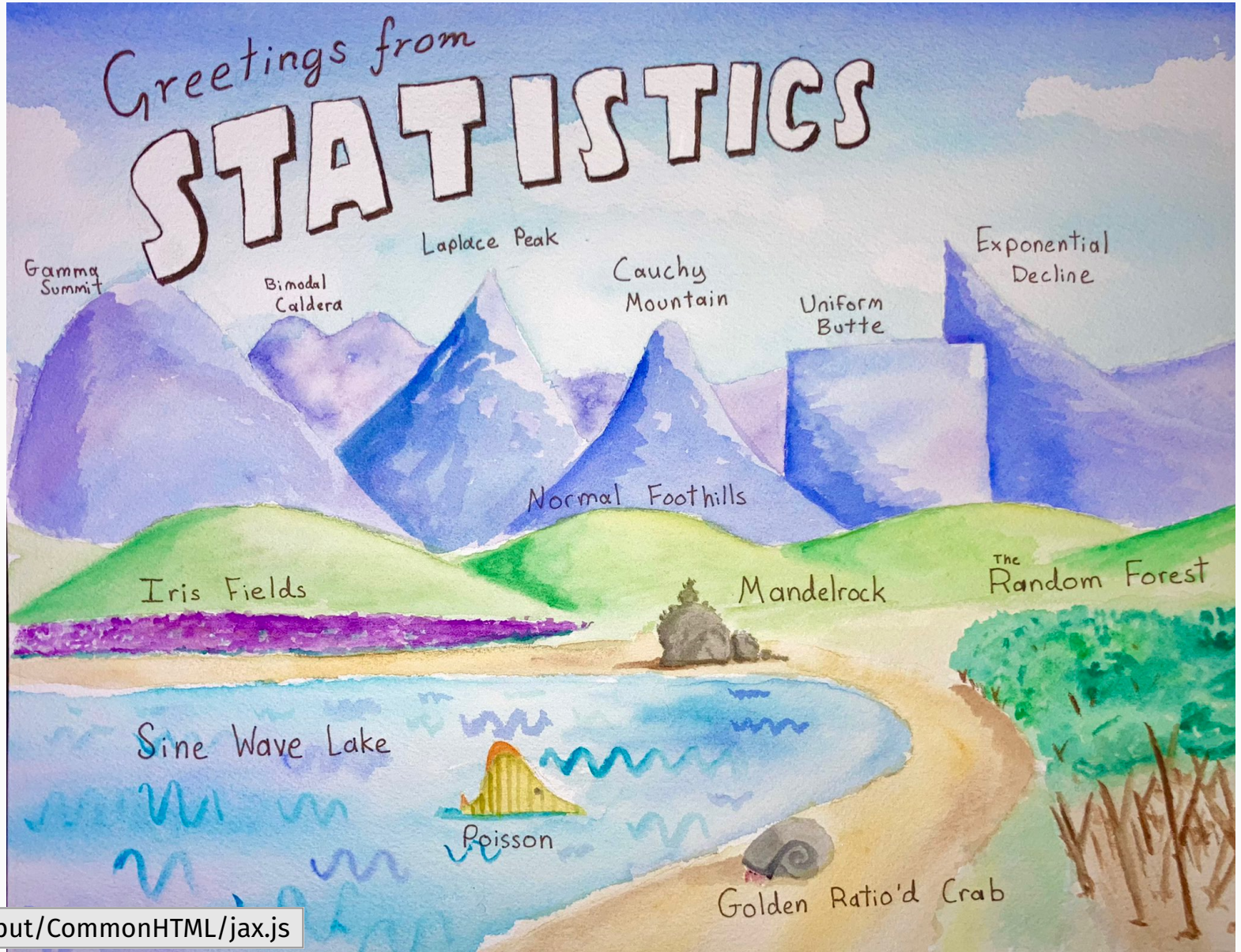
Introduction to DAV 5300

Computational Mathematics and Statistics

Jason Bryer, Ph.D.

Spring 2024



@skyetetra

Agenda

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

While waiting, please complete this formative assessment:

 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 (part of their FIPSE First in the World program) to develop a Diagnostic Assessment and Achievement of College Skills (www.DAACS.net)
- Authored over a dozen R packages including:
  - likert
  - sqlutils
  - timeline
- Specialize in propensity score methods. Three new methods/R packages developed include:
  - multilevelPSA
  - TriMatch
  - PSAboot

Also a Father...

Runner...


DOPEY
CHALLENGE
2020
20602


2019
TCS NEW YORK CITY MARATHON
NEW YORK ROAD

And photographer.

Syllabus

Syllabus and course materials are here: https://github.com/jbryer/DAV5300-2024-Spring

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 `tineytex` 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 at 5:30pm to 7:30pm.

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

Week	Start	End	Topic
1	Tuesday, January 16, 2024	Sunday, January 21, 2024	Introduction to R, Rstudio, and the course
2	Monday, January 22, 2024	Sunday, January 28, 2024	Introduction to Data and Data Visualization
3	Monday, January 29, 2024	Sunday, February 04, 2024	
4	Monday, February 05, 2024	Sunday, February 18, 2024	Probability
5	Sunday, February 11, 2024	Sunday, February 18, 2024	Bivariate Regression
6	Monday, February 19, 2024	Sunday, February 25, 2024	Multiple Regression
7	Monday, February 26, 2024	Sunday, March 03, 2024	Maximum Likelihood Estimation and Logistic Regression
8	Monday, March 04, 2024	Sunday, March 10, 2024	Foundation for Inference / Central Limit Theorem
9	Monday, March 11, 2024	Sunday, March 17, 2024	Inference for Categorical Data
10	Monday, March 18, 2024	Sunday, March 24, 2024	Inference for Numerical Data
11	Monday, March 25, 2024	Sunday, March 31, 2024	ANOVA
12	Monday, April 01, 2024	Sunday, April 07, 2024	Introduction to Predictive Modeling
13	Monday, April 08, 2024	Sunday, April 14, 2024	Bayesian Analysis
14	Monday, April 15, 2024	Sunday, April 21, 2024	Poster Session
	Monday, April 22, 2024	Tuesday, April 30, 2024	Passover Recess
15	Wednesday, May 01, 2024	Tuesday, May 07, 2024	Final Exam

Textbooks

Introduction to Modern Statistics by Mine Çetinkaya-Rundel and Johanna Hardin - This will be the primary textbook.

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

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

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.

Poster (25%) - We will hold a poster session on the second to last class. In a group of 2 to 3 students will create poster presenting 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 Sunday. Assignments submitted late will be penalized. Assignments will not be accepted more than one week after their due date.

Communication

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

Software Setup

Software

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

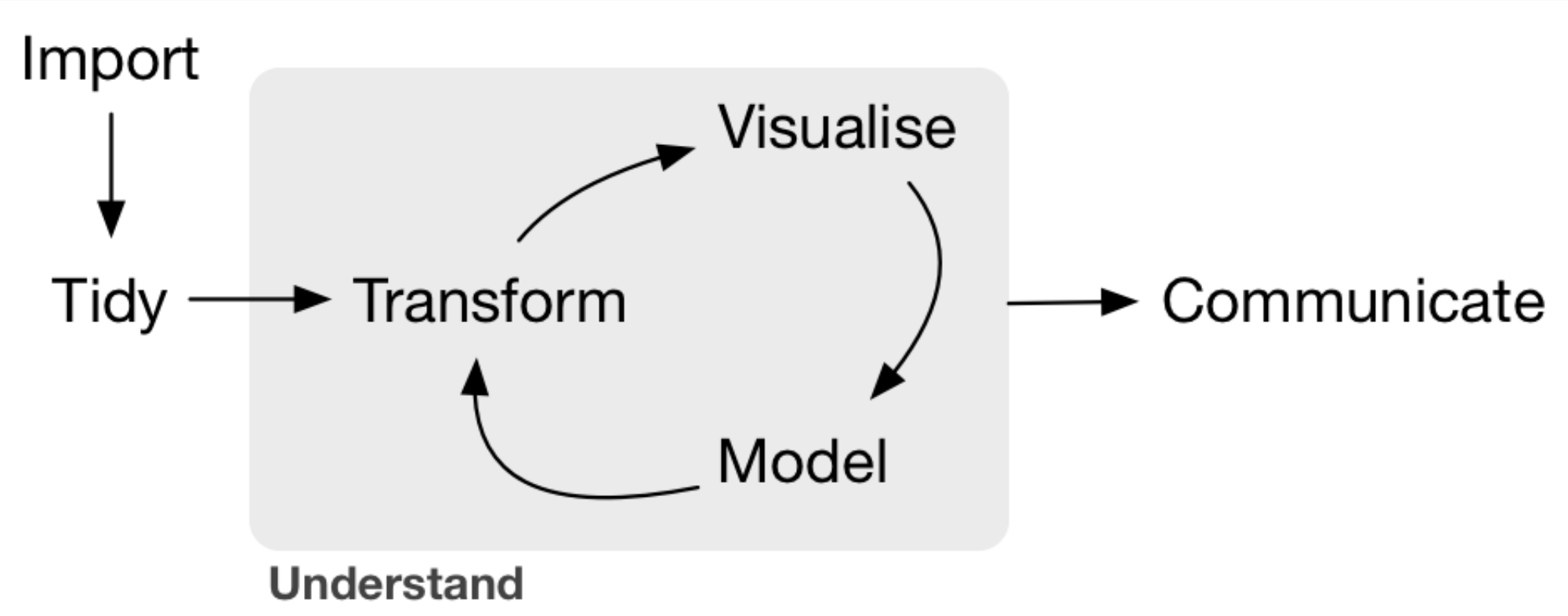
- Install R and RStudio on your own computer. I encourage everyone to do this at some point by the end of the semester.

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()
```

Introduction to R

Workflow



Source: Wickham & Grolemund, 2017

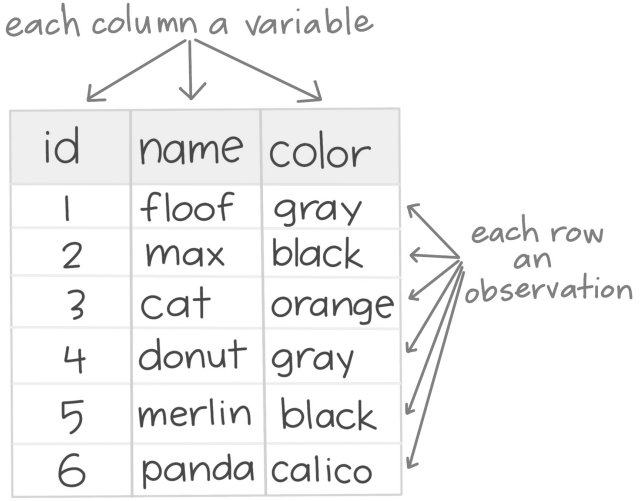
Tidy Data

"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



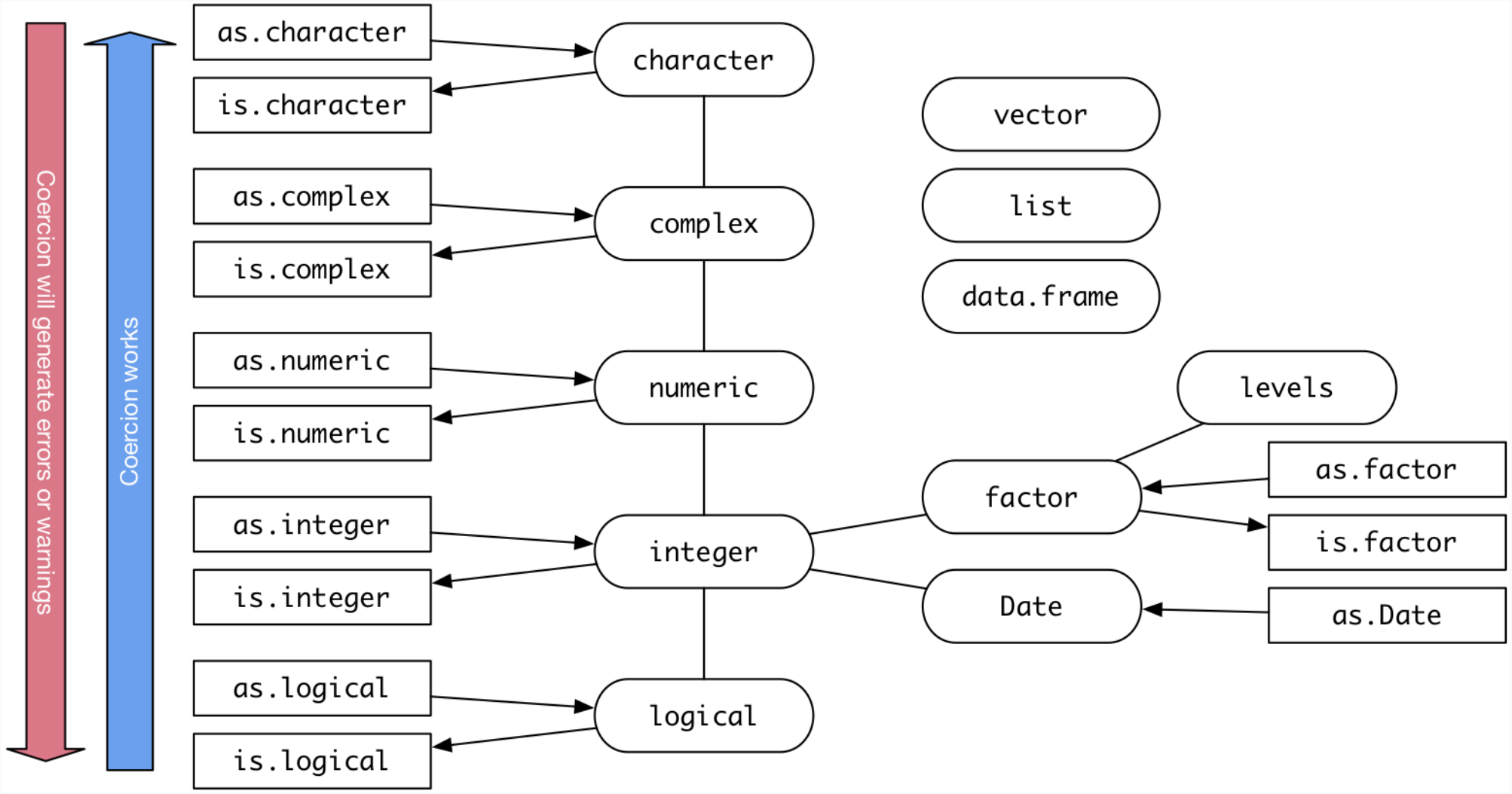
Wickham, H. (2014). Tidy Data. Journal of Statistical Software *59* (10). DOI: 10.18637/jss.v059.i10

See Wickham (2014) Tidy data.

Types of Data

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

Data Types in R



Data Types / Descriptives / Visualizations

Data Type	Descriptive Stats	Visualization
Continuous	mean, median, mode, standard deviation, IQR	histogram, density, box plot
Discrete	contingency table, proportional table, median	bar plot
Categorical	contingency table, proportional table	bar plot
Ordinal	contingency table, proportional table, median	bar plot
Two quantitative	correlation	scatter plot
Two qualitative	contingency table, chi-squared	mosaic plot, bar plot
Quantitative & Qualitative	grouped summaries, ANOVA, t-test	box plot

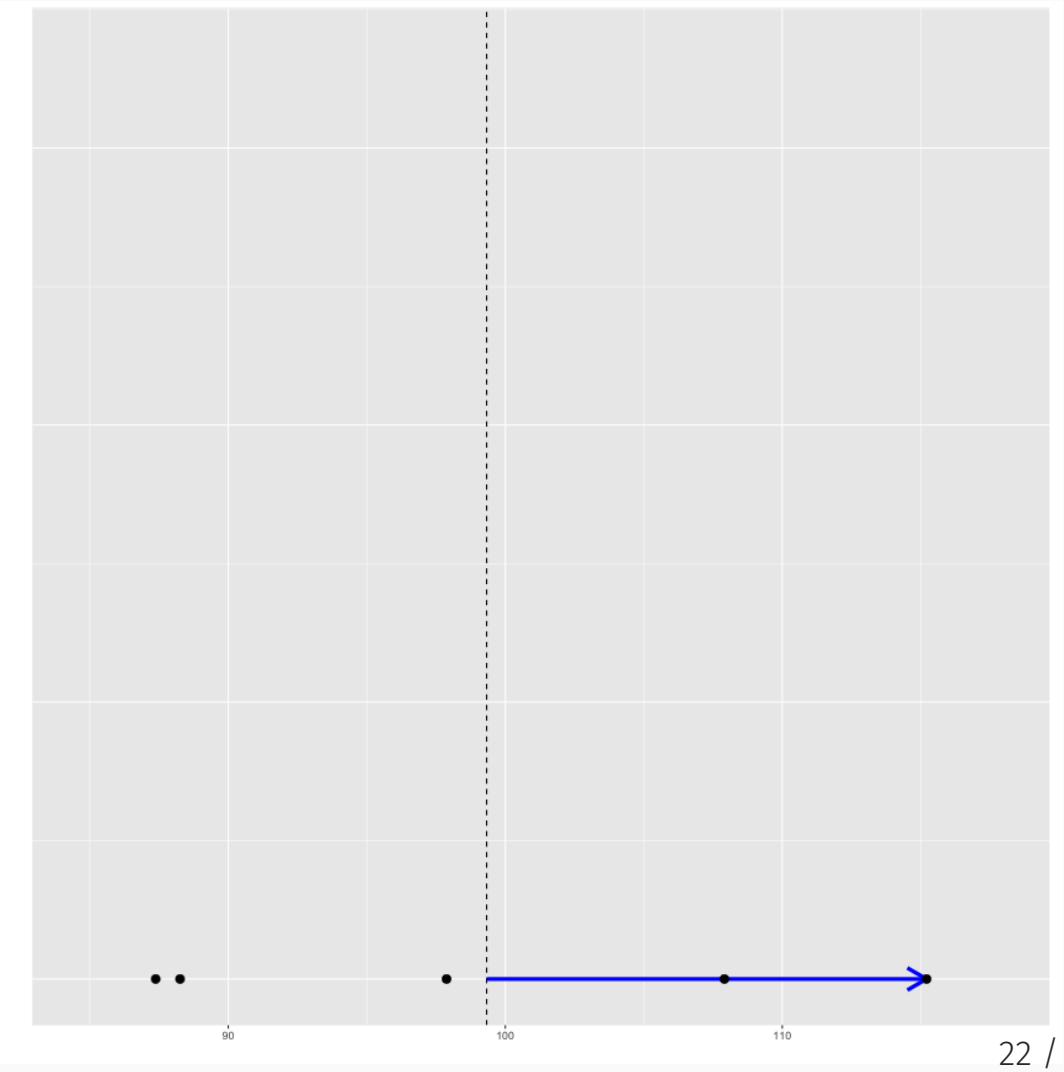
Variance

Population Variance:

$$S^2 = \frac{\Sigma(x_i - \bar{x})^2}{N}$$

Consider a dataset with five values (black points in the figure). For the largest value, the deviance is represented by the blue line ($x_i - \bar{x}$).

See also:
https://shiny.rit.albany.edu/stat/visualizess/
https://github.com/jbryer/VisualStats/

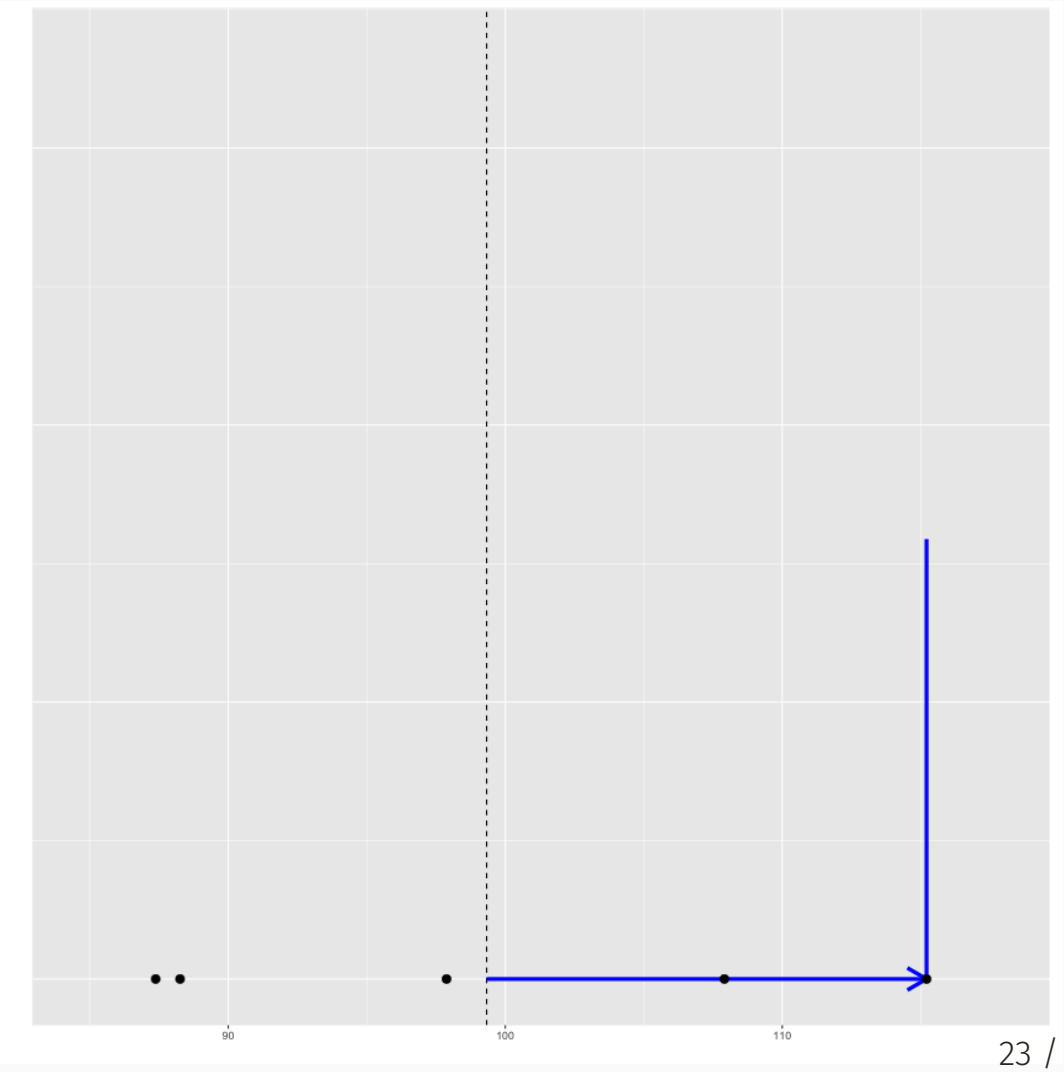


Variance (cont.)

Population Variance:

$$S^2 = \frac{\Sigma(x_i - \bar{x})^2}{N}$$

In the numerator, we square each of these deviances. We can conceptualize this as a square. Here, we add the deviance in the *y* direction.

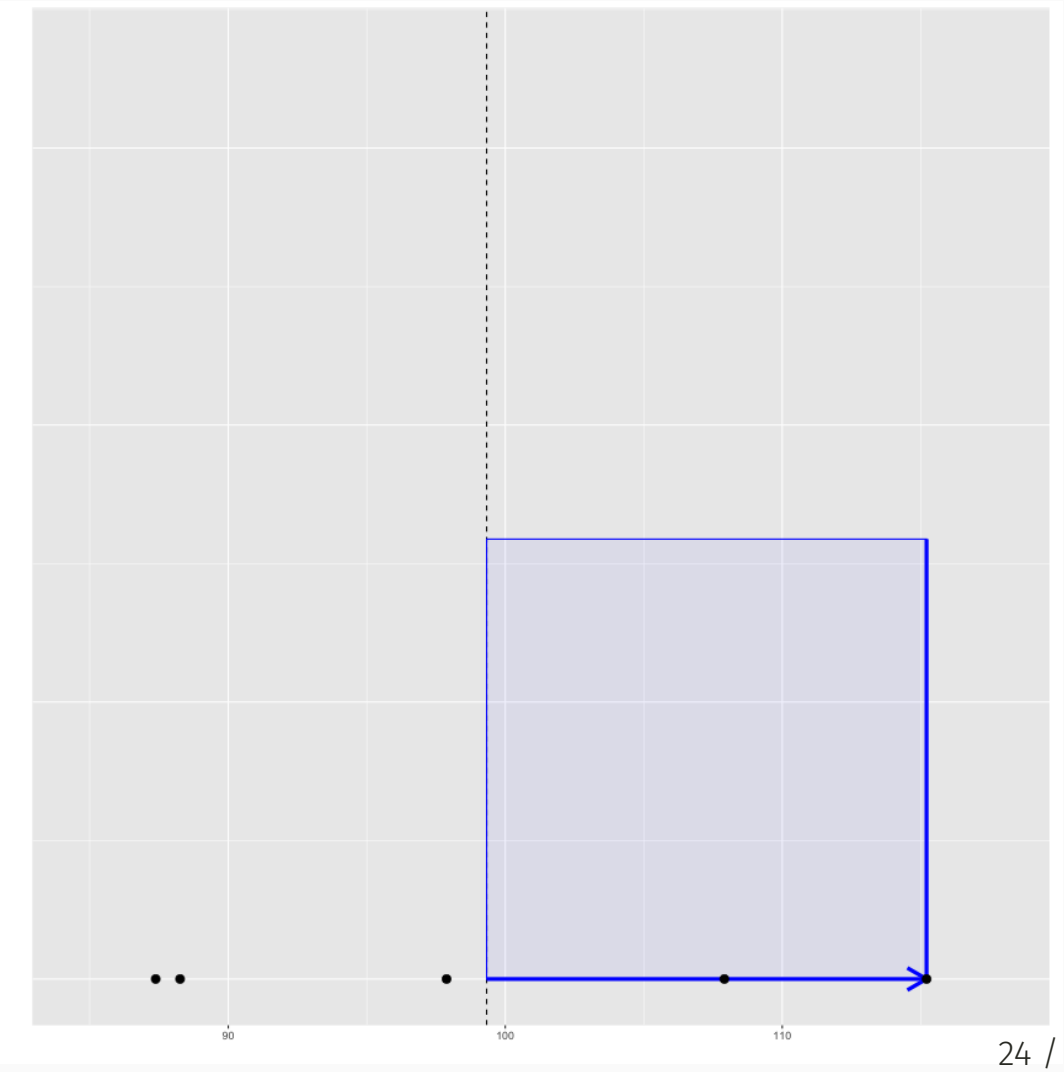


Variance (cont.)

Population Variance:

$$S^2 = \frac{\Sigma(x_i - \bar{x})^2}{N}$$

We end up with a square.

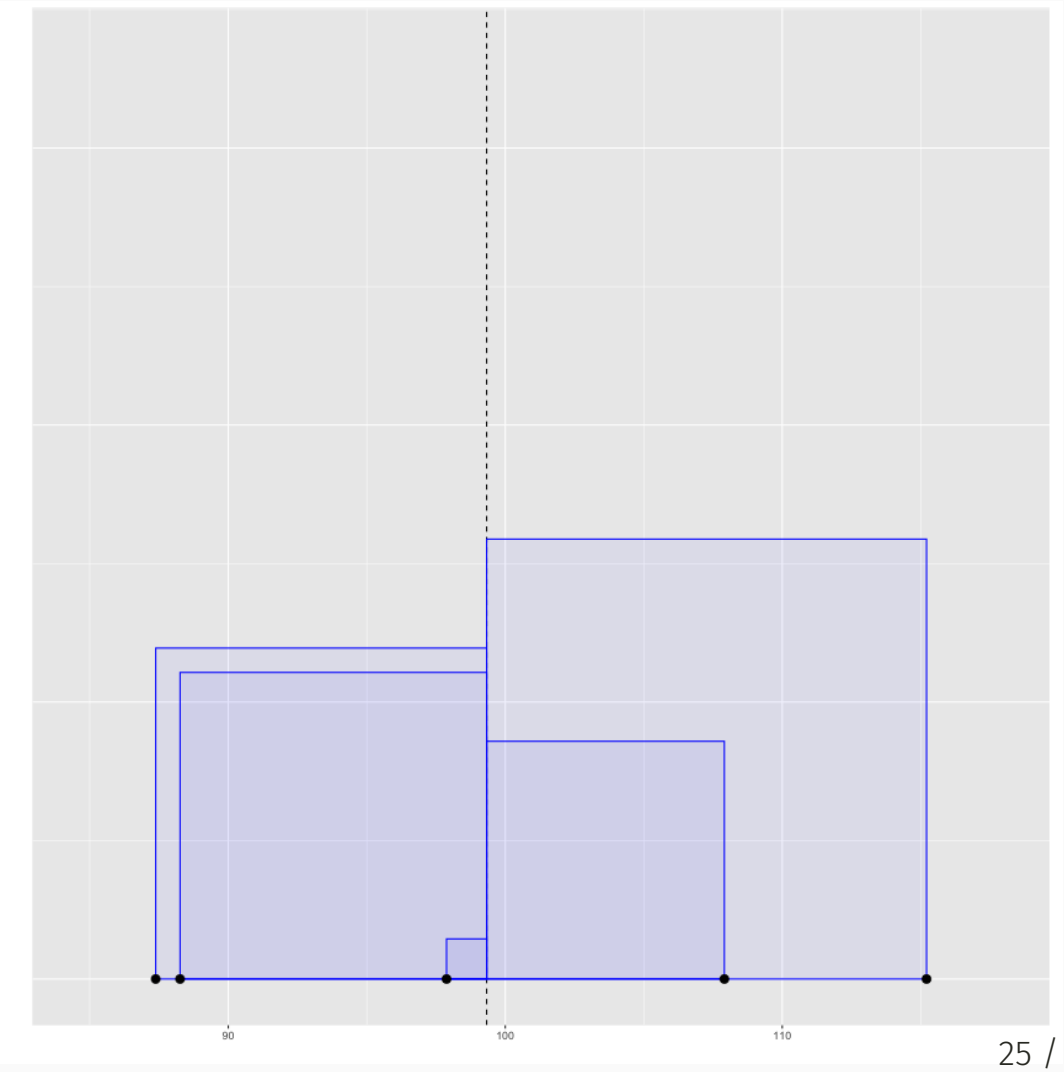


Variance (cont.)

Population Variance:

$$S^2 = \frac{\Sigma(x_i - \bar{x})^2}{N}$$

We can plot the squared deviance for all the data points. That is, each component in the numerator is the area of each of these squares.

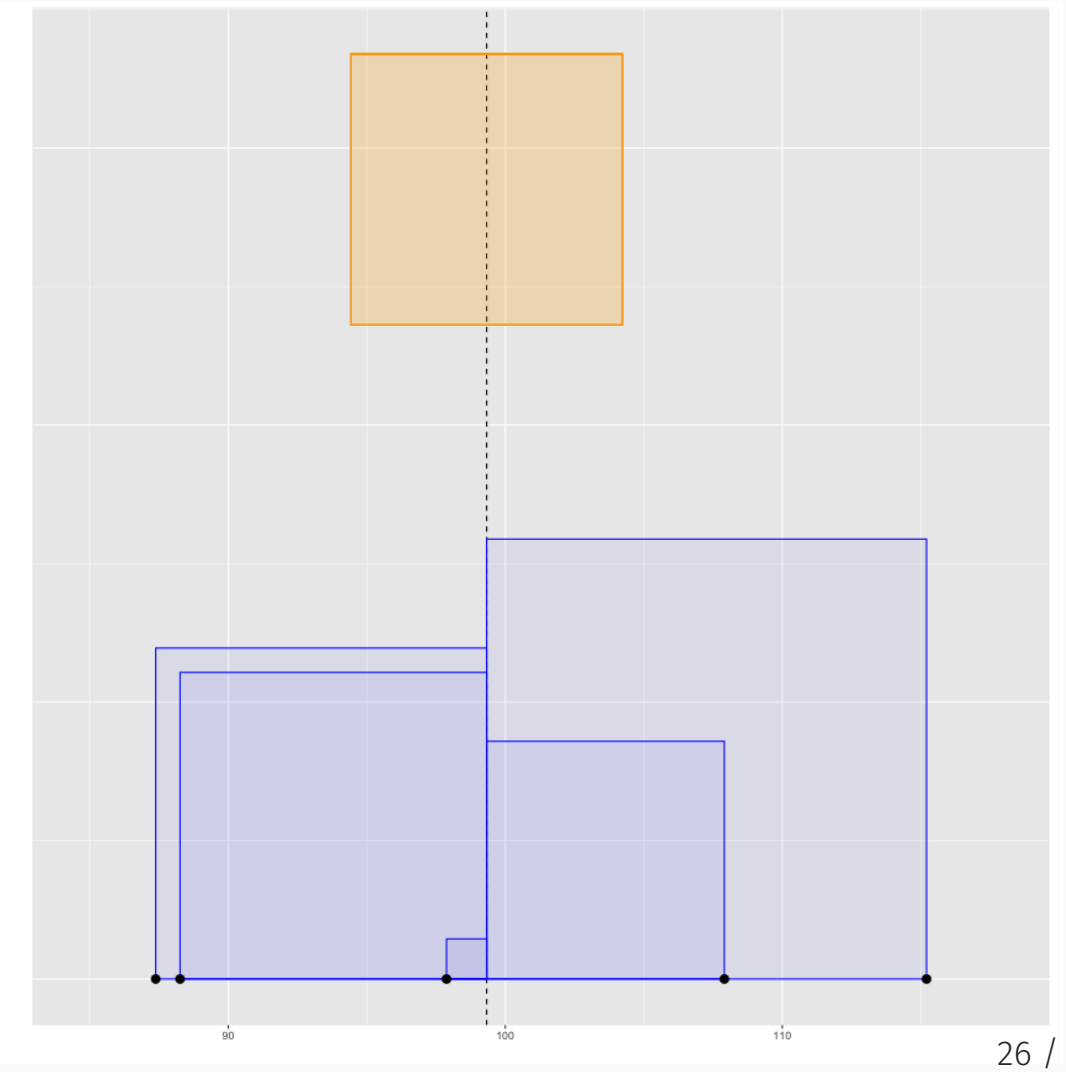


Variance (cont.)

Population Variance:

$$S^2 = \frac{\Sigma(x_i - \bar{x})^2}{N}$$

The variance is therefore the average of the area of all these squares, here represented by the orange square.



Population versus Sample Variance

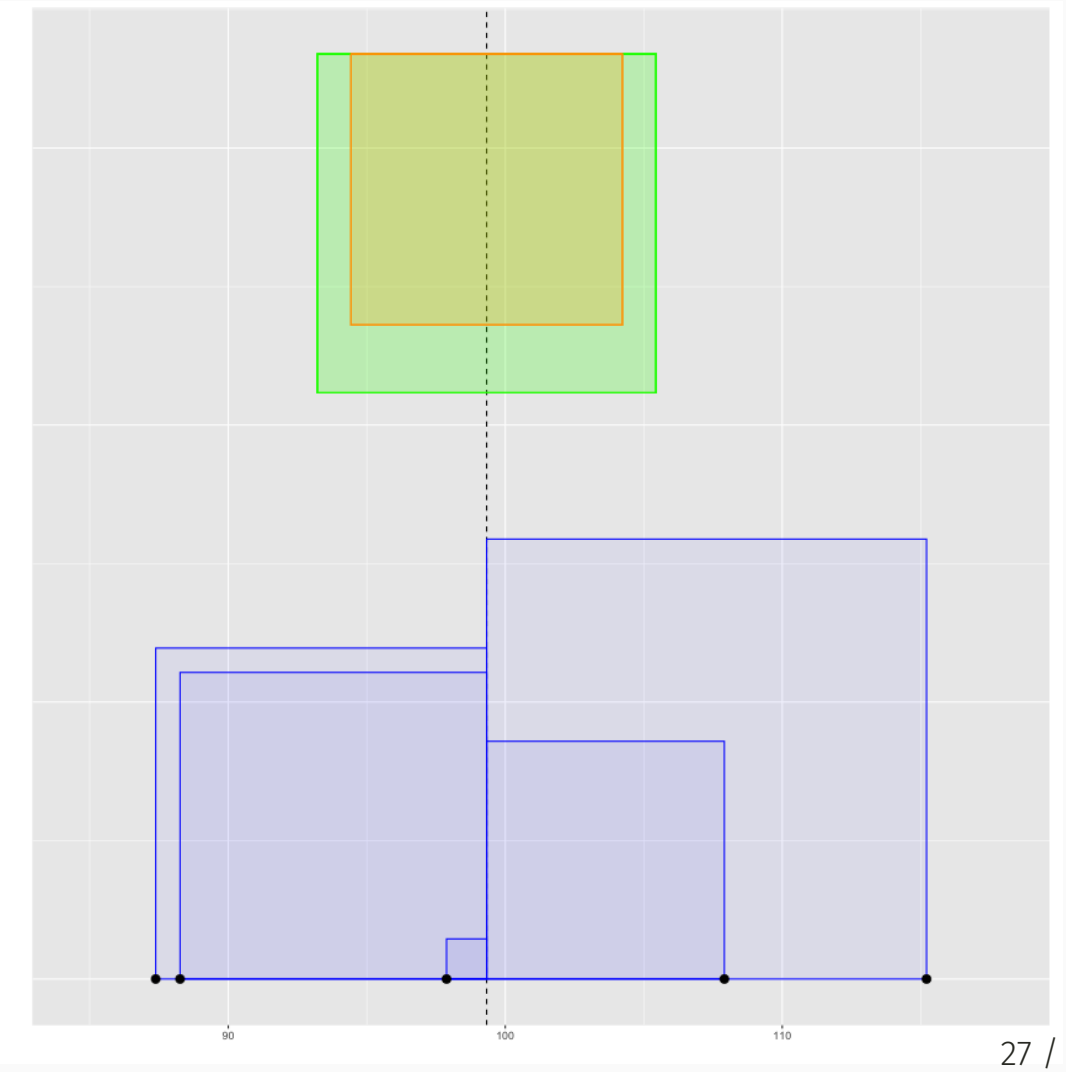
Typically we want the sample variance. The difference is we divide by $n-1$ to calculate the sample variance. This results in a slightly larger area (variance) then if we divide by n.

Population Variance (yellow):

$$S^2 = \frac{\Sigma(x_i - \bar{x})^2}{N}$$

Sample Variance (green):

$$s^2 = \frac{\Sigma(x_i - \bar{x})^2}{n-1}$$



Robust Statistics

Consider the following data randomly selected from the normal distribution:

```
set.seed(41)
x <- rnorm(30, mean = 100, sd = 15)
mean(x); sd(x)
```

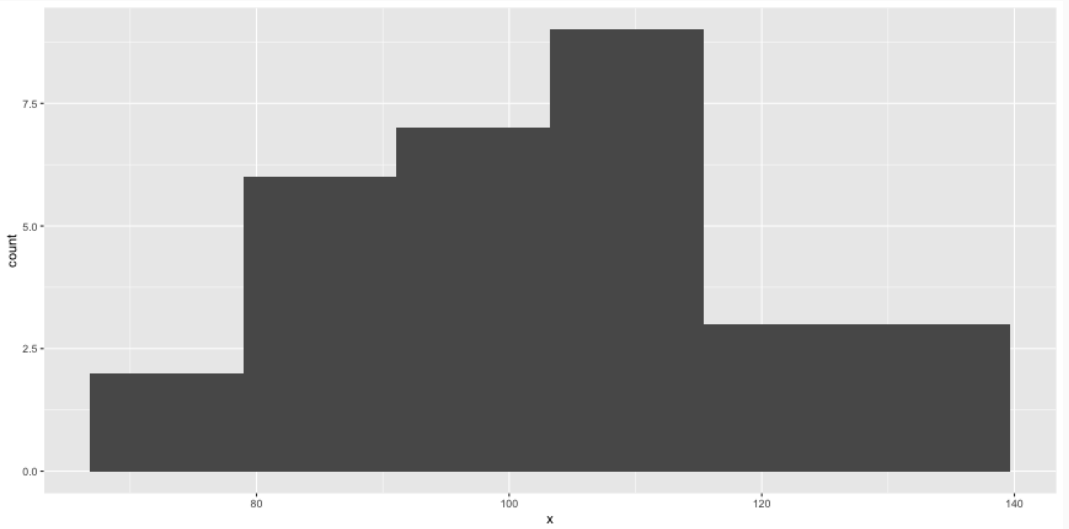
```
## [1] 103.1934
```

```
## [1] 16.8945
```

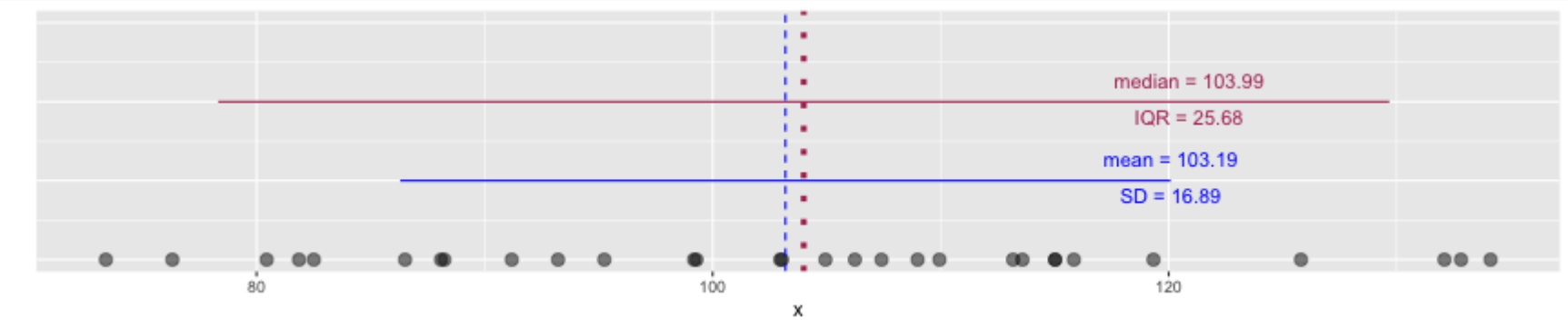
```
median(x); IQR(x)
```

```
## [1] 103.9947
```

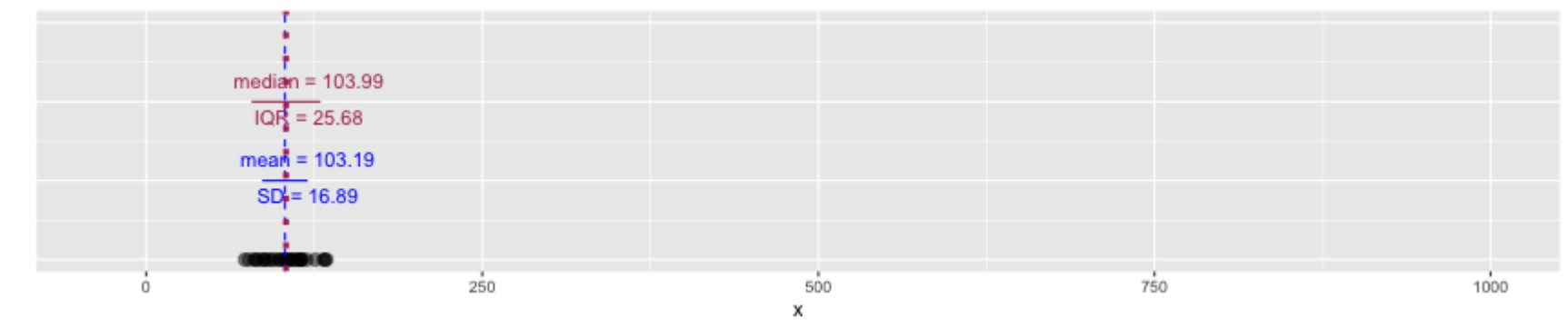
```
## [1] 25.68004
```



Robust Statistics

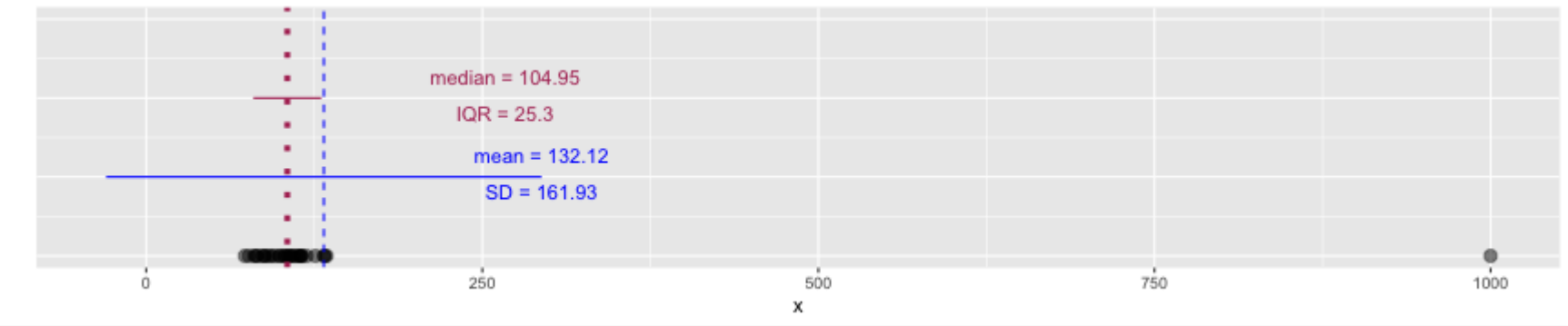


Robust Statistics



Let's add an extreme value:

```
x <- c(x, 1000)
```



Robust Statistics

Median and IQR are more robust to skewness and outliers than mean and SD. Therefore,

- for skewed distributions it is often more helpful to use median and IQR to describe the center and spread
- for symmetric distributions it is often more helpful to use the mean and SD to describe the center and spread

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 19409 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':    19409 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

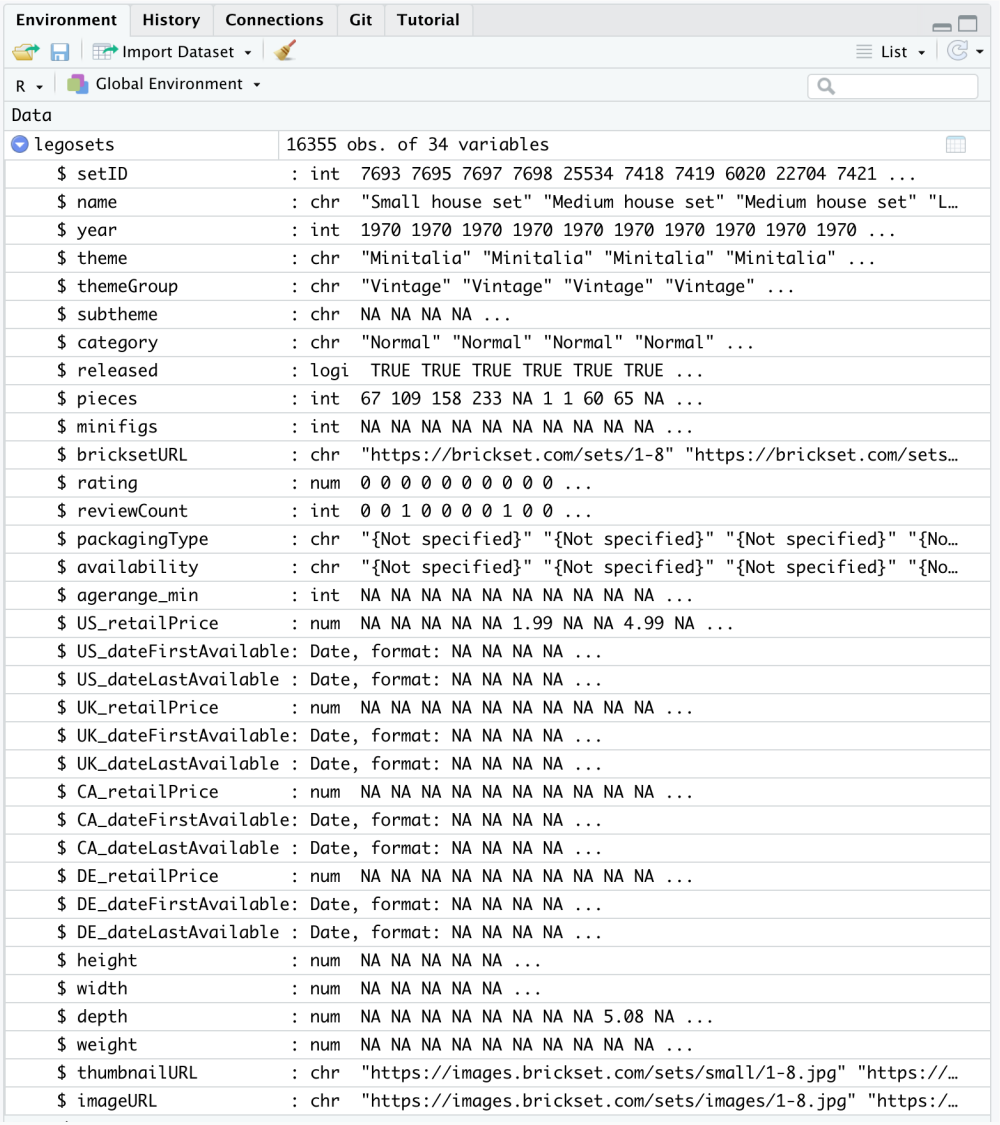


Table View

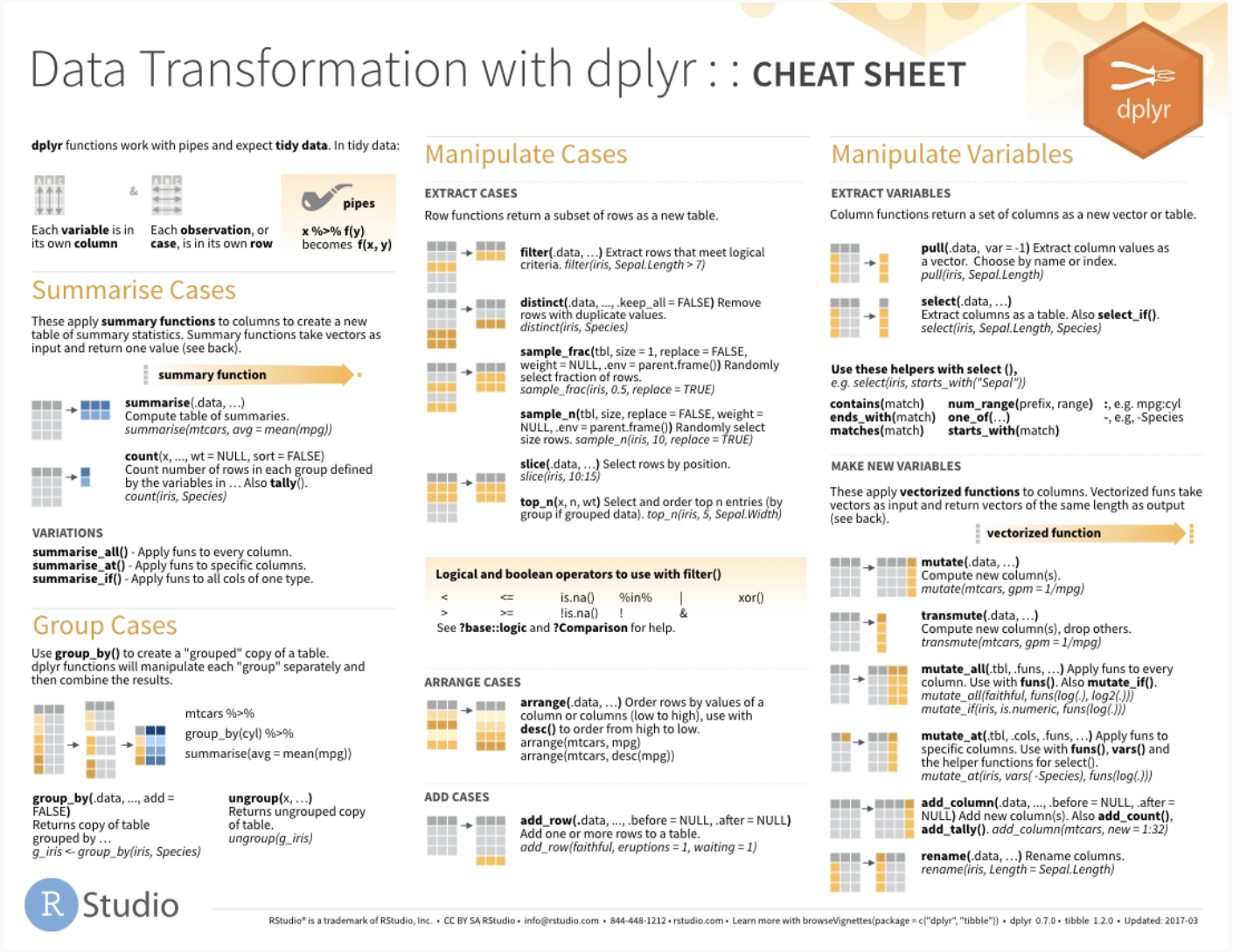
Show 10 entries Search:

	setID	name	year	theme	themeGroup	category	US_retailPrice	pieces	minifigs	rating
1	9712	Darth Maul	2012	Gear	Miscellaneous	Gear	4.99			3.7
2	28411	TIE Fighter Attack	2019	Star Wars	Licensed	Normal	19.99	77	2	3.5
3	24252	LEGO Minifigures - Series 14 - Monsters {Random bag}	2015	Collectable Minifigures	Miscellaneous	Random				0
4	1448	Head Stand	1998	Town	Modern day	Normal		96	3	0
5	32020	Mania Magazine March - April 1995	1995	Books	Miscellaneous	Book				0
6	28352	Genius LEGO Inventions with Bricks You Already Have	2018	Books	Miscellaneous	Book				0
7	34334	Friendship Flowers	2023	Friends	Modern day	Normal		84		3.8
8	31865	BRICK KICKS Summer 1991	1991	Books	Miscellaneous	Book				0
9	31061	LEGO Space Projects: 52 Galactic Models	2021	Books	Miscellaneous	Book				0
10	30688	James Potter	2020	Collectable Minifigures	Miscellaneous	Normal		7	1	3.8

Showing 1 to 10 of 100 entries

Previous 1 2 3 4 5 ... 10 Next

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

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

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.

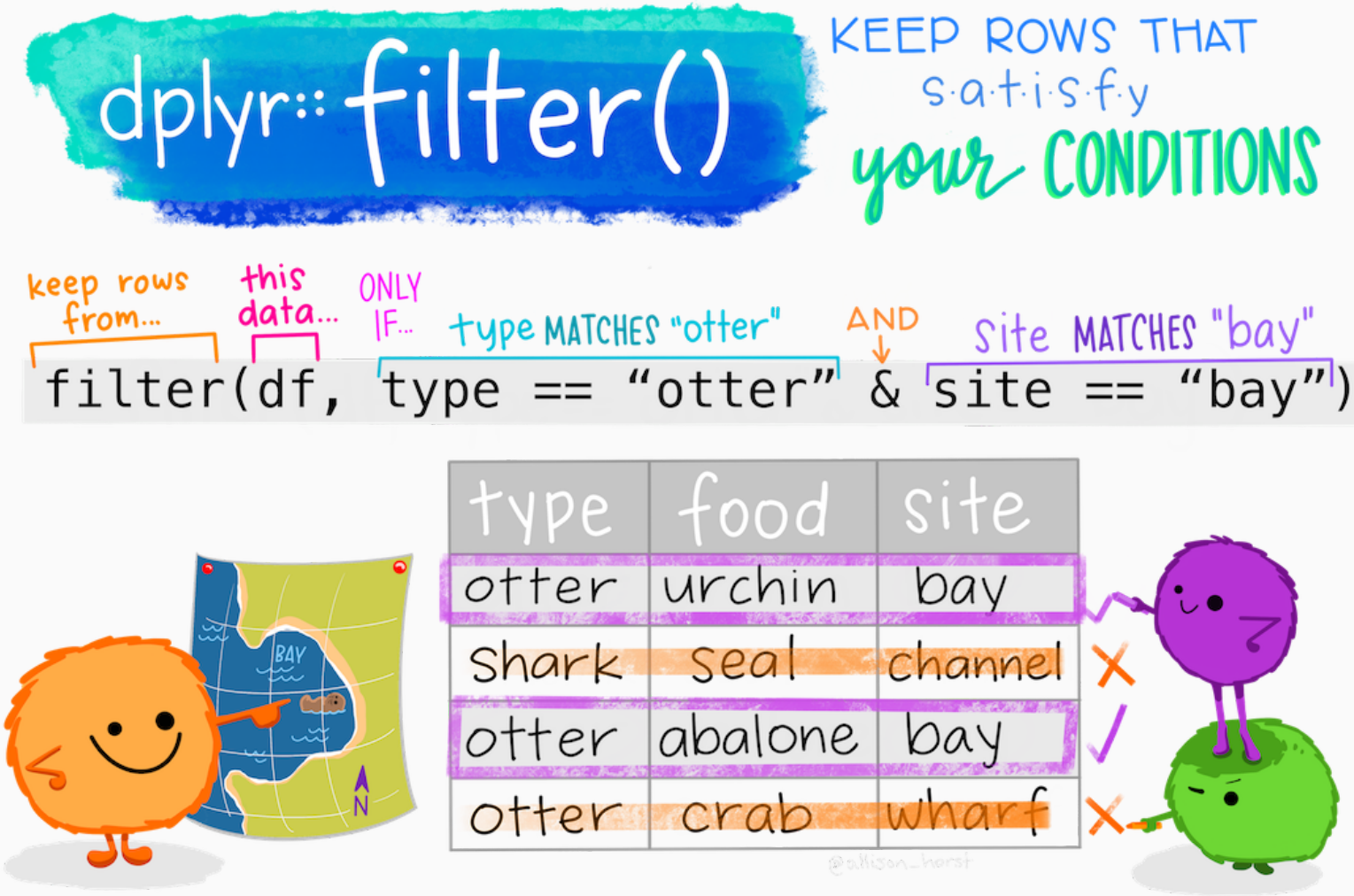
```
prop.table(table(legosets$category))
```

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

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

```
##
##        Book  Collection    Extended        Gear      Normal       Other
## 0.034468546 0.031377196 0.028749549 0.154515946 0.684682364 0.062599825
```

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

```
which( letters %in% c('a','e','i','o','u') )
```

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

- `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

Filter

dplyr

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

Base R

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

```
nrow(mylego)
```

```
## [1] 99
```

Select

dplyr

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

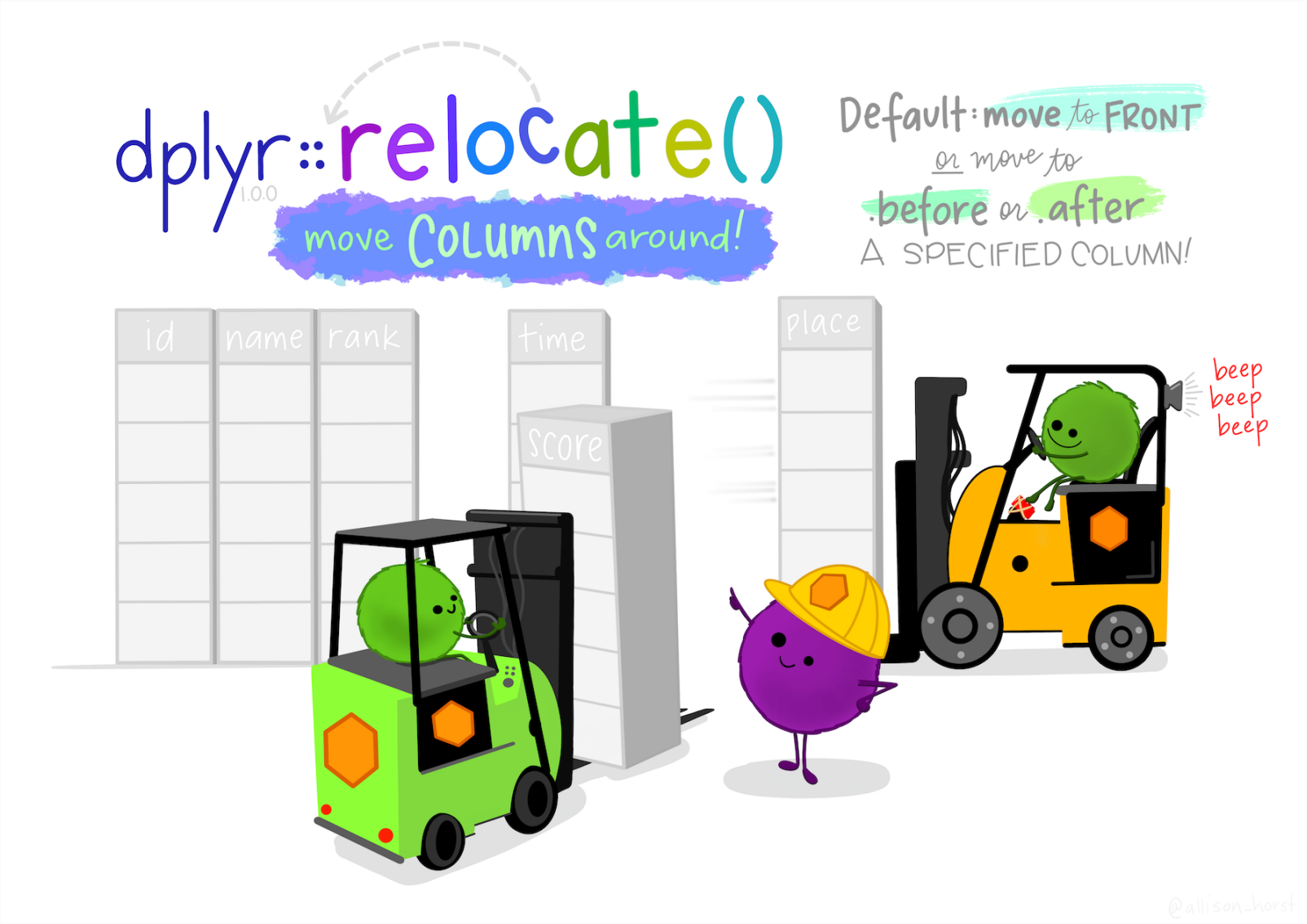
Base R

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

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

```
##   setID pieces     theme    availability US_retailPrice minifigs
## 1 26803    103 Education {Not specified}             NA        6
## 2 26689    142 Education {Not specified}             NA        4
## 3 26804     98 Education {Not specified}             NA        6
## 4 26277    188 Education     Educational          94.95       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    103             NA        6
## 2 Education {Not specified} 26689    142             NA        4
## 3 Education {Not specified} 26804     98             NA        6
```

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    103             NA        6
## 2 Education {Not specified} 26689    142             NA        4
## 3 Education {Not specified} 26804     98             NA        6
```

Rename

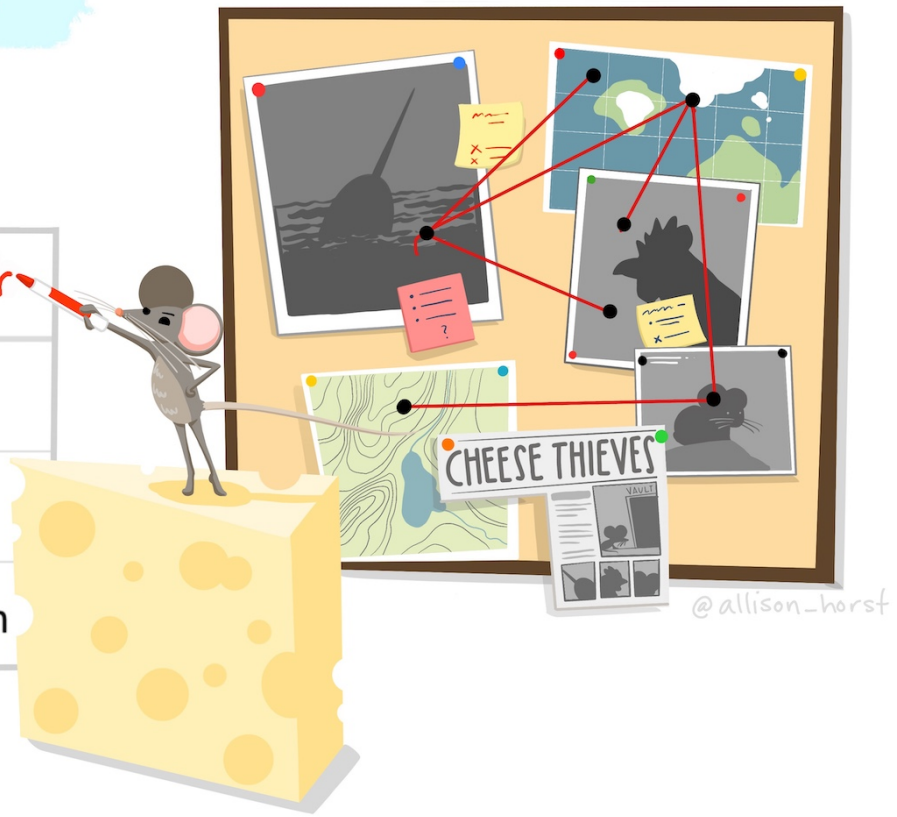
dplyr::rename()

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    103 Education {Not specified}  NA        6
## 2 26689    142 Education {Not specified}  NA        4
## 3 26804     98 Education {Not specified}  NA        6
```

Base R

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

```
##       theme    availability setID pieces USD minifigs
## 1 Education {Not specified} 26803    103  NA        6
## 2 Education {Not specified} 26689    142  NA        4
## 3 Education {Not specified} 26804     98  NA        6
```

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
## [5] US_retailPrice  minifigs        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       40.2     38.9         30.0  1474     779
##  2 Art and crafts         34.9     47.7         17.5    97       9
##  3 Basic                  21.6     19.2         15.0   873     733
##  4 Constraction           16.4     12.4         13.0   502     284
##  5 Educational           182.     188.          130.    503     465
##  6 Girls                  35.8     24.0         23.0   240     227
##  7 Historical             34.2     32.4         20.0   473     400
##  8 Junior                 22.0     10.1         20.0   228     165
##  9 Licensed               53.3     71.7         30.0  2775    1066
## 10 Miscellaneous          20.7     29.2         13.0  6253    3961
## 11 Model making           74.3     92.1         40.0   771     384
## 12 Modern day             38.2     35.6         30.0  2469    1535
## 13 Pre-school             30.8     22.7         25.0  1562    1103
## 14 Racing                 26.8     26.5         15.0   270     176
```

Describe and Describe By

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

```
##    vars    n  mean   sd median trimmed   mad  min    max range skew kurtosis
## X1    1 7483 38.96 56.5  19.99    27.7 17.79 1.49 849.99 848.5 5.32    44.74
##      se
## X1 0.65
```

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

```
##      item                group1 vars    n      mean        sd   min    max range         se
## X11     1       {Not specified}    1 1831  26.84733  39.96747  1.49 789.99 788.5  0.9340335
## X12     2           Educational    1   12 212.86667 105.88283 14.95 399.95 385.0 30.5657410
## X13     3        LEGO exclusive    1 1039  57.21203 106.63125  1.99 849.99 848.0  3.3080857
## X14     4    LEGOLAND exclusive    1    2   4.99000   0.00000  4.99   4.99   0.0  0.0000000
## X15     5              Not sold    1    1  12.99000        NA 12.99  12.99   0.0         NA
## X16     6           Promotional    1    5   4.79000   0.83666  3.99   5.99   2.0  0.3741657
## X17     7 Promotional (Airline)    1    0       NaN        NA   Inf   -Inf  -Inf         NA
## X18     8                Retail    1 4290  37.55889  38.44918  1.99 699.99 698.0  0.5870275
## X19     9      Retail - limited    1  302  63.54381  70.91908  2.49 449.99 447.5  4.0809343
## X110   10               Unknown    1    1   3.99000        NA  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

One Minute Paper

Complete the one minute paper:
https://forms.gle/CD5Qxkq3xtdxSheW8

1. What was the most important thing you learned during this class?
2. What important question remains unanswered for you?

Good luck with the semester!

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github.com/jbryer/DAV5300-2024-Spring