



# for **R**eproducible data wrangling

What happens before the stats:  
the power of **R** Tidyverse for  
wrangling, cleaning, and exploring your data

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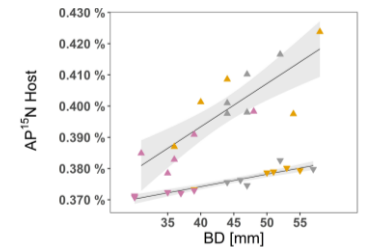
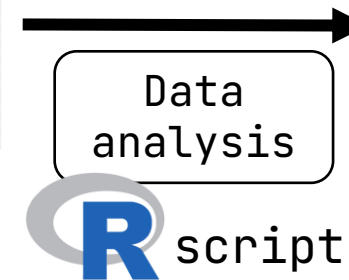
# R is for “Reproducible”

Analyze the same data and obtain the same results

## Data

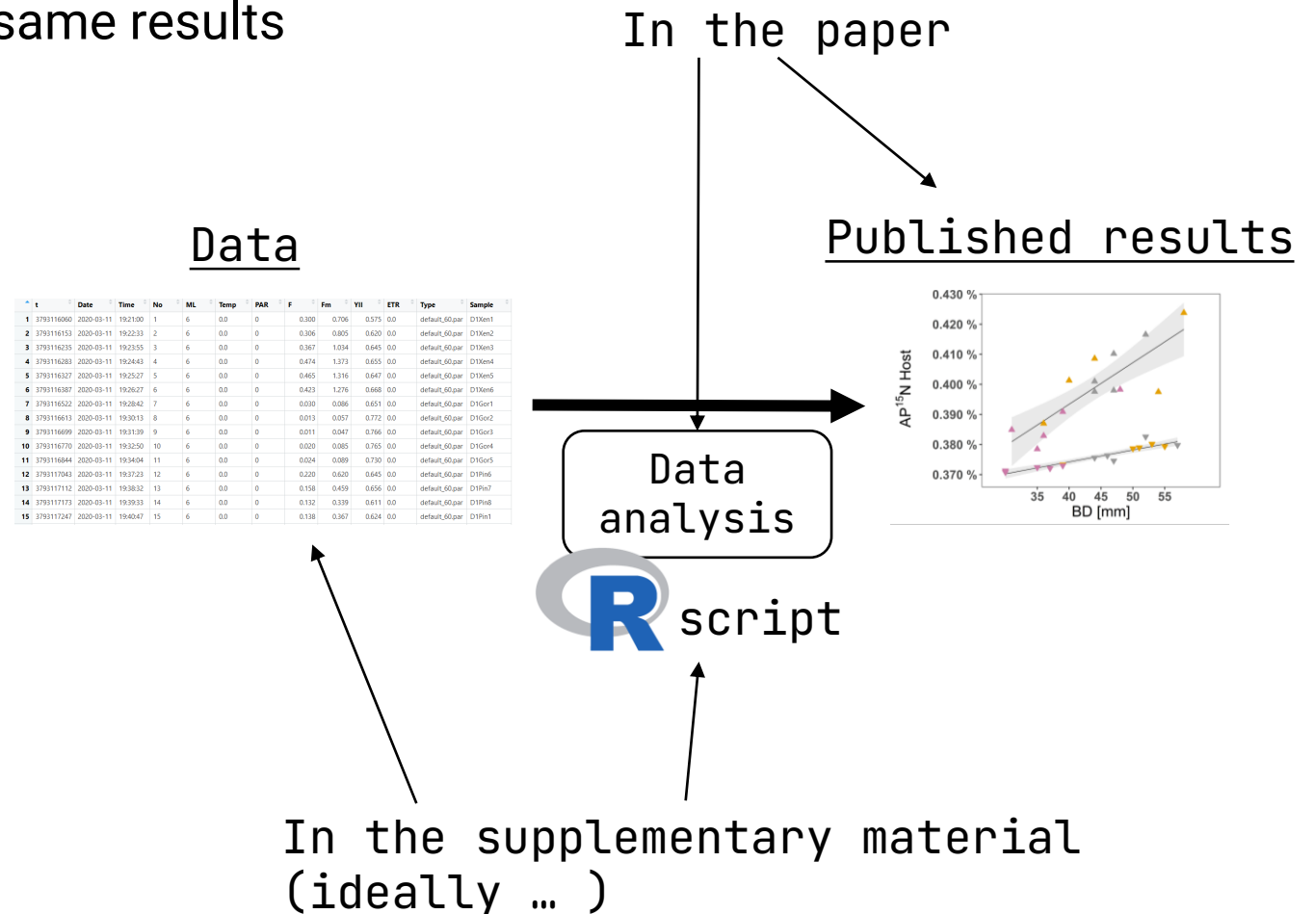
#	t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample
1	3793116090	2020-03-11	19:21:00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D13en1
2	3793116153	2020-03-11	19:22:33	2	6	0.0	0	0.306	0.805	0.620	0.0	default_60.par	D13en2
3	3793116259	2020-03-11	19:23:55	3	6	0.0	0	0.367	1.094	0.845	0.0	default_60.par	D13en3
4	3793116380	2020-03-11	19:24:43	4	6	0.0	0	0.474	1.373	0.853	0.0	default_60.par	D13en4
5	3793116327	2020-03-11	19:25:27	5	6	0.0	0	0.465	1.316	0.647	0.0	default_60.par	D13en5
6	3793116387	2020-03-11	19:26:27	6	6	0.0	0	0.423	1.276	0.668	0.0	default_60.par	D13en6
7	3793116522	2020-03-11	19:28:42	7	6	0.0	0	0.030	0.086	0.651	0.0	default_60.par	D13en1
8	3793116613	2020-03-11	19:30:13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D13en2
9	3793116699	2020-03-11	19:31:39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D13en3
10	3793116770	2020-03-11	19:32:50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D13en4
11	3793116844	2020-03-11	19:34:04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D13en5
12	3793117043	2020-03-11	19:37:23	12	6	0.0	0	0.220	0.620	0.645	0.0	default_60.par	D19In6
13	3793117112	2020-03-11	19:38:32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D19In7
14	3793117173	2020-03-11	19:39:33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D19In8
15	3793117247	2020-03-11	19:40:47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D19In1

## Published results



# R is for “Reproducible”

Analyze the same data and obtain the same results



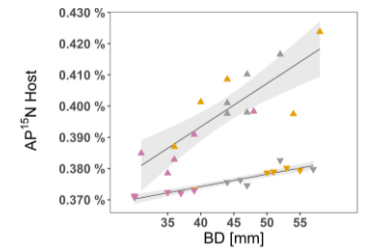
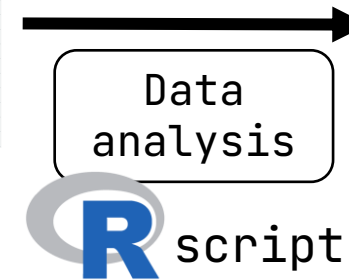
# R is for “Reproducible”

But there’s also that other part ...

## Data

#	t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample
1	3793116090	2020-03-11	19:21:00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D19en1
2	3793116153	2020-03-11	19:22:33	2	6	0.0	0	0.306	0.805	0.620	0.0	default_60.par	D19en2
3	3793116205	2020-03-11	19:23:55	3	6	0.0	0	0.367	1.094	0.845	0.0	default_60.par	D19en3
4	3793116280	2020-03-11	19:24:43	4	6	0.0	0	0.474	1.373	0.853	0.0	default_60.par	D19en4
5	3793116327	2020-03-11	19:25:07	5	6	0.0	0	0.465	1.316	0.847	0.0	default_60.par	D19en5
6	3793116387	2020-03-11	19:26:27	6	6	0.0	0	0.423	1.276	0.868	0.0	default_60.par	D19en6
7	3793116522	2020-03-11	19:28:42	7	6	0.0	0	0.030	0.086	0.651	0.0	default_60.par	D19en1
8	3793116613	2020-03-11	19:30:13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D19en2
9	3793116699	2020-03-11	19:31:39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D19en3
10	3793116770	2020-03-11	19:32:50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D19en4
11	3793116844	2020-03-11	19:34:04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D19en5
12	3793117043	2020-03-11	19:37:23	12	6	0.0	0	0.220	0.620	0.645	0.0	default_60.par	D19en6
13	3793117112	2020-03-11	19:38:32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D19en7
14	3793117173	2020-03-11	19:39:33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D19en8
15	3793117247	2020-03-11	19:40:47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D19en1

## Published results



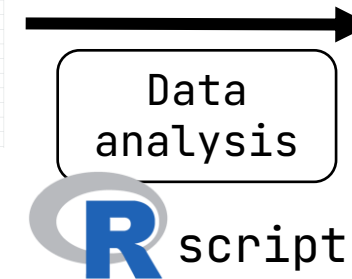
# R is for “Reproducible”

But there's also that other part ...

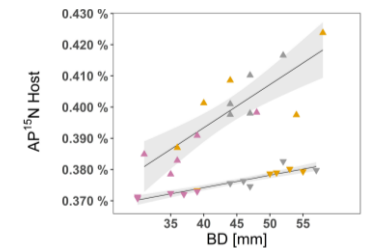
Cleaned data  
ready for stats

Data

#	t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample
1	3793116000	2020-03-11	19:21:00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D19en1
2	3793116153	2020-03-11	19:22:33	2	6	0.0	0	0.306	0.695	0.620	0.0	default_60.par	D19en2
3	3793116295	2020-03-11	19:23:55	3	6	0.0	0	0.367	1.094	0.645	0.0	default_60.par	D19en3
4	3793116380	2020-03-11	19:24:43	4	6	0.0	0	0.474	1.373	0.653	0.0	default_60.par	D19en4
5	3793116327	2020-03-11	19:25:07	5	6	0.0	0	0.465	1.316	0.647	0.0	default_60.par	D19en5
6	3793116387	2020-03-11	19:26:27	6	6	0.0	0	0.423	1.276	0.668	0.0	default_60.par	D19en6
7	3793116552	2020-03-11	19:28:42	7	6	0.0	0	0.030	0.066	0.651	0.0	default_60.par	D19en7
8	3793116613	2020-03-11	19:30:13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D19en8
9	3793116699	2020-03-11	19:31:39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D19en9
10	3793116770	2020-03-11	19:32:50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D19en10
11	3793116844	2020-03-11	19:34:04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D19en11
12	3793117043	2020-03-11	19:37:23	12	6	0.0	0	0.220	0.620	0.645	0.0	default_60.par	D19en12
13	3793117112	2020-03-11	19:38:32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D19en13
14	3793117173	2020-03-11	19:39:33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D19en14
15	3793117247	2020-03-11	19:40:47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D19en15



Published results



# R is for “Reproducible”

Original data



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T	A	B	C	D	E	F	G	H	I	J	K	L	M
1	Time	Temp	ML	CO <sub>2</sub>	Temp	PAR	F	Fm	Fv	YII	ETR		
1	19:00:00	19.01	0.00	100.00	19.01	0	0	0	0.4	0.706	0.575		
2	19:00:00	19.02	0.00	100.00	19.02	0	0	0	0.4	0.706	0.575		
3	19:00:00	19.03	0.00	100.00	19.03	0	0	0	0.4	0.706	0.575		
4	19:00:00	19.04	0.00	100.00	19.04	0	0	0	0.4	0.706	0.575		
5	19:00:00	19.05	0.00	100.00	19.05	0	0	0	0.4	0.706	0.575		
6	19:00:00	19.06	0.00	100.00	19.06	0	0	0	0.4	0.706	0.575		
7	19:00:00	19.07	0.00	100.00	19.07	0	0	0	0.4	0.706	0.575		
8	19:00:00	19.08	0.00	100.00	19.08	0	0	0	0.4	0.706	0.575		
9	19:00:00	19.09	0.00	100.00	19.09	0	0	0	0.4	0.706	0.575		
10	19:00:00	19.10	0.00	100.00	19.10	0	0	0	0.4	0.706	0.575		
11	19:00:00	19.11	0.00	100.00	19.11	0	0	0	0.4	0.706	0.575		
12	19:00:00	19.12	0.00	100.00	19.12	0	0	0	0.4	0.706	0.575		
13	19:00:00	19.13	0.00	100.00	19.13	0	0	0	0.4	0.706	0.575		
14	19:00:00	19.14	0.00	100.00	19.14	0	0	0	0.4	0.706	0.575		
15	19:00:00	19.15	0.00	100.00	19.15	0	0	0	0.4	0.706	0.575		
16	19:00:00	19.16	0.00	100.00	19.16	0	0	0	0.4	0.706	0.575		
17	19:00:00	19.17	0.00	100.00	19.17	0	0	0	0.4	0.706	0.575		
18	19:00:00	19.18	0.00	100.00	19.18	0	0	0	0.4	0.706	0.575		
19	19:00:00	19.19	0.00	100.00	19.19	0	0	0	0.4	0.706	0.575		
20	19:00:00	19.20	0.00	100.00	19.20	0	0	0	0.4	0.706	0.575		
21	19:00:00	19.21	0.00	100.00	19.21	0	0	0	0.4	0.706	0.575		
22	19:00:00	19.22	0.00	100.00	19.22	0	0	0	0.4	0.706	0.575		
23	19:00:00	19.23	0.00	100.00	19.23	0	0	0	0.4	0.706	0.575		
24	19:00:00	19.24	0.00	100.00	19.24	0	0	0	0.4	0.706	0.575		
25	19:00:00	19.25	0.00	100.00	19.25	0	0	0	0.4	0.706	0.575		
26	19:00:00	19.26	0.00	100.00	19.26	0	0	0	0.4	0.706	0.575		
27	19:00:00	19.27	0.00	100.00	19.27	0	0	0	0.4	0.706	0.575		
28	19:00:00	19.28	0.00	100.00	19.28	0	0	0	0.4	0.706	0.575		
29	19:00:00	19.29	0.00	100.00	19.29	0	0	0	0.4	0.706	0.575		
30	19:00:00	19.30	0.00	100.00	19.30	0	0	0	0.4	0.706	0.575		
31	19:00:00	19.31	0.00	100.00	19.31	0	0	0	0.4	0.706	0.575		
32	19:00:00	19.32	0.00	100.00	19.32	0	0	0	0.4	0.706	0.575		
33	19:00:00	19.33	0.00	100.00	19.33	0	0	0	0.4	0.706	0.575		
34	19:00:00	19.34	0.00	100.00	19.34	0	0	0	0.4	0.706	0.575		
35	19:00:00	19.35	0.00	100.00	19.35	0	0	0	0.4	0.706	0.575		
36	19:00:00	19.36	0.00	100.00	19.36	0	0	0	0.4	0.706	0.575		
37	19:00:00	19.37	0.00	100.00	19.37	0	0	0	0.4	0.706	0.575		
38	19:00:00	19.38	0.00	100.00	19.38	0	0	0	0.4	0.706	0.575		
39	19:00:00	19.39	0.00	100.00	19.39	0	0	0	0.4	0.706	0.575		
40	19:00:00	19.40	0.00	100.00	19.40	0	0	0	0.4	0.706	0.575		
41	19:00:00	19.41	0.00	100.00	19.41	0	0	0	0.4	0.706	0.575		
42	19:00:00	19.42	0.00	100.00	19.42	0	0	0	0.4	0.706	0.575		
43	19:00:00	19.43	0.00	100.00	19.43	0	0	0	0.4	0.706	0.575		
44	19:00:00	19.44	0.00	100.00	19.44	0	0	0	0.4	0.706	0.575		
45	19:00:00	19.45	0.00	100.00	19.45	0	0	0	0.4	0.706	0.575		
46	19:00:00	19.46	0.00	100.00	19.46	0	0	0	0.4	0.706	0.575		
47	19:00:00	19.47	0.00	100.00	19.47	0	0	0	0.4	0.706	0.575		
48	19:00:00	19.48	0.00	100.00	19.48	0	0	0	0.4	0.706	0.575		
49	19:00:00	19.49	0.00	100.00	19.49	0	0	0	0.4	0.706	0.575		
50	19:00:00	19.50	0.00	100.00	19.50	0	0	0	0.4	0.706	0.575		
51	19:00:00	19.51	0.00	100.00	19.51	0	0	0	0.4	0.706	0.575		
52	19:00:00	19.52	0.00	100.00	19.52	0	0	0	0.4	0.706	0.575		
53	19:00:00	19.53	0.00	100.00	19.53	0	0	0	0.4	0.706	0.575		
54	19:00:00	19.54	0.00	100.00	19.54	0	0	0	0.4	0.706	0.575		
55	19:00:00	19.55	0.00	100.00	19.55	0	0	0	0.4	0.706	0.575		
56	19:00:00	19.56	0.00	100.00	19.56	0	0	0	0.4	0.706	0.575		
57	19:00:00	19.57	0.00	100.00	19.57	0	0	0	0.4	0.706	0.575		
58	19:00:00	19.58	0.00	100.00	19.58	0	0	0	0.4	0.706	0.575		
59	19:00:00	19.59	0.00	100.00	19.59	0	0	0	0.4	0.706	0.575		
60	19:00:00	19.60	0.00	100.00	19.60	0	0	0	0.4	0.706	0.575		

original  
outputs

hand notes

digitalize


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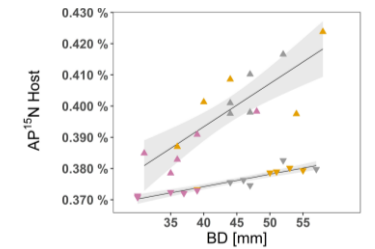
Data  
wrangling

Cleaned data  
ready for stats

t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample
1	2020-03-11	19:21:00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D19m1
2	2020-03-11	19:22:33	2	6	0.0	0	0.306	0.695	0.620	0.0	default_60.par	D19m2
3	2020-03-11	19:23:55	3	6	0.0	0	0.367	1.094	0.645	0.0	default_60.par	D19m3
4	2020-03-11	19:24:43	4	6	0.0	0	0.474	1.373	0.653	0.0	default_60.par	D19m4
5	2020-03-11	19:25:07	5	6	0.0	0	0.465	1.316	0.647	0.0	default_60.par	D19m5
6	2020-03-11	19:26:27	6	6	0.0	0	0.423	1.276	0.668	0.0	default_60.par	D19m6
7	2020-03-11	19:28:42	7	6	0.0	0	0.030	0.066	0.651	0.0	default_60.par	D19m7
8	2020-03-11	19:30:13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D19m8
9	2020-03-11	19:31:39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D19m9
10	2020-03-11	19:32:50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D19m10
11	2020-03-11	19:34:04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D19m11
12	2020-03-11	19:37:23	12	6	0.0	0	0.220	0.620	0.645	0.0	default_60.par	D19m12
13	2020-03-11	19:38:32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D19m13
14	2020-03-11	19:39:33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D19m14
15	2020-03-11	19:40:47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D19m15

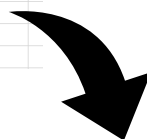
Published results

Data  
analysis  
 script



## Unusable format ...

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	t	Date	Time	No.	ML	Temp.	PAR	F	Fm'	Y(II)	ETR		
2	3.79E+09	11.03.20	19:09:54	Type:									
3	3.79E+09	11.03.20	19:21:01	default_60.par									
4	3.79E+09	11.03.20	19:21:00	1	6	0	0	0.3	0.706	0.575	0		
5	3.79E+09	11.03.20	19:21:43	D1Xen1									
6	3.79E+09	11.03.20	19:22:33	2	6	0	0	0.306	0.805	0.62	0		
7	3.79E+09	11.03.20	19:22:45	D1Xen2									
8	3.79E+09	11.03.20	19:23:55	3	6	0	0	0.367	1.034	0.645	0		
9	3.79E+09	11.03.20	19:24:11	D1Xen3									
10	3.79E+09	11.03.20	19:24:43	4	6	0	0	0.474	1.373	0.655	0		
11	3.79E+09	11.03.20	19:24:59	D1Xen4									
12	3.79E+09	11.03.20	19:25:27	5	6	0	0	0.465	1.316	0.647	0		
13	3.79E+09	11.03.20	19:25:52	D1Xen5									
14	3.79E+09	11.03.20	19:26:27	6	6	0	0	0.423	1.276	0.668	0		
15	3.79E+09	11.03.20	19:26:43	D1Xen6									
16	3.79E+09	11.03.20	19:28:42	7	6	0	0	0.03	0.086	0.651	0		
17	3.79E+09	11.03.20	19:28:59	D1Gor1									
18	3.79E+09	11.03.20	19:30:13	8	6	0	0	0.013	0.057	0.772	0		
19	3.79E+09	11.03.20	19:30:29	D1Gor2									



... ready to be analyzed ☺

	t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample
1	3793116060	2020-03-11	19:21:00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D1Xen1
2	3793116153	2020-03-11	19:22:33	2	6	0.0	0	0.306	0.805	0.620	0.0	default_60.par	D1Xen2
3	3793116235	2020-03-11	19:23:55	3	6	0.0	0	0.367	1.034	0.645	0.0	default_60.par	D1Xen3
4	3793116283	2020-03-11	19:24:43	4	6	0.0	0	0.474	1.373	0.655	0.0	default_60.par	D1Xen4
5	3793116327	2020-03-11	19:25:27	5	6	0.0	0	0.465	1.316	0.647	0.0	default_60.par	D1Xen5
6	3793116387	2020-03-11	19:26:27	6	6	0.0	0	0.423	1.276	0.668	0.0	default_60.par	D1Xen6
7	3793116522	2020-03-11	19:28:42	7	6	0.0	0	0.030	0.086	0.651	0.0	default_60.par	D1Gor1
8	3793116613	2020-03-11	19:30:13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D1Gor2
9	3793116699	2020-03-11	19:31:39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D1Gor3
10	3793116770	2020-03-11	19:32:50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D1Gor4
11	3793116844	2020-03-11	19:34:04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D1Gor5
12	3793117043	2020-03-11	19:37:23	12	6	0.0	0	0.220	0.620	0.645	0.0	default_60.par	D1Pin6
13	3793117112	2020-03-11	19:38:32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D1Pin7
14	3793117173	2020-03-11	19:39:33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D1Pin8
15	3793117247	2020-03-11	19:40:47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D1Pin1



# R is for “Reproducible”

Original data



+

t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample
1	2020-03-11	19:21:00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D19en1
2	2020-03-11	19:22:33	2	6	0.0	0	0.306	0.805	0.620	0.0	default_60.par	D19en2
3	2020-03-11	19:23:55	3	6	0.0	0	0.367	1.094	0.845	0.0	default_60.par	D19en3
4	2020-03-11	19:24:43	4	6	0.0	0	0.474	1.373	0.855	0.0	default_60.par	D19en4
5	2020-03-11	19:25:27	5	6	0.0	0	0.465	1.316	0.847	0.0	default_60.par	D19en5
6	2020-03-11	19:26:27	6	6	0.0	0	0.423	1.276	0.868	0.0	default_60.par	D19en6
7	2020-03-11	19:28:42	7	6	0.0	0	0.030	0.086	0.651	0.0	default_60.par	D19en7
8	2020-03-11	19:30:13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D19en8
9	2020-03-11	19:31:39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D19en9
10	2020-03-11	19:32:50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D19en10
11	2020-03-11	19:34:04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D19en11
12	2020-03-11	19:37:23	12	6	0.0	0	0.220	0.620	0.645	0.0	default_60.par	D19en12
13	2020-03-11	19:38:32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D19en13
14	2020-03-11	19:39:33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D19en14
15	2020-03-11	19:40:47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D19en15

original  
outputs

hand notes

digitalize

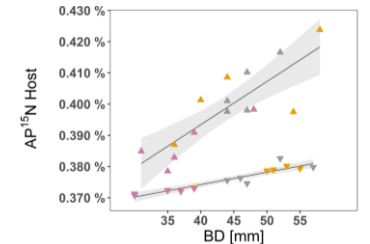
Sample	
1	2020-03-11 19:21:00
2	2020-03-11 19:22:33
3	2020-03-11 19:23:55
4	2020-03-11 19:24:43
5	2020-03-11 19:25:27
6	2020-03-11 19:26:27
7	2020-03-11 19:28:42
8	2020-03-11 19:30:13
9	2020-03-11 19:31:39
10	2020-03-11 19:32:50
11	2020-03-11 19:34:04
12	2020-03-11 19:37:23
13	2020-03-11 19:38:32
14	2020-03-11 19:39:33
15	2020-03-11 19:40:47

Data  
wrangling

Cleaned data  
ready for stats

t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample
1	2020-03-11	19:21:00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D19en1
2	2020-03-11	19:22:33	2	6	0.0	0	0.306	0.805	0.620	0.0	default_60.par	D19en2
3	2020-03-11	19:23:55	3	6	0.0	0	0.367	1.094	0.845	0.0	default_60.par	D19en3
4	2020-03-11	19:24:43	4	6	0.0	0	0.474	1.373	0.855	0.0	default_60.par	D19en4
5	2020-03-11	19:25:27	5	6	0.0	0	0.465	1.316	0.847	0.0	default_60.par	D19en5
6	2020-03-11	19:26:27	6	6	0.0	0	0.423	1.276	0.868	0.0	default_60.par	D19en6
7	2020-03-11	19:28:42	7	6	0.0	0	0.030	0.086	0.651	0.0	default_60.par	D19en7
8	2020-03-11	19:30:13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D19en8
9	2020-03-11	19:31:39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D19en9
10	2020-03-11	19:32:50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D19en10
11	2020-03-11	19:34:04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D19en11
12	2020-03-11	19:37:23	12	6	0.0	0	0.220	0.620	0.645	0.0	default_60.par	D19en12
13	2020-03-11	19:38:32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D19en13
14	2020-03-11	19:39:33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D19en14
15	2020-03-11	19:40:47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D19en15

Published results



Data  
analysis

**R** script

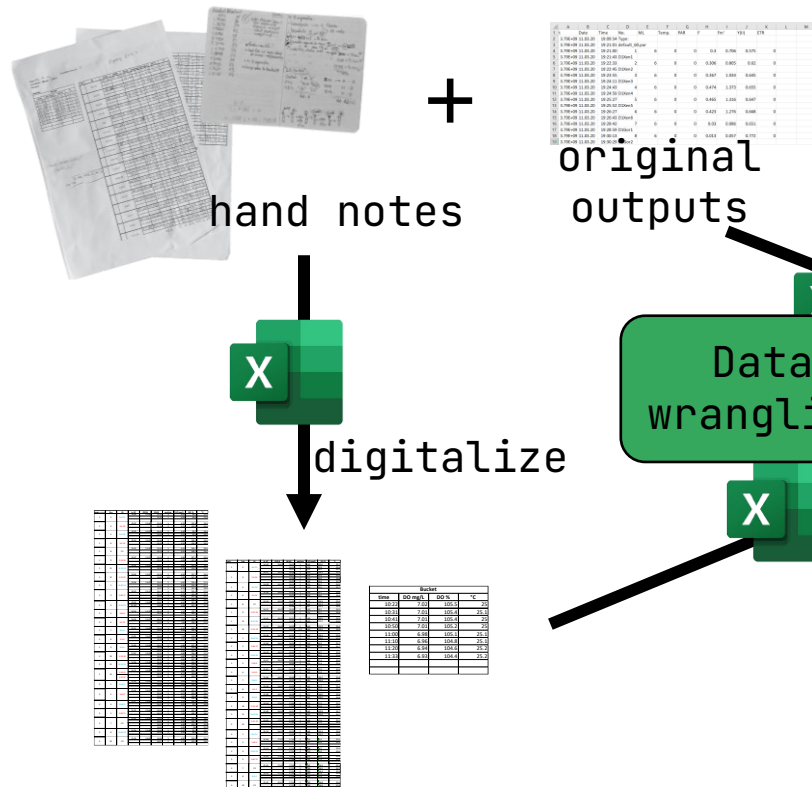
**Often overlooked/underestimated:**

- Not systematically taught (missing from typical R courses)  
⇒ badly done (= NOT reproducible)
- Time consuming (can take up as more time than stat testing)  
⇒ **sensitive step** ⇒ room for improvement!



# R is for “Reproducible”

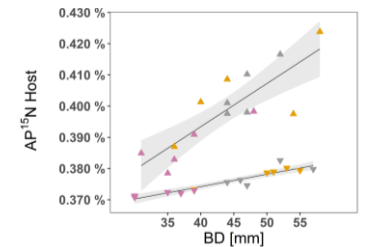
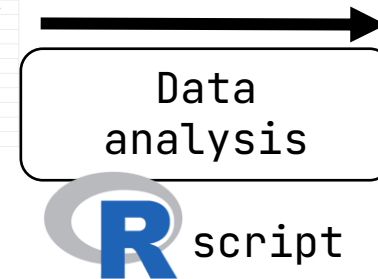
Original data



Cleaned data  
ready for stats

t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample	
1	3793116000	2020-03-11	1921.00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D13en1
2	3793116153	2020-03-11	1922.33	2	6	0.0	0	0.306	0.805	0.620	0.0	default_60.par	D13en2
3	3793116295	2020-03-11	1923.55	3	6	0.0	0	0.367	1.054	0.845	0.0	default_60.par	D13en3
4	3793116382	2020-03-11	1924.43	4	6	0.0	0	0.474	1.373	0.653	0.0	default_60.par	D13en4
5	3793116387	2020-03-11	1925.07	5	6	0.0	0	0.465	1.316	0.647	0.0	default_60.par	D13en5
6	3793116387	2020-03-11	1926.27	6	6	0.0	0	0.423	1.276	0.668	0.0	default_60.par	D13en6
7	3793116552	2020-03-11	1928.42	7	6	0.0	0	0.030	0.066	0.651	0.0	default_60.par	D13en7
8	3793116613	2020-03-11	1930.13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D13en8
9	3793116699	2020-03-11	1931.39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D13en9
10	3793116770	2020-03-11	1932.50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D13en10
11	3793116844	2020-03-11	1934.04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D13en11
12	3793117043	2020-03-11	1937.23	12	6	0.0	0	0.220	0.620	0.643	0.0	default_60.par	D13en12
13	3793117112	2020-03-11	1938.32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D13en13
14	3793117173	2020-03-11	1939.33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D13en14
15	3793117247	2020-03-11	1940.47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D13en15

Published results



# Beware of spreadsheets ...

Problems derived from working with spreadsheets:

- Messy (many files) ...
- **Error prone** (e.g. genuine mistakes + autocorrection ... )
- **Not scalable** (it just doesn't work with large data sets)
- **Not reproducible** (hard to keep track of every action)



**John Feminella** 🐦 @jxxf · 23h

Optimist: The glass is ½ full.

Pessimist: The glass is ½ empty.

Excel: The glass is January 2nd.

💬 70

🔄 4,241

❤️ 40K



**nature**

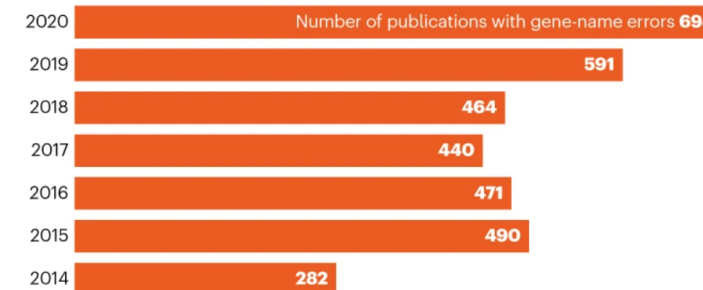
NEWS | 13 August 2021 | Correction [25 August 2021](#)

## Autocorrect errors in Excel still creating genomics headache

Despite geneticists being warned about spreadsheet problems, 30% of published papers contain mangled gene names in supplementary data.

### A GROWING PROBLEM

A 2016 analysis found that 20% of papers featuring gene names had errors created by spreadsheet autocorrect functions, but a bigger survey now finds the proportion is up to 30%. Since 2014, the number of papers with errors has increased significantly.



©nature

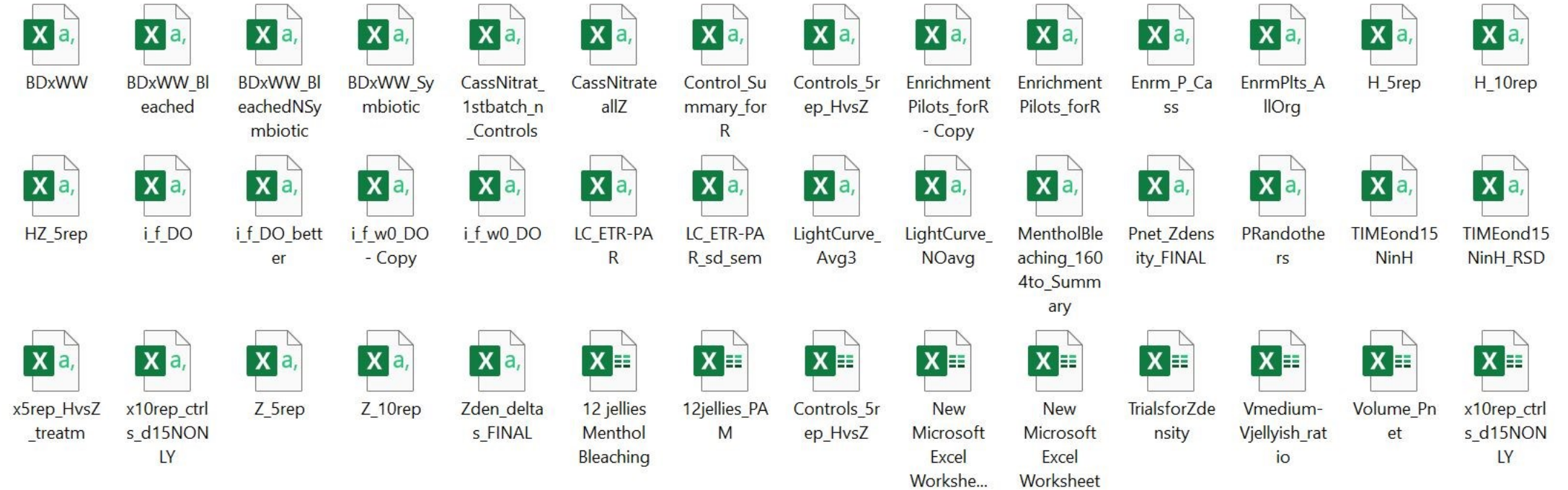
# Beware of spreadsheets ...

Problems derived from working with spreadsheets:

- Messy (many files) ...
- **Error prone** (e.g. genuine mistakes + autocorrection ... )
- **Not scalable** (it just doesn't work with large data sets)
- **Not reproducible** (hard to keep track of every action)

On the contrary, in **R**, you can do everything **without** ever **altering the original data!**  
(which also means that you can change your mind and easily un-do and re-do any operation)

Old me before discovering Tidyverse ...



Old me before discovering Tidyverse ...



# R is for “Reproducible”

Original data



+

1	A	B	C	D	E	F	G	H	I	J	K	L	M
2	Time	Temp	PAR	WEL	Temp	PAR	F	Fm	YII	ETR			
3	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
4	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
5	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
6	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
7	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
8	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
9	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
10	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
11	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
12	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
13	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
14	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
15	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
16	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
17	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
18	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
19	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
20	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
21	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
22	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
23	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
24	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
25	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
26	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
27	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
28	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
29	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
30	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
31	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
32	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
33	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
34	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
35	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
36	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
37	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
38	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
39	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
40	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
41	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
42	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
43	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
44	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
45	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
46	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
47	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
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49	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
50	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
51	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
52	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
53	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
54	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
55	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
56	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
57	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
58	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
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62	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
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67	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
68	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
69	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
70	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
71	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
72	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
73	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
74	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
75	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
76	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
77	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
78	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
79	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
80	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
81	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
82	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
83	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
84	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
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86	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
87	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
88	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
89	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
90	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
91	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
92	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
93	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
94	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
95	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
96	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
97	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
98	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
99	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			
100	19:00:00	18.02	0	0	20.0	0.0	0.3	0.706	0.575	0.0			

original  
outputs

hand notes

digitalize

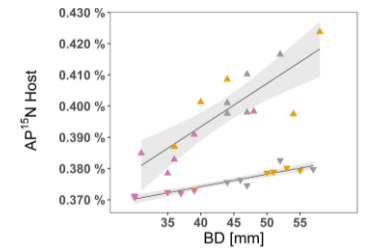
Data  
wrangling

Cleaned data  
ready for stats

Published results

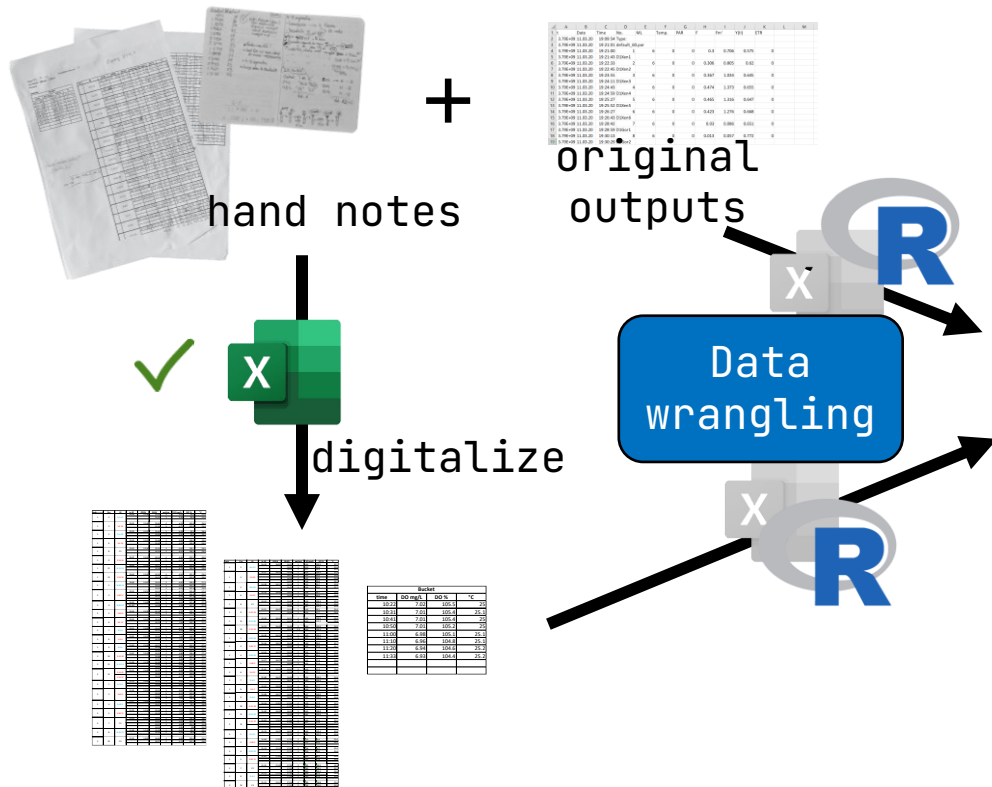
t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample	
1	1793116000	2020-03-11	1921.00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D19en1
2	1793116153	2020-03-11	1922.33	2	6	0.0	0	0.306	0.805	0.620	0.0	default_60.par	D19en2
3	1793116295	2020-03-11	1923.55	3	6	0.0	0	0.367	1.054	0.845	0.0	default_60.par	D19en3
4	1793116380	2020-03-11	1924.43	4	6	0.0	0	0.474	1.373	0.853	0.0	default_60.par	D19en4
5	1793116387	2020-03-11	1925.07	5	6	0.0	0	0.465	1.316	0.647	0.0	default_60.par	D19en5
6	1793116387	2020-03-11	1926.27	6	6	0.0	0	0.423	1.276	0.668	0.0	default_60.par	D19en6
7	1793116522	2020-03-11	1928.42	7	6	0.0	0	0.030	0.086	0.651	0.0	default_60.par	D19en7
8	1793116613	2020-03-11	1930.13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D19en8
9	1793116699	2020-03-11	1931.39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D19en9
10	1793116770	2020-03-11	1932.50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D19en10
11	1793116844	2020-03-11	1934.04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D19en11
12	1793117043	2020-03-11	1937.23	12	6	0.0	0	0.220	0.620	0.645	0.0	default_60.par	D19en12
13	1793117112	2020-03-11	1938.32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D19en13
14	1793117173	2020-03-11	1939.33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D19en14
15	1793117247	2020-03-11	1940.47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D19en15

Data  
analysis



# R is for “Reproducible”

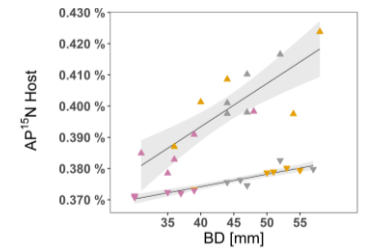
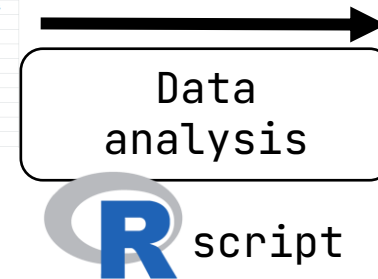
Original data



Cleaned data  
ready for stats

t	Date	Time	No	ML	Temp	PAR	F	Fm	YII	ETR	Type	Sample	
1	3793116000	2020-03-11	1921.00	1	6	0.0	0	0.300	0.706	0.575	0.0	default_60.par	D19en1
2	3793116153	2020-03-11	1922.33	2	6	0.0	0	0.306	0.695	0.620	0.0	default_60.par	D19en2
3	3793116295	2020-03-11	1923.55	3	6	0.0	0	0.367	1.094	0.645	0.0	default_60.par	D19en3
4	3793116380	2020-03-11	1924.43	4	6	0.0	0	0.474	1.373	0.653	0.0	default_60.par	D19en4
5	3793116387	2020-03-11	1925.07	5	6	0.0	0	0.465	1.316	0.647	0.0	default_60.par	D19en5
6	3793116387	2020-03-11	1926.27	6	6	0.0	0	0.423	1.276	0.668	0.0	default_60.par	D19en6
7	3793116552	2020-03-11	1928.42	7	6	0.0	0	0.030	0.066	0.651	0.0	default_60.par	D19en7
8	3793116613	2020-03-11	1930.13	8	6	0.0	0	0.013	0.057	0.772	0.0	default_60.par	D19en8
9	3793116699	2020-03-11	1931.39	9	6	0.0	0	0.011	0.047	0.766	0.0	default_60.par	D19en9
10	3793116770	2020-03-11	1932.50	10	6	0.0	0	0.020	0.085	0.765	0.0	default_60.par	D19en10
11	3793116844	2020-03-11	1934.04	11	6	0.0	0	0.024	0.089	0.730	0.0	default_60.par	D19en11
12	3793117043	2020-03-11	1937.23	12	6	0.0	0	0.220	0.620	0.645	0.0	default_60.par	D19en12
13	3793117112	2020-03-11	1938.32	13	6	0.0	0	0.158	0.459	0.656	0.0	default_60.par	D19en13
14	3793117173	2020-03-11	1939.33	14	6	0.0	0	0.132	0.339	0.611	0.0	default_60.par	D19en14
15	3793117247	2020-03-11	1940.47	15	6	0.0	0	0.138	0.367	0.624	0.0	default_60.par	D19en15

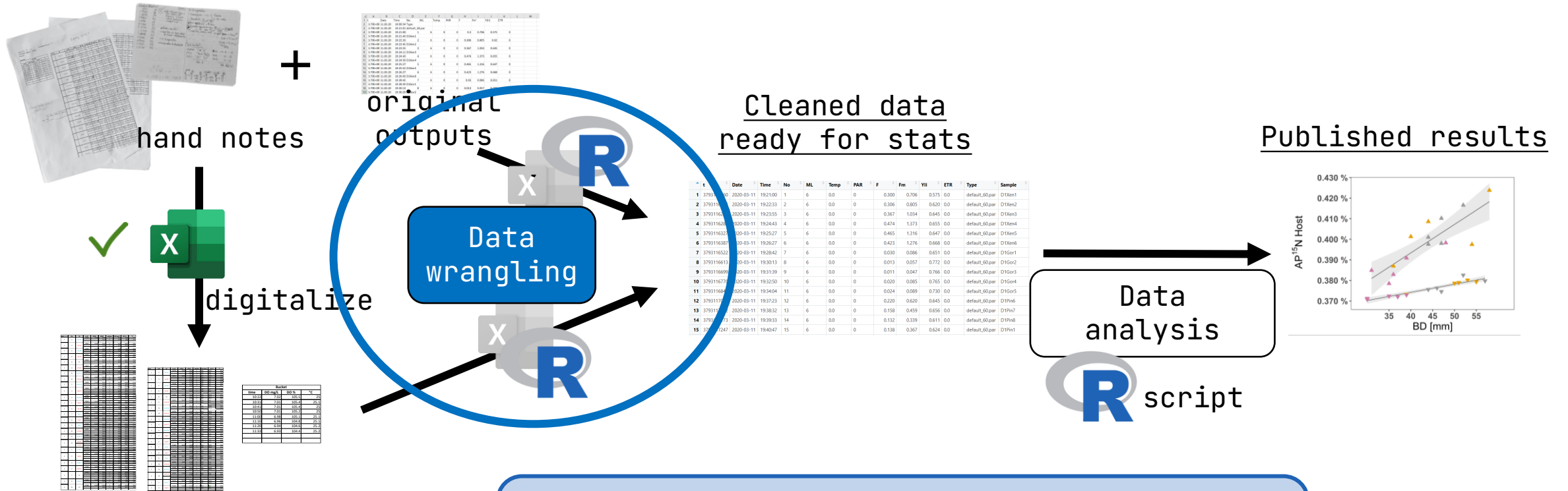
Published results





# R is for “Reproducible”

## Original data



Reproducible data manipulation:  
**use R from the very beginning** of your analysis  
(not just for the stats and plots)!



# Tidyverse



A **collection of R packages** designed for **data science**, that share an underlying design philosophy, grammar, and structure.

“A gateway drug.”  
- my friend James

Noteworthy aspects:

1. Concept of “**Tidy data**”
2. The **pipe** (`%>%`) (more human readable than nested functions)



# 1. Tidy data

Simple rules:

- Every **column** is a **variable**.
- Every **row** is an **observation**.
- Every **cell** is a **single value**.

country	year	cases	population
Afghanistan	1999	15	199871
Afghanistan	2000	566	2005360
Brazil	1999	3737	17206362
Brazil	2000	8488	17404898
China	1999	21258	127201272
China	2000	21796	12802583

variables

country	year	cases	population
Afghanistan	1999	15	199871
Afghanistan	2000	566	2005360
Brazil	1999	3737	17206362
Brazil	2000	8488	17404898
China	1999	21258	127201272
China	2000	21796	12802583

observations

country	year	cases	population
Afghanistan	1999	15	199871
Afghanistan	2000	566	2005360
Brazil	1999	3737	17206362
Brazil	2000	8488	17404898
China	1999	21258	127201272
China	2000	21796	12802583

values

Happy families are all alike; every  
unhappy family is unhappy in its own  
way.

Leo Tolstoy

<sup>12</sup> Tidy data | R for Data Science (had.co.nz)

# 1. Tidy data

Simple rules:

- Every **column** is a **variable**.
- Every **row** is an **observation**.
- Every **cell** is a **single value**.

country	year	cases	population
Afghanistan	1999	745	19987071
Afghanistan	2000	2666	20595360
Brazil	1999	37737	172006362
Brazil	2000	80488	174504898
China	1999	212258	1272915272
China	2000	213766	1280428583

variables

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country	year	rate
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China	1999	212258 / 1272915272
China	2000	213766 / 1280428583

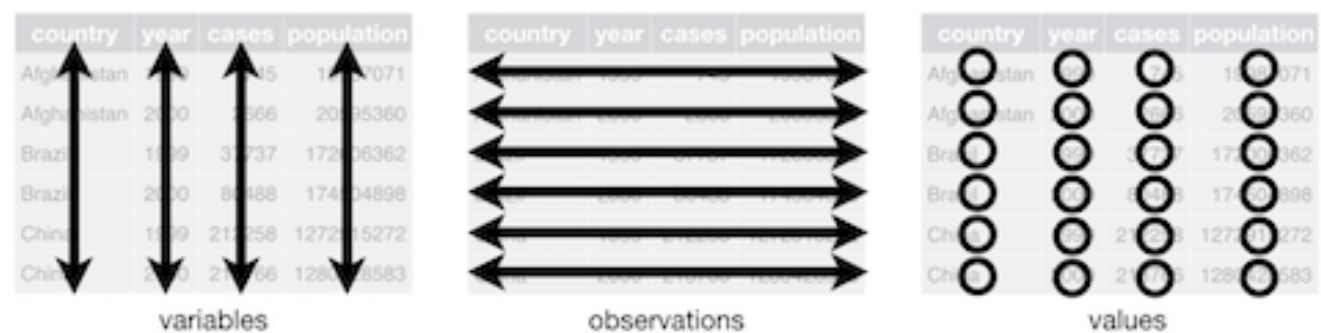
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China	2000	210706	1280005583
China	2000	210706	1280005583

values

[12 Tidy data | R for Data Science \(had.co.nz\)](#)

	treatmenta	treatmentb
John Smith	—	2
Jane Doe	16	11
Mary Johnson	3	1

	John Smith	Jane Doe	Mary Johnson
treatmenta	—	16	3
treatmentb	2	11	1

person	treatment	result
John Smith	a	—
Jane Doe	a	16
Mary Johnson	a	3
John Smith	b	2
Jane Doe	b	11
Mary Johnson	b	1

# 1. Tidy data

Happy families are all alike; every unhappy family is unhappy in its own way.

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observations

country	year	cases	population
Alghanistan	2000	2566	20005360
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Alghanistan	2000	2566	20005360
Alghanistan	2000	2566	20005360
Alghanistan	2000	2566	20005360

values

12 Tidy data | R for Data Science (had.co.nz)

	treatmenta	treatmentb
John Smith	—	2
Jane Doe	16	11
Mary Johnson	3	1

“wide”

	John Smith	Jane Doe	Mary Johnson
treatmenta	—	16	3
treatmentb	2	11	1

“wide”

person	treatment	result
John Smith	a	—
Jane Doe	a	16
Mary Johnson	a	3
John Smith	b	2
Jane Doe	b	11
Mary Johnson	b	1

“long”

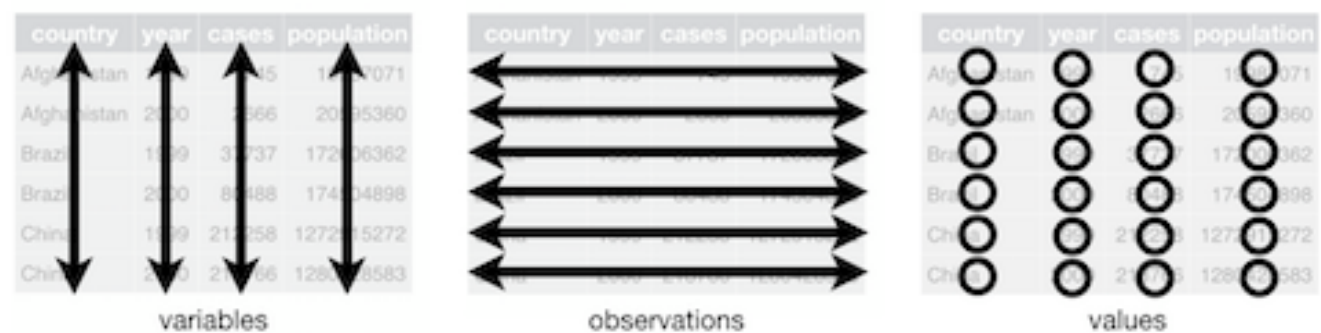
Happy families are all alike; every unhappy family is unhappy in its own way.

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# 1. Tidy data

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- Every **cell** is a single **value**.



[12 Tidy data | R for Data Science \(had.co.nz\)](#)

Only column names

Row names

Column names

	John Smith	Jane Doe	Mary Johnson
treatmenta	—	16	3
treatmentb	2	11	1

Not tidy

person	treatment	result
John Smith	a	—
Jane Doe	a	16
Mary Johnson	a	3
John Smith	b	2
Jane Doe	b	11
Mary Johnson	b	1

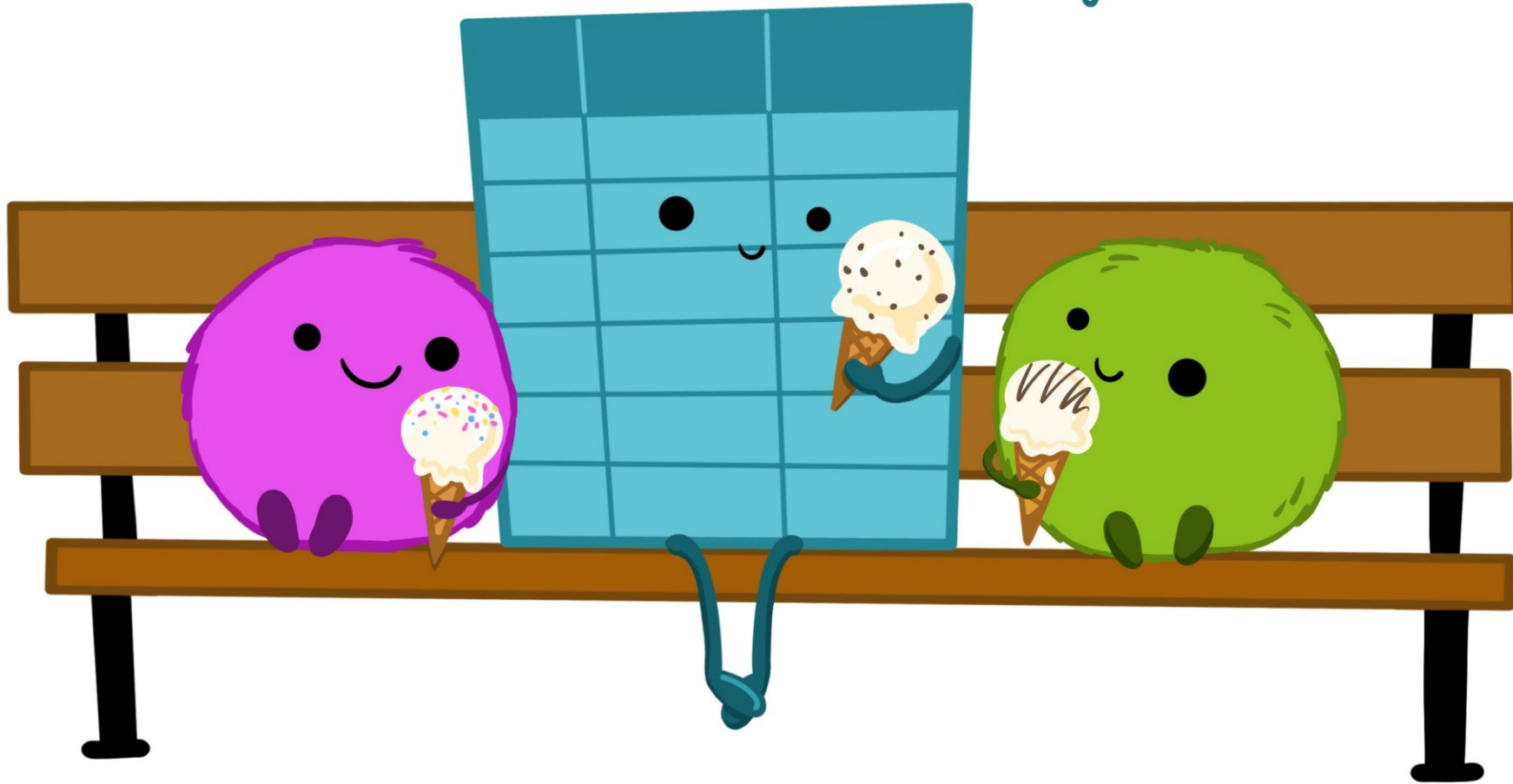
Tidy







make friends with tidy data.



## 2. Piping functions (vs nested)

Nested functions (base R)

3

2

1

```
length(unique(data$variable))
```

Using the pipe makes the code easier to write and to read (Tidyverse)

1

2

3

```
data$variable %>% unique() %>% length()
```



## 2. Piping functions (vs nested)

A more complex example of piping (from this workshop script):

```
data %>%  
  group_by(Species, Sex, Island) %>%  
  summarise(across(where(is.numeric), ~ mean(.x, na.rm = TRUE))) %>%  
  select(-Sample_Number) %>%  
  arrange(desc(Sex)) %>%  
  write_csv(., "./out/data_means.csv")
```

No need to create intermediate objects,  
just pipe the outcome of one function into the next  
(use "." as placeholder)

# String manipulation

stringr::str\_\*



## Work with character strings (text)

- Uses **regex** (regular expressions): a “codified” way to describe patterns in text strings, to do things with them (extract, select, replace, ... )
- Similar rules as `grep` or `sed` in Unix and Bash

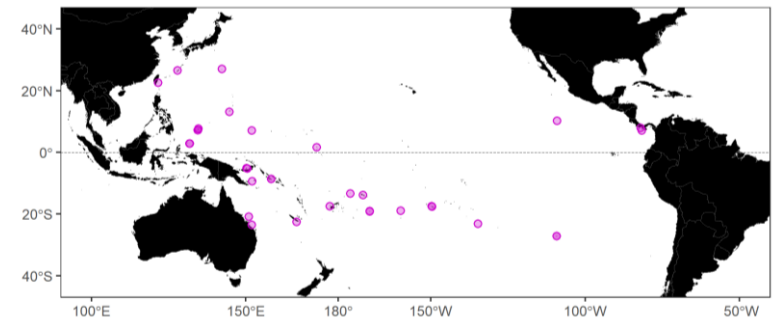
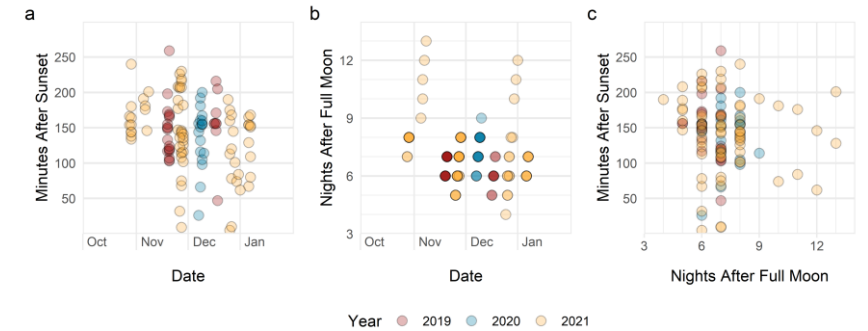
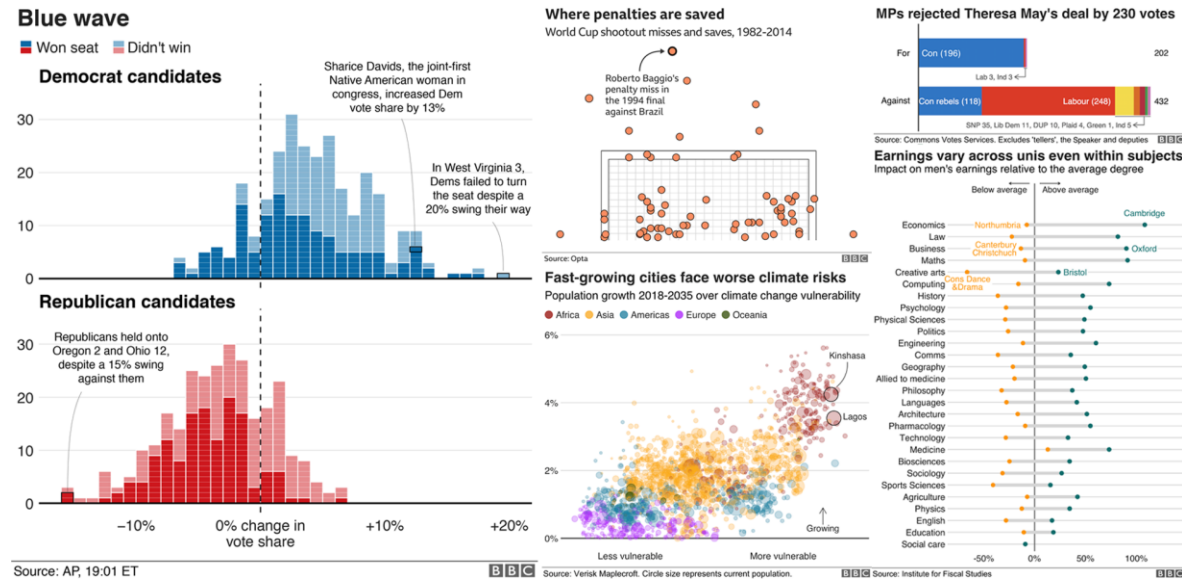
```
"d__Bacteria; p__Proteobacteria; c__Gammaproteobacteria; o__Pseudomonadales; f__Moraxellaceae; g__Acinetobacter"
```

```
"d__Bacteria;/p__Proteobacteria;/c__Gammaproteobacteria;/o__Pseudomonadales;/f__Moraxellaceae;/g__Acinetobacter"
```

```
"d__Bacteria; p__Proteobacteria; c__Gammaproteobacteria; o__Pseudomonadales; f__Moraxellaceae; g__Acinetobacter"
```

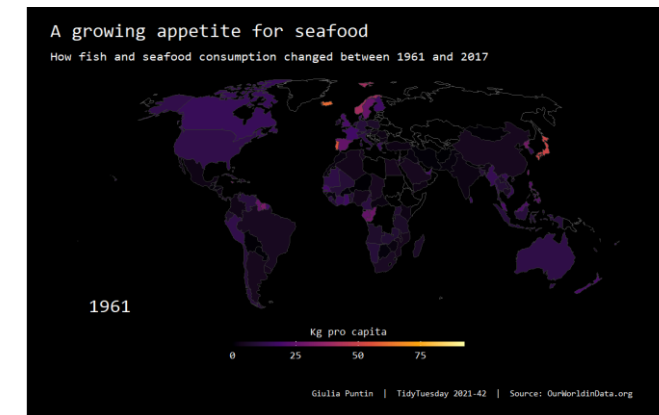
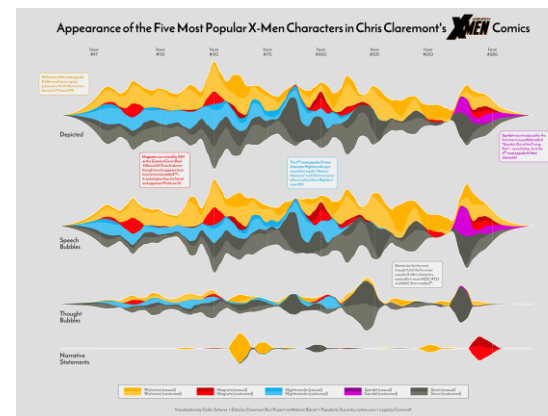
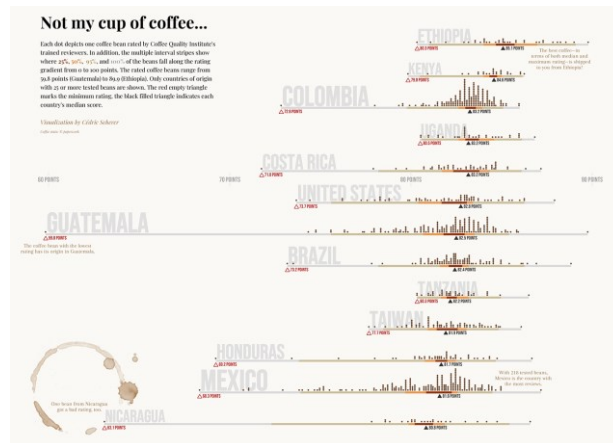
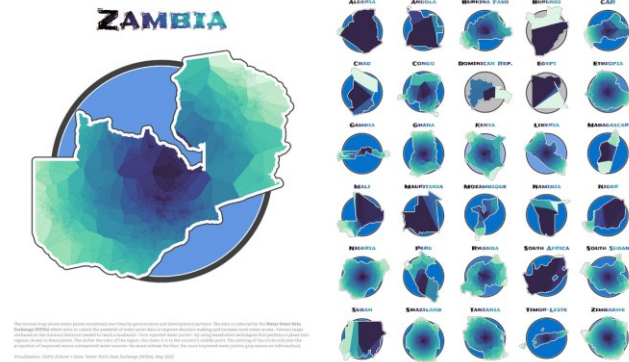
# Data Viz with ggplot

- Publication quality (also BBC, The Economist ...)



# Data Viz with ggplot

- Publication quality (also BBC, The Economist ...)
- Also just super beautiful:
  - Cedric Scherer [tutorial blog](#)
  - R graph gallery
  - #TidyTuesday



# Practical part: R and Tidyverse in action!

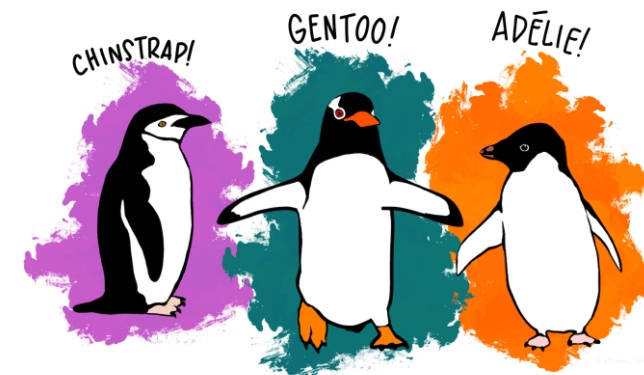


The R script is based on **dummy data**  
(I **modified** an **open data set** for didactic)

Data on penguins' body dimensions, stable isotope measurements, and life stages by species, sex, location, etc

Chosen because of properties:

- numeric data
- character data
- big enough that it would be annoying to do in Excel
- => good for showing my favorite Tidyverse functions
- Original data: `palmerpenguins::penguins_raw`
- For more info: `?penguins_raw`



# Data wrangling

Transform raw data into another format that is more suited for downstream applications (e.g., analytics)

But briefly:

- Create/modify variables
- Subset data
- Summarize
- Re-shape
- Merge
- Correct values
- Plot like a pro



# Data wrangling

Transform raw data into another format that is more suited for downstream applications (e.g., analytics)

But briefly:



Use in combination with  
`if_else()`, `case_when()`, `%in%`

- Create/modify variables: `mutate()`
- Subset data: `filter()`, `select()`
- Summarize: `summarise()`, `group_by()`
- Re-shape: `pivot_wider()`, `pivot_longer()`, `arrange()`
- Merge: `*_join()` ... (e.g. `left_join()`, `outer_join()`, ...)
- Correct values: `rename()`, `replace()`
- Plot like a pro: `ggplot()`

All workshop material  
available at

[https://github.com/sPuntinG/\*\*BiolPostgrad\\_Rworkshop2023\*\*](https://github.com/sPuntinG/BiolPostgrad_Rworkshop2023)

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in completed (draft of) R script

.gitignore changes to gitignore

README.md Update README.md

Rworkshop2023\_Demo.R completed (draft of) R script

Rworkshop2023\_Intro.pptx completed (draft of) R script

~\$R4ReproducibleResearch.pptx initial commit

~\$rksp\_outline.docx initial commit

Local

Codespaces

Clone



HTTPS

SSH

GitHub CLI

[https://github.com/sPuntinG/GenGen\\_Rworkshop2](https://github.com/sPuntinG/GenGen_Rworkshop2)



Use Git or checkout with SVN using the web URL.

Open with GitHub Desktop

Download ZIP

README.md



# ... and waaaay more!

This is **just a short demonstration** of what can be done (and how easily) in R Tidyverse,  
BUT there's so much more out there!

Recommend:

- Today: **ask** me/us about specific tasks/operations that you'd like to learn to execute in R
- Any time: Check out the package **cheat sheets** for inspiration (I use them a lot!)  
[https://posit.co/resources/cheatsheets/?type=posit-cheatsheets&\\_page=2/](https://posit.co/resources/cheatsheets/?type=posit-cheatsheets&_page=2/)

