Collaborative 3DUI Data Analysis

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Data analiyisis

This is a on going analysis of the data collected in the user experiment performed. . . .

Summary

First we set the environment, load and show the raw data.

```
setwd("/home/jeronimo/Documents/DataAnalysis3DController/Analysis/R")
dAvgPerTask <- read.csv("SummaryToR.csv")
dAvgPerTask
```

```
##    Members       T1       T2       T3        T4       E1        E2
## 1        1 44.60100 27.73000  44.5060  56.69900 4.280380 16.953010
## 2        1 86.26980 26.60070 129.5357  88.65650 3.869670  6.642847
## 3        1 37.22350 32.50000 130.7602  63.44300 1.317529  9.220284
## 4        1 71.42880 55.88850 281.5956 225.20610 4.024921  8.576299
## 5        1 32.65650 41.49640 105.6555 139.63410 4.456124  9.002918
## 6        2 19.92100 23.75830  86.0130  90.59442 1.923633 11.753480
## 7        2 13.64980 15.95330  87.2619 113.11968 3.004579  4.069859
## 8        2 16.45030 14.49990  69.3649  58.41970 2.192855  5.547572
## 9        2 17.20950 29.62760 139.3775 111.04040 2.576868  8.645294
## 10       2 59.33450 16.48410 109.5334  83.16500 4.601643  8.891509
## 11       2 35.49839 34.55538  99.4809  93.11320 1.390942  4.142436
## 12       3 58.66863 16.39880 127.2309  82.56380 0.867342  3.243309
## 13       3 29.00930 49.16030 120.6714  91.11170 2.359320  4.060901
## 14       3 36.21300 22.41350  76.8215  55.29020 2.259253  3.317118
## 15       3 21.44110 17.18680  86.8132  61.24430 1.300738  3.357939
## 16       3 20.20286 25.70100 283.4138 192.72400 2.329338  4.309965
## 17       3 24.40880 42.26010  41.2966  38.11630 2.187007  8.903512
## 18       4 47.19800 21.40800 162.9620  87.06737 1.554914  3.538198
## 19       4 22.00295 16.25100  74.4534  71.80547 1.402203  4.501410
## 20       4 21.09751 16.95763  56.4048  63.90760 3.145458  6.065219
## 21       4 54.20073 37.12230 127.1752  60.76750 1.623129  2.768127
##          E3       E4
## 1  9.070060 8.529819
## 2  7.381541 5.705525
## 3  6.207668 5.088869
## 4  3.341505 3.299659
## 5  6.817599 8.455383
## 6  3.251326 3.595758
## 7  4.849439 4.512303
## 8  6.037892 4.339551
## 9  4.726371 3.707839
## 10 4.380987 5.540681
## 11 4.699787 4.160006
## 12 2.972291 3.701374
## 13 3.978512 3.053629
## 14 4.150805 4.628316
## 15 3.179116 4.247869
## 16 2.652203 2.953497
## 17 4.778647 4.583976
## 18 2.389965 2.110792
## 19 3.337539 2.288988
## 20 3.023767 3.257560
## 21 1.776181 1.903549
```

The data is arranged by Task vs. Team members. Collumns are organized as follows:

- Members: Number of users in the team;
- T1, T2, T3, T4: Time to complete task 1 to 4;
- E1, E2, E3, E4: Errors in task 1 to 4.

We split the data for better manipulation:

```
dAvgTime <- subset(dAvgPerTask, select = c(2,3,4,5))
dAvgError <- subset(dAvgPerTask, select = c(6,7,8,9))
```

Below the data is summarized:

```
describe(dAvgTime)
```

```
##    vars  n   mean    sd median trimmed   mad   min    max  range skew
## T1    1 21  36.60 19.92  32.66   34.17 18.46 13.65  86.27  72.62 0.87
## T2    2 21  27.81 11.90  25.70   26.38 13.13 14.50  55.89  41.39 0.77
## T3    3 21 116.21 63.86 105.66  105.27 37.22 41.30 283.41 242.12 1.46
## T4    4 21  91.79 45.68  83.17   83.31 32.50 38.12 225.21 187.09 1.57
##    kurtosis    se
## T1    -0.25  4.35
## T2    -0.50  2.60
## T3     1.64 13.93
## T4     1.84  9.97
```

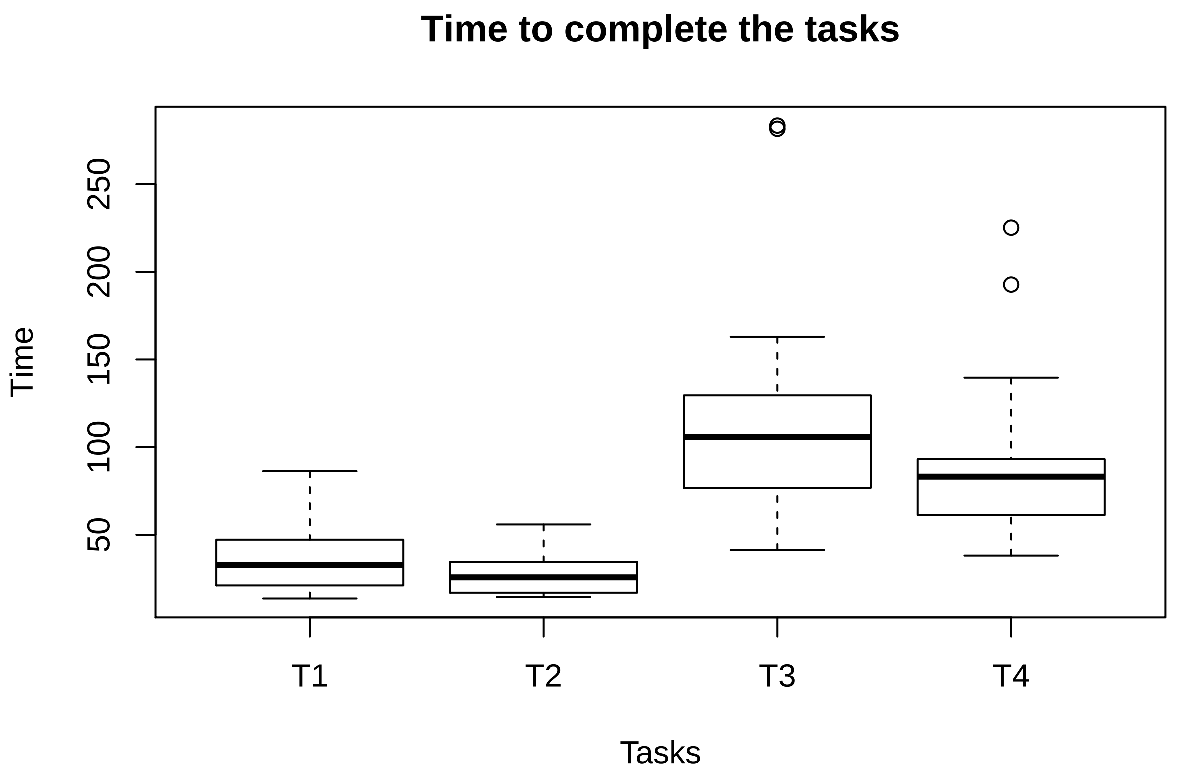
```
describe(dAvgError)
```

```
##    vars  n mean   sd median trimmed  mad  min   max range skew kurtosis
## E1    1 21 2.51 1.15   2.26    2.44 1.27 0.87  4.60  3.73 0.50    -1.15
## E2    2 21 6.55 3.55   5.55    6.05 3.31 2.77 16.95 14.18 1.17     1.04
## E3    3 21 4.43 1.82   4.15    4.26 1.44 1.78  9.07  7.29 0.83    -0.04
## E4    4 21 4.27 1.74   4.16    4.04 1.34 1.90  8.53  6.63 1.07     0.71
##      se
## E1 0.25
## E2 0.77
## E3 0.40
## E4 0.38
```

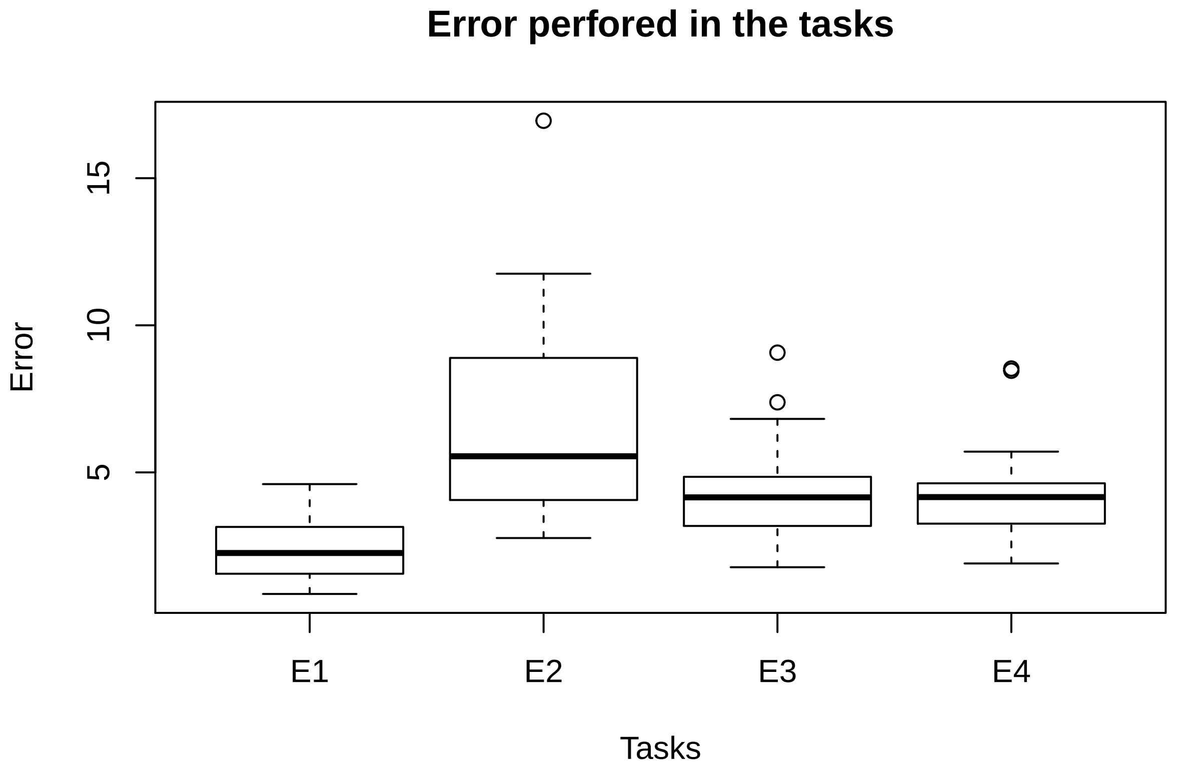
Plots

Time of task completion vs. Task for all combinations of teams: The code used to generate the charts is:

```
boxplot(dAvgTime,xlab="Tasks",ylab="Time",main="Time to complete the tasks")
```



```
boxplot(dAvgError,xlab="Tasks",ylab="Error",main="Error perfored in the tasks")
```



Analysis of time of completion per task

Shapiro

First, we perform the Shapiro normality test. This test determine if the data is normally distributed. It is important to determine if the data is normally distributed to conduce posterior tests.

```
shap_dT <- lapply(dAvgTime, shapiro.test)
shap_dE <- lapply(dAvgError, shapiro.test)
res_shap_dT <- sapply(shap_dT, `[`, c("statistic","p.value"))
res_shap_dE <- sapply(shap_dE, `[`, c("statistic","p.value"))

res_shap_dT
```

```
##           T1         T2        T3          T4
## statistic 0.8974621  0.9017898 0.812624    0.8037059
## p.value   0.03125427 0.0379083 0.001029792 0.0007478811
```

```
res_shap_dE
```

```
##           E1         E2          E3        E4
## statistic 0.9139373  0.8525865   0.9313148 0.8860365
## p.value   0.06570504 0.004708184 0.1462635 0.0189353
```

As we can see, the $p - value$ of most Shapiro tests reveled that the data are not normally distributed. Since in this test the comparisons are made with the same subjects and we are varying the tasks, the next step is to perform a Friedman analysis.

Friedman

Friedman test is a non-parametric randomized block analysis of variance. Which is to say it is a non-parametric version of a one way ANOVA with repeated measures. That means that while a simple ANOVA test requires the assumptions of a normal distribution and equal variances (of the residuals), the Friedman test is free from those restriction. The price of this parametric freedom is the loss of power (of Friedman's test compared to the parametric ANOVa versions).

The hypotheses for the comparison across repeated measures are:

- H0: The distributions (whatever they are) are the same across repeated measures

- H1: The distributions across repeated measures are different

The test statistic for the Friedman's test is a Chi-square with [(number of repeated measures)-1] degrees of freedom. A detailed explanation of the method for computing the Friedman test is available on Wikipedia.