NYPD Data

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Importing the Data

We read the data directly from the below URL, ad display the frist rows to get an idea of the schema.

```
library(tidyverse)
```

```
## ── Attaching core tidyverse packages ──────────────────────── tidyverse 2.0.0 ──
## ✔ dplyr     1.1.2     ✔ readr     2.1.4
## ✔ forcats   1.0.0     ✔ stringr   1.5.0
## ✔ ggplot2   3.4.2     ✔ tibble    3.2.1
## ✔ lubridate 1.9.2     ✔ tidyr     1.3.0
## ✔ purrr     1.0.1
## ── Conflicts ──────────────────────────────────────────── tidyverse_conflicts() ──
## ✖ dplyr::filter() masks stats::filter()
## ✖ dplyr::lag()    masks stats::lag()
## ℹ Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becom
e errors
```

```
url_i<-"https://data.cityofnewyork.us/api/views/833y-fsy8/rows.csv?accessType=DOWNLOAD"

d<-read.csv(url_i)
head(d)
```

	INCIDENT_... <int>	OCCUR_... <chr>	OCCUR_... <chr>	BORO <chr>	LOC_OF_OCCUR_... <chr>	PRECI... <int>	JURISDICTION_
1	228798151	05/27/2021	21:30:00	QUEENS		105	
2	137471050	06/27/2014	17:40:00	BRONX		40	
3	147998800	11/21/2015	03:56:00	QUEENS		108	
4	146837977	10/09/2015	18:30:00	BRONX		44	
5	58921844	02/19/2009	22:58:00	BRONX		47	
6	219559682	10/21/2020	21:36:00	BROOKLYN		81	

6 rows | 1-8 of 22 columns

```
length(d$INCIDENT_KEY)
```

```
## [1] 27312
```

Next we check the class type of each column,

```
sapply(d,typeof)
```

```
##            INCIDENT_KEY              OCCUR_DATE              OCCUR_TIME 
##               "integer"             "character"             "character" 
##                    BORO       LOC_OF_OCCUR_DESC                PRECINCT 
##             "character"             "character"               "integer" 
##       JURISDICTION_CODE      LOC_CLASSFCTN_DESC           LOCATION_DESC 
##               "integer"             "character"             "character" 
## STATISTICAL_MURDER_FLAG          PERP_AGE_GROUP                PERP_SEX 
##             "character"             "character"             "character" 
##               PERP_RACE           VIC_AGE_GROUP                 VIC_SEX 
##             "character"             "character"             "character" 
##                VIC_RACE              X_COORD_CD              Y_COORD_CD 
##             "character"                "double"                "double" 
##                Latitude               Longitude                 Lon_Lat 
##                "double"                "double"             "character"
```

We have to convert the dates from string to a date object

```
d['OCCUR_DATE2'] <- as.Date(d$OCCUR_DATE,"%m/%d/%Y")
head(d$OCCUR_DATE2)
```

```
## [1] "2021-05-27" "2014-06-27" "2015-11-21" "2015-10-09" "2009-02-19"
## [6] "2020-10-21"
```

We see that most of our variables are categorical, so it is better to expore by using frequenicies. We can ignore the coordinates as we won't conduct a geostatistical analysis.

```
pct_na<-sapply(d,function(x){sum(is.na(x))/length(x)*100})
names <-names(d)

df<-data.frame(names,pct_na)
df
```

	names <chr>	pct_na <dbl>
INCIDENT_KEY	INCIDENT_KEY	0.000000000
OCCUR_DATE	OCCUR_DATE	0.000000000
OCCUR_TIME	OCCUR_TIME	0.000000000
BORO	BORO	0.000000000
LOC_OF_OCCUR_DESC	LOC_OF_OCCUR_DESC	0.000000000

	names <chr>	pct_na <dbl>
PRECINCT	PRECINCT	0.000000000
JURISDICTION_CODE	JURISDICTION_CODE	0.007322789
LOC_CLASSFCTN_DESC	LOC_CLASSFCTN_DESC	0.000000000
LOCATION_DESC	LOCATION_DESC	0.000000000
STATISTICAL_MURDER_FLAG	STATISTICAL_MURDER_FLAG	0.000000000

1-10 of 22 rows Previous **1** 2 3 Next

For the Categorical let’s make a few frequencies

```
##  [1] "OCCUR_DATE"              "OCCUR_TIME"
##  [3] "BORO"                    "LOC_OF_OCCUR_DESC"
##  [5] "LOC_CLASSFCTN_DESC"      "LOCATION_DESC"
##  [7] "STATISTICAL_MURDER_FLAG" "PERP_AGE_GROUP"
##  [9] "PERP_SEX"                "PERP_RACE"
## [11] "VIC_AGE_GROUP"           "VIC_SEX"
## [13] "VIC_RACE"                "Lon_Lat"
```

```
## Warning: `as.tibble()` was deprecated in tibble 2.0.0.
## ℹ Please use `as_tibble()` instead.
## ℹ The signature and semantics have changed, see `?as_tibble`.
## This warning is displayed once every 8 hours.
## Call `lifecycle::last_lifecycle_warnings()` to see where this warning was
## generated.
```

```
## # A tibble: 5 × 2
##   x                 n
##   <chr>         <dbl>
## 1 BRONX         0.291
## 2 BROOKLYN      0.400
## 3 MANHATTAN     0.131
## 4 QUEENS        0.150
## 5 STATEN ISLAND 0.0284
## # A tibble: 3 × 2
##   x               n
##   <chr>       <dbl>
## 1 ""        0.937
## 2 "INSIDE"  0.00886
## 3 "OUTSIDE" 0.0540
## # A tibble: 10 × 2
##    x                   n
##    <chr>           <dbl>
##  1 ""            0.937
##  2 "COMMERCIAL"  0.00366
##  3 "DWELLING"    0.00465
##  4 "HOUSING"     0.0103
##  5 "OTHER"       0.00114
##  6 "PARKING LOT" 0.000256
##  7 "PLAYGROUND"  0.00110
##  8 "STREET"      0.0404
##  9 "TRANSIT"     0.000549
## 10 "VEHICLE"     0.000842
## # A tibble: 41 × 2
##    x                          n
##    <chr>                  <dbl>
##  1 ""                  0.548
##  2 "(null)"            0.0358
##  3 "ATM"               0.0000366
##  4 "BANK"              0.000110
##  5 "BAR/NIGHT CLUB"    0.0230
##  6 "BEAUTY/NAIL SALON" 0.00410
##  7 "CANDY STORE"       0.000256
##  8 "CHAIN STORE"       0.000183
##  9 "CHECK CASH"        0.0000366
## 10 "CLOTHING BOUTIQUE" 0.000513
## # ℹ 31 more rows
## # A tibble: 2 × 2
##   x         n
##   <chr> <dbl>
## 1 false 0.807
## 2 true  0.193
## # A tibble: 11 × 2
##    x                n
##    <chr>        <dbl>
##  1 ""         0.342
##  2 "(null)"  0.0234
##  3 "<18"     0.0583
```

```
##  4 "1020"    0.0000366
##  5 "18-24"   0.228
##  6 "224"     0.0000366
##  7 "25-44"   0.208
##  8 "45-64"   0.0226
##  9 "65+"     0.00220
## 10 "940"     0.0000366
## 11 "UNKNOWN" 0.115
## # A tibble: 5 × 2
##   x             n
##   <chr>     <dbl>
## 1 ""       0.341
## 2 "(null)" 0.0234
## 3 "F"      0.0155
## 4 "M"      0.565
## 5 "U"      0.0549
## # A tibble: 9 × 2
##   x                                        n
##   <chr>                                <dbl>
## 1 ""                                0.341
## 2 "(null)"                          0.0234
## 3 "AMERICAN INDIAN/ALASKAN NATIVE" 0.0000732
## 4 "ASIAN / PACIFIC ISLANDER"       0.00564
## 5 "BLACK"                          0.419
## 6 "BLACK HISPANIC"                 0.0481
## 7 "UNKNOWN"                        0.0672
## 8 "WHITE"                          0.0104
## 9 "WHITE HISPANIC"                 0.0857
## # A tibble: 7 × 2
##   x               n
##   <chr>       <dbl>
## 1 <18     0.104
## 2 1022    0.0000366
## 3 18-24   0.369
## 4 25-44   0.450
## 5 45-64   0.0682
## 6 65+     0.00663
## 7 UNKNOWN 0.00223
## # A tibble: 3 × 2
##   x            n
##   <chr>    <dbl>
## 1 F     0.0957
## 2 M     0.904
## 3 U     0.000403
## # A tibble: 7 × 2
##   x                                       n
##   <chr>                               <dbl>
## 1 AMERICAN INDIAN/ALASKAN NATIVE 0.000366
## 2 ASIAN / PACIFIC ISLANDER       0.0148
## 3 BLACK                          0.712
## 4 BLACK HISPANIC                 0.0969
## 5 UNKNOWN                        0.00242
```

```
## 6 WHITE                          0.0256
## 7 WHITE HISPANIC                 0.148
```

```
##   BORO        LOC_OF_OCCUR_DESC LOC_CLASSFCTN_DESC LOCATION_DESC
## x character,5 character,3       character,10       character,41
## n numeric,5   numeric,3         numeric,10         numeric,41
##   STATISTICAL_MURDER_FLAG PERP_AGE_GROUP PERP_SEX    PERP_RACE   VIC_AGE_GROUP
## x character,2             character,11   character,5 character,9 character,7
## n numeric,2               numeric,11     numeric,5   numeric,9   numeric,7
##   VIC_SEX     VIC_RACE
## x character,3 character,7
## n numeric,3   numeric,7
```

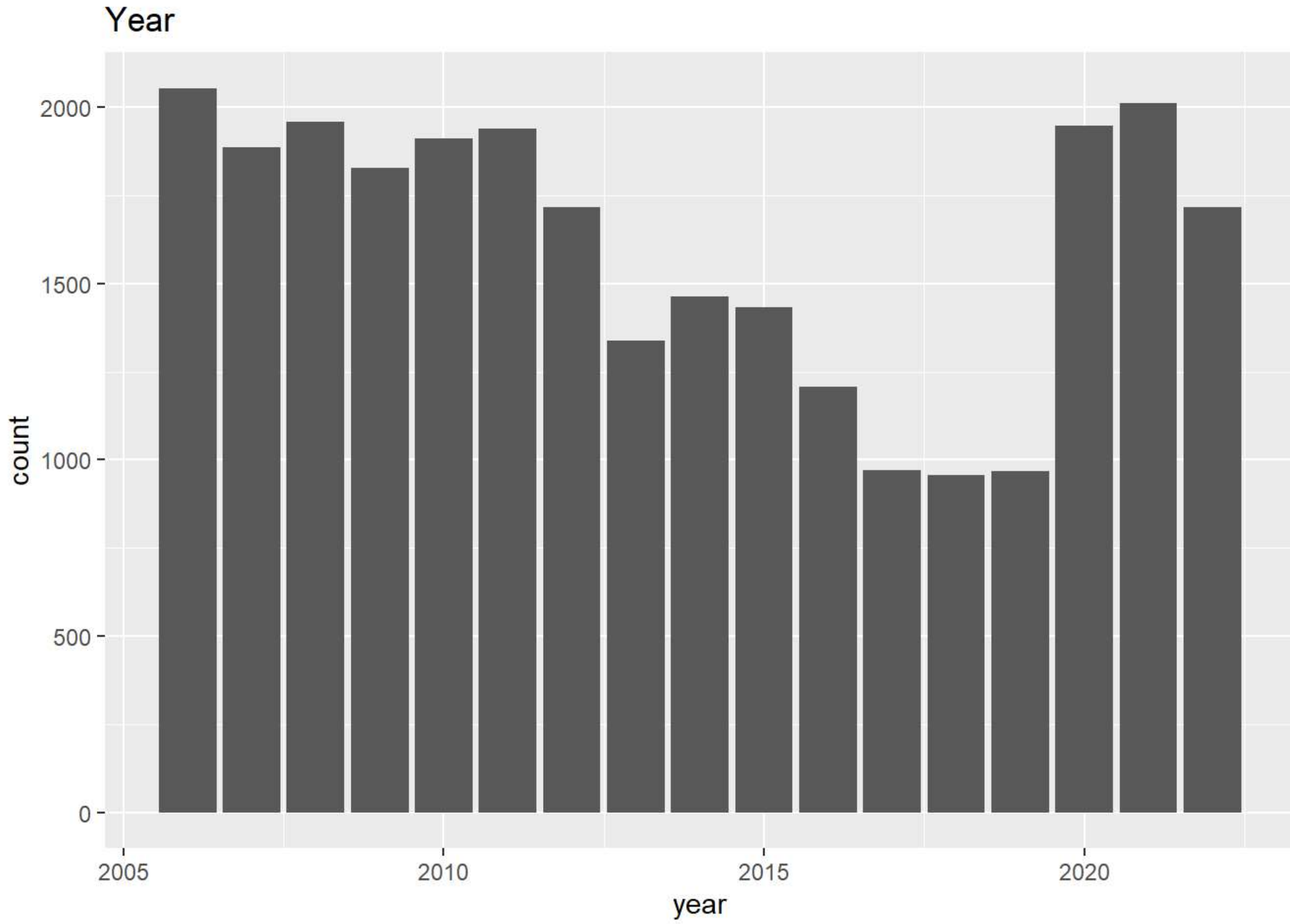
1.- We see that LOC_OF_OCCUR_DESC, LOC_CLASSFCTN_DESC have 93% missing so we can't use those columns. 2.- Sex of the perpetrator is empty for 36%, but it is safe to impute M 3.- Sex of the victim has no missing values and 90% is male.

So we see an obvious pattern, that males are way overrepresented as victims ad pepetrators in this type of violent crime. Which matches our intuition

Graphical Presentation of frequencies

Lets se the Frequencies Graphically

```
library(ggplot2)
ggplot(data=data)+geom_bar(aes(x=BORO))+ggtitle("Borough")
ggplot(data=data)+geom_bar(aes(x=PERP_AGE_GROUP))+ggtitle("Perpetrator Age Group")

ggplot(data=data)+geom_bar(aes(x=PERP_RACE))+ggtitle("Perpetrator Race")+coord_flip()

ggplot(data=data)+geom_bar(aes(x=VIC_RACE))+ggtitle("Victim Race")+coord_flip()
```

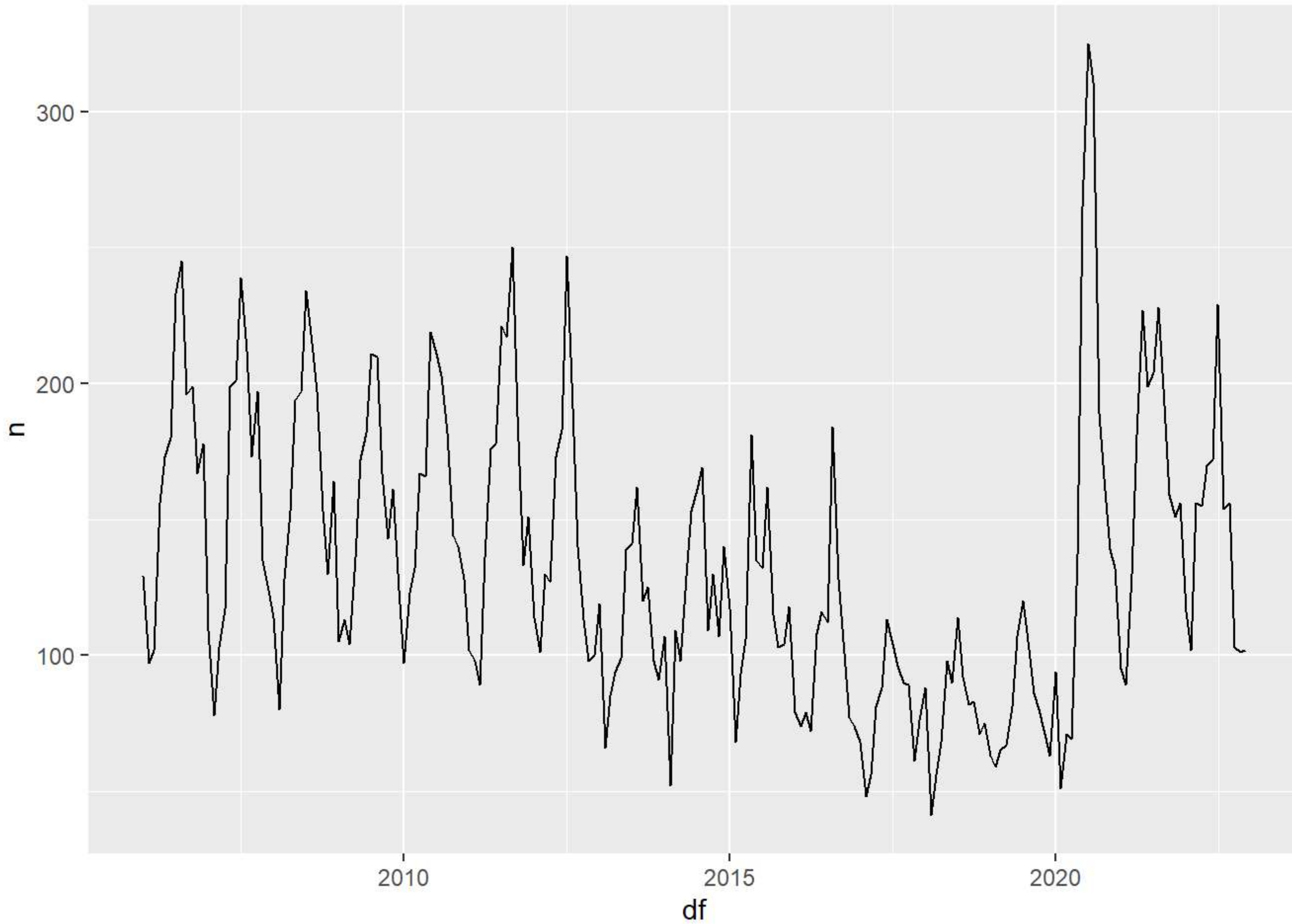


Seasonality

Lets group the events by month and see if there are any patterns

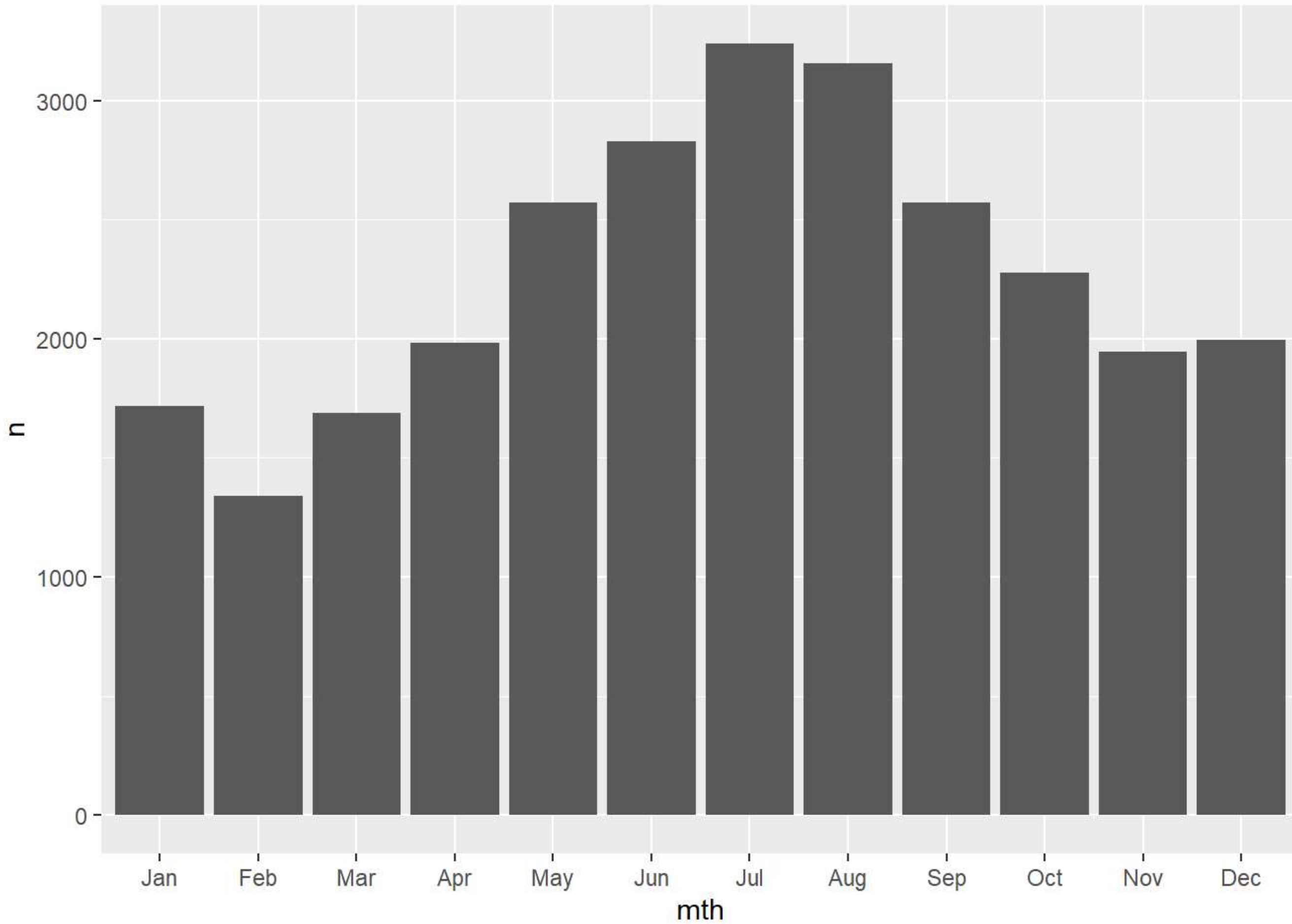
df <date>	n <int>
2006-01-01	129
2006-02-01	97
2006-03-01	102
2006-04-01	156
2006-05-01	173
2006-06-01	180

6 rows



mth <ord>	n <int>
Jan	1716
Feb	1340
Mar	1688
Apr	1983
May	2571
Jun	2829

6 rows



And we see a spike in Summer.

We see a clear Seasonality Patter.

Test Seasonality

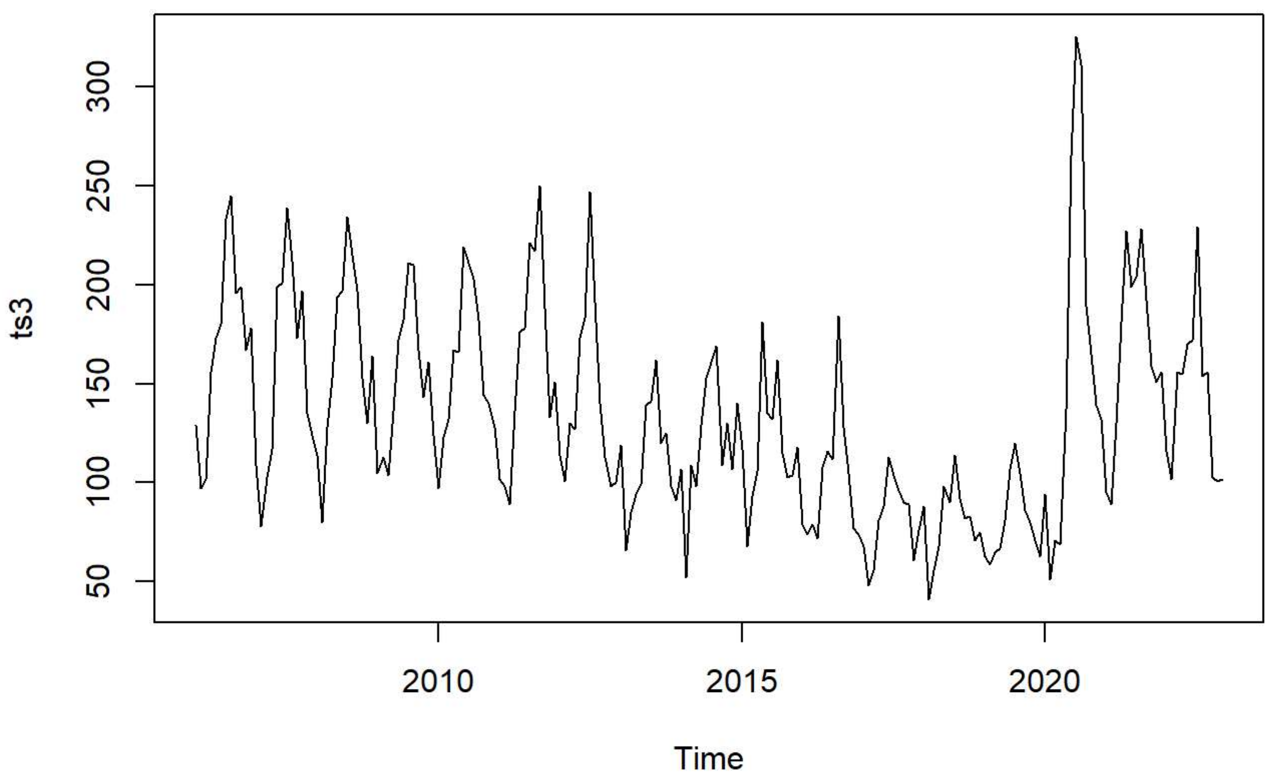
We will try to figure out the seasonality

```
ts2<- d %>%
  group_by(df ) %>%
  summarise( n = n())
head(ts2)
```

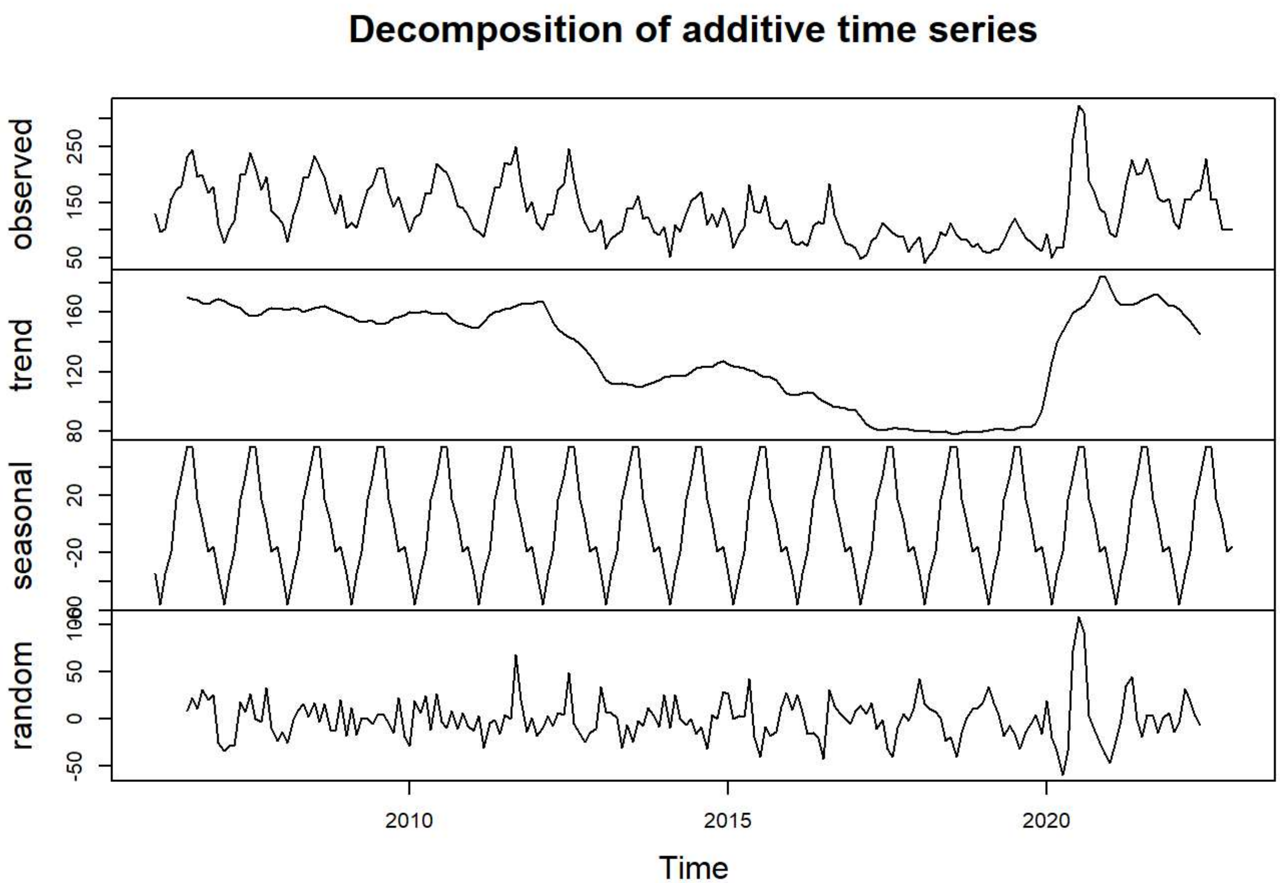
df <date>	n <int>
2006-01-01	129
2006-02-01	97
2006-03-01	102
2006-04-01	156
2006-05-01	173
2006-06-01	180

6 rows

```
ts3<-ts(ts2$n,frequency = 12,start=c(2006,1))
plot(ts3)
```




```
ts_components <- decompose(ts3)
plot(ts_components)
```




```
summary(ts_components)
```

```
##          Length Class  Mode
## x        204    ts     numeric
## seasonal 204    ts     numeric
## trend    204    ts     numeric
## random   204    ts     numeric
## figure    12    -none- numeric
## type       1    -none- character
```

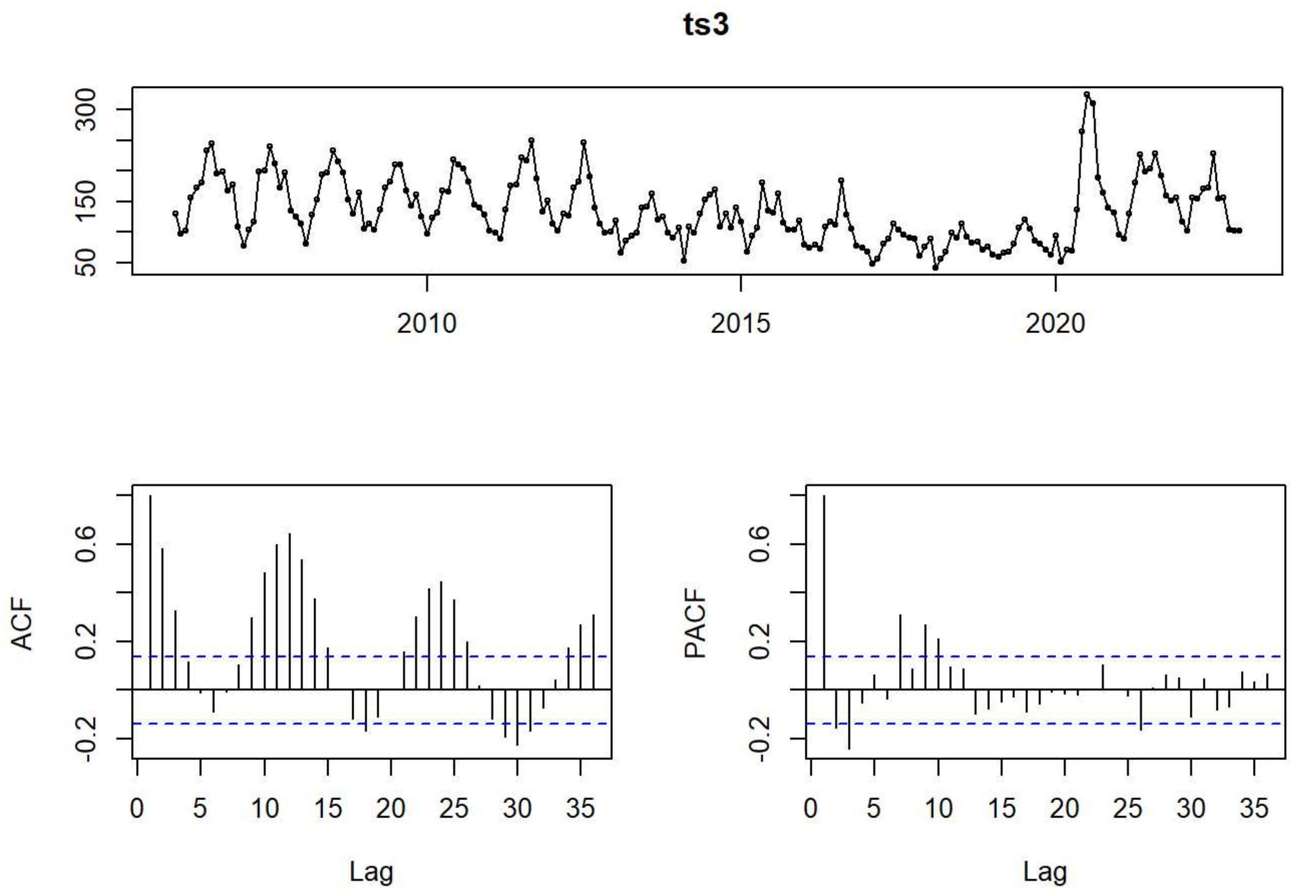
Notice in trend the the downward slope and the structural breakdown due to COVID which caused asharp increase and brought us back to pre 2010 levels. We see a strong seasonality component

Below, we fit an arima model and we can see that the seasonal components

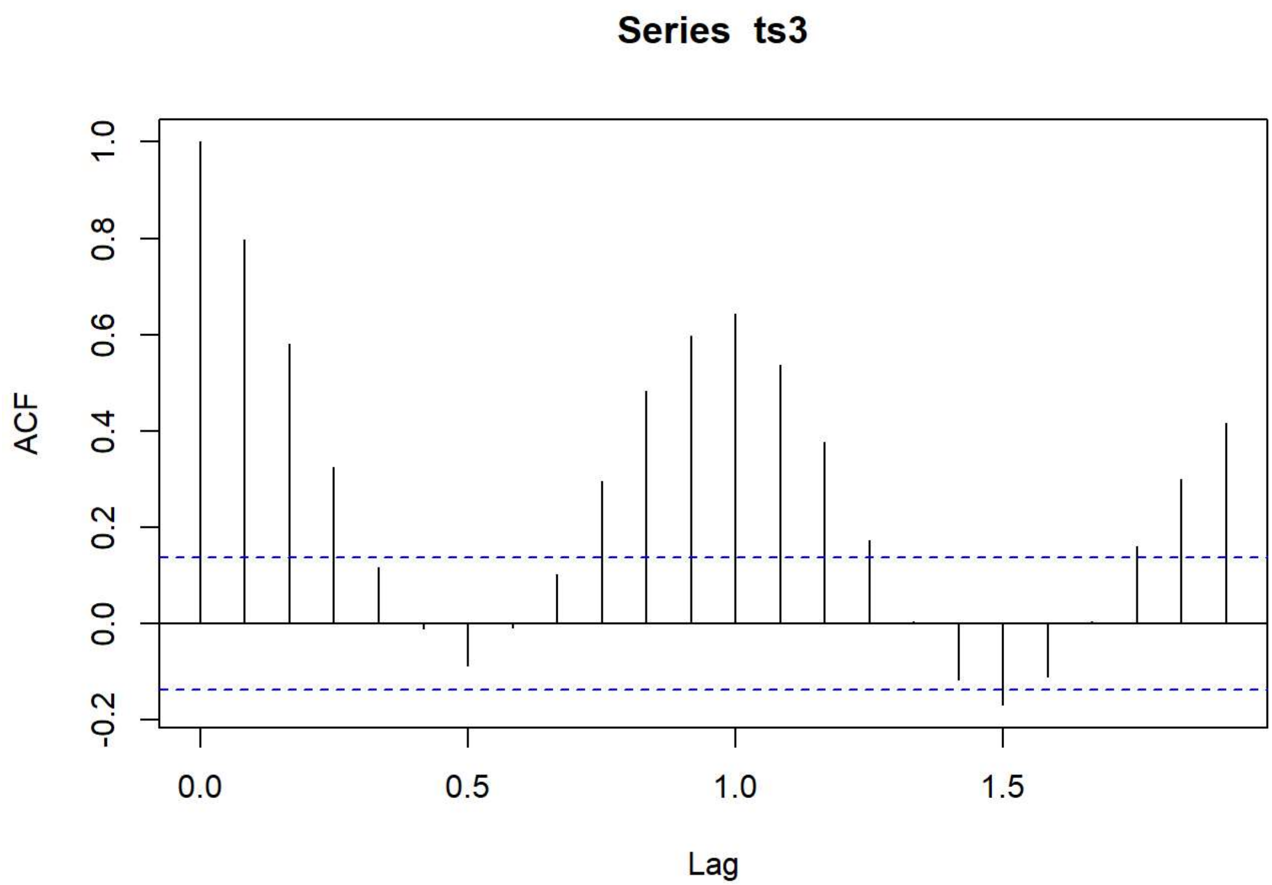
```
###

library(forecast)
```

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

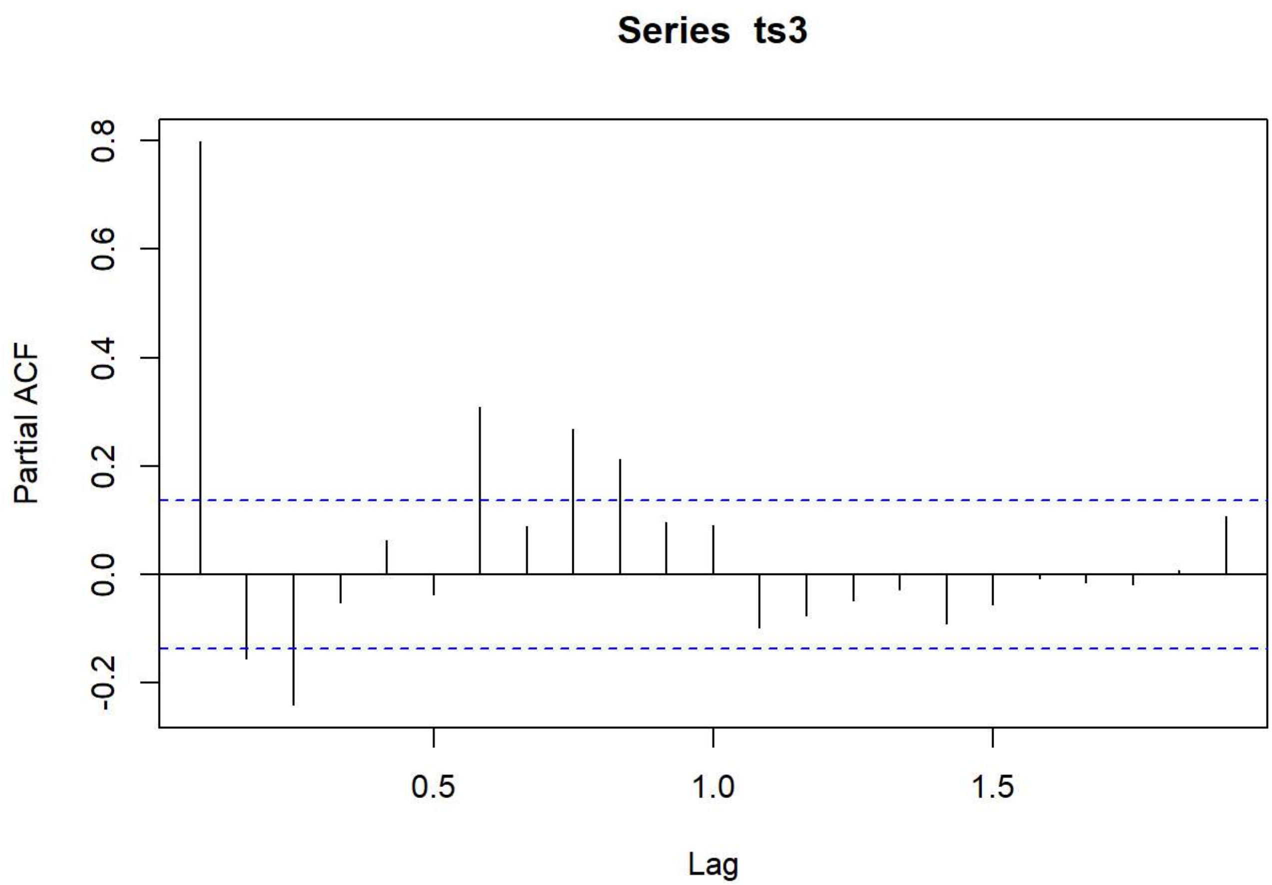
```
tsdisplay(ts3)
```



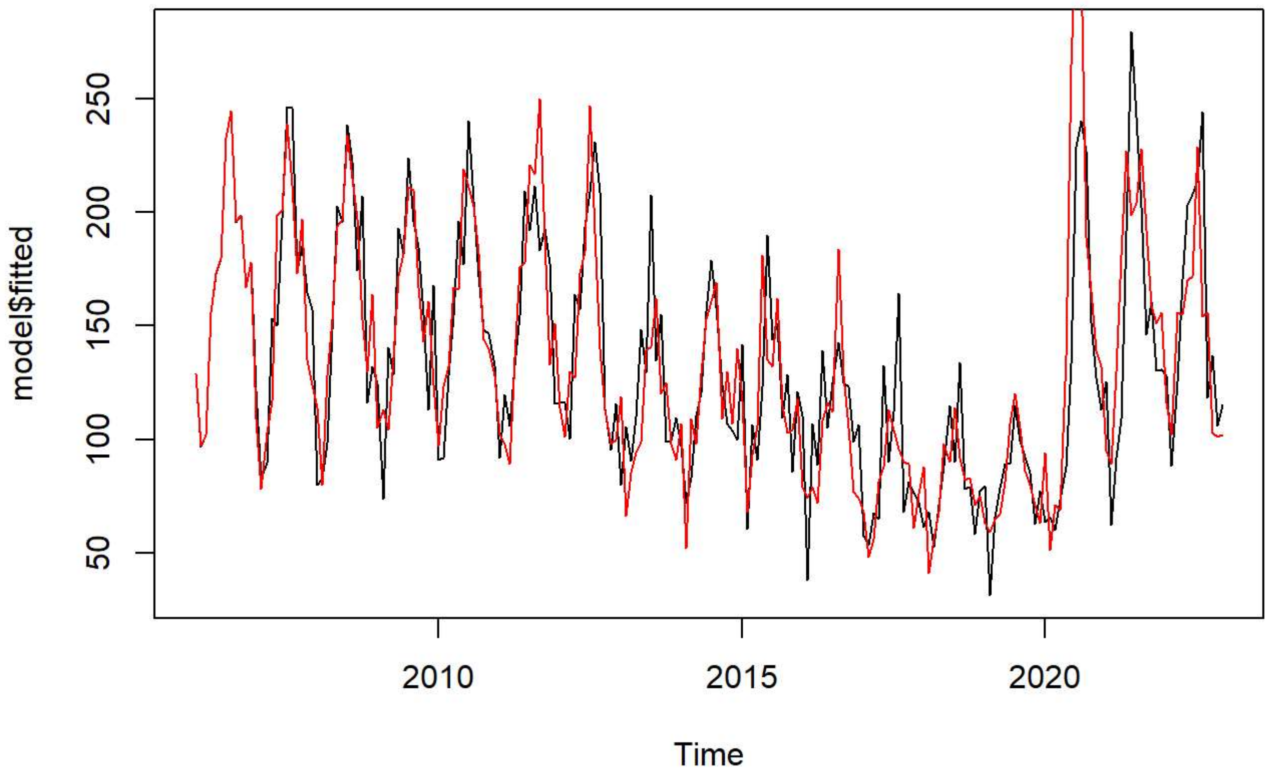

```
plot(acf(ts3))
```



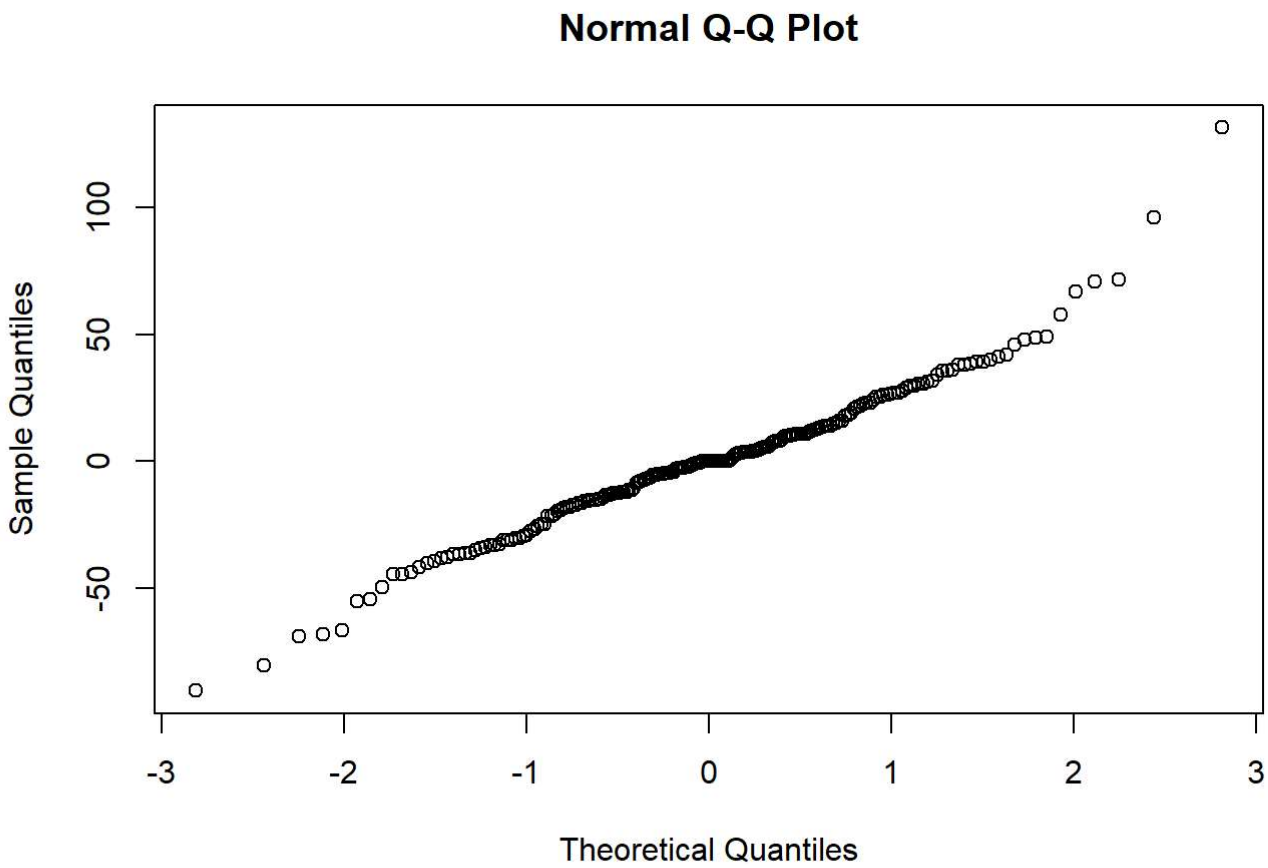

```
plot(pacf(ts3))
```




```
model<-auto.arima(ts3,seasonal = TRUE)
plot(model$fitted)
lines(ts3, col='red')
```




```
qqnorm(model$residuals)
```




```
summary(model)
```

```
## Series: ts3
## ARIMA(1,0,0)(1,1,0)[12] with drift
##
## Coefficients:
##          ar1      sar1    drift
##       0.6803   -0.3835  -0.1351
## s.e.  0.0532    0.0689   0.4114
##
## sigma^2 = 917.1:  log likelihood = -927.02
## AIC=1862.04   AICc=1862.25   BIC=1875.07
##
## Training set error measures:
##                        ME     RMSE     MAE       MPE     MAPE     MASE
## Training set -0.02437165 29.14876 21.3069 -2.240472 16.99186 0.767672
##                      ACF1
## Training set -0.08032225
```