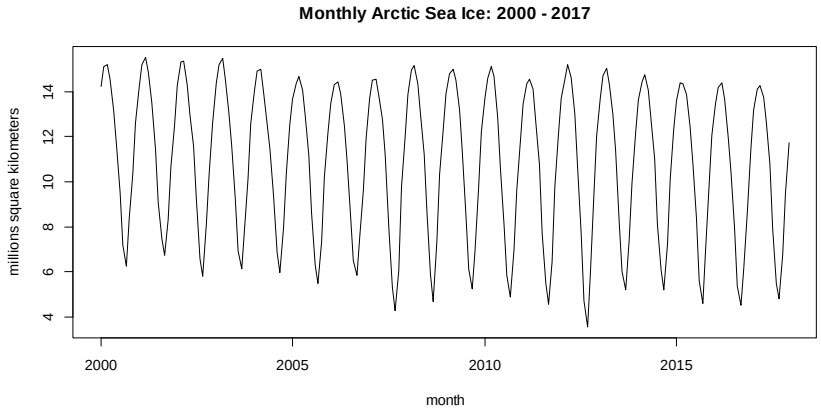
Department of Statistics
STATS 326: Applied Time Series
First Semester, 2019
Test 1

Appendix

Data: These data are monthly measurements of the area of sea ice (in millions of square kilometres) in the Arctic Ocean between 2000 and 2017.

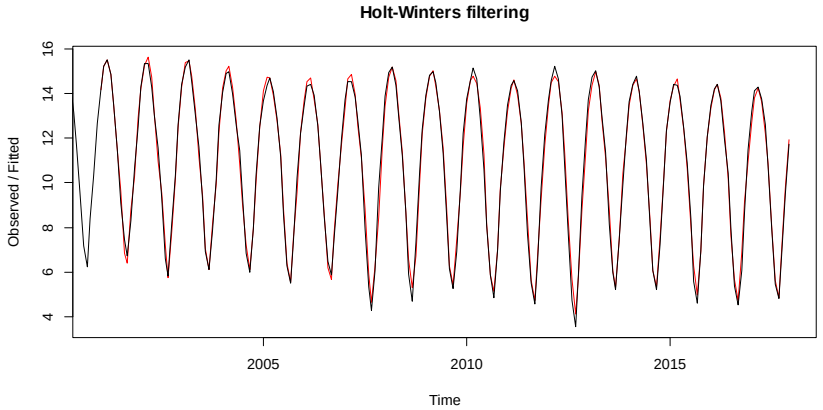
```
> Ice.ts = ts(Ice.df$Ice[1:216],frequency=12,start=2000)

> plot.ts(Ice.ts,xlab="month",ylab="millions square kilometers",
   main="Monthly Arctic Sea Ice: 2000 - 2017")
```




```
> actual
Jan 2018 Feb 2018 Mar 2018
   13.06    13.95    14.30
```


Holt-Winters Model:

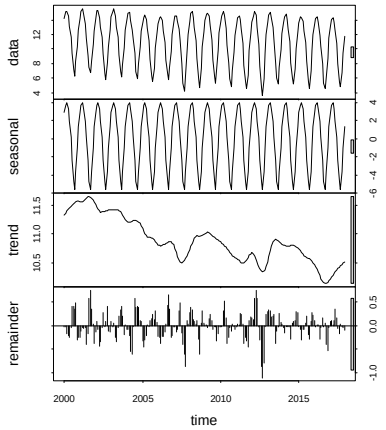
```
> HW.Ice = HoltWinters(Ice.ts)
> plot(HW.Ice)
```



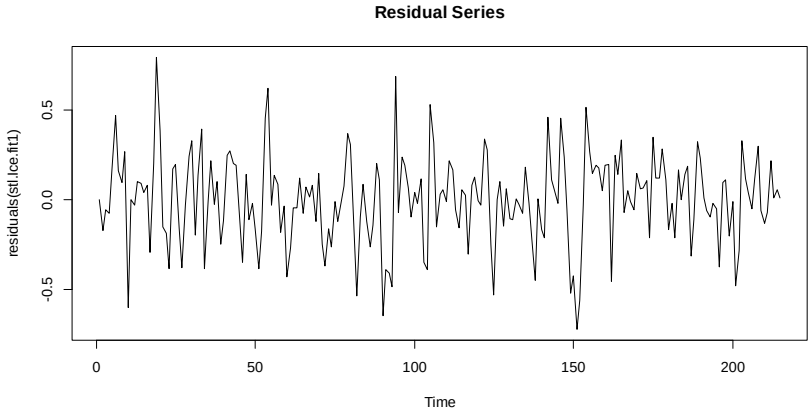

```
> HW.Ice
Holt-Winters exponential smoothing with trend and additive seasonal
component.

Call:
HoltWinters(x = Ice.ts)

Smoothing parameters:
 alpha: 0.8059899
 beta : 0
 gamma: 1

Coefficients:
              [,1]
a   10.043514876
b    0.009411422
s1   3.043538037
s2   3.717208561
s3   3.845767189
s4   3.214398543
s5   1.758173481
s6  -0.034788368
s7  -2.780165918
s8  -5.137436304
s9  -5.792183529
s10 -3.650371831
s11 -0.696691082
s12  1.696485124
```

Seasonal Trend Lowess Model:

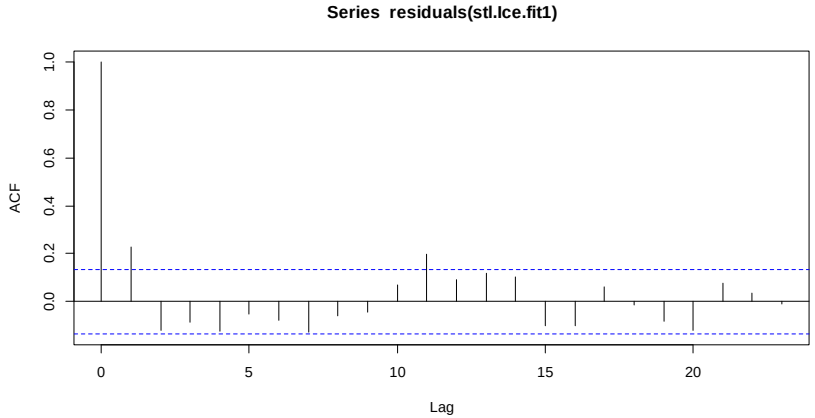
```
> stl.Ice = stl(Ice.ts,s.window="periodic")

> stl.Ice$time.series[1:12,1]
 [1]  2.8855419  3.7698393  3.9974701  3.3315367  1.9383810  0.2293830
 [7] -2.4001705 -4.7766671 -5.6609415 -3.6719690 -0.9635518  1.3211479

> plot(stl.Ice)
```




```
> stl.Ice.ts = Ice.ts-stl.Ice$time.series[,1]

> stl.Ice.fit1 = lm(stl.Ice.ts[-1]~Time[-1]+stl.Ice.ts[-216])

> plot.ts(residuals(stl.Ice.fit1),main="Residual Series")
```




```
> acf(residuals(stl.Ice.fit1))
```




```
> summary(stl.Ice.fit1)

Call:
lm(formula = stl.Ice.ts[-1] ~ Time[-1] + stl.Ice.ts[-216])

Residuals:
     Min       1Q   Median       3Q      Max
-0.71990 -0.14284  0.00249  0.14535  0.79299

Coefficients:
                 Estimate Std. Error t value Pr(>|t|)
(Intercept)       2.998559   0.533084   5.625 5.82e-08 ***
Time[-1]         -0.001460   0.000376  -3.884 0.000137 ***
stl.Ice.ts[-216]  0.738814   0.046276  15.966  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2486 on 212 degrees of freedom
Multiple R-squared:  0.7604,    Adjusted R-squared:  0.7581
F-statistic: 336.4 on 2 and 212 DF,  p-value: < 2.2e-16



> stl.Ice$time.series[1:12,1]
 [1]  2.8855419  3.7698393  3.9974701  3.3315367  1.9383810  0.2293830
 [7] -2.4001705 -4.7766671 -5.6609415 -3.6719690 -0.9635518  1.3211479



> stl.pred
Jan 2018 Feb 2018 Mar 2018
13.26479 ******** 14.32184
```