Automated Visualisation of Experimental Designs

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The Grammar of Experimental Designs

A computational framework that treats experimental design as an object that is declaratively defined by a series of composable functions.

Implemented in the `edibble` R-package.

```
library(edibble)
```

The final output is an **e**xperimental **d**esign table (or t**ibble**).

Completely Randomised Design

Suppose we have an experiment to compare high-carb and low-carb diets on the weight.

- We can gather twenty subjects in total.

```
crd <- design("Diet experiment") %>%
  set_units(subject = 20) %>%
  set_trts(diet = c("Low-carb", "High-carb")) %>%
  allot_trts(diet ~ subject) %>%
  assign_trts("random", seed = 2023) %>%
  serve_table()
```

Randomised Complete Block Design

We may recognise that *sex* is an influencing factor on the response.

- We may choose to block subjects by sex.
- We assign equal number of subjects for each sex.
- We modify the code to take this into account.

```
rcbdx <- design("Diet experiment by sex") %>%
  set_units(sex = c("F", "M"),
            subject = 20) %>%
  allot_units(sex ~ subject) %>%
  assign_units("systematic") %>%
  set_trts(diet = c("Low-carb", "High-carb")) %>%
  allot_trts(diet ~ subject) %>%
  assign_trts("random", seed = 2023)
```

At this stage, the edibble design object is in a network form (a pair of directed acyclic graphs).

`rcbdx`

```
Diet experiment by sex
├─sex (2 levels)
│ └─subject (20 levels)
└─diet (2 levels)
Allotment:
• diet ~ subject
• sex ~ subject
Assignment: random
```

- The same *unit structure* can alternatively be defined as below.

```
rcbd_alt <- design("Diet experiment by sex") %>%
  set_units(sex = c("F", "M"),
            subject = nested_in(sex, 10))
```

Split-Plot Design

The experimenter may wish to also see the effect of exercise in addition to the diet.

- This means that we have two treatment factors with two levels.
- The *treatment structure* is then 2×2 factorial.
- The experimenter has a constraint on allocation of exercise – it has to be done by session, which comprises of five subjects of one sex.
- Different diets can be assigned to each subject.
- The experimenter conducts two sessions for each sex.
- This constraint in the allocation of treatment results in a split-plot design.

```
spd <- design("Diet & exercise experiment") %>%
  set_units(sex = c("F", "M"),
            session = nested_in(sex, 2),
            subject = nested_in(session, 5)) %>%
  set_trts(diet = c("Low-carb", "High-carb"),
           exercise = c("Intense", "Light")) %>%
  allot_trts(diet ~ subject,
             exercise ~ session) %>%
  assign_trts("random", seed = 2023) %>%
  serve_table()
```

The output here is in a tabular form.

`spd`

```
# Diet & exercise experiment
# An edibble: 20 x 5
        sex   session    subject      diet exercise
  <unit(2)> <unit(4)> <unit(20)>  <trt(2)> <trt(2)>
1         F  session1  subject1  High-carb  Light
2         F  session1  subject2  Low-carb   Light
3         F  session1  subject3  Low-carb   Light
4         F  session1  subject4  Low-carb   Light
5         F  session1  subject5  High-carb  Light
6         F  session2  subject6  Low-carb   Intense
7         F  session2  subject7  High-carb  Intense
8         F  session2  subject8  Low-carb   Intense
9         F  session2  subject9  Low-carb   Intense
10        F  session2  subject10 High-carb  Intense
# ℹ 10 more rows
# ℹ Use `print(n = ...)` to see more rows
```

Visualising Experimental Designs

We leverage the structure that is already specified in an edibble design object.

Implemented in the `deggust` R-package.

```
library(deggust)
```

To degust is to savor appreciatively.

To deggust is to visualise edibble design objects appreciatively.

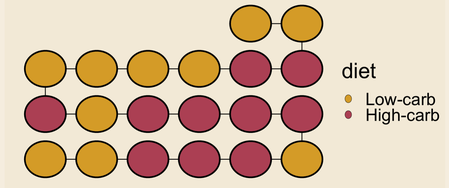
The final output is a **d**esign of **e**xperiments as a **gg**plot object.

Visualise your edibble design using only one command:

`autoplot()`

Completely Randomised Design

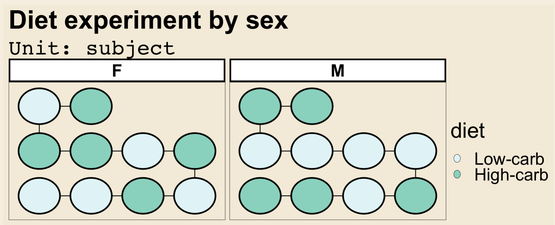
```
autoplot(crd)
```



Randomised Complete Block Design

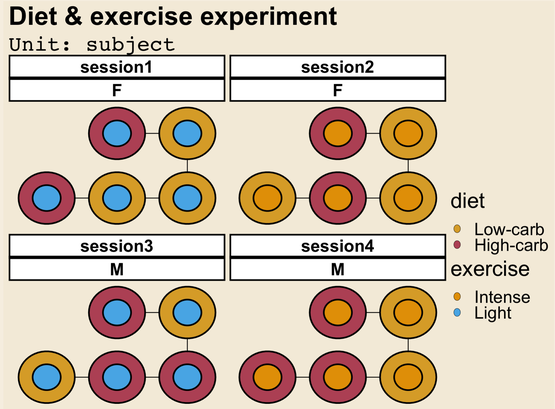
- Customise using `ggplot2` functions!

```
autoplot(serve_table(rcbdx)) +
  ggplot2::scale_fill_brewer(palette = 2)
```



Split-Plot Design

```
autoplot(spd)
```



See More

- `edibble` and `deggust` R-packages are available on CRAN or get the latest development at emitanaka/edibble and emitanaka/deggust.
- Find the HTML version of this poster at https://emitanaka.org/JSM2023poster.
- For more information and references, see https://emitanaka.org/research/edibble-design.

Acknowledgement

This poster was made using `posterdown` R-package.