

Zadatak 2

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Učitavanje i crtanje vremenskog niza

```
df= read.table("data.txt",sep = "", dec = ".")

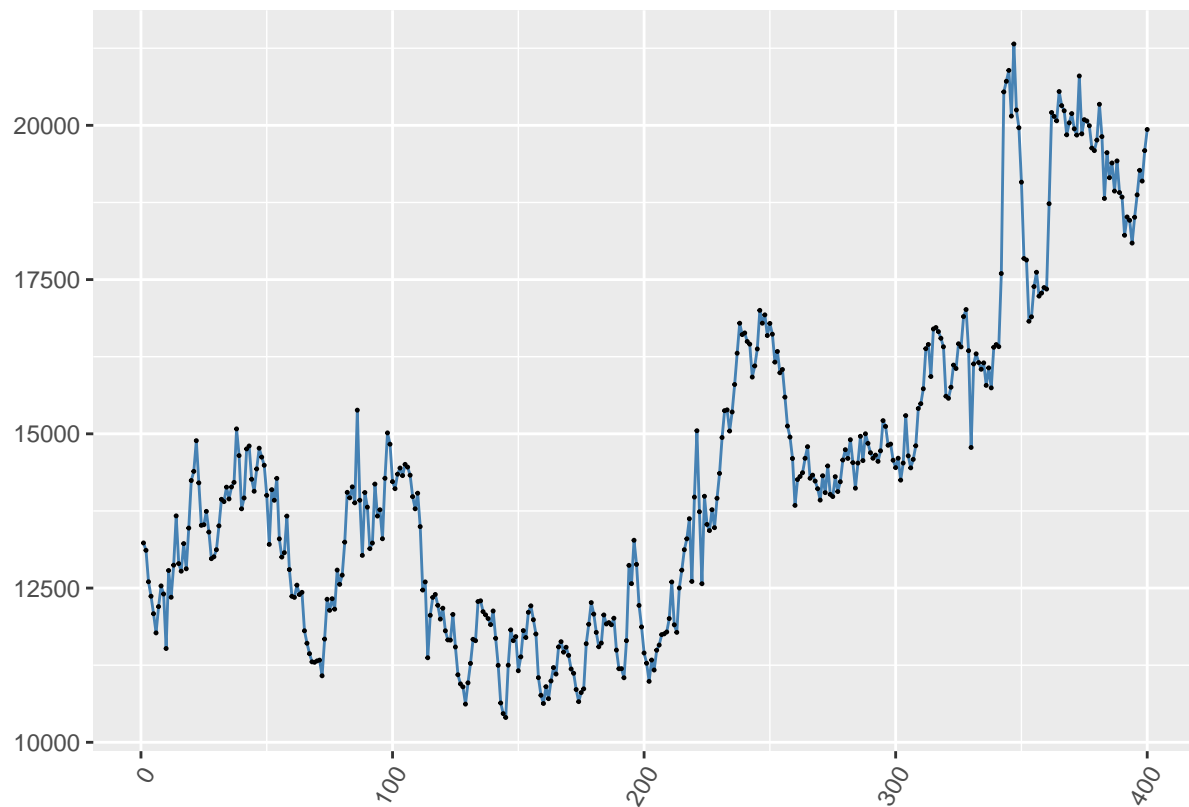
## Warning in read.table("data.txt", sep = "", dec = "."): incomplete final line
## found by readTableHeader on 'data.txt'

y = ts(as.numeric(df[1,]), frequency = 3)
data <- data.frame(x = c(1:400),y = y)

#df = transpose(df)
xt = ts(df)

ggplot(data, aes(x = x, y = y)) +
  geom_line(color="steelblue") +
  geom_point(size=0.2) +
  xlab("") +
  ylab("") +
  theme(axis.text.x=element_text(angle=60, hjust=1))

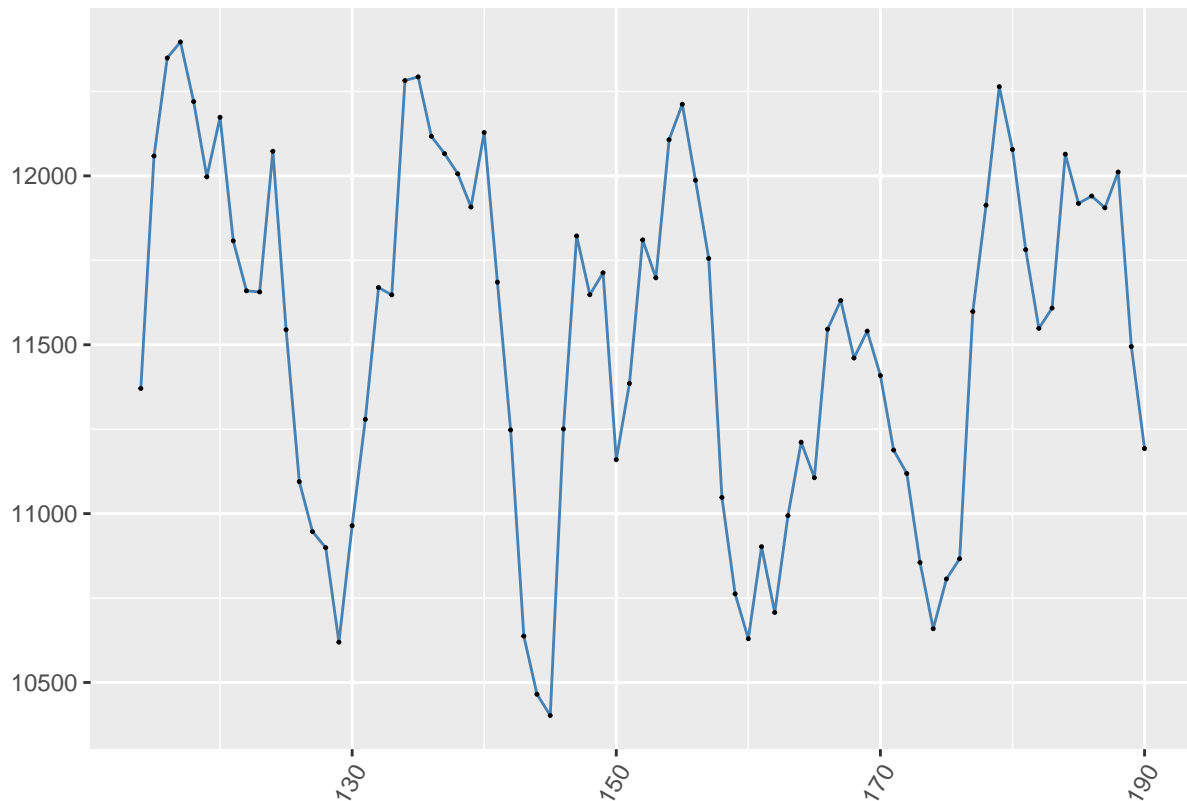
## Don't know how to automatically pick scale for object of type ts. Defaulting to continuous.
```



```
jarque.bera.test(data$y) #mala p value, podaci nisu homogeni, rast podataka kroz vrijeme
```

```
##
##  Jarque Bera Test
##
## data:  data$y
## X-squared = 39.619, df = 2, p-value = 2.493e-09
```

```
ggplot(data[114:190,], aes(x = x, y = y)) +
  geom_line(color="steelblue") +
  geom_point(size=0.2) +
  xlab("") +
  ylab("") +
  theme(axis.text.x=element_text(angle=60, hjust=1))
```



#Zadatak 2 - uklanjanje trenda

```
t = data$x
#plot(data$y)

model_trend_1 <- lm(data$y ~ t)
summary(model_trend_1)
```

```
##
## Call:
## lm(formula = data$y ~ t)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -3401.2 -1427.5  -185.2   1496.6  4584.4
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.112e+04  1.836e+02  60.57  <2e-16 ***
## t            1.618e+01  7.936e-01  20.39  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1833 on 398 degrees of freedom
## Multiple R-squared:  0.5108, Adjusted R-squared:  0.5095
## F-statistic: 415.5 on 1 and 398 DF, p-value: < 2.2e-16
```

```
data$Polinom_1 = predict(model_trend_1)
```

```

model_trend_2 <- lm(data$y ~ t+I(t^2))
summary(model_trend_2) #ovaj mi se čini najbolji

##
## Call:
## lm(formula = data$y ~ t + I(t^2))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2323.6  -928.9  -296.5   820.9  3677.6
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.412e+04  1.897e+02   74.41  <2e-16 ***
## t           -2.856e+01  2.185e+00  -13.07  <2e-16 ***
## I(t^2)        1.116e-01  5.277e-03   21.14  <2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1259 on 397 degrees of freedom
## Multiple R-squared:  0.7698, Adjusted R-squared:  0.7687
## F-statistic: 663.9 on 2 and 397 DF,  p-value: < 2.2e-16

data$Polinom_2 = predict(model_trend_2)

```

```

model_trend_3 <- lm(data$y ~ t+I(t^2)+I(t^3))
summary(model_trend_3)

##
## Call:
## lm(formula = data$y ~ t + I(t^2) + I(t^3))
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -2359.9  -929.2  -281.1   816.3  3671.8
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)  1.417e+04  2.544e+02  55.694  < 2e-16 ***
## t           -3.006e+01  5.487e+00  -5.477  7.7e-08 ***
## I(t^2)        1.209e-01  3.178e-02   3.804 0.000165 ***
## I(t^3)       -1.552e-05  5.210e-05  -0.298 0.765897
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1260 on 396 degrees of freedom
## Multiple R-squared:  0.7699, Adjusted R-squared:  0.7681
## F-statistic: 441.6 on 3 and 396 DF,  p-value: < 2.2e-16

data$Polinom_3 = predict(model_trend_3)

anova(model_trend_2, model_trend_3) #jednostavni model je dovoljan

```

```

## Analysis of Variance Table
##

```

```

## Model 1: data$y ~ t + I(t^2)
## Model 2: data$y ~ t + I(t^2) + I(t^3)
##   Res.Df      RSS Df Sum of Sq    F Pr(>F)
## 1    397 628945361
## 2    396 628804397   1    140965 0.0888 0.7659

#nacrtamo sva tri modela da vidimo koji je bolji fit
ggplot(data, aes(x = x)) +geom_line(aes(y = Polinom_2,col="Polinom drugog stupnja"), linetype="dashed")

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

```

```

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :

```



```
## for <87>
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

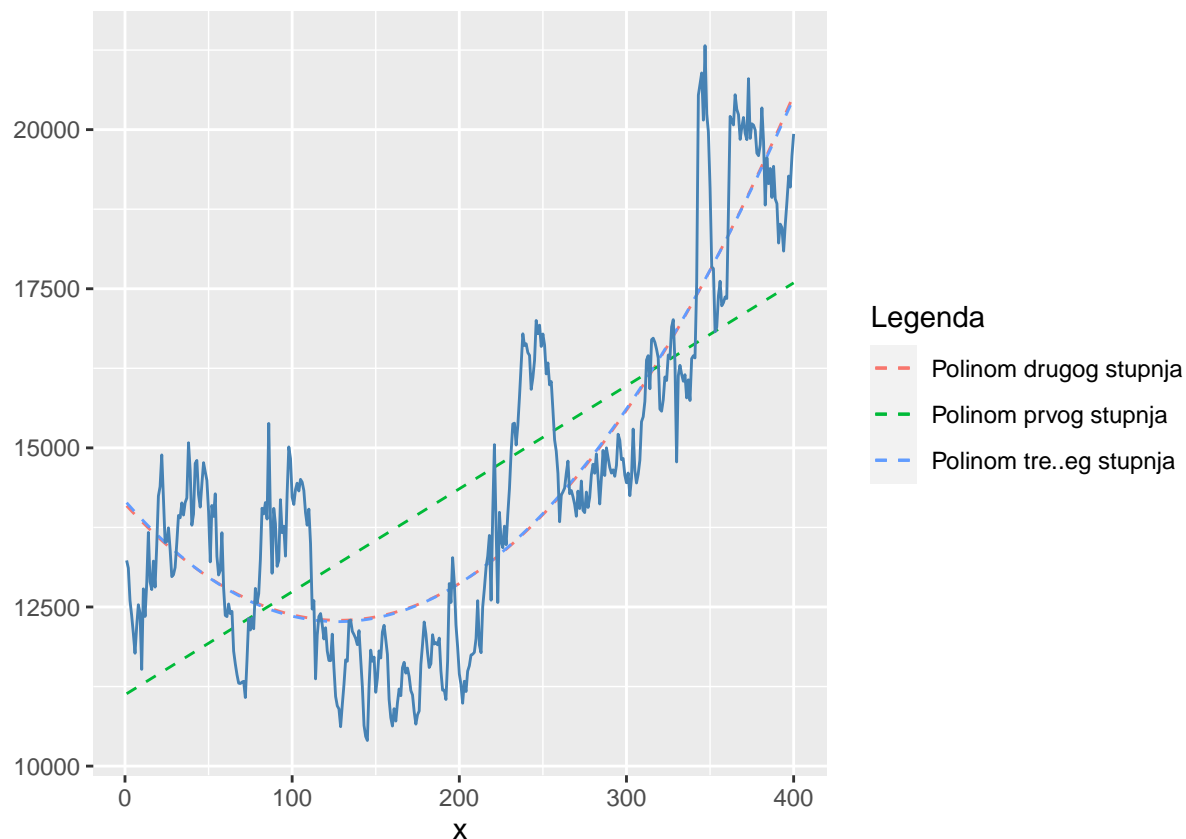
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <c4>

## Warning in grid.Call.graphics(C_text, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Polinom trećeg stupnja' in 'mbcsToSbcs': dot substituted
## for <87>
```



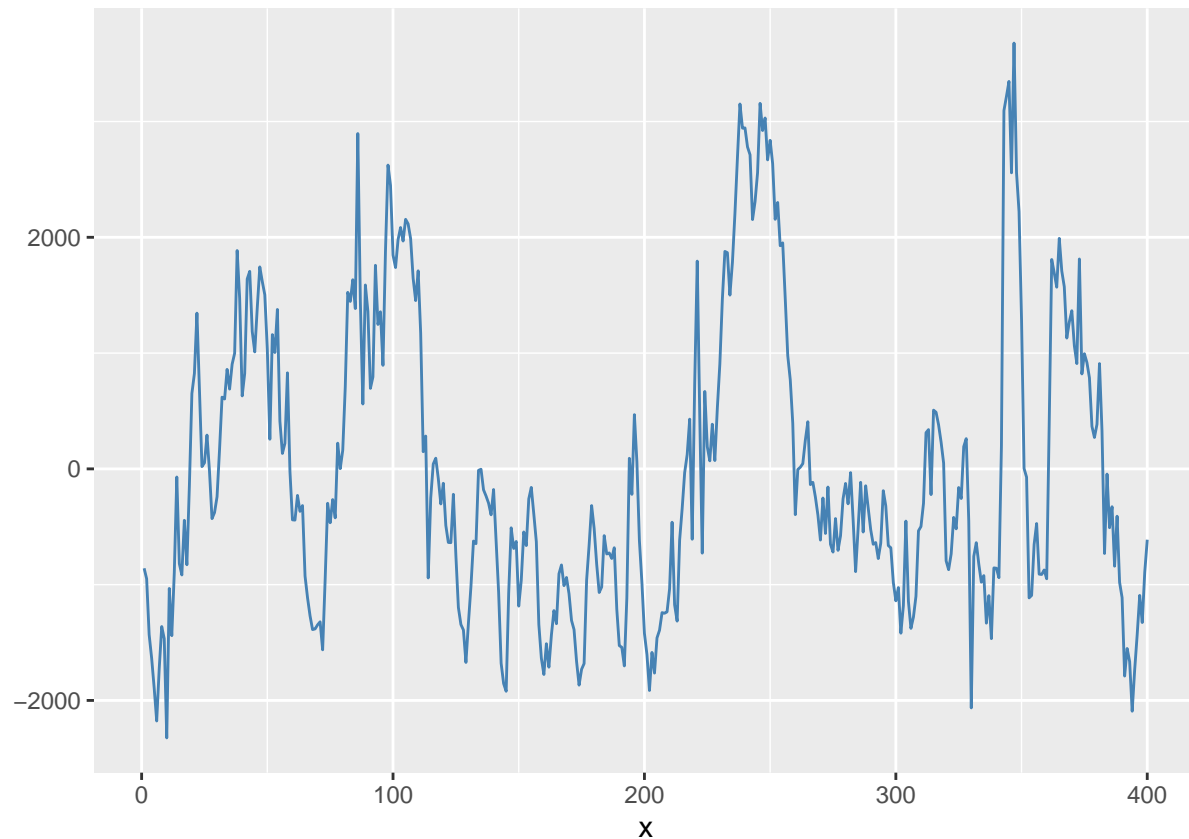
```
#odlučili smo se za polinom drugog stupnja
```

```
data$y_no_trend = data$y - data$Polinom_2
```

```
ggplot(data, aes(x = x)) + geom_line(aes(y = y_no_trend), col="steelblue") + ylab("") #podaci bez trenda
```



```
## Don't know how to automatically pick scale for object of type ts. Defaulting to continuous.
```



```
## Zadatak 2 - uklanjanje sezonalnosti
```

```
ggplot(data[1:30,], aes(x = x, y = y)) +  
  #geom_line(color="steelblue") +  
  #geom_point(size=0.2) +  
  # ylab("") +  
  #xlab("x")  
  #theme(axis.text.x=element_text(angle=60, hjust=1))
```

```
xt = ts(data$y, frequency = 3)  
x.stl=stl(xt,s.window = "periodic")  
#plot(x.stl)  
sum(abs(x.stl$time.series[,3]))
```

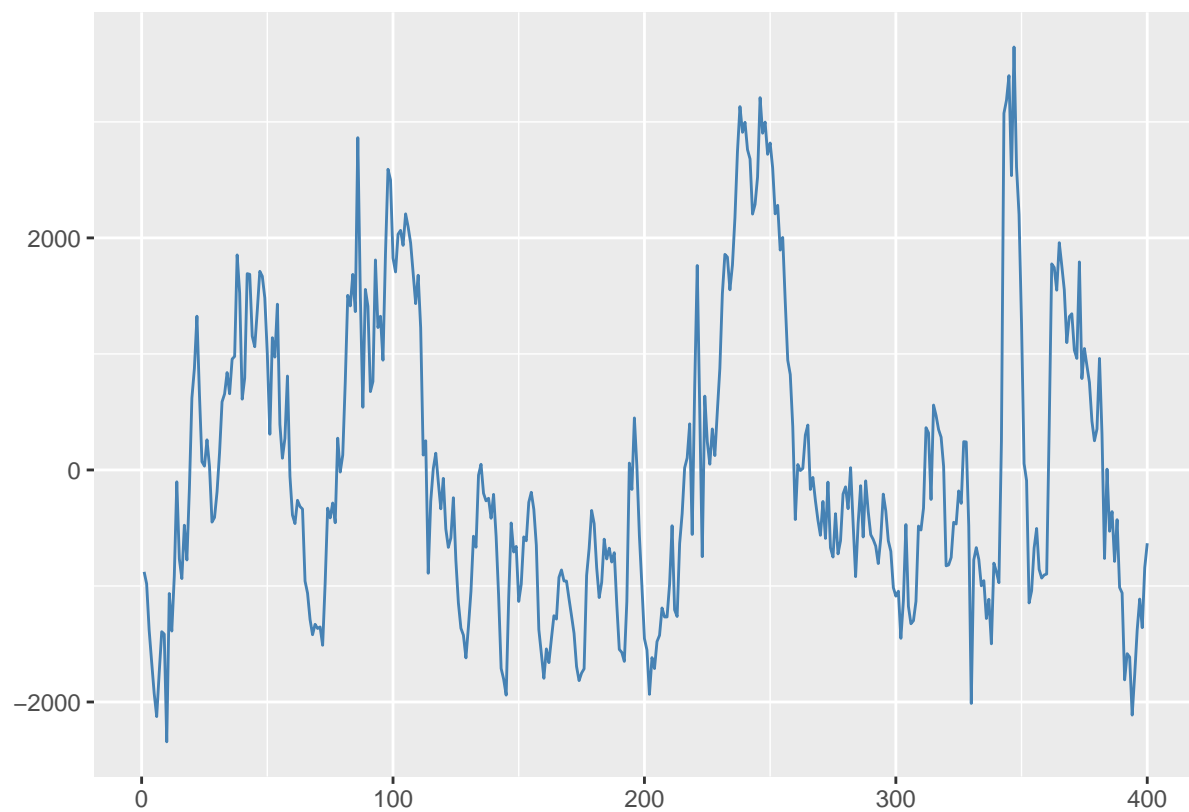
```
## [1] 59682.06
```

```
#sezonalnst, frequency je 3?
```

```
data$y_no_trend = data$y_no_trend - x.stl$time.series[,1] #uklanjam i sezonalnost
```

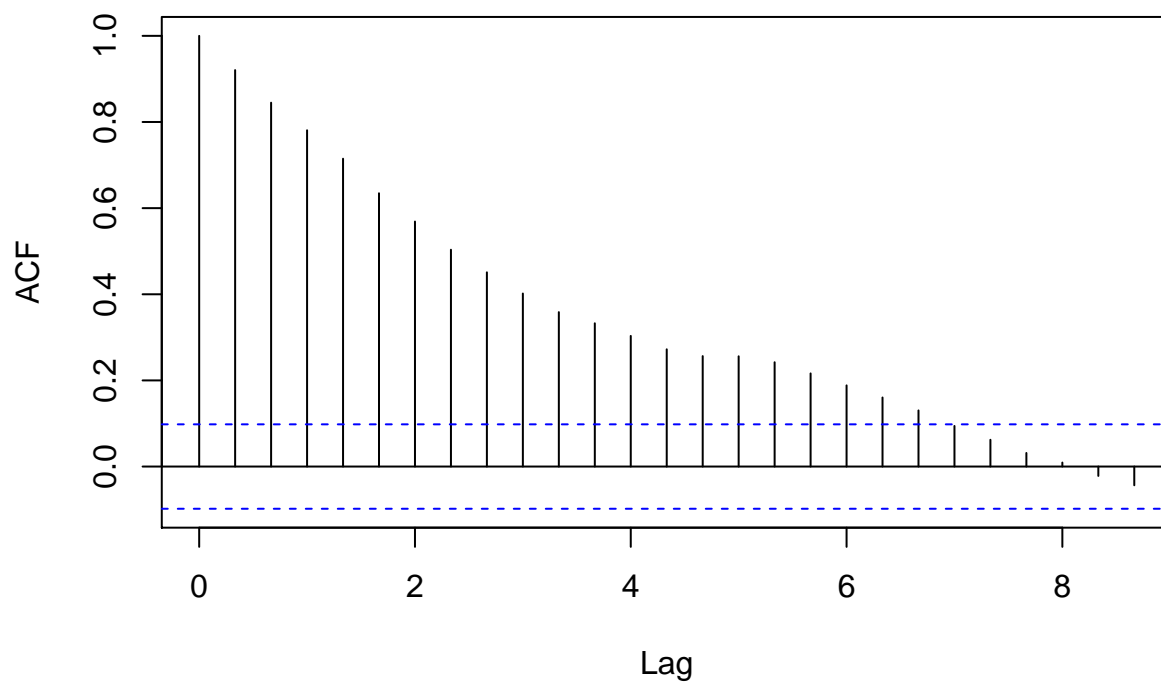
```
ggplot(data, aes(x = x, y = y_no_trend)) +  
  geom_line(color="steelblue") +  
  xlab("") +  
  ylab("")
```

```
## Don't know how to automatically pick scale for object of type ts. Defaulting to continuous.
```

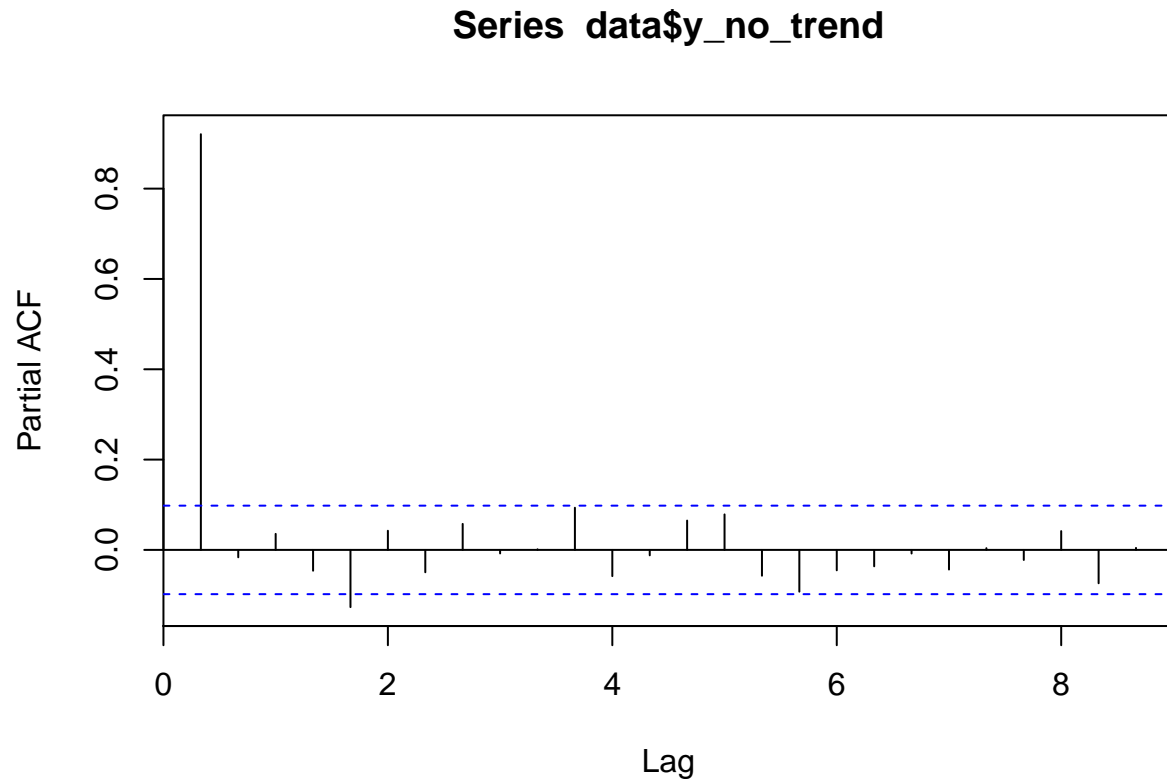


```
acf(data$y_no_trend)
```

Series data\$y_no_trend



```
pacf(data$y_no_trend)
```



```
#najbolji AR(p) model
```

```
#tražim onaj koji ima najmanji aic kriterij - isprobala za prvih 50, najbolji je za p = 1
```

```
p = c(1:5)
for(i in p){
  print(i)
  print(yw(data$y_no_trend, p = i)$aicc)
}
```

```
## [1] 1
## [1] 6091.87
## [1] 2
## [1] 6093.831
## [1] 3
## [1] 6095.142
## [1] 4
## [1] 6096.415
## [1] 5
## [1] 6092.452
```

```
#ar = yw(data$y_no_trend,, p = 1)
```

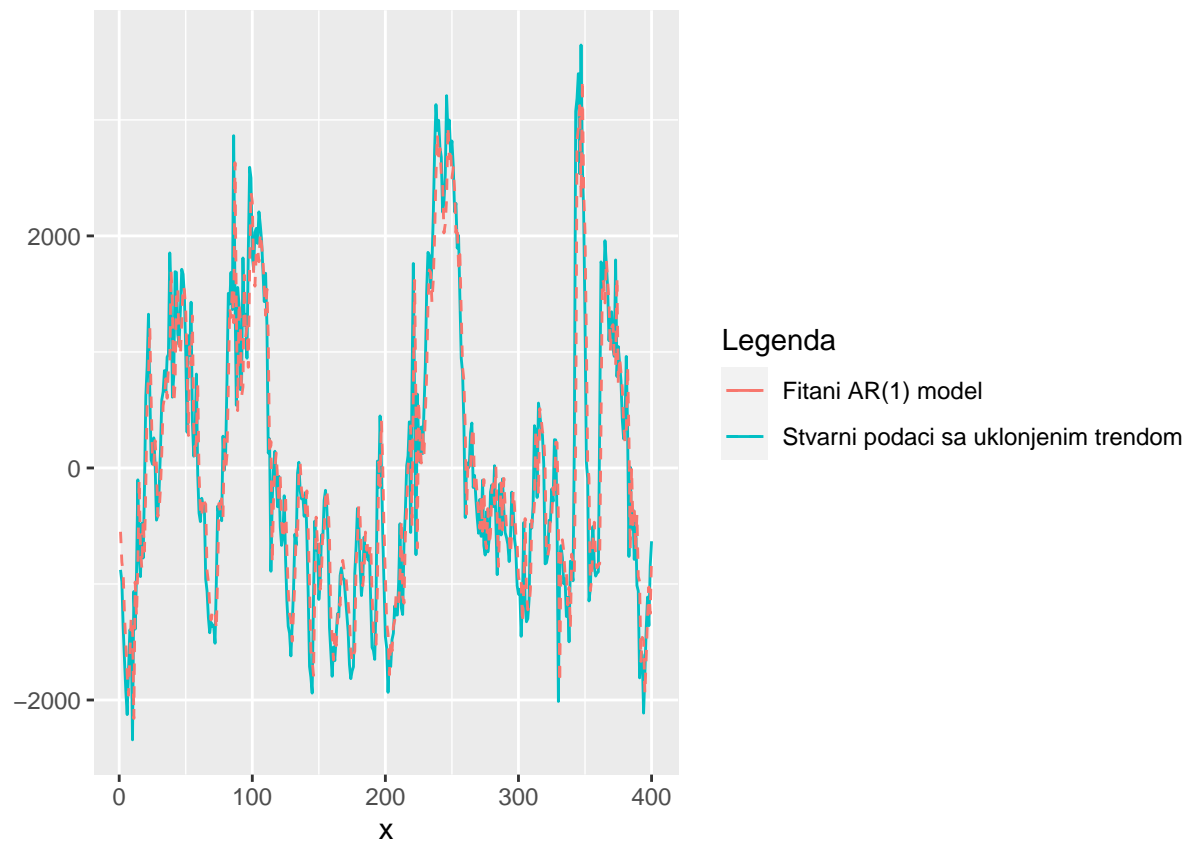
```
library(tseries)
```

```
AR <- arima(data$y_no_trend, order = c(1,0,0))
```

```
data$y_fit_AR = data$y_no_trend - residuals(AR)
```

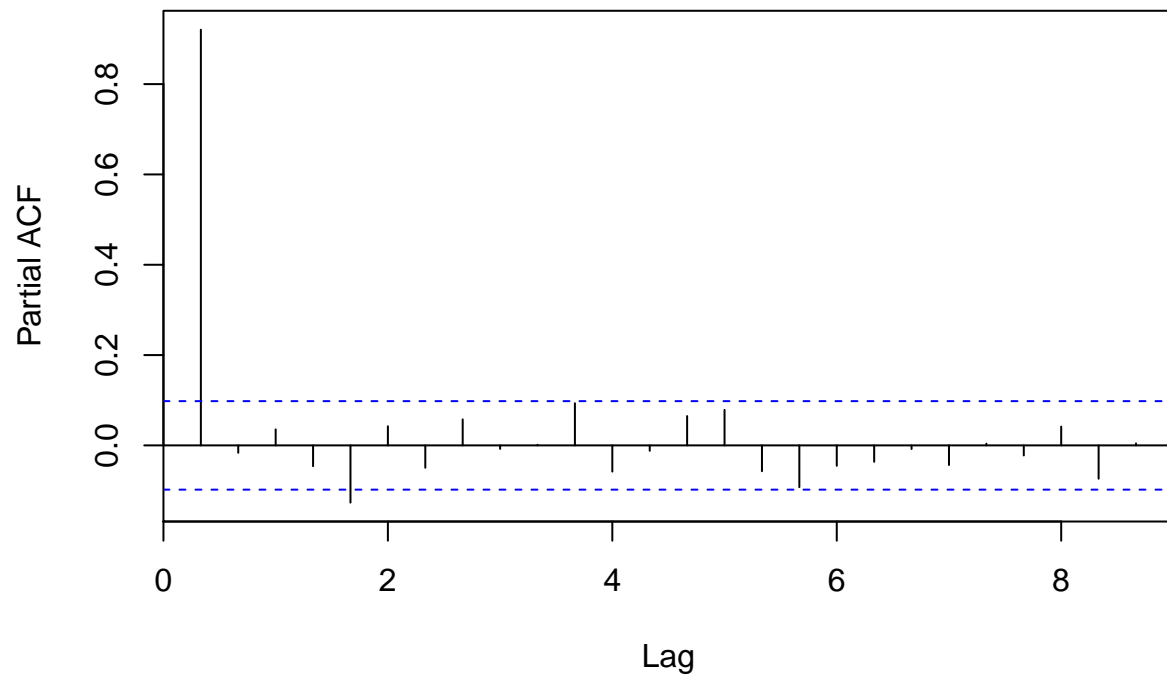
```
ggplot(data, aes(x = x)) + geom_line(aes(y = y_no_trend, col="Stvarni podaci sa uklonjenim trendom")) +
```

```
## Don't know how to automatically pick scale for object of type ts. Defaulting to continuous.
```



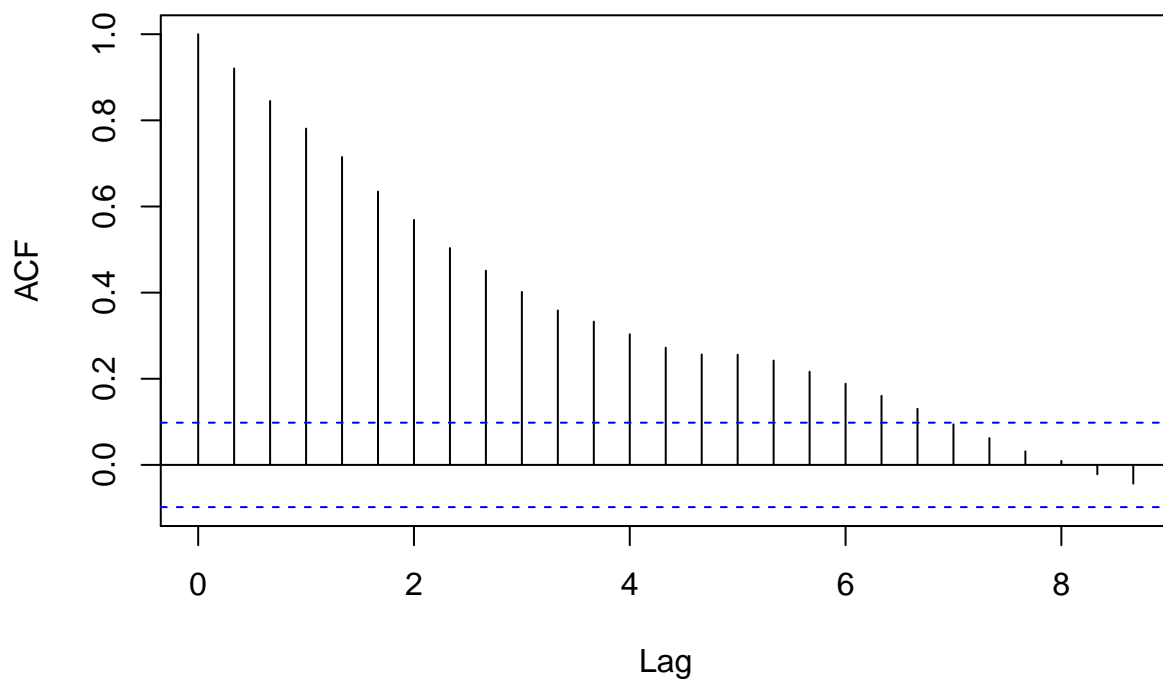
```
#drugi način  
ar(data$y_no_trend, method= "yule-walker")$order #isto se dobi jedinica  
  
## [1] 1  
pacf(data$y_no_trend) #komentiraj isto se vidi AR(1)
```

Series data\$y_no_trend



```
acf(data$y_no_trend)
```

Series data\$y_no_trend



```
AIC(AR)
```

```
## [1] 6093.819
```

```

BIC(AR)

## [1] 6105.794

#usporedba s ARMA(1,1) modelom
ARMA = arima(data$y_no_trend, order=c(1,0,1), include.mean = TRUE, method= "ML")
AIC(ARMA)

## [1] 6095.741

BIC(ARMA)

## [1] 6111.707

#najbolji MA(q) model koristeći AIC kriterij
library(tseries)
p = c(1:3)
for(i in p){
  print(i)
  print(arima(data$y_no_trend, order = c(0,0,i))$aic)
}

## [1] 1
## [1] 6501.232
## [1] 2
## [1] 6317.084
## [1] 3
## [1] 6259.805

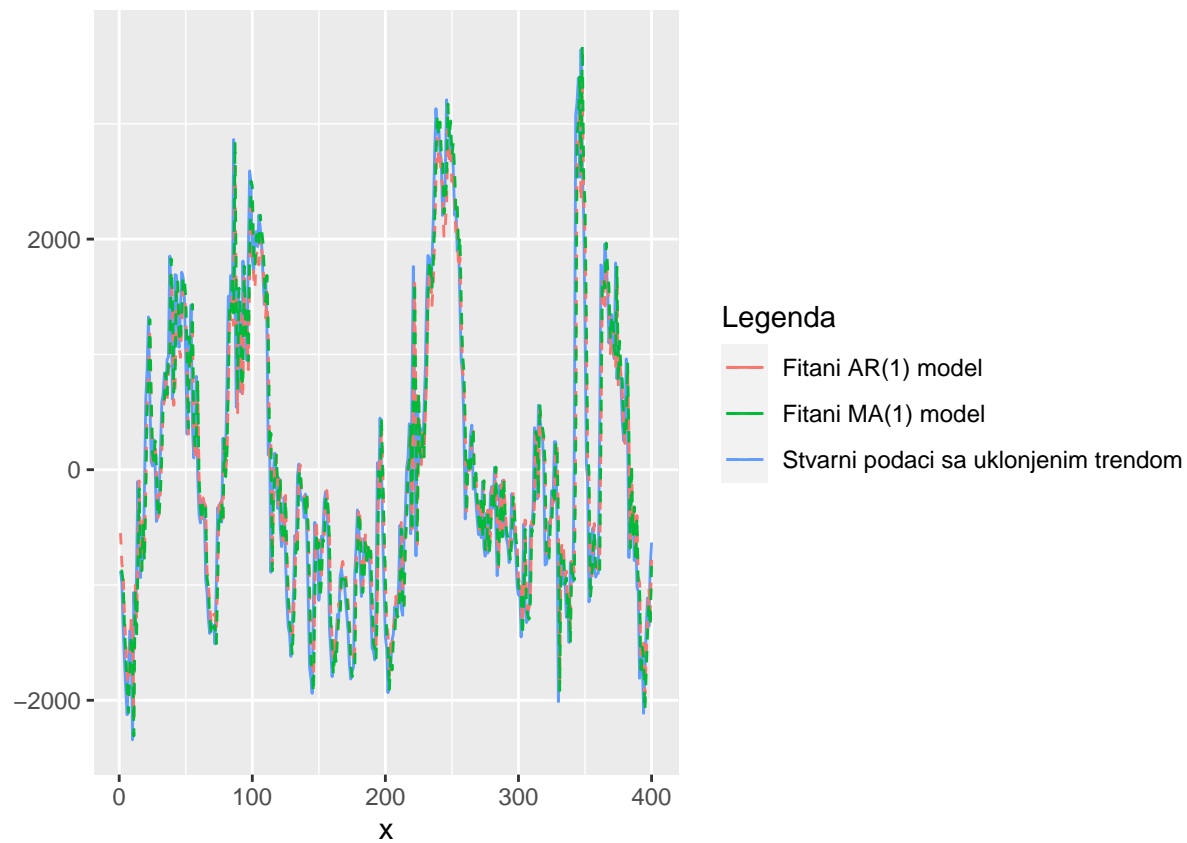
#najmanji aic za q=3
MA <- arima(data$y_no_trend, order = c(1,1,3))
MA

##
## Call:
## arima(x = data$y_no_trend, order = c(1, 1, 3))
##
## Coefficients:
##          ar1          ma1          ma2          ma3
##          0.3035    -0.3342    -0.0574    0.0366
## s.e.    0.6313    0.6299    0.0537    0.0650
##
## sigma^2 estimated as 245733:  log likelihood = -3042.36,  aic = 6094.71
data$y_fit_MA = data$y_no_trend - residuals(MA)

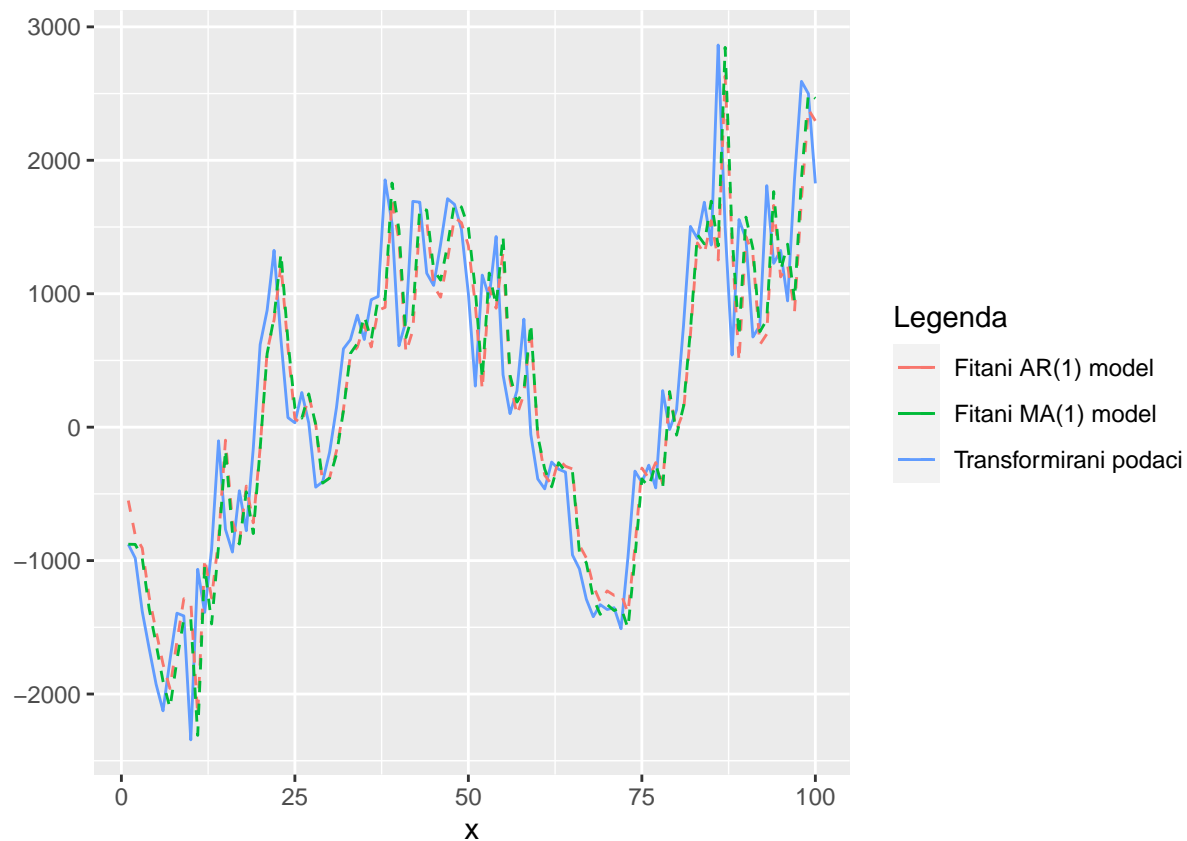
ggplot(data, aes(x = x)) + geom_line(aes(y = y_no_trend, col="Stvarni podaci sa uklonjenim trendom")) +
  geom_line(aes(y = y_fit_AR, col="Fitani AR(1) model"), linetype="dashed") + ylab("") + labs(color="Legend")
  geom_line(aes(y = y_fit_MA, col="Fitani MA(1) model"), linetype="dashed")

## Don't know how to automatically pick scale for object of type ts. Defaulting to continuous.

```



```
ggplot(data[0:100,], aes(x = x)) + geom_line(aes(y = y_no_trend, col="Transformirani podaci")) +
geom_line(aes(y = y_fit_AR, col="Fitani AR(1) model"), linetype="dashed") + ylab("") + labs(color="Legenda")
geom_line(aes(y = y_fit_MA, col="Fitani MA(1) model"), linetype="dashed")
```



AIC(MA)

```
## [1] 6094.711
```

BIC(MA)

```
## [1] 6114.656
```

#prilagodba GARCH(1,1) modela?

```
GARCH <- garch(data$y_no_trend, order = c(1,1))
```

```
##
```

```
## ***** ESTIMATION WITH ANALYTICAL GRADIENT *****
```

```
##
```

```
##
```

```
##      I      INITIAL X(I)      D(I)
```

```
##
```

```
##      1      1.417482e+06      1.000e+00
```

```
##      2      5.000000e-02      1.000e+00
```

```
##      3      5.000000e-02      1.000e+00
```

```
##
```

```
##      IT      NF      F      RELDF      PRELDF      RELDX      STPPAR      D*STEP      NPRELDF
```

```
##
```

```
##      0      1      3.033e+03
```

```
##      1      3      3.021e+03      4.04e-03      6.32e-03      3.5e-08      1.9e+03      1.0e-01      6.07e+00
```

```
##      2      5      3.020e+03      2.72e-04      2.68e-04      3.0e-09      1.5e+01      1.0e-02      6.87e-01
```

```
##      3      7      3.019e+03      5.15e-04      5.13e-04      5.8e-09      4.2e+00      2.0e-02      5.46e-01
```

```
##      4      9      3.016e+03      9.40e-04      9.32e-04      1.1e-08      2.9e+00      4.0e-02      5.04e-01
```

```
##      5      13      3.016e+03      1.79e-06      1.79e-06      2.0e-11      5.5e+03      8.0e-05      4.00e-01
```

```
##      6      16      3.016e+03      1.43e-05      1.43e-05      1.6e-10      1.9e+02      6.4e-04      2.13e-01
```



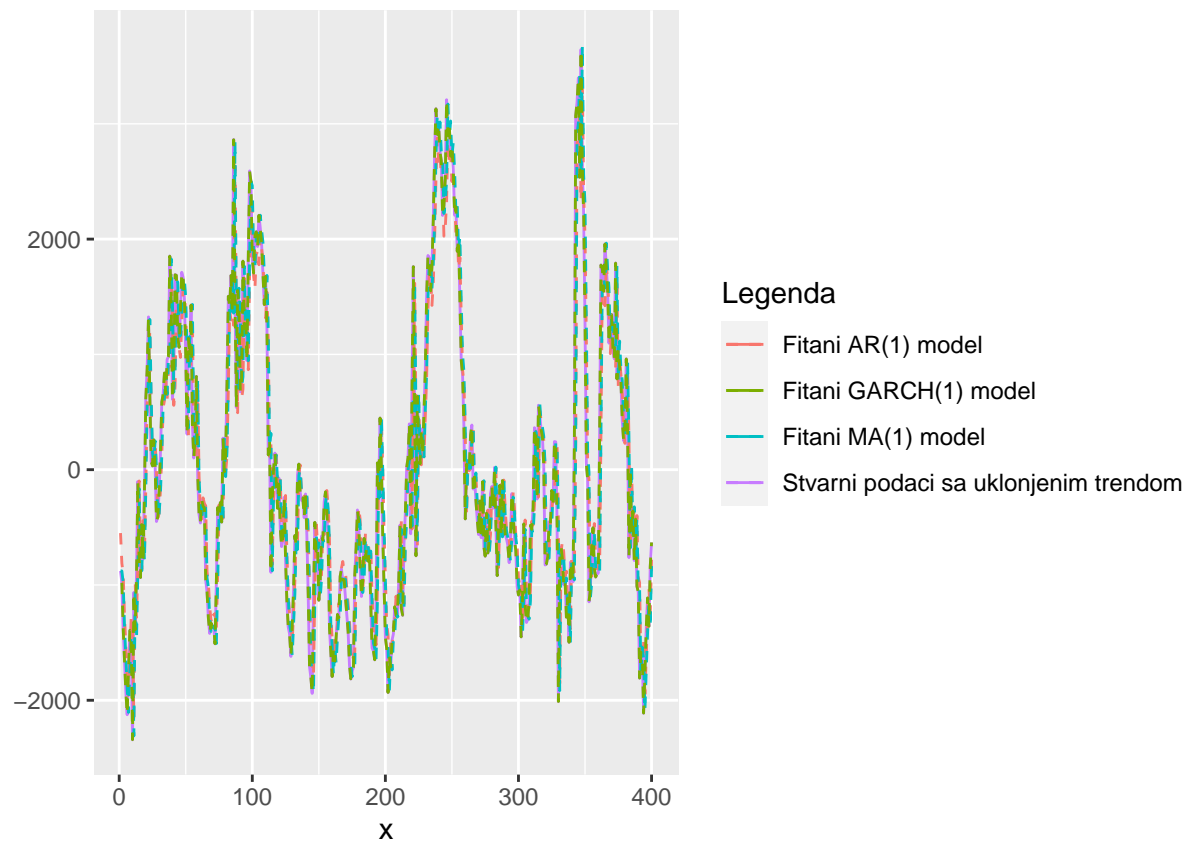
```

##      7   19  3.016e+03  2.86e-07  2.86e-07  3.2e-12  3.7e+04  1.3e-05  2.13e-01
##      8   22  3.016e+03  5.72e-09  5.72e-09  6.5e-14  1.8e+06  2.6e-07  2.11e-01
##      9   24  3.016e+03  1.14e-09  1.14e-09  1.3e-14  9.2e+06  5.1e-08  2.11e-01
##     10   26  3.016e+03  2.29e-09  2.29e-09  2.6e-14  1.2e+06  1.0e-07  2.11e-01
##     11   28  3.016e+03  4.58e-10  4.58e-10  5.2e-15  2.3e+07  2.0e-08  2.11e-01
##     12   30  3.016e+03  9.16e-10  9.16e-10  1.0e-14  2.9e+06  4.1e-08  2.11e-01
##     13   31  3.016e+03 -3.32e+06  1.83e-09  2.1e-14  5.8e+06  8.2e-08  2.11e-01
##
## ***** FALSE CONVERGENCE *****
##
## FUNCTION      3.015955e+03  RELDX      2.078e-14
## FUNC. EVALS    31          GRAD. EVALS    13
## PRELDF        1.832e-09    NPRELDF     2.105e-01
##
##      I      FINAL X(I)      D(I)      G(I)
##
##      1      1.417482e+06      1.000e+00      3.911e-05
##      2      2.062350e-01      1.000e+00     -4.687e+01
##      3      1.982608e-09      1.000e+00      4.849e+01
##
## Warning in garch(data$y_no_trend, order = c(1, 1)): singular information
#garch se koriste kada
data$y_fit_GARCH = data$y_no_trend - residuals(GARCH)

ggplot(data, aes(x = x)) + geom_line(aes(y = y_no_trend, col="Stvarni podaci sa uklonjenim trendom")) +
geom_line(aes(y = y_fit_AR, col="Fitani AR(1) model"), linetype="dashed") + ylab("") + labs(color="Legend")
geom_line(aes(y = y_fit_MA, col="Fitani MA(1) model"), linetype="dashed") +
geom_line(aes(y = y_fit_GARCH, col="Fitani GARCH(1) model"), linetype="dashed")

## Don't know how to automatically pick scale for object of type ts. Defaulting to continuous.
## Warning: Removed 1 row(s) containing missing values (geom_path).

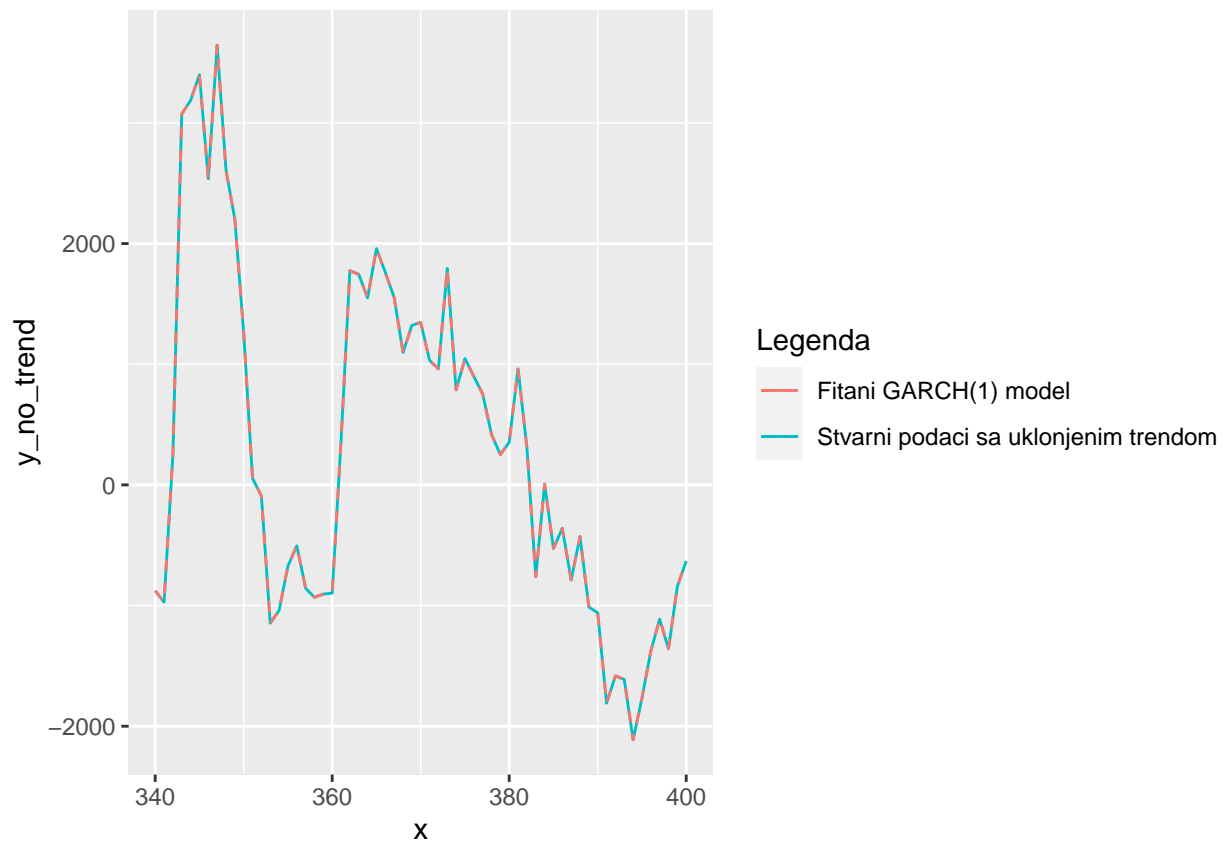
```



#još

grafičkih prikaza

```
ggplot(data[340:400,], aes(x = x)) + geom_line(aes(y = y_no_trend, col="Stvarni podaci sa uklonjenim trendom")) +  
geom_line(aes(y = y_fit_GARCH, col="Fitani GARCH(1) model"), linetype="dashed") + labs(color="Legenda")
```



5 zadatak - prediktiranje

```
new_t <- data.frame(t = c(401))
fc_t = predict(model_trend_2, new_t) #procjena trenda
```

```
#predikt za GARCH
library(fGarch)
```

```
## Loading required package: timeDate
```

```
## Loading required package: timeSeries
```

```
## Loading required package: fBasics
```

```
p = predict(garchFit(formula = ~ garch(1, 1), data = data$y_no_trend), n.ahead= 1)
```

```
##
## Series Initialization:
## ARMA Model:          arma
## Formula Mean:        ~ arma(0, 0)
## GARCH Model:         garch
## Formula Variance:    ~ garch(1, 1)
## ARMA Order:          0 0
## Max ARMA Order:      0
## GARCH Order:         1 1
## Max GARCH Order:     1
## Maximum Order:       1
## Conditional Dist:     norm
```

```

## h.start:                2
## llh.start:              1
## Length of Series:      400
## Recursion Init:        mci
## Series Scale:          1254.982
##
## Parameter Initialization:
## Initial Parameters:     $params
## Limits of Transformations: $U, $V
## Which Parameters are Fixed? $includes
## Parameter Matrix:
##           U           V      params includes
## mu      -0.000394933 3.94933e-04 -3.94933e-05      TRUE
## omega    0.000001000 1.00000e+02 1.00000e-01      TRUE
## alpha1   0.000000010 1.00000e+00 1.00000e-01      TRUE
## gamma1  -0.999999990 1.00000e+00 1.00000e-01     FALSE
## beta1    0.000000010 1.00000e+00 8.00000e-01      TRUE
## delta    0.000000000 2.00000e+00 2.00000e+00     FALSE
## skew     0.100000000 1.00000e+01 1.00000e+00     FALSE
## shape    1.000000000 1.00000e+01 4.00000e+00     FALSE
## Index List of Parameters to be Optimized:
## mu omega alpha1 beta1
## 1   2   3   5
## Persistence:           0.9
##
## --- START OF TRACE ---
## Selected Algorithm: nlminb
##
## R coded nlminb Solver:
##
## 0:    525.24100: -3.94933e-05 0.100000 0.100000 0.800000
## 1:    518.81664: -3.94933e-05 0.0780949 0.0998005 0.779524
## 2:    510.04926: -3.94934e-05 0.0618035 0.167305 0.762457
## 3:    507.51932: -3.94934e-05 0.0503031 0.166726 0.749891
## 4:    488.55828: -3.94938e-05 0.0417546 0.364001 0.561804
## 5:    487.53808: -3.94938e-05 0.0612365 0.370219 0.558852
## 6:    486.67457: -3.94939e-05 0.0531423 0.371907 0.539916
## 7:    485.24291: -3.94941e-05 0.0770854 0.385992 0.509322
## 8:    484.04209: -3.94949e-05 0.0743105 0.396366 0.427375
## 9:    482.98501: -3.95077e-05 0.124510 0.420163 0.366184
## 10:   480.52190: -3.95671e-05 0.0863551 0.481782 0.405879
## 11:   479.20830: -3.96502e-05 0.0698427 0.534878 0.344768
## 12:   477.86213: -3.98290e-05 0.0866862 0.590101 0.285804
## 13:   477.08888: -4.02855e-05 0.0863924 0.670384 0.254725
## 14:   476.98797: -4.07139e-05 0.0874786 0.698296 0.248341
## 15:   476.98084: -4.10976e-05 0.0881235 0.709100 0.243216
## 16:   476.98069: -4.13824e-05 0.0882994 0.709787 0.243070
## 17:   476.98064: -4.17293e-05 0.0883863 0.709958 0.242876
## 18:   476.98035: -4.42637e-05 0.0887567 0.710371 0.242133
## 19:   476.97988: -4.92730e-05 0.0891547 0.710686 0.241361
## 20:   476.97857: -6.37559e-05 0.0898322 0.711147 0.240060
## 21:   476.97511: -0.000104836 0.0910124 0.711904 0.237799
## 22:   476.96652: -0.000211954 0.0929273 0.713108 0.234129

```

```

## 23:      476.94107: -0.000394933 0.0935197 0.713170 0.232992
## 24:      476.92697: -0.000394933 0.0900587 0.710767 0.239574
## 25:      476.92520: -0.000394933 0.0881913 0.709761 0.243085
## 26:      476.92518: -0.000394933 0.0883427 0.709906 0.242801
## 27:      476.92518: -0.000394933 0.0883381 0.709924 0.242805
##
## Final Estimate of the Negative LLH:
## LLH: 3330.876      norm LLH: 8.32719
##      mu      omega      alpha1      beta1
## -4.956338e-01 1.391308e+05 7.099235e-01 2.428045e-01
##
## R-optimhess Difference Approximated Hessian Matrix:
##      mu      omega      alpha1      beta1
## mu      -9.607239e-05 1.909342e-07 1.432069e-02 1.289727e-01
## omega    1.909342e-07 -1.306081e-09 -3.216940e-04 -7.484216e-04
## alpha1   1.432069e-02 -3.216940e-04 -2.201571e+02 -2.927333e+02
## beta1    1.289727e-01 -7.484216e-04 -2.927333e+02 -6.834414e+02
## attr("time")
## Time difference of 0.009388924 secs
##
## --- END OF TRACE ---
##
## Time to Estimate Parameters:
## Time difference of 0.05384183 secs

## Warning: Using formula(x) is deprecated when x is a character vector of length > 1.
## Consider formula(paste(x, collapse = " ")) instead.

prediction = fc_t + p$meanForecast
upper = fc_t + 2* p$standardDeviation
lower = fc_t - 2 * p$standardDeviation

data_new = data.frame(x = c(data$x[390:400], 401), y = c(data$y[390:400], prediction), upper = c(data$y[
ggplot(data_new, aes(x = x)) + geom_line(aes(y = y, col="Procjena za sljedeću vrijednost")) +
geom_line(aes(y = upper, col="Pouzdana granice")) +
  geom_line(aes(y = lower, col="Pouzdana granice")) + geom_ribbon(aes(ymin = lower, ymax = upper), alpha

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

```

```
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
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## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>
```

```

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
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## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <87>

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## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

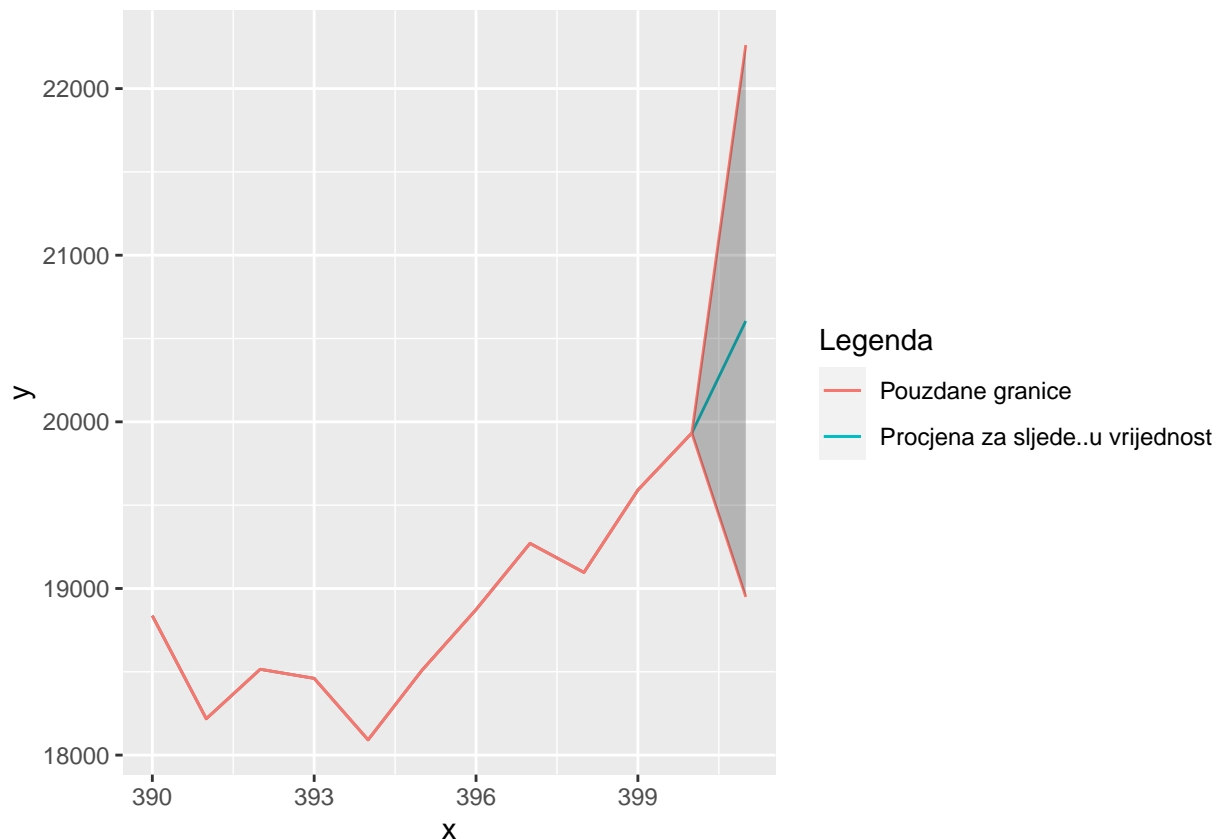
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :

```

```
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
## substituted for <87>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
## substituted for <c4>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
## substituted for <87>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
## substituted for <c4>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
## substituted for <87>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
## substituted for <c4>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
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## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
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## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
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## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
## substituted for <c4>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot  
## substituted for <87>
```

```
##predict za AR
```

```
AR_forecast <- predict(AR, n.ahead = 1)$pred
AR_forecast_se <- predict(AR, n.ahead = 1)$se
```

```
prediction = fc_t + AR_forecast
upper = fc_t + 2* AR_forecast_se
lower = fc_t - 2 * AR_forecast_se
```

```
data_new = data.frame(x = c(data$x[390:400], 401), y = c(data$y[390:400], prediction), upper = c(data$y[390:400], upper), lower = c(data$y[390:400], lower))
ggplot(data_new, aes(x = x)) + geom_line(aes(y = y, col="Procjena za sljedeću vrijednost")) +
geom_line(aes(y = upper, col="Pouzdate granice")) +
geom_line(aes(y = lower, col="Pouzdate granice")) + geom_ribbon(aes(ymin = lower, ymax = upper), alpha = 0.5)
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot
## substituted for <c4>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot
## substituted for <87>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot
## substituted for <c4>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbscsToSbcs': dot
```

```
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>
```

```

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <c4>

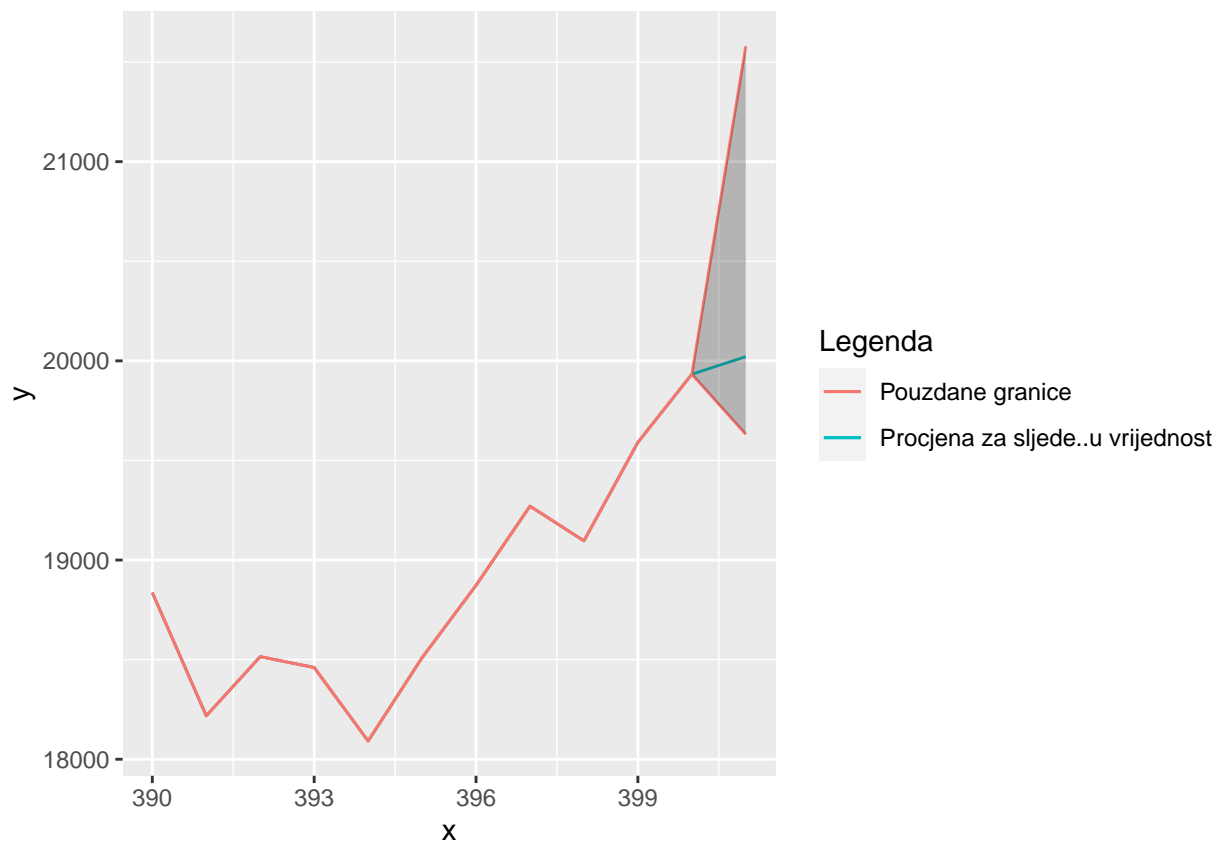
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbs': dot
## substituted for <87>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :

```

```
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot  
## substituted for <c4>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot  
## substituted for <87>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot  
## substituted for <c4>  
  
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot  
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot  
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot  
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot  
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :  
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot  
## substituted for <87>
```

```
## substituted for <87>
```



```
#predict za MA
```

```
MA_forecast <- predict(MA, n.ahead = 1)$pred
MA_forecast_se <- predict(MA, n.ahead = 1)$se
```

```
prediction = fc_t + MA_forecast
upper = fc_t + 2 * MA_forecast_se
lower = fc_t - 2 * MA_forecast_se
```

```
data_new = data.frame(x = c(data$x[390:400], 401), y = c(data$y[390:400], prediction), upper = c(data$y[390:400], upper), lower = c(data$y[390:400], lower))
ggplot(data_new, aes(x = x)) + geom_line(aes(y = y, col="Procjena za sljedeću vrijednost")) +
  geom_line(aes(y = upper, col="Pouzidane granice")) +
  geom_line(aes(y = lower, col="Pouzidane granice")) + geom_ribbon(aes(ymin = lower, ymax = upper), alpha = 0.5)
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>
```

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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <87>
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## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbcsToSbcs': dot
## substituted for <c4>
```

```
## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
```



```

## substituted for <c4>

## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbcs': dot
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## Warning in grid.Call(C_textBounds, as.graphicsAnnot(x$label), x$x, x$y, :
## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbcs': dot
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## conversion failure on 'Procjena za sljedeću vrijednost' in 'mbsToSbcs': dot
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