

## Part 1: R Foundations

(d) Data Frames and Tibbles

## Recap - R Data Types

	Homogenous	Heterogenous
1d	Atomic Vector	List
2d	Matrix	<b>Data Frame/Tibble</b>
nd	Array	

- ▶ The most common way of storing data in R
- ▶ Under the hood, a data frame is a list of equal-length vectors
- ▶ A two-dimensional structure, it shares properties of both a list and a matrix

## Creating a data frame

```
d <- data.frame(x=1:3, y = LETTERS[1:3], z = letters[1:3])  
d
```

```
##      x y z  
## 1 1 A a  
## 2 2 B b  
## 3 3 C c
```

```
d$x
```

```
## [1] 1 2 3
```

```
d$y
```

```
## [1] A B C  
## Levels: A B C
```

```
d$z
```

```
## [1] a b c  
## Levels: a b c
```

## summary function with data frames

```
d <- data.frame(x=1:3, y = LETTERS[1:3],  
                z = letters[1:3])
```

```
d
```

```
##    x y z  
##  1 1 A a  
##  2 2 B b  
##  3 3 C c
```

```
summary(d)
```

```
##           x           y           z  
##  Min.      :1.0      A:1      a:1  
##  1st Qu.:1.5      B:1      b:1  
##  Median :2.0      C:1      c:1  
##  Mean     :2.0  
##  3rd Qu.:2.5  
##  Max.     :3.0
```

## mtcars data frame

A data frame with 32 observations on 11 variables.

- ▶ **mpg** Miles/(US) gallon
- ▶ **cyl** Number of cylinders
- ▶ **disp** Displacement (cu.in.)
- ▶ **hp** Gross horsepower
- ▶ **drat** Rear axle ratio
- ▶ **wt** Weight (1000 lbs)
- ▶ **qsec** 1/4 mile time
- ▶ **vs** V/S
- ▶ **am** Transmission (0 = automatic, 1 = manual)
- ▶ **gear** Number of forward gears
- ▶ **carb** Number of carburetors

## mtcars sample data

```
knitr::kable(mtcars[1:10,1:6])
```

	mpg	cyl	disp	hp	drat	wt
Mazda RX4	21.0	6	160.0	110	3.90	2.620
Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875
Datsun 710	22.8	4	108.0	93	3.85	2.320
Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215
Hornet Sportabout	18.7	8	360.0	175	3.15	3.440
Valiant	18.1	6	225.0	105	2.76	3.460
Duster 360	14.3	8	360.0	245	3.21	3.570
Merc 240D	24.4	4	146.7	62	3.69	3.190
Merc 230	22.8	4	140.8	95	3.92	3.150
Merc 280	19.2	6	167.6	123	3.92	3.440

## mtcars using `str()`

```
str(mtcars)
```

```
## 'data.frame':    32 obs. of  11 variables:
##  $ mpg : num  21 21 22.8 21.4 18.7 18.1 14.3 24.4 22.8 1
##  $ cyl : num  6 6 4 6 8 6 8 4 4 6 ...
##  $ disp: num  160 160 108 258 360 ...
##  $ hp  : num  110 110 93 110 175 105 245 62 95 123 ...
##  $ drat: num  3.9 3.9 3.85 3.08 3.15 2.76 3.21 3.69 3.92
##  $ wt  : num  2.62 2.88 2.32 3.21 3.44 ...
##  $ qsec: num  16.5 17 18.6 19.4 17 ...
##  $ vs  : num  0 0 1 1 0 1 0 1 1 1 ...
##  $ am  : num  1 1 1 0 0 0 0 0 0 0 ...
##  $ gear: num  4 4 4 3 3 3 3 4 4 4 ...
##  $ carb: num  4 4 1 1 2 1 4 2 2 4 ...
```

## head() and tail() functions

```
head(mtcars[,1:6])
```

##	mpg	cyl	disp	hp	drat	wt
## Mazda RX4	21.0	6	160	110	3.90	2.620
## Mazda RX4 Wag	21.0	6	160	110	3.90	2.875
## Datsun 710	22.8	4	108	93	3.85	2.320
## Hornet 4 Drive	21.4	6	258	110	3.08	3.215
## Hornet Sportabout	18.7	8	360	175	3.15	3.440
## Valiant	18.1	6	225	105	2.76	3.460

```
tail(mtcars[,1:6])
```

##	mpg	cyl	disp	hp	drat	wt
## Porsche 914-2	26.0	4	120.3	91	4.43	2.140
## Lotus Europa	30.4	4	95.1	113	3.77	1.513
## Ford Pantera L	15.8	8	351.0	264	4.22	3.170
## Ferrari Dino	19.7	6	145.0	175	3.62	2.770
## Maserati Bora	15.0	8	301.0	335	3.54	3.570
## Volvo 142E	21.4	4	121.0	109	4.11	2.780



## Subsetting rows

```
mtcars[mtcars$gear == 5,]
```

##		mpg	cyl	disp	hp	drat	wt	qsec	vs	am
##	Porsche 914-2	26.0	4	120.3	91	4.43	2.140	16.7	0	1
##	Lotus Europa	30.4	4	95.1	113	3.77	1.513	16.9	1	1
##	Ford Pantera L	15.8	8	351.0	264	4.22	3.170	14.5	0	1
##	Ferrari Dino	19.7	6	145.0	175	3.62	2.770	15.5	0	1
##	Maserati Bora	15.0	8	301.0	335	3.54	3.570	14.6	0	1

## Accessing rows/columns

```
mtcars[1:10,1:6]
```

##	mpg	cyl	disp	hp	drat	wt
## Mazda RX4	21.0	6	160.0	110	3.90	2.620
## Mazda RX4 Wag	21.0	6	160.0	110	3.90	2.875
## Datsun 710	22.8	4	108.0	93	3.85	2.320
## Hornet 4 Drive	21.4	6	258.0	110	3.08	3.215
## Hornet Sportabout	18.7	8	360.0	175	3.15	3.440
## Valiant	18.1	6	225.0	105	2.76	3.460
## Duster 360	14.3	8	360.0	245	3.21	3.570
## Merc 240D	24.4	4	146.7	62	3.69	3.190
## Merc 230	22.8	4	140.8	95	3.92	3.150
## Merc 280	19.2	6	167.6	123	3.92	3.440

## Filtering rows and columns

```
mtcars[mtcars$cyl == 6, c("mpg", "cyl")]
```

##		mpg	cyl
##	Mazda RX4	21.0	6
##	Mazda RX4 Wag	21.0	6
##	Hornet 4 Drive	21.4	6
##	Valiant	18.1	6
##	Merc 280	19.2	6
##	Merc 280C	17.8	6
##	Ferrari Dino	19.7	6

## Challenge 1.5

- ▶ List all the cars that have an **mpg** greater than the average
- ▶ List the car(s) with the greatest displacement (**disp**)

## Adding new columns to a data frame

- ▶ Often the initial data set may not contain sufficient information for analysis
- ▶ Adding new variables (columns) is an important feature to have
- ▶ Data frames support this: columns can be combined or new information used

```
mtcars$name <- rownames(mtcars)
mtcars[1:5, -(1:8)]
```

##	am	gear	carb	name
## Mazda RX4	1	4	4	Mazda RX4
## Mazda RX4 Wag	1	4	4	Mazda RX4 Wag
## Datsun 710	1	4	1	Datsun 710
## Hornet 4 Drive	0	3	1	Hornet 4 Drive
## Hornet Sportabout	0	3	2	Hornet Sportabout

## Challenge 1.6

Create a new column on mtcars that contains kilometers per gallon.

## Missing data - complete.cases()

```
d <- data.frame(x=1:3, y = LETTERS[1:3],  
               z = letters[1:3])  
d[2,3] <- NA  
d
```

```
##    x y    z  
## 1 1 A    a  
## 2 2 B <NA>  
## 3 3 C    c
```

```
complete.cases(d)
```

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

```
d[complete.cases(d),]
```

```
##    x y z  
## 1 1 A a  
## 3 3 C c
```

# The tibble

- ▶ Tibbles are data frames, but they tweak some older behaviours to make life a little easier
- ▶ One of the unifying features of the tidyverse
- ▶ To coerce a data frame to a tibble, use `as_tibble()`
- ▶ A tibble can be created from individual vectors using `tibble()`

```
t <- tibble(x=1:3, y = LETTERS[1:3], z = letters[1:3])
t
```

```
## # A tibble: 3 x 3
##       x y      z
##   <int> <chr> <chr>
## 1     1 A      a
## 2     2 B      b
## 3     3 C      c
```



# Tibble abbreviations

t

```
## # A tibble: 3 x 3
##       x y      z
##   <int> <chr> <chr>
## 1     1  1 A     a
## 2     2  2 B     b
## 3     3  3 C     c
```

Abbreviation	Data Type
int	integers
dbl	double (numeric)
chr	character vectors
dtm	date-times
fctr	categorical
date	dates

## Summary - Part 1: R Foundations

	Homogenous	Heterogenous
1d	Atomic Vector	List
2d	<i>Matrix</i>	Data Frame/Tibble
nd	<i>Array</i>	

- ▶ Atomic Vectors
- ▶ Lists
- ▶ Functions and Functionals
- ▶ Data Frames & Tibbles

# Objects in R

- ▶ “Everything that exists in R is an object”. Chambers (2008)
- ▶ However, while everything is an object, not everything is object-oriented (Wickham 2019)
- ▶ Base objects come from S, and were developed before anyone thought that S might need an OOP system. **typeof()** provides information on the base object, and **sloop::otype()**

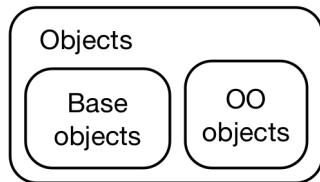


Figure 1: Objects in R

# Examples

```
typeof(1:10)
```

```
## [1] "integer"
```

```
sloop::otype(1:10)
```

```
## [1] "base"
```

```
mod <- lm(eruptions ~ waiting, data=faithful)  
typeof(mod)
```

```
## [1] "list"
```

```
sloop::otype(mod)
```

```
## [1] "S3"
```

```
class(mod)
```

```
## [1] "lm"
```

# Test Slide with Plot

