Stat 153 - Homework 3

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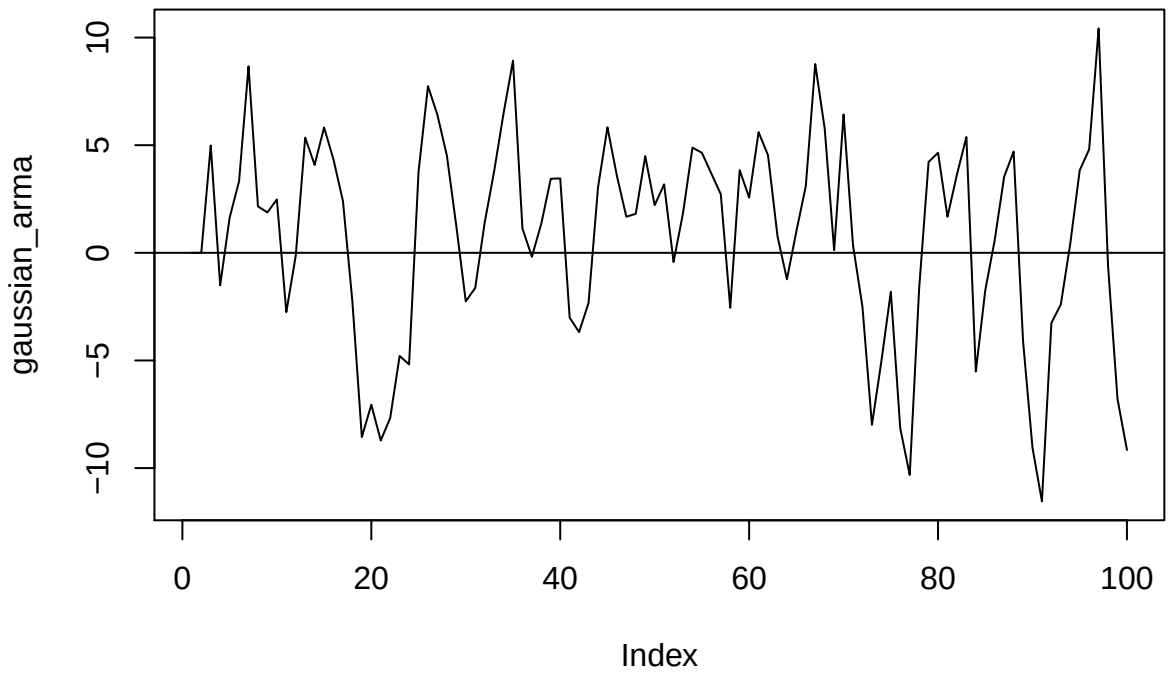
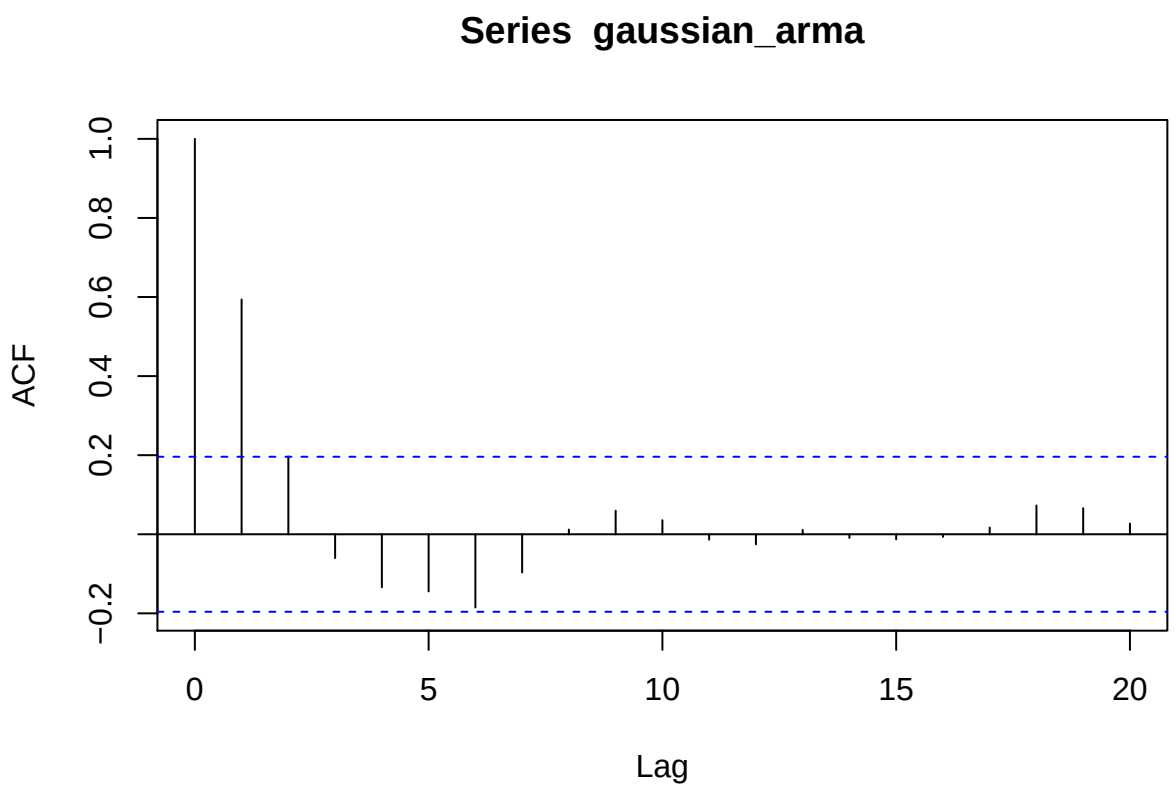
Question 1

(a)

```
gaussian_noise <- rnorm(100, mean = 0, sd = 1)

x1 <- 0
x2 <- 0

gaussian_arma <- c(x1, x2)

for (i in 3:100){
  gaussian_arma[i] <- 0.7*gaussian_arma[i-1] - 0.3*gaussian_arma[i-2] + gaussian_noise[i] + 4*gaussian_
}

plot(gaussian_arma, type = 'l')
abline(h = 0)
```

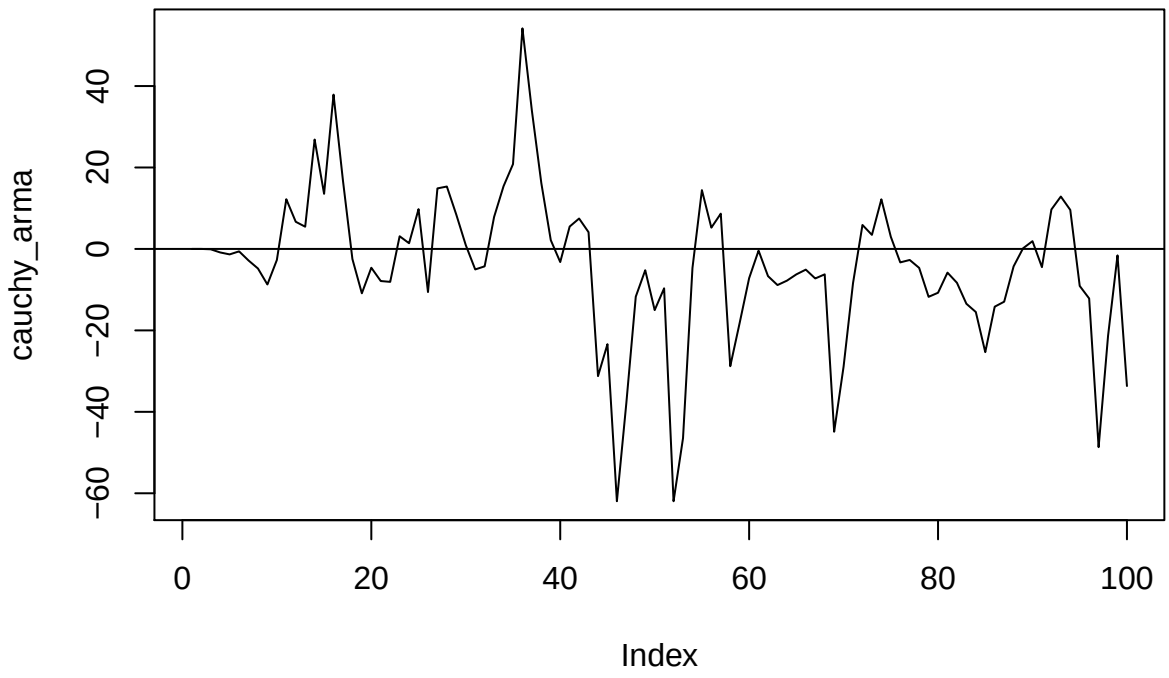


```r
acf(gaussian_arma)
```

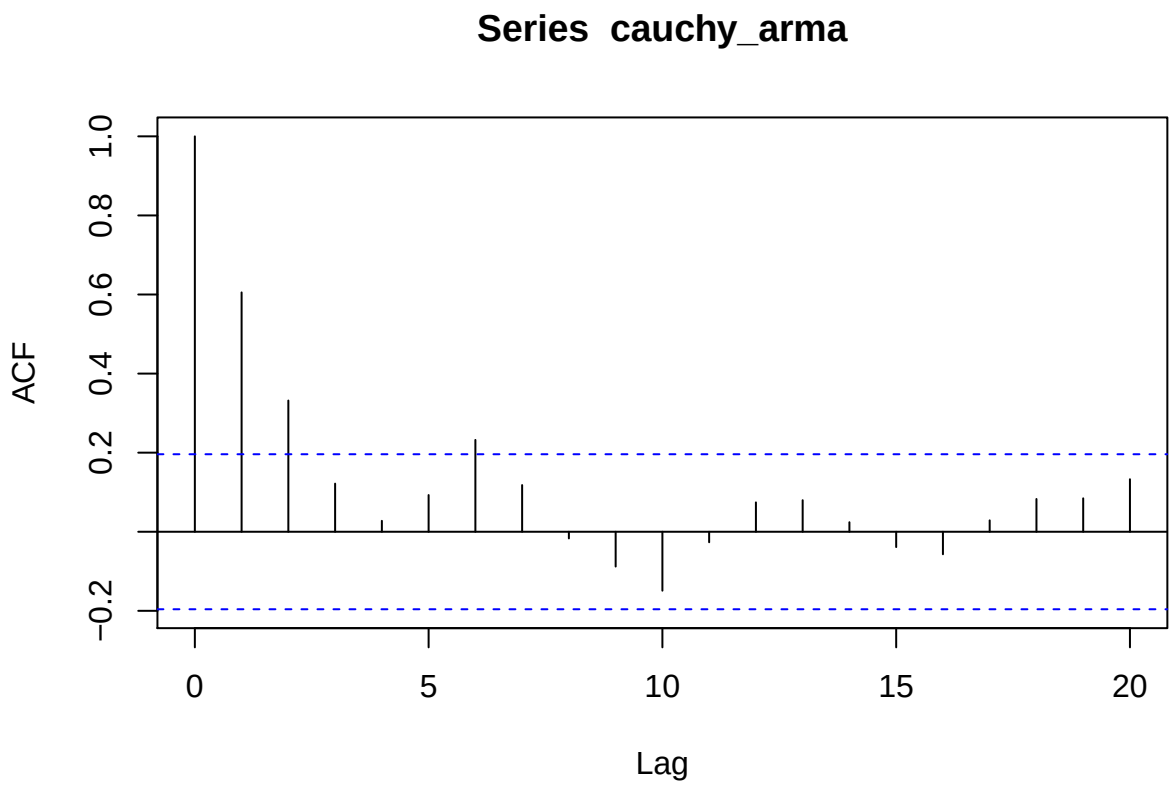


(b)

```r
cauchy_noise <- rcauchy(100, location = 0, scale = 1)

cauchy_arma <- c(x1, x2)

for (i in 3:100){
  cauchy_arma[i] <- 0.7*cauchy_arma[i-1] - 0.3*cauchy_arma[i-2] + cauchy_noise[i] + 4*cauchy_noise[i-2]
}

plot(cauchy_arma, type = 'l')
abline(h = 0)
```




```
acf(cauchy_arma)
```



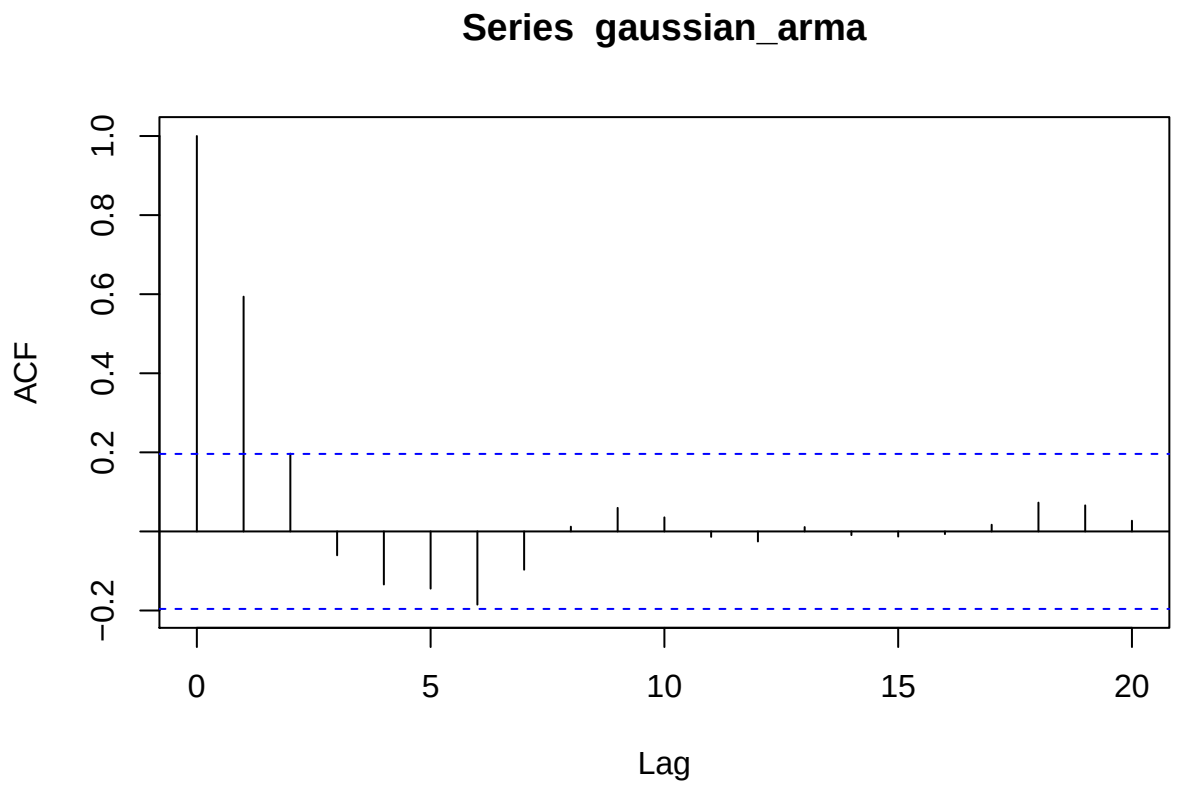
(c)

The two ACF functions look to be fairly different, in that the Cauchy ACF has a spike in the middle of the time series that is not present in the Gaussian ACF. The two ACF functions are similar, but the acfs of the Cauchy function seem to be smaller for most lags.

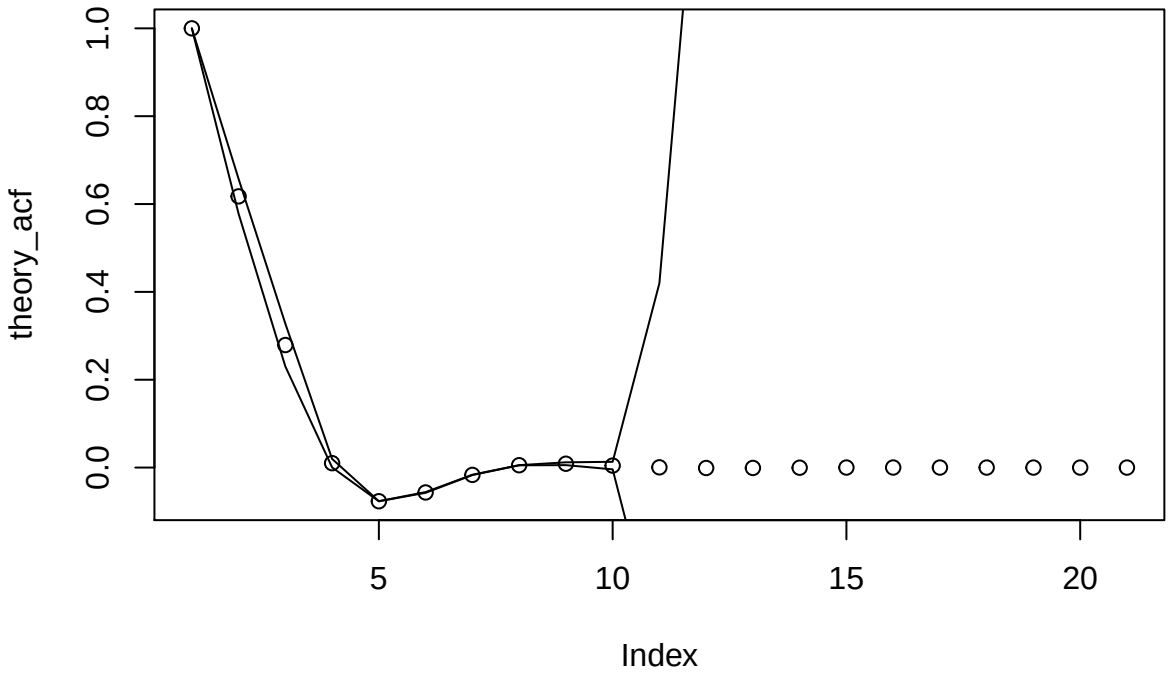
(d)

```
theory_acf <- ARMAacf(ar = c(0.7, -0.3), ma = c(0,4), lag.max = 20)
theory_acf <- as.vector(theory_acf)

variances <- c()
term <- 0
ci_max <- c(theory_acf[1])
ci_min <- c(theory_acf[1])

for (i in 1:20){
  for (m in 1:20){
    if ((i+m)<=20){
    term <- term + (2*theory_acf[m+i+1] - 2*    theory_acf[i+1]*theory_acf[m+1])^2}
    else{
      term <- term + (2*theory_acf[abs(m-i)+1] - 2*    theory_acf[i+1]*theory_acf[m+1])^2
    }
```

```
  }
  ci_max[i+1] <- theory_acf[i+1]+term/sqrt(20)
  ci_min[i+1] <- theory_acf[i+1]-term/sqrt(20)
  term <- 0
}


acf(gaussian_arma)
```

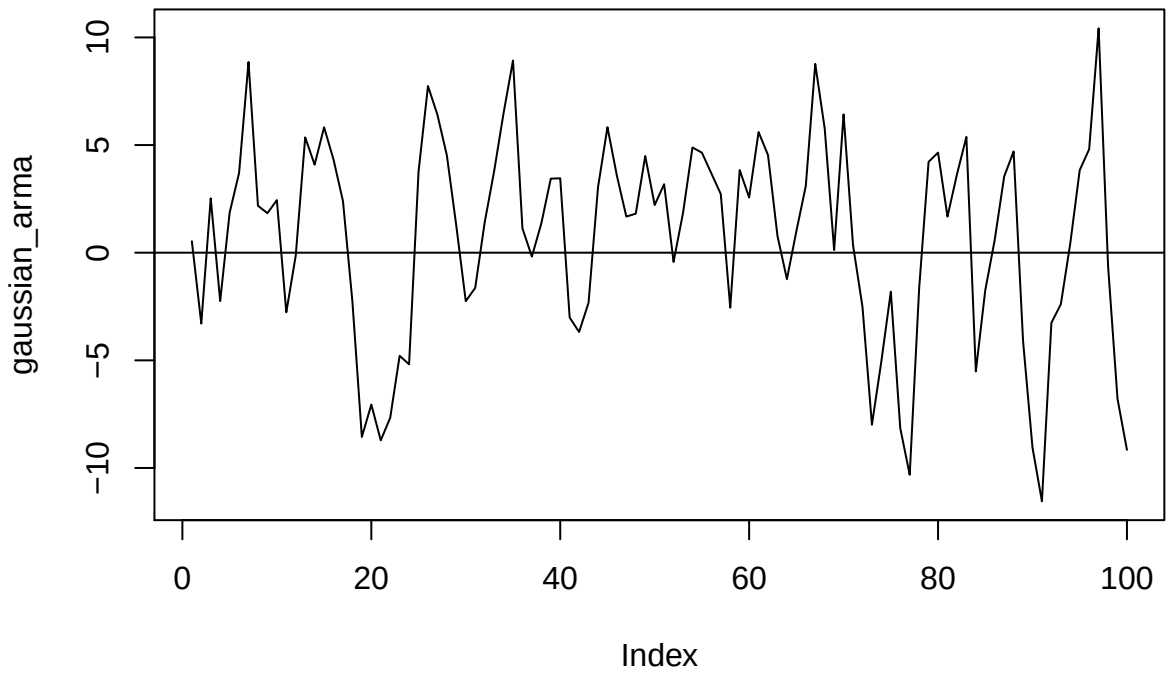



```
plot(theory_acf)
lines(ci_max, type = 'l')
lines(ci_min, type = 'l')
```

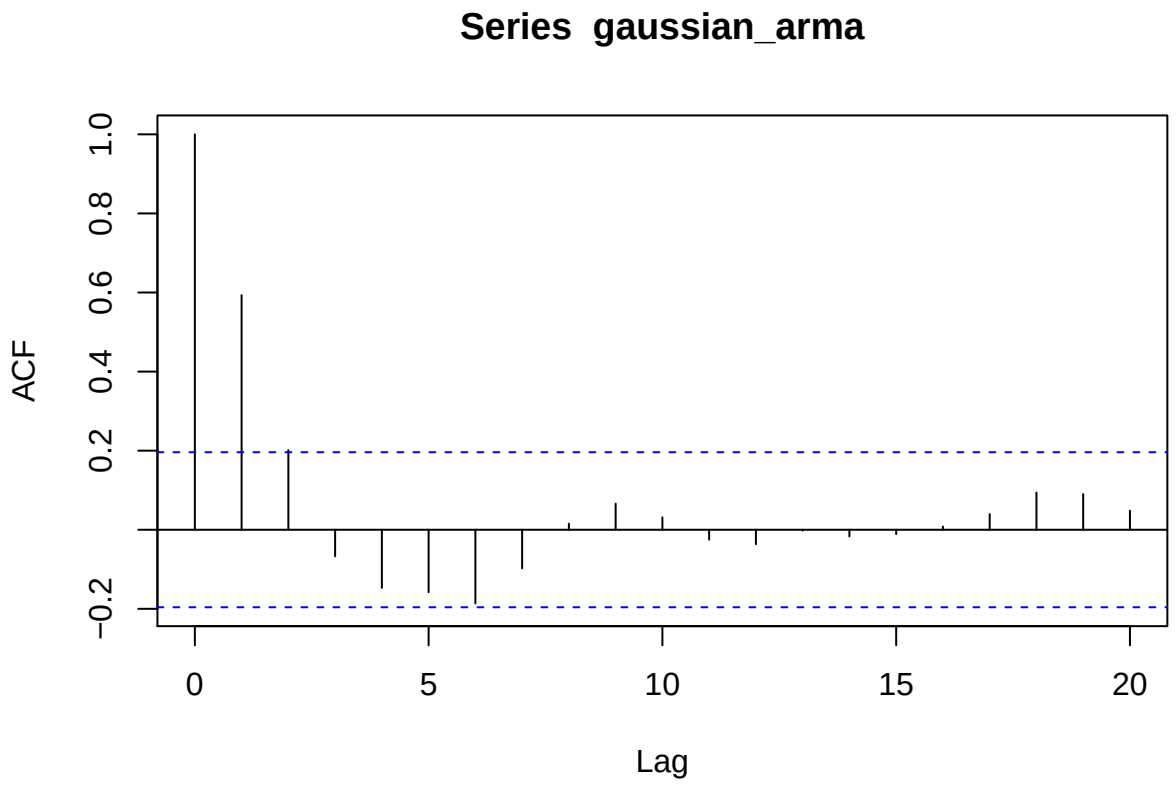


(e)

```
ma_coefs <- ARMAtoMA(ar = c(0.7, -0.3), ma = c(0,4), lag.max = 20)
gaussian_2 <- rnorm(20)
x1 <- sum(gaussian_2*ma_coefs)
x2 <- sum(gaussian_noise[1:20]*ma_coefs)

gaussian_arma <- c(x1, x2)

for (i in 3:100){
  gaussian_arma[i] <- 0.7*gaussian_arma[i-1] - 0.3*gaussian_arma[i-2] + gaussian_noise[i] + 4*gaussian_
}

plot(gaussian_arma, type = 'l')
abline(h = 0)
```




```
acf(gaussian_arma)
```



Looks much more similar to the theoretical calculated ACFs than (a).

(f)

```
1+4*ma_coefs[2]
```

```
## [1] 17.76
```

```
4*ma_coefs[1]
```

```
## [1] 2.8
```

```
4
```

```
## [1] 4
```

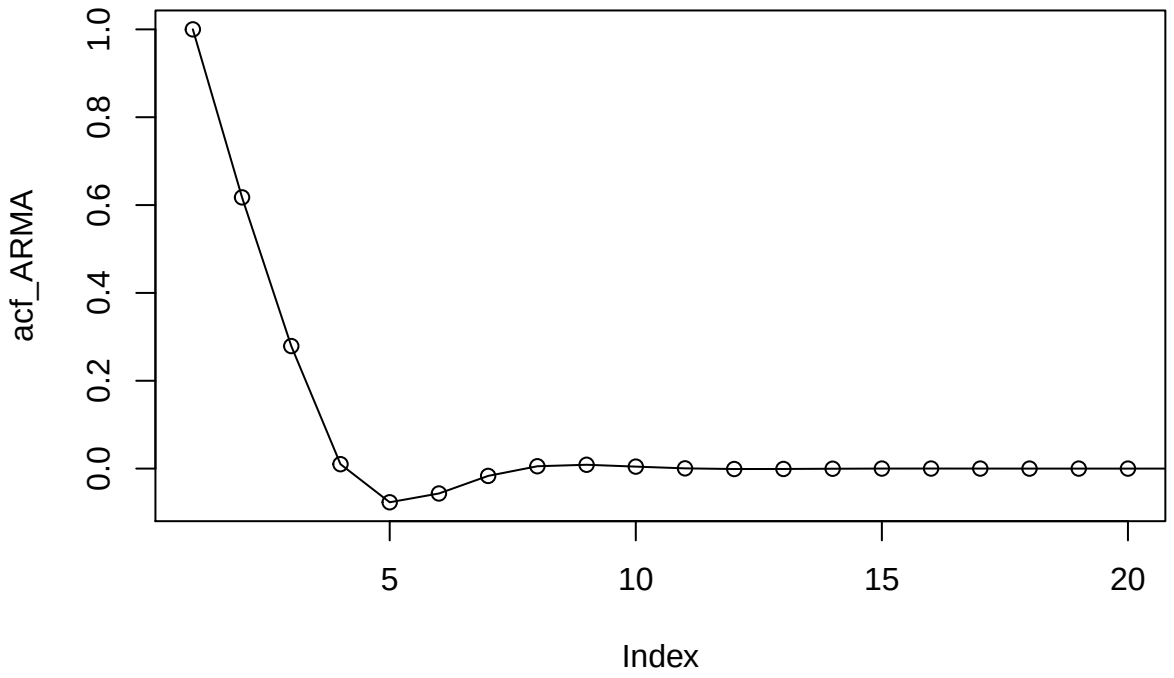
```
ro_1 <- 27.26
ro_2 <- 16.833
ro_3 <- 7.6048

acvf_ARMA <- c(ro_1, ro_2, ro_3)

for (i in 4:20){
  acvf_ARMA[i] <- 0.7*acvf_ARMA[i-1] - 0.3*acvf_ARMA[i-2]
}

acvf_ARMA
```

```
##  [1] 27.2600000000 16.8330000000  7.6048000000  0.2734600000 -2.0900180000
##  [6] -1.5450506000 -0.4545300200  0.1453441660  0.2380999222  0.1230666957
## [11]  0.0147167104 -0.0266183115 -0.0230478311 -0.0081479884  0.0012107575
## [16]  0.0032919268  0.0019411215  0.0003712070 -0.0003224915 -0.0003371062
```

```
acf_ARMA <- acvf_ARMA/acvf_ARMA[1]
acf_ARMA
```

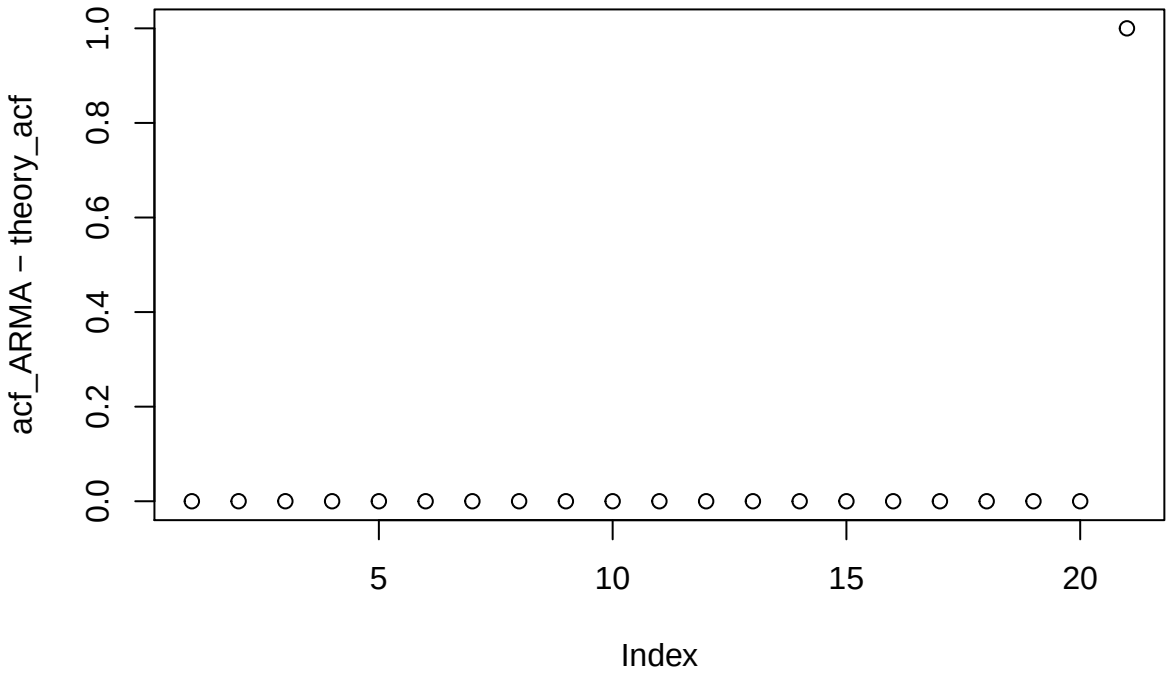
```
##  [1]  1.000000e+00  6.174982e-01  2.789729e-01  1.003155e-02 -7.666977e-02
##  [6] -5.667831e-02 -1.667388e-02  5.331774e-03  8.734407e-03  4.514552e-03
## [11]  5.398646e-04 -9.764604e-04 -8.454817e-04 -2.988991e-04  4.441517e-05
## [16]  1.207603e-04  7.120768e-05  1.361728e-05 -1.183021e-05 -1.236633e-05
```

```
plot(acf_ARMA)
lines(theory_acf)
```




```
plot(acf_ARMA - theory_acf)
```

```
## Warning in acf_ARMA - theory_acf: longer object length is not a multiple of
## shorter object length
```


acf_ARMA – theory_acf
0.0
0.2
0.4
0.6
0.8
1.0
5
10
15
20
Index