

## Forecast prices for Gold, Oil and S&P 500 for 2017.

Required packages are xts, utlis and hydroTSM. Loaded the monthly data sets for Gold and S&P 500 and Daily data set for Crude Oil. Read.zoo is used in order to read the date format. Converted the oil data set into xts data frame.

```
require(xts)

## Loading required package: xts
## Loading required package: zoo
##
## Attaching package: 'zoo'
## The following objects are masked from 'package:base':
##
##      as.Date, as.Date.numeric

require(utlis)

## Loading required package: utlis

## Warning in library(package, lib.loc = lib.loc, character.only = TRUE,
## logical.return = TRUE, : there is no package called 'utlis'

require(hydroTSM)

## Loading required package: hydroTSM

goldseries <---
read.zoo("//Users//ashwinichowdhary//Documents//Fall2016//BA//DataSets//goldm
onthly.csv",sep="," ,
                                header=TRUE,stringsAsFactors=FALSE)

sp500series <---
read.zoo("//Users//ashwinichowdhary//Documents//Fall2016//BA//DataSets//S&P50
0.csv",sep="," ,
                                header=TRUE,stringsAsFactors=FALSE)

oilmonth <---
as.xts(read.zoo("//Users//ashwinichowdhary//Documents//Fall2016//BA//DataSets
//oildaily.csv",sep="," ,header=TRUE))
```

## Converting Oil daily series to monthly series.

```
oilmonthly <--- apply.monthly(oilmonth,sum)
oilmonthly <--- daily2monthly(oilmonth, FUN=mean,na.rm=TRUE)
head(oilmonthly)
```

##		Open	High	Low	Close	Volume	Adj.Close
##	2011---11---01	24.91143	25.14143	24.65429	24.92714	490628.6	24.92714
##	2011---12---01	25.08857	25.28381	24.82952	25.06190	460404.8	25.06190
##	2012---01---01	25.58800	25.77050	25.31300	25.52650	561935.0	25.52650
##	2012---02---01	25.89600	26.11400	25.67050	25.95800	1083700.0	25.95800
##	2012---03---01	26.82955	27.05818	26.61409	26.86727	778954.5	26.86727
##	2012---04---01	25.85750	26.06050	25.67100	25.90700	612375.0	25.90700

## Time series for Gold, Oil and S&P 500.

```
ts.gold<---ts(goldseries)
ts.gold
```

## Time Series:

## Start = 1

## End = 61

## Frequency = 1

##		Open	High	Low	Close	Volume	Adj.Close
##	1	107.80	110.22	95.75	106.91	1001600	103.38049
##	2	106.72	109.64	97.15	102.10	568700	98.72928
##	3	105.69	115.44	105.21	114.41	476900	110.63289
##	4	115.81	119.73	108.63	114.73	517900	110.94232
##	5	115.69	117.28	85.33	87.98	1125300	85.07544
##	6	85.00	92.53	80.14	89.15	853000	86.20682
##	7	87.26	88.83	72.91	79.35	757000	77.12740
##	8	80.58	96.70	80.58	90.01	917200	87.48881
##	9	89.89	94.10	82.52	89.48	505300	86.97366
##	10	89.73	103.61	86.85	102.97	466300	100.08580
##	11	102.10	124.80	100.68	123.00	888100	119.55476
##	12	123.43	127.27	116.74	119.59	558500	116.24026
##	13	119.73	122.29	100.06	107.36	566000	104.35284
##	14	107.62	107.86	96.26	99.21	503100	96.43111
##	15	101.14	102.02	91.91	94.16	512300	91.52257
##	16	95.85	100.78	81.31	82.87	589400	80.54881
##	17	81.88	86.66	79.51	85.98	617100	83.57169
##	18	85.64	85.69	66.51	81.78	1067300	79.48933
##	19	80.90	81.53	70.92	78.38	919900	76.67519
##	20	78.50	80.50	60.44	64.00	1042500	62.60797
##	21	63.82	75.41	60.17	74.27	1143200	72.65459
##	22	75.10	84.61	66.05	78.02	1030100	76.32302
##	23	79.68	80.43	69.79	71.53	1032600	69.97418
##	24	69.60	79.77	67.68	73.90	783000	72.29264
##	25	73.15	79.33	67.52	70.75	943600	69.21115
##	26	69.09	69.25	60.90	62.81	810300	61.44385
##	27	63.37	71.50	59.19	68.90	880100	67.40139

```

## 28 71.80 81.89 70.11 79.04 946500 77.32084
## 29 82.13 85.48 74.04 75.00 804700 73.82177
## 30 74.95 81.63 74.60 80.07 659100 78.81213
## 31 79.12 81.35 72.69 73.93 418200 72.76859
## 32 73.56 84.89 72.14 84.60 542300 83.27096
## 33 85.60 89.89 84.48 86.14 558800 84.78677
## 34 85.61 86.92 80.06 84.15 467200 82.82803
## 35 83.05 83.33 67.35 67.59 763700 66.52818
## 36 67.44 70.91 58.00 58.21 1196200 57.29554
## 37 60.16 71.36 58.40 64.68 1284700 63.66390
## 38 66.48 69.52 61.11 67.41 958600 66.35101
## 39 66.83 85.84 66.69 85.26 1272200 83.92059
## 40 83.64 85.46 75.12 79.19 810200 77.94595
## 41 79.00 79.33 66.45 69.27 927800 68.77554
## 42 69.74 78.90 69.36 76.17 669000 75.62628
## 43 75.33 77.79 70.56 72.23 510700 71.71441
## 44 72.25 73.69 66.90 66.95 498700 66.47209
## 45 66.04 67.62 57.06 60.37 738000 59.93907
## 46 59.09 68.12 57.85 60.29 954600 59.85964
## 47 60.28 61.20 54.88 59.09 1017300 58.66821
## 48 60.27 72.07 58.34 66.87 990700 66.39267
## 49 66.12 67.20 58.77 60.60 880700 60.16742
## 50 61.68 65.35 59.08 61.93 639600 61.48793
## 51 63.03 70.78 59.96 70.72 846600 70.21519
## 52 72.00 93.67 71.59 91.25 1315900 90.59864
## 53 89.89 96.50 86.61 90.81 961000 90.81000
## 54 88.10 100.52 87.95 100.50 931600 100.50000
## 55 101.28 101.60 82.85 84.31 1072200 84.31000
## 56 85.39 112.13 83.63 112.04 1162300 112.04000
## 57 117.18 126.55 110.73 117.61 1253900 117.61000
## 58 117.61 120.72 93.03 93.65 986300 93.65000
## 59 93.47 106.01 93.32 100.07 929700 100.07000
## 60 100.72 100.93 82.49 88.73 1058300 88.73000
## 61 90.34 93.87 70.58 72.19 1686400 72.19000
## attr(,"index")
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## [6] "2012---04---02" "2012---05---01" "2012---06---01" "2012---07---02" "2012---08---01"
## [11] "2012---09---04" "2012---10---01" "2012---11---01" "2012---12---03" "2013---01---02"
## [16] "2013---02---01" "2013---03---01" "2013---04---01" "2013---05---01" "2013---06---03"
## [21] "2013---07---01" "2013---08---01" "2013---09---03" "2013---10---01" "2013---11---01"
## [26] "2013---12---02" "2014---01---02" "2014---02---03" "2014---03---03" "2014---04---01"
## [31] "2014---05---01" "2014---06---02" "2014---07---01" "2014---08---01" "2014---09---02"
## [36] "2014---10---01" "2014---11---03" "2014---12---01" "2015---01---02" "2015---02---02"
## [41] "2015---03---02" "2015---04---01" "2015---05---01" "2015---06---01" "2015---07---01"
## [46] "2015---08---03" "2015---09---01" "2015---10---01" "2015---11---02" "2015---12---01"
## [51] "2016---01---04" "2016---02---01" "2016---03---01" "2016---04---01" "2016---05---02"
## [56] "2016---06---01" "2016---07---01" "2016---08---01" "2016---09---01" "2016---10---03"
## [61] "2016---11---01"

```

```
ts.oil<---ts(oilmonthly)
```

```
ts.oil
```

```
## Time Series:
```

```
## Start = 1
```

```
## End = 61
```

```
## Frequency = 1
```

##		Open	High	Low	Close	Volume	Adj.Close
##	1	24.911429	25.141429	24.654285	24.927143	490628.6	24.927143
##	2	25.088572	25.283810	24.829524	25.061905	460404.8	25.061905
##	3	25.588000	25.770500	25.313000	25.526500	561935.0	25.526500
##	4	25.896000	26.114000	25.670500	25.958000	1083700.0	25.958000
##	5	26.829546	27.058182	26.614091	26.867273	778954.5	26.867273
##	6	25.857500	26.060500	25.671000	25.907000	612375.0	25.907000
##	7	23.569091	23.718636	23.296364	23.462273	783463.6	23.462273
##	8	20.216666	20.440000	19.937619	20.182381	799881.0	20.182381
##	9	21.462381	21.677619	21.264762	21.494286	690714.3	21.494286
##	10	22.966956	23.174348	22.794348	23.001739	710126.1	23.001739
##	11	23.126842	23.260000	22.821053	23.021053	660305.3	23.021053
##	12	21.821429	21.999048	21.560952	21.767143	559457.1	21.767143
##	13	20.790000	20.987143	20.612381	20.807619	515328.6	20.807619
##	14	21.026500	21.166000	20.896000	21.052000	471080.0	21.052000
##	15	22.544762	22.643333	22.406667	22.551905	373181.0	22.551905
##	16	22.566842	22.702632	22.388948	22.542632	407657.9	22.542632
##	17	21.756000	21.901000	21.608000	21.791500	411495.0	21.791500
##	18	21.450000	21.645000	21.257727	21.500000	629713.6	21.500000
##	19	21.966364	22.200455	21.803182	22.037727	631931.8	22.037727
##	20	22.174500	22.368000	22.028500	22.225500	409215.0	22.225500
##	21	24.407727	24.609546	24.246818	24.476363	667104.5	24.476363
##	22	25.064091	25.256818	24.895909	25.093636	686359.1	25.093636
##	23	25.068500	25.258000	24.928000	25.107000	542180.0	25.107000
##	24	23.783043	23.966956	23.651739	23.813478	420443.5	23.813478
##	25	22.115500	22.249500	21.974500	22.097000	481905.0	22.097000
##	26	22.938571	23.056190	22.859524	22.959524	288252.4	22.959524
##	27	22.205238	22.315238	22.046667	22.177143	540257.1	22.177143
##	28	23.561579	23.717895	23.459474	23.599474	261494.7	23.599474
##	29	23.675238	23.807619	23.532381	23.659048	290328.6	23.659048
##	30	24.210476	24.329048	24.094286	24.197143	340166.7	24.197143
##	31	24.347619	24.452857	24.253809	24.360476	191757.1	24.360476
##	32	25.366190	25.465238	25.253333	25.378095	242285.7	25.378095
##	33	24.803636	24.915909	24.636363	24.758182	206854.5	24.758182
##	34	23.242857	23.358572	23.107619	23.247143	179100.0	23.247143
##	35	22.725714	22.920000	22.520000	22.726190	235571.4	22.726190
##	36	20.665652	20.866956	20.398695	20.626522	510708.7	20.626522
##	37	18.590526	18.745263	18.324737	18.476316	568578.9	18.476316
##	38	14.125909	14.372727	13.831364	14.080454	2167231.8	14.080454
##	39	10.742500	10.975000	10.515500	10.730000	4198340.0	10.730000
##	40	11.457368	11.753684	11.203684	11.477368	6022363.2	11.477368
##	41	10.443636	10.625909	10.247273	10.440909	5389109.1	10.440909
##	42	11.425238	11.705238	11.300952	11.530952	4428895.2	11.530952

```

## 43 12.306500 12.461000 12.148500 12.305000 3459150.0 12.305000
## 44 12.205455 12.350455 12.076818 12.229545 2836650.0 12.229545
## 45 10.197273 10.318182 9.993182 10.120455 3770213.6 10.120455
## 46 8.128571 8.322381 7.964286 8.152381 5934681.0 8.152381
## 47 8.531905 8.683333 8.348571 8.515714 3761657.1 8.515714
## 48 8.675909 8.821364 8.536364 8.678636 2996286.4 8.678636
## 49 8.003500 8.109500 7.885500 7.987500 3098200.0 7.987500
## 50 6.571364 6.689091 6.475455 6.562727 3958018.2 6.562727
## 51 5.413158 5.523158 5.207895 5.343684 7627163.2 5.343684
## 52 4.720000 4.825500 4.585500 4.710000 3544060.0 4.710000
## 53 5.296818 5.404091 5.225000 5.325000 3036418.2 5.325000
## 54 5.458095 5.573810 5.383333 5.491429 3155709.5 5.491429
## 55 6.140476 6.234286 6.046190 6.149524 2268019.0 6.149524
## 56 6.375909 6.469545 6.292727 6.395000 2414404.5 6.395000
## 57 5.781500 5.852000 5.671000 5.751500 2825250.0 5.751500
## 58 5.588696 5.685217 5.503478 5.601739 2970339.1 5.601739
## 59 5.531429 5.636190 5.452857 5.544286 3231961.9 5.544286
## 60 6.105238 6.166667 6.027143 6.098095 2532823.8 6.098095
## 61 5.422857 5.501429 5.337857 5.415714 2954385.7 5.415714
## attr(,"index")
## [1] "2011---11---01" "2011---12---01" "2012---01---01" "2012---02---01" "2012---03---01"
## [6] "2012---04---01" "2012---05---01" "2012---06---01" "2012---07---01" "2012---08---01"
## [11] "2012---09---01" "2012---10---01" "2012---11---01" "2012---12---01" "2013---01---01"
## [16] "2013---02---01" "2013---03---01" "2013---04---01" "2013---05---01" "2013---06---01"
## [21] "2013---07---01" "2013---08---01" "2013---09---01" "2013---10---01" "2013---11---01"
## [26] "2013---12---01" "2014---01---01" "2014---02---01" "2014---03---01" "2014---04---01"
## [31] "2014---05---01" "2014---06---01" "2014---07---01" "2014---08---01" "2014---09---01"
## [36] "2014---10---01" "2014---11---01" "2014---12---01" "2015---01---01" "2015---02---01"
## [41] "2015---03---01" "2015---04---01" "2015---05---01" "2015---06---01" "2015---07---01"
## [46] "2015---08---01" "2015---09---01" "2015---10---01" "2015---11---01" "2015---12---01"
## [51] "2016---01---01" "2016---02---01" "2016---03---01" "2016---04---01" "2016---05---01"
## [56] "2016---06---01" "2016---07---01" "2016---08---01" "2016---09---01" "2016---10---01"
## [61] "2016---11---01"

ts.sp<--ts(sp500series)
ts.sp

## Time Series:
## Start = 1
## End = 60
## Frequency = 1
##      Open    High    Low   Close   Volume Adj.Close  X X.1
## 1 1426.19 1509.94 1426.19 1498.11 3802304200 1498.11 NA NA
## 2 1845.86 1850.84 1770.45 1782.59 3806266600 1782.59 NA NA
## 3 2058.90 2072.36 1988.12 1994.99 4091934500 1994.99 NA NA
## 4 1258.86 1333.47 1258.86 1312.41 4190155500 1312.41 NA NA
## 5 2038.20 2038.20 1812.29 1940.24 5153017800 1940.24 NA NA
## 6 1312.45 1378.04 1312.45 1365.68 4143404000 1365.68 NA NA
## 7 1498.11 1530.94 1485.01 1514.68 3851884200 1514.68 NA NA
## 8 1936.94 1962.96 1810.10 1932.23 4881887000 1932.23 NA NA

```

##	9	1996.67	2119.59	1980.90	2104.50	3806470500	2104.50	NA	NA
##	10	1782.68	1867.92	1737.92	1859.45	3875949400	1859.45	NA	NA
##	11	1365.90	1419.15	1340.03	1408.47	3980752200	1408.47	NA	NA
##	12	1514.68	1570.28	1501.48	1569.19	3591577500	1569.19	NA	NA
##	13	1937.09	2072.21	1937.09	2059.74	4379759000	2059.74	NA	NA
##	14	2105.23	2117.52	2039.69	2067.89	3638745400	2067.89	NA	NA
##	15	1857.68	1883.97	1834.44	1872.34	3579015700	1872.34	NA	NA
##	16	1569.18	1597.57	1536.03	1597.57	3674685000	1597.57	NA	NA
##	17	1873.96	1897.28	1814.36	1883.95	3589287600	1883.95	NA	NA
##	18	2067.63	2125.92	2048.38	2085.51	3521458000	2085.51	NA	NA
##	19	2056.62	2111.05	2033.80	2065.30	4087129000	2065.30	NA	NA
##	20	1408.47	1422.38	1357.38	1397.91	3916786000	1397.91	NA	NA
##	21	1397.86	1415.32	1291.98	1310.33	4158095900	1310.33	NA	NA
##	22	1597.55	1687.18	1581.28	1630.74	3661220400	1630.74	NA	NA
##	23	1884.39	1924.03	1859.79	1923.57	3185100900	1923.57	NA	NA
##	24	2087.38	2134.72	2067.93	2107.39	3455756000	2107.39	NA	NA
##	25	2067.17	2103.48	2025.91	2096.95	3971333800	2096.95	NA	NA
##	26	1309.87	1363.46	1266.74	1362.16	4103472300	1362.16	NA	NA
##	27	2108.64	2129.87	2056.32	2063.11	3513296300	2063.11	NA	NA
##	28	2093.94	2120.55	1991.68	2098.86	4157978100	2098.86	NA	NA
##	29	1923.87	1968.17	1915.98	1960.23	3158130000	1960.23	NA	NA
##	30	1631.71	1654.19	1560.33	1606.28	3996199000	1606.28	NA	NA
##	31	1609.78	1698.78	1604.57	1685.73	3270645900	1685.73	NA	NA
##	32	1962.29	1991.39	1930.67	1930.67	3214440400	1930.67	NA	NA
##	33	2067.00	2132.82	2044.02	2103.84	3709178600	2103.84	NA	NA
##	34	2099.34	2177.09	2074.02	2173.60	3678454500	2173.60	NA	NA
##	35	1362.33	1391.74	1325.41	1379.32	3663113300	1379.32	NA	NA
##	36	1379.32	1426.68	1354.65	1406.58	3183567800	1406.58	NA	NA
##	37	1689.42	1709.67	1627.47	1632.97	3069868600	1632.97	NA	NA
##	38	1929.80	2005.04	1904.78	2003.37	2875718500	2003.37	NA	NA
##	39	2173.15	2193.81	2147.58	2170.95	3451160800	2170.95	NA	NA
##	40	2104.49	2112.66	1867.01	1972.18	4216280400	1972.18	NA	NA
##	41	1970.09	2020.86	1871.91	1920.03	4024497100	1920.03	NA	NA
##	42	2171.33	2187.87	2119.12	2168.27	3878265700	2168.27	NA	NA
##	43	2004.07	2019.26	1964.04	1972.29	3364623800	1972.29	NA	NA
##	44	1635.95	1729.86	1633.41	1681.55	3474152000	1681.55	NA	NA
##	45	1406.54	1474.51	1396.56	1440.67	3857553100	1440.67	NA	NA
##	46	1440.90	1470.96	1403.28	1412.16	3587115700	1412.16	NA	NA
##	47	1682.41	1775.22	1646.47	1756.54	3498866500	1756.54	NA	NA
##	48	1971.44	2018.19	1820.66	2018.05	4260310800	2018.05	NA	NA
##	49	1919.65	2094.32	1893.70	2079.36	4095504500	2079.36	NA	NA
##	50	2164.33	2169.60	2114.72	2126.15	3672334700	2126.15	NA	NA
##	51	1412.20	1434.27	1343.35	1416.18	3593110000	1416.18	NA	NA
##	52	1758.70	1813.55	1746.20	1805.81	3261324500	1805.81	NA	NA
##	53	2128.68	2213.35	2083.79	2213.35	4285453800	2213.35	NA	NA
##	54	2080.76	2116.48	2019.39	2080.41	4007931000	2080.41	NA	NA
##	55	2018.21	2075.76	2001.01	2067.56	3479201500	2067.56	NA	NA
##	56	1246.91	1269.37	1202.37	1257.60	3667346600	1257.60	NA	NA
##	57	2065.78	2093.55	1972.56	2058.90	3788631300	2058.90	NA	NA
##	58	2082.93	2104.27	1993.26	2043.94	3922935900	2043.94	NA	NA

```
## 59 1806.55 1849.44 1767.99 1848.36 3203412300 1848.36 NA NA
## 60 1416.34 1448.00 1398.11 1426.19 3479625500 1426.19 NA NA
## attr(,"index")
## [1] "0001---02---13" "0001---02---14" "0001---02---15" "0001---03---12" "0001---04---16"
## [6] "0002---01---12" "0002---01---13" "0002---01---16" "0002---02---15" "0002---03---14"
## [11] "0003---01---12" "0003---01---13" "0003---01---16" "0003---02---15" "0003---03---14"
## [16] "0004---01---13" "0004---01---14" "0004---01---15" "0004---01---16" "0004---02---12"
## [21] "0005---01---12" "0005---01---13" "0005---01---14" "0005---01---15" "0005---02---16"
## [26] "0006---01---12" "0006---01---15" "0006---01---16" "0006---02---14" "0006---03---13"
## [31] "0007---01---13" "0007---01---14" "0007---01---15" "0007---01---16" "0007---02---12"
## [36] "0008---01---12" "0008---01---13" "0008---01---14" "0008---01---16" "0008---03---15"
## [41] "0009---01---15" "0009---01---16" "0009---02---14" "0009---03---13" "0009---04---12"
## [46] "0010---01---12" "0010---01---13" "0010---01---14" "0010---01---15" "0010---03---16"
## [51] "0011---01---12" "0011---01---13" "0011---01---16" "0011---02---15" "0011---03---14"
## [56] "0012---01---11" "0012---01---14" "0012---01---15" "0012---02---13" "0012---03---12"
```

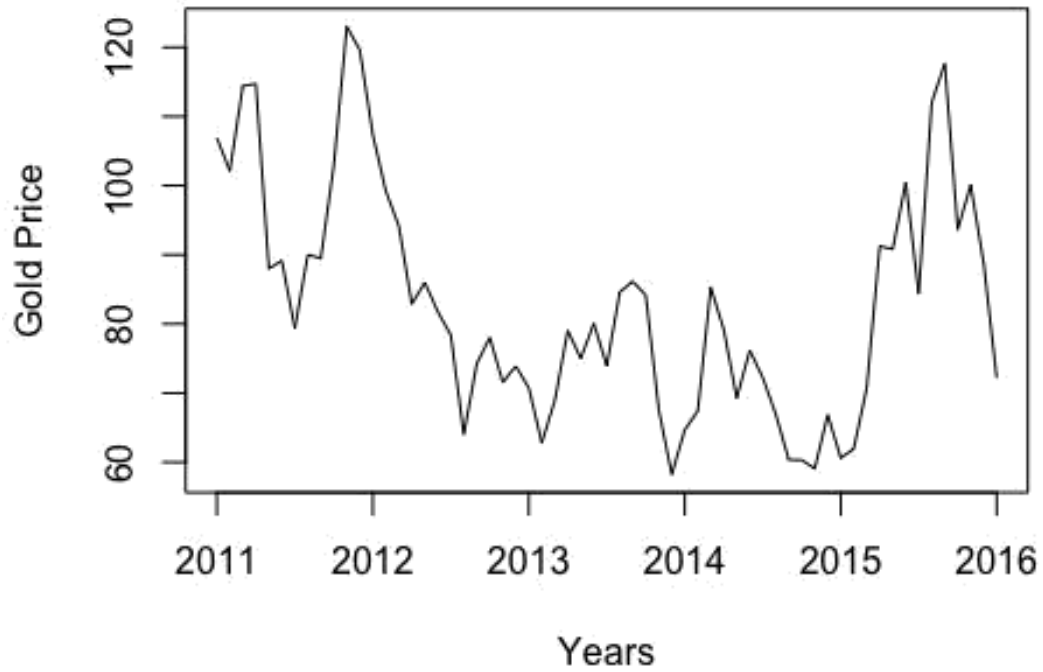
## Monthly Time series for Gold, Oil and S&P 500 with the plots.

```
ts.gold1<---ts(goldseries$Close, frequency = 12, start = c(2011), end =
c(2016)) # to select one series only
ts.gold1
```

```
##      Jan      Feb      Mar      Apr      May      Jun      Jul      Aug      Sep      Oct
## 2011 106.91 102.10 114.41 114.73  87.98  89.15  79.35  90.01  89.48 102.97
## 2012 107.36  99.21  94.16  82.87  85.98  81.78  78.38  64.00  74.27  78.02
## 2013  70.75  62.81  68.90  79.04  75.00  80.07  73.93  84.60  86.14  84.15
## 2014  64.68  67.41  85.26  79.19  69.27  76.17  72.23  66.95  60.37  60.29
## 2015  60.60  61.93  70.72  91.25  90.81 100.50  84.31 112.04 117.61  93.65
## 2016  72.19
##      NovDec
## 2011 123.00 119.59
## 2012  71.53  73.90
## 2013  67.59  58.21
## 2014  59.09  66.87
## 2015 100.07  88.73
## 2016
```

```
plot.ts(ts.gold1, xlab="Years", ylab="Gold Price", main="Time Series for
Gold")
```

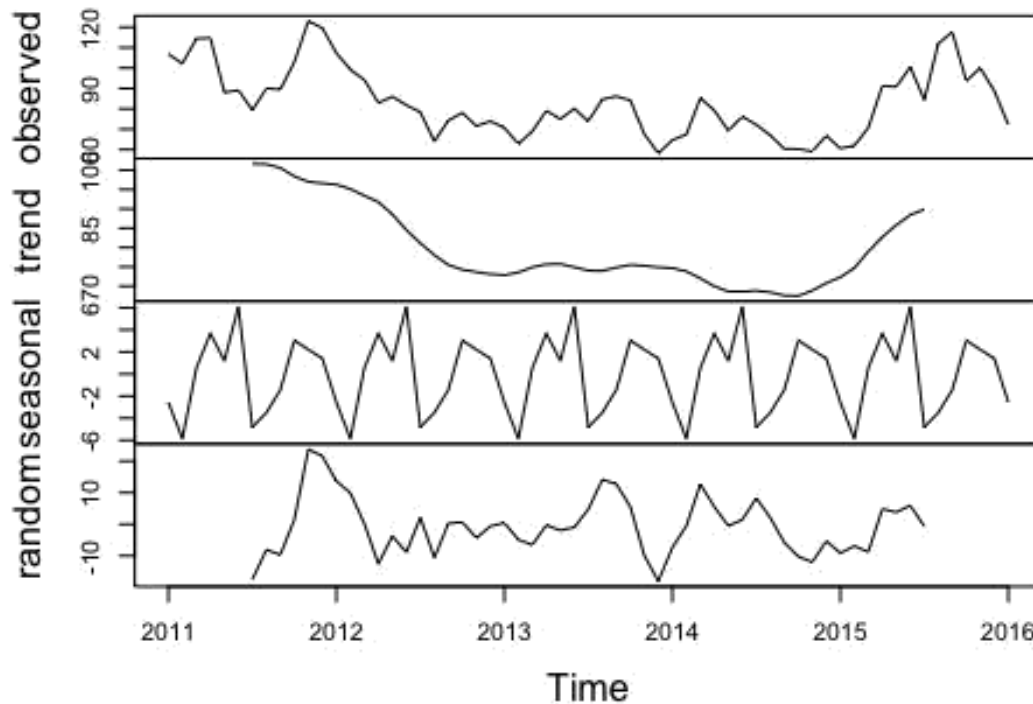
## Time Series for Gold



```
ts.gold2 <---decompose(ts.gold1)
plot(ts.gold2)
```



## Decomposition of additive time series

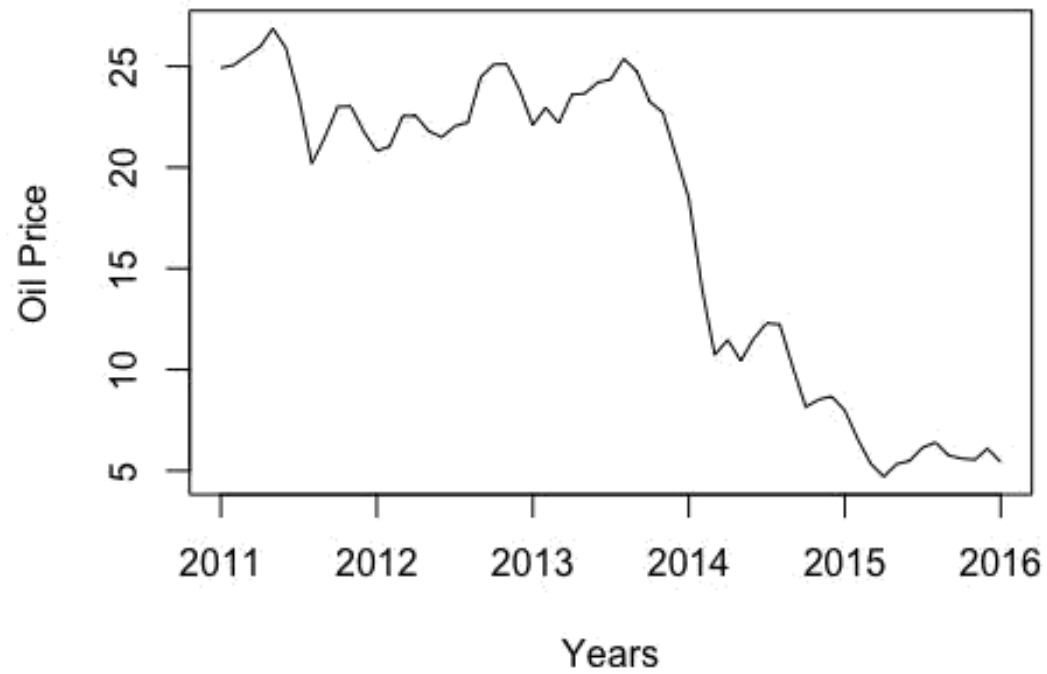


```
ts.oil1<---ts(oilmonthly$Close, frequency = 12, start = c(2011), end =
c(2016)) ts.oil1
```

```
##           Jan      Feb      Mar      Apr      May      Jun      Jul
## 2011 24.927143 25.061905 25.526500 25.958000 26.867273 25.907000 23.462273
## 2012 20.807619 21.052000 22.551905 22.542632 21.791500 21.500000 22.037727
## 2013 22.097000 22.959524 22.177143 23.599474 23.659048 24.197143 24.360476
## 2014 18.476316 14.080454 10.730000 11.477368 10.440909 11.530952 12.305000
## 2015  7.987500  6.562727  5.343684  4.710000  5.325000  5.491429  6.149524
## 2016  5.415714
##           Aug      Sep      Oct      Nov      Dec
## 2011 20.182381 21.494286 23.001739 23.021053 21.767143
## 2012 22.225500 24.476363 25.093636 25.107000 23.813478
## 2013 25.378095 24.758182 23.247143 22.726190 20.626522
## 2014 12.229545 10.120455  8.152381  8.515714  8.678636
## 2015  6.395000  5.751500  5.601739  5.544286  6.098095
## 2016
```

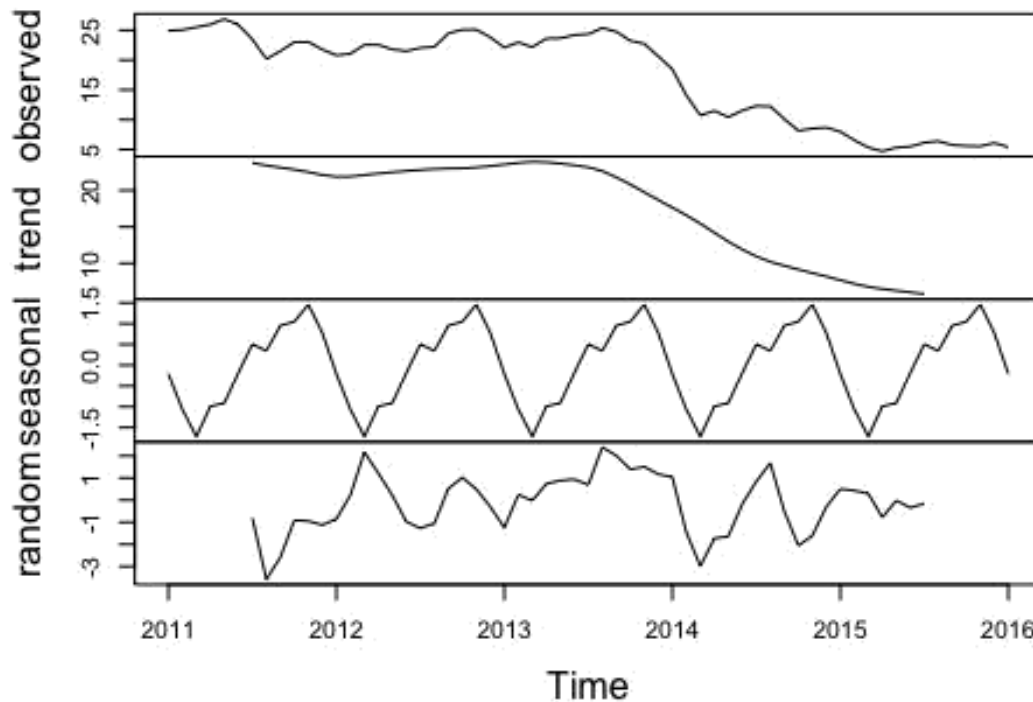
```
plot.ts(ts.oil1, xlab="Years", ylab="Oil Price", main="Time Series for Oil")
```

## Time Series for Oil



```
ts.oil2 <---decompose(ts.oil1)  
plot(ts.oil2)
```

## Decomposition of additive time series

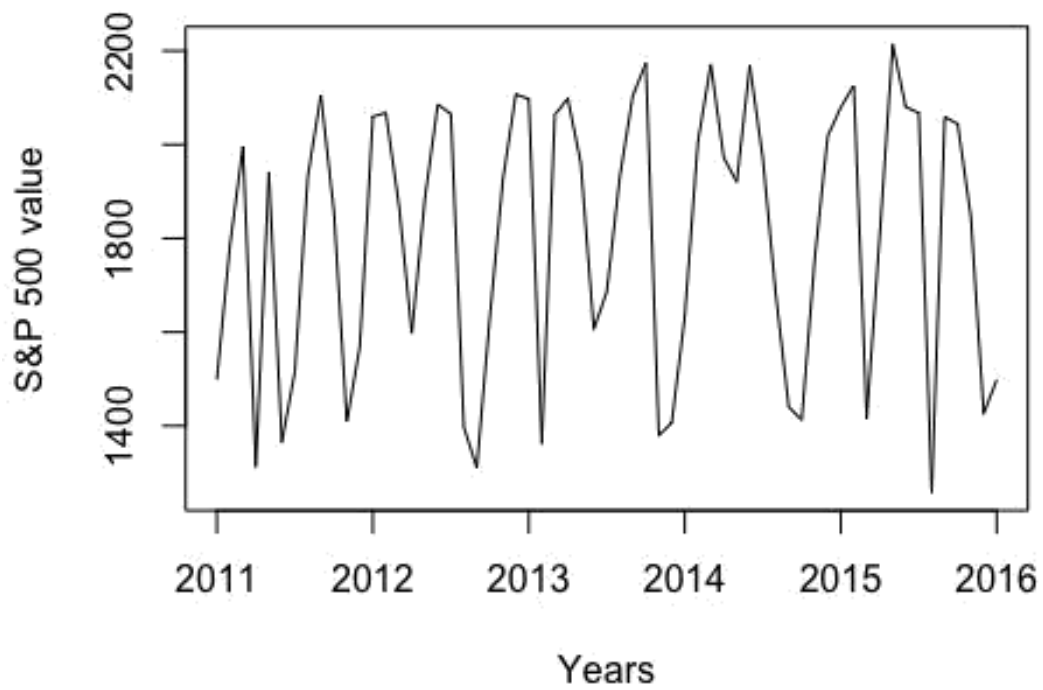


```
ts.sp1<---ts(sp500series$Close, frequency = 12, start = c(2011), end =
c(2016)) ts.sp1
```

```
##           Jan      Feb      Mar      Apr      May      Jun      Jul      Aug
## 2011 1498.11 1782.59 1994.99 1312.41 1940.24 1365.68 1514.68 1932.23
## 2012 2059.74 2067.89 1872.34 1597.57 1883.95 2085.51 2065.30 1397.91
## 2013 2096.95 1362.16 2063.11 2098.86 1960.23 1606.28 1685.73 1930.67
## 2014 1632.97 2003.37 2170.95 1972.18 1920.03 2168.27 1972.29 1681.55
## 2015 2079.36 2126.15 1416.18 1805.81 2213.35 2080.41 2067.56 1257.60
## 2016 1498.11
##           Sep      Oct      Nov      Dec
## 2011 2104.50 1859.45 1408.47 1569.19
## 2012 1310.33 1630.74 1923.57 2107.39
## 2013 2103.84 2173.60 1379.32 1406.58
## 2014 1440.67 1412.16 1756.54 2018.05
## 2015 2058.90 2043.94 1848.36 1426.19
## 2016
```

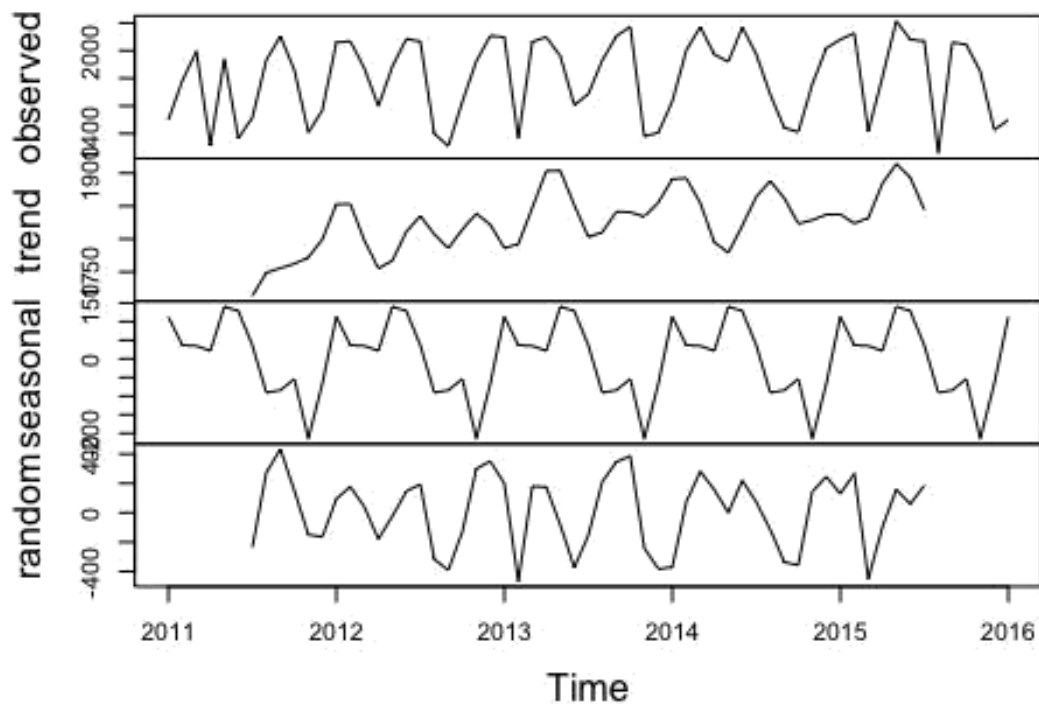
```
plot.ts(ts.sp1, xlab="Years", ylab="S&P 500 value", main="Time Series for
S&P500")
```

## Time Series for S&P500



```
ts.sp2 <---decompose(ts.sp1)  
plot(ts.sp2)
```

## Decomposition of additive time series

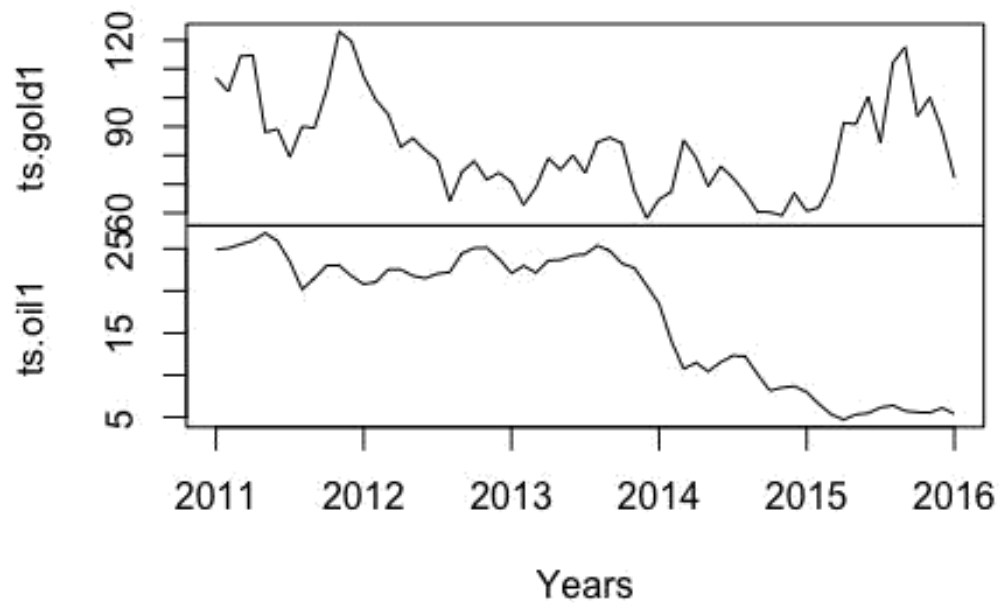


## Correlation between Gold and Oil using time series analysis

Merging the Gold and Oil time series as they are of the same frequency.

```
combine <--- cbind(ts.gold1,ts.oil1)
plot.ts (combine, xlab="Years", main="Correlation between Gold and Oil")
```

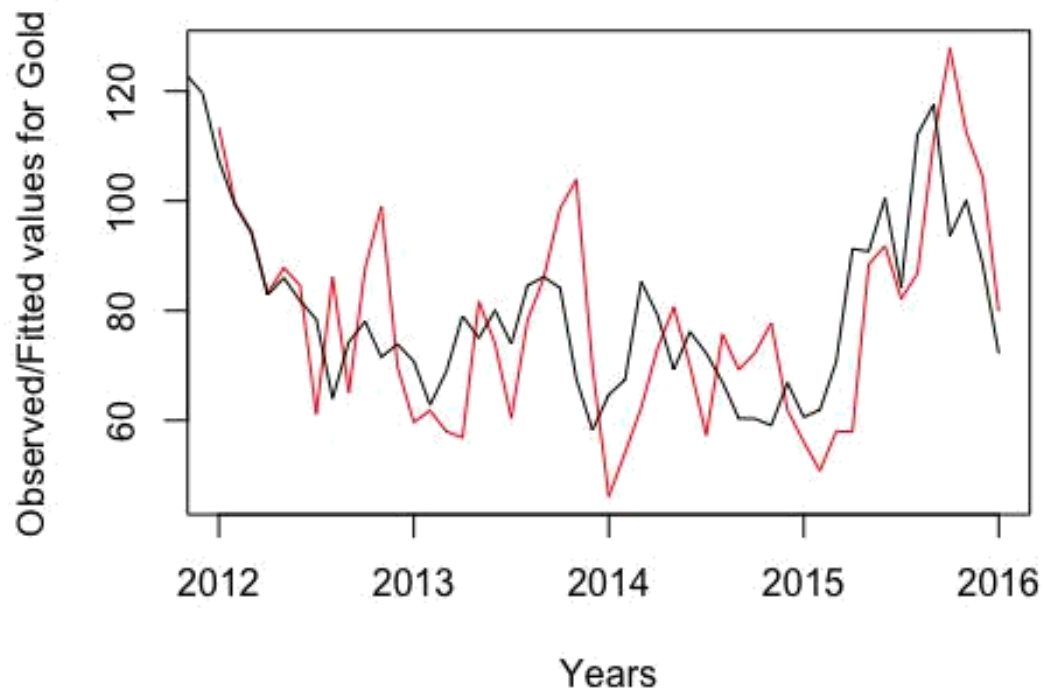
## Correlation between Gold and Oil



### HoltWinter's filtering for Gold, Oil and S&P500 with plots.

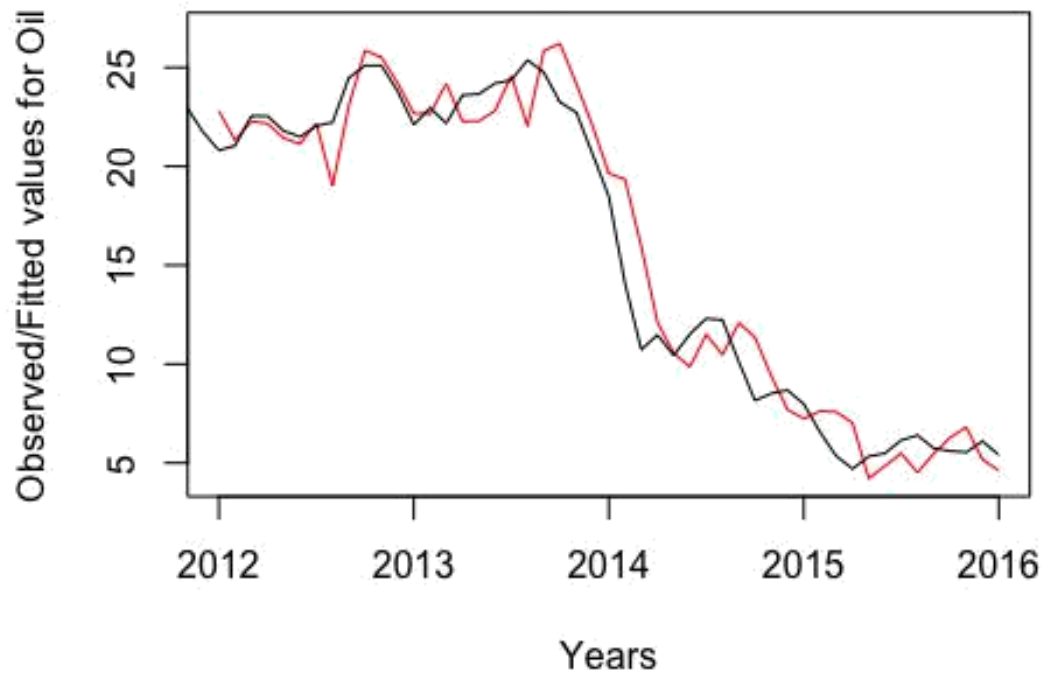
```
rain.gold<--- HoltWinters(ts.gold1, gamma=TRUE)
plot(rain.gold,xlab="Years", ylab="Observed/Fitted values for Gold",
main="Holt---Winter's filtering for Gold")
```

## Holt-Winter's filtering for Gold



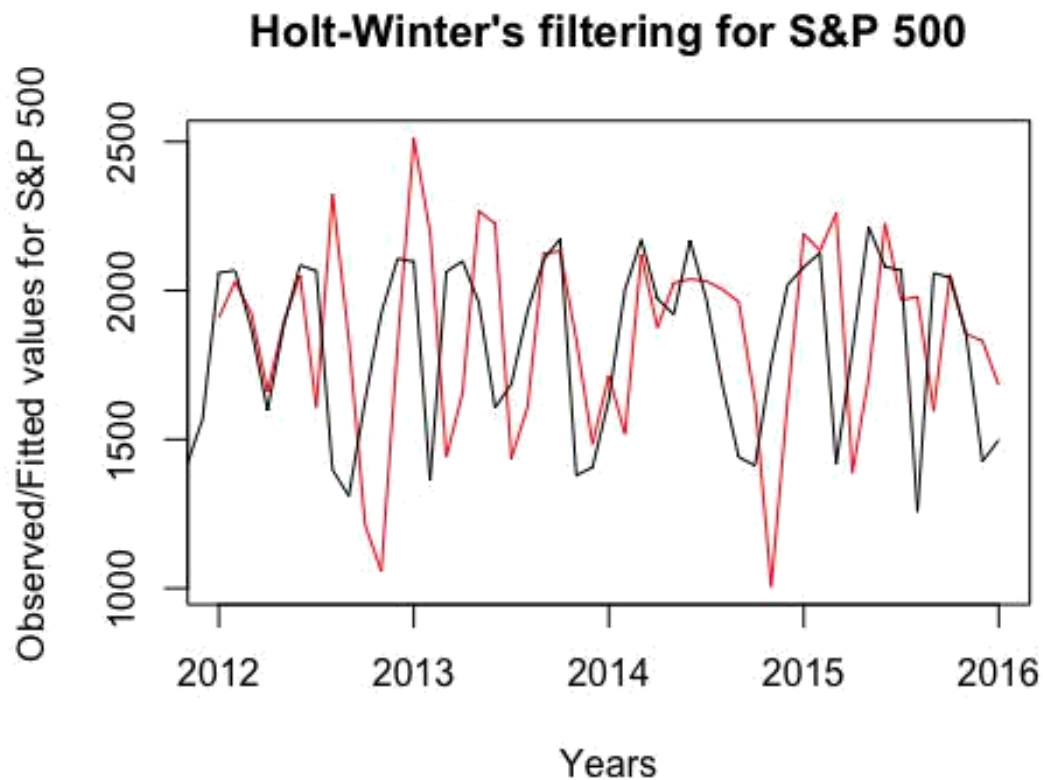
```
rain.oil<--- HoltWinters(ts.oil1, gamma=TRUE)
plot(rain.oil,xlab="Years", ylab="Observed/Fitted values for Oil",
main="Holt---Winter's filtering for Oil")
```

## Holt-Winter's filtering for Oil



```
rain.sp <--- HoltWinters(ts.sp1, gamma=TRUE)
plot(rain.sp,xlab="Years", ylab="Observed/Fitted values for S&P 500",
main="Holt---Winter's filtering for S&P 500" )
```





### Forecasts from HoltWinters for Gold, Oil and S&P 500.

```
library(forecast)

## Loading required package: timeDate

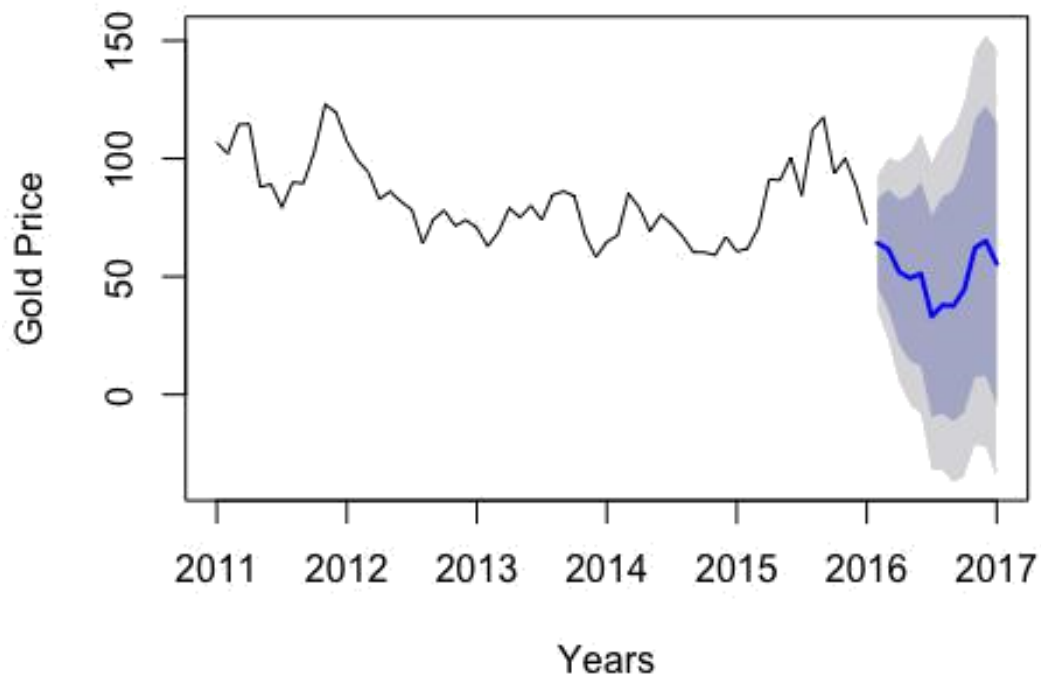
## This is forecast 7.3

##
## Attaching package: 'forecast'

## The following object is masked from 'package:hydroTSM':
##
##      ma

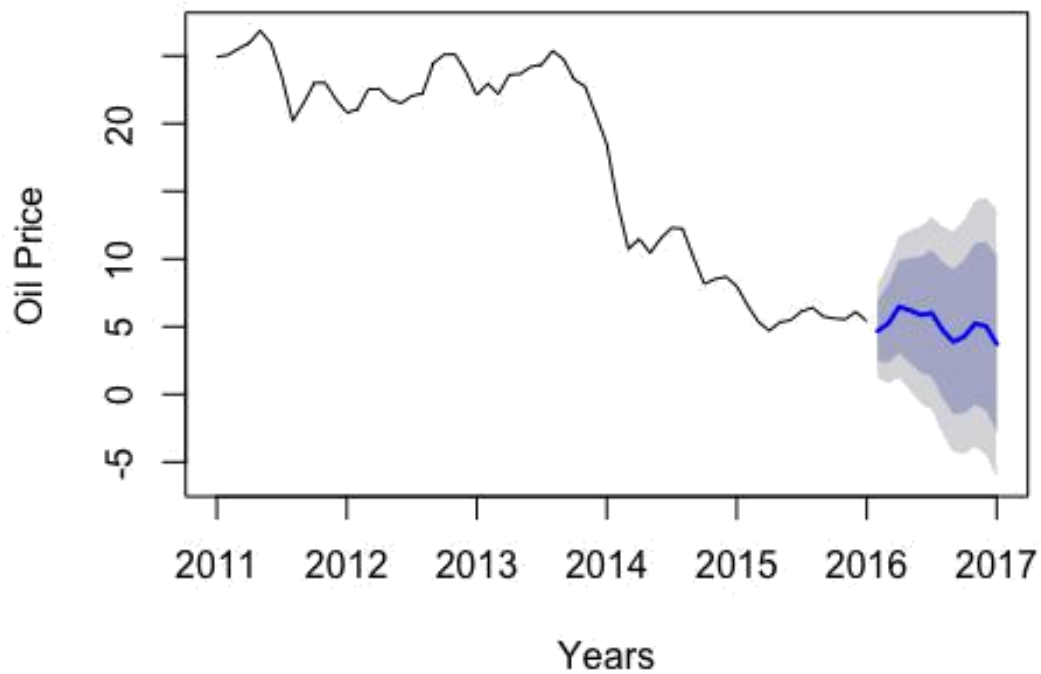
rain.forecastgold <--- forecast.HoltWinters(rain.gold, h=12,
start=c(2011), end=c(2016))
plot.forecast(rain.forecastgold,xlab="Years",ylab="Gold Price", main
="Forecasts from HoltWinters for Gold")
```

## Forecasts from HoltWinters for Gold



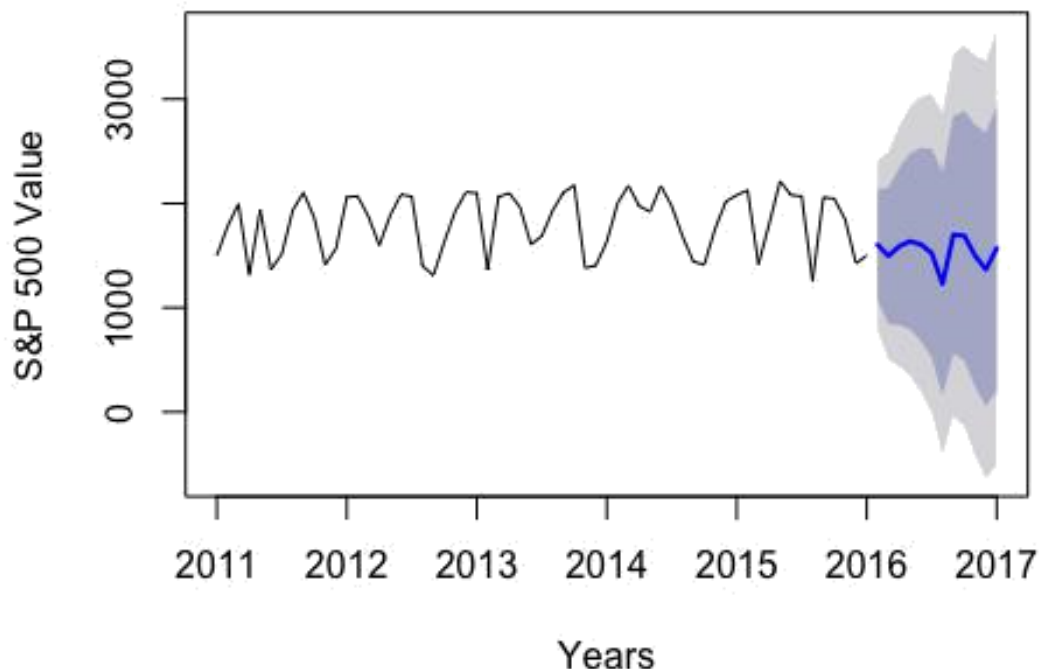
```
rain.forecastoil <--- forecast.HoltWinters(rain.oil, h=12,  
start=c(2011), end=c(2016))  
plot.forecast(rain.forecastoil,xlab ="Years",ylab = "Oil Price", main  
= "Forecasts from HoltWinters for Oil")
```

## Forecasts from HoltWinters for Oil



```
rain.forecastsp <--- forecast.HoltWinters(rain.sp, h=12,  
start=c(2012), end=c(2016))  
plot.forecast(rain.forecastsp,xlab ="Years",ylab = "S&P 500 Value", main =  
"Forecasts from HoltWinters for S&P 500")
```

## Forecasts from HoltWinters for S&P 500



## Forecasts from ARIMA 1,2,1 for Gold, Oil and S&P 500

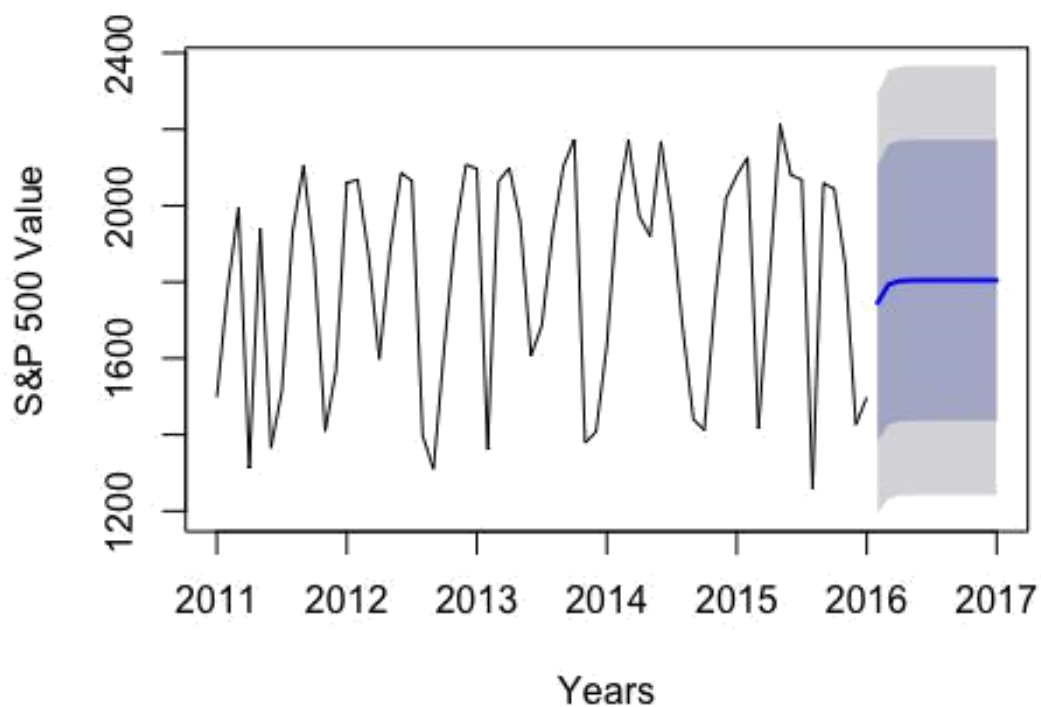
To quantify the variance in time series forecasts.

```
auto.arima(ts.sp1)

## Series: ts.sp1
## ARIMA(0,0,0)(1,0,0)[12] with non---zero mean
##
## Coefficients:
##          sar1  intercept
##          ---0.4524  1814.1593
## s.e.      0.1260   24.2843
##
## sigma^2 estimated as 68549: log likelihood=---426.54
## AIC=859.08  AICc=859.5  BIC=865.41

sp500.arima<---arima(ts.sp1, c(1,0,0))
sp500.arima.forecasts <--- forecast.Arima(sp500.arima, h=12)
plot(sp500.arima.forecasts,xlab ="Years",ylab = "S&P 500 Value", main
= "Forecasts from ARIMA for S&P 500")
```

## Forecasts from ARIMA for S&P 500



```

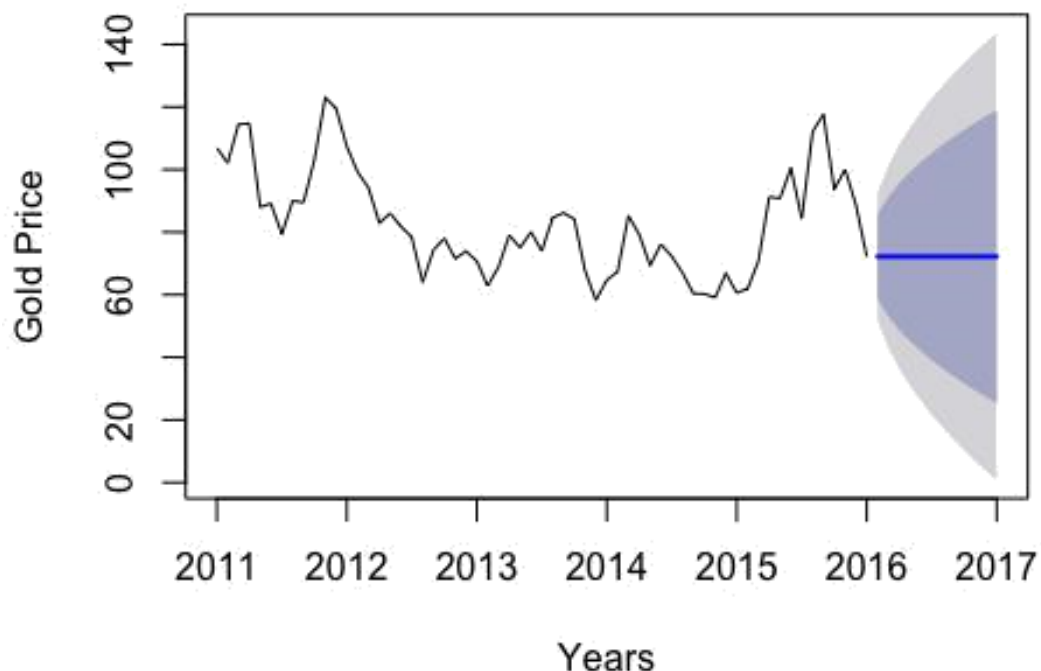
auto.arima(ts.gold1)

## Series: ts.gold1
## ARIMA(0,1,0)(0,1,1)[12]
##
## Coefficients:
##          sma1
##          ---0.7881
## s.e.    0.4297
##
## sigma^2 estimated as 131.1:  log likelihood=---189.86
## AIC=383.73   AICc=384    BIC=387.47

gold.arima<---arima(ts.gold1, c(0,1,0))
gold.arima.forecasts <--- forecast.Arima(gold.arima, h=12)
plot(gold.arima.forecasts,xlab ="Years",ylab = "Gold Price", main
= "Forecasts from ARIMA for Gold" )

```

## Forecasts from ARIMA for Gold

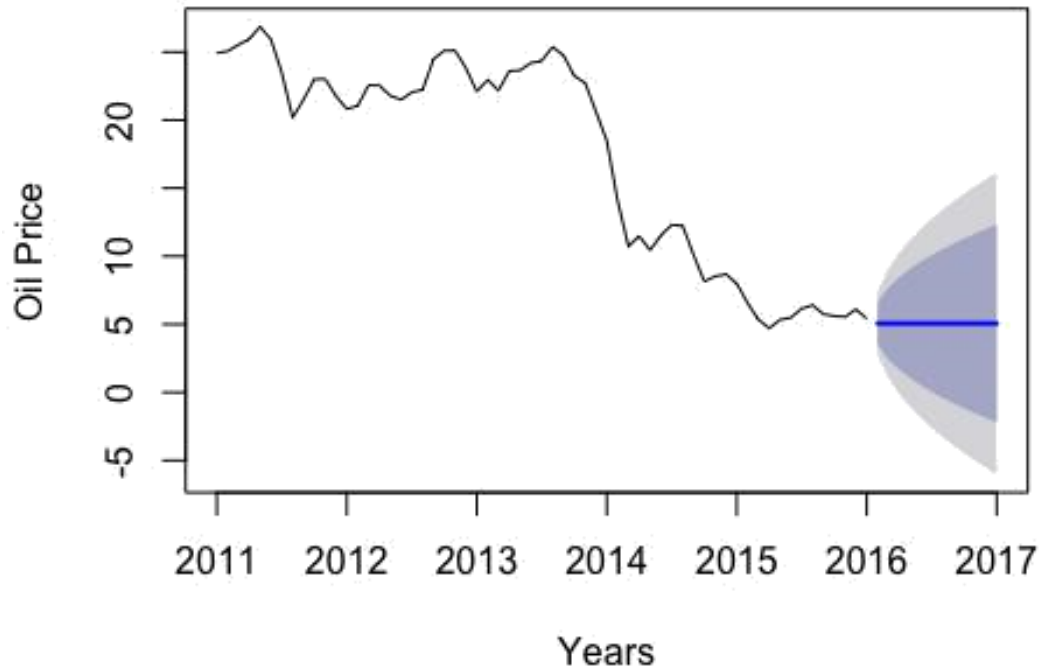


```
auto.arima(ts.oil1)

## Series: ts.oil1
## ARIMA(0,1,1)(0,0,1)[12]
##
## Coefficients:
##          ma1smal
##      0.3742  0.3334
## s.e.  0.1079  0.1437
##
## sigma^2 estimated as 1.348: log likelihood=---93.87
## AIC=193.73  AICc=194.16  BIC=200.01

oil.arima<---arima(ts.oil1, c(0,1,1))
oil.arima.forecasts <--- forecast.Arima(oil.arima, h=12)
plot(oil.arima.forecasts,xlab="Years",ylab="Oil Price", main="Forecasts
from ARIMA for Oil")
```

## Forecasts from ARIMA for Oil



### Correlation between Gold and Oil using time series analysis

The time series proves the fact that Gold and Oil prices are dollar dominated, hence they are strongly linked. For an instance, consider the 2014 to 2016, the time series plot shows that for Gold prices is going high while the oil prices at the same time are going completely low, almost below the average. This shows that there is negative correlation. Similarly, if we look at before 2013, the oil and gold prices show almost similar respective ups and downs in the prices, proving that there is an average correlation. Hence there is a correlation between gold and crude oil prices.

### Complete the forecast between Gold, Oil, or SP500 based for 2017.

#### Investment Strategy:

Decomposition of additive time series:

Trend Analysis for Gold: For Gold, there is a major downfall between 2012 and 2013. After the downfall, the prices didn't get over the fall until 2015. Though there is a slight improvement last year, but the trend shows that it's quite unruly.

Trend Analysis for Oil: For Oil, the prices are on the same average level till mid of 2013.

While from 2014, there has been a major downfall. And hence choosing Crude oil to invest money is not at all an option.

Trend Analysis for S&P 500: For S&P 500, there is almost the same trend for every year and also the seasonality also shows that there are same observed changes very year.

Forecast from HoltWinters:

For Oil: For the year 2017, there is the same trend followed like the year 2016. There is no major increase in the price of the crude oil. So looking at the trend and HoltWinters forecast, we can say that investing in crude oil is not an option.

For Gold: The starting of the year 2017 will show a downfall going below 50 dollar. And it continues even for the mid of the year. When nearing the end of the year, the prices go high up to 65---75 dollar. But at the end of the year there is downfall by few dollars.

For S&P 500: The value for S&P 500 for 2017 is on a average scale up to mid of 2017 where there is a downfall. But there is a peak in price after that and a slight downfall and again increase by the end of the year. This can be an option for investing, as the trend is not same like last year. There is no high decrease in prices.

Hence, considering the Trend and Forecast from HoltWinters we can say that, investment in crude oil is a bad choice. Investment in S&P 500, can be a good option, if only the investment is done in the beginning of the year and sold when there is a increase in prices at the mid of the year. And investment in Gold also similar, though its unruly but still it can also be an option if bought at starting of the year and sold at the end of the year when there is peak in prices.

But if we look at "Forecast from ARIMA", the S&P 500 forecast at (1,0,0) is almost a straight line after an increase in the price and for gold is a straight line at (0,1,0). So if we consider the forecast from ARIMA at (0,1,1) for Oil, which is also a straight constant line. Since there is an increase in the beginning for S&P 500, we should invest money in S&P 500.

This investment choice is done only considering the previous 5 year's prices data. We are not actually considering the Tesla impact, new presidency of U.S. which is effecting the dollar rate which will indirectly affect the prices of commodities. The Economic growth also plays major role. Hence, considering only the prices of last 5 years is bad way to calculate whether to invest the money on Crude Oil, Gold or S&P 500.

### **Quantify the variance in time series forecasts.**

We quantify the time series using the ARIMA forecast. We can choose an optimal model on the basis of (p, d, q) values. In order to choose the optimal model for the forecast, we use the function `auto.arima()` which gives the options to choose the optimal method. Out of which, the best model is chosen.



So after choosing the optimal  $(p, d, q)$  model for ARIMA, we can see that the forecast for S&P 500 for  $(1,0,0)$  has the low price in the beginning and then there is a increase and the price remains constant after that. Hence, if we invest in S&P 500, then we can buy at low price and sold it off at any point of the year, as the increase in price remains constant.