Rbasics

PhD toolbox - 41th PhD cycle

Part II - `How to manage data in spreadsheets`

Data Organization in Spreadsheets

Now you should know the basic R syntax and you're ready to start to import real datasets in R!

but

Your data requires a clear structure

Spreadsheets (mostly Excel) are useful tools for data entry but not suitable for reproducible research

Example: statistical procedures in Excel are manual. If you need to change one parameter of your analysis you'll have to redo all your job.

Data Organization in Spreadsheets

Do not treat your data spreadsheet as your lab book!

- Your data needs to be correctly read and interpreted by your Computer (not by your supervisor!)
- Additional notes and graphic layout of your data are useless most of the time
- keep your spreadsheet as tidy as possible

Some operative TIPS according to https://datacarpentry.org/spreadsheet-ecology-lesson/

Data Organization in Spreadsheets

Some cardinal rules to correctly compile your data spreadsheet

1) variables in column, observations in rows

Observations	Factor_A	Factor_B	Measure_1	Measure_2
Observation_1	X	1		
Observation_2	Y	1		
Observation_3	X	2		
Observation_4	X	2		

Data Organization in Spreadsheets

Some cardinal rules to correctly compile your data spreadsheet

2) Don’t mix multiple information in one cell

Plot	Species-Sex	Weight
1	DM-M	40
1	DM-F	36
1	DS-F	135
1	DM-F	39
2	DM-M	43

Plot	Species	Sex	Weight
1	DM	M	40
1	DM	F	36
1	DS	F	135
1	DM	F	39
2	DM	M	43

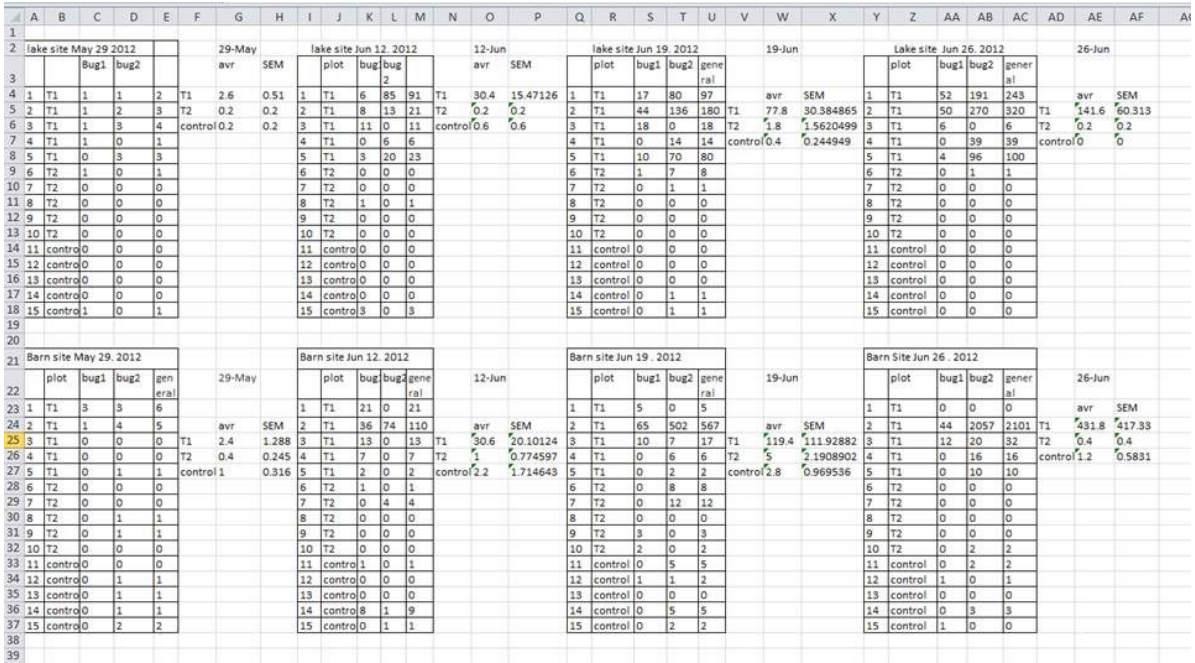
Data Organization in Spreadsheets

Some cardinal rules to correctly compile your data spreadsheet

3) **NEVER** touch the raw data! If needed you can make a copy and modify it.
4) Export and store your data as a text-based file (csv, tsv…)

Data Organization in Spreadsheets

Some common **errors**



1																																				
2	lake site May 29 2012					29-May			lake site Jun 12. 2012					12-Jun			lake site Jun 19. 2012					19-Jun			Lake site Jun 26. 2012					26-Jun					
3			Bug1	bug2		avr	SEM		plot	bug1	bug2			avr	SEM		plot	bug1	bug2	general		avr	SEM		plot	bug1	bug2	general		avr	SEM				
4	1	T1	1	1	2	T1	2.6	0.51	1	T1	6	85	91	T1	30.4	15.47126	1	T1	17	80	97		avr	SEM	1	T1	52	191	243		avr	SEM				
5	2	T1	1	2	3	T2	0.2	0.2	2	T1	8	13	21	T2	0.2	0.2	2	T1	44	136	180	T1	77.8	30.384865	2	T1	50	270	320	T1	141.6	60.313				
6	3	T1	1	3	4	control	0.2	0.2	3	T1	11	0	11	control	0.6	0.6	3	T1	18	0	18	T2	1.8	1.5620499	3	T1	6	0	6	T2	0.2	0.2				
7	4	T1	1	0	1				4	T1	0	6	6				4	T1	0	14	14	control	0.4	0.244949	4	T1	0	39	39	control	0	0				
8	5	T1	0	3	3				5	T1	3	20	23				5	T1	10	70	80				5	T1	4	96	100							
9	6	T2	1	0	1				6	T2	0	0	0				6	T2	1	7	8				6	T2	0	1	1							
10	7	T2	0	0	0				7	T2	0	0	0				7	T2	0	1	1				7	T2	0	0	0							
11	8	T2	0	0	0				8	T2	1	0	1				8	T2	0	0	0				8	T2	0	0	0							
12	9	T2	0	0	0				9	T2	0	0	0				9	T2	0	0	0				9	T2	0	0	0							
13	10	T2	0	0	0				10	T2	0	0	0				10	T2	0	0	0				10	T2	0	0	0							
14	11	contro	0	0	0				11	contro	0	0	0				11	control	0	0	0				11	control	0	0	0							
15	12	contro	0	0	0				12	contro	0	0	0				12	control	0	0	0				12	control	0	0	0							
16	13	contro	0	0	0				13	contro	0	0	0				13	control	0	0	0				13	control	0	0	0							
17	14	contro	0	0	0				14	contro	0	0	0				14	control	0	1	1				14	control	0	0	0							
18	15	contro	1	0	1				15	contro	3	0	3				15	control	0	1	1				15	control	0	0	0							
19																																				
20																																				
21	Barn site May 29. 2012					29-May			Barn site Jun 12. 2012					12-Jun			Barn site Jun 19 . 2012					19-Jun			Barn Site Jun 26 . 2012					26-Jun					
22		plot	bug1	bug2	general		avr	SEM		plot	bug1	bug2	general		avr	SEM		plot	bug1	bug2	general		avr	SEM		plot	bug1	bug2	general		avr	SEM				
23	1	T1	3	3	6				1	T1	21	0	21				1	T1	5	0	5				1	T1	0	0	0		avr	SEM				
24	2	T1	1	4	5		avr	SEM	2	T1	36	74	110		avr	SEM	2	T1	65	502	567		avr	SEM	2	T1	44	2057	2101	T1	431.8	417.33				
25	3	T1	0	0	0	T1	2.4	1.288	3	T1	13	0	13	T1	30.6	20.10124	3	T1	10	7	17	T1	119.4	111.92882	3	T1	12	20	32	T2	0.4	0.4				
26	4	T1	0	0	0	T2	0.4	0.245	4	T1	7	0	7	T2	1	0.774597	4	T1	0	6	6	T2	5	2.1908902	4	T1	0	16	16	control	1.2	0.5831				
27	5	T1	0	1	1	control	1	0.316	5	T1	2	0	2	control	2.2	1.714643	5	T1	0	2	2	control	2.8	0.969536	5	T1	0	10	10							
28	6	T2	0	0	0				6	T2	1	0	1				6	T2	0	8	8				6	T2	0	0	0							
29	7	T2	0	0	0				7	T2	0	4	4				7	T2	0	12	12				7	T2	0	0	0							
30	8	T2	0	1	1				8	T2	0	0	0				8	T2	0	0	0				8	T2	0	0	0							
31	9	T2	0	1	1				9	T2	0	0	0				9	T2	3	0	3				9	T2	0	0	0							
32	10	T2	0	0	0				10	T2	0	0	0				10	T2	2	0	2				10	T2	0	2	2							
33	11	contro	0	0	0				11	contro	1	0	1				11	control	0	5	5				11	control	0	2	2							
34	12	contro	0	1	1				12	contro	0	0	0				12	control	1	1	2				12	control	1	0	1							
35	13	contro	0	1	1				13	contro	0	0	0				13	control	0	0	0				13	control	0	0	0							
36	14	contro	0	1	1				14	contro	8	1	9				14	control	0	5	5				14	control	0	3	3							
37	15	contro	0	2	2				15	contro	0	1	1				15	control	0	2	2				15	control	1	0	0							
38																																				
39																																				

1) Using multiple tables

The computer reads your table "by row".

Here, a computer will assign to the same sample values from 4 different samples!

Data Organization in Spreadsheets

2) Using multiple tabs

This can look tidy but does not allows you to make data communicating in different tabs. Sooner or later you'll need to collapse all your data in a single table.

3) Do not properly indicate real zeros and missing data

- write always all the real zeros
- leave blank (or fill with **NA** values) if data is missing

Data Organization in Spreadsheets

4) Do not use formatting to convey information!

- it will be lost when exporting your table in a text file

Solution:

Add a new variable encoding which observation will need to be excluded from the analysis.

More in general:
Don't be afraid to add as much as variables are needed to properly annotate your sample

Date collecte	Species	Sex	Weight	Calibrated
1/8/14	NA			
1/8/14	DM	M	44	Y
1/8/14	DM	M	38	Y
1/8/14	OL			
1/8/14	PE	M	22	Y
1/8/14	DM	M	38	Y
1/8/14	DM	M	48	Y
1/8/14	DM	M	43	Y
1/8/14	DM	F	35	Y
1/8/14	DM	M	43	Y
1/8/14	DM	F	37	Y
1/8/14	PF	F	7	Y
1/8/14	DM	M	45	Y
1/8/14	OT			
1/8/14	DS	M	157	N
1/8/14	OX			
2/18/14	NA	M	218	N
2/18/14	PF	F	7	Y
2/18/14	DM	M	52	Y

Data Organization in Spreadsheets

5) Do not merge cells!

It will create artifacts or issues when exporting into a text file.

Solution: re-structure your data such as merging cells is not required

- this is common in table headers! (but they should not)

Data Organization in Spreadsheets

6) Headers should be one line

- see the previous point
- column names should avoid problematic characters
  - symbols (°, ?, %, !, +,[], ())
  - spaces
- use underscore (_) or **camel case** notations

  Example:

  Root diameter (mm) -> Root_diameter or RootDiameter
- keep it as simple as possible: e.g. RD.

  <u>You'll need an annotation file to track the meaning of your codes!</u>

Data Organization in Spreadsheets

6) **do not includes measure units in your data spreadsheet**

Measure units are essential, but:

- do not include in your data (your observations can have all the same measure unit).

  If not so: can you convert them to the same unit? Otherwise add a variable indicating the measure unit for each of your observation.

- do not include in your column header.

  Compile e README file writing annotation of your column names.

Data Organization in Spreadsheets

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  Compile e README file writing annotation of your column names.

Data Organization in Spreadsheets

R	S	T
L media lato corto dente	L media lato lungo dente	Ampiezza media rachide
0,106 cm + 0,121 cm + 0,094 cm / 3 = 0,107 cm	0,294 cm + 0,342 cm + 0,237 cm / 3 = 0,291 cm	0,093 cm + 0,296 cm + 0,253 cm / 3 = 0,214 cm
0,085 cm + 0,071 cm + 0,111 cm / 3 = 0,089 cm	0,234 cm + 0,251 cm + 0,329 cm / 3 = 0,271 cm	0,155 cm + 0,189 cm + 0,218 cm /3 = 0,187 cm
0,086 cm + 0,115 cm + 0,100 cm / 3 = 0,100 cm	0,323 cm + 0,242 cm + 0,367 cm / 3 = 0,311 cm	0,150 cm + 0,320 cm + 0,244 cm / 3 = 0,238 cm
0,072 cm + 0,069 cm + 0,074 cm / 3 = 0,072 cm	0,299 cm + 0,383 cm + 0,257 cm / 3 = 0,313 cm	0,089 cm + 0,242 cm + 0,313 cm / 3 = 0,21
0,109 cm + 0,144 cm + 0,201 cm / 3 = 0,151 cm	0,391 cm + 0,437 cm + 0,415 cm / 3 = 0,414 cm	0,153 cm + 0,298 cm + 0,365 cm / 3 = 0,272 cm
0,040 cm + 0,058 cm + 0,029 cm / 3 = 0,042 cm	0,215 cm + 0,345 cm + 0,216 cm / 3 = 0,258 cm	0,187 cm + 0,247 cm + 0,230 cm / 3 = 0,221 cm
0,026 cm + 0,037 cm + 0,025 cm / 3 = 0,029 cm	0,210 cm + 0,238 cm + 0,148 cm / 3 = 0,199 cm	0,193 cm + 0,310 cm + 0,295 cm / 3 = 0,266 cm
0,033 cm + 0,027 cm + 0,048 cm / 3 = 0,036 cm	0,169 cm + 0,165 cm + 0,238 cm / 3 = 0,190 cm	0,107 cm + 0,283 cm + 0,328 cm / 3 = 0,23
0,031 cm + 0,044 cm + 0,036 cm / 3 = 0,037 cm	0,188 cm + 0,251 cm + 0,208 cm / 3 = 0,216 cm	0,165 cm + 0,247 cm + 0,367 cm / 3 = 0,260 cm
0,078 cm + 0,042 cm + 0,048 cm / 3 = 0,056 cm	1,795 cm + 1,748 cm + 0,062 cm / 3 = 1,201 cm	0,075 cm + 0,229 cm + 0,338 cm / 3 = 0,214 cm
0,040 cm + 0,031 cm + 0,051 cm / 3 = 0,041 cm	2,038 cm + 1,062 cm + 1,083 cm / 3 = 1,394 cm	0,111 cm + 0,218 cm + 0,353 cm / 3 = 0,277 cm
0,100 cm + 0,033 cm + 0,018 cm / 3 = 0,050 cm	0,158 cm + 0,202 cm + 2,273 cm / 3 = 0,878 cm	0,120 cm + 0,359 cm + 0,539 cm / 3 = 0,339 cm
0,079 cm + 0,051 cm + 0,035 cm / 3 = 0,055 cm	0,169 cm + 0,129 cm + 1,645 cm / 3 = 0,648 cm	0,144 cm + 0,220 cm + 0,422 cm / 3 = 0,262 cm
0,029 cm + 0,032 cm + 0,042 cm / 3 = 0,034 cm	0,107 cm + 0,140 cm + 1,501 cm / 3 = 0,583 cm	0,146 cm + 0,324 cm + 0,325 cm / 3 = 0,265 cm
0,030 cm + 0,039 cm + 0,037 cm / 3 = 0,035 cm	0,188 cm + 0,201 cm + 0,065 cm / 3 = 0,151 cm	0,102 cm + 0,199 cm + 0,291 cm / 3 = 0,197 cm
0,033 cm + 0,023 cm + 0,034 cm / 3 = 0,030 cm	0,061 cm + 0,099 cm + 0,195 cm / 3 = 0,118 cm	0,053 cm + 0,149 cm + 0,238 cm / 3 = 0,147 cm
0,036 cm + 0,023 cm + 0,014 cm / 3 = 0,024 cm	0,205 cm + 0,169 cm + 0,820 cm / 3 = 0,398 cm	0,118 cm + 0,182 cm + 0,262 cm / 3 = 0,187 cm
0,064 cm + 0,040 cm + 0,038 cm / 3 = 0,047 cm	0,131 cm + 0,149 cm + 2,123 cm / 3 = 0,801 cm	0,130 cm + 0,322 cm + 0,436 cm / 3 = 0,296 cm
0,056 cm + 0,025 cm + 0,027 cm / 3 = 0,036 cm	0,126 cm + 0,198 cm + 0,179 cm / 3 = 0,168 cm	0,182 cm + 0,297 cm + 0,302 cm / 3 = 0,260
0,033 cm + 0,045 cm + 0,041 cm / 3 = 0,040 cm	0,134 cm + 0,201 cm + 0,183 cm / 3 = 0,173 cm	0,111 cm + 0,143 cm + 0,189 cm / 3 = 0,148 cm
0,088 cm + 0,086 cm + 0,068 cm / 3 = 0,081 cm	0,495 cm + 0,241 cm + 0,214 cm / 3 = 0,317 cm	0,121 cm + 0,199 cm + 0,245 cm / 3 = 0,183 cm
0,024 cm + 0,020 cm + 0,027 cm / 3 = 0,024 cm	0,328 cm + 0,243 cm + 0,316 cm / 3 = 0,296 cm	0,078 cm + 0,134 cm + 0,201 cm / 3 = 0,138 cm
0,126 cm + 0,057 cm + 0,034 cm / 3 = 0,072 cm	0,138 cm + 1,354 cm + 1,203 cm / 3 = 0,895 cm	0,059 cm + 0,124 cm + 0,235 cm / 3 = 0,139 cm
0,055 cm + 0,050 cm + 0,075 cm / 3 = 0,060 cm	0,163 cm + 0,265 cm + 0,249 cm / 3 = 0,226 cm	0,165 cm + 0,219 cm + 0,263 cm / 3 = 0,216 cm
0,088 cm + 0,100 cm + 0,029 cm / 3 = 0,072 cm	0,221 cm + 0,212 cm + 1,975 cm / 3 = 0,803 cm	0,132 cm + 0,324 cm + 0,617 cm / 3 = 0,358 cm
0,101 cm + 0,049 cm + 0,054 cm / 3 = 0,068 cm	0,205 cm + 0,130 cm + 2,370 cm / 3 = 0,902 cm	0,117 cm + 0,433 cm + 0,663 cm / 3 = 0,404 cm
0,185 cm + 0,037 cm + 0,086 cm / 3 = 0,103 cm	0,102 cm + 1,315 cm + 0,165 cm / 3 = 0,527 cm	0,168 cm + 0,382 cm + 0,452 cm / 3 = 0,334 cm
0,072 cm + 0,046 cm + 0,065 cm / 3 = 0,061 cm	0,196 cm + 0,165 cm + 1,636 cm / 3 = 0,666 cm	0,161 cm + 0,489 cm + 0,675 cm / 3 = 0,441 cm
0,056 cm + 0,066 cm + 0,037 cm / 3 = 0,053 cm	2,316 cm + 0,172 cm + 1,907 cm / 3 = 1,465 cm	0,112 cm + 0,197 cm + 0,359 cm / 3 = 0,223 cm
0,053 cm + 0,040 cm + 0,054 cm / 3 = 0,049 cm	0,160 cm + 0,881 cm + 0,149 cm / 3 = 0,397 cm	0,069 cm + 0,171 cm + 0,238 cm / 3 = 0,159 cm
0,034 cm + 0,040 cm + 0,029 cm / 3 = 0,024 cm	0,083 cm + 0,084 cm + 1,206 cm / 3 = 0,458 cm	0,091 cm + 0,143 cm + 0,247 cm / 3 = 0,160 cm
0,092 cm + 0,045 cm + 0,041 cm / 3 = 0,059 cm	0,152 cm + 0,302 cm + 1,298 cm / 3 = 1,752 cm	0,126 cm + 0,241 cm + 0,345 cm / 3 = 0,237 cm
0,042 cm + 0,047 cm + 0,045 cm / 3 = 0,045 cm	0,137 cm + 0,061 cm + 0,055 cm / 3 = 0,084 cm	0,166 cm + 0,267 cm + 0,242 cm / 3 = 0,218 cm
0,030 cm + 0,043 cm + 0,030 cm / 3 = 0,034 cm	0,070 cm + 0,077 cm + 0,082 cm / 3 = 0,076 cm	0,085 cm + 0,175 cm + 0,210 cm / 3 = 0,157 cm
0,036 cm + 0,035 cm + 0,025 cm / 3 = 0,032 cm	0,087 cm + 0,129 cm + 1,442 cm / 3 = 0,553 cm	0,080 cm + 0,165 cm + 0,260 cm / 3 = 0,168 cm
0,059 cm + 0,042 cm + 0,029 cm / 3 = 0,043 cm	0,112 cm + 0,182 cm + 1,615 cm / 3 = 0,636 cm	0,069 cm + 0,136 cm + 0,241 cm / 3 = 0,149 cm
0,086 cm + 0,067 cm + 0,036 cm / 3 = 0,063 cm	0,134 cm + 0,149 cm + 0,166 cm / 3 = 0,150 cm	0,109 cm + 0,212 cm + 0,295 cm / 3 = 0,205 cm

0,299 cm + 0,383 cm + 0,257 cm / 3 = 0,313 cm

Data Organization in Spreadsheets

7) Write your annotations for every sample

- Computers are very literal. If you do not write in each row sample information, your computer won't understand where is the sample from

not belonging to any site!

SampleID	Site	plot	root_weight
Plant_1	Site 1	1	0.56
Plant_2	?	2	0.8
Plant_3	?	3	0.59
Plant_1	Site 2	1	0.7
Plant_2	?	2	0.69
Plant_3	?	3	0.92

Each row must be unique!

8) Include your replicate number, but only for tracking purposes

Most of the analyses do not require a replicate number!

Often they are stored along with the sample name -> split in a new variable!

Some notes about date/hour formatting

- Storing dates/times in one field in the format (“15/01/2024”) can cause compatibility issues between softwares
- Storing dates as YEAR, MONTH, DAY in separate columns eliminates any ambiguities!
- as a single string YYYYMMDDhhmmss format (or YYYYMMDD for date only)
- as YEAR, DAY-OF-YEAR (**DOI**):

  “=A1-DATE(YEAR(A1);1;0)” where A2 is the date”

  see

  > **library**(anytime) # in R for format conversion!

Data Organization in Spreadsheets

Do your exercise!

```
>download.file("https://ndownloader.figshare.com/files/2252083",
"survey_data_spreadsheet_messy.xls")
```