Introduction to DAV 5300

Computational Mathematics and Statistics

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January 20, 2026

Agenda

- Introductions
- Syllabus
- Class meetups
- Course Schedule
- Assignments (how you will be graded)
- Software setup
- Brief introduction to R

While waiting, please complete this formative assessment:

A little about me...

- Earned my Ph.D. in Educational Pschology and Methodology from the University at Albany. Dissertation: A National Study Comparing Charter and Traditional Public Schools Using Propensity Score Analysis
- Assistant Professor at CUNY in Data Science and Information Systems
- Principal Investigator for a Department of Education Grant to develop and test the Diagnostic Assessment and Achievement of College Skills (www.DAACS.net)
- Authored over a dozen R packages including:
  - likert
  - clav
  - VisualStats
- Specialize in propensity score methods. Three new methods/R packages developed include:
  - multilevelPSA
  - TriMatch
  - PSAboot

Also a Father...

Runner...

And photographer.

Your turn...

What is your name?

What are your career goals?

Something unique about you (e.g. hobby, interest, favorite movie)?

Syllabus

Syllabus and course materials are here:
https://spring2026.dav5300.net

We will use Canvas primary for submitting assignments only. Please submit PDFs.

PDFs are preferred for the homework as there is some LaTeX formatting in the R markdown files. The `tinytex` R package helps with install LaTeX, but you can also install LaTeX using MiKTeX (for Windows) and BasicTeX (for Mac).

Class Meetings

Class will meet every Tuesday.

In order to get the most out of this class attendance is required.

One Minute Papers - Complete the one minute paper after each Meetup (whether you watch live or watch the recordings). It should take approximately one to two minutes to complete.

Schedule

Topic	Date
Intro to the Course / Intro to Data	2026-01-20
Summarizing Data	2026-01-27
Probability and Distributions	2026-02-03
Foundation for Inference	2026-02-10
NO CLASS	2026-02-17
Inference for Categorical Data	2026-02-24
NO CLASS - Purim-No	2026-03-03
Inference for Numerical Data	2026-03-10
Linear Regression	2026-03-17
Maximum Likelihood Estimation and Logistic Regression	2026-03-24
Multiple Regression	2026-03-31
NO CLASS - Spring Break	2026-04-07
Conferences (online)	2026-04-14
Predictive Modeling and CART Methods	2026-04-21
Bayesian Analysis and Propensity Score Analysis	2026-04-28
Presentations	2026-05-05
Final Exam	2026-05-12

Assignments are due before the next class.

Textbooks

OpenIntro Statistics by David Diaz, Mine Çetinkaya-Rundel, and Christopher D Barr.

Learning Statistics with R by Danielle Navaro - We will only use the Bayesian chapter from this book.

Optional

R for Data Science by Hadley Wickham and Garrett Grolemund - Recommended reference for those new to R.

Assignments

Labs (30%) - Labs are designed to provide you an opportunity to apply statistical concepts using statistical software.

Textbook questions (15%) - The assigned questions from the textbook provide an opportunity to assess conceptional understandings.

Participation (10%) - You are expected to attend every class and to complete a one minute paper at the conclusion of class.

Data Project (25%) - In a group of 2 to 3 students will present the results of analysis using a data set of your choice. More details will be provided a few weeks into the class.

Final exam (20%) - A multiple choice exam will be given on the last day of class.

All assignments are due on Tuesday. Assignments submitted late will be penalized. Assignments will not be accepted more than two weeks after their due date.

Academic Integrity

With the exception of the data project, I expect you to complete all assignments (e.g. homework, labs) on your own. It is fine to ask questions of your peers and professor, but working together and/or sharing answers is not allowed.

Yeshiva's Policy

The submission by a student of any examination, course assignment, or degree requirement is assumed to guarantee that the thoughts and expressions therein not expressly credited to another are literally the student's own. Evidence to the contrary will result in appropriate penalties. For more information, visit https://www.yu.edu/academic-integrity.

Use of Artificial Intelligence (AI)

First, AI is a marketing term. I prefer to be more specific regarding what we are doing:

1. Machine Learning (ML) - This course will provide the foundations for how ML algorithms work. Generally speaking, the goal is to predict some known (and sometimes unknown in the case of unsupervised learning models) outcome.

2. Large Language Models (LLM) - This is often what people mean when they say AI. This includes producsts like ChatGPT, Antrhopic, Google Gemini, etc. LLMs generate text, images, videos, etc. from a prompt.

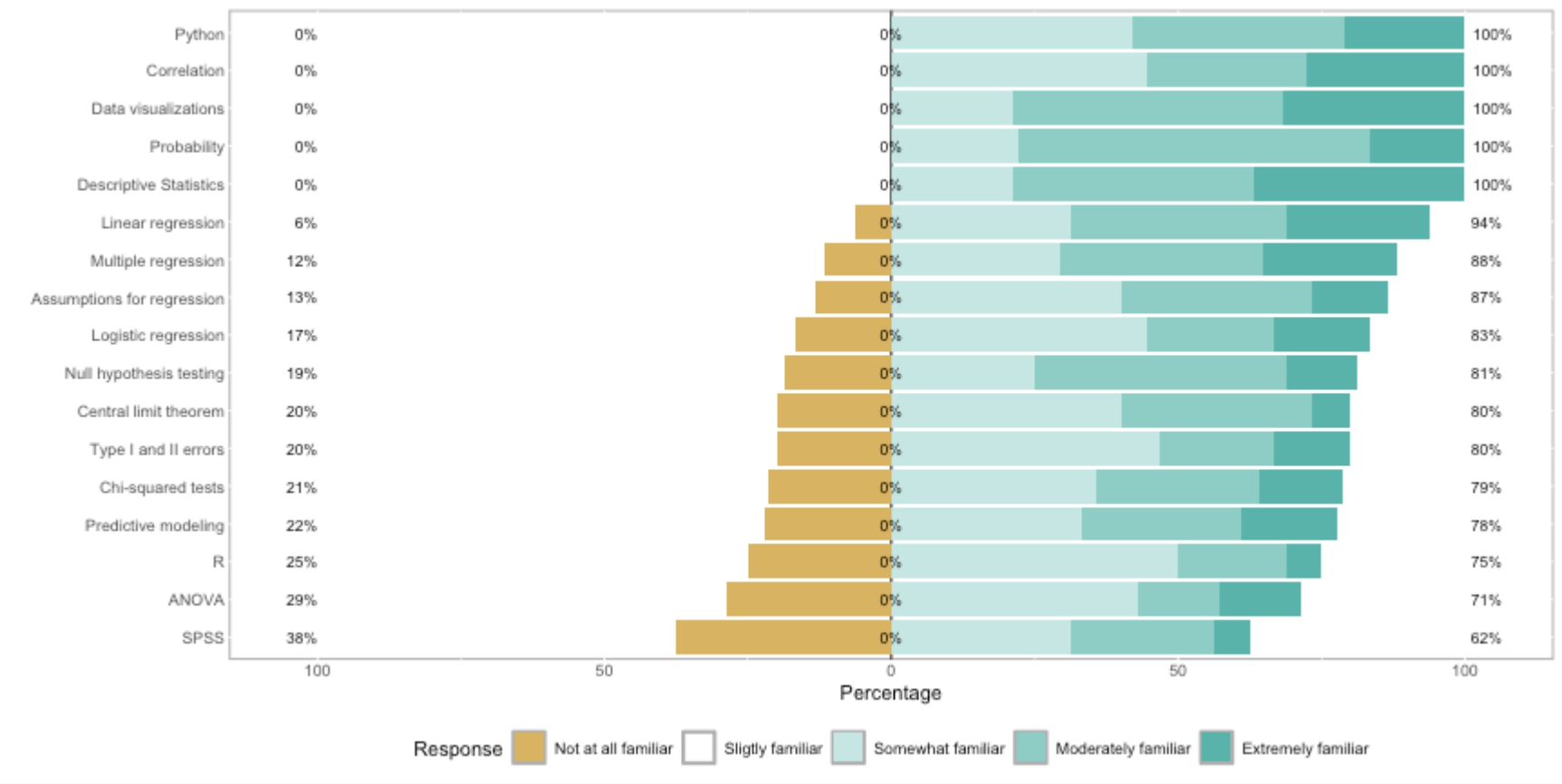
The goal of this course is for *you to develop the foundation knowledge and skills to do statistics.* Using chat bots to do the assignments subverts this goal. **The content generated by LLMs is often wrong!** If you use LLMs to assist in completing the assignments, **you must include the prompt and response in your submission**.

Communication

- Email: jason.bryer@yu.edu.
- Canvas
- Office hours before and after class and by appointment.

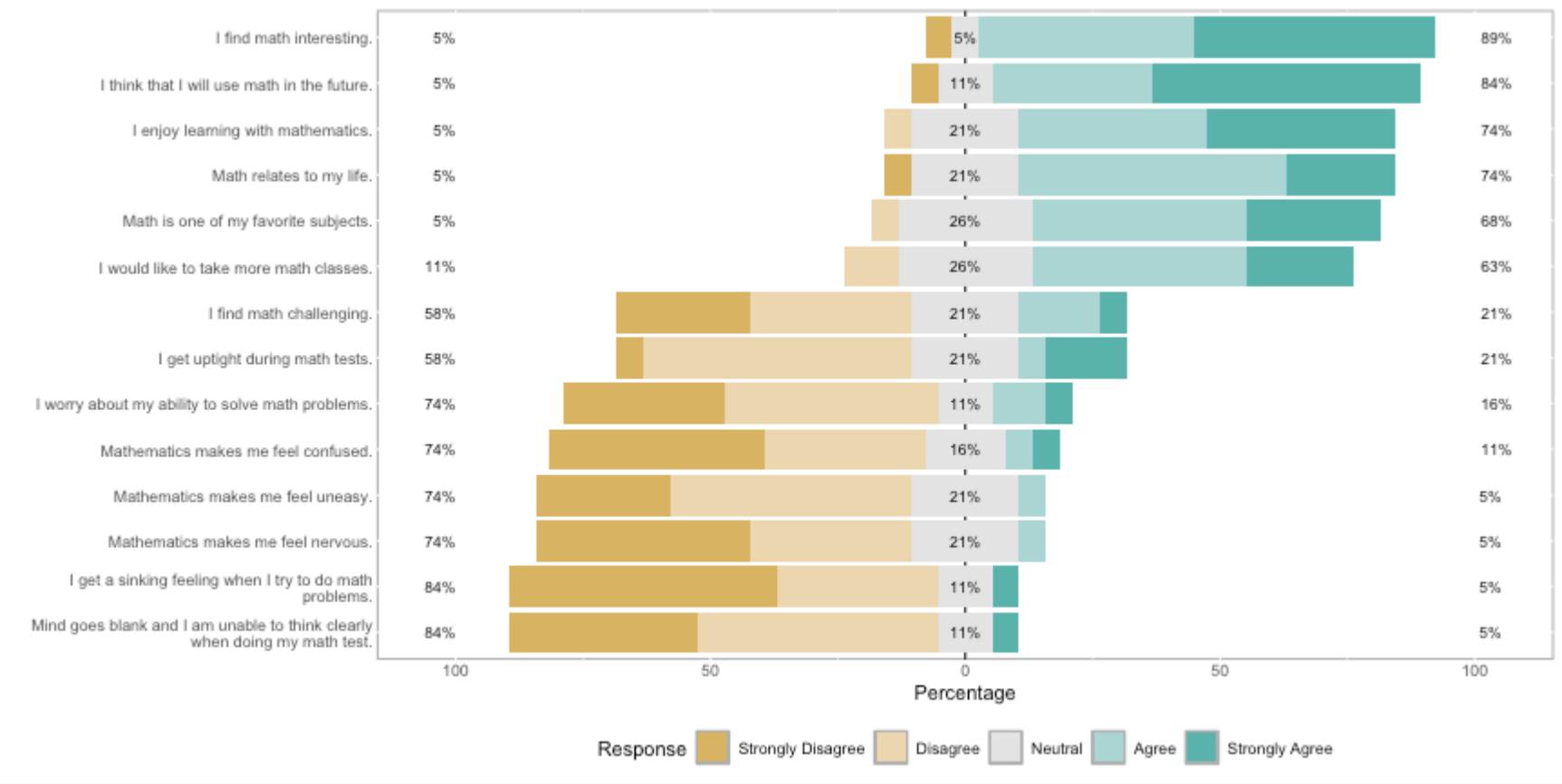
Familiarity with Statistical Topics

```
likert(stats.results) |> plot(center = 2.5)
```



Math Anxiety Survey Scale

```
likert(mass.results) |> plot()
```



Software Setup

Why R?

There are many languages data scientists use. R is specifically designed for statistics. We will leverage many R packages that are specifically designed to conduct, teach, and communicate statistical analysis.

To be a well rounded data scientists, I believe you need to have experience in both R and Python. For this course:

- Use R for the labs (they are designed to help you learn the core commands).
- You may use Python or R for the homework and data project.

Software

This is an applied statistics course so we will make extensive use of the R statistical programming language.

- Install R and RStudio on your own computer. I encourage everyone to do this at some point by the end of the semester.

You will also need to have LaTeX installed as well in order to create PDFs. The `tinytex` R package helps with this process:

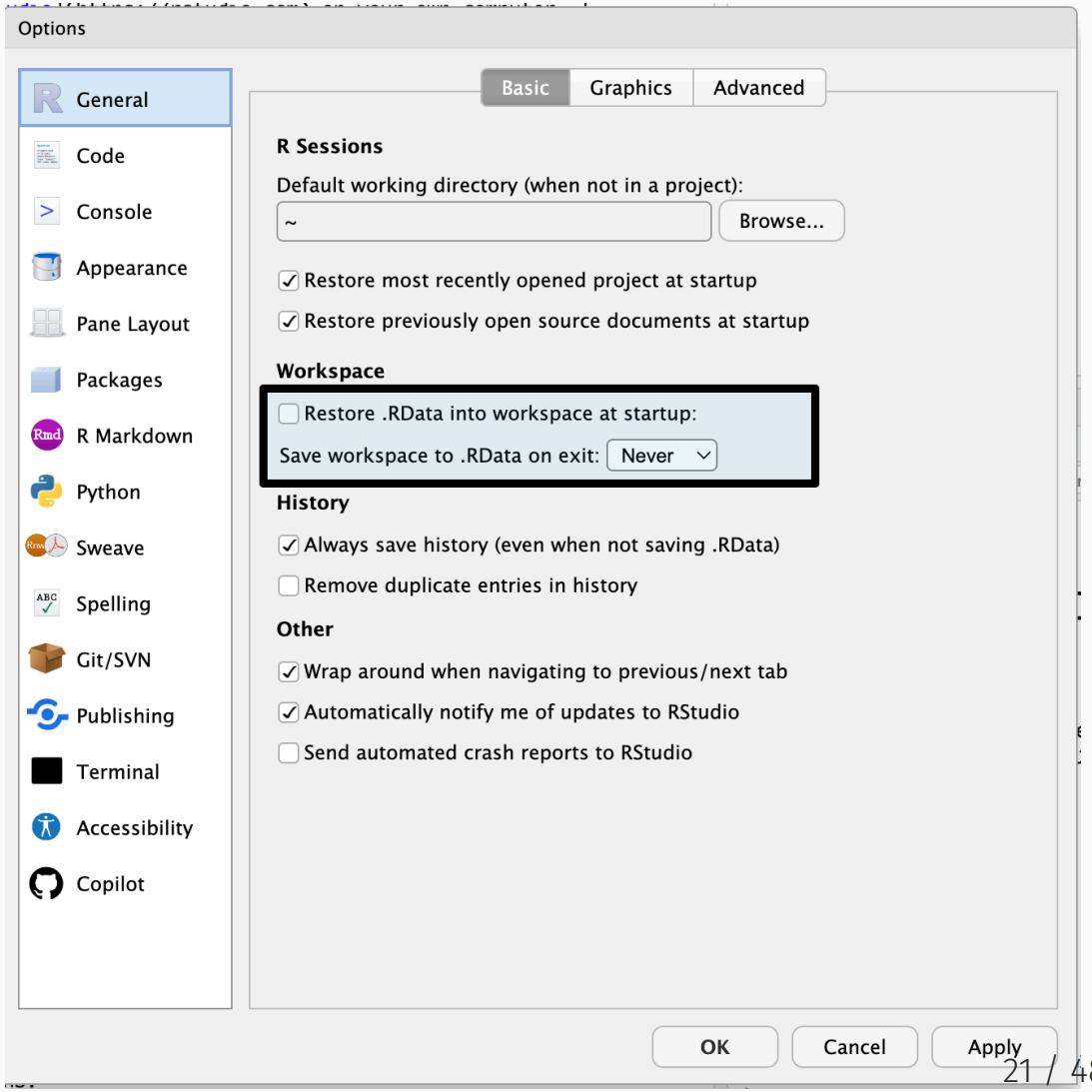
```
install.packages('tinytex')
tinytex::install_tinytex()
```

Clean Environment Between Sessions

By default RStudio will ask you to save your session when closing the application. Additionally, if the `.RData` file exists in the project directory, data saved in that file will be loaded into your session. *I highly recommend turning this off.* Doing so will ensure you have a clean environment everytime you start RStudio.

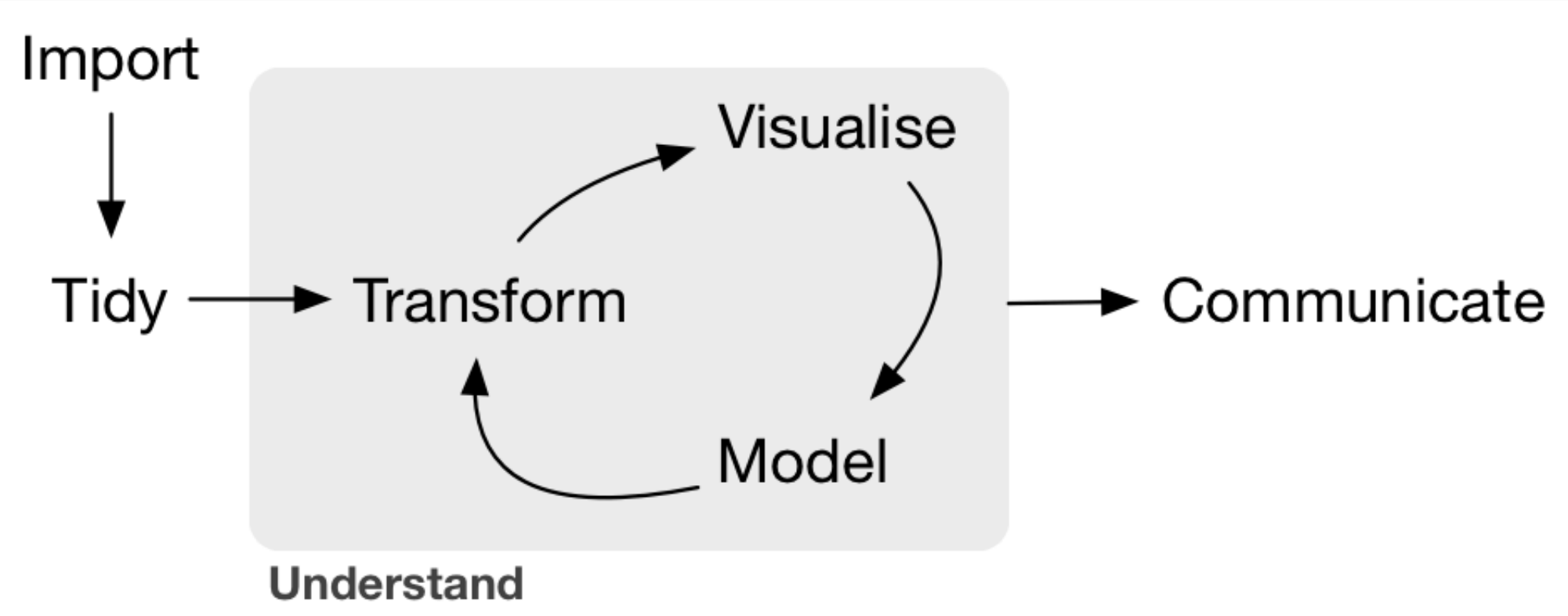
- In RStudio, click the `Tools` menu then `Global Options`
- Uncheck *"Restore .RData into workspace at startup"*
- For *"Save worksopace to .RData on exit"* select "Never"

Why do this? Whenever you knit a document (e.g. Rmarkdow, Quarto) R will create a new, blank, session to knit the document. When working interactively it is easy to run commands out of order. It is alwasy good to check your work by resetting your environment (click `Session --> Restart R`) and running your commands in order to ensure everyting will work as intended.



Introduction to R

Workflow



Source: Wickham & Grolemund, 2017

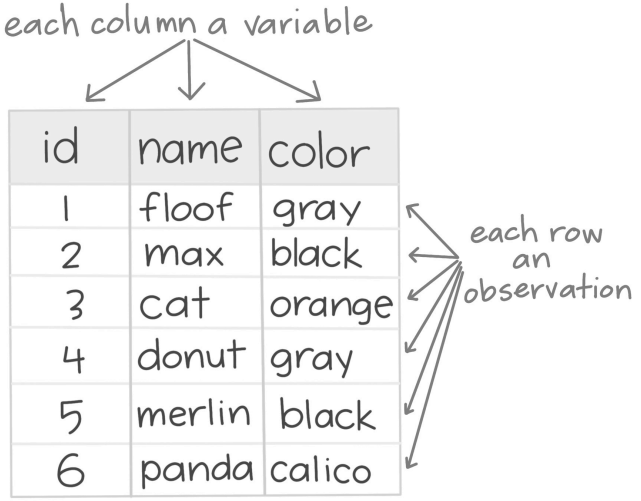
Tidy Data

"TIDY DATA is a standard way of mapping the meaning of a dataset to its structure."

—HADLEY WICKHAM

In tidy data:

- each variable forms a column
- each observation forms a row
- each cell is a single measurement



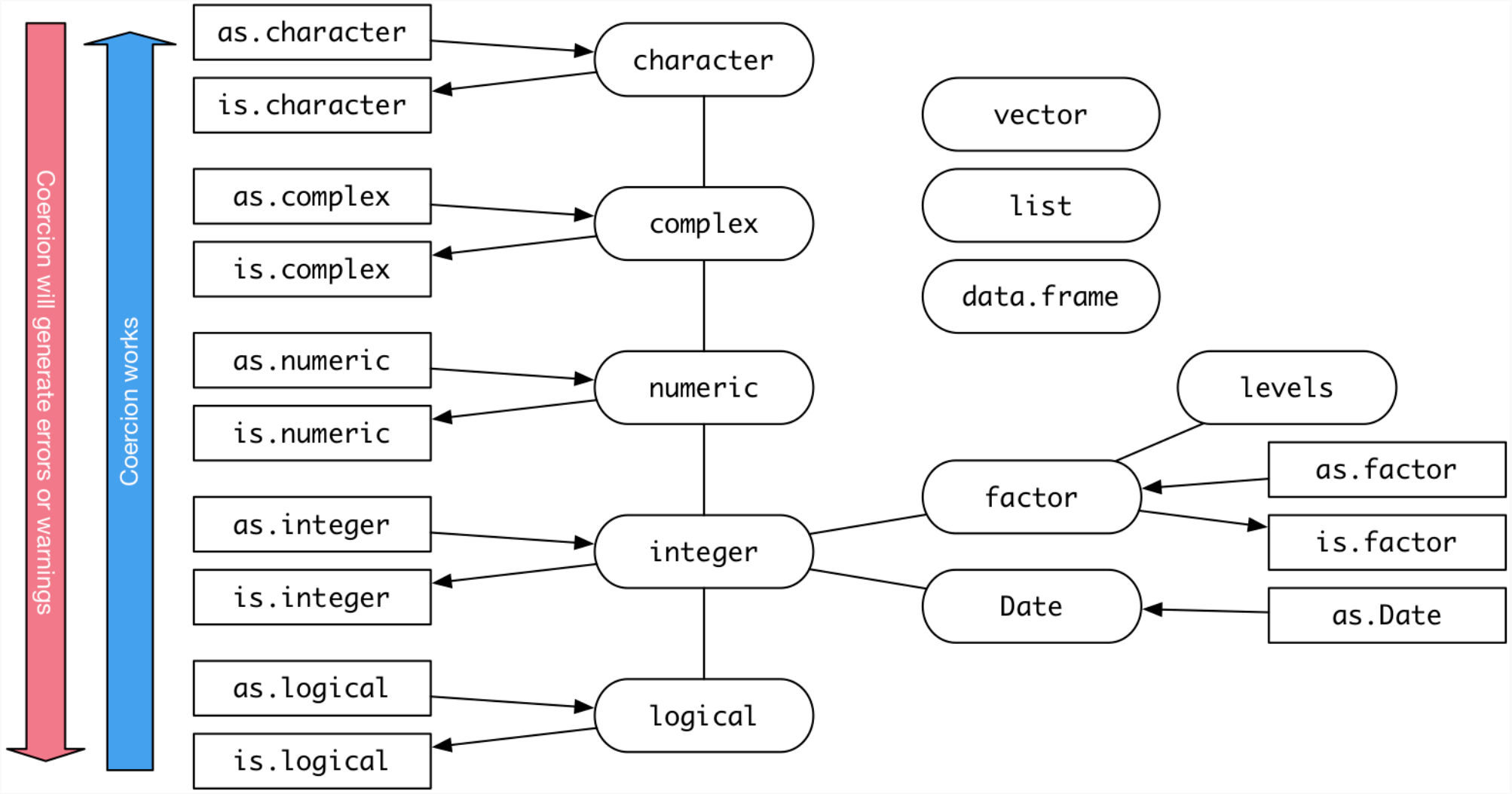
Wickham, H. (2014). Tidy Data. Journal of Statistical Software *59* (10). DOI: 10.18637/jss.v059.i10

See Wickham (2014) Tidy data.

Types of Data

- Numerical (quantitative)
  - Continuous
  - Discrete
- Categorical (qualitative)
  - Regular categorical
  - Ordinal

Data Types in R



About `legosets`

To install the `brickset` package:

```
remotes::install_github('jbryer/brickset')
```

To load the load the `legosets` dataset.

```
data('legosets', package = 'brickset')
```

The `legosets` data has 21546 observations of 36 variables.

```
names(legosets)
```

```
##  [1] "setID"                "number"               "numberVariant"
##  [4] "name"                 "year"                 "theme"
##  [7] "themeGroup"           "subtheme"             "category"
## [10] "released"             "pieces"               "minifigs"
## [13] "bricksetURL"          "rating"               "reviewCount"
## [16] "packagingType"        "availability"         "agerange_min"
## [19] "thumbnailURL"         "imageURL"             "US_retailPrice"
## [22] "US_dateFirstAvailable" "US_dateLastAvailable" "UK_retailPrice"
## [25] "UK_dateFirstAvailable" "UK_dateLastAvailable" "CA_retailPrice"
## [28] "CA_dateFirstAvailable" "CA_dateLastAvailable" "DE_retailPrice"
## [31] "DE_dateFirstAvailable" "DE_dateLastAvailable" "height"
## [34] "width"                "depth"                "weight"
```

Structure (`str`)

```
str(legosets)
```

```
## 'data.frame':    21546 obs. of  36 variables:
##  $ setID                : int  7693 7695 7697 7698 25534 7418 7419 6020 22704 7421 ...
##  $ number               : chr  "1" "2" "3" "4" ...
##  $ numberVariant        : int  8 8 6 4 6 1 1 1 3 4 ...
##  $ name                 : chr  "Small house set" "Medium house set" "Medium house set" "Large house set" ...
##  $ year                 : int  1970 1970 1970 1970 1970 1970 1970 1970 1970 1970 ...
##  $ theme                : chr  "Minitalia" "Minitalia" "Minitalia" "Minitalia" ...
##  $ themeGroup           : chr  "Vintage" "Vintage" "Vintage" "Vintage" ...
##  $ subtheme             : chr  NA NA NA NA ...
##  $ category             : chr  "Normal" "Normal" "Normal" "Normal" ...
##  $ released             : logi  TRUE TRUE TRUE TRUE TRUE TRUE ...
##  $ pieces               : int  67 109 158 233 NA 1 1 60 65 NA ...
##  $ minifigs             : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ bricksetURL          : chr  "https://brickset.com/sets/1-8" "https://brickset.com/sets/2-8" "https://brickset.com/sets/3-6" "https://brickset.com/sets/4-4" ...
##  $ rating               : num  0 0 0 0 0 0 0 0 0 0 ...
##  $ reviewCount          : int  0 0 1 0 0 0 0 0 0 0 ...
##  $ packagingType        : chr  "{Not specified}" "{Not specified}" "{Not specified}" "{Not specified}" ...
##  $ availability         : chr  "{Not specified}" "{Not specified}" "{Not specified}" "{Not specified}" ...
##  $ agerange_min         : int  NA NA NA NA NA NA NA NA NA NA ...
##  $ thumbnailURL         : chr  "https://images.brickset.com/sets/small/1-8.jpg" "https://images.brickset.com/sets/small/2-8.jpg" "https://images.brickset.com/sets/small/3-6.jpg" "https:
##  $ imageURL             : chr  "https://images.brickset.com/sets/images/1-8.jpg" "https://images.brickset.com/sets/images/2-8.jpg" "https://images.brickset.com/sets/images/3-6.jpg" "ht
##  $ US_retailPrice       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ US_dateFirstAvailable: Date, format: NA NA ...
##  $ US_dateLastAvailable : Date, format: NA NA ...
##  $ UK_retailPrice       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ UK_dateFirstAvailable: Date, format: NA NA ...
##  $ UK_dateLastAvailable : Date, format: NA NA ...
##  $ CA_retailPrice       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ CA_dateFirstAvailable: Date, format: NA NA ...
##  $ CA_dateLastAvailable : Date, format: NA NA ...
##  $ DE_retailPrice       : num  NA NA NA NA NA NA NA NA NA NA ...
##  $ DE_dateFirstAvailable: Date, format: NA NA ...
##  $ DE_dateLastAvailable : Date, format: NA NA ...
##  $ height               : num  NA NA NA NA NA ...
##  $ width                : num  NA NA NA NA NA ...
```

RStudio Eenvironment tab can help

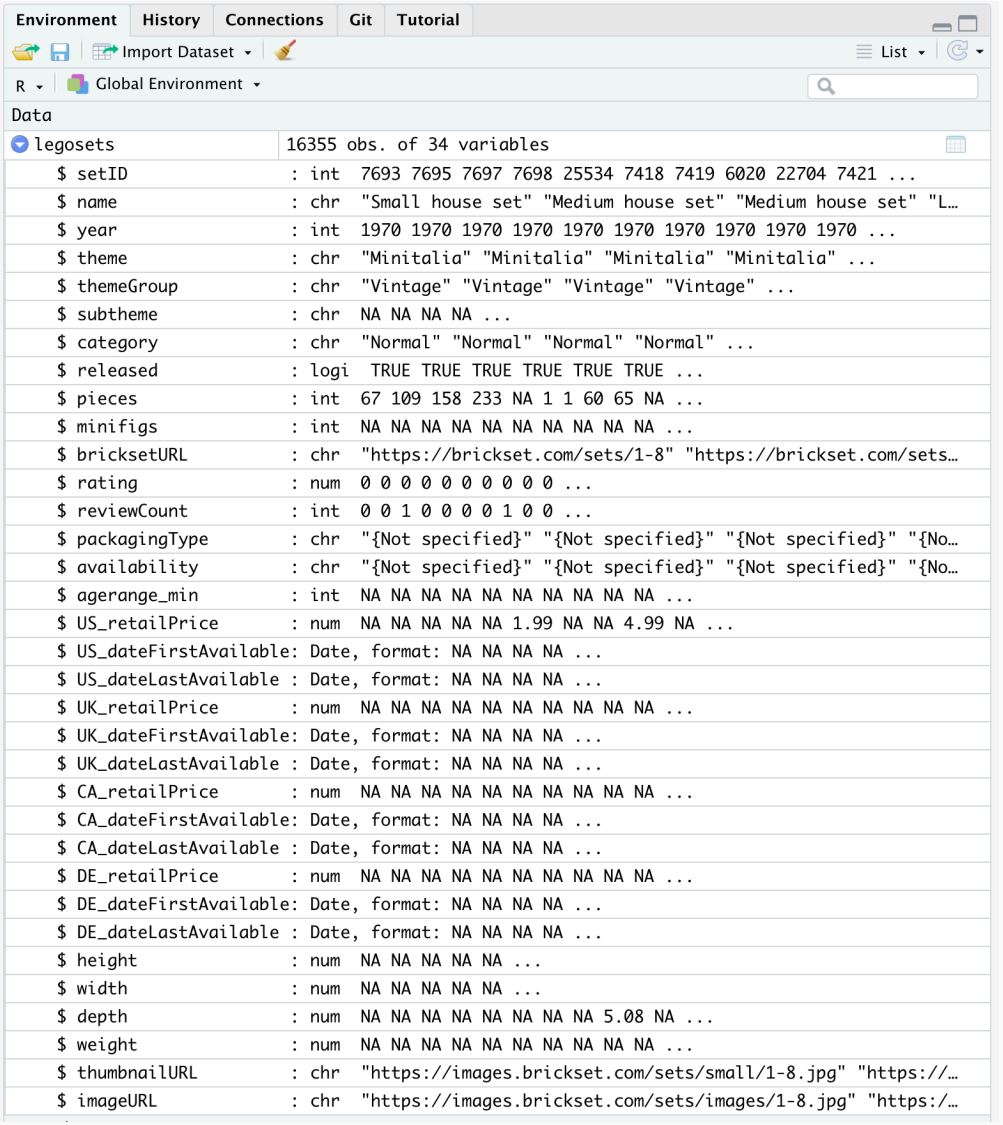


Table View

Show 10 entries

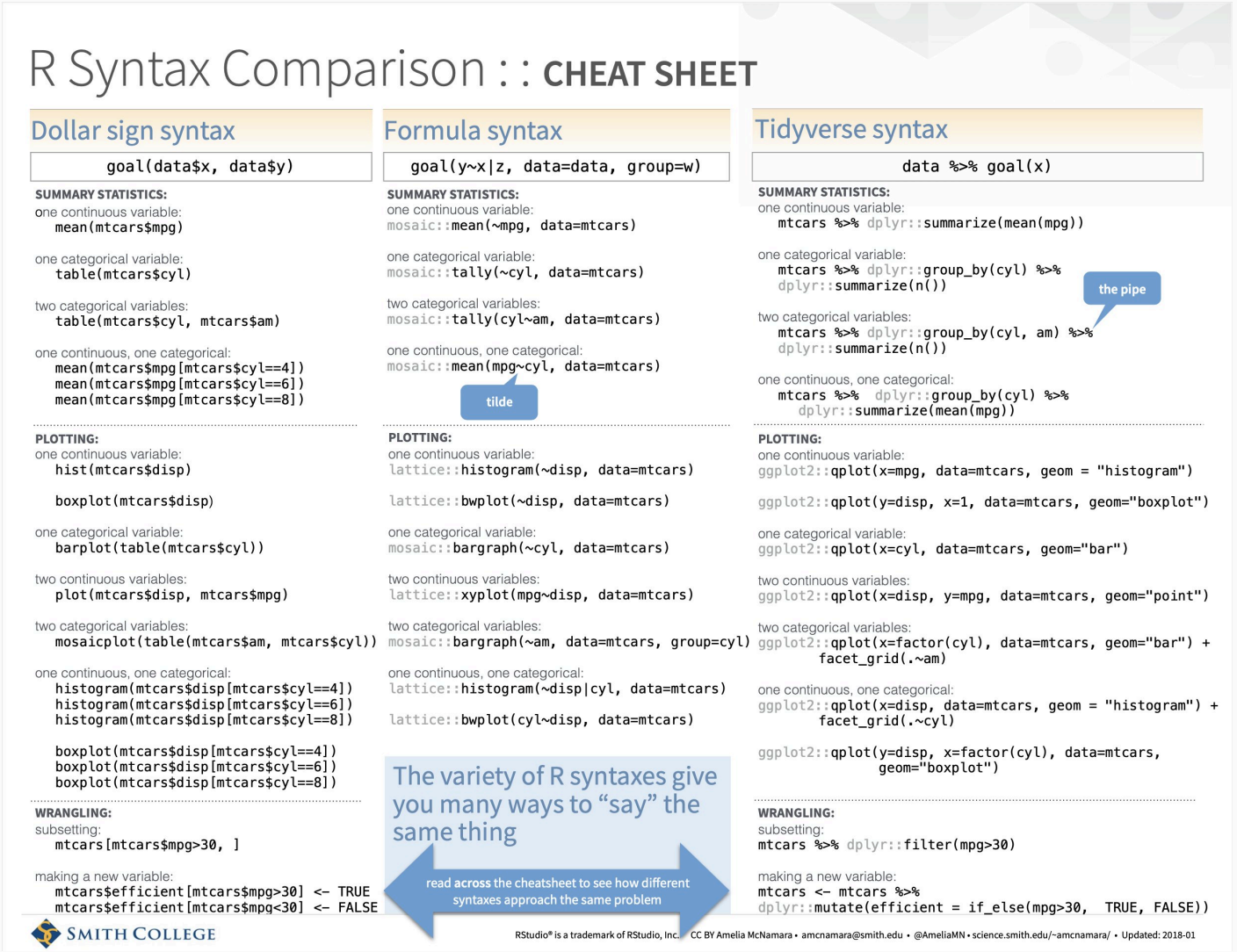
Search:

	setID	name	year	theme	themeGroup	category	US_retailPrice	pieces	minifigs	rating
1	34275	Dump Truck	2023	Technic	Technical	Normal	12.99	177		3.8
2	524	Pen Darth Vader	2002	Gear	Miscellaneous	Gear				0
3	50401	Zane	2024	Ninjago	Action/Adventure	Other		11	1	0
4	26333	LEGO Star Wars: The Force Awakens - PlayStation 4	2016	Gear	Miscellaneous	Gear	69.99			0
5	6100	Gordon's Express	2007	Duplo	Pre-school	Normal	19.99	13	1	0
6	5051	Farm Animals Set	1986	Dacta	Educational	Normal		30		0
7	30791	Hogwarts Moment: Herbology Class	2021	Harry Potter	Licensed	Normal	29.99	233	3	3.8
8	3623	Galaxy Trekkor	1987	Space	Action/Adventure	Normal		29	1	3.2
9	49158	Brick Lunch Bag – Blue	2024	Gear	Miscellaneous	Gear	28			0
10	5397	Speedboat	2006	Creator	Model making	Normal		18		0

Showing 1 to 10 of 100 entries

Previous 1 2 3 4 5 ... 10 Next

Tidyverse vs Base R



R Syntax Comparison : : CHEAT SHEET

Dollar sign syntax

`goal(data$x, data$y)`

SUMMARY STATISTICS:

one continuous variable:
```
mean(mtcars$mpg)
```

one categorical variable:
```
table(mtcars$cyl)
```

two categorical variables:
```
table(mtcars$cyl, mtcars$am)
```

one continuous, one categorical:
```
mean(mtcars$mpg[mtcars$cyl==4])
mean(mtcars$mpg[mtcars$cyl==6])
mean(mtcars$mpg[mtcars$cyl==8])
```

PLOTTING:

one continuous variable:
```
hist(mtcars$disp)

boxplot(mtcars$disp)
```

one categorical variable:
```
barplot(table(mtcars$cyl))
```

two continuous variables:
```
plot(mtcars$disp, mtcars$mpg)
```

two categorical variables:
```
mosaicplot(table(mtcars$am, mtcars$cyl))
```

one continuous, one categorical:
```
histogram(mtcars$disp[mtcars$cyl==4])
histogram(mtcars$disp[mtcars$cyl==6])
histogram(mtcars$disp[mtcars$cyl==8])

boxplot(mtcars$disp[mtcars$cyl==4])
boxplot(mtcars$disp[mtcars$cyl==6])
boxplot(mtcars$disp[mtcars$cyl==8])
```

WRANGLING:

subsetting:
```
mtcars[mtcars$mpg>30, ]
```

making a new variable:
```
mtcars$efficient[mtcars$mpg>30] <- TRUE
mtcars$efficient[mtcars$mpg<30] <- FALSE
```

Formula syntax

`goal(y~x|z, data=data, group=w)`

SUMMARY STATISTICS:

one continuous variable:
```
mosaic::mean(~mpg, data=mtcars)
```

one categorical variable:
```
mosaic::tally(~cyl, data=mtcars)
```

two categorical variables:
```
mosaic::tally(cyl~am, data=mtcars)
```

one continuous, one categorical:
```
mosaic::mean(mpg~cyl, data=mtcars)
```

tilde

PLOTTING:

one continuous variable:
```
lattice::histogram(~disp, data=mtcars)

lattice::bwplot(~disp, data=mtcars)
```

one categorical variable:
```
mosaic::bargraph(~cyl, data=mtcars)
```

two continuous variables:
```
lattice::xyplot(mpg~disp, data=mtcars)
```

two categorical variables:
```
mosaic::bargraph(~am, data=mtcars, group=cyl)
```

one continuous, one categorical:
```
lattice::histogram(~disp|cyl, data=mtcars)

lattice::bwplot(cyl~disp, data=mtcars)
```

The variety of R syntaxes give you many ways to "say" the same thing

read **across** the cheatsheet to see how different syntaxes approach the same problem

Tidyverse syntax

`data %>% goal(x)`

SUMMARY STATISTICS:

one continuous variable:
```
mtcars %>% dplyr::summarize(mean(mpg))
```

one categorical variable:
```
mtcars %>% dplyr::group_by(cyl) %>%
  dplyr::summarize(n())
```

the pipe

two categorical variables:
```
mtcars %>% dplyr::group_by(cyl, am) %>%
  dplyr::summarize(n())
```

one continuous, one categorical:
```
mtcars %>%  dplyr::group_by(cyl) %>%
   dplyr::summarize(mean(mpg))
```

PLOTTING:

one continuous variable:
```
ggplot2::qplot(x=mpg, data=mtcars, geom = "histogram")

ggplot2::qplot(y=disp, x=1, data=mtcars, geom="boxplot")
```

one categorical variable:
```
ggplot2::qplot(x=cyl, data=mtcars, geom="bar")
```

two continuous variables:
```
ggplot2::qplot(x=disp, y=mpg, data=mtcars, geom="point")
```

two categorical variables:
```
ggplot2::qplot(x=factor(cyl), data=mtcars, geom="bar") +
        facet_grid(.~am)
```

one continuous, one categorical:
```
ggplot2::qplot(x=disp, data=mtcars, geom = "histogram") +
        facet_grid(.~cyl)

ggplot2::qplot(y=disp, x=factor(cyl), data=mtcars,
               geom="boxplot")
```

WRANGLING:

subsetting:
```
mtcars %>% dplyr::filter(mpg>30)
```

making a new variable:
```
mtcars <- mtcars %>%
dplyr::mutate(efficient = if_else(mpg>30,  TRUE, FALSE))
```

SMITH COLLEGE

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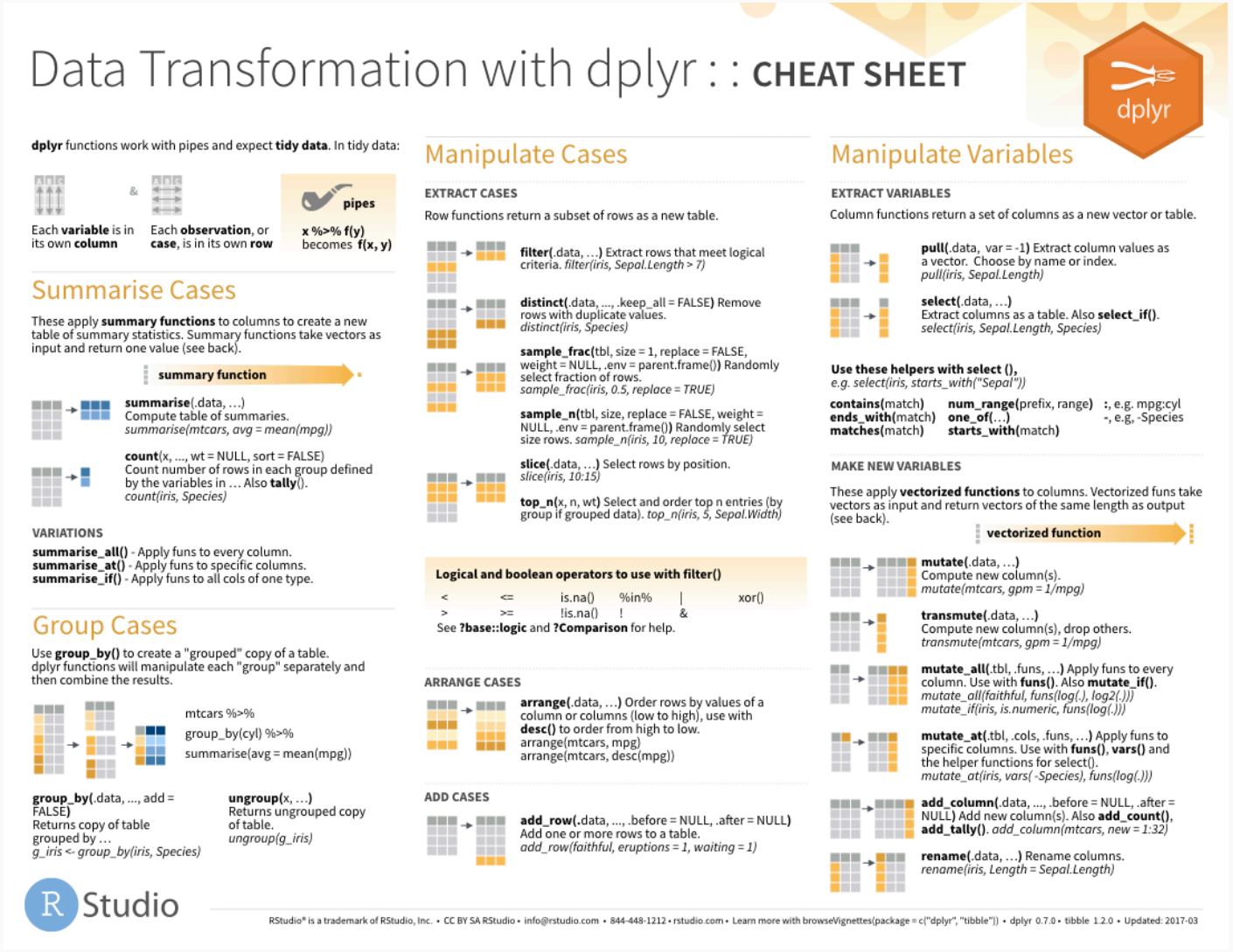
Data Wrangling Cheat Sheet



Data Transformation with dplyr : : CHEAT SHEET

dplyr

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

These 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(x, ..., wt = NULL, sort = FALSE)
Count number of rows in each group defined by the variables in … Also **tally**().
count(iris, Species)

VARIATIONS

summarise_all() - Apply funs to every column.
summarise_at() - Apply funs to specific columns.
summarise_if() - Apply funs to all cols of one type.

Group Cases

Use **group_by()** to create a "grouped" copy of a table. dplyr functions will manipulate each "group" separately and then combine the results.

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

group_by(.data, ..., add = FALSE)
Returns copy of table grouped by …
g_iris <- group_by(iris, Species)

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

Manipulate Cases

EXTRACT CASES

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

filter(.data, …) Extract rows that meet logical criteria. *filter(iris, Sepal.Length > 7)*

distinct(.data, ..., .keep_all = FALSE) Remove rows with duplicate values.
distinct(iris, Species)

sample_frac(tbl, size = 1, replace = FALSE, weight = NULL, .env = parent.frame()) Randomly select fraction of rows.
sample_frac(iris, 0.5, replace = TRUE)

sample_n(tbl, size, replace = FALSE, weight = NULL, .env = parent.frame()) Randomly select size rows. *sample_n(iris, 10, replace = TRUE)*

slice(.data, …) Select rows by position.
slice(iris, 10:15)

top_n(x, n, wt) Select and order top n entries (by group if grouped data). *top_n(iris, 5, Sepal.Width)*

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, …) 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(faithful, eruptions = 1, waiting = 1)

Manipulate Variables

EXTRACT VARIABLES

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

pull(.data, var = -1) Extract column values as a vector. Choose by name or index.
pull(iris, Sepal.Length)

select(.data, …)
Extract columns as a table. Also **select_if()**.
select(iris, Sepal.Length, Species)

Use these helpers with select (),
e.g. select(iris, starts_with("Sepal"))

contains(match)
ends_with(match)
matches(match)
num_range(prefix, range)
one_of(…)
starts_with(match)
:, e.g. mpg:cyl
-, e.g, -Species

MAKE NEW VARIABLES

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

vectorized function

mutate(.data, …)
Compute new column(s).
mutate(mtcars, gpm = 1/mpg)

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

mutate_all(.tbl, .funs, …) Apply funs to every column. Use with **funs()**. Also **mutate_if()**.
mutate_all(faithful, funs(log(.), log2(.)))
mutate_if(iris, is.numeric, funs(log(.)))

mutate_at(.tbl, .cols, .funs, …) Apply funs to specific columns. Use with **funs()**, **vars()** and the helper functions for select().
mutate_at(iris, vars(-Species), funs(log(.)))

add_column(.data, ..., .before = NULL, .after = NULL) Add new column(s). Also **add_count()**, **add_tally()**. *add_column(mtcars, new = 1:32)*

rename(.data, …) Rename columns.
rename(iris, Length = Sepal.Length)

RStudio

Pipes %>% and |>

The pipe operator (`%>%`) introduced with the `magrittr` R package allows for the chaining of R operations. Base R has now added their own pipe operator (`|>`). They take the output from the left-hand side and passes it as the first parameter to the function on the right-hand side.

You can do this in two steps:

```
tab_out <- table(legosets$category)
prop.table(tab_out)
```

Or as nested function calls.

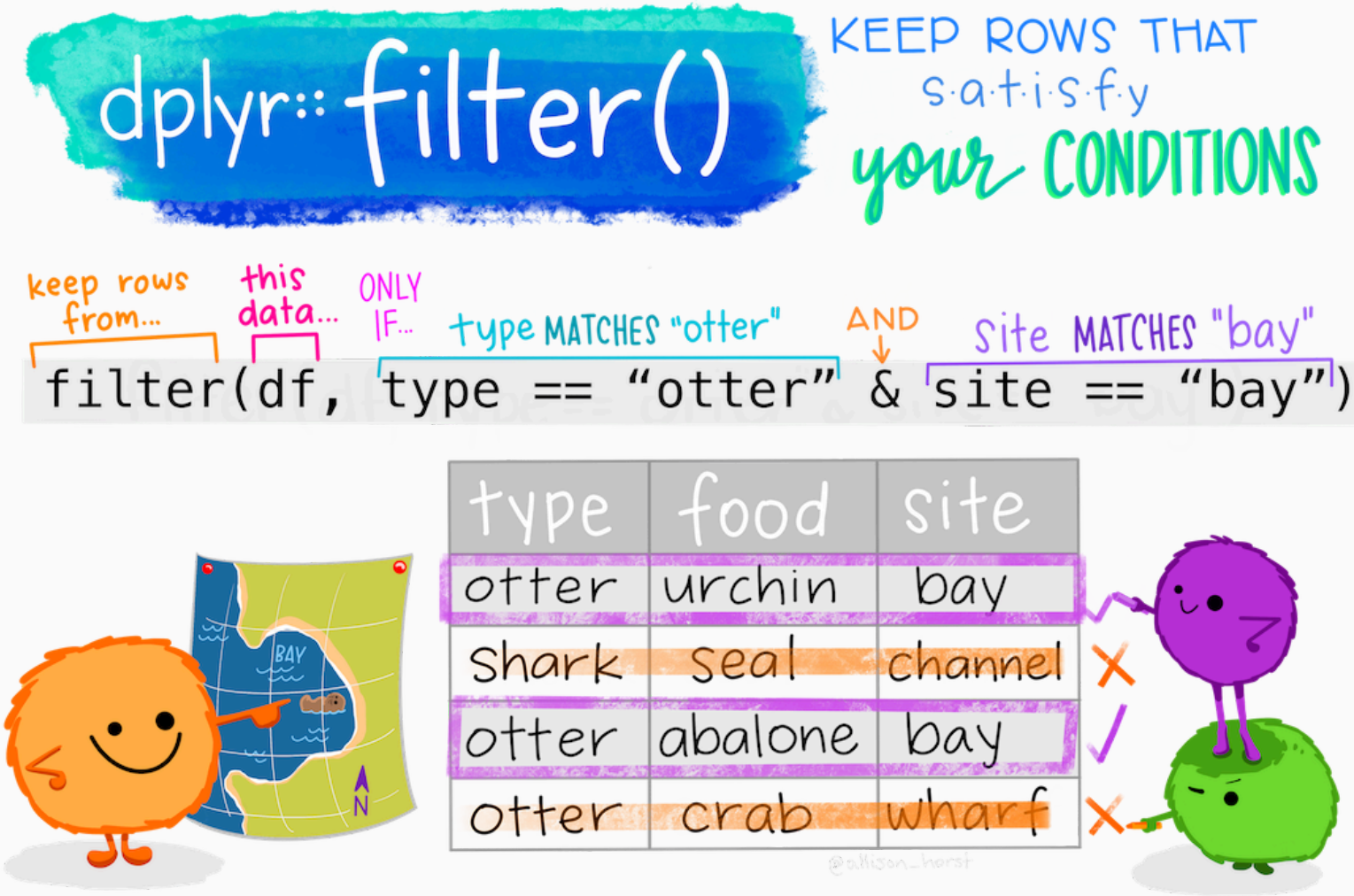
```
prop.table(table(legosets$category))
```

Using the pipe (`|>`) operator we can chain these calls in a what is arguably a more readable format:

```
legosets$category |> table() |> prop.table()
```

```
##
##        Book  Collection    Extended        Gear      Normal       Other
## 0.035087719 0.029889539 0.036248027 0.158869396 0.668894458 0.067205050
```

Filter


dplyr::filter()
KEEP ROWS THAT satisfy your CONDITIONS
keep rows from...
this data...
ONLY IF...
type MATCHES "otter"
AND
site MATCHES "bay"
filter(df, type == "otter" & site == "bay")
BAY
N
type food site
otter urchin bay
shark seal channel
otter abalone bay
otter crab wharf
@allison_horst

Logical Operators

- `!a` - TRUE if a is FALSE
- `a == b` - TRUE if a and be are equal
- `a != b` - TRUE if a and b are not equal
- `a > b` - TRUE if a is larger than b, but not equal
- `a >= b` - TRUE if a is larger or equal to b
- `a < b` - TRUE if a is smaller than be, but not equal
- `a <= b` - TRUE if a is smaller or equal to b
- `a %in% b` - TRUE if a is in b where b is a vector
- `a | b` - TRUE if a *or* b are TRUE
- `a & b` - TRUE if a *and* b are TRUE
- `isTRUE(a)` - TRUE if a is TRUE

`%in%` operator

```
vowels <- c('a', 'e', 'i', 'o', 'u')
```

```
letters %in% vowels
```

```
##  [1]  TRUE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE  TRUE FALSE
## [17] FALSE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE
```

Which is equivalent to doing a bunch of or statements.

```
letters == 'a' | letters == 'e' | letters == 'i' | letters == 'o' | letters == 'u'
```

```
##  [1]  TRUE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE  TRUE FALSE
## [17] FALSE FALSE FALSE FALSE  TRUE FALSE FALSE FALSE FALSE FALSE
```

We can use the `which()` function to determine the position of `TRUE`s.

```
letters %in% vowels |> which()
```

```
## [1]  1  5  9 15 21
```

Filter

dplyr

```
mylego <- legosets |> filter(themeGroup == 'Educational' & year > 2015)
```

Base R

```
mylego <- legosets[legosets$themeGroups == 'Educational' & legosets$year > 2015,]
```

```
nrow(mylego)
```

```
## [1] 121
```

Select

dplyr

```
mylego <- mylego |> select(setID, pieces, theme, availability, US_retailPrice, minifigs)
```

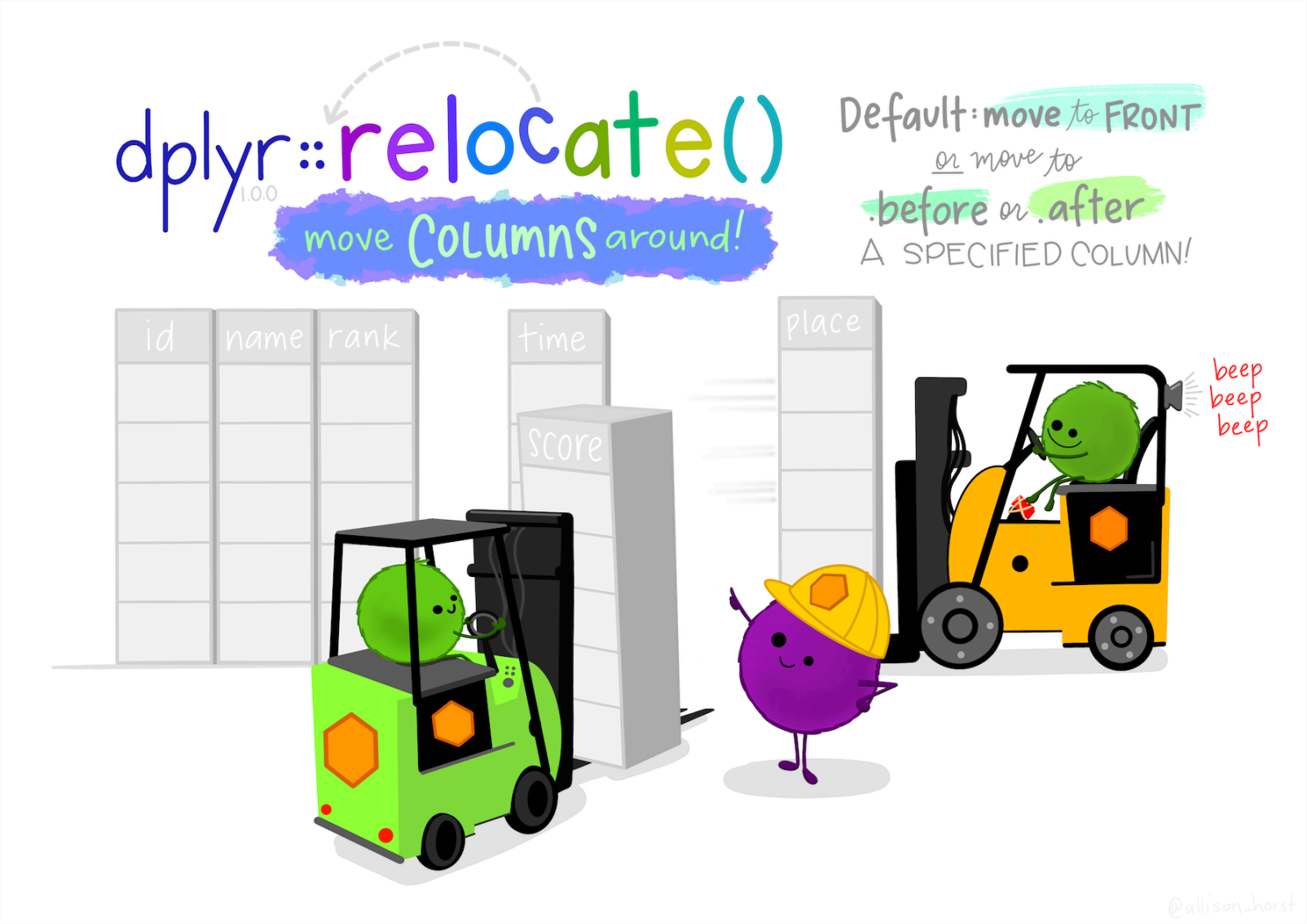
Base R

```
mylego <- mylego[,c('setID', 'pieces', 'theme', 'availability', 'US_retailPrice', 'minifigs')]
```

```
head(mylego, n = 4)
```

```
##   setID pieces     theme    availability US_retailPrice minifigs
## 1 26803    109 Education {Not specified}             NA        6
## 2 26277    188 Education     Educational          94.95       NA
## 3 27742    160 Education {Not specified}             NA       NA
## 4 26805   1000 Education {Not specified}             NA       NA
```

Relocate


dplyr::relocate()
1.0.0
move columns around!
Default: move to FRONT
or move to
.before or .after
A SPECIFIED COLUMN!
id
name
rank
time
score
place
beep
beep
beep
@allison_horst

Relocate

dplyr

```
mylego |> relocate(where(is.numeric), .after = where(is.character)) |> head(n = 3)
```

```
##       theme    availability setID pieces US_retailPrice minifigs
## 1 Education {Not specified} 26803    109             NA        6
## 2 Education     Educational 26277    188          94.95       NA
## 3 Education {Not specified} 27742    160             NA       NA
```

Base R

```
mylego2 <- mylego[,c('theme', 'availability', 'setID', 'pieces', 'US_retailPrice', 'minifigs')]
head(mylego2, n = 3)
```

```
##       theme    availability setID pieces US_retailPrice minifigs
## 1 Education {Not specified} 26803    109             NA        6
## 2 Education     Educational 26277    188          94.95       NA
## 3 Education {Not specified} 27742    160             NA       NA
```

Rename

dplyr::rename()

RENAME COLUMNS*

```
df %>% rename(lair = site)
```

~~species~~ nemesis	status	~~site~~ lair
narwhal	unknown	ocean
chicken	active	coop
pika	active	mountain

*See **rename_with()** to rename using a function.

Rename

dplyr

```
mylego |> dplyr::rename(USD = US_retailPrice) |> head(n = 3)
```

```
##   setID pieces     theme    availability   USD minifigs
## 1 26803    109 Education {Not specified}    NA        6
## 2 26277    188 Education     Educational 94.95       NA
## 3 27742    160 Education {Not specified}    NA       NA
```

Base R

```
names(mylego2)[5] <- 'USD'
head(mylego2, n = 3)
```

```
##       theme    availability setID pieces   USD minifigs
## 1 Education {Not specified} 26803    109    NA        6
## 2 Education     Educational 26277    188 94.95       NA
## 3 Education {Not specified} 27742    160    NA       NA
```

Mutate


dplyr::mutate
add Column(s),
keep existing.
A
B
C
1
5
10
0
2
-3
4
9
6
3
2
14
9
8
THE PLAN:
A
B
C
+
=
HORST '18

Mutate

dplyr

```
mylego |> filter(!is.na(pieces) & !is.na(US_retailPrice)) |>
    mutate(Price_per_piece = US_retailPrice / pieces) |> head(n = 3)
```

```
##   setID pieces     theme availability US_retailPrice minifigs Price_per_piece
## 1 26277    188 Education  Educational          94.95       NA       0.5050532
## 2 25949    280 Education  Educational         224.95       NA       0.8033929
## 3 25954      1 Education  Educational          14.95       NA      14.9500000
```

Base R

```
mylego2 <- mylego[!is.na(mylego$US_retailPrice) & !is.na(mylego$Price_per_piece),]
mylego2$Price_per_piece <- mylego2$Price_per_piece / mylego2$US_retailPrice
head(mylego2, n = 3)
```

```
## [1] setID           pieces          theme           availability    US_retailPrice  minifigs
## [7] Price_per_piece
## <0 rows> (or 0-length row.names)
```

Group By and Summarize


```
legosets |> group_by(themeGroup) |> summarize(mean_price = mean(US_retailPrice, na.rm = TRUE),
                                               sd_price = sd(US_retailPrice, na.rm = TRUE),
                                               median_price = median(US_retailPrice, na.rm = TRUE),
                                               n = n(),
                                               missing = sum(is.na(US_retailPrice)))
```

```
## # A tibble: 17 × 6
##    themeGroup       mean_price sd_price median_price     n missing
##    <chr>                 <dbl>    <dbl>        <dbl> <int>   <int>
##  1 Action/Adventure       43.0     41.9         30.0  1620     845
##  2 Art and crafts         41.0     53.0         20.0   104       9
##  3 Basic                  22.8     19.4         15.0   884     733
##  4 Constraction           16.4     12.4         13.0   503     285
##  5 Educational           185.     188.          138.    546     508
##  6 Girls                  35.8     24.0         23.0   240     227
##  7 Historical             34.2     32.4         20.0   474     401
##  8 Junior                 22.0     10.1         20.0   228     165
##  9 Licensed               55.5     72.9         35.0  3353    1245
## 10 Miscellaneous          23.4     33.5         15.0  7151    4501
## 11 Model making           86.2     99.4         50.0   919     422
## 12 Modern day             39.8     36.8         30.0  2669    1594
## 13 Pre-school             31.7     23.2         25.0  1613    1108
## 14 Racing                 26.4     26.8         15.0   266     176
```

Describe and Describe By

```
library(psych)
describe(legosets$US_retailPrice)
```

```
##    vars    n  mean    sd median trimmed   mad  min    max range skew kurtosis   se
## X1    1 8674 42.26 59.75  24.99   30.25 22.24 1.49 999.99 998.5 4.97    40.38 0.64
```

```
describeBy(legosets$US_retailPrice, group = legosets$availability, mat = TRUE, skew = FALSE)
```

```
##      item                          group1 vars    n      mean        sd median   min    max range         se
## X11     1                {Not specified}    1 2004  27.76015  38.92310  19.99  1.49 789.99 788.5  0.8694780
## X12     2                    Educational    1   12 217.03333 108.17617 232.45 14.95 399.95 385.0 31.2277699
## X13     3 Gift with Purchase at LEGO.com    1    0       NaN        NA     NA   Inf   -Inf  -Inf         NA
## X14     4                Insiders Reward    1    0       NaN        NA     NA   Inf   -Inf  -Inf         NA
## X15     5                 LEGO exclusive    1 1268  65.12353 112.88247  14.99  1.99 999.99 998.0  3.1700555
## X16     6             LEGOLAND exclusive    1    2   4.99000   0.00000   4.99  4.99   4.99   0.0  0.0000000
## X17     7                       Not sold    1    1  12.99000        NA  12.99 12.99  12.99   0.0         NA
## X18     8                     Promotional    1    5   4.79000   0.83666   4.99  3.99   5.99   2.0  0.3741657
## X19     9          Promotional (Airline)    1    0       NaN        NA     NA   Inf   -Inf  -Inf         NA
## X110   10                         Retail    1 5062  40.59401  40.96294  29.99  1.99 699.99 698.0  0.5757448
## X111   11              Retail - limited    1  319  63.40755  69.70365  39.99  2.49 449.99 447.5  3.9026552
## X112   12                       Unknown    1    1   3.99000        NA   3.99  3.99   3.99   0.0         NA
```

Additional Resources

For data wrangling:

- `dplyr` website: https://dplyr.tidyverse.org
- R for Data Science book: https://r4ds.had.co.nz/wrangle-intro.html
- Wrangling penguins tutorial: https://allisonhorst.shinyapps.io/dplyr-learnr/#section-welcome
- Data transformation cheat sheet: https://github.com/rstudio/cheatsheets/raw/master/data-transformation.pdf

Good luck with the semester!

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