

Subsetting Data in R

Data Wrangling in R

Dealing with Missing Data

Missing data types

One of the most important aspects of data cleaning is missing values.

Types of “missing” data:

- NA - general missing data
- NaN - stands for “**N**ot **a** **N**umber”, happens when you do $0/0$.
- Inf and -Inf - Infinity, happens when you take a positive number (or negative number) by 0.

Finding Missing data

Each missing data type has a function that returns `TRUE` if the data is missing:

- `NA` - `is.na`
- `NaN` - `is.nan`
- `Inf` and `-Inf` - `is.infinite`
- `is.finite` returns `FALSE` for all missing data and `TRUE` for non-missing

Missing Data with Logicals

One important aspect (esp with subsetting) is that logical operations return NA for NA values. Think about it, the data could be > 2 or not we don't know, so R says there is no TRUE or FALSE, so that is missing:

```
x = c(0, NA, 2, 3, 4)
x > 2
```

```
[1] FALSE    NA FALSE  TRUE  TRUE
```

Missing Data with Logicals

What to do? What if we want if $x > 2$ and x isn't NA?
Don't do $x \neq \text{NA}$, do $x > 2$ and x is NOT NA:

```
x != NA
```

```
[1] NA NA NA NA NA
```

```
x > 2 & !is.na(x)
```

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

Missing Data with Logicals

What about seeing if a value is equal to multiple values? You can do `(x == 1 | x == 2) & !is.na(x)`, but that is not efficient.

```
(x == 0 | x == 2) # has NA
```

```
[1] TRUE    NA  TRUE FALSE FALSE
```

```
(x == 0 | x == 2) & !is.na(x) # No NA
```

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

what to do?

Missing Data with Logicals: `%in%`

Introduce the `%in%` operator:

```
x %in% c(0, 2) # NEVER has NA and returns logical
```

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

reads “return TRUE if `x` is in 0 or 2”. (Like `inlist` in Stata).

Missing Data with Logicals: `%in%`

NEVER has NA, even if you put it there (BUT DON'T DO THIS):

```
x %in% c(0, 2, NA) # NEVER has NA and returns logical
```

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

```
x %in% c(0, 2) | is.na(x)
```

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

Missing Data with Operations

Similarly with logicals, operations/arithmetic with NA will result in NAs:

```
x + 2
```

```
[1] 2 NA 4 5 6
```

```
x * 2
```

```
[1] 0 NA 4 6 8
```

UFO data again

```
ufo = read_csv("../data/ufo/ufo_data_complete.csv", col_types =
               cols(
                 .default = col_character(),
                 `duration (seconds)` = col_double(),
                 longitude = col_double()
               ))
head(ufo)
```

Warning: 199 parsing failures.

row	col	expected	actual	file
877	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'
1712	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'
1814	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'
2857	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'
3733	--	11 columns	12 columns	'../data/ufo/ufo_data_complete.csv'

.....

See problems(...) for more details.

A tibble: 6 x 11

	datetime	city	state	country	shape	`duration (seco...	`duration (hour...	comment
	<chr>	<chr>	<chr>	<chr>	<chr>	<dbl>	<chr>	<chr>
1	10/10/1...	san ...	tx	us	cyli...	2700	45 minutes	This ev
2	10/10/1...	lack...	tx	<NA>	light	7200	1-2 hrs	1949 La
3	10/10/1...	ches...	<NA>	gb	circ...	20	20 seconds	Green/O
4	10/10/1...	edna	tx	us	circ...	20	1/2 hour	My olde
5	10/10/1...	kane...	hi	us	light	900	15 minutes	AS a Ma
6	10/10/1...	bris...	tn	us	sphe...	300	5 minutes	My fath

... with 3 more variables: `date posted` <chr>, latitude <chr>, longitude <dbl>

Filtering and tibbles

Missing value and filter can be powerful (head - show first few rows)

```
ufo %>%  
  filter(is.na(state) | is.na(country)) %>%  
  head
```

```
# A tibble: 6 x 11  
  datetime city state country shape `duration (seco...` `duration (hour... comment  
  <chr>    <chr> <chr> <chr>    <chr>          <dbl> <chr>          <chr>  
1 10/10/1... lack... tx    <NA>    light          7200 1-2 hrs        1949 La  
2 10/10/1... ches... <NA>    gb      circ...         20 20 seconds    Green/O  
3 10/10/1... pena... <NA>    gb      circ...        180 about 3 mins    penarth  
4 10/10/1... berm... <NA>    <NA>    light          20 20 sec.        saw fas  
5 10/10/1... will... az     <NA>    light          120 2 min         The obj  
6 10/10/1... card... <NA>    gb      disk          1200 20 minutes    back in  
# ... with 3 more variables: `date posted` <chr>, latitude <chr>, longitude <dbl>
```

Filtering and tibbles

Group logical statements with parentheses

```
ufo %>%  
  filter(  
    (!is.na(state) & is.na(country)) | city == "seattle") %>%  
  head
```

```
# A tibble: 6 x 11  
  datetime city state country shape `duration (seco...` `duration (hour... comment  
  <chr>      <chr> <chr> <chr> <chr> <dbl> <chr> <chr>  
1 10/10/1... lack... tx <NA> light 7200 1-2 hrs 1949 La  
2 10/10/1... will... az <NA> light 120 2 min The obj  
3 10/10/1... sadd... ab <NA> tria... 270 4.5 or more min. Lights  
4 10/10/1... holm... ny <NA> chev... 180 3 minutes Football  
5 10/10/1... mani... on <NA> disk 600 10/mins We coul  
6 10/10/1... kran... ky <NA> tria... 180 3min Triangl  
# ... with 3 more variables: `date posted` <chr>, latitude <chr>, longitude <dbl>
```

Renaming Columns

Renaming Columns of a `data.frame`

To rename columns in `dplyr`, you use the `rename` command (NEW=old)

```
ufo = ufo %>% rename(City = city, duration_s = `duration (seconds)`)
head(ufo)
```

```
# A tibble: 6 x 11
  datetime City state country shape duration_s `duration (hour... comments
  <chr>      <chr> <chr> <chr>    <chr>      <dbl> <chr>              <chr>
1 10/10/1... san ... tx      us      cyli...    2700 45 minutes        This ev...
2 10/10/1... lack... tx      <NA>    light    7200 1-2 hrs           1949 La...
3 10/10/1... ches... <NA>    gb      circ...     20 20 seconds        Green/O...
4 10/10/1... edna  tx      us      circ...     20 1/2 hour          My olde...
5 10/10/1... kane... hi      us      light    900 15 minutes        AS a Ma...
6 10/10/1... bris... tn      us      sphe...    300 5 minutes         My fath...
# ... with 3 more variables: `date posted` <chr>, latitude <chr>, longitude <dbl>
```

Renaming All Columns of a `data.frame`: `dplyr`

To rename all columns you use the `rename_all` command (with a function)

```
ufo_upper = ufo %>% rename_all(toupper)
head(ufo_upper)
```

```
# A tibble: 6 x 11
  DATETIME CITY STATE COUNTRY SHAPE DURATION_S `DURATION (HOUR... COMMENTS
  <chr>    <chr> <chr> <chr>    <chr>      <dbl> <chr>          <chr>
1 10/10/1... san ... tx      us      cyli...    2700 45 minutes    This ev...
2 10/10/1... lack... tx      <NA>    light     7200 1-2 hrs       1949 La...
3 10/10/1... ches... <NA>    gb      circ...     20 20 seconds    Green/O...
4 10/10/1... edna  tx      us      circ...     20 1/2 hour      My olde...
5 10/10/1... kane... hi      us      light     900 15 minutes    AS a Ma...
6 10/10/1... bris... tn      us      sphe...     300 5 minutes     My fath...
# ... with 3 more variables: `DATE POSTED` <chr>, LATITUDE <chr>, LONGITUDE <dbl>
```


Adding columns to a `data.frame`

`mutate` - allows you to add or replace columns (need to reassign for it to stick)

```
ufo2 = ufo %>% mutate(State = toupper(state)) # we renamed city  
ufo2 %>% select(State) %>% head
```

```
# A tibble: 6 x 1  
  State  
  <chr>  
1 TX  
2 TX  
3 <NA>  
4 TX  
5 HI  
6 TN
```

Recoding to missing

Sometimes people code missing data in weird or inconsistent ways.

```
ages = data.frame(age = c(23, -999, 21, 44, 32, 57, 65, 54))  
range(ages$age)
```

```
[1] -999    65
```

Adding new columns to a `data.frame`: base R

Can also use `$` to add columns, but only one column at a time

```
ufo2$State2 = tolower(ufo2$State)
ufo2 %>% select(state, State, State2) %>% head
```

```
# A tibble: 6 x 3
  state State State2
  <chr> <chr> <chr>
1 tx    TX    tx
2 tx    TX    tx
3 <NA>  <NA>  <NA>
4 tx    TX    tx
5 hi    HI    hi
6 tn    TN    tn
```

Creating conditional variables

One frequently-used tool is creating variables with conditions.

A general function for creating new variables based on existing variables is the `ifelse()` function, which “returns a value with the same shape as test which is filled with elements selected from either yes or no depending on whether the element of test is TRUE or FALSE.”

```
ifelse(test, yes, no)
```

```
# test: an object which can be coerced  
#       to logical mode.
```

```
# yes: return values for true elements of test.
```

```
# no: return values for false elements of test.
```

Recoding to missing

How do we change the -999 to be treated as missing?

```
ages = ages %>% mutate(age = ifelse(age == -999, NA, age))  
range(ages$age)
```

```
[1] NA NA
```

```
range(ages$age, na.rm=TRUE)
```

```
[1] 21 65
```

```
ages
```

	age
1	23
2	NA
3	21
4	44
5	32
6	57
7	65
8	54

Recoding from missing

What if you were the person that coded the -999

```
ages = ages %>% mutate(age = ifelse(is.na(age), -999, age))
ages
```

	age
1	23
2	-999
3	21
4	44
5	32
6	57
7	65
8	54

Adding columns to a `data.frame`: `dplyr`

```
ufo = ufo %>% mutate(  
  region = ifelse(  
    country %in% c("us", "ca"),  
    "North America",  
    "Not North America")  
)  
ufo %>% select(country, region) %>% head
```

```
# A tibble: 6 x 2  
  country region  
  <chr>    <chr>  
1 us      North America  
2 <NA>    Not North America  
3 gb      Not North America  
4 us      North America  
5 us      North America  
6 us      North America
```

Adding columns to a `data.frame`: `dplyr`

Alternatively, `case_when` provides a more general way:

```
ufo = ufo %>% mutate(  
  region = case_when(  
    country %in% c("us", "ca") ~ "North America",  
    country %in% c("de") ~ "Europe",  
    country %in% "gb" ~ "Great Britain",  
    TRUE ~ "Other"  
  )  
)  
ufo %>% select(country, region) %>% head
```

```
# A tibble: 6 x 2  
  country region  
  <chr>    <chr>  
1 us      North America  
2 <NA>    Other  
3 gb      Great Britain  
4 us      North America  
5 us      North America  
6 us      North America
```


Ordering the rows of a `data.frame`: dplyr

The `arrange` function can reorder rows By default, `arrange` orders in ascending order:

```
ufo %>% arrange(duration_s)
```

```
# A tibble: 88,875 x 12
  datetime City state country shape duration_s `duration (hour... comments
  <chr>      <chr> <chr> <chr>   <chr>      <dbl> <chr>      <chr>
1 10/10/1... puer... pr   <NA>   <NA>         0 <NA>      Woman c...
2 10/10/1... ashl... mo   us    light         0 two seperate ti... We saw ...
3 10/10/2... baha... <NA> <NA>   egg          0 <NA>      we are ...
4 10/10/2... burn... <NA> au    cross         0 12        the cra...
5 10/10/2... edge... fl    us    <NA>         0 300       orange ...
6 10/10/2... fran... in    us    disk          0 ?         two yel...
7 10/10/2... knik   ak    us    tria...        0 5         Slow mo...
8 10/10/2... bake... ca    us    circ...        0 had a call of a... UFO sig...
9 10/10/2... amar... tx    us    flash         0 <NA>      we saw ...
10 10/10/2... gree... <NA> <NA>   rect...        0 <NA>      Found t...
# ... with 88,865 more rows, and 4 more variables: `date posted` <chr>,
# latitude <chr>, longitude <dbl>, region <chr>
```

Ordering the rows of a `data.frame`: `dplyr`

Use the `desc` to arrange the rows in descending order:

```
ufo %>% arrange(desc(duration_s))
```

```
# A tibble: 88,875 x 12
  datetime City state country shape duration_s `duration (hour... comments
  <chr>      <chr> <chr> <chr>   <chr>      <dbl> <chr>          <chr>
1 10/1/19... birm... <NA>   gb      sphe...  97836000 31 years      Firstly...
2 6/3/201... otta... on     ca      other   82800000 23000hrs      ((HOAX?...
3 9/15/19... gree... ar     us      light   66276000 21 years      Orange ...
4 4/2/198... dont... <NA>   <NA>    <NA>    52623200 2 months      Hi&#44 ...
5 8/10/20... finl... wa     us      light   52623200 2 months      There h...
6 8/24/20... engl... fl     us      light   52623200 2 months      bright ...
7 6/30/19... some... <NA>   gb      cone    25248000 8 years       First t...
8 10/7/20... okla... ok     <NA>   circ...  10526400 4 months      Bright ...
9 3/1/199... meni... ca     us      unkn...  10526400 4 months      Sun Cit...
10 8/3/200... virg... va     us      fire...  10526400 4 months      this ob...
# ... with 88,865 more rows, and 4 more variables: `date posted` <chr>,
# latitude <chr>, longitude <dbl>, region <chr>
```

Ordering the rows of a `data.frame`: `dplyr`

It is a bit more straightforward to mix increasing and decreasing orderings:

```
ufo %>% arrange(country, desc(duration_s))
```

```
# A tibble: 88,875 x 12
  datetime City state country shape duration_s `duration (hour... comments
  <chr>      <chr> <chr> <chr>   <chr>      <dbl> <chr>          <chr>
1 11/12/2... moun... <NA> au     sphe... 1209600 2 weeks      Orange ...
2 5/12/20... sydn... <NA> au     light  345600 4 days+      Infra r...
3 4/18/20... sydn... <NA> au     light   86400 day       It was ...
4 4/15/19... bris... <NA> au     chan... 37800 1 1/2 hours  A brill...
5 4/18/19... bris... <NA> au     <NA>    18000 5 hours plus Five ho...
6 6/9/200... melb... <NA> au     circ... 18000 5 hours +   UFO sig...
7 11/6/20... pert... <NA> au     light  14400 4hrs        Unusual...
8 3/15/20... adel... <NA> au     form... 10800 1-3 hrs     ive got...
9 3/2/201... pert... <NA> au     light  10800 2-3 hours   Constan...
10 6/20/20... canb... <NA> au     tear... 10800 3 hrs       8 tear ...
# ... with 88,865 more rows, and 4 more variables: `date posted` <chr>,
# latitude <chr>, longitude <dbl>, region <chr>
```

Lab

[Link to Lab](#)