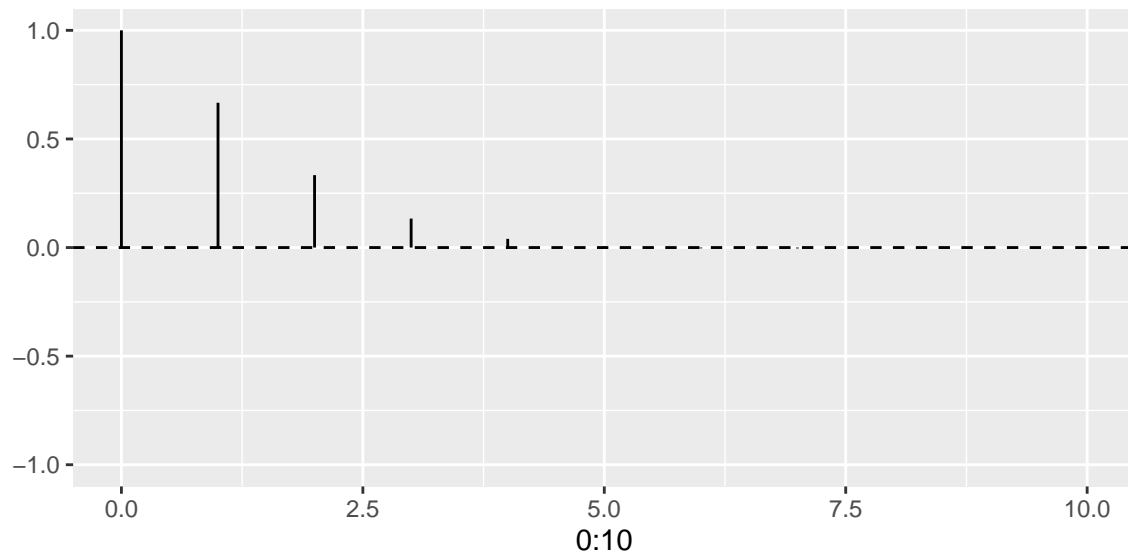# Question #5 ARIMA simulation
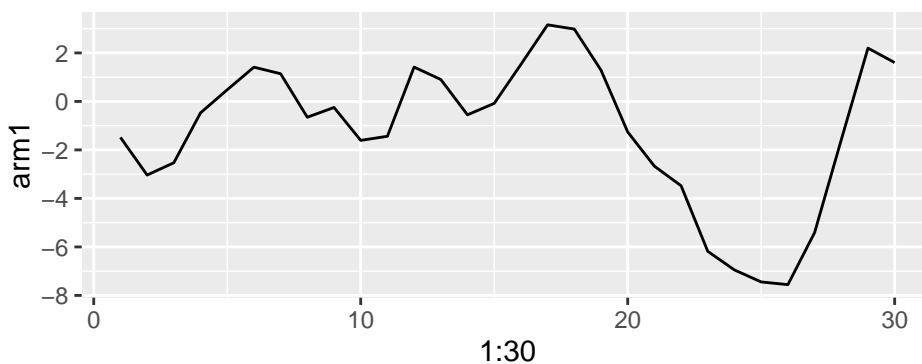
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Simulation using ARMAacf function in R

(a) Theoretical estimation of ACF using ARIMAacf gives 0.699 at lag 1.

(b) Estimating using ACF using 1 simulation for length of 30 for lag of 1 gives 0.8.

- (c) On simulation of timeseries model length of 30 gives an autocorrelation of 0.8 with maximum lag of 1. In the other hand running 1000 simulation looks biased with small bias from the true value.

    - $Bias(acf) = E(acf) - \hat{acf}$
    - $= 0.719 - 0.667 = 0.088$

- (d)With longer time series of length =100, ACF = 0.777. It looks with increasing length of the timeseries the ACF value tends to increase. Still the value is biased with higher bias of 11.

- (e)The variance with autocorrelation tends to decrease with increasing length. Variance result from simulation of section (c) with different length.

Time series length	Variance
10	0.0343274
30	0.0074787
50	0.003899
100	0.001920

Appendix

```
knitr::opts_chunk$set(echo=FALSE, message = FALSE,
  warning = FALSE, results = "hide", fig.height = 3, fig.width = 6)
#1 simulate AR(2)
library('ggplot2')
#Theoretical ACF using ARMAacf
arma11 <- ARMAacf(ar=c(0.8,-.2),lag.max = 10)
qplot(x=0:10,ymin=0,
            ymax=arma11,geom="linerange")+
    geom_hline(yintercept=0,
                         linetype="dashed")+ylim(c(-1,1))
# (b) 1 simulation model
arm1<-arima.sim(model=list(ar=c(0.8,-0.2),ma=1,sd=1),30)
qplot(1:30,arm1,geom="line")
ar.acf <-acf(arm1,lag.max = 1,plot=F)
#1000 simulation
ts.length = 30   #ts length
arm1000<-replicate(1000,arima.sim(model=list(ar=c(0.8,-0.2),ma=1,sd=1),ts.length))
#estimate of simulated data
acf.as <- apply(arm1000,2,function(x){acf(x,lag.max =1)$acf[2]})
acf.as.mean <- mean(acf.as)  #average overall simulation
```