Final

Prateek Kumar

11 November 2018

# Question1

A2 <- read.csv("A2\_1\_MOPP.csv", header=T)  
B1 <- read.csv("B1\_2\_BDU.csv", header=T)  
C2 <- read.csv("C2\_2\_MOPP.csv", header=T)  
D2 <- read.csv("D2\_2\_MOPP.csv", header=T)  
  
library(dplyr)

##   
## Attaching package: 'dplyr'

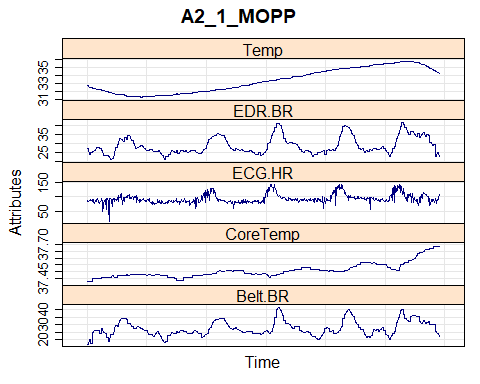
## The following objects are masked from 'package:stats':  
##   
## filter, lag

## The following objects are masked from 'package:base':  
##   
## intersect, setdiff, setequal, union

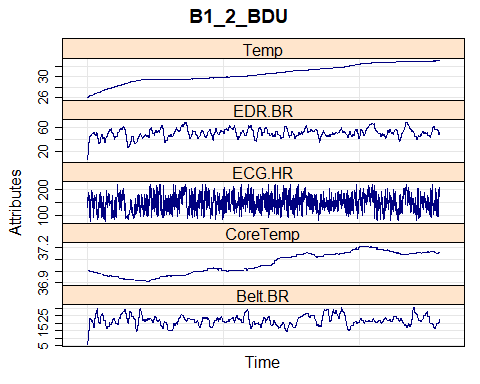
dfA2 <- A2 %>% select(Time, ECG.HR, EDR.BR, Belt.BR, CoreTemp, Temp)  
dfB1 <- B1 %>% select(Time, ECG.HR, EDR.BR, Belt.BR, CoreTemp, Temp)  
dfC2 <- C2 %>% select(Time, ECG.HR, EDR.BR, Belt.BR, CoreTemp, Temp)  
dfD2 <- D2 %>% select(Time, ECG.HR, EDR.BR, Belt.BR, CoreTemp, Temp)  
  
# sapply(dfA2, class)  
# summary(dfA2)  
# sapply(dfB1, class)  
# summary(dfB1)  
# sapply(dfC2, class)  
# summary(dfC2)  
# sapply(dfD2, class)  
# summary(dfD2)  
  
  
# colSums(is.na(dfA2)) #No missing values in the 4 dataframes  
# colSums(is.na(dfB1))  
# colSums(is.na(dfC2))  
# colSums(is.na(dfD2))  
  
# ECG.HR average 60-100 per minute  
# CoreTemp average 36.3-37.3 C  
# Temp average 36.5-37.5 C  
  
dfA2$CoreTemp[which(dfA2$CoreTemp==0)] = NA  
dfB1$CoreTemp[which(dfB1$CoreTemp==0)] = NA  
dfC2$CoreTemp[which(dfC2$CoreTemp==0)] = NA  
dfD2$CoreTemp[which(dfD2$CoreTemp==0)] = NA  
  
  
require(lattice)

## Loading required package: lattice

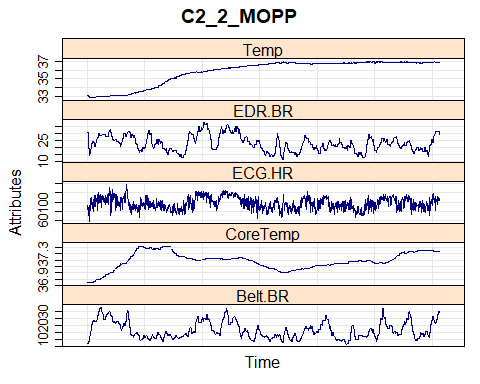
# A2\_1\_MOPP  
xplot <- rep((0:(length(dfA2$Time)-1))/1000,5)  
yplot <- c(dfA2$ECG.HR, dfA2$EDR.BR, dfA2$Belt.BR, dfA2$CoreTemp, dfA2$Temp)  
gplot <- c(rep("ECG.HR",length(dfA2$ECG.HR)),  
 rep("EDR.BR",length(dfA2$EDR.BR)),  
 rep("Belt.BR",length(dfA2$Belt.BR)),  
 rep("CoreTemp",length(dfA2$CoreTemp)),  
 rep("Temp",length(dfA2$Temp)))  
  
tp <- xyplot(yplot~xplot|gplot, type="l", layout=c(1,5),   
 xlab="Time", ylab="Attributes", grid=T, lwd=1.5, main = "A2\_1\_MOPP", col="Navy",  
 scales=list(x=list(draw=FALSE),   
 y=list(relation='free',limits=list(c(17,41.6), c(37.42,37.69),   
 c(14.5,144.8), c(21,41.7), c(31.2,35.8)))))  
tp



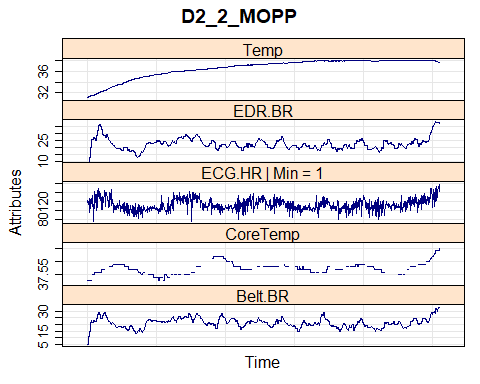
# B1\_2\_BDU  
xplot <- rep((0:(length(dfB1$Time)-1))/1000,5)  
yplot <- c(dfB1$ECG.HR, dfB1$EDR.BR, dfB1$Belt.BR, dfB1$CoreTemp, dfB1$Temp)  
gplot <- c(rep("ECG.HR",length(dfB1$ECG.HR)),  
 rep("EDR.BR",length(dfB1$EDR.BR)),  
 rep("Belt.BR",length(dfB1$Belt.BR)),  
 rep("CoreTemp",length(dfB1$CoreTemp)),  
 rep("Temp",length(dfB1$Temp)))  
  
tp <- xyplot(yplot~xplot|gplot, type="l", layout=c(1,5),   
 xlab="Time", ylab="Attributes", grid=T, lwd=1.5, main = "B1\_2\_BDU", col="Navy",  
 scales=list( x=list(draw=FALSE),   
 y=list(relation='free',limits=list(c(6,30.7), c(36.9,37.22),   
 c(76.2,221.1), c(6,69.1), c(25.9,33.1)))))  
tp



# C2\_2\_MOPP  
xplot <- rep((0:(length(dfC2$Time)-1))/1000,5)  
yplot <- c(dfC2$ECG.HR, dfC2$EDR.BR, dfC2$Belt.BR, dfC2$CoreTemp, dfC2$Temp)  
gplot <- c(rep("ECG.HR",length(dfC2$ECG.HR)),  
 rep("EDR.BR",length(dfC2$EDR.BR)),  
 rep("Belt.BR",length(dfC2$Belt.BR)),  
 rep("CoreTemp",length(dfC2$CoreTemp)),  
 rep("Temp",length(dfC2$Temp)))  
  
tp <- xyplot(yplot~xplot|gplot, type="l", layout=c(1,5),   
 xlab="Time", ylab="Attributes", grid=T, lwd=1.5, main = "C2\_2\_MOPP", col="Navy",  
 scales=list( x=list(draw=FALSE),   
 y=list(relation='free',limits=list(c(6.7,32.7), c(36.84,37.43),   
 c(59,139.4), c(11.2,37.8), c(32.8,37.1)))))  
tp



# D2\_2\_MOPP  
xplot <- rep((0:(length(dfD2$Time)-1))/1000,5)  
yplot <- c(dfD2$ECG.HR, dfD2$EDR.BR, dfD2$Belt.BR, dfD2$CoreTemp, dfD2$Temp)  
gplot <- c(rep("ECG.HR | Min = 1",length(dfD2$ECG.HR)),  
 rep("EDR.BR",length(dfD2$EDR.BR)),  
 rep("Belt.BR",length(dfD2$Belt.BR)),  
 rep("CoreTemp",length(dfD2$CoreTemp)),  
 rep("Temp",length(dfD2$Temp)))  
  
tp <- xyplot(yplot~xplot|gplot, type=c("l"), layout=c(1,5),   
 xlab="Time", ylab="Attributes", grid=T, lwd=1, main = "D2\_2\_MOPP", col="Navy",  
 scales=list( x=list(draw=FALSE),   
 y=list(relation='free',limits=list(c(5,32.9), c(37.52,37.66),   
 c(77.3,159.9), c(11.2,37.8), c(31,38)))))  
tp

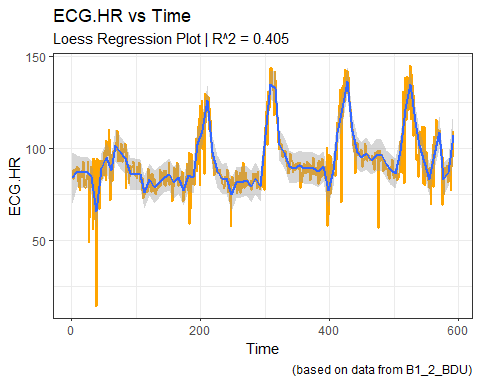


# Question2

A2 <- read.csv("A2\_1\_MOPP.csv", header=T)  
B1 <- read.csv("B1\_2\_BDU.csv", header=T)  
C2 <- read.csv("C2\_2\_MOPP.csv", header=T)  
D2 <- read.csv("D2\_2\_MOPP.csv", header=T)  
  
library(dplyr)  
  
dfA2 <- A2 %>% select(Time, ECG.HR, EDR.BR, Belt.BR, CoreTemp, Temp)  
dfB1 <- B1 %>% select(Time, ECG.HR, EDR.BR, Belt.BR, CoreTemp, Temp)  
dfC2 <- C2 %>% select(Time, ECG.HR, EDR.BR, Belt.BR, CoreTemp, Temp)  
dfD2 <- D2 %>% select(Time, ECG.HR, EDR.BR, Belt.BR, CoreTemp, Temp)  
  
library(ggplot2)  
dfA2$ECG.HR[which(dfA2$ECG.HR==0)] = NA  
dfB1$ECG.HR[which(dfA2$ECG.HR==0)] = NA  
dfC2$ECG.HR[which(dfA2$ECG.HR==0)] = NA  
dfD2$ECG.HR[which(dfA2$ECG.HR==0)] = NA  
  
p <- ggplot(data=dfA2, aes(x=as.numeric(Time),y=ECG.HR))  
p+geom\_line(color="orange",size=1)+geom\_smooth(method = "loess",stat="smooth",size=1,span=0.02)+ theme\_bw()+  
 xlab("Time")+labs(title = "ECG.HR vs Time", subtitle = "Loess Regression Plot | R^2 = 0.405",  
 caption = "(based on data from B1\_2\_BDU)")

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : k-d tree limited by memory. ncmax= 592

## Warning in predLoess(object$y, object$x, newx = if  
## (is.null(newdata)) object$x else if (is.data.frame(newdata))  
## as.matrix(model.frame(delete.response(terms(object)), : k-d tree limited by  
## memory. ncmax= 592



lmodel <- loess(as.numeric(dfA2$Time)~dfA2$ECG.HR,span=0.02)

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : pseudoinverse used at 86.5

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : neighborhood radius 0.1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : reciprocal condition number 0

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : There are other near singularities as well. 0.04

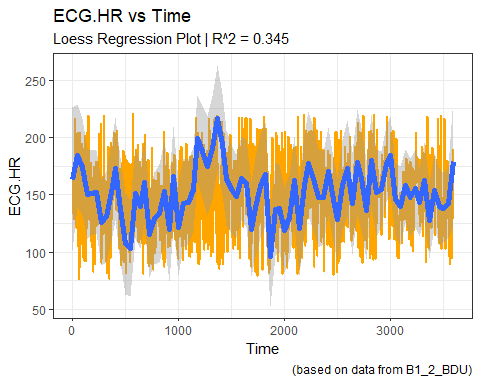
cor(as.numeric(dfA2$Time),predict(lmodel))^2

## [1] 0.4054559

p <- ggplot(data=dfB1, aes(x=as.numeric(Time),y=ECG.HR))  
p+geom\_line(color="orange",size=1)+geom\_smooth(method = "loess",stat="smooth",size=2,span=0.008)+ theme\_bw()+  
 xlab("Time")+labs(title = "ECG.HR vs Time", subtitle = "Loess Regression Plot | R^2 = 0.345",  
 caption = "(based on data from B1\_2\_BDU)")

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : k-d tree limited by memory. ncmax= 1294

## Warning in predLoess(object$y, object$x, newx = if  
## (is.null(newdata)) object$x else if (is.data.frame(newdata))  
## as.matrix(model.frame(delete.response(terms(object)), : k-d tree limited by  
## memory. ncmax= 1294



lmodel <- loess(as.numeric(dfB1$Time)~dfB1$ECG.HR,span=0.008)

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : pseudoinverse used at 122

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : neighborhood radius 0.1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : reciprocal condition number 0

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : There are other near singularities as well. 0.04

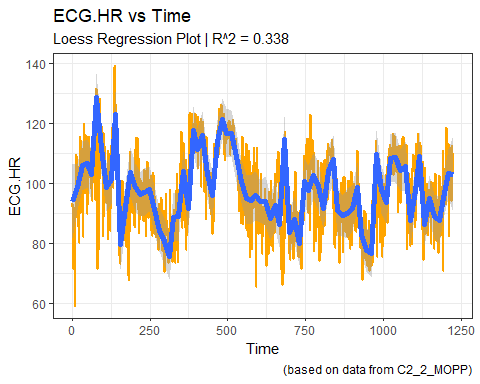
cor(as.numeric(dfB1$Time),predict(lmodel))^2

## [1] 0.3450782

p <- ggplot(data=dfC2, aes(x=as.numeric(Time),y=ECG.HR))  
p+geom\_line(color="orange",size=1)+geom\_smooth(method = "loess",stat="smooth",size=2,span=0.008)+ theme\_bw()+  
 xlab("Time")+labs(title = "ECG.HR vs Time", subtitle = "Loess Regression Plot | R^2 = 0.338",  
 caption = "(based on data from C2\_2\_MOPP)")

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : k-d tree limited by memory. ncmax= 1226

## Warning in predLoess(object$y, object$x, newx = if  
## (is.null(newdata)) object$x else if (is.data.frame(newdata))  
## as.matrix(model.frame(delete.response(terms(object)), : k-d tree limited by  
## memory. ncmax= 1226



lmodel <- loess(as.numeric(dfC2$Time)~dfC2$ECG.HR,span=0.008)

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : pseudoinverse used at 87.5

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : neighborhood radius 0.1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : reciprocal condition number 0

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : There are other near singularities as well. 0.01

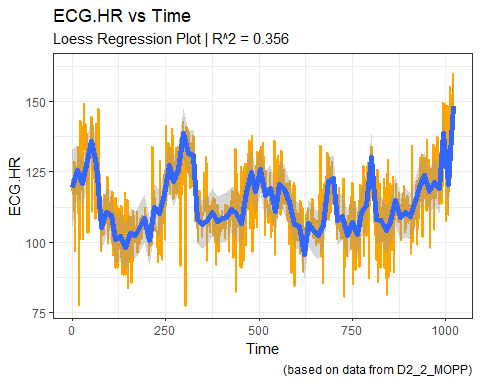
cor(as.numeric(dfC2$Time),predict(lmodel))^2

## [1] 0.3378101

p <- ggplot(data=dfD2, aes(x=as.numeric(Time),y=ECG.HR))  
p+geom\_line(color="orange",size=1)+geom\_smooth(method = "loess",stat="smooth",size=2,span=0.011)+ theme\_bw()+  
 xlab("Time")+labs(title = "ECG.HR vs Time", subtitle = "Loess Regression Plot | R^2 = 0.356",  
 caption = "(based on data from D2\_2\_MOPP)")

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : k-d tree limited by memory. ncmax= 1021

## Warning in predLoess(object$y, object$x, newx = if  
## (is.null(newdata)) object$x else if (is.data.frame(newdata))  
## as.matrix(model.frame(delete.response(terms(object)), : k-d tree limited by  
## memory. ncmax= 1021



lmodel <- loess(as.numeric(dfD2$Time)~dfD2$ECG.HR,span=0.011)

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : pseudoinverse used at 112.3

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : neighborhood radius 0.1

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : reciprocal condition number 0

## Warning in simpleLoess(y, x, w, span, degree = degree, parametric =  
## parametric, : There are other near singularities as well. 0.01

cor(as.numeric(dfD2$Time),predict(lmodel))^2

## [1] 0.3561628

# Question3

A2 <- read.csv("A2\_1\_MOPP.csv", header=T)  
B1 <- read.csv("B1\_2\_BDU.csv", header=T)  
  
A2\_BR <- c(A2$EDR.BR, A2$Belt.BR)  
t <- rep(1:nrow(A2),2)  
c <- rep(c("ecg","belt"), times = 1, length.out = NA, each = 592)  
  
df\_A2 = cbind(time=t,type=c,rate=A2\_BR)  
df\_A2 = data.frame(df\_A2)  
df\_A2$time = as.numeric(df\_A2$time)  
df\_A2$rate = as.numeric(as.matrix(df\_A2$rate))  
  
B1\_BR <- c(B1$EDR.BR, B1$Belt.BR)  
t <- rep(1:nrow(B1),2)  
c <- rep(c("ecg","belt"), times = 1, length.out = NA, each = 1294)  
  
df\_B1 = cbind(time=t,type=c,rate=B1\_BR)  
df\_B1 = data.frame(df\_B1)  
df\_B1$time = as.numeric(df\_B1$time)  
df\_B1$rate = as.numeric(as.matrix(df\_B1$rate))  
  
# library(ggplot2)  
# plot of BR and Time:  
# plot(as.numeric(df\_A2$time),as.numeric(df\_A2$rate),pch=16 , cex=0.5, col=rgb(0.4,0.4,0.8,0.6))   
# abline(model\_A2\_1$coefficients)  
# Can we find a polynome that fit this function ?  
model\_A2\_1 <- lm(rate ~ poly(time, 1, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_1)

##   
## Call:  
## lm(formula = rate ~ poly(time, 1, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -12.3805 -2.8427 -0.9323 2.3863 14.4491   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.471e+01 2.962e-01 83.415 < 2e-16 \*\*\*  
## poly(time, 1, raw = TRUE) 9.398e-03 7.744e-04 12.136 < 2e-16 \*\*\*  
## typeecg 1.262e+00 2.647e-01 4.768 2.1e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.554 on 1181 degrees of freedom  
## Multiple R-squared: 0.1258, Adjusted R-squared: 0.1244   
## F-statistic: 85 on 2 and 1181 DF, p-value: < 2.2e-16

model\_A2\_2 <- lm(rate ~ poly(time, 2, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_2)

##   
## Call:  
## lm(formula = rate ~ poly(time, 2, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -11.7962 -3.0008 -0.8352 2.3835 14.1481   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.405e+01 4.191e-01 57.395 < 2e-16 \*\*\*  
## poly(time, 2, raw = TRUE)1 1.602e-02 3.098e-03 5.173 2.71e-07 \*\*\*  
## poly(time, 2, raw = TRUE)2 -1.117e-05 5.058e-06 -2.208 0.0274 \*   
## typeecg 1.262e+00 2.643e-01 4.776 2.02e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.547 on 1180 degrees of freedom  
## Multiple R-squared: 0.1294, Adjusted R-squared: 0.1272   
## F-statistic: 58.48 on 3 and 1180 DF, p-value: < 2.2e-16

model\_A2\_3 <- lm(rate ~ poly(time, 3, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_3)

##   
## Call:  
## lm(formula = rate ~ poly(time, 3, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -12.3520 -3.0157 -0.9299 2.3728 13.9873   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.335e+01 5.474e-01 42.659 < 2e-16 \*\*\*  
## poly(time, 3, raw = TRUE)1 3.023e-02 7.751e-03 3.899 0.000102 \*\*\*  
## poly(time, 3, raw = TRUE)2 -7.100e-05 3.036e-05 -2.339 0.019524 \*   
## poly(time, 3, raw = TRUE)3 6.726e-08 3.366e-08 1.999 0.045891 \*   
## typeecg 1.262e+00 2.639e-01 4.782 1.96e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.541 on 1179 degrees of freedom  
## Multiple R-squared: 0.1324, Adjusted R-squared: 0.1294   
## F-statistic: 44.97 on 4 and 1179 DF, p-value: < 2.2e-16

model\_A2\_4 <- lm(rate ~ poly(time, 4, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_4)

##   
## Call:  
## lm(formula = rate ~ poly(time, 4, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -11.608 -2.792 -1.115 2.433 14.767   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.055e+01 6.657e-01 30.872 < 2e-16 \*\*\*  
## poly(time, 4, raw = TRUE)1 1.239e-01 1.523e-02 8.134 1.05e-15 \*\*\*  
## poly(time, 4, raw = TRUE)2 -7.804e-04 1.043e-04 -7.480 1.45e-13 \*\*\*  
## poly(time, 4, raw = TRUE)3 1.927e-06 2.642e-07 7.293 5.56e-13 \*\*\*  
## poly(time, 4, raw = TRUE)4 -1.568e-09 2.211e-10 -7.094 2.25e-12 \*\*\*  
## typeecg 1.262e+00 2.586e-01 4.881 1.20e-06 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.449 on 1178 degrees of freedom  
## Multiple R-squared: 0.1679, Adjusted R-squared: 0.1644   
## F-statistic: 47.54 on 5 and 1178 DF, p-value: < 2.2e-16

model\_A2\_5 <- lm(rate ~ poly(time, 5, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_5)

##   
## Call:  
## lm(formula = rate ~ poly(time, 5, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -11.9334 -2.8575 -0.6788 1.9020 13.9405   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.385e+01 7.789e-01 30.619 < 2e-16 \*\*\*  
## poly(time, 5, raw = TRUE)1 -4.102e-02 2.611e-02 -1.571 0.117   
## poly(time, 5, raw = TRUE)2 1.160e-03 2.723e-04 4.259 2.22e-05 \*\*\*  
## poly(time, 5, raw = TRUE)3 -6.786e-06 1.163e-06 -5.834 6.99e-09 \*\*\*  
## poly(time, 5, raw = TRUE)4 1.496e-08 2.162e-09 6.918 7.50e-12 \*\*\*  
## poly(time, 5, raw = TRUE)5 -1.115e-11 1.451e-12 -7.682 3.29e-14 \*\*\*  
## typeecg 1.262e+00 2.524e-01 4.999 6.63e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.343 on 1177 degrees of freedom  
## Multiple R-squared: 0.2076, Adjusted R-squared: 0.2036   
## F-statistic: 51.41 on 6 and 1177 DF, p-value: < 2.2e-16

model\_A2\_6 <- lm(rate ~ poly(time, 6, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_6)

##   
## Call:  
## lm(formula = rate ~ poly(time, 6, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -11.8626 -2.8780 -0.6886 1.9165 13.9815   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.410e+01 9.108e-01 26.463 < 2e-16 \*\*\*  
## poly(time, 6, raw = TRUE)1 -5.860e-02 4.197e-02 -1.396 0.1630   
## poly(time, 6, raw = TRUE)2 1.455e-03 6.148e-04 2.366 0.0181 \*   
## poly(time, 6, raw = TRUE)3 -8.771e-06 3.888e-06 -2.256 0.0243 \*   
## poly(time, 6, raw = TRUE)4 2.123e-08 1.192e-08 1.781 0.0752 .   
## poly(time, 6, raw = TRUE)5 -2.045e-11 1.745e-11 -1.172 0.2414   
## poly(time, 6, raw = TRUE)6 5.229e-15 9.773e-15 0.535 0.5927   
## typeecg 1.262e+00 2.525e-01 4.998 6.68e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.344 on 1176 degrees of freedom  
## Multiple R-squared: 0.2078, Adjusted R-squared: 0.2031   
## F-statistic: 44.08 on 7 and 1176 DF, p-value: < 2.2e-16

model\_A2\_7 <- lm(rate ~ poly(time, 7, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_7)

##   
## Call:  
## lm(formula = rate ~ poly(time, 7, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -12.1759 -2.9170 -0.7141 1.9552 14.1951   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.494e+01 1.044e+00 23.875 < 2e-16 \*\*\*  
## poly(time, 7, raw = TRUE)1 -1.356e-01 6.322e-02 -2.145 0.03215 \*   
## poly(time, 7, raw = TRUE)2 3.195e-03 1.233e-03 2.591 0.00968 \*\*   
## poly(time, 7, raw = TRUE)3 -2.503e-05 1.072e-05 -2.336 0.01967 \*   
## poly(time, 7, raw = TRUE)4 9.651e-08 4.775e-08 2.021 0.04349 \*   
## poly(time, 7, raw = TRUE)5 -2.031e-10 1.135e-10 -1.789 0.07390 .   
## poly(time, 7, raw = TRUE)6 2.276e-13 1.370e-13 1.662 0.09676 .   
## poly(time, 7, raw = TRUE)7 -1.072e-16 6.582e-17 -1.628 0.10378   
## typeecg 1.262e+00 2.523e-01 5.001 6.56e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.341 on 1175 degrees of freedom  
## Multiple R-squared: 0.2096, Adjusted R-squared: 0.2042   
## F-statistic: 38.95 on 8 and 1175 DF, p-value: < 2.2e-16

model\_A2\_8 <- lm(rate ~ poly(time, 8, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_8)

##   
## Call:  
## lm(formula = rate ~ poly(time, 8, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -11.3125 -2.8033 -0.5668 1.8434 14.0474   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.721e+01 1.174e+00 23.186 < 2e-16 \*\*\*  
## poly(time, 8, raw = TRUE)1 -4.040e-01 9.019e-02 -4.480 8.21e-06 \*\*\*  
## poly(time, 8, raw = TRUE)2 1.104e-02 2.255e-03 4.898 1.10e-06 \*\*\*  
## poly(time, 8, raw = TRUE)3 -1.217e-04 2.562e-05 -4.748 2.31e-06 \*\*\*  
## poly(time, 8, raw = TRUE)4 7.063e-07 1.545e-07 4.570 5.39e-06 \*\*\*  
## poly(time, 8, raw = TRUE)5 -2.339e-09 5.275e-10 -4.435 1.01e-05 \*\*\*  
## poly(time, 8, raw = TRUE)6 4.428e-12 1.022e-12 4.331 1.61e-05 \*\*\*  
## poly(time, 8, raw = TRUE)7 -4.443e-15 1.048e-15 -4.240 2.41e-05 \*\*\*  
## poly(time, 8, raw = TRUE)8 1.828e-18 4.409e-19 4.146 3.63e-05 \*\*\*  
## typeecg 1.262e+00 2.506e-01 5.036 5.51e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.312 on 1174 degrees of freedom  
## Multiple R-squared: 0.221, Adjusted R-squared: 0.215   
## F-statistic: 37.01 on 9 and 1174 DF, p-value: < 2.2e-16

model\_A2\_9 <- lm(rate ~ poly(time, 9, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_9)

##   
## Call:  
## lm(formula = rate ~ poly(time, 9, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -10.7326 -2.7479 -0.6991 1.8391 14.5076   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.530e+01 1.308e+00 19.346 < 2e-16 \*\*\*  
## poly(time, 9, raw = TRUE)1 -1.248e-01 1.243e-01 -1.004 0.31549   
## poly(time, 9, raw = TRUE)2 8.065e-04 3.867e-03 0.209 0.83485   
## poly(time, 9, raw = TRUE)3 3.856e-05 5.550e-05 0.695 0.48733   
## poly(time, 9, raw = TRUE)4 -6.070e-07 4.323e-07 -1.404 0.16051   
## poly(time, 9, raw = TRUE)5 3.851e-09 1.975e-09 1.950 0.05145 .   
## poly(time, 9, raw = TRUE)6 -1.295e-11 5.442e-12 -2.380 0.01746 \*   
## poly(time, 9, raw = TRUE)7 2.425e-14 8.888e-15 2.729 0.00645 \*\*   
## poly(time, 9, raw = TRUE)8 -2.388e-17 7.918e-18 -3.015 0.00262 \*\*   
## poly(time, 9, raw = TRUE)9 9.632e-21 2.963e-21 3.251 0.00118 \*\*   
## typeecg 1.262e+00 2.496e-01 5.056 4.96e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.294 on 1173 degrees of freedom  
## Multiple R-squared: 0.228, Adjusted R-squared: 0.2214   
## F-statistic: 34.64 on 10 and 1173 DF, p-value: < 2.2e-16

model\_A2\_10 <- lm(rate ~ poly(time, 10, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_10)

##   
## Call:  
## lm(formula = rate ~ poly(time, 10, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -10.6691 -2.7009 -0.6537 1.8941 14.4991   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.567e+01 1.451e+00 17.687 <2e-16 \*\*\*  
## poly(time, 10, raw = TRUE)1 -1.892e-01 1.669e-01 -1.134 0.257   
## poly(time, 10, raw = TRUE)2 3.696e-03 6.319e-03 0.585 0.559   
## poly(time, 10, raw = TRUE)3 -1.736e-05 1.115e-04 -0.156 0.876   
## poly(time, 10, raw = TRUE)4 -3.162e-08 1.085e-06 -0.029 0.977   
## poly(time, 10, raw = TRUE)5 3.659e-10 6.340e-09 0.058 0.954   
## poly(time, 10, raw = TRUE)6 8.832e-14 2.319e-11 0.004 0.997   
## poly(time, 10, raw = TRUE)7 -6.240e-15 5.346e-14 -0.117 0.907   
## poly(time, 10, raw = TRUE)8 1.949e-17 7.539e-17 0.259 0.796   
## poly(time, 10, raw = TRUE)9 -2.467e-20 5.938e-20 -0.416 0.678   
## poly(time, 10, raw = TRUE)10 1.157e-23 2.000e-23 0.578 0.563   
## typeecg 1.262e+00 2.497e-01 5.055 5e-07 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 4.295 on 1172 degrees of freedom  
## Multiple R-squared: 0.2282, Adjusted R-squared: 0.221   
## F-statistic: 31.5 on 11 and 1172 DF, p-value: < 2.2e-16

model\_A2\_20 <- lm(rate ~ poly(time, 20, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_20)

##   
## Call:  
## lm(formula = rate ~ poly(time, 20, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -11.8809 -1.8051 0.0575 1.7975 9.5421   
##   
## Coefficients: (4 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.544e+01 1.706e+00 9.051 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)1 3.724e+00 4.422e-01 8.422 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)2 -4.071e-01 3.832e-02 -10.625 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)3 1.935e-02 1.592e-03 12.156 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)4 -5.023e-04 3.786e-05 -13.266 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)5 8.005e-06 5.700e-07 14.043 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)6 -8.384e-08 5.771e-09 -14.529 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)7 6.022e-10 4.079e-11 14.765 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)8 -3.041e-12 2.056e-13 -14.791 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)9 1.091e-14 7.449e-16 14.648 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)10 -2.768e-17 1.926e-18 -14.371 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)11 4.839e-20 3.458e-21 13.993 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)12 -5.443e-23 4.021e-24 -13.539 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)13 3.208e-26 2.462e-27 13.032 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)14 NA NA NA NA   
## poly(time, 20, raw = TRUE)15 -9.678e-33 8.115e-34 -11.925 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)16 NA NA NA NA   
## poly(time, 20, raw = TRUE)17 3.506e-39 3.254e-40 10.775 < 2e-16 \*\*\*  
## poly(time, 20, raw = TRUE)18 NA NA NA NA   
## poly(time, 20, raw = TRUE)19 NA NA NA NA   
## poly(time, 20, raw = TRUE)20 -6.178e-49 6.793e-50 -9.095 < 2e-16 \*\*\*  
## typeecg 1.262e+00 1.819e-01 6.939 6.55e-12 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 3.129 on 1166 degrees of freedom  
## Multiple R-squared: 0.5925, Adjusted R-squared: 0.5866   
## F-statistic: 99.73 on 17 and 1166 DF, p-value: < 2.2e-16

model\_A2\_30 <- lm(rate ~ poly(time, 30, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_30)

##   
## Call:  
## lm(formula = rate ~ poly(time, 30, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -12.1090 -1.6156 0.1164 1.7973 8.8975   
##   
## Coefficients: (11 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.303e+01 1.923e+00 11.976 < 2e-16 \*\*\*  
## poly(time, 30, raw = TRUE)1 2.165e-01 6.208e-01 0.349 0.72732   
## poly(time, 30, raw = TRUE)2 2.871e-02 6.715e-02 0.428 0.66899   
## poly(time, 30, raw = TRUE)3 -4.898e-03 3.495e-03 -1.402 0.16132   
## poly(time, 30, raw = TRUE)4 2.460e-04 1.045e-04 2.353 0.01877 \*   
## poly(time, 30, raw = TRUE)5 -6.375e-06 1.987e-06 -3.208 0.00137 \*\*   
## poly(time, 30, raw = TRUE)6 1.005e-07 2.551e-08 3.938 8.71e-05 \*\*\*  
## poly(time, 30, raw = TRUE)7 -1.042e-09 2.298e-10 -4.534 6.39e-06 \*\*\*  
## poly(time, 30, raw = TRUE)8 7.429e-12 1.486e-12 4.999 6.66e-07 \*\*\*  
## poly(time, 30, raw = TRUE)9 -3.718e-14 6.958e-15 -5.344 1.09e-07 \*\*\*  
## poly(time, 30, raw = TRUE)10 1.310e-16 2.345e-17 5.585 2.92e-08 \*\*\*  
## poly(time, 30, raw = TRUE)11 -3.181e-19 5.544e-20 -5.737 1.23e-08 \*\*\*  
## poly(time, 30, raw = TRUE)12 4.999e-22 8.591e-23 5.819 7.66e-09 \*\*\*  
## poly(time, 30, raw = TRUE)13 -4.158e-25 7.115e-26 -5.844 6.62e-09 \*\*\*  
## poly(time, 30, raw = TRUE)14 NA NA NA NA   
## poly(time, 30, raw = TRUE)15 2.623e-31 4.541e-32 5.775 9.86e-09 \*\*\*  
## poly(time, 30, raw = TRUE)16 NA NA NA NA   
## poly(time, 30, raw = TRUE)17 -2.207e-37 3.934e-38 -5.612 2.50e-08 \*\*\*  
## poly(time, 30, raw = TRUE)18 NA NA NA NA   
## poly(time, 30, raw = TRUE)19 NA NA NA NA   
## poly(time, 30, raw = TRUE)20 2.066e-46 3.899e-47 5.298 1.40e-07 \*\*\*  
## poly(time, 30, raw = TRUE)21 NA NA NA NA   
## poly(time, 30, raw = TRUE)22 NA NA NA NA   
## poly(time, 30, raw = TRUE)23 -2.441e-55 4.902e-56 -4.979 7.34e-07 \*\*\*  
## poly(time, 30, raw = TRUE)24 NA NA NA NA   
## poly(time, 30, raw = TRUE)25 NA NA NA NA   
## poly(time, 30, raw = TRUE)26 2.086e-64 4.444e-65 4.694 3.00e-06 \*\*\*  
## poly(time, 30, raw = TRUE)27 NA NA NA NA   
## poly(time, 30, raw = TRUE)28 NA NA NA NA   
## poly(time, 30, raw = TRUE)29 NA NA NA NA   
## poly(time, 30, raw = TRUE)30 -1.017e-76 2.324e-77 -4.377 1.31e-05 \*\*\*  
## typeecg 1.262e+00 1.774e-01 7.112 1.99e-12 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 3.053 on 1163 degrees of freedom  
## Multiple R-squared: 0.6131, Adjusted R-squared: 0.6065   
## F-statistic: 92.17 on 20 and 1163 DF, p-value: < 2.2e-16

model\_A2\_50 <- lm(rate ~ poly(time, 50, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_50)

##   
## Call:  
## lm(formula = rate ~ poly(time, 50, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -12.5420 -1.5483 0.1586 1.8712 9.1832   
##   
## Coefficients: (28 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.515e+01 2.124e+00 11.841 < 2e-16 \*\*\*  
## poly(time, 50, raw = TRUE)1 -9.529e-01 7.936e-01 -1.201 0.230095   
## poly(time, 50, raw = TRUE)2 2.053e-01 9.954e-02 2.062 0.039399 \*   
## poly(time, 50, raw = TRUE)3 -1.686e-02 6.022e-03 -2.799 0.005211 \*\*   
## poly(time, 50, raw = TRUE)4 6.949e-04 2.098e-04 3.313 0.000952 \*\*\*  
## poly(time, 50, raw = TRUE)5 -1.685e-05 4.649e-06 -3.624 0.000302 \*\*\*  
## poly(time, 50, raw = TRUE)6 2.633e-07 6.972e-08 3.777 0.000167 \*\*\*  
## poly(time, 50, raw = TRUE)7 -2.802e-09 7.349e-10 -3.813 0.000144 \*\*\*  
## poly(time, 50, raw = TRUE)8 2.099e-11 5.570e-12 3.769 0.000172 \*\*\*  
## poly(time, 50, raw = TRUE)9 -1.125e-13 3.063e-14 -3.674 0.000250 \*\*\*  
## poly(time, 50, raw = TRUE)10 4.314e-16 1.215e-16 3.550 0.000400 \*\*\*  
## poly(time, 50, raw = TRUE)11 -1.157e-18 3.391e-19 -3.413 0.000664 \*\*\*  
## poly(time, 50, raw = TRUE)12 2.036e-21 6.220e-22 3.273 0.001096 \*\*   
## poly(time, 50, raw = TRUE)13 -1.919e-24 6.118e-25 -3.136 0.001757 \*\*   
## poly(time, 50, raw = TRUE)14 NA NA NA NA   
## poly(time, 50, raw = TRUE)15 1.607e-30 5.572e-31 2.885 0.003989 \*\*   
## poly(time, 50, raw = TRUE)16 NA NA NA NA   
## poly(time, 50, raw = TRUE)17 -1.874e-36 7.017e-37 -2.671 0.007679 \*\*   
## poly(time, 50, raw = TRUE)18 NA NA NA NA   
## poly(time, 50, raw = TRUE)19 NA NA NA NA   
## poly(time, 50, raw = TRUE)20 3.079e-45 1.277e-45 2.411 0.016068 \*   
## poly(time, 50, raw = TRUE)21 NA NA NA NA   
## poly(time, 50, raw = TRUE)22 NA NA NA NA   
## poly(time, 50, raw = TRUE)23 -7.039e-54 3.192e-54 -2.205 0.027628 \*   
## poly(time, 50, raw = TRUE)24 NA NA NA NA   
## poly(time, 50, raw = TRUE)25 NA NA NA NA   
## poly(time, 50, raw = TRUE)26 1.326e-62 6.518e-63 2.034 0.042164 \*   
## poly(time, 50, raw = TRUE)27 NA NA NA NA   
## poly(time, 50, raw = TRUE)28 NA NA NA NA   
## poly(time, 50, raw = TRUE)29 NA NA NA NA   
## poly(time, 50, raw = TRUE)30 -2.734e-74 1.488e-74 -1.838 0.066345 .   
## poly(time, 50, raw = TRUE)31 NA NA NA NA   
## poly(time, 50, raw = TRUE)32 NA NA NA NA   
## poly(time, 50, raw = TRUE)33 NA NA NA NA   
## poly(time, 50, raw = TRUE)34 5.116e-86 3.076e-86 1.663 0.096584 .   
## poly(time, 50, raw = TRUE)35 NA NA NA NA   
## poly(time, 50, raw = TRUE)36 NA NA NA NA   
## poly(time, 50, raw = TRUE)37 NA NA NA NA   
## poly(time, 50, raw = TRUE)38 NA NA NA NA   
## poly(time, 50, raw = TRUE)39 -8.331e-101 5.696e-101 -1.463 0.143834   
## poly(time, 50, raw = TRUE)40 NA NA NA NA   
## poly(time, 50, raw = TRUE)41 NA NA NA NA   
## poly(time, 50, raw = TRUE)42 NA NA NA NA   
## poly(time, 50, raw = TRUE)43 NA NA NA NA   
## poly(time, 50, raw = TRUE)44 NA NA NA NA   
## poly(time, 50, raw = TRUE)45 1.074e-118 8.659e-119 1.240 0.215133   
## poly(time, 50, raw = TRUE)46 NA NA NA NA   
## poly(time, 50, raw = TRUE)47 NA NA NA NA   
## poly(time, 50, raw = TRUE)48 NA NA NA NA   
## poly(time, 50, raw = TRUE)49 NA NA NA NA   
## poly(time, 50, raw = TRUE)50 NA NA NA NA   
## typeecg 1.262e+00 1.768e-01 7.139 1.65e-12 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 3.041 on 1160 degrees of freedom  
## Multiple R-squared: 0.6171, Adjusted R-squared: 0.6095   
## F-statistic: 81.28 on 23 and 1160 DF, p-value: < 2.2e-16

model\_A2\_70 <- lm(rate ~ poly(time, 70, raw = TRUE) + type, data = df\_A2)  
summary(model\_A2\_70)

##   
## Call:  
## lm(formula = rate ~ poly(time, 70, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -13.167 -1.560 0.115 1.712 9.323   
##   
## Coefficients: (45 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.435e+01 2.267e+00 10.742 < 2e-16 \*\*\*  
## poly(time, 70, raw = TRUE)1 -4.493e-01 9.341e-01 -0.481 0.630582   
## poly(time, 70, raw = TRUE)2 1.163e-01 1.294e-01 0.899 0.369048   
## poly(time, 70, raw = TRUE)3 -9.769e-03 8.655e-03 -1.129 0.259270   
## poly(time, 70, raw = TRUE)4 3.820e-04 3.337e-04 1.145 0.252565   
## poly(time, 70, raw = TRUE)5 -8.264e-06 8.194e-06 -1.009 0.313424   
## poly(time, 70, raw = TRUE)6 1.064e-07 1.362e-07 0.781 0.434703   
## poly(time, 70, raw = TRUE)7 -8.109e-10 1.592e-09 -0.509 0.610698   
## poly(time, 70, raw = TRUE)8 2.983e-12 1.340e-11 0.223 0.823812   
## poly(time, 70, raw = TRUE)9 4.823e-15 8.180e-14 0.059 0.952989   
## poly(time, 70, raw = TRUE)10 -1.173e-16 3.607e-16 -0.325 0.745166   
## poly(time, 70, raw = TRUE)11 6.389e-19 1.119e-18 0.571 0.568296   
## poly(time, 70, raw = TRUE)12 -1.816e-21 2.286e-21 -0.794 0.427103   
## poly(time, 70, raw = TRUE)13 2.497e-24 2.505e-24 0.997 0.319047   
## poly(time, 70, raw = TRUE)14 NA NA NA NA   
## poly(time, 70, raw = TRUE)15 -3.819e-30 2.840e-30 -1.345 0.178967   
## poly(time, 70, raw = TRUE)16 NA NA NA NA   
## poly(time, 70, raw = TRUE)17 7.295e-36 4.474e-36 1.631 0.103245   
## poly(time, 70, raw = TRUE)18 NA NA NA NA   
## poly(time, 70, raw = TRUE)19 NA NA NA NA   
## poly(time, 70, raw = TRUE)20 -2.273e-44 1.151e-44 -1.975 0.048533 \*   
## poly(time, 70, raw = TRUE)21 NA NA NA NA   
## poly(time, 70, raw = TRUE)22 NA NA NA NA   
## poly(time, 70, raw = TRUE)23 9.284e-53 4.130e-53 2.248 0.024757 \*   
## poly(time, 70, raw = TRUE)24 NA NA NA NA   
## poly(time, 70, raw = TRUE)25 NA NA NA NA   
## poly(time, 70, raw = TRUE)26 -3.053e-61 1.235e-61 -2.473 0.013553 \*   
## poly(time, 70, raw = TRUE)27 NA NA NA NA   
## poly(time, 70, raw = TRUE)28 NA NA NA NA   
## poly(time, 70, raw = TRUE)29 NA NA NA NA   
## poly(time, 70, raw = TRUE)30 1.326e-72 4.876e-73 2.719 0.006648 \*\*   
## poly(time, 70, raw = TRUE)31 NA NA NA NA   
## poly(time, 70, raw = TRUE)32 NA NA NA NA   
## poly(time, 70, raw = TRUE)33 NA NA NA NA   
## poly(time, 70, raw = TRUE)34 -5.430e-84 1.859e-84 -2.921 0.003551 \*\*   
## poly(time, 70, raw = TRUE)35 NA NA NA NA   
## poly(time, 70, raw = TRUE)36 NA NA NA NA   
## poly(time, 70, raw = TRUE)37 NA NA NA NA   
## poly(time, 70, raw = TRUE)38 NA NA NA NA   
## poly(time, 70, raw = TRUE)39 2.659e-98 8.491e-99 3.131 0.001785 \*\*   
## poly(time, 70, raw = TRUE)40 NA NA NA NA   
## poly(time, 70, raw = TRUE)41 NA NA NA NA   
## poly(time, 70, raw = TRUE)42 NA NA NA NA   
## poly(time, 70, raw = TRUE)43 NA NA NA NA   
## poly(time, 70, raw = TRUE)44 NA NA NA NA   
## poly(time, 70, raw = TRUE)45 -1.915e-115 5.740e-116 -3.337 0.000873 \*\*\*  
## poly(time, 70, raw = TRUE)46 NA NA NA NA   
## poly(time, 70, raw = TRUE)47 NA NA NA NA   
## poly(time, 70, raw = TRUE)48 NA NA NA NA   
## poly(time, 70, raw = TRUE)49 NA NA NA NA   
## poly(time, 70, raw = TRUE)50 NA NA NA NA   
## poly(time, 70, raw = TRUE)51 1.222e-132 3.484e-133 3.507 0.000470 \*\*\*  
## poly(time, 70, raw = TRUE)52 NA NA NA NA   
## poly(time, 70, raw = TRUE)53 NA NA NA NA   
## poly(time, 70, raw = TRUE)54 NA NA NA NA   
## poly(time, 70, raw = TRUE)55 NA NA NA NA   
## poly(time, 70, raw = TRUE)56 NA NA NA NA   
## poly(time, 70, raw = TRUE)57 NA NA NA NA   
## poly(time, 70, raw = TRUE)58 -7.391e-153 2.013e-153 -3.672 0.000252 \*\*\*  
## poly(time, 70, raw = TRUE)59 NA NA NA NA   
## poly(time, 70, raw = TRUE)60 NA NA NA NA   
## poly(time, 70, raw = TRUE)61 NA NA NA NA   
## poly(time, 70, raw = TRUE)62 NA NA NA NA   
## poly(time, 70, raw = TRUE)63 NA NA NA NA   
## poly(time, 70, raw = TRUE)64 NA NA NA NA   
## poly(time, 70, raw = TRUE)65 NA NA NA NA   
## poly(time, 70, raw = TRUE)66 NA NA NA NA   
## poly(time, 70, raw = TRUE)67 5.105e-179 0.000e+00 Inf < 2e-16 \*\*\*  
## poly(time, 70, raw = TRUE)68 NA NA NA NA   
## poly(time, 70, raw = TRUE)69 NA NA NA NA   
## poly(time, 70, raw = TRUE)70 NA NA NA NA   
## typeecg 1.262e+00 1.755e-01 7.191 1.15e-12 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 3.019 on 1157 degrees of freedom  
## Multiple R-squared: 0.6236, Adjusted R-squared: 0.6151   
## F-statistic: 73.71 on 26 and 1157 DF, p-value: < 2.2e-16

model\_A2\_110 <- lm(rate ~ poly(time, 110, raw = TRUE) + type, data = df\_A2)  
#summary(model\_A2\_110)$adj.r.squared  
summary(model\_A2\_110)

##   
## Call:  
## lm(formula = rate ~ poly(time, 110, raw = TRUE) + type, data = df\_A2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -14.4615 -1.4067 0.1824 1.6095 8.7135   
##   
## Coefficients: (82 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)  
## (Intercept) 2.782e+01 2.262e+00 12.295 < 2e-16  
## poly(time, 110, raw = TRUE)1 -2.731e+00 9.942e-01 -2.746 0.006119  
## poly(time, 110, raw = TRUE)2 5.399e-01 1.470e-01 3.672 0.000252  
## poly(time, 110, raw = TRUE)3 -4.530e-02 1.052e-02 -4.307 1.79e-05  
## poly(time, 110, raw = TRUE)4 2.038e-03 4.338e-04 4.698 2.95e-06  
## poly(time, 110, raw = TRUE)5 -5.628e-05 1.140e-05 -4.937 9.08e-07  
## poly(time, 110, raw = TRUE)6 1.034e-06 2.028e-07 5.098 4.00e-07  
## poly(time, 110, raw = TRUE)7 -1.327e-08 2.539e-09 -5.226 2.05e-07  
## poly(time, 110, raw = TRUE)8 1.223e-10 2.287e-11 5.346 1.08e-07  
## poly(time, 110, raw = TRUE)9 -8.188e-13 1.496e-13 -5.472 5.45e-08  
## poly(time, 110, raw = TRUE)10 3.966e-15 7.071e-16 5.609 2.55e-08  
## poly(time, 110, raw = TRUE)11 -1.354e-17 2.352e-18 -5.756 1.10e-08  
## poly(time, 110, raw = TRUE)12 3.044e-20 5.148e-21 5.914 4.40e-09  
## poly(time, 110, raw = TRUE)13 -3.677e-23 6.050e-24 -6.078 1.65e-09  
## poly(time, 110, raw = TRUE)14 NA NA NA NA  
## poly(time, 110, raw = TRUE)15 5.068e-29 7.895e-30 6.419 2.00e-10  
## poly(time, 110, raw = TRUE)16 NA NA NA NA  
## poly(time, 110, raw = TRUE)17 -9.689e-35 1.433e-35 -6.762 2.16e-11  
## poly(time, 110, raw = TRUE)18 NA NA NA NA  
## poly(time, 110, raw = TRUE)19 NA NA NA NA  
## poly(time, 110, raw = TRUE)20 3.317e-43 4.573e-44 7.254 7.42e-13  
## poly(time, 110, raw = TRUE)21 NA NA NA NA  
## poly(time, 110, raw = TRUE)22 NA NA NA NA  
## poly(time, 110, raw = TRUE)23 -1.574e-51 2.043e-52 -7.702 2.86e-14  
## poly(time, 110, raw = TRUE)24 NA NA NA NA  
## poly(time, 110, raw = TRUE)25 NA NA NA NA  
## poly(time, 110, raw = TRUE)26 6.190e-60 7.641e-61 8.100 1.39e-15  
## poly(time, 110, raw = TRUE)27 NA NA NA NA  
## poly(time, 110, raw = TRUE)28 NA NA NA NA  
## poly(time, 110, raw = TRUE)29 NA NA NA NA  
## poly(time, 110, raw = TRUE)30 -3.508e-71 4.103e-72 -8.551 < 2e-16  
## poly(time, 110, raw = TRUE)31 NA NA NA NA  
## poly(time, 110, raw = TRUE)32 NA NA NA NA  
## poly(time, 110, raw = TRUE)33 NA NA NA NA  
## poly(time, 110, raw = TRUE)34 1.918e-82 2.152e-83 8.915 < 2e-16  
## poly(time, 110, raw = TRUE)35 NA NA NA NA  
## poly(time, 110, raw = TRUE)36 NA NA NA NA  
## poly(time, 110, raw = TRUE)37 NA NA NA NA  
## poly(time, 110, raw = TRUE)38 NA NA NA NA  
## poly(time, 110, raw = TRUE)39 -1.386e-96 1.496e-97 -9.264 < 2e-16  
## poly(time, 110, raw = TRUE)40 NA NA NA NA  
## poly(time, 110, raw = TRUE)41 NA NA NA NA  
## poly(time, 110, raw = TRUE)42 NA NA NA NA  
## poly(time, 110, raw = TRUE)43 NA NA NA NA  
## poly(time, 110, raw = TRUE)44 NA NA NA NA  
## poly(time, 110, raw = TRUE)45 1.665e-113 1.743e-114 9.552 < 2e-16  
## poly(time, 110, raw = TRUE)46 NA NA NA NA  
## poly(time, 110, raw = TRUE)47 NA NA NA NA  
## poly(time, 110, raw = TRUE)48 NA NA NA NA  
## poly(time, 110, raw = TRUE)49 NA NA NA NA  
## poly(time, 110, raw = TRUE)50 NA NA NA NA  
## poly(time, 110, raw = TRUE)51 -1.886e-130 1.939e-131 -9.726 < 2e-16  
## poly(time, 110, raw = TRUE)52 NA NA NA NA  
## poly(time, 110, raw = TRUE)53 NA NA NA NA  
## poly(time, 110, raw = TRUE)54 NA NA NA NA  
## poly(time, 110, raw = TRUE)55 NA NA NA NA  
## poly(time, 110, raw = TRUE)56 NA NA NA NA  
## poly(time, 110, raw = TRUE)57 NA NA NA NA  
## poly(time, 110, raw = TRUE)58 2.510e-150 2.556e-151 9.818 < 2e-16  
## poly(time, 110, raw = TRUE)59 NA NA NA NA  
## poly(time, 110, raw = TRUE)60 NA NA NA NA  
## poly(time, 110, raw = TRUE)61 NA NA NA NA  
## poly(time, 110, raw = TRUE)62 NA NA NA NA  
## poly(time, 110, raw = TRUE)63 NA NA NA NA  
## poly(time, 110, raw = TRUE)64 NA NA NA NA  
## poly(time, 110, raw = TRUE)65 NA NA NA NA  
## poly(time, 110, raw = TRUE)66 NA NA NA NA  
## poly(time, 110, raw = TRUE)67 -6.841e-176 0.000e+00 -Inf < 2e-16  
## poly(time, 110, raw = TRUE)68 NA NA NA NA  
## poly(time, 110, raw = TRUE)69 NA NA NA NA  
## poly(time, 110, raw = TRUE)70 NA NA NA NA  
## poly(time, 110, raw = TRUE)71 NA NA NA NA  
## poly(time, 110, raw = TRUE)72 NA NA NA NA  
## poly(time, 110, raw = TRUE)73 NA NA NA NA  
## poly(time, 110, raw = TRUE)74 NA NA NA NA  
## poly(time, 110, raw = TRUE)75 NA NA NA NA  
## poly(time, 110, raw = TRUE)76 NA NA NA NA  
## poly(time, 110, raw = TRUE)77 2.789e-204 0.000e+00 Inf < 2e-16  
## poly(time, 110, raw = TRUE)78 NA NA NA NA  
## poly(time, 110, raw = TRUE)79 NA NA NA NA  
## poly(time, 110, raw = TRUE)80 NA NA NA NA  
## poly(time, 110, raw = TRUE)81 NA NA NA NA  
## poly(time, 110, raw = TRUE)82 NA NA NA NA  
## poly(time, 110, raw = TRUE)83 NA NA NA NA  
## poly(time, 110, raw = TRUE)84 NA NA NA NA  
## poly(time, 110, raw = TRUE)85 NA NA NA NA  
## poly(time, 110, raw = TRUE)86 NA NA NA NA  
## poly(time, 110, raw = TRUE)87 NA NA NA NA  
## poly(time, 110, raw = TRUE)88 -1.375e-235 0.000e+00 -Inf < 2e-16  
## poly(time, 110, raw = TRUE)89 NA NA NA NA  
## poly(time, 110, raw = TRUE)90 NA NA NA NA  
## poly(time, 110, raw = TRUE)91 NA NA NA NA  
## poly(time, 110, raw = TRUE)92 NA NA NA NA  
## poly(time, 110, raw = TRUE)93 NA NA NA NA  
## poly(time, 110, raw = TRUE)94 NA NA NA NA  
## poly(time, 110, raw = TRUE)95 NA NA NA NA  
## poly(time, 110, raw = TRUE)96 NA NA NA NA  
## poly(time, 110, raw = TRUE)97 NA NA NA NA  
## poly(time, 110, raw = TRUE)98 NA NA NA NA  
## poly(time, 110, raw = TRUE)99 NA NA NA NA  
## poly(time, 110, raw = TRUE)100 5.922e-270 0.000e+00 Inf < 2e-16  
## poly(time, 110, raw = TRUE)101 NA NA NA NA  
## poly(time, 110, raw = TRUE)102 NA NA NA NA  
## poly(time, 110, raw = TRUE)103 NA NA NA NA  
## poly(time, 110, raw = TRUE)104 NA NA NA NA  
## poly(time, 110, raw = TRUE)105 NA NA NA NA  
## poly(time, 110, raw = TRUE)106 NA NA NA NA  
## poly(time, 110, raw = TRUE)107 NA NA NA NA  
## poly(time, 110, raw = TRUE)108 NA NA NA NA  
## poly(time, 110, raw = TRUE)109 NA NA NA NA  
## poly(time, 110, raw = TRUE)110 NA NA NA NA  
## typeecg 1.262e+00 1.665e-01 7.580 7.09e-14  
##   
## (Intercept) \*\*\*  
## poly(time, 110, raw = TRUE)1 \*\*   
## poly(time, 110, raw = TRUE)2 \*\*\*  
## poly(time, 110, raw = TRUE)3 \*\*\*  
## poly(time, 110, raw = TRUE)4 \*\*\*  
## poly(time, 110, raw = TRUE)5 \*\*\*  
## poly(time, 110, raw = TRUE)6 \*\*\*  
## poly(time, 110, raw = TRUE)7 \*\*\*  
## poly(time, 110, raw = TRUE)8 \*\*\*  
## poly(time, 110, raw = TRUE)9 \*\*\*  
## poly(time, 110, raw = TRUE)10 \*\*\*  
## poly(time, 110, raw = TRUE)11 \*\*\*  
## poly(time, 110, raw = TRUE)12 \*\*\*  
## poly(time, 110, raw = TRUE)13 \*\*\*  
## poly(time, 110, raw = TRUE)14   
## poly(time, 110, raw = TRUE)15 \*\*\*  
## poly(time, 110, raw = TRUE)16   
## poly(time, 110, raw = TRUE)17 \*\*\*  
## poly(time, 110, raw = TRUE)18   
## poly(time, 110, raw = TRUE)19   
## poly(time, 110, raw = TRUE)20 \*\*\*  
## poly(time, 110, raw = TRUE)21   
## poly(time, 110, raw = TRUE)22   
## poly(time, 110, raw = TRUE)23 \*\*\*  
## poly(time, 110, raw = TRUE)24   
## poly(time, 110, raw = TRUE)25   
## poly(time, 110, raw = TRUE)26 \*\*\*  
## poly(time, 110, raw = TRUE)27   
## poly(time, 110, raw = TRUE)28   
## poly(time, 110, raw = TRUE)29   
## poly(time, 110, raw = TRUE)30 \*\*\*  
## poly(time, 110, raw = TRUE)31   
## poly(time, 110, raw = TRUE)32   
## poly(time, 110, raw = TRUE)33   
## poly(time, 110, raw = TRUE)34 \*\*\*  
## poly(time, 110, raw = TRUE)35   
## poly(time, 110, raw = TRUE)36   
## poly(time, 110, raw = TRUE)37   
## poly(time, 110, raw = TRUE)38   
## poly(time, 110, raw = TRUE)39 \*\*\*  
## poly(time, 110, raw = TRUE)40   
## poly(time, 110, raw = TRUE)41   
## poly(time, 110, raw = TRUE)42   
## poly(time, 110, raw = TRUE)43   
## poly(time, 110, raw = TRUE)44   
## poly(time, 110, raw = TRUE)45 \*\*\*  
## poly(time, 110, raw = TRUE)46   
## poly(time, 110, raw = TRUE)47   
## poly(time, 110, raw = TRUE)48   
## poly(time, 110, raw = TRUE)49   
## poly(time, 110, raw = TRUE)50   
## poly(time, 110, raw = TRUE)51 \*\*\*  
## poly(time, 110, raw = TRUE)52   
## poly(time, 110, raw = TRUE)53   
## poly(time, 110, raw = TRUE)54   
## poly(time, 110, raw = TRUE)55   
## poly(time, 110, raw = TRUE)56   
## poly(time, 110, raw = TRUE)57   
## poly(time, 110, raw = TRUE)58 \*\*\*  
## poly(time, 110, raw = TRUE)59   
## poly(time, 110, raw = TRUE)60   
## poly(time, 110, raw = TRUE)61   
## poly(time, 110, raw = TRUE)62   
## poly(time, 110, raw = TRUE)63   
## poly(time, 110, raw = TRUE)64   
## poly(time, 110, raw = TRUE)65   
## poly(time, 110, raw = TRUE)66   
## poly(time, 110, raw = TRUE)67 \*\*\*  
## poly(time, 110, raw = TRUE)68   
## poly(time, 110, raw = TRUE)69   
## poly(time, 110, raw = TRUE)70   
## poly(time, 110, raw = TRUE)71   
## poly(time, 110, raw = TRUE)72   
## poly(time, 110, raw = TRUE)73   
## poly(time, 110, raw = TRUE)74   
## poly(time, 110, raw = TRUE)75   
## poly(time, 110, raw = TRUE)76   
## poly(time, 110, raw = TRUE)77 \*\*\*  
## poly(time, 110, raw = TRUE)78   
## poly(time, 110, raw = TRUE)79   
## poly(time, 110, raw = TRUE)80   
## poly(time, 110, raw = TRUE)81   
## poly(time, 110, raw = TRUE)82   
## poly(time, 110, raw = TRUE)83   
## poly(time, 110, raw = TRUE)84   
## poly(time, 110, raw = TRUE)85   
## poly(time, 110, raw = TRUE)86   
## poly(time, 110, raw = TRUE)87   
## poly(time, 110, raw = TRUE)88 \*\*\*  
## poly(time, 110, raw = TRUE)89   
## poly(time, 110, raw = TRUE)90   
## poly(time, 110, raw = TRUE)91   
## poly(time, 110, raw = TRUE)92   
## poly(time, 110, raw = TRUE)93   
## poly(time, 110, raw = TRUE)94   
## poly(time, 110, raw = TRUE)95   
## poly(time, 110, raw = TRUE)96   
## poly(time, 110, raw = TRUE)97   
## poly(time, 110, raw = TRUE)98   
## poly(time, 110, raw = TRUE)99   
## poly(time, 110, raw = TRUE)100 \*\*\*  
## poly(time, 110, raw = TRUE)101   
## poly(time, 110, raw = TRUE)102   
## poly(time, 110, raw = TRUE)103   
## poly(time, 110, raw = TRUE)104   
## poly(time, 110, raw = TRUE)105   
## poly(time, 110, raw = TRUE)106   
## poly(time, 110, raw = TRUE)107   
## poly(time, 110, raw = TRUE)108   
## poly(time, 110, raw = TRUE)109   
## poly(time, 110, raw = TRUE)110   
## typeecg \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 2.864 on 1154 degrees of freedom  
## Multiple R-squared: 0.6622, Adjusted R-squared: 0.6537   
## F-statistic: 78.02 on 29 and 1154 DF, p-value: < 2.2e-16

# summary(model\_A2\_1)  
# model\_A2\_1$coefficients  
  
data.frame(model = paste ("lm" ,1:15 , sep =""),   
 rbind ( extractAIC ( model\_A2\_1 ),   
 extractAIC ( model\_A2\_2 ),   
 extractAIC ( model\_A2\_3 ),   
 extractAIC ( model\_A2\_4 ),   
 extractAIC ( model\_A2\_5 ),  
 extractAIC ( model\_A2\_6 ),  
 extractAIC ( model\_A2\_7 ),  
 extractAIC ( model\_A2\_8 ),  
 extractAIC ( model\_A2\_9 ),  
 extractAIC ( model\_A2\_10 ),  
 extractAIC ( model\_A2\_20 ),  
 extractAIC ( model\_A2\_30 ),  
 extractAIC ( model\_A2\_50 ),  
 extractAIC ( model\_A2\_70 ),  
 extractAIC ( model\_A2\_110 )))

## model X1 X2  
## 1 lm1 3 3592.892  
## 2 lm2 4 3590.008  
## 3 lm3 5 3588.004  
## 4 lm4 6 3540.478  
## 5 lm5 7 3484.557  
## 6 lm6 8 3486.269  
## 7 lm7 9 3485.601  
## 8 lm8 10 3470.394  
## 9 lm9 11 3461.773  
## 10 lm10 12 3463.435  
## 11 lm11 18 2719.201  
## 12 lm12 21 2663.670  
## 13 lm13 24 2657.552  
## 14 lm14 27 2643.376  
## 15 lm15 30 2521.038

extractBIC <- function (model)   
 {   
 extractAIC (model ,k= log ( length ( model $ residuals )))   
 }  
data.frame( model = paste ("lm" ,1:15 , sep =""),   
 rbind ( extractBIC ( model\_A2\_1 ),   
 extractBIC ( model\_A2\_2 ),   
 extractBIC ( model\_A2\_3 ),   
 extractBIC ( model\_A2\_4 ),   
 extractBIC ( model\_A2\_5 ),  
 extractBIC ( model\_A2\_6 ),  
 extractBIC ( model\_A2\_7 ),  
 extractBIC ( model\_A2\_8 ),  
 extractBIC ( model\_A2\_9 ),  
 extractBIC ( model\_A2\_10 ),  
 extractBIC ( model\_A2\_20 ),  
 extractBIC ( model\_A2\_30 ),  
 extractBIC ( model\_A2\_50 ),  
 extractBIC ( model\_A2\_70 ),  
 extractBIC ( model\_A2\_110 )))

## model X1 X2  
## 1 lm1 3 3608.122  
## 2 lm2 4 3610.315  
## 3 lm3 5 3613.387  
## 4 lm4 6 3570.938  
## 5 lm5 7 3520.094  
## 6 lm6 8 3526.882  
## 7 lm7 9 3531.291  
## 8 lm8 10 3521.161  
## 9 lm9 11 3517.616  
## 10 lm10 12 3524.355  
## 11 lm11 18 2810.581  
## 12 lm12 21 2770.280  
## 13 lm13 24 2779.392  
## 14 lm14 27 2780.445  
## 15 lm15 30 2673.338

anova(model\_A2\_1, model\_A2\_2, model\_A2\_3, model\_A2\_4, model\_A2\_5, model\_A2\_6, model\_A2\_7, model\_A2\_8,   
 model\_A2\_9, model\_A2\_10, model\_A2\_20, model\_A2\_30, model\_A2\_50, model\_A2\_70, model\_A2\_110)

## Analysis of Variance Table  
##   
## Model 1: rate ~ poly(time, 1, raw = TRUE) + type  
## Model 2: rate ~ poly(time, 2, raw = TRUE) + type  
## Model 3: rate ~ poly(time, 3, raw = TRUE) + type  
## Model 4: rate ~ poly(time, 4, raw = TRUE) + type  
## Model 5: rate ~ poly(time, 5, raw = TRUE) + type  
## Model 6: rate ~ poly(time, 6, raw = TRUE) + type  
## Model 7: rate ~ poly(time, 7, raw = TRUE) + type  
## Model 8: rate ~ poly(time, 8, raw = TRUE) + type  
## Model 9: rate ~ poly(time, 9, raw = TRUE) + type  
## Model 10: rate ~ poly(time, 10, raw = TRUE) + type  
## Model 11: rate ~ poly(time, 20, raw = TRUE) + type  
## Model 12: rate ~ poly(time, 30, raw = TRUE) + type  
## Model 13: rate ~ poly(time, 50, raw = TRUE) + type  
## Model 14: rate ~ poly(time, 70, raw = TRUE) + type  
## Model 15: rate ~ poly(time, 110, raw = TRUE) + type  
## Res.Df RSS Df Sum of Sq F Pr(>F)   
## 1 1181 24492.5   
## 2 1180 24391.7 1 100.8 12.2927 0.0004722 \*\*\*  
## 3 1179 24309.4 1 82.4 10.0417 0.0015706 \*\*   
## 4 1178 23313.5 1 995.9 121.4356 < 2.2e-16 \*\*\*  
## 5 1177 22200.5 1 1113.0 135.7201 < 2.2e-16 \*\*\*  
## 6 1176 22195.0 1 5.4 0.6589 0.4171076   
## 7 1175 22145.1 1 50.0 6.0915 0.0137275 \*   
## 8 1174 21825.6 1 319.5 38.9600 6.066e-10 \*\*\*  
## 9 1173 21630.7 1 194.9 23.7681 1.239e-06 \*\*\*  
## 10 1172 21624.5 1 6.2 0.7528 0.3857726   
## 11 1166 11417.1 6 10207.4 207.4438 < 2.2e-16 \*\*\*  
## 12 1163 10839.0 3 578.2 23.5006 9.112e-15 \*\*\*  
## 13 1160 10728.6 3 110.4 4.4861 0.0038719 \*\*   
## 14 1157 10547.3 3 181.3 7.3682 6.827e-05 \*\*\*  
## 15 1154 9463.8 3 1083.5 44.0389 < 2.2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

####################################################################  
  
model\_B1\_1 <- lm(rate ~ poly(time, 1, raw = TRUE) + type, data = df\_B1)  
#summary(model\_B1\_1)$adj.r.squared  
summary(model\_B1\_1)

##   
## Call:  
## lm(formula = rate ~ poly(time, 1, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -44.851 -3.061 -0.066 3.171 18.365   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 21.9853008 0.2622622 83.829 <2e-16 \*\*\*  
## poly(time, 1, raw = TRUE) -0.0001967 0.0003138 -0.627 0.531   
## typeecg 28.8662287 0.2344657 123.115 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.964 on 2585 degrees of freedom  
## Multiple R-squared: 0.8543, Adjusted R-squared: 0.8542   
## F-statistic: 7579 on 2 and 2585 DF, p-value: < 2.2e-16

model\_B1\_2 <- lm(rate ~ poly(time, 2, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_2)

##   
## Call:  
## lm(formula = rate ~ poly(time, 2, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -45.649 -3.047 -0.099 3.038 18.755   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.279e+01 3.706e-01 61.480 < 2e-16 \*\*\*  
## poly(time, 2, raw = TRUE)1 -3.908e-03 1.254e-03 -3.116 0.00185 \*\*   
## poly(time, 2, raw = TRUE)2 2.866e-06 9.378e-07 3.056 0.00226 \*\*   
## typeecg 2.887e+01 2.341e-01 123.313 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.954 on 2584 degrees of freedom  
## Multiple R-squared: 0.8548, Adjusted R-squared: 0.8547   
## F-statistic: 5072 on 3 and 2584 DF, p-value: < 2.2e-16

model\_B1\_3 <- lm(rate ~ poly(time, 3, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_3)

##   
## Call:  
## lm(formula = rate ~ poly(time, 3, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -46.179 -3.067 -0.083 3.072 18.829   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.332e+01 4.837e-01 48.212 < 2e-16 \*\*\*  
## poly(time, 3, raw = TRUE)1 -8.850e-03 3.138e-03 -2.821 0.00483 \*\*   
## poly(time, 3, raw = TRUE)2 1.240e-05 5.629e-06 2.203 0.02766 \*   
## poly(time, 3, raw = TRUE)3 -4.909e-09 2.857e-09 -1.718 0.08590 .   
## typeecg 2.887e+01 2.340e-01 123.360 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.952 on 2583 degrees of freedom  
## Multiple R-squared: 0.855, Adjusted R-squared: 0.8548   
## F-statistic: 3808 on 4 and 2583 DF, p-value: < 2.2e-16

model\_B1\_4 <- lm(rate ~ poly(time, 4, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_4)

##   
## Call:  
## lm(formula = rate ~ poly(time, 4, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -46.007 -3.066 -0.081 3.075 18.888   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.315e+01 5.993e-01 38.621 <2e-16 \*\*\*  
## poly(time, 4, raw = TRUE)1 -6.167e-03 6.284e-03 -0.981 0.326   
## poly(time, 4, raw = TRUE)2 3.089e-06 1.972e-05 0.157 0.876   
## poly(time, 4, raw = TRUE)3 6.275e-09 2.288e-08 0.274 0.784   
## poly(time, 4, raw = TRUE)4 -4.318e-12 8.765e-12 -0.493 0.622   
## typeecg 2.887e+01 2.340e-01 123.342 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.953 on 2582 degrees of freedom  
## Multiple R-squared: 0.855, Adjusted R-squared: 0.8547   
## F-statistic: 3045 on 5 and 2582 DF, p-value: < 2.2e-16

model\_B1\_5 <- lm(rate ~ poly(time, 5, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_5)

##   
## Call:  
## lm(formula = rate ~ poly(time, 5, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -45.544 -3.065 -0.069 3.097 18.971   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.267e+01 7.164e-01 31.647 <2e-16 \*\*\*  
## poly(time, 5, raw = TRUE)1 4.754e-03 1.101e-02 0.432 0.666   
## poly(time, 5, raw = TRUE)2 -5.585e-05 5.265e-05 -1.061 0.289   
## poly(time, 5, raw = TRUE)3 1.276e-07 1.030e-07 1.238 0.216   
## poly(time, 5, raw = TRUE)4 -1.097e-10 8.771e-11 -1.250 0.211   
## poly(time, 5, raw = TRUE)5 3.254e-14 2.696e-14 1.207 0.227   
## typeecg 2.887e+01 2.340e-01 123.353 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.952 on 2581 degrees of freedom  
## Multiple R-squared: 0.8551, Adjusted R-squared: 0.8548   
## F-statistic: 2538 on 6 and 2581 DF, p-value: < 2.2e-16

model\_B1\_6 <- lm(rate ~ poly(time, 6, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_6)

##   
## Call:  
## lm(formula = rate ~ poly(time, 6, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -44.298 -2.893 -0.181 2.876 18.246   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.971e+01 8.274e-01 23.826 < 2e-16 \*\*\*  
## poly(time, 6, raw = TRUE)1 1.000e-01 1.750e-02 5.717 1.21e-08 \*\*\*  
## poly(time, 6, raw = TRUE)2 -7.898e-04 1.176e-04 -6.718 2.25e-11 \*\*\*  
## poly(time, 6, raw = TRUE)3 2.392e-06 3.407e-07 7.021 2.80e-12 \*\*\*  
## poly(time, 6, raw = TRUE)4 -3.388e-09 4.784e-10 -7.080 1.85e-12 \*\*\*  
## poly(time, 6, raw = TRUE)5 2.260e-12 3.208e-13 7.044 2.38e-12 \*\*\*  
## poly(time, 6, raw = TRUE)6 -5.732e-16 8.228e-17 -6.967 4.09e-12 \*\*\*  
## typeecg 2.887e+01 2.319e-01 124.484 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.898 on 2580 degrees of freedom  
## Multiple R-squared: 0.8578, Adjusted R-squared: 0.8574   
## F-statistic: 2223 on 7 and 2580 DF, p-value: < 2.2e-16

model\_B1\_7 <- lm(rate ~ poly(time, 7, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_7)

##   
## Call:  
## lm(formula = rate ~ poly(time, 7, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -44.104 -2.824 -0.126 3.005 18.535   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.120e+01 9.443e-01 22.451 < 2e-16 \*\*\*  
## poly(time, 7, raw = TRUE)1 3.632e-02 2.625e-02 1.383 0.16663   
## poly(time, 7, raw = TRUE)2 -1.279e-04 2.351e-04 -0.544 0.58649   
## poly(time, 7, raw = TRUE)3 -4.432e-07 9.365e-07 -0.473 0.63605   
## poly(time, 7, raw = TRUE)4 2.630e-09 1.912e-09 1.375 0.16915   
## poly(time, 7, raw = TRUE)5 -4.429e-12 2.083e-12 -2.126 0.03356 \*   
## poly(time, 7, raw = TRUE)6 3.157e-15 1.151e-15 2.743 0.00612 \*\*   
## poly(time, 7, raw = TRUE)7 -8.229e-19 2.532e-19 -3.250 0.00117 \*\*   
## typeecg 2.887e+01 2.315e-01 124.714 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.887 on 2579 degrees of freedom  
## Multiple R-squared: 0.8583, Adjusted R-squared: 0.8579   
## F-statistic: 1953 on 8 and 2579 DF, p-value: < 2.2e-16

model\_B1\_8 <- lm(rate ~ poly(time, 8, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_8)

##   
## Call:  
## lm(formula = rate ~ poly(time, 8, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -44.392 -2.787 -0.089 3.027 18.482   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 2.151e+01 1.064e+00 20.207 <2e-16 \*\*\*  
## poly(time, 8, raw = TRUE)1 1.960e-02 3.760e-02 0.521 0.602   
## poly(time, 8, raw = TRUE)2 9.715e-05 4.318e-04 0.225 0.822   
## poly(time, 8, raw = TRUE)3 -1.715e-06 2.251e-06 -0.762 0.446   
## poly(time, 8, raw = TRUE)4 6.309e-09 6.223e-09 1.014 0.311   
## poly(time, 8, raw = TRUE)5 -1.034e-11 9.732e-12 -1.062 0.288   
## poly(time, 8, raw = TRUE)6 8.476e-15 8.639e-15 0.981 0.327   
## poly(time, 8, raw = TRUE)7 -3.338e-18 4.055e-18 -0.823 0.411   
## poly(time, 8, raw = TRUE)8 4.854e-22 7.814e-22 0.621 0.534   
## typeecg 2.887e+01 2.315e-01 124.699 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.888 on 2578 degrees of freedom  
## Multiple R-squared: 0.8584, Adjusted R-squared: 0.8579   
## F-statistic: 1736 on 9 and 2578 DF, p-value: < 2.2e-16

model\_B1\_9 <- lm(rate ~ poly(time, 9, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_9)

##   
## Call:  
## lm(formula = rate ~ poly(time, 9, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -43.453 -2.708 0.026 3.006 18.867   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.961e+01 1.183e+00 16.583 < 2e-16 \*\*\*  
## poly(time, 9, raw = TRUE)1 1.489e-01 5.172e-02 2.878 0.004032 \*\*   
## poly(time, 9, raw = TRUE)2 -2.087e-03 7.400e-04 -2.820 0.004833 \*\*   
## poly(time, 9, raw = TRUE)3 1.399e-05 4.874e-06 2.870 0.004139 \*\*   
## poly(time, 9, raw = TRUE)4 -5.273e-08 1.741e-08 -3.029 0.002478 \*\*   
## poly(time, 9, raw = TRUE)5 1.172e-10 3.645e-11 3.216 0.001318 \*\*   
## poly(time, 9, raw = TRUE)6 -1.556e-13 4.601e-14 -3.382 0.000731 \*\*\*  
## poly(time, 9, raw = TRUE)7 1.207e-16 3.442e-17 3.508 0.000459 \*\*\*  
## poly(time, 9, raw = TRUE)8 -5.041e-20 1.404e-20 -3.590 0.000337 \*\*\*  
## poly(time, 9, raw = TRUE)9 8.734e-24 2.406e-24 3.630 0.000289 \*\*\*  
## typeecg 2.887e+01 2.309e-01 124.993 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.874 on 2577 degrees of freedom  
## Multiple R-squared: 0.8591, Adjusted R-squared: 0.8585   
## F-statistic: 1571 on 10 and 2577 DF, p-value: < 2.2e-16

model\_B1\_10 <- lm(rate ~ poly(time, 10, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_10)

##   
## Call:  
## lm(formula = rate ~ poly(time, 10, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -43.243 -2.859 0.009 3.042 18.709   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.827e+01 1.304e+00 14.012 < 2e-16 \*\*\*  
## poly(time, 10, raw = TRUE)1 2.605e-01 6.911e-02 3.769 0.000168 \*\*\*  
## poly(time, 10, raw = TRUE)2 -4.399e-03 1.204e-03 -3.653 0.000264 \*\*\*  
## poly(time, 10, raw = TRUE)3 3.455e-05 9.757e-06 3.541 0.000405 \*\*\*  
## poly(time, 10, raw = TRUE)4 -1.498e-07 4.354e-08 -3.441 0.000590 \*\*\*  
## poly(time, 10, raw = TRUE)5 3.868e-10 1.167e-10 3.315 0.000929 \*\*\*  
## poly(time, 10, raw = TRUE)6 -6.180e-13 1.956e-13 -3.160 0.001598 \*\*   
## poly(time, 10, raw = TRUE)7 6.160e-16 2.065e-16 2.983 0.002883 \*\*   
## poly(time, 10, raw = TRUE)8 -3.730e-19 1.334e-19 -2.797 0.005203 \*\*   
## poly(time, 10, raw = TRUE)9 1.256e-22 4.811e-23 2.611 0.009090 \*\*   
## poly(time, 10, raw = TRUE)10 -1.805e-26 7.421e-27 -2.432 0.015079 \*   
## typeecg 2.887e+01 2.307e-01 125.113 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.869 on 2576 degrees of freedom  
## Multiple R-squared: 0.8594, Adjusted R-squared: 0.8588   
## F-statistic: 1432 on 11 and 2576 DF, p-value: < 2.2e-16

model\_B1\_20 <- lm(rate ~ poly(time, 20, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_20)

##   
## Call:  
## lm(formula = rate ~ poly(time, 20, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -45.165 -2.823 -0.125 2.999 17.751   
##   
## Coefficients: (4 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.038e+01 1.948e+00 5.326 1.09e-07 \*\*\*  
## poly(time, 20, raw = TRUE)1 1.168e+00 2.294e-01 5.093 3.79e-07 \*\*\*  
## poly(time, 20, raw = TRUE)2 -3.230e-02 8.981e-03 -3.596 0.000329 \*\*\*  
## poly(time, 20, raw = TRUE)3 4.405e-04 1.675e-04 2.630 0.008585 \*\*   
## poly(time, 20, raw = TRUE)4 -3.682e-06 1.779e-06 -2.069 0.038610 \*   
## poly(time, 20, raw = TRUE)5 2.097e-08 1.190e-08 1.762 0.078171 .   
## poly(time, 20, raw = TRUE)6 -8.507e-11 5.317e-11 -1.600 0.109723   
## poly(time, 20, raw = TRUE)7 2.489e-13 1.644e-13 1.514 0.130224   
## poly(time, 20, raw = TRUE)8 -5.235e-16 3.581e-16 -1.462 0.143956   
## poly(time, 20, raw = TRUE)9 7.807e-19 5.497e-19 1.420 0.155654   
## poly(time, 20, raw = TRUE)10 -8.010e-22 5.818e-22 -1.377 0.168656   
## poly(time, 20, raw = TRUE)11 5.280e-25 3.983e-25 1.326 0.185082   
## poly(time, 20, raw = TRUE)12 -1.826e-28 1.444e-28 -1.264 0.206303   
## poly(time, 20, raw = TRUE)13 NA NA NA NA   
## poly(time, 20, raw = TRUE)14 1.952e-35 1.757e-35 1.111 0.266722   
## poly(time, 20, raw = TRUE)15 NA NA NA NA   
## poly(time, 20, raw = TRUE)16 -2.944e-42 3.180e-42 -0.926 0.354698   
## poly(time, 20, raw = TRUE)17 NA NA NA NA   
## poly(time, 20, raw = TRUE)18 3.226e-49 4.476e-49 0.721 0.471114   
## poly(time, 20, raw = TRUE)19 NA NA NA NA   
## poly(time, 20, raw = TRUE)20 -1.635e-56 3.226e-56 -0.507 0.612272   
## typeecg 2.887e+01 2.250e-01 128.297 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.723 on 2570 degrees of freedom  
## Multiple R-squared: 0.8666, Adjusted R-squared: 0.8657   
## F-statistic: 982.2 on 17 and 2570 DF, p-value: < 2.2e-16

model\_B1\_30 <- lm(rate ~ poly(time, 30, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_30)

##   
## Call:  
## lm(formula = rate ~ poly(time, 30, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -45.475 -2.743 -0.043 2.974 17.773   
##   
## Coefficients: (11 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.400e+01 2.191e+00 6.390 1.96e-10 \*\*\*  
## poly(time, 30, raw = TRUE)1 3.372e-01 3.225e-01 1.045 0.295908   
## poly(time, 30, raw = TRUE)2 1.693e-02 1.582e-02 1.070 0.284634   
## poly(time, 30, raw = TRUE)3 -8.504e-04 3.703e-04 -2.296 0.021743 \*   
## poly(time, 30, raw = TRUE)4 1.498e-05 4.954e-06 3.024 0.002521 \*\*   
## poly(time, 30, raw = TRUE)5 -1.461e-07 4.187e-08 -3.490 0.000492 \*\*\*  
## poly(time, 30, raw = TRUE)6 9.062e-10 2.374e-10 3.817 0.000138 \*\*\*  
## poly(time, 30, raw = TRUE)7 -3.809e-12 9.366e-13 -4.067 4.90e-05 \*\*\*  
## poly(time, 30, raw = TRUE)8 1.118e-14 2.618e-15 4.272 2.01e-05 \*\*\*  
## poly(time, 30, raw = TRUE)9 -2.309e-17 5.194e-18 -4.445 9.15e-06 \*\*\*  
## poly(time, 30, raw = TRUE)10 3.294e-20 7.167e-21 4.597 4.49e-06 \*\*\*  
## poly(time, 30, raw = TRUE)11 -3.058e-23 6.463e-24 -4.731 2.35e-06 \*\*\*  
## poly(time, 30, raw = TRUE)12 1.516e-26 3.124e-27 4.852 1.29e-06 \*\*\*  
## poly(time, 30, raw = TRUE)13 NA NA NA NA   
## poly(time, 30, raw = TRUE)14 -3.583e-33 7.079e-34 -5.062 4.45e-07 \*\*\*  
## poly(time, 30, raw = TRUE)15 NA NA NA NA   
## poly(time, 30, raw = TRUE)16 1.364e-39 2.604e-40 5.239 1.74e-07 \*\*\*  
## poly(time, 30, raw = TRUE)17 NA NA NA NA   
## poly(time, 30, raw = TRUE)18 -4.624e-46 8.572e-47 -5.394 7.52e-08 \*\*\*  
## poly(time, 30, raw = TRUE)19 NA NA NA NA   
## poly(time, 30, raw = TRUE)20 1.038e-52 1.876e-53 5.533 3.47e-08 \*\*\*  
## poly(time, 30, raw = TRUE)21 NA NA NA NA   
## poly(time, 30, raw = TRUE)22 NA NA NA NA   
## poly(time, 30, raw = TRUE)23 -8.960e-63 1.567e-63 -5.718 1.20e-08 \*\*\*  
## poly(time, 30, raw = TRUE)24 NA NA NA NA   
## poly(time, 30, raw = TRUE)25 NA NA NA NA   
## poly(time, 30, raw = TRUE)26 7.014e-73 1.193e-73 5.882 4.59e-09 \*\*\*  
## poly(time, 30, raw = TRUE)27 NA NA NA NA   
## poly(time, 30, raw = TRUE)28 NA NA NA NA   
## poly(time, 30, raw = TRUE)29 NA NA NA NA   
## poly(time, 30, raw = TRUE)30 -1.520e-86 2.504e-87 -6.071 1.46e-09 \*\*\*  
## typeecg 2.887e+01 2.230e-01 129.459 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.672 on 2567 degrees of freedom  
## Multiple R-squared: 0.8692, Adjusted R-squared: 0.8681   
## F-statistic: 852.6 on 20 and 2567 DF, p-value: < 2.2e-16

model\_B1\_50 <- lm(rate ~ poly(time, 50, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_50)

##   
## Call:  
## lm(formula = rate ~ poly(time, 50, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -45.084 -2.744 -0.074 2.863 17.320   
##   
## Coefficients: (28 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.180e+01 2.389e+00 4.940 8.3e-07 \*\*\*  
## poly(time, 50, raw = TRUE)1 8.943e-01 4.091e-01 2.186 0.0289 \*   
## poly(time, 50, raw = TRUE)2 -1.951e-02 2.335e-02 -0.836 0.4034   
## poly(time, 50, raw = TRUE)3 2.001e-04 6.372e-04 0.314 0.7535   
## poly(time, 50, raw = TRUE)4 -1.643e-06 9.948e-06 -0.165 0.8688   
## poly(time, 50, raw = TRUE)5 1.615e-08 9.822e-08 0.164 0.8694   
## poly(time, 50, raw = TRUE)6 -1.397e-10 6.516e-10 -0.214 0.8302   
## poly(time, 50, raw = TRUE)7 8.285e-13 3.012e-12 0.275 0.7833   
## poly(time, 50, raw = TRUE)8 -3.269e-15 9.882e-15 -0.331 0.7409   
## poly(time, 50, raw = TRUE)9 8.665e-18 2.306e-17 0.376 0.7071   
## poly(time, 50, raw = TRUE)10 -1.533e-20 3.751e-20 -0.409 0.6828   
## poly(time, 50, raw = TRUE)11 1.718e-23 3.998e-23 0.430 0.6674   
## poly(time, 50, raw = TRUE)12 -1.007e-26 2.291e-26 -0.440 0.6602   
## poly(time, 50, raw = TRUE)13 NA NA NA NA   
## poly(time, 50, raw = TRUE)14 3.176e-33 7.370e-33 0.431 0.6665   
## poly(time, 50, raw = TRUE)15 NA NA NA NA   
## poly(time, 50, raw = TRUE)16 -1.535e-39 3.914e-39 -0.392 0.6950   
## poly(time, 50, raw = TRUE)17 NA NA NA NA   
## poly(time, 50, raw = TRUE)18 6.303e-46 1.900e-45 0.332 0.7401   
## poly(time, 50, raw = TRUE)19 NA NA NA NA   
## poly(time, 50, raw = TRUE)20 -1.620e-52 6.303e-52 -0.257 0.7972   
## poly(time, 50, raw = TRUE)21 NA NA NA NA   
## poly(time, 50, raw = TRUE)22 NA NA NA NA   
## poly(time, 50, raw = TRUE)23 1.370e-62 1.053e-61 0.130 0.8965   
## poly(time, 50, raw = TRUE)24 NA NA NA NA   
## poly(time, 50, raw = TRUE)25 NA NA NA NA   
## poly(time, 50, raw = TRUE)26 4.967e-74 1.820e-71 0.003 0.9978   
## poly(time, 50, raw = TRUE)27 NA NA NA NA   
## poly(time, 50, raw = TRUE)28 NA NA NA NA   
## poly(time, 50, raw = TRUE)29 NA NA NA NA   
## poly(time, 50, raw = TRUE)30 -2.950e-85 1.695e-84 -0.174 0.8618   
## poly(time, 50, raw = TRUE)31 NA NA NA NA   
## poly(time, 50, raw = TRUE)32 NA NA NA NA   
## poly(time, 50, raw = TRUE)33 NA NA NA NA   
## poly(time, 50, raw = TRUE)34 4.930e-98 1.501e-97 0.328 0.7427   
## poly(time, 50, raw = TRUE)35 NA NA NA NA   
## poly(time, 50, raw = TRUE)36 NA NA NA NA   
## poly(time, 50, raw = TRUE)37 NA NA NA NA   
## poly(time, 50, raw = TRUE)38 NA NA NA NA   
## poly(time, 50, raw = TRUE)39 -2.863e-114 5.855e-114 -0.489 0.6249   
## poly(time, 50, raw = TRUE)40 NA NA NA NA   
## poly(time, 50, raw = TRUE)41 NA NA NA NA   
## poly(time, 50, raw = TRUE)42 NA NA NA NA   
## poly(time, 50, raw = TRUE)43 NA NA NA NA   
## poly(time, 50, raw = TRUE)44 9.073e-131 1.484e-130 0.611 0.5411   
## poly(time, 50, raw = TRUE)45 NA NA NA NA   
## poly(time, 50, raw = TRUE)46 NA NA NA NA   
## poly(time, 50, raw = TRUE)47 NA NA NA NA   
## poly(time, 50, raw = TRUE)48 NA NA NA NA   
## poly(time, 50, raw = TRUE)49 NA NA NA NA   
## poly(time, 50, raw = TRUE)50 NA NA NA NA   
## typeecg 2.887e+01 2.227e-01 129.648 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.663 on 2564 degrees of freedom  
## Multiple R-squared: 0.8697, Adjusted R-squared: 0.8685   
## F-statistic: 744 on 23 and 2564 DF, p-value: < 2.2e-16

model\_B1\_70 <- lm(rate ~ poly(time, 70, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_70)

##   
## Call:  
## lm(formula = rate ~ poly(time, 70, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -44.183 -2.690 -0.145 2.722 17.179   
##   
## Coefficients: (45 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.574e+01 2.521e+00 6.245 4.96e-10 \*\*\*  
## poly(time, 70, raw = TRUE)1 -2.486e-01 4.771e-01 -0.521 0.602376   
## poly(time, 70, raw = TRUE)2 6.670e-02 3.011e-02 2.215 0.026843 \*   
## poly(time, 70, raw = TRUE)3 -2.673e-03 9.094e-04 -2.939 0.003320 \*\*   
## poly(time, 70, raw = TRUE)4 5.100e-05 1.572e-05 3.244 0.001194 \*\*   
## poly(time, 70, raw = TRUE)5 -5.795e-07 1.719e-07 -3.370 0.000762 \*\*\*  
## poly(time, 70, raw = TRUE)6 4.319e-09 1.264e-09 3.416 0.000645 \*\*\*  
## poly(time, 70, raw = TRUE)7 -2.217e-11 6.480e-12 -3.421 0.000633 \*\*\*  
## poly(time, 70, raw = TRUE)8 8.025e-14 2.359e-14 3.402 0.000679 \*\*\*  
## poly(time, 70, raw = TRUE)9 -2.057e-16 6.110e-17 -3.367 0.000771 \*\*\*  
## poly(time, 70, raw = TRUE)10 3.665e-19 1.104e-19 3.320 0.000913 \*\*\*  
## poly(time, 70, raw = TRUE)11 -4.268e-22 1.308e-22 -3.263 0.001117 \*\*   
## poly(time, 70, raw = TRUE)12 2.667e-25 8.339e-26 3.198 0.001401 \*\*   
## poly(time, 70, raw = TRUE)13 NA NA NA NA   
## poly(time, 70, raw = TRUE)14 -1.015e-31 3.329e-32 -3.049 0.002322 \*\*   
## poly(time, 70, raw = TRUE)15 NA NA NA NA   
## poly(time, 70, raw = TRUE)16 6.345e-38 2.203e-38 2.880 0.004010 \*\*   
## poly(time, 70, raw = TRUE)17 NA NA NA NA   
## poly(time, 70, raw = TRUE)18 -3.614e-44 1.339e-44 -2.698 0.007017 \*\*   
## poly(time, 70, raw = TRUE)19 NA NA NA NA   
## poly(time, 70, raw = TRUE)20 1.404e-50 5.595e-51 2.509 0.012179 \*   
## poly(time, 70, raw = TRUE)21 NA NA NA NA   
## poly(time, 70, raw = TRUE)22 NA NA NA NA   
## poly(time, 70, raw = TRUE)23 -2.971e-60 1.339e-60 -2.219 0.026561 \*   
## poly(time, 70, raw = TRUE)24 NA NA NA NA   
## poly(time, 70, raw = TRUE)25 NA NA NA NA   
## poly(time, 70, raw = TRUE)26 6.527e-70 3.377e-70 1.933 0.053346 .   
## poly(time, 70, raw = TRUE)27 NA NA NA NA   
## poly(time, 70, raw = TRUE)28 NA NA NA NA   
## poly(time, 70, raw = TRUE)29 NA NA NA NA   
## poly(time, 70, raw = TRUE)30 -8.492e-83 5.412e-83 -1.569 0.116752   
## poly(time, 70, raw = TRUE)31 NA NA NA NA   
## poly(time, 70, raw = TRUE)32 NA NA NA NA   
## poly(time, 70, raw = TRUE)33 NA NA NA NA   
## poly(time, 70, raw = TRUE)34 1.084e-95 8.783e-96 1.234 0.217311   
## poly(time, 70, raw = TRUE)35 NA NA NA NA   
## poly(time, 70, raw = TRUE)36 NA NA NA NA   
## poly(time, 70, raw = TRUE)37 NA NA NA NA   
## poly(time, 70, raw = TRUE)38 NA NA NA NA   
## poly(time, 70, raw = TRUE)39 -7.197e-112 8.357e-112 -0.861 0.389196   
## poly(time, 70, raw = TRUE)40 NA NA NA NA   
## poly(time, 70, raw = TRUE)41 NA NA NA NA   
## poly(time, 70, raw = TRUE)42 NA NA NA NA   
## poly(time, 70, raw = TRUE)43 NA NA NA NA   
## poly(time, 70, raw = TRUE)44 3.688e-128 6.840e-128 0.539 0.589821   
## poly(time, 70, raw = TRUE)45 NA NA NA NA   
## poly(time, 70, raw = TRUE)46 NA NA NA NA   
## poly(time, 70, raw = TRUE)47 NA NA NA NA   
## poly(time, 70, raw = TRUE)48 NA NA NA NA   
## poly(time, 70, raw = TRUE)49 NA NA NA NA   
## poly(time, 70, raw = TRUE)50 NA NA NA NA   
## poly(time, 70, raw = TRUE)51 -2.983e-151 1.807e-150 -0.165 0.868925   
## poly(time, 70, raw = TRUE)52 NA NA NA NA   
## poly(time, 70, raw = TRUE)53 NA NA NA NA   
## poly(time, 70, raw = TRUE)54 NA NA NA NA   
## poly(time, 70, raw = TRUE)55 NA NA NA NA   
## poly(time, 70, raw = TRUE)56 NA NA NA NA   
## poly(time, 70, raw = TRUE)57 NA NA NA NA   
## poly(time, 70, raw = TRUE)58 NA NA NA NA   
## poly(time, 70, raw = TRUE)59 -5.328e-177 0.000e+00 -Inf < 2e-16 \*\*\*  
## poly(time, 70, raw = TRUE)60 NA NA NA NA   
## poly(time, 70, raw = TRUE)61 NA NA NA NA   
## poly(time, 70, raw = TRUE)62 NA NA NA NA   
## poly(time, 70, raw = TRUE)63 NA NA NA NA   
## poly(time, 70, raw = TRUE)64 NA NA NA NA   
## poly(time, 70, raw = TRUE)65 NA NA NA NA   
## poly(time, 70, raw = TRUE)66 NA NA NA NA   
## poly(time, 70, raw = TRUE)67 1.527e-202 0.000e+00 Inf < 2e-16 \*\*\*  
## poly(time, 70, raw = TRUE)68 NA NA NA NA   
## poly(time, 70, raw = TRUE)69 NA NA NA NA   
## poly(time, 70, raw = TRUE)70 NA NA NA NA   
## typeecg 2.887e+01 2.213e-01 130.447 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.629 on 2561 degrees of freedom  
## Multiple R-squared: 0.8714, Adjusted R-squared: 0.8701   
## F-statistic: 667.6 on 26 and 2561 DF, p-value: < 2.2e-16

model\_B1\_90 <- lm(rate ~ poly(time, 90, raw = TRUE) + type, data = df\_B1)  
summary(model\_B1\_90)

##   
## Call:  
## lm(formula = rate ~ poly(time, 90, raw = TRUE) + type, data = df\_B1)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -44.195 -2.695 -0.141 2.737 17.165   
##   
## Coefficients: (63 not defined because of singularities)  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) 1.565e+01 2.595e+00 6.031 1.87e-09 \*\*\*  
## poly(time, 90, raw = TRUE)1 -2.207e-01 5.151e-01 -0.428 0.6684   
## poly(time, 90, raw = TRUE)2 6.441e-02 3.409e-02 1.889 0.0590 .   
## poly(time, 90, raw = TRUE)3 -2.590e-03 1.080e-03 -2.398 0.0166 \*   
## poly(time, 90, raw = TRUE)4 4.935e-05 1.960e-05 2.518 0.0119 \*   
## poly(time, 90, raw = TRUE)5 -5.592e-07 2.250e-07 -2.486 0.0130 \*   
## poly(time, 90, raw = TRUE)6 4.154e-09 1.736e-09 2.393 0.0168 \*   
## poly(time, 90, raw = TRUE)7 -2.124e-11 9.342e-12 -2.274 0.0231 \*   
## poly(time, 90, raw = TRUE)8 7.659e-14 3.571e-14 2.145 0.0320 \*   
## poly(time, 90, raw = TRUE)9 -1.955e-16 9.712e-17 -2.013 0.0442 \*   
## poly(time, 90, raw = TRUE)10 3.467e-19 1.843e-19 1.881 0.0601 .   
## poly(time, 90, raw = TRUE)11 -4.018e-22 2.294e-22 -1.751 0.0800 .   
## poly(time, 90, raw = TRUE)12 2.497e-25 1.537e-25 1.625 0.1043   
## poly(time, 90, raw = TRUE)13 NA NA NA NA   
## poly(time, 90, raw = TRUE)14 -9.388e-32 6.776e-32 -1.385 0.1660   
## poly(time, 90, raw = TRUE)15 NA NA NA NA   
## poly(time, 90, raw = TRUE)16 5.784e-38 4.958e-38 1.167 0.2435   
## poly(time, 90, raw = TRUE)17 NA NA NA NA   
## poly(time, 90, raw = TRUE)18 -3.236e-44 3.336e-44 -0.970 0.3321   
## poly(time, 90, raw = TRUE)19 NA NA NA NA   
## poly(time, 90, raw = TRUE)20 1.229e-50 1.544e-50 0.796 0.4260   
## poly(time, 90, raw = TRUE)21 NA NA NA NA   
## poly(time, 90, raw = TRUE)22 NA NA NA NA   
## poly(time, 90, raw = TRUE)23 -2.490e-60 4.320e-60 -0.576 0.5644   
## poly(time, 90, raw = TRUE)24 NA NA NA NA   
## poly(time, 90, raw = TRUE)25 NA NA NA NA   
## poly(time, 90, raw = TRUE)26 5.135e-70 1.279e-69 0.401 0.6881   
## poly(time, 90, raw = TRUE)27 NA NA NA NA   
## poly(time, 90, raw = TRUE)28 NA NA NA NA   
## poly(time, 90, raw = TRUE)29 NA NA NA NA   
## poly(time, 90, raw = TRUE)30 -5.812e-83 2.555e-82 -0.227 0.8201   
## poly(time, 90, raw = TRUE)31 NA NA NA NA   
## poly(time, 90, raw = TRUE)32 NA NA NA NA   
## poly(time, 90, raw = TRUE)33 NA NA NA NA   
## poly(time, 90, raw = TRUE)34 5.603e-96 5.218e-95 0.107 0.9145   
## poly(time, 90, raw = TRUE)35 NA NA NA NA   
## poly(time, 90, raw = TRUE)36 NA NA NA NA   
## poly(time, 90, raw = TRUE)37 NA NA NA NA   
## poly(time, 90, raw = TRUE)38 NA NA NA NA   
## poly(time, 90, raw = TRUE)39 -8.609e-113 6.731e-111 -0.013 0.9898   
## poly(time, 90, raw = TRUE)40 NA NA NA NA   
## poly(time, 90, raw = TRUE)41 NA NA NA NA   
## poly(time, 90, raw = TRUE)42 NA NA NA NA   
## poly(time, 90, raw = TRUE)43 NA NA NA NA   
## poly(time, 90, raw = TRUE)44 -3.025e-128 7.655e-127 -0.040 0.9685   
## poly(time, 90, raw = TRUE)45 NA NA NA NA   
## poly(time, 90, raw = TRUE)46 NA NA NA NA   
## poly(time, 90, raw = TRUE)47 NA NA NA NA   
## poly(time, 90, raw = TRUE)48 NA NA NA NA   
## poly(time, 90, raw = TRUE)49 NA NA NA NA   
## poly(time, 90, raw = TRUE)50 NA NA NA NA   
## poly(time, 90, raw = TRUE)51 2.374e-150 3.399e-149 0.070 0.9443   
## poly(time, 90, raw = TRUE)52 NA NA NA NA   
## poly(time, 90, raw = TRUE)53 NA NA NA NA   
## poly(time, 90, raw = TRUE)54 NA NA NA NA   
## poly(time, 90, raw = TRUE)55 NA NA NA NA   
## poly(time, 90, raw = TRUE)56 NA NA NA NA   
## poly(time, 90, raw = TRUE)57 NA NA NA NA   
## poly(time, 90, raw = TRUE)58 NA NA NA NA   
## poly(time, 90, raw = TRUE)59 -8.831e-176 0.000e+00 -Inf < 2e-16 \*\*\*  
## poly(time, 90, raw = TRUE)60 NA NA NA NA   
## poly(time, 90, raw = TRUE)61 NA NA NA NA   
## poly(time, 90, raw = TRUE)62 NA NA NA NA   
## poly(time, 90, raw = TRUE)63 NA NA NA NA   
## poly(time, 90, raw = TRUE)64 NA NA NA NA   
## poly(time, 90, raw = TRUE)65 NA NA NA NA   
## poly(time, 90, raw = TRUE)66 NA NA NA NA   
## poly(time, 90, raw = TRUE)67 2.409e-201 0.000e+00 Inf < 2e-16 \*\*\*  
## poly(time, 90, raw = TRUE)68 NA NA NA NA   
## poly(time, 90, raw = TRUE)69 NA NA NA NA   
## poly(time, 90, raw = TRUE)70 NA NA NA NA   
## poly(time, 90, raw = TRUE)71 NA NA NA NA   
## poly(time, 90, raw = TRUE)72 NA NA NA NA   
## poly(time, 90, raw = TRUE)73 NA NA NA NA   
## poly(time, 90, raw = TRUE)74 NA NA NA NA   
## poly(time, 90, raw = TRUE)75 NA NA NA NA   
## poly(time, 90, raw = TRUE)76 NA NA NA NA   
## poly(time, 90, raw = TRUE)77 -1.886e-233 0.000e+00 -Inf < 2e-16 \*\*\*  
## poly(time, 90, raw = TRUE)78 NA NA NA NA   
## poly(time, 90, raw = TRUE)79 NA NA NA NA   
## poly(time, 90, raw = TRUE)80 NA NA NA NA   
## poly(time, 90, raw = TRUE)81 NA NA NA NA   
## poly(time, 90, raw = TRUE)82 NA NA NA NA   
## poly(time, 90, raw = TRUE)83 NA NA NA NA   
## poly(time, 90, raw = TRUE)84 NA NA NA NA   
## poly(time, 90, raw = TRUE)85 NA NA NA NA   
## poly(time, 90, raw = TRUE)86 NA NA NA NA   
## poly(time, 90, raw = TRUE)87 NA NA NA NA   
## poly(time, 90, raw = TRUE)88 6.522e-269 0.000e+00 Inf < 2e-16 \*\*\*  
## poly(time, 90, raw = TRUE)89 NA NA NA NA   
## poly(time, 90, raw = TRUE)90 NA NA NA NA   
## typeecg 2.887e+01 2.214e-01 130.396 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 5.631 on 2559 degrees of freedom  
## Multiple R-squared: 0.8714, Adjusted R-squared: 0.87   
## F-statistic: 619.4 on 28 and 2559 DF, p-value: < 2.2e-16

data.frame(model = paste ("lm" ,1:15 , sep =""),   
 rbind ( extractAIC ( model\_B1\_1 ),   
 extractAIC ( model\_B1\_2 ),   
 extractAIC ( model\_B1\_3 ),   
 extractAIC ( model\_B1\_4 ),   
 extractAIC ( model\_B1\_5 ),  
 extractAIC ( model\_B1\_6 ),  
 extractAIC ( model\_B1\_7 ),  
 extractAIC ( model\_B1\_8 ),  
 extractAIC ( model\_B1\_9 ),  
 extractAIC ( model\_B1\_10 ),  
 extractAIC ( model\_B1\_20 ),  
 extractAIC ( model\_B1\_30 ),  
 extractAIC ( model\_B1\_50 ),  
 extractAIC ( model\_B1\_70 ),  
 extractAIC ( model\_B1\_90 )))

## model X1 X2  
## 1 lm1 3 9245.922  
## 2 lm2 4 9238.585  
## 3 lm3 5 9237.629  
## 4 lm4 6 9239.385  
## 5 lm5 7 9239.924  
## 6 lm6 8 9193.687  
## 7 lm7 9 9185.111  
## 8 lm8 10 9186.723  
## 9 lm9 11 9175.522  
## 10 lm10 12 9171.586  
## 11 lm11 18 9047.470  
## 12 lm12 21 9003.785  
## 13 lm13 24 8999.176  
## 14 lm14 27 8970.397  
## 15 lm15 29 8974.368

extractBIC <- function (model)   
{   
 extractAIC (model ,k= log ( length ( model $ residuals )))   
}  
data.frame( model = paste ("lm" ,1:15 , sep =""),   
 rbind ( extractBIC ( model\_B1\_1 ),   
 extractBIC ( model\_B1\_2 ),   
 extractBIC ( model\_B1\_3 ),   
 extractBIC ( model\_B1\_4 ),   
 extractBIC ( model\_B1\_5 ),  
 extractBIC ( model\_B1\_6 ),  
 extractBIC ( model\_B1\_7 ),  
 extractBIC ( model\_B1\_8 ),  
 extractBIC ( model\_B1\_9 ),  
 extractBIC ( model\_B1\_10 ),  
 extractBIC ( model\_B1\_20 ),  
 extractBIC ( model\_B1\_30 ),  
 extractBIC ( model\_B1\_50 ),  
 extractBIC ( model\_B1\_70 ),  
 extractBIC ( model\_B1\_90 )))

## model X1 X2  
## 1 lm1 3 9263.498  
## 2 lm2 4 9262.019  
## 3 lm3 5 9266.922  
## 4 lm4 6 9274.537  
## 5 lm5 7 9280.935  
## 6 lm6 8 9240.556  
## 7 lm7 9 9237.838  
## 8 lm8 10 9245.310  
## 9 lm9 11 9239.967  
## 10 lm10 12 9241.890  
## 11 lm11 18 9152.926  
## 12 lm12 21 9126.816  
## 13 lm13 24 9139.783  
## 14 lm14 27 9128.580  
## 15 lm15 29 9144.268

anova(model\_B1\_1, model\_B1\_2, model\_B1\_3, model\_B1\_4, model\_B1\_5, model\_B1\_6, model\_B1\_7, model\_B1\_8,   
 model\_B1\_9, model\_B1\_10, model\_B1\_20, model\_B1\_30, model\_B1\_50, model\_B1\_70, model\_B1\_90)

## Analysis of Variance Table  
##   
## Model 1: rate ~ poly(time, 1, raw = TRUE) + type  
## Model 2: rate ~ poly(time, 2, raw = TRUE) + type  
## Model 3: rate ~ poly(time, 3, raw = TRUE) + type  
## Model 4: rate ~ poly(time, 4, raw = TRUE) + type  
## Model 5: rate ~ poly(time, 5, raw = TRUE) + type  
## Model 6: rate ~ poly(time, 6, raw = TRUE) + type  
## Model 7: rate ~ poly(time, 7, raw = TRUE) + type  
## Model 8: rate ~ poly(time, 8, raw = TRUE) + type  
## Model 9: rate ~ poly(time, 9, raw = TRUE) + type  
## Model 10: rate ~ poly(time, 10, raw = TRUE) + type  
## Model 11: rate ~ poly(time, 20, raw = TRUE) + type  
## Model 12: rate ~ poly(time, 30, raw = TRUE) + type  
## Model 13: rate ~ poly(time, 50, raw = TRUE) + type  
## Model 14: rate ~ poly(time, 70, raw = TRUE) + type  
## Model 15: rate ~ poly(time, 90, raw = TRUE) + type  
## Res.Df RSS Df Sum of Sq F Pr(>F)   
## 1 2585 91944   
## 2 2584 91613 1 331.1 10.4438 0.0012463 \*\*   
## 3 2583 91508 1 104.6 3.2982 0.0694742 .   
## 4 2582 91500 1 8.6 0.2713 0.6025109   
## 5 2581 91448 1 51.6 1.6288 0.2019876   
## 6 2580 89759 1 1688.7 53.2592 3.882e-13 \*\*\*  
## 7 2579 89393 1 366.1 11.5453 0.0006896 \*\*\*  
## 8 2578 89380 1 13.4 0.4221 0.5159675   
## 9 2577 88925 1 454.7 14.3421 0.0001559 \*\*\*  
## 10 2576 88721 1 203.7 6.4253 0.0113097 \*   
## 11 2570 84176 6 4545.7 23.8943 < 2.2e-16 \*\*\*  
## 12 2567 82575 3 1600.6 16.8272 7.989e-11 \*\*\*  
## 13 2564 82237 3 337.8 3.5514 0.0138783 \*   
## 14 2561 81140 3 1097.8 11.5406 1.634e-07 \*\*\*  
## 15 2559 81139 2 0.9 0.0143 0.9858132   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

# Question4

D2 <- read.csv("D2\_2\_MOPP.csv", header=T)  
  
  
lm1 <- lm(Belt.BR~EDR.BR+Temp+CoreTemp+ECG.HR+Motion+Body.Pos+poly(as.numeric(Time)),data=D2)  
summary(lm1)

##   
## Call:  
## lm(formula = Belt.BR ~ EDR.BR + Temp + CoreTemp + ECG.HR + Motion +   
## Body.Pos + poly(as.numeric(Time)), data = D2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -5.2755 -1.1006 -0.0544 1.0306 7.2436   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -23.102896 2.867861 -8.056 2.21e-15 \*\*\*  
## EDR.BR 0.702480 0.016828 41.745 < 2e-16 \*\*\*  
## Temp 0.703901 0.072157 9.755 < 2e-16 \*\*\*  
## CoreTemp -0.004752 0.003551 -1.338 0.181   
## ECG.HR 0.025982 0.005637 4.609 4.56e-06 \*\*\*  
## Motion STATIONARY 0.148425 0.275557 0.539 0.590   
## Body.Pos UNKNOWN 1.142111 0.812337 1.406 0.160   
## Body.Pos UPRIGHT -0.261574 0.408468 -0.640 0.522   
## poly(as.numeric(Time)) -42.766385 4.044098 -10.575 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 1.879 on 1012 degrees of freedom  
## Multiple R-squared: 0.7336, Adjusted R-squared: 0.7315   
## F-statistic: 348.3 on 8 and 1012 DF, p-value: < 2.2e-16

summary(lm1)$adj.r.squared

## [1] 0.7314569

drop1(lm1, test = "F")

## Single term deletions  
##   
## Model:  
## Belt.BR ~ EDR.BR + Temp + CoreTemp + ECG.HR + Motion + Body.Pos +   
## poly(as.numeric(Time))  
## Df Sum of Sq RSS AIC F value Pr(>F)   
## <none> 3572.8 1296.9   
## EDR.BR 1 6152.2 9725.0 2317.2 1742.6441 < 2.2e-16 \*\*\*  
## Temp 1 336.0 3908.7 1386.6 95.1614 < 2.2e-16 \*\*\*  
## CoreTemp 1 6.3 3579.1 1296.7 1.7907 0.1811   
## ECG.HR 1 75.0 3647.8 1316.1 21.2434 4.561e-06 \*\*\*  
## Motion 1 1.0 3573.8 1295.2 0.2901 0.5903   
## Body.Pos 2 14.7 3587.5 1297.0 2.0812 0.1253   
## poly(as.numeric(Time)) 1 394.8 3967.6 1401.9 111.8309 < 2.2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

lm2 <- lm(Belt.BR~EDR.BR+Temp+CoreTemp+ECG.HR+Body.Pos+poly(as.numeric(Time)),data=D2)  
summary(lm2)

##   
## Call:  
## lm(formula = Belt.BR ~ EDR.BR + Temp + CoreTemp + ECG.HR + Body.Pos +   
## poly(as.numeric(Time)), data = D2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -5.2693 -1.1027 -0.0473 1.0295 7.2501   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -22.891040 2.839766 -8.061 2.12e-15 \*\*\*  
## EDR.BR 0.701640 0.016750 41.890 < 2e-16 \*\*\*  
## Temp 0.703751 0.072132 9.756 < 2e-16 \*\*\*  
## CoreTemp -0.004794 0.003549 -1.351 0.177   
## ECG.HR 0.025660 0.005603 4.579 5.24e-06 \*\*\*  
## Body.Pos UNKNOWN 1.147704 0.811986 1.413 0.158   
## Body.Pos UPRIGHT -0.270587 0.407982 -0.663 0.507   
## poly(as.numeric(Time)) -42.749751 4.042563 -10.575 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 1.878 on 1013 degrees of freedom  
## Multiple R-squared: 0.7335, Adjusted R-squared: 0.7316   
## F-statistic: 398.3 on 7 and 1013 DF, p-value: < 2.2e-16

summary(lm2)$adj.r.squared

## [1] 0.7316451

drop1(lm2, test = "F")

## Single term deletions  
##   
## Model:  
## Belt.BR ~ EDR.BR + Temp + CoreTemp + ECG.HR + Body.Pos + poly(as.numeric(Time))  
## Df Sum of Sq RSS AIC F value Pr(>F)   
## <none> 3573.8 1295.2   
## EDR.BR 1 6190.6 9764.4 2319.4 1754.7532 < 2.2e-16 \*\*\*  
## Temp 1 335.8 3909.6 1384.8 95.1888 < 2.2e-16 \*\*\*  
## CoreTemp 1 6.4 3580.2 1295.0 1.8242 0.1771   
## ECG.HR 1 74.0 3647.8 1314.1 20.9706 5.243e-06 \*\*\*  
## Body.Pos 2 15.1 3588.9 1295.5 2.1401 0.1182   
## poly(as.numeric(Time)) 1 394.5 3968.3 1400.1 111.8288 < 2.2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

lm3 <- lm(Belt.BR~EDR.BR+Temp+ECG.HR+Body.Pos+poly(as.numeric(Time)),data=D2)  
summary(lm3)

##   
## Call:  
## lm(formula = Belt.BR ~ EDR.BR + Temp + ECG.HR + Body.Pos + poly(as.numeric(Time)),   
## data = D2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -5.3257 -1.0860 -0.0751 1.0414 7.1895   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -23.480166 2.807207 -8.364 < 2e-16 \*\*\*  
## EDR.BR 0.702642 0.016740 41.974 < 2e-16 \*\*\*  
## Temp 0.714507 0.071720 9.962 < 2e-16 \*\*\*  
## ECG.HR 0.025838 0.005604 4.611 4.53e-06 \*\*\*  
## Body.Pos UNKNOWN 1.142305 0.812306 1.406 0.160   
## Body.Pos UPRIGHT -0.247469 0.407788 -0.607 0.544   
## poly(as.numeric(Time)) -42.983733 4.040491 -10.638 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 1.879 on 1014 degrees of freedom  
## Multiple R-squared: 0.733, Adjusted R-squared: 0.7314   
## F-statistic: 464 on 6 and 1014 DF, p-value: < 2.2e-16

summary(lm3)$adj.r.squared

## [1] 0.731427

drop1(lm3, test = "F")

## Single term deletions  
##   
## Model:  
## Belt.BR ~ EDR.BR + Temp + ECG.HR + Body.Pos + poly(as.numeric(Time))  
## Df Sum of Sq RSS AIC F value Pr(>F)   
## <none> 3580.2 1295.0   
## EDR.BR 1 6220.5 9800.8 2321.2 1761.796 < 2.2e-16 \*\*\*  
## Temp 1 350.4 3930.7 1388.3 99.251 < 2.2e-16 \*\*\*  
## ECG.HR 1 75.1 3655.3 1314.2 21.257 4.528e-06 \*\*\*  
## Body.Pos 2 14.3 3594.6 1295.1 2.032 0.1316   
## poly(as.numeric(Time)) 1 399.6 3979.8 1401.0 113.172 < 2.2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

lm4 <- lm(Belt.BR~EDR.BR+Temp+ECG.HR+poly(as.numeric(Time),27),data=D2)  
summary(lm4)

##   
## Call:  
## lm(formula = Belt.BR ~ EDR.BR + Temp + ECG.HR + poly(as.numeric(Time),   
## 27), data = D2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -4.3539 -1.0080 -0.1049 0.9782 5.4775   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -38.183247 45.606471 -0.837 0.402664   
## EDR.BR 0.609417 0.026574 22.933 < 2e-16 \*\*\*  
## Temp 1.208315 1.246026 0.970 0.332416   
## ECG.HR 0.012495 0.005393 2.317 0.020699 \*   
## poly(as.numeric(Time), 27)1 -66.051077 61.394393 -1.076 0.282257   
## poly(as.numeric(Time), 27)2 18.865447 31.524632 0.598 0.549687   
## poly(as.numeric(Time), 27)3 9.071181 10.300138 0.881 0.378702   
## poly(as.numeric(Time), 27)4 13.815377 5.935803 2.327 0.020141 \*   
## poly(as.numeric(Time), 27)5 -5.261649 3.186891 -1.651 0.099050 .   
## poly(as.numeric(Time), 27)6 3.906838 1.792717 2.179 0.029546 \*   
## poly(as.numeric(Time), 27)7 -2.230958 2.494845 -0.894 0.371418   
## poly(as.numeric(Time), 27)8 -13.389868 1.869502 -7.162 1.55e-12 \*\*\*  
## poly(as.numeric(Time), 27)9 5.395406 2.669748 2.021 0.043555 \*   
## poly(as.numeric(Time), 27)10 1.456727 1.918735 0.759 0.447906   
## poly(as.numeric(Time), 27)11 7.622182 1.922338 3.965 7.87e-05 \*\*\*  
## poly(as.numeric(Time), 27)12 -2.116816 1.659444 -1.276 0.202390   
## poly(as.numeric(Time), 27)13 -8.839005 1.840728 -4.802 1.81e-06 \*\*\*  
## poly(as.numeric(Time), 27)14 4.021833 1.642626 2.448 0.014521 \*   
## poly(as.numeric(Time), 27)15 6.738900 1.638488 4.113 4.23e-05 \*\*\*  
## poly(as.numeric(Time), 27)16 2.638968 1.705395 1.547 0.122081   
## poly(as.numeric(Time), 27)17 4.839641 1.712545 2.826 0.004808 \*\*   
## poly(as.numeric(Time), 27)18 -3.921606 1.605229 -2.443 0.014739 \*   
## poly(as.numeric(Time), 27)19 2.878976 1.596897 1.803 0.071715 .   
## poly(as.numeric(Time), 27)20 2.555550 1.596688 1.601 0.109800   
## poly(as.numeric(Time), 27)21 9.274716 1.628505 5.695 1.62e-08 \*\*\*  
## poly(as.numeric(Time), 27)22 -5.907276 1.592999 -3.708 0.000220 \*\*\*  
## poly(as.numeric(Time), 27)23 -12.138438 1.605799 -7.559 9.23e-14 \*\*\*  
## poly(as.numeric(Time), 27)24 -3.840111 1.602778 -2.396 0.016764 \*   
## poly(as.numeric(Time), 27)25 13.113129 1.762791 7.439 2.20e-13 \*\*\*  
## poly(as.numeric(Time), 27)26 6.296521 1.616501 3.895 0.000105 \*\*\*  
## poly(as.numeric(Time), 27)27 -0.639362 1.601650 -0.399 0.689840   
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 1.592 on 990 degrees of freedom  
## Multiple R-squared: 0.8129, Adjusted R-squared: 0.8073   
## F-statistic: 143.4 on 30 and 990 DF, p-value: < 2.2e-16

summary(lm4)$adj.r.squared

## [1] 0.8072514

drop1(lm4, test = "F")

## Single term deletions  
##   
## Model:  
## Belt.BR ~ EDR.BR + Temp + ECG.HR + poly(as.numeric(Time), 27)  
## Df Sum of Sq RSS AIC F value Pr(>F)   
## <none> 2508.6 979.83   
## EDR.BR 1 1332.64 3841.3 1412.84 525.9085 <2e-16 \*\*\*  
## Temp 1 2.38 2511.0 978.80 0.9404 0.3324   
## ECG.HR 1 13.61 2522.2 983.35 5.3691 0.0207 \*   
## poly(as.numeric(Time), 27) 27 1481.27 3989.9 1399.61 21.6506 <2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

##############################################################################################  
  
step1 <- step(lm1, direction = "both", k=log(nrow(D2)))

## Start: AIC=1341.22  
## Belt.BR ~ EDR.BR + Temp + CoreTemp + ECG.HR + Motion + Body.Pos +   
## poly(as.numeric(Time))  
##   
## Df Sum of Sq RSS AIC  
## - Body.Pos 2 14.7 3587.5 1331.5  
## - Motion 1 1.0 3573.8 1334.6  
## - CoreTemp 1 6.3 3579.1 1336.1  
## <none> 3572.8 1341.2  
## - ECG.HR 1 75.0 3647.8 1355.5  
## - Temp 1 336.0 3908.7 1426.0  
## - poly(as.numeric(Time)) 1 394.8 3967.6 1441.3  
## - EDR.BR 1 6152.2 9725.0 2356.7  
##   
## Step: AIC=1331.55  
## Belt.BR ~ EDR.BR + Temp + CoreTemp + ECG.HR + Motion + poly(as.numeric(Time))  
##   
## Df Sum of Sq RSS AIC  
## - Motion 1 1.4 3588.9 1325.0  
## - CoreTemp 1 5.6 3593.0 1326.2  
## <none> 3587.5 1331.5  
## + Body.Pos 2 14.7 3572.8 1341.2  
## - ECG.HR 1 76.9 3664.4 1346.3  
## - Temp 1 332.2 3919.7 1415.0  
## - poly(as.numeric(Time)) 1 390.4 3977.9 1430.1  
## - EDR.BR 1 6456.2 10043.7 2375.7  
##   
## Step: AIC=1325.03  
## Belt.BR ~ EDR.BR + Temp + CoreTemp + ECG.HR + poly(as.numeric(Time))  
##   
## Df Sum of Sq RSS AIC  
## - CoreTemp 1 5.7 3594.6 1319.7  
## <none> 3588.9 1325.0  
## + Motion 1 1.4 3587.5 1331.5  
## + Body.Pos 2 15.1 3573.8 1334.6  
## - ECG.HR 1 75.6 3664.5 1339.4  
## - Temp 1 331.9 3920.8 1408.4  
## - poly(as.numeric(Time)) 1 389.9 3978.8 1423.4  
## - EDR.BR 1 6486.7 10075.6 2372.1  
##   
## Step: AIC=1319.72  
## Belt.BR ~ EDR.BR + Temp + ECG.HR + poly(as.numeric(Time))  
##   
## Df Sum of Sq RSS AIC  
## <none> 3594.6 1319.7  
## + CoreTemp 1 5.7 3588.9 1325.0  
## + Motion 1 1.5 3593.0 1326.2  
## + Body.Pos 2 14.3 3580.2 1329.5  
## - ECG.HR 1 76.6 3671.2 1334.3  
## - Temp 1 346.5 3941.1 1406.7  
## - poly(as.numeric(Time)) 1 395.3 3989.9 1419.3  
## - EDR.BR 1 6508.9 10103.5 2367.9

summary(step1)

##   
## Call:  
## lm(formula = Belt.BR ~ EDR.BR + Temp + ECG.HR + poly(as.numeric(Time)),   
## data = D2)  
##   
## Residuals:  
## Min 1Q Median 3Q Max   
## -5.3308 -1.0941 -0.0721 1.0365 7.1754   
##   
## Coefficients:  
## Estimate Std. Error t value Pr(>|t|)   
## (Intercept) -23.567292 2.800510 -8.415 < 2e-16 \*\*\*  
## EDR.BR 0.705954 0.016459 42.892 < 2e-16 \*\*\*  
## Temp 0.707759 0.071519 9.896 < 2e-16 \*\*\*  
## ECG.HR 0.026081 0.005606 4.653 3.71e-06 \*\*\*  
## poly(as.numeric(Time)) -42.548616 4.025174 -10.571 < 2e-16 \*\*\*  
## ---  
## Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1  
##   
## Residual standard error: 1.881 on 1016 degrees of freedom  
## Multiple R-squared: 0.7319, Adjusted R-squared: 0.7309   
## F-statistic: 693.5 on 4 and 1016 DF, p-value: < 2.2e-16

##############################################################################################