

Introduction to Data Wrangling III

Summer Institute in Data Science

Rolando J. Acosta



HARVARD
SCHOOL OF PUBLIC HEALTH

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@RJANunez

What to expected today

- Today we will learn about functions to process strings
- Specifically, we will learn about functions to detect, locate, extract, and replace strings
- Furthermore, we will learn the basics of regular expressions (regex)



The stringr package

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- Hence, we first present the functions available in the ***stringr*** package
- Then, we will use some of them in the lecture and hands-on sections today

Detect functions

Function	Description
str_detect	Is the pattern in the string?
str_which	Returns the index of entries that contain the pattern
str_subset	Returns the subset of strings that contain the pattern

Locate functions

Function	Description
<code>str_locate</code>	Returns the position of first occurrence of the pattern in the string
<code>str_locate_all</code>	Returns the positions of all occurrences of the pattern in the string
<code>str_view</code>	Shows the first part of the string that matches the pattern
<code>str_view_all</code>	Shows all the parts of the string that matches the pattern

Extract functions

Function	Description
<code>str_extract</code>	Extract the first part of the string that matches the pattern
<code>str_extract_all</code>	Extract all the parts of the string that match the pattern
<code>str_match</code>	Extract the first part of the string that matches the groups and the patterns defined by the groups
<code>str_match_all</code>	Extract all the parts of the string that match the groups and the patterns defined by the groups
<code>str_sub</code>	Extract a substring
<code>str_split</code>	Split a string into a list with parts separated by the pattern
<code>str_split_fixed</code>	Split a string into a matrix with parts separated by the patterns

Describe functions

Function	Description
str_count	Count the number of times a pattern appears in a string
str_length	Number of characters in the string

Replace functions

Function	Description
<code>str_replace</code>	Replace first part of a string matching a pattern with another.
<code>str_replace_all</code>	Replace all parts of a string matching a pattern with another.
<code>str_to_upper</code>	Change all characters to upper case.
<code>str_to_lower</code>	Change all characters to lower case.
<code>str_to_title</code>	Change first character to upper and rest to lower.
<code>str_replace_na</code>	Replace all NAs to a new value.
<code>str_trim</code>	Remove white space from start and end of string.

Manipulate functions

Function	Description
str_c	Join multiple strings
str_conv	Change the encoding of the string
str_sort	Sort the vector in alphabetical order
str_order	Index needed to order the vector in alphabetical order
str_trunc	Truncate a string to a fixed size
str_pad	Add white space to string to make it a fixed size
str_dup	Repeat a string
str_wrap	Wrap things into formatted paragraphs
str_interp	String interpolation

Basics of a string

- In R, you can create strings with either double quotes or single quotes

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string1 <- "This is a string"  
[1] "This is a string"
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```

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```
string3 <- "Say you want to add a "quote" quote"
```

```
Error: unexpected symbol in "string2 <- "Say you want to add a "quote"
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Error: unexpected symbol in "string2 <- "Say you want to add a “quote”"
```

```
string4 <- 'Say you want to add a "quote" quote'
```

```
[1] "Say you want to add a \"quote\" quote"
```


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string4 <- 'Say you want to add a "quote" quote'  
[1] "Say you want to add a \"quote\" quote"
```

- You can also save multiple strings in a vector

```
c("rolando", "inter", "puerto rico")  
[1] "rolando"      "inter"        "puerto rico"
```

Basics of a string

- As one last example, suppose you want to write 5'10" as a string

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'5'10''
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'5'10''
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```
"5'10""
```

```
+ . . .
```

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```

- The former yields an error because we are closing the string after 5

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- The former yields an error because we are closing the string after 5
- The latter closes the string after 10, and then opens a new string!

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- The former yields an error because we are closing the string after 5
- The latter closes the string after 10, and then opens a new string!
- In this situation we need to escape the string with the backslash \

Basics of a string

- As one last example, suppose you want to write 5'10" as a string

```
'5'10" '  
Error: unexpected numeric constant in "'5'10"  
  
"5'10"  
+. . .
```

- The former yields an error because we are closing the string after 5
- The latter closes the string after 10, and then opens a new string!
- In this situation we need to escape the string with the backslash \
- Here is how you do it

```
'5\'10" '  
[1] "5'10\""
```

Regular expressions (regex)

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- Consider the following example where we want to know the strings that contain the pattern cm or inches

```
yes <- c("180 cm", "70 inches")
no  <- c("180", "70' ")
s   <- c(yes, no)
s
[1] "180 cm"      "70 inches" "180"        "70' "
```

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[1] "180 cm"      "70 inches" "180"        "70' "

str_detect(s, "cm") | str_detect(s, "inches")
[1] TRUE  TRUE FALSE FALSE
```

Regular expressions (regex)

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- For example, the special character `|` means “or”:

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s
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- For example, the special character `|` means “or”:

```
s
[1] "180 cm"      "70 inches" "180"        "70' '"

str_detect(s, "cm|inches")
[1] TRUE  TRUE FALSE FALSE
```

- Note that order does not matter. We can write “`cm|inches`” or “`inches|cm`”

```
s
[1] "180 cm"      "70 inches" "180"        "70' '"

str_detect(s, "inches|cm")
[1] TRUE  TRUE FALSE FALSE
```

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- Here is an example:

```
yes <- c("5", "6", "5'10", "5 feet", "4'11")
no  <- c("", ".", "Five", "six")
s   <- c(yes, no)
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s   <- c(yes, no)
s
[1] "5" "6" "5'10" "5 feet" "4'11" "" "." "Five" "six"

pattern <- "\\d"
str_detect(s, pattern)
[1] TRUE TRUE TRUE TRUE TRUE FALSE FALSE FALSE FALSE
```

Regular expressions (regex)

- The function `str_view` and `str_view_all` allow us to see the matches

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- Here is an example:

```
str_view(s, pattern)
```

5
6
5'10
5 feet
4'11
.
Five
six

```
str_view_all(s, pattern)
```

5
6
5'10
5 feet
4'11
.
Five
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Character classes

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- We define character classes with square brackets
- Here is an example where the pattern matches only if we have a 5 or a 6:

```
str_view(s, "[56]")
```

5

6

5'10

5 feet

4'11

.

Five

six

```
str_view_all(s, "[56]")
```

5

6

5'10

5 feet

4'11

.

Five

six

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- For this, we can use ranges. For example, `[0-9]` is equivalent to `\\d`
- The pattern we want is therefore `[4-7]`:

```
yes <- as.character(4:7)
no  <- as.character(1:3)
s   <- c(yes, no)
s
[1] "4" "5" "6" "7" "1" "2" "3"

str_detect(s, "[4-7]")
[1] TRUE TRUE TRUE TRUE FALSE FALSE FALSE
```

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yes <- as.character(4:7)
no  <- as.character(1:3)
s   <- c(yes, no)
s
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str_detect(s, "[4-7]")
[1] TRUE TRUE TRUE TRUE FALSE FALSE FALSE
```

- However, recall that in *regex* everything is a character
- Hence, 4 is the character “4”, not the number 4

Character classes

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yes <- as.character(4:7)
no  <- as.character(1:3)
s   <- c(yes, no)
s
[1] "4" "5" "6" "7" "1" "2" "3"

str_detect(s, "[4-7]")
[1] TRUE TRUE TRUE TRUE FALSE FALSE FALSE
```

- However, recall that in *regex* everything is a character
- Hence, 4 is the character “4”, not the number 4
- This is a common mistake and you have be wary of it

Anchors

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Anchors

- Now suppose you want to find patterns with exactly one digit
- For this, we can use *anchors*, which let us define patterns that start and end at a specific place
- The most commonly used anchors are ^ and \$ which represent the beginning and end of a string, respectively
- Therefore, the pattern `^\d$` reads as “start of the string followed by one digit followed by the end of the string”

Anchors

```
yes <- c("1", "5", "9")
no  <- c("12", "123", " 1", "a4", "b")
s   <- c(yes, no)
s
[1] "1"    "5"    "9"    "12"   "123"  " 1"   "a4"   "b"

pattern <- "^\\d$"
str_view_all(s, pattern)
```

1

5

9

12

123

1

a4

b

Quantifiers

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- To do this, we follow the pattern with curly brackets, {}, containing the number of times the previous entry can be repeated

Quantifiers

- Here is an example:

```
yes <- c("1", "5", "9", "12")
no  <- c("123", " 1", "a4", "b")
s   <- c(yes, no)
s
[1] "1"    "5"    "9"    "12"   "123"  "a4"   "b"

pattern <- "^\\d{1,2}$"
str_view_all(s, pattern)
```

1

5

9

12

123

a4

b

Other special characters

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- `\\s` : white space
- `*` : zero or more instances of the previous character
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- `+` : one more instances of the previous character
- `[^]` : this specifies patterns we do **NOT** want to detect

Groups

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- You want to fix that

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- Suppose that you have height data that was self reported by a group of people, and that some of them incorrectly typed, for example, 5,6 instead of 5'6
- You want to fix that
- Here is an example

```
yes <- c("5,9", "5,11", "6,", "6,1")
no  <- c("5'9", " ", "2,8", "6.1.1")
s   <- c(yes, no)
s
[1] "5,9"    "5,11"   "6,"     "6,1"    "5'9"    " ",     "2,8"    "6.1.1"

pattern_without_groups <- "[4-7],\\d*$"
pattern_with_groups    <- "([4-7]),(\\d*)$"
```

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- These groups are defined by the addition of parenthesis, `()`, to the *regex*
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yes <- c("5,9", "5,11", "6,", "6,1")
no  <- c("5'9", " ", "2,8", "6.1.1")
s   <- c(yes, no)
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[1] "5,9"    "5,11"   "6,"     "6,1"    "5'9"    " "      "2,8"    "6.1.1"

pattern_without_groups <- "[4-7],\\d*$"
pattern_with_groups    <- "([4-7]),(\\d*)$"
```

- Who wants to guess what these two patterns do?

Groups

```
s
[1] "5,9"    "5,11"   "6,"     "6,1"    "5'9"    ", "     "2,8"    "6.1.1"

str_detect(s, pattern_without_groups)
[1] TRUE TRUE TRUE TRUE FALSE FALSE FALSE FALSE

str_detect(s, pattern_with_groups)
[1] TRUE TRUE TRUE TRUE FALSE FALSE FALSE FALSE
```

Groups

```
s
[1] "5,9"    "5,11"   "6,"     "6,1"    "5'9"    ", "     "2,8"    "6.1.1"

str_detect(s, pattern_without_groups)
[1] TRUE TRUE TRUE TRUE FALSE FALSE FALSE FALSE

str_detect(s, pattern_with_groups)
[1] TRUE TRUE TRUE TRUE FALSE FALSE FALSE FALSE
```

- Both patterns detect the same thing!

Groups

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s
[1] "5,9"    "5,11"   "6,"     "6,1"    "5'9"    ",,"     "2,8"    "6.1.1"

str_detect(s, pattern_without_groups)
[1] TRUE TRUE TRUE TRUE FALSE FALSE FALSE FALSE

str_detect(s, pattern_with_groups)
[1] TRUE TRUE TRUE TRUE FALSE FALSE FALSE FALSE
```

- Both patterns detect the same thing!
- However, when we use groups, we can use the `str_match` to extract the values defined by these groups

Groups

```
s
[1] "5,9"    "5,11"   "6,"     "6,1"    "5'9"    ", "     "2,8"    "6.1.1"

str_match(s, pattern_with_groups)
```

	V1	V2	V3
1	5,9	5	9
2	5,11	5	11
3	6,	6	
4	6,1	6	1
5	NA	NA	NA
6	NA	NA	NA
7	NA	NA	NA
8	NA	NA	NA

References

1. Introduction to Data Science: Data analysis and prediction algorithms with R by Rafael A. Irizarry, Chapter 24. <https://rafalab.github.io/dsbook/>
2. R for Data Science by Grolemund & Wickham, Chapter 14. <https://r4ds.had.co.nz/index.html>

Referencias en español:

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2. R para Ciencia de Datos por Grolemund & Wickham, Capítulo 14. <https://es.r4ds.hadley.nz>

Your turn!

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