Report coursework assignment A - 2021

CS4125 Seminar Research Methodology for Data Science

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Contents

1 Part 1 - Design and set-up of true experiment

1.1 The motivation for the planned research

(Max 250 words)

1.2 The theory underlying the research

(Max 250 words) Preferable based on theories reported in literature

1.3 Research questions

The research question that will be examined in the experiment (or alternatively the hypothesis that will be tested in the experiment)

1.4 The related conceptual model

This model should include: *Independent variable(s)* Dependent variable *Mediating variable (at least 1)* Moderating variable (at least 1)

1.5 Experimental Design

Note that the study should have a true experimental design

1.6 Experimental procedure

Describe how the experiment will be executed step by step

1.7 Measures

Describe the measure that will be used

1.8 Participants

Describe which participants will recruit in the study and how they will be recruited

1.9 Suggested statistical analyses

Describe the statistical test you suggest to care out on the collected data

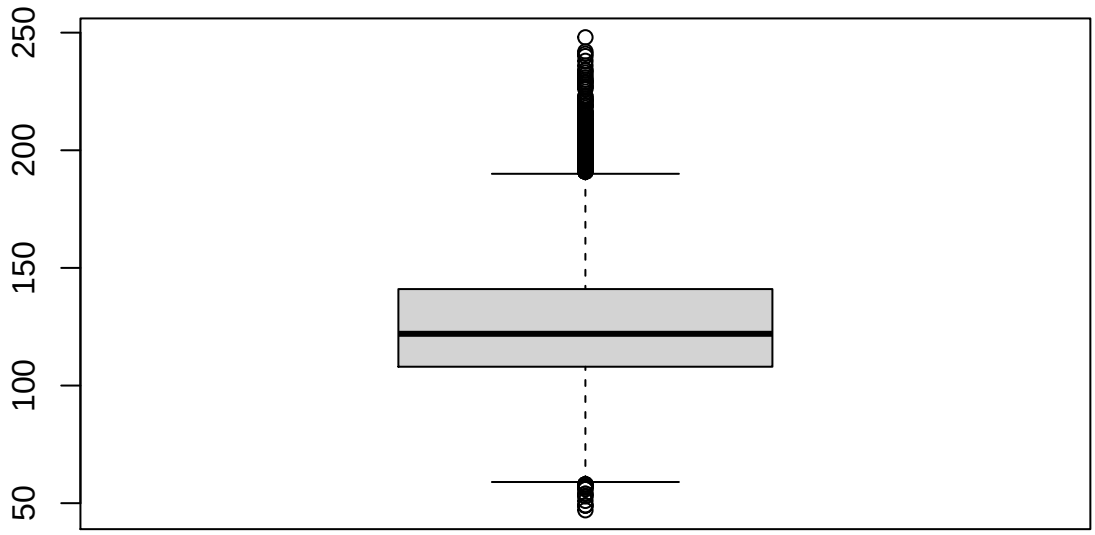
2 Part 3 - Multilevel model

2.1 Visual inspection

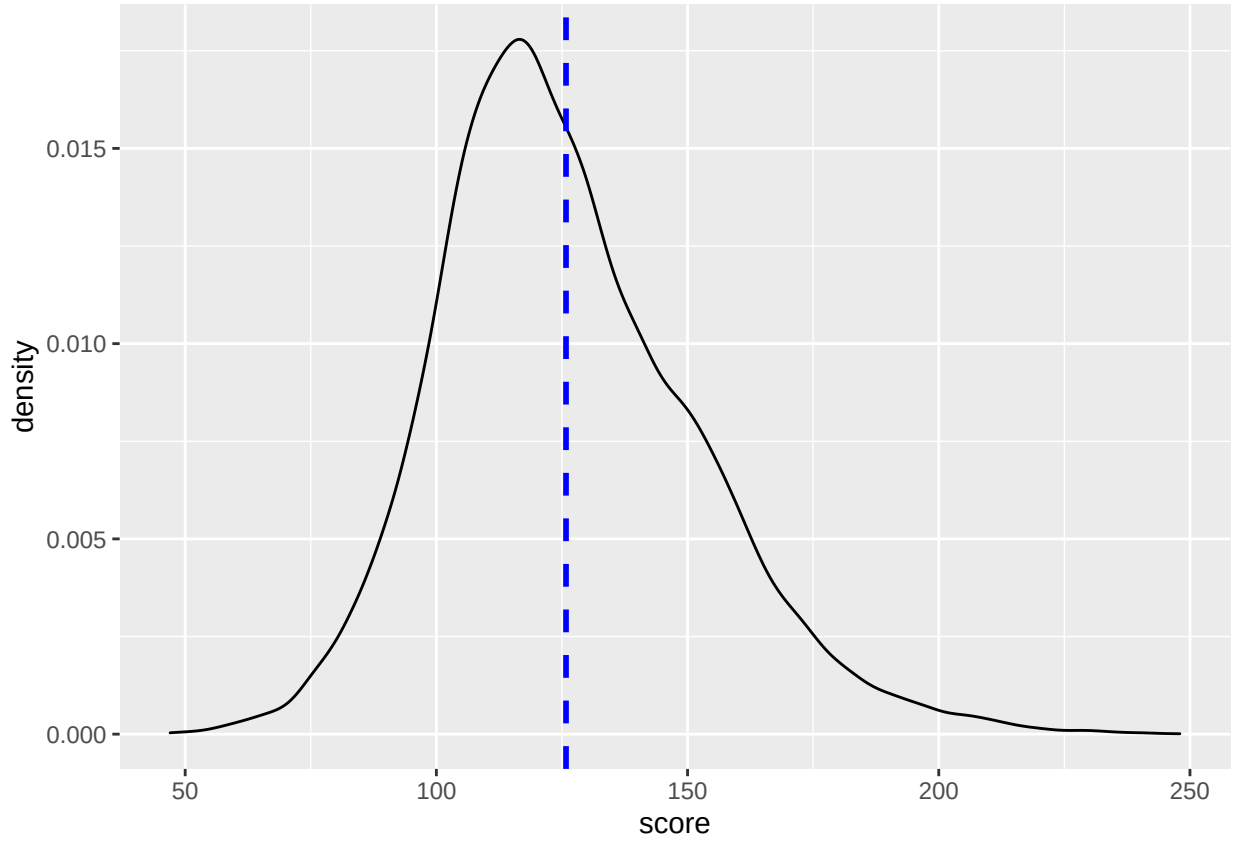
```
library(ggplot2)

# Get data
filepath <- ("set0.csv")
ds <- read.csv(file=filepath, header=TRUE)
ds <- data.frame(ds)

# boxplot score overall distribution (session independent)
boxplot(ds$score)
```

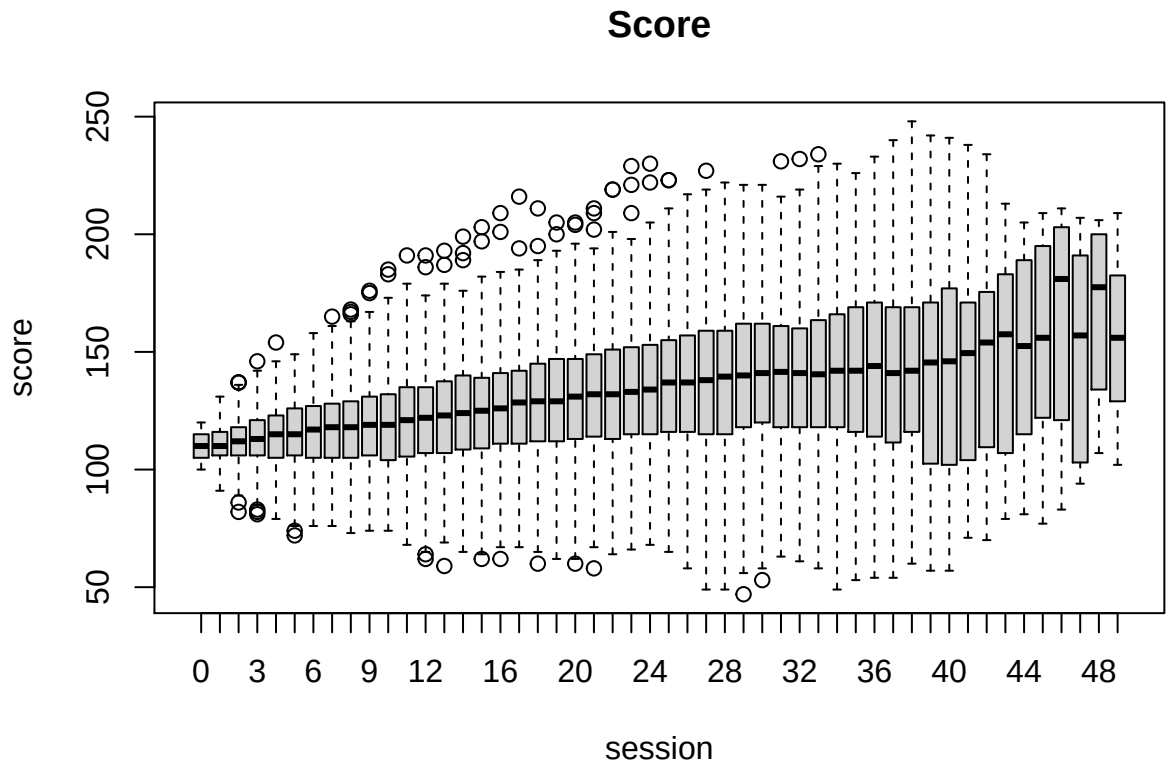



```
# density score overall distribution (with mean line)
p <- ggplot(ds, aes(x=score)) + geom_density()
p + geom_vline(aes(xintercept=mean(score)), color="blue", linetype="dashed",size=1)
```



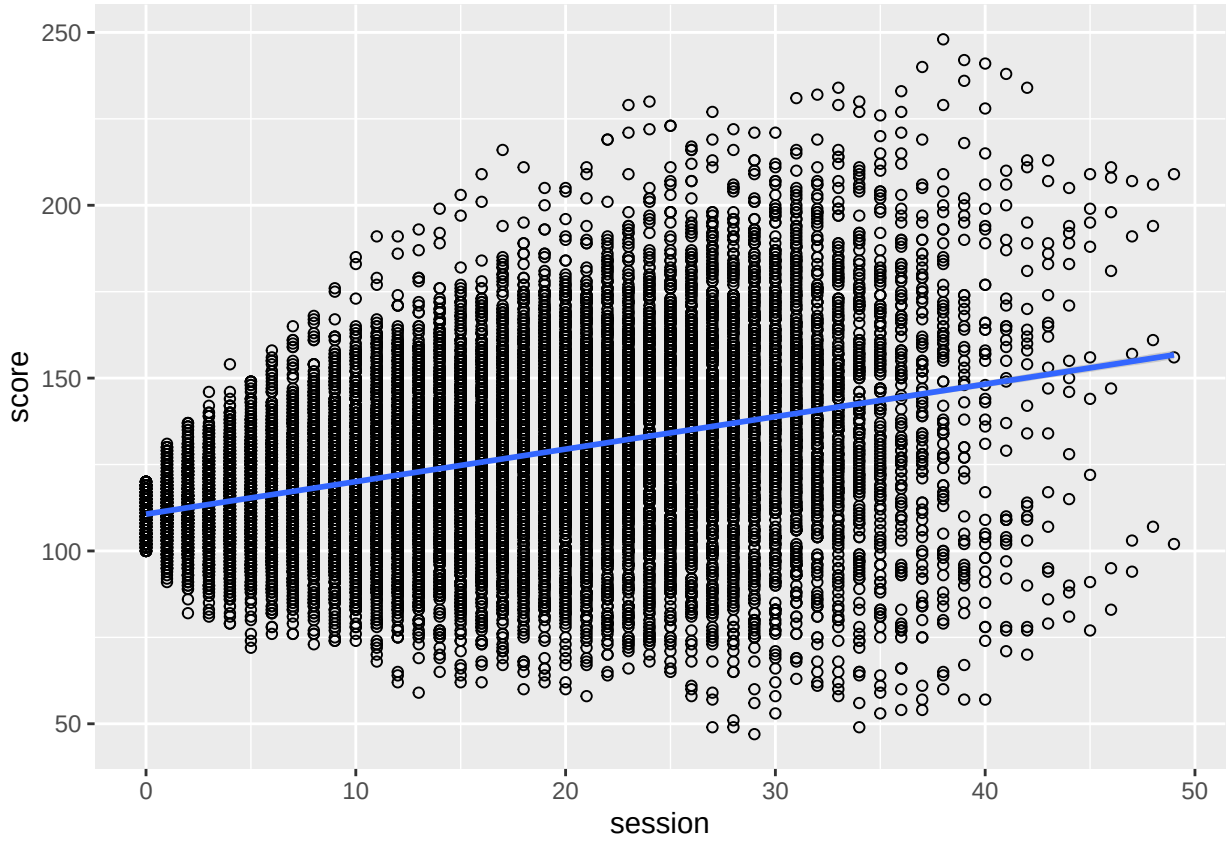

```
# set labels
ds$sessionF <- factor(ds$session, levels=c(0:49), labels=c(0:49))

# boxplot score per session
boxplot(score~sessionF, data=ds, main="Score", xlab="session", ylab="score")
```




```
# ggplot score per session
hp <- ggplot(ds, aes(x=session, y=score)) + geom_point(shape=1) + geom_smooth(method=lm)
hp
```

```
## `geom_smooth()` using formula 'y ~ x'
```



2.2 Frequentist approach

2.2.1 Multilevel analysis

We have conducted a multilevel analysis and calculated the 95% confidence intervals. The results show that the session has impact on the scores: the more sessions, the better the score. It can be observed that this increase in score stagnates around 30 sessions.

There is a significant variance between the participants in their score when the session number increases. (I think?) TODO

```
# Get data
filepath <- "set0.csv"
ds <- read.csv(file=filepath, header=TRUE)
ds <- data.frame(ds)

# set labels
ds$sessionF <- factor(ds$session, levels=c(0:49), labels=c(0:49))

# create models as given in slides lecture 4
model0 <- lm(formula=score~1, data=ds, na.action=na.exclude)
model1 <- lm(formula=score~sessionF, data=ds, na.action=na.exclude)

# analysis, see if predictor improves fitting
anova(model0,model1)
```

```
## Analysis of Variance Table
##
```

```
## Model 1: score ~ 1
## Model 2: score ~ sessionF
##   Res.Df      RSS Df Sum of Sq      F    Pr(>F)
## 1  16127 10713477
## 2  16078  9228641 49   1484836 52.793 < 2.2e-16 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
summary(model1)
```

```
##
## Call:
## lm(formula = score ~ sessionF, data = ds, na.action = na.exclude)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -92.038 -13.872   0.289  14.176 105.304
##
## Coefficients:
##             Estimate Std. Error t value Pr(>|t|)
## (Intercept) 110.2735     1.0704 103.024  < 2e-16 ***
## sessionF1     0.7166     1.5137   0.473 0.635950
## sessionF2     1.9082     1.5137   1.261 0.207478
## sessionF3     2.9601     1.5137   1.955 0.050543 .
## sessionF4     3.8383     1.5137   2.536 0.011233 *
## sessionF5     5.0040     1.5137   3.306 0.000949 ***
## sessionF6     5.9721     1.5137   3.945 8.01e-05 ***
## sessionF7     7.0160     1.5137   4.635 3.60e-06 ***
## sessionF8     7.6367     1.5137   5.045 4.59e-07 ***
## sessionF9     8.5509     1.5137   5.649 1.64e-08 ***
## sessionF10    9.0973     1.5152   6.004 1.97e-09 ***
## sessionF11   10.3578     1.5152   6.836 8.45e-12 ***
## sessionF12   11.2155     1.5152   7.402 1.41e-13 ***
## sessionF13   12.4380     1.5152   8.209 2.41e-16 ***
## sessionF14   13.5983     1.5152   8.974  < 2e-16 ***
## sessionF15   14.4540     1.5152   9.539  < 2e-16 ***
## sessionF16   15.6284     1.5152  10.314  < 2e-16 ***
## sessionF17   16.6944     1.5160  11.012  < 2e-16 ***
## sessionF18   18.0680     1.5183  11.900  < 2e-16 ***
## sessionF19   19.1757     1.5206  12.610  < 2e-16 ***
## sessionF20   19.8039     1.5214  13.017  < 2e-16 ***
## sessionF21   20.8477     1.5246  13.674  < 2e-16 ***
## sessionF22   21.3461     1.5294  13.957  < 2e-16 ***
## sessionF23   22.3946     1.5360  14.580  < 2e-16 ***
## sessionF24   23.3188     1.5419  15.124  < 2e-16 ***
## sessionF25   25.0569     1.5551  16.113  < 2e-16 ***
## sessionF26   26.1071     1.5740  16.586  < 2e-16 ***
## sessionF27   26.5383     1.5966  16.622  < 2e-16 ***
## sessionF28   27.3690     1.6397  16.691  < 2e-16 ***
## sessionF29   28.7646     1.6805  17.117  < 2e-16 ***
## sessionF30   29.5175     1.7295  17.067  < 2e-16 ***
## sessionF31   30.6567     1.8044  16.990  < 2e-16 ***
## sessionF32   30.0179     1.9082  15.731  < 2e-16 ***
## sessionF33   30.1901     2.0335  14.846  < 2e-16 ***
## sessionF34   30.0795     2.2130  13.592  < 2e-16 ***
```

```
## sessionF35   30.8377     2.3877  12.915  < 2e-16 ***
## sessionF36   31.1742     2.5714  12.123  < 2e-16 ***
## sessionF37   29.2265     2.8247  10.347  < 2e-16 ***
## sessionF38   32.4222     3.0764  10.539  < 2e-16 ***
## sessionF39   31.7720     3.7671   8.434  < 2e-16 ***
## sessionF40   32.7792     4.0312   8.131 4.55e-16 ***
## sessionF41   32.0599     4.5032   7.119 1.13e-12 ***
## sessionF42   34.5526     5.1090   6.763 1.40e-11 ***
## sessionF43   37.3377     5.7475   6.496 8.47e-11 ***
## sessionF44   38.7980     6.4919   5.976 2.33e-09 ***
## sessionF45   43.1710     8.0575   5.358 8.54e-08 ***
## sessionF46   50.1551     9.1184   5.500 3.85e-08 ***
## sessionF47   40.1265    10.7677   3.727 0.000195 ***
## sessionF48   56.7265    12.0268   4.717 2.42e-06 ***
## sessionF49   45.3932    13.8736   3.272 0.001070 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 23.96 on 16078 degrees of freedom
## Multiple R-squared:  0.1386, Adjusted R-squared:  0.136
## F-statistic: 52.79 on 49 and 16078 DF,  p-value: < 2.2e-16
```

```
# examine estimators
anova(model1)
```

```
## Analysis of Variance Table
##
## Response: score
##              Df  Sum Sq Mean Sq F value    Pr(>F)
## sessionF     49 1484836   30303  52.793 < 2.2e-16 ***
## Residuals 16078 9228641     574
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

```
# gives CI95%
confint(model1)
```

```
##                    2.5 %     97.5 %
## (Intercept) 108.175408166 112.371498
## sessionF1    -2.250516726   3.683650
## sessionF2    -1.058899959   4.875267
## sessionF3    -0.007003752   5.927163
## sessionF4     0.871239761   6.805407
## sessionF5     2.036908424   7.971076
## sessionF6     3.004972296   8.939139
## sessionF7     4.048884472   9.983052
## sessionF8     4.669642955  10.603810
## sessionF9     5.583814612  11.517982
## sessionF10    6.127233256  12.067344
## sessionF11    7.387754298  13.327865
## sessionF12    8.245469729  14.185580
## sessionF13    9.467914618  15.408025
## sessionF14   10.628235260  16.568346
## sessionF15   11.483946682  17.424057
## sessionF16   12.658295380  18.598406
## sessionF17   13.722869661  19.665967
```

```
## sessionF18   15.091899875  21.044022
## sessionF19   16.195112212  22.156356
## sessionF20   16.821787305  22.786093
## sessionF21   17.859365283  23.836028
## sessionF22   18.348321730  24.343857
## sessionF23   19.383949293  25.405297
## sessionF24   20.296539040  26.341104
## sessionF25   22.008713118  28.105135
## sessionF26   23.021851788  29.192263
## sessionF27   23.408790988  29.667775
## sessionF28   24.154986252  30.583054
## sessionF29   25.470619859  32.058497
## sessionF30   26.127442948  32.907644
## sessionF31   27.119815970  34.193572
## sessionF32   26.277524407  33.758178
## sessionF33   26.204148297  34.176029
## sessionF34   25.741803760  34.417172
## sessionF35   26.157470199  35.517846
## sessionF36   26.133865257  36.214467
## sessionF37   23.689820367  34.763273
## sessionF38   26.392055312  38.452343
## sessionF39   24.388086311  39.155917
## sessionF40   24.877536137  40.680821
## sessionF41   23.233118228  40.886642
## sessionF42   24.538428125  44.566840
## sessionF43   26.071853518  48.603463
## sessionF44   26.073075399  51.522876
## sessionF45   27.377482890  58.964500
## sessionF46   32.282111551  68.028125
## sessionF47   19.020590328  61.232503
## sessionF48   33.152698987  80.300395
## sessionF49   18.199443267  72.586984
```

2.2.2 Report section for a scientific publication

A Linear Model analysis was conducted to test the difference between sessions on the score. The results found a significant effect ($F(49,16078) = 52.793$, $p < .001$) for the sessions on the score. TODO

2.3 Bayesian approach

2.3.1 Model description

2.3.2 Model comparison

2.3.3 Estimates examination