Assignment 8

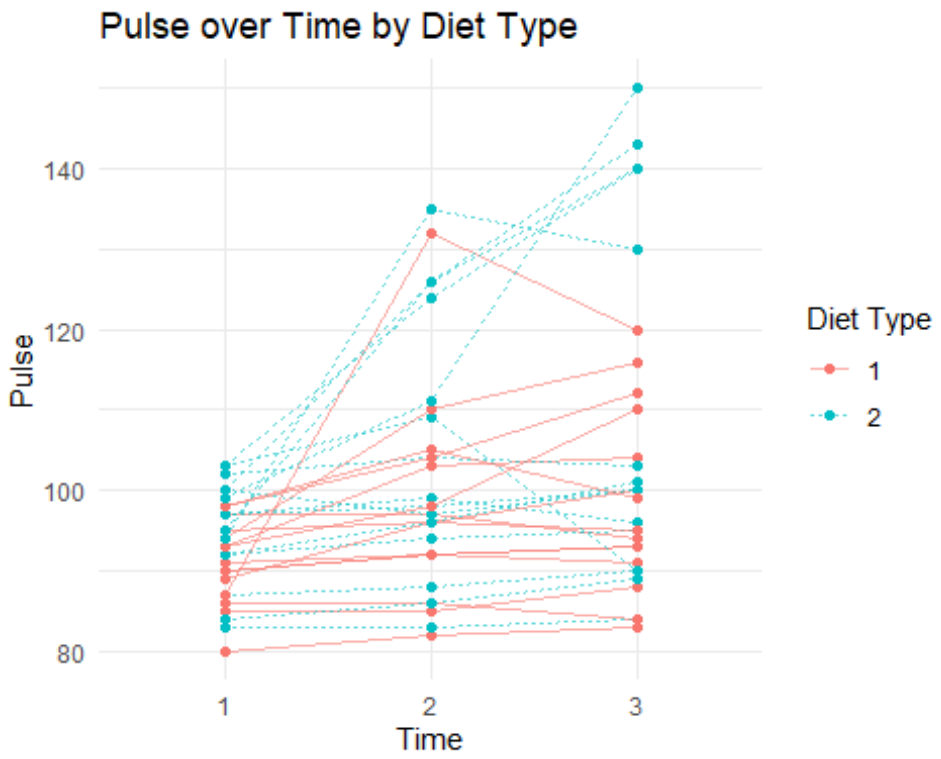
Shinjon Ghosh

2025-03-28

```
exer <- read.csv("https://stats.idre.ucla.edu/stat/data/exer.csv")
 ## Convert variables to factor
exer <- within(exer, {
   diet <- factor(diet)
   exertype <- factor(exertype)
    time <- factor(time)
    id <- factor(id)
})

# Load Pacakage
library (ggplot2)
library(lme4)

## Warning: package 'lme4' was built under R version 4.4.3

## Loading required package: Matrix

library(nlme)

## Warning: package 'nlme' was built under R version 4.4.3

##
## Attaching package: 'nlme'

## The following object is masked from 'package:lme4':
##
##     lmList

library(Matrix)
```

Question 1:

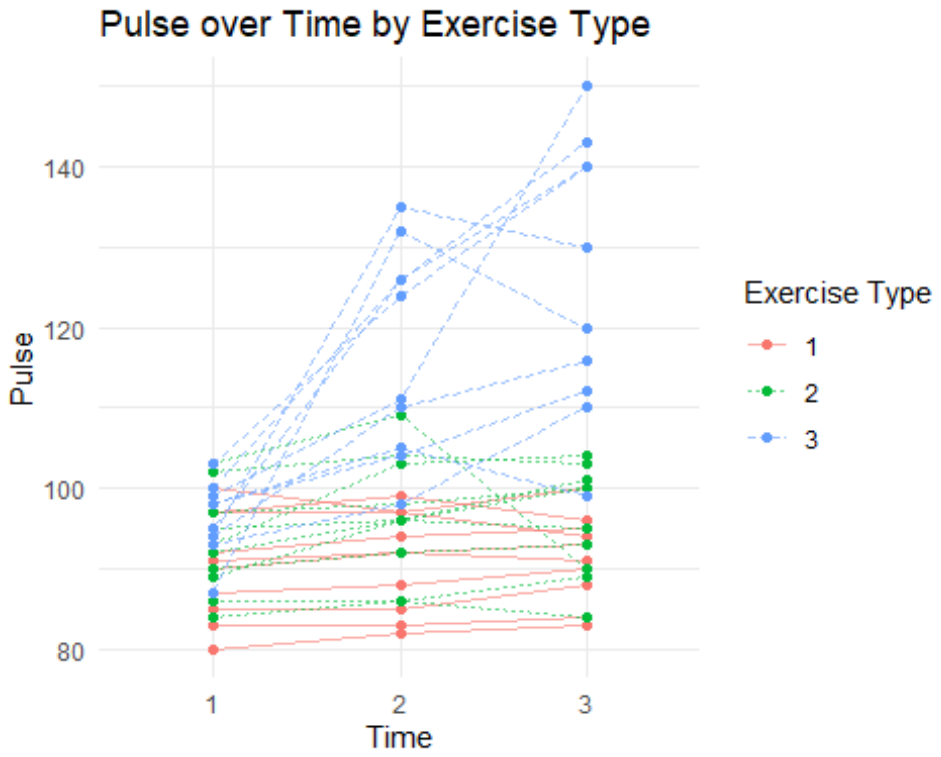
```
ggplot(exer, aes(x = time, y = pulse, group = id, color = diet, linetype = di
et)) +
     geom_line(alpha = 0.6) +
     geom_point() +
     labs(title = "Pulse over Time by Diet Type",
          x = "Time",
          y = "Pulse",
          color = "Diet Type",
          linetype = "Diet Type") +
     theme_minimal()
```



Conclusion: Pulse tends to rise from Time 1 to Time 3, regardless of diet type.The blue dashed lines (Diet 2) show a more upward trend, especially between Time 2 and Time 3.There's greater spread in the pulse values for Diet 2, especially at Time 3, indicating more variation in individual responses.On the other hand, Diet Type 1 shows more clustered trends.

Question 2:

```
ggplot(exer, aes(x = time, y = pulse, group = id, color = exertype, linetype
= exertype)) +
     geom_line(alpha = 0.6) +
    geom_point() +
     labs(title = "Pulse over Time by Exercise Type",
          x = "Time",
          y = "Pulse",
         color = "Exercise Type",
          linetype = "Exercise Type") +
     theme_minimal()
```



Conclusion:Participants in Exercise Type 3 show a sharp and consistent increase in pulse over time. Moreover, Exercise Type 2 show a mild upward trend from Time 1 to Time 3. In addition, Exercise Type 3 show minimal change in pulse over time.

Question 3:

```
# Fit linear regression model
lin <- lm(pulse ~ diet + exertype, data = exer)

# View summary of the model
summary(lin)

##
## Call:
## lm(formula = pulse ~ diet + exertype, data = exer)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -22.811  -6.853   0.794   5.019  33.189
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   87.089      2.280  38.193  < 2e-16 ***
## diet2          7.489      2.280   3.284  0.00148 **
## exertype2      4.367      2.793   1.564  0.12158
## exertype3     22.233      2.793   7.961 6.34e-12 ***
```

```
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.82 on 86 degrees of freedom
## Multiple R-squared:  0.488,  Adjusted R-squared:  0.4701
## F-statistic: 27.32 on 3 and 86 DF,  p-value: 1.668e-12
```

Question: 4

```
# Linear regression model (fixed effects only)
 lm_model <- lm(pulse ~ diet + exertype, data = exer)
summary (lm_model)

##
## Call:
## lm(formula = pulse ~ diet + exertype, data = exer)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -22.811  -6.853   0.794   5.019  33.189
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept)   87.089      2.280  38.193  < 2e-16 ***
## diet2          7.489      2.280   3.284  0.00148 **
## exertype2      4.367      2.793   1.564  0.12158
## exertype3     22.233      2.793   7.961 6.34e-12 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 10.82 on 86 degrees of freedom
## Multiple R-squared:  0.488,  Adjusted R-squared:  0.4701
## F-statistic: 27.32 on 3 and 86 DF,  p-value: 1.668e-12

 # Linear mixed model with random intercept for id
 lmer_model <- lmer(pulse ~ diet + exertype + (1 | id), data = exer)

## boundary (singular) fit: see help('isSingular')

 summary (lmer_model)

## Linear mixed model fit by REML ['lmerMod']
## Formula: pulse ~ diet + exertype + (1 | id)
##    Data: exer
##
## REML criterion at convergence: 666.9
##
## Scaled residuals:
##      Min       1Q   Median       3Q      Max
## -2.10900 -0.63357  0.07345  0.46407  3.06847
##
```

```
## Random effects:
##  Groups   Name        Variance Std.Dev.
##  id       (Intercept)   0       0.00
##  Residual             117      10.82
## Number of obs: 90, groups:  id, 30
##
## Fixed effects:
##             Estimate Std. Error t value
## (Intercept)   87.089      2.280  38.193
## diet2          7.489      2.280   3.284
## exertype2      4.367      2.793   1.564
## exertype3     22.233      2.793   7.961
##
## Correlation of Fixed Effects:
##           (Intr) diet2  exrty2
## diet2     -0.500
## exertype2 -0.612  0.000
## exertype3 -0.612  0.000  0.500
## optimizer (nloptwrap) convergence code: 0 (OK)
## boundary (singular) fit: see help('isSingular')
```

```
coef(lm_model)
```

```
## (Intercept)       diet2   exertype2   exertype3
##   87.088889    7.488889    4.366667   22.233333
```

```
coef(lmer_model)
```

```
## $id
##    (Intercept)    diet2 exertype2 exertype3
## 1     87.08889 7.488889  4.366667  22.23333
## 2     87.08889 7.488889  4.366667  22.23333
## 3     87.08889 7.488889  4.366667  22.23333
## 4     87.08889 7.488889  4.366667  22.23333
## 5     87.08889 7.488889  4.366667  22.23333
## 6     87.08889 7.488889  4.366667  22.23333
## 7     87.08889 7.488889  4.366667  22.23333
## 8     87.08889 7.488889  4.366667  22.23333
## 9     87.08889 7.488889  4.366667  22.23333
## 10    87.08889 7.488889  4.366667  22.23333
## 11    87.08889 7.488889  4.366667  22.23333
## 12    87.08889 7.488889  4.366667  22.23333
## 13    87.08889 7.488889  4.366667  22.23333
## 14    87.08889 7.488889  4.366667  22.23333
## 15    87.08889 7.488889  4.366667  22.23333
## 16    87.08889 7.488889  4.366667  22.23333
## 17    87.08889 7.488889  4.366667  22.23333
## 18    87.08889 7.488889  4.366667  22.23333
## 19    87.08889 7.488889  4.366667  22.23333
## 20    87.08889 7.488889  4.366667  22.23333
## 21    87.08889 7.488889  4.366667  22.23333
```

```
## 22    87.08889 7.488889  4.366667  22.23333
## 23    87.08889 7.488889  4.366667  22.23333
## 24    87.08889 7.488889  4.366667  22.23333
## 25    87.08889 7.488889  4.366667  22.23333
## 26    87.08889 7.488889  4.366667  22.23333
## 27    87.08889 7.488889  4.366667  22.23333
## 28    87.08889 7.488889  4.366667  22.23333
## 29    87.08889 7.488889  4.366667  22.23333
## 30    87.08889 7.488889  4.366667  22.23333
##
## attr(,"class")
## [1] "coef.mer"
```