Homework 12

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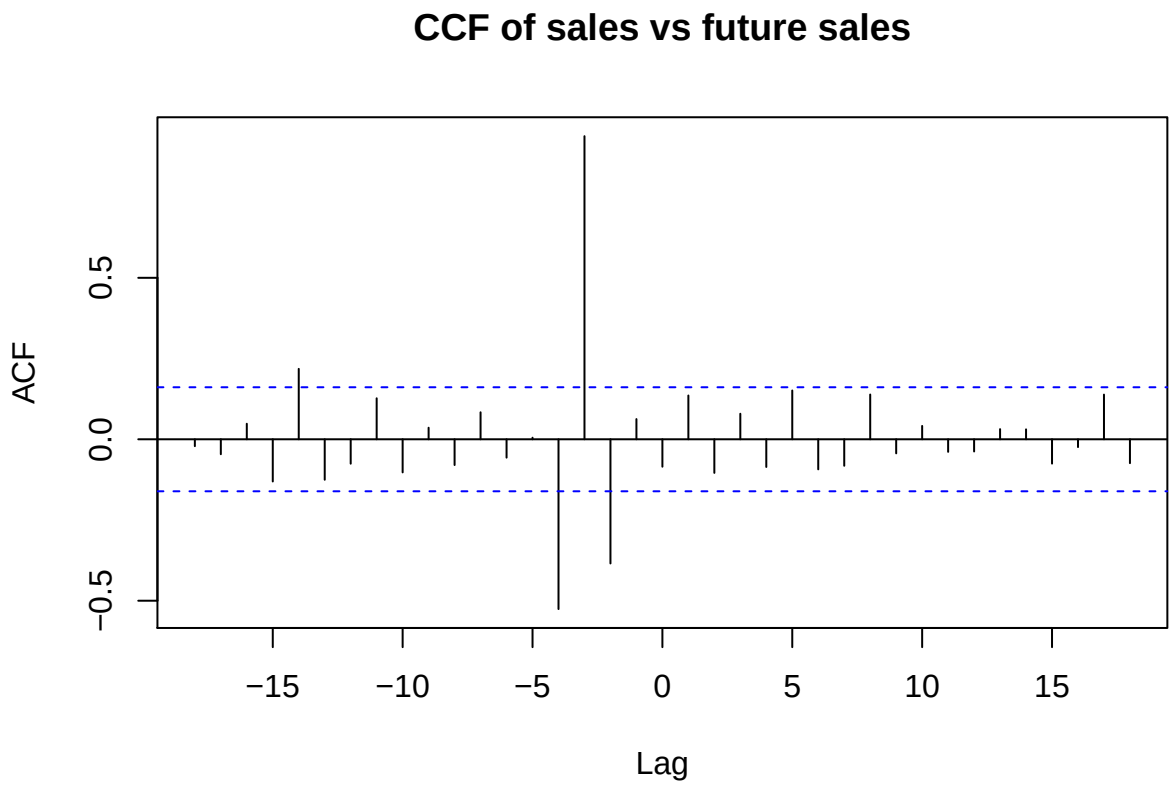
1.

a.

```
x<-ts(scan("lead.dat"))
y<-ts(scan("sales.dat"))

dx<-diff(x)
dy<-diff(diff(y))

ccf(dx,dy, main = "CCF of sales vs future sales")
```



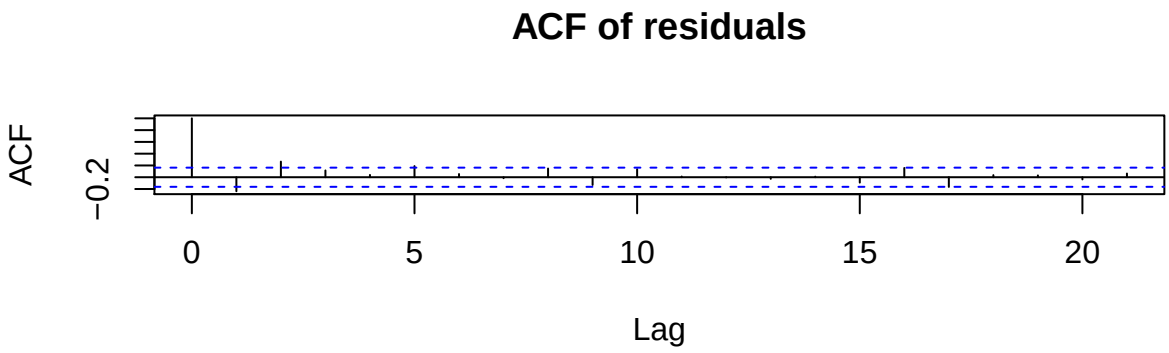
There are significant correlations at lags -2, -3, and -4. There is also a significant lag at -14, but I will not add this one to the model.

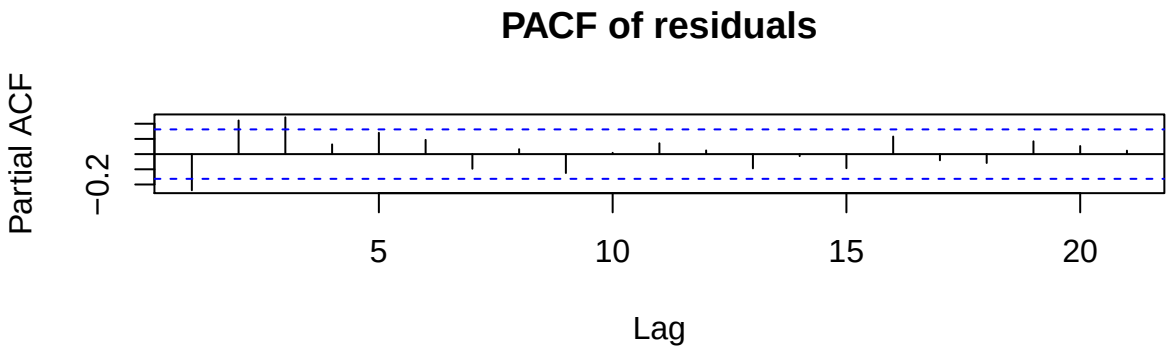
b.

```
dx2<-lag(dx,-2)
dx3<-lag(dx,-3)
dx4<-lag(dx,-4)
a<-cbind(dy,dx2,dx3,dx4)

result<-lm(dy~dx2+dx3+dx4,data=a,na.action=na.omit)

summary(result)
```

```
##
## Call:
## lm(formula = dy ~ dx2 + dx3 + dx4, data = a, na.action = na.omit)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -1.30942 -0.35108 -0.00276  0.34594  1.32585
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) -0.09992    0.04373  -2.285   0.0238 *
## dx2          0.12015    0.15307   0.785   0.4338
## dx3          4.83671    0.17014  28.428  < 2e-16 ***
## dx4         -0.70835    0.15273  -4.638 7.95e-06 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 0.5165 on 141 degrees of freedom
##   (7 observations deleted due to missingness)
## Multiple R-squared:  0.9111, Adjusted R-squared:  0.9092
## F-statistic: 481.4 on 3 and 141 DF,  p-value: < 2.2e-16
```

```
par(mfrow=c(2,1))
acf(result$residuals, main = "ACF of residuals")
pacf(result$residuals, main = "PACF of residuals")
```





The estimates for dx2 and dx3 and significant while the coefficient for dx1 is not. This is not indicative of white noise since there are many significant lags in both the ACF and PACF.

c.

```
library(TSA)
```

```
## Warning: package 'TSA' was built under R version 3.2.5
```

```
## Loading required package: leaps
```

```
## Warning: package 'leaps' was built under R version 3.2.5
```

```
## Loading required package: locfit
```

```
## Warning: package 'locfit' was built under R version 3.2.5
```

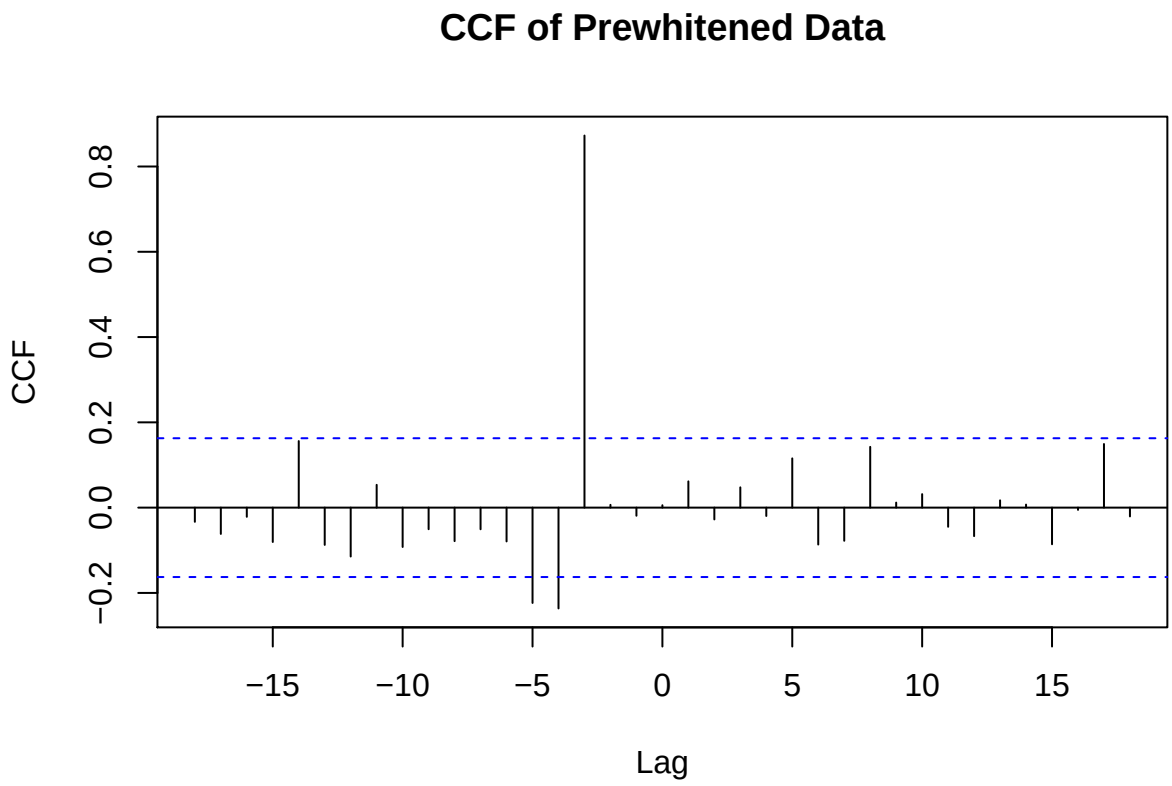
```
## locfit 1.5-9.1    2013-03-22
```

```
## Loading required package: mgcv
```

```
## Loading required package: nlme
```

```
## This is mgcv 1.8-7. For overview type 'help("mgcv-package")'.

## Loading required package: tseries

## Warning: package 'tseries' was built under R version 3.2.4

##
## Attaching package: 'TSA'

## The following objects are masked from 'package:stats':
##
##     acf, arima

## The following object is masked from 'package:utils':
##
##     tar
```

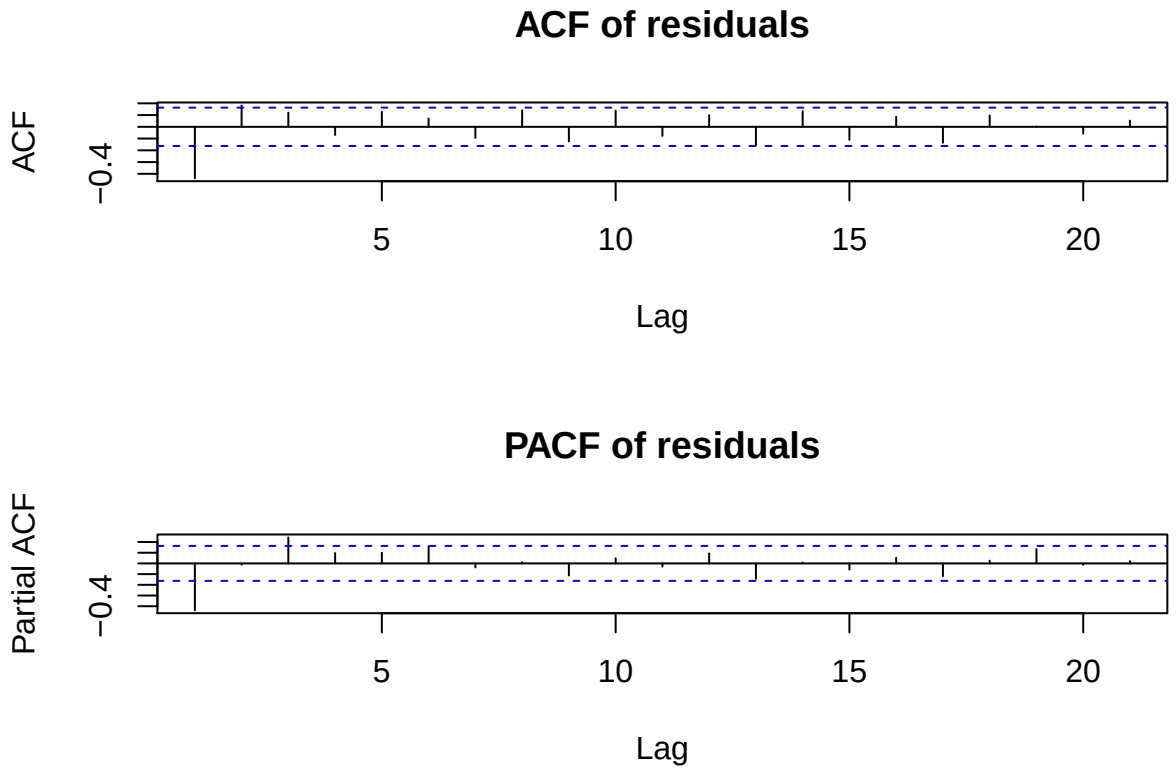
```
xy<-ts.intersect(as.ts(dx),as.ts(dy))

par(mfrow=c(1,1))
prewhiten(as.vector(xy[,1]),as.vector(xy[,2]), main="CCF of Prewhitened Data")
```



A CCF is affected by common trends between the two datasets. Prewhitening allows us to remove those trends.

d.

```
dx3<-lag(dx,-3)
dx4<-lag(dx,-4)
dx5<-lag(dx,-5)
b<-cbind(dy,dx3,dx4,dx5)
result2<-lm(dy~dx3+dx4+dx5,data=b,na.action=na.omit)

par(mfrow=c(2,1))
acf(result2$residuals, main = "ACF of residuals")
pacf(result2$residuals, main = "PACF of residuals")
```



After the first lag in both the ACF and PACF there is a pattern, but none are significant aside from lag 3 in the PACF. This could be considered white noise.

e.

```
dy<-b[4:148,1]
dx3<-b[4:148,2]
dx4<-b[4:148,3]
dx5<-b[4:148,4]
```

```
result.arma<-arima(dy,order=c(3,0,2),xreg=data.frame(dx3, dx4, dx5))
result.arma$aic
```

```
## [1] 143.7014
```

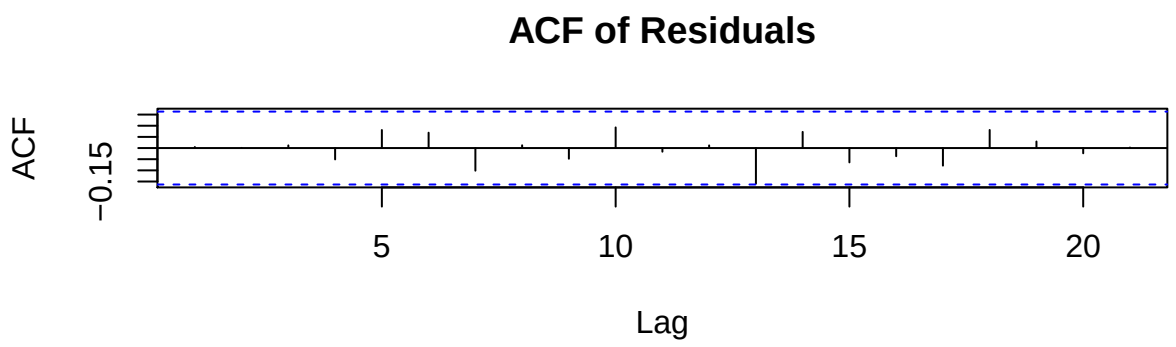
```
result.arma2<-arima(dy,order=c(2,0,1),xreg=data.frame(dx3, dx4, dx5))
result.arma2$aic
```

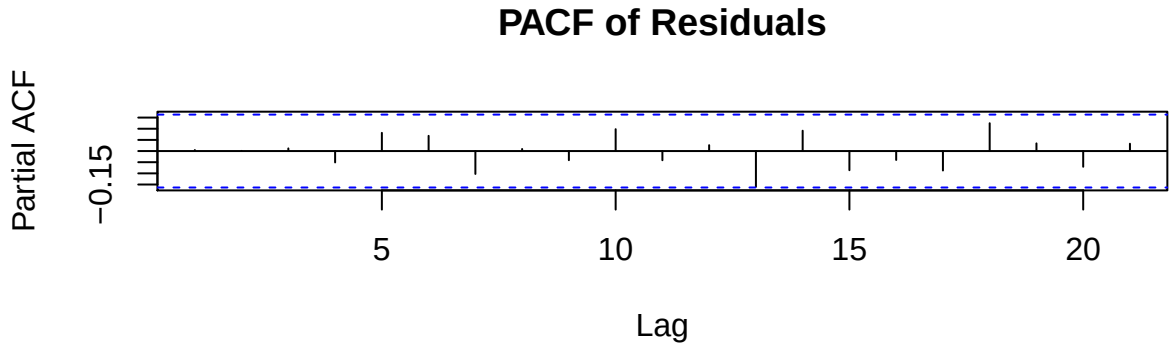
```
## [1] 151.5092
```

```
result.arma3<-arima(dy,order=c(1,0,1),xreg=data.frame(dx3, dx4, dx5))
result.arma3$aic
```

```
## [1] 154.4939
```

```
r<-residuals(result.arma)
r<-r[2:145]
par(mfrow=c(2,1))
acf(r, main="ACF of Residuals")
pacf(r, main="PACF of Residuals")
```





The final regression equation would include dx3, dx4, and dx5, and it would be an ARMA(3,2) model.