Supplmentary material for "Towards a unified language in experimental designs propagated by a software framework"

Emi Tanaka

2023-07-24

Applications

The following code uses the R-package edibble (Tanaka 2023) in the R language (R Core Team 2020) to construct three types of experimental design described in the main paper. The full design tables for the split-plot design, complex nested design and unbalanced factorial design are shown in Table 1, Table 2 and Table 3, respectively.

```
library(edibble)
```

Classic Split-Plot Design

The experiment, described in Fisher (1950), is a classic split-plot design for testing the yield of a crop with 12 varieties under 3 different types of fertilizer.

Below we define the unit and treatment factors.

You may also set the responses.

At this stage, the design is not complete and stored in the network form.

```
des1strr
```

```
Fisher's split-plot design
+-patch (36 levels)
| +-plot (108 levels)
| | \-yield
| \-biomass
+-variety (12 levels)
\-fertilizer (3 levels)
```

We need to specify the relationship between factors. We can then get the design table.

The output is a special class of data.frame. See Table 1 for the full design table.

des1

```
# Fisher's split-plot design
# An edibble: 108 x 6
       patch
                    plot
                           variety fertilizer yield biomass
  <unit(36)> <unit(108)> <trt(12)>
                                     <trt(3)> <rcrd>
 1
      patch1
                  plot1 variety11
                                     sulphate
                                                   0
2
      patch1
                  plot2 variety11
                                    chloride
                                                   0
                                                           X
 3
      patch1
                  plot3 variety11
                                    basal
                                                   0
                                                           х
 4
                  plot4 variety9
                                     chloride
      patch2
                                                   0
                                                           0
5
      patch2
                  plot5 variety9
                                     sulphate
                                                   0
                                                           Х
6
                  plot6 variety9
                                     basal
      patch2
                                                   0
                                                           X
7
      patch3
                  plot7 variety6
                                     sulphate
8
      patch3
                  plot8 variety6
                                     basal
                                                           Х
```

9	patch3	plot9	variety6	chloride	0	x
10	patch4	plot10	variety2	basal	0	0
# i 98	more rows					

Table 1: Design table output for the classic split plot design.

patch	plot	variety	fertilizer	yield	biomass
patch1	plot1	variety11	sulphate	NA	NA
patch1	plot2	variety11	chloride	NA	NA
patch1	plot3	variety11	basal	NA	NA
patch2	plot4	variety9	chloride	NA	NA
patch2	plot5	variety9	sulphate	NA	NA
patch2	plot6	variety9	basal	NA	NA
patch3	plot7	variety6	sulphate	NA	NA
patch3	plot8	variety6	basal	NA	NA
patch3	plot9	variety6	chloride	NA	NA
patch4	plot10	variety2	basal	NA	NA
patch4	plot11	variety2	chloride	NA	NA
patch4	plot12	variety2	sulphate	NA	NA
patch5	plot13	variety5	basal	NA	NA
patch5	plot14	variety5	chloride	NA	NA
patch5	plot15	variety5	sulphate	NA	NA
patch6	plot16	variety5	sulphate	NA	NA
patch6	plot17	variety5	chloride	NA	NA
patch6	plot18	variety5	basal	NA	NA
patch7	plot19	variety8	basal	NA	NA
patch7	plot20	variety8	sulphate	NA	NA
patch7	plot21	variety8	chloride	NA	NA
patch8	plot22	variety10	chloride	NA	NA
patch8	plot23	variety10	sulphate	NA	NA
patch8	plot24	variety10	basal	NA	NA
patch9	plot25	variety1	basal	NA	NA
patch9	plot26	variety1	sulphate	NA	NA
patch9	plot27	variety1	chloride	NA	NA
patch10	plot28	variety3	chloride	NA	NA
patch10	plot29	variety3	sulphate	NA	NA
patch10	plot30	variety3	basal	NA	NA
patch11	plot31	variety3	chloride	NA	NA
patch11	plot32	variety3	basal	NA	NA
patch11	plot33	variety3	sulphate	NA	NA
patch12	plot34	variety8	basal	NA	NA
patch12	plot35	variety8	sulphate	NA	NA

patch	plot	variety	fertilizer	yield	biomass
patch12	plot36	variety8	chloride	NA	NA
patch13	plot37	variety3	$\operatorname{chloride}$	NA	NA
patch13	plot38	variety3	sulphate	NA	NA
patch13	plot39	variety3	basal	NA	NA
patch14	plot40	variety12	basal	NA	NA
patch14	plot41	variety12	sulphate	NA	NA
patch14	plot42	variety12	chloride	NA	NA
patch15	plot43	variety11	basal	NA	NA
patch15	plot44	variety11	sulphate	NA	NA
patch15	plot45	variety11	chloride	NA	NA
patch16	plot46	variety12	sulphate	NA	NA
patch16	plot47	variety12	chloride	NA	NA
patch16	plot48	variety12	basal	NA	NA
patch17	plot49	variety10	basal	NA	NA
patch17	plot50	variety10	chloride	NA	NA
patch17	-plot 51	variety10	sulphate	NA	NA
patch18	plot52	variety4	basal	NA	NA
patch18	-plot53	variety4	chloride	NA	NA
patch18	plot54	variety4	sulphate	NA	NA
patch19	-plot55	variety5	basal	NA	NA
patch19	plot56	variety5	chloride	NA	NA
patch19	plot57	variety5	sulphate	NA	NA
patch20	plot58	variety11	basal	NA	NA
patch20	plot59	variety11	chloride	NA	NA
patch20	plot60	variety11	sulphate	NA	NA
patch21	plot61	variety8	chloride	NA	NA
patch21	plot62	variety8	sulphate	NA	NA
patch21	plot63	variety8	basal	NA	NA
patch22	plot64	variety9	sulphate	NA	NA
patch22	plot65	variety9	chloride	NA	NA
patch22	plot66	variety9	basal	NA	NA
patch23	plot67	variety7	basal	NA	NA
patch23	plot68	variety7	chloride	NA	NA
patch23	plot69	variety7	sulphate	NA	NA
patch24	plot70	variety1	chloride	NA	NA
patch24	plot71	variety1	basal	NA	NA
patch24	plot72	variety1	sulphate	NA	NA
patch25	plot73	variety7	basal	NA	NA
patch25	plot74	variety7	chloride	NA	NA
patch25	plot75	variety7	sulphate	NA	NA
patch26	plot76	variety7	chloride	NA	NA
	-	ž.			

patch	plot	variety	fertilizer	yield	biomass
patch26	plot77	variety7	basal	NA	NA
patch26	plot78	variety7	sulphate	NA	NA
patch27	plot79	variety2	basal	NA	NA
patch27	plot80	variety2	chloride	NA	NA
patch27	plot81	variety2	sulphate	NA	NA
patch28	plot82	variety12	basal	NA	NA
patch28	plot83	variety12	chloride	NA	NA
patch28	plot84	variety12	sulphate	NA	NA
patch29	plot85	variety4	basal	NA	NA
patch29	plot86	variety4	sulphate	NA	NA
patch29	plot87	variety4	chloride	NA	NA
patch30	plot88	variety4	chloride	NA	NA
patch30	plot89	variety4	basal	NA	NA
patch30	plot90	variety4	sulphate	NA	NA
patch31	plot91	variety9	sulphate	NA	NA
patch31	plot92	variety9	basal	NA	NA
patch31	plot93	variety9	chloride	NA	NA
patch32	plot94	variety6	chloride	NA	NA
patch32	plot95	variety6	sulphate	NA	NA
patch32	plot96	variety6	basal	NA	NA
patch33	plot97	variety1	sulphate	NA	NA
patch33	plot98	variety1	$\operatorname{chloride}$	NA	NA
patch33	plot99	variety1	basal	NA	NA
patch34	plot100	variety2	basal	NA	NA
patch34	plot101	variety2	chloride	NA	NA
patch34	plot 102	variety2	sulphate	NA	NA
patch35	plot 103	variety10	sulphate	NA	NA
patch35	plot 104	variety10	basal	NA	NA
patch35	plot 105	variety10	chloride	NA	NA
patch36	plot 106	variety6	sulphate	NA	NA
patch36	plot 107	variety6	$\operatorname{chloride}$	NA	NA
patch36	plot108	variety6	basal	NA	NA

Alternative unit specification

In the above code, we have specified the units as below.

```
des1unit <- design("Unit specification") %>%
   set_units(patch = 36,
```

```
plot = nested_in(patch, 3))
```

In another instance, you may be told the total number of plots $(36 \times 3 = 108)$. In this case, it may cognitively make more sense to specify the total number of plots directly as below.

The above code does not, however, the relationship between patch and plot. For this, we can use allot_units() to signal the nesting of the units and assign_units() to actually assign the small units to large units as below.

```
des1unitalt %>%
    allot_units(patch ~ plot) %>%
    assign_units("systematic")

Alternative unit specification
\-patch (36 levels)
    \-plot (108 levels)
Allotment:
```

The above is more verbose than the first approach, however, this may cognitively align with how the units are specified in conversation. Ultimately, it will be user choice on how this is specified, but the end result is essentially the same.

Complex Nested Design

Consider next the experiment in Martin, Johnson, and Forsyth (1996) aimed to investigate if insecticides used to control grasshoppers affected the weight of young chicks of ring-necked pheasants, either by affecting the grass around the chicks or by affecting the grasshoppers eaten by the chicks.

```
pen = nested_in(swath, 2),
chick = nested_in(pen, 6)) %>%

allot_trts(insecticide ~ strip,
dose_level ~ swath,
food_type ~ pen) %>%
assign_trts(seed = 1) %>%
serve_table()
```

Table 2: Design table output for the complex nested design.

insecticide	dose_level	food_type	week	strip	swath	pen	chick
insecticide2	high	unsprayed	week1	strip1	swath1	pen1	chick1
insecticide2	high	unsprayed	week1	strip1	swath1	pen1	chick2
insecticide2	high	unsprayed	week1	strip1	swath1	pen1	chick3
insecticide2	high	unsprayed	week1	strip1	swath1	pen1	chick4
insecticide2	high	unsprayed	week1	strip1	swath1	pen1	chick5
insecticide2	high	unsprayed	week1	strip1	swath1	pen1	chick6
insecticide2	high	sprayed	week1	strip1	swath1	pen2	chick7
insecticide2	high	sprayed	week1	strip1	swath1	pen2	chick8
insecticide2	high	sprayed	week1	strip1	swath1	pen2	chick9
insecticide2	high	sprayed	week1	strip1	swath1	pen2	chick10
insecticide2	high	sprayed	week1	strip1	swath1	pen2	chick11
insecticide2	high	sprayed	week1	strip1	swath1	pen2	chick12
insecticide2	low	unsprayed	week1	strip1	swath2	pen3	chick13
insecticide2	low	unsprayed	week1	strip1	swath2	pen3	chick14
insecticide2	low	unsprayed	week1	strip1	swath2	pen3	chick 15
insecticide2	low	unsprayed	week1	strip1	swath2	pen3	chick16
insecticide2	low	unsprayed	week1	strip1	swath2	pen3	chick 17
insecticide2	low	unsprayed	week1	strip1	swath2	pen3	chick18
insecticide2	low	sprayed	week1	strip1	swath2	pen4	chick19
insecticide2	low	sprayed	week1	strip1	swath2	pen4	chick20
insecticide2	low	sprayed	week1	strip1	swath2	pen4	chick21
insecticide2	low	sprayed	week1	strip1	swath2	pen4	chick22
insecticide2	low	sprayed	week1	strip1	swath2	pen4	chick23
insecticide2	low	sprayed	week1	strip1	swath2	pen4	chick24
insecticide3	high	sprayed	week1	strip2	swath3	pen5	chick 25
insecticide3	high	sprayed	week1	strip2	swath3	pen5	chick 26
insecticide3	high	sprayed	week1	strip2	swath3	pen5	chick 27
insecticide3	high	sprayed	week1	strip2	swath3	pen5	chick28
insecticide3	high	sprayed	week1	strip2	swath3	pen5	chick29
insecticide3	high	sprayed	week1	strip2	swath3	pen5	chick30

insecticide	dose_level	food_type	week	strip	swath	pen	chick
in secticide 3	high	unsprayed	week1	strip2	swath3	pen6	chick31
insecticide3	high	unsprayed	week1	strip2	swath3	pen6	chick32
insecticide3	high	unsprayed	week1	strip2	swath3	pen6	chick33
insecticide3	high	unsprayed	week1	strip2	swath3	pen6	chick34
insecticide3	high	unsprayed	week1	strip2	swath3	pen6	chick35
insecticide3	high	unsprayed	week1	strip2	swath3	pen6	chick36
insecticide3	low	unsprayed	week1	strip2	swath4	pen7	chick37
insecticide3	low	unsprayed	week1	strip2	swath4	pen7	chick38
insecticide3	low	unsprayed	week1	strip2	swath4	pen7	chick39
insecticide3	low	unsprayed	week1	strip2	swath4	pen7	chick 40
insecticide3	low	unsprayed	week1	strip2	swath4	pen7	chick41
insecticide3	low	unsprayed	week1	strip2	swath4	pen7	chick 42
insecticide3	low	sprayed	week1	strip2	swath4	pen8	chick 43
insecticide3	low	sprayed	week1	strip2	swath4	pen8	chick 44
insecticide3	low	sprayed	week1	strip2	swath4	pen8	chick 45
insecticide3	low	sprayed	week1	strip2	swath4	pen8	chick46
insecticide3	low	sprayed	week1	strip2	swath4	pen8	chick 47
insecticide3	low	sprayed	week1	strip2	swath4	pen8	chick48
insecticide1	high	sprayed	week1	strip3	swath5	pen9	chick 49
insecticide1	high	sprayed	week1	strip3	swath5	pen9	chick 50
insecticide1	high	sprayed	week1	strip3	swath5	pen9	chick51
insecticide1	high	sprayed	week1	strip3	swath5	pen9	chick 52
insecticide1	high	sprayed	week1	strip3	swath5	pen9	chick53
insecticide1	high	sprayed	week1	strip3	swath5	pen9	chick 54
insecticide1	high	unsprayed	week1	strip3	swath5	pen10	chick55
insecticide1	high	unsprayed	week1	strip3	swath5	pen10	chick 56
insecticide1	high	unsprayed	week1	strip3	swath5	pen10	chick 57
insecticide1	high	unsprayed	week1	strip3	swath5	pen10	chick58
insecticide1	high	unsprayed	week1	strip3	swath5	pen10	chick 59
insecticide1	high	unsprayed	week1	strip3	swath5	pen10	chick 60
insecticide1	low	unsprayed	week1	strip3	swath6	pen11	chick61
insecticide1	low	unsprayed	week1	strip3	swath6	pen11	chick 62
insecticide1	low	unsprayed	week1	strip3	swath6	pen11	chick 63
insecticide1	low	unsprayed	week1	strip3	swath6	pen11	chick 64
insecticide1	low	unsprayed	week1	strip3	swath6	pen11	chick 65
in sectic ide 1	low	unsprayed	week1	strip3	swath6	pen11	chick 66
in sectic ide 1	low	sprayed	week1	strip3	swath6	pen12	chick 67
in sectic ide 1	low	sprayed	week1	strip3	swath6	pen12	chick 68
in sectic ide 1	low	sprayed	week1	strip3	swath6	pen12	chick69
in sectic ide 1	low	sprayed	week1	strip3	swath6	pen12	chick 70
in sectic ide 1	low	sprayed	week1	strip3	swath6	pen12	chick71

1	1 1 1	C 1 .	1		. 1		1 . 1
insecticide	dose_level	food_type	week	strip	swath	pen	chick
insecticide 1	low	sprayed	week1	strip3	swath6	pen12	chick 72
insecticide 3	low	unsprayed	week2	strip4	swath7	pen13	chick73
insecticide3	low	unsprayed	week2	strip4	swath7	pen13	chick74
insecticide3	low	unsprayed	week2	strip4	swath7	pen13	chick75
insecticide3	low	unsprayed	week2	strip4	swath7	pen13	chick 76
insecticide3	low	unsprayed	week2	strip4	swath7	pen13	chick77
insecticide3	low	unsprayed	week2	strip4	swath7	pen13	chick78
insecticide3	low	sprayed	week2	strip4	swath7	pen14	chick 79
insecticide3	low	sprayed	week2	strip4	swath7	pen14	chick 80
insecticide3	low	sprayed	week2	strip4	swath7	pen14	chick81
insecticide3	low	sprayed	week2	strip4	swath7	pen14	chick 82
insecticide3	low	sprayed	week2	strip4	swath7	pen14	chick 83
insecticide3	low	sprayed	week2	strip4	swath7	pen14	chick 84
insecticide3	high	sprayed	week2	strip4	swath8	pen15	chick 85
insecticide3	high	sprayed	week2	strip4	swath8	pen15	chick 86
insecticide3	high	sprayed	week2	strip4	swath8	pen15	chick 87
insecticide3	high	sprayed	week2	strip4	swath8	pen15	chick88
insecticide3	high	sprayed	week2	strip4	swath8	pen15	chick 89
insecticide3	high	sprayed	week2	strip4	swath8	pen15	chick90
insecticide3	high	unsprayed	week2	strip4	swath8	pen16	chick91
insecticide3	high	unsprayed	week2	strip4	swath8	pen16	chick92
insecticide3	high	unsprayed	week2	strip4	swath8	pen16	chick93
insecticide3	high	unsprayed	week2	strip4	swath8	pen16	chick 94
insecticide3	high	unsprayed	week2	strip4	swath8	pen16	chick95
insecticide3	high	unsprayed	week2	strip4	swath8	pen16	chick96
insecticide1	high	sprayed	week2	strip5	swath9	pen17	chick97
insecticide1	high	sprayed	week2	strip5	swath9	pen17	chick98
insecticide1	high	sprayed	week2	strip5	swath9	pen17	chick99
insecticide1	high	sprayed	week2	strip5	swath9	pen17	chick 100
insecticide1	high	sprayed	week2	strip5	swath9	pen17	chick101
insecticide1	high	sprayed	week2	strip5	swath9	pen17	chick 102
insecticide1	high	unsprayed	week2	strip5	swath9	pen18	chick 103
insecticide1	high	unsprayed	week2	strip5	swath9	pen18	chick 104
insecticide1	high	unsprayed	week2	strip5	swath9	pen18	chick 105
insecticide1	high	unsprayed	week2	strip5	swath9	pen18	chick 106
insecticide 1	high	unsprayed	week2	strip5	swath9	pen18	chick 107
insecticide 1	high	unsprayed	week2	strip5	swath9	pen18	chick 108
insectic ide 1	low	unsprayed	week2	strip5	swath10	pen19	chick 109
insecticide1	low	unsprayed	week2	strip5	swath10	pen19	chick 110
insectic ide 1	low	unsprayed	week2	strip5	swath10	pen19	chick111
insecticide 1	low	unsprayed	week2	strip5	swath10	pen19	chick 112

-							
insecticide	$dose_level$	${\rm food_type}$	week	strip	swath	pen	chick
insecticide1	low	unsprayed	week2	strip5	swath10	pen19	chick113
insecticide1	low	unsprayed	week2	strip5	swath10	pen19	chick114
insecticide1	low	sprayed	week2	strip5	swath10	pen20	chick115
insecticide1	low	sprayed	week2	strip5	swath10	pen20	chick116
insecticide1	low	sprayed	week2	strip5	swath10	pen20	chick117
insecticide1	low	sprayed	week2	strip5	swath10	pen20	chick118
insecticide1	low	sprayed	week2	strip5	swath10	pen20	chick119
insecticide1	low	sprayed	week2	strip5	swath10	pen20	chick 120
insecticide2	low	unsprayed	week2	strip6	swath11	pen21	chick121
insecticide2	low	unsprayed	week2	strip6	swath11	pen21	chick 122
insecticide2	low	unsprayed	week2	strip6	swath11	pen21	chick 123
insecticide2	low	unsprayed	week2	strip6	swath11	pen21	chick124
insecticide2	low	unsprayed	week2	strip6	swath11	pen21	chick 125
insecticide2	low	unsprayed	week2	strip6	swath11	pen21	chick 126
insecticide2	low	sprayed	week2	strip6	swath11	pen22	chick 127
insecticide2	low	sprayed	week2	strip6	swath11	pen22	chick128
insecticide2	low	sprayed	week2	strip6	swath11	pen22	chick 129
insecticide2	low	sprayed	week2	strip6	swath11	pen22	chick 130
insecticide2	low	sprayed	week2	strip6	swath11	pen22	chick 131
insecticide2	low	sprayed	week2	strip6	swath11	pen22	chick 132
insecticide2	high	sprayed	week2	strip6	swath12	pen23	chick 133
insecticide2	high	sprayed	week2	strip6	swath12	pen23	chick 134
insecticide2	high	sprayed	week2	strip6	swath12	pen23	chick 135
insecticide2	high	sprayed	week2	strip6	swath12	pen23	chick 136
insecticide2	high	sprayed	week2	strip6	swath12	pen23	chick 137
insecticide2	high	sprayed	week2	strip6	swath12	pen23	chick 138
insecticide2	high	unsprayed	week2	strip6	swath12	pen24	chick 139
insecticide2	high	unsprayed	week2	strip6	swath12	pen24	chick 140
insecticide2	high	unsprayed	week2	strip6	swath12	pen24	chick 141
insecticide2	high	unsprayed	week2	strip6	swath12	pen24	chick142
insecticide2	high	unsprayed	week2	strip6	swath12	pen24	chick 143
insecticide2	high	unsprayed	week2	strip6	swath12	pen24	chick 144
insecticide3	high	unsprayed	week3	strip7	swath13	pen25	chick 145
insecticide3	high	unsprayed	week3	strip7	swath13	pen25	chick 146
insecticide3	high	unsprayed	week3	strip7	swath13	pen25	chick 147
insecticide3	high	unsprayed	week3	strip7	swath13	pen25	chick 148
insecticide3	high	unsprayed	week3	strip7	swath13	pen25	chick 149
insecticide3	high	unsprayed	week3	strip7	swath 13	pen25	chick 150
in sectic ide 3	high	sprayed	week3	strip7	swath 13	pen26	chick 151
in sectic ide 3	high	sprayed	week3	strip7	swath 13	pen26	chick 152
insecticide3	high	sprayed	week3	strip7	swath13	pen26	chick 153

-							
insecticide	$dose_level$	${\rm food_type}$	week	strip	swath	pen	chick
insecticide3	high	sprayed	week3	strip7	swath13	pen26	chick154
insecticide3	high	sprayed	week3	strip7	swath13	pen26	chick 155
insecticide3	high	sprayed	week3	strip7	swath13	pen26	chick 156
insecticide3	low	unsprayed	week3	strip7	swath14	pen27	chick157
insecticide3	low	unsprayed	week3	strip7	swath14	pen27	chick158
insecticide3	low	unsprayed	week3	strip7	swath14	pen27	chick159
insecticide3	low	unsprayed	week3	strip7	swath14	pen27	chick 160
insecticide3	low	unsprayed	week3	strip7	swath14	pen27	chick 161
insecticide3	low	unsprayed	week3	strip7	swath14	pen27	chick 162
insecticide3	low	sprayed	week3	strip7	swath14	pen28	chick 163
insecticide3	low	sprayed	week3	strip7	swath14	pen28	chick 164
insecticide3	low	sprayed	week3	strip7	swath14	pen28	chick 165
insecticide3	low	sprayed	week3	strip7	swath14	pen28	chick 166
insecticide3	low	sprayed	week3	strip7	swath14	pen28	chick 167
insecticide3	low	sprayed	week3	strip7	swath14	pen28	chick 168
insecticide2	low	unsprayed	week3	strip8	swath15	pen29	chick 169
insecticide2	low	unsprayed	week3	strip8	swath15	pen29	chick 170
insecticide2	low	unsprayed	week3	strip8	swath15	pen29	chick 171
insecticide2	low	unsprayed	week3	strip8	swath15	pen29	chick 172
insecticide2	low	unsprayed	week3	strip8	swath15	pen29	chick 173
insecticide2	low	unsprayed	week3	strip8	swath15	pen29	chick 174
insecticide2	low	sprayed	week3	strip8	swath15	pen30	chick 175
insecticide2	low	sprayed	week3	strip8	swath15	pen30	chick 176
insecticide2	low	sprayed	week3	strip8	swath15	pen30	chick 177
insecticide2	low	sprayed	week3	strip8	swath15	pen30	chick 178
insecticide2	low	sprayed	week3	strip8	swath15	pen30	chick 179
insecticide2	low	sprayed	week3	strip8	swath15	pen30	chick 180
insecticide2	high	sprayed	week3	strip8	swath16	pen31	chick181
insecticide2	high	sprayed	week3	strip8	swath16	pen31	chick182
insecticide2	high	sprayed	week3	strip8	swath16	pen31	chick183
insecticide2	high	sprayed	week3	strip8	swath16	pen31	chick184
insecticide2	high	sprayed	week3	strip8	swath16	pen31	chick185
insecticide2	high	sprayed	week3	strip8	swath16	pen31	chick 186
insecticide2	high	unsprayed	week3	strip8	swath16	pen32	chick 187
insecticide2	high	unsprayed	week3	strip8	swath16	pen32	chick188
insecticide2	high	unsprayed	week3	strip8	swath16	pen32	chick189
insecticide 2	high	unsprayed	week3	strip8	swath16	pen32	chick 190
insecticide 2	high	unsprayed	week3	strip8	swath16	pen32	chick 191
insecticide 2	high	unsprayed	week3	strip8	swath16	pen32	chick 192
insecticide 1	high	sprayed	week3	strip9	swath17	pen33	chick 193
in sectic ide 1	high	sprayed	week3	strip9	swath17	pen33	chick 194

insecticide	dose_level	food_type	week	strip	swath	pen	chick
insecticide1	high	sprayed	week3	strip9	swath17	pen33	chick 195
insecticide1	high	sprayed	week3	strip9	swath17	pen33	chick 196
insecticide1	high	sprayed	week3	strip9	swath 17	pen33	chick 197
insecticide1	high	sprayed	week3	strip9	swath 17	pen33	chick198
insecticide1	high	unsprayed	week3	strip9	swath 17	pen34	chick 199
insecticide1	high	unsprayed	week3	strip9	swath 17	pen34	chick200
insecticide1	high	unsprayed	week3	strip9	swath 17	pen34	chick201
insecticide1	high	unsprayed	week3	strip9	swath 17	pen34	chick 202
insecticide1	high	unsprayed	week3	strip9	swath17	pen34	chick 203
insecticide1	high	unsprayed	week3	strip9	swath17	pen34	chick 204
insecticide1	low	sprayed	week3	strip9	swath18	pen35	chick 205
insecticide1	low	sprayed	week3	strip9	swath18	pen35	chick 206
insecticide1	low	sprayed	week3	strip9	swath18	pen35	chick 207
insecticide1	low	sprayed	week3	strip9	swath18	pen35	chick 208
insecticide1	low	sprayed	week3	strip9	swath18	pen35	chick 209
insecticide1	low	sprayed	week3	strip9	swath18	pen35	chick210
insecticide1	low	unsprayed	week3	strip9	swath18	pen36	chick211
insecticide1	low	unsprayed	week3	strip9	swath18	pen36	chick212
insecticide1	low	unsprayed	week3	strip9	swath18	pen36	chick213
insecticide1	low	unsprayed	week3	strip9	swath18	pen36	chick214
insecticide1	low	unsprayed	week3	strip9	swath18	pen36	chick 215
insecticide1	low	unsprayed	week3	strip9	swath18	pen36	chick216

Unbalanced Factorial Design

Here we consider the first four motion sickness experiments reported in Burns (1984).

```
des3 <- design("Motion sickness incidence") %>%
     set_units(experiment = 4,
3
               subject = nested_in(experiment,
                                   1 ~ 21,
                                   2 ~ 20,
                                   3 ~ 29,
                                   4 ~ 59)) %>%
     set_trts(frequency = c(0.167, 0.250),
              acceleration = c(0.111, 0.222)) \%%
     allot_trts(frequency:acceleration ~ experiment) %>%
10
     assign_trts(order = "systematic") %>%
11
     serve_table()
12
```

Table 3: Design table output for the unbalanced factorial design.

experiment	subject	frequency	acceleration
experiment1	subject1	0.167	0.111
experiment1	$\operatorname{subject2}$	0.167	0.111
experiment1	subject3	0.167	0.111
experiment1	subject4	0.167	0.111
experiment1	subject5	0.167	0.111
experiment1	subject6	0.167	0.111
experiment1	subject7	0.167	0.111
experiment1	subject8	0.167	0.111
experiment1	subject9	0.167	0.111
experiment1	subject 10	0.167	0.111
experiment1	subject11	0.167	0.111
experiment1	subject 12	0.167	0.111
experiment1	subject 13	0.167	0.111
experiment1	subject 14	0.167	0.111
experiment1	subject 15	0.167	0.111
experiment1	subject16	0.167	0.111
experiment1	subject 17	0.167	0.111
experiment1	subject18	0.167	0.111
experiment1	subject19	0.167	0.111
experiment1	subject20	0.167	0.111
experiment1	subject21	0.167	0.111
experiment2	subject22	0.25	0.111
experiment2	subject23	0.25	0.111
experiment2	subject 24	0.25	0.111
experiment2	subject25	0.25	0.111
experiment2	subject26	0.25	0.111
experiment2	subject27	0.25	0.111
experiment2	subject28	0.25	0.111
experiment2	subject29	0.25	0.111
experiment2	subject30	0.25	0.111
experiment2	subject31	0.25	0.111
experiment2	subject32	0.25	0.111
experiment2	subject33	0.25	0.111
experiment2	subject34	0.25	0.111
experiment2	subject35	0.25	0.111
experiment2	subject36	0.25	0.111
experiment2	subject37	0.25	0.111
experiment2	subject38	0.25	0.111
experiment2	subject39	0.25	0.111
- F		·	

experiment	subject	frequency	acceleration
experiment2	subject40	0.25	0.111
experiment2	subject 41	0.25	0.111
experiment3	subject 42	0.167	0.222
experiment3	subject 43	0.167	0.222
experiment3	subject 44	0.167	0.222
experiment3	subject 45	0.167	0.222
experiment3	subject 46	0.167	0.222
experiment3	subject 47	0.167	0.222
experiment3	subject48	0.167	0.222
experiment3	subject 49	0.167	0.222
experiment3	subject 50	0.167	0.222
experiment3	subject51	0.167	0.222
experiment3	subject 52	0.167	0.222
experiment3	subject53	0.167	0.222
experiment3	subject54	0.167	0.222
experiment3	subject55	0.167	0.222
experiment3	subject 56	0.167	0.222
experiment3	subject 57	0.167	0.222
experiment3	subject 58	0.167	0.222
experiment3	subject 59	0.167	0.222
experiment3	subject60	0.167	0.222
experiment3	subject 61	0.167	0.222
experiment3	subject 62	0.167	0.222
experiment3	subject 63	0.167	0.222
experiment3	subject 64	0.167	0.222
experiment3	subject 65	0.167	0.222
experiment3	subject 66	0.167	0.222
experiment3	subject 67	0.167	0.222
experiment3	subject 68	0.167	0.222
experiment3	subject 69	0.167	0.222
experiment3	subject70	0.167	0.222
experiment4	subject71	0.25	0.222
experiment4	subject72	0.25	0.222
experiment4	subject73	0.25	0.222
experiment4	subject74	0.25	0.222
experiment4	subject75	0.25	0.222
experiment4	subject 76	0.25	0.222
experiment4	subject77	0.25	0.222
experiment4	subject78	0.25	0.222
experiment4	subject79	0.25	0.222
experiment4	subject80	0.25	0.222

experiment	$\operatorname{subject}$	frequency	acceleration
experiment4	subject81	0.25	0.222
experiment4	subject82	0.25	0.222
experiment4	subject83	0.25	0.222
experiment4	subject84	0.25	0.222
experiment4	subject 85	0.25	0.222
experiment4	subject 86	0.25	0.222
experiment4	subject 87	0.25	0.222
experiment4	subject 88	0.25	0.222
experiment4	subject 89	0.25	0.222
experiment4	subject 90	0.25	0.222
experiment4	subject91	0.25	0.222
experiment4	subject 92	0.25	0.222
experiment4	subject93	0.25	0.222
experiment4	subject 94	0.25	0.222
experiment4	subject 95	0.25	0.222
experiment4	subject 96	0.25	0.222
experiment4	subject 97	0.25	0.222
experiment4	subject98	0.25	0.222
experiment4	subject 99	0.25	0.222
experiment4	subject 100	0.25	0.222
experiment4	subject 101	0.25	0.222
experiment4	subject 102	0.25	0.222
experiment4	subject 103	0.25	0.222
experiment4	subject 104	0.25	0.222
experiment4	subject 105	0.25	0.222
experiment4	subject 106	0.25	0.222
experiment4	subject 107	0.25	0.222
experiment4	subject 108	0.25	0.222
experiment4	subject 109	0.25	0.222
experiment4	subject110	0.25	0.222
experiment4	subject111	0.25	0.222
experiment4	subject 112	0.25	0.222
experiment4	subject113	0.25	0.222
experiment4	subject114	0.25	0.222
experiment4	subject 115	0.25	0.222
experiment4	subject 116	0.25	0.222
experiment4	subject117	0.25	0.222
experiment4	subject118	0.25	0.222
experiment4	subject119	0.25	0.222
experiment4	subject 120	0.25	0.222
experiment4	subject 121	0.25	0.222

experiment	subject	frequency	acceleration
experiment	subject	rrequency	acceleration
experiment4	subject 122	0.25	0.222
experiment4	subject 123	0.25	0.222
experiment4	subject 124	0.25	0.222
experiment4	subject 125	0.25	0.222
experiment4	subject 126	0.25	0.222
experiment4	subject 127	0.25	0.222
experiment4	subject 128	0.25	0.222
experiment4	subject 129	0.25	0.222

Acknowledgement

This paper uses knitr (Xie 2015), rmarkdown (Xie, Allaire, and Grolemund 2018) and Quarto for creating reproducible documents. The code presented uses version 0.1.3 of the edibble package available on CRAN. The latest development of edibble can be found at https://github.com/emitanaka/edibble.

References

- Burns, K. C. 1984. "Motion Sickness Incidence: Distribution of Time to First Emesis and Comparison of Some Complex Motion Conditions." Aviation, Space, and Environmental Medicine 55 (6): 521–27.
- Fisher, Ronald A. 1950. Statistical Methods for Research Workers. 11th ed. Oliver and Boyd.
- Martin, Pamela A., Daniel L. Johnson, and Douglas J. Forsyth. 1996. "Effects of Grasshopper-Control Insecticides on Survival and Brain Acetylcholinesterase of Pheasant (*Phasianus Colchicus*) Chicks." *Environmental Toxicology and Chemistry / SETAC* 15 (4): 518–24. https://doi.org/10.1897/1551-5028(1996)015%3C0518:EOGCIO%3E2.3.CO;2.
- R Core Team. 2020. R: A Language and Environment for Statistical Computing. Vienna, Austria: R Foundation for Statistical Computing. https://www.R-project.org/.
- Tanaka, Emi. 2023. edibble: Designing Comparative Experiments. https://CRAN.R-project.org/package=edibble.
- Xie, Yihui. 2015. Dynamic Documents with R and Knitr. 2nd ed. Boca Raton, Florida: Chapman; Hall/CRC. https://yihui.org/knitr/.
- Xie, Yihui, J. J. Allaire, and Garrett Grolemund. 2018. *R Markdown: The Definitive Guide*. Boca Raton, Florida: Chapman; Hall/CRC. https://bookdown.org/yihui/rmarkdown.