

# Nina\_sleep

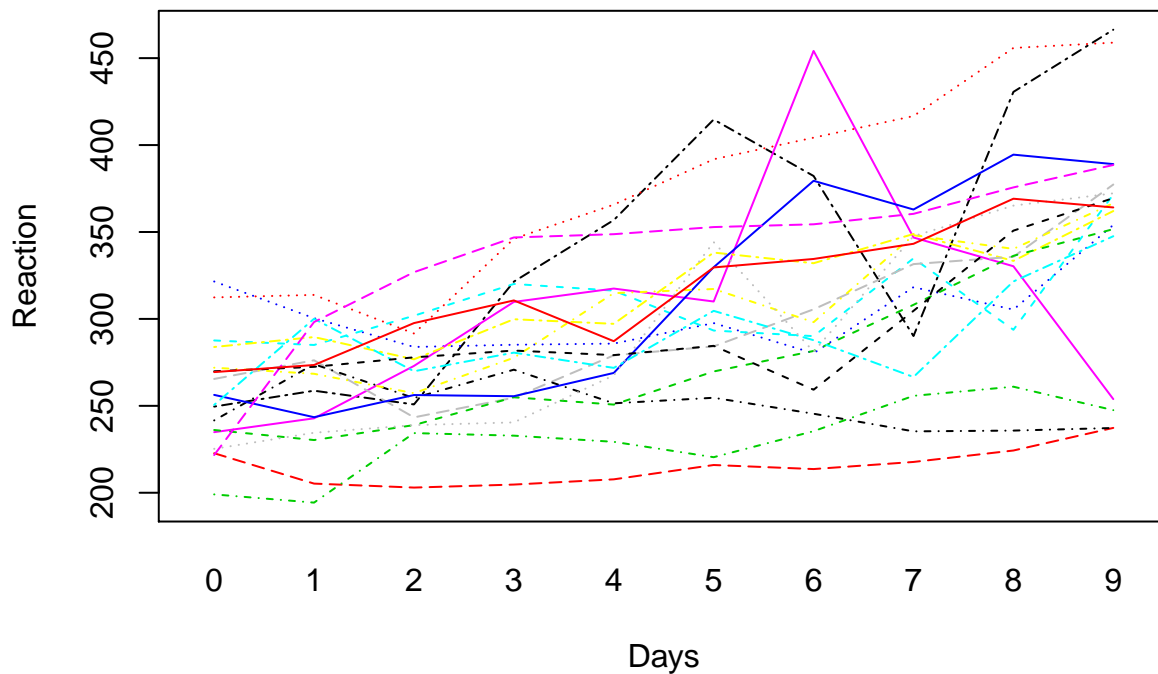
## Exploratory analysis

```
sleep <- read.table('sleep.txt')
```

## Spaghetti Plot

```
n <- sleep$Subject %>% unique %>% length
interaction.plot(sleep$Days, sleep$Subject, sleep$Reaction, xlab="Days", ylab="Reaction", col=c(1:n), lty=1:n)
```

### Spaghetti Plot



## Descriptive Statistics

### Overview

```
sleep.mean <- tapply(sleep$Reaction, list(sleep$Days), mean)
sleep.sd <- tapply(sleep$Reaction, list(sleep$Days), sd)
sleep.var <- tapply(sleep$Reaction, list(sleep$Days), var)
sleep.n <- table(sleep$Days)

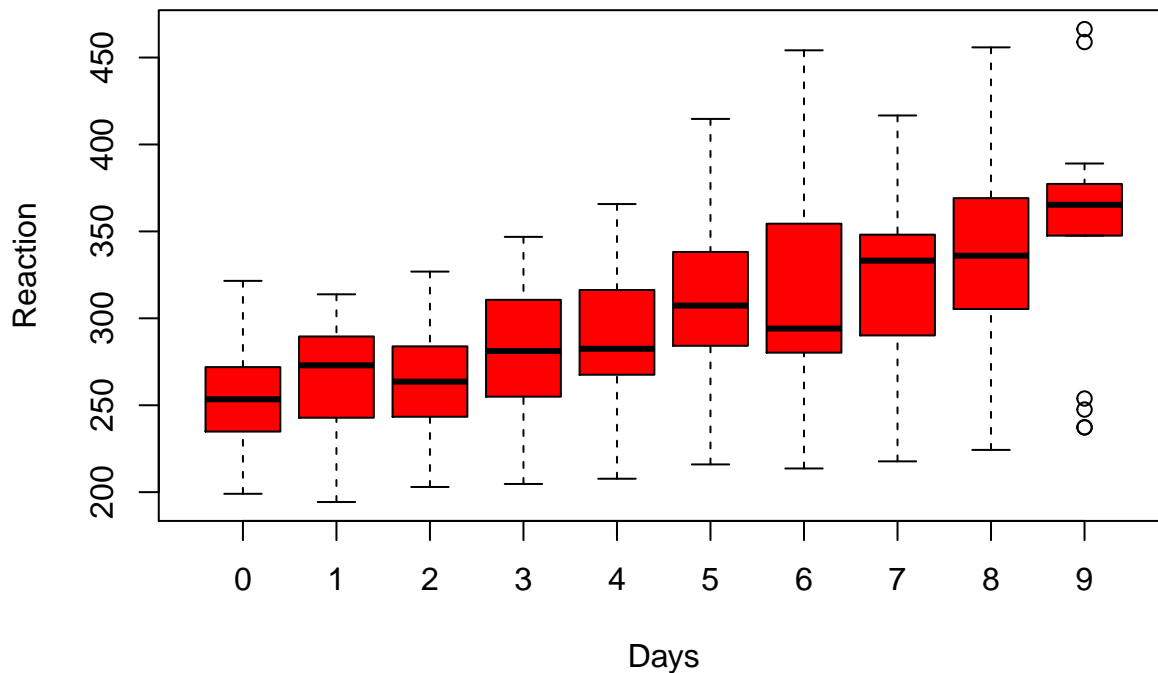
overview <- cbind(c(0:9), sleep.mean, sleep.sd, sleep.var, sleep.n)
colnames(overview) <- c('Days', 'Mean', 'SD', 'Var', 'n')
round(overview, 2)
```

```
## Days Mean SD Var n
## 0 0 256.65 32.13 1032.30 18
```

```
## 1 1 264.50 33.43 1117.59 18
## 2 2 265.36 29.47 868.68 18
## 3 3 282.99 38.86 1509.92 18
## 4 4 288.65 42.54 1809.47 18
## 5 5 308.52 51.77 2680.09 18
## 6 6 312.18 63.17 3990.92 18
## 7 7 318.75 50.10 2510.41 18
## 8 8 336.63 60.20 3624.01 18
## 9 9 350.85 66.99 4487.15 18
```

### Boxplot

```
boxplot(Reaction~Days, data=sleep, xlab='Days', ylab='Reaction', col=2)
```



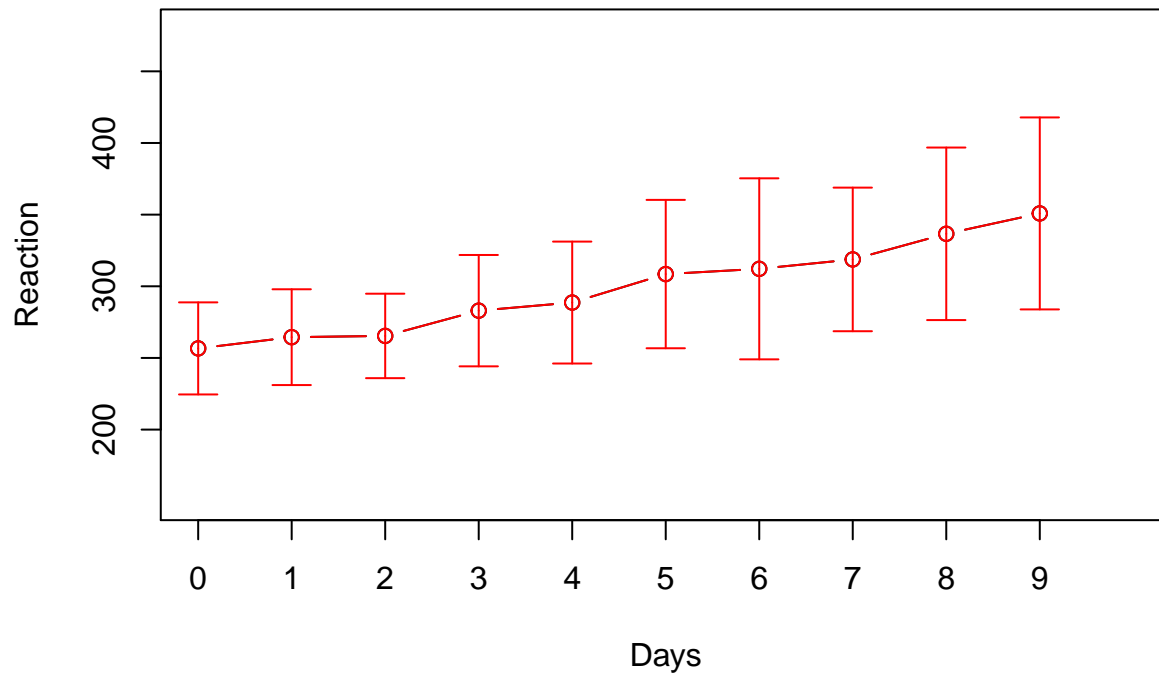
### Mean evolution

```
# General function to plot error bars
errbar=function(x,y,height,width,lty=1,col="black"){
  arrows(x,y,x,y+height,angle=90,length=width,lty=lty, col=col)
  arrows(x,y,x,y-height,angle=90,length=width,lty=lty, col=col)}

## Plotting mean evolution
plot(c(0:9), overview[,2],type="b",xlim=c(0,10), ylim=c(150,480),xlab="Days",ylab="Reaction",axes=F, mar=c(0,0,0,0))
axis(side=1,at=c(0:9),labels=c(0:9))
axis(side=2,at=seq(200,450,50))

box()
points(c(0:9), overview[,2],type="b",col="red")
errbar(c(0:9),overview[,2], sleep.sd, 0.1, col="red")
```

## Mean evolution (with 1 SE intervals)



## Correlations

```
## Reshaping the data into a wide form
sleep.resch <- reshape(sleep, timevar = "Days", idvar = c("Subject"), direction = "wide")
sleep.resch
```

##	Subject	Reaction.0	Reaction.1	Reaction.2	Reaction.3	Reaction.4
## 1	308	249.5600	258.7047	250.8006	321.4398	356.8519
## 11	309	222.7339	205.2658	202.9778	204.7070	207.7161
## 21	310	199.0539	194.3322	234.3200	232.8416	229.3074
## 31	330	321.5426	300.4002	283.8565	285.1330	285.7973
## 41	331	287.6079	285.0000	301.8206	320.1153	316.2773
## 51	332	234.8606	242.8118	272.9613	309.7688	317.4629
## 61	333	283.8424	289.5550	276.7693	299.8097	297.1710
## 71	334	265.4731	276.2012	243.3647	254.6723	279.0244
## 81	335	241.6083	273.9472	254.4907	270.8021	251.4519
## 91	337	312.3666	313.8058	291.6112	346.1222	365.7324
## 101	349	236.1032	230.3167	238.9256	254.9220	250.7103
## 111	350	256.2968	243.4543	256.2046	255.5271	268.9165
## 121	351	250.5265	300.0576	269.8939	280.5891	271.8274
## 131	352	221.6771	298.1939	326.8785	346.8555	348.7402
## 141	369	271.9235	268.4369	257.2424	277.6566	314.8222
## 151	370	225.2640	234.5235	238.9008	240.4730	267.5373
## 161	371	269.8804	272.4428	277.8989	281.7895	279.1705
## 171	372	269.4117	273.4740	297.5968	310.6316	287.1726
##	Reaction.5	Reaction.6	Reaction.7	Reaction.8	Reaction.9	
## 1	414.6901	382.2038	290.1486	430.5853	466.3535	
## 11	215.9618	213.6303	217.7272	224.2957	237.3142	

```
## 21      220.4579    235.4208    255.7511    261.0125    247.5153
## 31      297.5855    280.2396    318.2613    305.3495    354.0487
## 41      293.3187    290.0750    334.8177    293.7469    371.5811
## 51      309.9976    454.1619    346.8311    330.3003    253.8644
## 61      338.1665    332.0265    348.8399    333.3600    362.0428
## 71      284.1912    305.5248    331.5229    335.7469    377.2990
## 81      254.6362    245.4523    235.3110    235.7541    237.2466
## 91      391.8385    404.2601    416.6923    455.8643    458.9167
## 101     269.7744    281.5648    308.1020    336.2806    351.6451
## 111     329.7247    379.4445    362.9184    394.4872    389.0527
## 121     304.6336    287.7466    266.5955    321.5418    347.5655
## 131     352.8287    354.4266    360.4326    375.6406    388.5417
## 141     317.2135    298.1353    348.1229    340.2800    366.5131
## 151     344.1937    281.1481    347.5855    365.1630    372.2288
## 161     284.5120    259.2658    304.6306    350.7807    369.4692
## 171     329.6076    334.4818    343.2199    369.1417    364.1236
```

```
## Correlation between the Reaction scores at different days
cor(sleep.resh[, 2:11])
```

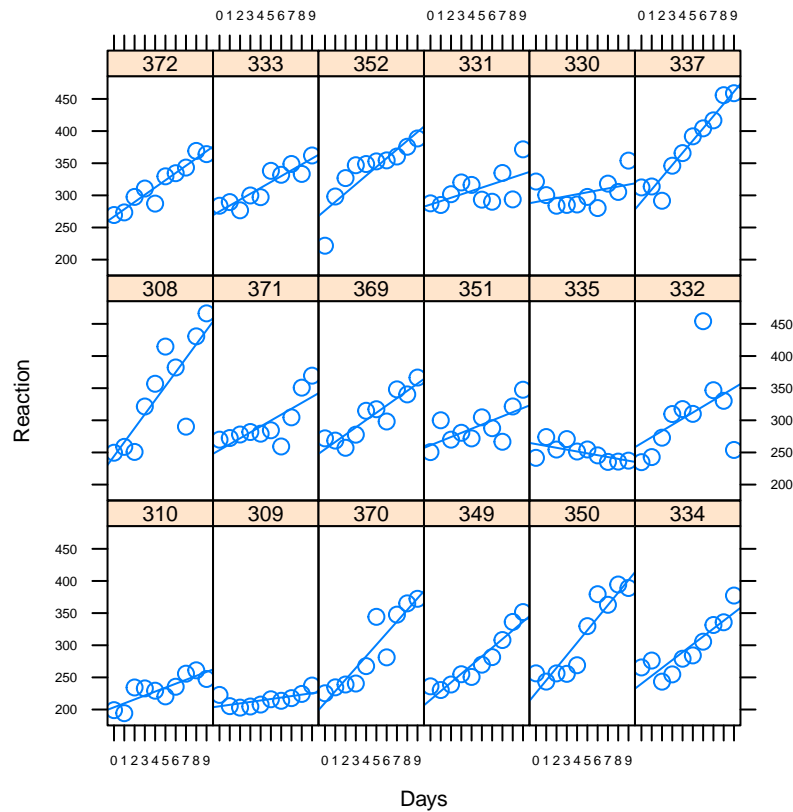
```
##          Reaction.0 Reaction.1 Reaction.2 Reaction.3 Reaction.4
## Reaction.0  1.0000000  0.7367164  0.4698205  0.4636914  0.4488568
## Reaction.1  0.7367164  1.0000000  0.7704196  0.7414557  0.6510015
## Reaction.2  0.4698205  0.7704196  1.0000000  0.8750718  0.6940106
## Reaction.3  0.4636914  0.7414557  0.8750718  1.0000000  0.9136854
## Reaction.4  0.4488568  0.6510015  0.6940106  0.9136854  1.0000000
## Reaction.5  0.3719603  0.5289910  0.4921226  0.7220647  0.8541181
## Reaction.6  0.2217822  0.3149630  0.4543265  0.6748239  0.7493110
## Reaction.7  0.4928691  0.4762225  0.5903260  0.5995546  0.6948864
## Reaction.8  0.3290845  0.3951707  0.4063653  0.5958373  0.7445692
## Reaction.9  0.5157377  0.5464951  0.4232455  0.5657073  0.7155773
##          Reaction.5 Reaction.6 Reaction.7 Reaction.8 Reaction.9
## Reaction.0  0.3719603  0.2217822  0.4928691  0.3290845  0.5157377
## Reaction.1  0.5289910  0.3149630  0.4762225  0.3951707  0.5464951
## Reaction.2  0.4921226  0.4543265  0.5903260  0.4063653  0.4232455
## Reaction.3  0.7220647  0.6748239  0.5995546  0.5958373  0.5657073
## Reaction.4  0.8541181  0.7493110  0.6948864  0.7445692  0.7155773
## Reaction.5  1.0000000  0.7431791  0.6903115  0.9009653  0.8377065
## Reaction.6  0.7431791  1.0000000  0.7034522  0.7287104  0.4601183
## Reaction.7  0.6903115  0.7034522  1.0000000  0.7616930  0.6586754
## Reaction.8  0.9009653  0.7287104  0.7616930  1.0000000  0.8813894
## Reaction.9  0.8377065  0.4601183  0.6586754  0.8813894  1.0000000
```

## Regression per person

```
## Trellis graph
## Displaying the linear regression per person

cf <-sapply(sleep$Subject, function(x) coef(lm(Reaction~Days, data=subset(sleep, Subject==x))))

Sx <-reorder(sleep$Subject, cf[,1])
#
xyplot(Reaction ~ Days|Sx, data=sleep, type=c('p', 'r'), auto.key=T,aspect="xy", par.settings=list(axis
```



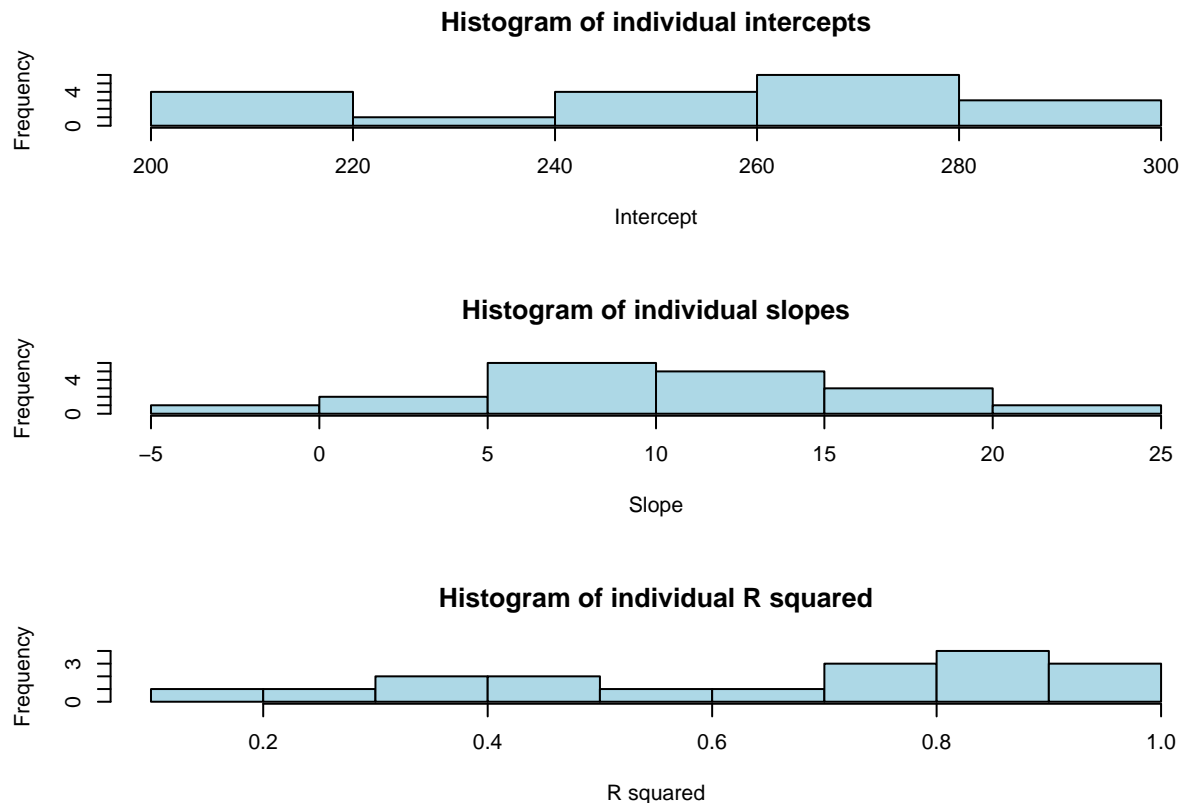
### Between subject variability

```
## Linear regression per participant of Reaction on Days

## Coefficients
lin.reg.coef <- by(sleep, sleep$Subject, function(data) coef(lm(Reaction ~ Days, data=data)))
lin.reg.coef1 <- unlist(lin.reg.coef)
names(lin.reg.coef1) <- NULL
lin.reg.coef2=matrix(lin.reg.coef1,length(lin.reg.coef1)/2,2,byrow = TRUE)

## R squared
lin.reg.r.squared <- by(sleep, sleep$Subject, function(data) summary(lm(Reaction ~ Days, data=data))$r.squared)
lin.reg.r.squared1<- as.vector(unlist(lin.reg.r.squared))

## Histograms
par(mfrow=c(3,1))
hist(lin.reg.coef2[,1],xlab="Intercept",col="lightblue",main="Histogram of individual intercepts")
hist(lin.reg.coef2[,2],xlab="Slope",col="lightblue",main="Histogram of individual slopes")
hist(lin.reg.r.squared1,xlab="R squared",col="lightblue",main="Histogram of individual R squared")
```



### Fitting the model - with REML

```
sleep.reml <- lmer(formula = Reaction ~ 1+Days + (1 + Days|Subject), data=sleep)
summary(sleep.reml)
```

```
## Linear mixed model fit by REML ['lmerMod']
## Formula: Reaction ~ 1 + Days + (1 + Days | Subject)
## Data: sleep
##
## REML criterion at convergence: 1743.6
##
## Scaled residuals:
##    Min      1Q  Median      3Q      Max
## -3.9536 -0.4634  0.0231  0.4633  5.1793
##
## Random effects:
##  Groups   Name                Variance Std.Dev. Corr
##  Subject (Intercept)  611.90    24.737
##           Days         35.08     5.923  0.07
## Residual              654.94    25.592
## Number of obs: 180, groups: Subject, 18
##
## Fixed effects:
##              Estimate Std. Error t value
## (Intercept)  251.405     6.824   36.843
## Days         10.467     1.546    6.771
##
```

```
## Correlation of Fixed Effects:
##      (Intr)
## Days -0.138
```

## Testing fixed effects

```
confint(sleep.reml, par=5:6, method='Wald', oldNames=F)
```

```
##              2.5 %    97.5 %
## (Intercept) 238.030755 264.77945
## Days        7.437264  13.49731
```

```
confint(sleep.reml, method='boot', boot.type='perc', oldNames=F, nsim=500)
```

```
## Computing bootstrap confidence intervals ...
```

```
##
```

```
## 8 message(s): boundary (singular) fit: see ?isSingular
```

```
## 156 warning(s): Model failed to converge with max|grad| = 0.00202609 (tol = 0.002, component 1) (and
```

```
##              2.5 %    97.5 %
## sd_(Intercept)|Subject    11.1936511  35.8815139
## cor_Days.(Intercept)|Subject -0.5051895   0.9388739
## sd_Days|Subject           3.1110509   8.4512733
## sigma                     22.6945301  28.6024327
## (Intercept)               237.3863827 264.5817853
## Days                      6.9845360  13.5586691
```

```
confint(sleep.reml, level=0.95, method='profile', oldNames=F)
```

```
##Computing profile confidence intervals ...
```

```
##              2.5 %    97.5 %
## sd_(Intercept)|Subject    14.3821019  37.7137452
## cor_Days.(Intercept)|Subject -0.4814998   0.6849868
## sd_Days|Subject           3.8011759   8.7540501
## sigma                     22.8982726  28.8579976
## (Intercept)               237.6806976 265.1295138
## Days                      7.3586543  13.5759173
```