Homework 2

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```
data <- read.csv("Data/congress.csv")
attach(data)
library(tseries)
```

```
## Warning: package 'tseries' was built under R version 3.4.4
```

```
library(pander)
```

```
## Warning: package 'pander' was built under R version 3.4.2
```

```
library(forecast)
```

```
## Warning: package 'forecast' was built under R version 3.4.4
```

```
library(simcf)
library(tile)
```

```
## Warning: package 'tile' was built under R version 3.4.2
```

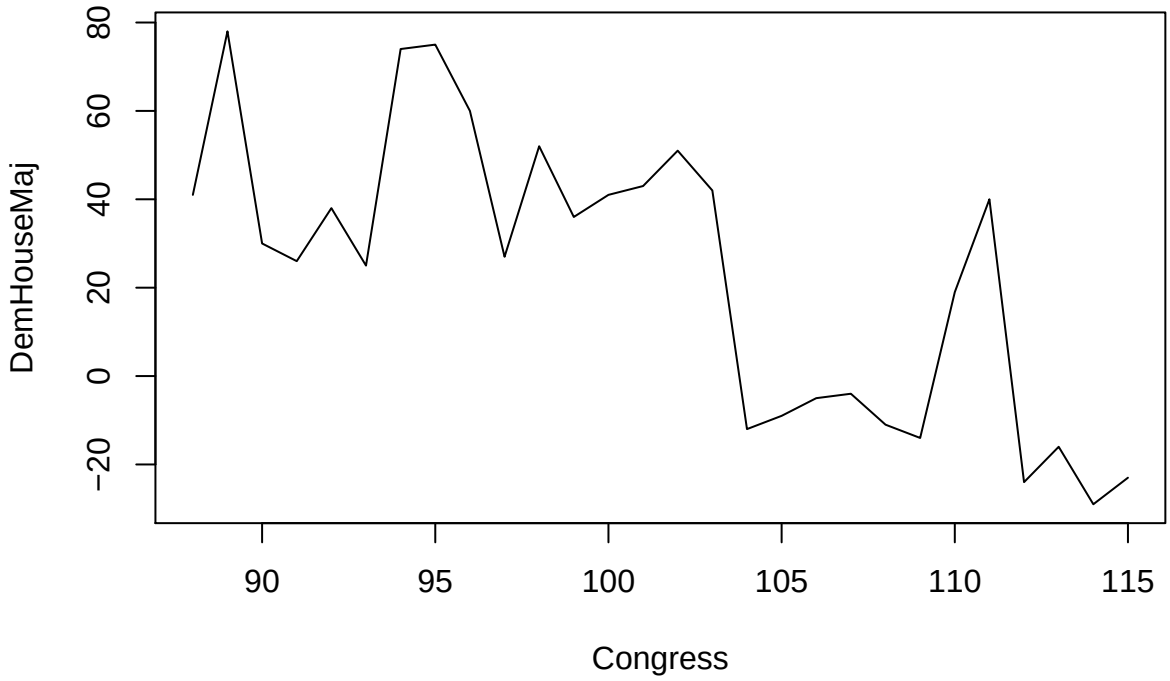
```
## Loading required package: grid
```

```
library(RColorBrewer)
options(digits = 3)
```

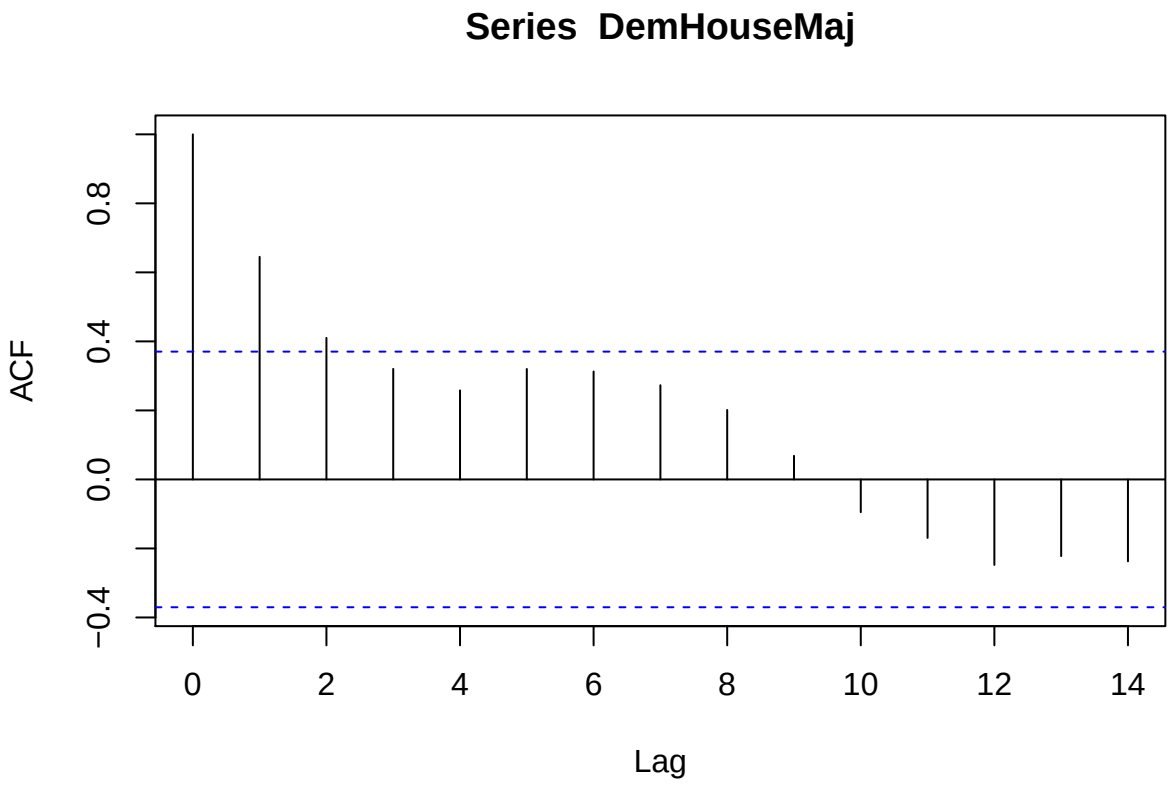
Question 1

Part A

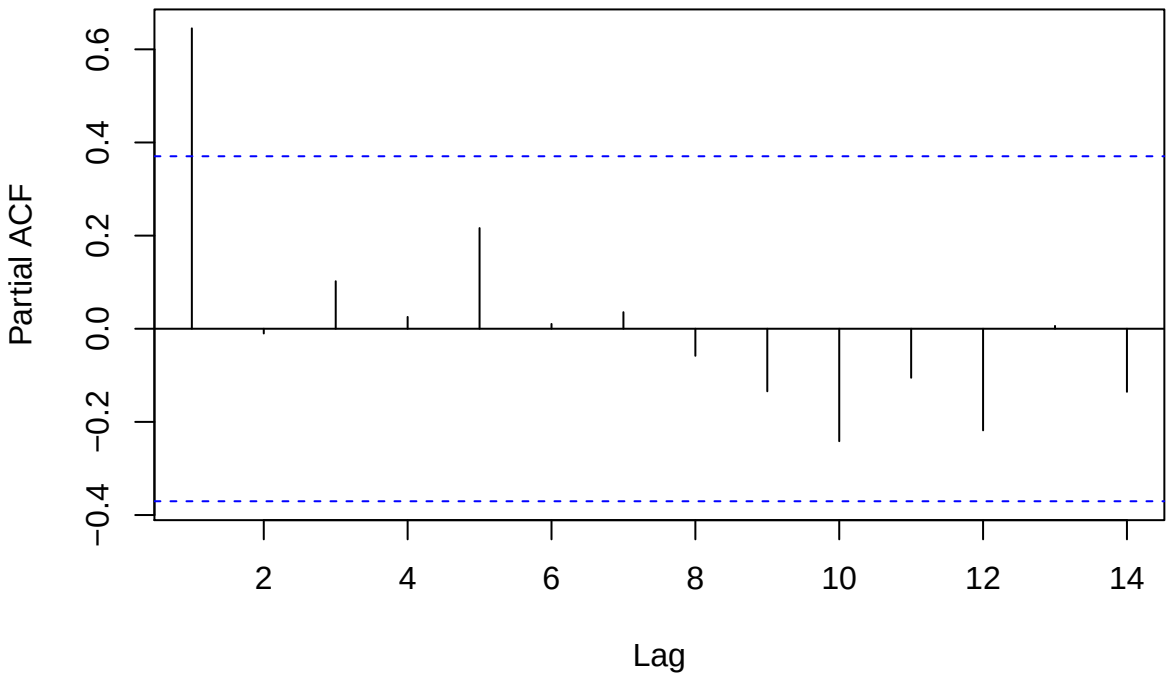
```
plot(Congress, DemHouseMaj, type="l")
```




```
acf(DemHouseMaj)
```




```
pacf(DemHouseMaj)
```



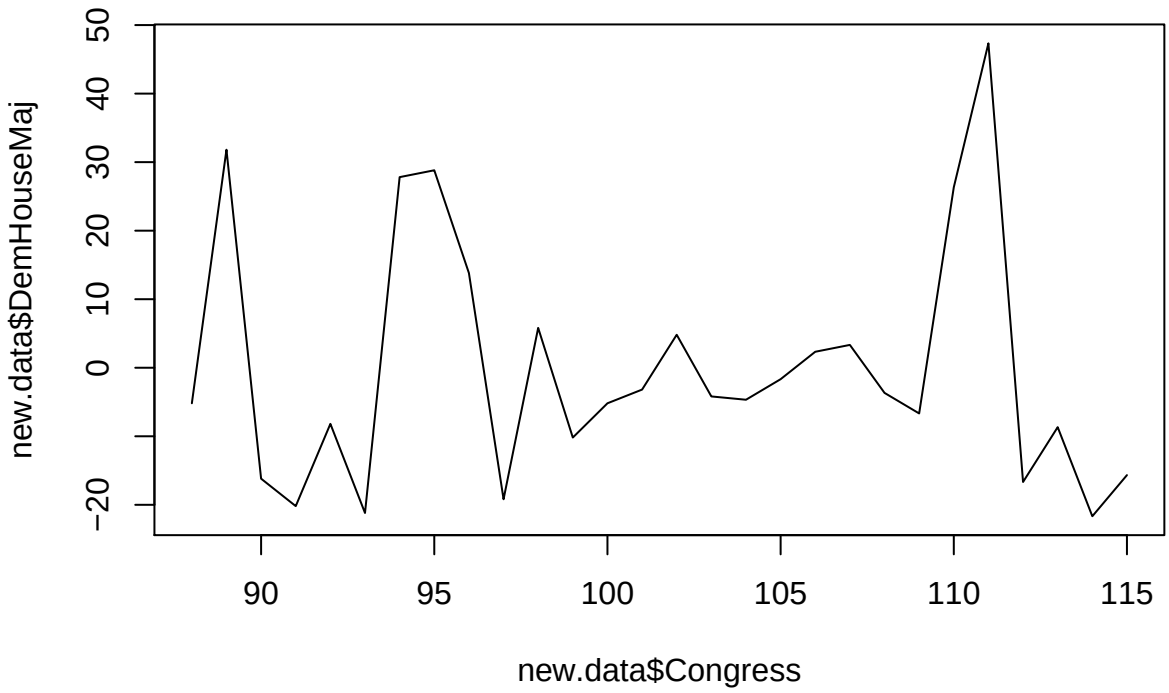

```
adf.test(DemHouseMaj)
```

```
##
##  Augmented Dickey-Fuller Test
##
## data:  DemHouseMaj
## Dickey-Fuller = -3, Lag order = 3, p-value = 0.3
## alternative hypothesis: stationary
```

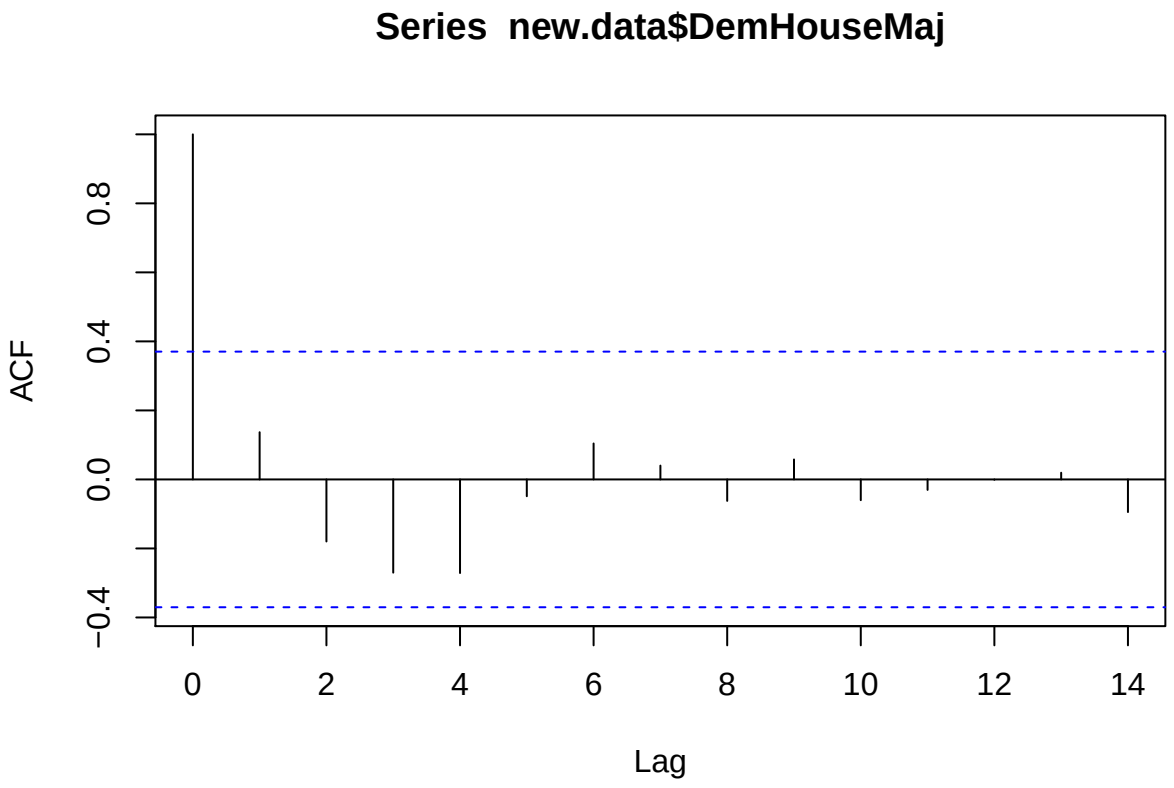
```
PP.test(DemHouseMaj)
```

```
##
##  Phillips-Perron Unit Root Test
##
## data:  DemHouseMaj
## Dickey-Fuller = -4, Truncation lag parameter = 2, p-value = 0.04
```

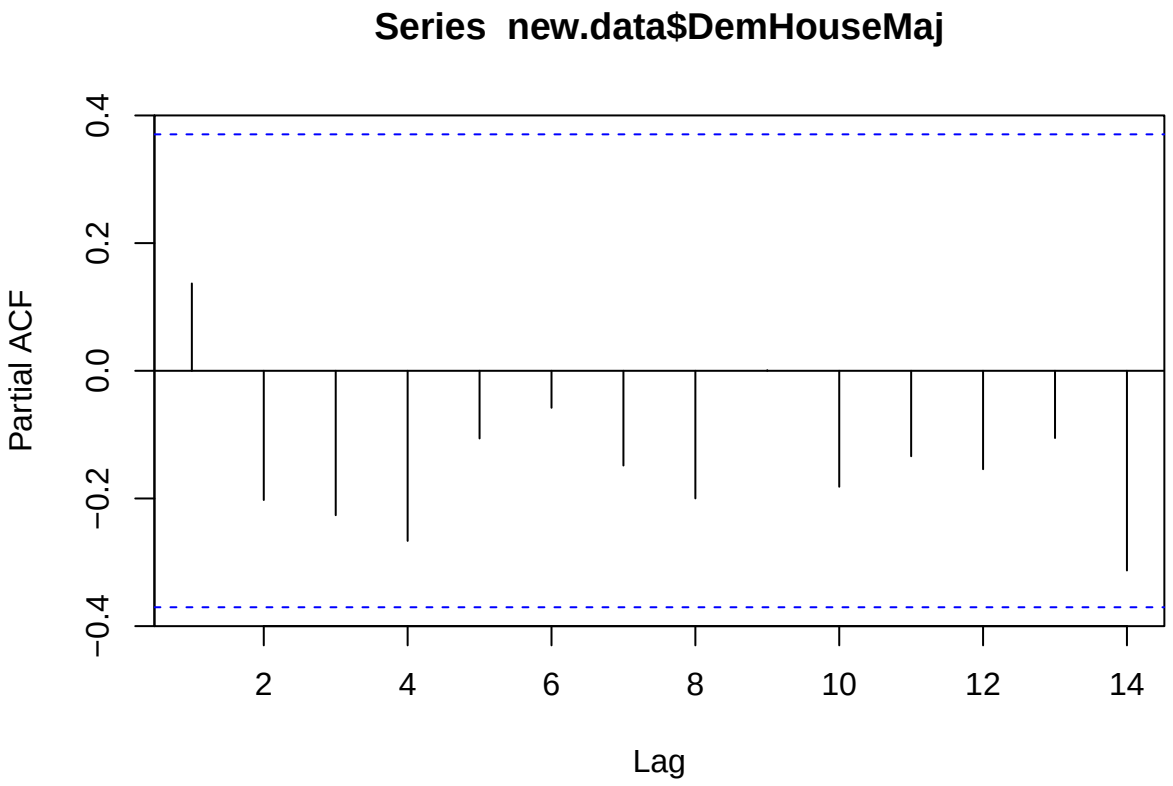
```
pre1994 <- data[StartYear<1994,]
post1994 <- data[StartYear>1994,]
pre1994$DemHouseMaj <- pre1994$DemHouseMaj - mean(pre1994$DemHouseMaj)
post1994$DemHouseMaj <- post1994$DemHouseMaj - mean(post1994$DemHouseMaj)
new.data <- rbind(pre1994, post1994)


plot(new.data$Congress, new.data$DemHouseMaj, type="l")
```




```
acf(new.data$DemHouseMaj)
```




```
pacf(new.data$DemHouseMaj)
```



Part B

```
xcovariates <- cbind(PartisanMidterm, PartisanUnem, Coattails, Pre1994)
ar0 <- arima(DemHouseMaj, order = c(0,0,0),
             xreg = xcovariates, include.mean = TRUE)
```

Table 1: Model Evaluation

Model Components	AIC	$\hat{\sigma}^2$	N	$\hat{\beta}_{PM}$	$\hat{\beta}_{PU}$	$\hat{\beta}_{CT}$	$\hat{\beta}_{1994}$
AR(0)	239.243	195.964	28	-7.27 (3.823)	-2.053 (1.733)	18.396 (5.331)	47.994 (5.703)

Part C

```
ar1 <- arima(DemHouseMaj, order = c(1,0,0),
             xreg = xcovariates, include.mean = TRUE)

ar2 <- arima(DemHouseMaj, order = c(2,0,0),
             xreg = xcovariates, include.mean = TRUE)

ma1 <- arima(DemHouseMaj, order = c(0,0,1),
             xreg = xcovariates, include.mean = TRUE)
```

```
arma11 <- arima(DemHouseMaj, order = c(1,0,1),
             xreg = xcovariates, include.mean = TRUE)
```

Table 2: Model Comparison

Model Components	AIC	$\hat{\sigma}^2$	N	$\hat{\beta}_{PM}$	$\hat{\beta}_{PU}$	$\hat{\beta}_{CT}$	$\hat{\beta}_{1994}$
AR(0)	239.243	195.964	28	-7.27	-2.053	18.396	47.994
				(3.823)	(1.733)	(5.331)	(5.703)
AR(1)	240.221	188.565	28	-8.848	-2.42	15.364	46.656
				(3.86)	(1.75)	(5.828)	(7.023)
AR(2)	239.243	169.879	28	-10.726	-2.858	10.279	44.729
				(3.158)	(1.744)	(5.862)	(6.038)
MA(1)	239.495	183.033	28	-9.866	-2.761	13.121	45.386
				(3.743)	(1.841)	(6.315)	(7.58)
ARMA(1,1)	238.096	148.58	28	-11.673	-2.758	14.522	42.887
				(3.204)	(1.484)	(6.058)	(6.623)

Part D

```
ar0.cv <- arimaCV(DemHouseMaj, order = c(0,0,0), forward=3,
                  xreg=xcovariates, include.mean = TRUE, minper = 20)

ar1.cv <- arimaCV(DemHouseMaj, order = c(1,0,0), forward=3,
                  xreg=xcovariates, include.mean = TRUE, minper = 20)

ar2.cv <- arimaCV(DemHouseMaj, order = c(2,0,0), forward=3,
                  xreg=xcovariates, include.mean = TRUE, minper = 20)

ma1.cv <- arimaCV(DemHouseMaj, order = c(0,0,1), forward=3,
                  xreg=xcovariates, include.mean = TRUE, minper = 20)

arma11.cv <- arimaCV(DemHouseMaj, order = c(1,0,1), forward=3,
                  xreg=xcovariates, include.mean = TRUE, minper = 20)

allCV <- cbind(ar0.cv, ar1.cv, ar2.cv, ma1.cv, arma11.cv)
labs <- c("AR(0)", "AR(1)", "AR(2)", "MA(1)", "ARMA(1,1)")

col <- c(brewer.pal(7, "Reds")[3:7],
         brewer.pal(8, "Blues")[3:8])

matplot(allCV, type="l", col=col, lty=1, ylab="Mean Absolute Error", xlab="Periods Forward",
        main="Cross-validation of accident deaths models", xlim=c(0.75,3.75))
text(labs, x=rep(3.5,length(labs)), y=allCV[nrow(allCV),], col=col)
```

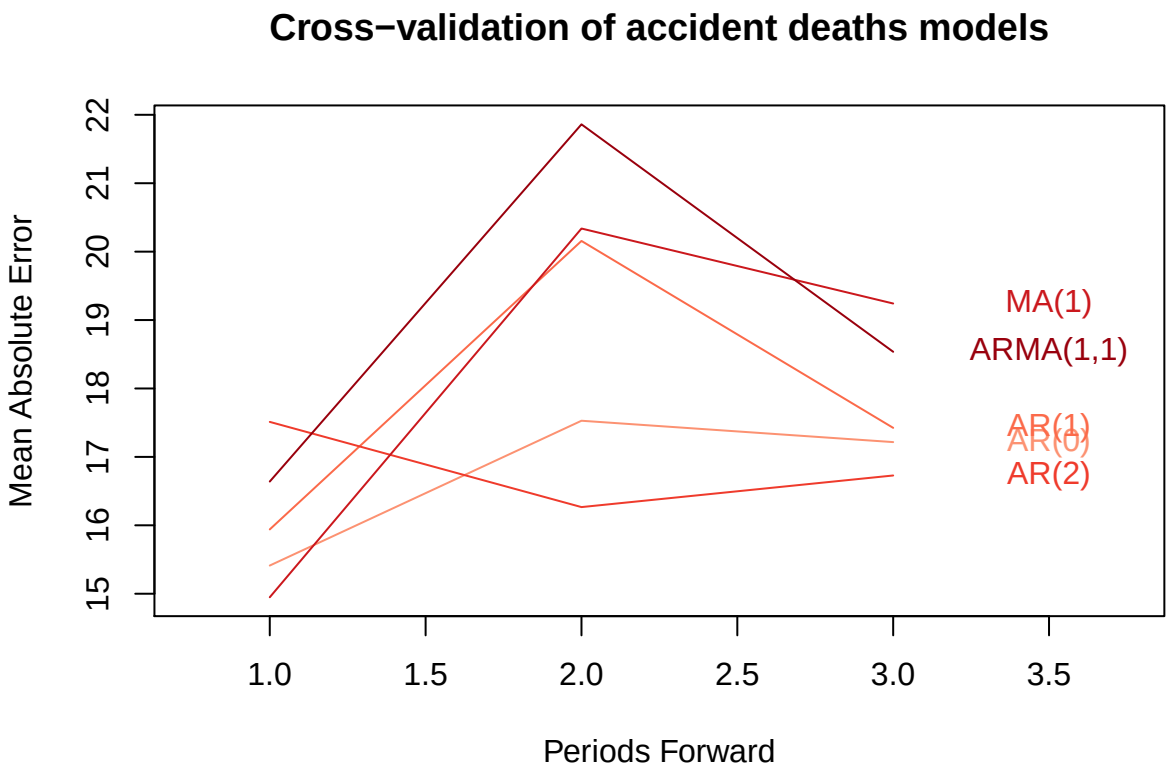


Table 3: Model Comparison

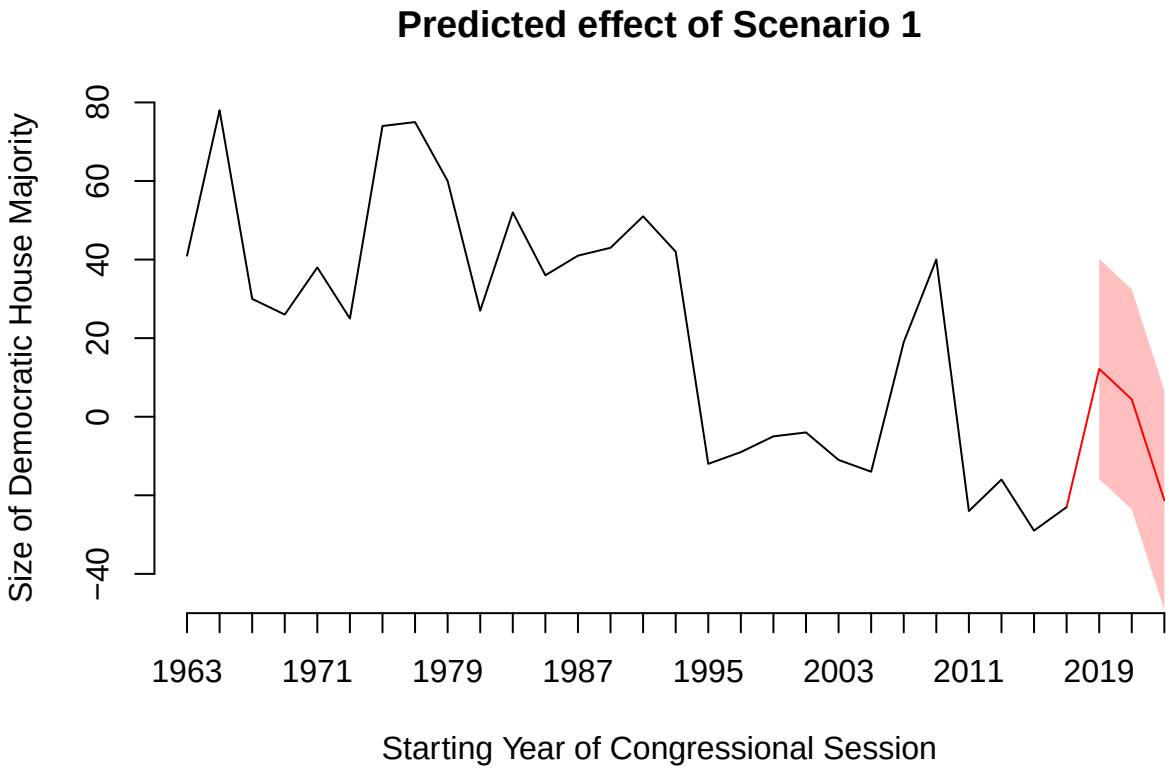
Model Components	AIC	RMSE	MAE_1	MAE_2	MAE_3	Average MAE
AR(0)	239.243	195.964	15.412	17.528	17.216	16.719
AR(1)	240.221	188.565	15.94	20.156	17.424	17.84
AR(2)	239.662	169.879	17.512	16.266	16.728	16.835
MA(1)	239.495	183.033	14.949	20.338	19.242	18.176
ARMA(1,1)	238.096	148.58	16.64	21.86	18.536	19.012

AR(0) is best model

Part E

```
n.ahead <- 3
PartisanMidterm.cf <- c(-1,0,1)
Unemployment.cf1 <- rep(4.6, n.ahead)
Unemployment.cf2 <- rep(3.6, n.ahead)
Unemployment.cf3 <- rep(5.6, n.ahead)
PartisanUnem.cf1 <- c(-1,1,1)*Unemployment.cf1
PartisanUnem.cf2 <- c(-1,1,1)*Unemployment.cf2
PartisanUnem.cf3 <- c(-1,1,1)*Unemployment.cf3
Coattails.cf <- c(0,1,0)
Pre1994.cf <- rep(0, n.ahead)
```

```r
cf1.cov <- as.data.frame(cbind(PartisanMidterm.cf, PartisanUnem.cf1, Coattails.cf, Pre1994.cf))
cf2.cov <- as.data.frame(cbind(PartisanMidterm.cf, PartisanUnem.cf2, Coattails.cf, Pre1994.cf))
cf3.cov <- as.data.frame(cbind(PartisanMidterm.cf, PartisanUnem.cf3, Coattails.cf, Pre1994.cf))

names(cf1.cov) <- c("PartisanMidterm", "PartisanUnem", "Coattails", "Pre1994")
names(cf2.cov) <- c("PartisanMidterm", "PartisanUnem", "Coattails", "Pre1994")
names(cf3.cov) <- c("PartisanMidterm", "PartisanUnem", "Coattails", "Pre1994")

ypred1 <- predict(ar0, n.ahead=n.ahead, newxreg = cf1.cov)
ypred2 <- predict(ar0, n.ahead=n.ahead, newxreg = cf2.cov)
ypred3 <- predict(ar0, n.ahead=n.ahead, newxreg = cf3.cov)

# Make a plot
plot.new()
par(usr = c(0, length(DemHouseMaj) + n.ahead, -50, 80) )
# make the x-axis
axis(1,
     at = seq(from = 1, to = 31, by = 1),
     labels = seq(from = 1963, to = 2023, by = 2)
)
axis(2)

title(xlab = "Starting Year of Congressional Session",
      ylab = "Size of Democratic House Majority",
      main="Predicted effect of Scenario 1")


# Polygon of predictive interval for no law (optional)
x0 <- (length(DemHouseMaj)+1):(length(DemHouseMaj) + n.ahead)
y0 <- c(ypred1$pred - 2*ypred1$se, rev(ypred1$pred + 2*ypred1$se), (ypred1$pred - 2*ypred1$se)[1] )
polygon(x = c(x0, rev(x0), x0[1]),
        y = y0,
        border=NA,
        col="#FFBFBFFF"
)

# Plot the actual data
lines(x = 1:length(DemHouseMaj),
      y = DemHouseMaj
)

# Add the predictions for no law
lines(x = length(DemHouseMaj):(length(DemHouseMaj)+n.ahead),
      y = c(DemHouseMaj[length(DemHouseMaj)],ypred1$pred),  # link up the actual data to the prediction
      col = "red"
)
```


Predicted effect of Scenario 1
Size of Democratic House Majority
−40
0
20
40
60
80
1963
1971
1979
1987
1995
2003
2011
2019
Starting Year of Congressional Session