

Analysis of MicroSurgeryPerformance Data

Suchismitha Lavanya.S.S Yashwanth

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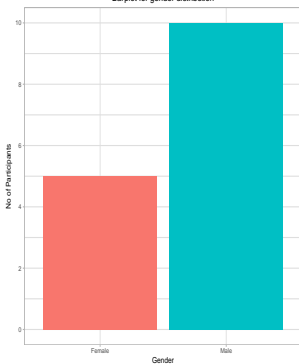
Outline

- 1 Motivation
- 2 Data Cleaning and Reorganization
- 3 Initial Analysis
- 4 Quality Control
- 5 Linear Model
- 6 Hypothesis Testing
- 7 Summary

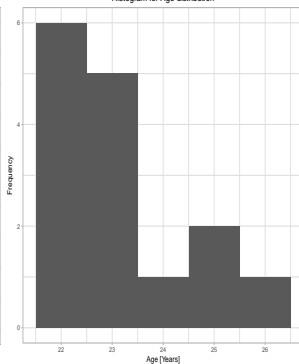
Quality Control

- Number of female subject is half as number of male subjects
- More number of subjects are in the age group 22 and 23
- Most of the subjects had TAI scores in the range 25-55

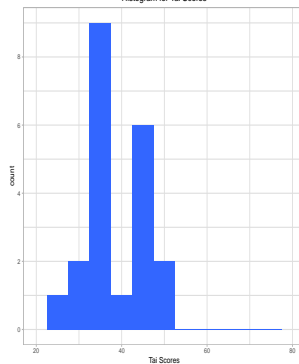
Barplot for gender distribution



Histogram for Age distribution

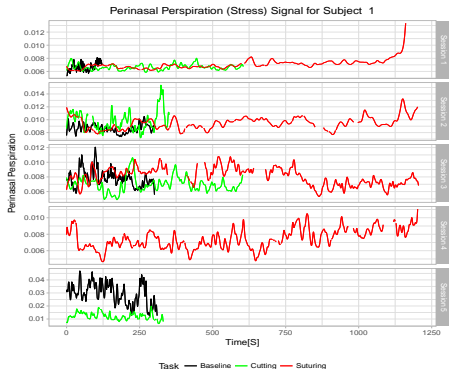
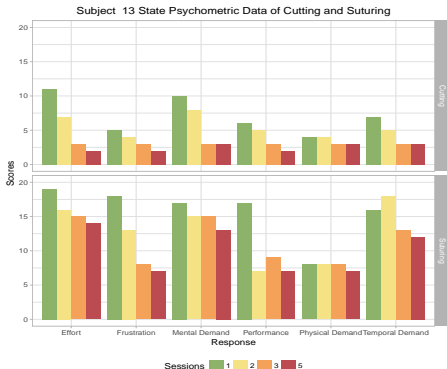


Histogram for Tai Scores



Quality Control

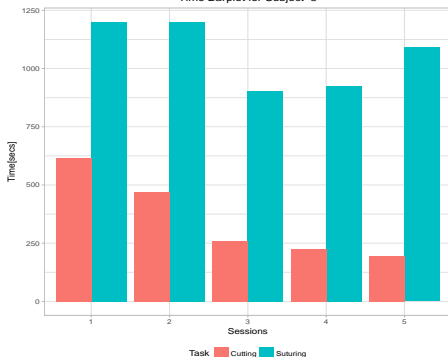
- The effort , frustration , mental demand , performance and physical demand , temporal demand are all maintaining a downward trend
- Stress is high for Suturing task



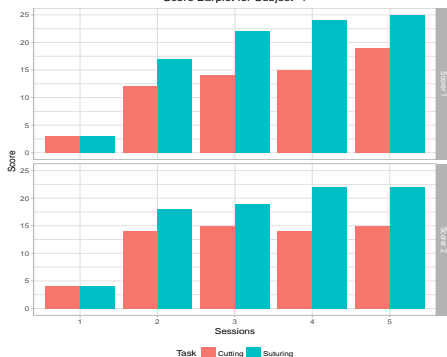
Quality Control

- Time taken by subject to perform cutting is decreasing session by session and Downward trend for Cutting task
- The scores obtained for cutting and suturing is increasing for each session

Time Barplot for Subject 3



Score Barplot for Subject 4



Linear Model

Score with all Other attributes

Null Hypothesis : H_0 = The score obtained does not depend on the demographics of the subject , session , age , year , sex and perspiration.
Alternate Hypothesis : H_1 = The score obtained depends on the demographics of the subject , session , age , year , sex and perspiration.

```
Call:
lm(formula = Scores ~ log(Normalised_PP) + Age + Sex + Task +
    Scorer + Session, data = data)

Residuals:
    Min       1Q   Median       3Q      Max
-9.0904 -2.0812  0.1778  2.4703  8.4800

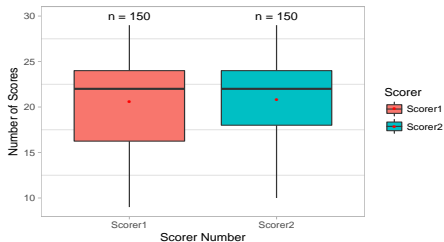
Coefficients:
              Estimate Std. Error t value      Pr(>|t|)
(Intercept)   0.43830    5.71336   0.077    0.93891
log(Normalised_PP) -1.13961    0.74582  -1.528    0.12772
Age            0.49486    0.17195   2.878    0.00433 **
SexMale       -2.17630    0.47007  -4.630    0.00000576827 ***
TaskSuturing  -0.97517    0.42795  -2.279    0.02349 *
ScorerScorer2  0.02941    0.42648   0.069    0.94507
SessionSession2 4.26300    0.69164   6.164    0.00000000267 ***
SessionSession3 6.38075    0.69130   9.230 < 0.0000000000000002 ***
SessionSession4 7.68358    0.70093  10.962 < 0.0000000000000002 ***
SessionSession5 8.17553    0.71138  11.492 < 0.0000000000000002 ***

Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
---
Residual standard error: 3.517 on 262 degrees of freedom
(28 observations deleted due to missingness)
Multiple R-squared:  0.4606,    Adjusted R-squared:  0.442
F-statistic: 24.86 on 9 and 262 DF,  p-value: < 0.00000000000000022
```

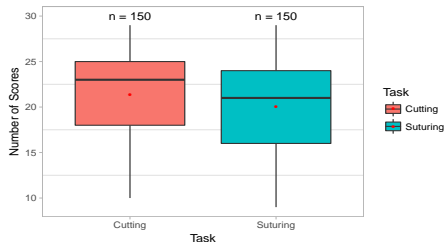
Linear Model

Score with all Other attributes

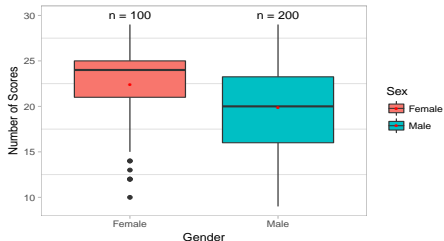
Analysis of Scores based on Scorer



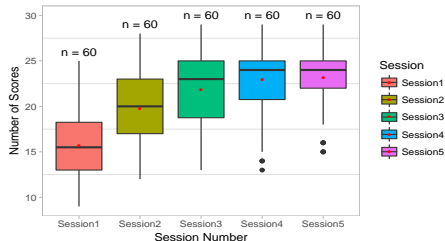
Analysis of Scores based on Task



Analysis of Scores based on Gender



Analysis of Scores based on Scorer



Linear Model

Time with all Other attributes

Null Hypothesis : H_0 = The time taken to do a task is not dependent of age, session, sex, Perspiration.

Alternate Hypothesis : H_1 = The time taken to do a task depends on age, session, sex, Perspiration.

```
Call:
lm(formula = Time ~ log(Normalised_PP) + Age + Sex + Task + Session,
    data = data)

Residuals:
    Min       1Q   Median       3Q      Max
-340.68  -66.10    4.40    78.19   302.39

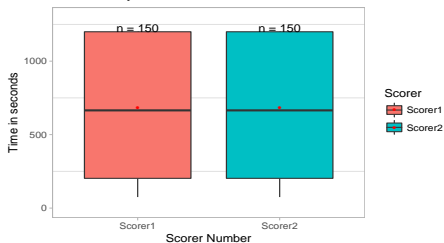
Coefficients:
              Estimate Std. Error t value      Pr(>|t|)
(Intercept)    90.273    189.620   0.476      0.634
log(Normalised_PP) -15.595     24.770  -0.630      0.530
Age              7.915      5.711   1.386      0.167
SexMale         18.922     15.612   1.212      0.227
TaskSuturing     872.331     14.213  61.375 < 0.0000000000000002 ***
SessionSession2 -105.645     22.971  -4.599  0.0000065992793776 ***
SessionSession3 -113.626     22.959  -4.949  0.0000013335710345 ***
SessionSession4 -185.969     23.279  -7.989  0.0000000000000429 ***
SessionSession5 -170.059     23.626  -7.198  0.0000000000064042 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 116.8 on 263 degrees of freedom
(28 observations deleted due to missingness)
Multiple R-squared:  0.9365,    Adjusted R-squared:  0.9345
F-statistic: 484.7 on 8 and 263 DF,  p-value: < 0.00000000000000022
```

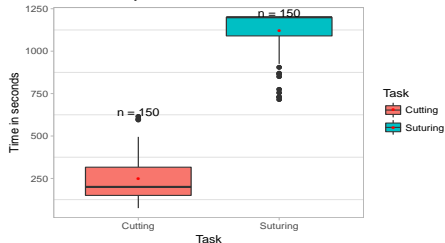

Linear Model

Time with all Other attributes

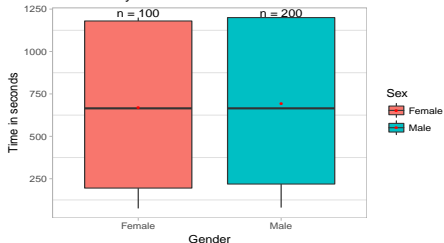
Analysis of Time based on Scorer



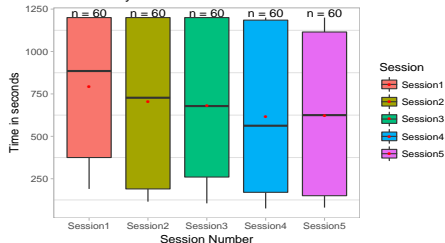
Analysis of Time based on Task



Analysis of Time based on Gender



Analysis of Time based on Session

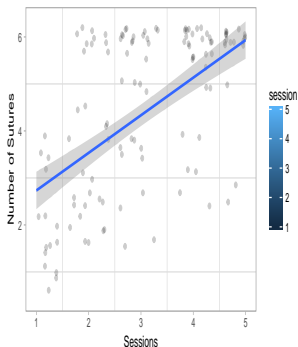


Linear Model

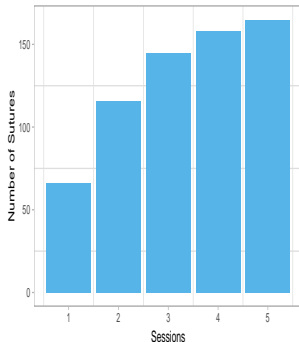
Performance Analysis of Suturing Task

- The number of sutures increases with each session.
- The number of sutures increase with decrease in time across session.

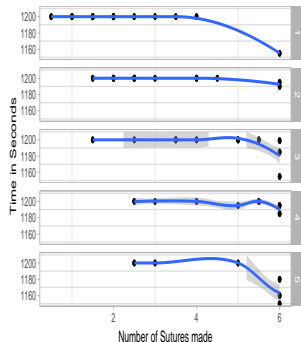
Performance WRT number of sutures made



Performance WRT Sutures of all subjects



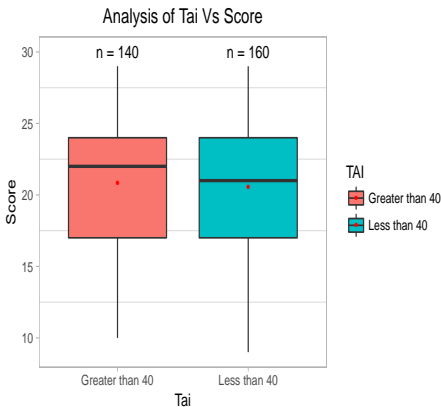
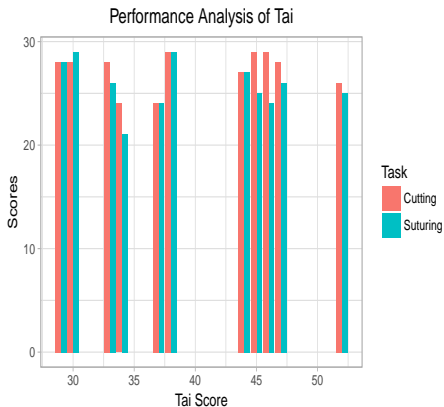
Performance Analysis of Suturing



Hypothesis Testing

Analysis of Tai on Scores

- There is no effect of anxiety on the scores of individuals



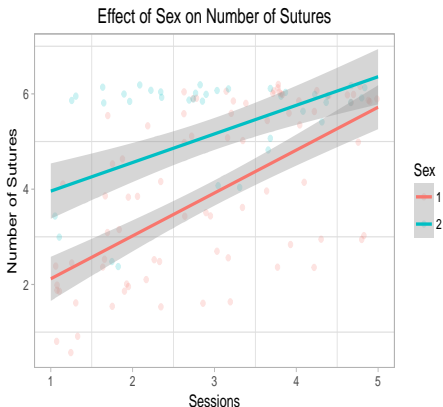
Summary

- Majority of the plots in state psychometric data followed Downward trend specifying the subjects were getting familiar and comfortable with the task session by session
- The stress signal states that there was a downward trend from the beginning of session then there is a increase at the end of session inferring that subjects were anxious to finish the task while nearing the end time
- Performance data reveals that time taken by each subject decreased as the subjects learnt the procedure session by session
- Performance data reveals that score scored by each subject increased and performance improved as the subjects learnt the procedure session by session
- Hypothesis testing with score infers that score was dependent on variables like gender , task , session and scorer
- Hypothesis testing with time infers that task time was dependent on variables like gender , task , session and scorer

For Further Analysis

Hypothesis Testing: Analysis of Number of Sutures WRT Sex and Session

- Sex has an effect on Number of Sutures Made and females made more sutures
- Performance gets better with Session



For Further Analysis

Random Effects of Linear Model WRT Score

- There is a significant difference in score increment due to peri nasal perspiration [0.8029] and age[0.5996] other variables does not have much effect on the final scores. Variance between different attributes[2.80091] is more than residual variance [2.7923]

```
> result=lme(as.numeric(as.character(Score)))~as.numeric(as.character(perspiration))+Age+sex+Task+session,random = ~1 | Subject,data = newdata)
> summary(result)
Linear mixed-effects model fit by REML
Data: newdata
      AIC      BIC    logLik
694.4907 717.431  -339.2433

Random effects:
Formula: ~1 | Subject
      (Intercept) Residual
stdDev:    2.80091  2.79239

Fixed effects: as.numeric(as.character(Score)) ~ as.numeric(as.character(perspiration)) + Age + sex + Task + session
              Value Std.Error DF   t-value p-value
(Intercept)  4.54370   14.11204  118   0.321973  0.7480
as.numeric(as.character(perspiration)) 32.92182  131.63338  118   0.250102  0.8029
Age          0.33819   0.62725  12   0.539165  0.5996
sex          2.64402   1.67522  12   1.578316  0.1405
TaskSuturing -1.55775   0.48198  118  -3.231959  0.0016
session      1.81826   0.18501  118   9.827868  0.0000

Correlation:
              (Intr) a. (. ) Age    sex    TskStr
as.numeric(as.character(perspiration)) -0.012
Age                                     -0.985 -0.041
sex                                     0.112 -0.033 -0.261
TaskSuturing -0.016 -0.113  0.005  0.004
session       -0.032 -0.311  0.015 -0.005  0.035

Standardized Within-Group Residuals:
      Min       Q1       Med       Q3       Max
-3.5315979 -0.6243848  0.1294255  0.6873352  1.7306847

Number of Observations: 136
Number of Groups: 15
> summary(anova(result))
      numDF denDF      F-value      p-value
Min.: 1 Min.: 12.00 Min.: 0.7439 Min.: 0.000000
1st Qu.: 1 1st Qu.: 38.50 1st Qu.: 4.6276 1st Qu.: 0.000125
Median: 1 Median: 118.00 Median: 11.5970 Median: 0.001074
Mean: 1 Mean: 82.67 Mean: 144.8192 Mean: 0.088843
```

For Further Analysis

Correlation Matrix Visualization of Plots of Data based on Task

