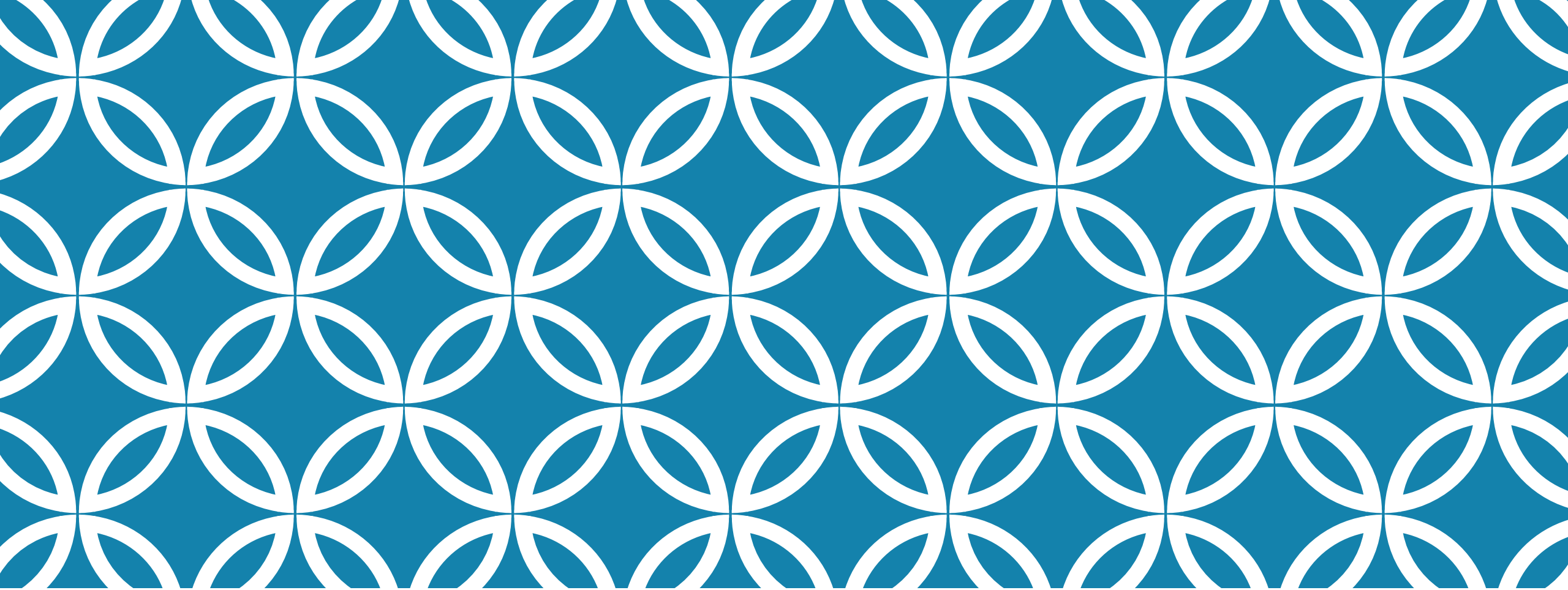
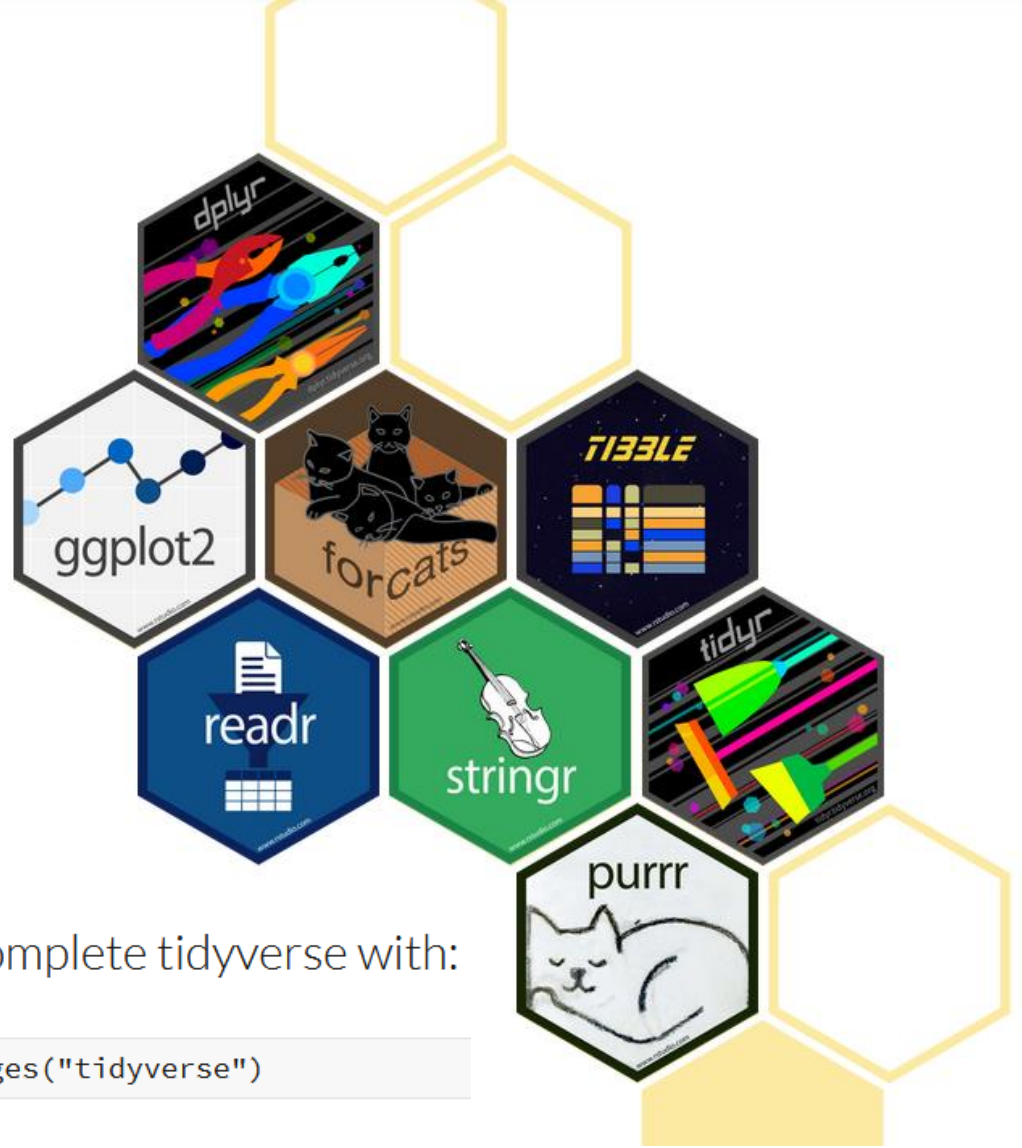


TIDY VERSE PART 1

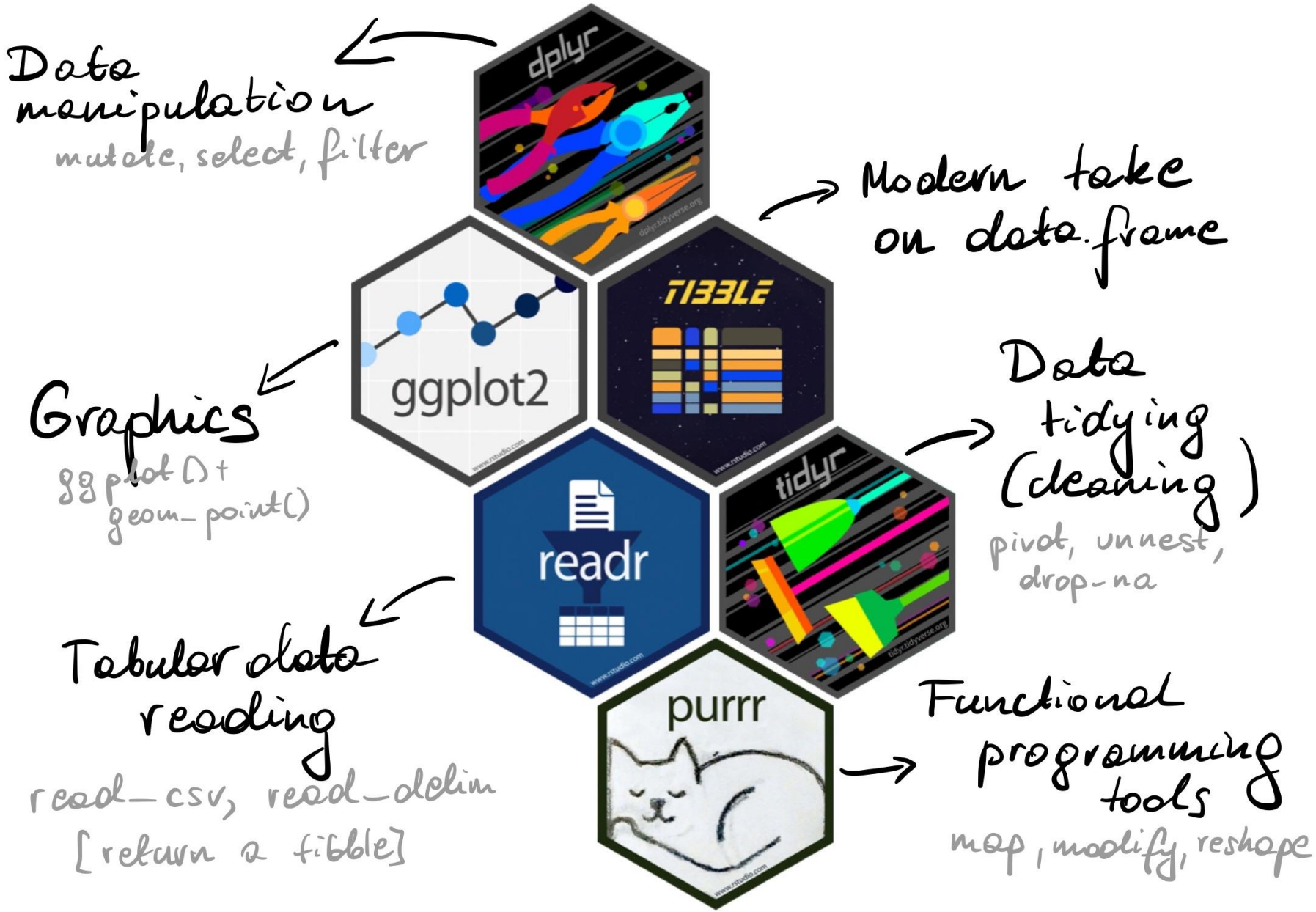
mgr Maria Kubara, WNE UW

TIDYVERSE

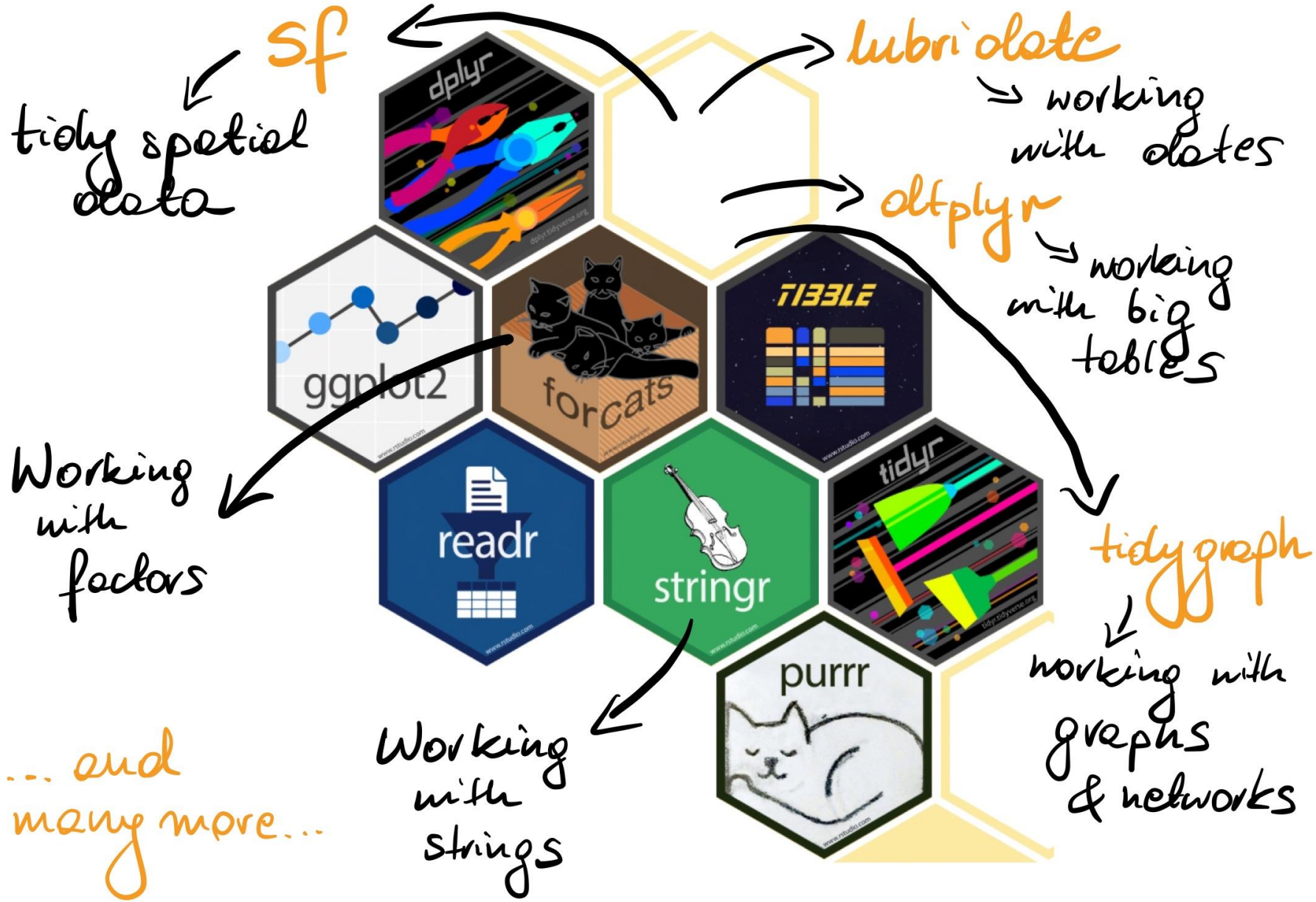
- Environment with packages for easier and tidier data processing in R
- All based on tibble structure (refreshed data.frame)
- Concerned about the tidy data
- „All packages share an underlying design philosophy, grammar, and data structures”



https://www.tidyverse.org/



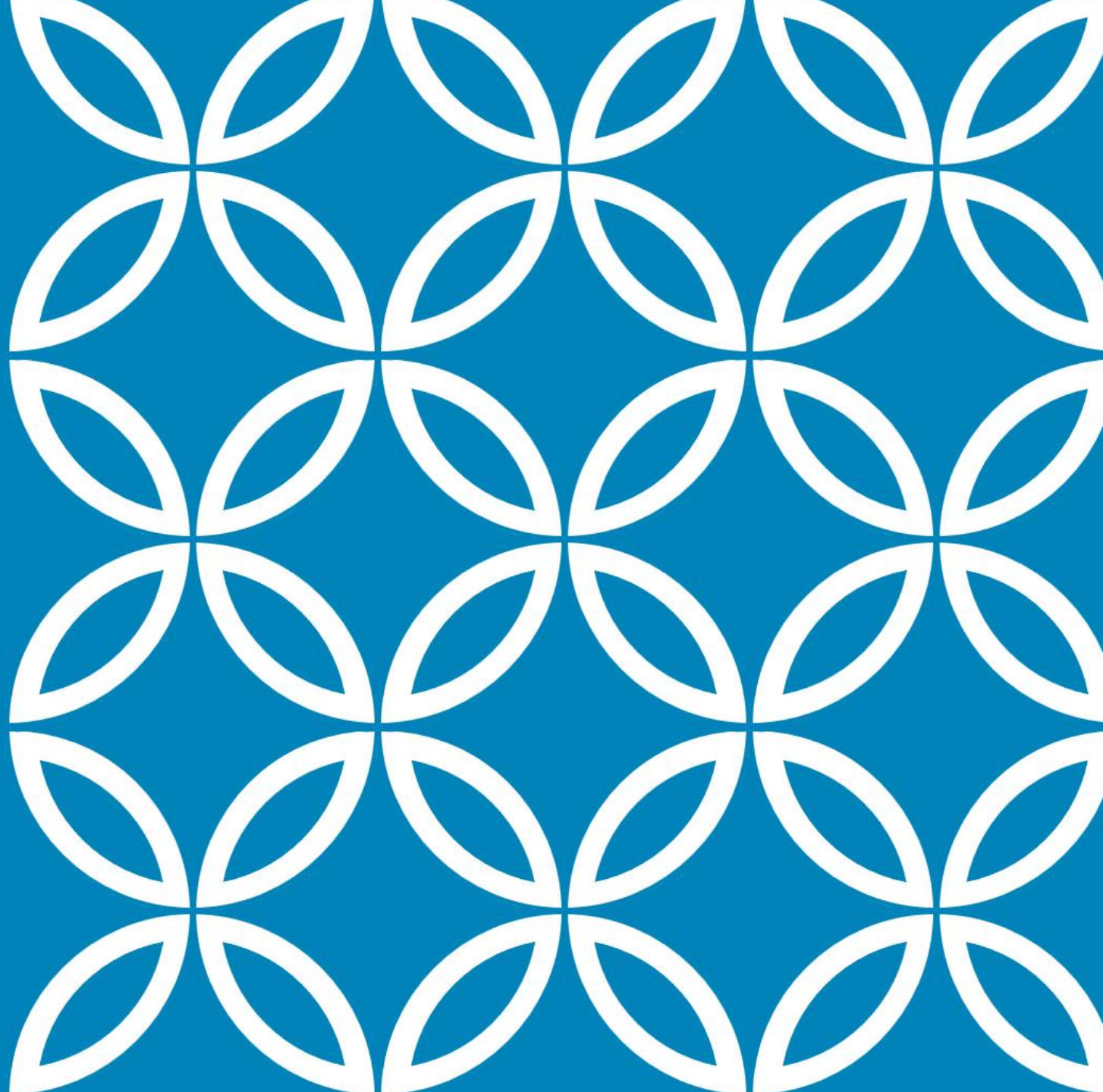
https://www.tidyverse.org/packages/



https://www.tidyverse.org/packages/

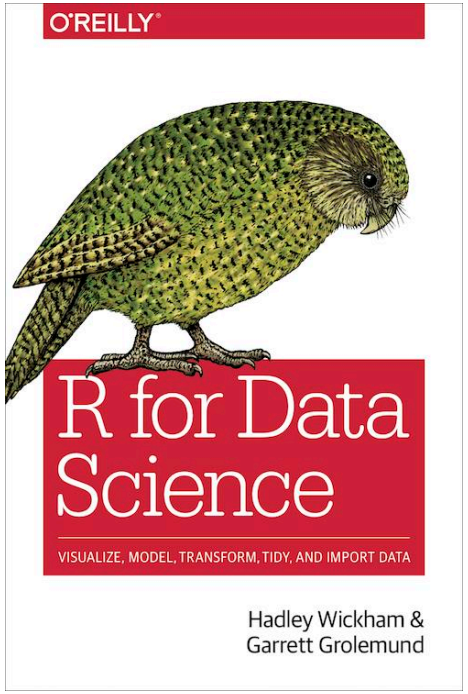
TIDY DATA

Golden standard in data analytics



TIDYVERSE

Tidy data is a standard way of mapping the meaning of a dataset to its structure. A dataset is messy or tidy depending on how rows, columns and tables are matched up with observations, variables and types.



In tidy data:

1. Each variable forms a column.
2. Each observation forms a row.
3. Each type of observational unit forms a table.

Wickham, H. . (2014). Tidy Data. Journal of Statistical Software, 59(10), 1–23. https://doi.org/10.18637/jss.v059.i10

TIDY DATA MANIPULATION

Four fundamental **verbs** of data manipulation:

- Filter: subsetting or removing observations based on some condition.
- Transform: adding or modifying variables. These modications can involve either a single variable (e.g., log-transformation), or multiple variables (e.g., computing density from weight and volume).
- Aggregate: collapsing multiple values into a single value (e.g., by summing or taking means).
- Sort: changing the order of observations.

Wickham, H. . (2014). Tidy Data. Journal of Statistical Software, 59(10), 1–23. https://doi.org/10.18637/jss.v059.i10

BASIC DATA MANIPULATION WITH DPLYR

Filter

filter()

Aggregate

summarize()

count()

Group-wise operations:
group_by()
rowwise()

Transform

mutate()

Sort

arrange()

iris$Double.Length <- 2*iris$Sepal.Length

CONTEXT FOR TIDYVERSE FUNCTIONS

mutate(iris, Double.Length = 2*Sepal.Length)

All tidyverse functions take DATA as their first argument and work with its context. In this way we can just specify the name of a variable (column) and use it without any $ symbols to show its source.

filter(iris, Sepal.Length > 2)

```
filter(iris, Sepal.Length > 2)
```

filter function „knows" that Sepal.Length is a variable within iris dataset

```
mutate(iris, Double.Sepal.Length = Sepal.Length*2)
```

A new variable Double.Sepal.Length is created in the iris dataset which uses the values in Sepal.Length to create its own

In tidyverse there is a convention: new goes first, older comes second
Here we first specify the name of the new variable and then get its value (based on the older info already present in the dataset)

PIPELINE OPERATOR

Handy shortcut in RStudio to write a pipeline: Ctrl+Shift+M

%>% pipeline operator allows for passing on the result from the previous operation as the first input for the next function (or where the dot is – for more control)

```
filter(iris, Sepal.Length > 2)
iris %>% filter(Sepal.Length > 2)
iris %>% filter(., Sepal.Length > 2)
```

Note: in R 4.0 „base pipe" has been introducted, written as |> It controlls the function flow in a similar way like the pipeline operator. You can use it without loading any additional package.

data1

Age	Class	other
10	A	X
20	B	Y
30	B	Z
20	A	J

data1 ← data1 %>% rename(Category = other)

data1 ← data1 %>% mutate(DoubleAge = 2 * Age)

Age	Class	Category	DoubleAge
10	A	X	20
20	B	Y	40
30	B	Z	60
20	A	J	40

Another Approach

data1 ← data1 %>% rename(Category = other) %>% mutate(D... = 2*Age)

Age	Class	Category
...	...	...

%>% mutate(....)

mutate(rename(data1, Category = other), DoubleAge = 2*Age)

Age	Class	Category	DoubleAge
...	...	...	...

```
data1 %>%
  rename(Category = other) %>%
  mutate(DoubleAge = 2*Age) %>%
  filter(DoubleAge > 30) -> data1
```

this works ok.

BUT

here you won't forget about SAVING

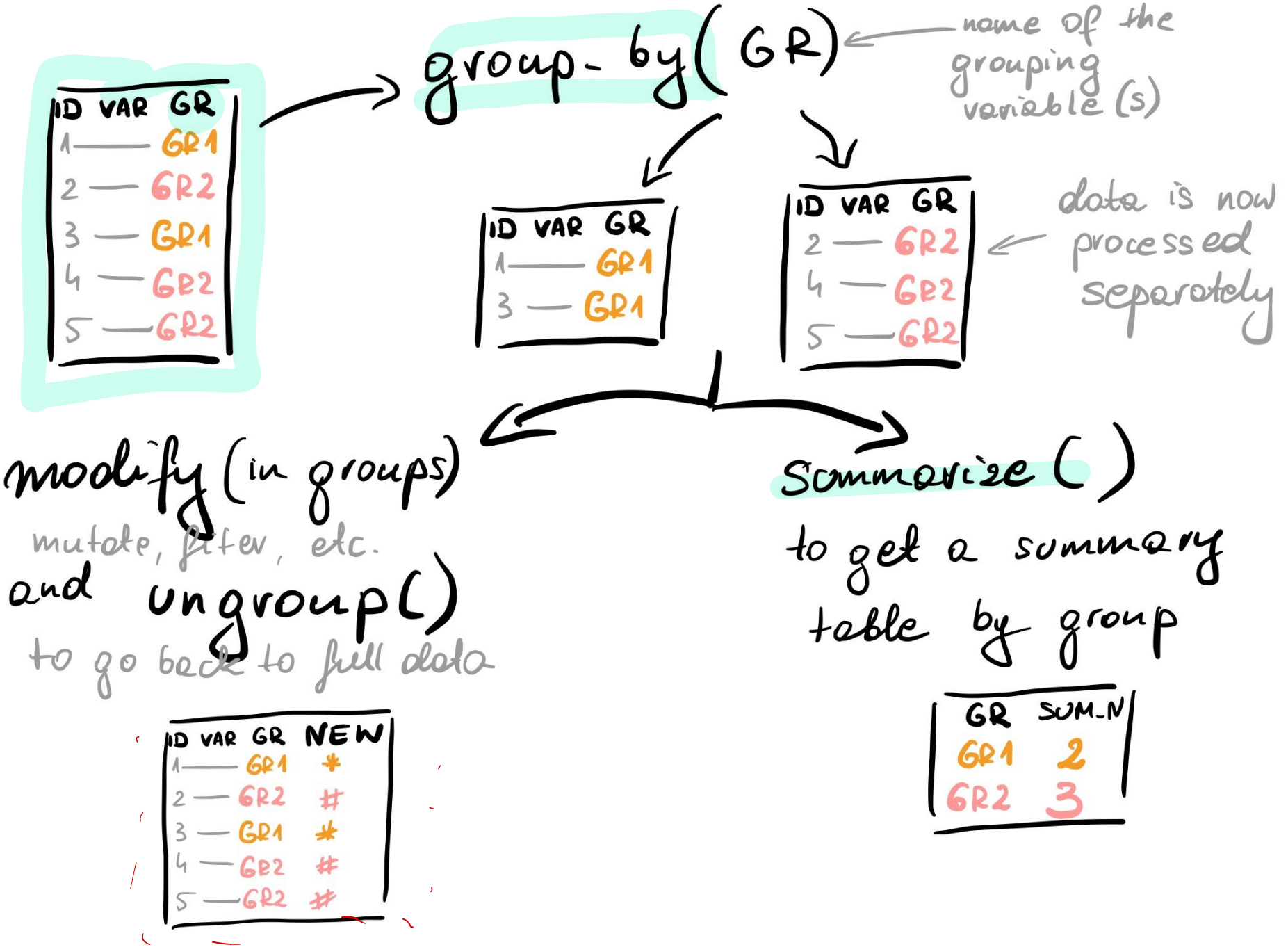
```
data1 <- data1 %>%
  rename(Category = other) %>%
  mutate(DoubleAge = 2*Age) %>%
  filter(DoubleAge > 30)
```

GROUP-WISE OPERATIONS

group_by() „splits” the data by given group division and allows for processing the dataset separately for given groups

Mostly used for summary table cration or by adding a variable which value differs by groups

Similarly rowwise() allows for processing data for each row indiviudally (group_by is far more popular)



Age	Class	other	Av.Age.In.Class
10	A	x	15
20	B	y	25
30	B	z	25
20	A	j	15

```
summary_Age <- data1 %>% group_by(Class) %>%
  summarize(Av.Age = mean(Age, na.rm=T),
            max.Age = max(Age))
```

```
data1 <- data1 %>% group_by(Class) %>%
  mutate(Av.Age.In.Class = mean(Age)) %>%
  ungroup()
```

PER GROUP

Summary table

Class	Av. Age	max. Age
A	15	
B	25	

OTHER HELPFUL DPLYR FUNCTIONS

Dplyr function	Description
rename()	Changes the name of a given variable (new name first)
distinct()	Remove duplicated rows in the dataset
slice()	Select rows by positions (specify vector of positions which you'd like to get)
add_row()	Add new row to data (arguments go as names of variables and their value)
bind_cols()	Bind two datasets by columns (like cbind)
bind_rows()	Bind two datasets by rows (like rbind)
left_join()/right_join() inner_join()/full_join()	Merging functions which take their names exactly from SQL syntax
%in%	Operator for the filter() function, allows for checking if a value is within the values given in a longer vector e.g. gender %in% c("male","female")
glimpse	Get an overview of the data (like summary/str function)

merge

Data transformation with dplyr : : CHEAT SHEET

dplyr functions work with pipes and expect **tidy data**. In tidy data:

Each **variable** is in its own **column**

&

Each **observation**, or **case**, is in its own **row**

pipes

x %>% f(y) becomes **f(x, y)**

Summarise Cases

Apply **summary functions** to columns to create a new table of summary statistics. Summary functions take vectors as input and return one value (see back).

summary function

summarise(.data, …**)** Compute table of summaries.
summarise(mtcars, avg = mean(mpg))

count(.data, …, wt = NULL, sort = FALSE, name = NULL**)** Count number of rows in each group defined by the variables in … Also **tally()**.
count(mtcars, cyl)

Group Cases

Use **group_by(**.data, …, .add = FALSE, .drop = TRUE**)** to create a "grouped" copy of a table grouped by columns in ... dplyr functions will manipulate each "group" separately and combine the results.

```
mtcars %>%
  group_by(cyl) %>%
  summarise(avg = mean(mpg))
```

Use **rowwise(**.data, …**)** to group data into individual rows. dplyr functions will compute results for each row. Also apply functions to list-columns. See tidyr cheat sheet for list-column workflow.

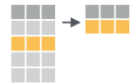
```
starwars %>%
  rowwise() %>%
  mutate(film_count = length(films))
```

ungroup(x, …**)** Returns ungrouped copy of table.
ungroup(g_mtcars)

Manipulate Cases

EXTRACT CASES

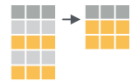
Row functions return a subset of rows as a new table.



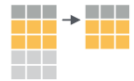
filter(.data, …, .preserve = FALSE**)** Extract rows that meet logical criteria.
filter(mtcars, mpg > 20)

distinct(.data, …, .keep_all = FALSE**)** Remove rows with duplicate values.
distinct(mtcars, gear)

slice(.data, …, .preserve = FALSE**)** Select rows by position.
slice(mtcars, 10:15)



slice_sample(.data, …, n, prop, weight_by = NULL, replace = FALSE**)** Randomly select rows. Use n to select a number of rows and prop to select a fraction of rows.
slice_sample(mtcars, n = 5, replace = TRUE)



slice_min(.data, order_by, …, n, prop, with_ties = TRUE**)** and **slice_max()** Select rows with the lowest and highest values.
slice_min(mtcars, mpg, prop = 0.25)

slice_head(.data, …, n, prop**)** and **slice_tail()** Select the first or last rows.
slice_head(mtcars, n = 5)

Logical and boolean operators to use with filter()

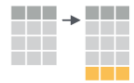
==	<	<=	is.na()	%in%	|	xor()
!=	>	>=	!is.na()	!	&	

See **?base::Logic** and **?Comparison** for help.

ARRANGE CASES

arrange(.data, …, .by_group = FALSE**)** Order rows by values of a column or columns (low to high), use with **desc()** to order from high to low.
arrange(mtcars, mpg)
arrange(mtcars, desc(mpg))

ADD CASES



add_row(.data, …, .before = NULL, .after = NULL**)** Add one or more rows to a table.
add_row(cars, speed = 1, dist = 1)

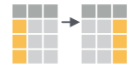
Manipulate Variables

EXTRACT VARIABLES

Column functions return a set of columns as a new vector or table.

pull(.data, var = -1, name = NULL, …**)** Extract column values as a vector, by name or index.
pull(mtcars, wt)

select(.data, …**)** Extract columns as a table.
select(mtcars, mpg, wt)



relocate(.data, …, .before = NULL, .after = NULL**)** Move columns to new position.
relocate(mtcars, mpg, cyl, .after = last_col())

Use these helpers with select() and across()
e.g. select(mtcars, mpg:cyl)

contains(match**)**	**num_range(**prefix, range**)**	**:**, e.g. mpg:cyl
ends_with(match**)**	**all_of(**x**)/any_of(**x, …, vars**)**	**-**, e.g. -gear
starts_with(match**)**	**matches(**match**)**	**everything()**

MANIPULATE MULTIPLE VARIABLES AT ONCE

across(.cols, .funs, …, .names = NULL**)** Summarise or mutate multiple columns in the same way.
summarise(mtcars, across(everything(), mean))

c_across(.cols**)** Compute across columns in row-wise data.
transmute(rowwise(UKgas), total = sum(c_across(1:2)))

MAKE NEW VARIABLES

Apply **vectorized functions** to columns. Vectorized functions take vectors as input and return vectors of the same length as output (see back).

vectorized function

mutate(.data, …, .keep = "all", .before = NULL, .after = NULL**)** Compute new column(s). Also **add_column(), add_count(),** and **add_tally().**
mutate(mtcars, gpm = 1 / mpg)

transmute(.data, …**)** Compute new column(s), drop others.
transmute(mtcars, gpm = 1 / mpg)

rename(.data, …**)** Rename columns. Use **rename_with()** to rename with a function.
rename(cars, distance = dist)

posit™

Vectorized Functions

TO USE WITH MUTATE ()

mutate() and **transmute()** apply vectorized functions to columns to create new columns. Vectorized functions take vectors as input and return vectors of the same length as output.

vectorized function

OFFSET

dplyr::**lag()** - offset elements by 1
dplyr::**lead()** - offset elements by -1

CUMULATIVE AGGREGATE

dplyr::**cumall()** - cumulative all()
dplyr::**cumany()** - cumulative any()
cummax() - cumulative max()
dplyr::**cummean()** - cumulative mean()
cummin() - cumulative min()
cumprod() - cumulative prod()
cumsum() - cumulative sum()

RANKING

dplyr::**cume_dist()** - proportion of all values <=
dplyr::**dense_rank()** - rank w ties = min, no gaps
dplyr::**min_rank()** - rank with ties = min
dplyr::**ntile()** - bins into n bins
dplyr::**percent_rank()** - min_rank scaled to [0,1]
dplyr::**row_number()** - rank with ties = "first"

MATH

+, - , *, /, ^, %/%, %% - arithmetic ops
log(), log2(), log10() - logs
<, <=, >, >=, !=, == - logical comparisons
dplyr::**between()** - x >= left & x <= right
dplyr::**near()** - safe == for floating point numbers

MISCELLANEOUS

dplyr::**case_when()** - multi-case if_else()

```
starwars %>%
  mutate(type = case_when(
    height > 200 | mass > 200 ~ "large",
    species == "Droid"        ~ "robot",
    TRUE                      ~ "other")
  )
```

dplyr::**coalesce()** - first non-NA values by element across a set of vectors
dplyr::**if_else()** - element-wise if() + else()
dplyr::**na_if()** - replace specific values with NA
pmax() - element-wise max()
pmin() - element-wise min()

Summary Functions

TO USE WITH SUMMARISE ()

summarise() applies summary functions to columns to create a new table. Summary functions take vectors as input and return single values as output.

summary function

COUNT

dplyr::**n()** - number of values/rows
dplyr::**n_distinct()** - # of uniques
sum(!is.na()) - # of non-NA's

POSITION

mean() - mean, also **mean(!is.na())**
median() - median

LOGICAL

mean() - proportion of TRUE's
sum() - # of TRUE's

ORDER

dplyr::**first()** - first value
dplyr::**last()** - last value
dplyr::**nth()** - value in nth location of vector

RANK

quantile() - nth quantile
min() - minimum value
max() - maximum value

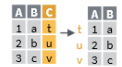
SPREAD

IQR() - Inter-Quartile Range
mad() - median absolute deviation
sd() - standard deviation
var() - variance

Row Names

Tidy data does not use rownames, which store a variable outside of the columns. To work with the rownames, first move them into a column.

tibble::**rownames_to_column()**
Move row names into col.
a <- rownames_to_column(mtcars, var = "C")



tibble::**column_to_rownames()**
Move col into row names.
column_to_rownames(a, var = "C")

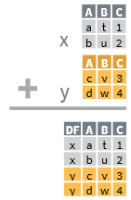
Also tibble::**has_rownames()** and tibble::**remove_rownames()**.

Combine Tables

COMBINE VARIABLES

bind_cols(…, .name_repair**)** Returns tables placed side by side as a single table. Column lengths must be equal. Columns will NOT be matched by id (to do that look at Relational Data below), so be sure to check that both tables are ordered the way you want before binding.

COMBINE CASES



bind_rows(…, .id = NULL**)** Returns tables one on top of the other as a single table. Set .id to a column name to add a column of the original table names (as pictured).

RELATIONAL DATA

Use a "**Mutating Join**" to join one table to columns from another, matching values with the rows that they correspond to. Each join retains a different combination of values from the tables.

left_join(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), …, keep = FALSE, na_matches = "na"**)** Join matching values from y to x.

right_join(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), …, keep = FALSE, na_matches = "na"**)** Join matching values from x to y.

inner_join(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), …, keep = FALSE, na_matches = "na"**)** Join data. Retain only rows with matches.

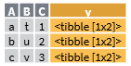
full_join(x, y, by = NULL, copy = FALSE, suffix = c(".x", ".y"), …, keep = FALSE, na_matches = "na"**)** Join data. Retain all values, all rows.

Use a "**Filtering Join**" to filter one table against the rows of another.

semi_join(x, y, by = NULL, copy = FALSE, …, na_matches = "na"**)** Return rows of x that have a match in y. Use to see what will be included in a join.

anti_join(x, y, by = NULL, copy = FALSE, …, na_matches = "na"**)** Return rows of x that do not have a match in y. Use to see what will not be included in a join.

Use a "**Nest Join**" to inner join one table to another into a nested data frame.



nest_join(x, y, by = NULL, copy = FALSE, keep = FALSE, name = NULL, …**)** Join data, nesting matches from y in a single new data frame column.

COLUMN MATCHING FOR JOINS

Use **by = c("col1", "col2", …)** to specify one or more common columns to match on.
left_join(x, y, by = "A")

Use a named vector, **by = c("col1" = "col2")**, to match on columns that have different names in each table.
left_join(x, y, by = c("C" = "D"))

Use **suffix** to specify the suffix to give to unmatched columns that have the same name in both tables.
left_join(x, y, by = c("C" = "D"), suffix = c("1", "2"))

SET OPERATIONS

intersect(x, y, …)
Rows that appear in both x and y.

setdiff(x, y, …)
Rows that appear in x but not y.

union(x, y, …)
Rows that appear in x or y. (Duplicates removed). **union_all()** retains duplicates.

Use **setequal()** to test whether two data sets contain the exact same rows (in any order).