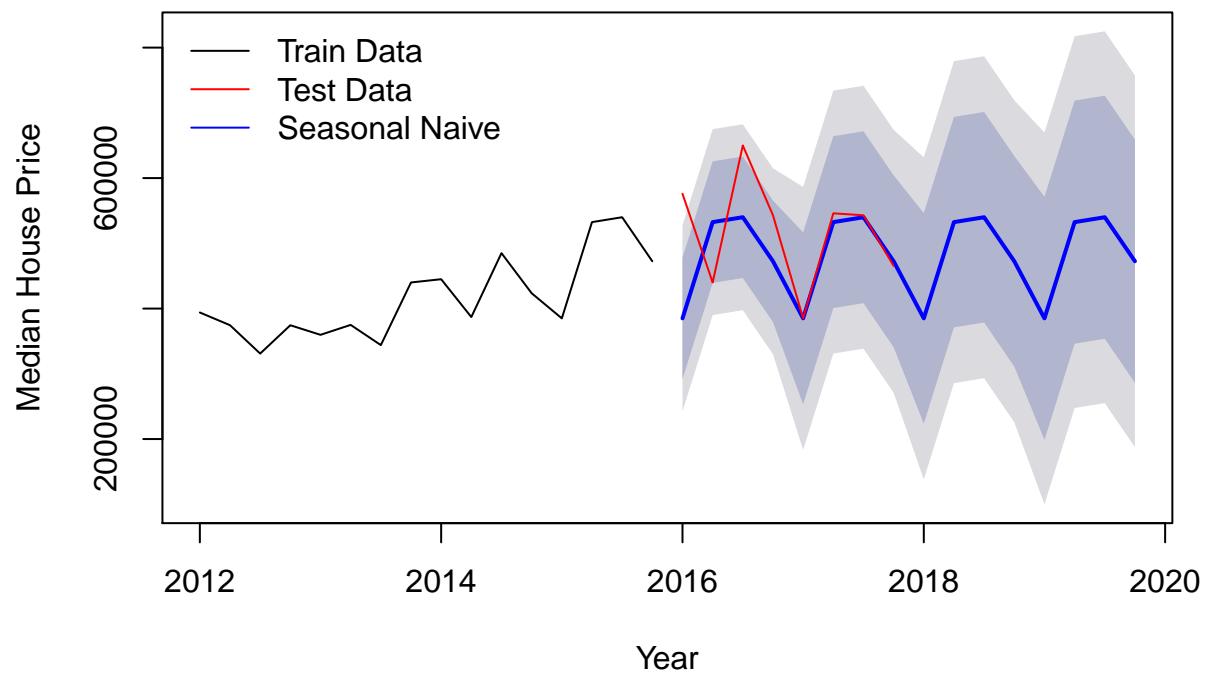
Portland, OR – Glenfair : Full TS Models Comparison



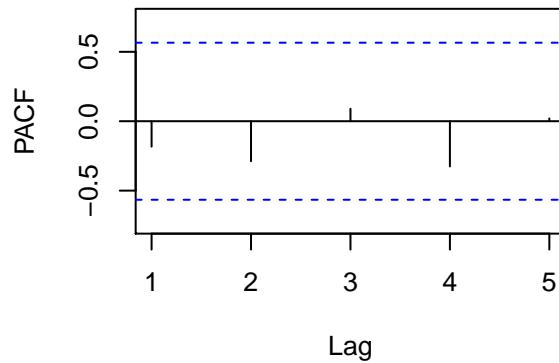
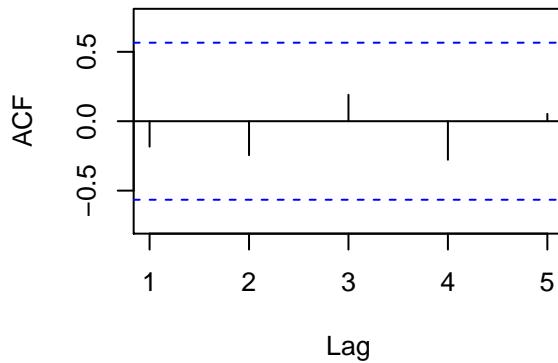
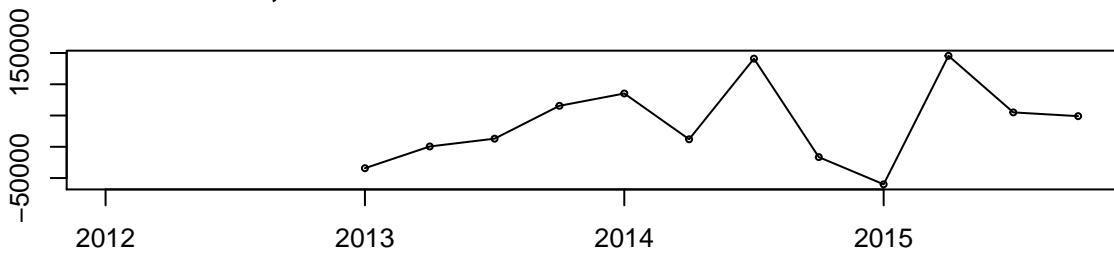
Portland, OR – Buckman



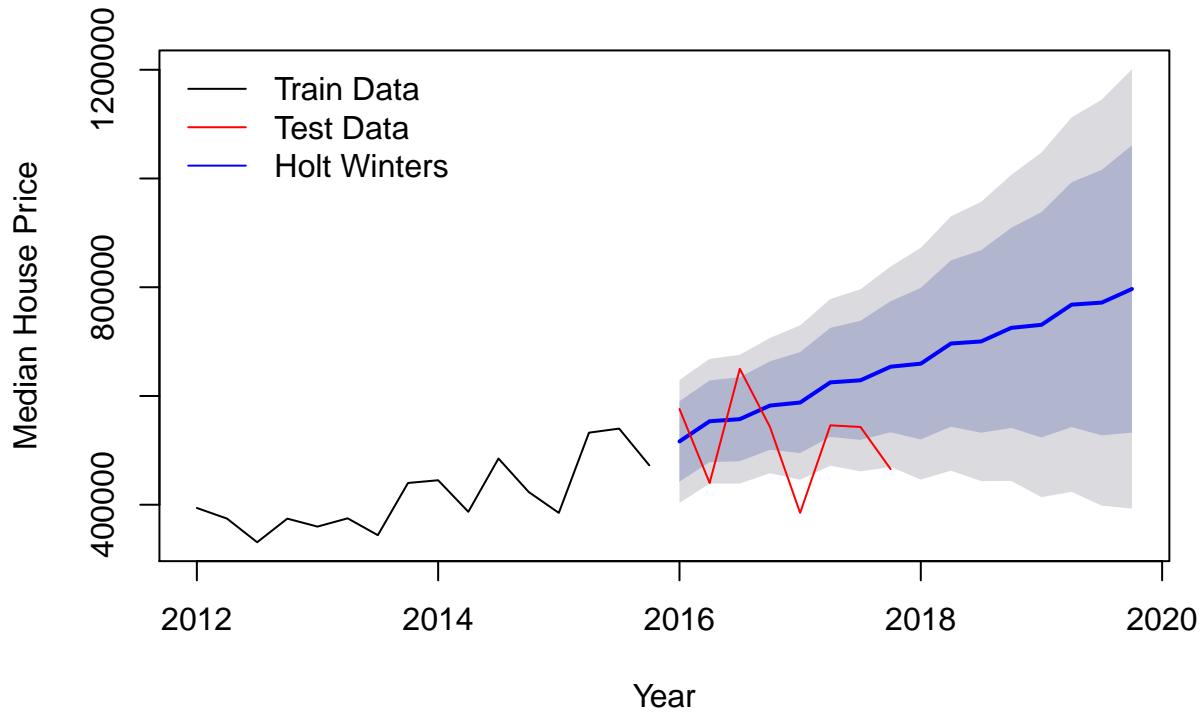
Portland, OR – Buckman : Naive Model Forecast



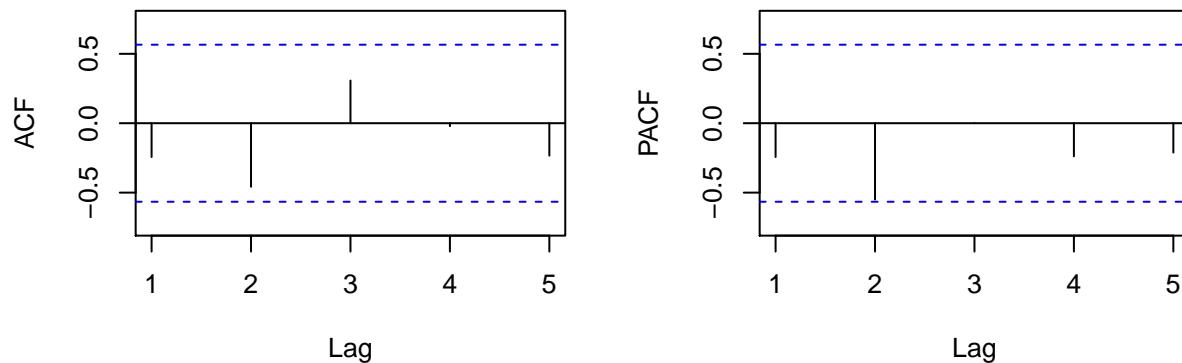
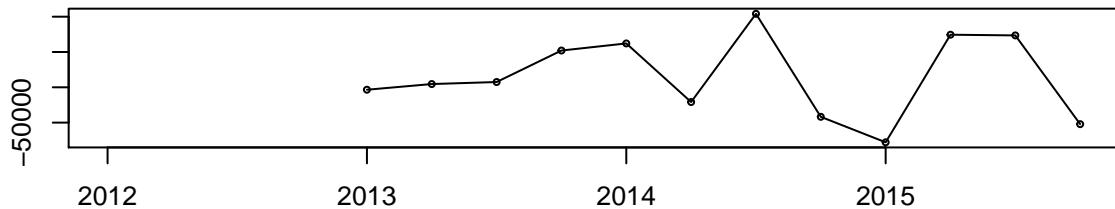
Portland, OR – Buckman : Naive Model Forecast Residuals



Portland, OR – Buckman : Holt Winters Model Forecast

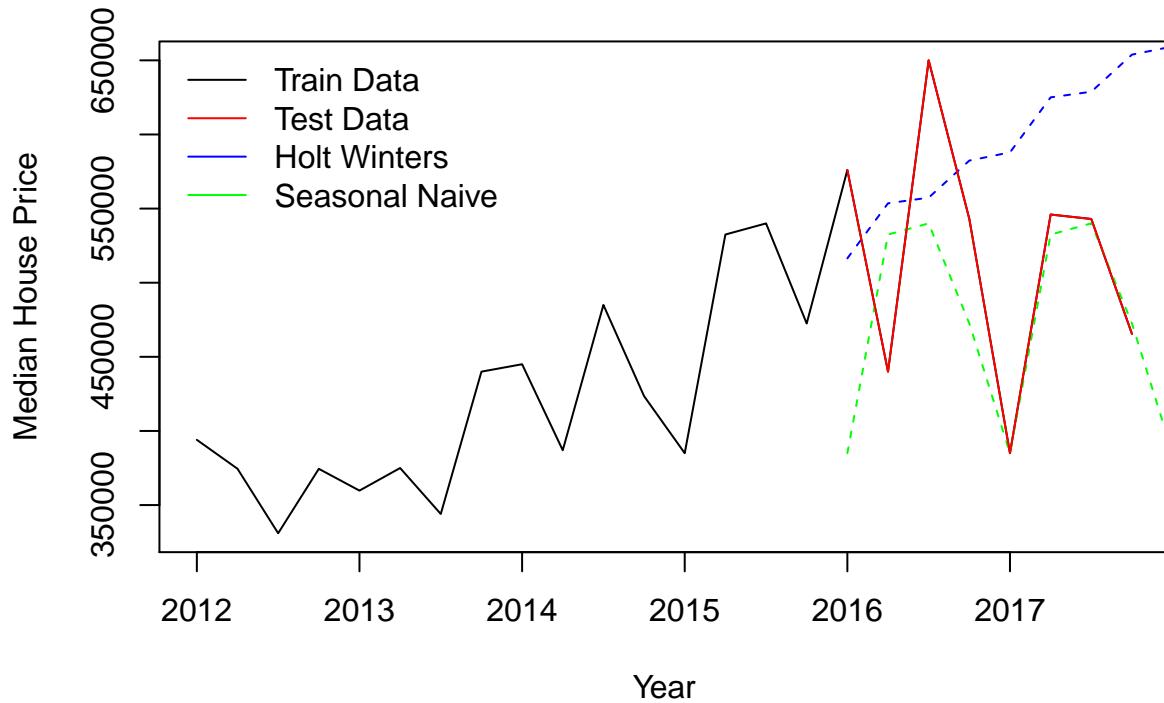


Portland, OR – Buckman : Holt Winters Model Forecast Residuals

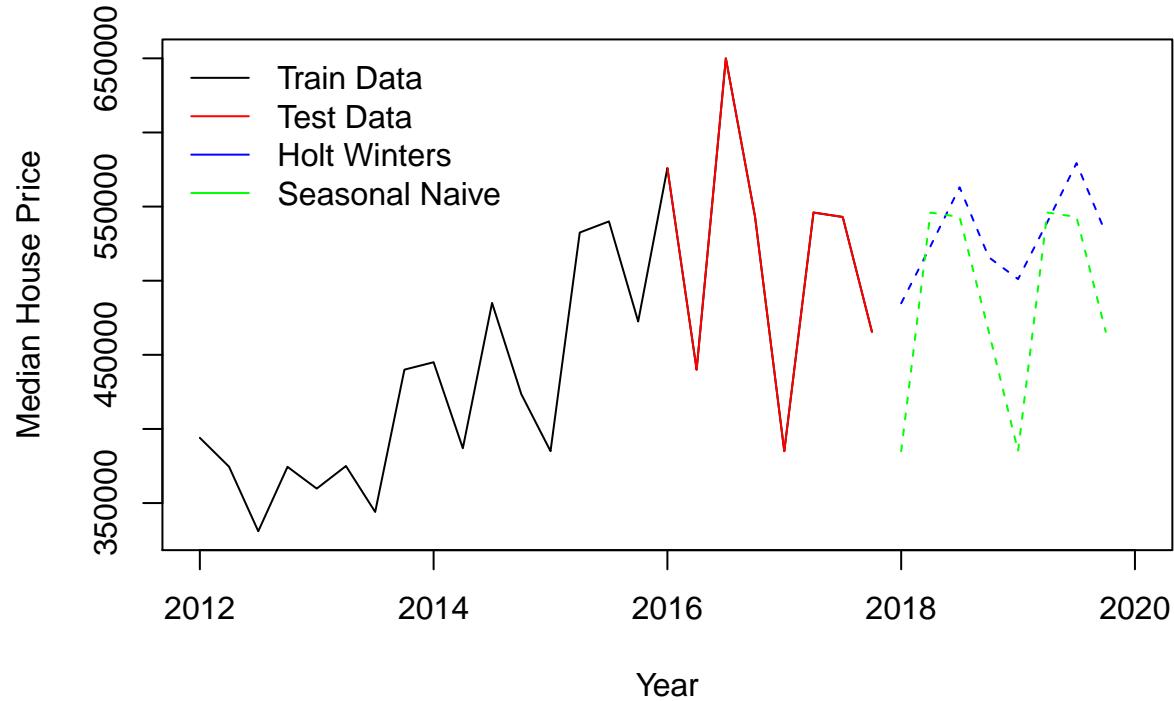


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Buckman"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 38004.17 72686.64 56462.5 7.418238 12.25174 1.000000
## Test set     36062.50 88280.62 60937.5 5.445594 11.07722 1.079256
##          ACF1 Theil's U
## Training set -0.1832036      NA
## Test set     -0.4839283 0.4145233
## [1] "Holt Winters Accuracy for Portland, OR - Buckman"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 15183.29 57308.54 47874.82 2.564448 10.47871 0.8479046
## Test set     -69610.31 120850.57 107658.29 -16.490018 22.63782 1.9067219
##          ACF1 Theil's U
## Training set -0.2434104      NA
## Test set     -0.1101547 0.8369431
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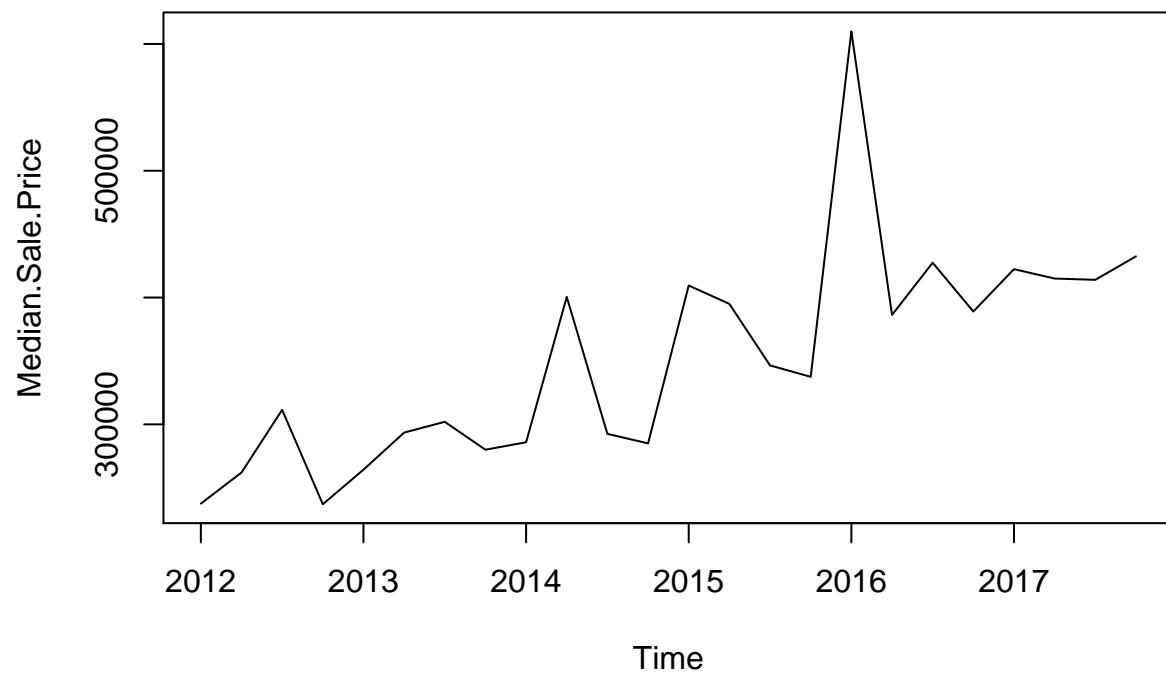
Portland, OR – Buckman : TS Training Model Comparison



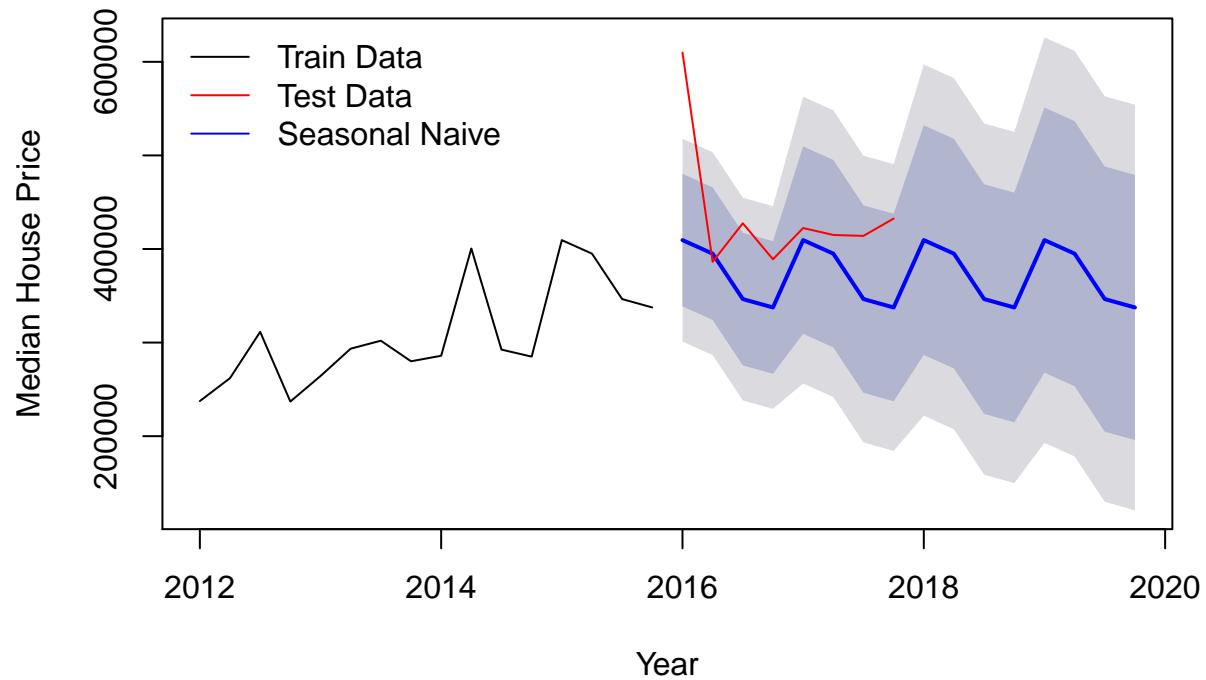
Portland, OR – Buckman : Full TS Models Comparison



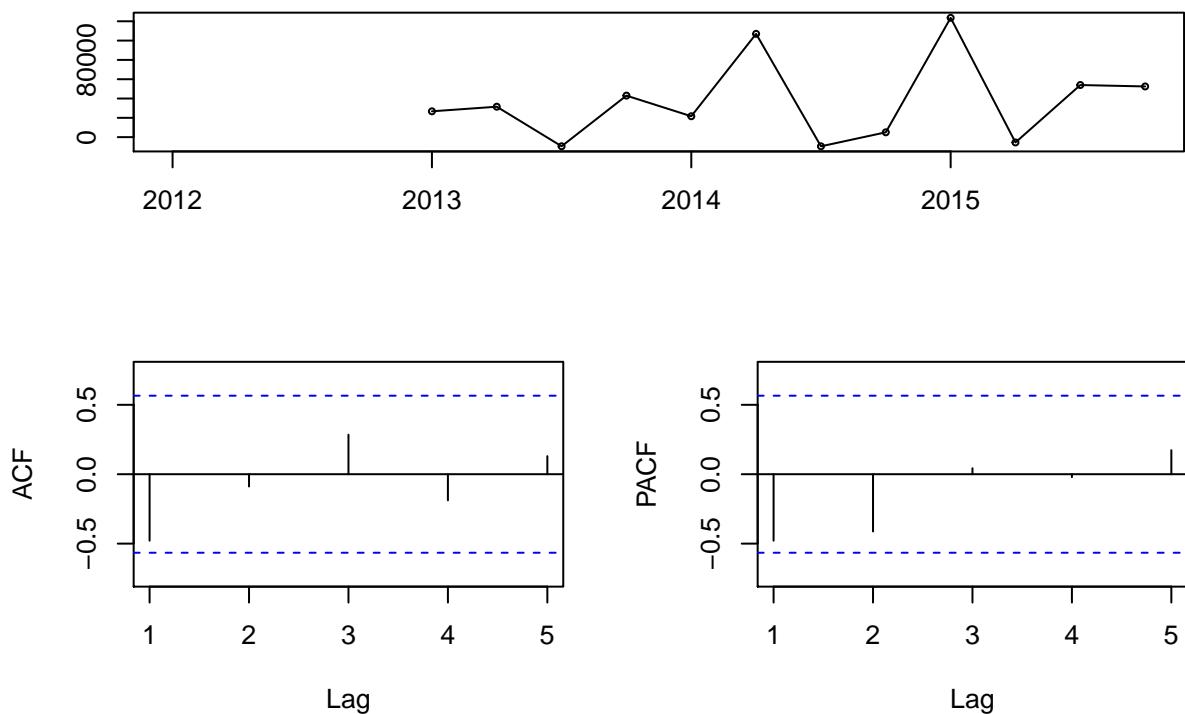
Portland, OR – Crestwood



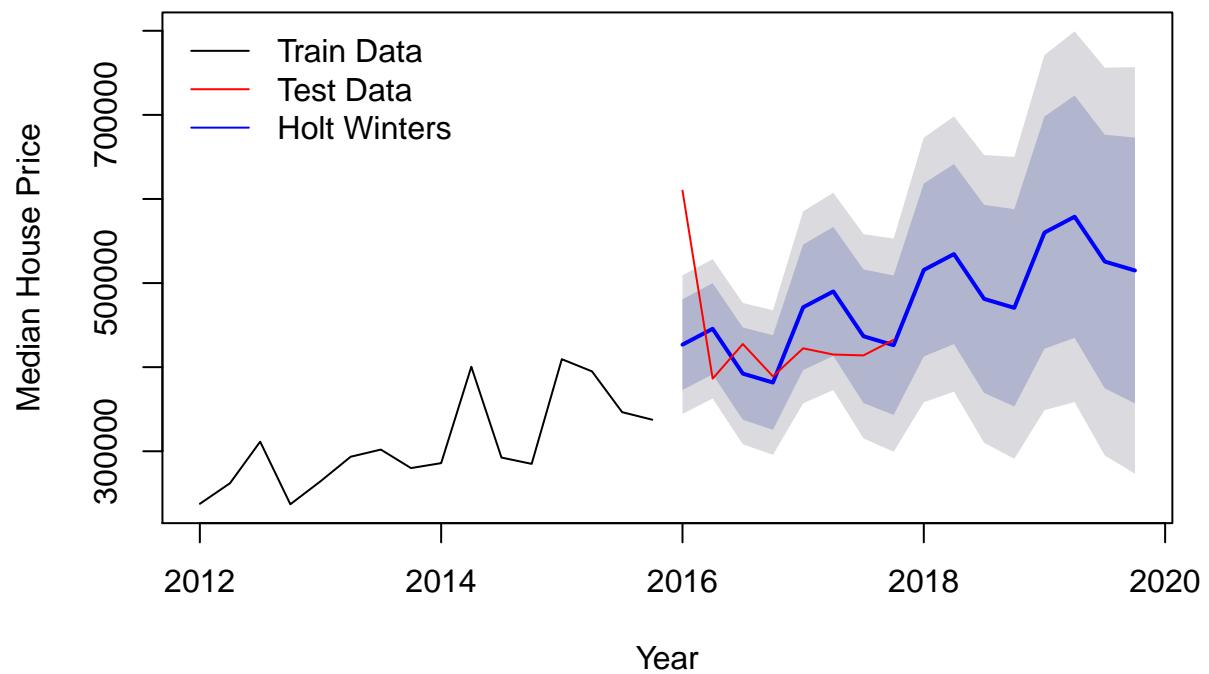
Portland, OR – Crestwood : Naive Model Forecast



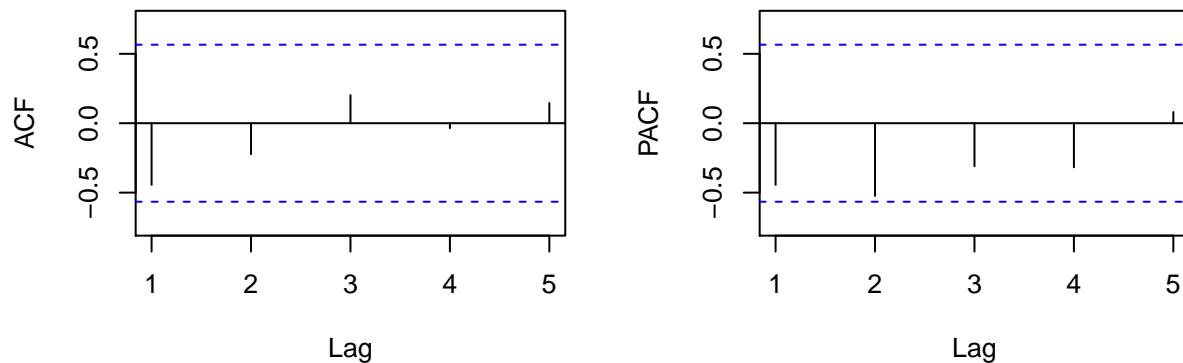
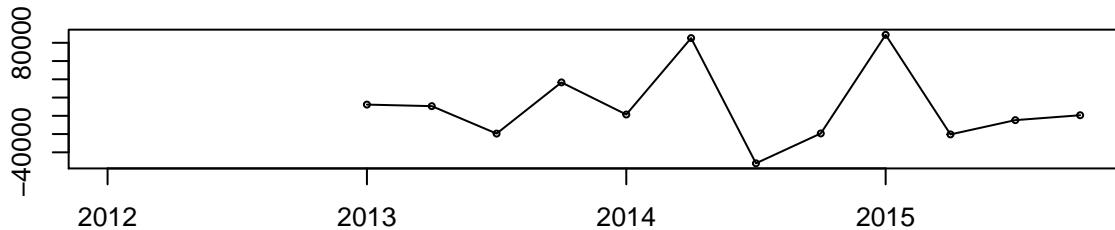
Portland, OR – Crestwood : Naive Model Forecast Residuals



Portland, OR – Crestwood : Holt Winters Model Forecast

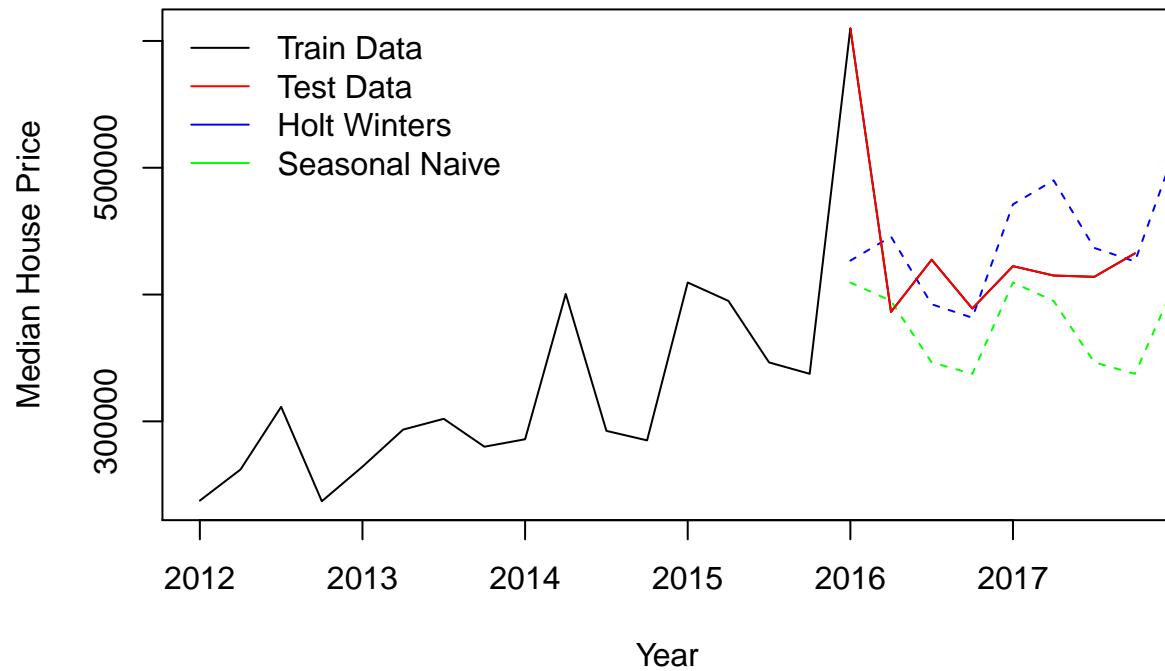


Portland, OR – Crestwood : Holt Winters Model Forecast Residuals

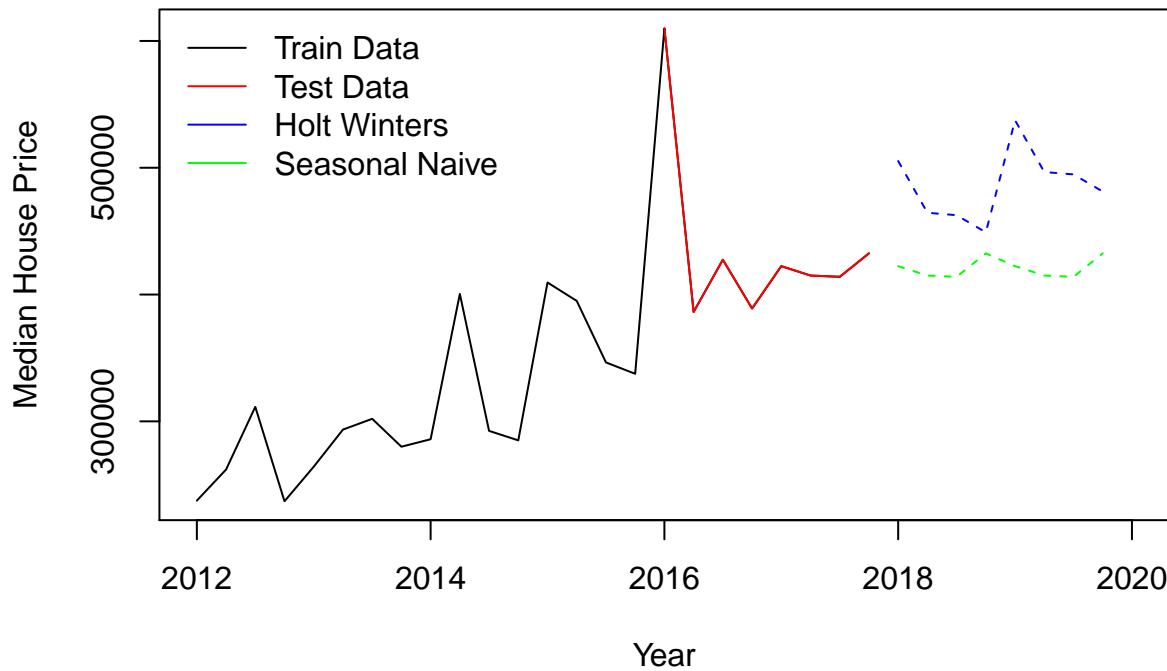


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Crestwood"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 36710.83 55269.33 40785.83 10.48376 11.77866 1.000000
## Test set     64961.25 89178.71 67136.25 13.61876 14.18179 1.646068
##          ACF1 Theil's U
## Training set -0.4790635      NA
## Test set     -0.2804800 0.9288921
## [1] "Holt Winters Accuracy for Portland, OR - Crestwood"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 9963.021 41464.40 29281.93  2.285533  8.54113 0.7179436
## Test set     3250.595 76602.56 54744.75 -1.113076 11.51265 1.3422492
##          ACF1 Theil's U
## Training set -0.4440075      NA
## Test set     -0.1560325 0.6474979
```

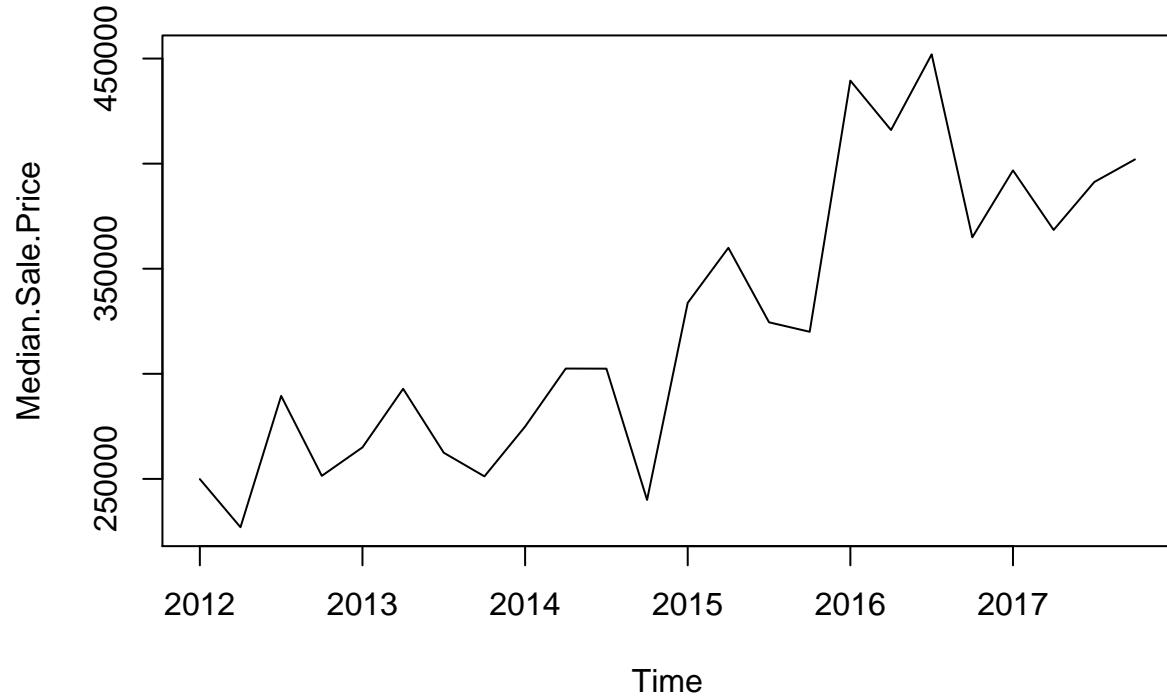
Portland, OR – Crestwood : TS Training Model Comparison



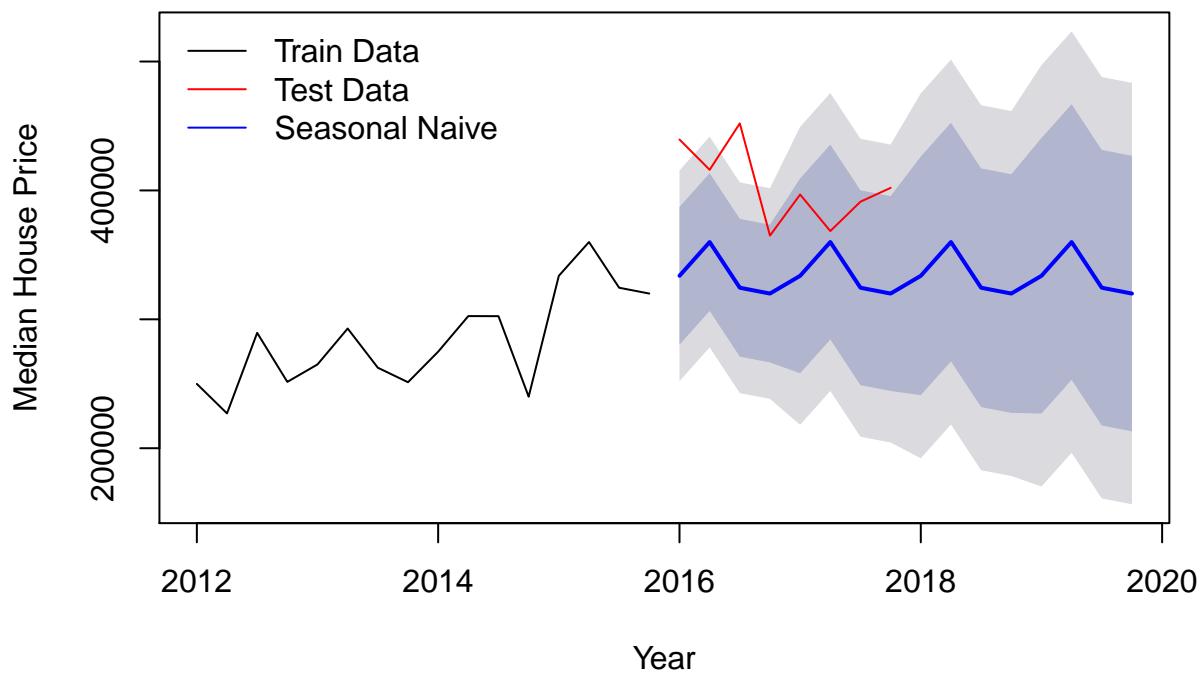
Portland, OR – Crestwood : Full TS Models Comparison



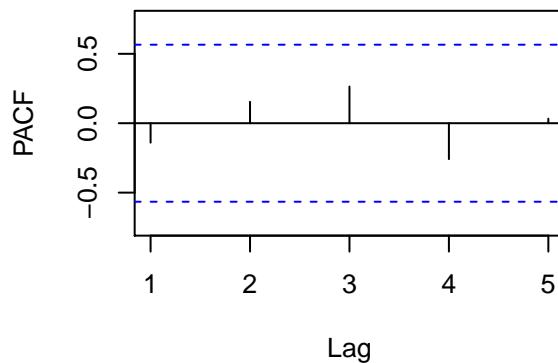
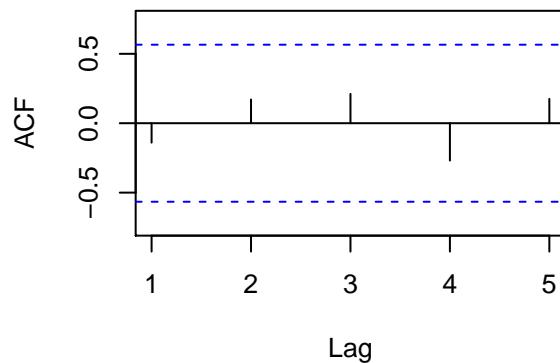
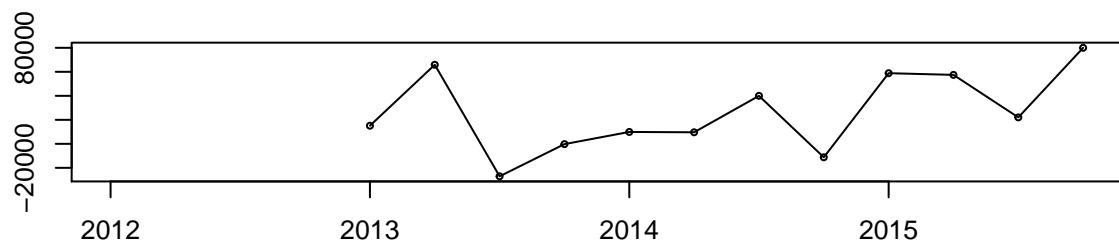
Portland, OR – West Portland Park



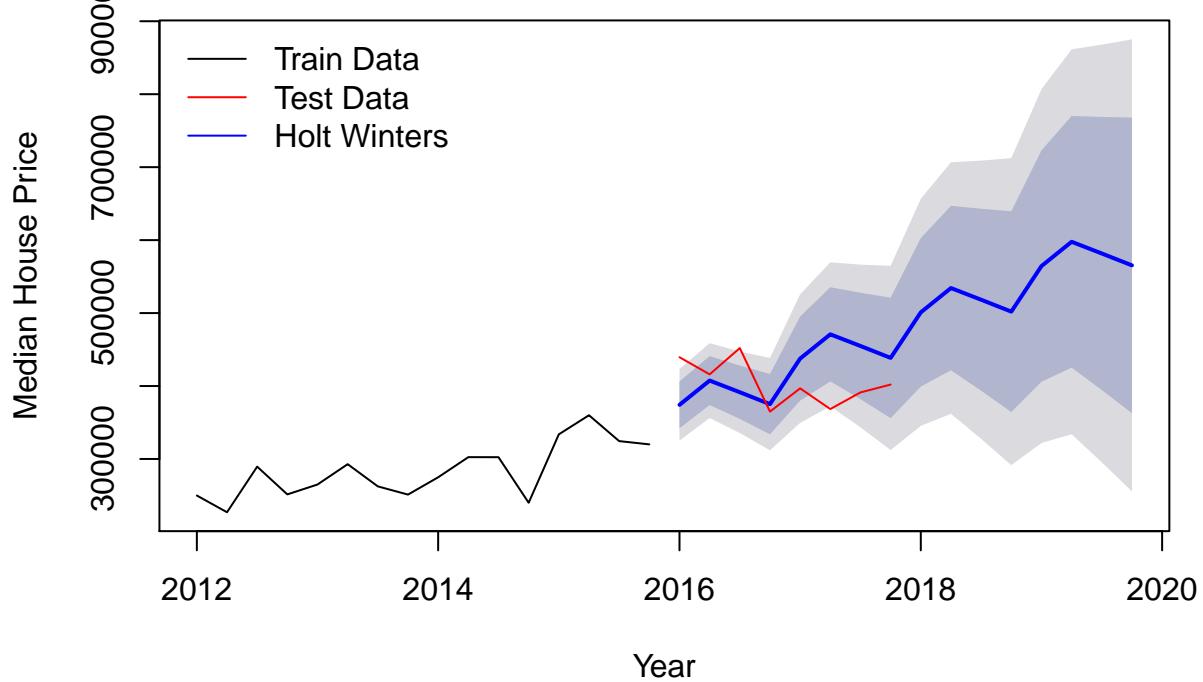
Portland, OR – West Portland Park : Naive Model Forecast



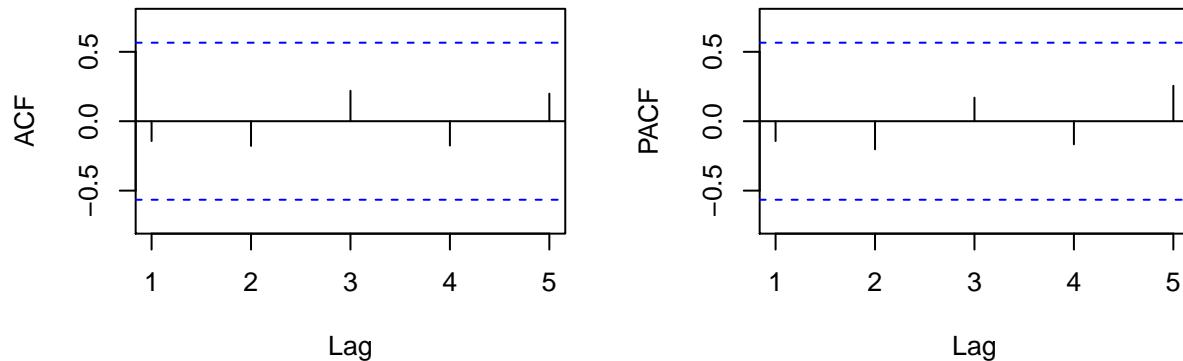
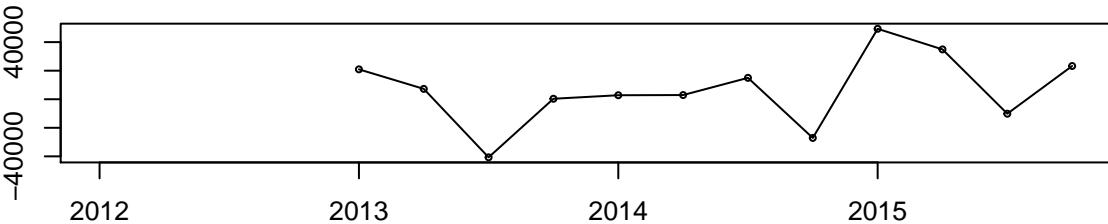
Portland, OR – West Portland Park : Naive Model Forecast Residuals



Portland, OR – West Portland Park : Holt Winters Model Forecast

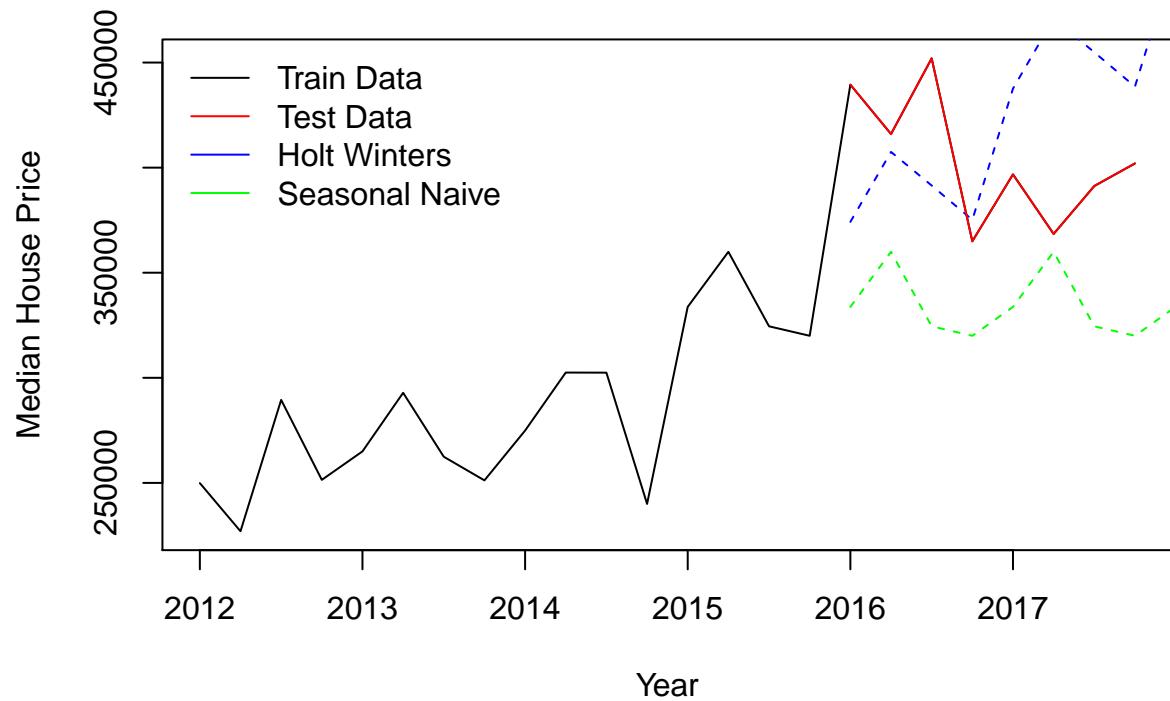


Portland, OR – West Portland Park : Holt Winters Model Forecast Residuals

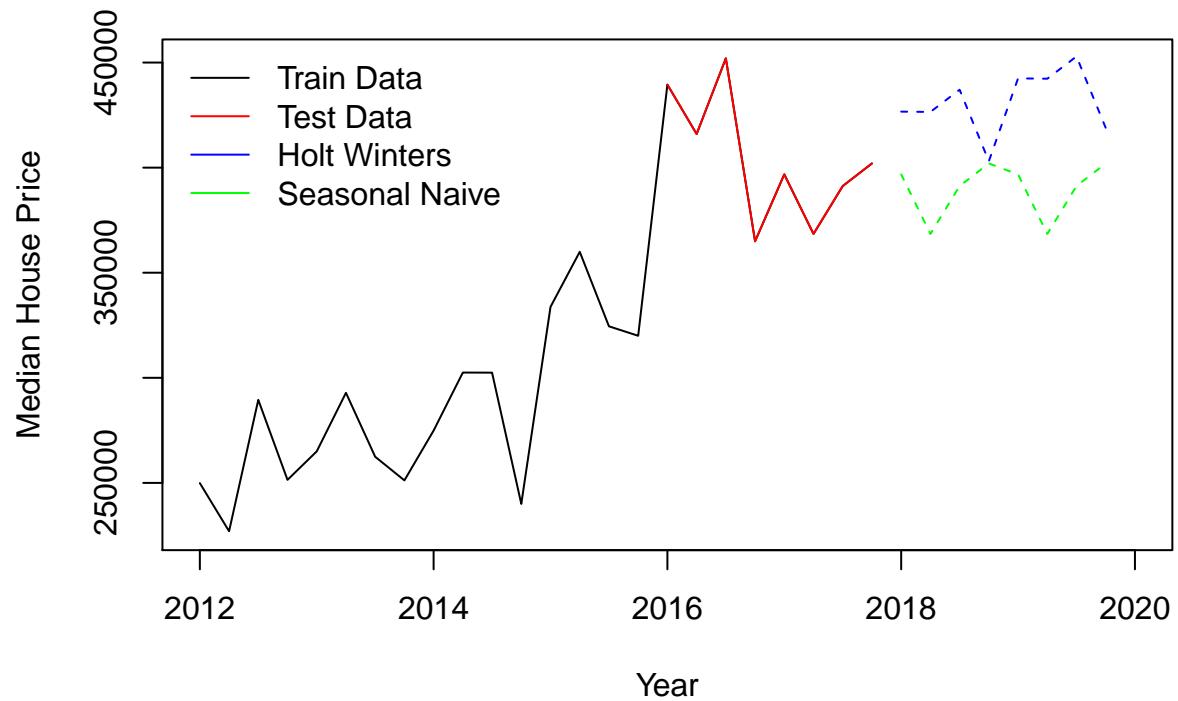


```
## [1] "Seasonal Naive Accuracy for Portland, OR - West Portland Park"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 26695.83 41698.78 33112.50 8.209562 10.72171 1.000000
## Test set     69319.62 77321.29 69319.62 16.714607 16.71461 2.093458
##          ACF1 Theil's U
## Training set -0.1400042      NA
## Test set     -0.2147169  1.873129
## [1] "Holt Winters Accuracy for Portland, OR - West Portland Park"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set  6564.927 24854.46 19547.76 1.605949  6.590626 0.5903437
## Test set     -14908.676 56617.77 48495.94 -4.492114 12.066472 1.4645810
##          ACF1 Theil's U
## Training set -0.1426197      NA
## Test set      0.4803508  1.469099
```

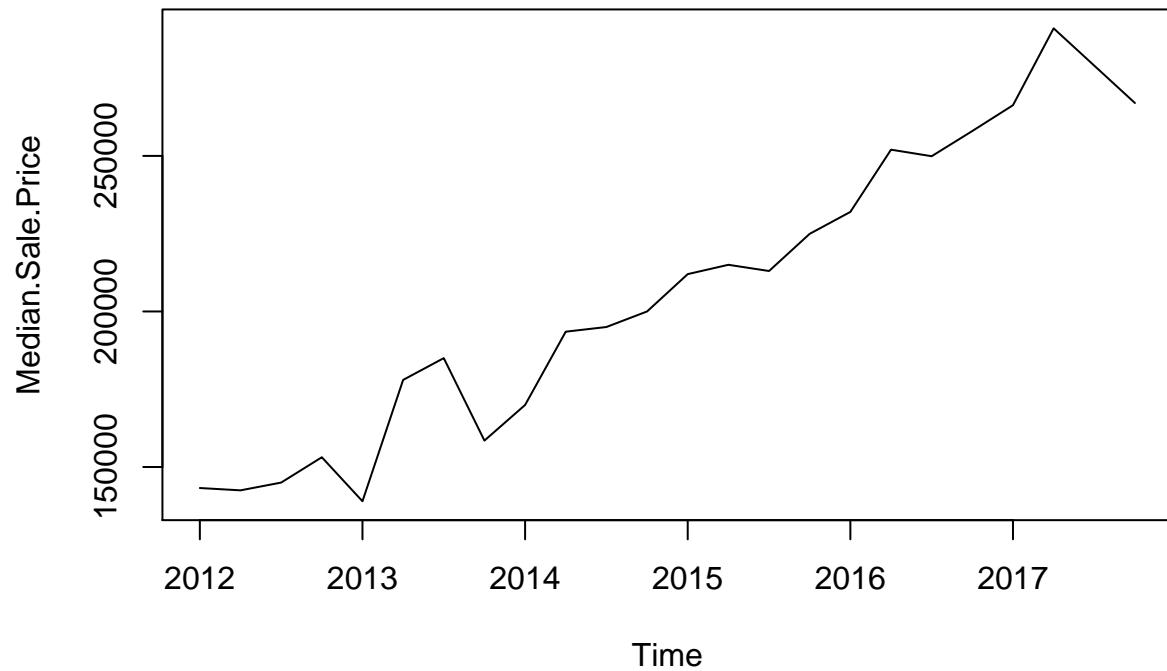
Portland, OR – West Portland Park : TS Training Model Comparisor



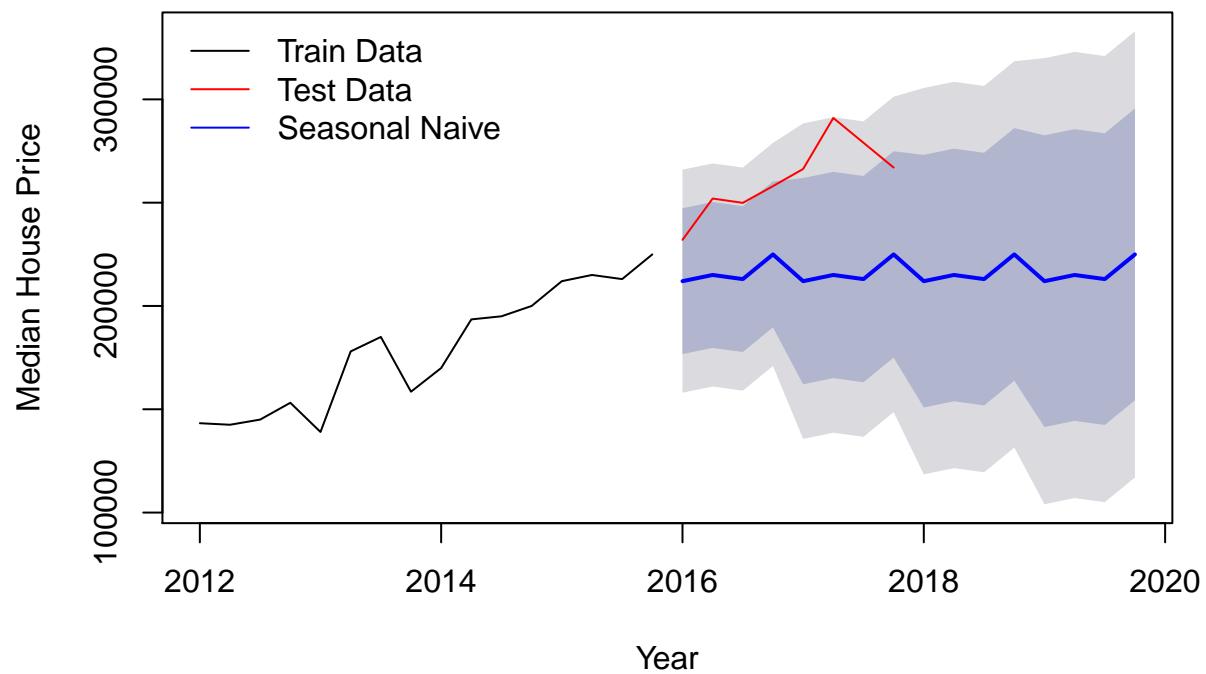
Portland, OR – West Portland Park : Full TS Models Comparison



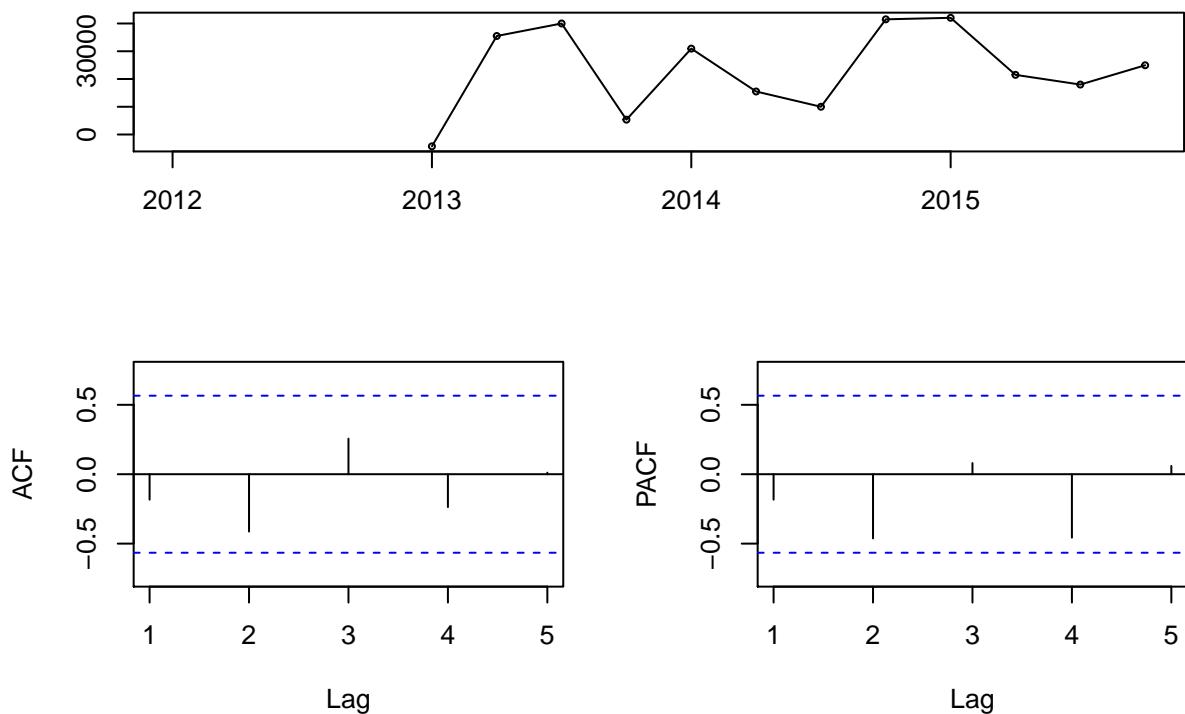
Portland, OR – Powellhurst–Gilbert



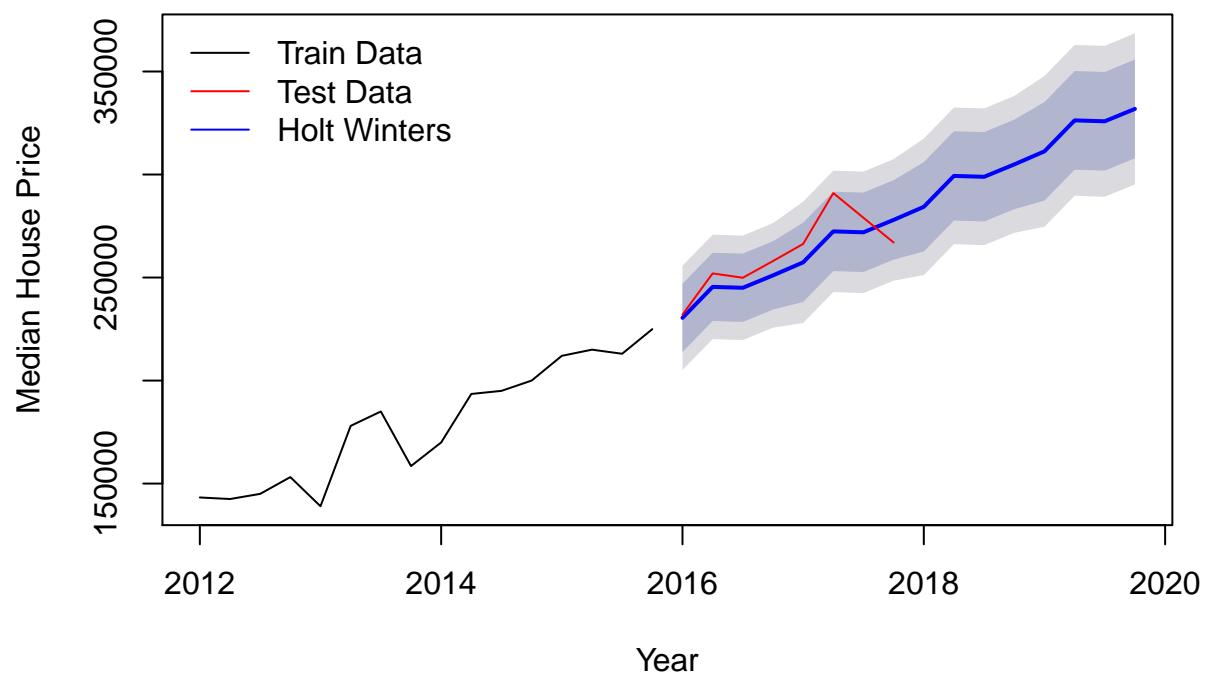
Portland, OR – Powellhurst–Gilbert : Naive Model Forecast



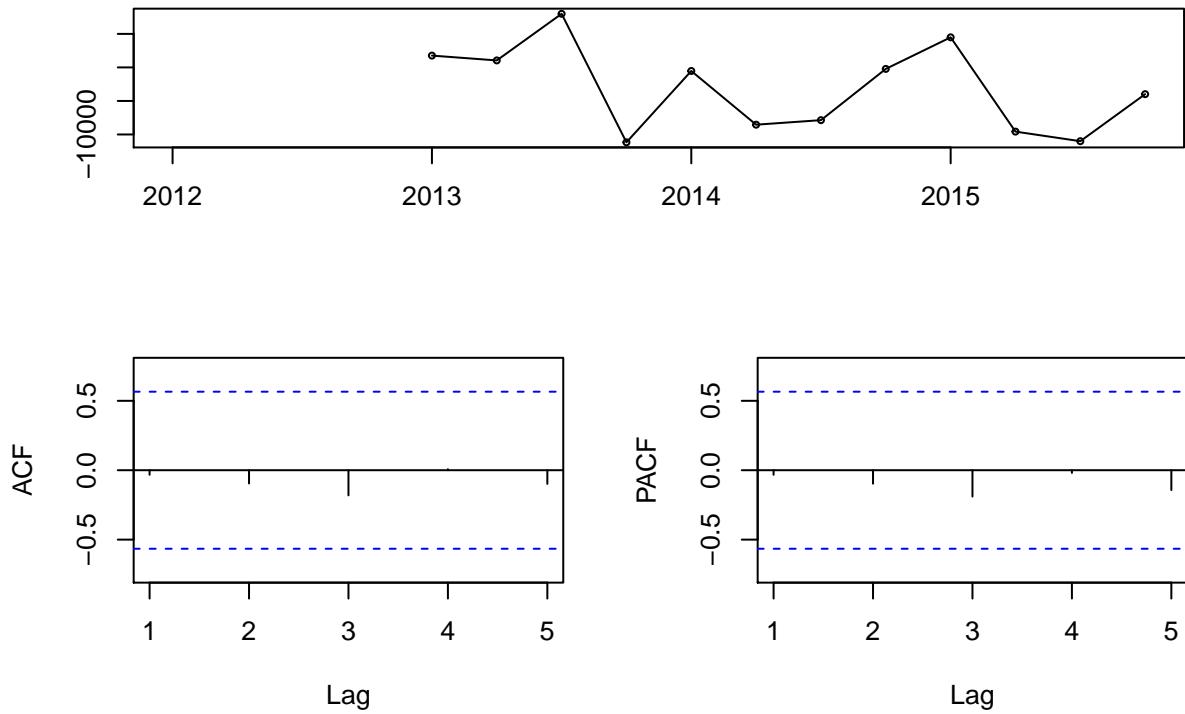
Portland, OR – Powellhurst–Gilbert : Naive Model Forecast Residuals



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

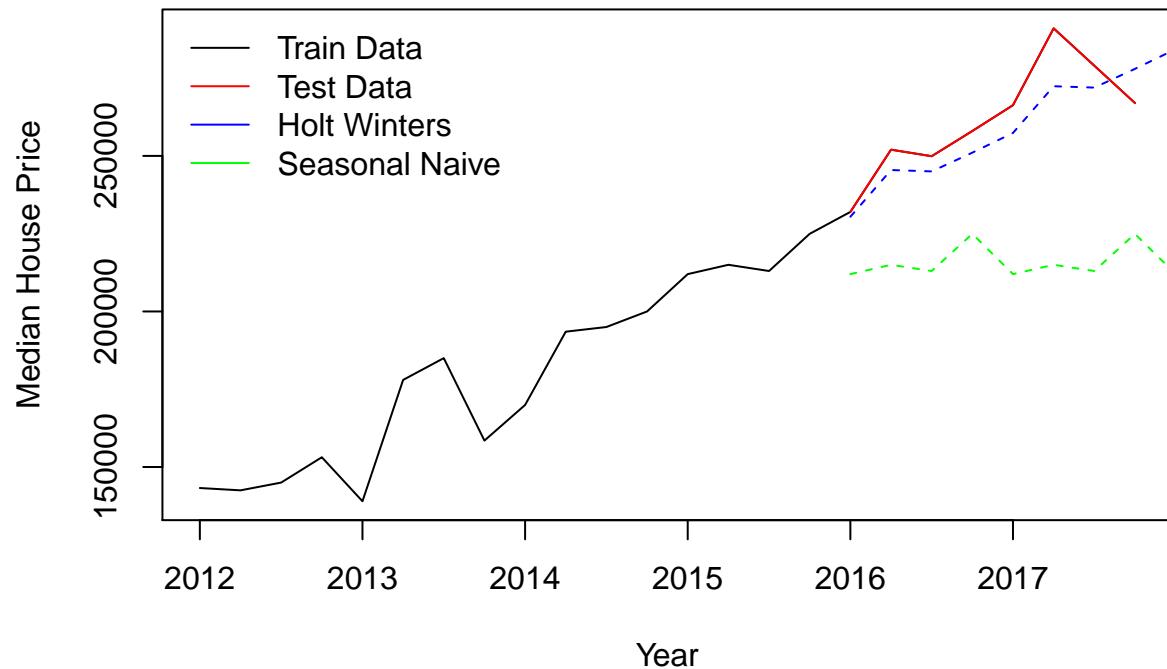


Portland, OR – Powellhurst–Gilbert : Holt Winters Model Forecast Residuals



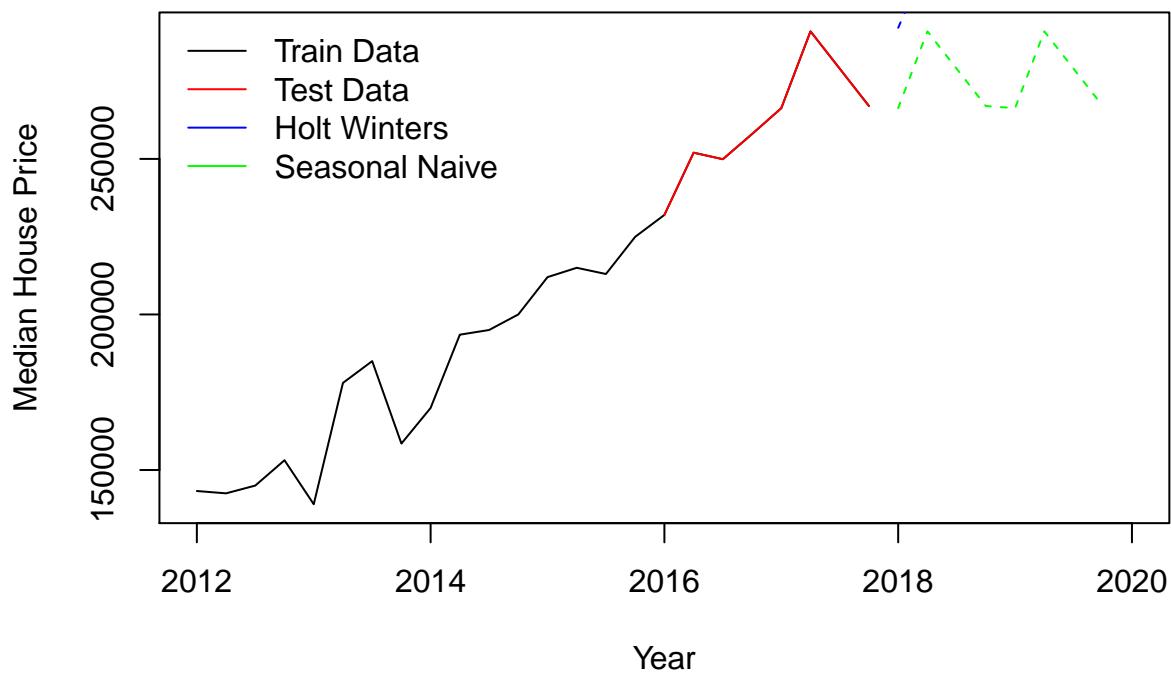
```
## [1] "Seasonal Naive Accuracy for Portland, OR – Powellhurst–Gilbert"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 23421.42 27544.46 24129.75 11.94704 12.45663 1.000000
## Test set     45662.50 48825.72 45662.50 17.09895 17.09895 1.892374
##          ACF1 Theil's U
## Training set -0.1833402      NA
## Test set     0.4622750 3.48651
## [1] "Holt Winters Accuracy for Portland, OR – Powellhurst–Gilbert"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 3734.801 12917.990 11448.779 2.183055 6.227002 0.4744674
## Test set     5443.005 9443.238 8187.295 2.009945 3.037769 0.3393029
##          ACF1 Theil's U
## Training set -0.03302632      NA
## Test set     0.08435278 0.6835315
```

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

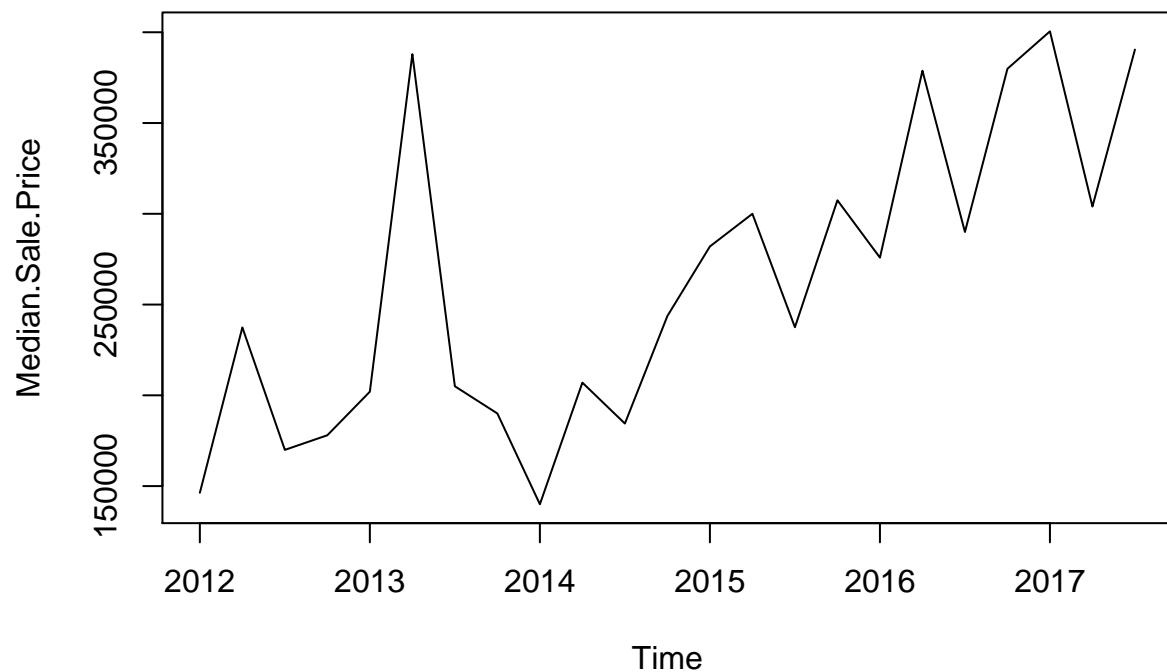


```
## Warning in window.default(x, ...): 'end' value not changed
```

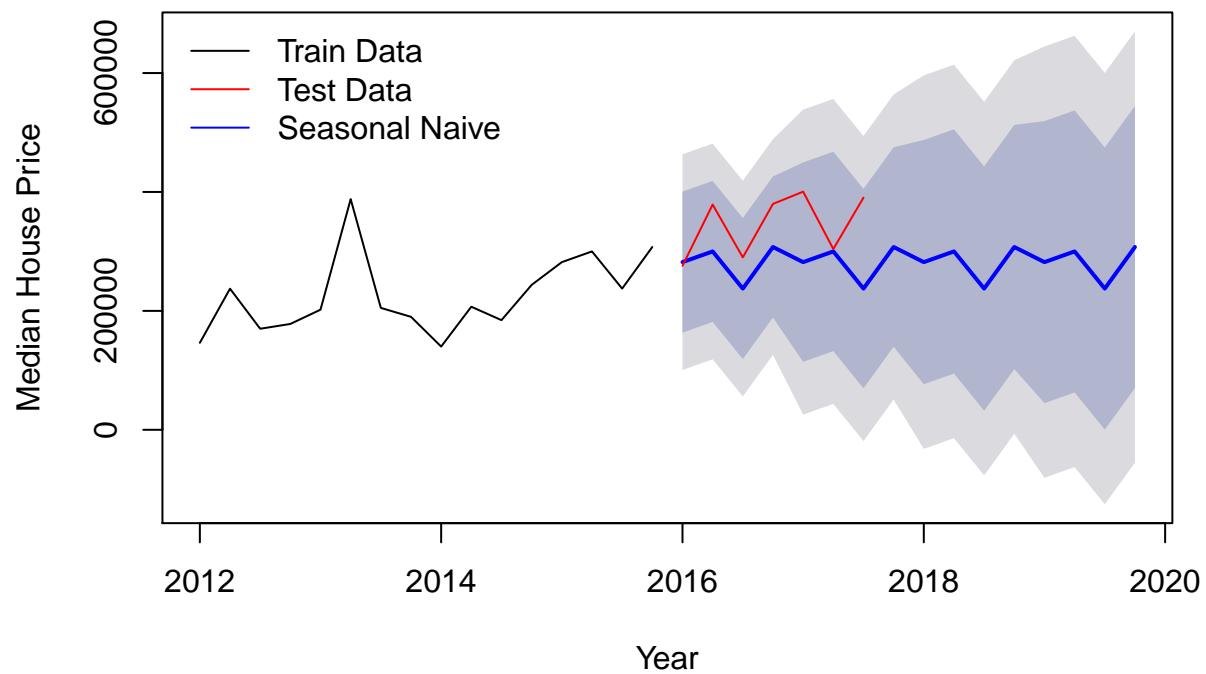
Portland, OR – Powellhurst–Gilbert : Full TS Models Comparison



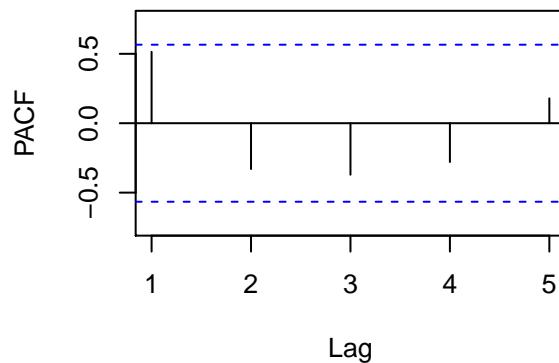
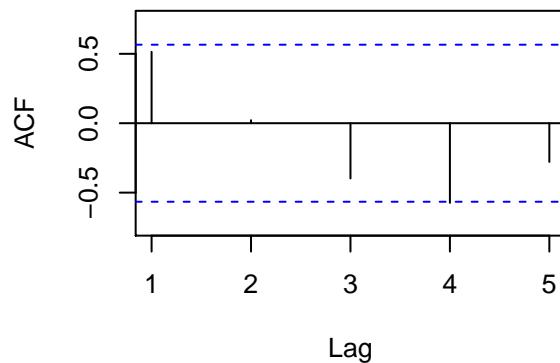
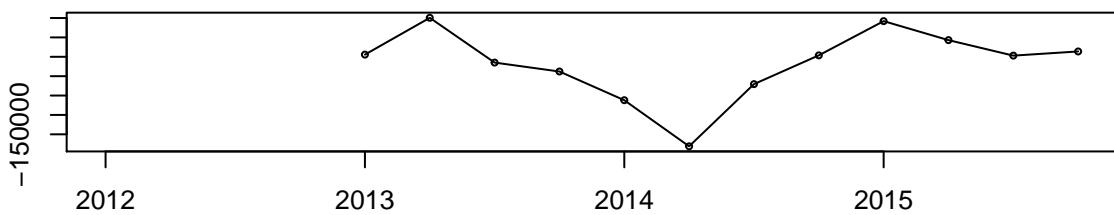
Portland, OR – East Columbia



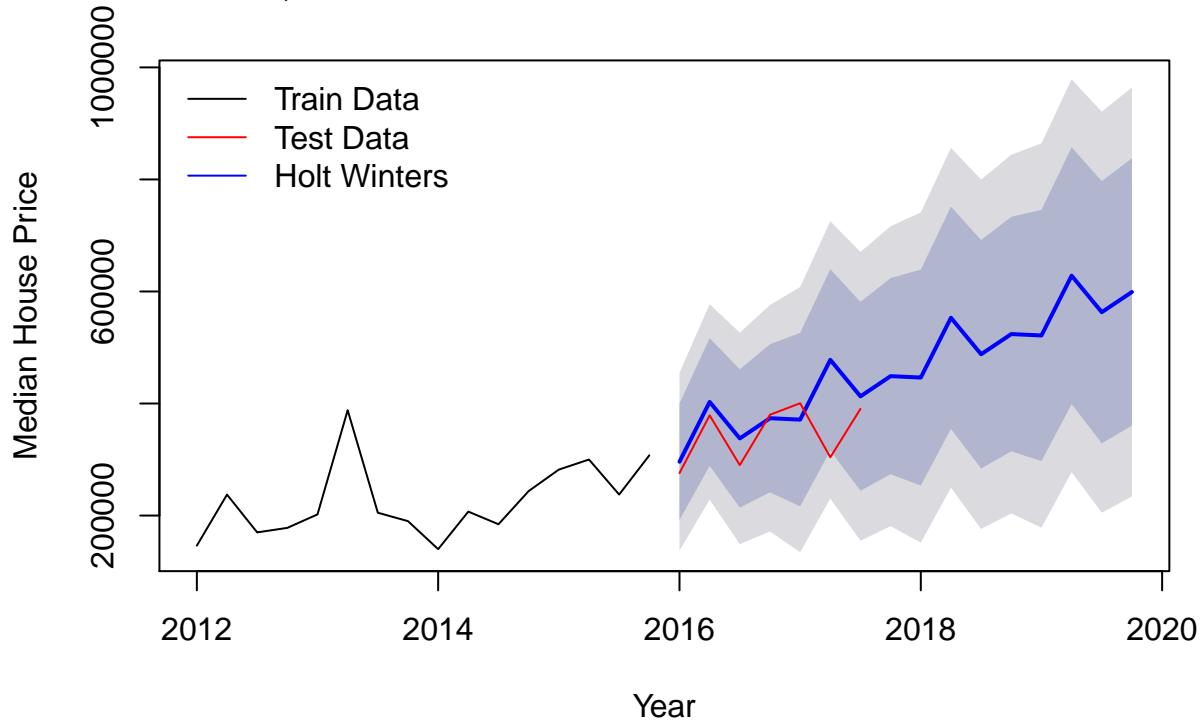
Portland, OR – East Columbia : Naive Model Forecast



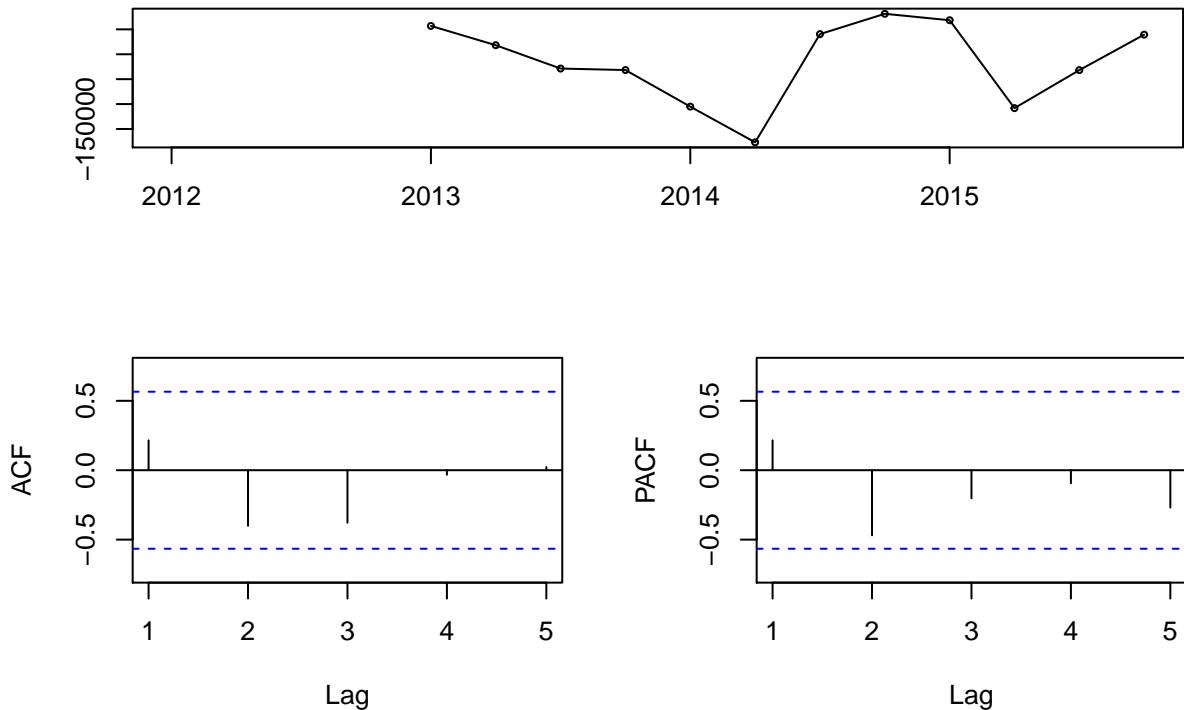
Portland, OR – East Columbia : Naive Model Forecast Residuals



Portland, OR – East Columbia : Holt Winters Model Forecast



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

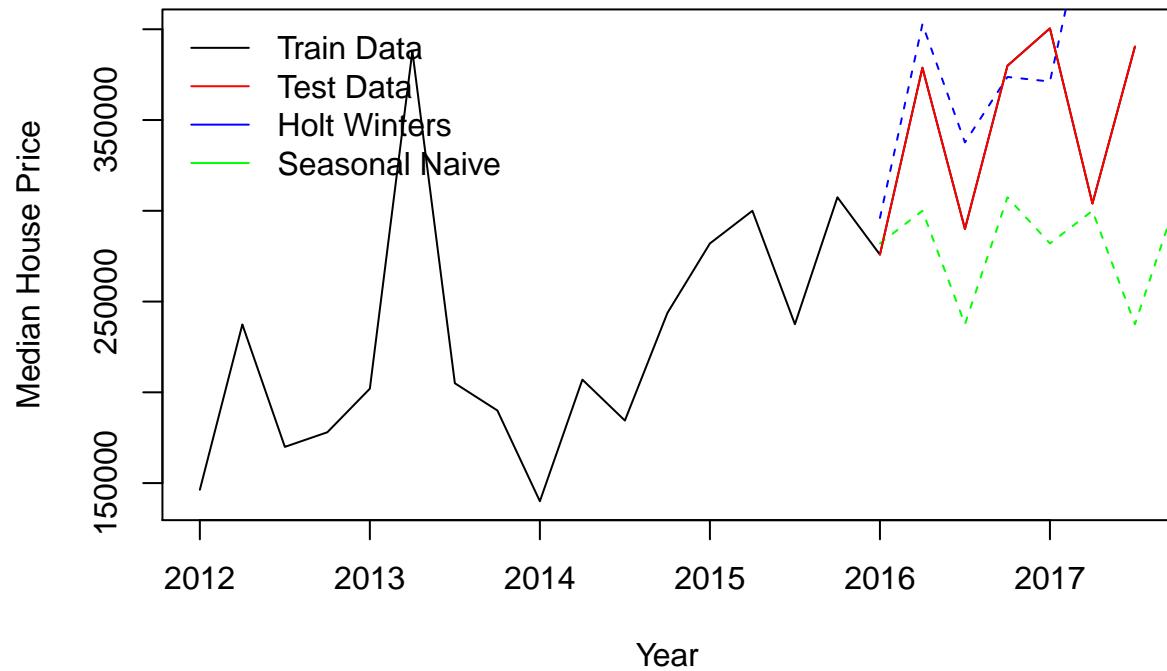


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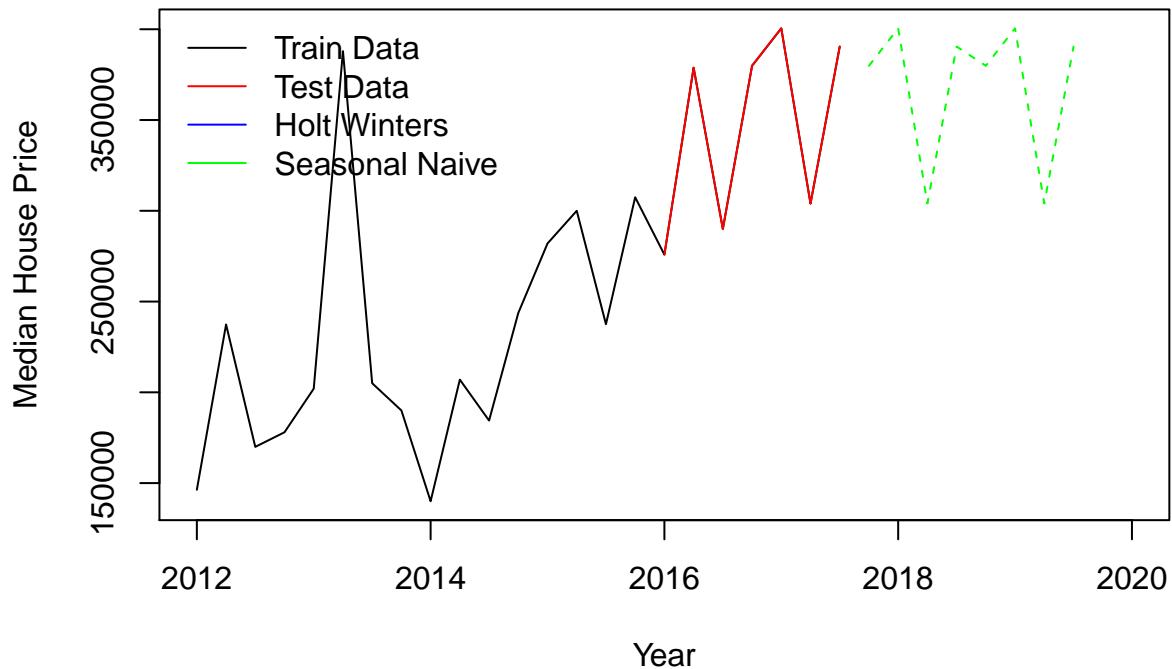
## [1] "Seasonal Naive Accuracy for Portland, OR - East Columbia"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 32939.75 92522.82 76856.42  7.783401 31.59047 1.0000000
## Test set     67583.57 85947.97 69339.29 17.976120 18.61259 0.9021925
##          ACF1 Theil's U
## Training set  0.5143958      NA
## Test set      -0.4807355  1.090268
## [1] "Holt Winters Accuracy for Portland, OR - East Columbia"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set -14813.18 78980.96 65561.53 -9.620941 30.48248 0.8530391
## Test set     -36093.14 70608.76 46229.37 -12.012674 14.56746 0.6015031
##          ACF1 Theil's U
## Training set  0.2153089      NA
## Test set      -0.3329082  0.719495

```

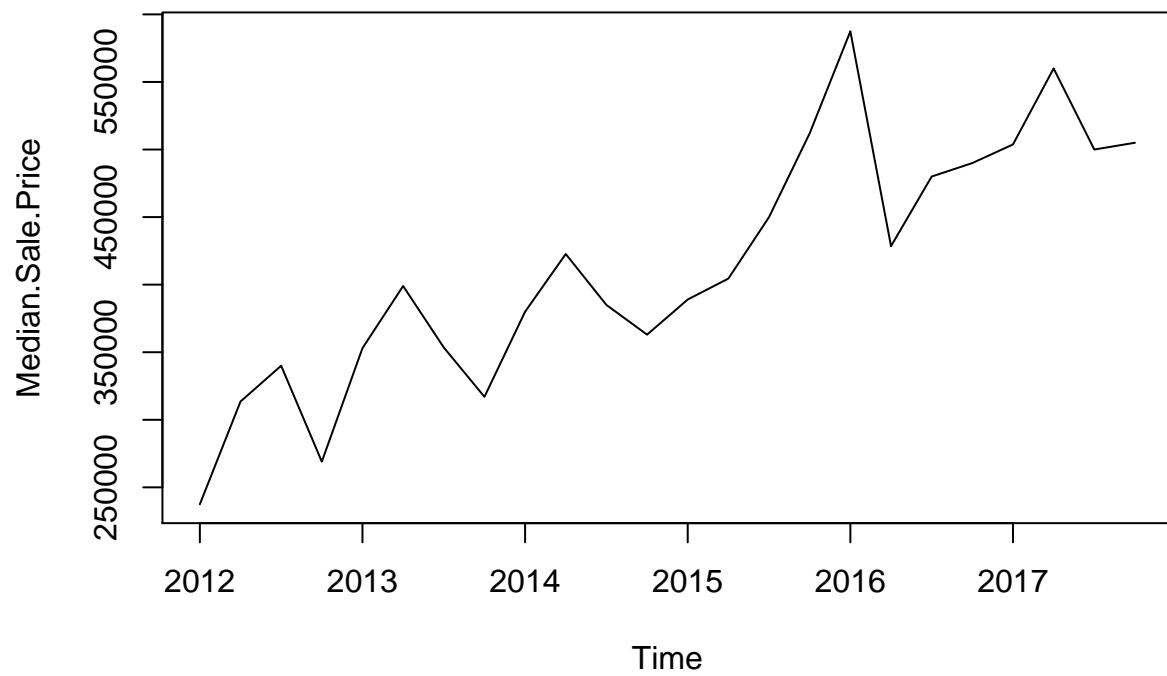
Portland, OR – East Columbia : TS Training Model Comparison



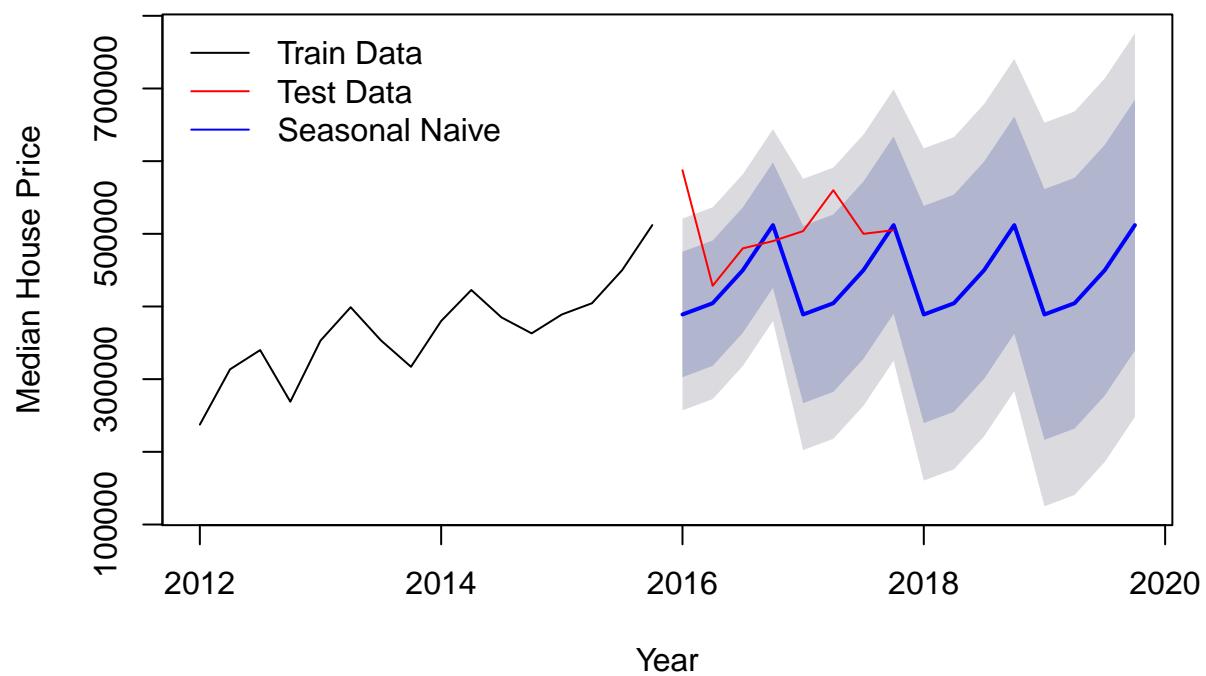
Portland, OR – East Columbia : Full TS Models Comparison



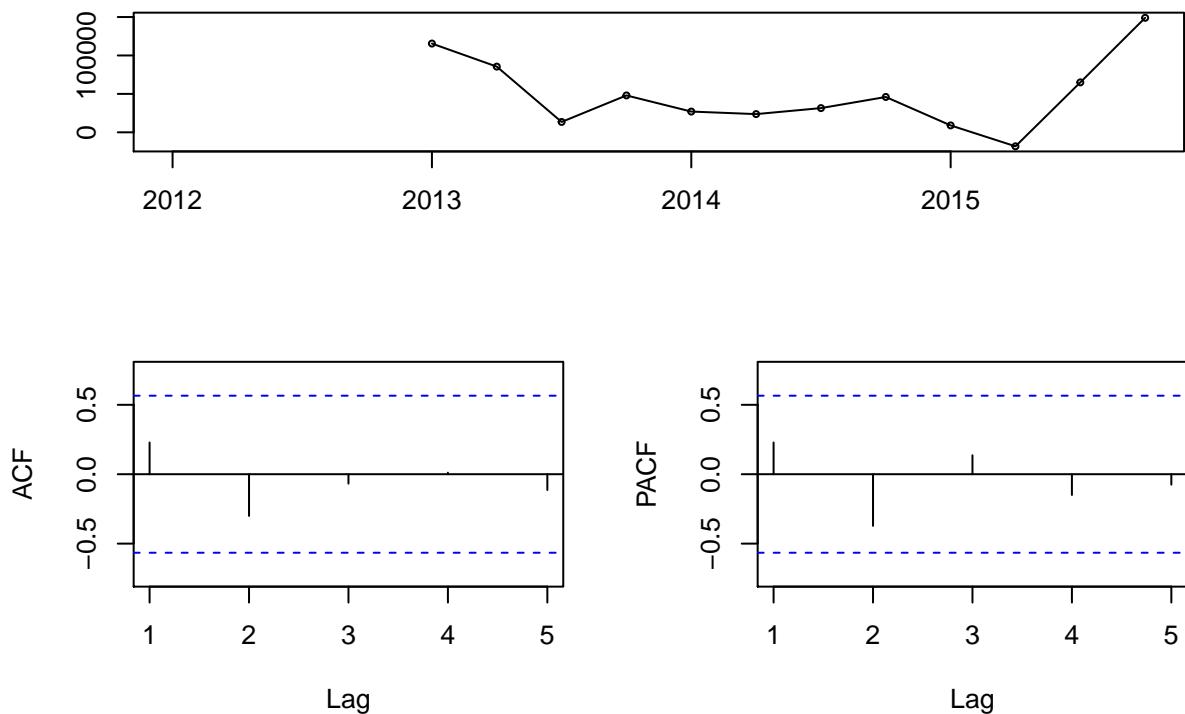
Portland, OR – Humboldt



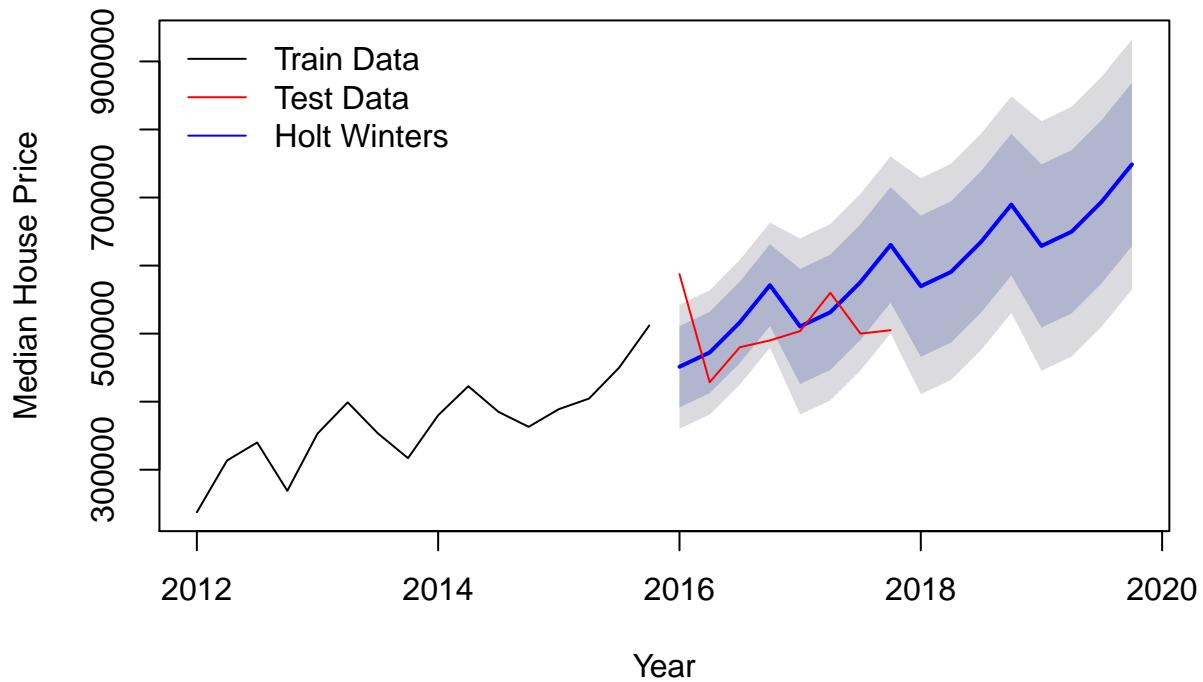
Portland, OR – Humboldt : Naive Model Forecast



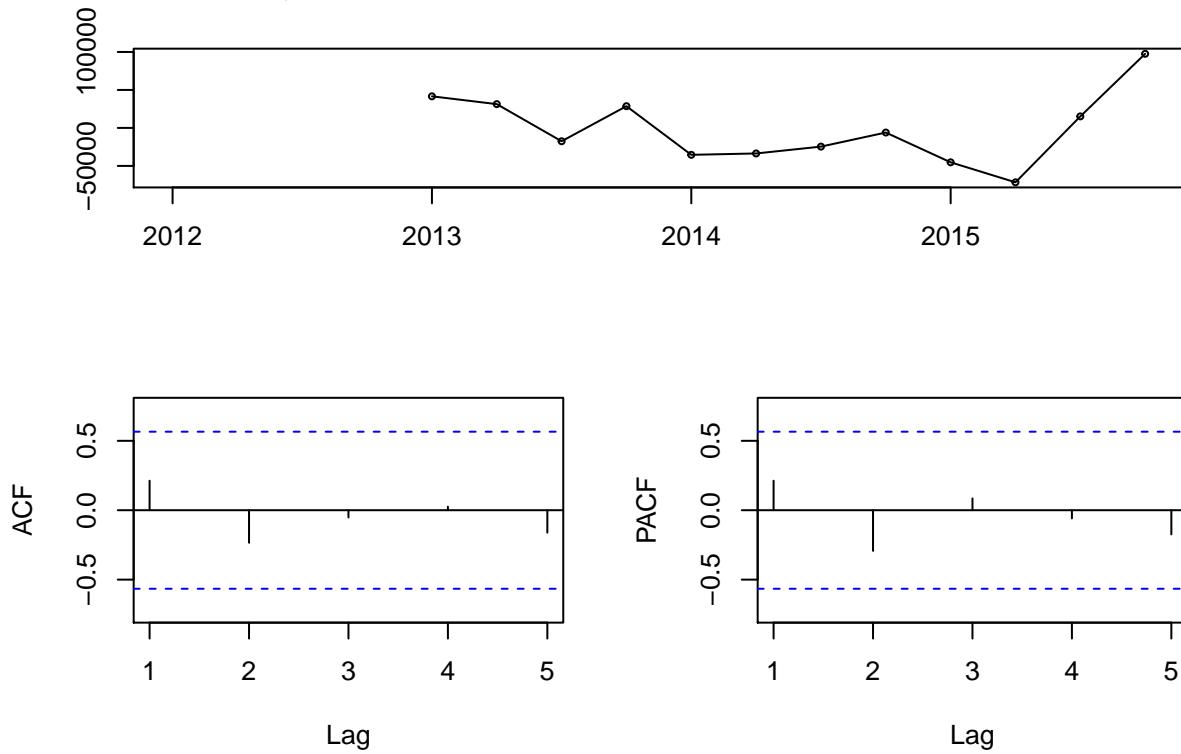
Portland, OR – Humboldt : Naive Model Forecast Residuals



Portland, OR – Humboldt : Holt Winters Model Forecast



Portland, OR – Humboldt : Holt Winters Model Forecast Residuals

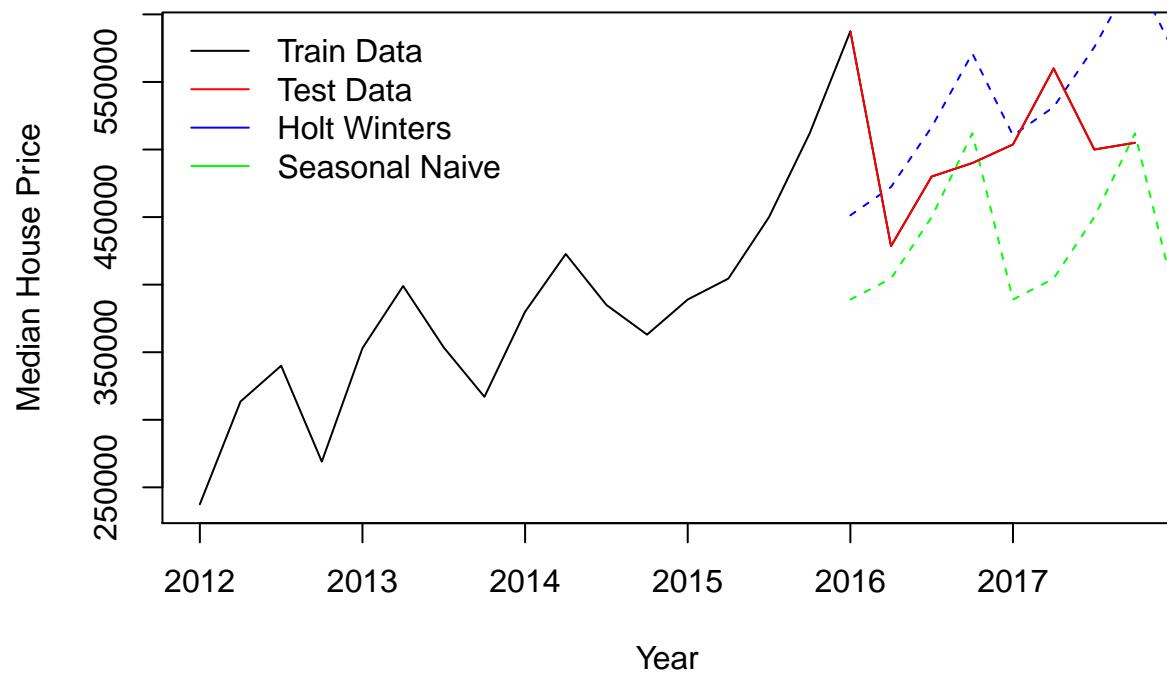


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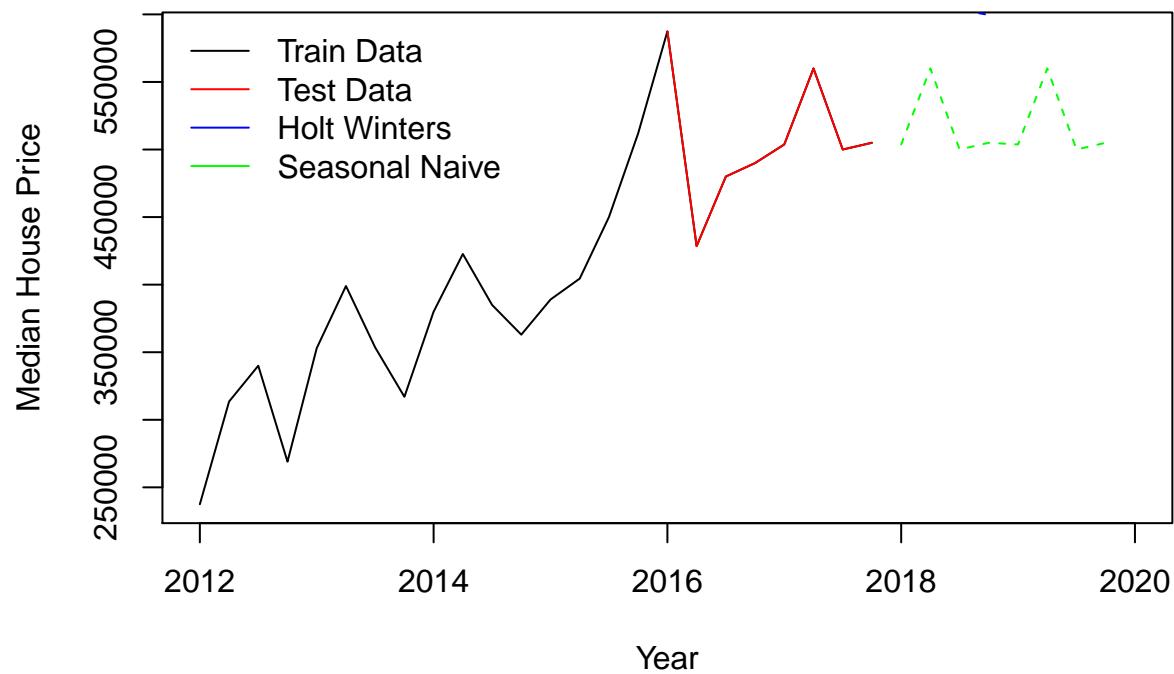
## [1] "Seasonal Naive Accuracy for Portland, OR - Humboldt"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 49625.0 67313.9 52658.33 12.33628 13.08618 1.000000
## Test set     67962.5 100771.5 75212.50 12.53795 14.00693 1.428311
##          ACF1 Theil's U
## Training set 0.22853029      NA
## Test set     -0.02239358  1.21596
## [1] "Holt Winters Accuracy for Portland, OR - Humboldt"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -1650.608 44525.55 37365.88 -0.7114111 9.227041 0.7095909
## Test set     -25583.412 79604.01 66762.22 -5.9296655 12.999021 1.2678376
##          ACF1 Theil's U
## Training set 0.212553049      NA
## Test set     0.002992962  1.056333

```

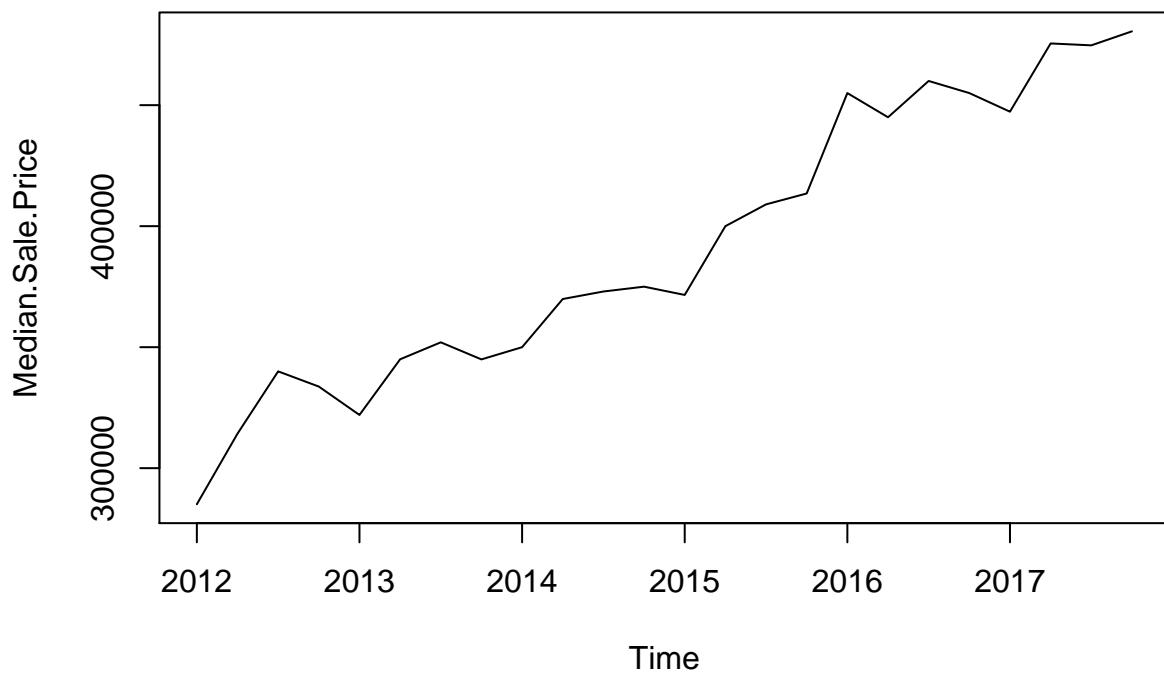
Portland, OR – Humboldt : TS Training Model Comparison



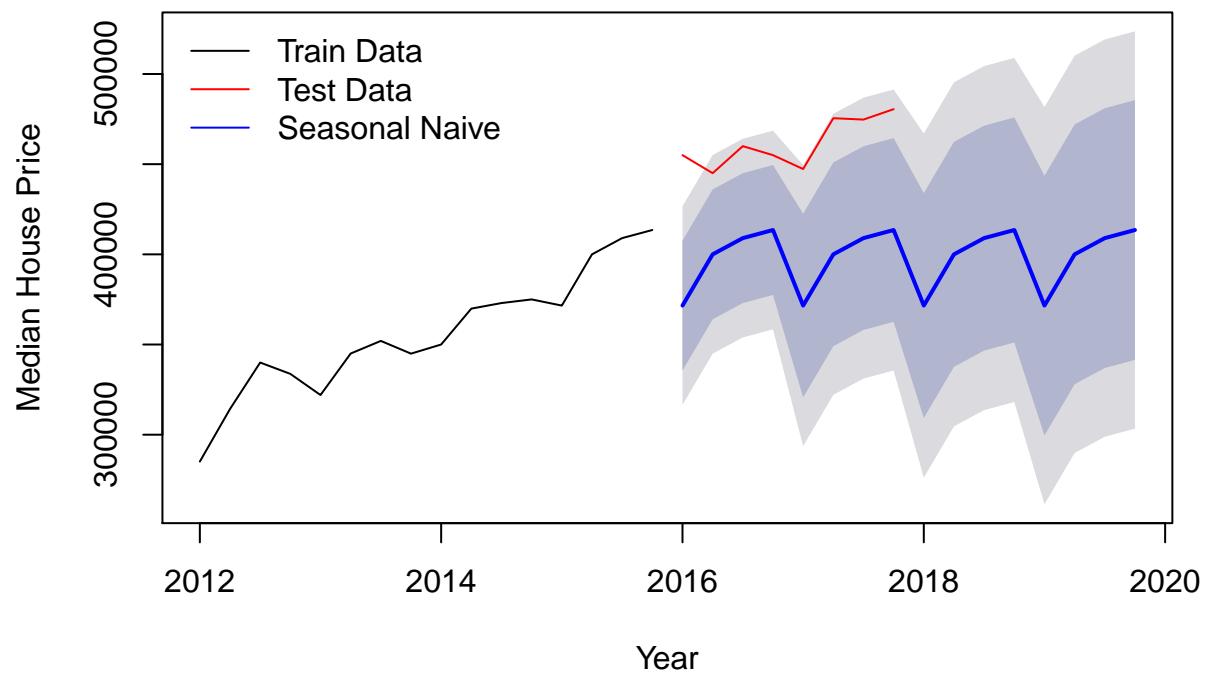
Portland, OR – Humboldt : Full TS Models Comparison



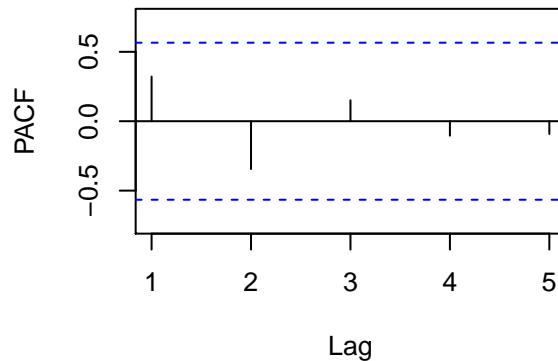
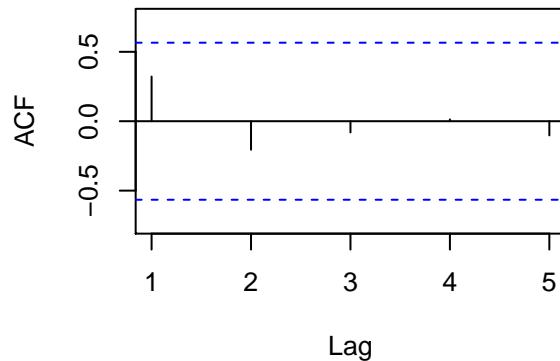
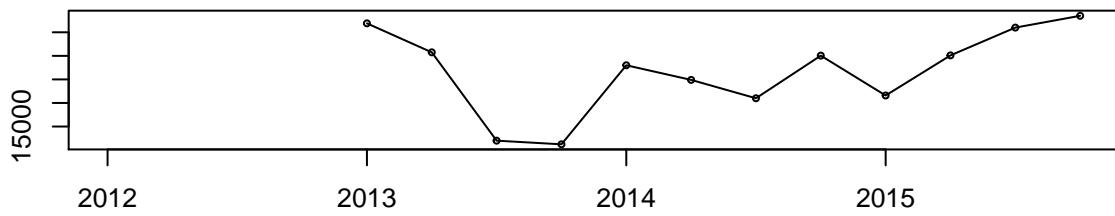
Portland, OR – Lair Hill



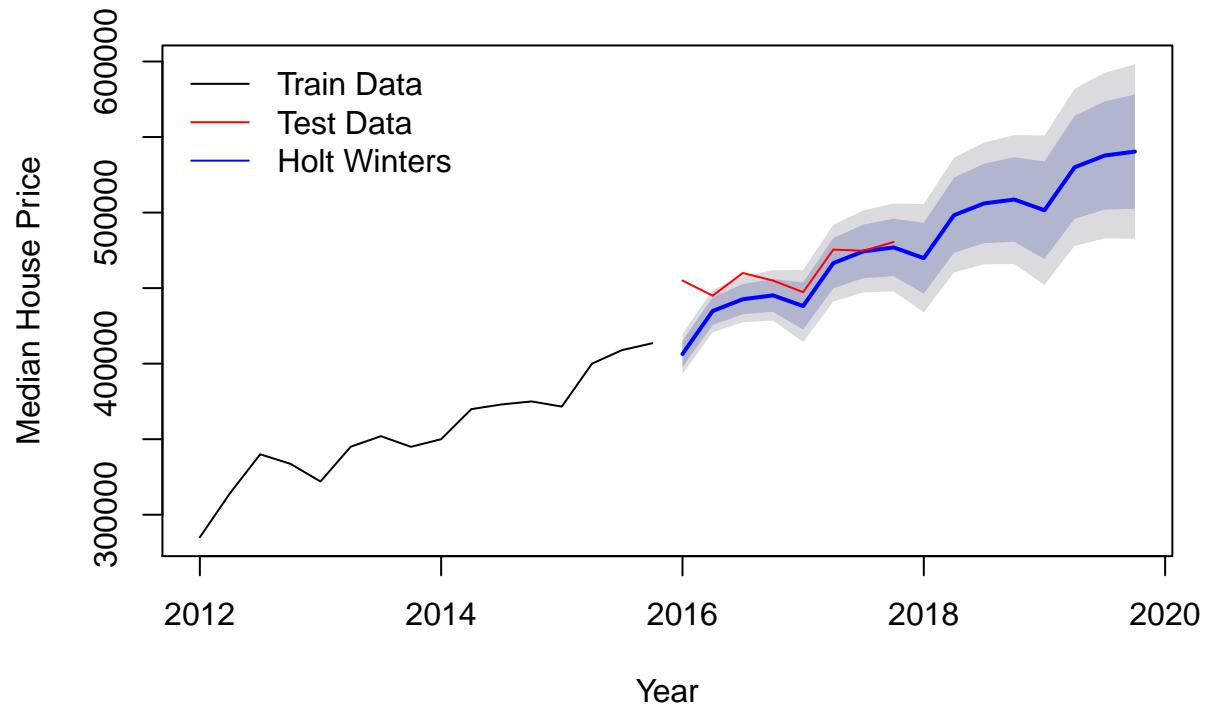
Portland, OR – Lair Hill : Naive Model Forecast



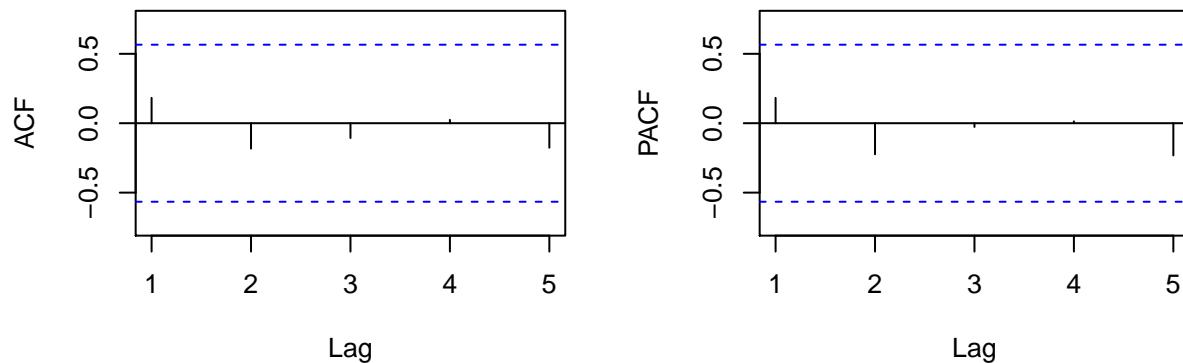
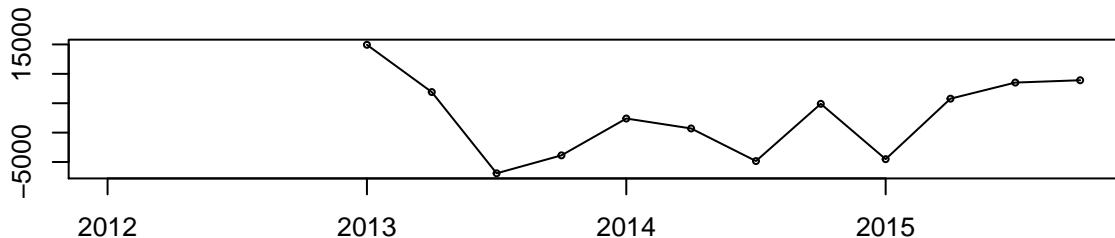
Portland, OR – Lair Hill : Naive Model Forecast Residuals



Portland, OR – Lair Hill : Holt Winters Model Forecast

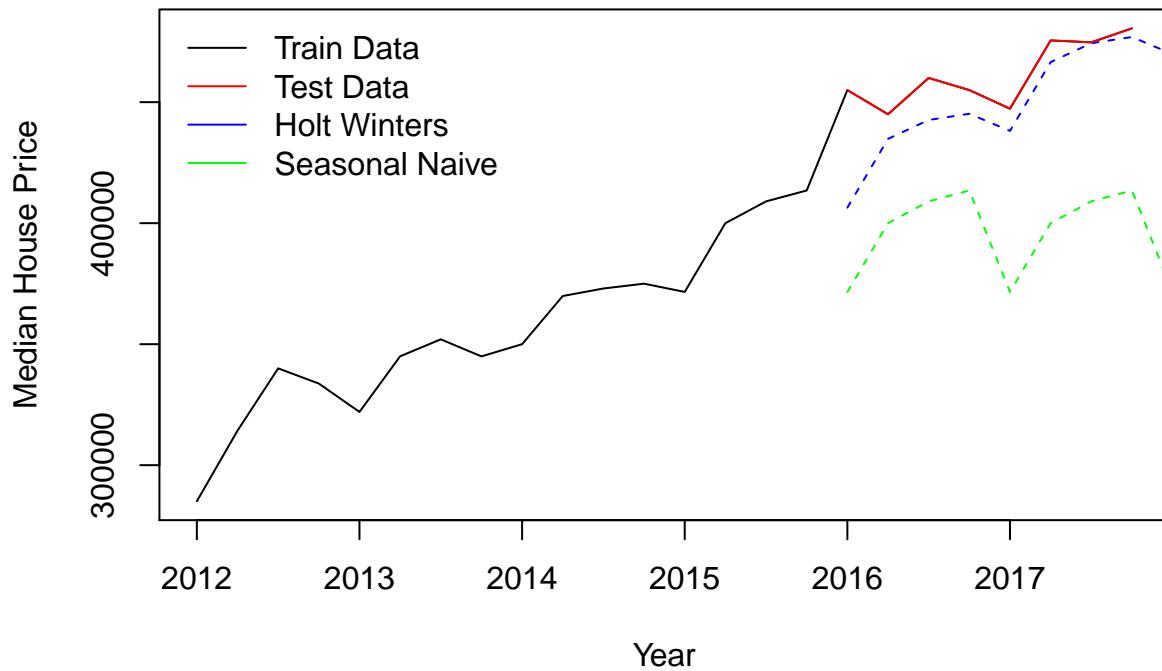


Portland, OR – Lair Hill : Holt Winters Model Forecast Residuals

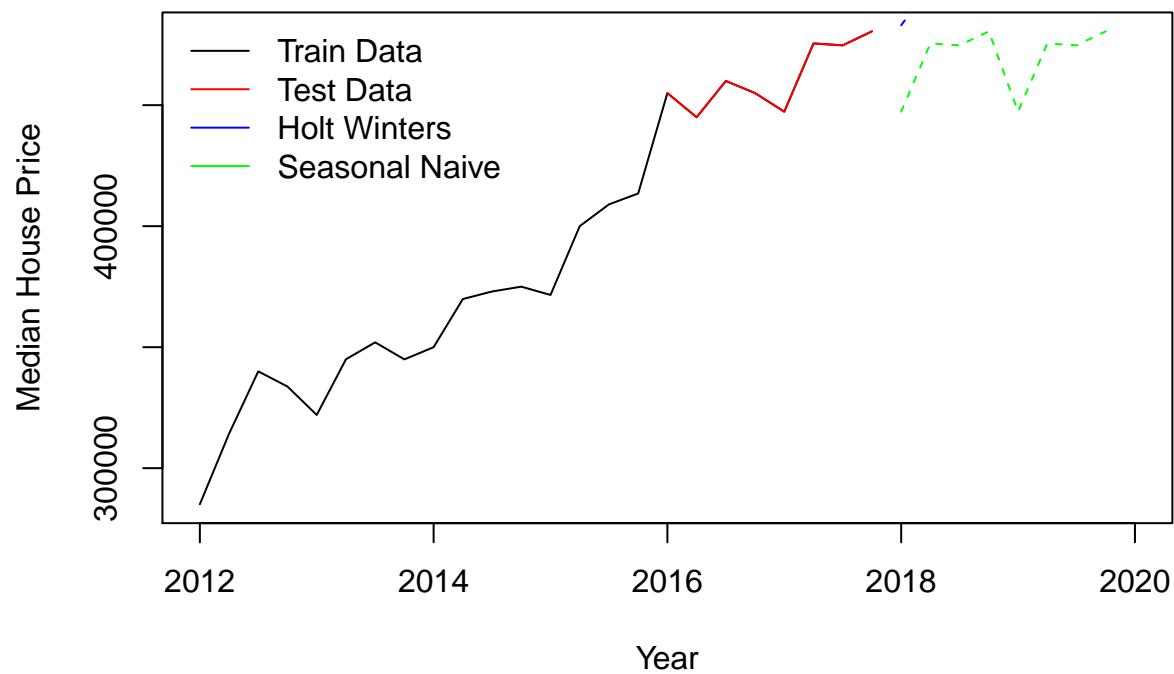


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Lair Hill"
##          ME      RMSE       MAE       MPE       MAPE      MASE
## Training set 26751.04 28100.22 26751.04 7.238168 7.238168 1.000000
## Test set     63106.62 64757.10 63106.62 13.655805 13.655805 2.359034
##          ACF1 Theil's U
## Training set 0.32194768      NA
## Test set     0.02337939 4.532371
## [1] "Holt Winters Accuracy for Portland, OR – Lair Hill"
##          ME      RMSE       MAE       MPE       MAPE      MASE
## Training set 2740.505 7029.171 6098.659 0.7415727 1.675162 0.2279784
## Test set     13497.532 19489.920 13497.532 2.9556874 2.955687 0.5045610
##          ACF1 Theil's U
## Training set 0.18283949      NA
## Test set     0.05147343 0.7370467
```

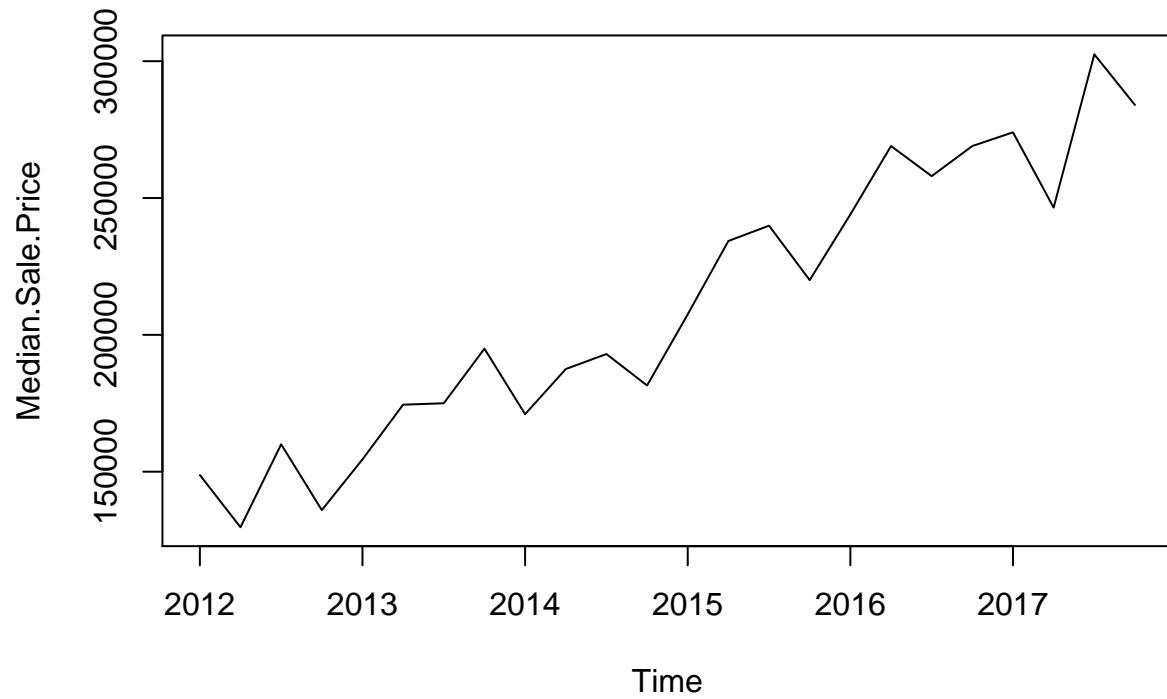
Portland, OR – Lair Hill : TS Training Model Comparison



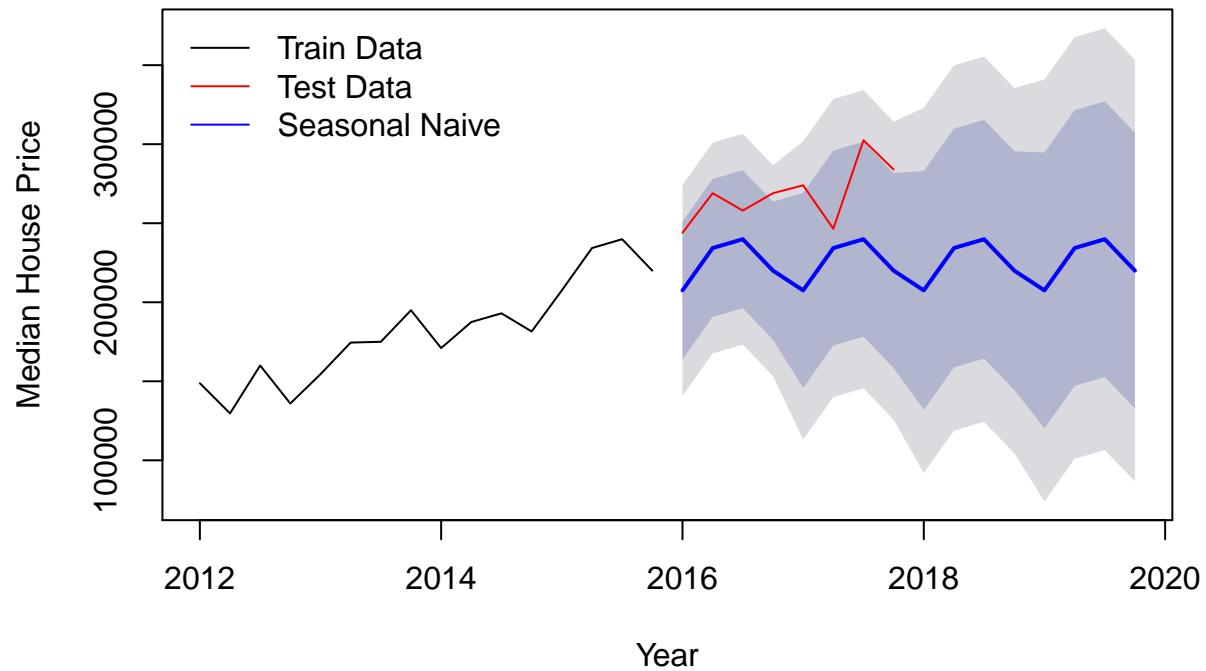
Portland, OR – Lair Hill : Full TS Models Comparison



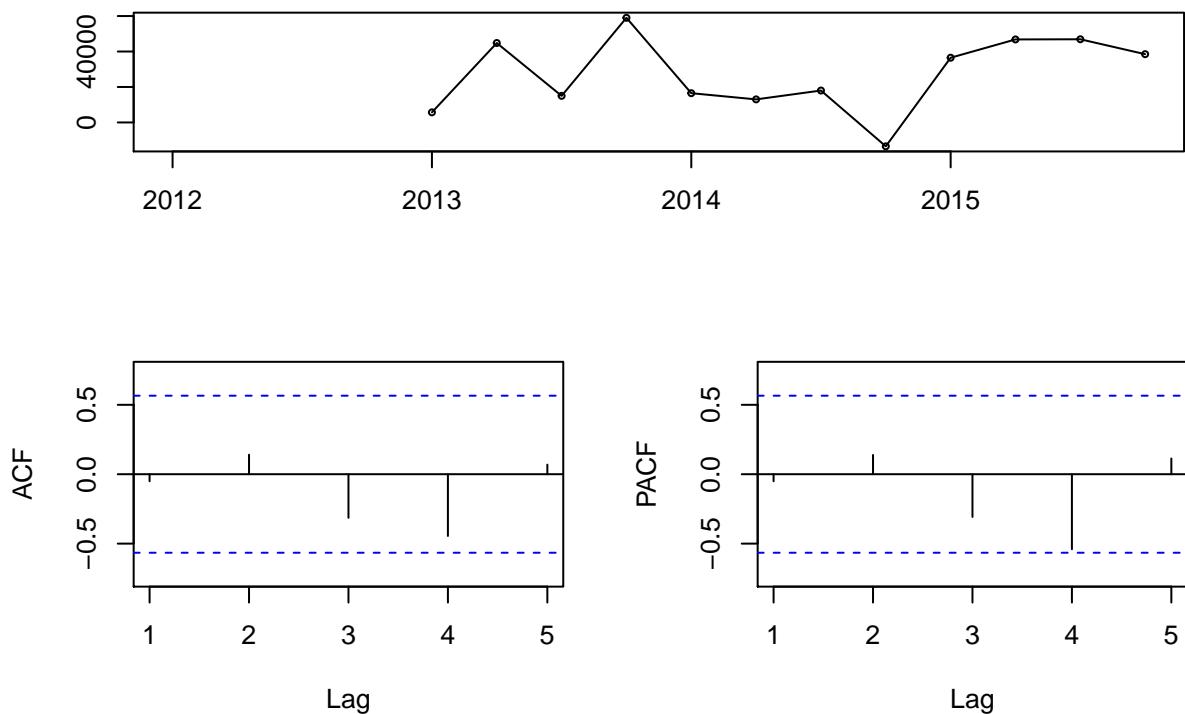
Portland, OR – Mill Park



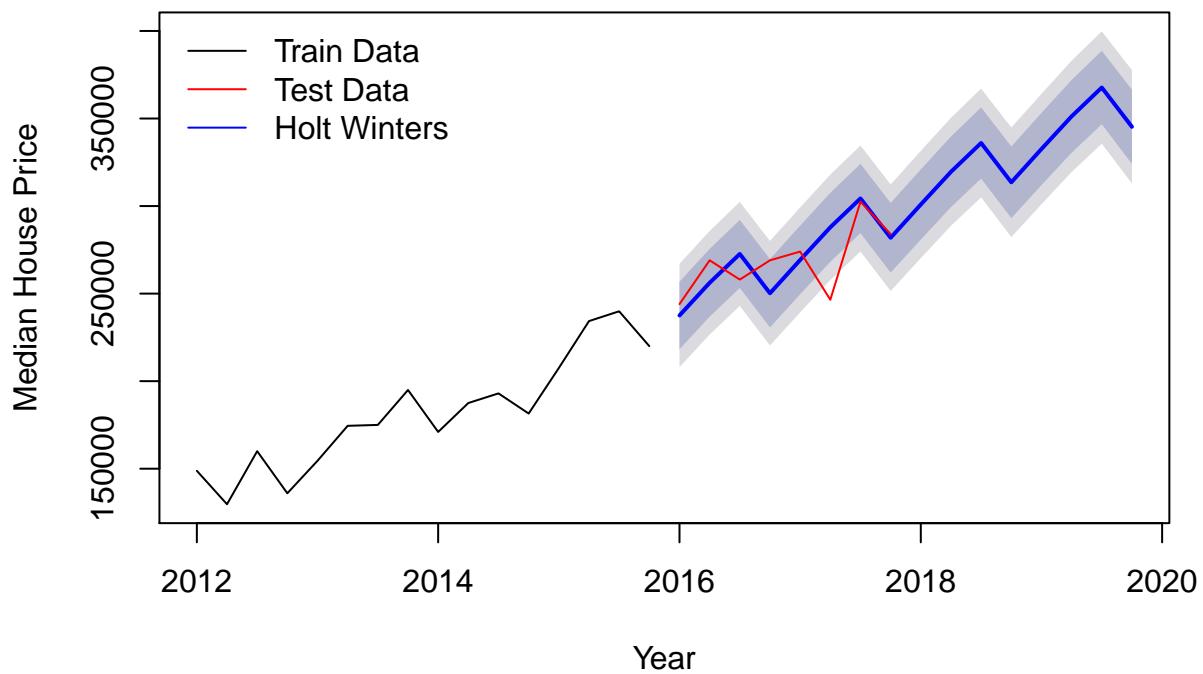
Portland, OR – Mill Park : Naive Model Forecast



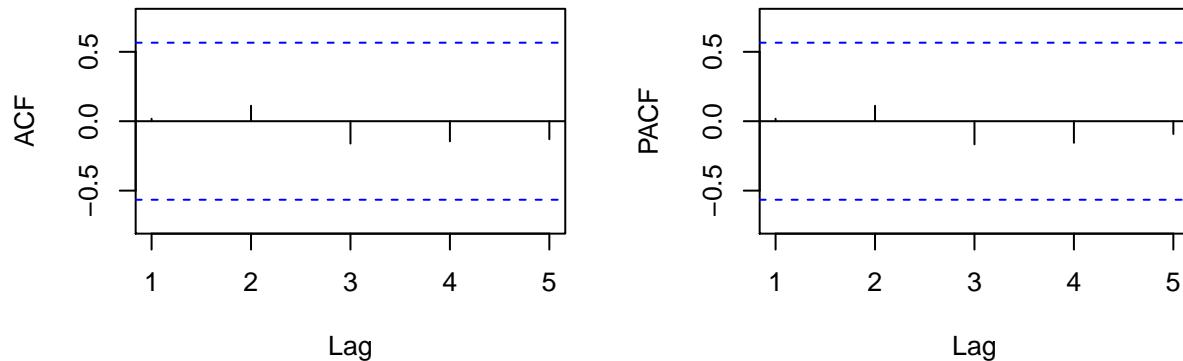
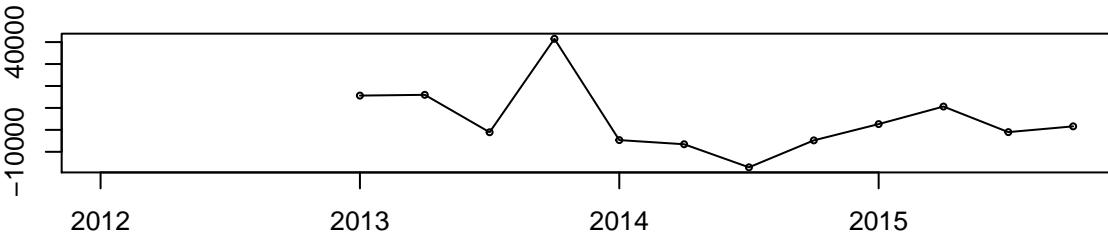
Portland, OR – Mill Park : Naive Model Forecast Residuals



Portland, OR – Mill Park : Holt Winters Model Forecast

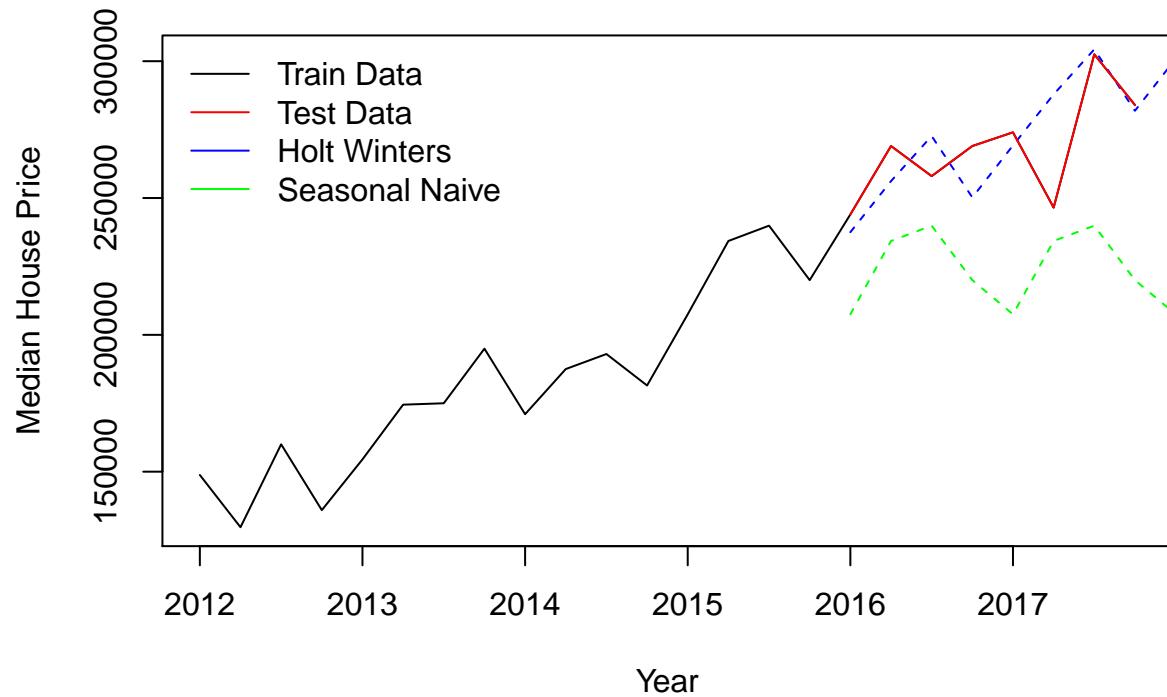


Portland, OR – Mill Park : Holt Winters Model Forecast Residuals

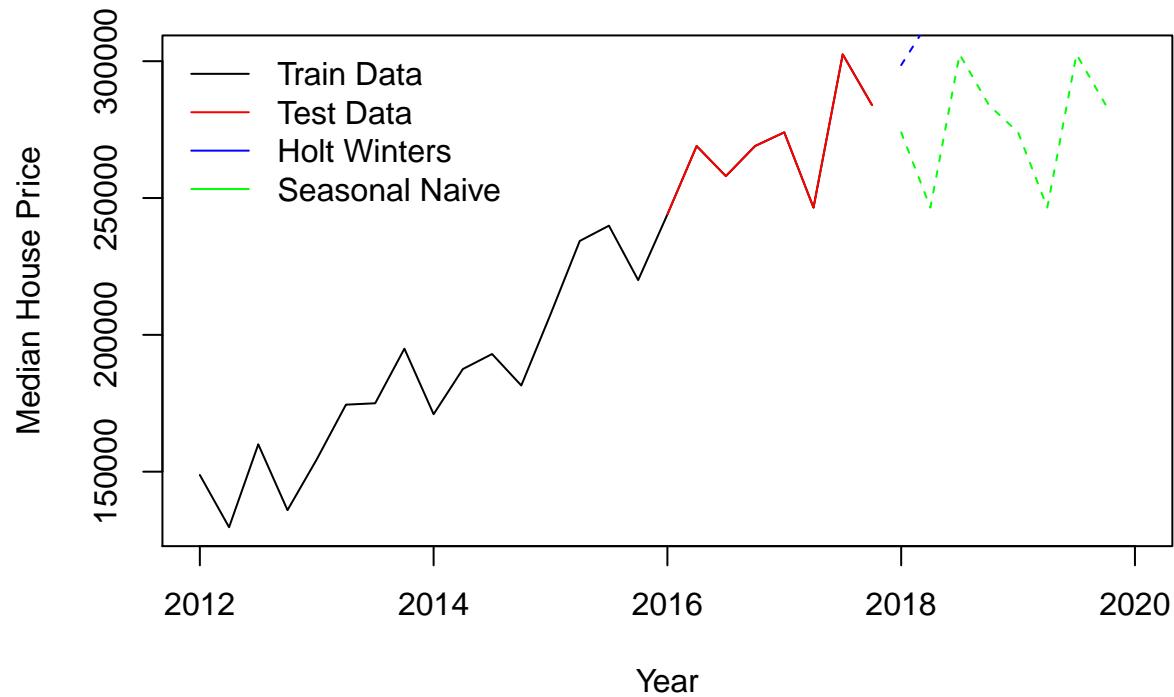


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Mill Park"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 27270.83 34028.93 29512.5 13.44266 14.67774 1.000000
## Test set     42950.00 47237.17 42950.0 15.69232 15.69232 1.455316
##          ACF1 Theil's U
## Training set -0.05079479    NA
## Test set     -0.21479755 1.709835
## [1] "Holt Winters Accuracy for Portland, OR - Mill Park"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 4395.418 15066.0 10260.36 2.359802 5.485600 0.3476614
## Test set     -1605.168 17734.3 12855.52 -0.770167 4.995671 0.4355957
##          ACF1 Theil's U
## Training set  0.01788091    NA
## Test set     -0.18167934 0.6552594
```

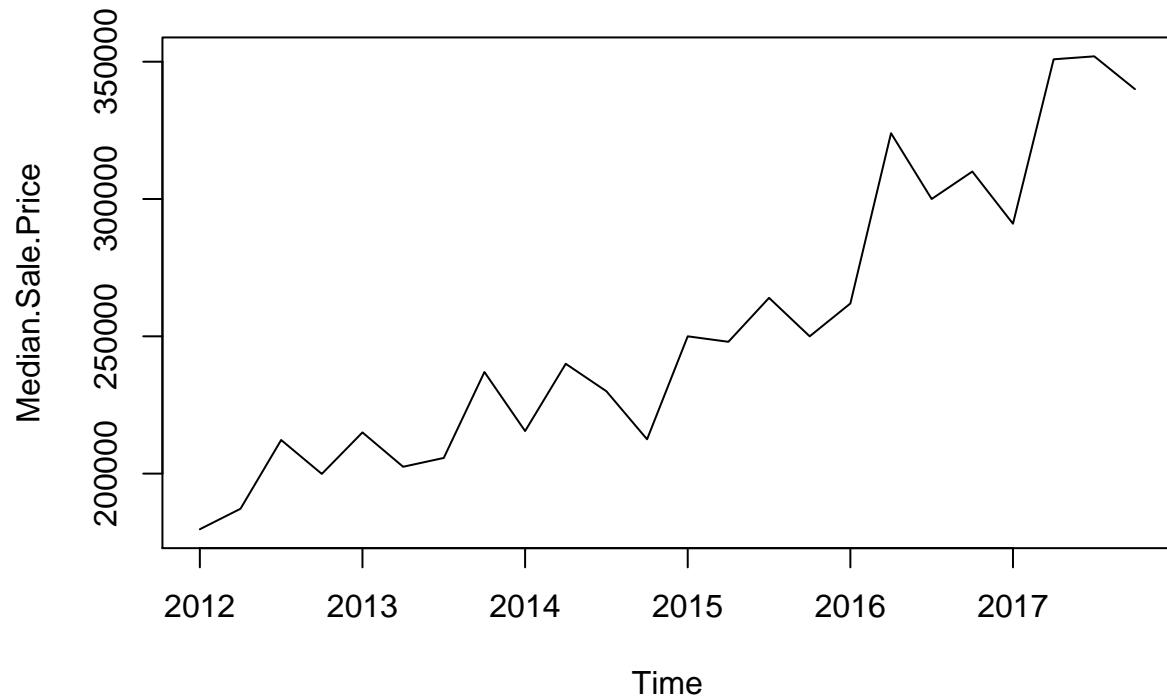
Portland, OR – Mill Park : TS Training Model Comparison



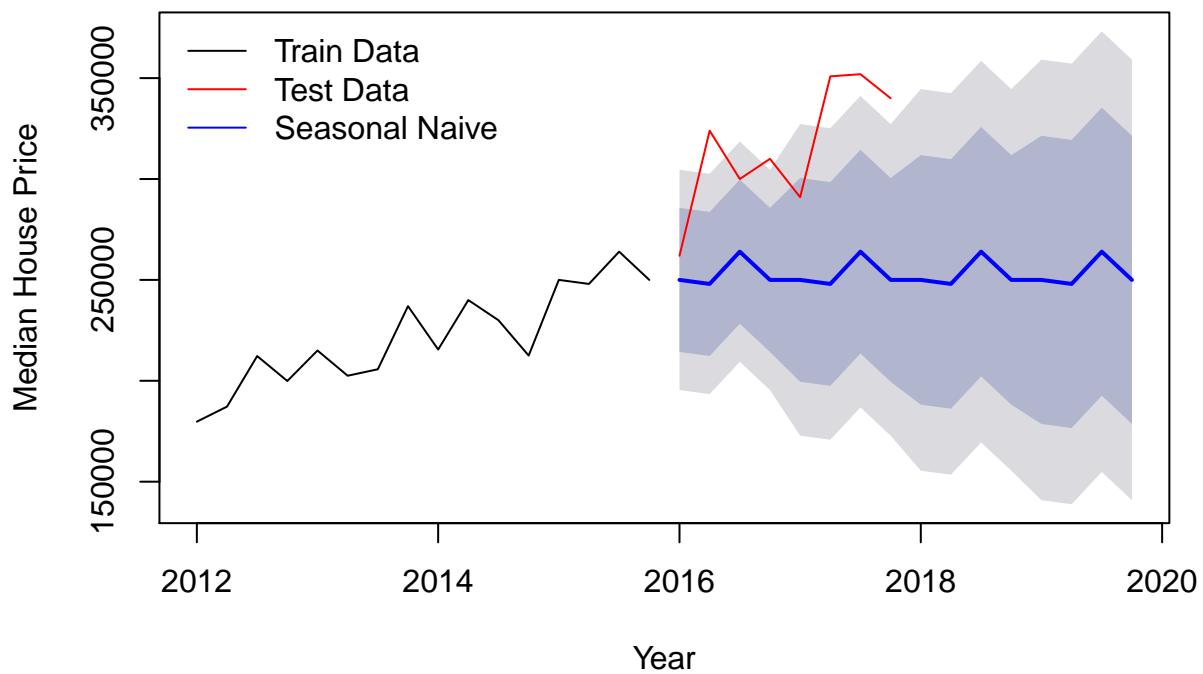
Portland, OR – Mill Park : Full TS Models Comparison



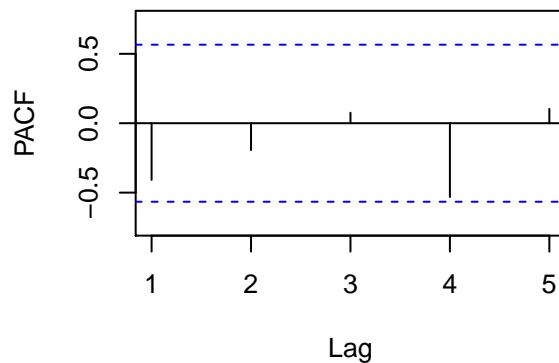
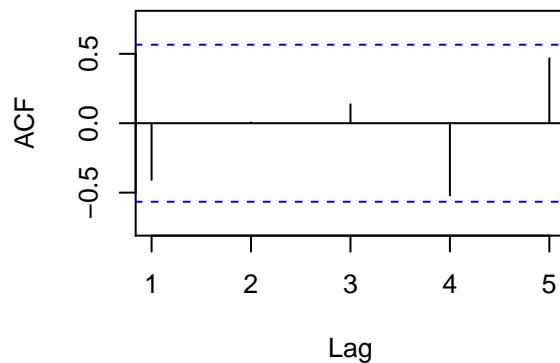
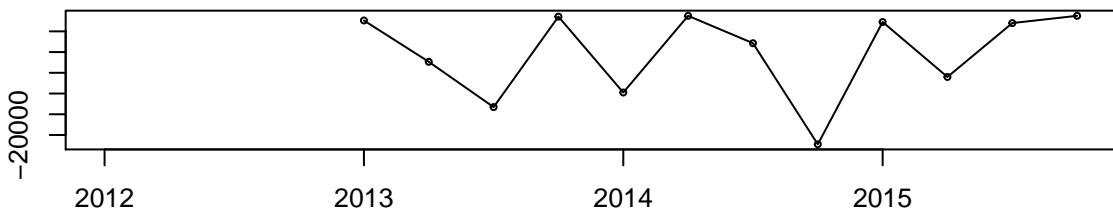
Portland, OR – Russell



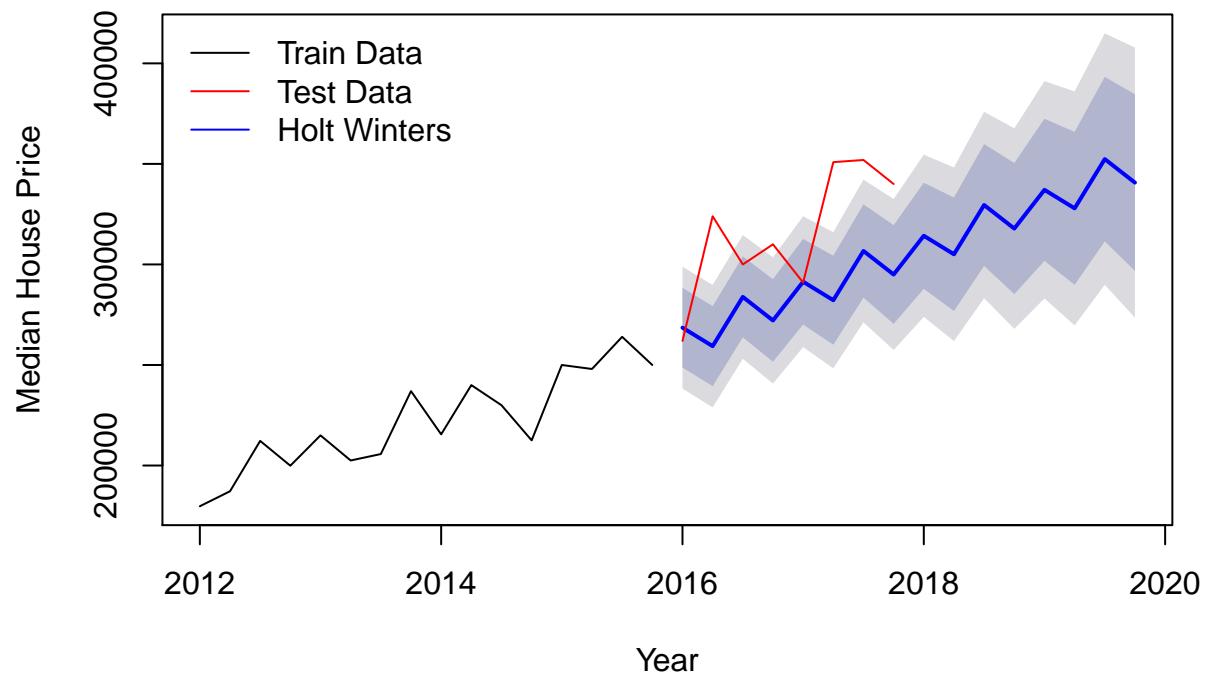
Portland, OR – Russell : Naive Model Forecast



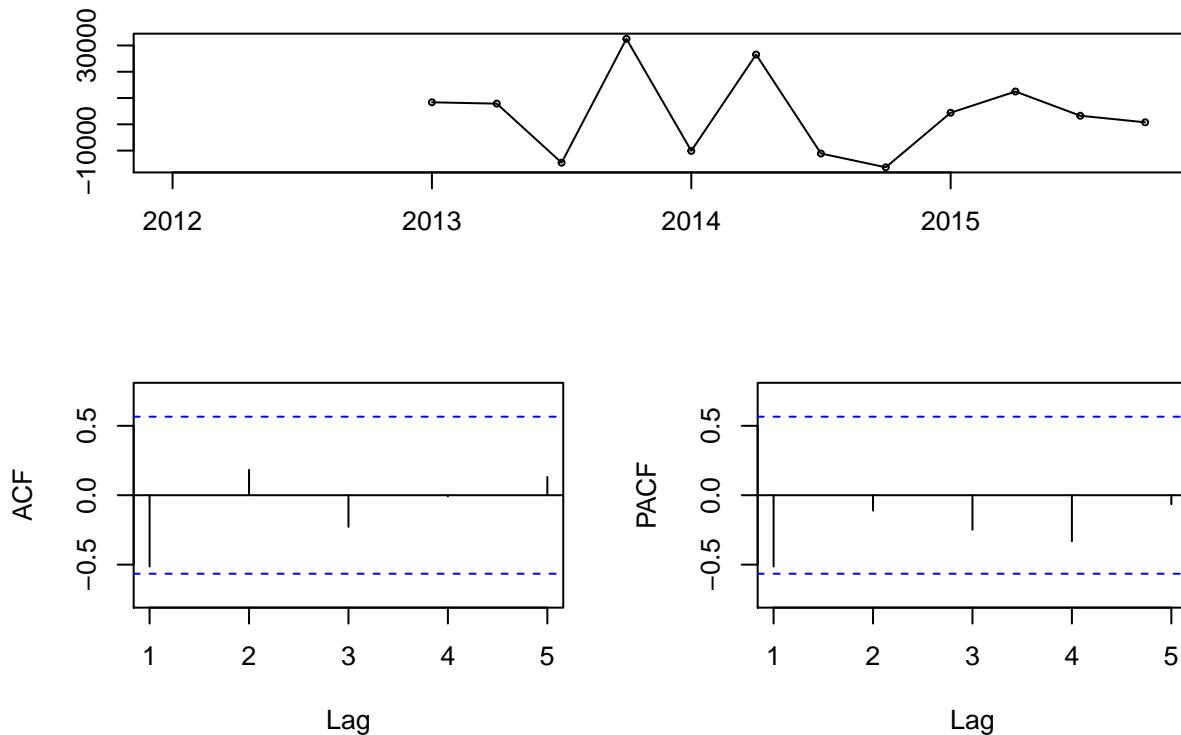
Portland, OR – Russell : Naive Model Forecast Residuals



Portland, OR – Russell : Holt Winters Model Forecast

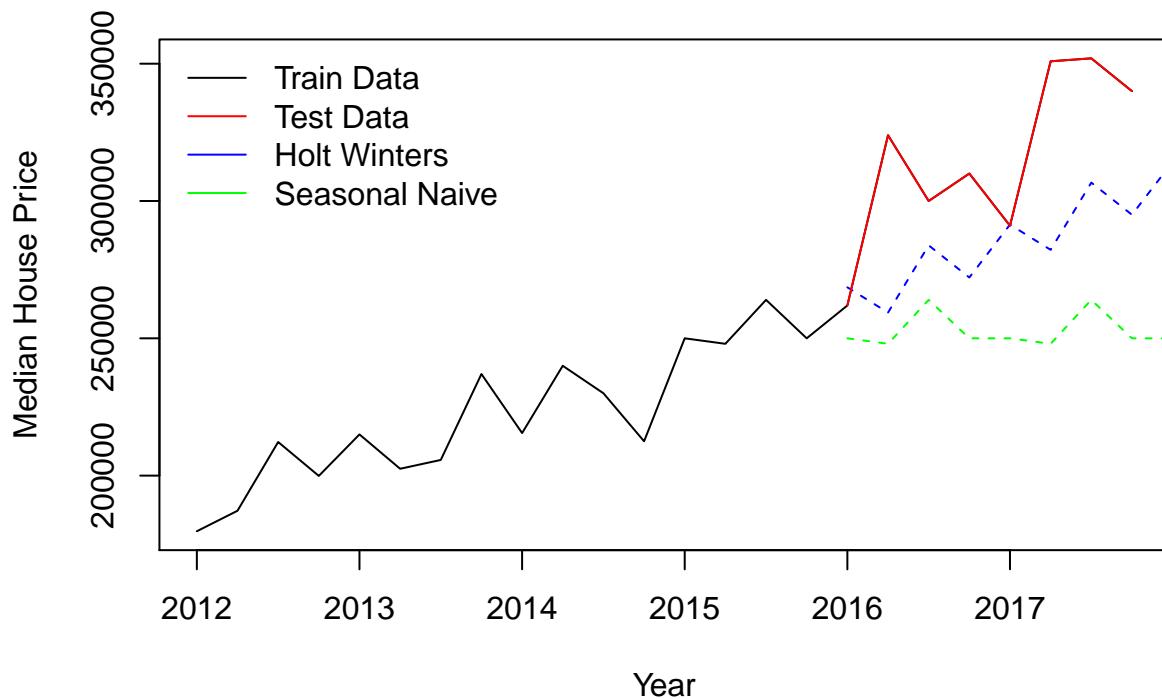


Portland, OR – Russell : Holt Winters Model Forecast Residuals

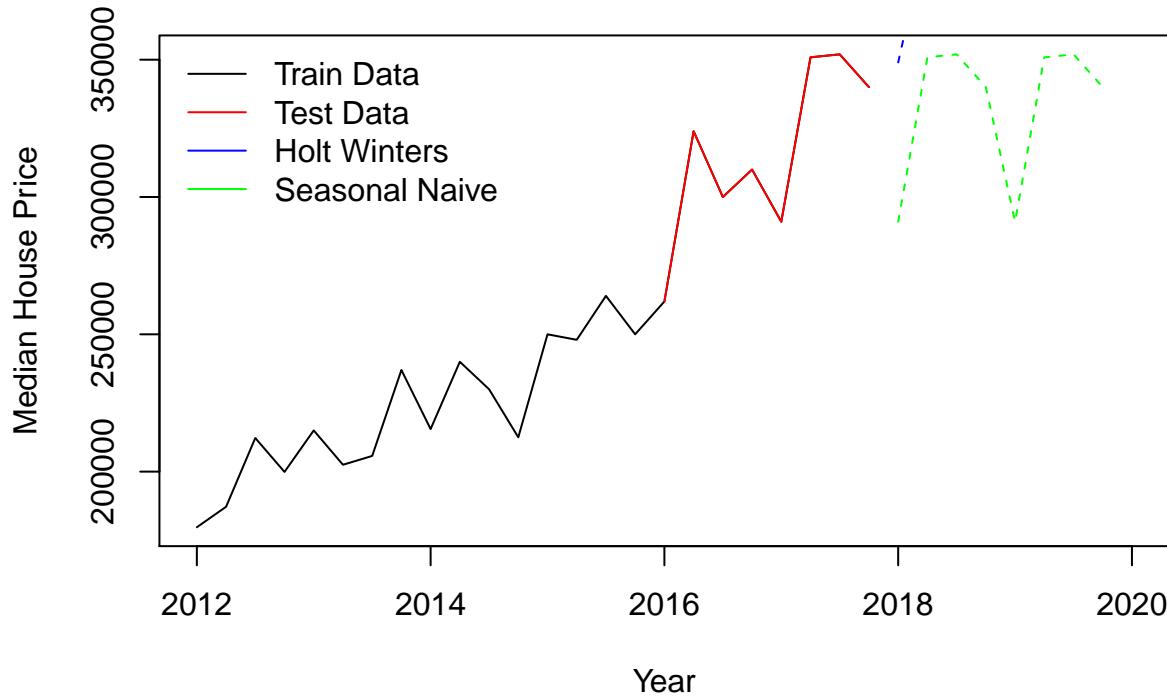


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Russell"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 19408.33 27852.19 24581.25 8.018243 10.46947 1.000000
## Test set     63215.00 69736.82 63215.00 19.278691 19.27869 2.571676
##          ACF1 Theil's U
## Training set -0.40874703      NA
## Test set     -0.01130038 1.925087
## [1] "Holt Winters Accuracy for Portland, OR – Russell"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 3674.292 15241.79 12366.89 1.383663 5.434782 0.5031026
## Test set     33811.093 42862.39 35566.89 10.066240 10.732614 1.4469115
##          ACF1 Theil's U
## Training set -0.5139354      NA
## Test set     -0.4797972 1.236192
```

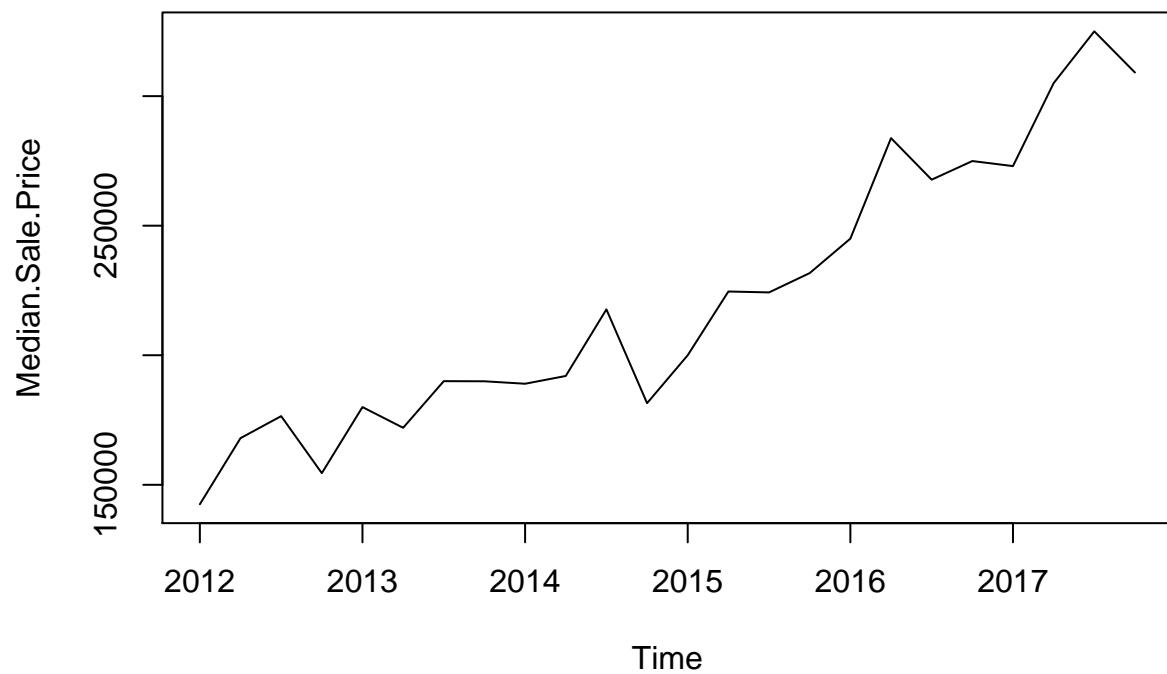
Portland, OR – Russell : TS Training Model Comparison



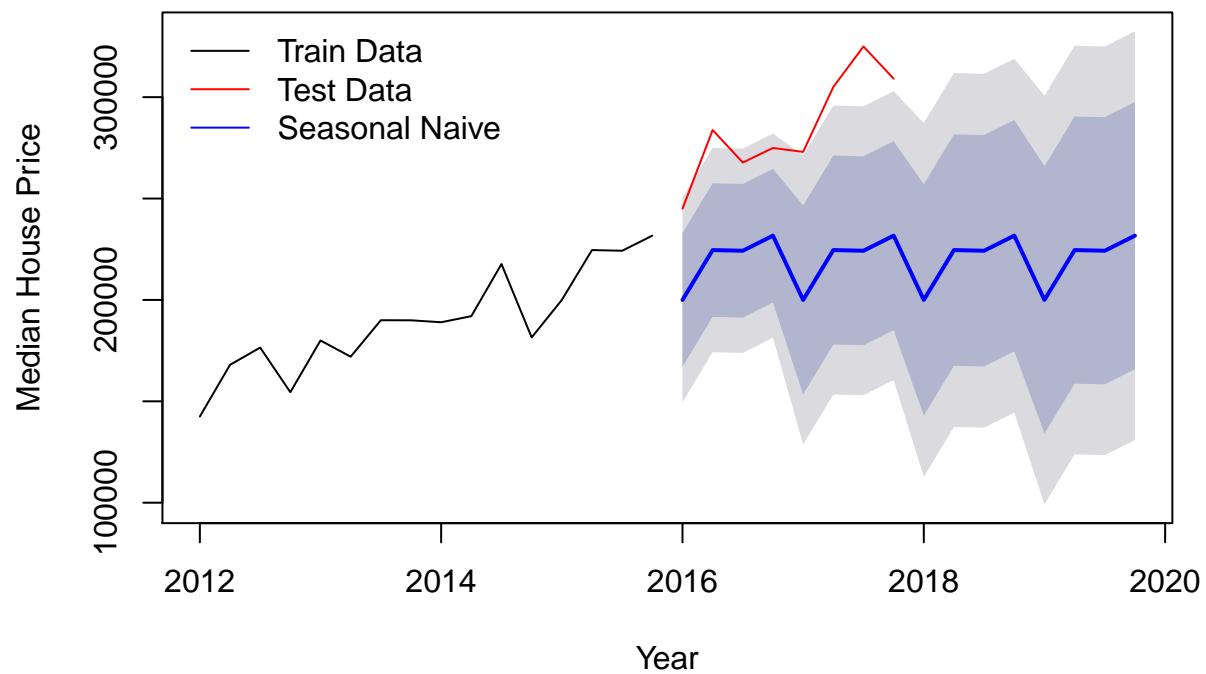
Portland, OR – Russell : Full TS Models Comparison



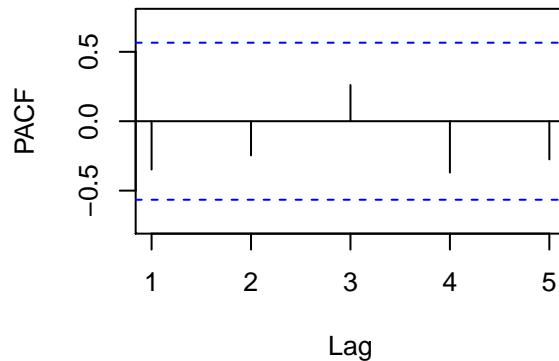
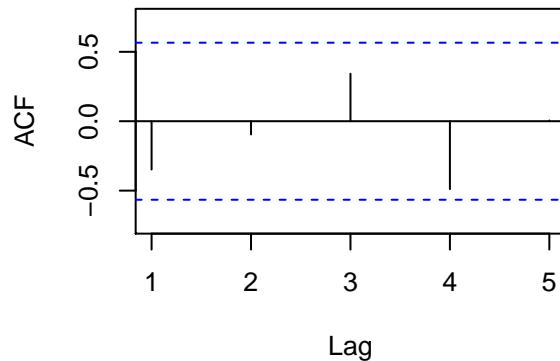
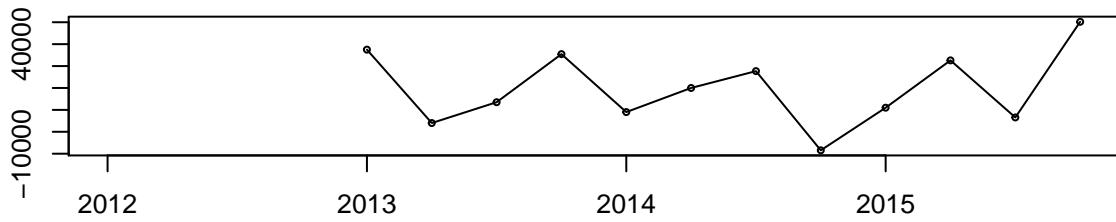
Portland, OR – Hazelwood



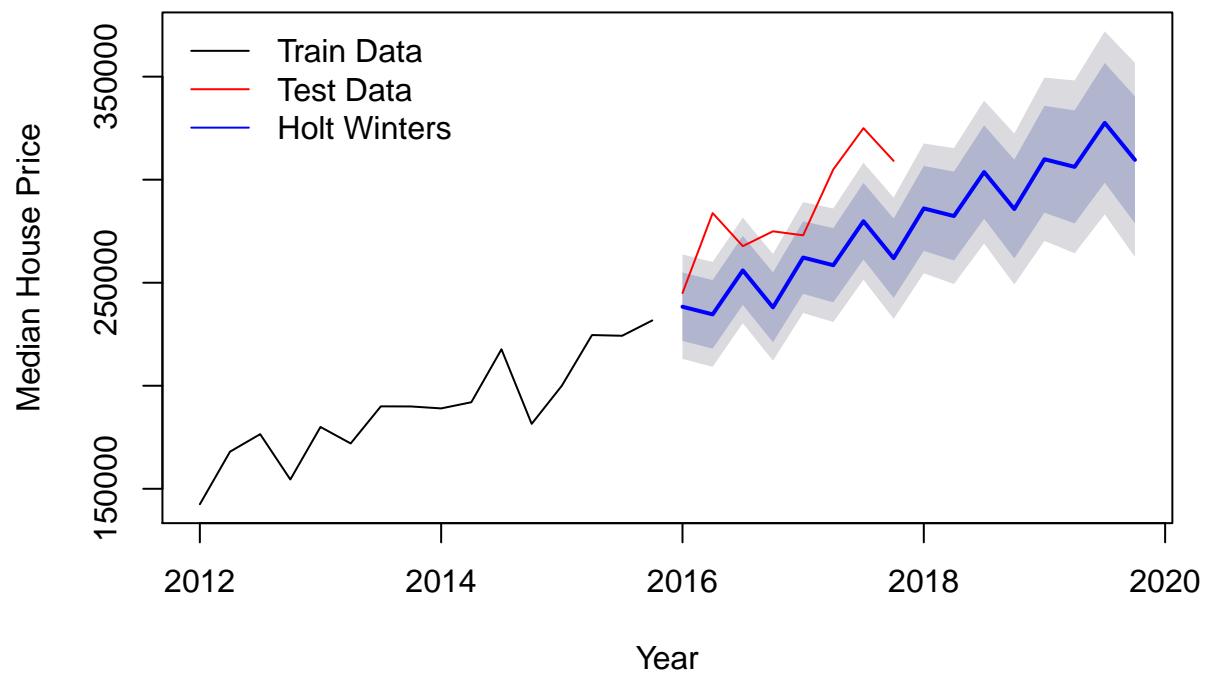
Portland, OR – Hazelwood : Naive Model Forecast



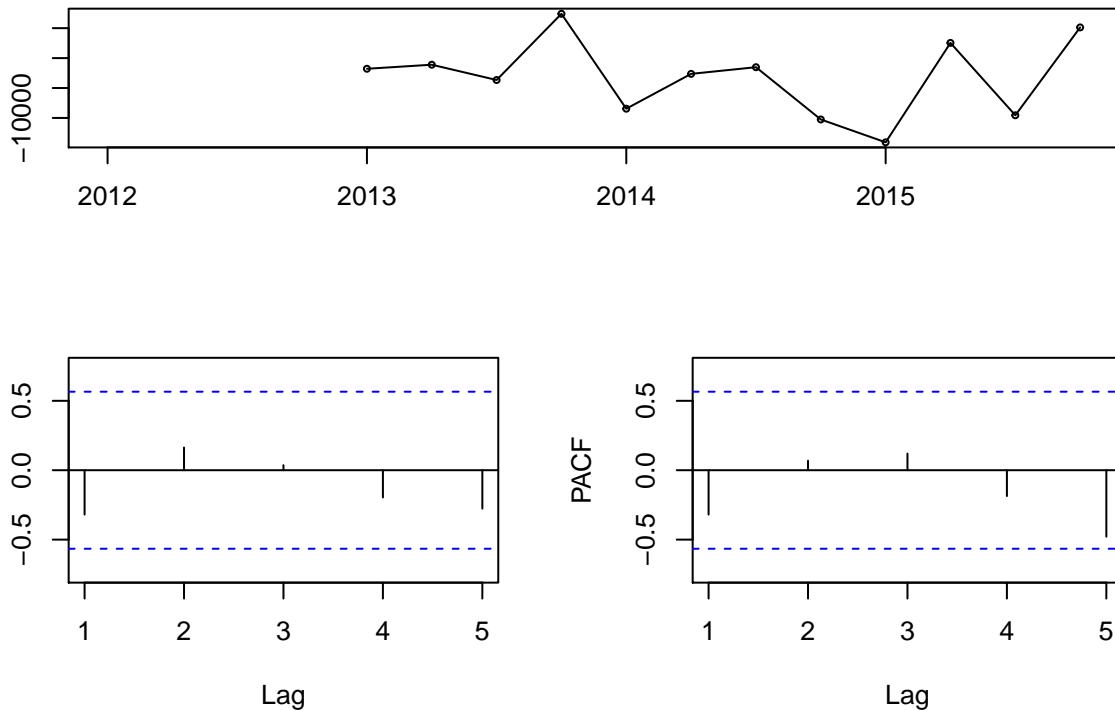
Portland, OR – Hazelwood : Naive Model Forecast Residuals



Portland, OR – Hazelwood : Holt Winters Model Forecast



Portland, OR – Hazelwood : Holt Winters Model Forecast Residuals

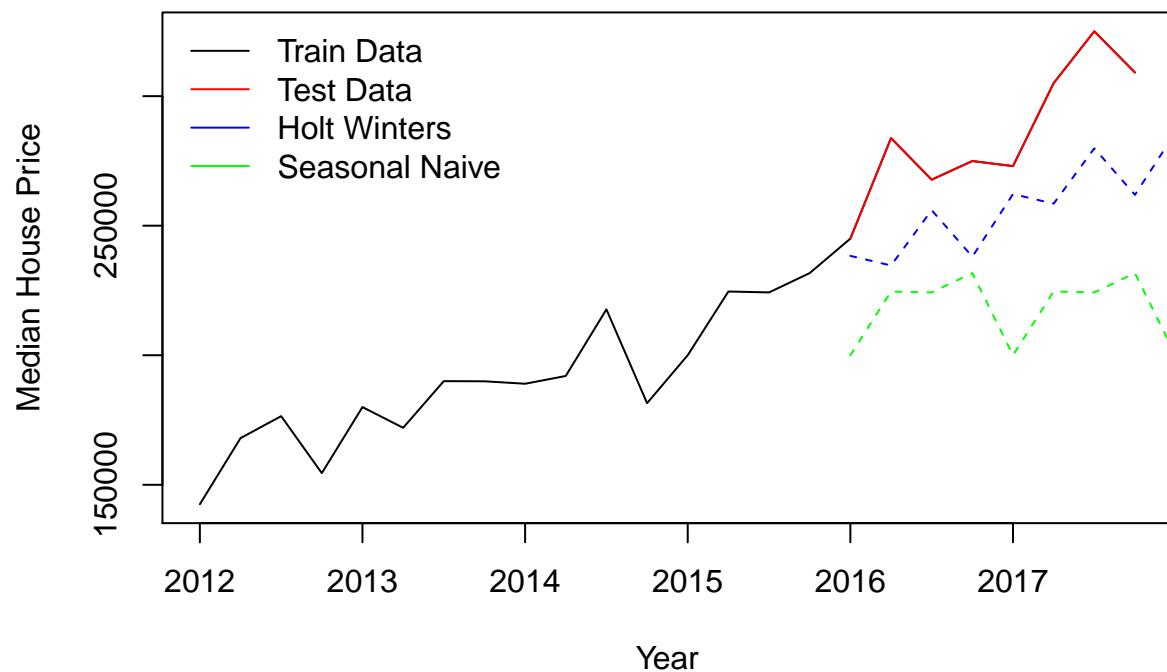


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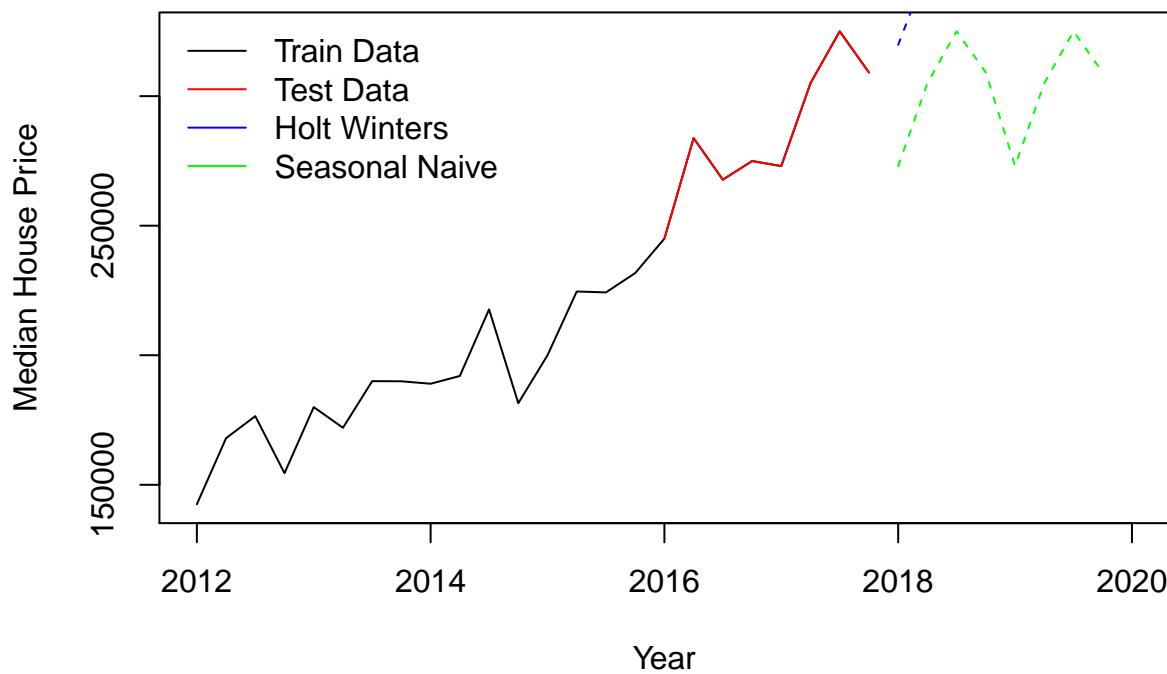
## [1] "Seasonal Naive Accuracy for Portland, OR - Hazelwood"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 19920.83 25702.78 21329.17 9.731277 10.50722 1.00000
## Test set     65313.75 68217.01 65313.75 22.543398 22.54340 3.06218
##          ACF1 Theil's U
## Training set -0.3482230      NA
## Test set     0.5315237  2.95147
## [1] "Holt Winters Accuracy for Portland, OR - Hazelwood"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 3671.05 12917.86 11115.52 1.758764 5.521701 0.5211417
## Test set     31770.05 36245.25 31770.05 10.778371 10.778371 1.4895122
##          ACF1 Theil's U
## Training set -0.3198007      NA
## Test set     -0.3700858  1.649165

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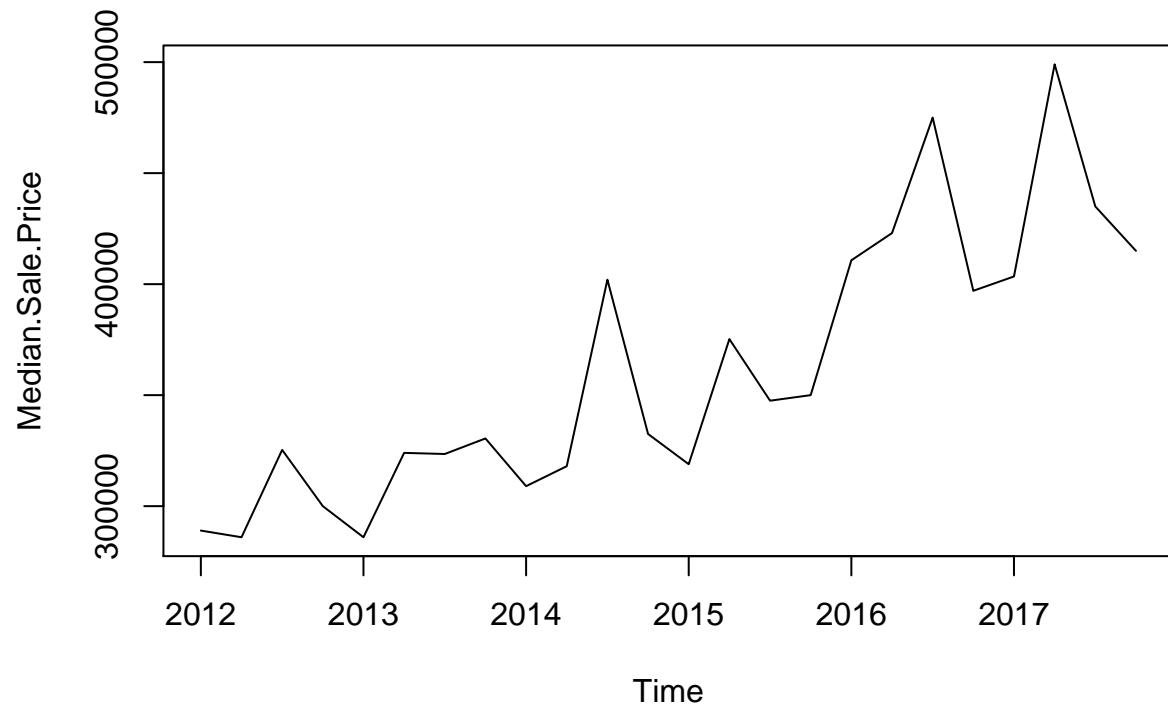
Portland, OR – Hazelwood : TS Training Model Comparison



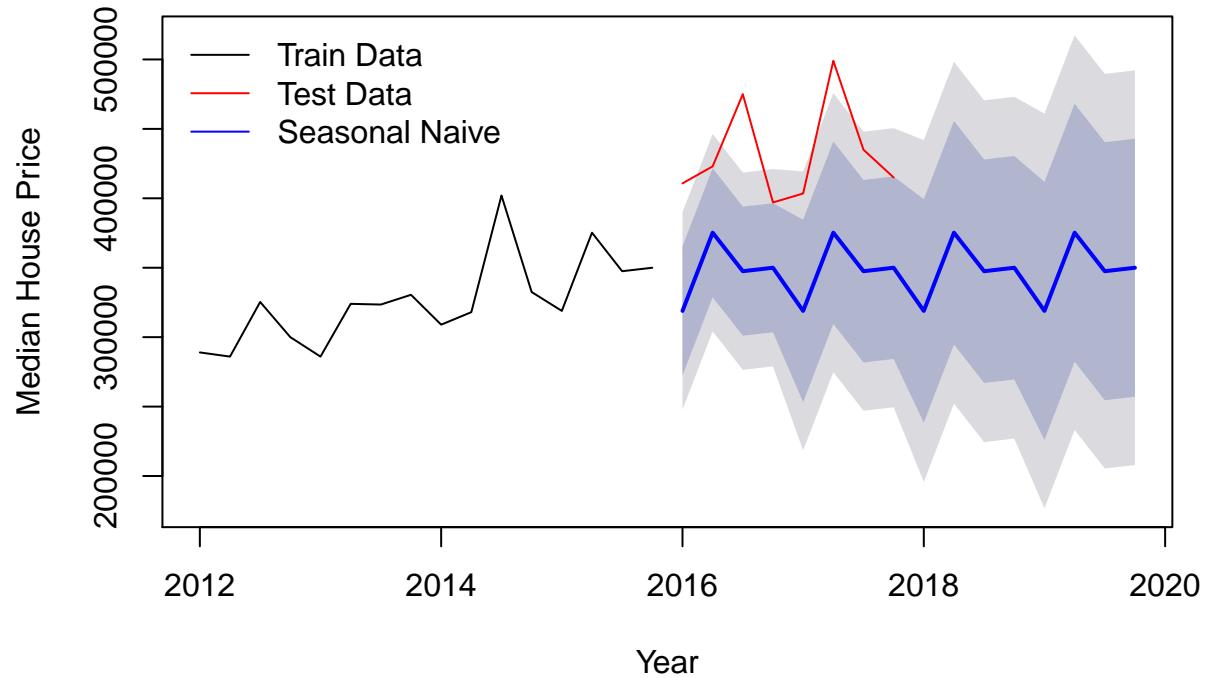
Portland, OR – Hazelwood : Full TS Models Comparison



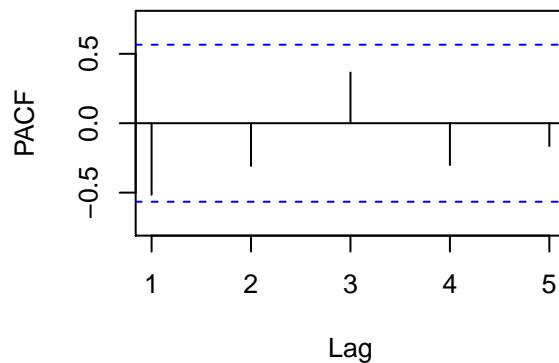
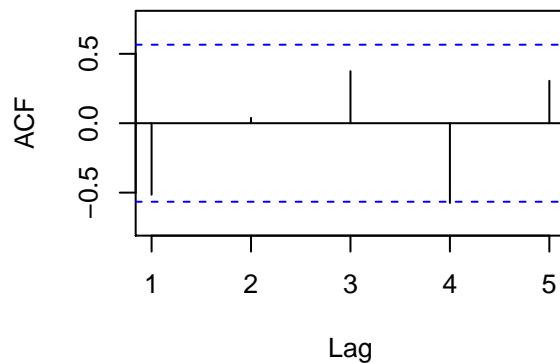
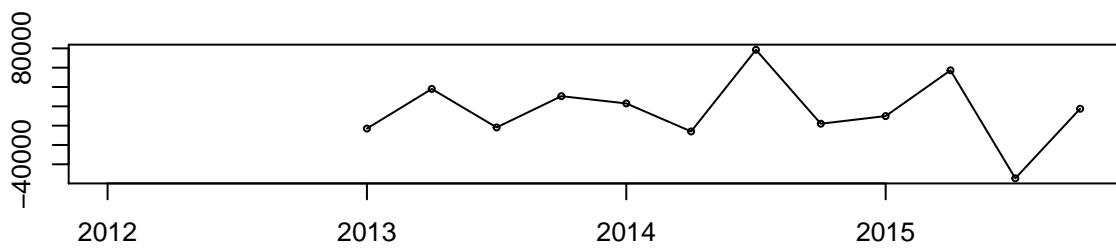
Portland, OR – Markham



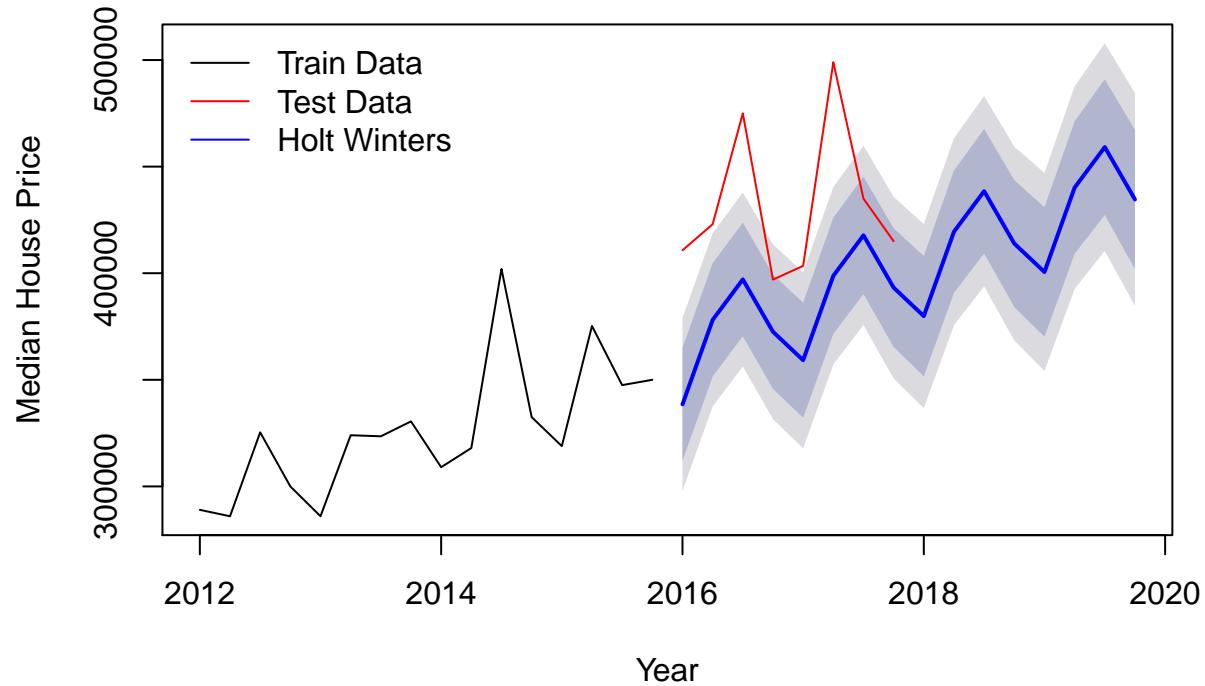
Portland, OR – Markham : Naive Model Forecast



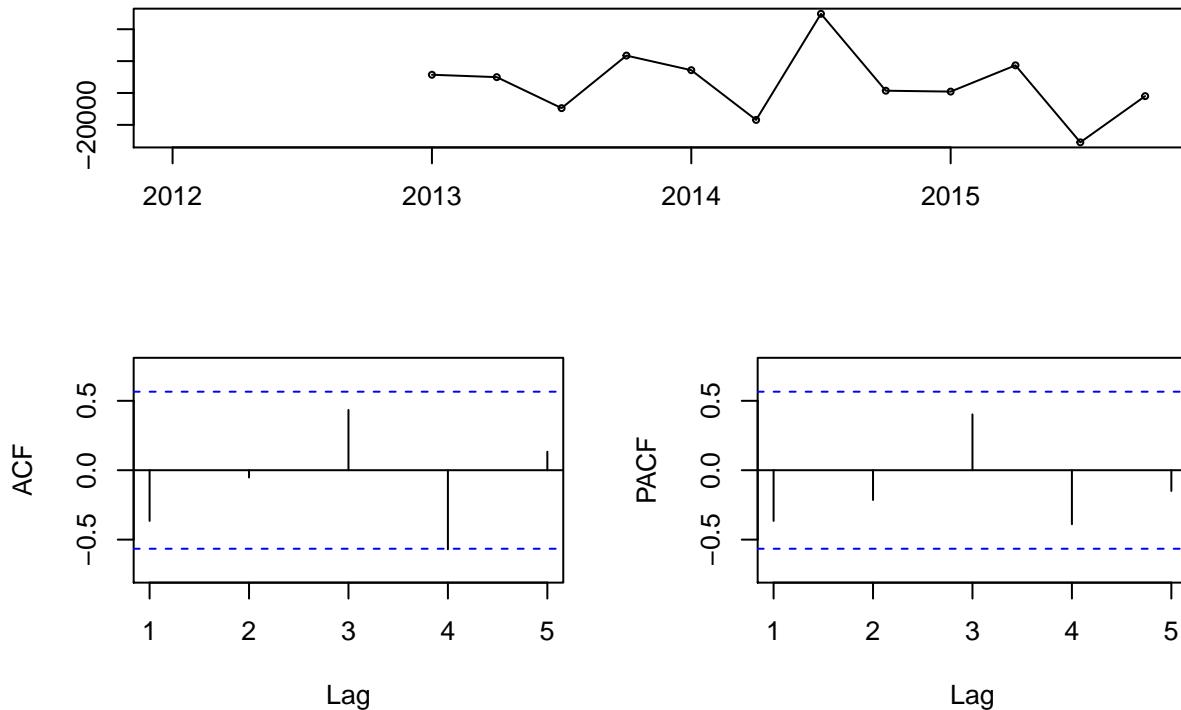
Portland, OR – Markham : Naive Model Forecast Residuals



Portland, OR – Markham : Holt Winters Model Forecast



Portland, OR – Markham : Holt Winters Model Forecast Residuals

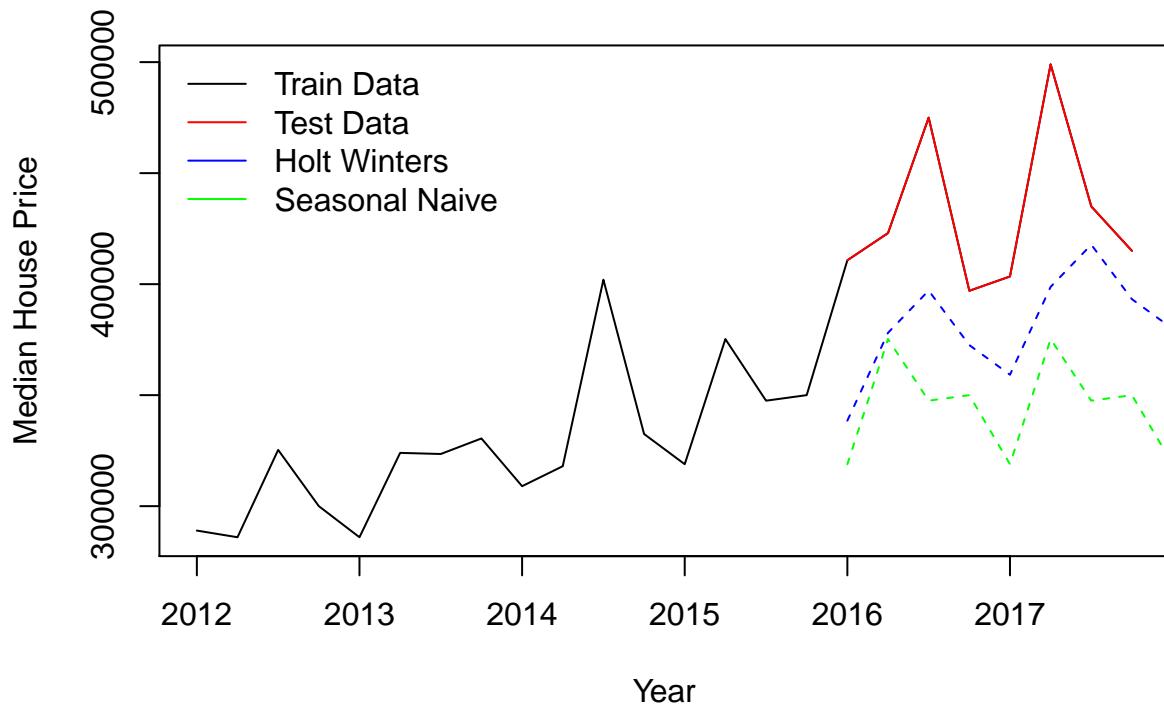


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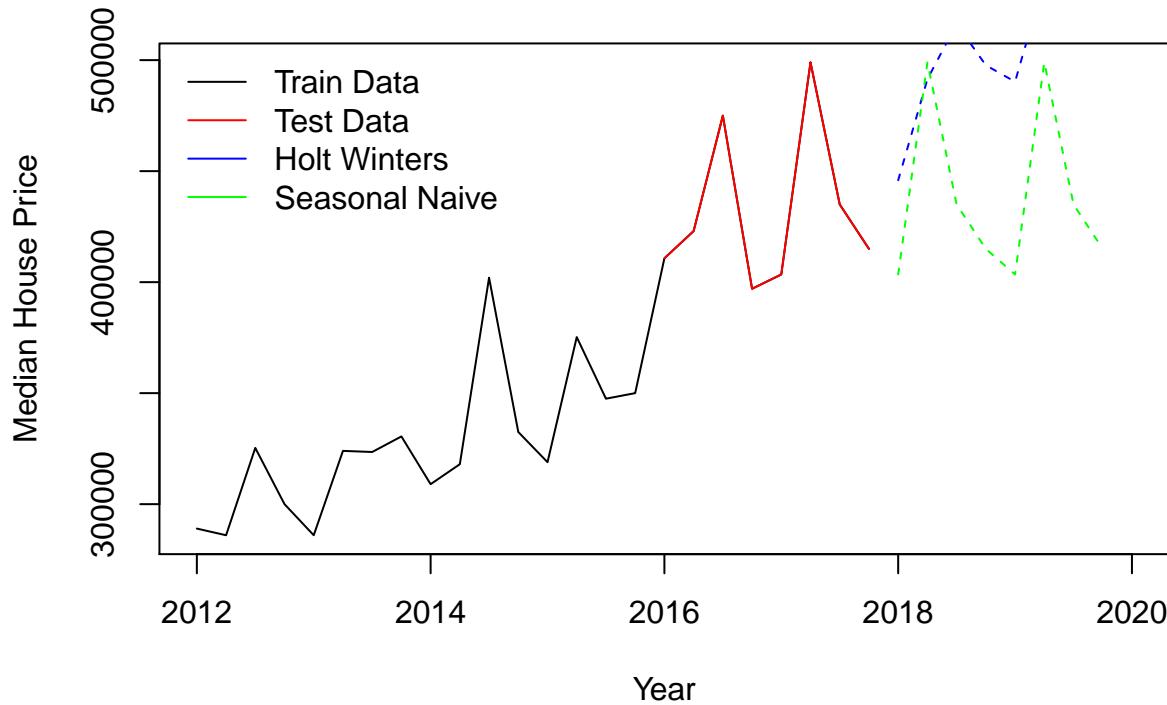
## [1] "Seasonal Naive Accuracy for Portland, OR - Markham"
##          ME      RMSE       MAE       MPE       MAPE       MASE
## Training set 15941.67 36251.43 26833.33 4.391577 7.590088 1.000000
## Test set     84362.50 89110.71 84362.50 19.233098 19.233098 3.143944
##          ACF1 Theil's U
## Training set -0.5150131      NA
## Test set     -0.5162797  1.612914
## [1] "Holt Winters Accuracy for Portland, OR - Markham"
##          ME      RMSE       MAE       MPE       MAPE       MASE
## Training set  5762.711 20603.55 15650.66 1.56328  4.517066 0.5832546
## Test set      50368.937 57742.05 50368.94 11.37723 11.377234 1.8771032
##          ACF1 Theil's U
## Training set -0.3653336      NA
## Test set     -0.2876412  1.035227

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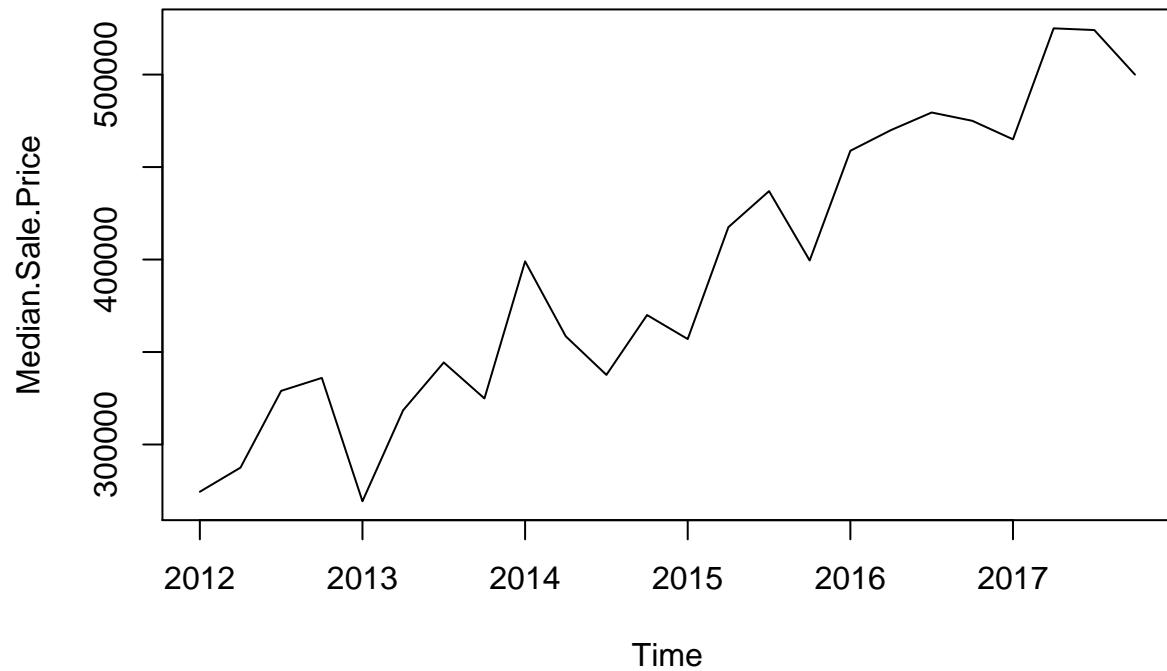
Portland, OR – Markham : TS Training Model Comparison



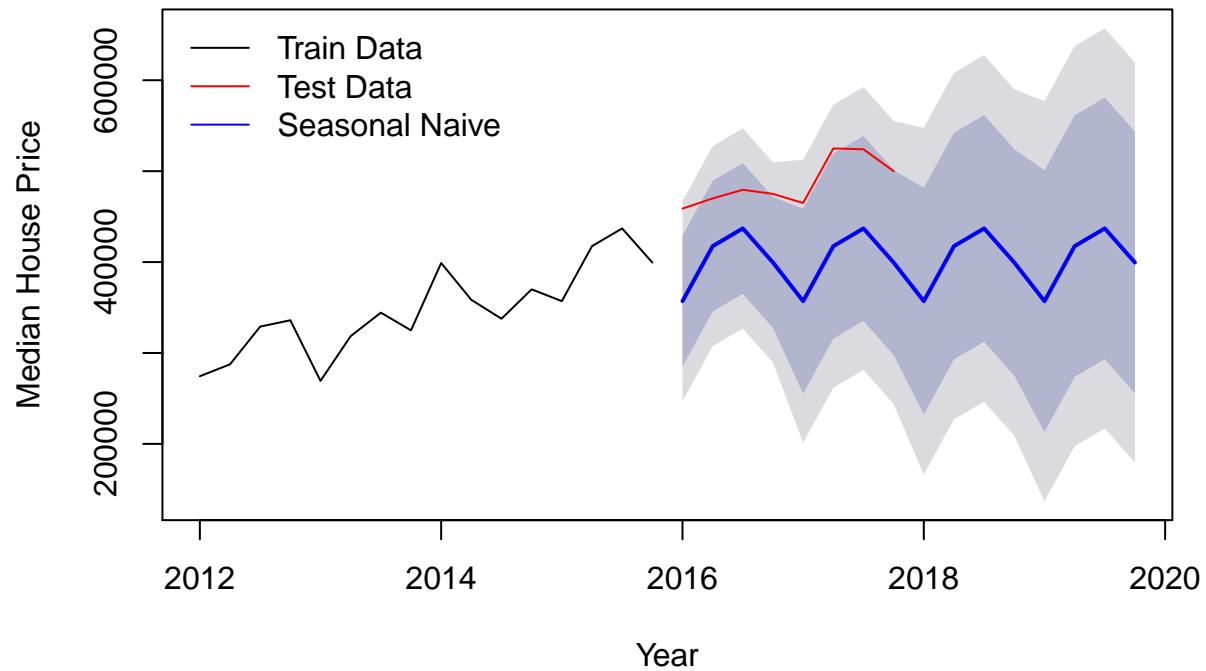
Portland, OR – Markham : Full TS Models Comparison



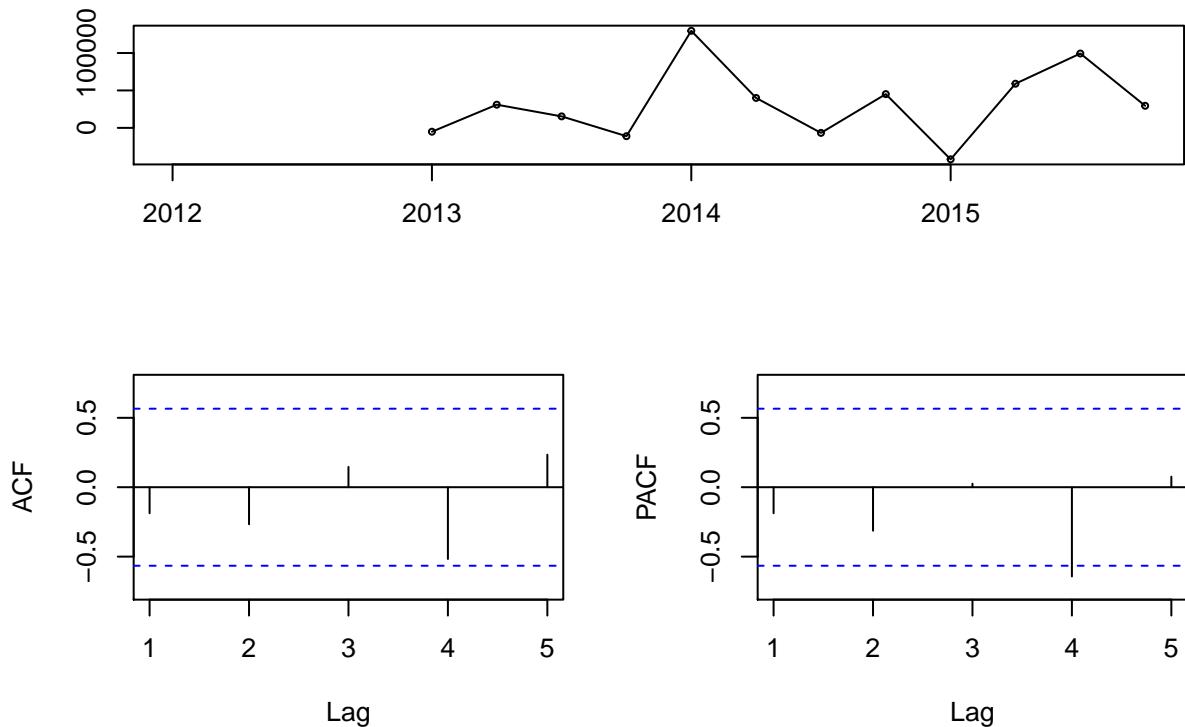
Portland, OR – King



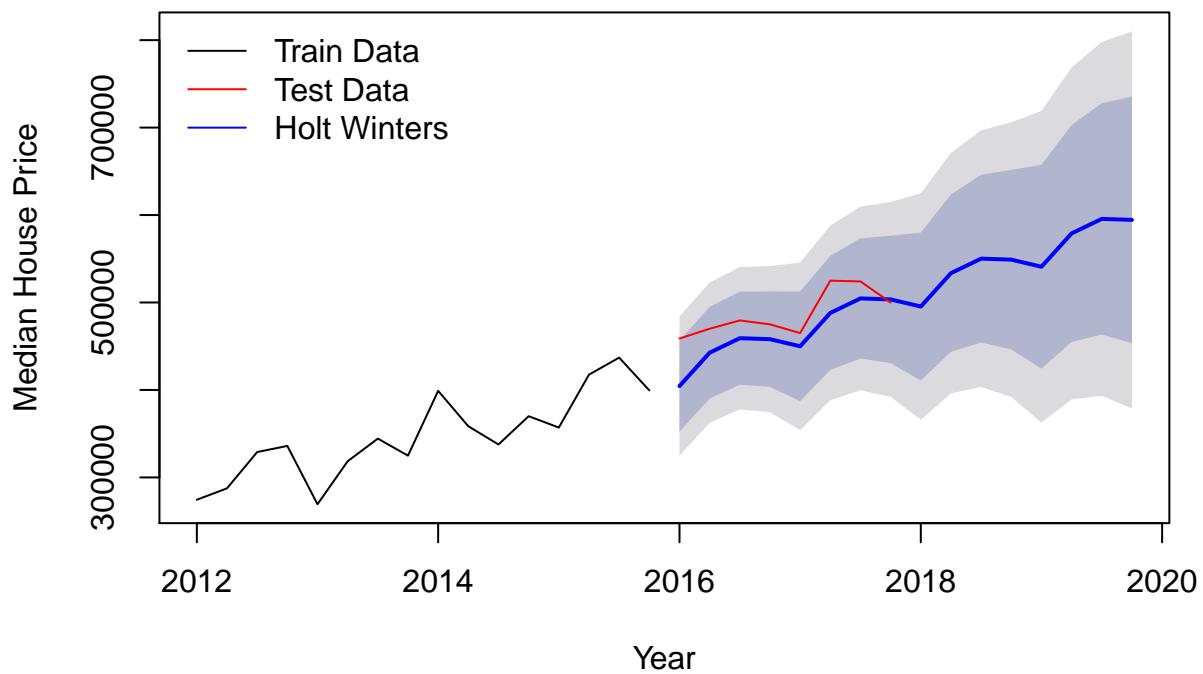
Portland, OR – King : Naive Model Forecast



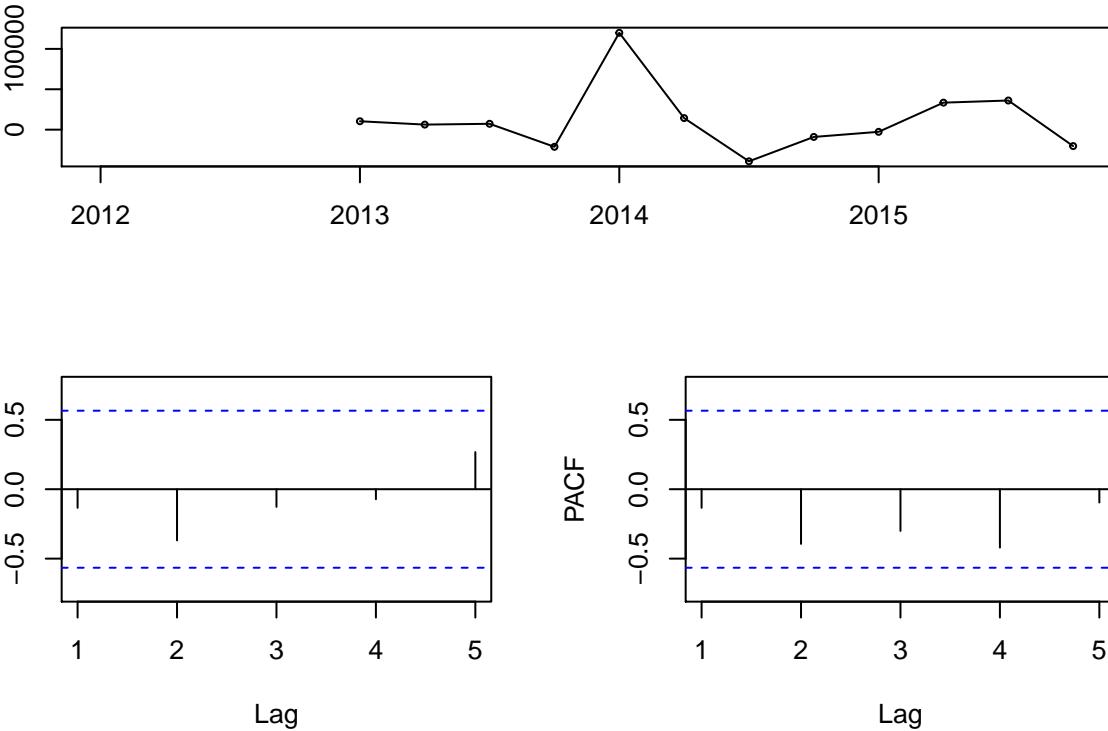
Portland, OR – King : Naive Model Forecast Residuals



Portland, OR – King : Holt Winters Model Forecast



Portland, OR – King : Holt Winters Model Forecast Residuals

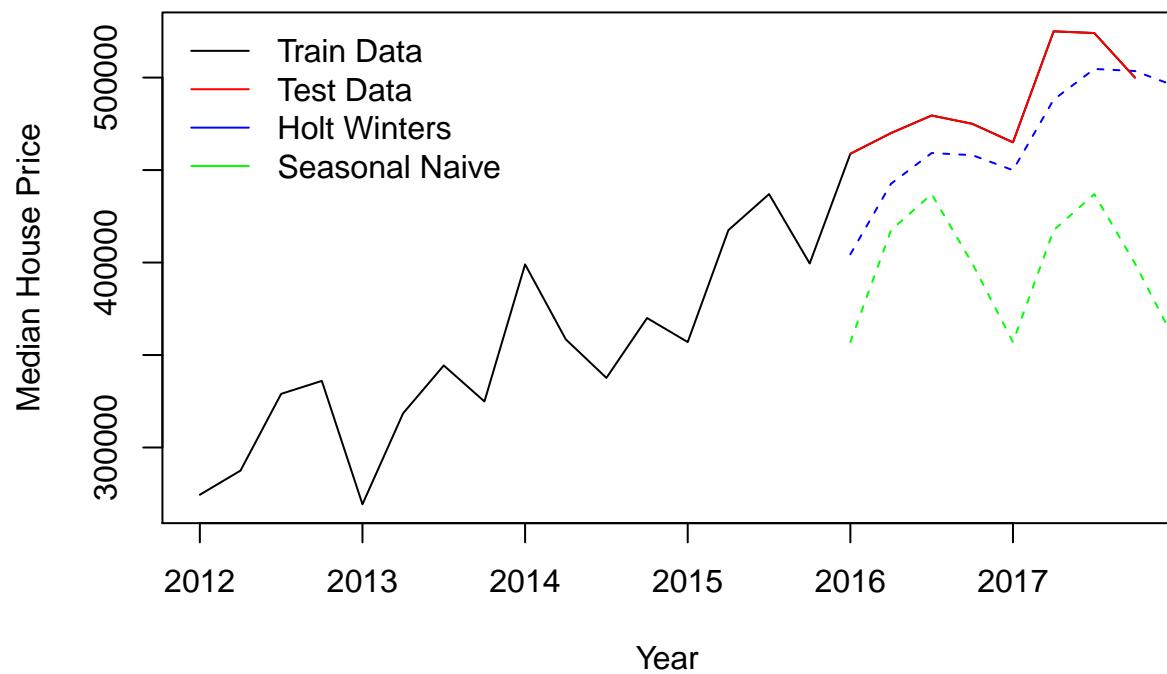


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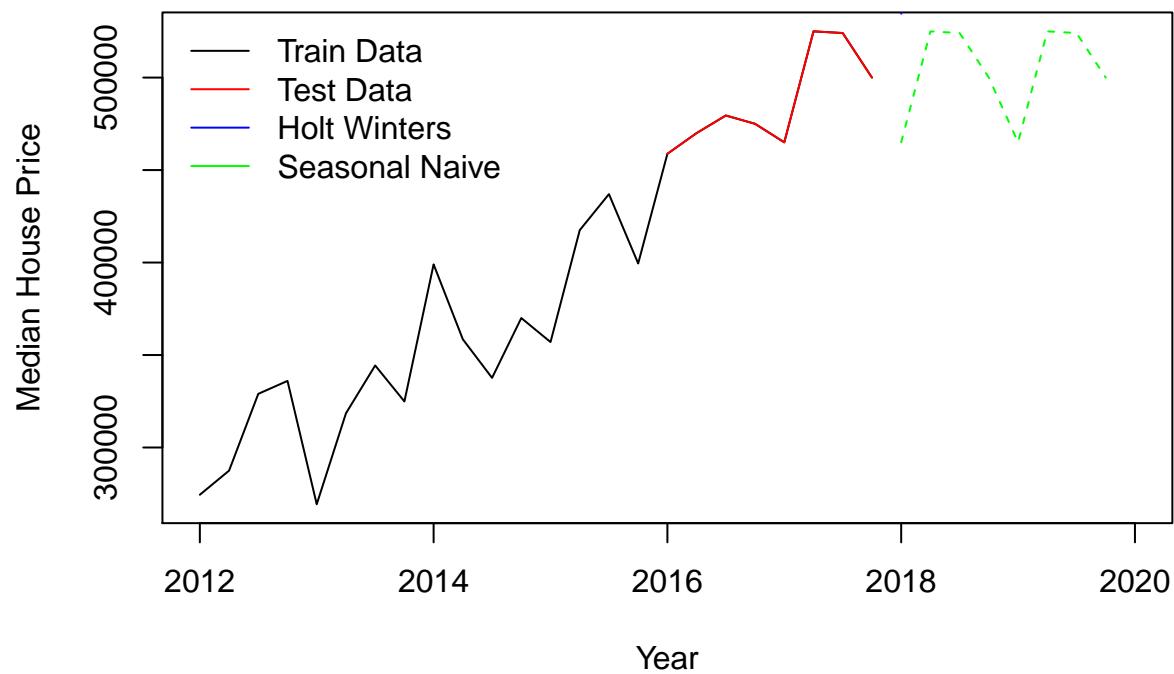
## [1] "Seasonal Naive Accuracy for Portland, OR – King"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 32004.17 56145.17 42825.67 7.934937 11.11325 1.000000
## Test set     84421.88 87698.74 84421.88 17.316706 17.31671 1.971292
##          ACF1 Theil's U
## Training set -0.1876241      NA
## Test set     0.3535296 3.258213
## [1] "Holt Winters Accuracy for Portland, OR – King"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 11274.97 40506.67 26676.71 2.654291 7.055434 0.6229142
## Test set     23352.51 28242.30 24235.61 4.842293 5.018914 0.5659133
##          ACF1 Theil's U
## Training set -0.13407756      NA
## Test set     0.06236009 0.8710045

```

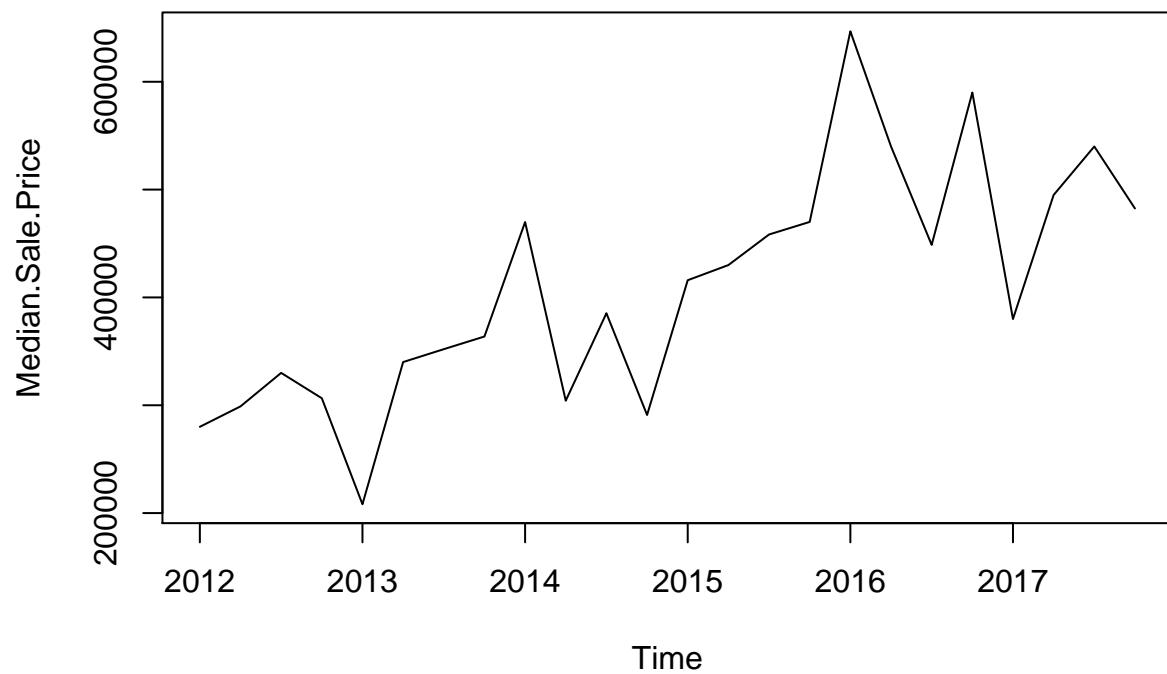
Portland, OR – King : TS Training Model Comparison



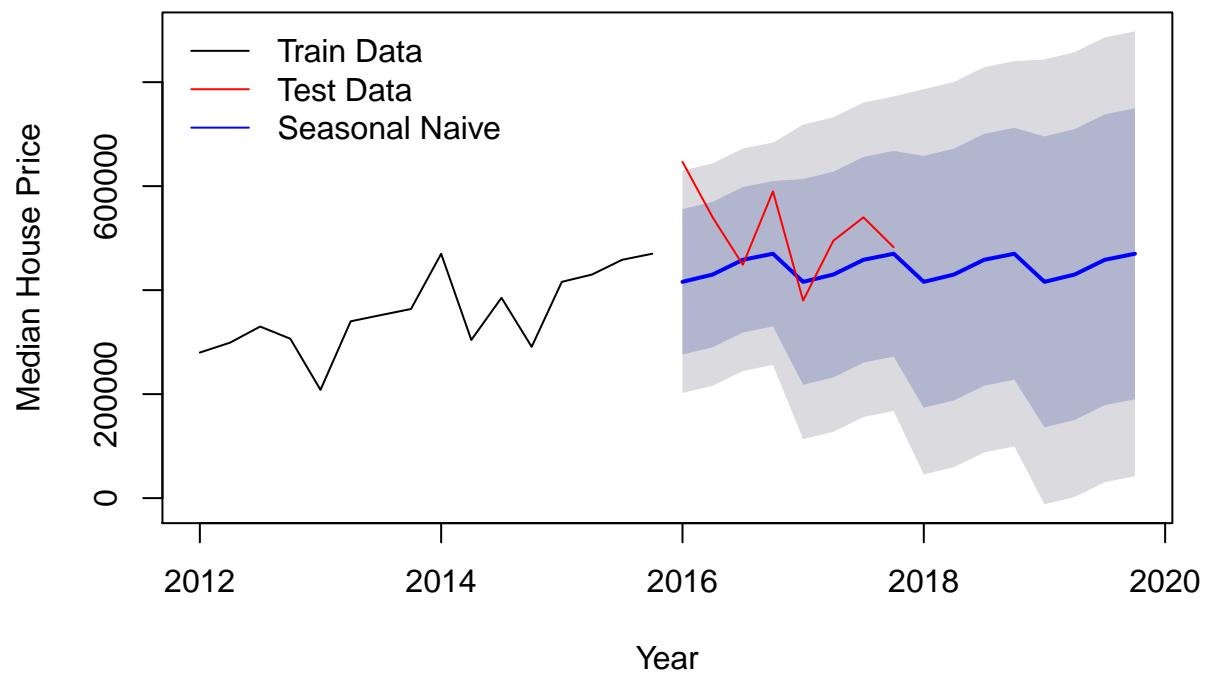
Portland, OR – King : Full TS Models Comparison



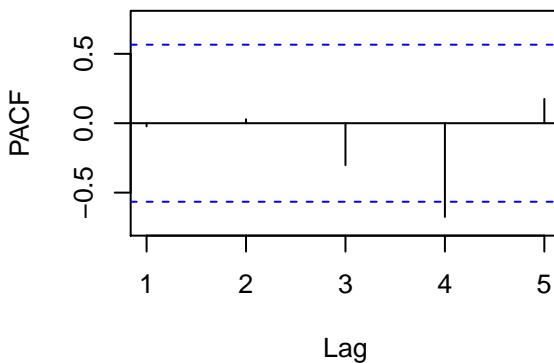
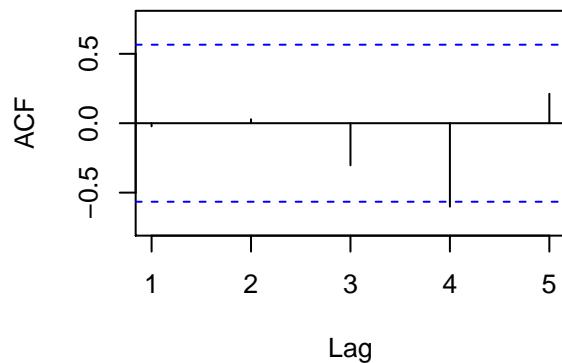
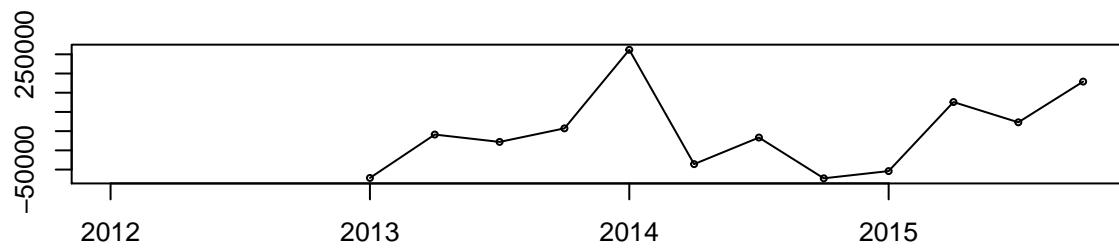
Portland, OR – Kerns



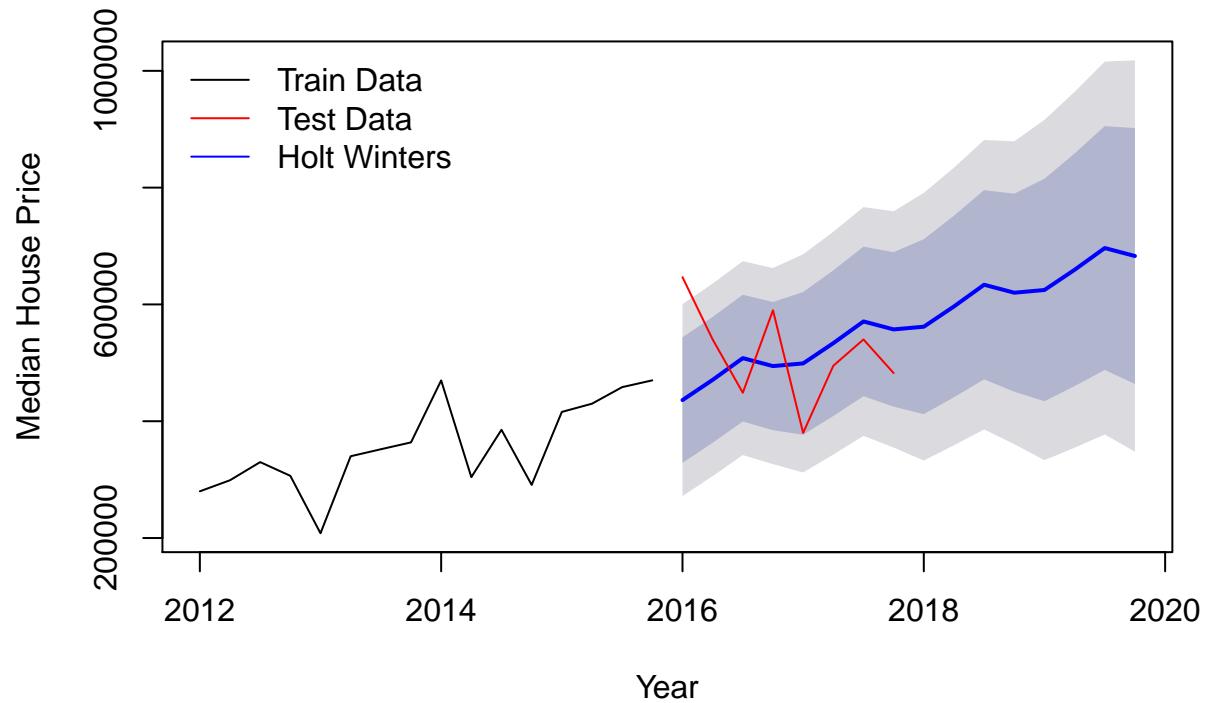
Portland, OR – Kerns : Naive Model Forecast



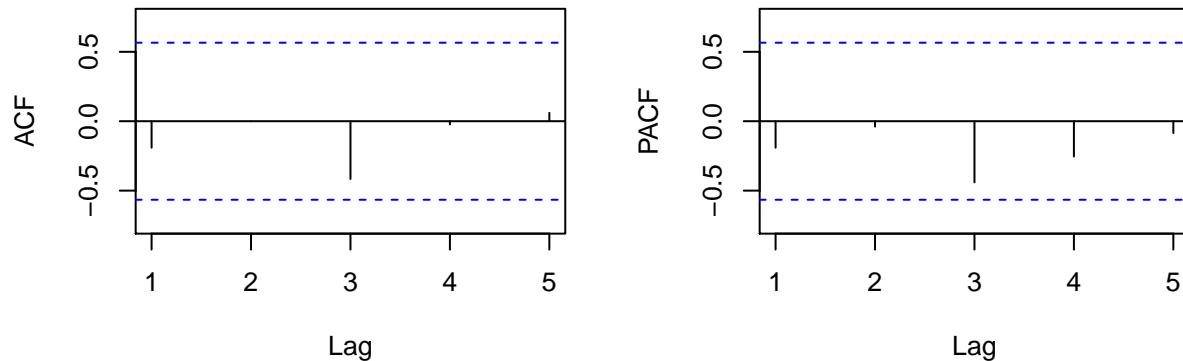
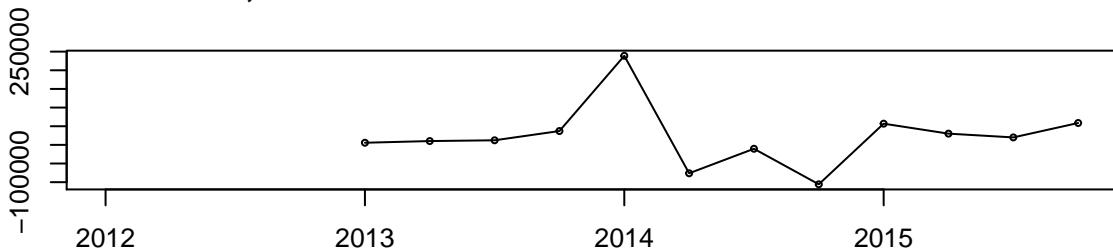
Portland, OR – Kerns : Naive Model Forecast Residuals



Portland, OR – Kerns : Holt Winters Model Forecast



Portland, OR – Kerns : Holt Winters Model Forecast Residuals

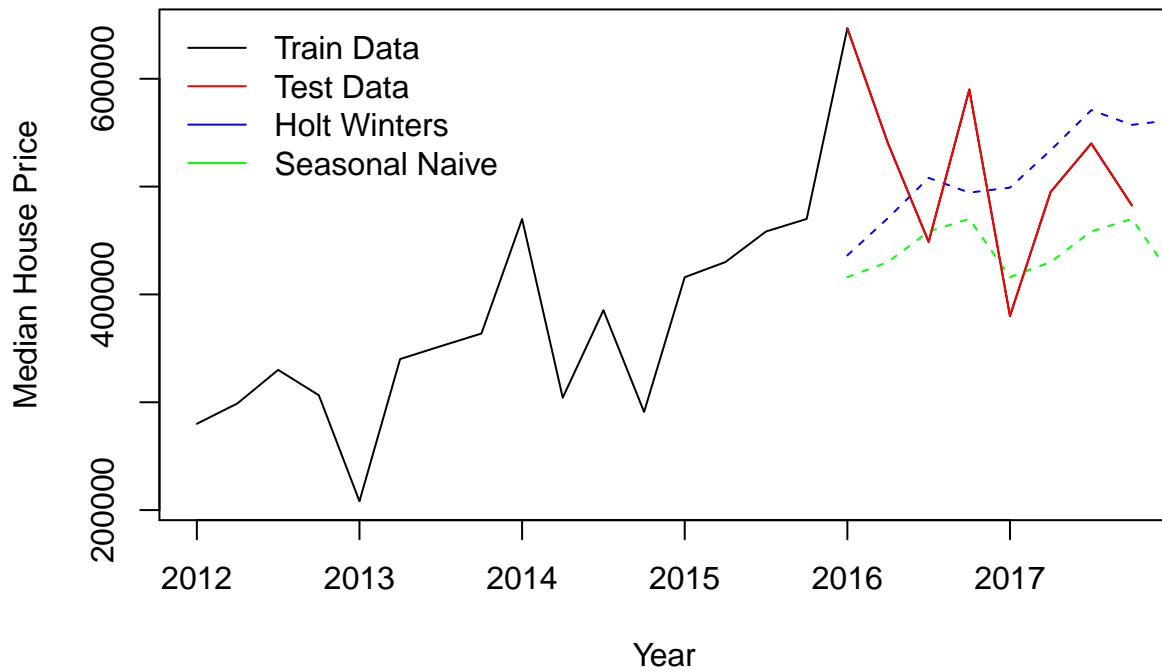


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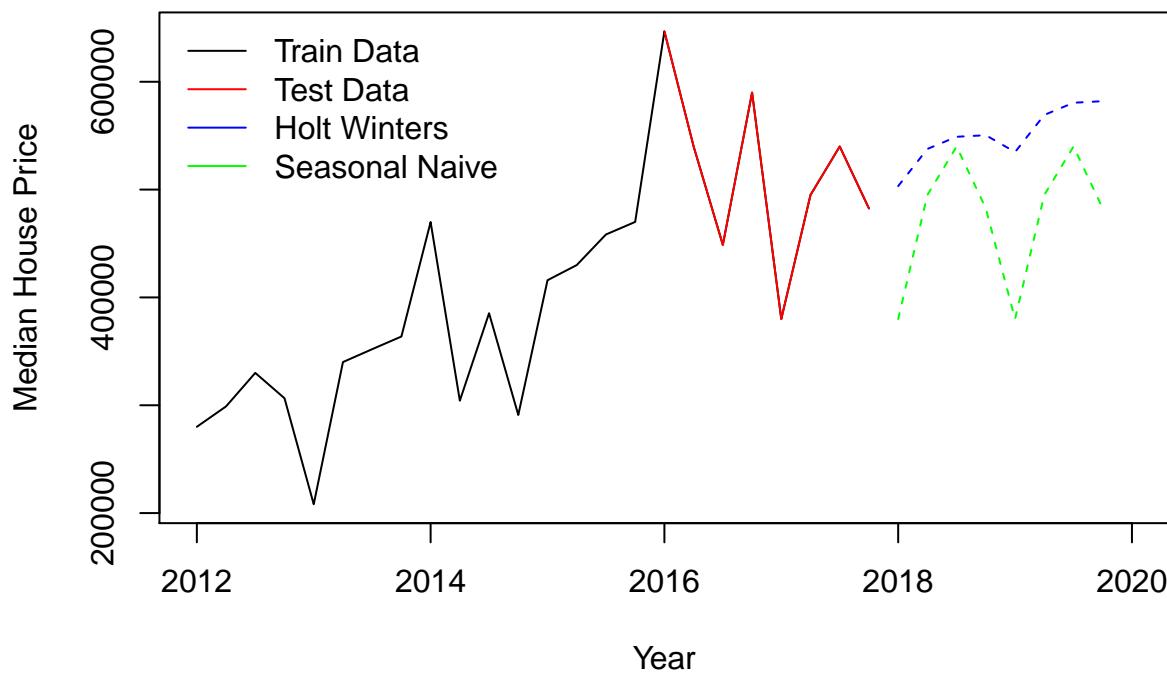
## [1] "Seasonal Naive Accuracy for Portland, OR - Kerns"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 46571.25 109116.4 85623.33 8.121269 22.15912 1.0000000
## Test set     71798.12 107353.5 83186.88 11.954437 14.85467 0.9715445
##          ACF1 Theil's U
## Training set -0.02231233      NA
## Test set     -0.11914771 0.6411827
## [1] "Holt Winters Accuracy for Portland, OR - Kerns"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 23114.601 83541.18 55174.21 3.641294 14.32165 0.6443829
## Test set     6586.378 102455.88 87245.51 -1.499106 16.89140 1.0189455
##          ACF1 Theil's U
## Training set -0.19085210      NA
## Test set     0.02417211 0.6033948

```

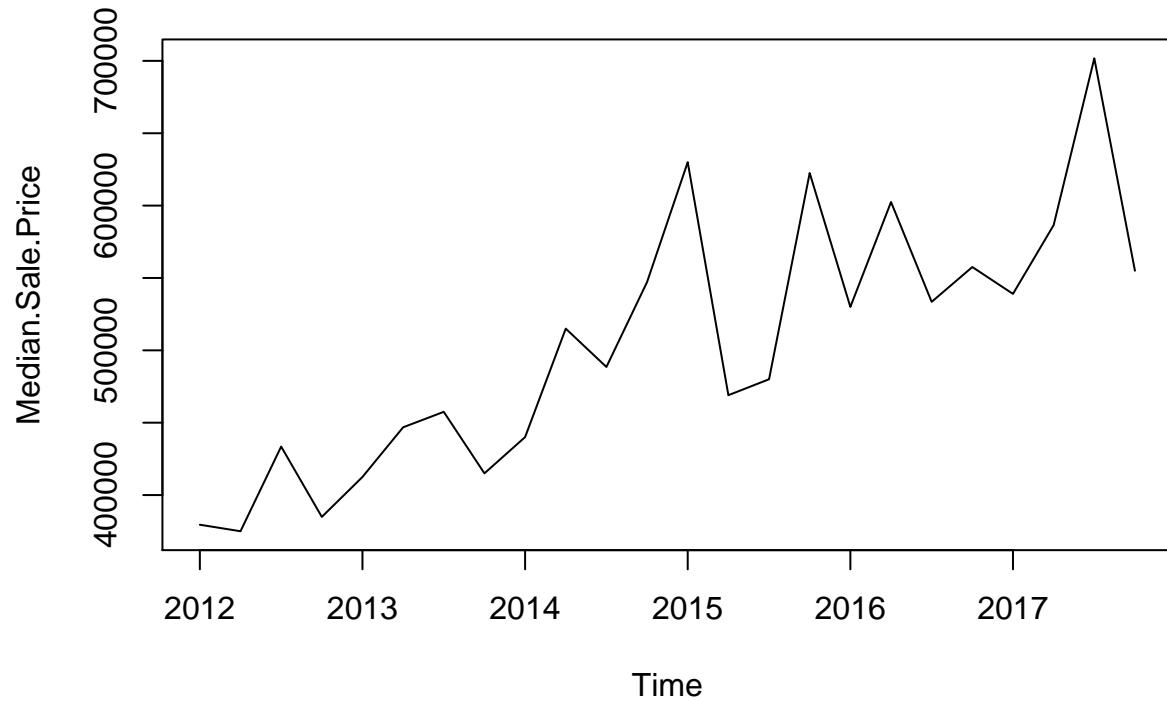
Portland, OR – Kerns : TS Training Model Comparison



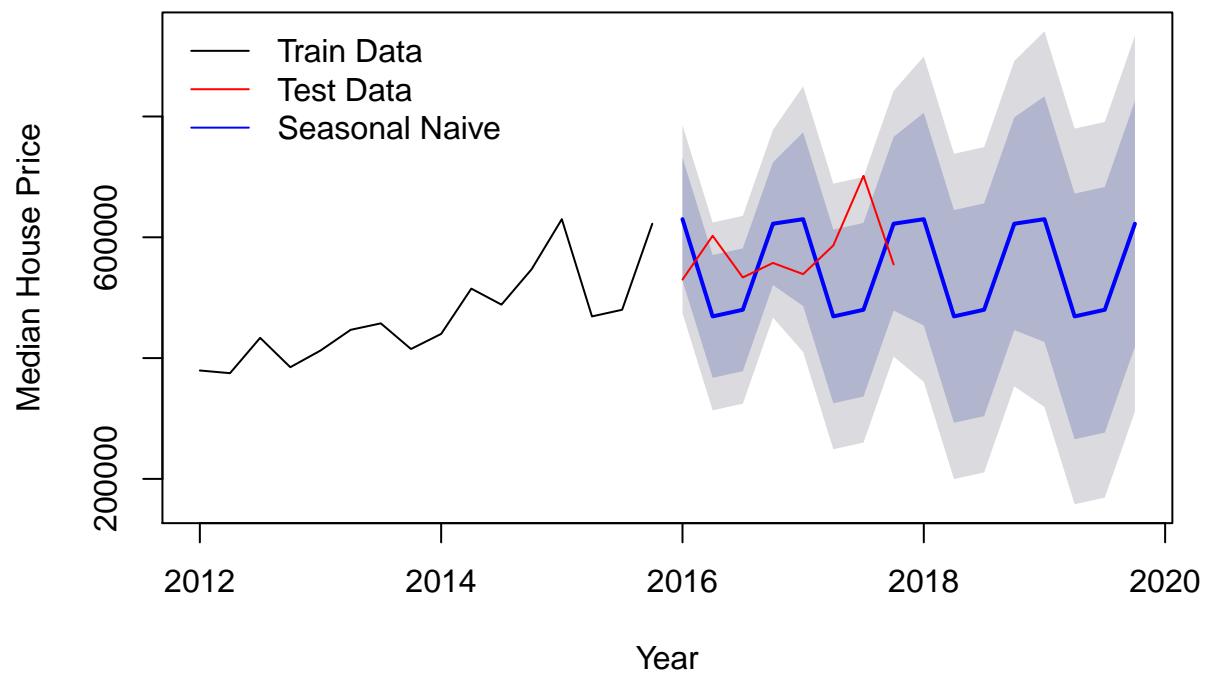
Portland, OR – Kerns : Full TS Models Comparison



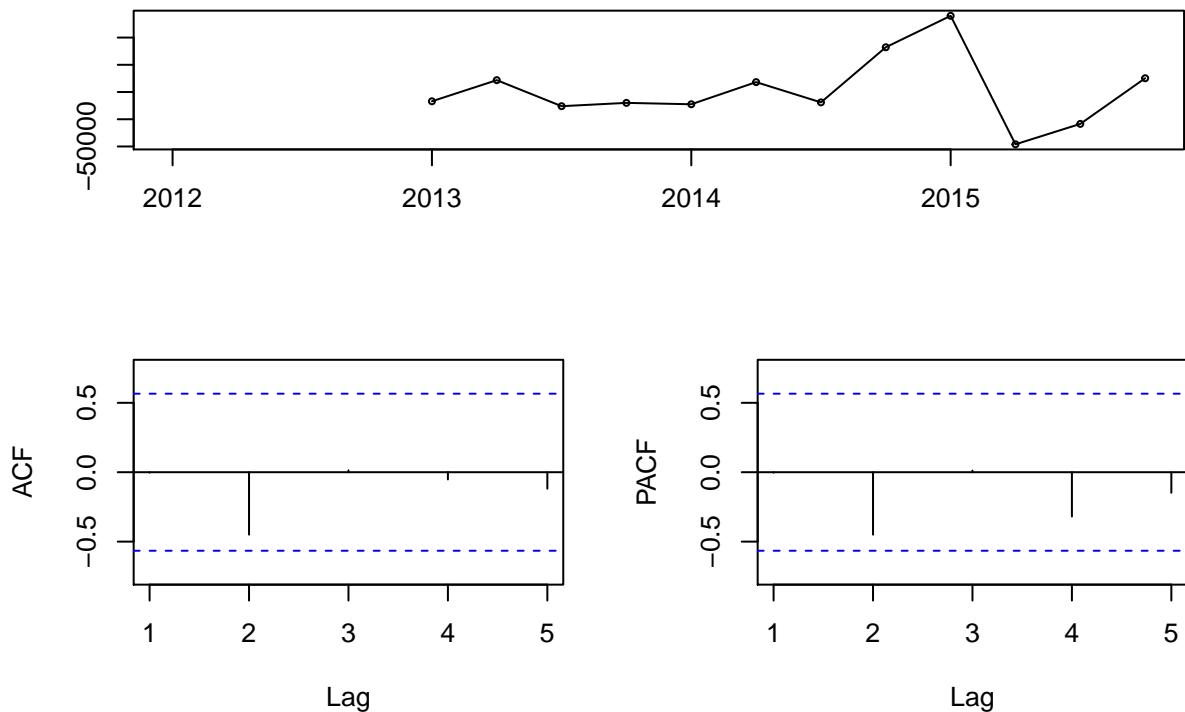
Portland, OR – Beaumont–Wilshire



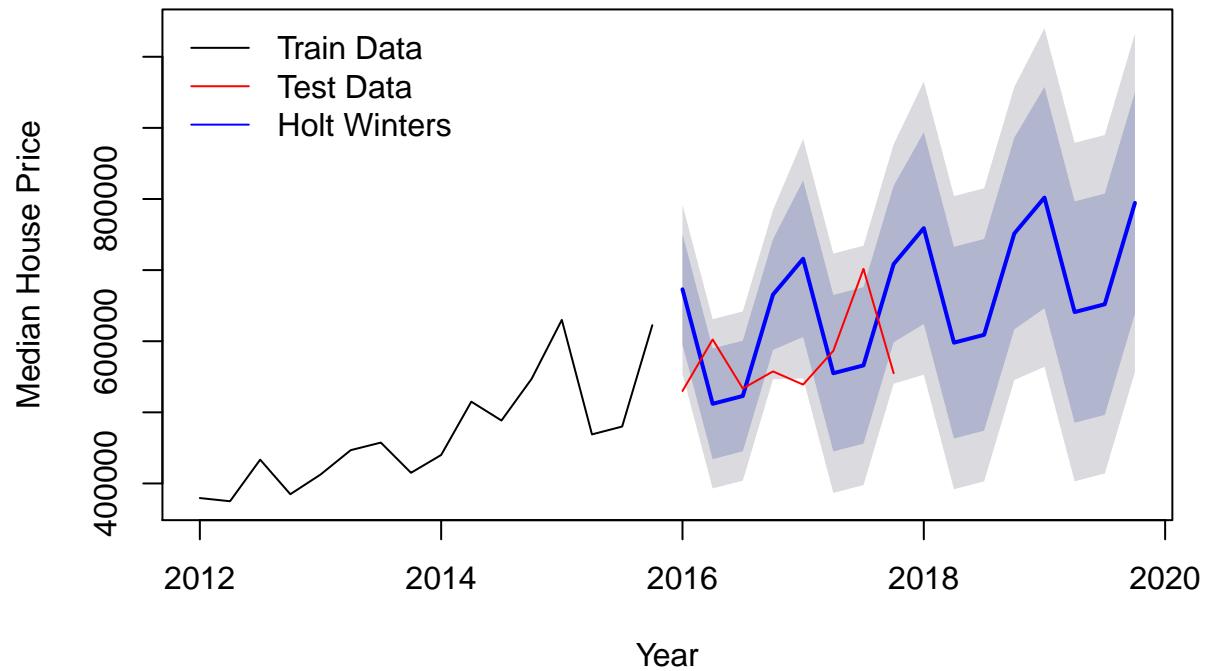
Portland, OR – Beaumont–Wilshire : Naive Model Forecast



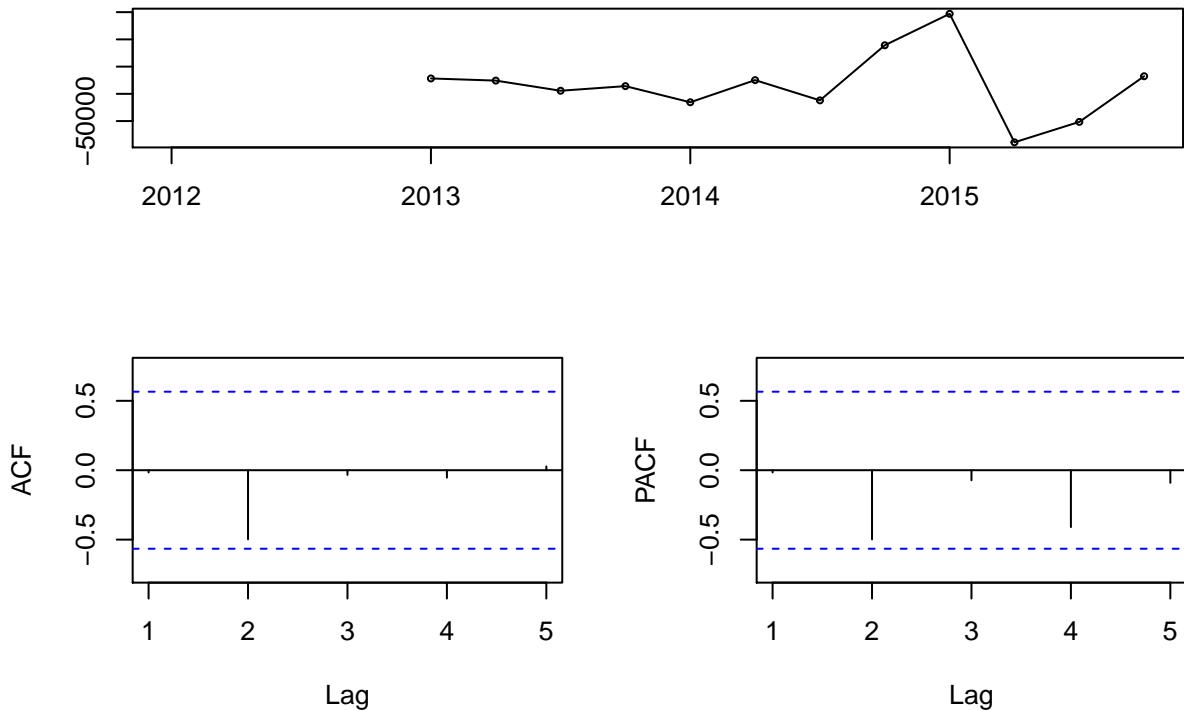
Portland, OR – Beaumont–Wilshire : Naive Model Forecast Residuals



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

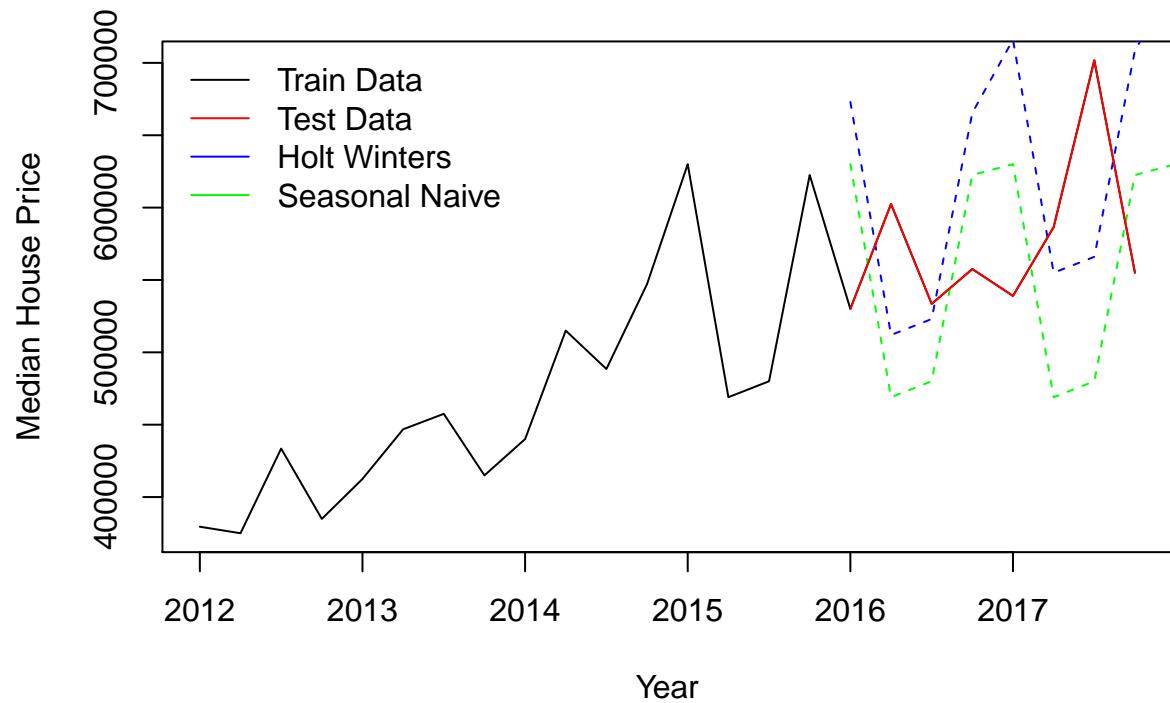


Portland, OR – Beaumont–Wilshire : Holt Winters Model Forecast Residuals

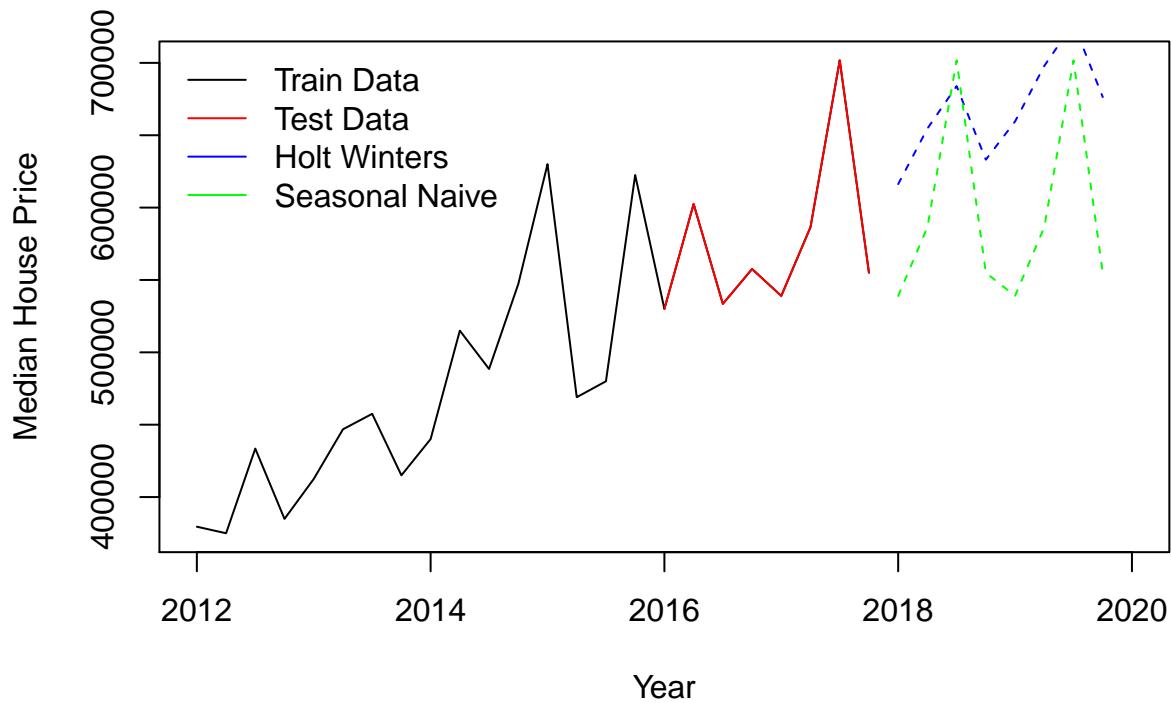


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Beaumont–Wilshire"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 52383.33 79327.26 61466.67 9.770466 11.70029 1.000000
## Test set     25350.00 117643.30 106212.50 3.032135 17.92273 1.727969
##          ACF1 Theil's U
## Training set -0.00326111      NA
## Test set     -0.12698458  1.580692
## [1] "Holt Winters Accuracy for Portland, OR – Beaumont–Wilshire"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 16507.06 60419.48 44498.31 2.581252 8.526693 0.7239421
## Test set     -39149.06 119746.43 106212.50 -8.141669 18.567877 1.7279691
##          ACF1 Theil's U
## Training set -0.01647581      NA
## Test set     -0.17902021  1.485519
```

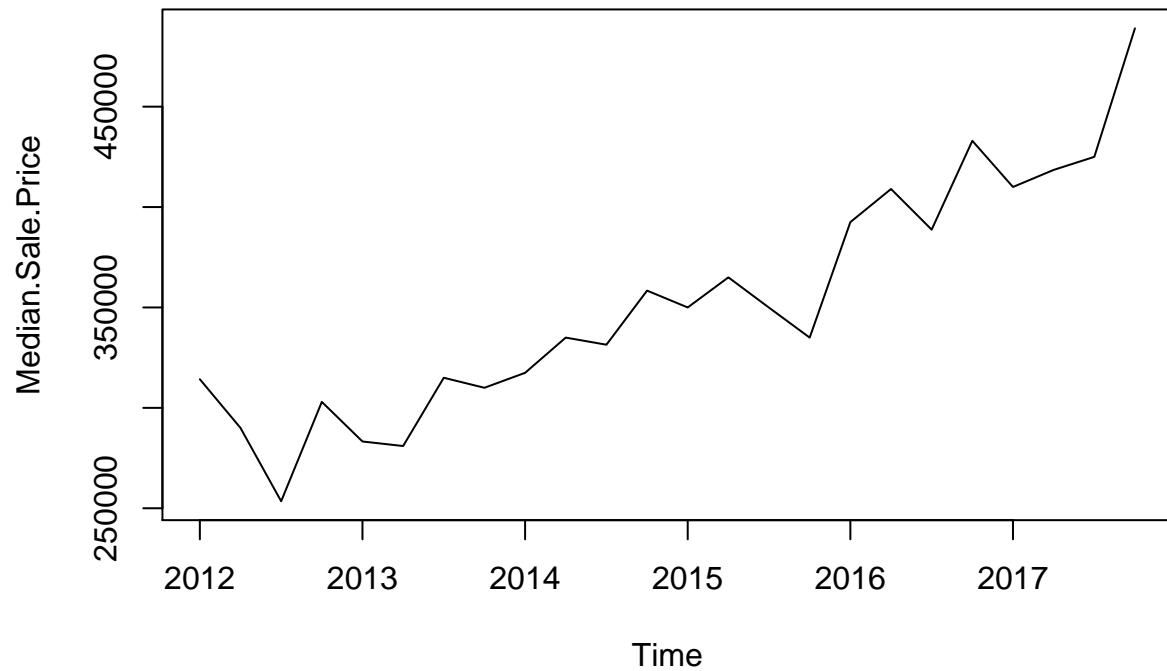
Portland, OR – Beaumont–Wilshire : TS Training Model Comparison



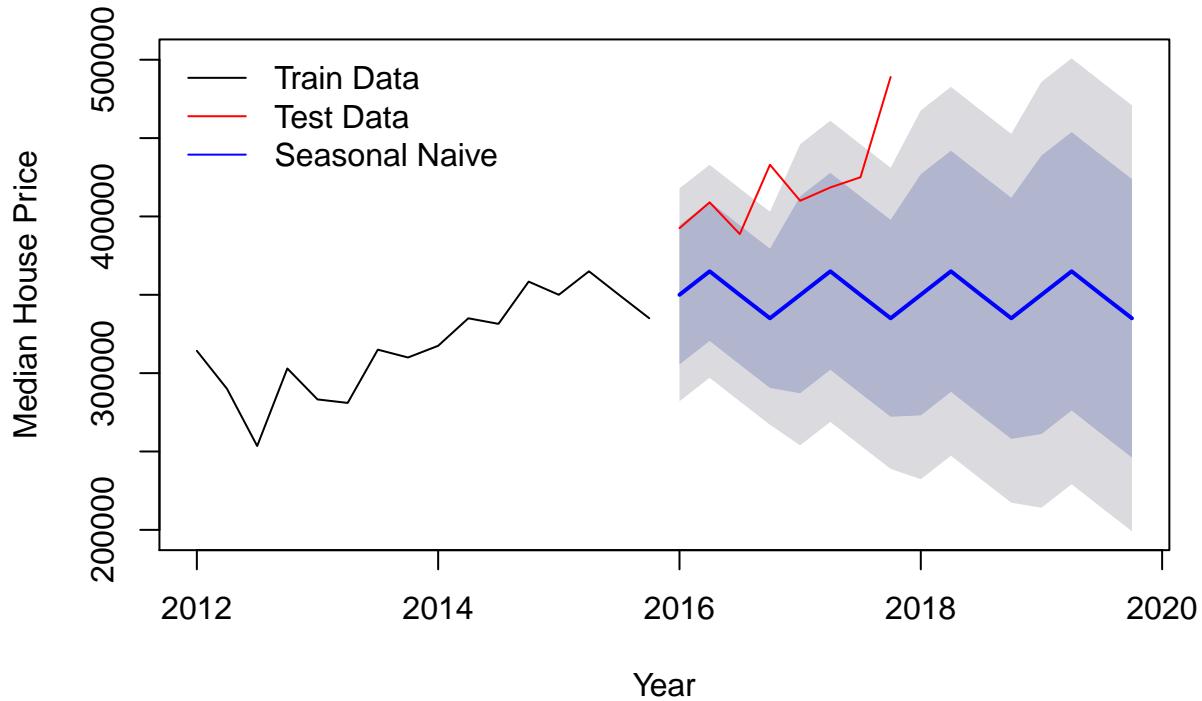
Portland, OR – Beaumont–Wilshire : Full TS Models Comparison



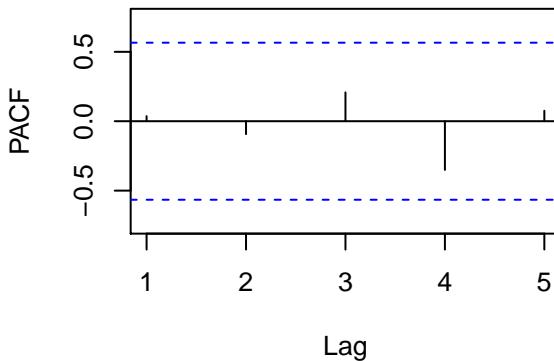
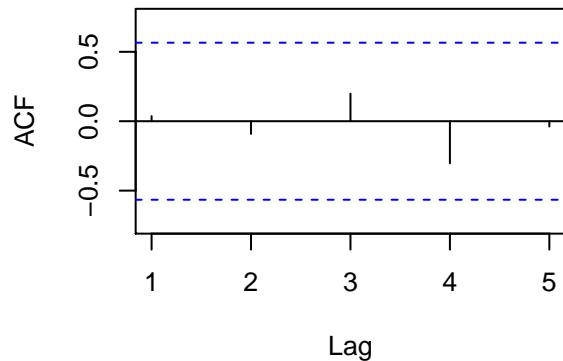
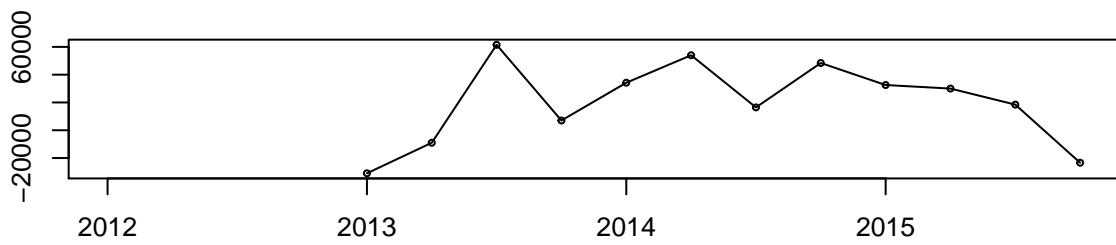
Portland, OR – Multnomah Village



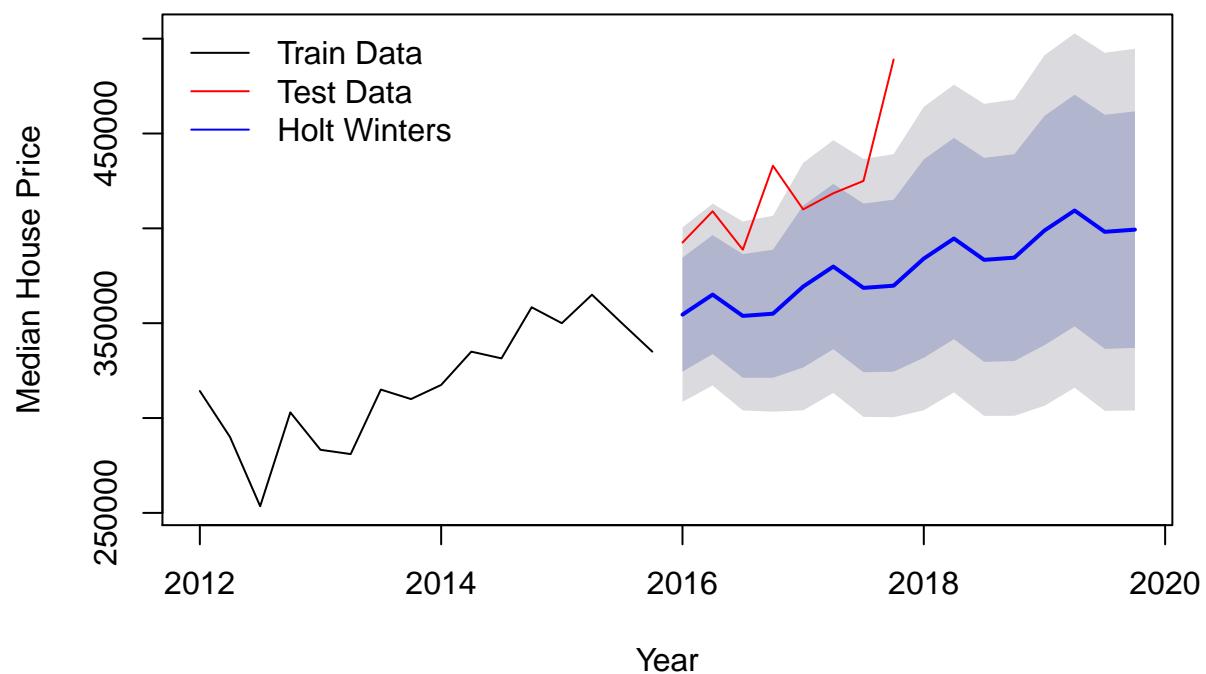
Portland, OR – Multnomah Village : Naive Model Forecast



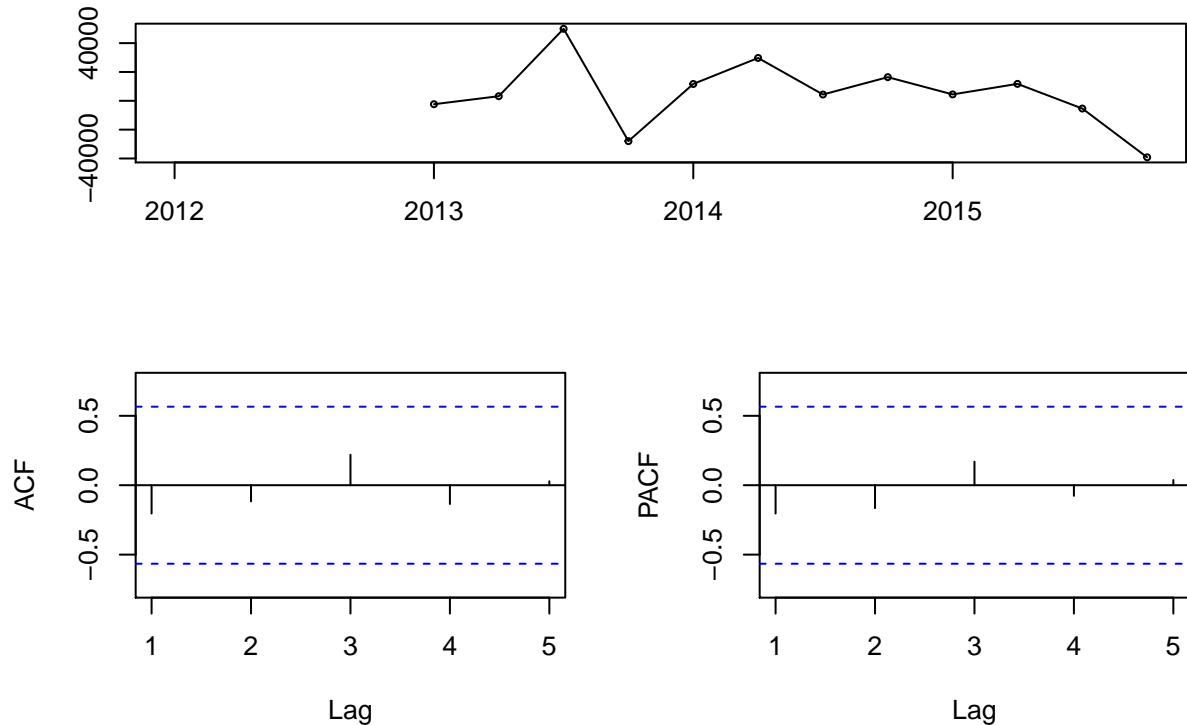
Portland, OR – Multnomah Village : Naive Model Forecast Residuals



Portland, OR – Multnomah Village : Holt Winters Model Forecast



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

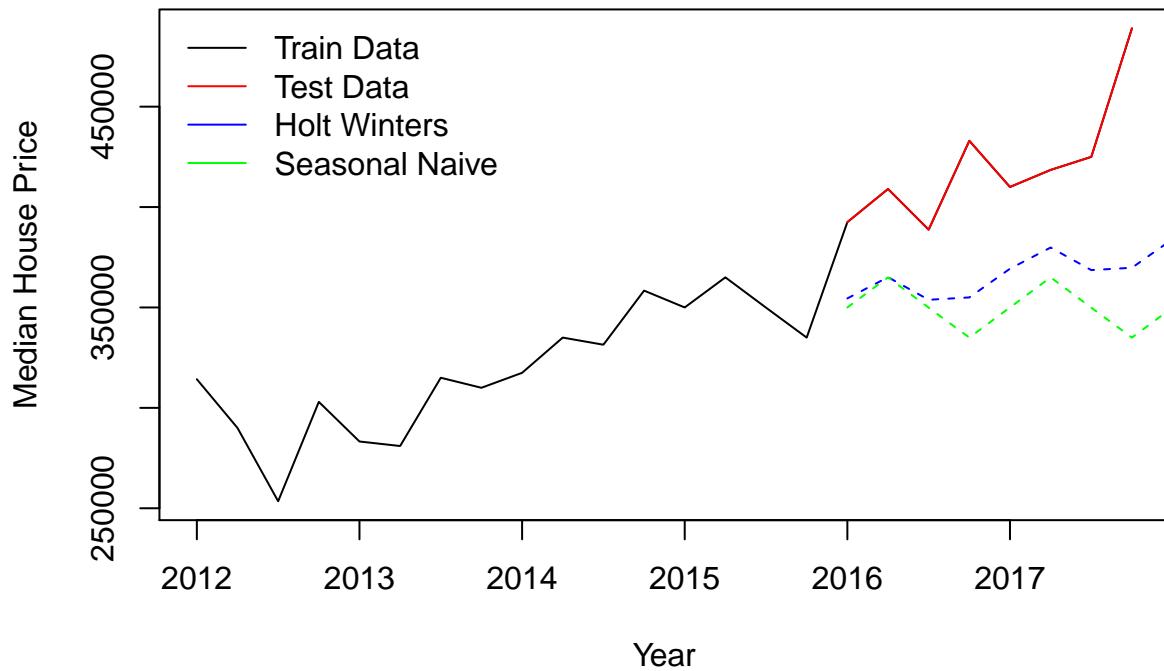


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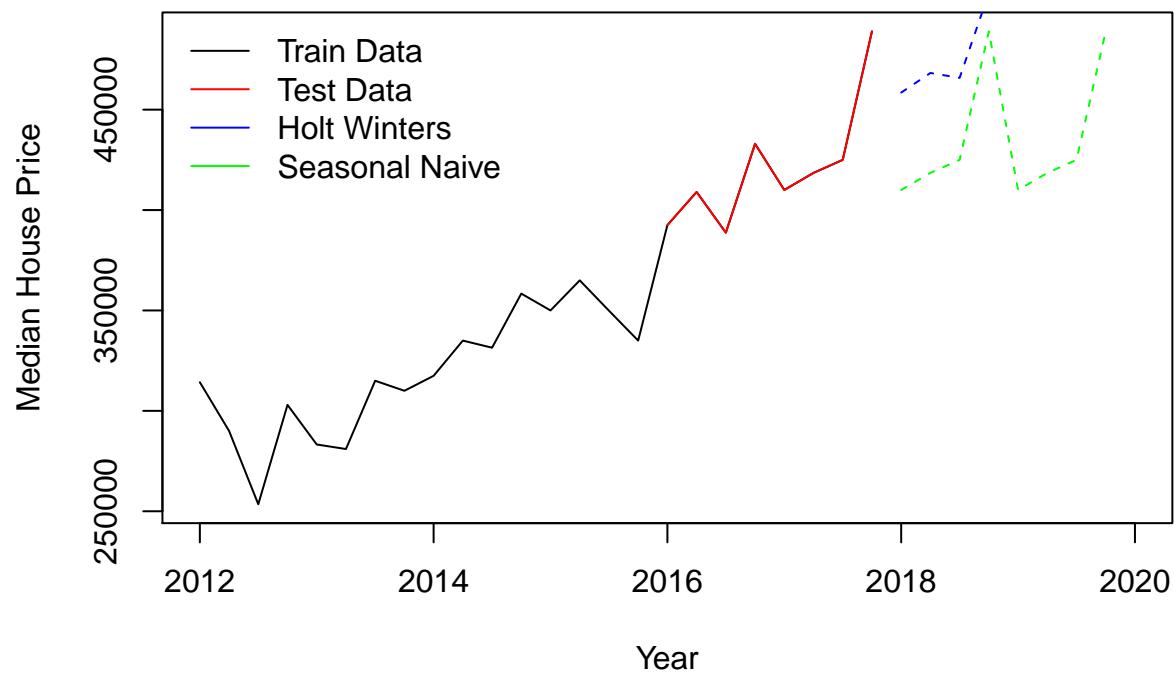
## [1] "Seasonal Naive Accuracy for Portland, OR – Multnomah Village"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 19931.25 34664.88 30497.92 5.734166 9.256219 1.000000
## Test set     70743.75 79587.87 70743.75 16.349208 16.349208 2.319626
##          ACF1 Theil's U
## Training set 0.03674274      NA
## Test set     0.08640073 2.563637
## [1] "Holt Winters Accuracy for Portland, OR – Multnomah Village"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 4715.318 22951.25 17196.28 1.402414 5.250425 0.5638509
## Test set     56228.749 62474.49 56228.75 13.029245 13.029245 1.8436915
##          ACF1 Theil's U
## Training set -0.204124988      NA
## Test set     -0.005983378 2.007423

```

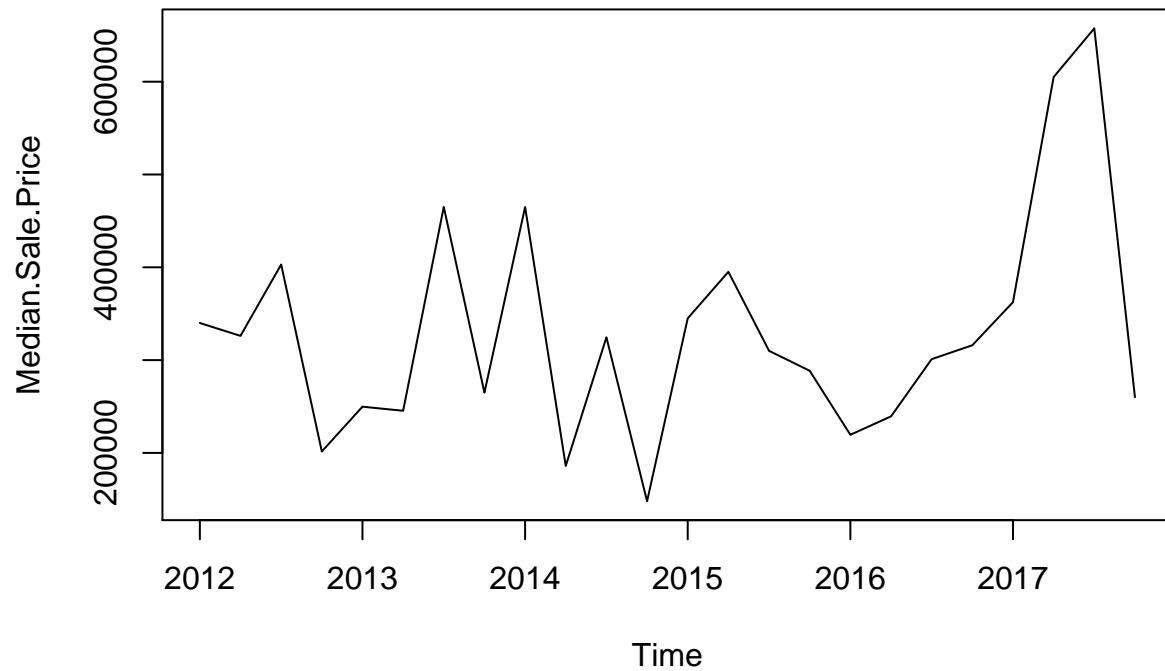
Portland, OR – Multnomah Village : TS Training Model Comparison



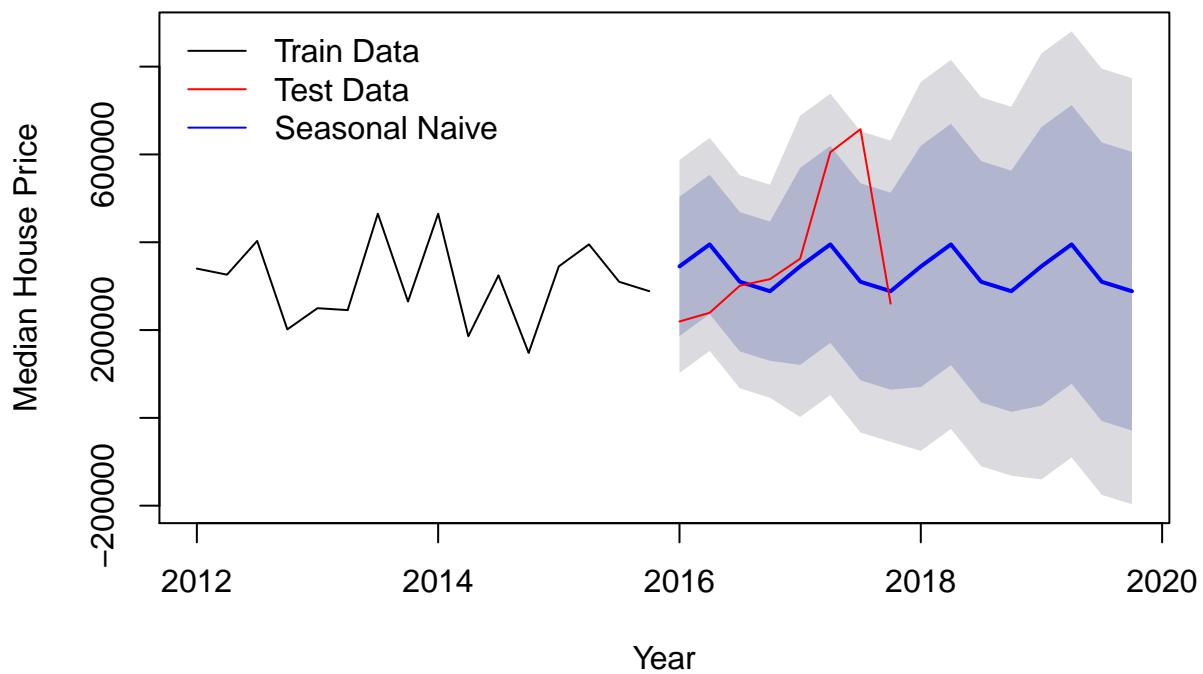
Portland, OR – Multnomah Village : Full TS Models Comparison



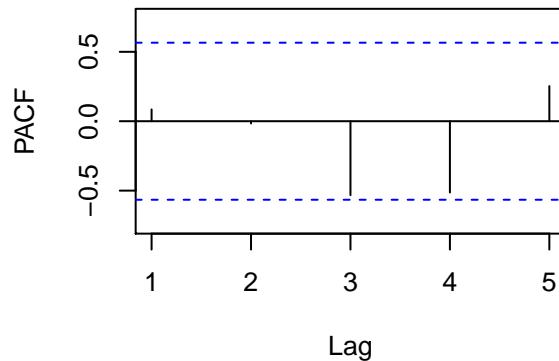
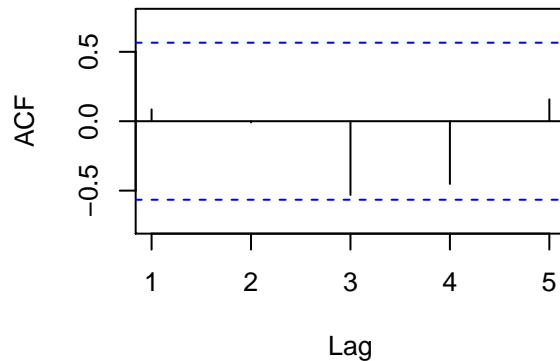
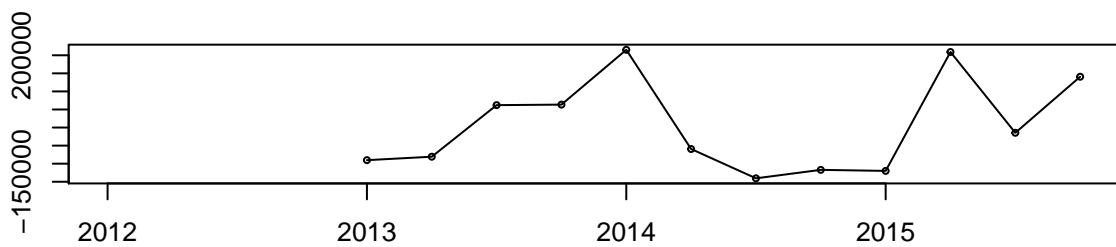
Portland, OR – Homestead



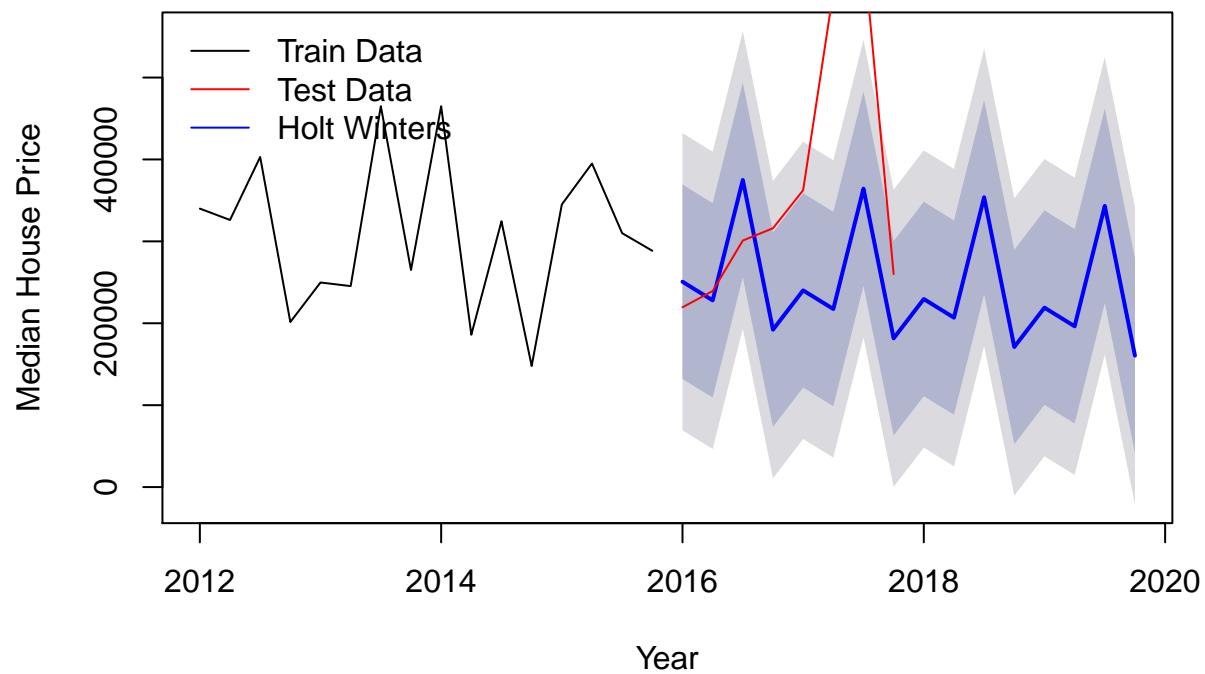
Portland, OR – Homestead : Naive Model Forecast



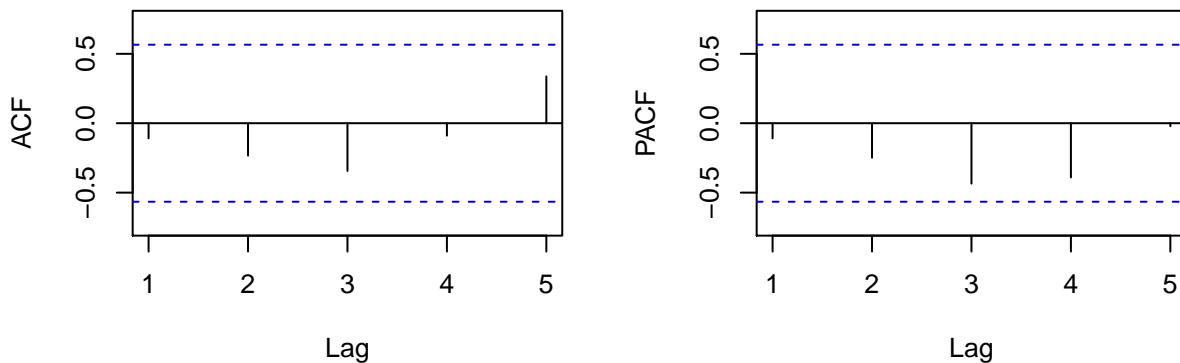
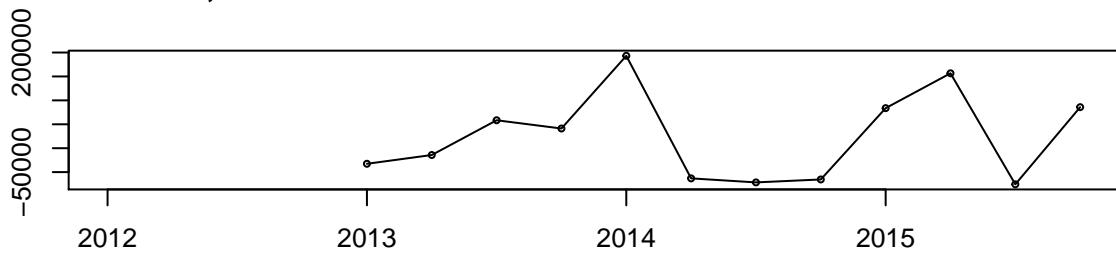
Portland, OR – Homestead : Naive Model Forecast Residuals



Portland, OR – Homestead : Holt Winters Model Forecast

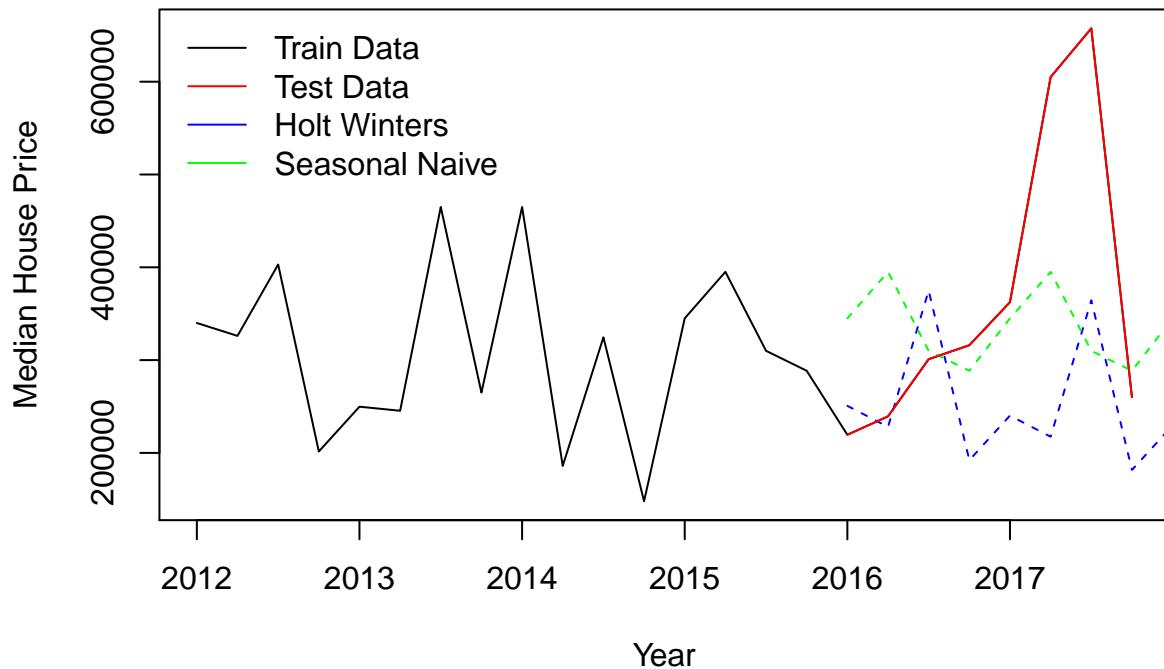


Portland, OR – Homestead : Holt Winters Model Forecast Residuals

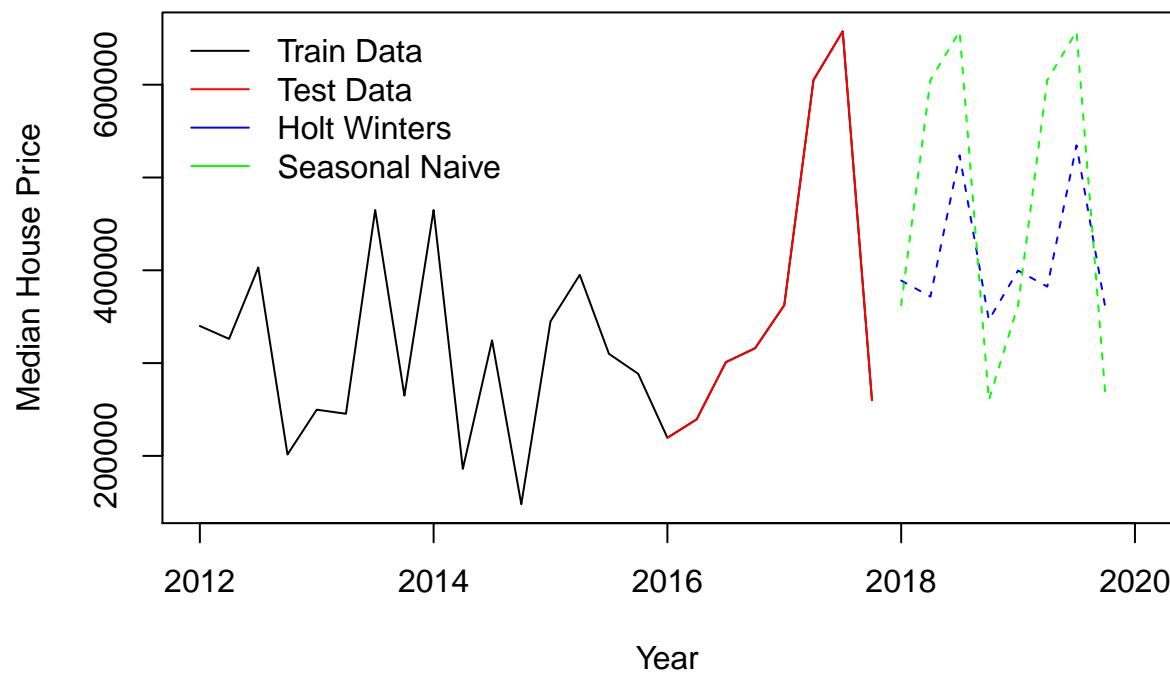


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Homestead"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 5666.667 123785.9 109391.7 -6.467958 37.33921 1.000000
## Test set     35450.000 160770.2 115137.5 -4.392016 29.65774 1.052525
##          ACF1 Theil's U
## Training set 0.08521163      NA
## Test set     0.36147476 1.134515
## [1] "Holt Winters Accuracy for Portland, OR - Homestead"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 24709.38  92021.75  78421.88  1.659911 25.55118 0.7168908
## Test set     113918.75 186786.27 140209.38 22.208107 31.90528 1.2817190
##          ACF1 Theil's U
## Training set -0.1091423      NA
## Test set     0.4411291 1.402804
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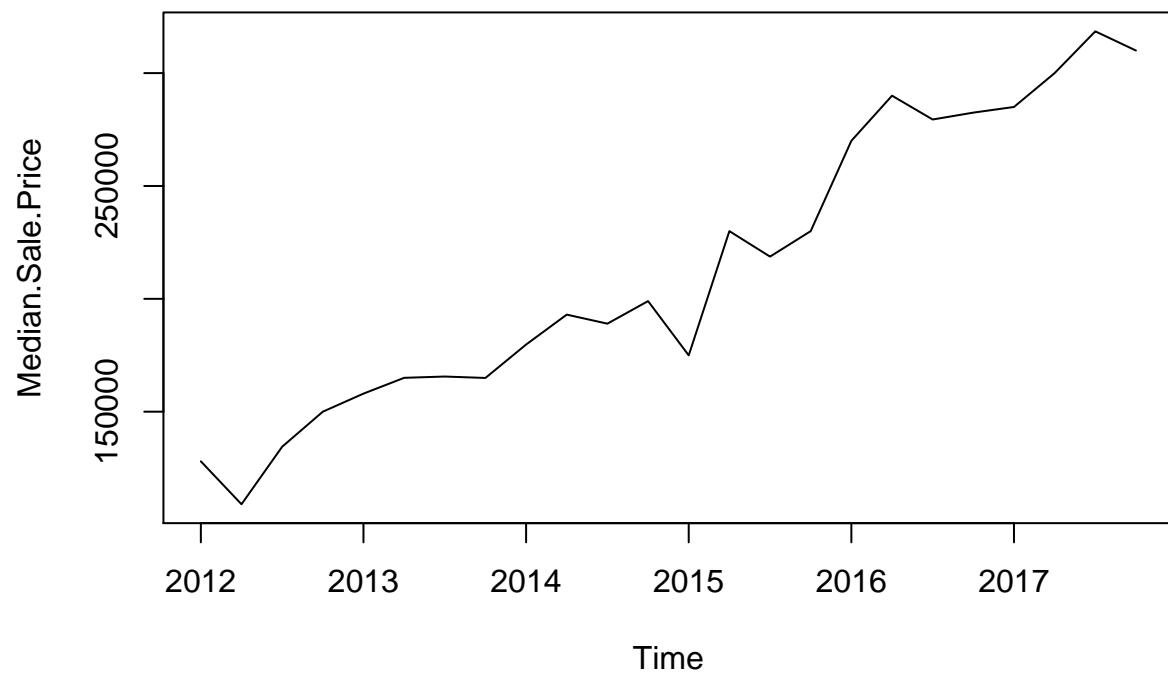
Portland, OR – Homestead : TS Training Model Comparison



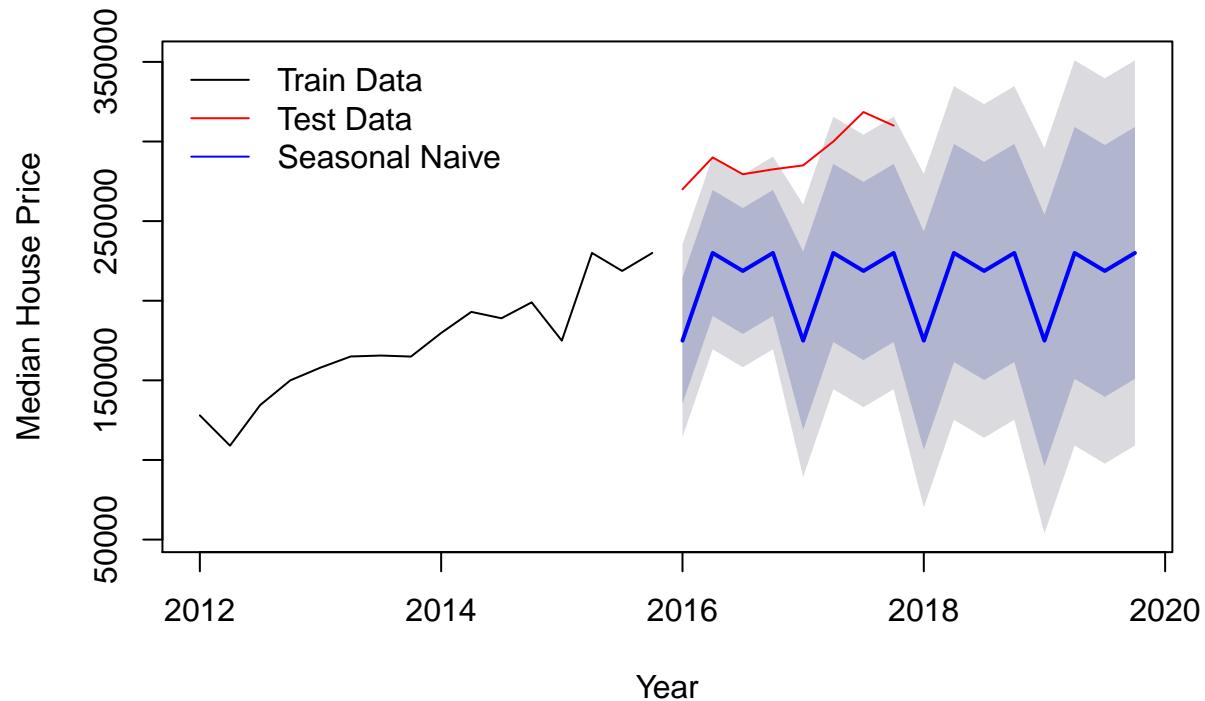
Portland, OR – Homestead : Full TS Models Comparison



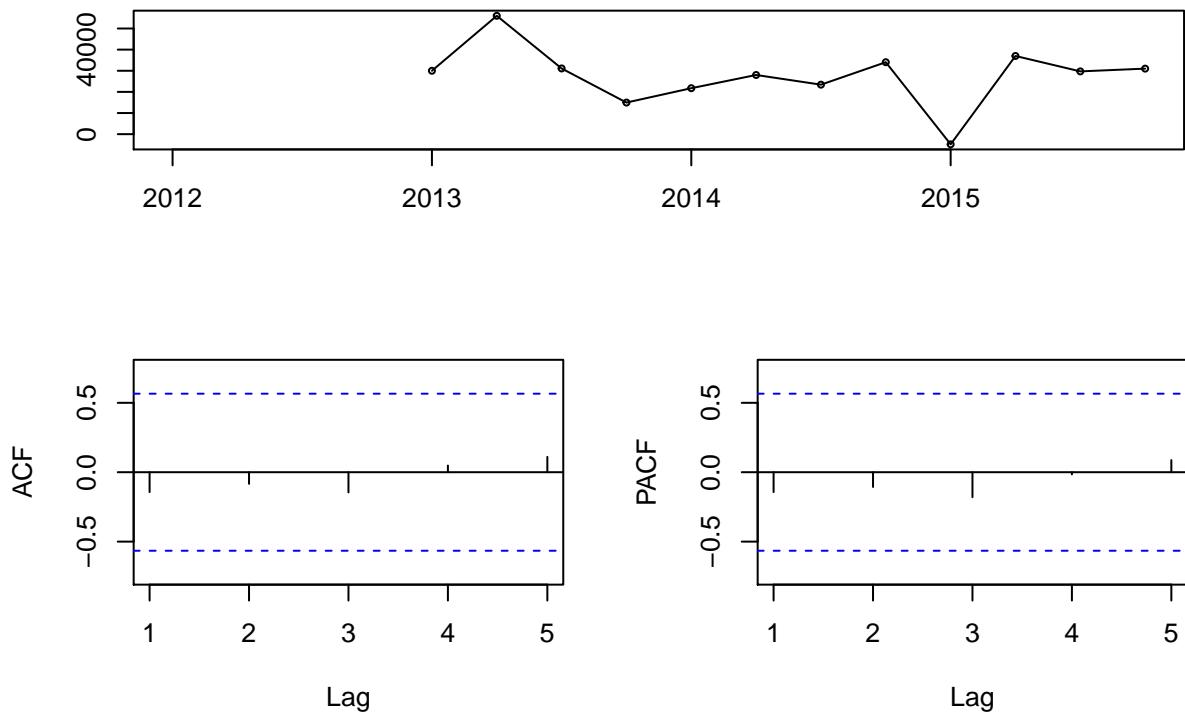
Portland, OR – Sumner



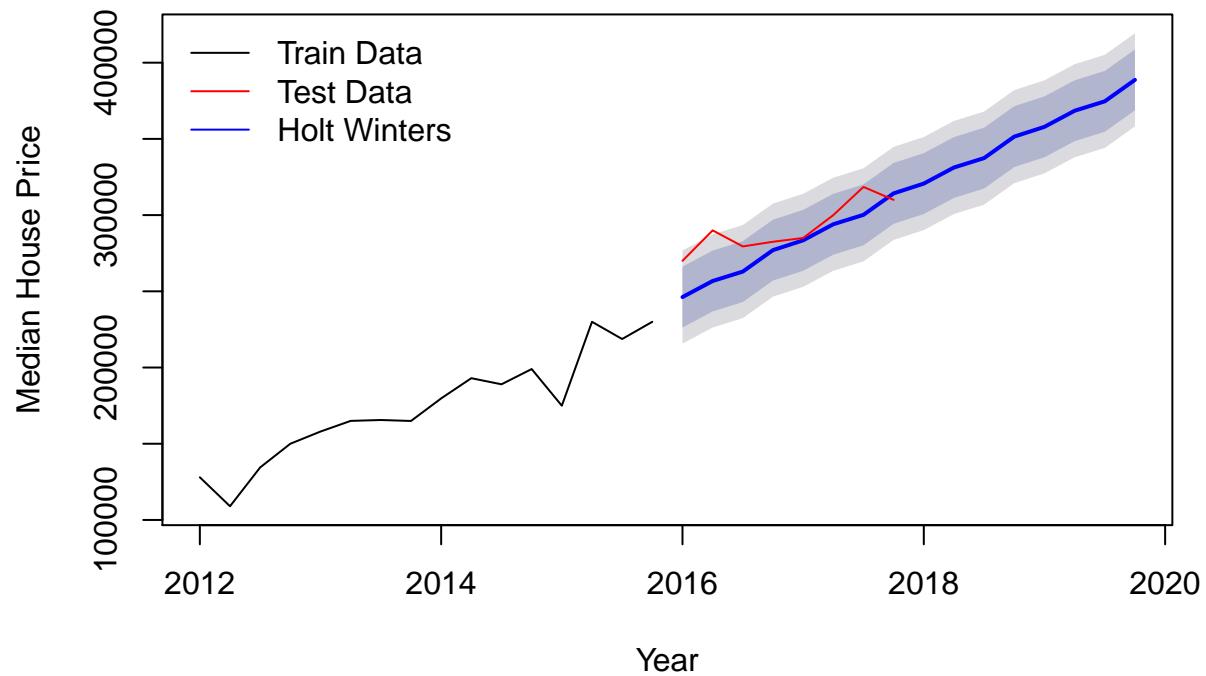
Portland, OR – Sumner : Naive Model Forecast



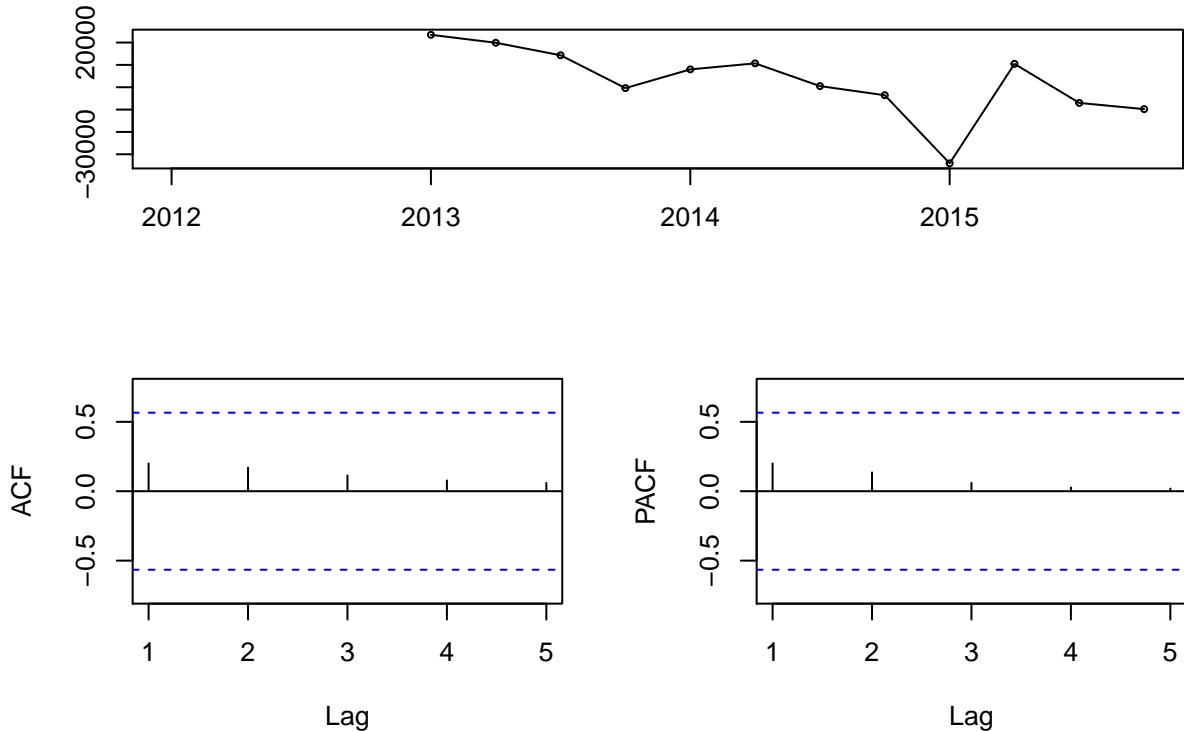
Portland, OR – Sumner : Naive Model Forecast Residuals



Portland, OR – Sumner : Holt Winters Model Forecast



Portland, OR – Sumner : Holt Winters Model Forecast Residuals

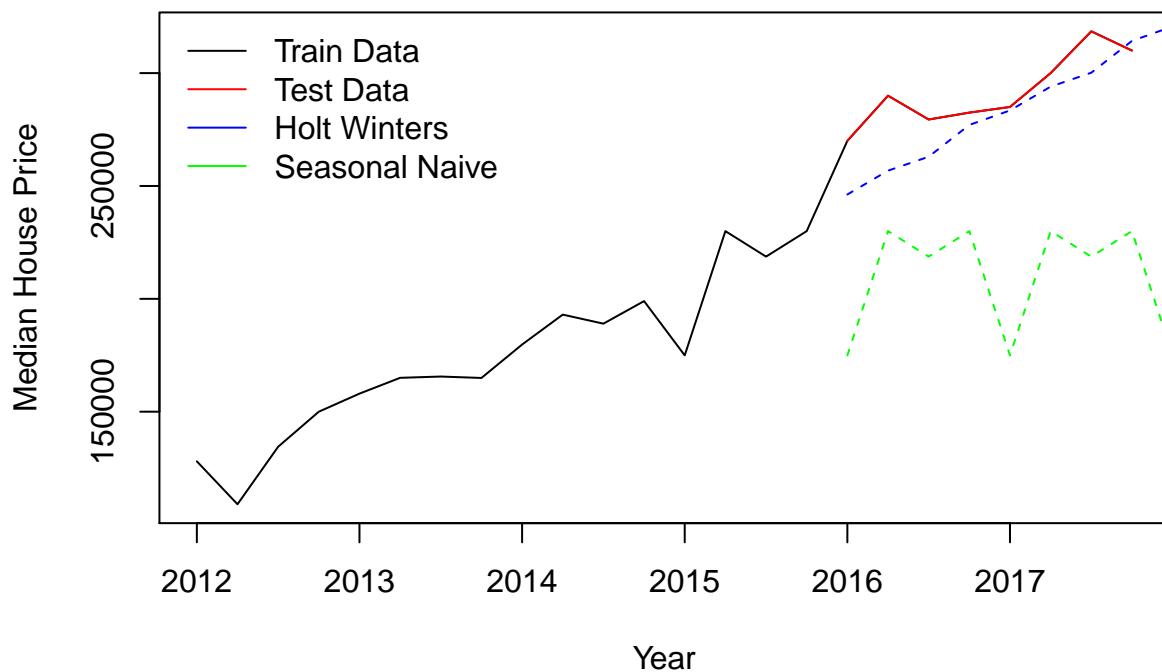


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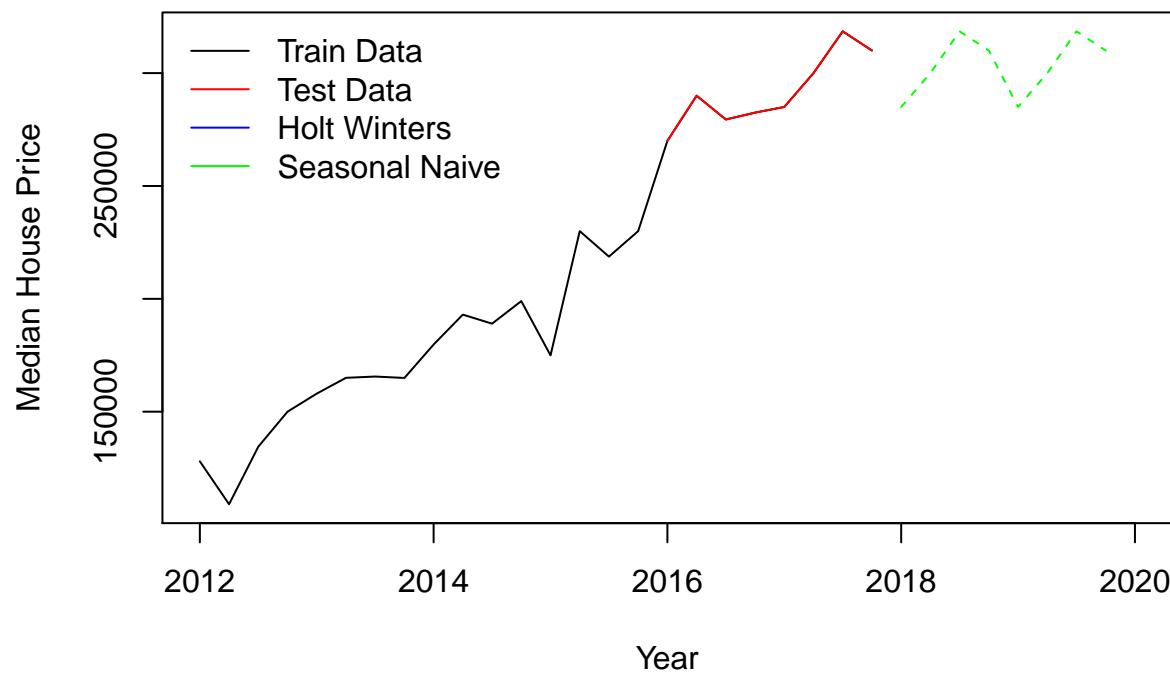
## [1] "Seasonal Naive Accuracy for Portland, OR – Sumner"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 27681.25 30858.60 28481.25 14.77397 15.23124 1.000000
## Test set     78518.75 80972.49 78518.75 26.91310 26.91310 2.756858
##          ACF1 Theil's U
## Training set -0.1433347      NA
## Test set     -0.2406856  5.999142
## [1] "Holt Winters Accuracy for Portland, OR – Sumner"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 2702.188 15155.01 11845.05 1.779683 6.609335 0.4158895
## Test set     12570.937 17187.64 13636.17 4.377558 4.721182 0.4787772
##          ACF1 Theil's U
## Training set 0.2004910      NA
## Test set     0.2736896  1.272454

```

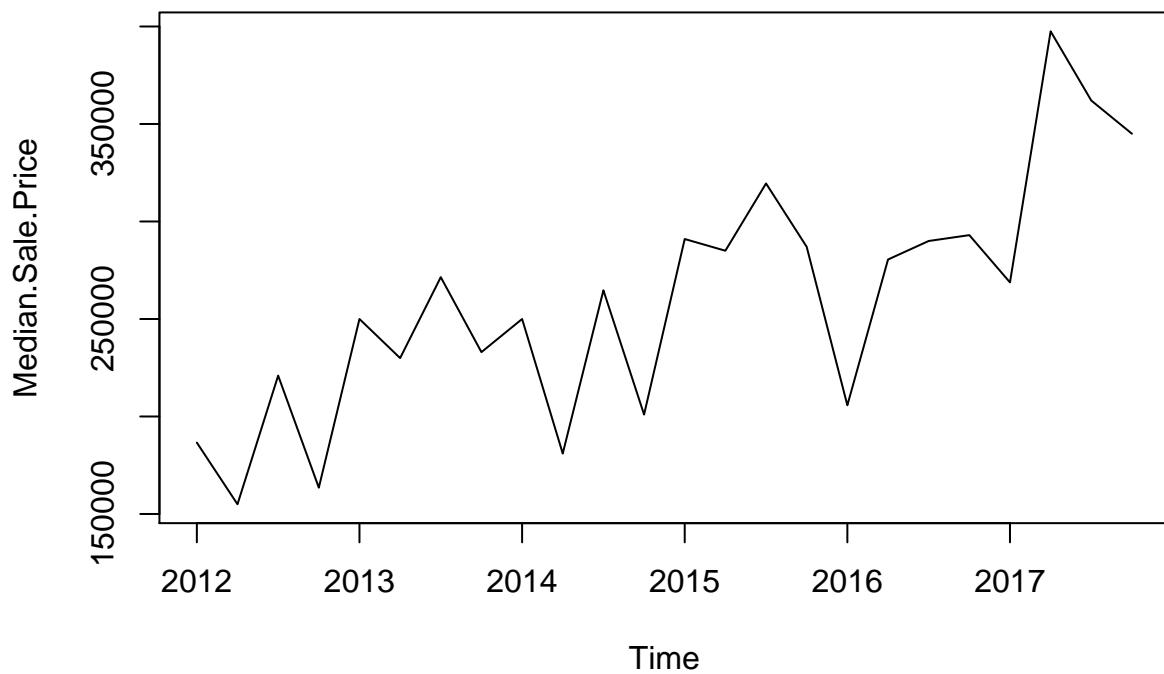
Portland, OR – Sumner : TS Training Model Comparison



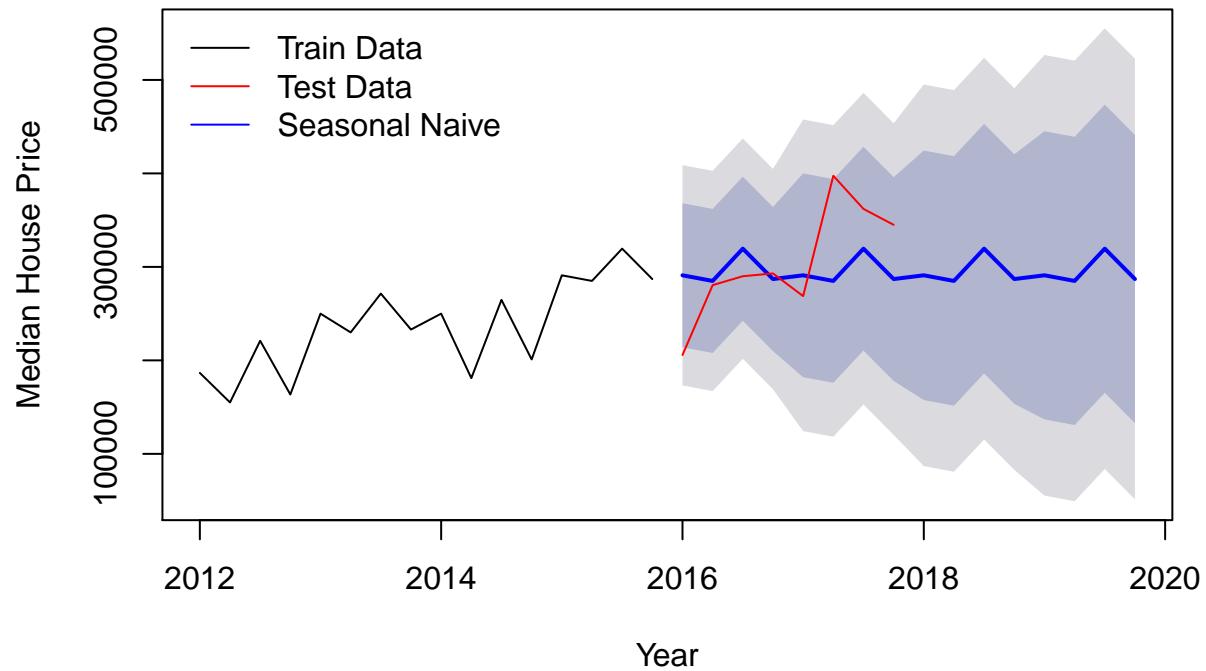
Portland, OR – Sumner : Full TS Models Comparison



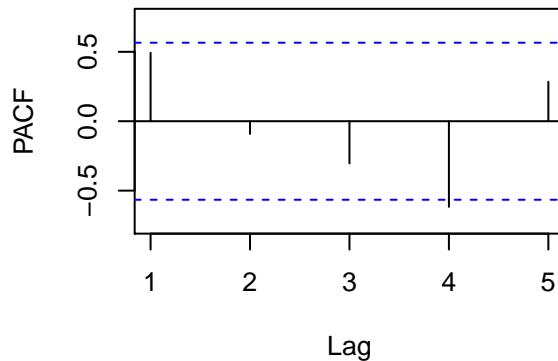
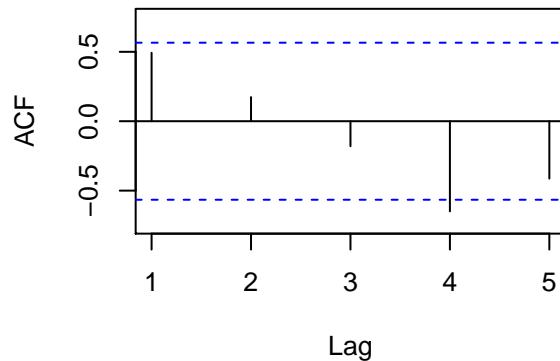
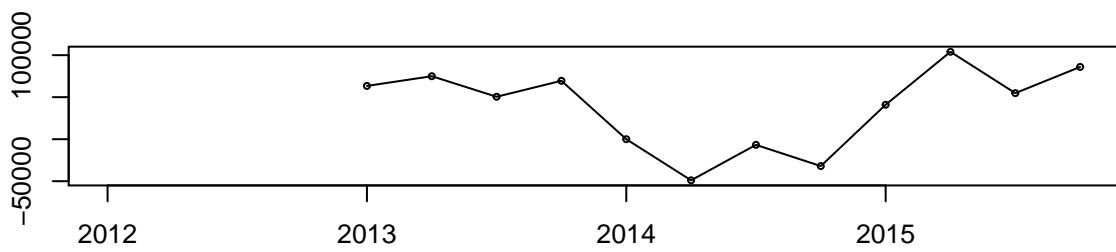
Portland, OR – Cathedral Park



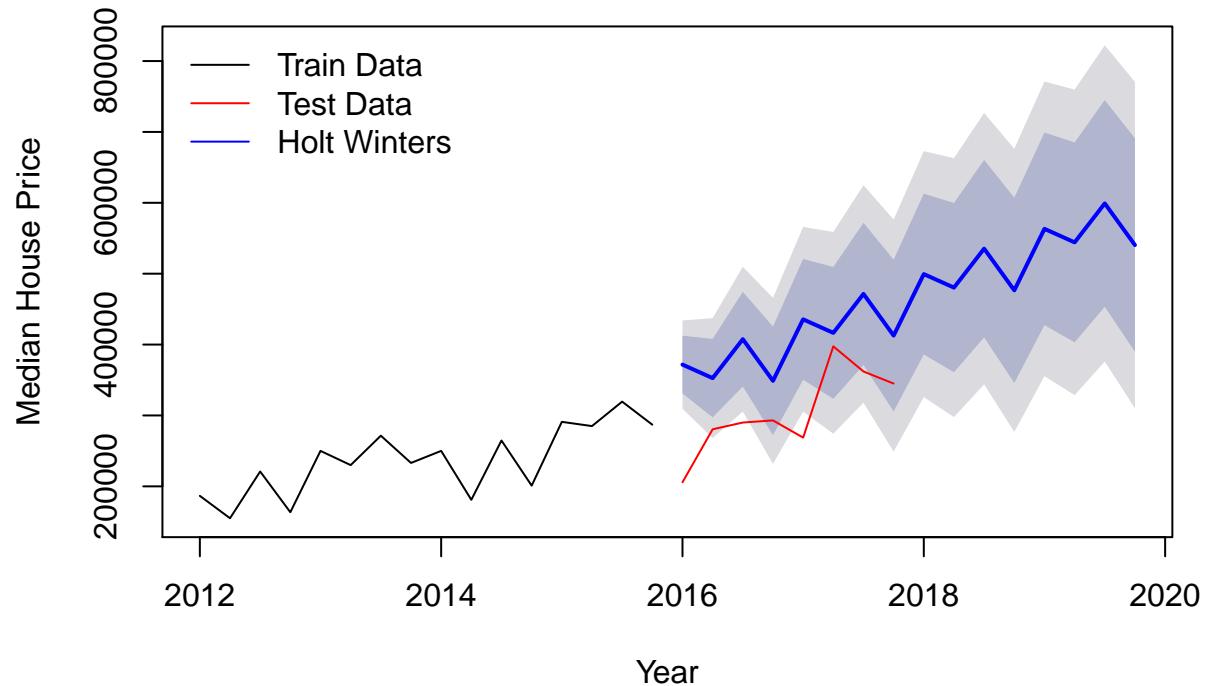
Portland, OR – Cathedral Park : Naive Model Forecast



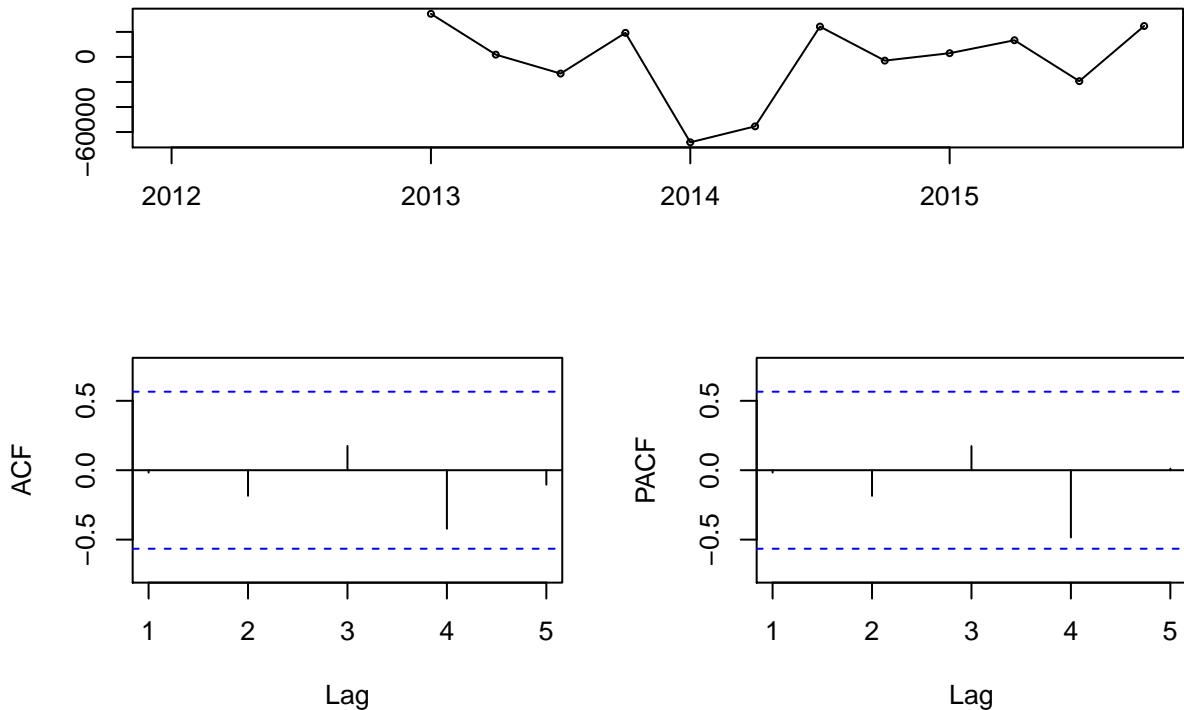
Portland, OR – Cathedral Park : Naive Model Forecast Residuals



Portland, OR – Cathedral Park : Holt Winters Model Forecast

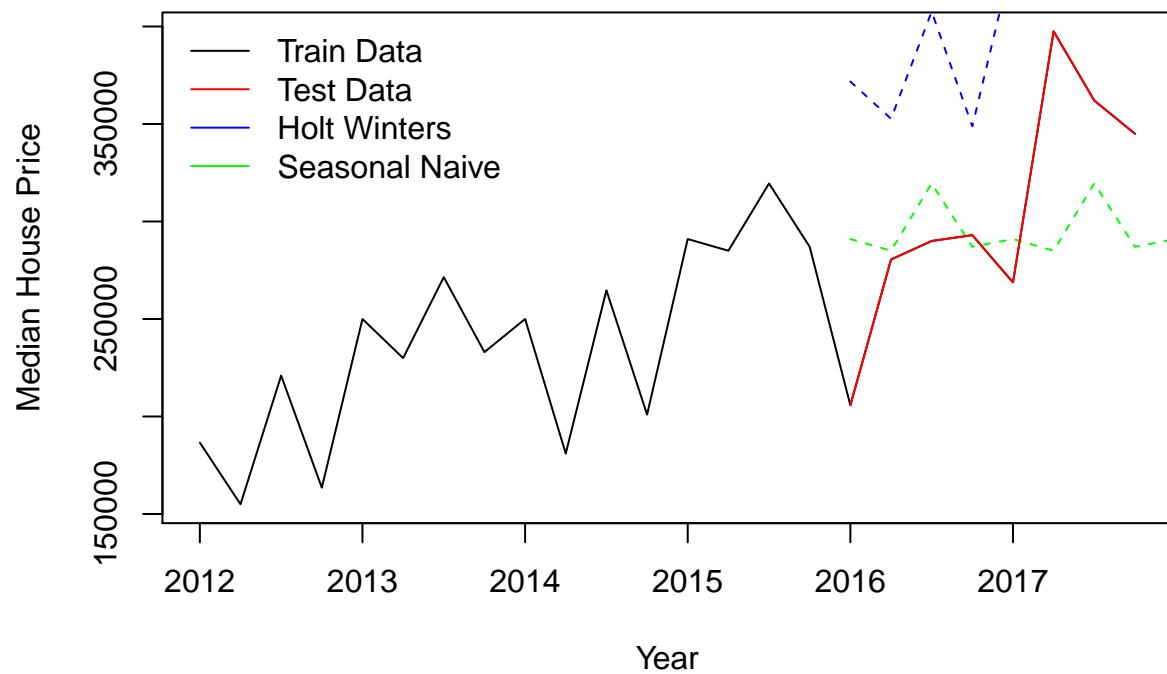


Portland, OR – Cathedral Park : Holt Winters Model Forecast Residuals

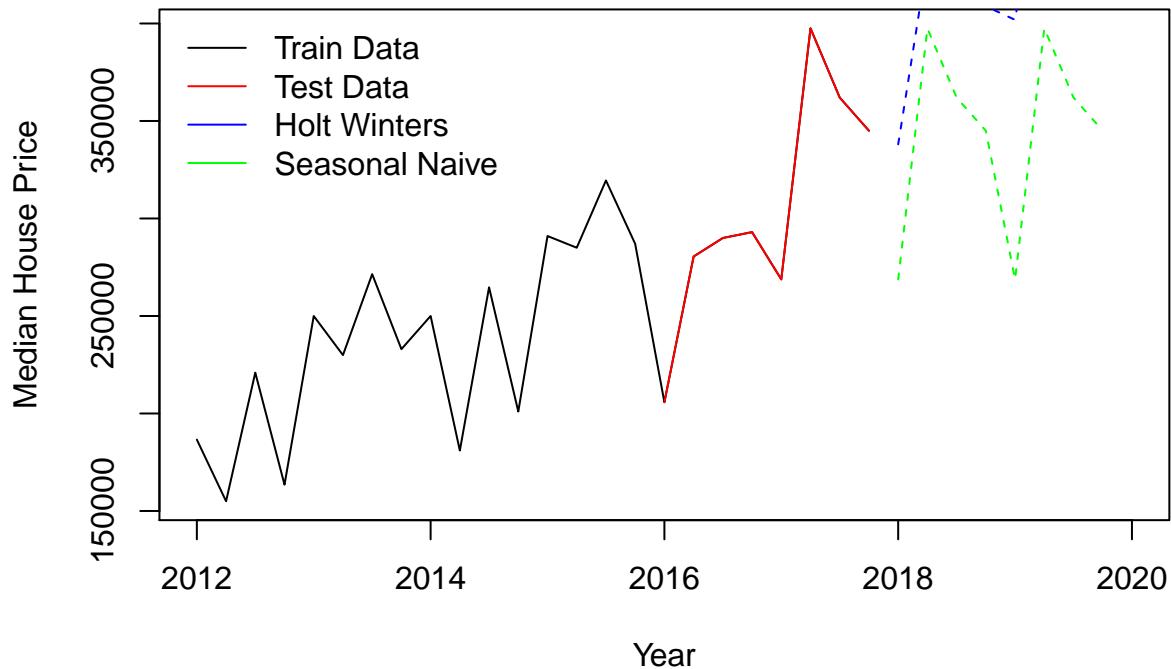


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Cathedral Park"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 38037.5 60124.36 52654.17 13.2140867 20.79986 1.0000000
## Test set     9687.5 57571.29 45062.50 -0.3234933 15.04889 0.8558202
##          ACF1 Theil's U
## Training set 0.4931651      NA
## Test set     0.1490553 0.7783194
## [1] "Holt Winters Accuracy for Portland, OR – Cathedral Park"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -3202.424 30598.37 23339.90 -2.001809 9.721856 0.4432678
## Test set     -96832.586 108678.41 96832.59 -35.345031 35.345031 1.8390299
##          ACF1 Theil's U
## Training set -0.01720408      NA
## Test set     -0.65419299 1.429482
```

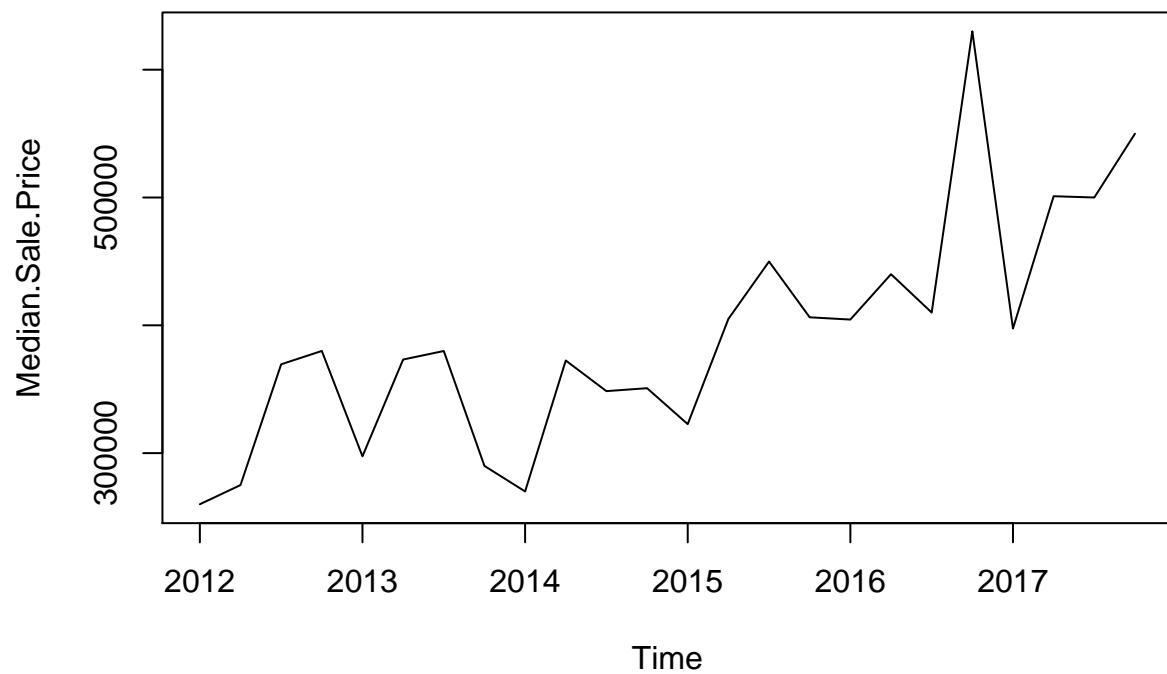
Portland, OR – Cathedral Park : TS Training Model Comparison



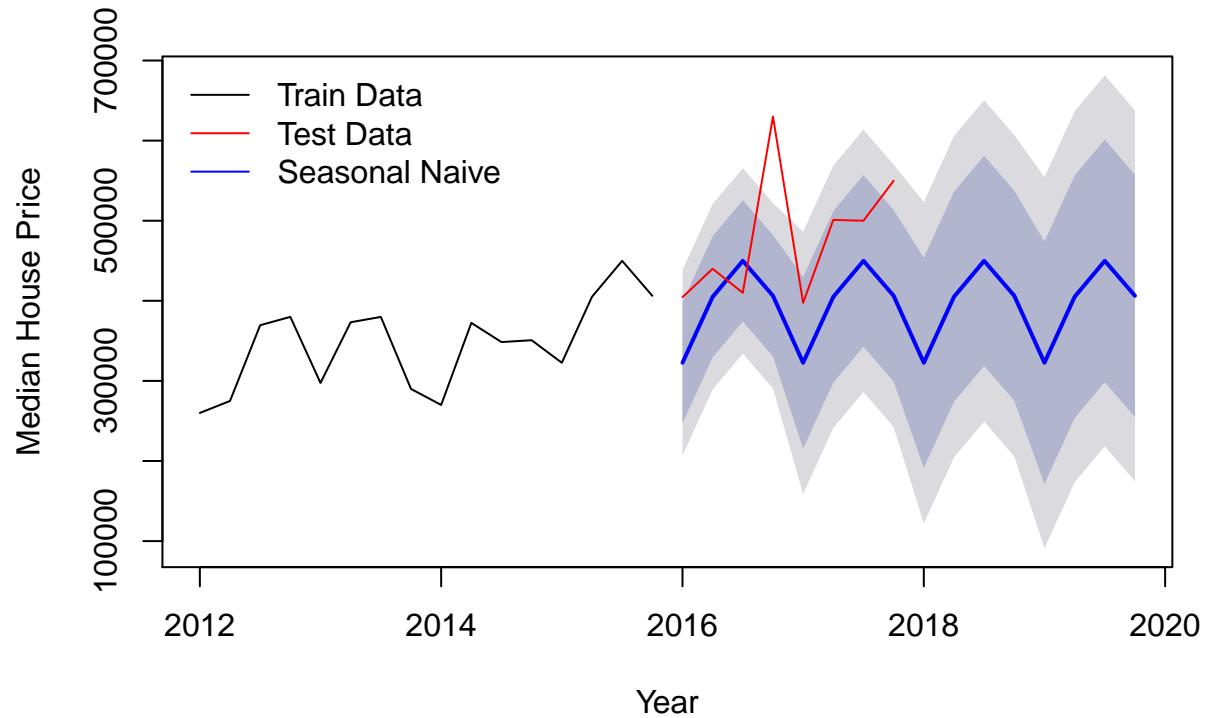
Portland, OR – Cathedral Park : Full TS Models Comparison



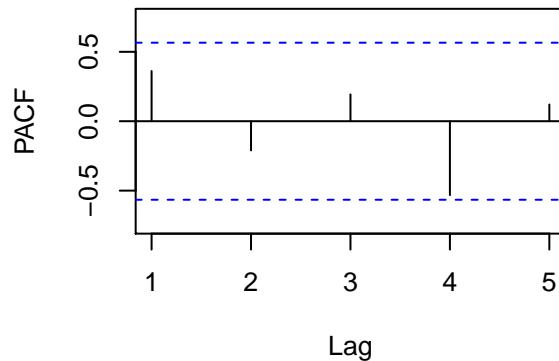
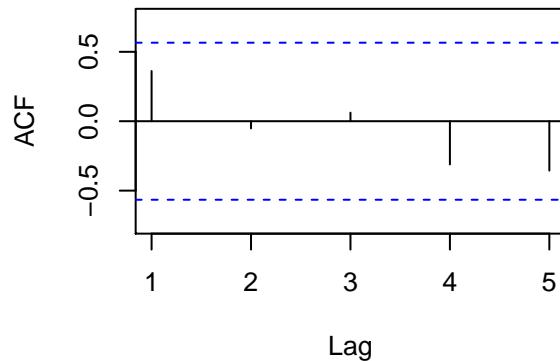
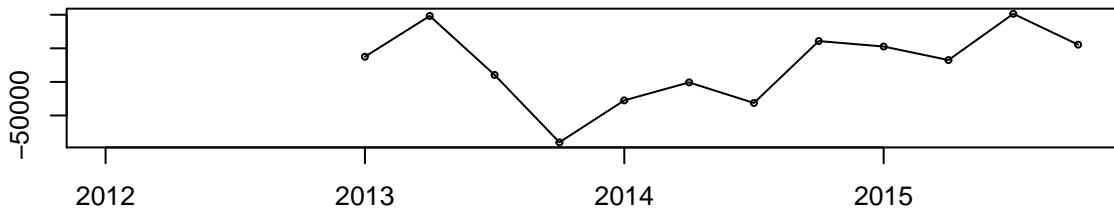
Portland, OR – Collins View



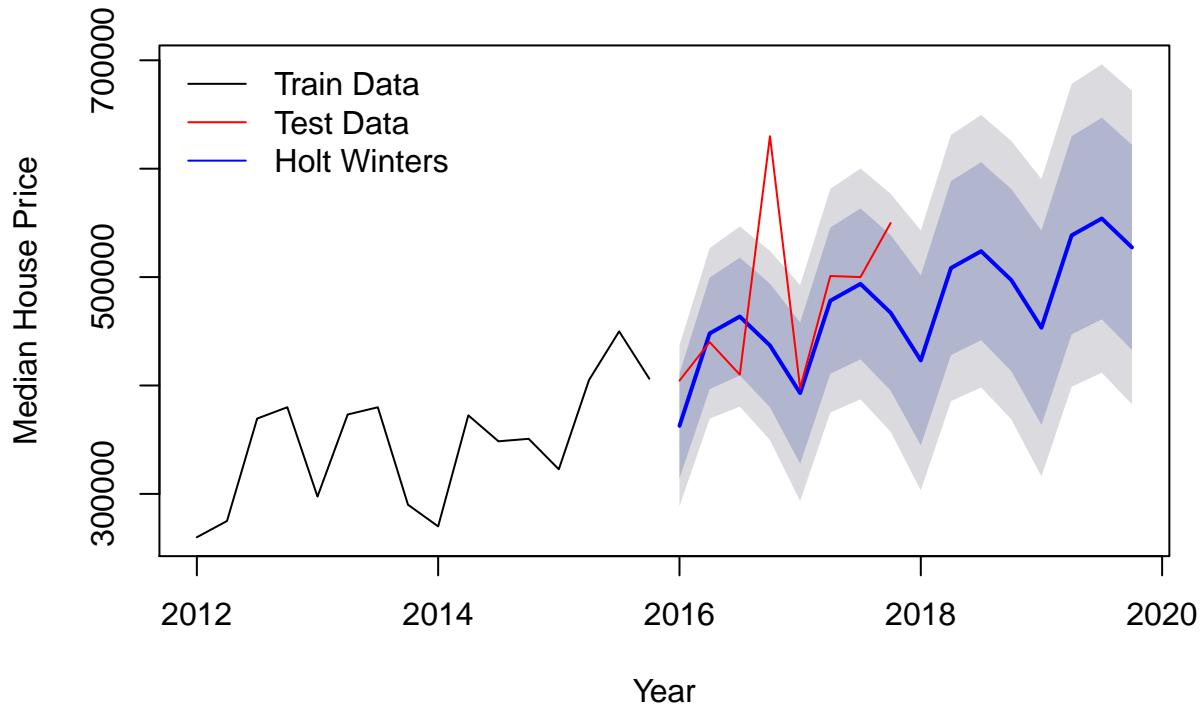
Portland, OR – Collins View : Naive Model Forecast



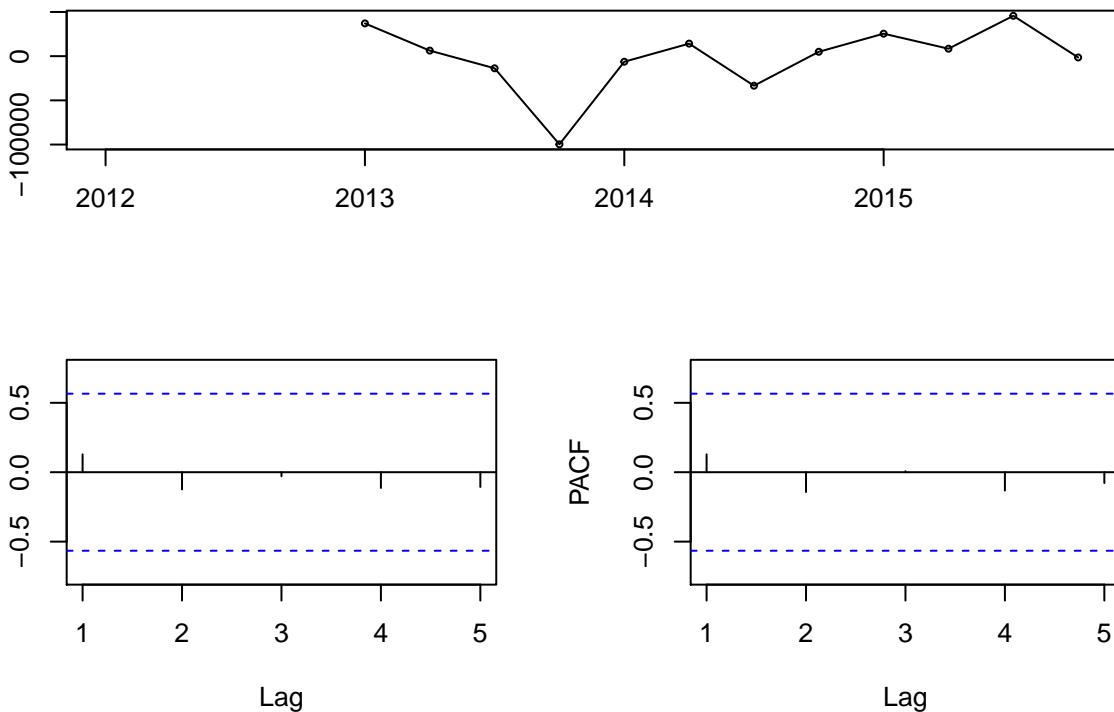
Portland, OR – Collins View : Naive Model Forecast Residuals



Portland, OR – Collins View : Holt Winters Model Forecast



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

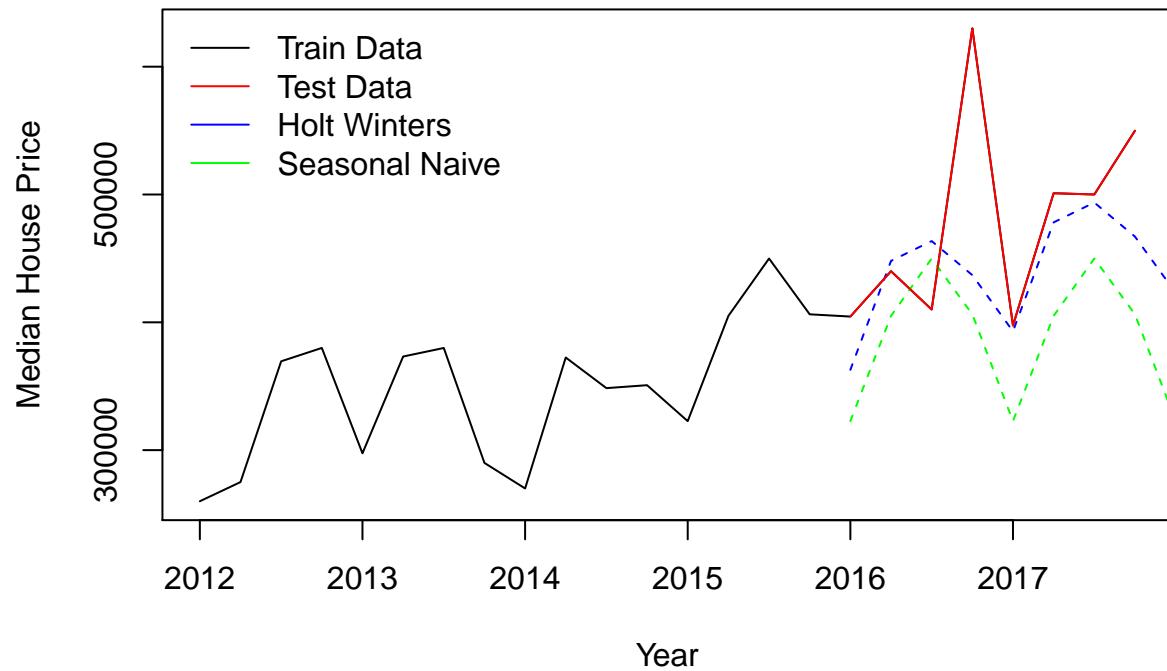


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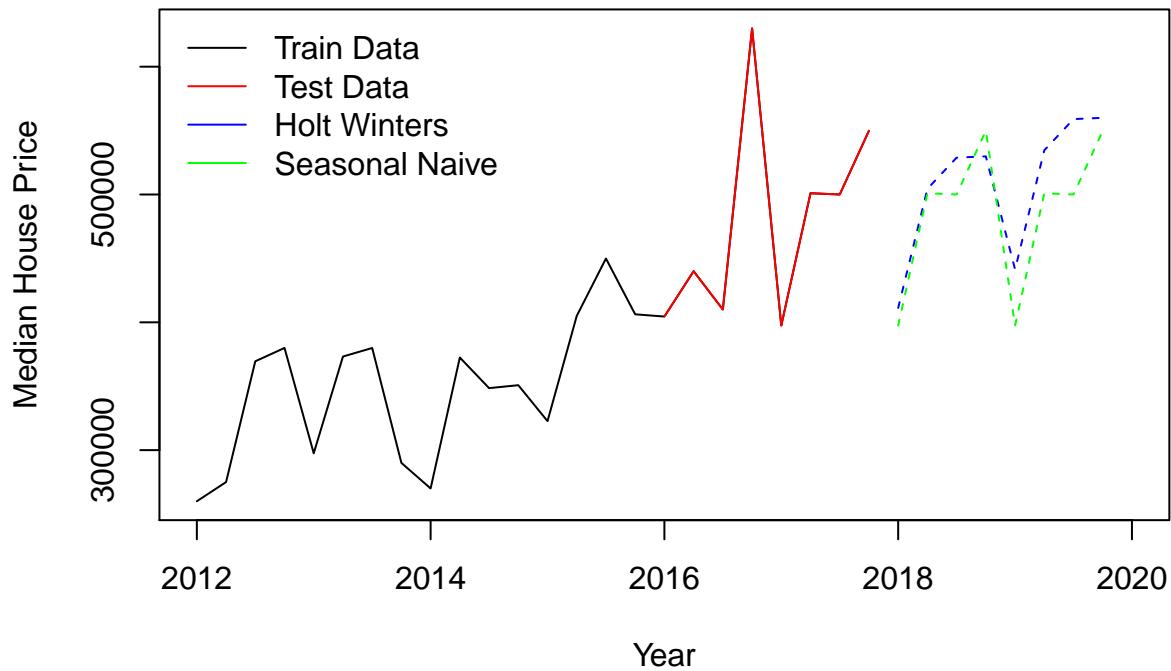
## [1] "Seasonal Naive Accuracy for Portland, OR - Collins View"
##          ME      RMSE      MAE      MPE      MAPE      MASE       ACF1
## Training set 24948  59079.0 49885.5  5.760093 14.16352 1.000000  0.3616969
## Test set     83156 110417.5 93131.0 16.011925 18.44485 1.866895 -0.3556309
##          Theil's U
## Training set     NA
## Test set        0.9646392
## [1] "Holt Winters Accuracy for Portland, OR - Collins View"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -1051.344 36205.05 24718.65 -0.9004074 7.479233 0.4955077
## Test set      36201.521 78576.48 51605.72  6.0091861 9.732877 1.0344834
##          ACF1 Theil's U
## Training set  0.1283691      NA
## Test set      -0.4084346 0.7218325

```

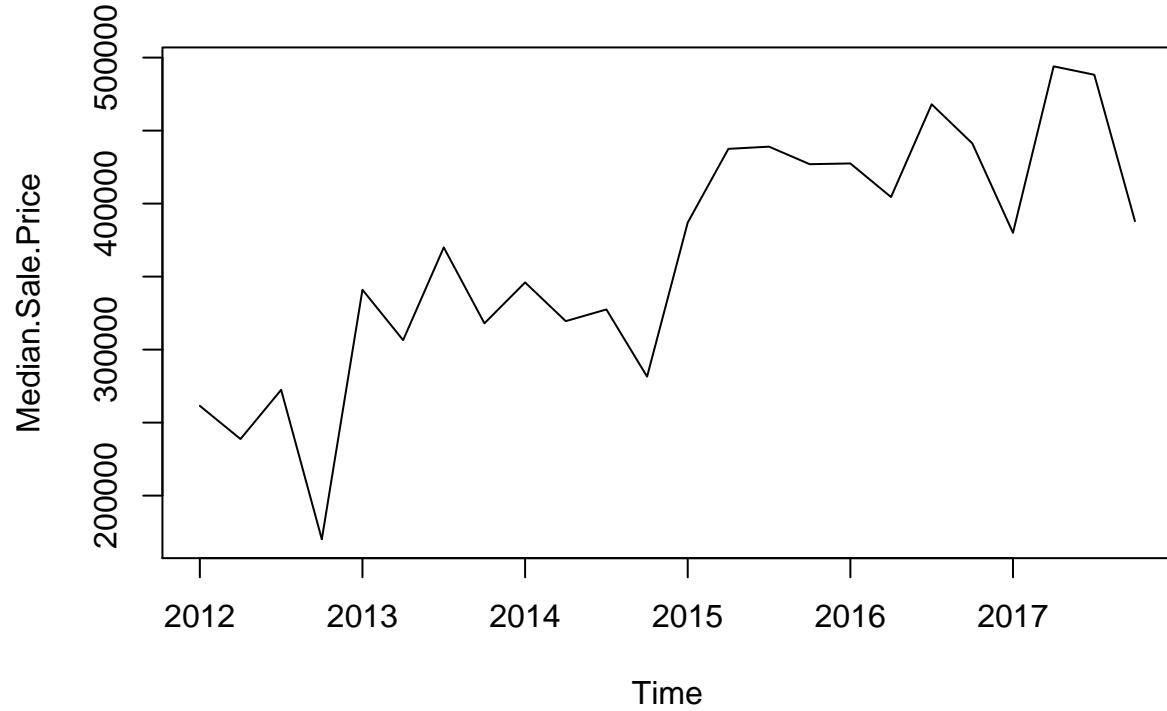
Portland, OR – Collins View : TS Training Model Comparison



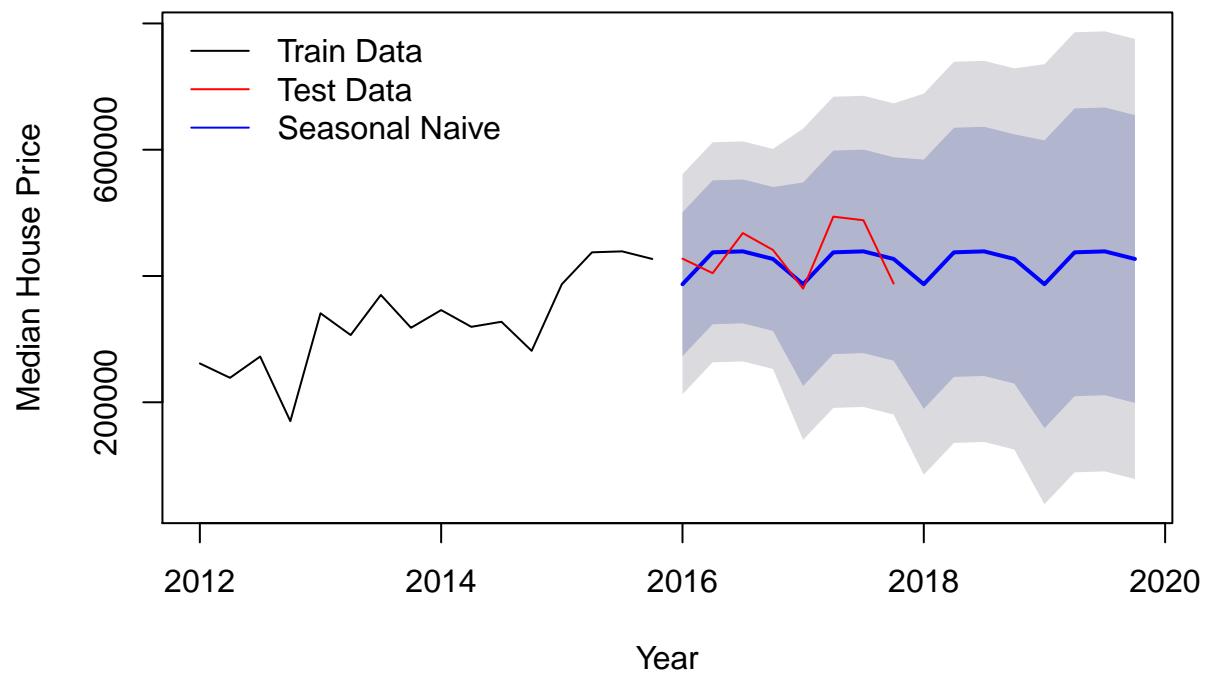
Portland, OR – Collins View : Full TS Models Comparison



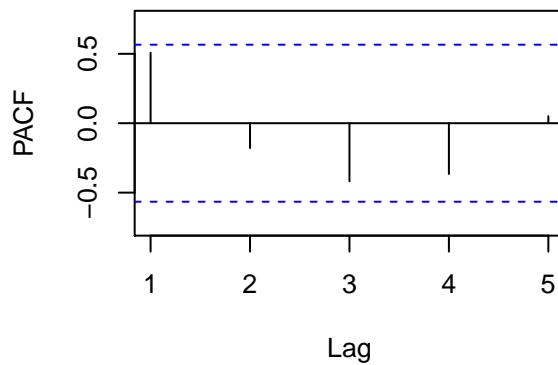
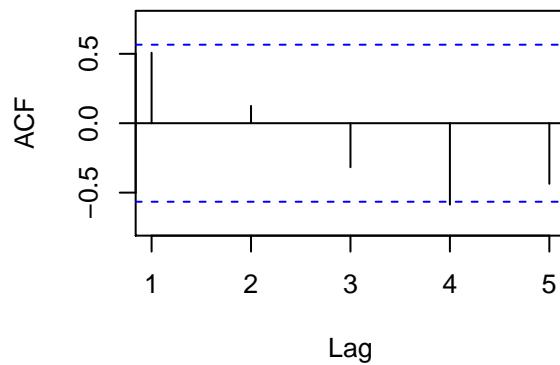
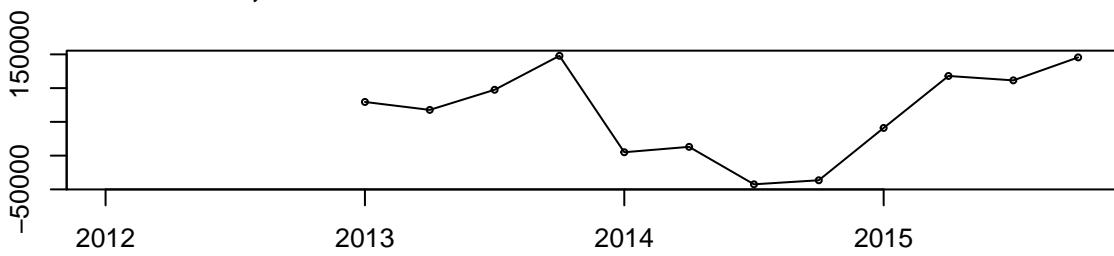
Portland, OR – North Tabor



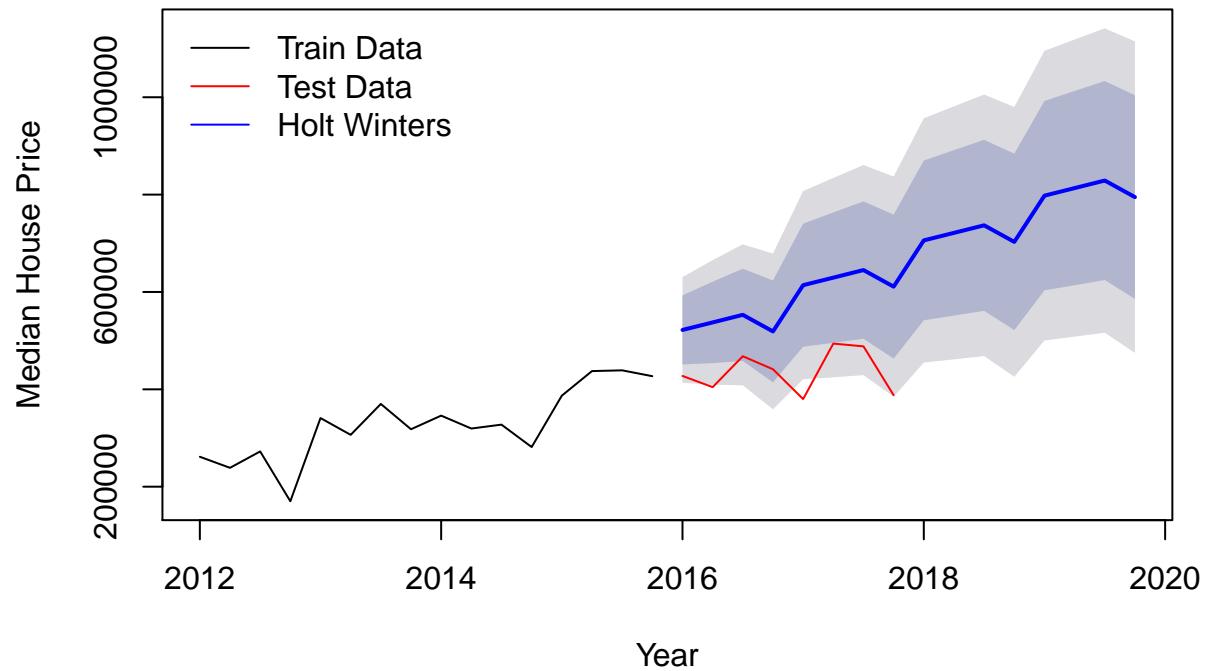
Portland, OR – North Tabor : Naive Model Forecast



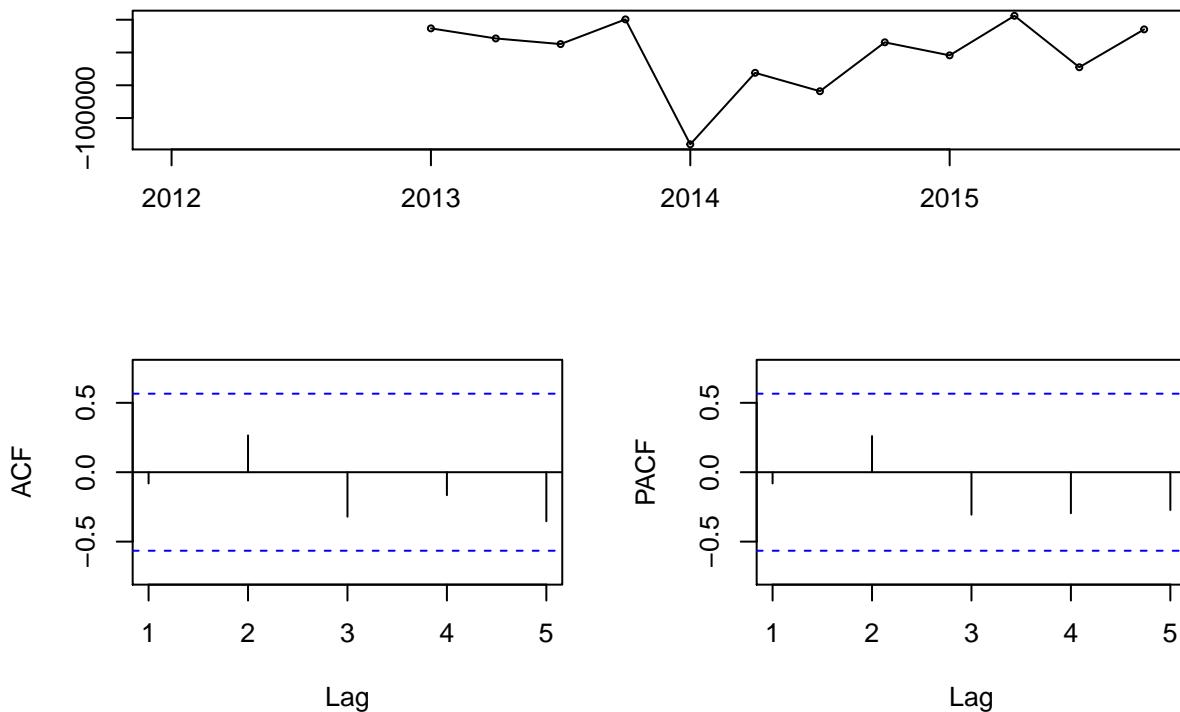
Portland, OR – North Tabor : Naive Model Forecast Residuals



Portland, OR – North Tabor : Holt Winters Model Forecast

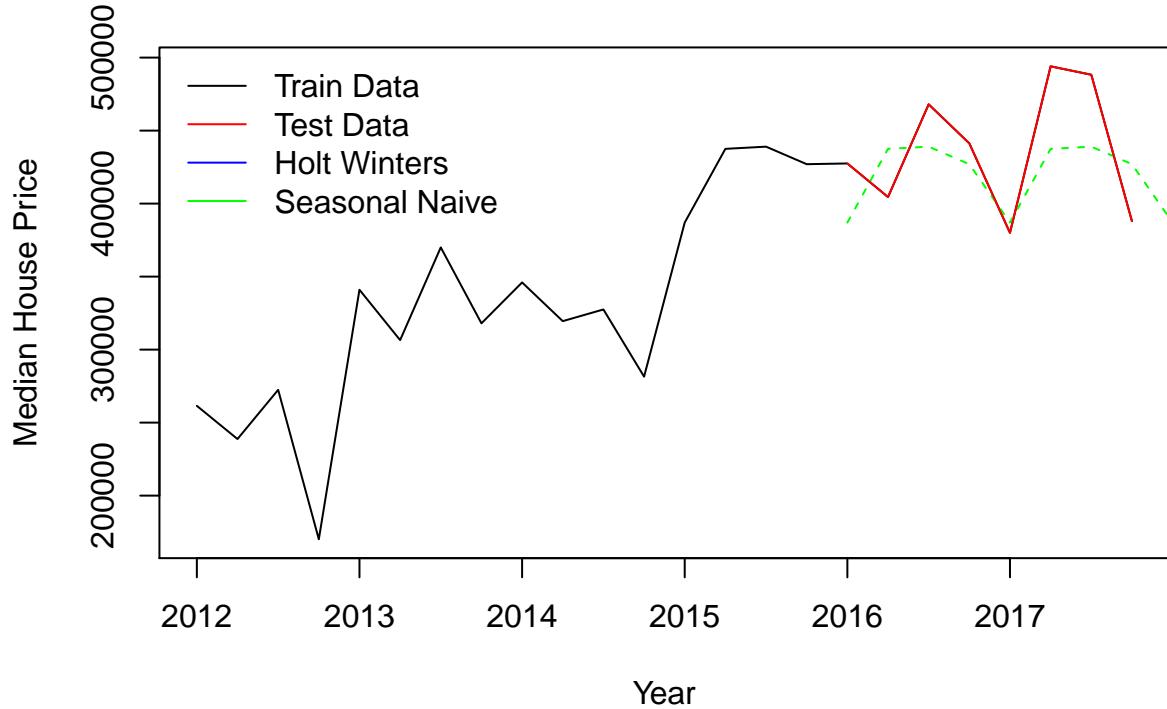


Portland, OR – North Tabor : Holt Winters Model Forecast Residuals

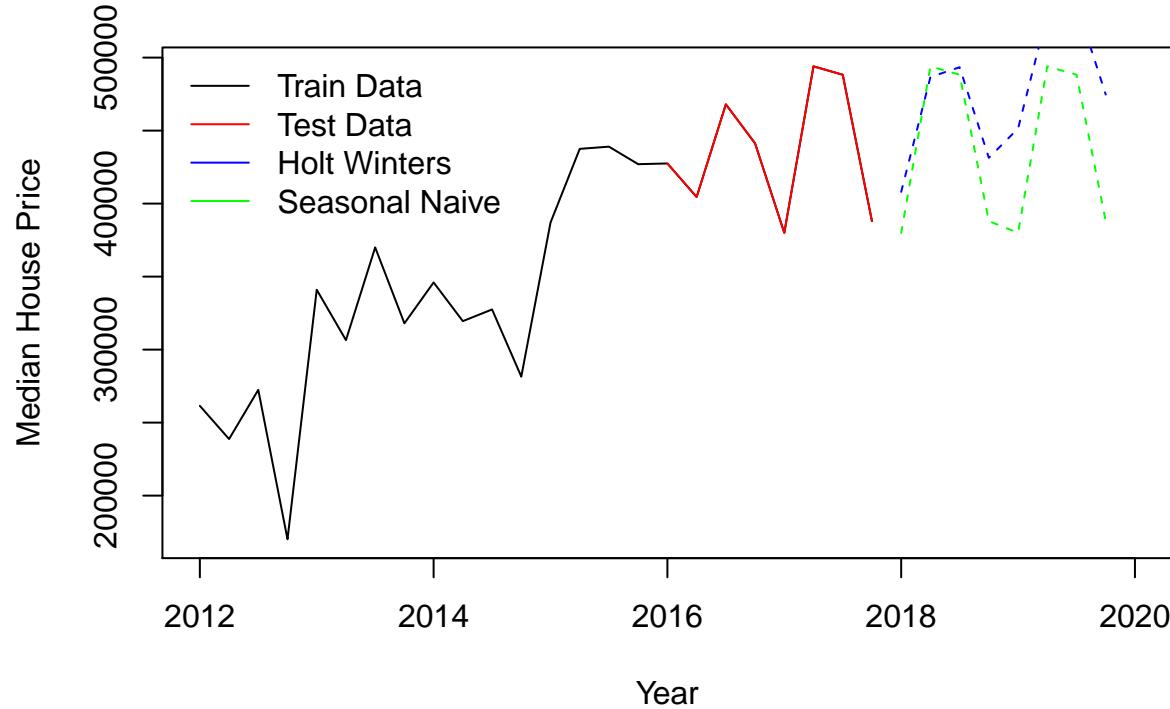


```
## [1] "Seasonal Naive Accuracy for Portland, OR – North Tabor"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 62305.83 88896.87 75472.5 16.241080 20.564972 1.0000000
## Test set     13812.50 37015.41 33562.5  2.546519  7.559486 0.4446984
##          ACF1 Theil's U
## Training set 0.5077408      NA
## Test set     -0.3402253 0.5272881
## [1] "Holt Winters Accuracy for Portland, OR – North Tabor"
##          ME      RMSE      MAE      MPE      MAPE
## Training set -2370.486 53031.14 40452.14 -0.8923235 11.51688
## Test set     -142412.626 152982.96 142412.63 -33.6632960 33.66330
##          MASE      ACF1 Theil's U
## Training set 0.5359852 -0.08076055      NA
## Test set     1.8869473 -0.03212064  2.203949
```

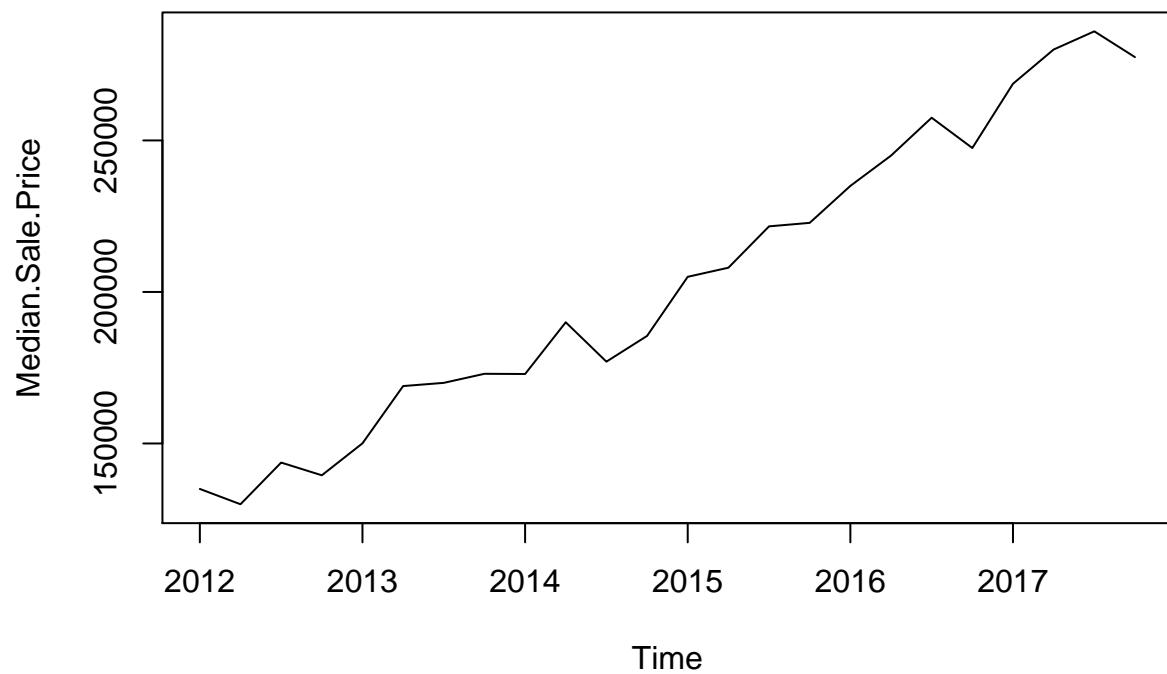
Portland, OR – North Tabor : TS Training Model Comparison



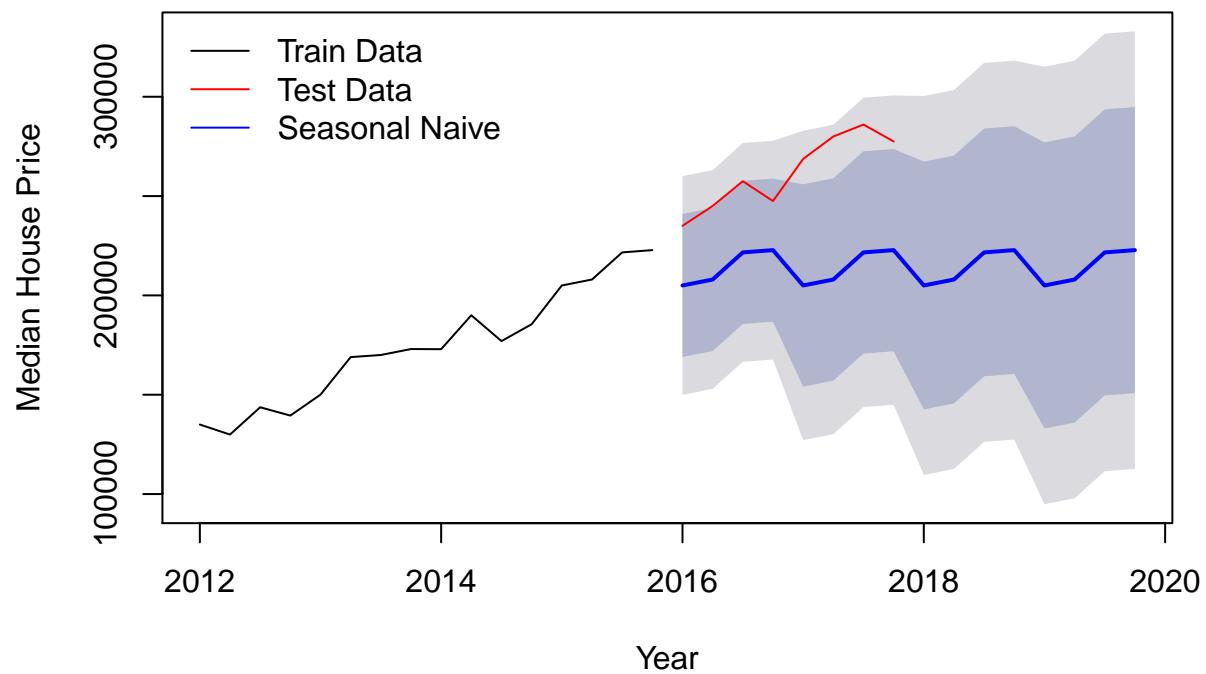
Portland, OR – North Tabor : Full TS Models Comparison



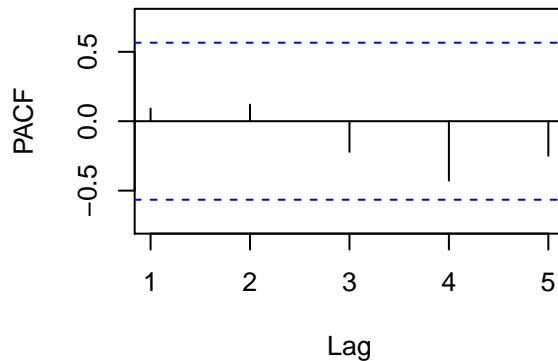
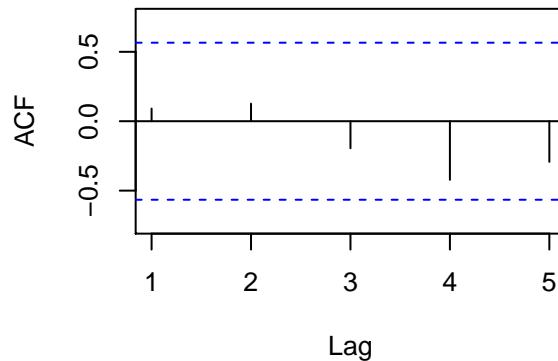
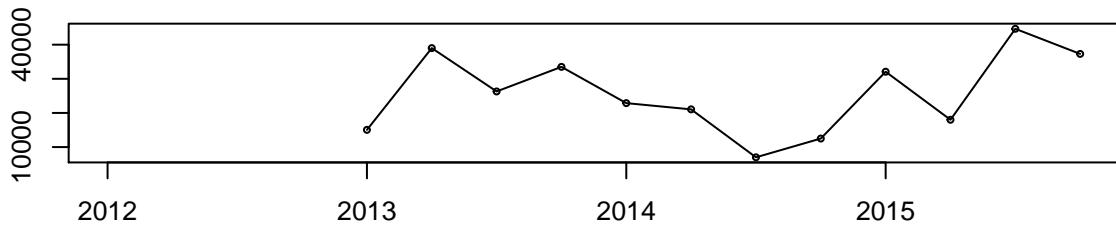
Portland, OR – Centennial



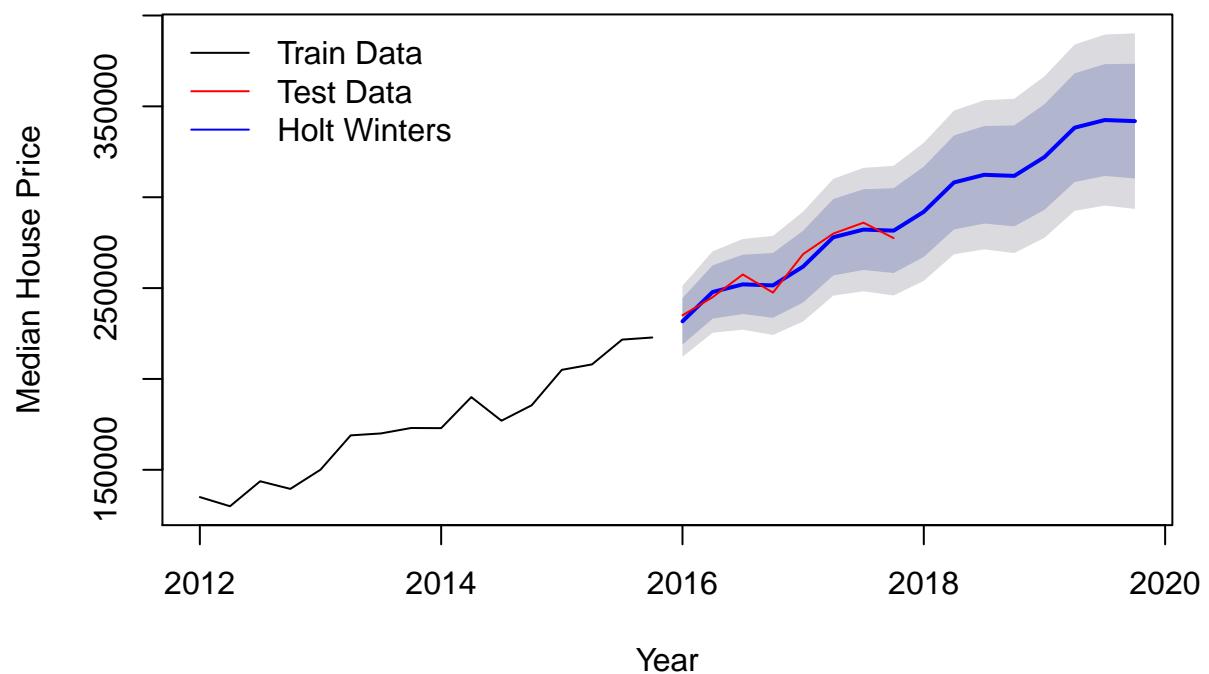
Portland, OR – Centennial : Naive Model Forecast



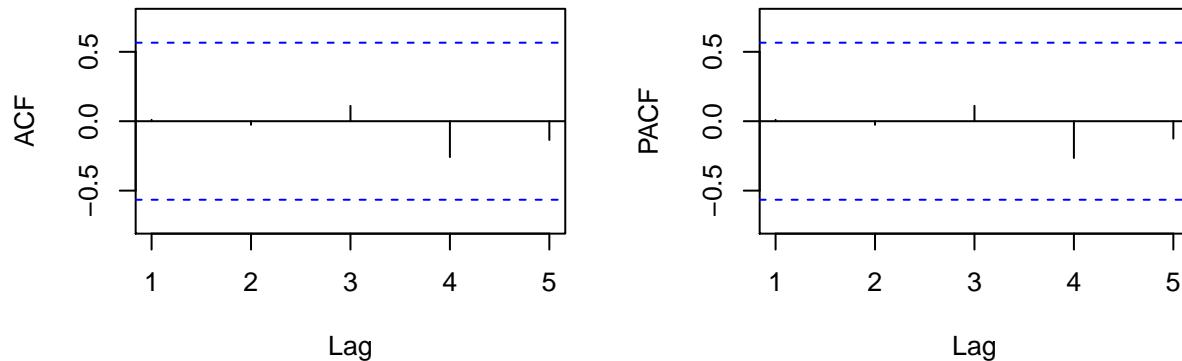
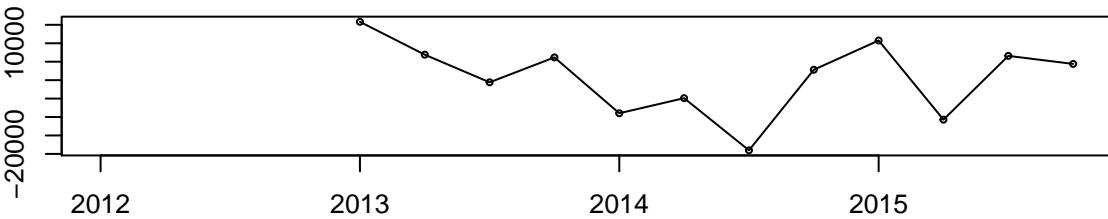
Portland, OR – Centennial : Naive Model Forecast Residuals



Portland, OR – Centennial : Holt Winters Model Forecast

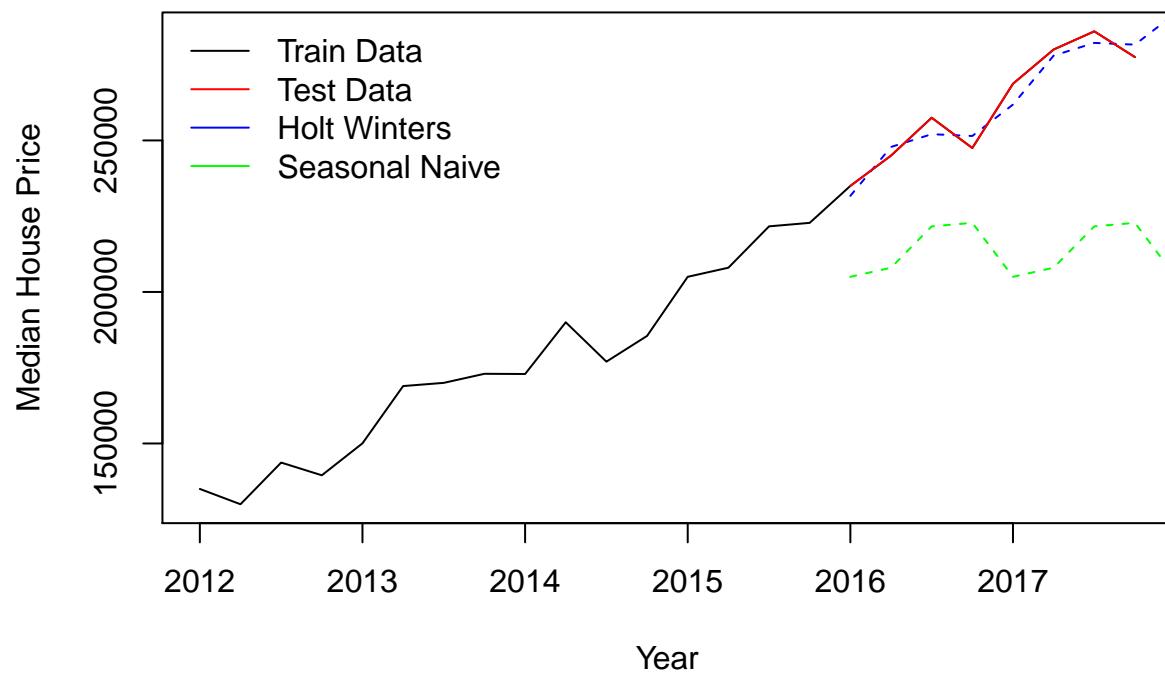


Portland, OR – Centennial : Holt Winters Model Forecast Residuals

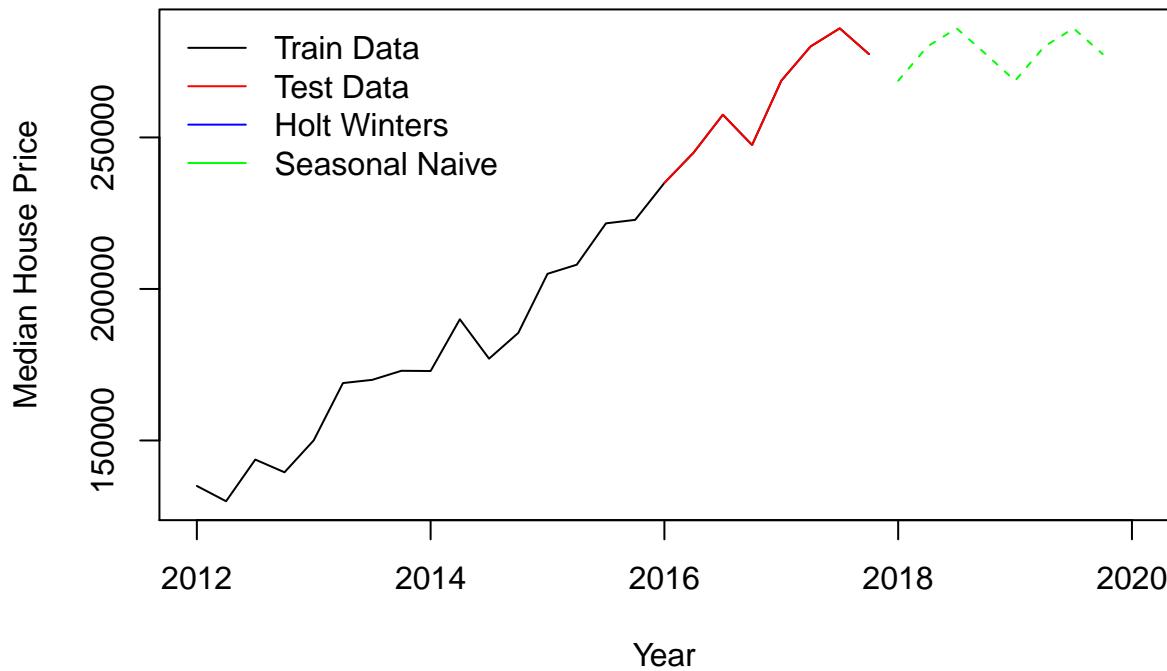


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Centennial"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 25775.0 28093.31 25775.0 13.67792 13.67792 1.000000
## Test set     47787.5 50669.29 47787.5 17.92536 17.92536 1.854025
##          ACF1 Theil's U
## Training set 0.09112251      NA
## Test set     0.49768618 4.156676
## [1] "Holt Winters Accuracy for Portland, OR - Centennial"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 770.7019 9589.115 8134.634 0.4910133 4.491841 0.3156017
## Test set     1310.4039 4283.268 4042.382 0.4836085 1.545508 0.1568334
##          ACF1 Theil's U
## Training set 0.009908612      NA
## Test set     -0.634316916 0.3575389
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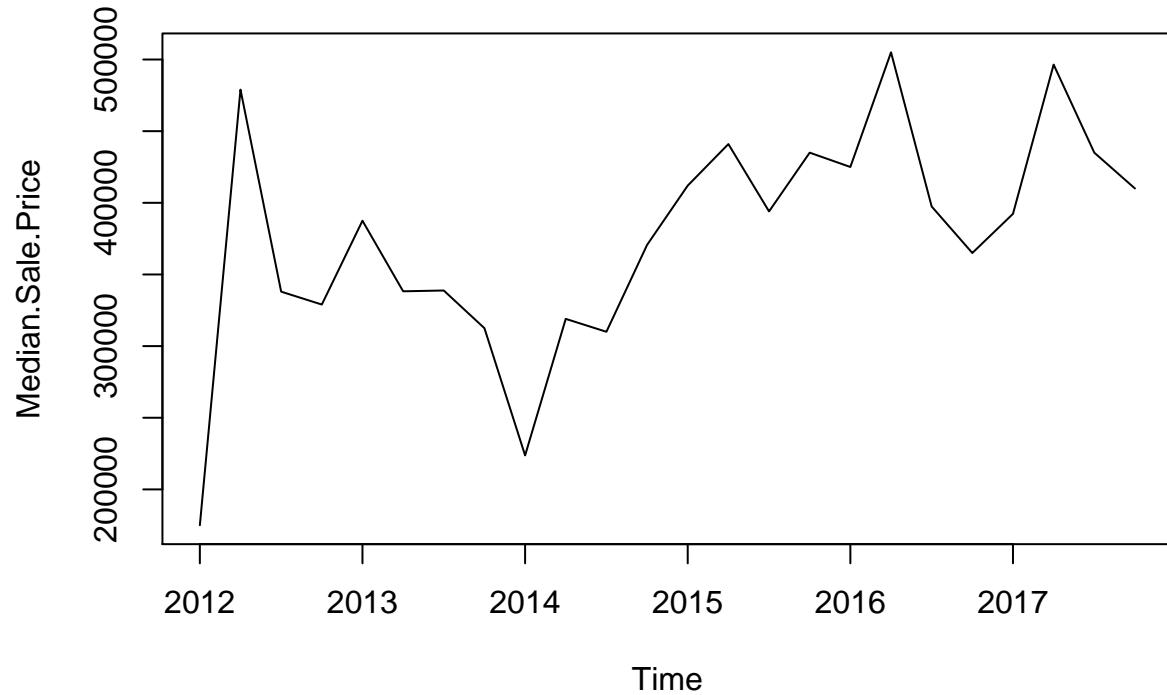
Portland, OR – Centennial : TS Training Model Comparison



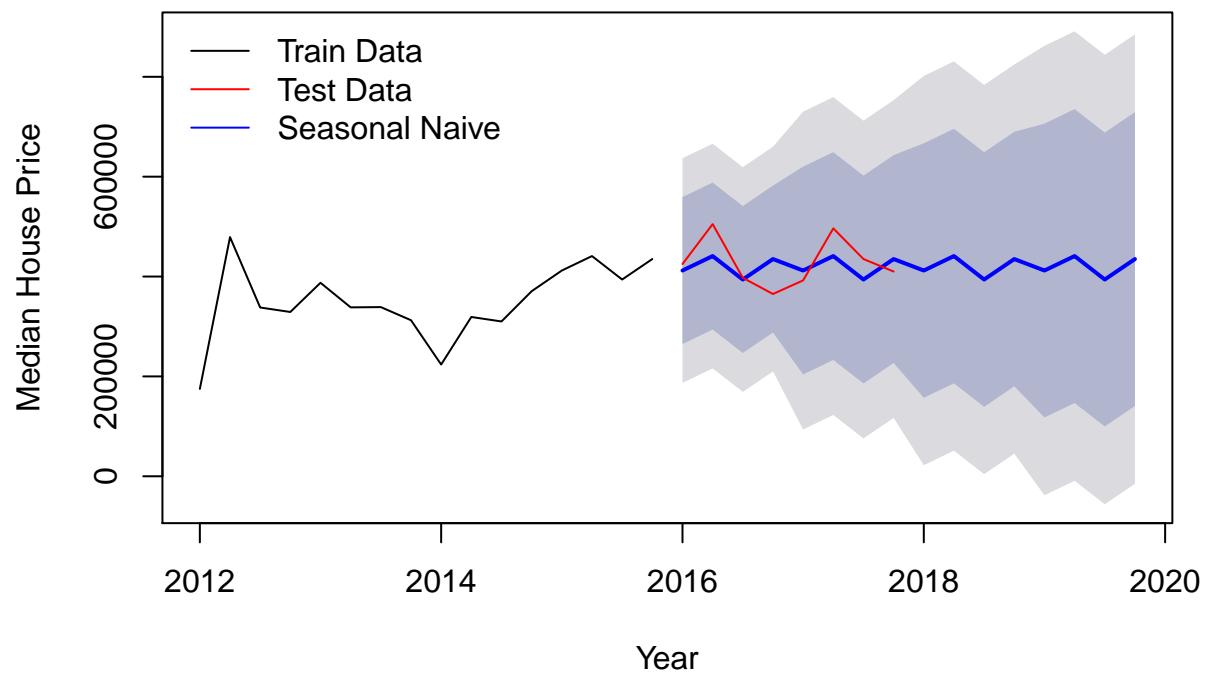
Portland, OR – Centennial : Full TS Models Comparison



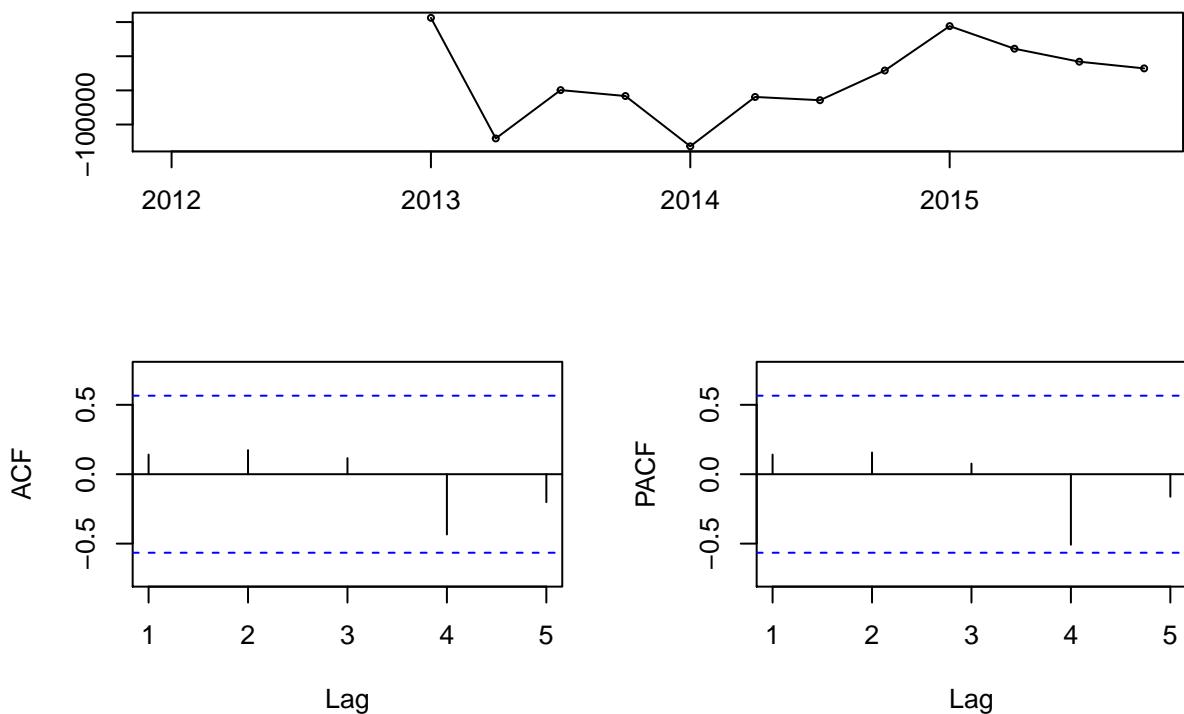
Portland, OR – Far Southwest



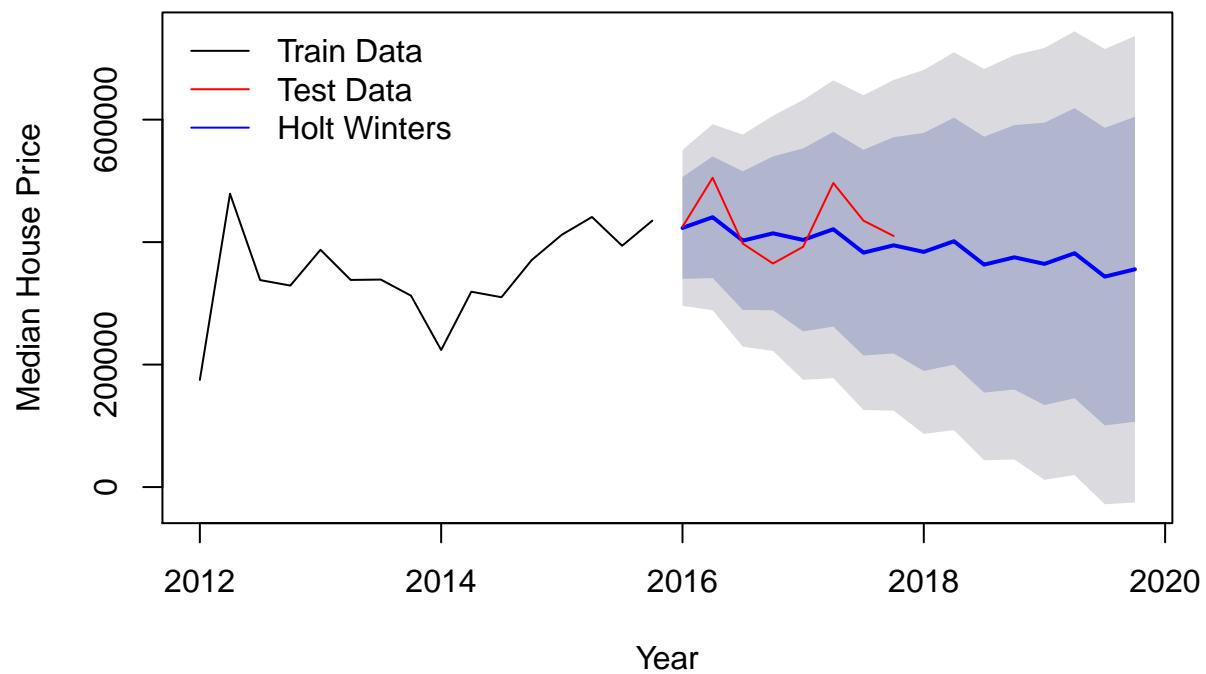
Portland, OR – Far Southwest : Naive Model Forecast



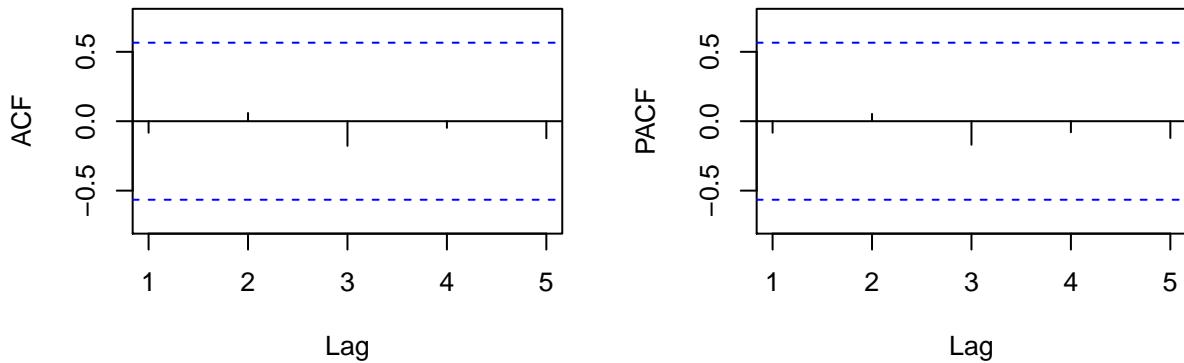
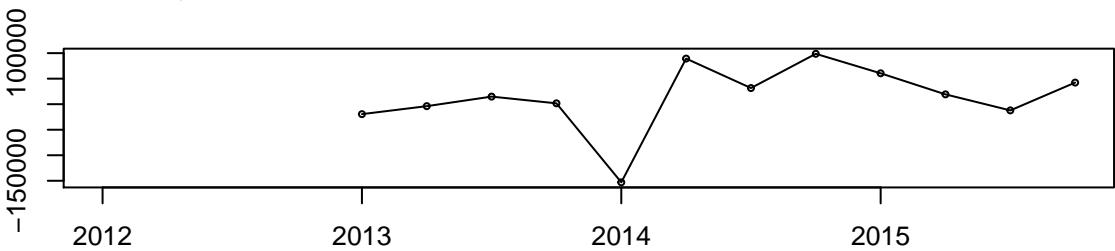
Portland, OR – Far Southwest : Naive Model Forecast Residuals



Portland, OR – Far Southwest : Holt Winters Model Forecast

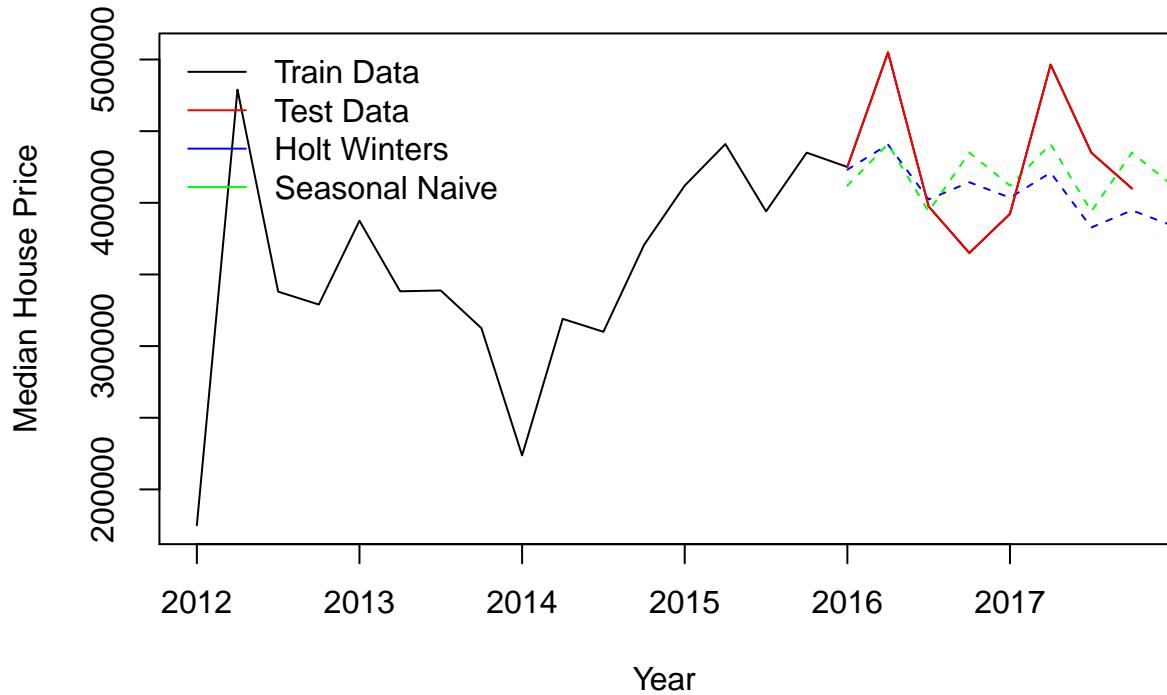


Portland, OR – Far Southwest : Holt Winters Model Forecast Residuals

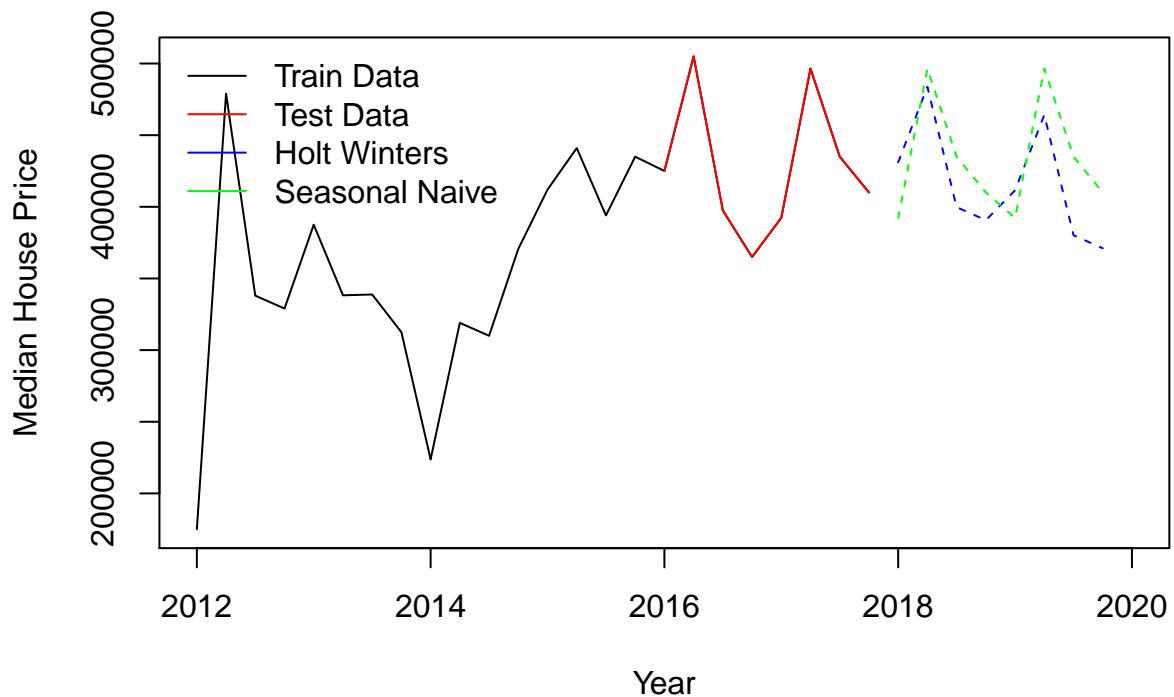


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Far Southwest"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 30083.33 114802.18 91591.67 3.7360168 26.302750 1.000000
## Test set     7775.00 43222.82 36450.00 0.8621755 8.436503 0.397962
##          ACF1 Theil's U
## Training set 0.1414008      NA
## Test set     0.1181731 0.6901332
## [1] "Holt Winters Accuracy for Portland, OR - Far Southwest"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 14152.94 63711.89 45557.83 1.743801 14.679381 0.4974015
## Test set     17942.98 43840.49 34324.45 3.307711 7.714585 0.3747552
##          ACF1 Theil's U
## Training set -0.08283983      NA
## Test set     0.14792267 0.6975247
```

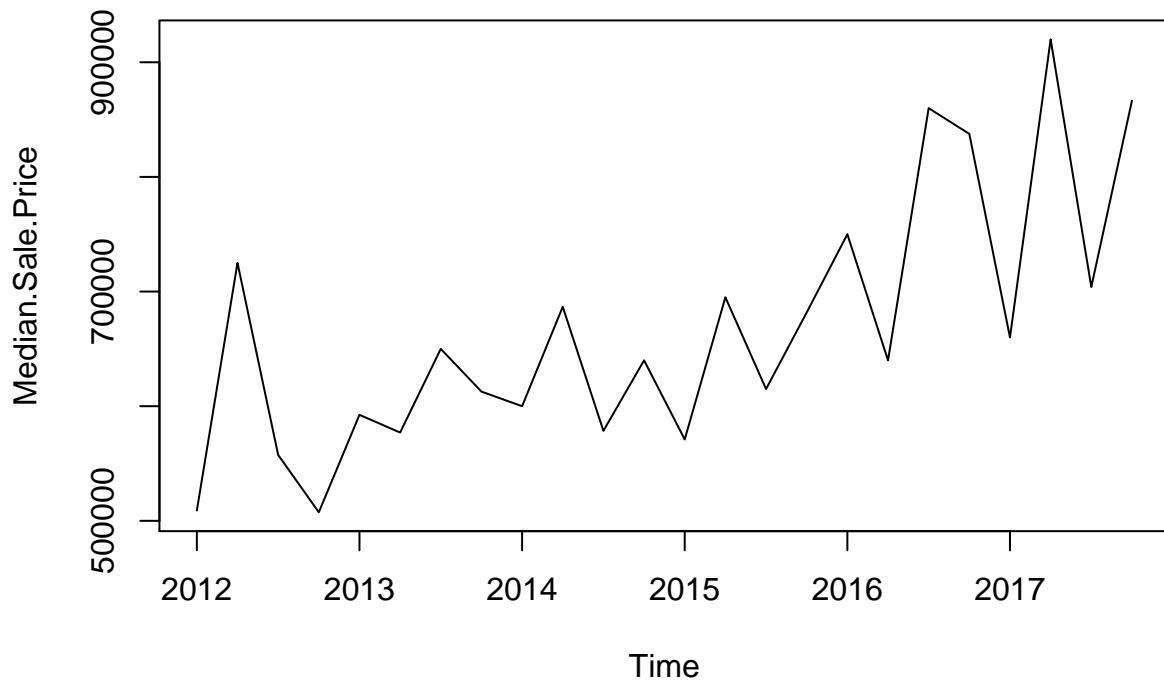
Portland, OR – Far Southwest : TS Training Model Comparison



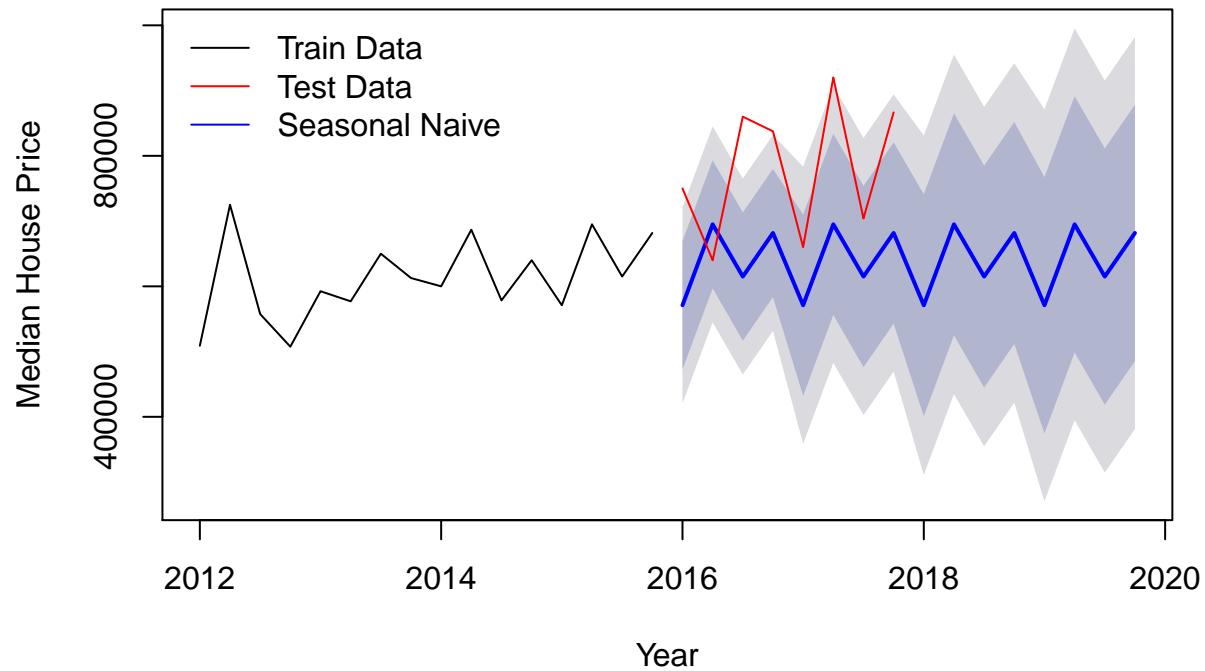
Portland, OR – Far Southwest : Full TS Models Comparison



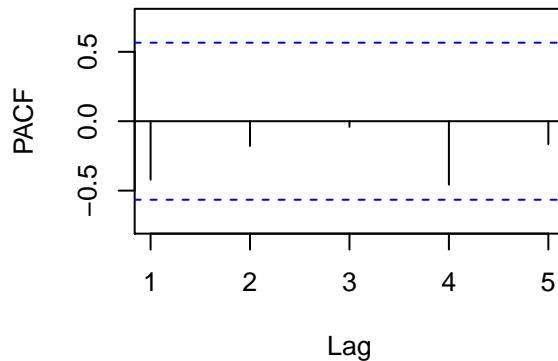
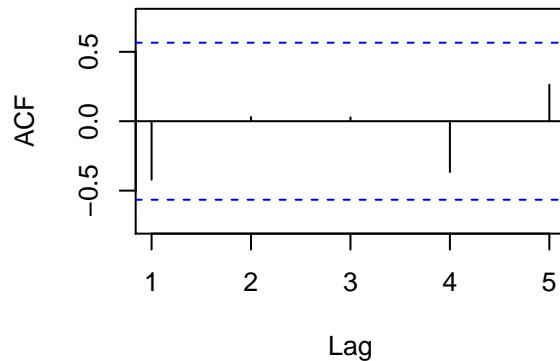
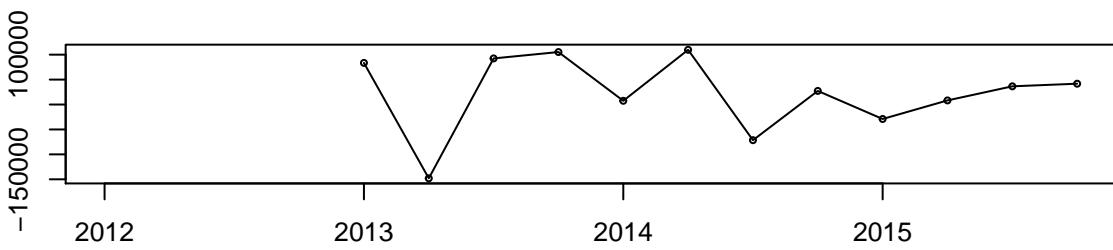
Portland, OR – Hillside



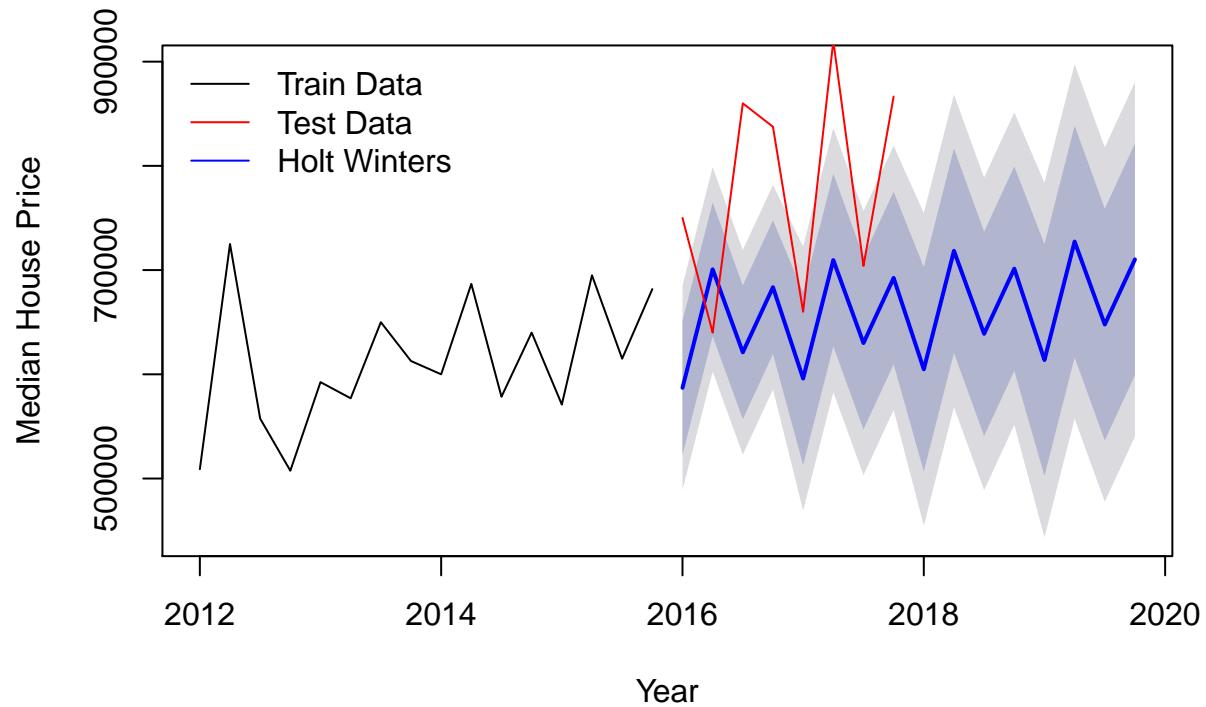
Portland, OR – Hillside : Naive Model Forecast



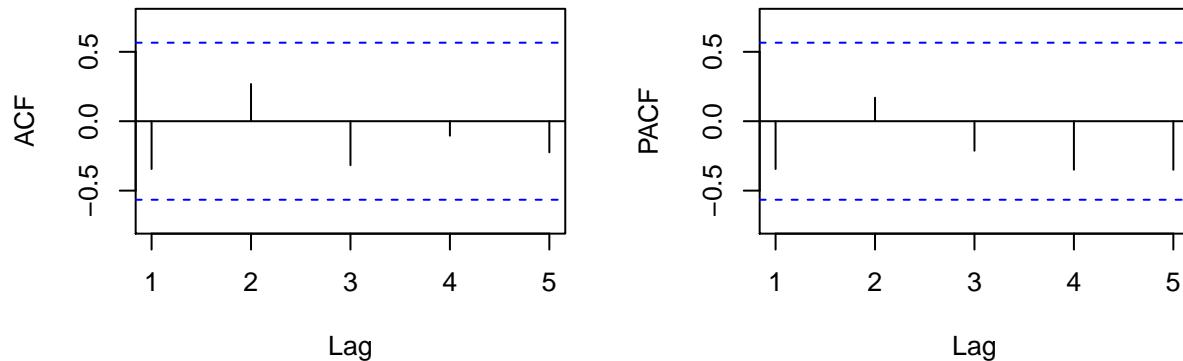
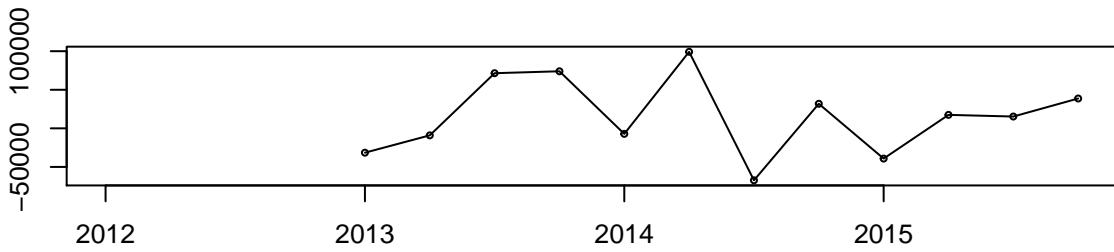
Portland, OR – Hillside : Naive Model Forecast Residuals



Portland, OR – Hillside : Holt Winters Model Forecast

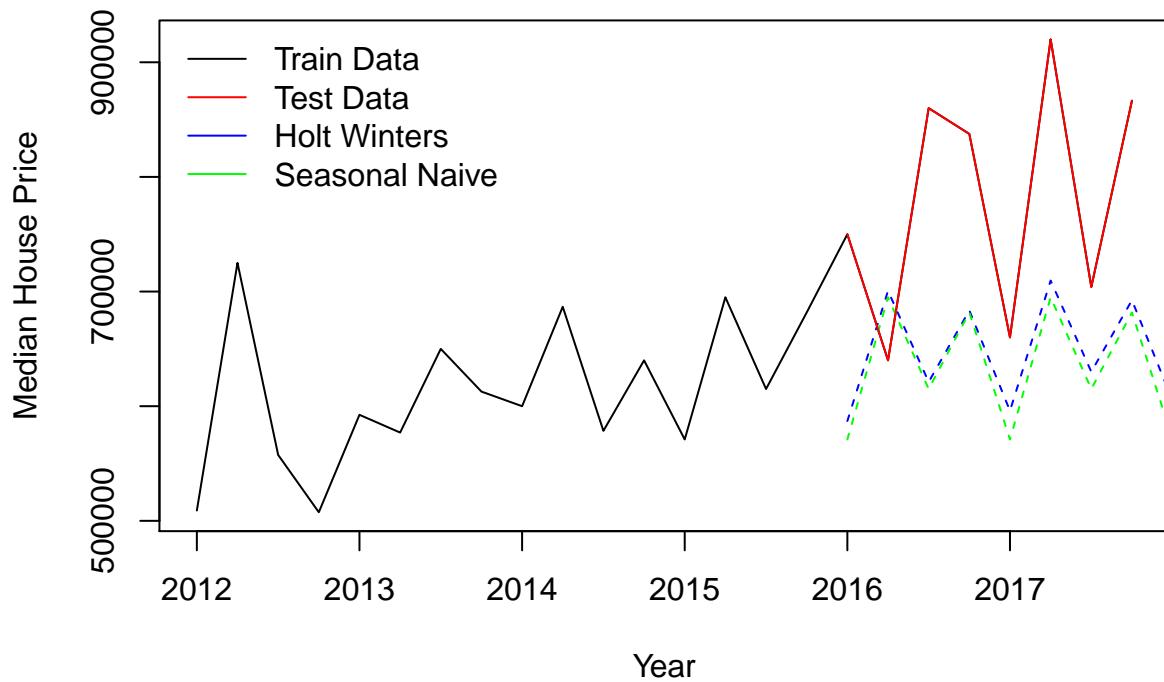


Portland, OR – Hillside : Holt Winters Model Forecast Residuals

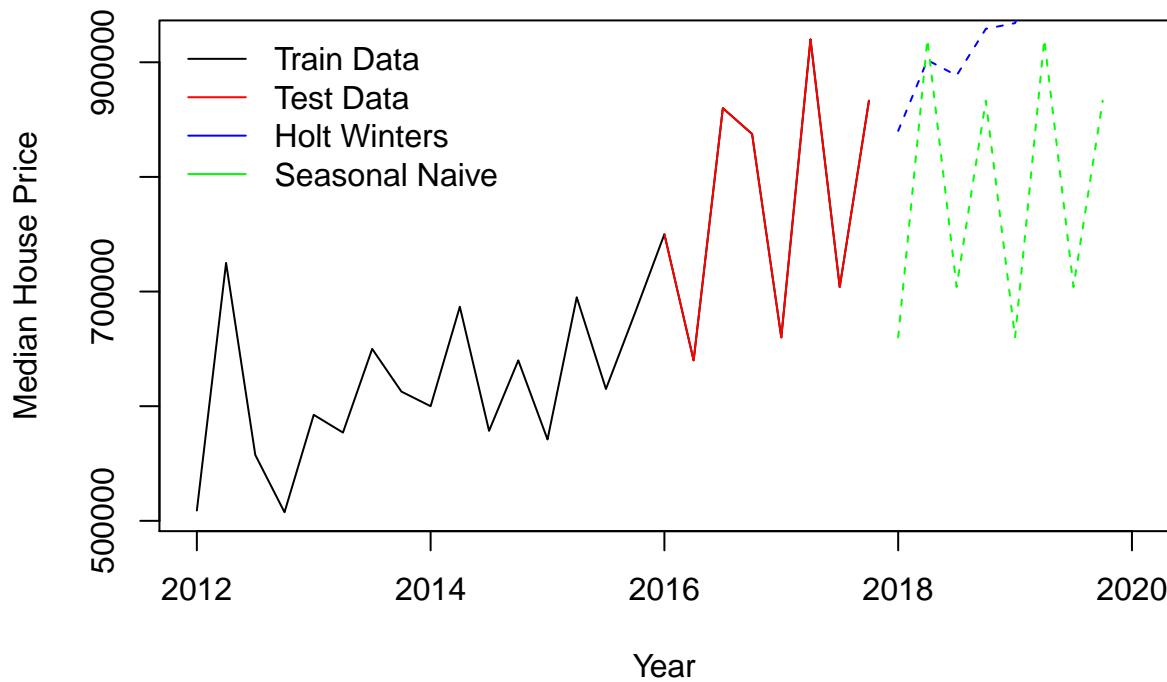


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Hillside"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 21979.17 76621.67 63395.83 3.095569 10.27695 1.00000
## Test set     139062.50 165811.88 152812.50 16.782891 18.93133 2.41045
##          ACF1 Theil's U
## Training set -0.4211226      NA
## Test set      -0.5865610 0.9326727
## [1] "Holt Winters Accuracy for Portland, OR - Hillside"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 16141.64 50559.95 41857.82 2.215067 6.647037 0.6602614
## Test set     127203.57 156186.86 142378.69 15.197523 17.568635 2.2458683
##          ACF1 Theil's U
## Training set -0.3441994      NA
## Test set      -0.5871327 0.8868117
```

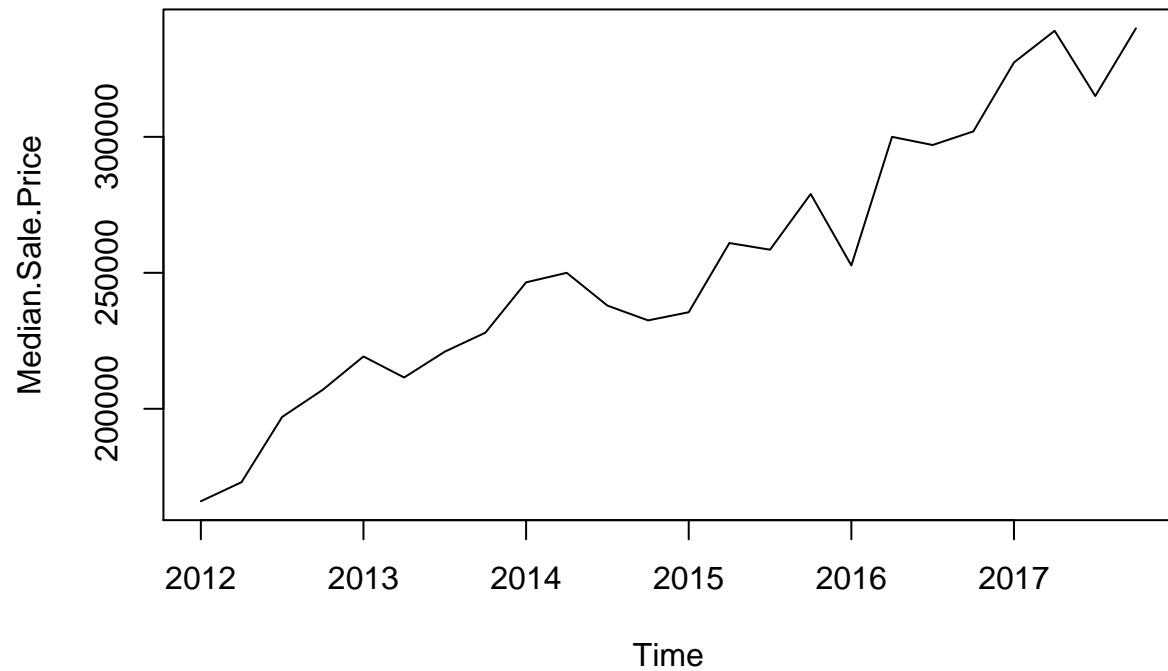
Portland, OR – Hillside : TS Training Model Comparison



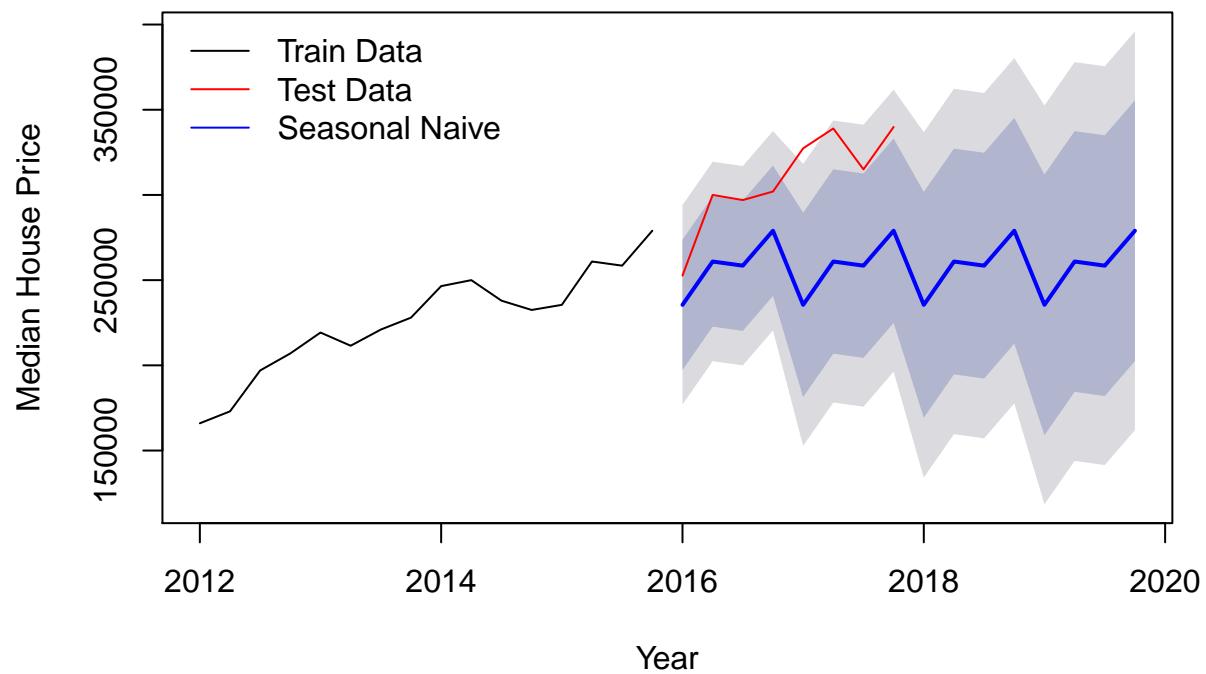
Portland, OR – Hillside : Full TS Models Comparison



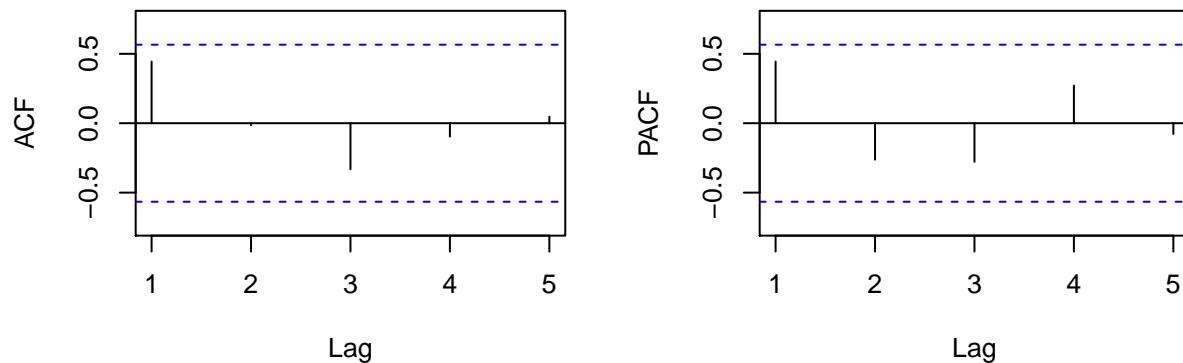
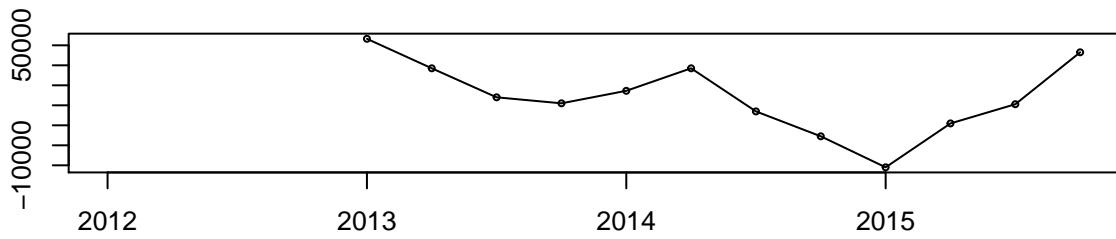
Portland, OR – Wilkes



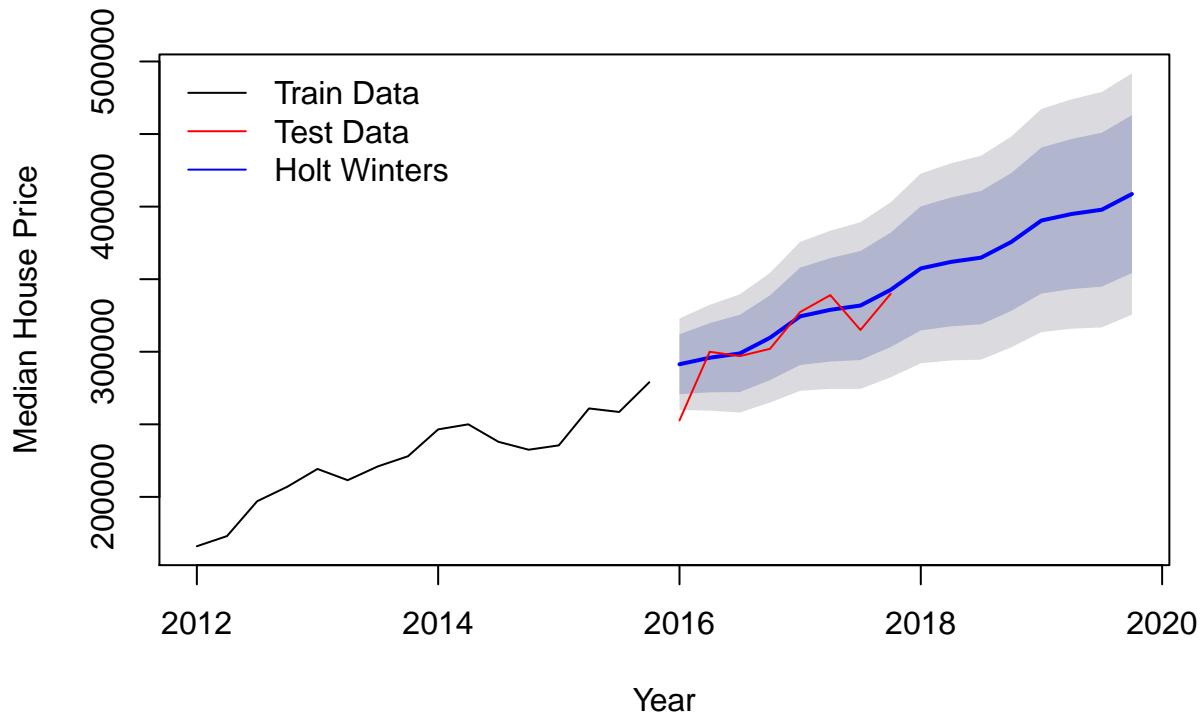
Portland, OR – Wilkes : Naive Model Forecast



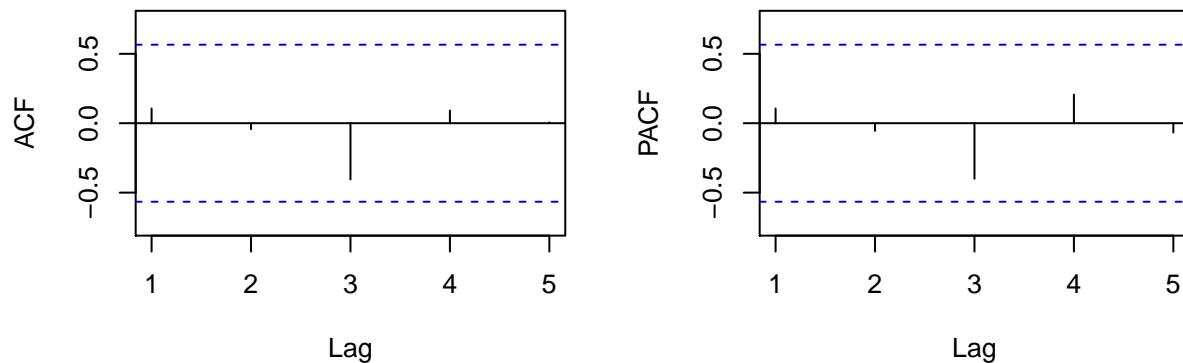
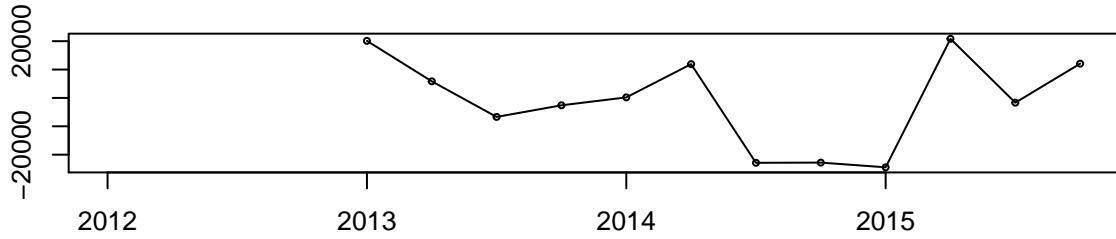
Portland, OR – Wilkes : Naive Model Forecast Residuals



Portland, OR – Wilkes : Holt Winters Model Forecast



Portland, OR – Wilkes : Holt Winters Model Forecast Residuals

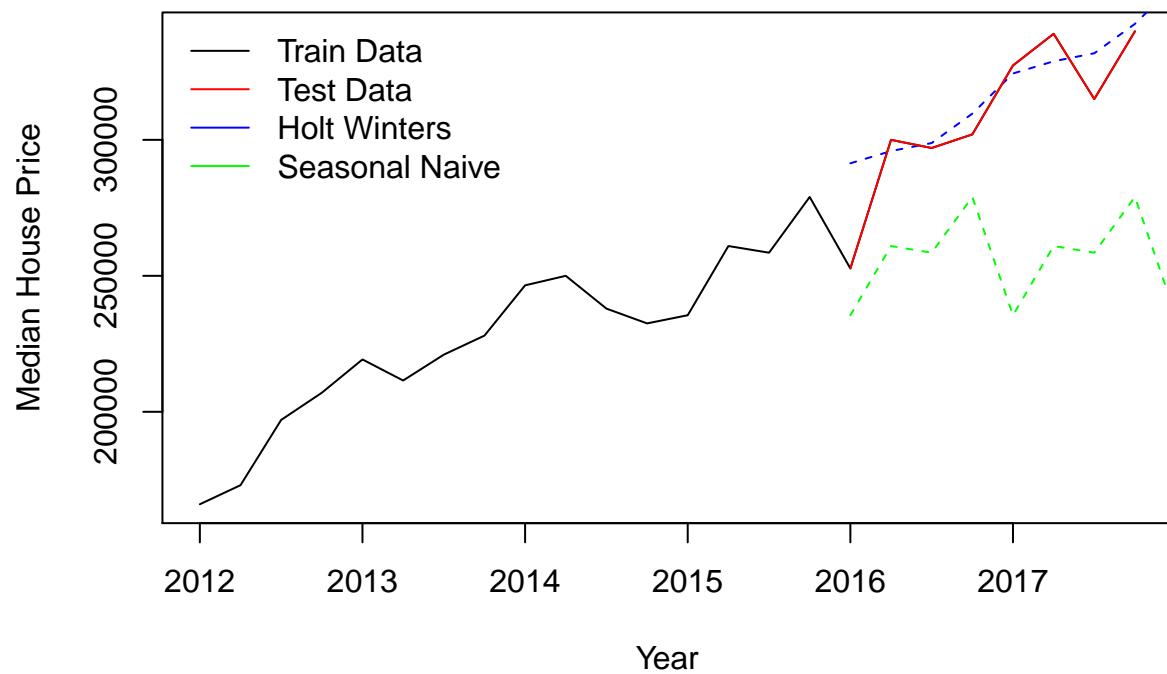


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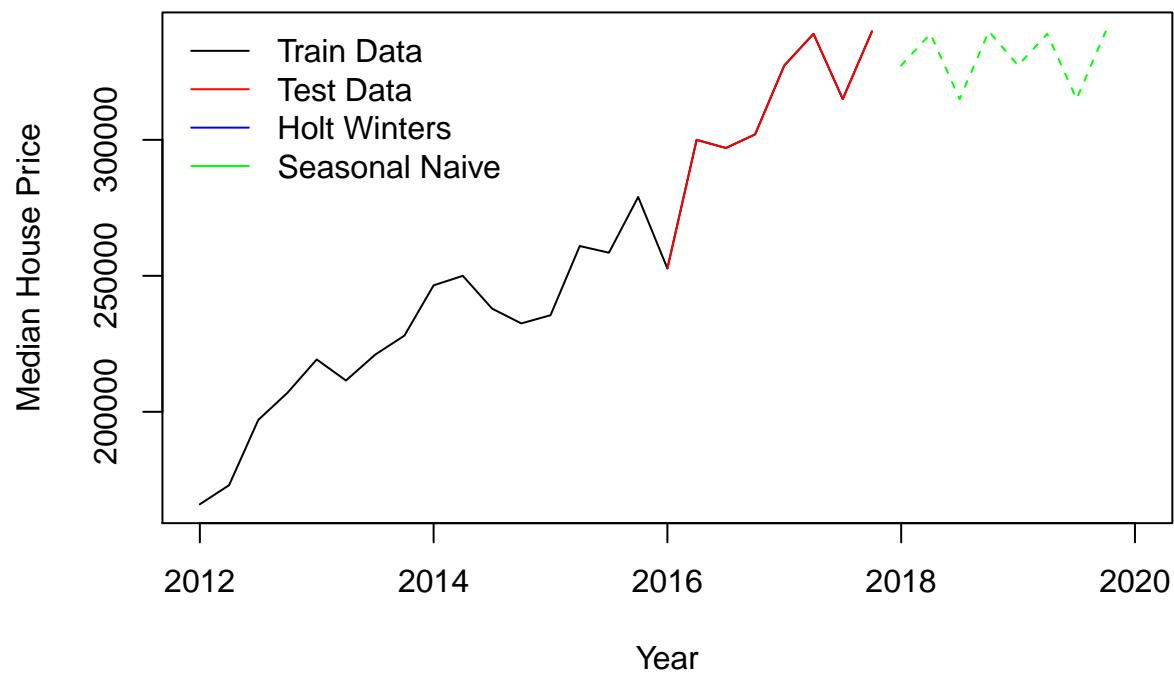
## [1] "Seasonal Naive Accuracy for Portland, OR – Wilkes"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 24245.83 29850.51 26079.17 10.18468 10.96317 1.000000
## Test set     50631.25 56193.06 50631.25 15.91723 15.91723 1.941444
##          ACF1 Theil's U
## Training set 0.4439795      NA
## Test set     0.2262301 2.177936
## [1] "Holt Winters Accuracy for Portland, OR – Wilkes"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -843.6185 15425.28 12671.28 -0.4605857 5.308955 0.4858774
## Test set     -6319.7945 15720.11 10614.94 -2.4188070 3.733055 0.4070274
##          ACF1 Theil's U
## Training set 0.1063735      NA
## Test set     -0.2214455 0.2878594

```

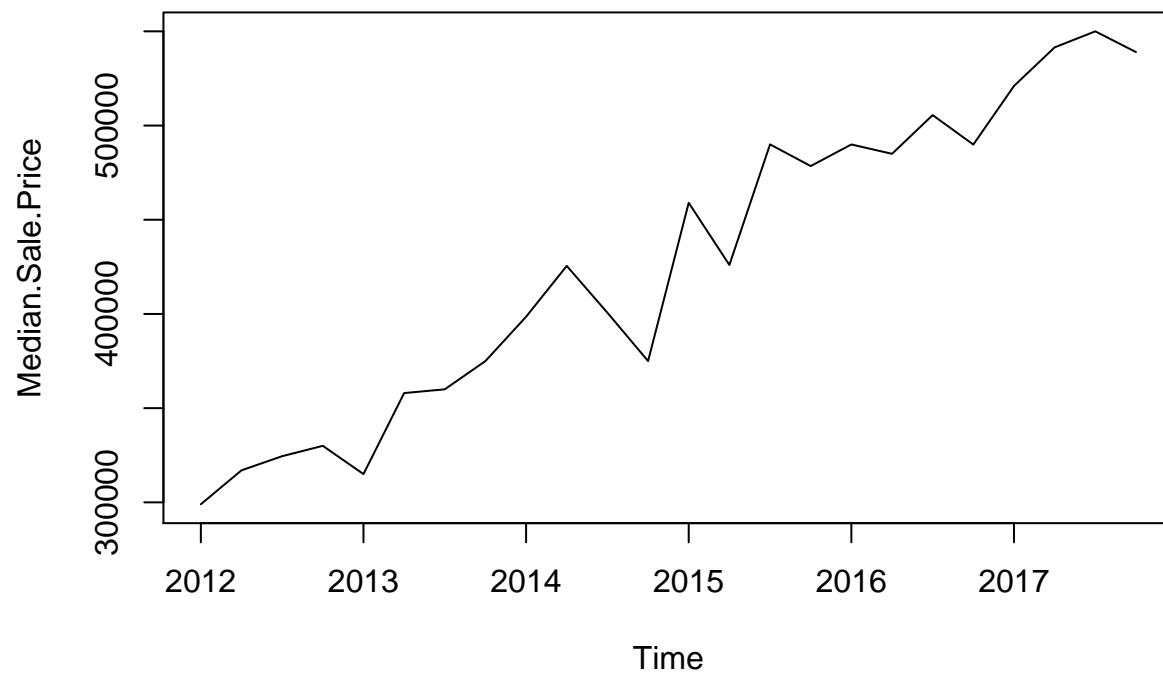
Portland, OR – Wilkes : TS Training Model Comparison



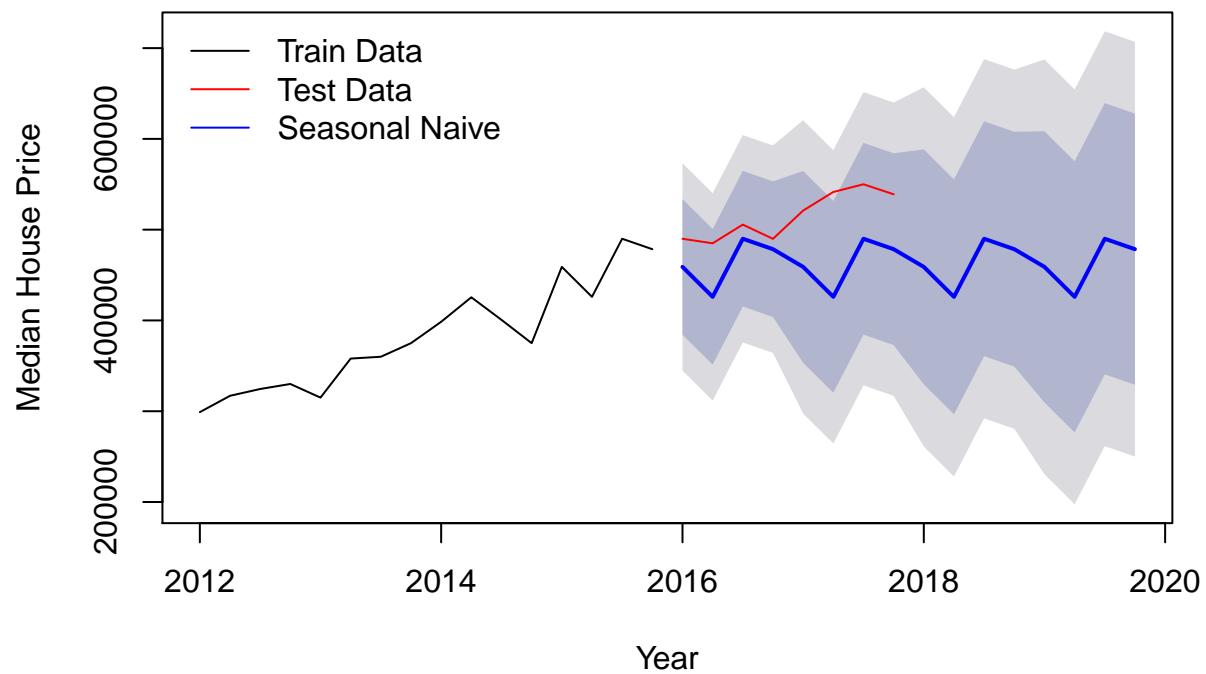
Portland, OR – Wilkes : Full TS Models Comparison



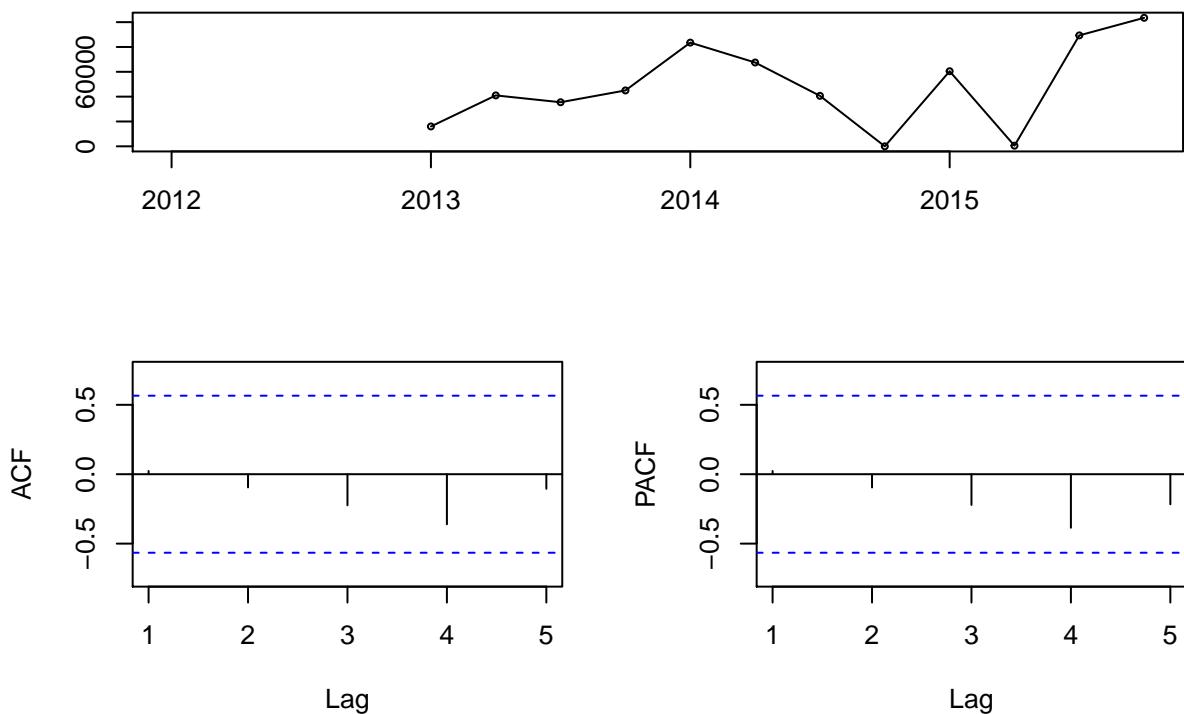
Portland, OR – Westmoreland



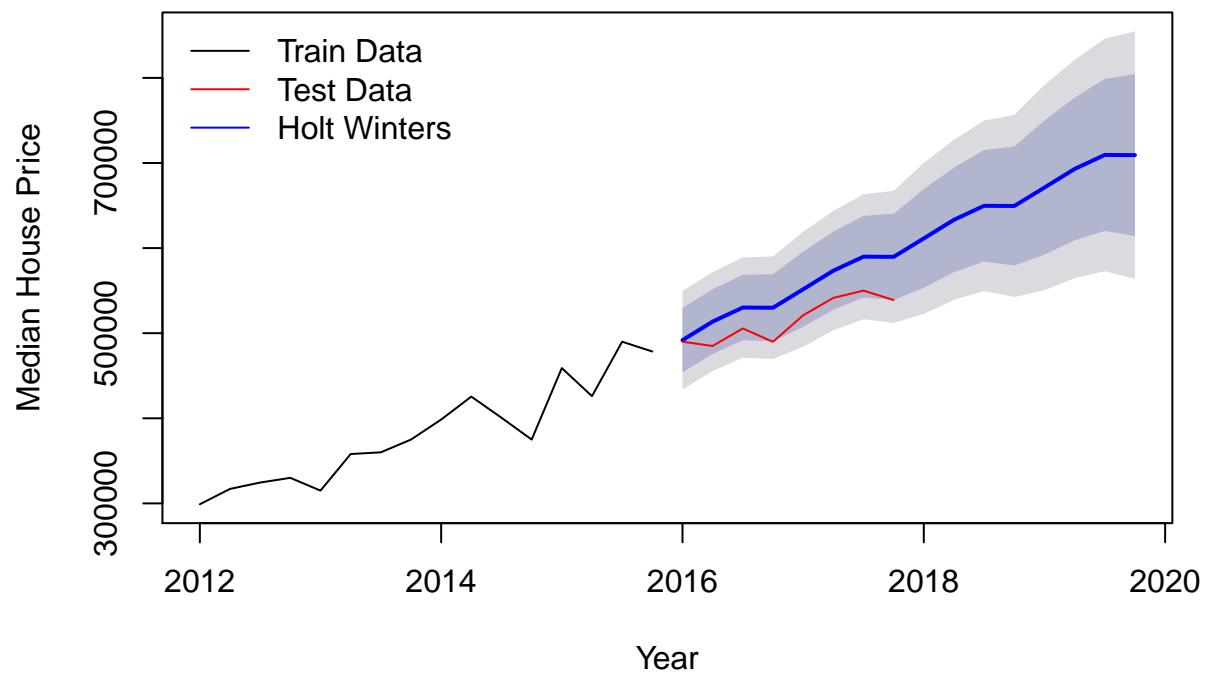
Portland, OR – Westmoreland : Naive Model Forecast



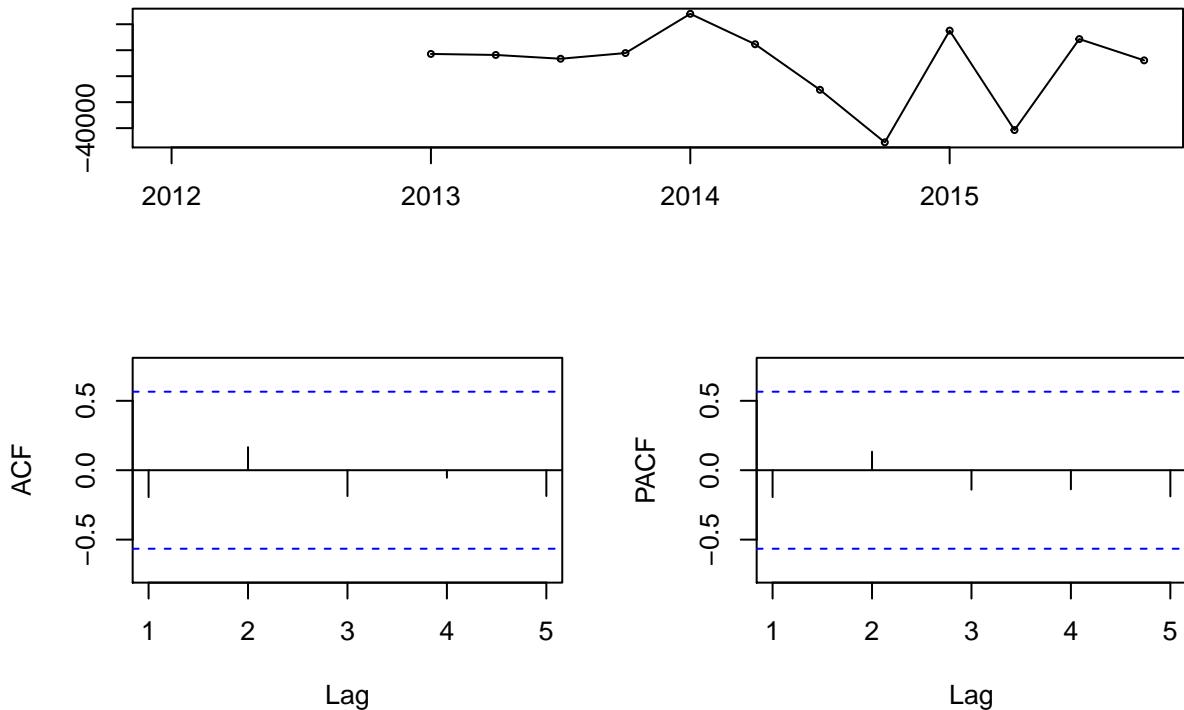
Portland, OR – Westmoreland : Naive Model Forecast Residuals



Portland, OR – Westmoreland : Holt Winters Model Forecast

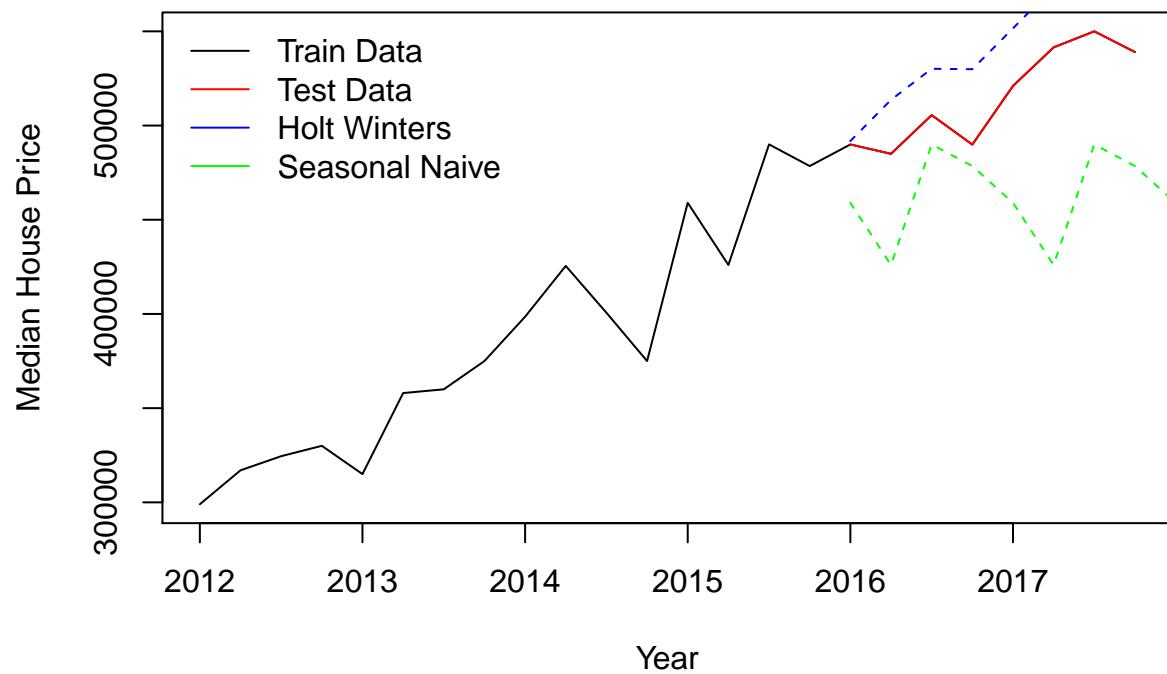


Portland, OR – Westmoreland : Holt Winters Model Forecast Residuals

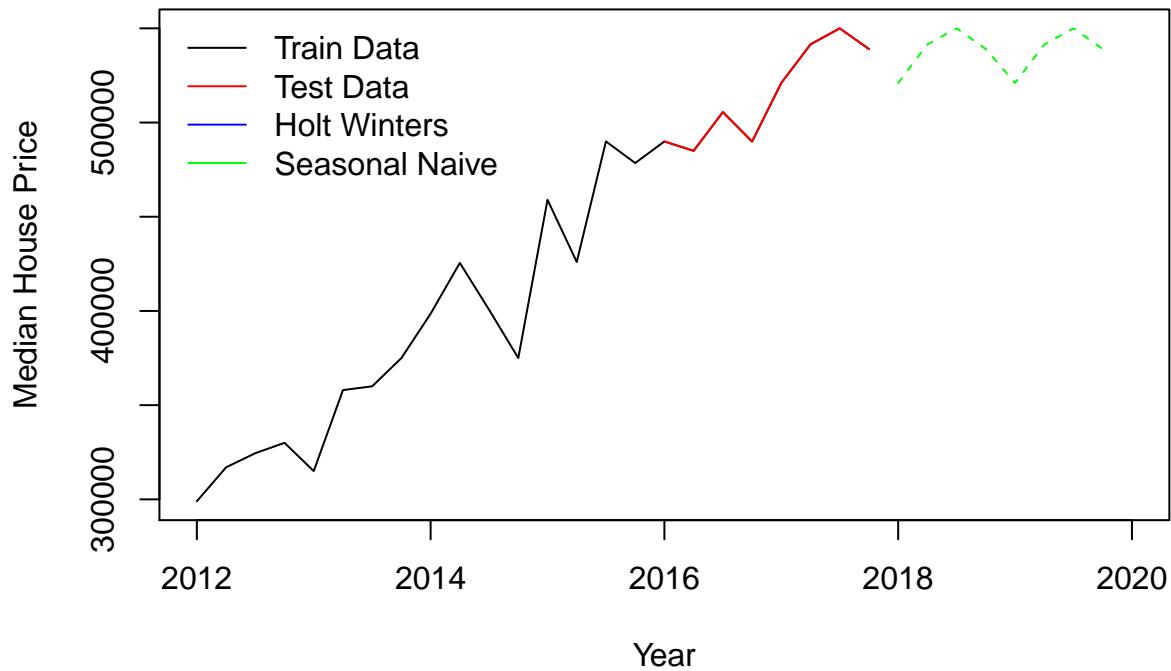


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Westmoreland"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 48583.33 58281.28 48583.33 11.543231 11.543231 1.000000
## Test set     51863.75 60472.91 51863.75 9.906263 9.906263 1.067521
##          ACF1 Theil's U
## Training set 0.02358877      NA
## Test set     0.24350298 3.409764
## [1] "Holt Winters Accuracy for Portland, OR – Westmoreland"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 9191.501 29707.36 26340.52 2.200423 6.522916 0.5421719
## Test set     -31022.822 33812.79 31022.82 -5.967133 5.967133 0.6385487
##          ACF1 Theil's U
## Training set -0.1938774      NA
## Test set     0.1415455 1.930171
```

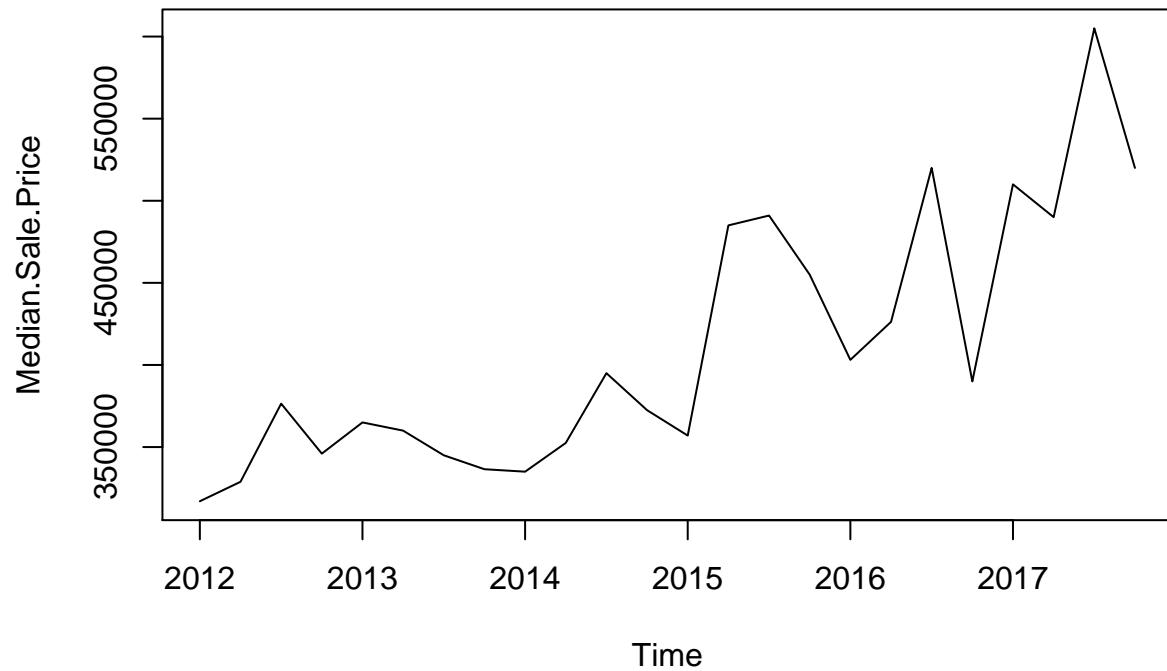
Portland, OR – Westmoreland : TS Training Model Comparison



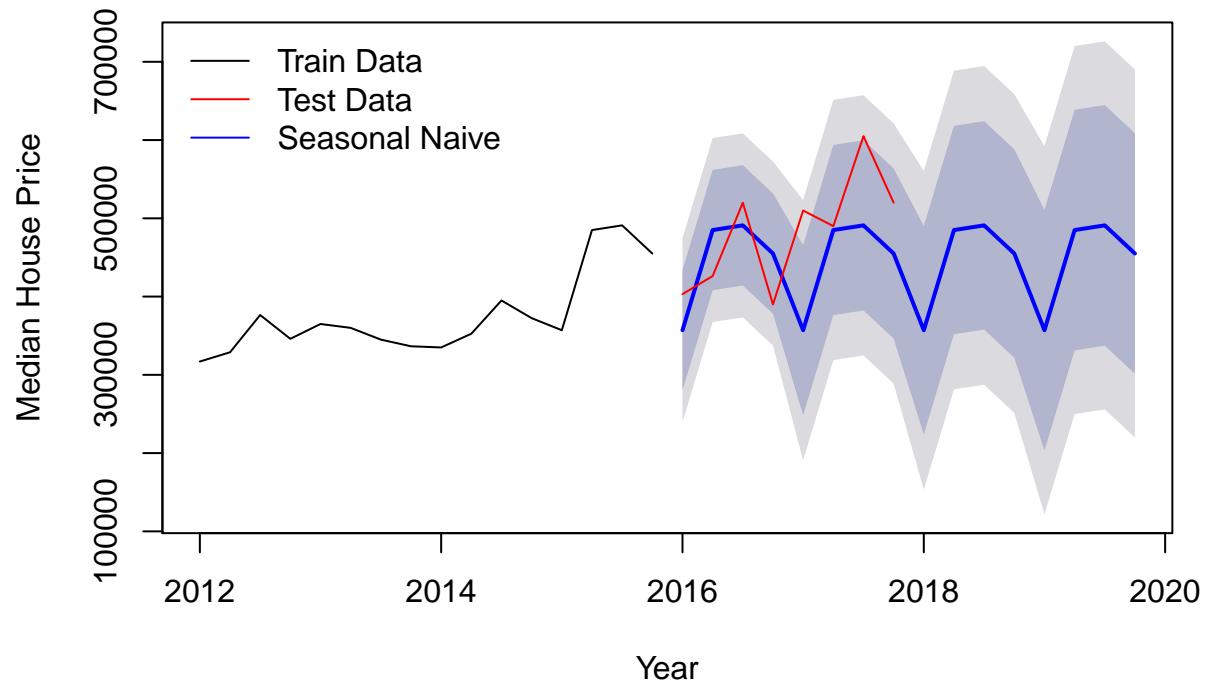
Portland, OR – Westmoreland : Full TS Models Comparison



Portland, OR – Eliot

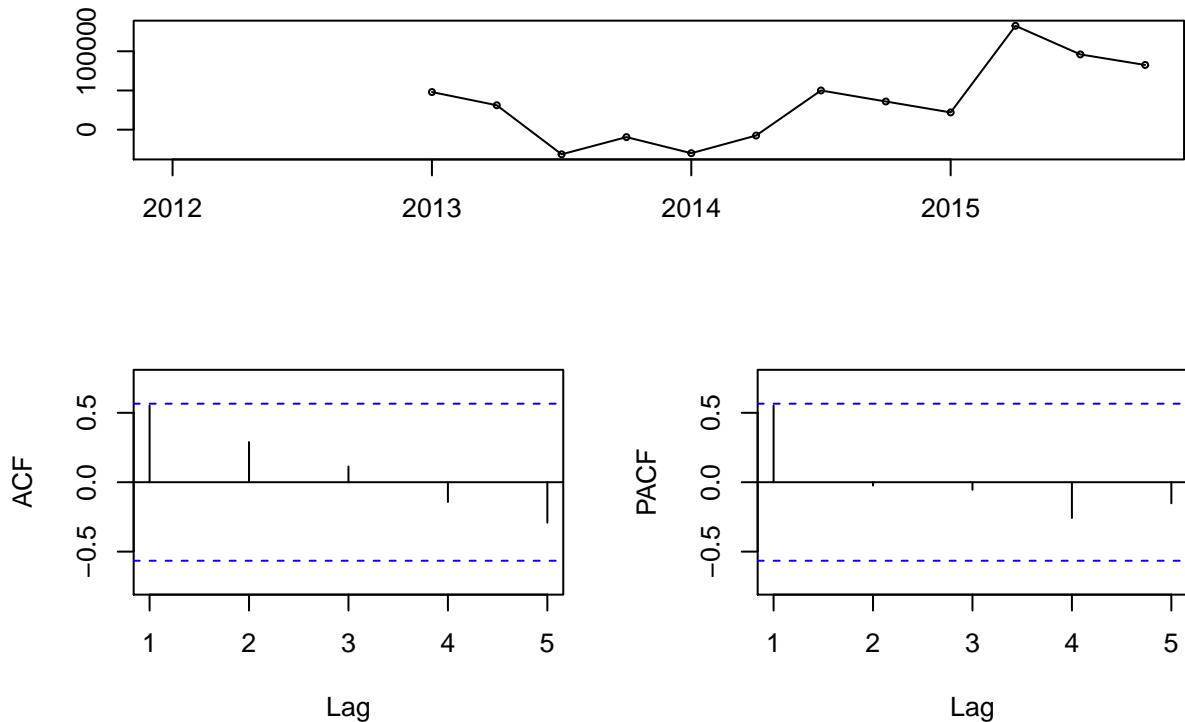


Portland, OR – Eliot : Naive Model Forecast

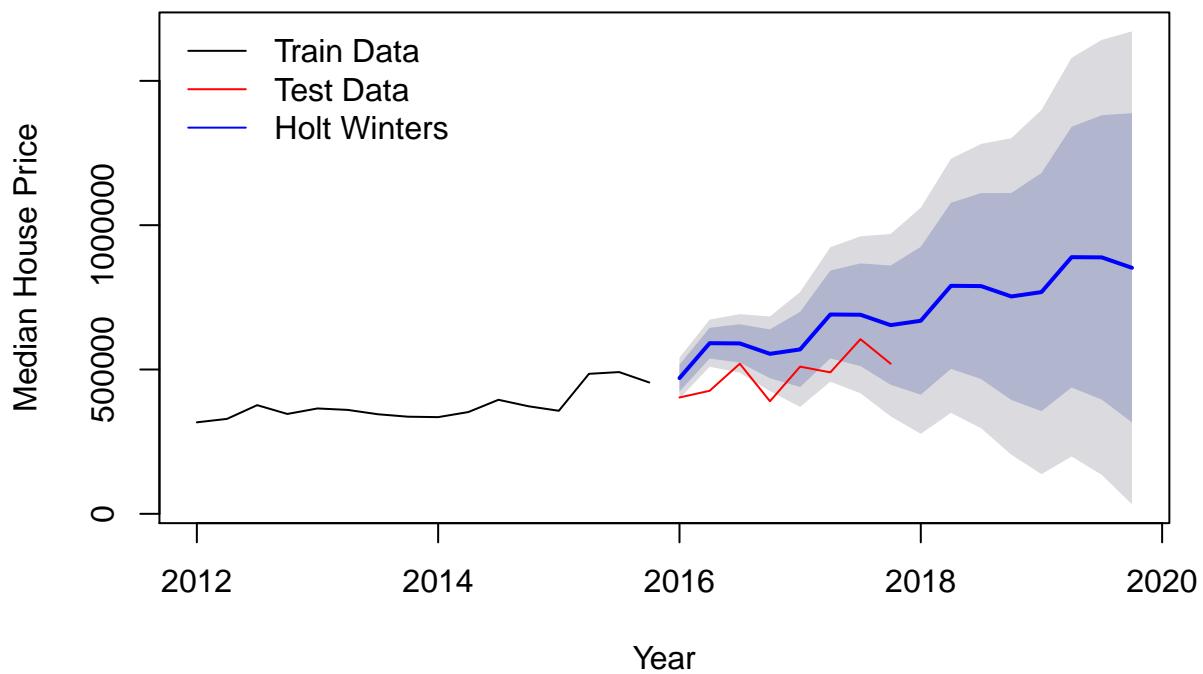


```
## Warning in HoltWinters(trainingData): optimization difficulties: ERROR:  
## ABNORMAL_TERMINATION_IN_LNSRCH
```

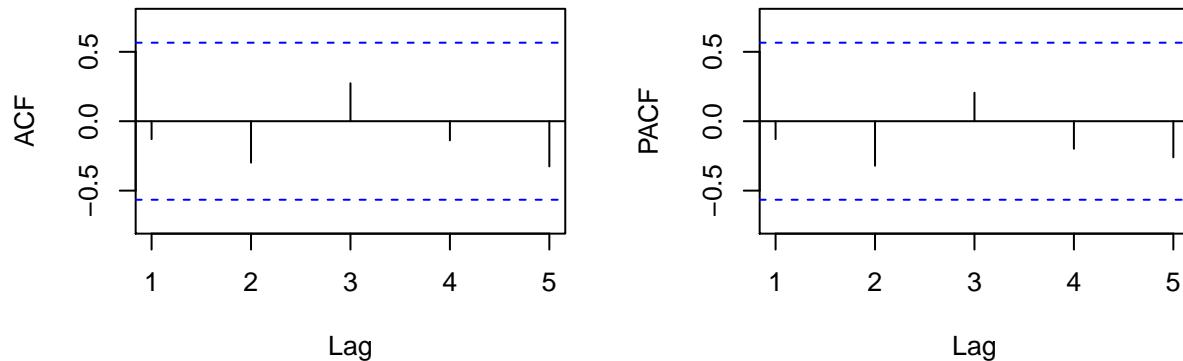
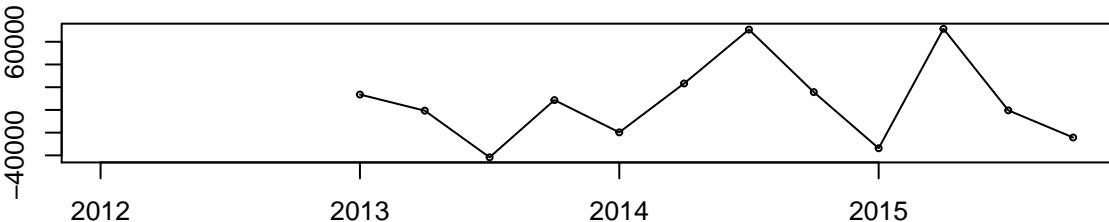
Portland, OR – Eliot : Naive Model Forecast Residuals



Portland, OR – Eliot : Holt Winters Model Forecast



Portland, OR – Eliot : Holt Winters Model Forecast Residuals

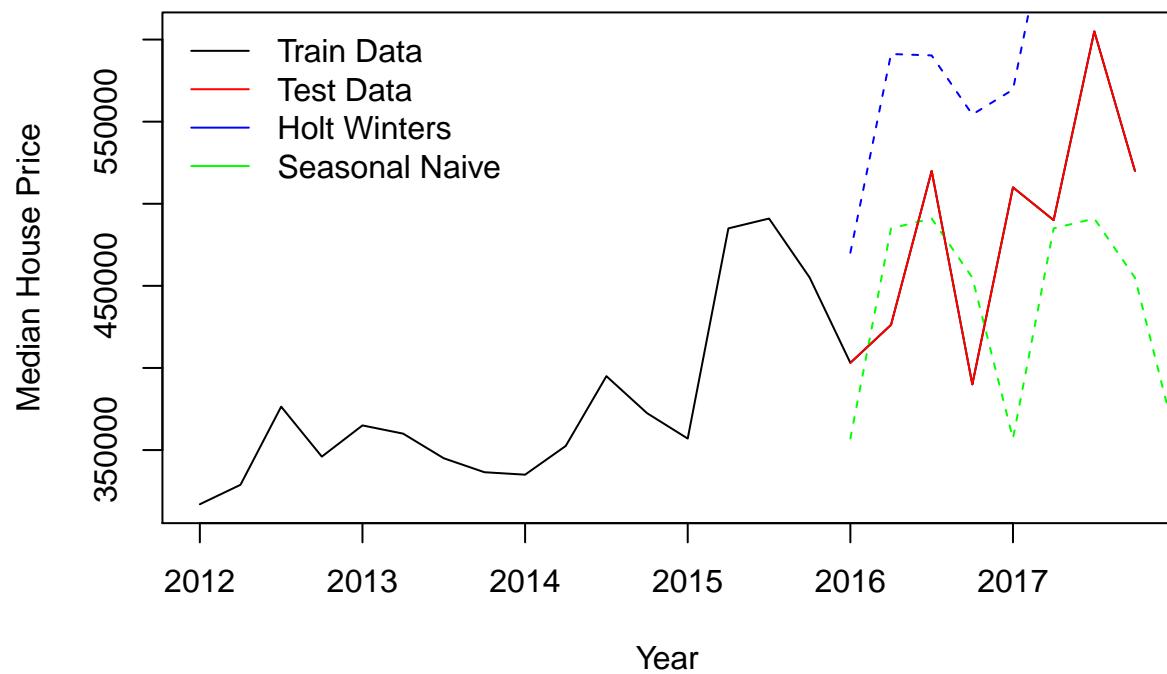


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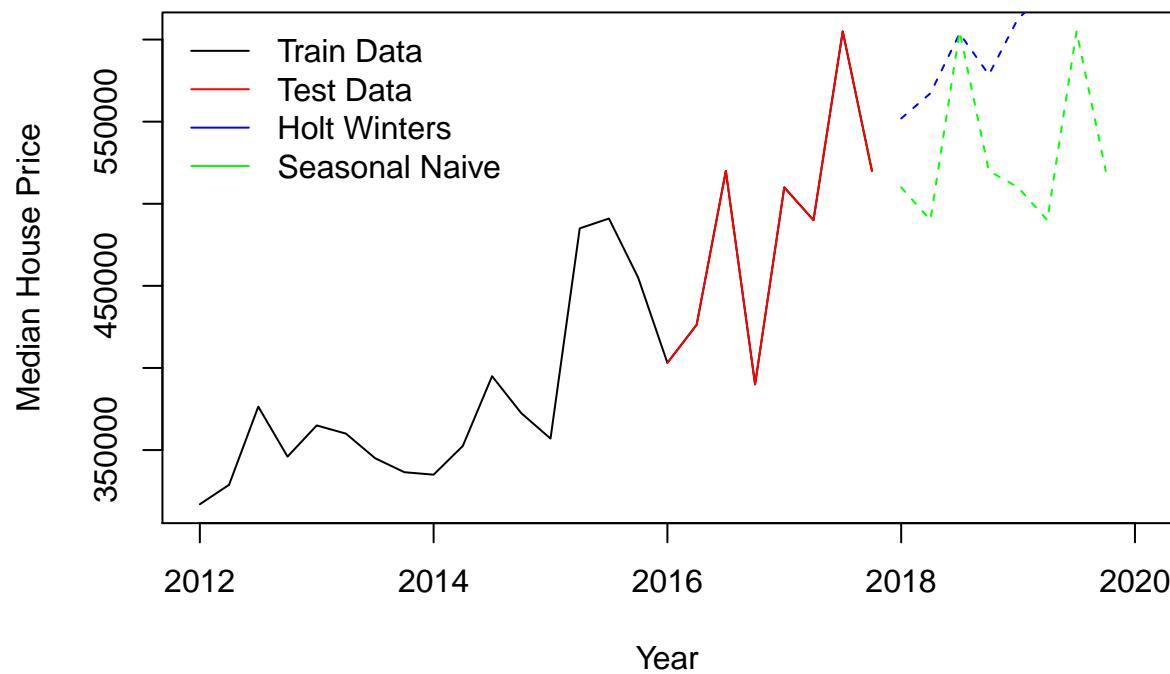
## [1] "Seasonal Naive Accuracy for Portland, OR - Eliot"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 34977.71 59980.97 48049.38 7.689842 11.52588 1.000000
## Test set     36043.75 80076.35 66981.25 6.115877 13.72829 1.394009
##          ACF1 Theil's U
## Training set  0.5531427      NA
## Test set     -0.3712308 0.9569313
## [1] "Holt Winters Accuracy for Portland, OR - Eliot"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set   6898.06 35362.82 26982.26  1.391067 6.896001 0.5615528
## Test set      -118143.23 128680.34 118143.23 -25.413647 25.413647 2.4587880
##          ACF1 Theil's U
## Training set -0.1292361      NA
## Test set      -0.8484345 1.390175

```

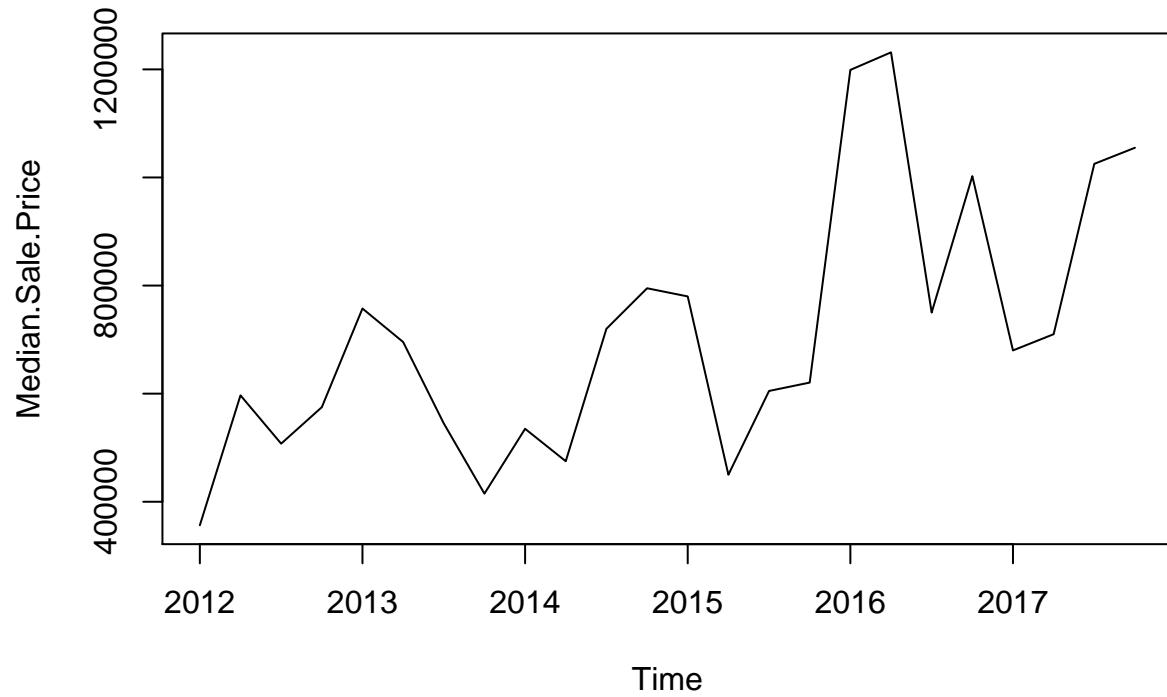
Portland, OR – Eliot : TS Training Model Comparison



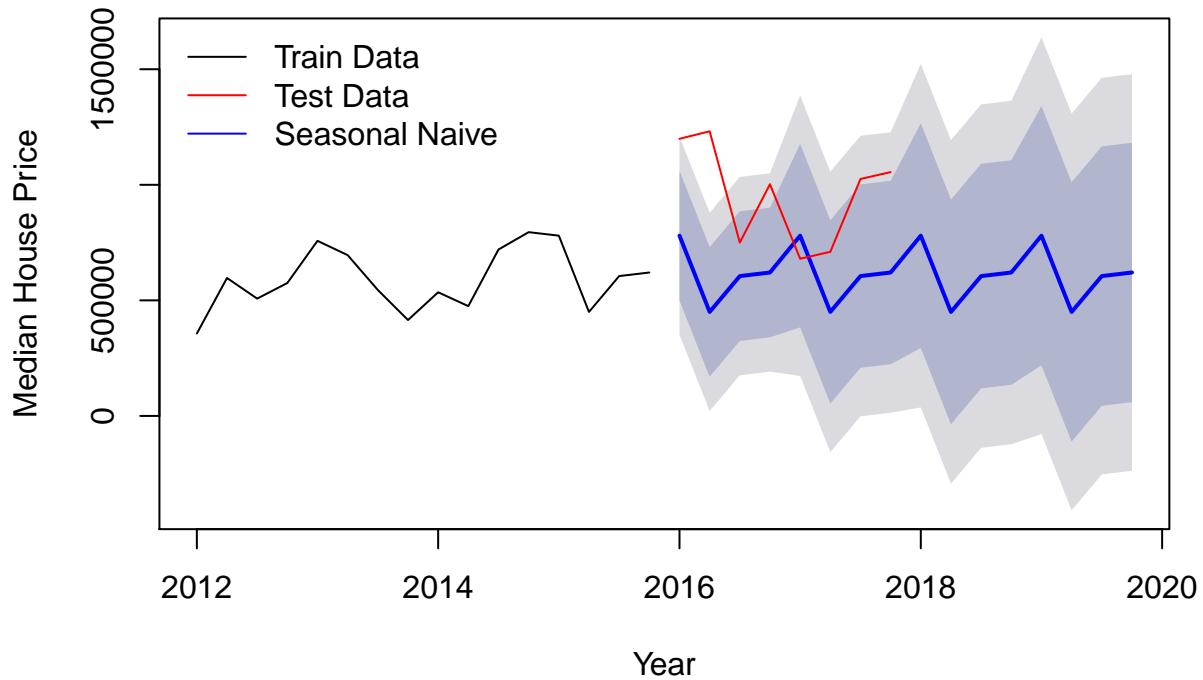
Portland, OR – Eliot : Full TS Models Comparison



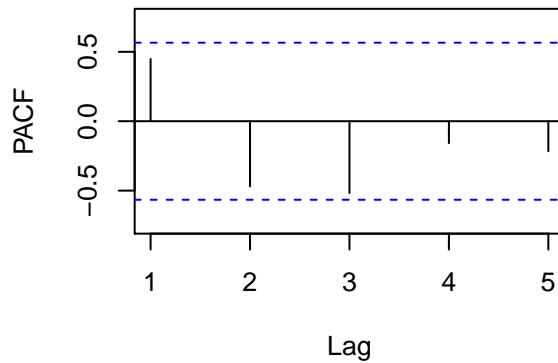
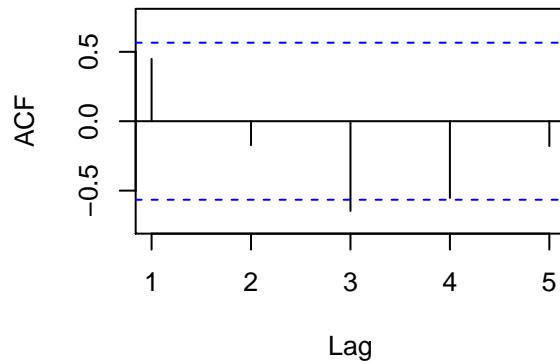
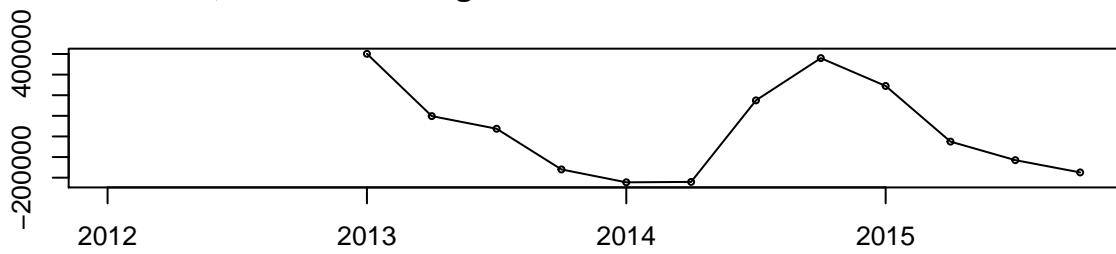
Portland, OR – Forest Highlands



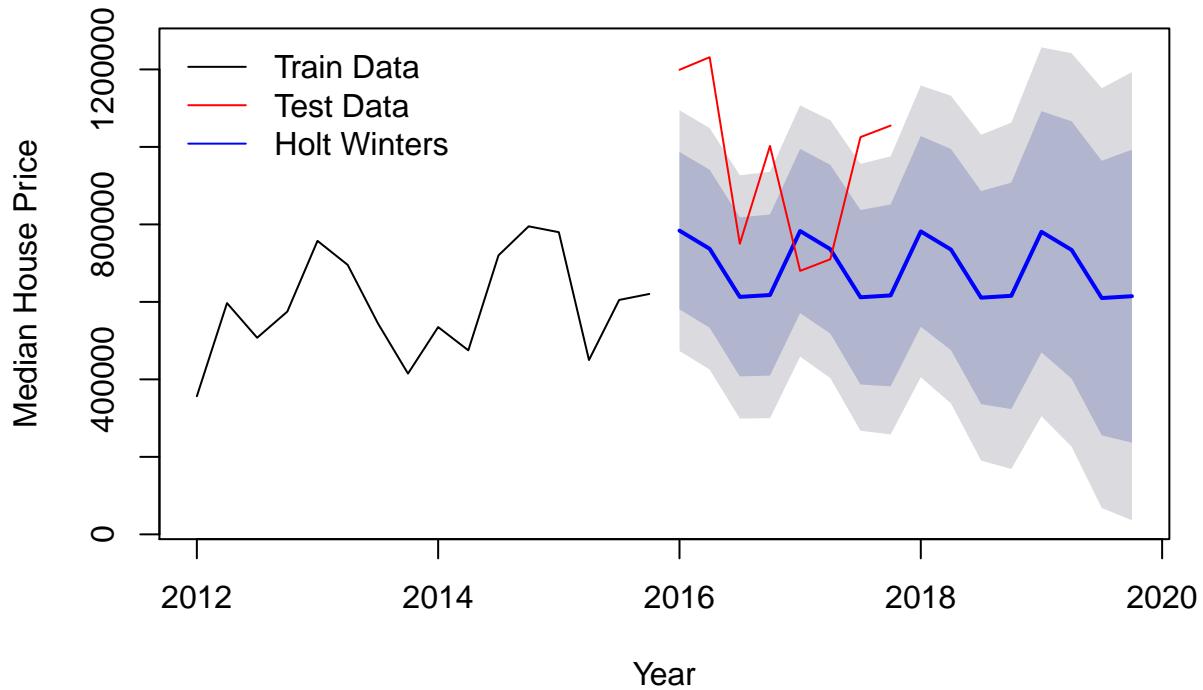
Portland, OR – Forest Highlands : Naive Model Forecast



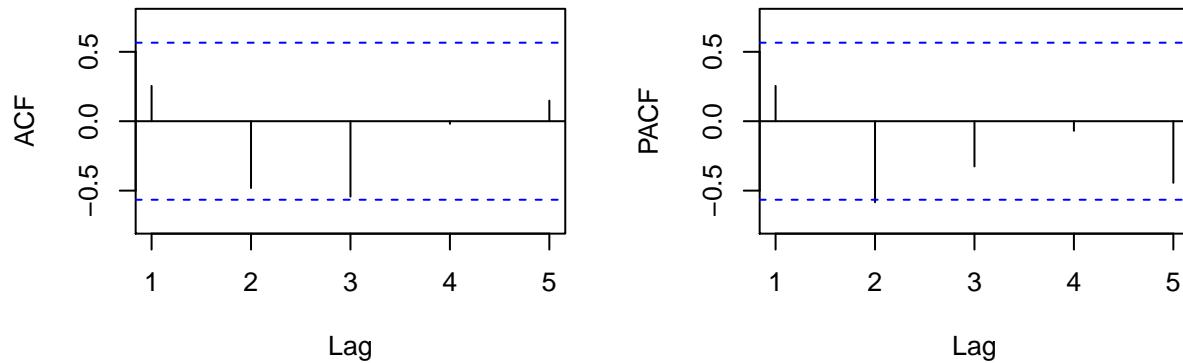
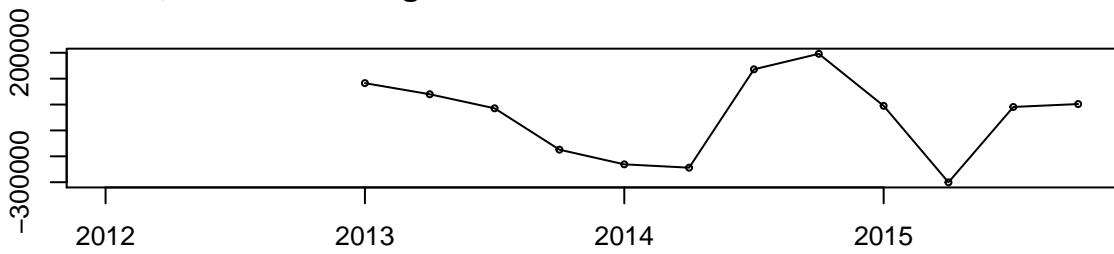
Portland, OR – Forest Highlands : Naive Model Forecast Residuals



Portland, OR – Forest Highlands : Holt Winters Model Forecast

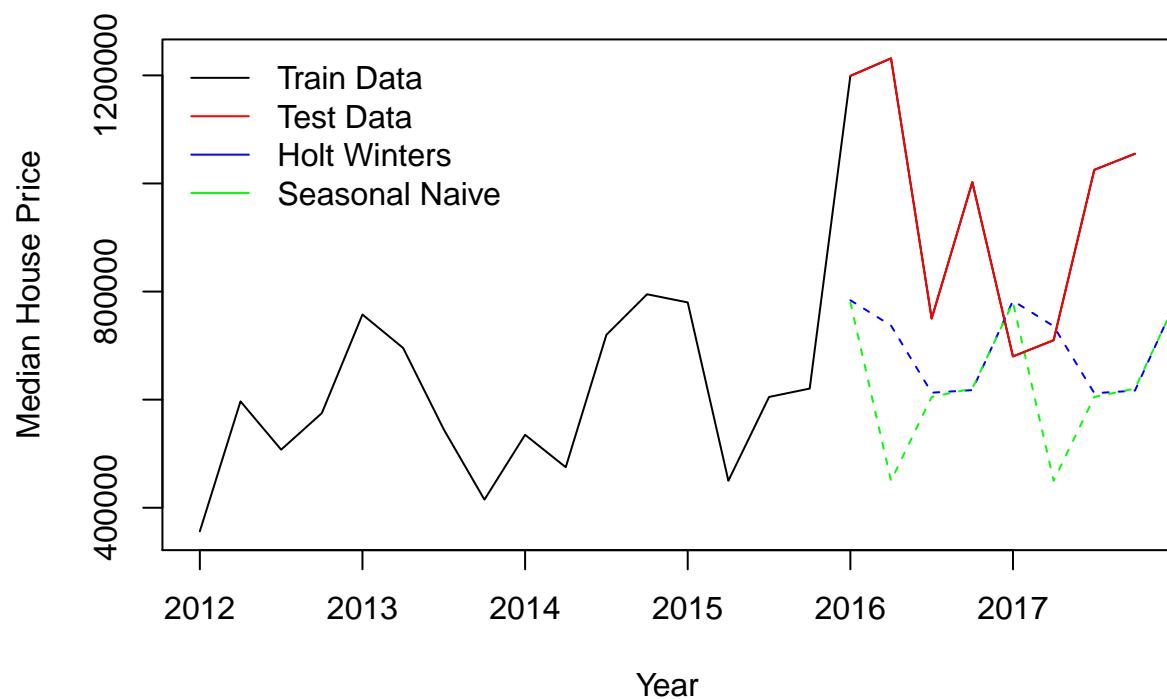


Portland, OR – Forest Highlands : Holt Winters Model Forecast Residuals

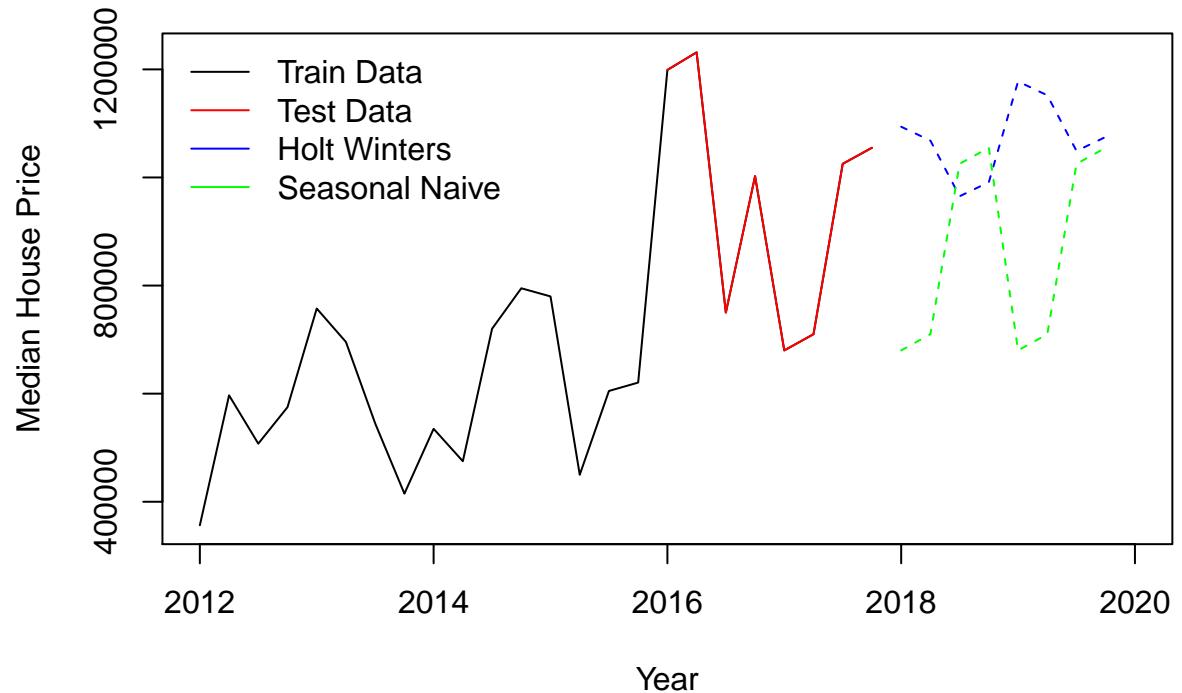


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Forest Highlands"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 34958.83 218897.5 187888.0 -0.1463728 29.73132 1.000000
## Test set     342818.75 417783.6 367793.8 32.4956911 36.16849 1.957516
##          ACF1 Theil's U
## Training set 0.4493549      NA
## Test set     -0.0899135 1.558047
## [1] "Holt Winters Accuracy for Portland, OR - Forest Highlands"
##      ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -43515.96 157855.1 119541.6 -12.30419 22.37982 0.6362388
## Test set     269263.57 346022.3 301513.3 24.31134 29.01345 1.6047503
##          ACF1 Theil's U
## Training set 0.25444267      NA
## Test set     0.09674476 1.310544
```

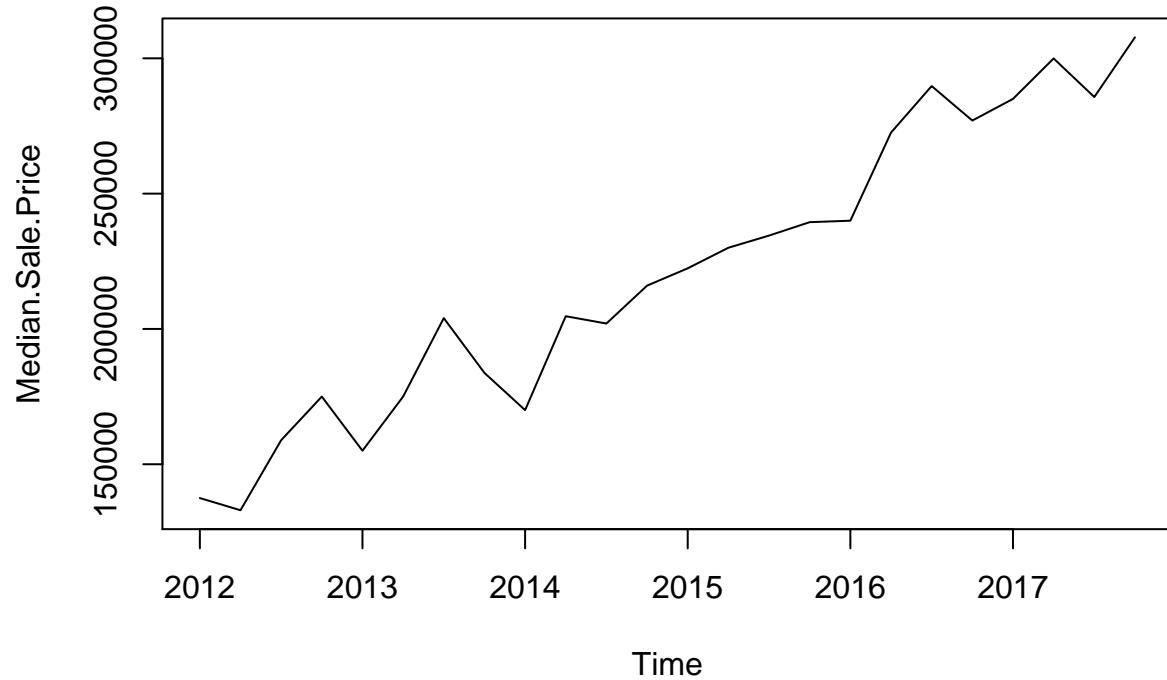
Portland, OR – Forest Highlands : TS Training Model Comparison



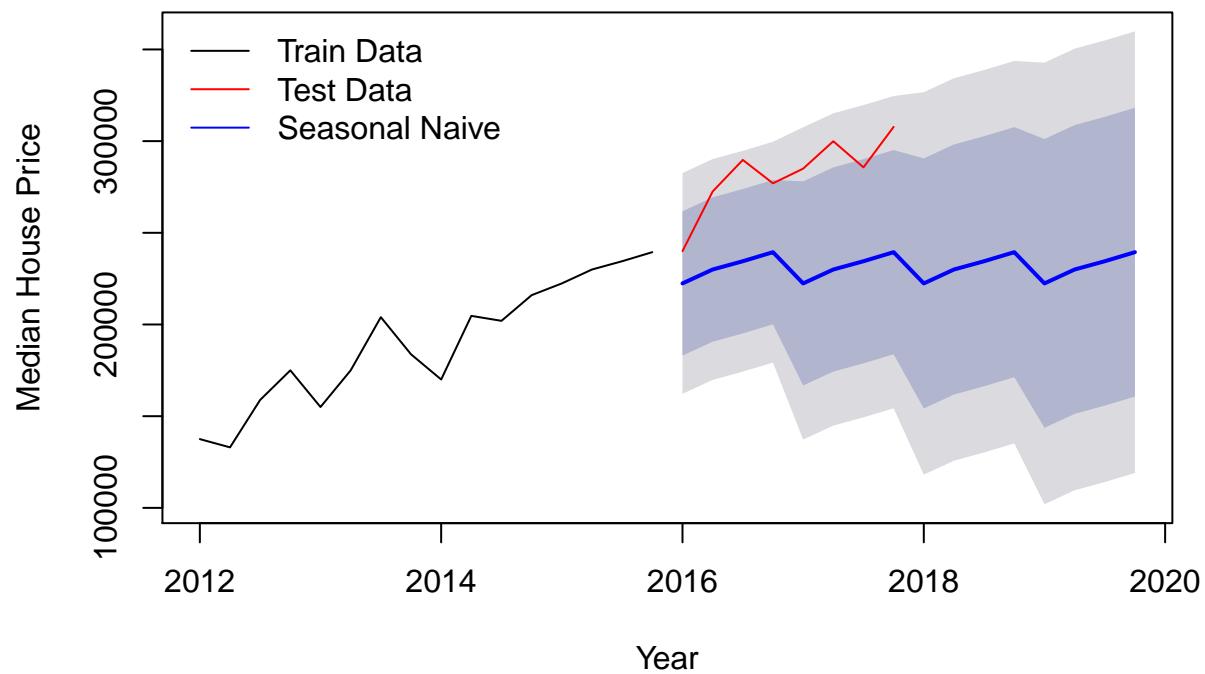
Portland, OR – Forest Highlands : Full TS Models Comparison



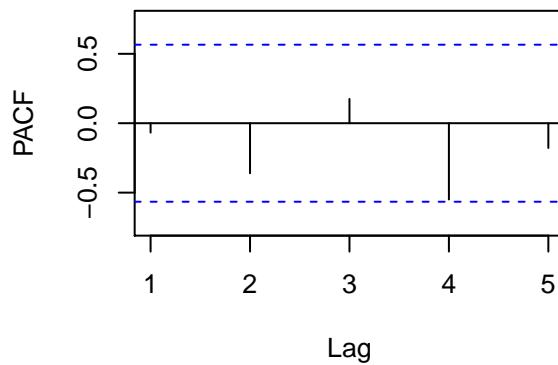
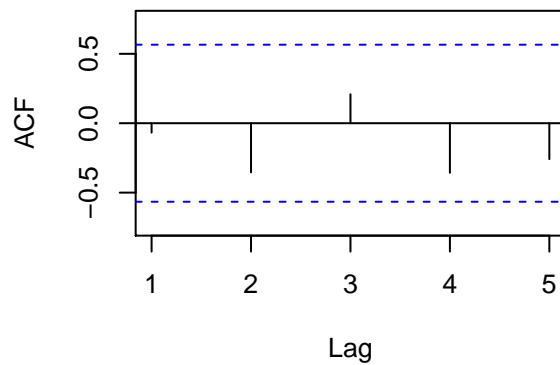
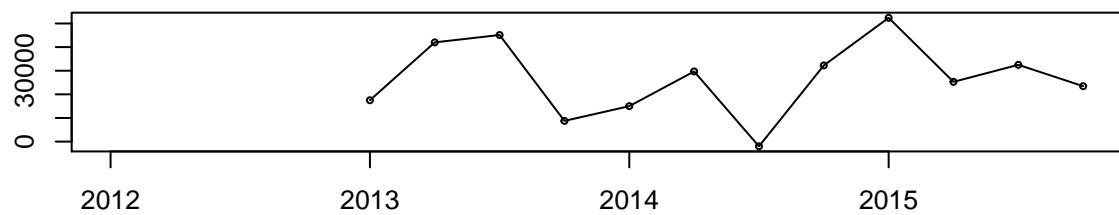
Portland, OR – Southgate



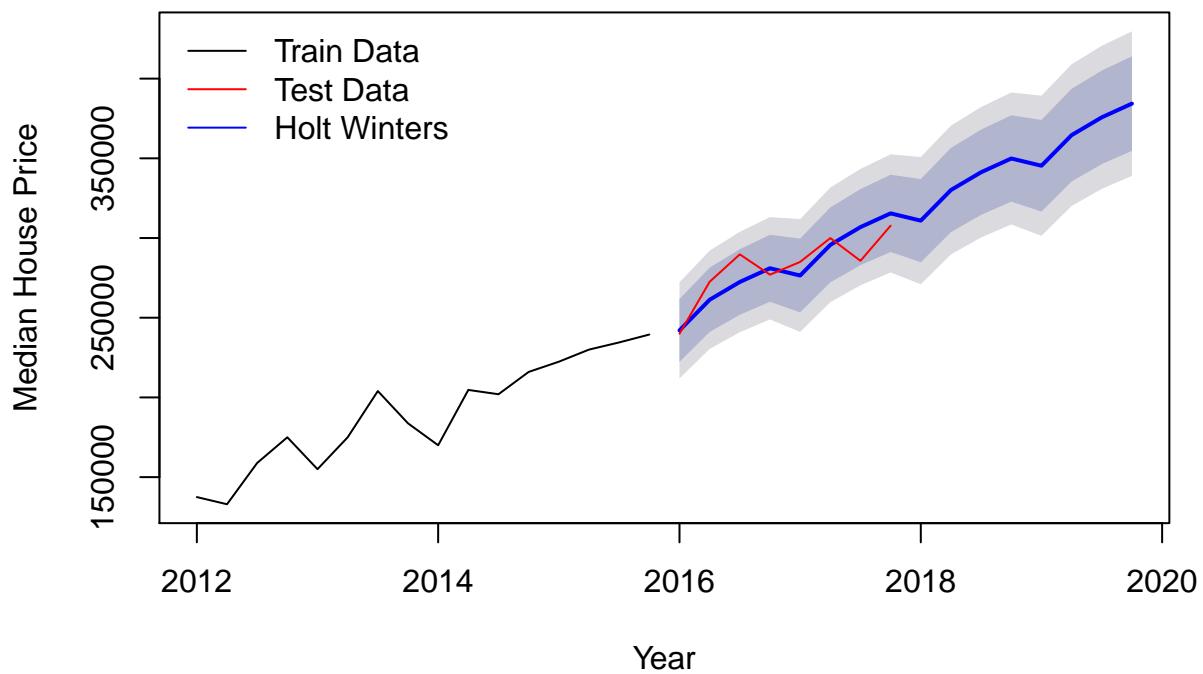
Portland, OR – Southgate : Naive Model Forecast



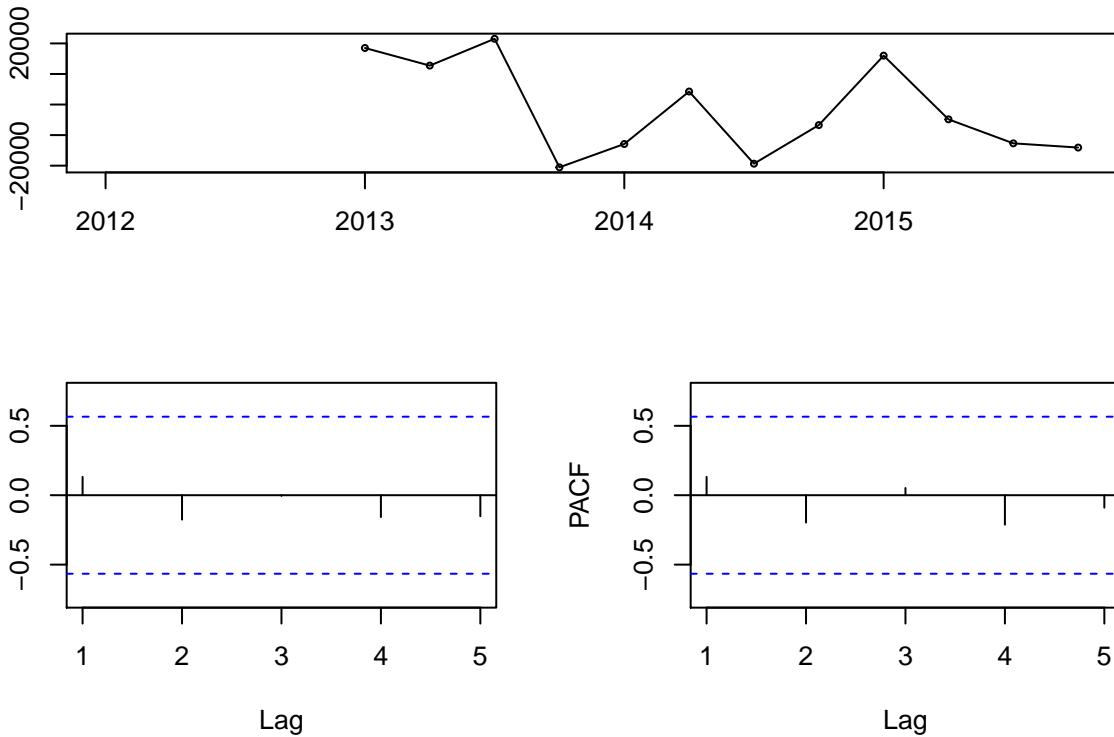
Portland, OR – Southgate : Naive Model Forecast Residuals



Portland, OR – Southgate : Holt Winters Model Forecast



Portland, OR – Southgate : Holt Winters Model Forecast Residuals

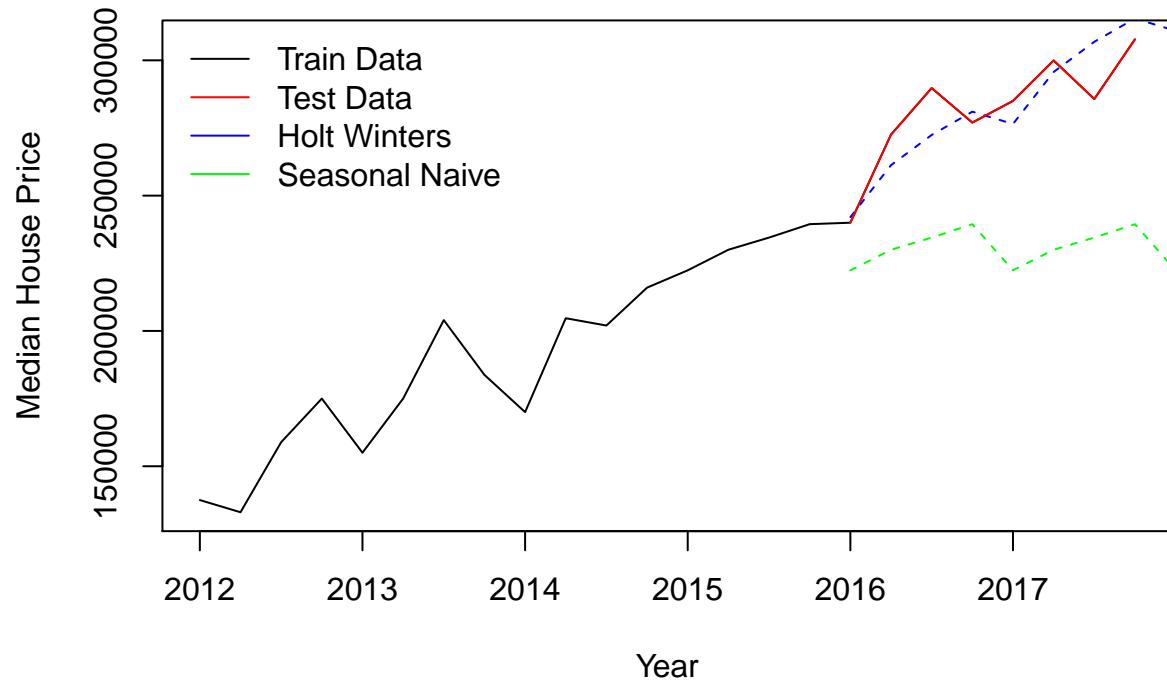


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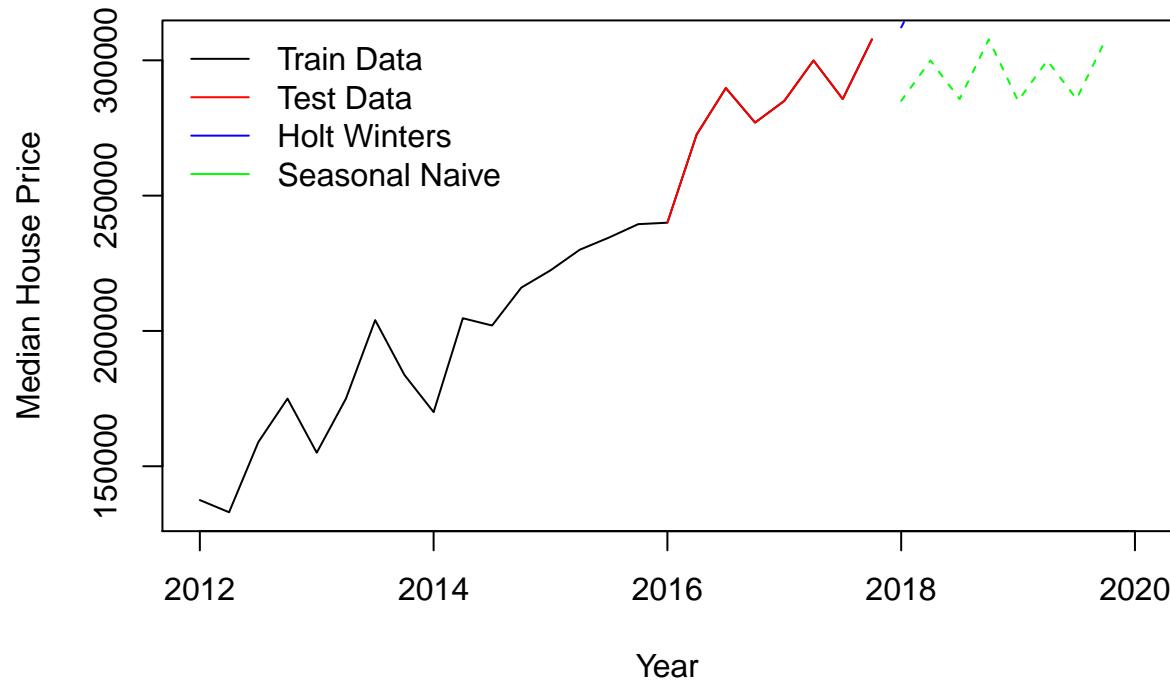
## [1] "Seasonal Naive Accuracy for Portland, OR – Southgate"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set 26830.50 30720.42 27163.83 13.13794 13.30295 1.000000
## Test set     50624.88 53245.76 50624.88 17.62107 17.62107 1.863687
##          ACF1 Theil's U
## Training set -0.06778224      NA
## Test set     0.12167299 2.818679
## [1] "Holt Winters Accuracy for Portland, OR – Southgate"
##          ME      RMSE       MAE       MPE      MAPE      MASE
## Training set -1510.808 14814.59 13682.579 -0.4854117 6.993279 0.5037057
## Test set     808.894 11433.85  9543.423  0.2899983 3.344083 0.3513283
##          ACF1 Theil's U
## Training set 0.1323585      NA
## Test set     0.1574428 0.6073428

```

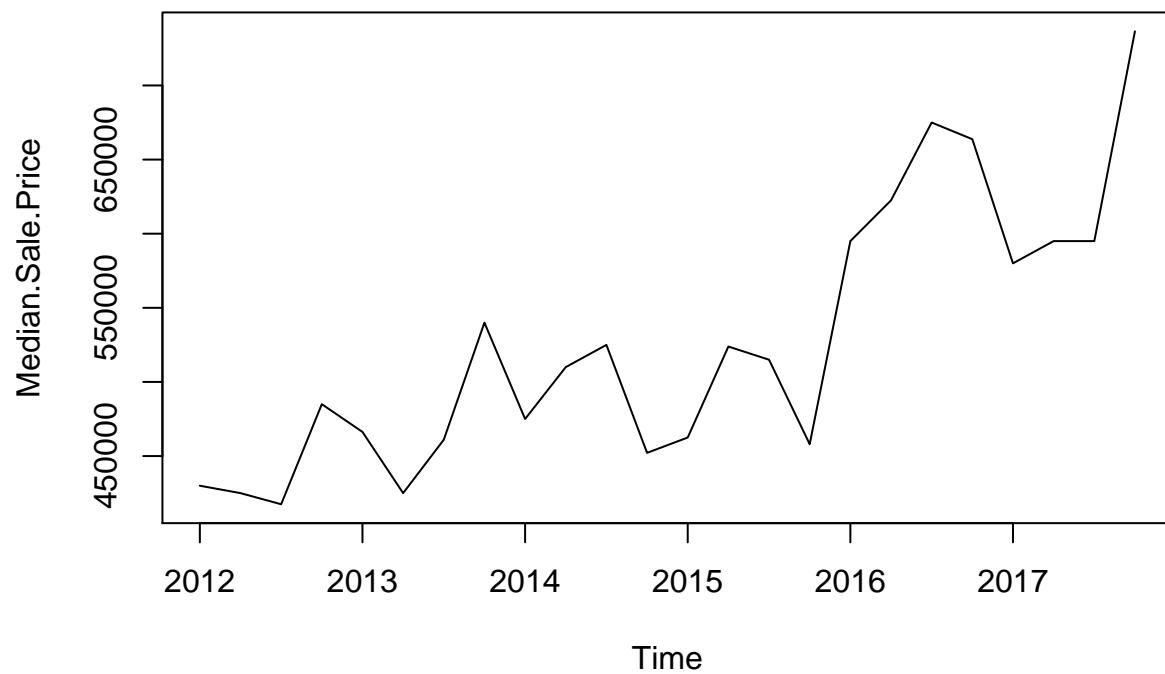
Portland, OR – Southgate : TS Training Model Comparison



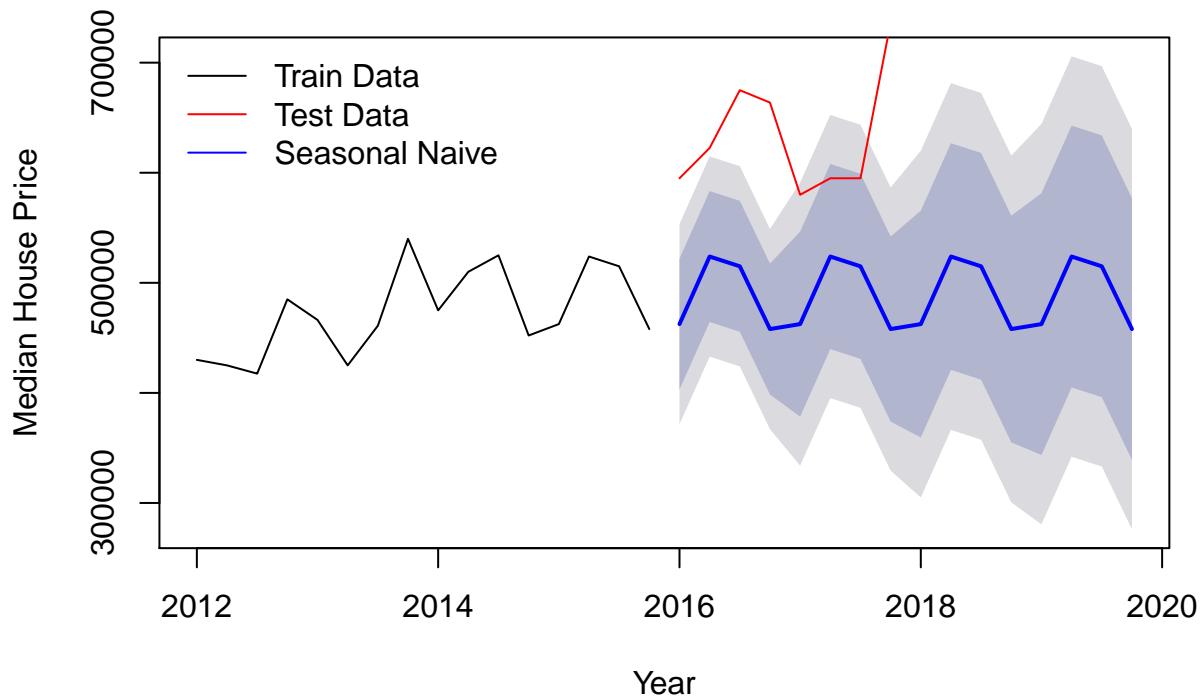
Portland, OR – Southgate : Full TS Models Comparison



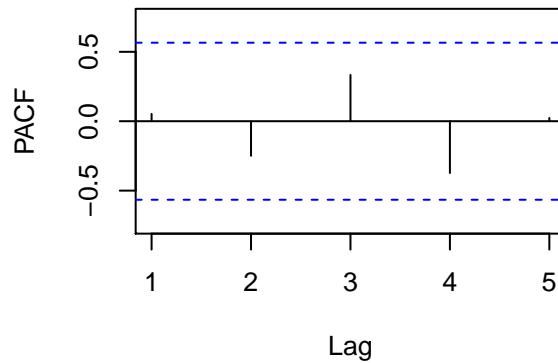
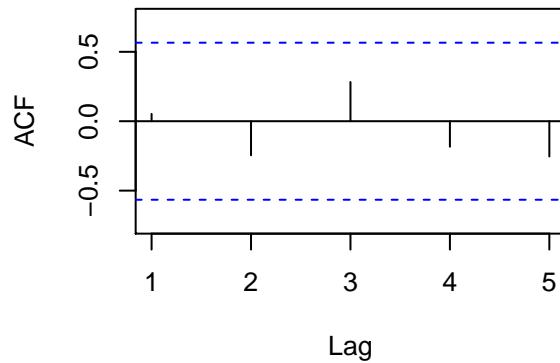
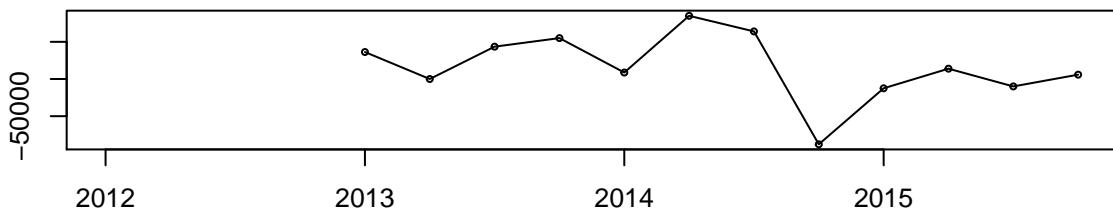
Portland, OR – Northwest District



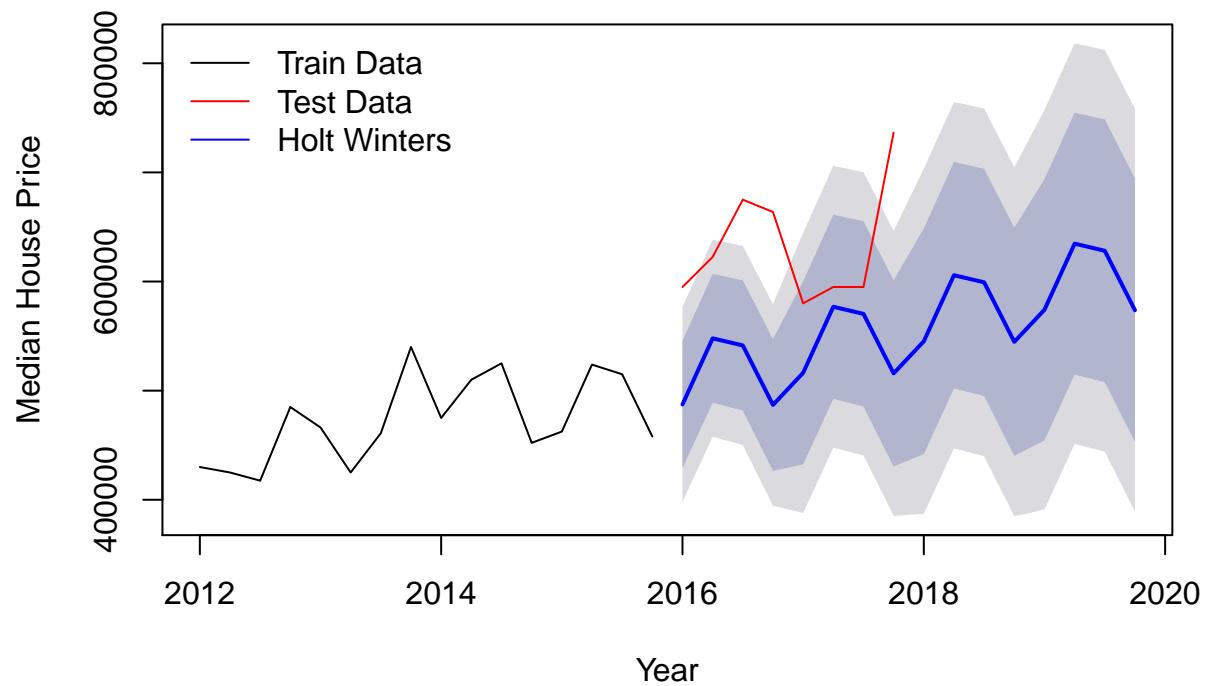
Portland, OR – Northwest District : Naive Model Forecast



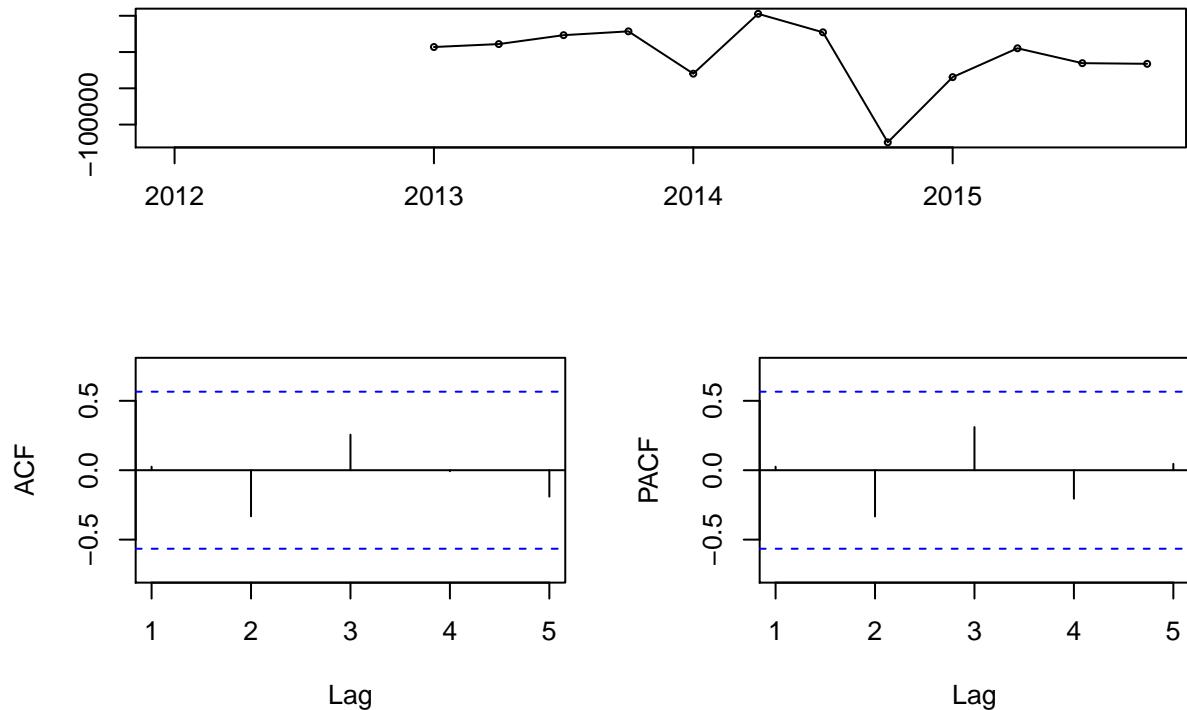
Portland, OR – Northwest District : Naive Model Forecast Residuals



Portland, OR – Northwest District : Holt Winters Model Forecast

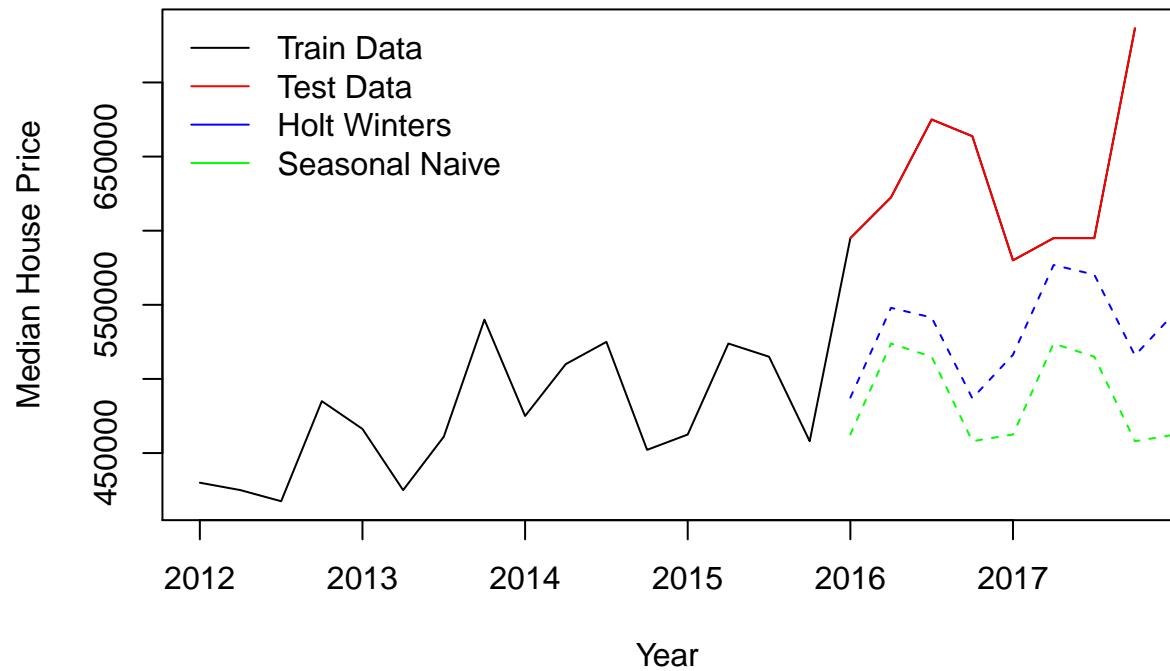


Portland, OR – Northwest District : Holt Winters Model Forecast Residuals

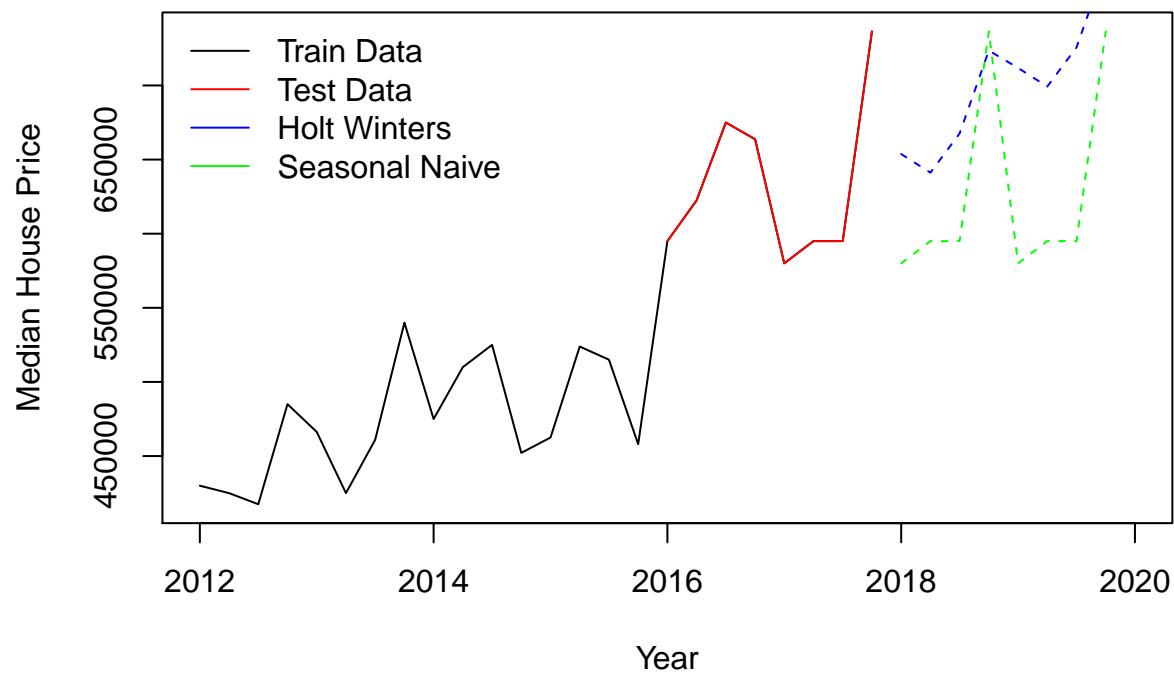


```
## [1] "Seasonal Naive Accuracy for Portland, OR - Northwest District"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 16822.92 46396.44 35214.58 3.162229 7.174536 1.000000
## Test set     143000.00 157338.60 143000.00 22.035733 22.035733 4.060818
##          ACF1 Theil's U
## Training set 0.05290857      NA
## Test set     -0.08700282 2.384322
## [1] "Holt Winters Accuracy for Portland, OR - Northwest District"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set -5466.979 43912.81 31267.14 -1.407601 6.558695 0.8879033
## Test set     102463.138 122441.74 102463.14 15.578125 15.578125 2.9096791
##          ACF1 Theil's U
## Training set 0.02541834      NA
## Test set     -0.02636987 1.839709
```

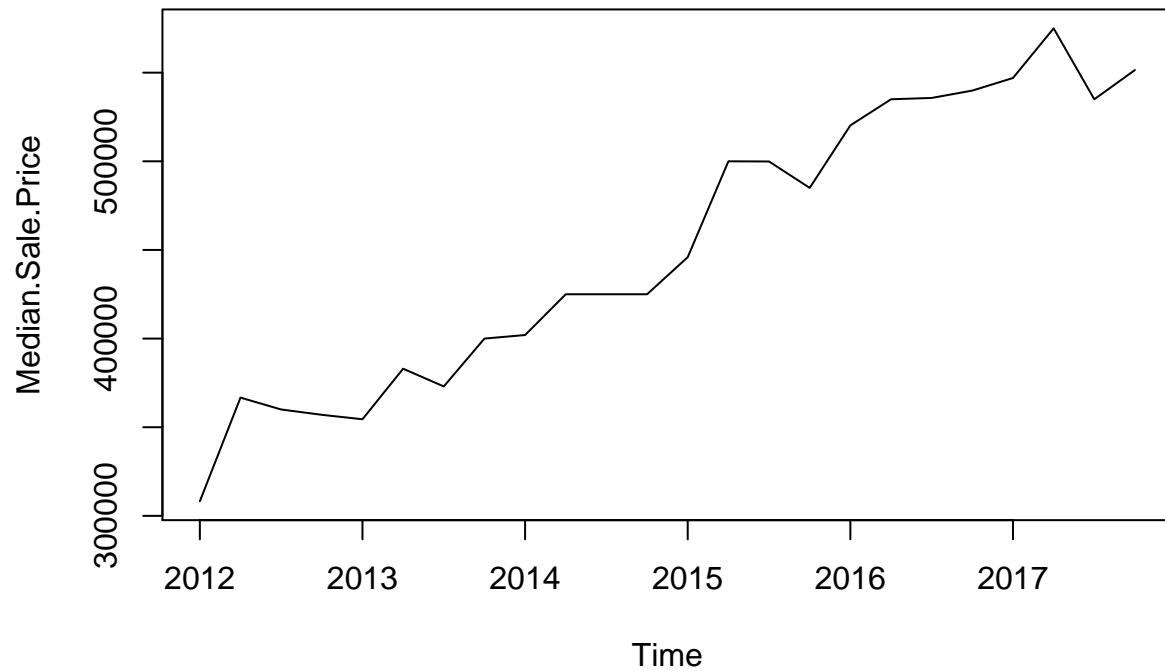
Portland, OR – Northwest District : TS Training Model Comparison



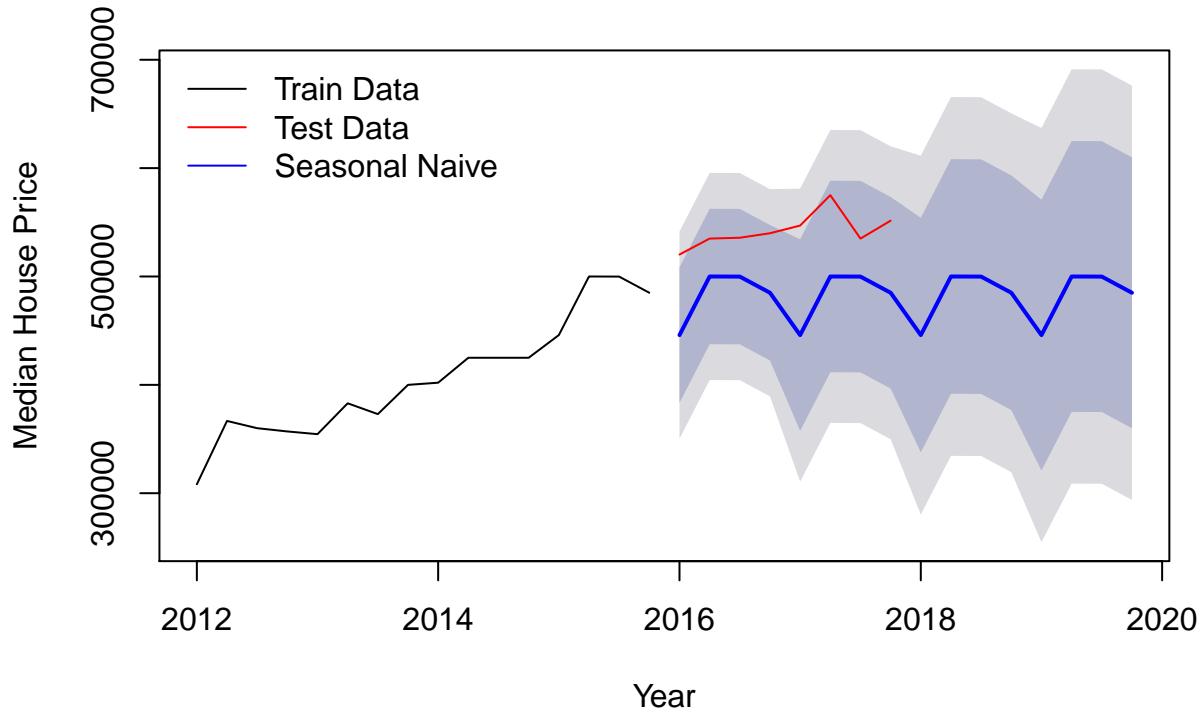
Portland, OR – Northwest District : Full TS Models Comparison



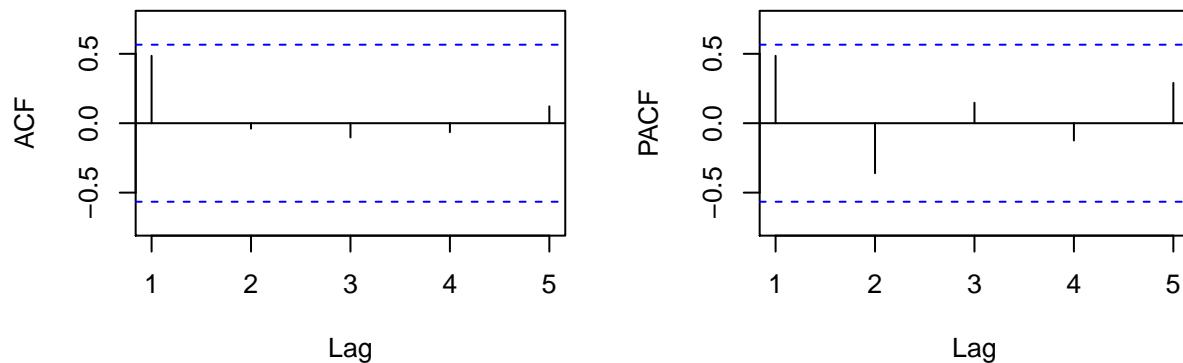
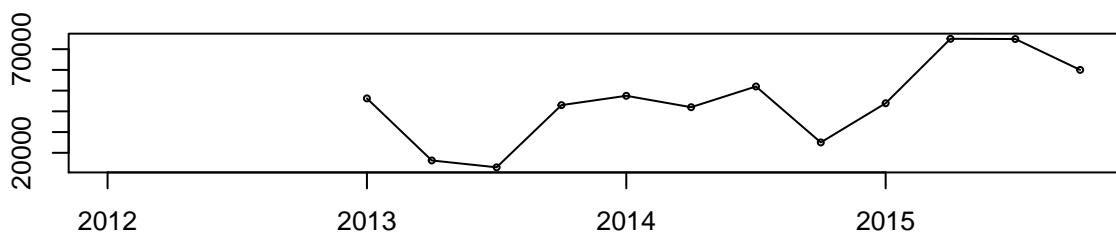
Portland, OR – Hawthorne District



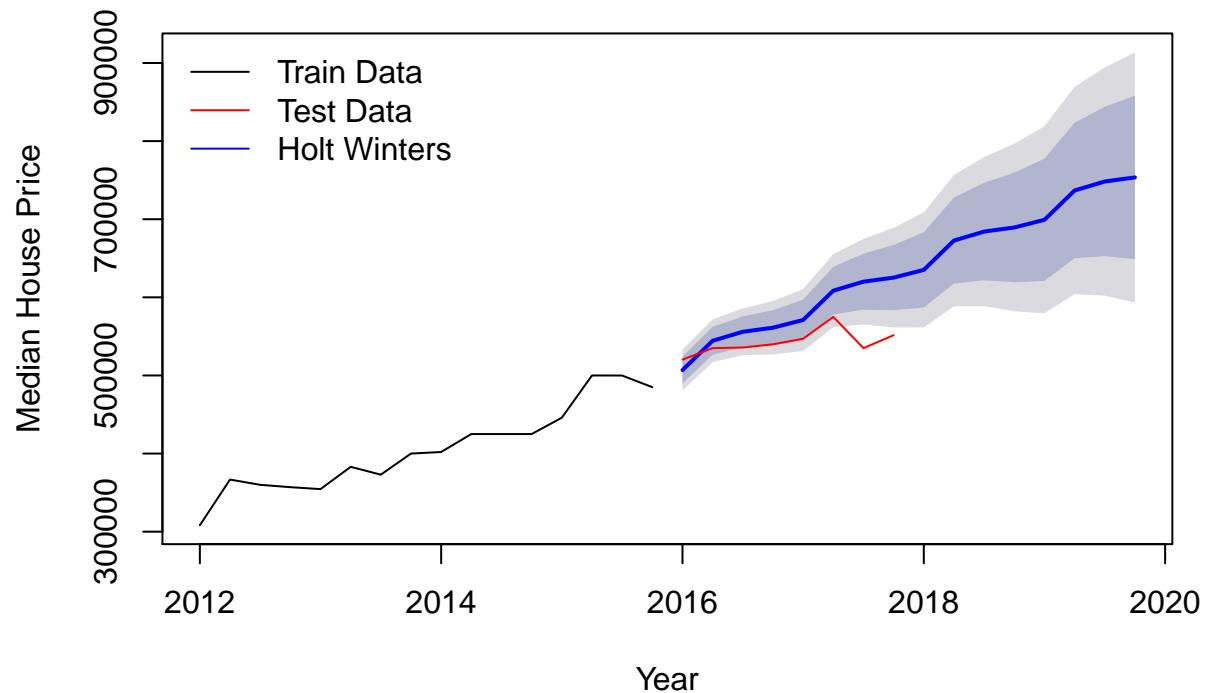
Portland, OR – Hawthorne District : Naive Model Forecast



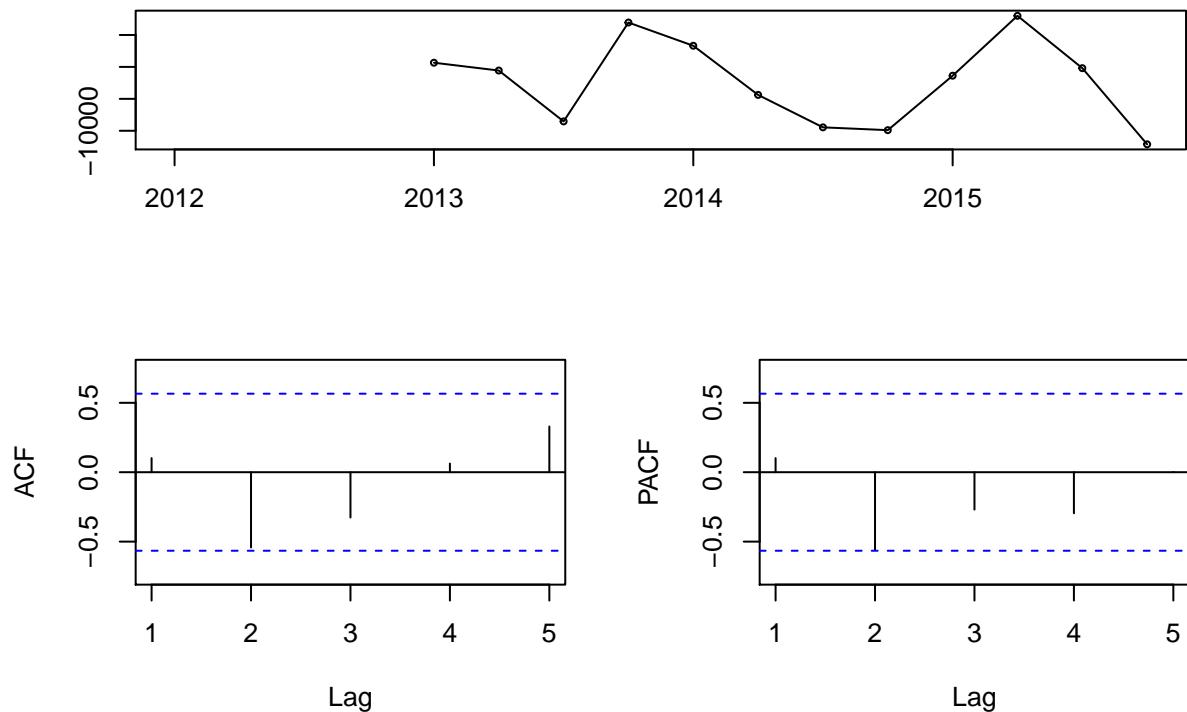
Portland, OR – Hawthorne District : Naive Model Forecast Residuals



Portland, OR – Hawthorne District : Holt Winters Model Forecast

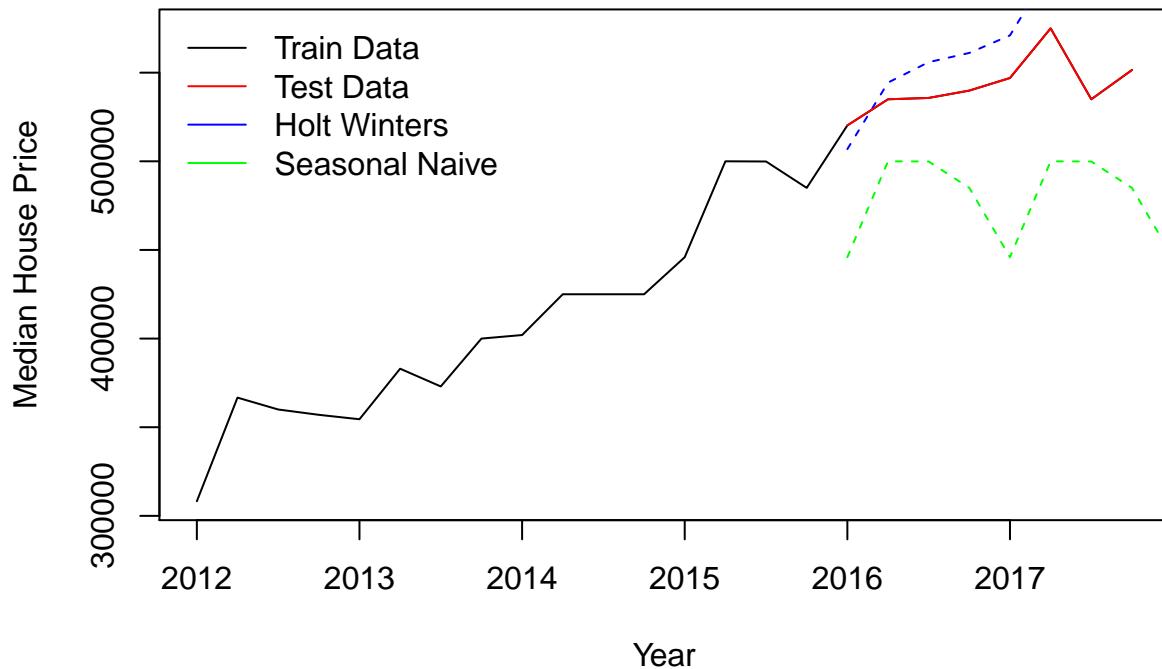


Portland, OR – Hawthorne District : Holt Winters Model Forecast Residuals

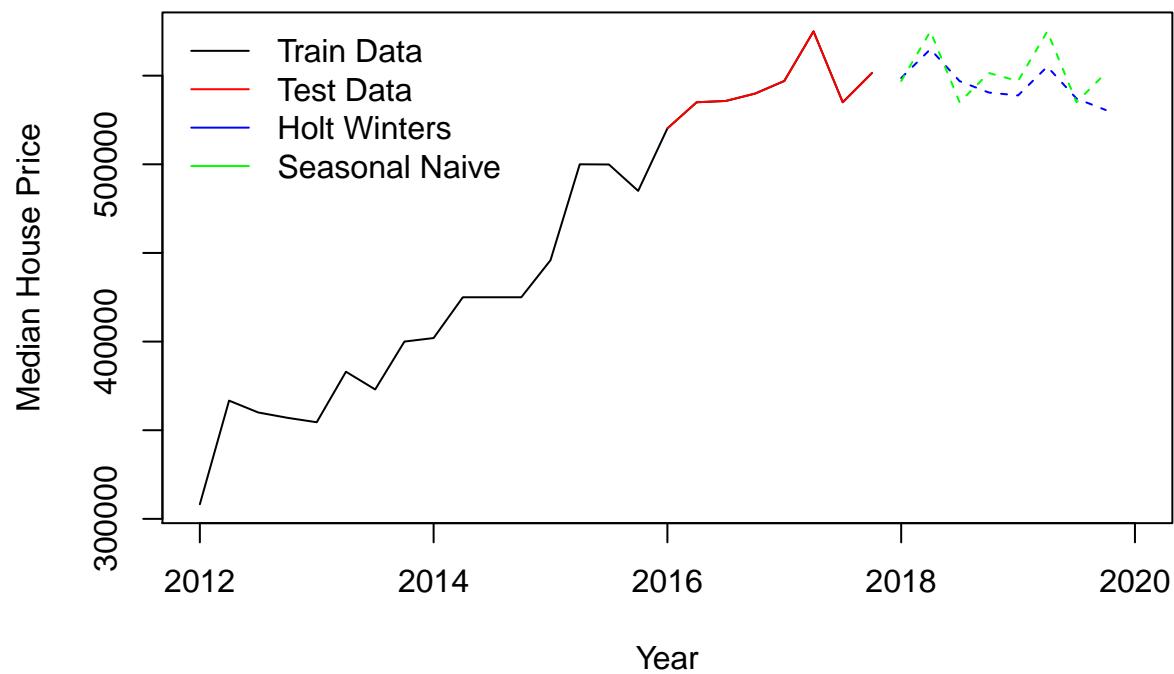


```
## [1] "Seasonal Naive Accuracy for Portland, OR – Hawthorne District"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 44905.62 48764.54 44905.62 10.29638 10.29638 1.000000
## Test set     59720.62 63783.31 59720.62 10.97896 10.97896 1.329914
##          ACF1 Theil's U
## Training set 0.48553614      NA
## Test set     0.05815725 3.129504
## [1] "Holt Winters Accuracy for Portland, OR – Hawthorne District"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 5396.551 13859.88 12069.17 1.28476 2.824341 0.2687675
## Test set     -31732.781 44024.61 35074.54 -5.79894 6.441277 0.7810722
##          ACF1 Theil's U
## Training set 0.1018733      NA
## Test set     0.5088974 2.29935
```

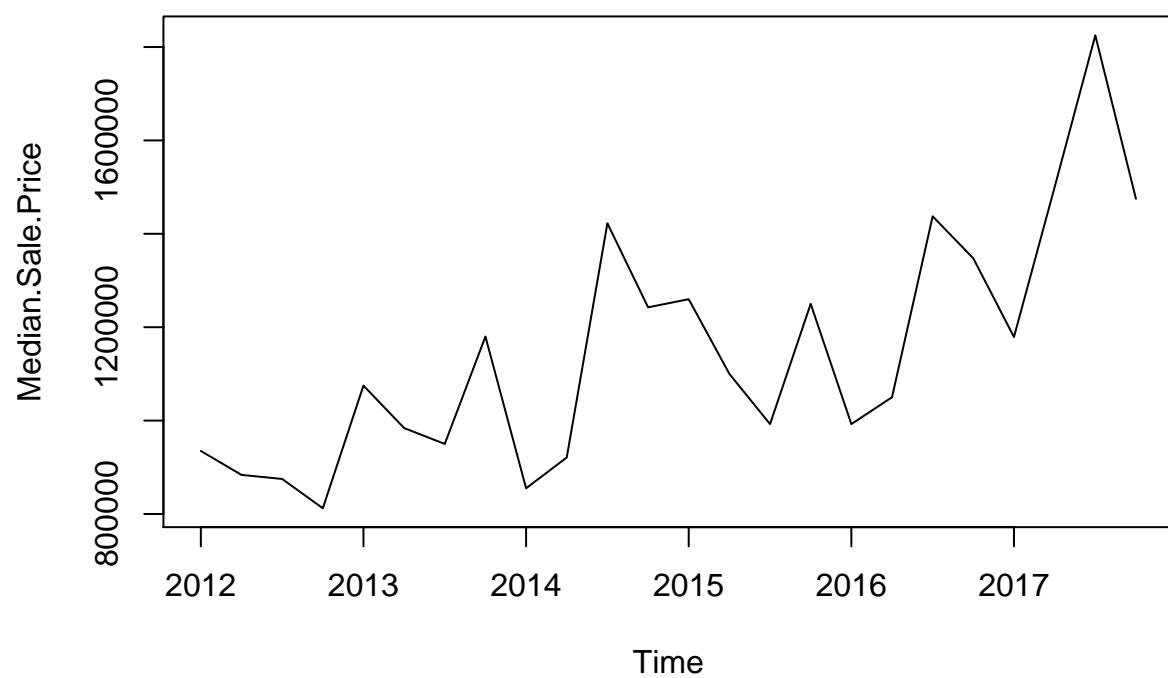
Portland, OR – Hawthorne District : TS Training Model Comparison



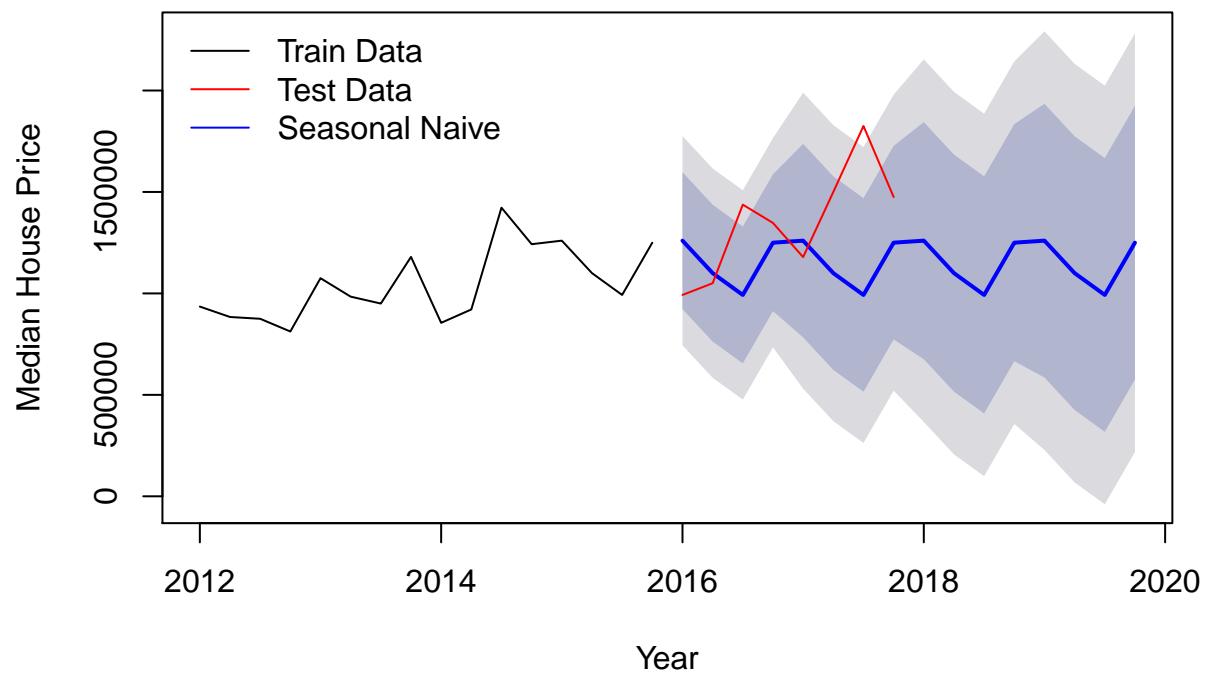
Portland, OR – Hawthorne District : Full TS Models Comparison



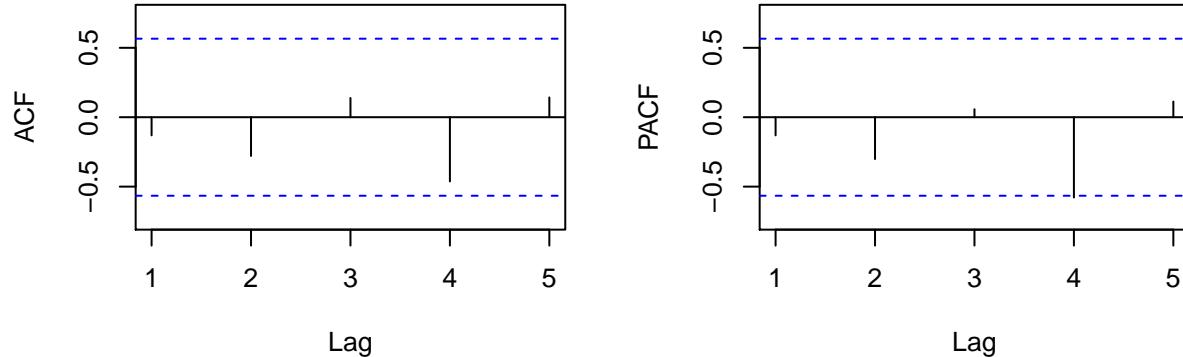
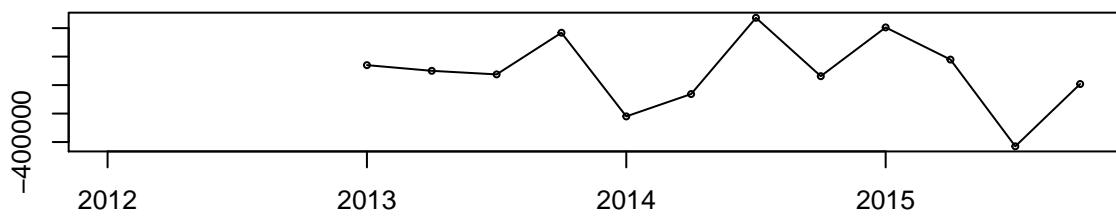
Portland, OR – Dunthorpe



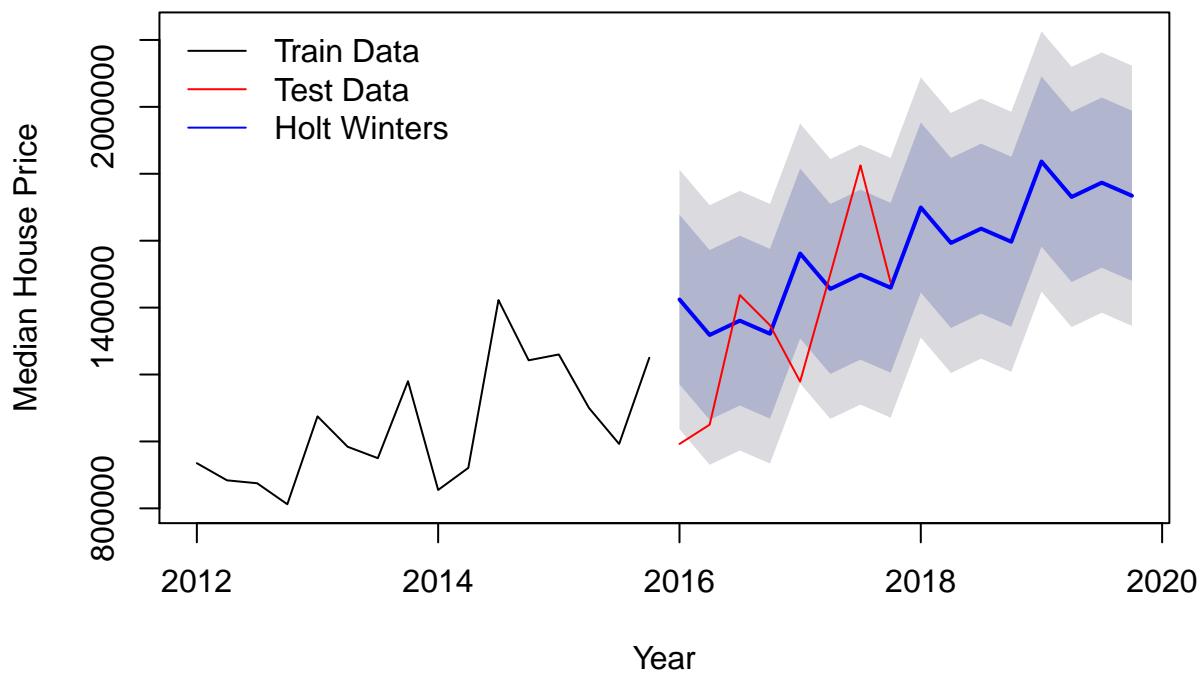
Portland, OR – Dunthorpe : Naive Model Forecast



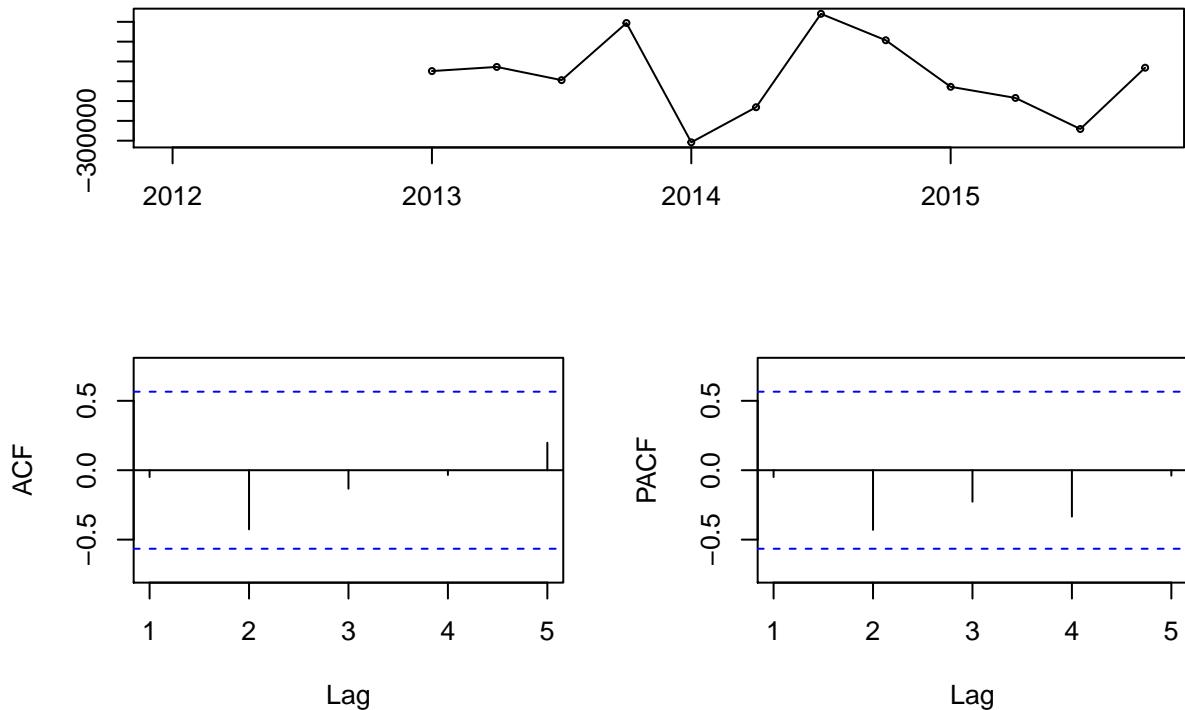
Portland, OR – Dunthorpe : Naive Model Forecast Residuals



Portland, OR – Dunthorpe : Holt Winters Model Forecast



Portland, OR – Dunthorpe : Holt Winters Model Forecast Residuals

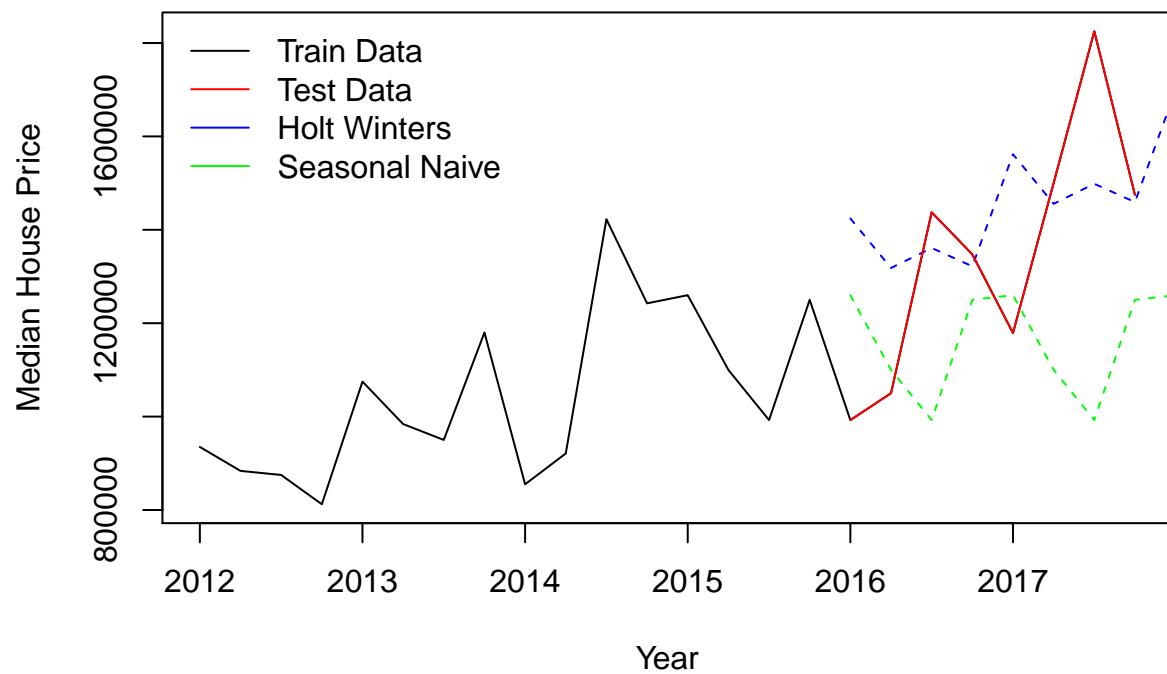


```

## [1] "Seasonal Naive Accuracy for Portland, OR – Dunthorpe"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 91370.83 263159.0 210204.2 6.136052 18.78544 1.000000
## Test set     200181.25 385971.3 299781.2 10.893107 20.53668 1.426143
##          ACF1 Theil's U
## Training set -0.1307815      NA
## Test set      0.1668141 1.408519
## [1] "Holt Winters Accuracy for Portland, OR – Dunthorpe"
##          ME      RMSE      MAE      MPE      MAPE      MASE
## Training set 20608.21 190616.7 152672.5 -0.056777 14.01478 0.7263058
## Test set     -74290.47 254979.6 196378.6 -9.048766 16.32703 0.9342277
##          ACF1 Theil's U
## Training set -0.04933653      NA
## Test set      0.14982900 0.8104735

```

Portland, OR – Dunthorpe : TS Training Model Comparison



Portland, OR – Dunthorpe : Full TS Models Comparison

