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This is the analysis report of the given project. First I load the data in R and did analysis in three steps :

*Data Quality - Check for redundancy, NA's, duplicates, any other issues related to raw data and tried to remove them.
*Data Manipulation - Subset and sliced the data in different dimensions for analysis.
*Data Analysis - Finding patterns in data and answered the given problems.

The data in given csv file contains 14143 rows and 16 columns. The data is collected from 13 users and has following features/columns :

```
##  [1] "clientTimeStamp"     "serverTimeStamp"     "clientVersion"
##  [4] "totalTimePlayed"     "userId"              "deviceId"
##  [7] "activityId"          "sessionId"           "attempt"
## [10] "sessionOrder"        "action"              "data"
## [13] "X.detail."           "X.value."
"X.detail..x..value."
## [16] "X.ex."
```

Then I check for total NA's in the raw data and further found columns having NA's from summary of data.

```
## Total NA's :  56
```

```
##  clientTimeStamp    totalTimePlayed     userId        attempt
##  Length:14143       Min.   :    0   Min.   : 262   Min.   :-1.00
##  Class :character   1st Qu.: 1029   1st Qu.:6707   1st Qu.: 1.00
##  Mode  :character   Median : 3911   Median :6709   Median : 2.00
##                     Mean   : 7050   Mean   :6674   Mean   : 2.73
##                     3rd Qu.:11353   3rd Qu.:6712   3rd Qu.: 4.00
##                     Max.   :67196   Max.   :6721   Max.   :45.00
##                                     NA's   :11     NA's   :45
```

It is clear that the data has 11 NA's in “userId” and 45 NA's in “attempt” columns. “attempt” column also has some negative values. Last four columns looks optional as they have fewer entries and the purpose of putting them in data is also not clear from labels. First I fix the problem of NA's in “userId”. As it is clearly visible from

```
##   totalTimePlayed userId
deviceId
## 1               0   6706 6706_0E08FB43-A854-44BF-B9BD-
A5A12B00D383
## 2               0   6706 6706_0E08FB43-A854-44BF-B9BD-
A5A12B00D383
```

“userId” is first part of the “deviceId” so I replaced them with correct userId after parsing and splitting “deviceId”.

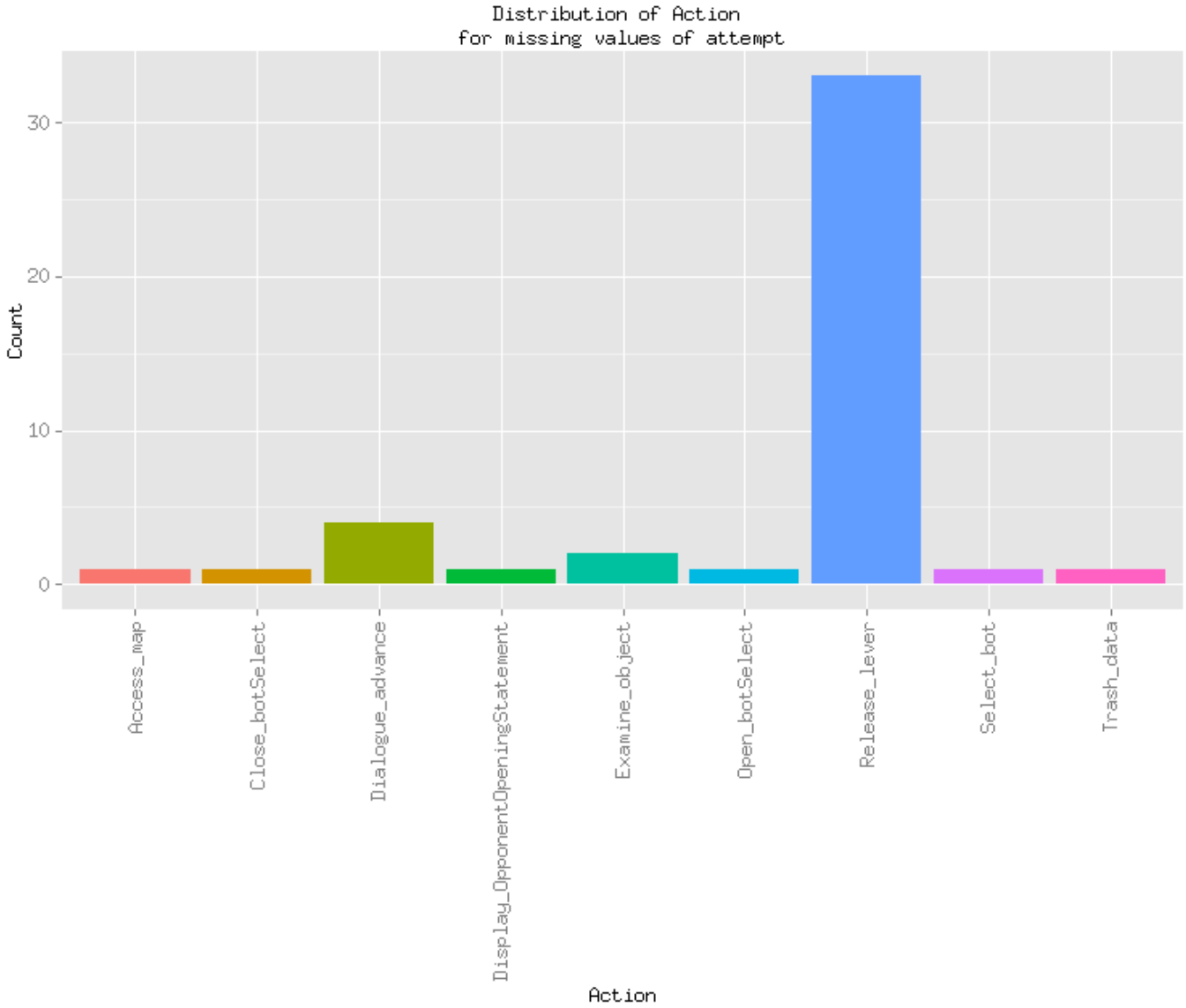
```
# finding index of NA's of userId and replacing them with correct
values.
nas_in_userId <- which(is.na(new_data$userId))
for (i in nas_in_userId) {
    new_data[i, 5] <- (strsplit(new_data[i, 6], "_")[1])
}
```

The data also has duplicate values.

```
## Number of duplicate rows :  1
```

I found that rows 2954 and 2955 are identical. I used unique command to remove duplicate rows.

For NA's and negative values in attempt column. First I analyzed data for missing or NA values of attempt.

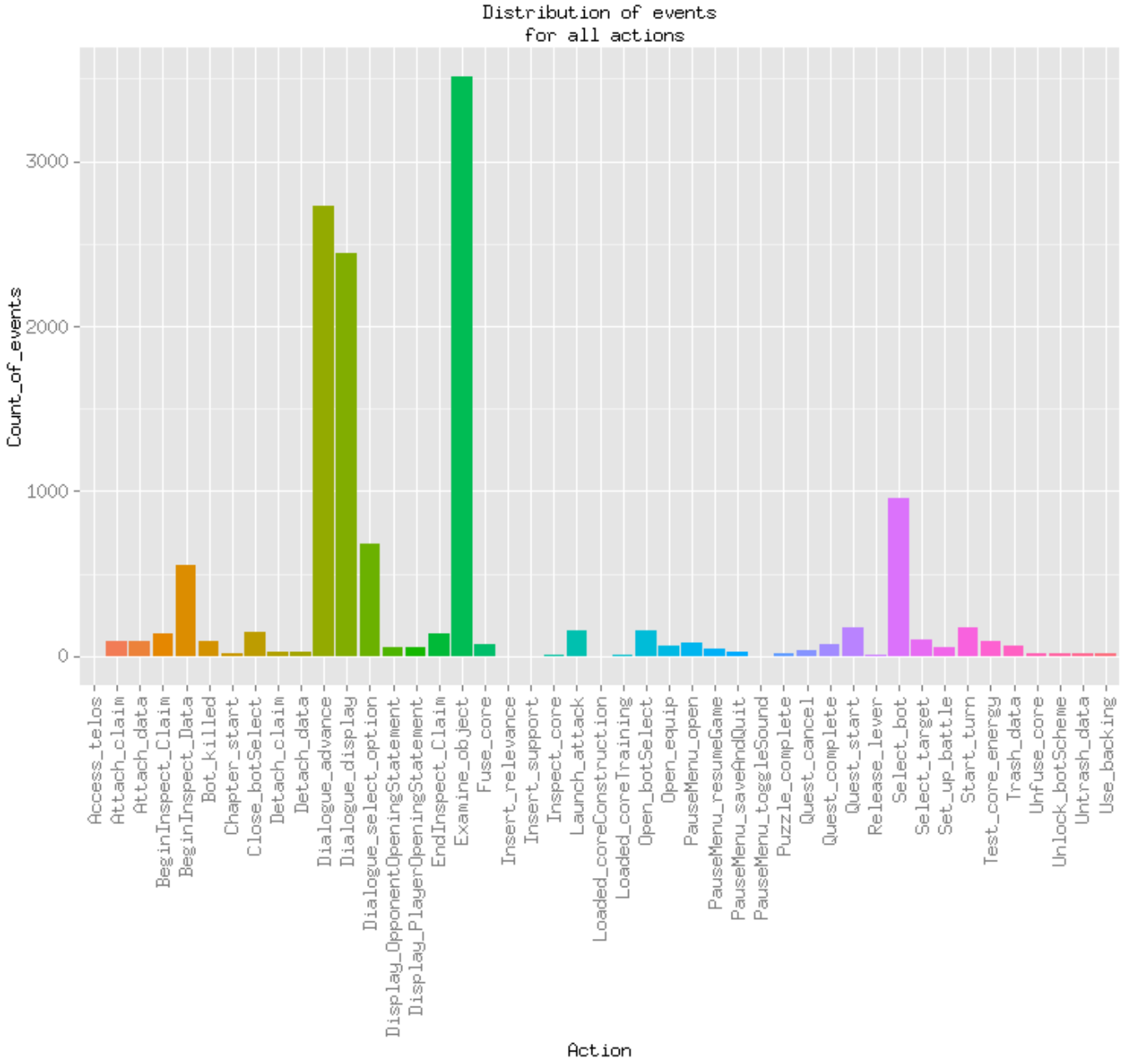


It is clear from the above graph that most missing values for attempt are in action category- “Release_lever” and their values in “data” column are also missing. I stored data for negative attempts in sepearate dataframe for further analysis.

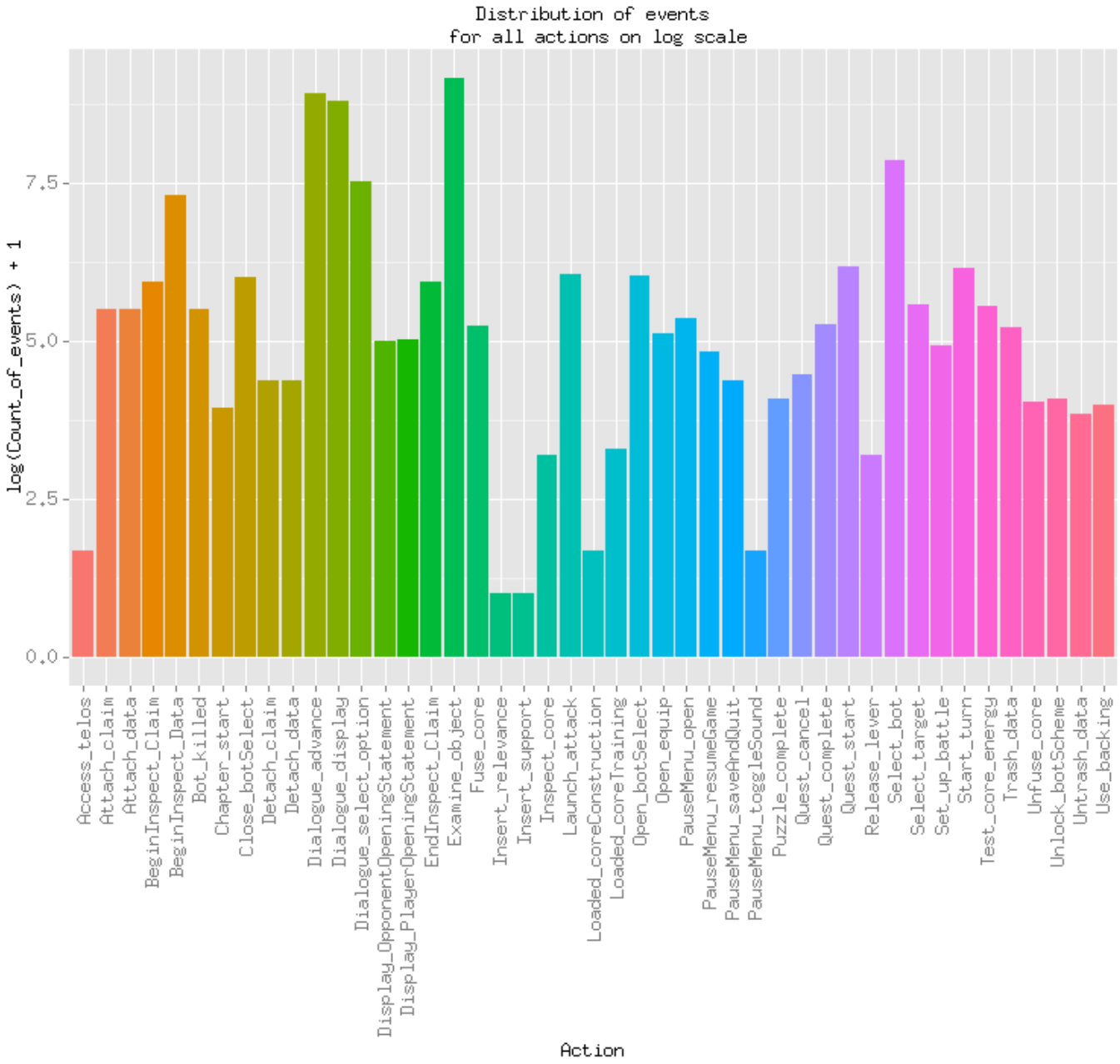
Problem 1: Using one or more statistical tool, preferably coded in some language like R. Extract the number of times students have performed an action (eg: ‘fused core’).

Analysis: The list of actions is

```
##                              Action Count_of_events
## 1                      Access_telos               2
## 2                      Attach_claim              91
## 3                       Attach_data              90
## 4                 BeginInspect_Claim             138
## 5                  BeginInspect_Data             554
## 6                         Bot_killed              91
## 7                     Chapter_start              19
## 8                   Close_botSelect             149
## 9                      Detach_claim              29
## 10                      Detach_data              29
## 11                 Dialogue_advance            2732
## 12                 Dialogue_display            2443
## 13            Dialogue_select_option             678
## 14 Display_OpponentOpeningStatement              55
## 15   Display_PlayerOpeningStatement              56
## 16                 EndInspect_Claim             139
## 17                   Examine_object            3515
## 18                        Fuse_core              70
## 19                 Insert_relevance               1
## 20                   Insert_support               1
## 21                     Inspect_core               9
## 22                    Launch_attack             158
## 23          Loaded_coreConstruction               2
## 24              Loaded_coreTraining              10
## 25                   Open_botSelect             153
## 26                       Open_equip              61
## 27                   PauseMenu_open              79
## 28             PauseMenu_resumeGame              46
## 29            PauseMenu_saveAndQuit              29
## 30            PauseMenu_toggleSound               2
## 31                  Puzzle_complete              22
## 32                     Quest_cancel              32
## 33                   Quest_complete              71
## 34                      Quest_start             178
## 35                    Release_lever               9
## 36                       Select_bot             957
## 37                    Select_target              97
## 38                    Set_up_battle              51
## 39                       Start_turn             173
## 40                 Test_core_energy              95
## 41                       Trash_data              67
## 42                     Unfuse_core              21
## 43                 Unlock_botScheme              22
## 44                     Untrash_data              17
## 45                      Use_backing              20
```



As some actions were not visible in above graph, though they represent actual numbers. There is lot of variation in attempt column as the minimum value is 1 and maximum reaches to 45. I made the bar graph again using log



Code for extracting number of times students have performed an action i.e. “Fuse core”

```
count <- pb1_table[(pb1_table$Action == "Fuse_core"), 2]
cat("Number of attempts for Fused core :", count)
```

```
## Number of attempts for Fused core : 70
```

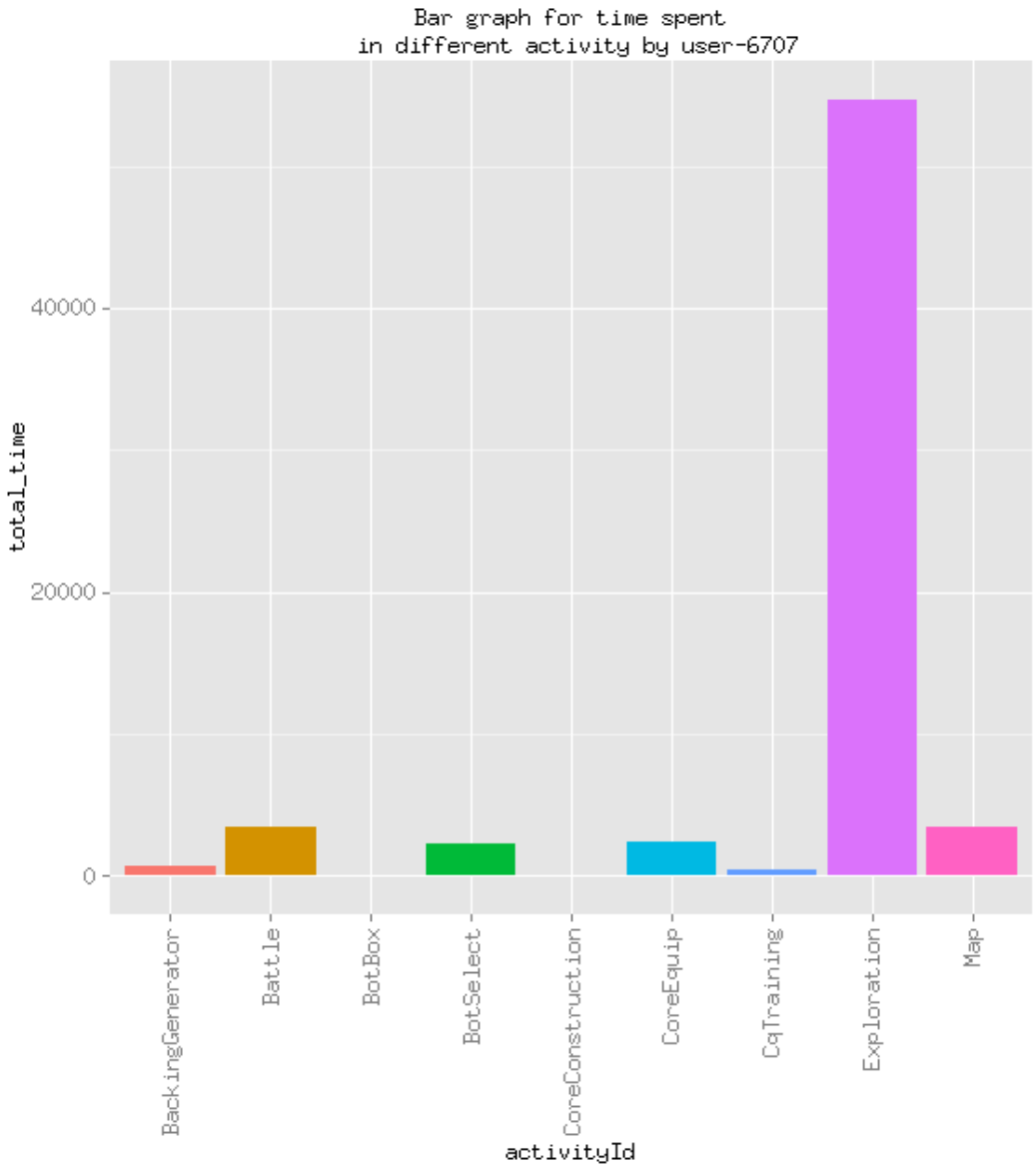
Problem 2 & 3. Determine some patterns on session open & close. Provide the algorithm to do so and any/all code used to demonstration marking open/close of session.

Analysis:

For the analysis of session I analysed the data in virtual and real time. The virtual time analysis is based on “clienttimestamp” and real time time analysis is based on “totaltimeplayed”.

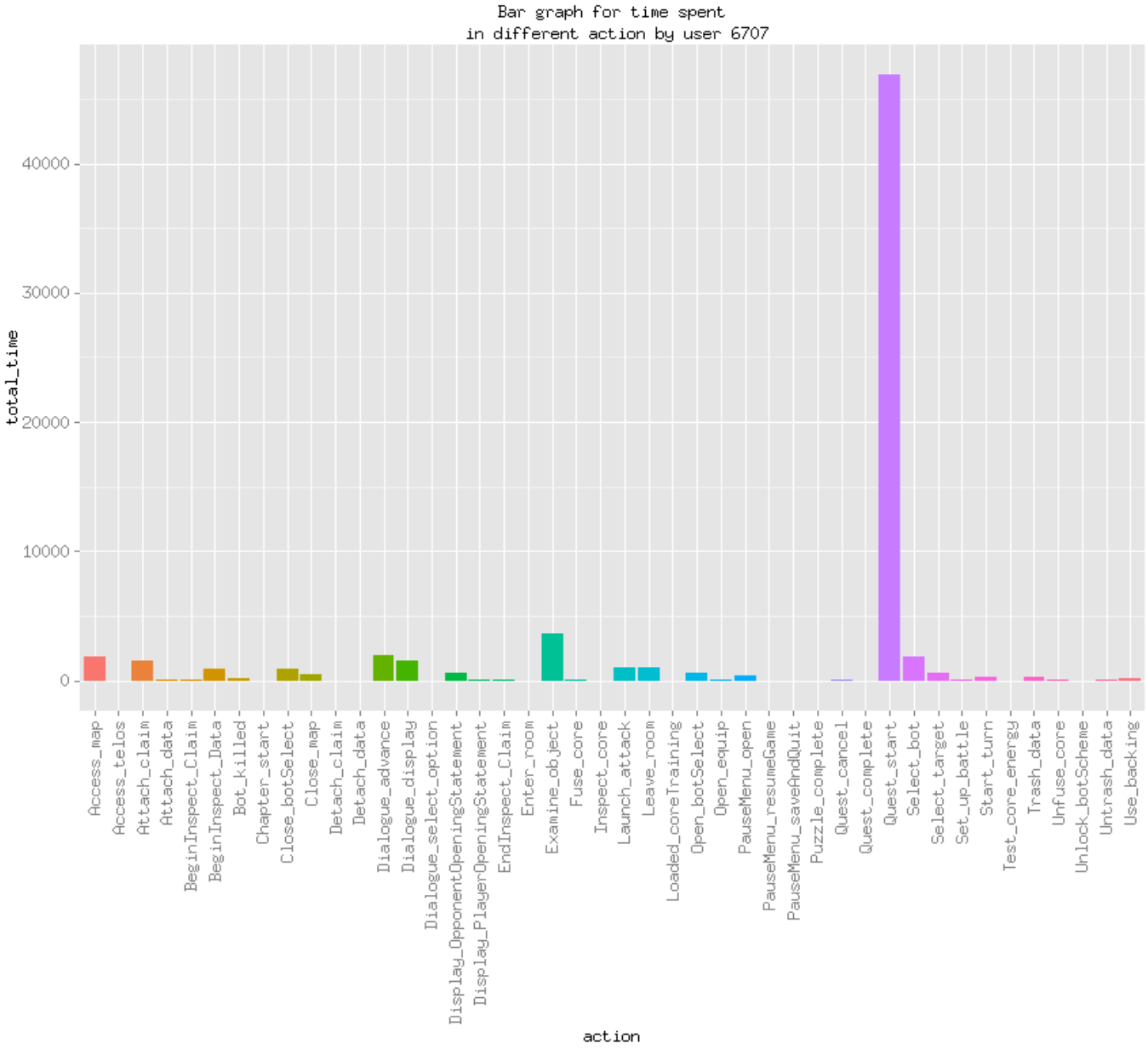
Graphs in real time

```
##         activityId total_time
## 1 BackingGenerator        695
## 2           Battle       3362
## 3           BotBox          3
## 4        BotSelect       2203
## 5 CoreConstruction         82
## 6        CoreEquip       2374
## 7       CqTraining        400
## 8      Exploration      54722
## 9              Map       3378
```



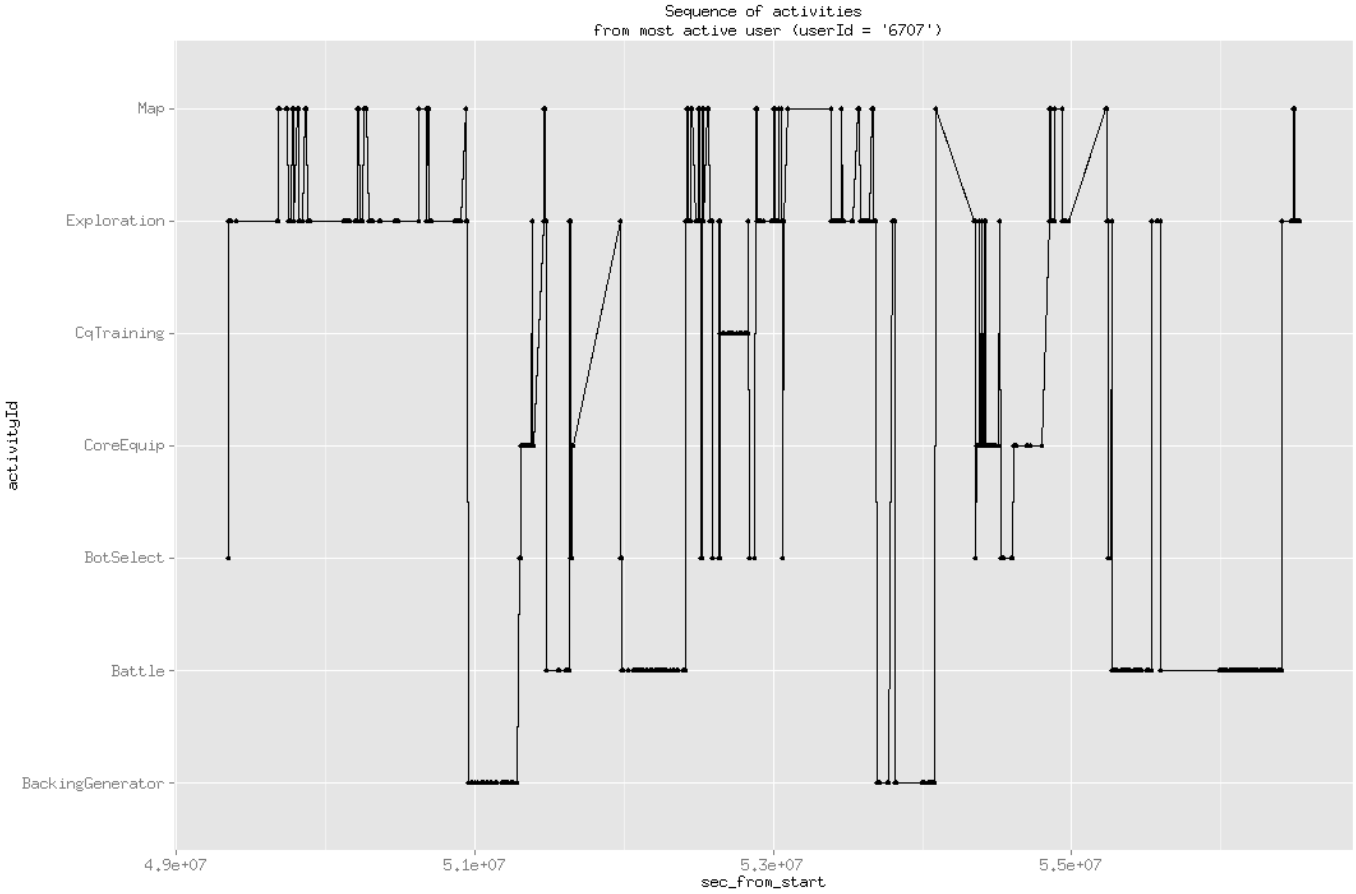
From the above graph it is clear that user-6707 mostly spent his time in Exploration activity and he also tried “Backing generator” which other users did not try.

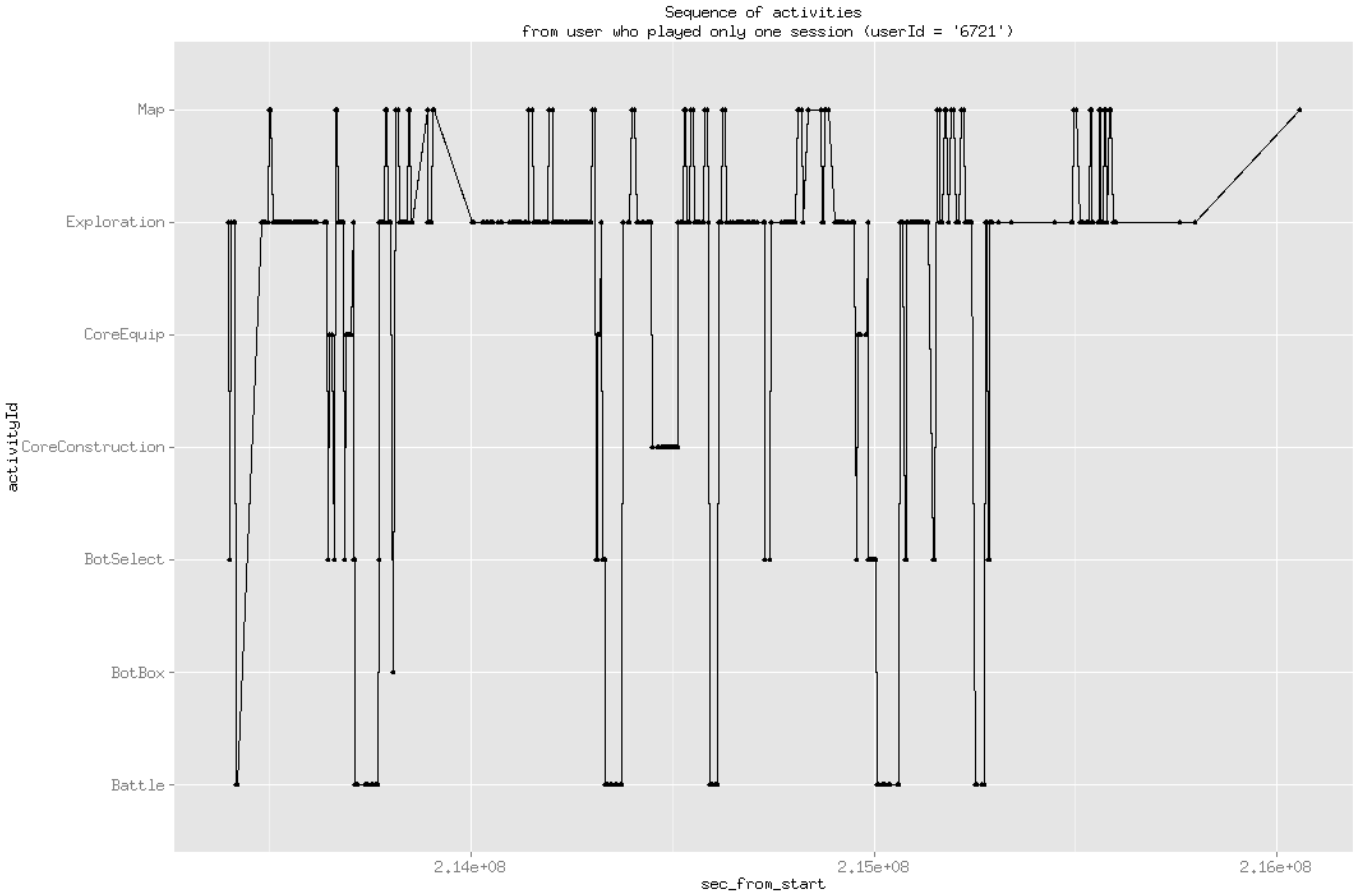
```
##                                action total_time
## 1                          Access_map       1834
## 2                         Access_telos         14
## 3                         Attach_claim       1534
## 4                          Attach_data         37
## 5                  BeginInspect_Claim        114
## 6                   BeginInspect_Data        961
## 7                          Bot_killed        138
## 8                       Chapter_start          3
## 9                     Close_botSelect        897
## 10                          Close_map        520
## 11                       Detach_claim         11
## 12                        Detach_data          6
## 13                   Dialogue_advance       1912
## 14                   Dialogue_display       1506
## 15             Dialogue_select_option          2
## 16 Display_OpponentOpeningStatement        556
## 17   Display_PlayerOpeningStatement         35
## 18                   EndInspect_Claim         74
## 19                         Enter_room          0
## 20                       Examine_object       3591
## 21                            Fuse_core         40
## 22                         Inspect_core          3
## 23                        Launch_attack       1005
## 24                           Leave_room       1024
## 25                Loaded_coreTraining          4
## 26                     Open_botSelect        620
## 27                         Open_equip         30
## 28                      PauseMenu_open        425
## 29                PauseMenu_resumeGame          0
## 30               PauseMenu_saveAndQuit          0
## 31                     Puzzle_complete          9
## 32                        Quest_cancel         25
## 33                      Quest_complete          0
## 34                         Quest_start      46877
## 35                          Select_bot       1850
## 36                       Select_target        597
## 37                       Set_up_battle         50
## 38                          Start_turn        326
## 39                   Test_core_energy         11
## 40                         Trash_data        295
## 41                       Unfuse_core         39
## 42                   Unlock_botScheme          0
## 43                       Untrash_data         78
## 44                          Use_backing        166
```



In the above graph missing bars represent that the user did not perform those actions. This analysis can be extended for other users also.

Graphs in virtual time


Sequence of activities
from most active user (userId = '6707')
activityId
Map
Exploration
CqTraining
CoreEquip
BotSelect
Battle
BackingGenerator
4.9e+07
5.1e+07
5.3e+07
5.5e+07
sec_from_start

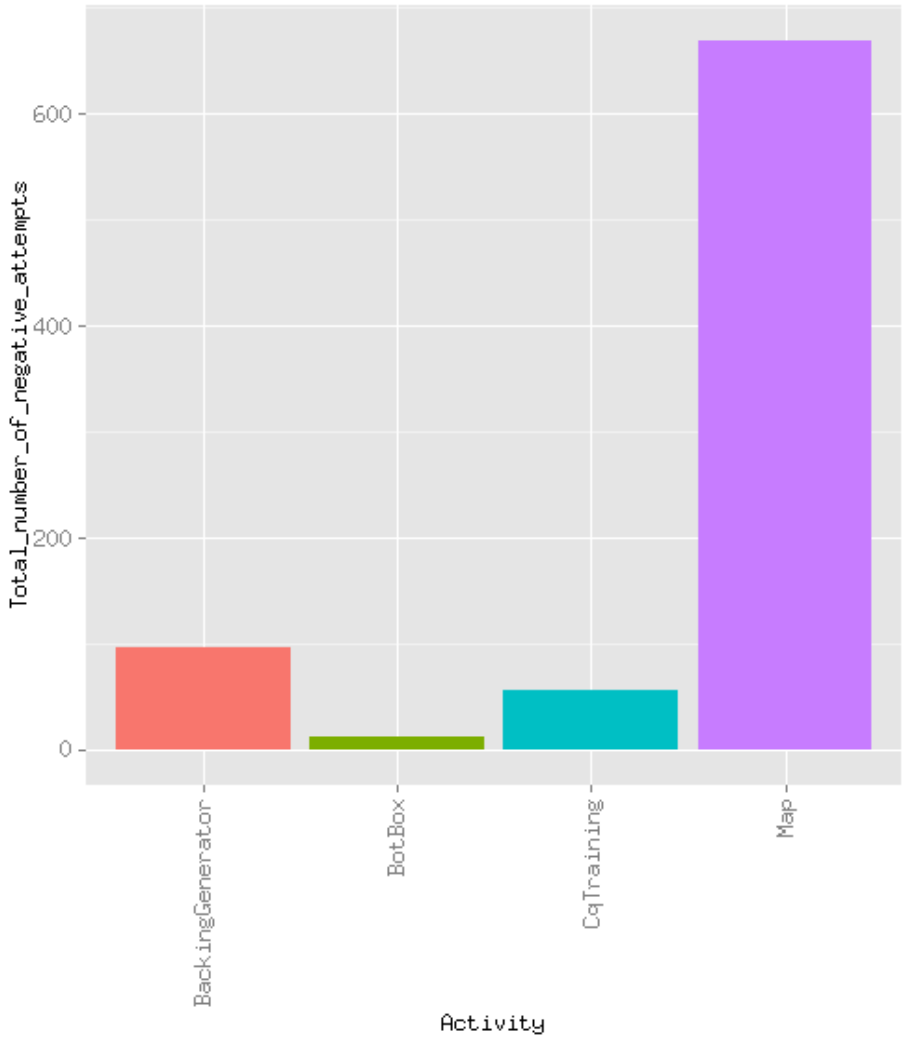

Sequence of activities
from user who played only one session (userId = '6721')
activityId
Map
Exploration
CoreEquip
CoreConstruction
BotSelect
BotBox
Battle
2.14e+08
2.15e+08
2.16e+08
sec_from_start

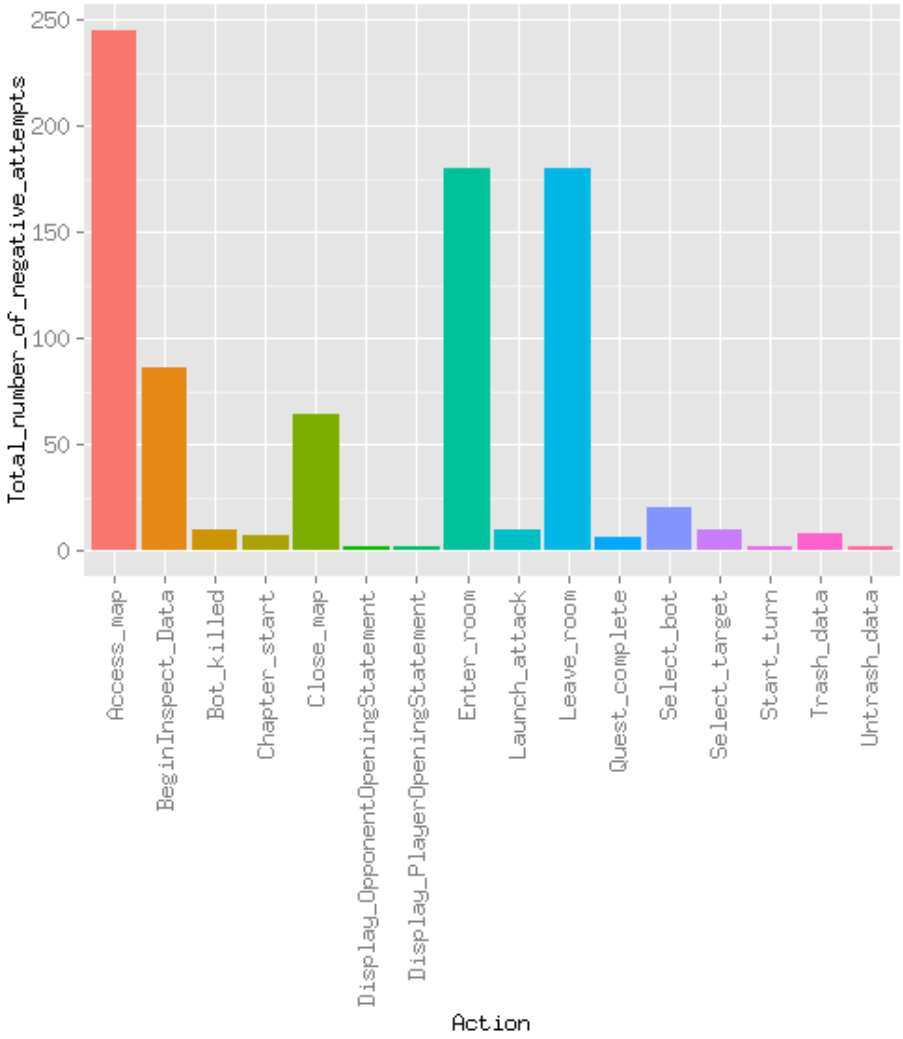
From graph it is clear that user “6707” is very active and he tried every game except botbox. From graph it is also clear that “Exploration” is most popular among all users of data. This is how I found pattern in sessions using time and sessionId column.

Problem 4. Find one or more other interesting pattern in the data.

Analysis part 1

In this section I first analysed data for negative “attempt”. “attempt” column has only -1, negative value for 834 rows. It is interesting to know that maximaum negative values occur for map activity and acess_map, enter_room, leave_room actions.





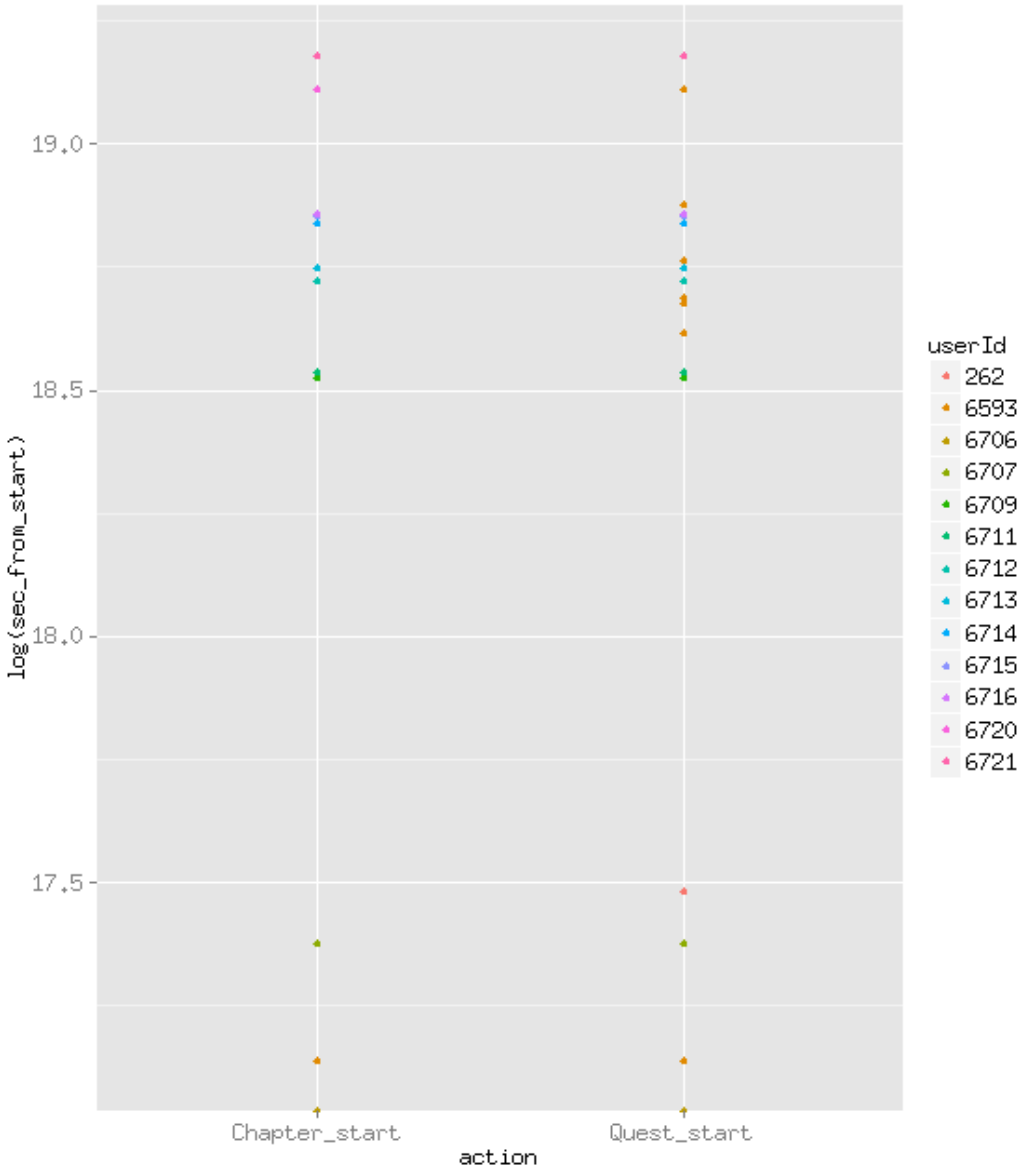
Analysis part 2

In this part I analysed data for “totalTimePlayed” having 0 values. All those values occurred only for Exploration activity and for chapter_start and quest_start actions.

```
##       userId totalTimePlayed  activityId
## 1       6706               0 Exploration
## 2       6706               0 Exploration
## 1496    6593               0 Exploration
## 1497    6593               0 Exploration
## 1597    6707               0 Exploration
## 1598    6707               0 Exploration
## 2624     262               0 Exploration
## 5853    6709               0 Exploration
## 5854    6709               0 Exploration
## 6323    6711               0 Exploration
## 6324    6711               0 Exploration
## 8382    6593               0 Exploration
## 9891    6593               0 Exploration
## 9942    6593               0 Exploration
## 10109   6712               0 Exploration
```

```
## 10110   6712               0 Exploration
## 10780   6713               0 Exploration
## 10781   6713               0 Exploration
## 11404   6593               0 Exploration
## 12091   6714               0 Exploration
## 12092   6714               0 Exploration
## 12408   6715               0 Exploration
## 12409   6715               0 Exploration
## 12512   6716               0 Exploration
## 12513   6716               0 Exploration
## 12701   6593               0 Exploration
## 12702   6593               0 Exploration
## 12707   6720               0 Exploration
## 12708   6720               0 Exploration
## 12750   6593               0 Exploration
## 12752    262               0 Exploration
## 12757   6593               0 Exploration
## 12765   6721               0 Exploration
## 12766   6721               0 Exploration
##                                      sessionId attempt sessionOrder
## 1     13b78a70-25ed-11e4-adc4-b1ca37c95b39       1            2
## 2     13b78a70-25ed-11e4-adc4-b1ca37c95b39       1            3
## 1496  a9d88280-262d-11e4-9600-69986cc0e309       1            2
## 1497  a9d88280-262d-11e4-9600-69986cc0e309       1            3
## 1597  0939b710-263f-11e4-9600-69986cc0e309       1            2
## 1598  0939b710-263f-11e4-9600-69986cc0e309       1            3
## 2624  457f29e0-2648-11e4-9600-69986cc0e309       1            2
## 5853  d373fa30-26ef-11e4-b64c-23ecc8f0c749       1            2
## 5854  d373fa30-26ef-11e4-b64c-23ecc8f0c749       1            3
## 6323  ef771f20-26f2-11e4-b64c-23ecc8f0c749       1            2
## 6324  ef771f20-26f2-11e4-b64c-23ecc8f0c749       1            3
## 8382  d8e79ef0-2707-11e4-b64c-23ecc8f0c749       1            2
## 9891  253da4a0-2719-11e4-b64c-23ecc8f0c749       1            2
## 9942  5500fb20-271d-11e4-b64c-23ecc8f0c749       1            2
## 10109 13e39fd0-2727-11e4-b64c-23ecc8f0c749       1            2
## 10110 13e39fd0-2727-11e4-b64c-23ecc8f0c749       1            3
## 10780 3a5c52c0-2730-11e4-b64c-23ecc8f0c749       1            2
## 10781 3a5c52c0-2730-11e4-b64c-23ecc8f0c749       1            3
## 11404 19ed75a0-2735-11e4-b64c-23ecc8f0c749       1            2
## 12091 be177c20-274e-11e4-b64c-23ecc8f0c749       1            2
## 12092 be177c20-274e-11e4-b64c-23ecc8f0c749       1            3
## 12408 6630fc60-2754-11e4-b64c-23ecc8f0c749       1            2
## 12409 6630fc60-2754-11e4-b64c-23ecc8f0c749       1            3
## 12512 fbef7d30-2754-11e4-b64c-23ecc8f0c749       1            2
## 12513 fbef7d30-2754-11e4-b64c-23ecc8f0c749       1            3
## 12701 60fbb2a0-275c-11e4-b64c-23ecc8f0c749       1            2
## 12702 60fbb2a0-275c-11e4-b64c-23ecc8f0c749       1            2
## 12707 ad89ed70-27bc-11e4-b888-3f4840ca9c86       1            2
## 12708 ad89ed70-27bc-11e4-b888-3f4840ca9c86       1            3
## 12750 dc92d4f0-27bd-11e4-b888-3f4840ca9c86       1            2
## 12752 708c5c20-27dd-11e4-9845-175fcf1a3e72       1            2
## 12757 830eabf0-27dd-11e4-9845-175fcf1a3e72       1            1
## 12765 ee76b450-27dd-11e4-9845-175fcf1a3e72       1            2
```

```
## 12766 ee76b450-27dd-11e4-9845-175fcf1a3e72       1            3
##              action sec_from_start
## 1       Quest_start              0
## 2     Chapter_start              0
## 1496    Quest_start       27744000
## 1497  Chapter_start       27744000
## 1597    Quest_start       35201000
## 1598  Chapter_start       35201000
## 2624    Quest_start       39161000
## 5853    Quest_start      111131000
## 5854  Chapter_start      111131000
## 6323    Quest_start      112284000
## 6324  Chapter_start      112284000
## 8382    Quest_start      121379000
## 9891    Quest_start      128879000
## 9942    Quest_start      130677000
## 10109   Quest_start      134858000
## 10110 Chapter_start      134858000
## 10780   Quest_start      138796000
## 10781 Chapter_start      138796000
## 11404   Quest_start      140876000
## 12091   Quest_start      151769000
## 12092 Chapter_start      151769000
## 12408   Quest_start      154320000
## 12409 Chapter_start      154320000
## 12512   Quest_start      154572000
## 12513 Chapter_start      154572000
## 12701   Quest_start      157587000
## 12702   Quest_start      157587000
## 12707   Quest_start      199105000
## 12708 Chapter_start      199105000
## 12750   Quest_start      199611000
## 12752   Quest_start      213177000
## 12757   Quest_start      213224000
## 12765   Quest_start      213398000
## 12766 Chapter_start      213398000
```



Analysis part 3

There are six devices. Same device is used by multiple users, this can be infer from following table:

```
## [1] "0E08FB43-A854-44BF-B9BD-A5A12B00D383"
## [2] "DFD58325-26E1-4EE1-942A-A813560340C1"
## [3] "75BF90B6-EBBF-4B97-9D7A-A6B934E770E6"
## [4] "24CED89F-F6D5-4B31-9442-CD29DCD8465F"
## [5] "585A3601-E316-4296-A693-FF4B2192AA72"
## [6] "4C0AEE21-D51A-4030-90DC-BBCA081742D2"
```

```
##       userId                       only_device_id
## 1       6706 0E08FB43-A854-44BF-B9BD-A5A12B00D383
## 1496    6593 DFD58325-26E1-4EE1-942A-A813560340C1
## 1597    6707 75BF90B6-EBBF-4B97-9D7A-A6B934E770E6
## 2626     262 DFD58325-26E1-4EE1-942A-A813560340C1
## 5864    6709 0E08FB43-A854-44BF-B9BD-A5A12B00D383
## 6334    6711 24CED89F-F6D5-4B31-9442-CD29DCD8465F
## 10146   6712 75BF90B6-EBBF-4B97-9D7A-A6B934E770E6
## 10818   6713 0E08FB43-A854-44BF-B9BD-A5A12B00D383
## 12133   6714 585A3601-E316-4296-A693-FF4B2192AA72
## 12450   6715 75BF90B6-EBBF-4B97-9D7A-A6B934E770E6
## 12555   6716 4C0AEE21-D51A-4030-90DC-BBCA081742D2
## 12750   6720 0E08FB43-A854-44BF-B9BD-A5A12B00D383
## 12808   6721 DFD58325-26E1-4EE1-942A-A813560340C1
```

Problem 5. What would you change in the telemetry data?

At times, server and client are not syncronized well which cause repeated messages. Local time from user device and location data can help us understand when user behavior and given that the purpose of these games to enhance learning, these are important factors. Location data for individual users may be used to locate and analyse less used or popular activities.

Problem 6. What are some compression methods for this data?

1. DeviceId has userId embedded into it so userId field is redundant.
2. There are repeated rows with server time different.
3. Last four columns appear to be key value pair which are already present in “data” column. Although it is possible that implementation requires those columns to simplify processing
4. Some of the columns can be encoded.

Future work:

This is exploratory analysis and lot more can be done to analyse relations between activity, action with respect to time and user after melting and reshaping the data. The data can be analysed more to predict which activity user like, based on past data or can group users with similar playing behavior. This data can be analysed for those users who spent less time and can make changes to attract those. Shiny can be used to make the analysis more user friendly(for data analysis purpose). I wanted to explore “data” column more but I couldn't do that due to lack of time.