ST565: Time Series HW2

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Data Analysis

- Summarise and describe the trend and seasonality
- Remove the trend and seasonality to estimate residual noise
- Examine the residual noise for non-stationarity in variance and for autocorrelation.

Introduction

The United States Census Bureau collects and provides data on US retail sales through the Monthly Retail Trade Surveys. For this homework we analyse the estimates of the total monthly sales for motor vehicle and parts dealers in the USA from 1992 to 2014.

The monthly total sales for motor vehicles and parts dealers in the USA from 1992 to 2014 are shown below. The goal of this analysis is to describe the seasonality, trend and the properties of the residual variation in this series.

```
library(plyr)
library(lubridate)
```

```
##
## Attaching package: 'lubridate'
```

```
## The following object is masked from 'package:plyr':
##
##     here
```

```
library(ggplot2)
options(stringsAsFactors = FALSE)

# import data
load(url("http://stat565.cwick.co.nz/data/sales.rda"))
class(sales)
```

```
## [1] "data.frame"
```

```
head(sales)
```

```
##         date value
## 1 1992-01-15 29811
## 2 1992-02-15 31217
## 3 1992-03-15 35136
## 4 1992-04-15 36082
## 5 1992-05-15 36460
## 6 1992-06-15 38389
```

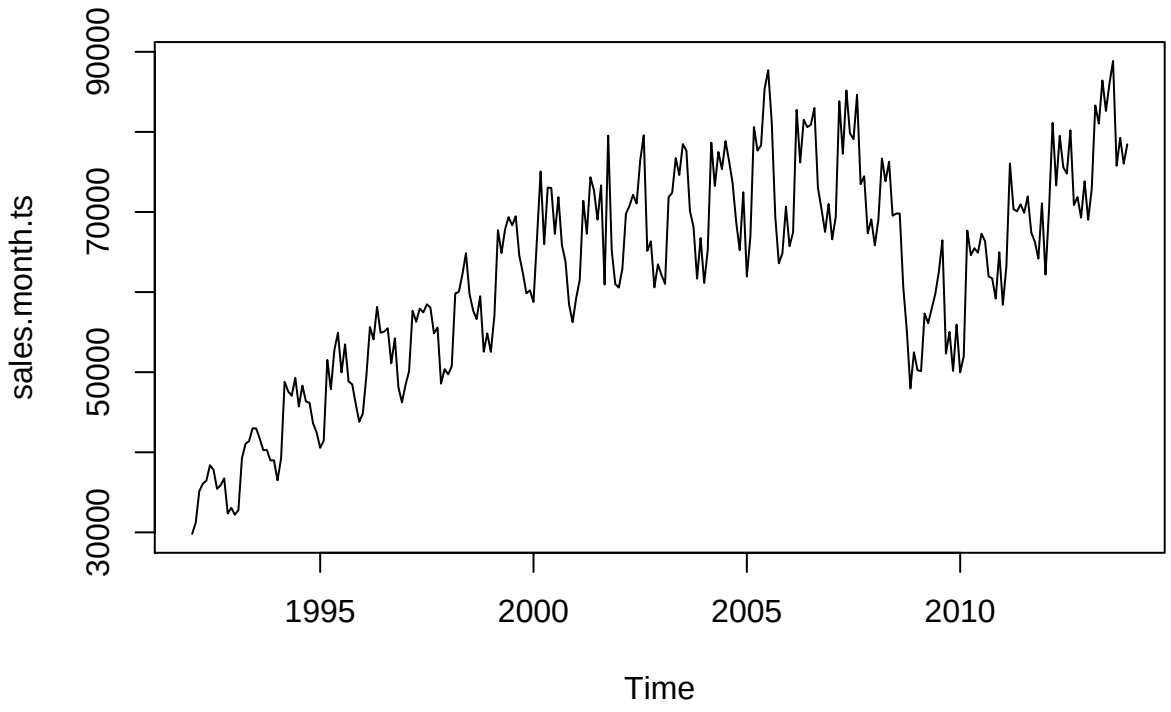
```r
tail(sales)
```

```
##           date value
## 259 2013-07-15 86067
## 260 2013-08-15 88856
## 261 2013-09-15 75778
## 262 2013-10-15 79262
## 263 2013-11-15 76041
## 264 2013-12-15 78448
```

```r
# sales <- sales %>% select(value)
sales <- sales$value

# Convert to a Time Series object
sales.month.ts <- ts(sales, start = c(1992, 1), frequency = 12)
head(sales.month.ts)
```

```
## [1] 29811 31217 35136 36082 36460 38389
```

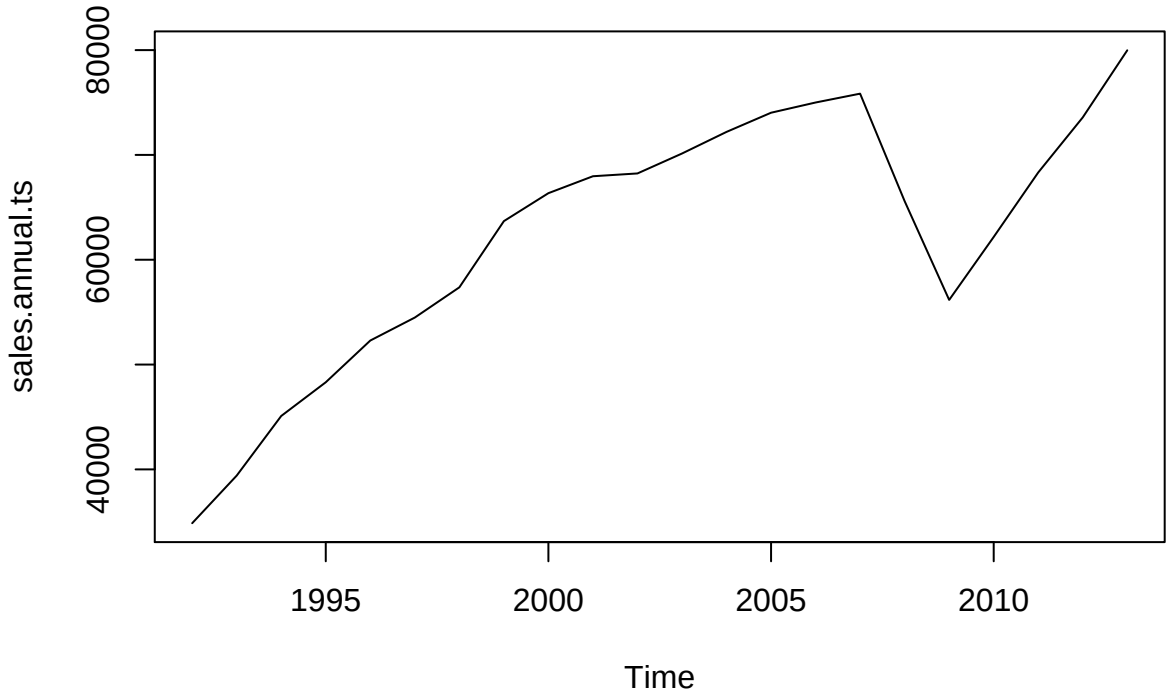
```r
plot(sales.month.ts)
```



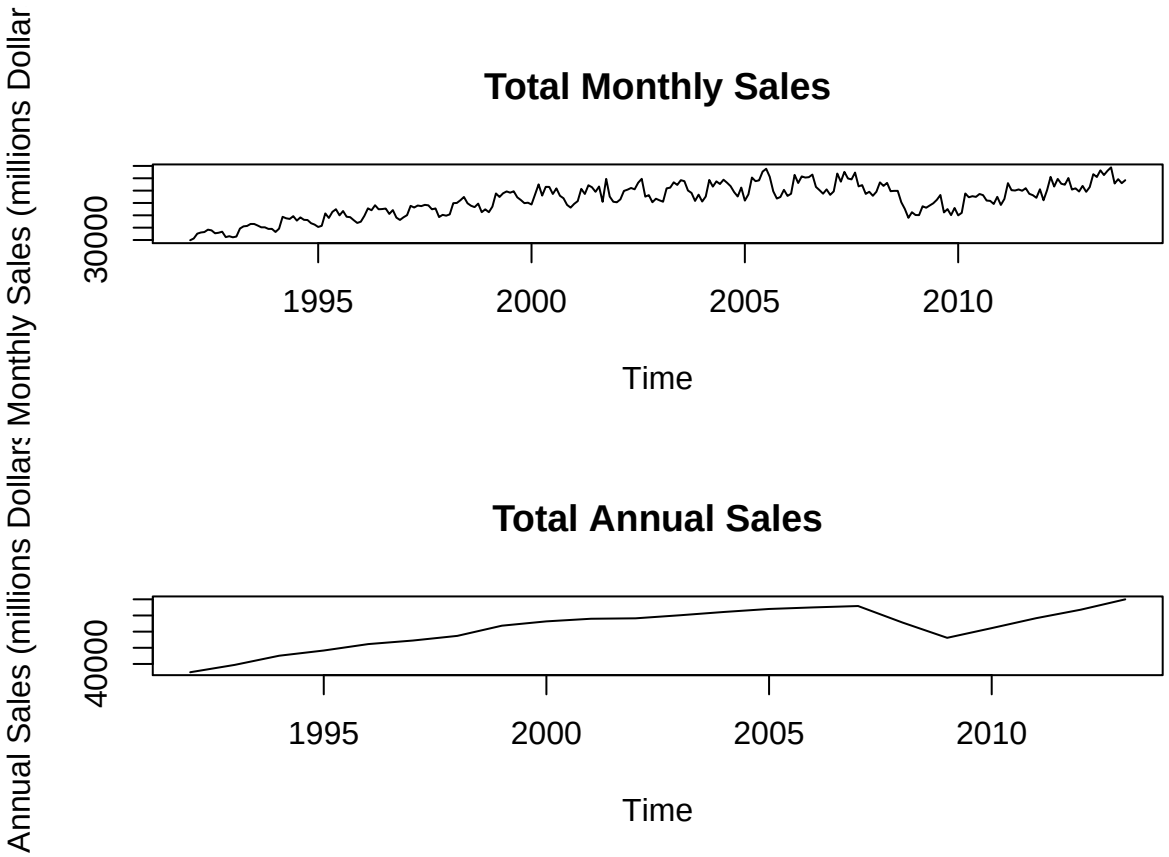

```r
# create an annual aggregate object
sales.annual.ts <- aggregate(sales.month.ts)/12
head(sales.annual.ts)
```

```
## [1] 34866.08 39409.67 45095.08 48309.58 52292.25 54484.75
```

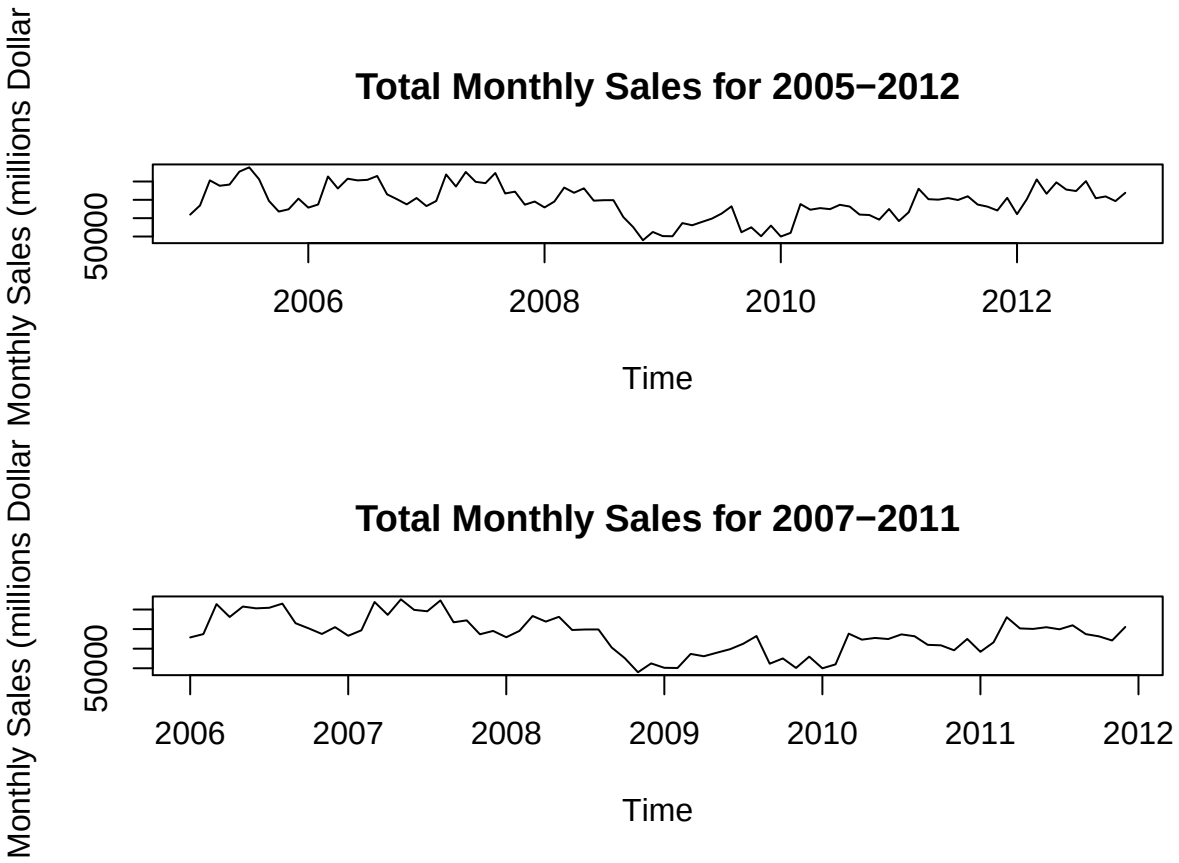
```r
plot(sales.annual.ts)
```




```r
layout(1:2)
plot(sales.month.ts, ylab = "Monthly Sales (millions Dollars)", main = "Total Monthly Sales")
plot(sales.annual.ts, ylab = "Annual Sales (millions Dollars)", main = "Total Annual Sales")
```




```
# explore the dip, zoom in to see better resolution
plot(window(sales.month.ts, start=c(2005, 1), end=c(2012, 12)), ylab = "Monthly Sales (millions Dollars)

plot(window(sales.month.ts, start=c(2006, 1), end=c(2011, 12)), ylab = "Monthly Sales (millions Dollars)
```



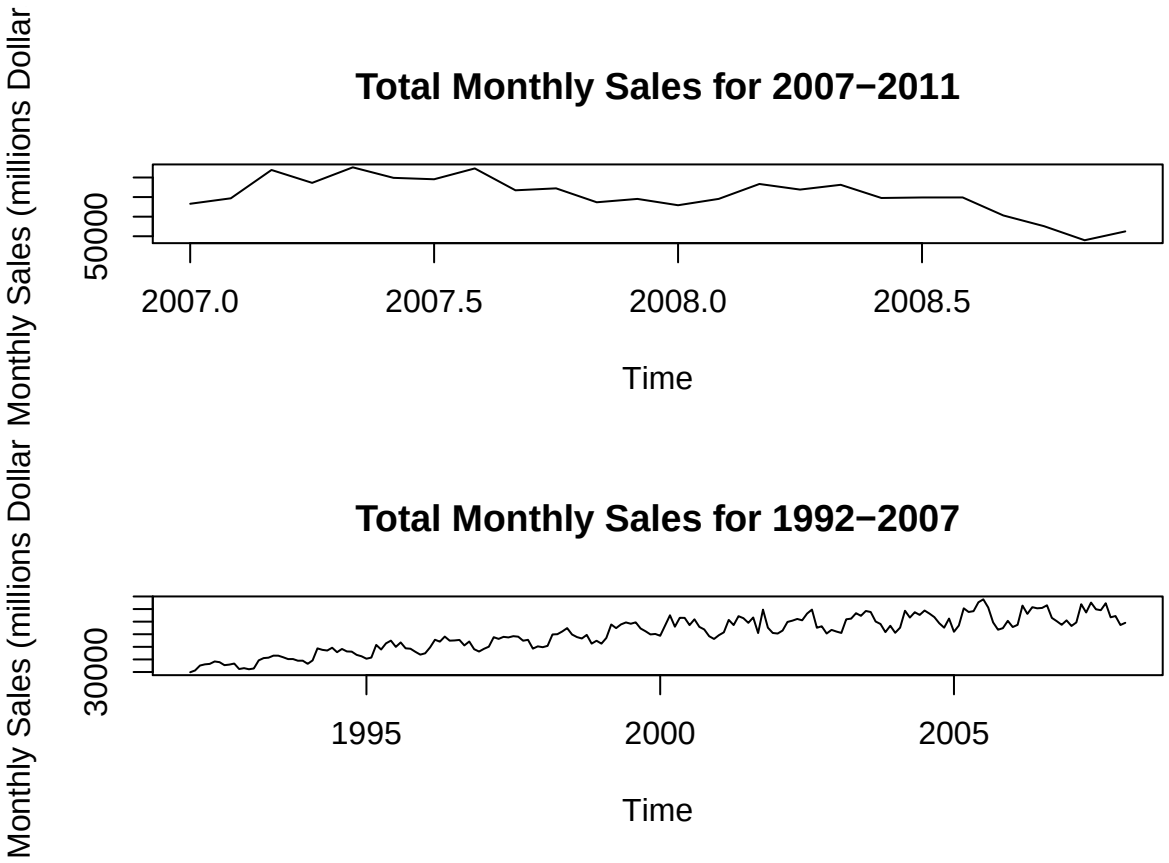

```r
plot(window(sales.month.ts, start=c(2007, 1), end=c(2008, 12)), ylab = "Monthly Sales (millions Dollars)

sales.1992to2007 <- window(sales.month.ts, start=c(1992, 1), end=c(2007, 12))
sales.2008 <- window(sales.month.ts, start=c(2008, 1), end=c(2008, 12))
sales.2009to2013 <- window(sales.month.ts, start=c(2009, 1), end=c(2013, 12))

sales.2006 <- window(sales.month.ts, start=c(2006, 1), end=c(2006, 12))
sales.2006
```

```
##        Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov
## 2006 65737 67452 82754 76180 81517 80599 80889 82997 73000 70365 67512
##        Dec
## 2006 70995
```

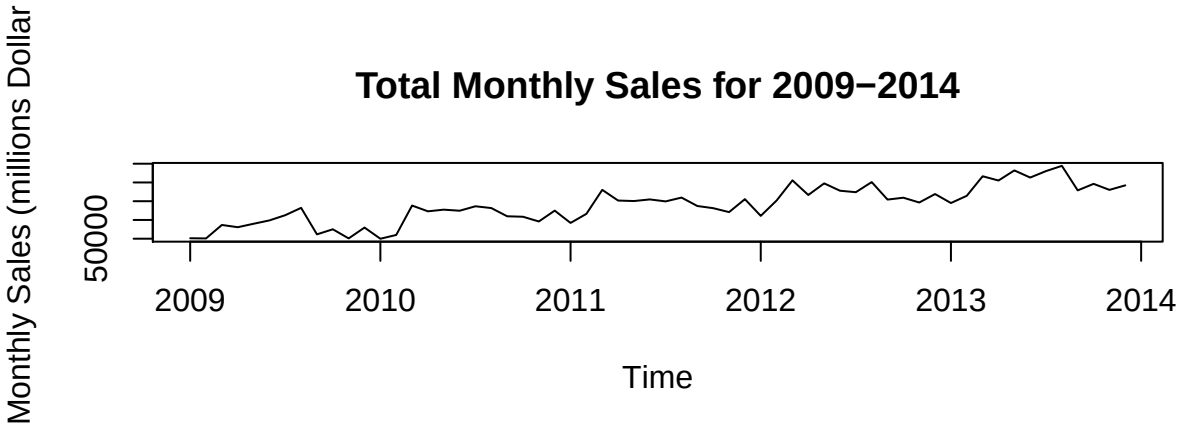
```r
sales.2008
```

```
##        Jan   Feb   Mar   Apr   May   Jun   Jul   Aug   Sep   Oct   Nov
## 2008 65842 69073 76685 73837 76268 69543 69800 69812 60618 55151 47965
##        Dec
## 2008 52485
```

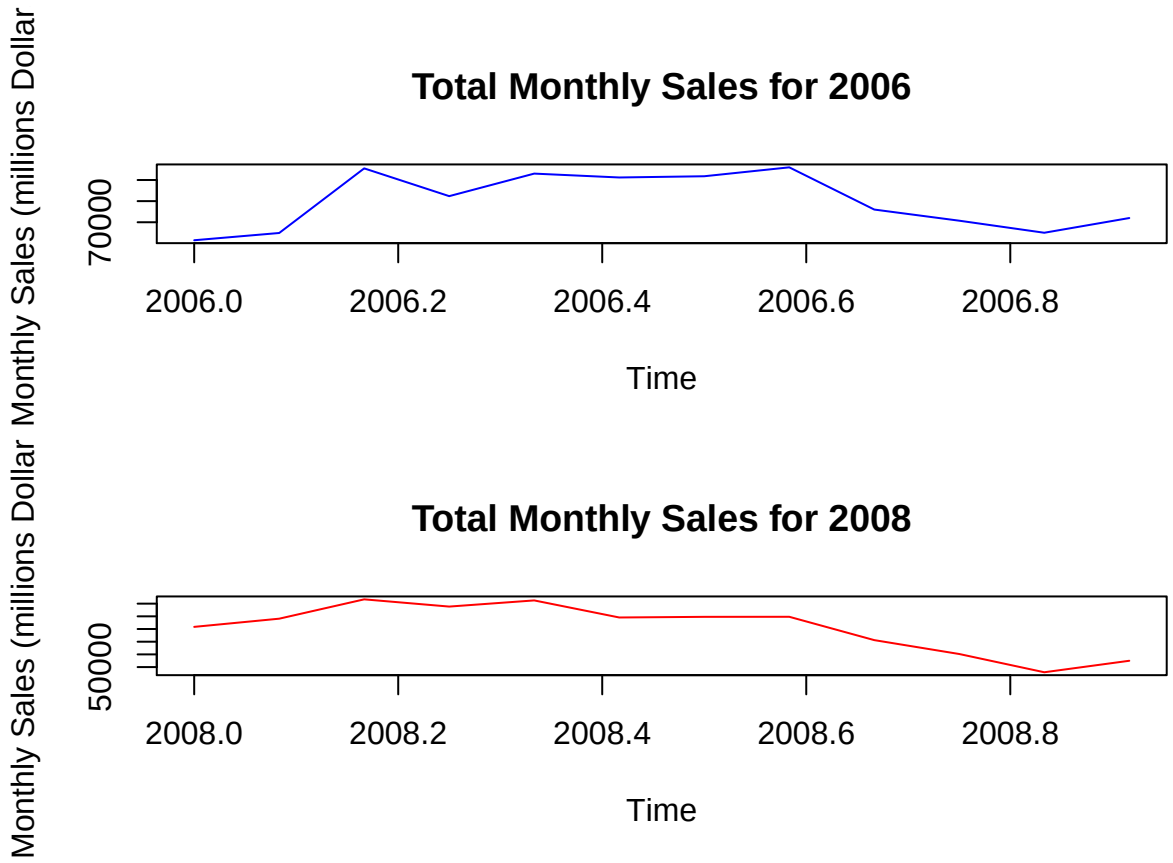
```r
plot(sales.1992to2007, ylab = "Monthly Sales (millions Dollars)", main = "Total Monthly Sales for 1992-
```




```
plot(sales.2009to2013, ylab = "Monthly Sales (millions Dollars)", main = "Total Monthly Sales for 2009-

layout(1:2)
```




```
plot(sales.2006, ylab = "Monthly Sales (millions Dollars)", main = "Total Monthly Sales for 2006", col =
plot(sales.2008, ylab = "Monthly Sales (millions Dollars)", main = "Total Monthly Sales for 2008", col =
```

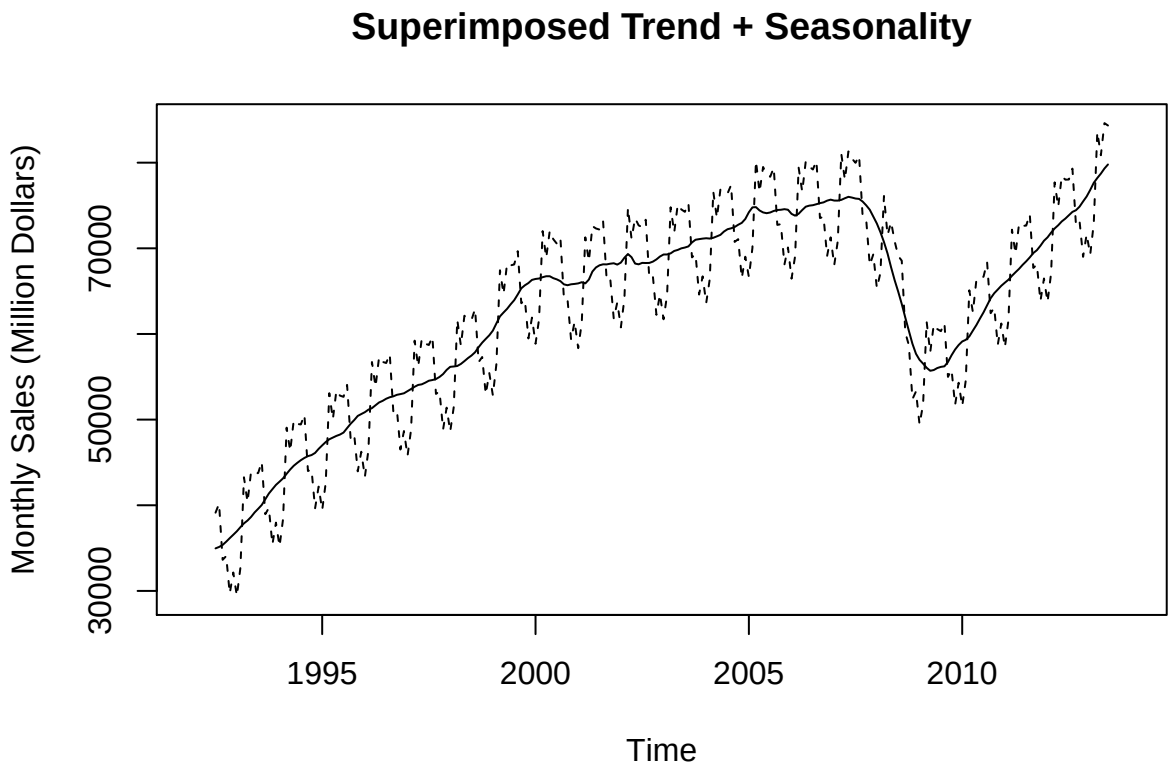


Decomposition

```
# plot(decompose(sales.month.ts))
# plot(decompose(sales.month.ts, type = "add"))
# plot(decompose(sales.month.ts, type = "mult"))
layout(1:1)
sales.month.ts.decomposed <- decompose(sales.month.ts, type = "add")
Trend <- sales.month.ts.decomposed$trend
Seasonal <- sales.month.ts.decomposed$seasonal
Noise <- sales.month.ts.decomposed$random
str(sales.month.ts.decomposed)
```

```
## List of 6
##  $ x       : Time-Series [1:264] from 1992 to 2014: 29811 31217 35136 36082 36460 38389 37814 35436 3
##  $ seasonal: Time-Series [1:264] from 1992 to 2014: -7562 -4742 5385 2141 5303 ...
##  $ trend   : Time-Series [1:264] from 1992 to 2014: NA NA NA NA NA ...
##  $ random  : Time-Series [1:264] from 1992 to 2014: NA NA NA NA NA ...
##  $ figure  : num [1:12] -7562 -4742 5385 2141 5303 ...
##  $ type    : chr "additive"
##  - attr(*, "class")= chr "decomposed.ts"
```

```
ts.plot(cbind(Trend, Trend + Seasonal), lty = 1:2, main = "Superimposed Trend + Seasonality", ylab = "M
```



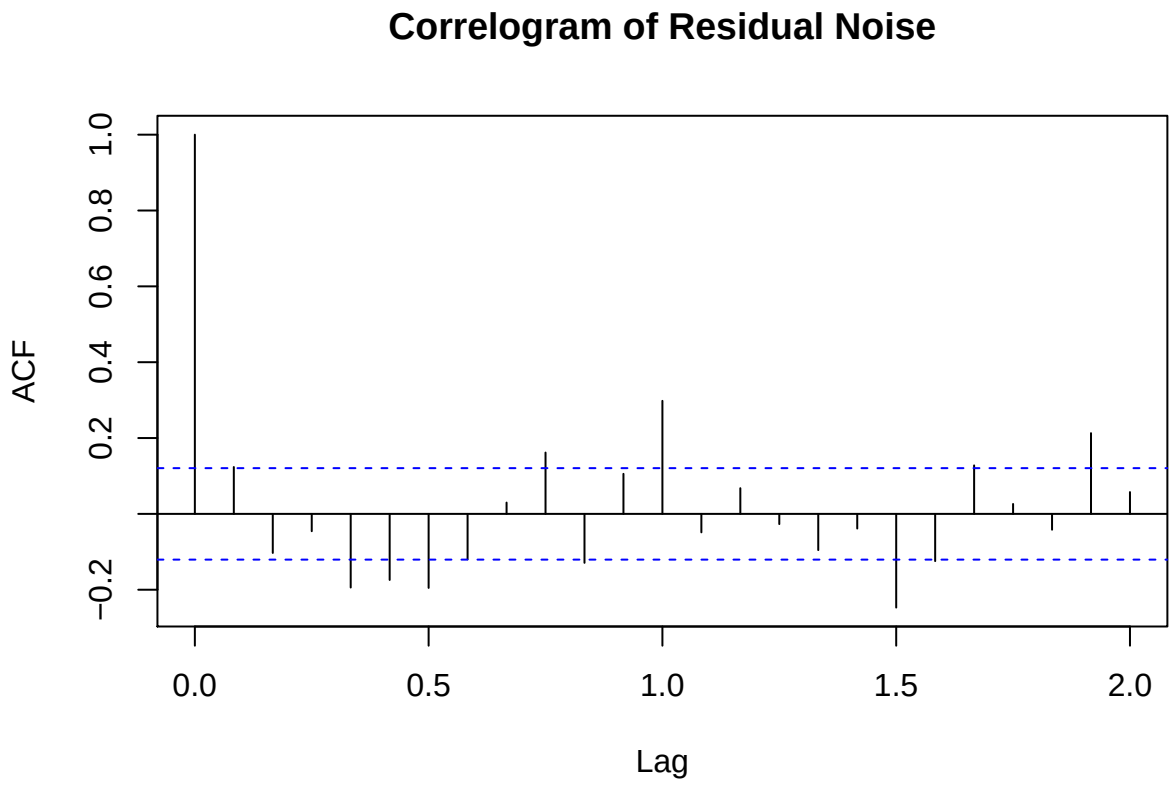
Trend

Seasonality

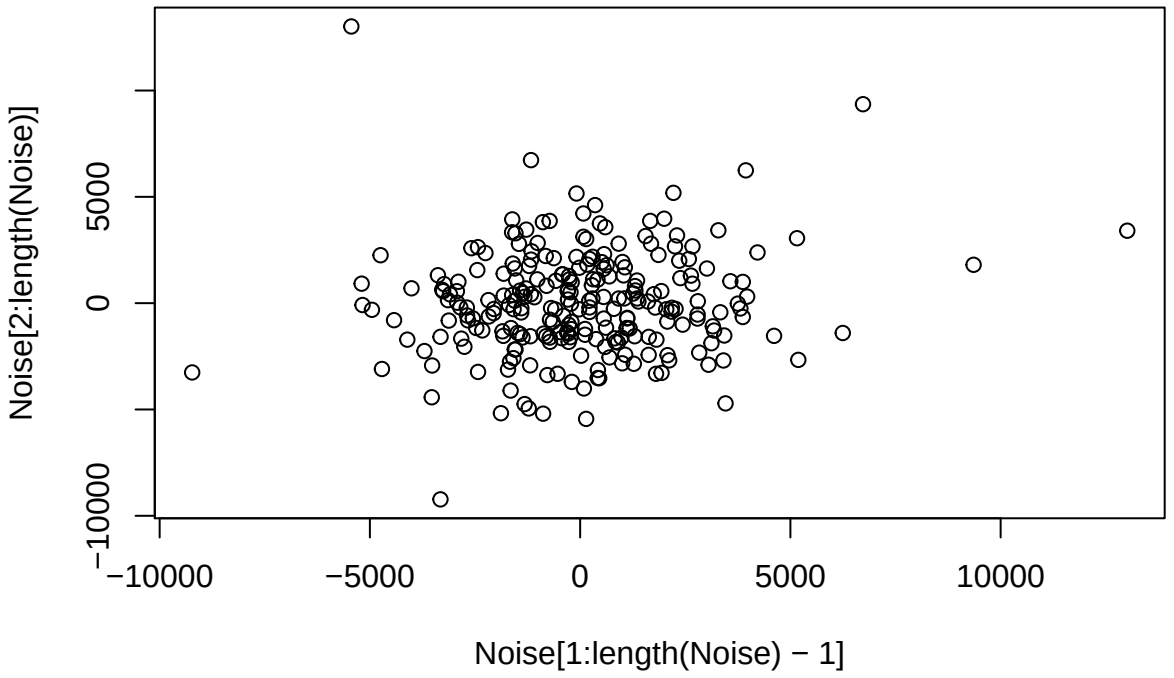
Residual Noise

Examine the residual noise for non-stationarity in variance and for autocorrelation.

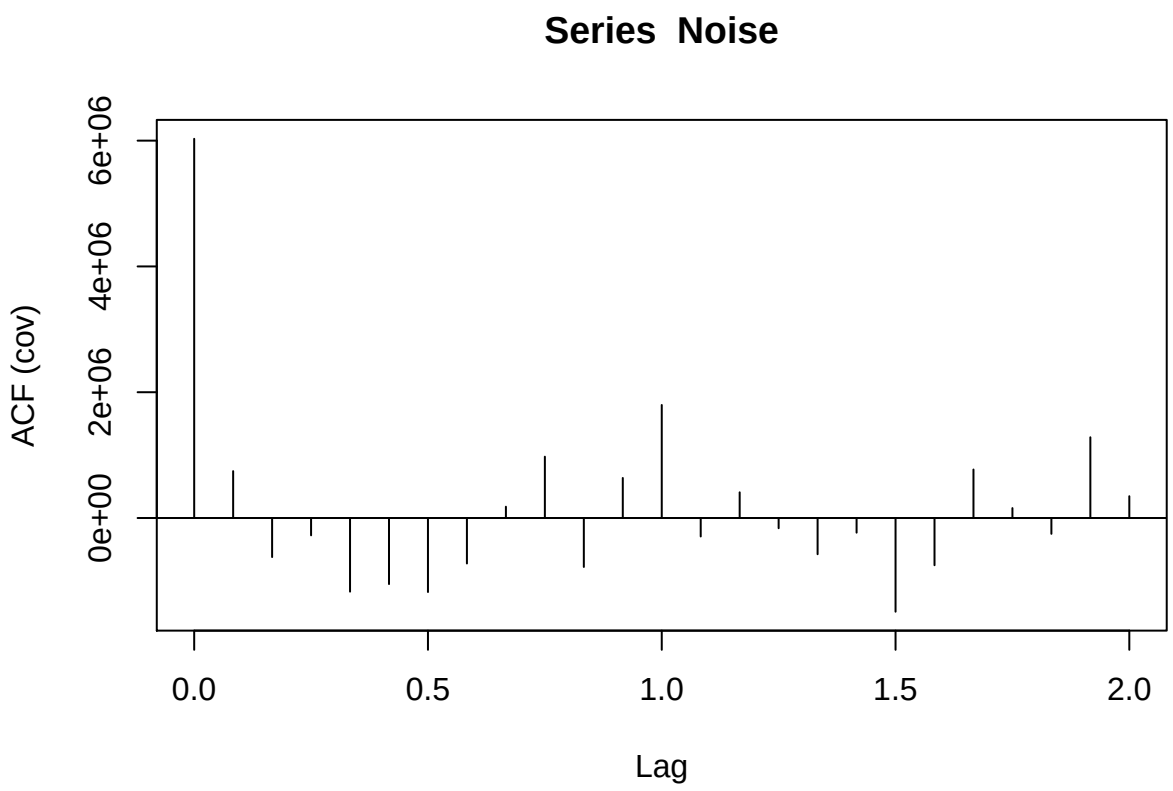
```
# ?acf

# correlogram
acf(Noise, na.action = na.pass, main = "Correlogram of Residual Noise")
```




```
# acf(Noise, na.action = na.pass)$acf[1:10]

# scatterplot of each autocorrelation for lag 1
# length(Noise)
plot(Noise[1:length(Noise)-1], Noise[2:length(Noise)])
```



```r
# get autocovariances
acf(Noise,type = c("covariance"), na.action = na.pass)$acf[2]
```




```
## [1] 745150.7
```

In summary,

- The greatest source of variation in daily temperatures in Corvallis is the annual pattern, warm temperatures in the summer, cool in the winter.
- There doesn't appear to be a systematic trend in the temperatures, although 2008 & 2009 appeared to be cooler than average
- The serial correlation of daily temperatures (beyond the seasonal norms and trend) is high but falls rapidly and is negligible on a time scale of two weeks.
- The variation in temperature is higher during the winter but shows no long term changes.