Data munging basics

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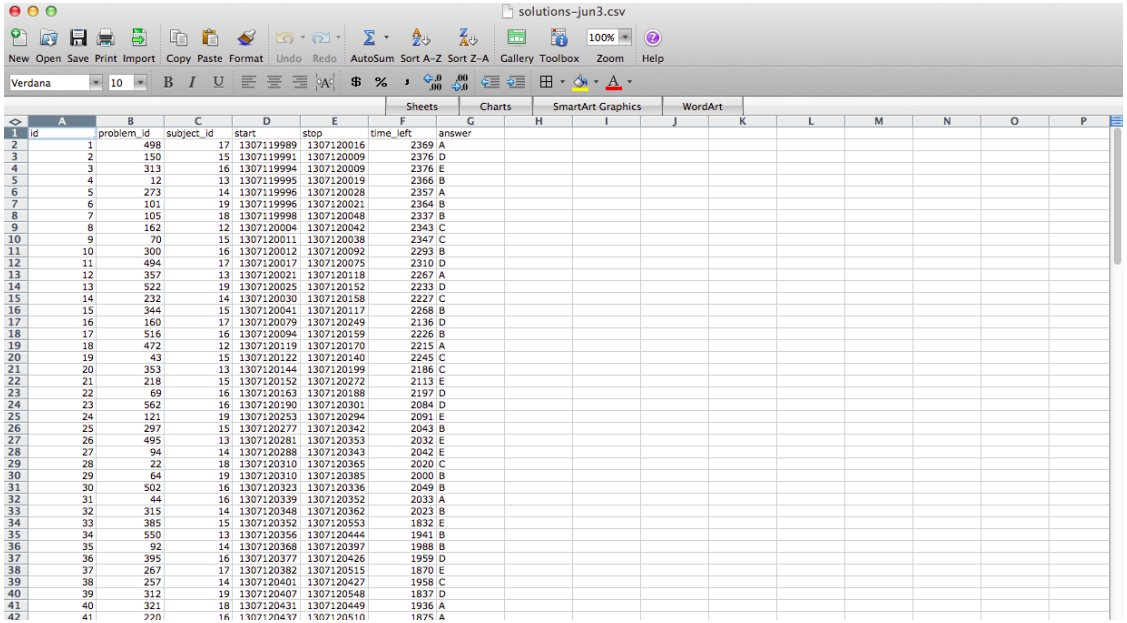
Recall Tidy Data



	id	problem_id	subject_id	start	stop	time_left	answer
1	1	498	17	1307119989	1307120016	2369	A
2	2	150	15	1307119991	1307120009	2376	D
3	3	313	16	1307119994	1307120009	2376	E
4	4	12	13	1307119995	1307120019	2366	B
5	5	273	14	1307119996	1307120028	2357	A
6	6	101	19	1307119996	1307120021	2364	B
7	7	105	18	1307119998	1307120048	2337	B
8	8	162	12	1307120004	1307120042	2343	C
9	9	70	15	1307120011	1307120038	2347	C
10	10	300	16	1307120012	1307120092	2293	B
11	11	494	17	1307120017	1307120075	2310	D
12	12	357	13	1307120021	1307120118	2267	A
13	13	522	19	1307120025	1307120152	2233	D
14	14	232	14	1307120030	1307120158	2227	C
15	15	344	15	1307120041	1307120117	2268	B
16	16	160	17	1307120079	1307120249	2136	D
17	17	516	16	1307120094	1307120159	2226	B
18	18	472	12	1307120119	1307120170	2215	A
19	19	43	15	1307120122	1307120140	2245	C
20	20	353	13	1307120144	1307120199	2186	C
21	21	218	15	1307120152	1307120272	2113	E
22	22	69	16	1307120163	1307120188	2197	D
23	23	562	16	1307120190	1307120301	2084	D
24	24	121	19	1307120253	1307120294	2091	E
25	25	297	15	1307120277	1307120342	2043	B
26	26	495	13	1307120281	1307120353	2032	E
27	27	94	14	1307120288	1307120343	2042	E
28	28	22	18	1307120310	1307120365	2020	C
29	29	64	19	1307120310	1307120385	2000	B
30	30	502	16	1307120323	1307120336	2049	B
31	31	44	16	1307120339	1307120352	2033	A
32	32	315	14	1307120348	1307120362	2023	B
33	33	385	15	1307120352	1307120553	1832	E
34	34	550	13	1307120356	1307120444	1941	B
35	35	92	14	1307120368	1307120397	1988	B
36	36	395	16	1307120377	1307120426	1959	D
37	37	267	17	1307120382	1307120515	1870	E
38	38	257	14	1307120401	1307120427	1958	C
39	39	312	19	1307120407	1307120548	1837	D
40	40	321	18	1307120431	1307120449	1936	A
41	41	220	16	1307120437	1307120510	1875	A

1. Each variable forms a column
2. Each observation forms a row
3. Each table/file stores data about one kind of observation (e.g. people/hospitals).

http://vita.had.co.nz/papers/tidy-data.pdf

Leek, Taub, and Pineda 2011 PLoS One

Where we would like to be

- Tidy data refers to the shape of the data
  - Variables in columns
  - Observations in rows
  - Tables holding elements of only one kind
- Plus
  - Column names are easy to use and informative
  - Row names are easy to use and informative
  - Obvious mistakes in the data have been removed
  - Variable values are internally consistent
  - Appropriate transformed variables have been added

A partial list of munging operations

- Fix variable names
- Create new variables
- Merge data sets
- Reshape data sets
- Deal with missing data
- Take transforms of variables
- Check on and remove inconsistent values

These steps must be recorded

90% of your effort will often be spent here

A partial list of munging operations

- Fix variable names
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- Merge data sets
- Reshape data sets
- Deal with missing data
- Take transforms of variables
- Check on and remove inconsistent values

Fixing character vectors - tolower(), toupper()

```
cameraData <- read.csv("./data/cameras.csv")
names(cameraData)
```

```
[1] "address"      "direction"    "street"       "crossStreet"
[5] "intersection" "Location.1"
```

```
tolower(names(cameraData))
```

```
[1] "address"      "direction"    "street"       "crossstreet"
[5] "intersection" "location.1"
```

Fixing character vectors - strsplit()

- Good for automatically splitting variable names
- Important parameters: *x*, *split*

```
splitNames = strsplit(names(cameraData),"\\.")
splitNames[[5]]
```

```
[1] "intersection"
```

```
splitNames[[6]]
```

```
[1] "Location" "1"
```

Fixing character vectors - sapply()

- Applies a function to each element in a vector or list
- Important parameters: *X*,*FUN*

```
splitNames[[6]][1]
```

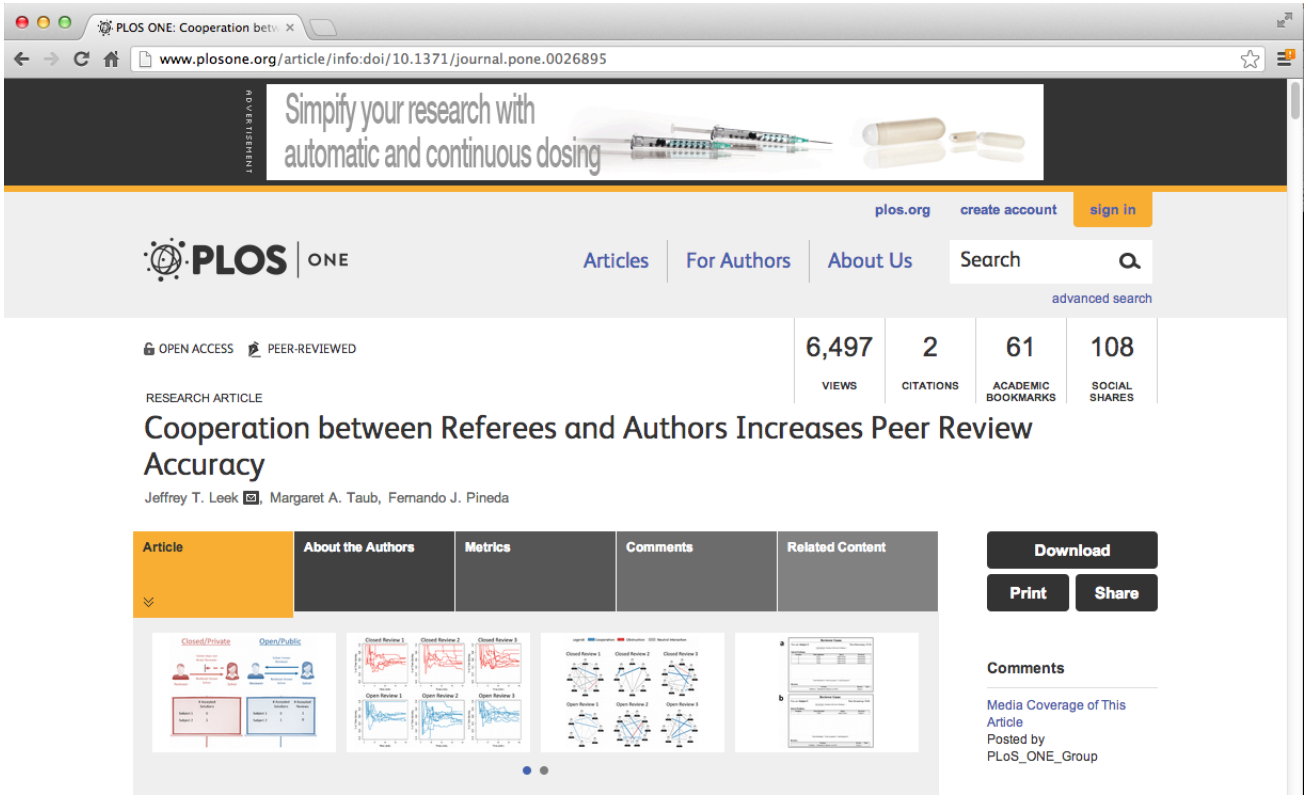
```
[1] "Location"
```

```
firstElement <- function(x){x[1]}
sapply(splitNames,firstElement)
```

```
[1] "address"      "direction"    "street"       "crossStreet"
[5] "intersection" "Location"
```

Peer review experiment data

- Data on submissions/reviews in an experiment



http://www.plosone.org/article/info:doi/10.1371/journal.pone.0026895

Peer review data

```
fileUrl1 <- "https://dl.dropboxusercontent.com/u/7710864/data/reviews-apr29.csv"
fileUrl2 <- "https://dl.dropboxusercontent.com/u/7710864/data/solutions-apr29.csv"
download.file(fileUrl1,destfile="./data/reviews.csv",method="curl")
download.file(fileUrl2,destfile="./data/solutions.csv",method="curl")
reviews <- read.csv("./data/reviews.csv"); solutions <- read.csv("./data/solutions.csv")
head(reviews,2)
```

```
  id solution_id reviewer_id      start       stop time_left accept
1  1           3          27 1304095698 1304095758      1754      1
2  2           4          22 1304095188 1304095206      2306      1
```

```
head(solutions,2)
```

```
  id problem_id subject_id      start       stop time_left answer
1  1        156         29 1304095119 1304095169      2343      B
2  2        269         25 1304095119 1304095183      2329      C
```

Fixing character vectors - sub(),gsub()

- Important parameters: *pattern*, *replacement*, *x*

```
names(reviews)
```

```
[1] "id"          "solution_id" "reviewer_id" "start"
[5] "stop"        "time_left"   "accept"
```

```
sub("_","",names(reviews),)
```

```
[1] "id"         "solutionid" "reviewerid" "start"      "stop"
[6] "timeleft"   "accept"
```

Fixing character vectors - sub(),gsub()

```
testName <- "this_is_a_test"
sub("_","",testName)
```

```
[1] "thisis_a_test"
```

```
gsub("_","",testName)
```

```
[1] "thisisatest"
```

Quantitative variables in ranges - - cut()

- Important parameters: *x*,*breaks*

```
reviews$time_left[1:10]
```

```
 [1] 1754 2306 2192 2089 2043 1999 2130   NA 1899 2024
```

```
timeRanges <- cut(reviews$time_left,seq(0,3600,by=600))
timeRanges[1:10]
```

```
 [1] (1.2e+03,1.8e+03] (1.8e+03,2.4e+03] (1.8e+03,2.4e+03]
 [4] (1.8e+03,2.4e+03] (1.8e+03,2.4e+03] (1.8e+03,2.4e+03]
 [7] (1.8e+03,2.4e+03] <NA>              (1.8e+03,2.4e+03]
[10] (1.8e+03,2.4e+03]
6 Levels: (0,600] (600,1.2e+03] ... (3e+03,3.6e+03]
```

Quantitative variables in ranges - - cut()

```
class(timeRanges)
```

```
[1] "factor"
```

```
table(timeRanges,useNA="ifany")
```

```
timeRanges
          (0,600]     (600,1.2e+03] (1.2e+03,1.8e+03]
               30                32                25
(1.8e+03,2.4e+03]   (2.4e+03,3e+03]   (3e+03,3.6e+03]
               28                 0                 0
             <NA>
               84
```

Quantitative variables in ranges - cut2() {Hmisc}

You may need to run `install.packages("Hmisc")`

```
library("Hmisc")
timeRanges<- cut2(reviews$time_left,g=6)
table(timeRanges,useNA="ifany")
```

```
timeRanges
[  22, 384) [ 384, 759) [ 759,1150) [1150,1496) [1496,1909)
         20          19          19          19          19
[1909,2306]        <NA>
         19          84
```

Quantitative variables in ranges - cut2() {Hmisc}

```
table(timeRanges,useNA="ifany")
```

```
timeRanges
[  22, 384) [ 384, 759) [ 759,1150) [1150,1496) [1496,1909)
         20          19          19          19          19
[1909,2306]        <NA>
         19          84
```

Adding an extra variable

```
timeRanges <- cut2(reviews$time_left,g=6)
reviews$timeRanges <- timeRanges
head(reviews,2)
```

```
  id solution_id reviewer_id      start       stop time_left accept
1  1           3          27 1304095698 1304095758      1754      1
2  2           4          22 1304095188 1304095206      2306      1
   timeRanges
1 [1496,1909)
2 [1909,2306]
```

Merging data - merge()

- Merges data frames
- Important parameters: *x*,*y*,*by*,*by.x*,*by.y*,*all*

```
names(reviews)
```

```
[1] "id"          "solution_id" "reviewer_id" "start"
[5] "stop"        "time_left"   "accept"      "timeRanges"
```

```
names(solutions)
```

```
[1] "id"         "problem_id" "subject_id" "start"      "stop"
[6] "time_left"  "answer"
```

Merging data - merge()

```
mergedData <- merge(reviews,solutions,all=TRUE)
head(mergedData)
```

```
  id      start       stop time_left solution_id reviewer_id accept
1  1 1304095119 1304095169      2343          NA          NA     NA
2  1 1304095698 1304095758      1754           3          27      1
3  2 1304095119 1304095183      2329          NA          NA     NA
4  2 1304095188 1304095206      2306           4          22      1
5  3 1304095127 1304095146      2366          NA          NA     NA
6  3 1304095276 1304095320      2192           5          28      1
   timeRanges problem_id subject_id answer
1        <NA>        156         29      B
2 [1496,1909)         NA         NA   <NA>
3        <NA>        269         25      C
4 [1909,2306]         NA         NA   <NA>
5        <NA>         34         22      C
6 [1909,2306]         NA         NA   <NA>
```

Merging data - merge()

```
mergedData2 <- merge(reviews, solutions, by.x = "solution_id", by.y = "id", all=TRUE)
head(mergedData2[,1:6],3)
```

```
  solution_id id reviewer_id    start.x     stop.x time_left.x
1           1  4          26 1304095267 1304095423        2089
2           2  6          29 1304095471 1304095513        1999
3           3  1          27 1304095698 1304095758        1754
```

```
reviews[1,1:6]
```

```
  id solution_id reviewer_id      start       stop time_left
1  1           3          27 1304095698 1304095758      1754
```

Sorting values - sort()

- Important parameters: *x*, *decreasing*

```
mergedData2$reviewer_id[1:10]
```

```
 [1] 26 29 27 22 28 22 29 23 25 29
```

```
sort(mergedData2$reviewer_id)[1:10]
```

```
 [1] 22 22 22 22 22 22 22 22 22 22
```

Ordering values - order()

- Important parameters: *list of variables to order*, *na.last*,*decreasing*

```
mergedData2$reviewer_id[1:10]
```

```
 [1] 26 29 27 22 28 22 29 23 25 29
```

```
order(mergedData2$reviewer_id)[1:10]
```

```
 [1]  4  6 14 22 23 24 27 32 37 39
```

Ordering values - order()

```
mergedData2$reviewer_id[order(mergedData2$reviewer_id)]
```

```
  [1] 22 22 22 22 22 22 22 22 22 22 22 22 22 22 22 22 22 22 22 22 22
 [22] 22 22 22 22 22 22 22 22 23 23 23 23 23 23 23 23 23 23 23 23 23
 [43] 23 23 23 23 23 23 23 23 23 23 23 23 23 23 23 23 24 24 24 24 24
 [64] 24 24 24 24 24 24 24 24 24 24 25 25 25 25 25 25 25 25 25 25 25
 [85] 25 25 25 25 25 25 25 25 25 25 25 26 26 26 26 26 26 26 26 26 26
[106] 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 26 27 27 27 27
[127] 27 27 27 27 27 27 27 27 27 27 27 27 27 27 27 27 27 27 27 27 27
[148] 27 27 27 27 27 28 28 28 28 28 28 28 28 28 28 28 28 28 28 28 28
[169] 28 28 28 28 28 28 28 28 28 28 29 29 29 29 29 29 29 29 29 29 29
[190] 29 29 29 29 29 29 29 29 29 29 NA NA NA NA NA NA
```

Reordering a data frame

```
head(mergedData2[,1:6],3)
```

```
  solution_id id reviewer_id    start.x     stop.x time_left.x
1           1  4          26 1304095267 1304095423        2089
2           2  6          29 1304095471 1304095513        1999
3           3  1          27 1304095698 1304095758        1754
```

```
sortedData <- mergedData2[order(mergedData2$reviewer_id),]
head(sortedData[,1:6],3)
```

```
   solution_id id reviewer_id    start.x     stop.x time_left.x
4            4  2          22 1304095188 1304095206        2306
6            6 16          22 1304095303 1304095471        2041
14          14 12          22 1304095280 1304095301        2211
```

Reordering by multiple variables

```
head(mergedData2[,1:6],3)
```

```
  solution_id id reviewer_id    start.x     stop.x time_left.x
1           1  4          26 1304095267 1304095423        2089
2           2  6          29 1304095471 1304095513        1999
3           3  1          27 1304095698 1304095758        1754
```

```
sortedData <- mergedData2[order(mergedData2$reviewer_id,mergedData2$id),]
head(sortedData[,1:6],3)
```

```
   solution_id id reviewer_id    start.x     stop.x time_left.x
4            4  2          22 1304095188 1304095206        2306
14          14 12          22 1304095280 1304095301        2211
6            6 16          22 1304095303 1304095471        2041
```

Reshaping data - example

```
misShaped <- as.data.frame(matrix(c(NA,5,1,4,2,3),byrow=TRUE,nrow=3))
names(misShaped) <- c("treatmentA","treatmentB")
misShaped$people <- c("John","Jane","Mary")
misShaped
```

```
  treatmentA treatmentB people
1         NA          5   John
2          1          4   Jane
3          2          3   Mary
```

http://vita.had.co.nz/papers/tidy-data.pdf

Reshaping data - melt() {reshape2}

You may need to run `install.packages("reshape2")` before using the `melt()` function

- Important parameters: *id.vars*, *measure.vars*, *variable.name*

```
library("reshape2")
melt(misShaped,id.vars="people",variable.name="treatment",value.name="value")
```

```
  people  treatment value
1   John treatmentA    NA
2   Jane treatmentA     1
3   Mary treatmentA     2
4   John treatmentB     5
5   Jane treatmentB     4
6   Mary treatmentB     3
```

More resources

- Tidy data and tidy tools
- Andrew Jaffe's Data Cleaning Lecture
- Hadley Wickham on regular expressions
- Long, painful experience :-)