Time Series: Assignment 3

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Q6

We read in the given data as a csv file, which we transformed beforehand and get the raw gdp data. This will be declared as a time series of quarterly data with start in 1991 and end in 2017.

```
gdp_seas_adj <- read.csv("C:/Users/lucas/OneDrive/Dokumente/2. Semester/Time Series/Data/GDP_DE_seas_ad
gdp <- gdp_seas_adj[2]
gdp <- ts(gdp, frequency = 4, start = c(1991, 1))
```

We compute the quarterly growth rate as given in the assignment using R's built-in log and lag functions.

```
growth_rate <- log(gdp) - log(lag(gdp))
```

With the data now ready, we can now turn to fitting the ARMA model. We will use a nested for loop, looping over all combinations of the respective levels of p and q, to find the optimal model. We create an empty matrix that will be filled with the parameters p and q and the respective AIC of the ARMA(p, q) model. The maximum value of p and q we investigate is 3 respectively.

```
p_max = 3
q_max = 3
ARMA_models <- matrix(NA, nrow = (p_max + 1)*(q_max + 1), ncol = 3)
colnames(ARMA_models) <- c("p", "q", "AIC")
#loop over p
count <- 0
for(p in 0:3){
  #loop over q
    for(q in 0:3){
      count <- count + 1
      ARMA_models[count, 1] <- p
      ARMA_models[count, 2] <- q
      model <- arima(x = growth_rate, order = c(p, 0 , q))
      ARMA_models[count, 3] <- model$aic
    }
}
```

Now that we calculated the AIC for each model we can simply get model with the lowest AIC.

```
p_opt <- ARMA_models[which(ARMA_models[, 3] == min(ARMA_models[, 3])), 1]
q_opt <- ARMA_models[which(ARMA_models[, 3] == min(ARMA_models[, 3])), 2]
AIC_opt <- ARMA_models[which(ARMA_models[, 3] == min(ARMA_models[, 3])), 3]
```

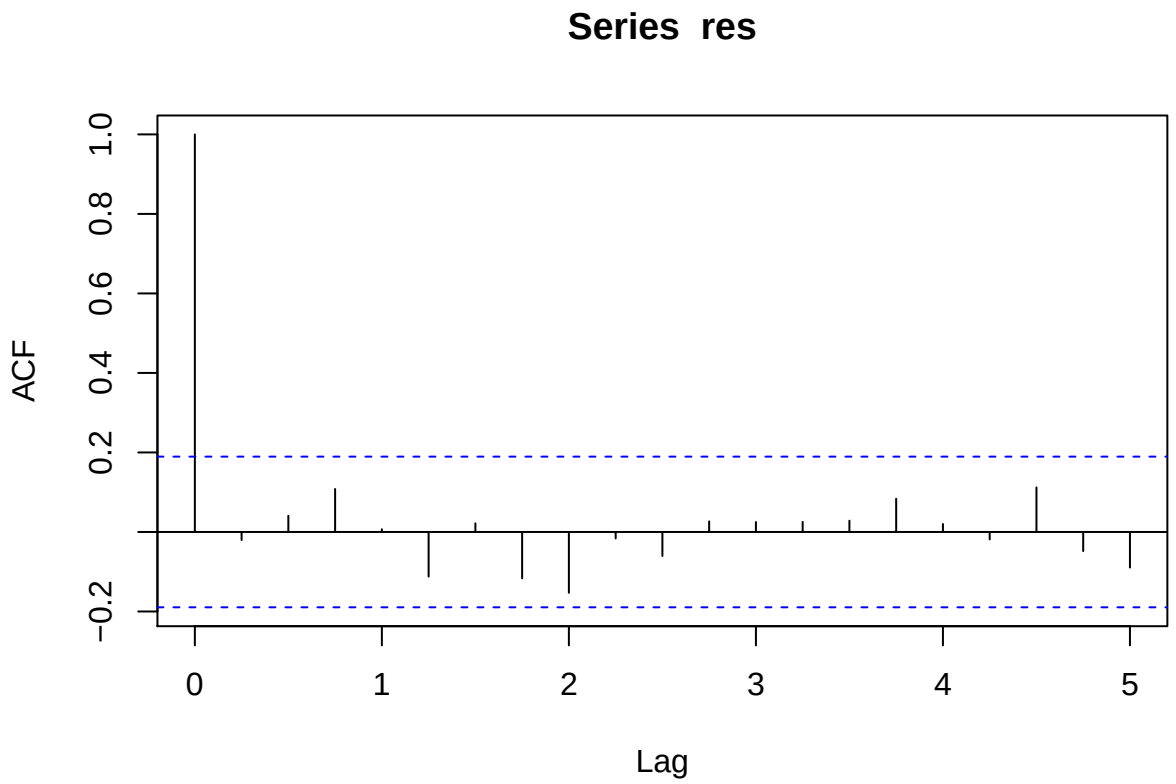
We can see that $p = $ 1 and $q = $0, which has an AIC of $AIC = $ -726.9300683. The model with the best fit using the AIC as the evaluation criterion is therefore an ARMA(1, 0) model. The coefficients of this specification are then:

```
ARMA_opt <- arima(x = growth_rate, order = c(p_opt, 0, q_opt))
ARMA_opt$coef
```

```
##          ar1    intercept
##  0.269877617 -0.007158814
```

To evaluate whether it captures all dynamics we can take a look at the autcorrelation between the residuals of our optimal model.

```r
#estimate the optimal model to get the residuals
res <- residuals(ARMA_opt)
autocorr <- acf(res)
```



We can clearly see that after the current period (i.e. $h > 0$) there is no significant autocorrelation between the residuals further strengthening the result of our model evaluation based on the AIC.