Overview

1. Data frames
2. Importing and exporting data
3. Lists
4. Subsetting

Data frames

Data frames

A data frame is a tabular object consisting of rows and columns.

Row names

Column names

	mpg	cyl	disp	hp	drat	wt
Mazda RX4	21.0	6	160	110	3.9	2.6
Mazda RX4 Wag	21.0	6	160	110	3.9	2.9
Datsun 710	22.8	4	108	93	3.9	2.3
Hornet 4 Drive	21.4	6	258	110	3.1	3.2
Hornet Sportabout	18.7	8	360	175	3.2	3.4
Valiant	18.1	6	225	105	2.8	3.5
Duster 360	14.3	8	360	245	3.2	3.6
Merc 240D	24.4	4	147	62	3.7	3.2
Merc 230	22.8	4	141	95	3.9	3.2

This is similar to Stata or SPSS datasets, or Excel spreadsheets.

Data frames

We can create data frames with the `data.frame` function:

```
# Define three vectors
> x <- sample(1:100, 5)
> y <- letters[1:5]
> z <- rnorm(5)

# Combine them to create a data frame
> data.frame(x, y, z)
   x y           z
1 41 a  0.41417411
2 88 b -0.61963691
3 21 c  0.12795071
4 10 d -1.20726869
5 37 e -0.07773731
```

You can define your vectors and data frame at the same time:

```
> data.frame(var1 = c(1, 2, 3, 4, 5),
>            var2 = seq(1, 5),
>            var3 = 1:5)
  var1 var2 var3
  1    1    1
  2    2    2
  3    3    3
  4    4    4
  5    5    5
```

Most of the time, we're importing data from other sources (e.g., from SPSS, Stat, Excel, or CSV).

(More on that in a moment).

5 things you should know about data frames

1. All variables must be of equal length.

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```
> data.frame(1:5, 1:4)
Error in data.frame(1:5, 1:4)
arguments imply differing number of rows: 5, 4
```

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```
> mydata <- data.frame(v1 = 1:4,
>                      v2 = c("Strongly agree",
>                             "Agree",
>                             "Disagree",
>                             "Strongly agree"))
> names(mydata)
[1] "v1"  "v2"
>
> names(mydata) <- c("id", "response")
```

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```
> nrow(mydata)
[1] 2

> ncol(mydata)
[1] 4
```

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5. You can view the top/bottom of a data frame with `head` and `tail`.

```
head(mydata)      # Returns 6 rows by default
tail(mydata)
head(mydata, 20)  # But we can request more.
```

These functions (`head` / `tail`) can be applied to other objects.

Importing data

Importing data

We often need to work with data stored as:

`.csv`	Comma- or tab-separated values (CSV, TSV)
`.xlsx`	Microsoft Excel files
`.sav`	SPSS datasets
`.dta`	Stata datasets

(Any others?).

`readr`

CSV and TSV

`readxl`

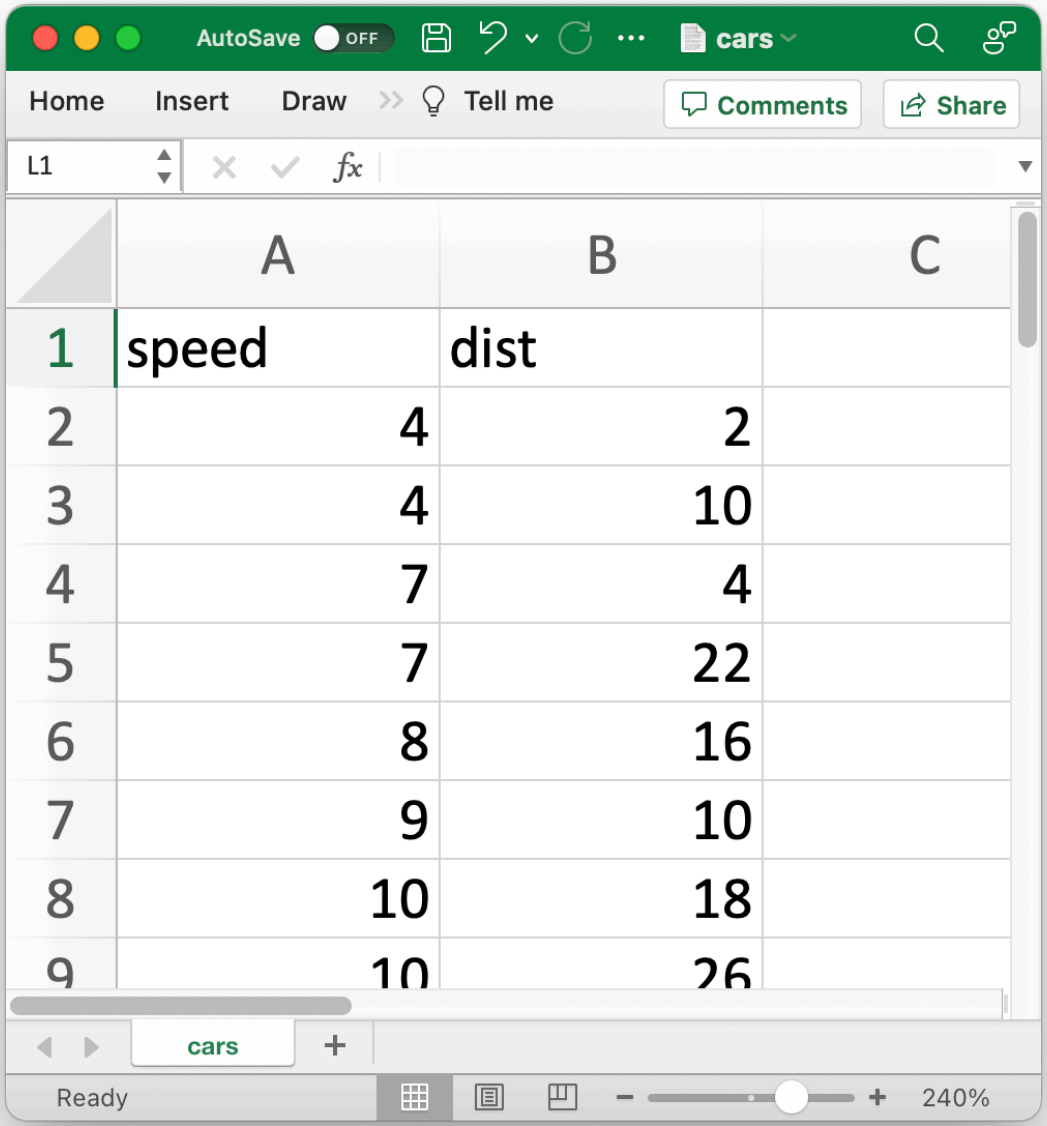
Microsoft Excel

`haven`

Stata, SPSS, SAS

https://r4ds.hadley.nz/data-import.html

Importing CSVs with `readr`



```
> library(readr)
> cars <- read_csv("cars.csv")
Rows: 50 Columns: 2
-- Column specification --------------------------------
Delimiter: ","
dbl (2): speed, dist

Use `spec()` to retrieve the full column specification
for this data.

> head(cars)
  speed dist
1     4    2
2     4   10
3     7    4
4     7   22
5     8   16
6     9   10
```

It’s not always so easy…

```
le_cols <- cols(`Country Name` = col_character(),
                `Country Code` = col_character(),
                `Series Name` = col_character(),
                `Series Code` = col_character(),
                `2019 [YR2019]` = col_double())

life_expectancy <- read_csv("life_expectancy.csv",
                            n_max = 49,
                            na = "..",
                            col_types = le_cols)
```

Importing Excel files with `readxl`

```
> library(readxl)
> cars <- read_xlsx("cars.xlsx")
```

Like `read_csv`, column types will be guessed. This isn't always helpful. Some useful arguments:

`sheet`	Specify a sheet (e.g., `1` or `"Sheet1"`).
`range`	Specify a range (e.g., `B3:D87`).
`col_types`	Specify the column types.
`na`	Specify which values should be interpreted as `NA`.
`skip`	Skip the first few rows (e.g., `skip = 5`).
`n_max`	Specify how many rows to import.

Importing Stata/SPSS/SAS files with haven

```
> library(haven)
> df_stata <- read_dta("stata.dta")
> df_spss <- read_sav("spss.sav")
> df_sas <- read_sav("sas.sas7bdat")
```

Importing Stata/SPSS/SAS files with `haven`

```
> library(haven)
> df_stata <- read_dta("stata.dta")
> df_spss <- read_sav("spss.sav")
> df_sas <- read_sav("sas.sas7bdat")
```

We can also import from a URL:

```
> df_stata <- read_dta(
>  "http://www.stata-press.com/data/r17/auto.dta"
> )
```

To export, find the corresponding `write_*` function:

- `write_csv`
- `write_xlsx` (from the `writexl` package).
- `write_dta`, `write_sav`

To learn more:

```
https://r4ds.hadley.nz/import.html
```

And then:

```
https://readr.tidyverse.org
https://readxl.tidyverse.org
https://haven.tidyverse.org
https://docs.ropensci.org/writexl/
```

Lists

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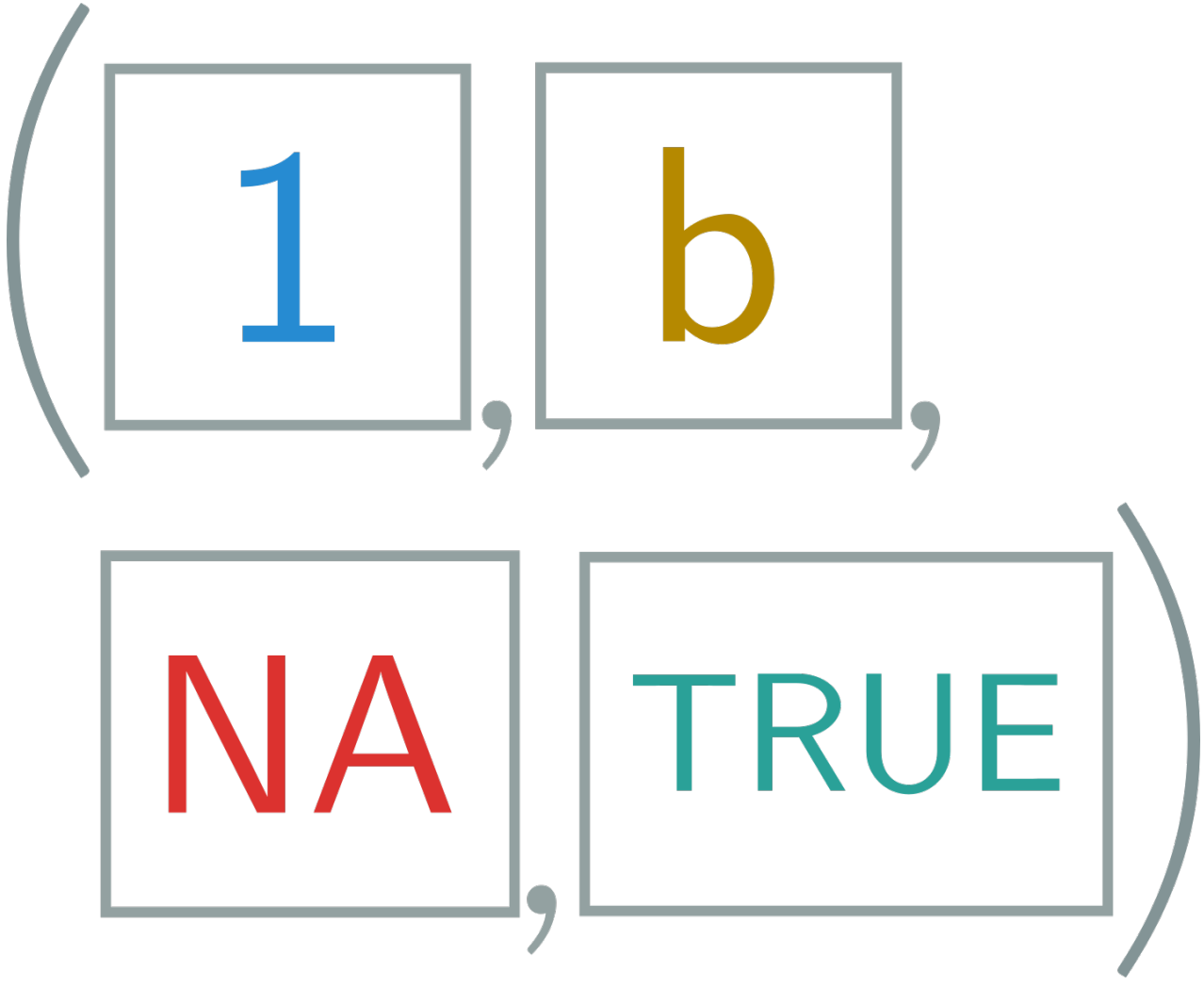

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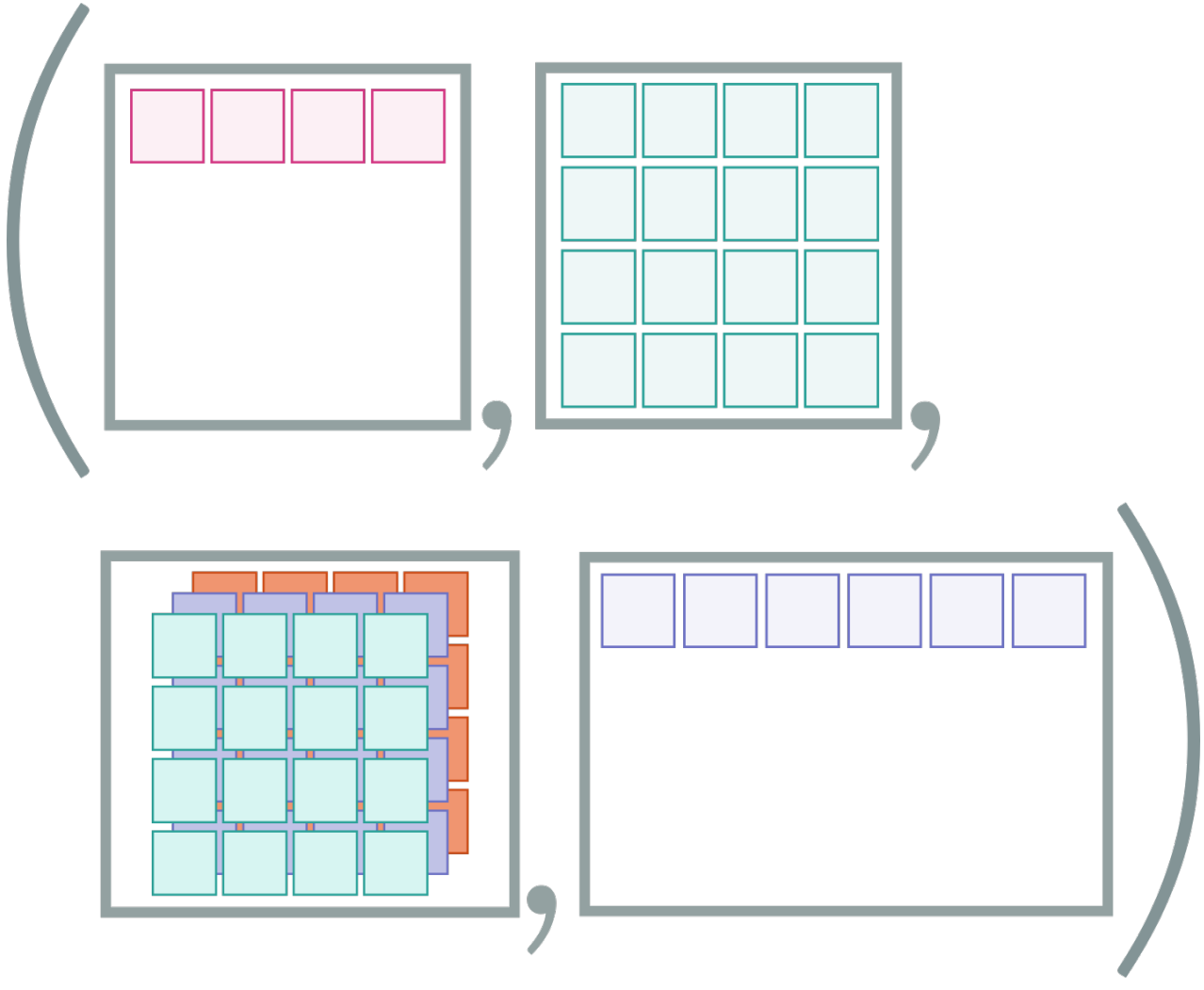

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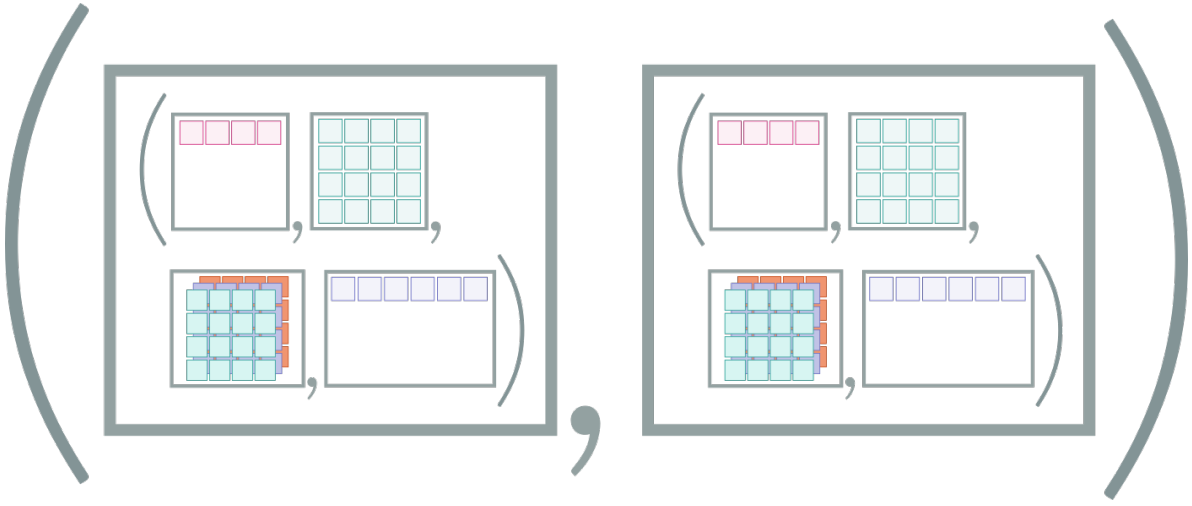

Even other lists... 🤯

```r
# Create some objects
x <- "A string."                    # Character
y <- seq(1, 100, 2)                 # Vector
z <- data.frame(a = rnorm(10),
                y = 1:10)           # Data frame

# Create a list
my_list <- list(x, y, z)
```

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# Create some objects
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                y = 1:10)           # Data frame

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my_list <- list(x, y, z)
```

```
> my_list
[[1]]
[1] "A string."

[[2]]
[1]  1  3  5  7  9 11 13 15 17 19 21 23 25 27 29 31 33 3
[29] 57 59 61 63 65 67 69 71 73 75 77 79 81 83 85 87 89

[[3]]
      rnorm.100. X1.100
1    0.455326375      1
2    0.692059671      2
```

Subsetting

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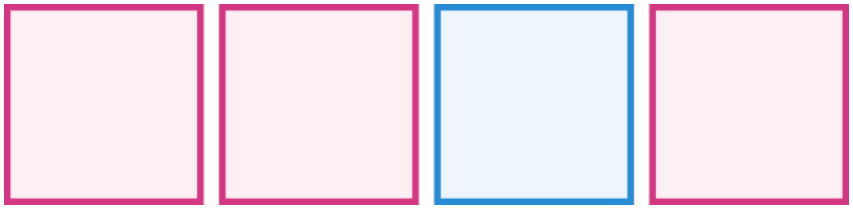

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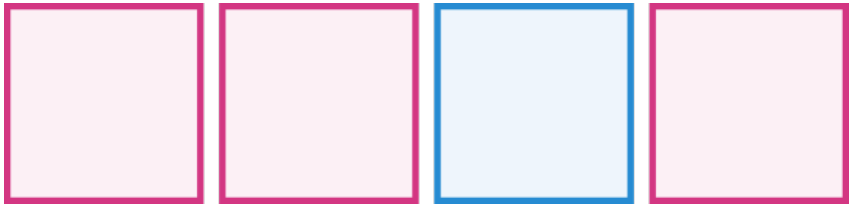

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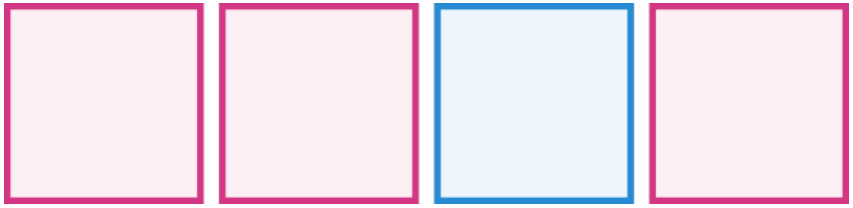

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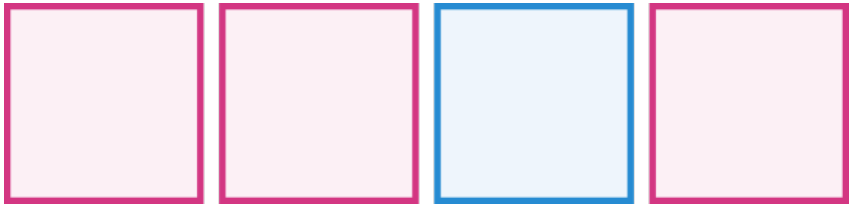

- Or you want to extract particular rows or columns from a `data.frame`.
- You will use this all the time.
- Helpful to combine with `str`.

    i) Check object structure with `str`;

    ii) Select required elements with subsetting.

Subsetting vectors

We can select elements by position with square brackets (e.g. `x[4]`).

```
x <- c("A", "B", "C", "D", "E", "F")

x[1]              # 1st element
x[3]              # 3rd element
x[length(x)]      # Last element
```

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x <- c("A", "B", "C", "D", "E", "F")

x[1]             # 1st element
x[3]             # 3rd element
x[length(x)]     # Last element
```

We can use a vector to select multiple items.

```
x[c(1, 2)]         # 1st & 2nd element
x[1:5]             # First 5 elements
x[seq(1, 6, 2)]    # Odd elements
```

We can omit items by negating the index.

```
x[-1]              # All except 1st
x[-(1:3)]          # 4th to 6th only
x[-c(5, 6)]        # All except 5/6th
```

Subsetting matrices

This is the same, but now we have two dimensions.

```
mat <- matrix(1:20, ncol = 5)
     [,1] [,2] [,3] [,4] [,5]
[1,]    1    5    9   13   17
[2,]    2    6   10   14   18
[3,]    3    7   11   15   19
[4,]    4    8   12   16   20
```

We can select single elements by row and column position: `mat[row, col]`

```
mat[1, 1]           # Row 1, column 1.
mat[1, 2]           # Row 1, column 2.
```

As before, we can select multiple elements and omit elements with negation.

```
mat[1, c(1, 3)]  # Row 1, columns 1 & 3.
mat[1:3, 2:4]    # Rows 1-3, columns 2-4.
mat[-1, -1]      # Omit first row/column.
```

If we omit an index, that entire row/column is returned.

```
mat[1, ]         # Row 1, all columns.
mat[, 2:3]       # All rows, columns 2-3.
```

Subsetting data frames

We're using the starwars dataset from tidyverse.

```
> data(starwars)
> head(starwars)
           name height mass  hair_color  skin_color eye_c
Luke Skywalker    172   77       blond        fair
         C-3PO    167   75        <NA>        gold    ye
         R2-D2     96   32        <NA> white, blue
   Darth Vader    202  136        none       white    ye

birth_year gender homeworld species
      19.0   male  Tatooine   Human
     112.0   <NA>  Tatooine   Droid
      33.0   <NA>     Naboo   Droid
      41.9   male  Tatooine   Human
```

```
# We can select columns by name:
starwars$height
 [1] 172 167  96 202 150 178 165  97 183 182 18
[17] 170 180  66 170 183 200 190 177 175 180 15
```

```
# We can select columns by name:
starwars$height
 [1] 172 167  96 202 150 178 165  97 183 182 18
[17] 170 180  66 170 183 200 190 177 175 180 15


# Or, alternatively:
starwars[["height"]]
```

```r
# We can select columns by name:
starwars$height
 [1] 172 167  96 202 150 178 165  97 183 182 18
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starwars[["height"]]


# Or by position:
starwars[[2]]
```

```r
# We can select columns by name:
starwars$height
 [1] 172 167  96 202 150 178 165  97 183 182 18
[17] 170 180  66 170 183 200 190 177 175 180 15


# Or, alternatively:
starwars[["height"]]


# Or by position:
starwars[[2]]


# We can select multiple columns:
starwars[, c("height","species")]
starwars[, c(1, 2)]
```

Subsetting lists

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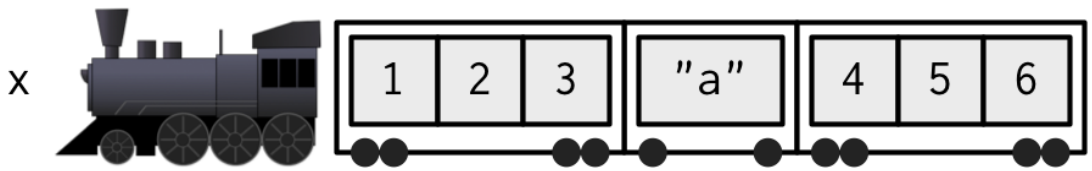
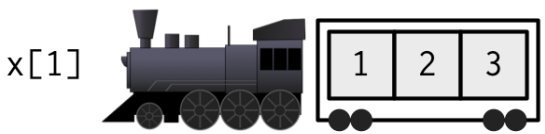
A list can contain any number of other objects (even other lists). We need some way of referring the elements of a list as well as the contents of these elements.

Suppose we have a list with three elements:

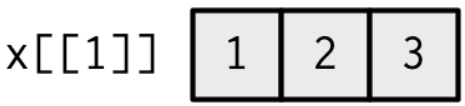
```
x <- list(1:3, "a", 4:6)
```



Select the first element with `x[1]`:



Select the contents of the first element with `x[[1]]`:



```
> x <- list(1:3, "a", 4:6)
> x
[[1]]
[1] 1 2 3

[[2]]
[1] "a"

[[3]]
[1] 4 5 6

> x[1]
[[1]]
[1] 1 2 3

> x[[1]]
[1] 1 2 3
```

```
> x <- list(1:3, "a", 4:6)
> x
[[1]]
[1] 1 2 3

[[2]]
[1] "a"

[[3]]
[1] 4 5 6

> x[1]
[[1]]
[1] 1 2 3

> x[[1]]
[1] 1 2 3
```

We can select elements contained within other elements by combining subsetting operators.

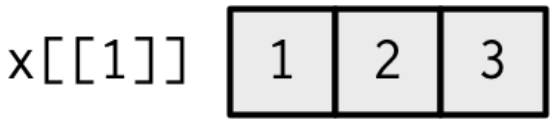
```
> x[[1]][1]
[1] 1

> x[[3]][2]
[1] 5
```

This also applies to data frames:

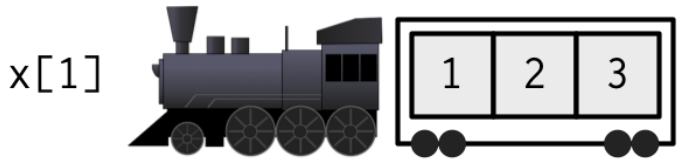
Select the **contents** of the height column:

```
starwars[["height"]
starwars$height
starwars[[2]]
```



Select the **entire column**, returning a data frame:

```
starwars["height"]
starwars[, "height"]
starwars[2]
starwars[, 2]
```



Subsetting named lists

We can create a list with named elements.

```
> x <- list(first   = seq(0, 50, 5),
>           second  = c("A", "string", "vector"),
>           third   = rnorm(10))
> x
$first
[1]  0  5 10 15 20 25 30 35 40 45 50

$second
[1] "A"      "string" "vector"

$third
[1] -0.11864667  1.20817170 -0.59353976  1.91463235
[7] -0.53772881  0.06389441  0.91135953 -0.91389382
```

We can then select items by name:

```
> x$first
[1]  0  5 10 15 20 25 30 35 40 45 50

> x["third"]
[1] -0.11864667  1.20817170 -0.59353976  1.91463235
[7] -0.53772881  0.06389441  0.91135953 -0.91389382
```

We can then select items by name:

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> x$first
[1]  0  5 10 15 20 25 30 35 40 45 50

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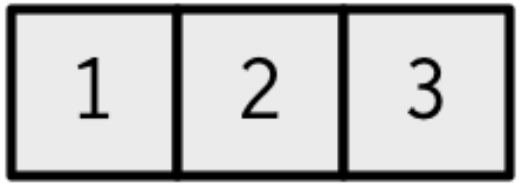
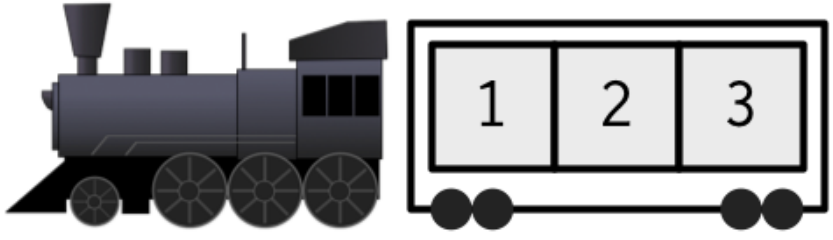
[1] -0.11864667  1.20817170 -0.59353976  1.91463235
[7] -0.53772881  0.06389441  0.91135953 -0.91389382
```

Again, notice the difference between `[[` and `[`:

```
> x[["third"]]
[1] -0.11864667  1.208171
[7] -0.53772881  0.063894
```




```
> x["third"]
$third
 [1] -0.11864667  1.208171
 [7] -0.53772881  0.063894
```



Materials on subsetting are adapted from Chapter 4 of *Advanced R*, available online at:

https://adv-r.hadley.nz/subsetting.html