# 빅데이터론 HW#5 16012993 이준희

```
library("TTR")
```

```
## Warning: package 'TTR' was built under R version 3.6.3
```

```
library("forecast")
```

```
## Warning: package 'forecast' was built under R version 3.6.3
```

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

```
library("tseries")
```

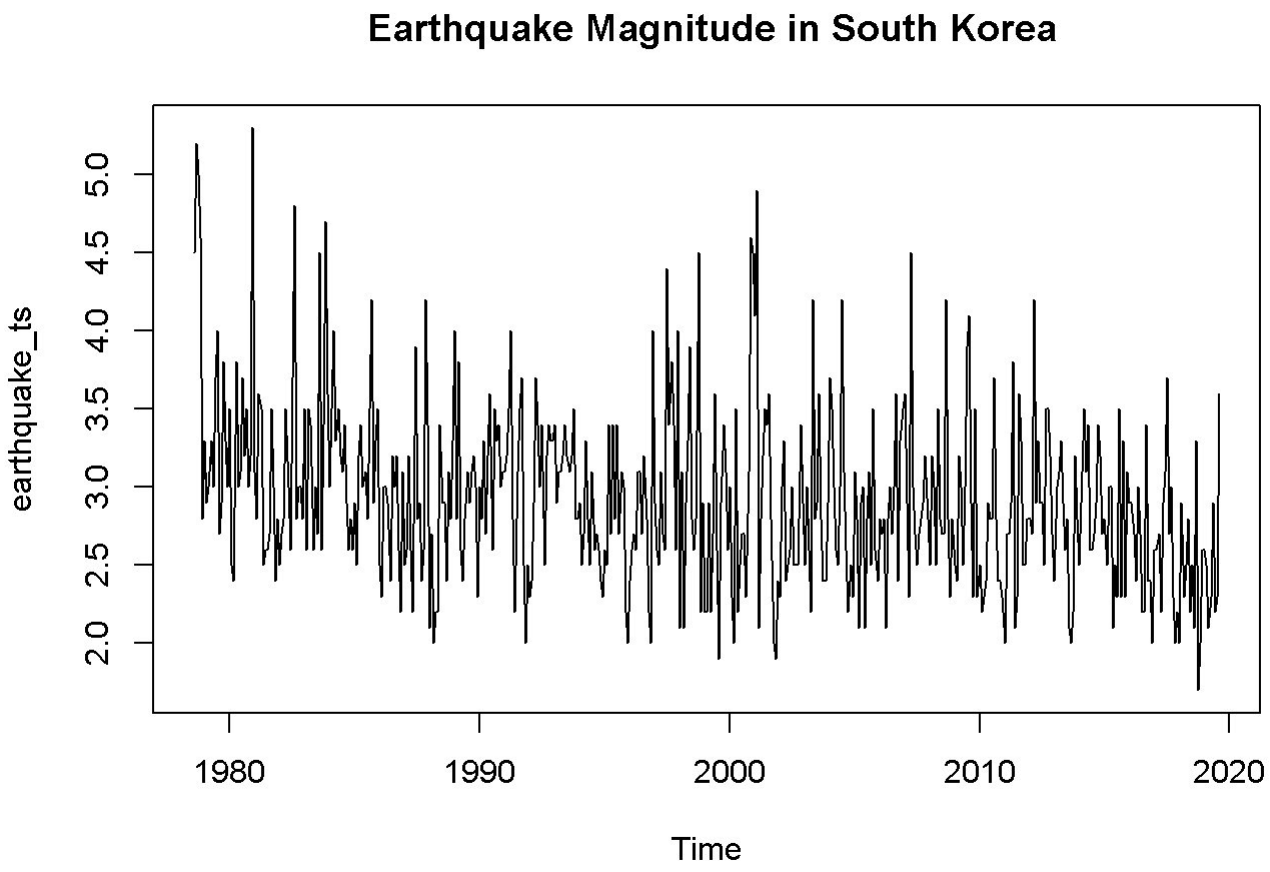
```
## Warning: package 'tseries' was built under R version 3.6.3
```

```
earthquake <- read.csv("korea earthquake.csv",encoding ="UTF-8")
#earthquake
```

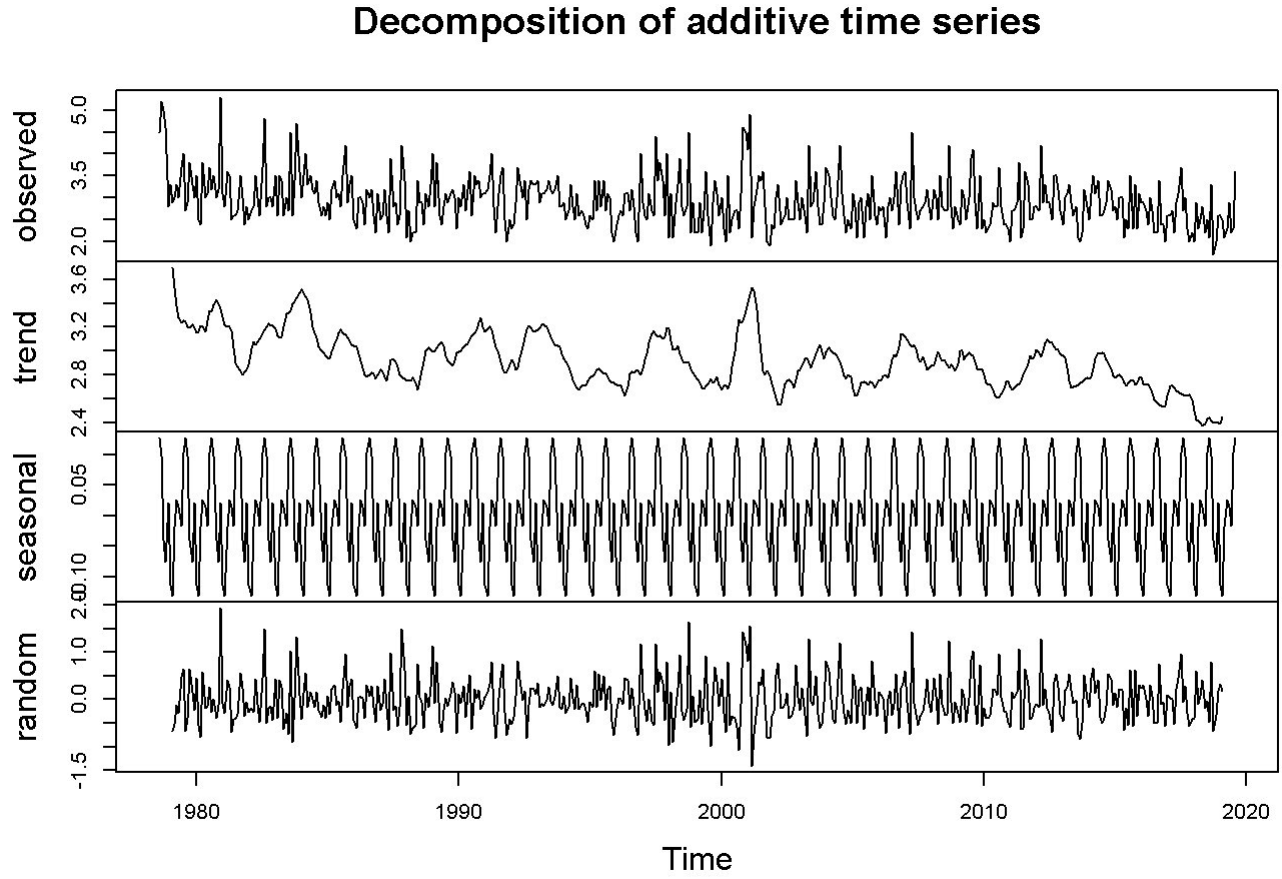
```
earthquake_ts <- ts(earthquake$Magnitude,start=c(1978,8),end=c(2019,8),freq=12)
earthquake_ts
```

```
##      Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
## 1978                             4.5 5.2 5.0 4.6 2.8
## 1979 3.3 2.9 3.0 3.3 3.0 3.7 4.0 2.7 2.9 3.8 3.3 3.0
## 1980 3.5 2.5 2.4 3.8 3.0 3.1 3.7 3.2 3.5 3.0 3.2 5.3
## 1981 3.1 2.8 3.6 3.5 2.5 2.6 2.6 2.7 3.5 3.0 2.4 2.8
## 1982 2.5 2.7 2.8 3.5 3.0 2.6 3.7 4.8 2.8 3.0 3.0 2.8
## 1983 3.5 2.6 3.5 3.4 2.6 3.0 2.7 4.5 2.6 3.4 4.7 3.6
## 1984 3.0 3.5 4.0 3.3 3.5 3.2 3.1 3.4 2.9 2.6 2.8 2.6
## 1985 2.9 2.5 3.2 3.4 3.0 3.1 2.8 3.5 4.2 2.9 3.3 3.5
## 1986 2.5 2.3 3.0 3.0 2.9 2.4 3.2 3.0 3.2 2.6 2.2 3.1
## 1987 2.5 2.6 3.2 2.6 2.2 3.9 2.8 2.9 2.4 2.6 4.2 3.4
## 1988 2.1 2.7 2.0 2.2 2.2 3.4 2.9 2.9 2.4 3.1 2.8 3.3
## 1989 4.0 2.8 3.8 2.6 2.4 2.8 3.1 2.9 3.1 3.2 3.0 2.3
## 1990 3.0 2.8 3.3 2.7 3.2 3.6 2.6 3.5 3.3 3.4 3.0 3.1
## 1991 3.1 3.2 3.5 4.0 2.8 2.2 3.1 3.5 3.7 2.5 2.0 2.5
## 1992 2.3 2.4 2.9 3.7 3.4 3.0 3.4 2.5 3.2 3.4 3.3 3.3
## 1993 3.4 2.9 3.1 3.1 3.2 3.4 3.2 3.1 3.2 3.5 2.8 2.8
## 1994 2.9 2.5 2.7 3.3 2.8 2.5 3.1 2.6 2.7 2.6 2.4 2.3
## 1995 2.6 2.5 3.4 2.7 3.4 2.8 3.4 2.7 3.1 3.0 2.2 2.0
## 1996 2.4 2.6 2.7 2.6 3.1 3.1 2.7 3.2 2.8 2.2 2.0 4.0
## 1997 2.9 2.6 2.5 3.1 2.7 2.6 4.4 3.4 3.8 3.4 2.6 4.0
## 1998 2.1 3.1 2.1 2.9 3.3 3.9 2.8 2.6 2.8 4.5 2.2 2.9
## 1999 2.2 2.2 2.9 2.2 2.7 3.6 2.6 1.9 2.9 3.4 3.1 2.6
## 2000 3.0 2.3 2.0 3.5 2.2 2.5 2.7 2.7 2.3 3.1 4.6 4.5
## 2001 4.1 4.9 2.1 2.8 3.2 3.5 3.4 3.6 2.8 2.0 1.9 2.4
## 2002 2.3 3.0 3.3 2.4 2.5 2.6 3.0 2.5 2.5 2.5 3.4 2.9
## 2003 2.5 3.0 2.6 2.2 4.2 2.8 2.9 3.6 2.8 2.4 2.4 2.9
## 2004 3.7 3.5 3.0 2.6 2.5 3.0 4.2 3.1 2.6 2.2 2.5 2.3
## 2005 3.1 2.8 2.1 2.9 3.0 2.1 2.8 3.1 2.5 3.5 2.6 2.4
## 2006 2.8 2.7 2.8 2.1 2.8 3.0 2.7 3.0 3.6 2.4 3.3 3.5
## 2007 3.6 2.9 2.3 4.5 3.0 2.7 2.5 2.7 2.8 2.9 3.2 2.8
## 2008 2.5 3.2 3.0 2.5 3.5 2.8 2.7 2.7 4.2 2.8 2.3 2.8
## 2009 2.5 2.4 3.2 3.0 2.5 3.0 3.9 4.1 2.9 2.3 3.5 2.3
## 2010 2.5 2.2 2.3 2.4 2.9 2.8 2.8 3.7 2.8 2.4 2.4 2.3
## 2011 2.0 2.7 2.7 2.9 3.8 2.1 2.3 3.6 3.3 2.5 2.5 2.8
## 2012 2.8 2.7 4.2 2.9 3.3 2.9 2.9 2.5 3.5 3.5 3.2 2.7
## 2013 2.4 3.0 3.1 3.3 2.9 2.6 2.8 2.1 2.0 2.2 3.2 2.8
## 2014 2.5 3.1 3.5 3.1 3.4 2.6 2.6 2.7 2.9 3.4 3.2 2.7
## 2015 2.8 2.5 3.0 3.0 2.1 2.5 2.3 3.5 2.3 3.3 2.3 3.1
## 2016 2.9 2.9 2.7 2.4 3.0 2.7 2.2 2.2 3.4 2.4 2.4 2.0
## 2017 2.6 2.6 2.7 2.2 2.9 3.1 3.7 2.7 3.0 2.3 2.0 2.2
## 2018 2.0 2.9 2.3 2.5 2.8 2.2 2.5 2.1 3.3 1.7 2.0 2.6
## 2019 2.6 2.5 2.1 2.3 2.9 2.2 2.3 3.6
```

```
plot.ts(earthquake_ts,main= " Earthquake Magnitude in South Korea")
```




```
earthquake_ts_comp <- decompose(earthquake_ts)
plot(earthquake_ts_comp)
```




```
earthquake_ts_comp$trend
```

```
##           Jan      Feb      Mar      Apr      May      Jun      Jul      Aug
## 1978                                                                      NA
## 1979       NA 3.700000 3.529167 3.383333 3.279167 3.233333 3.250000 3.241667
## 1980 3.154167 3.162500 3.208333 3.200000 3.162500 3.254167 3.333333 3.329167
## 1981 3.287500 3.220833 3.200000 3.200000 3.166667 3.029167 2.900000 2.870833
## 1982 2.887500 3.020833 3.079167 3.050000 3.075000 3.100000 3.141667 3.179167
## 1983 3.183333 3.129167 3.108333 3.116667 3.204167 3.308333 3.320833 3.337500
## 1984 3.516667 3.487500 3.454167 3.433333 3.320833 3.200000 3.154167 3.108333
## 1985 2.945833 2.937500 2.995833 3.062500 3.095833 3.154167 3.175000 3.150000
## 1986 3.041667 3.037500 2.975000 2.920833 2.862500 2.800000 2.783333 2.795833
## 1987 2.841667 2.820833 2.783333 2.750000 2.833333 2.929167 2.925000 2.912500
## 1988 2.745833 2.750000 2.750000 2.770833 2.733333 2.670833 2.745833 2.829167
## 1989 2.991667 3.000000 3.029167 3.062500 3.075000 3.041667 2.958333 2.916667
## 1990 2.995833 3.000000 3.033333 3.050000 3.058333 3.091667 3.129167 3.150000
## 1991 3.162500 3.183333 3.200000 3.179167 3.100000 3.033333 2.975000 2.908333
## 1992 2.929167 2.900000 2.837500 2.854167 2.945833 3.033333 3.112500 3.179167
## 1993 3.175000 3.191667 3.216667 3.220833 3.204167 3.162500 3.120833 3.083333
## 1994 2.937500 2.912500 2.870833 2.812500 2.758333 2.720833 2.687500 2.675000
## 1995 2.770833 2.787500 2.808333 2.841667 2.850000 2.829167 2.808333 2.804167
## 1996 2.712500 2.704167 2.712500 2.666667 2.625000 2.700000 2.804167 2.825000
## 1997 2.845833 2.925000 2.975000 3.066667 3.141667 3.166667 3.133333 3.120833
## 1998 3.183333 3.083333 3.008333 3.012500 3.041667 2.979167 2.937500 2.904167
## 1999 2.791667 2.754167 2.729167 2.687500 2.679167 2.704167 2.725000 2.762500
## 2000 2.670833 2.708333 2.716667 2.679167 2.729167 2.870833 2.995833 3.150000
## 2001 3.404167 3.470833 3.529167 3.504167 3.345833 3.145833 2.983333 2.829167
## 2002 2.666667 2.604167 2.545833 2.554167 2.637500 2.720833 2.750000 2.758333
## 2003 2.837500 2.879167 2.937500 2.945833 2.900000 2.858333 2.908333 2.979167
## 2004 2.995833 3.029167 3.000000 2.983333 2.979167 2.958333 2.908333 2.854167
## 2005 2.683333 2.625000 2.620833 2.670833 2.729167 2.737500 2.729167 2.712500
## 2006 2.754167 2.745833 2.787500 2.787500 2.770833 2.845833 2.925000 2.966667
## 2007 3.116667 3.095833 3.050000 3.037500 3.054167 3.020833 2.945833 2.912500
## 2008 2.875000 2.883333 2.941667 2.995833 2.954167 2.916667 2.916667 2.883333
## 2009 2.891667 3.000000 3.004167 2.929167 2.958333 2.987500 2.966667 2.958333
## 2010 2.795833 2.733333 2.712500 2.712500 2.670833 2.625000 2.604167 2.604167
## 2011 2.695833 2.670833 2.687500 2.712500 2.720833 2.745833 2.800000 2.833333
## 2012 3.008333 2.987500 2.950000 3.000000 3.070833 3.095833 3.075000 3.070833
## 2013 2.962500 2.941667 2.862500 2.745833 2.691667 2.695833 2.704167 2.712500
## 2014 2.766667 2.783333 2.845833 2.933333 2.983333 2.979167 2.987500 2.975000
## 2015 2.770833 2.791667 2.800000 2.770833 2.729167 2.708333 2.729167 2.750000
## 2016 2.779167 2.720833 2.712500 2.720833 2.687500 2.645833 2.587500 2.562500
## 2017 2.620833 2.704167 2.708333 2.687500 2.666667 2.658333 2.641667 2.629167
## 2018 2.500000 2.425000 2.412500 2.400000 2.375000 2.391667 2.433333 2.441667
## 2019 2.391667 2.445833       NA       NA       NA       NA       NA       NA
##           Sep      Oct      Nov      Dec
## 1978       NA       NA       NA       NA
## 1979 3.200000 3.195833 3.216667 3.191667
## 1980 3.391667 3.429167 3.395833 3.354167
## 1981 2.833333 2.800000 2.820833 2.841667
## 1982 3.204167 3.229167 3.208333 3.208333
## 1983 3.395833 3.412500 3.445833 3.491667
## 1984 3.033333 3.004167 2.987500 2.962500
## 1985 3.133333 3.108333 3.087500 3.054167
```

```
## 1986 2.816667 2.808333 2.762500 2.795833
## 1987 2.866667 2.800000 2.783333 2.762500
## 1988 2.908333 3.000000 3.025000 3.008333
## 1989 2.895833 2.879167 2.916667 2.983333
## 1990 3.175000 3.237500 3.275000 3.200000
## 1991 2.850000 2.812500 2.825000 2.883333
## 1992 3.208333 3.191667 3.158333 3.166667
## 1993 3.050000 3.041667 3.033333 2.979167
## 1994 2.704167 2.708333 2.708333 2.745833
## 1995 2.779167 2.745833 2.729167 2.729167
## 1996 2.816667 2.829167 2.833333 2.795833
## 1997 3.125000 3.100000 3.116667 3.195833
## 1998 2.900000 2.904167 2.850000 2.812500
## 1999 2.729167 2.745833 2.779167 2.712500
## 2000 3.262500 3.237500 3.250000 3.333333
## 2001 2.800000 2.833333 2.787500 2.720833
## 2002 2.729167 2.691667 2.754167 2.833333
## 2003 3.016667 3.050000 2.995833 2.933333
## 2004 2.787500 2.762500 2.795833 2.779167
## 2005 2.737500 2.733333 2.691667 2.720833
## 2006 2.954167 3.033333 3.141667 3.137500
## 2007 2.954167 2.900000 2.837500 2.862500
## 2008 2.858333 2.887500 2.866667 2.833333
## 2009 2.912500 2.850000 2.841667 2.850000
## 2010 2.641667 2.679167 2.737500 2.745833
## 2011 2.895833 2.958333 2.937500 2.950000
## 2012 3.037500 3.008333 3.008333 2.979167
## 2013 2.733333 2.741667 2.754167 2.775000
## 2014 2.929167 2.904167 2.845833 2.787500
## 2015 2.754167 2.716667 2.729167 2.775000
## 2016 2.550000 2.541667 2.529167 2.541667
## 2017 2.625000 2.620833 2.629167 2.587500
## 2018 2.416667 2.400000 2.395833 2.400000
## 2019
```

```
earthquake_ts_comp$seasonal
```

```
##              Jan         Feb         Mar         Apr         May         Jun
## 1978
## 1979 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
## 1980 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
## 1981 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
## 1982 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
## 1983 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
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## 1987 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
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## 2011 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
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## 2015 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
## 2016 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
## 2017 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
## 2018 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
## 2019 -0.11281186 -0.13115282 -0.01885353  0.02656314  0.01520897 -0.01687436
##              Jul         Aug         Sep         Oct         Nov         Dec
## 1978              0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 1979  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 1980  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 1981  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
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## 1985  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
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## 1986  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
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## 2012  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 2013  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 2014  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 2015  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 2016  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 2017  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 2018  0.10406314  0.12770897  0.09906314 -0.03895770 -0.07531186  0.02135480
## 2019  0.10406314  0.12770897
```
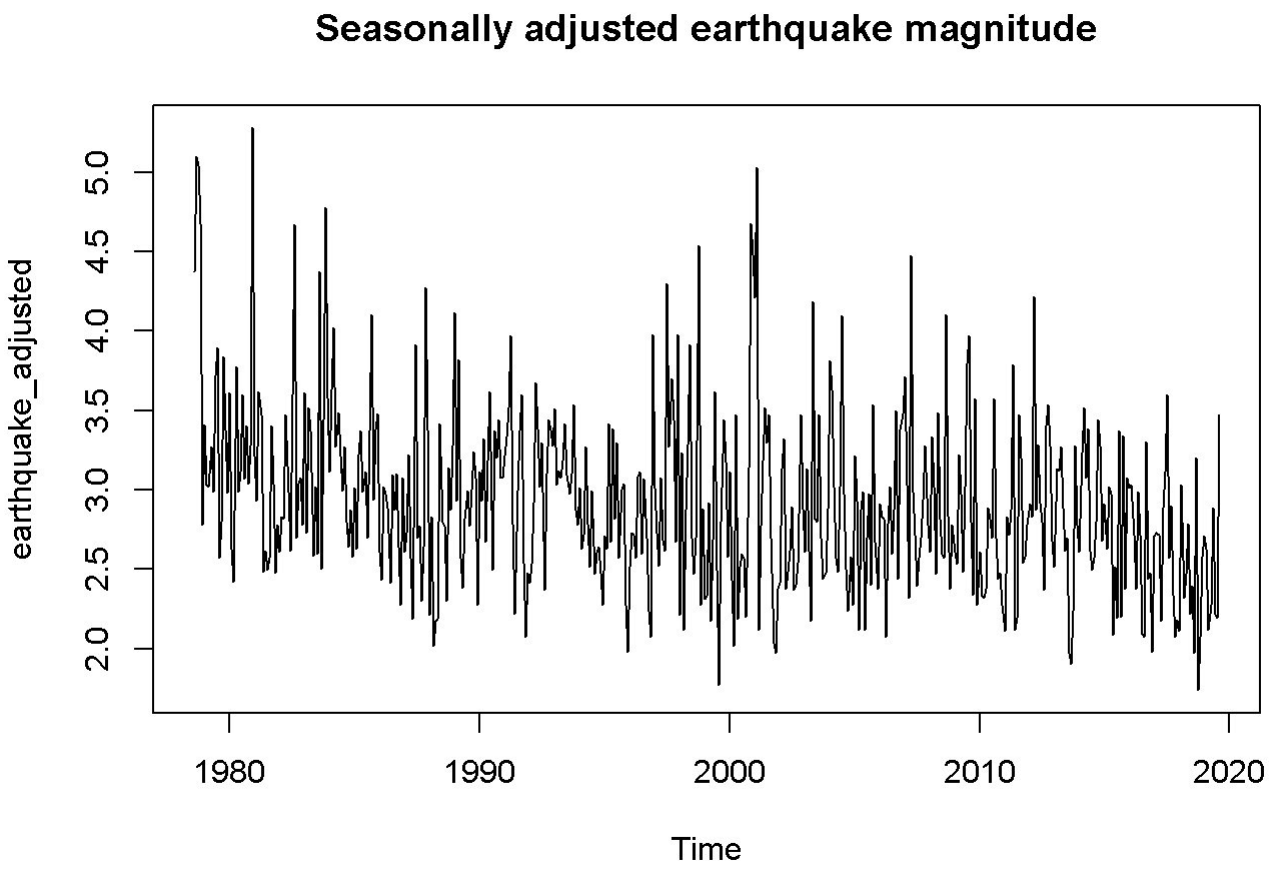
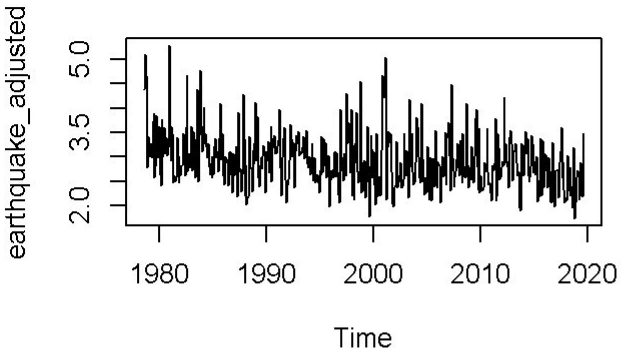
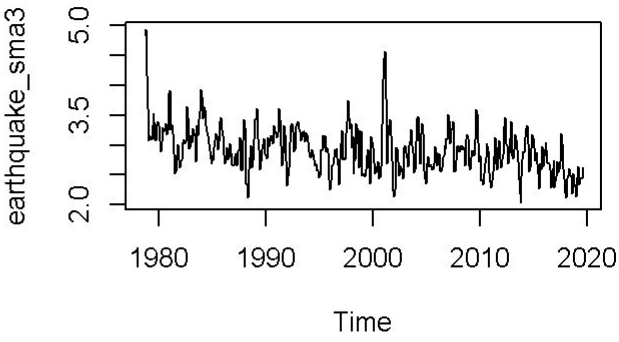

```
earthquake_adjusted <- earthquake_ts - earthquake_ts_comp$seasonal
plot.ts(earthquake_adjusted,main="Seasonally adjusted earthquake magnitude")
```

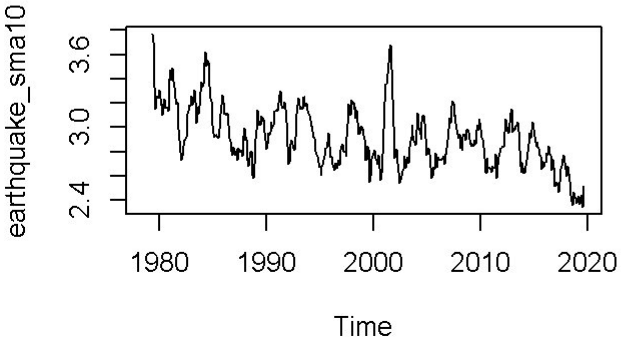


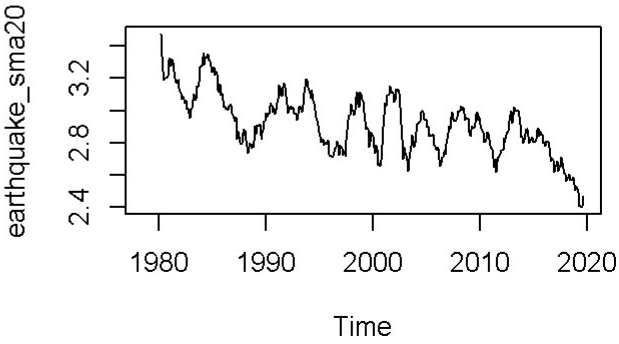

```
earthquake_sma3 <- SMA(earthquake_adjusted,n=3)
earthquake_sma10 <- SMA(earthquake_adjusted,n=10)
earthquake_sma20 <- SMA(earthquake_adjusted,n=20)
```

```
par(mfrow=c(2,2))

plot.ts(earthquake_adjusted)
plot.ts(earthquake_sma3)
plot.ts(earthquake_sma10)
plot.ts(earthquake_sma20)
```

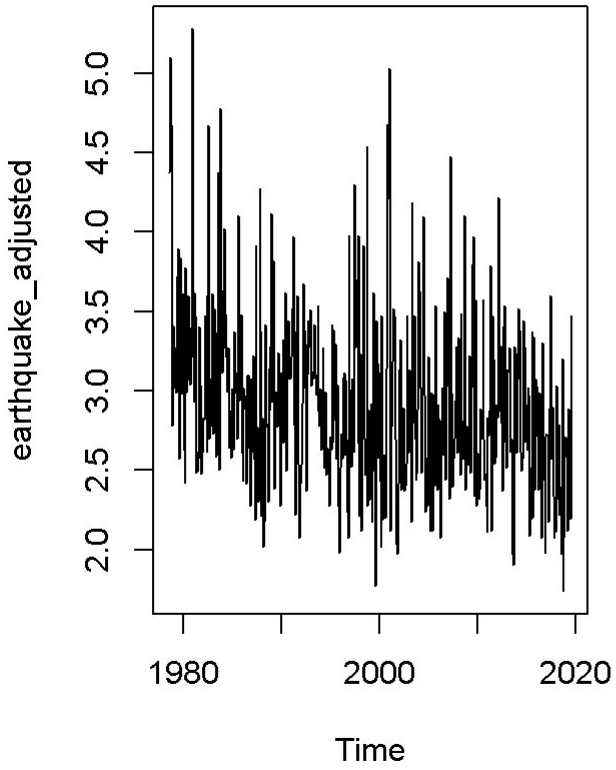


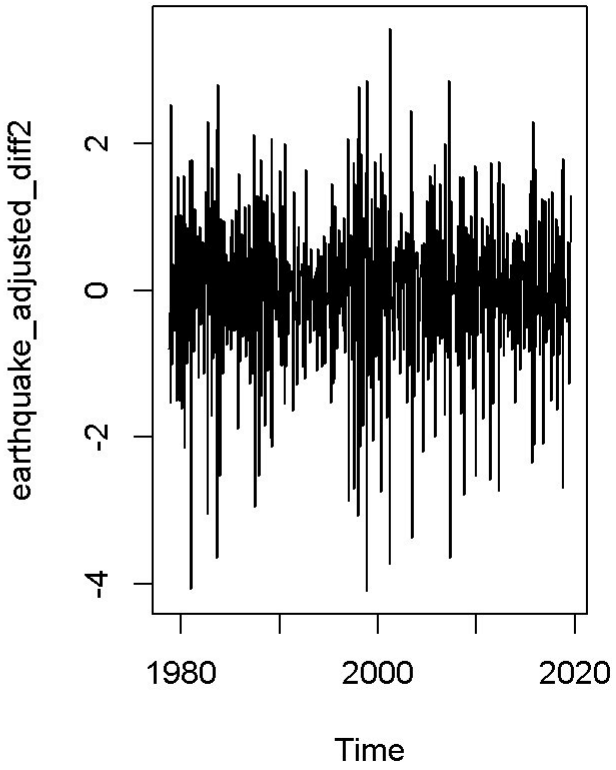




```
earthquake_adjusted_diff2 <- diff(earthquake_adjusted,differences=2)

par(mfrow=c(1,2))

plot.ts(earthquake_adjusted)
plot.ts(earthquake_adjusted_diff2)
```



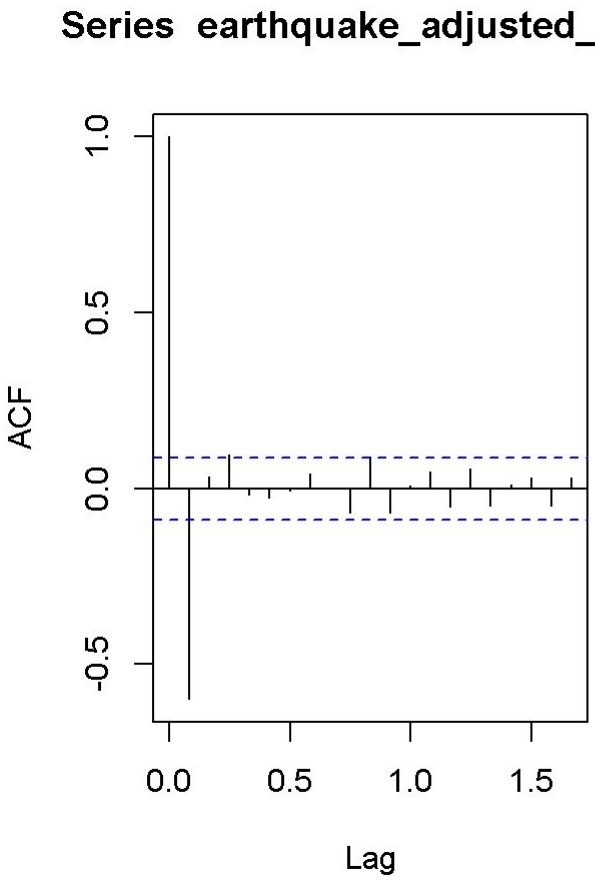



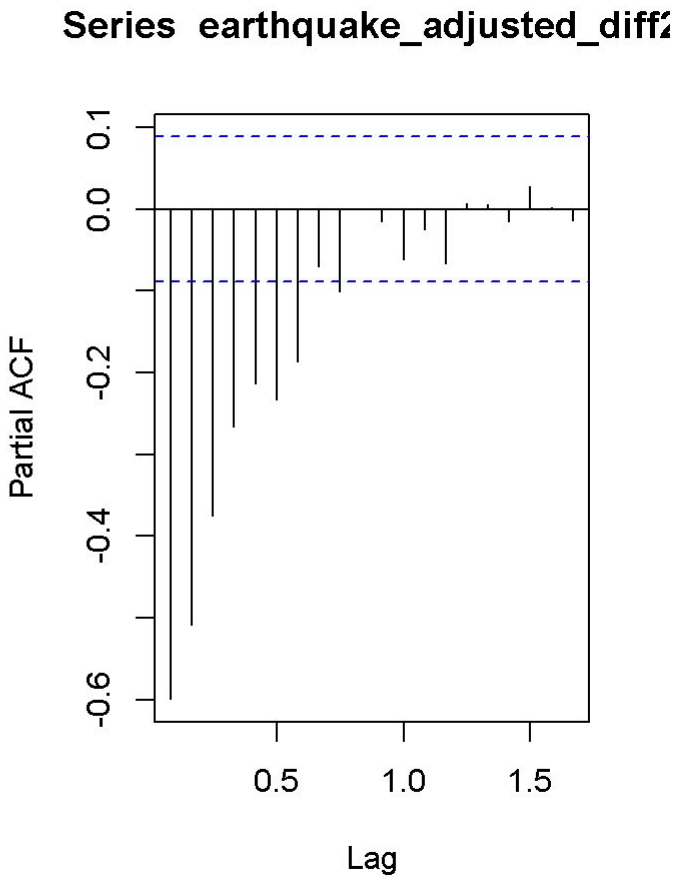

```
mean(earthquake_adjusted_diff2); sd(earthquake_adjusted_diff2)
```

```
## [1] 0.001115496
```

```
## [1] 1.163005
```

```
par(mfrow=c(1,2))
acf(earthquake_adjusted_diff2,lag.max=20) #from lag0.2, inside dotted line:MA(0.1)
pacf(earthquake_adjusted_diff2,lag.max=20) #from lag0.7, inside dotted line:AR(0.6)
```




```
auto.arima(earthquake_adjusted)
```

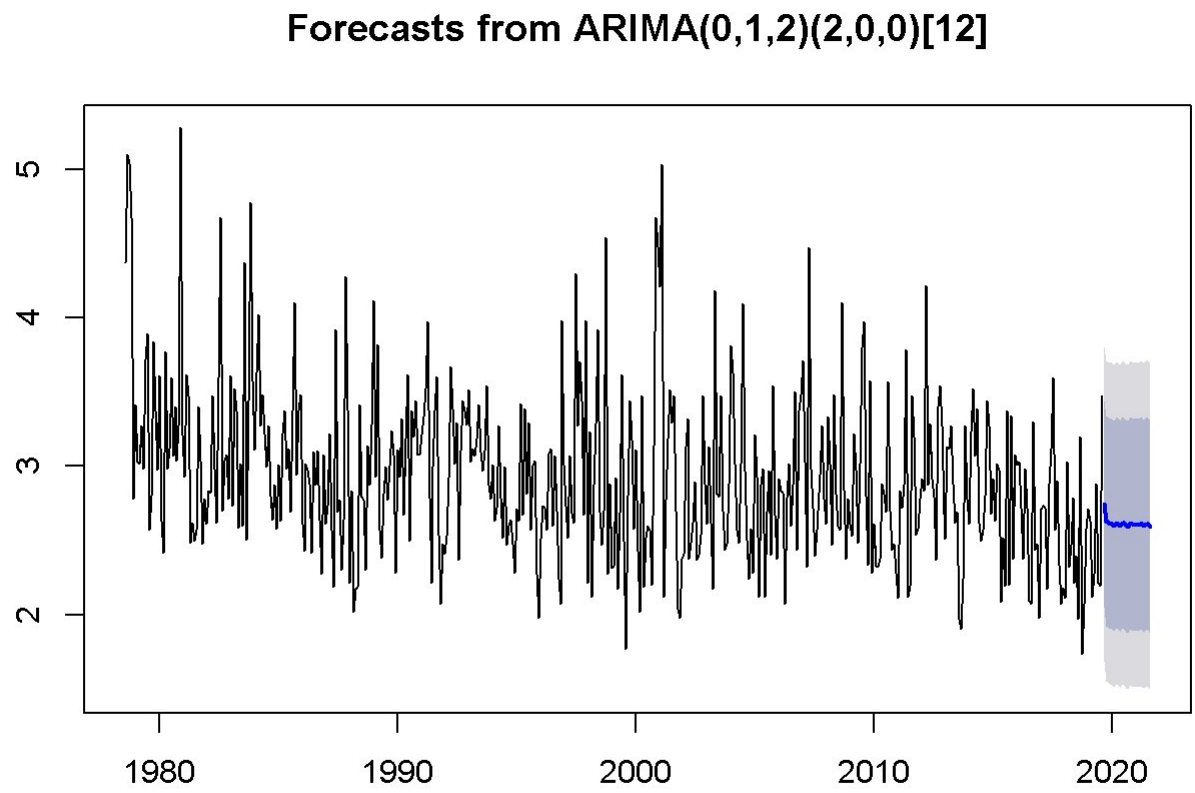
```
## Series: earthquake_adjusted
## ARIMA(0,1,2)(2,0,0)[12]
##
## Coefficients:
##           ma1      ma2     sar1     sar2
##       -0.7901  -0.1696  -0.0206  -0.0179
## s.e.   0.0455   0.0462   0.0471   0.0470
##
## sigma^2 estimated as 0.2936:  log likelihood=-395.85
## AIC=801.71   AICc=801.83   BIC=822.7
```

```
earthquake_arima <- arima(earthquake_adjusted,order=c(0,1,2),seasonal=list(orderc=c(2,0,0),pe
riod=12))
```

```
par(mfrow=c(1,1))

earthquake_forecast <- forecast(earthquake_arima,h=24)
earthquake_forecast
```

```
##          Point Forecast    Lo 80    Hi 80    Lo 95    Hi 95
## Sep 2019       2.747145 2.055579 3.438710 1.689486 3.804803
## Oct 2019       2.627506 1.920876 3.334137 1.546808 3.708204
## Nov 2019       2.625292 1.918114 3.332470 1.543757 3.706827
## Dec 2019       2.613089 1.905365 3.320813 1.530718 3.695460
## Jan 2020       2.611504 1.903233 3.319774 1.528297 3.694710
## Feb 2020       2.596787 1.887970 3.305603 1.512746 3.680828
## Mar 2020       2.620047 1.910686 3.329409 1.535172 3.704923
## Apr 2020       2.614106 1.904199 3.324013 1.528398 3.699815
## May 2020       2.595966 1.885515 3.306417 1.509425 3.682508
## Jun 2020       2.619851 1.908856 3.330847 1.532477 3.707225
## Jul 2020       2.617085 1.905546 3.328624 1.528880 3.705290
## Aug 2020       2.598384 1.886301 3.310466 1.509347 3.687420
## Sep 2020       2.591368 1.879156 3.303580 1.502134 3.680603
## Oct 2020       2.619934 1.907290 3.332579 1.530039 3.709830
## Nov 2020       2.613974 1.900809 3.327139 1.523283 3.704666
## Dec 2020       2.605238 1.891553 3.318923 1.513751 3.696725
## Jan 2021       2.602875 1.888671 3.317080 1.510594 3.695157
## Feb 2021       2.604636 1.889912 3.319360 1.511560 3.697712
## Mar 2021       2.613305 1.898062 3.328547 1.519435 3.707174
## Apr 2021       2.610667 1.894906 3.326428 1.516004 3.705329
## May 2021       2.600124 1.883845 3.316404 1.504670 3.695579
## Jun 2021       2.611559 1.894761 3.328356 1.515312 3.707805
## Jul 2021       2.611989 1.894675 3.329304 1.514951 3.709027
## Aug 2021       2.589585 1.871753 3.307416 1.491756 3.687413
```

```
plot(earthquake_forecast)
```




```
adf.test(earthquake_adjusted,k=3) #earthquake data is stationary
```

```
## Warning in adf.test(earthquake_adjusted, k = 3): p-value smaller than printed p-
## value
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  earthquake_adjusted
## Dickey-Fuller = -10.769, Lag order = 3, p-value = 0.01
## alternative hypothesis: stationary
```