PSTAT 174 Lab 5

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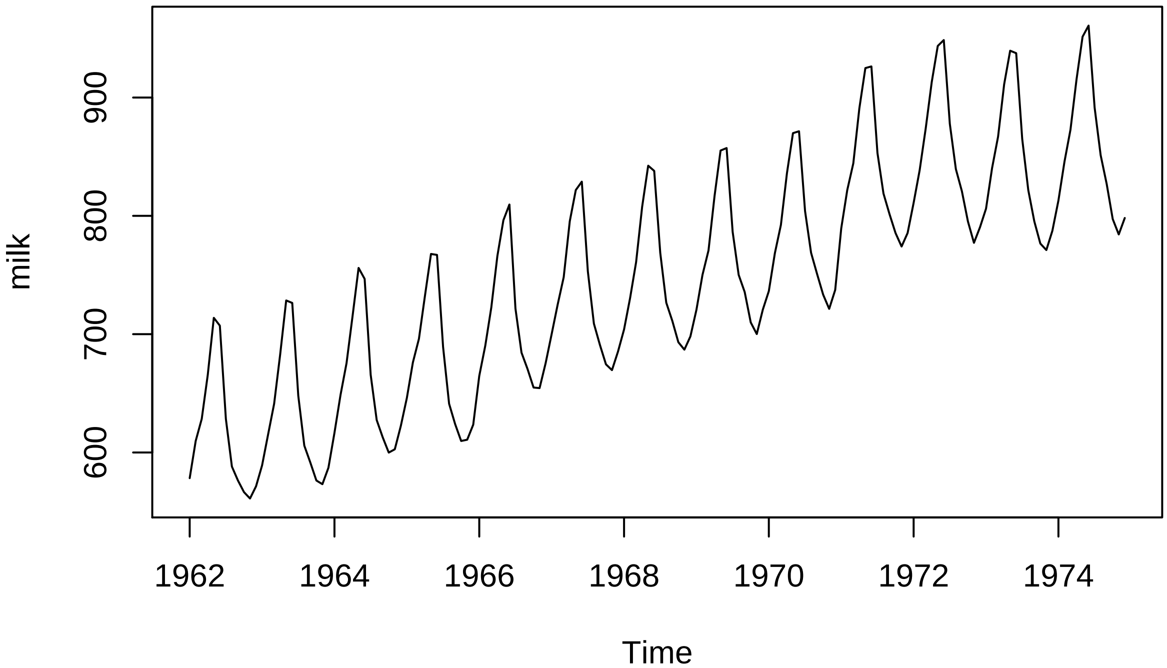
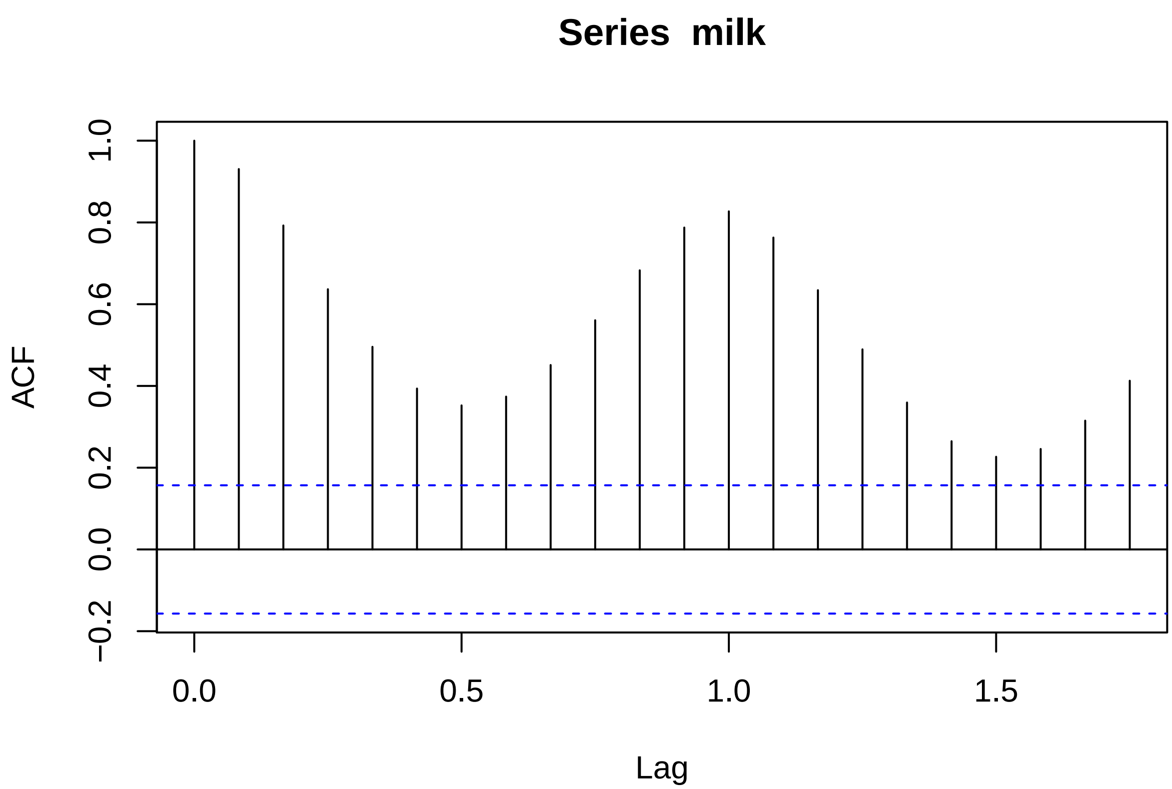
** 1 Milk Time series **

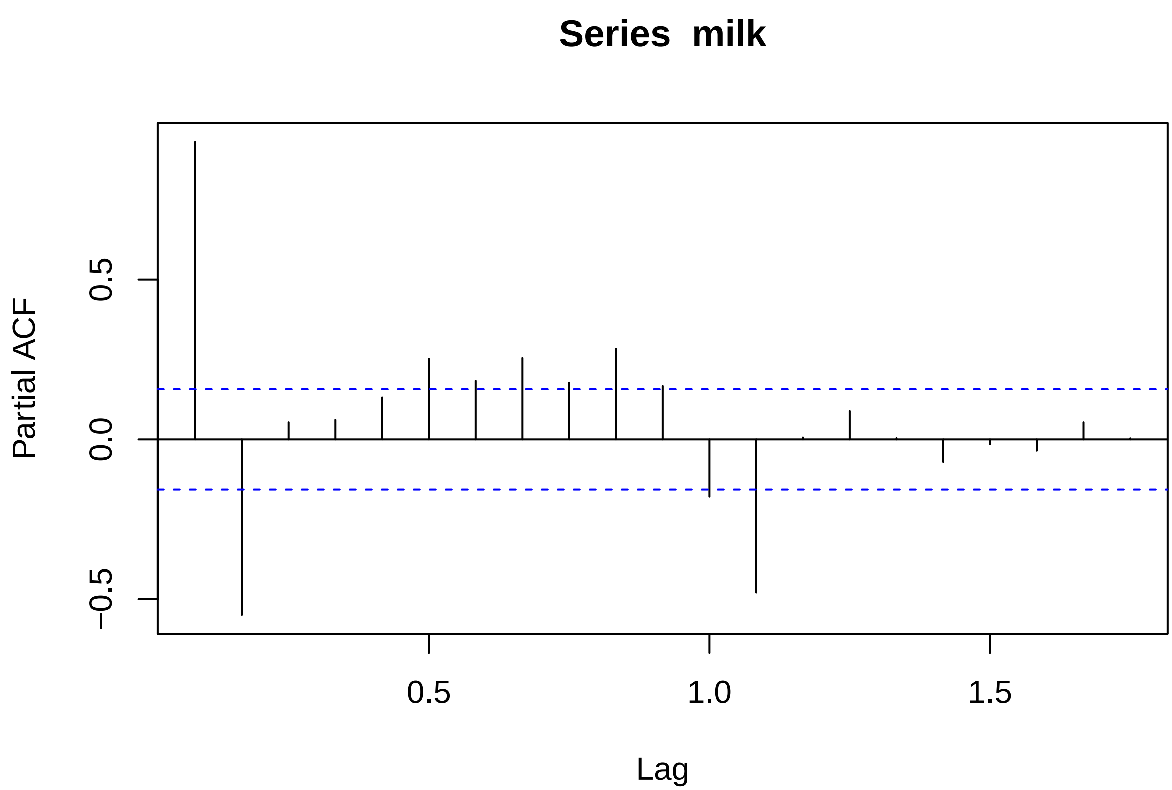
```
#Monthly milk production: Jan. 1962 to Dec. 1975
# Xt: time series milk
library(tsdl)
milk <- subset(tsdl, 12, "Agriculture")[[3]]
plot(milk)
```




```
acf(milk)
```

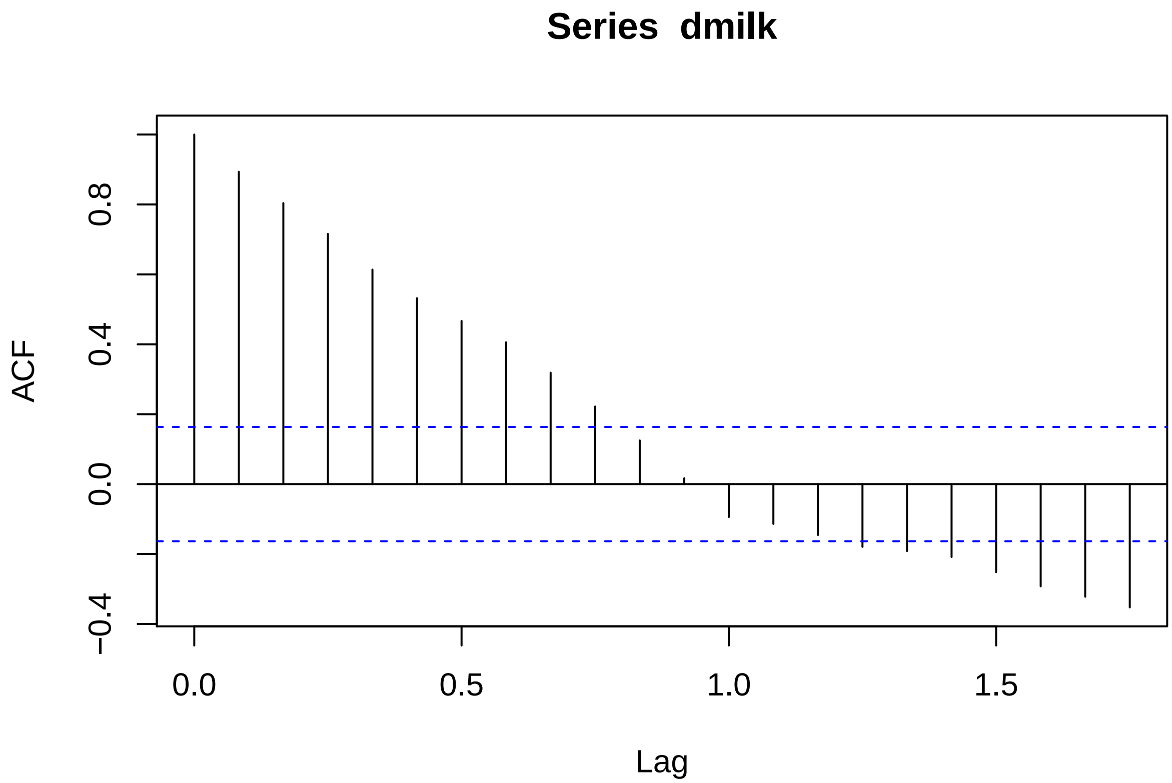



```
pacf(milk)
```

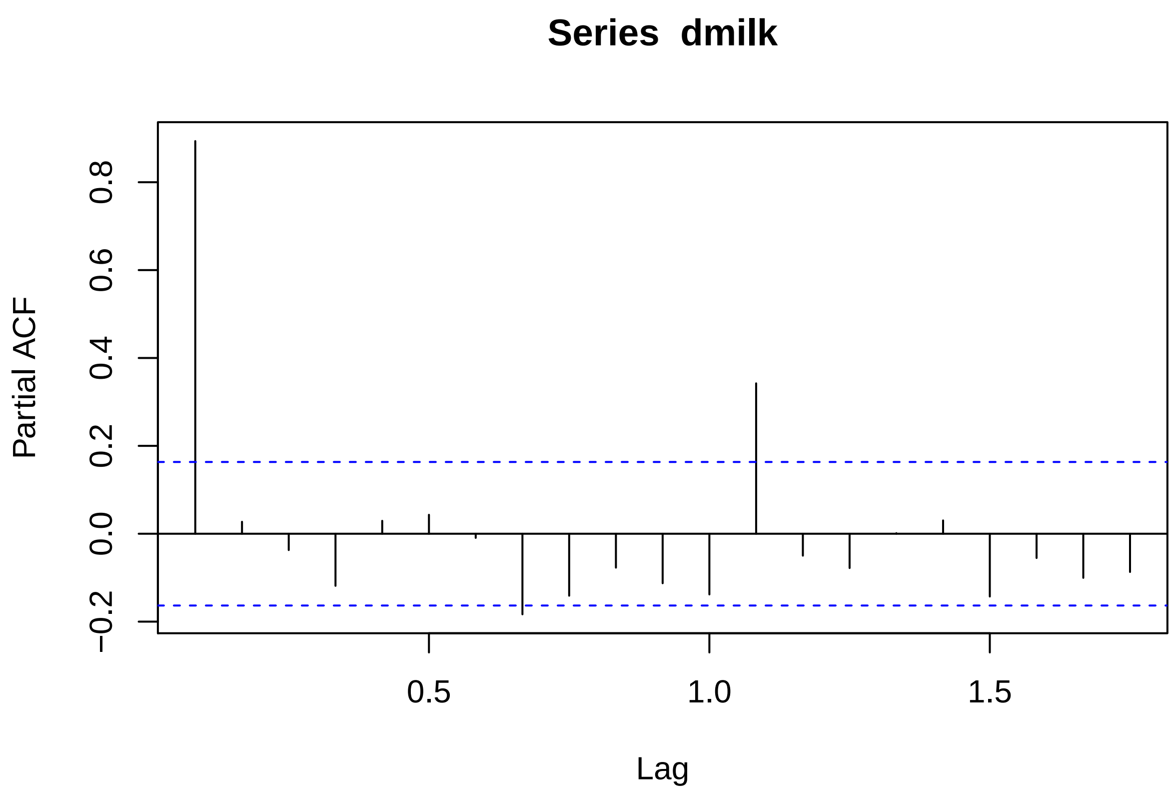



```
#Make stationary
#Remove seasonality, lag(12)
dmilk <- diff(milk, 12)
```

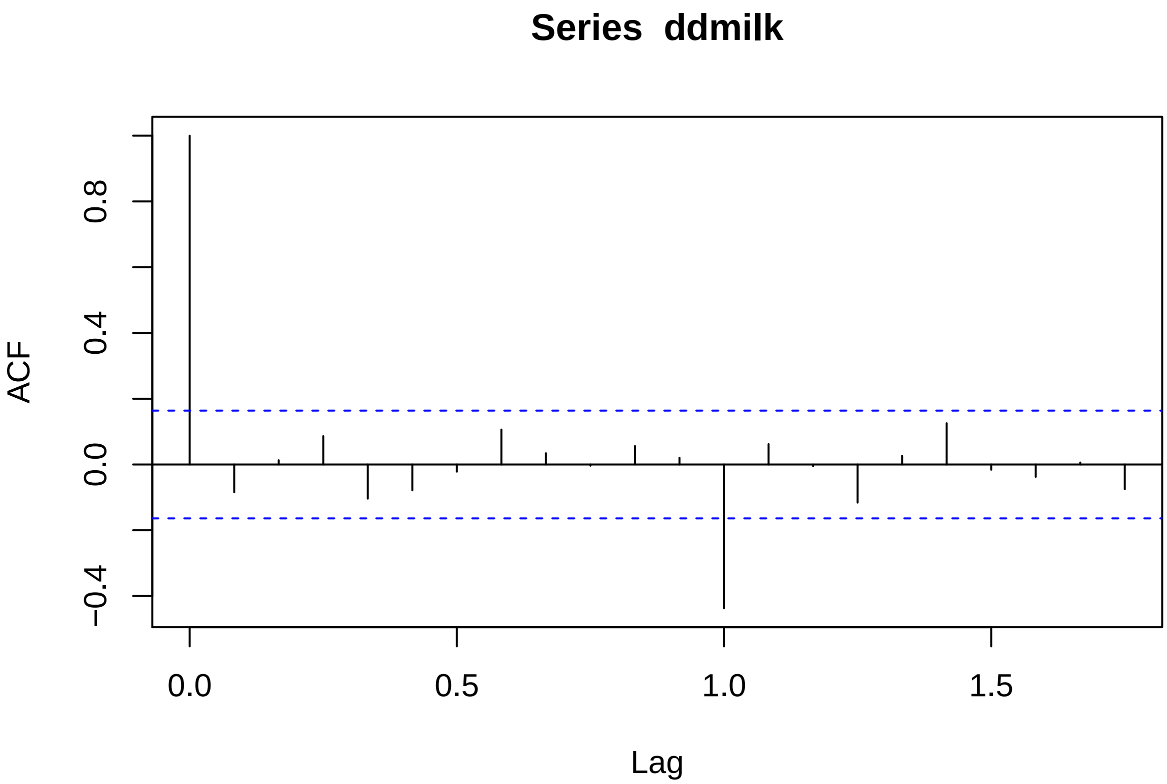
```
acf(dmilk)
```



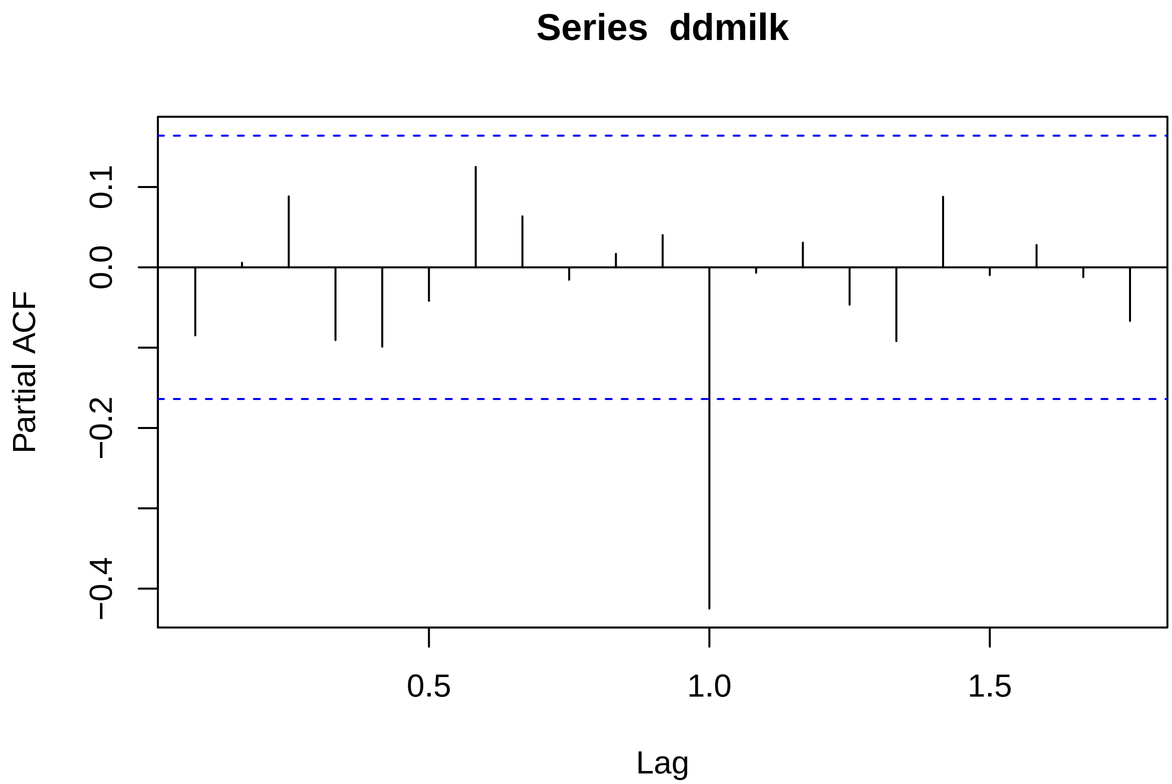

```
pacf(dmilk)
```



```r
#Remove trend, lag(1)
ddmilk <- diff(dmilk, 1)
acf(ddmilk)
```




```r
pacf(ddmilk)
```

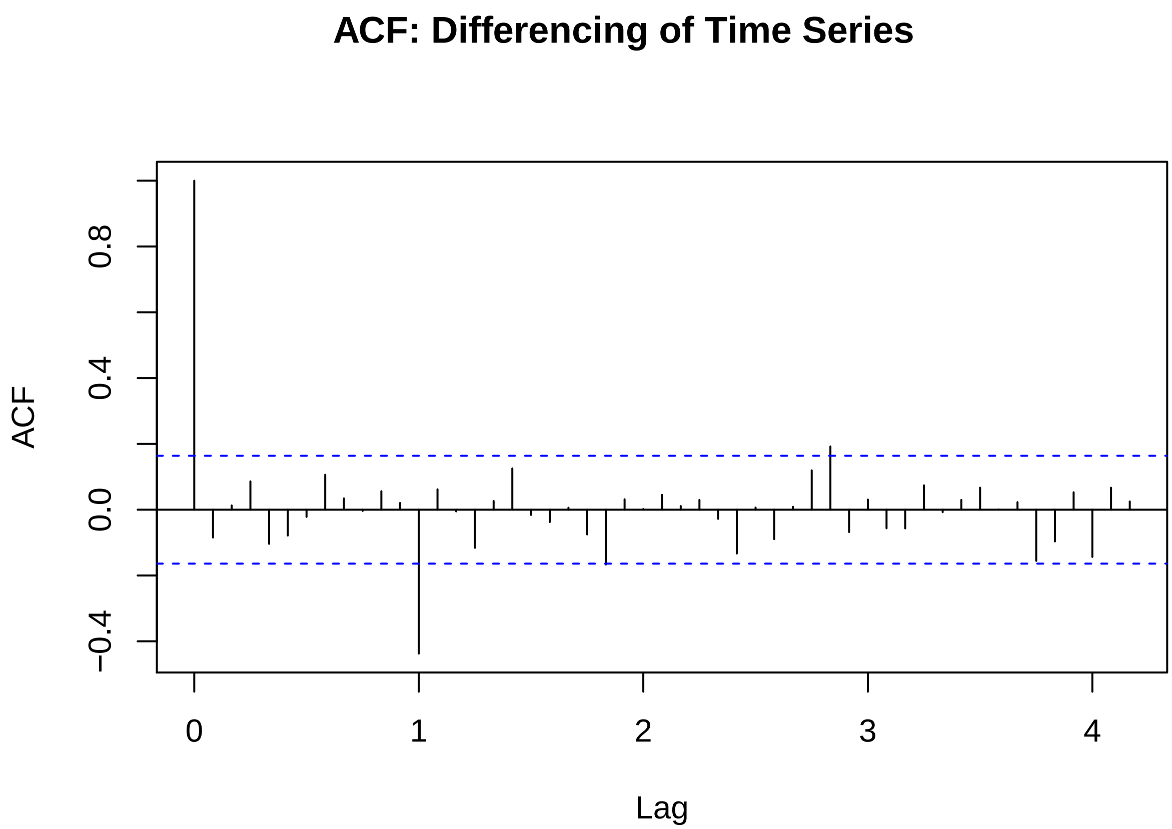


(a) Explain why the series milk looks not stationary.

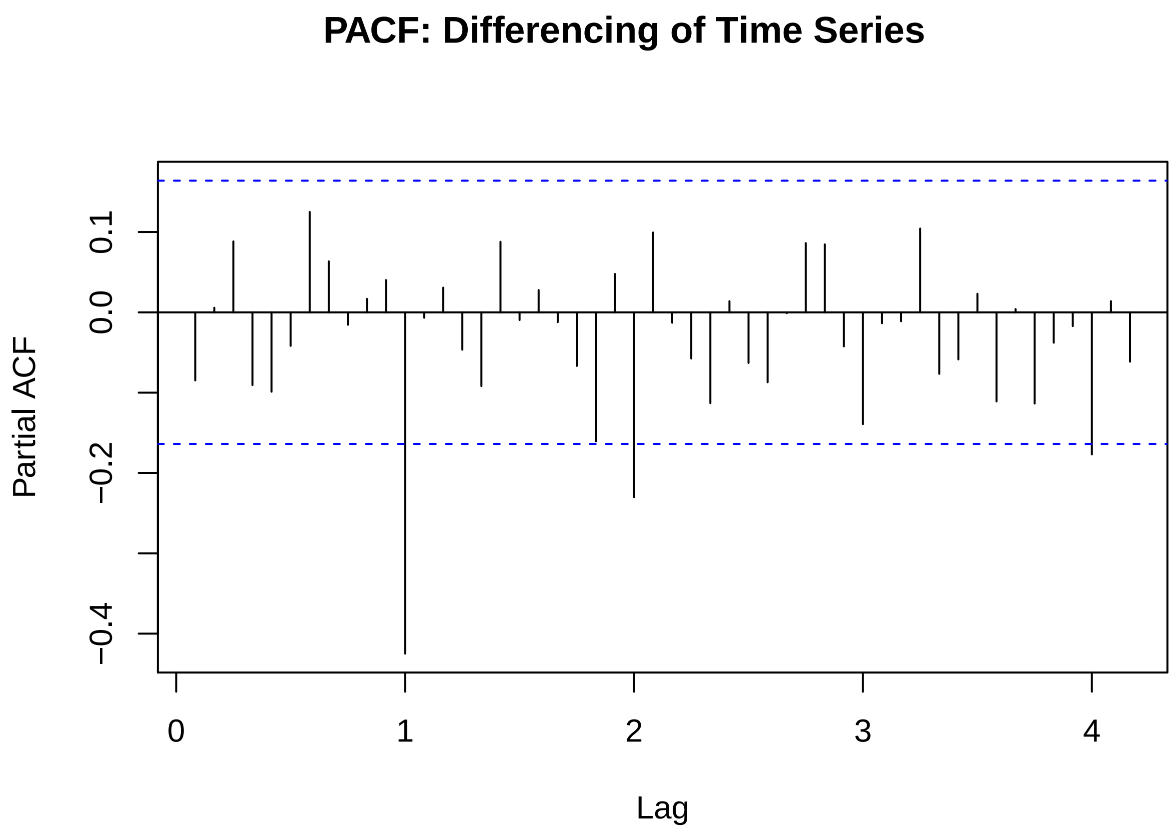
The milk time series is not stationary becuase it has a linear trend and seasonality. This is why we must difference at lag 12 to remove seasonality and difference at lag 1 to remove trend.

(b) Let Yt be the series ddmilk, that is, Yt = (1-B)(1-B^12)Xt Plot the ACF and PACF of Yt with lag.max = 50.

```
acf( ddmilk, lag.max = 50, main = "")
title("ACF: Differencing of Time Series", line = -1, outer = TRUE)
```




```
#PACF
pacf( ddmilk, lag.max = 50, main = "")
title("PACF: Differencing of Time Series", line = -1, outer = TRUE)
```



(c) Now, we assume that Yt corresponds to a SARIMA model. Determine possible candidate models SARIMA(p, d, q) × (P, D, Q)s for the series Yt.

One seasonal differencing, so D = 1 at lag s = 12. ACF shows a strong peak at h = 1s and smaller peaks appearing at h = 2.8s, 3.7s. So, MA most likely is Q = 1 The PACF shows two stronk peaks at h = 1s, 2s and smaller peaks at h = 4s. So, AR part could be P = 1 or P = 2.

We applied one differencing to remove the trend: d = 1 The ACF shows a strong peak at h = 1s So, MA part could be q = 1 The PACF shows a strong peak at h = 1s So, AR part could be p = 1.

SARIMA(1, 1, 1) × (1, 1, 1)s=12 SARIMA(1, 1, 1) × (2, 1, 1)s=12

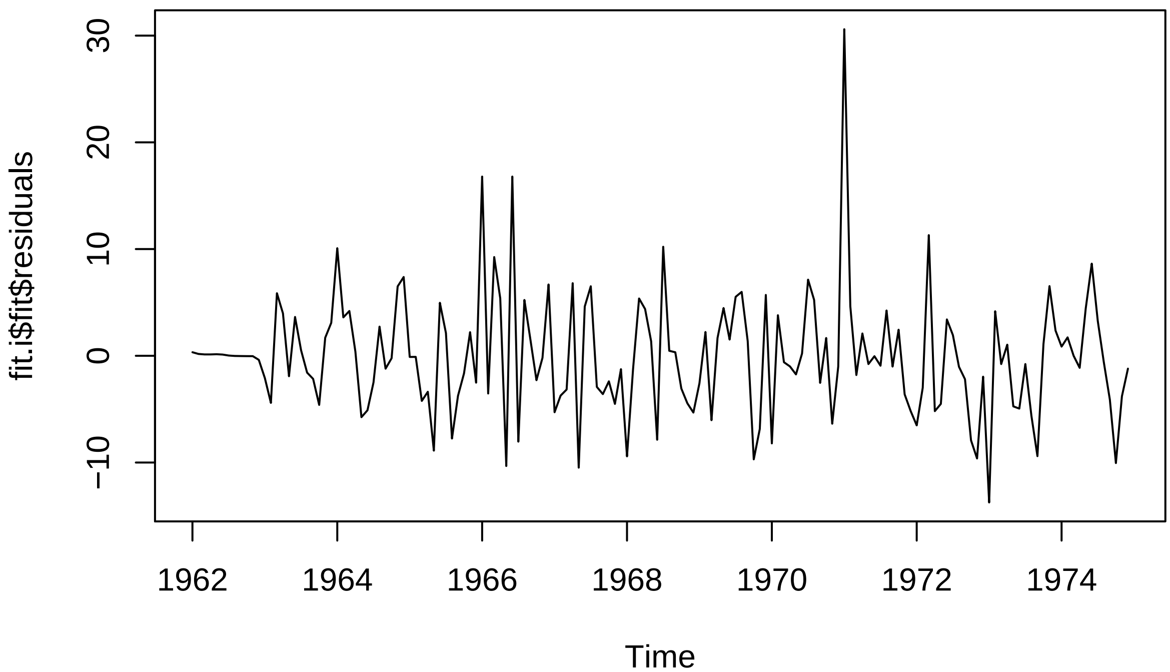
```
library(astsa)
fit.i <- sarima( xdata = milk,
p = 1, d = 1, q = 1,
P = 1  , D = 1, Q = 1, S = 12,
details = F)
print('Coefficients')
```

```
## [1] "Coefficients"
```

```
fit.i$fit$coef
```

```
##         ar1         ma1        sar1        sma1
## -0.08519589  0.03563241  0.01368689 -0.67697748
```

```r
plot(fit.i$fit$residuals)
```



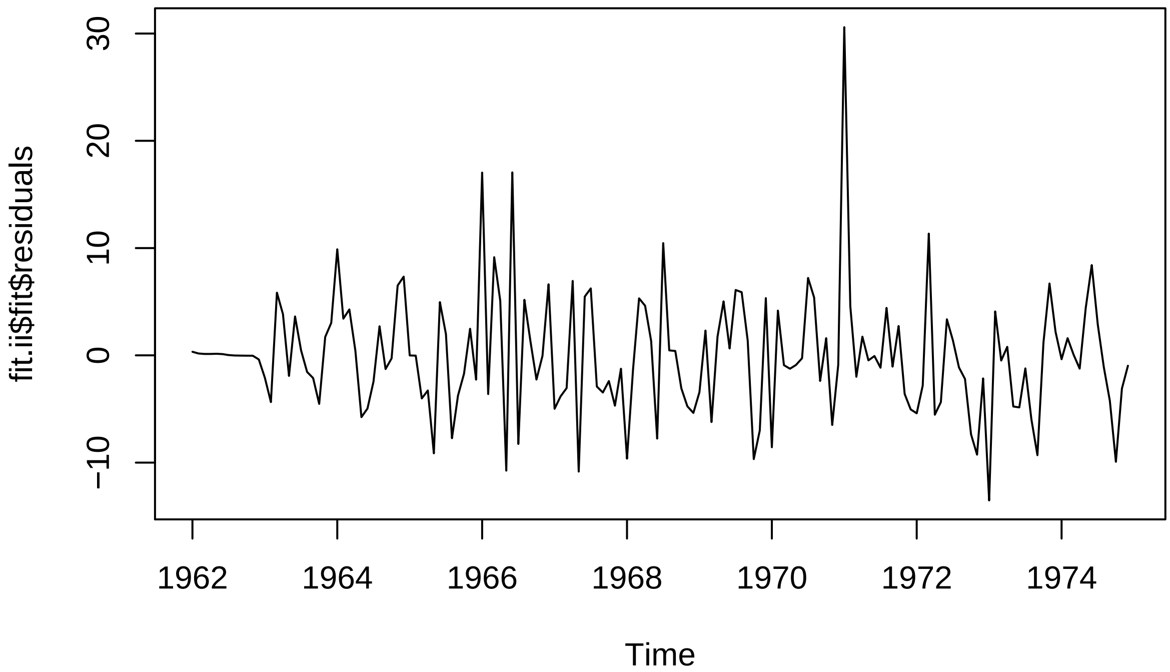

```r
fit.ii <- sarima( xdata = milk,
p = 1, d = 1, q = 1,
P = 2 , D = 1, Q = 1, S = 12,
details = F)
print('Coefficients')
```

```
## [1] "Coefficients"
```

```r
fit.ii$fit$coef
```

```
##         ar1         ma1        sar1        sar2        sma1
## -0.01063378 -0.02794334 -0.09255664 -0.05280335 -0.59752874
```

```r
plot(fit.ii$fit$residuals)
```



fit.iifitresiduals
30
20
10
0
−10
1962
1964
1966
1968
1970
1972
1974
Time