Homework-4

```
> library(fpp)
> library(fpp2)
> library(TTR)  #library for moving average
> usconsumption #is my chosen timeseries
           consumption      income
1970 Q1  0.61227692  0.496540045
1970 Q2  0.45492979  1.736459591
1970 Q3  0.87467302  1.344880981
1970 Q4 -0.27251439 -0.328145953
1971 Q1  1.89218699  1.965432327
1971 Q2  0.91337819  1.490757133
1971 Q3  0.79285790  0.442927733
1971 Q4  1.64999566  1.050230993
1972 Q1  1.32724825  0.629713564
1972 Q2  1.88990506  0.934207242
1972 Q3  1.53272416  2.024456496
1972 Q4  2.31705777  3.901784825
1973 Q1  1.81385569  1.129195652
1973 Q2 -0.05055772  0.981487307
1973 Q3  0.35966722  0.503626895
1973 Q4 -0.29331546  1.211474571
1974 Q1 -0.87877094 -1.546943855
1974 Q2  0.34672003 -0.860297695
1974 Q3  0.41195356  0.310671244
1974 Q4 -1.47820468 -0.452458059
1975 Q1  0.83735987 -0.393048299
1975 Q2  1.65397369  4.564235521
1975 Q3  1.41431884 -1.359432036
1975 Q4  1.05310993  1.006575406
1976 Q1  1.97774749  1.462092078
1976 Q2  0.91507218  0.819999864
1976 Q3  1.05074607  0.896376224
1976 Q4  1.29519619  0.715996597
1977 Q1  1.13545889  0.082385052
1977 Q2  0.55153240  1.131054305
1977 Q3  0.95015960  1.490114704
1977 Q4  1.49616150  1.995499552
1978 Q1  0.58229978  0.614904129
1978 Q2  2.11467168  1.141343133
1978 Q3  0.41869886  0.808026906
1978 Q4  0.80276430  0.782540078
1979 Q1  0.50412878  1.087249832
1979 Q2 -0.05855113 -0.700631545
1979 Q3  0.97755597  0.568900915
1979 Q4  0.26591209  0.797134552
1980 Q1 -0.17368425  0.279831351
1980 Q2 -2.29656300 -1.409415369
1980 Q3  1.06691983  1.024445050
```

1980	Q4	1.32441742	2.043130338
1981	Q1	0.54583283	-0.229300048
1981	Q2	0.00000000	0.013772840
1981	Q3	0.40482184	2.193050433
1981	Q4	-0.75874883	0.201893379
1982	Q1	0.64399814	0.116463988
1982	Q2	0.35685950	0.698172650
1982	Q3	0.76412375	0.436938581
1982	Q4	1.80788661	0.351269015
1983	Q1	0.97593734	0.784231599
1983	Q2	1.96559809	0.726007440
1983	Q3	1.75134970	1.489909944
1983	Q4	1.57374005	2.042140999
1984	Q1	0.85322727	2.163513516
1984	Q2	1.42002574	1.707008683
1984	Q3	0.76950200	1.545359737
1984	Q4	1.30747803	0.946974902
1985	Q1	1.68128155	-0.246259445
1985	Q2	0.90791081	1.966841071
1985	Q3	1.88085044	-0.620830801
1985	Q4	0.21986403	1.030018787
1986	Q1	0.83153359	1.183355120
1986	Q2	1.05966370	1.128116143
1986	Q3	1.73244172	0.523753063
1986	Q4	0.60006243	0.059897054
1987	Q1	-0.15228800	0.611885129
1987	Q2	1.32935729	-1.090188910
1987	Q3	1.11041685	1.772266694
1987	Q4	0.24012547	1.410476141
1988	Q1	1.65692852	1.248862406
1988	Q2	0.72306031	0.934536046
1988	Q3	0.78681412	0.766858588
1988	Q4	1.17068014	0.896061766
1989	Q1	0.36522624	1.130999186
1989	Q2	0.44694325	-0.411533933
1989	Q3	1.03134287	0.645197097
1989	Q4	0.48794531	0.762948357
1990	Q1	0.78786794	0.750360325
1990	Q2	0.32958888	0.655150176
1990	Q3	0.37909401	0.072718052
1990	Q4	-0.78228237	-0.676795704
1991	Q1	-0.28358087	0.307585359
1991	Q2	0.75819378	0.755588074
1991	Q3	0.38256742	0.211957150
1991	Q4	-0.04493204	0.649885878
1992	Q1	1.70442848	1.497981581
1992	Q2	0.59103346	0.763512573
1992	Q3	1.09931218	0.506330196
1992	Q4	1.21261583	1.412562187
1993	Q1	0.40511535	-1.477541558

1993	Q2	0.95540152	1.543168336
1993	Q3	1.07908089	0.212590891
1993	Q4	0.88609934	1.463027070
1994	Q1	1.10781585	-0.400479849
1994	Q2	0.73801073	1.691849180
1994	Q3	0.79832641	0.732048430
1994	Q4	0.98235581	1.317421015
1995	Q1	0.11670364	0.646210704
1995	Q2	0.81643944	0.009071803
1995	Q3	0.89012327	0.745603285
1995	Q4	0.70025668	0.591013847
1996	Q1	0.90999511	1.059530012
1996	Q2	1.12517415	1.068869375
1996	Q3	0.59749105	0.847813936
1996	Q4	0.81104981	0.547321447
1997	Q1	1.00231479	0.890373141
1997	Q2	0.40370845	0.748012589
1997	Q3	1.68561876	1.138248868
1997	Q4	1.13779625	1.379965421
1998	Q1	0.98935016	2.248544314
1998	Q2	1.70668759	1.417721496
1998	Q3	1.31690105	1.045312610
1998	Q4	1.52238359	0.730112366
1999	Q1	0.98149855	0.675449171
1999	Q2	1.56147049	0.228461748
1999	Q3	1.19479035	0.644917550
1999	Q4	1.40026421	1.555650840
2000	Q1	1.50504064	2.079917327
2000	Q2	0.93588274	1.019653998
2000	Q3	0.97432184	1.055609188
2000	Q4	0.88064976	0.149548646
2001	Q1	0.39868539	0.748024500
2001	Q2	0.37651229	-0.274110069
2001	Q3	0.43918859	2.514669298
2001	Q4	1.55369100	-1.173044414
2002	Q1	0.34382689	2.659477606
2002	Q2	0.50665404	0.549165469
2002	Q3	0.67571194	-0.343744371
2002	Q4	0.35472465	0.236234260
2003	Q1	0.50387273	0.367138124
2003	Q2	0.98555573	1.501775306
2003	Q3	1.33766670	1.390030780
2003	Q4	0.54254673	0.573803177
2004	Q1	0.88074795	0.443164179
2004	Q2	0.44397949	0.983686803
2004	Q3	0.87037870	0.666082163
2004	Q4	1.07395152	1.388903698
2005	Q1	0.79393888	-1.225522766
2005	Q2	0.98477889	0.701673549
2005	Q3	0.75627802	0.594778066

```
2005 Q4  0.24819787  0.545328307
2006 Q1  1.01902713  1.855678610
2006 Q2  0.60048219  0.882341774
2006 Q3  0.59799998  0.479144681
2006 Q4  0.92584113  1.302357376
2007 Q1  0.55424125  0.451389832
2007 Q2  0.38257957  0.149334878
2007 Q3  0.43929546  0.392083863
2007 Q4  0.29465872  0.548559897
2008 Q1 -0.25266521  1.430770981
2008 Q2 -0.03553182  1.973964634
2008 Q3 -0.97177447 -2.308604067
2008 Q4 -1.31350400 -0.057706851
2009 Q1 -0.38748400 -0.969060881
2009 Q2 -0.47008302  0.063290188
2009 Q3  0.57400096 -1.392556217
2009 Q4  0.10932885 -0.144713401
2010 Q1  0.67101795  1.187165135
2010 Q2  0.71771819  1.354354721
2010 Q3  0.65314326  0.561169813
2010 Q4  0.87535215  0.371057940
> usconsumption[,"income"] #is my chosen column from the above timeseries
            Qtr1            Qtr2            Qtr3            Qtr4
1970  0.496540045  1.736459591  1.344880981 -0.328145953
1971  1.965432327  1.490757133  0.442927733  1.050230993
1972  0.629713564  0.934207242  2.024456496  3.901784825
1973  1.129195652  0.981487307  0.503626895  1.211474571
1974 -1.546943855 -0.860297695  0.310671244 -0.452458059
1975 -0.393048299  4.564235521 -1.359432036  1.006575406
1976  1.462092078  0.819999864  0.896376224  0.715996597
1977  0.082385052  1.131054305  1.490114704  1.995499552
1978  0.614904129  1.141343133  0.808026906  0.782540078
1979  1.087249832 -0.700631545  0.568900915  0.797134552
1980  0.279831351 -1.409415369  1.024445050  2.043130338
1981 -0.229300048  0.013772840  2.193050433  0.201893379
1982  0.116463988  0.698172650  0.436938581  0.351269015
1983  0.784231599  0.726007440  1.489909944  2.042140999
1984  2.163513516  1.707008683  1.545359737  0.946974902
1985 -0.246259445  1.966841071 -0.620830801  1.030018787
1986  1.183355120  1.128116143  0.523753063  0.059897054
1987  0.611885129 -1.090188910  1.772266694  1.410476141
1988  1.248862406  0.934536046  0.766858588  0.896061766
1989  1.130999186 -0.411533933  0.645197097  0.762948357
1990  0.750360325  0.655150176  0.072718052 -0.676795704
1991  0.307585359  0.755588074  0.211957150  0.649885878
1992  1.497981581  0.763512573  0.506330196  1.412562187
1993 -1.477541558  1.543168336  0.212590891  1.463027070
1994 -0.400479849  1.691849180  0.732048430  1.317421015
1995  0.646210704  0.009071803  0.745603285  0.591013847
1996  1.059530012  1.068869375  0.847813936  0.547321447
```

```
1997  0.890373141  0.748012589  1.138248868  1.379965421
1998  2.248544314  1.417721496  1.045312610  0.730112366
1999  0.675449171  0.228461748  0.644917550  1.555650840
2000  2.079917327  1.019653998  1.055609188  0.149548646
2001  0.748024500 -0.274110069  2.514669298 -1.173044414
2002  2.659477606  0.549165469 -0.343744371  0.236234260
2003  0.367138124  1.501775306  1.390030780  0.573803177
2004  0.443164179  0.983686803  0.666082163  1.388903698
2005 -1.225522766  0.701673549  0.594778066  0.545328307
2006  1.855678610  0.882341774  0.479144681  1.302357376
2007  0.451389832  0.149334878  0.392083863  0.548559897
2008  1.430770981  1.973964634 -2.308604067 -0.057706851
2009 -0.969060881  0.063290188 -1.392556217 -0.144713401
2010  1.187165135  1.354354721  0.561169813  0.371057940
> attributes(usconsumption[,"income"]) # it is timeseries, starts from year 1970 to
2010, the periodicity is quaterly meaning
$tsp
[1] 1970.00 2010.75    4.00

$class
[1] "ts"
> # biggest change is around 1975, getting rid of all of it before forecasting so that it
does not hamper the forecast.
>
> cwindow <- window(usconsumption[,"income"], start = 1977) #my chosen window
to use for the forecast
> plot(cwindow)
> Acf(cwindow)
>
> #take Mean of all available history
>
> mean_forecast <- meanf(cwindow,10) #give me the forecast for the next 10
months using mean forecast method
> plot(mean_forecast)
>
> # Naive
>
> naive_forecast <- naive(cwindow,8) #give me the forecast for the next 8 months
using Naive forecast method
> plot(naive_forecast)
>
> # Random Walk
>
> rwf_forecast <- rwf(cwindow,5)  #basically random walk forecast predicts the future
values where the future is not
>                          #dependent on the past values.
> rwf_forecast2 <- rwf(cwindow,5, drift=TRUE) #trying to include a trend component
in the model but no effect from it
>                                  #can be observed.
> plot(rwf_forecast)
```

```
> plot(rwf_forecast2)
>
> # Seasonal Naive
>
> snaive_forecast <- snaive(cwindow,5)
> plot(snaive_forecast)
>
> # Moving Averages
>
> MA5_forecast <- ma(cwindow,order=5) #taking into account the 5 most recent
values
> MA9_forecast <- ma(cwindow,order=9) #taking into account the 9 most recent
values
> plot(MA5_forecast)  #plotting the forecast based on the recent 5 values
> plot(MA9_forecast)  #plotting the forecast based on the recent 9 values
>
> # plot all in a single chart
> plot(mean_forecast)
> lines(naive_forecast$mean,col="red")
> lines(rwf_forecast$mean,col="green")
> lines(rwf_forecast2$mean,col="purple")  #slight effect can be observed from the
drift component
> lines(snaive_forecast$mean,col="black")
> lines(MA5_forecast,col="orange")
> lines(MA9_forecast,col="Blue")
>
> attributes(naive_forecast)
$names
 [1] "method"    "model"     "lambda"    "x"         "fitted"    "residuals" "series"    "mean"
"level"     "lower"
[11] "upper"

$class
[1] "forecast"

>
> #$names
> #[1] "method"    "model"     "lambda"    "x"         "fitted"    "residuals" "series"
"mean"      "level"     "lower"
> #[11] "upper"
>
> #$class
> #[1] "forecast"
>
>
> # Decomposition
>
> ets_forecast <- ets(cwindow)
> plot(ets_forecast)
> attributes(ets_forecast)
```

```
$names
 [1] "loglik"     "aic"        "bic"        "aicc"       "mse"        "amse"       "fit"        "residuals"
"fitted"
[10] "states"     "par"        "m"          "method"     "series"     "components" "call"
"initstate"  "sigma2"
[19] "x"

$class
[1] "ets"

>
> #$names
> #[1] "loglik"     "aic"        "bic"        "aicc"       "mse"        "amse"       "fit"
"residuals"  "fitted"
> #[10] "states"     "par"        "m"          "method"     "series"     "components" "call"
"initstate"  "sigma2"
> #[19] "x"
>
> #$class
> #[1] "ets"
>
> ets_forecast$mse
[1] 0.710923
> #[1] 0.710923
>
> # HoltWinters
>
> HW_forecast <- HoltWinters(cwindow)
> plot(HW_forecast)
> SSE_Simple <- HoltWinters(cwindow,beta=FALSE,gamma=FALSE)
> attributes(SSE_Simple)
$names
[1] "fitted"       "x"            "alpha"        "beta"         "gamma"        "coefficients"
"seasonal"     "SSE"
[9] "call"

$class
[1] "HoltWinters"

> #$names
> #[1] "fitted"       "x"            "alpha"        "beta"         "gamma"        "coefficients"
"seasonal"     "SSE"
> #[9] "call"
>
> #$class
> #[1] "HoltWinters"
>
>
> plot(SSE_Simple)
> SSE_Simple$SSE
```

```
[1] 103.1529
> #[1] 103.1529
>
> head(SSE_Simple$fitted)
              xhat      level
1977 Q2 0.08238505 0.08238505
1977 Q3 0.15983743 0.15983743
1977 Q4 0.25808875 0.25808875
1978 Q1 0.38641004 0.38641004
1978 Q2 0.40328611 0.40328611
1978 Q3 0.45779735 0.45779735
>
>             #xhat      level
> #1977 Q2 0.08238505 0.08238505
> #1977 Q3 0.15983743 0.15983743
> #1977 Q4 0.25808875 0.25808875
> #1978 Q1 0.38641004 0.38641004
> #1978 Q2 0.40328611 0.40328611
> #1978 Q3 0.45779735 0.45779735
>
>
> #Forecast
>
> forecast_ets_1 <- forecast.ets(ets_forecast, h=5)
> plot(forecast_ets_1)
> forecast_ets_2 <- forecast(ets_forecast, h=5) #same result but a better method to
plot the ets forecast
> plot(forecast_ets_2)
```