CSSS508, Lecture 8

Strings

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(based on slides from Chuck Lanfear)

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UW CS&SS

Reminders

- Homework 7 is due at *midnight* tonight!
- Lab on Tuesday will review previous homeworks!
- *No assignment next week* due to Thanksgiving!!

Mid-Quarter Feedback

Thank you very much for your feedback! Here are some findings:

- Students generally preferred the current course structure.
- There were generally positive feelings towards the lectures, balance between material/activities, and usefulness of homework/peer review.
- Many students provided helpful suggestions for change:
  - Workload: 2 credit course instead of 1? (*let's discuss!*)
  - Homework: Many thought the homework was too challenging (*I will be sure to include more questions to build up the basic skills, as well as some challenge questions*)
  - Lectures: Many thought the lectures cover too much material (*I agree! This course actually covers much less than previous iterations, but with more activities. I will work to make the course content more manageable, without removing the key info!*)

If you have any additional thoughts, let's chat!!

Topics

Last time, we learned about,

1. Aside: Visualizing the Goal
2. Building blocks of functions
3. Simple functions
4. Using functions with `apply()`

Today, we will cover,

1. Basics of Strings
2. Strings in Base R
3. Strings in `stringr` (Tidyverse)

1. Basics of Strings

Basics of Strings

- A general programming term for a unit of character data is a **string**
  - Strings are a *sequence of characters*
  - In R, "strings" and "character data" are mostly interchangeable.
  - Some languages have more precise distinctions, but we won't worry about that here!
- We can create strings by surrounding text, numbers, spaces, or symbols with quotes!
  - Examples: `"Hello! My name is Michael"` or `"%*$#01234"`

Basics of Strings

R can treat strings in funny ways!

```
"01" == "1"
```

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

```
"01" == 1
```

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

```
"1" == 1
```

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

Reminder: We can check **data types** using the `class()` function!

```
c(class("1"),class(1))
```

```
## [1] "character" "numeric"
```

2. Strings in Base R

- `nchar()`
- `substr()`
- `paste()`

Data: King County Restaurant Inspections!

Today we'll study real data on **food safety inspections in King County**, collected from data.kingcounty.gov.

Note these data are *fairly large*. The following code can be used to download the data directly from my Github page:

```
load(url("https://pearce790.github.io/CSSS508/Lectures/Lecture8/resta
```

Quick Examination of the Data

```
names(restaurants)
```

```
##  [1] "Name"                        "Program_Identifier"
##  [3] "Inspection_Date"             "Description"
##  [5] "Address"                     "City"
##  [7] "Zip_Code"                    "Phone"
##  [9] "Longitude"                   "Latitude"
## [11] "Inspection_Business_Name"    "Inspection_Type"
## [13] "Inspection_Score"            "Inspection_Result"
## [15] "Inspection_Closed_Business" "Violation_Type"
## [17] "Violation_Description"       "Violation_Points"
## [19] "Business_ID"                 "Inspection_Serial_Num"
## [21] "Violation_Record_ID"         "Grade"
## [23] "Date"
```

```
dim(restaurants)
```

```
## [1] 258630     23
```

Quick Examination of the Data

Good Questions to Ask:

- What does each row represent?
- Is the data in long or wide format?
- What are the key variables?
- How are the data stored? (*data type*)

`nchar()`

The `nchar()` function calculates the *number of characters* in a given string.

- `length()` doesn't work with strings!!
- Why not?

```r
nchar("Mike Pearce")
```

```
## [1] 11
```

In our `restaurants` data, let's see how many characters are in each zip code:

```r
length_zip <- nchar(restaurants$Zip_Code)
table(length_zip)
```

```
## length_zip
##      5     10 
## 258629      1
```

`substr()`

The `substr()` function allows us to extract characters from a string.

For example, we can extract the third through fifth elements of a string as follows:

```r
substr("98126",3,5)
```

```
## [1] "126"
```

`substr()`

Let's extract the first five chararacters from each zip code in the restaurants data, and add it to our dataset.

```
library(dplyr)
restaurants <- restaurants %>%
    mutate(ZIP_5 = substr(Zip_Code, 1, 5))
restaurants %>% distinct(ZIP_5) %>% head()
```

```
## # A tibble: 6 × 1
##   ZIP_5
##   <chr>
## 1 98126
## 2 98109
## 3 98101
## 4 98032
## 5 98102
## 6 98004
```

`paste()`

We combine strings together using `paste()`. By default, it puts a space between different strings.

For example, we can combine `"Michael"` and `"Pearce"` as follows:

```r
paste("Michael","Pearce")
```

```
## [1] "Michael Pearce"
```

More complex `paste()` commands

There are two additional common arguments to use with `paste()`:

1. `sep=` controls what separates vectors, entry-wise
2. `collapse=` controls if/how multiple outputs are collapsed into a single string.

```r
paste("CSSS","508",sep= "_")
```

```
## [1] "CSSS_508"
```

```r
paste(c("CSSS","STAT"),"508",sep= "_")
```

```
## [1] "CSSS_508" "STAT_508"
```

```r
paste(c("CSSS","STAT"),"508",sep= "_",collapse=" , ")
```

```
## [1] "CSSS_508 , STAT_508"
```

When do we get one string as output vs. two?

paste()

Let's use paste() to create complete mailing addresses for each restaurant:

```r
restaurants <- restaurants %>%
    mutate(mailing_address =
           paste(Address, ", ", City, ", WA ", ZIP_5, sep = ""))
restaurants %>% distinct(mailing_address) %>% head()
```

```
## # A tibble: 6 × 1
##   mailing_address
##   <chr>
## 1 2920 SW AVALON WAY, Seattle, WA 98126
## 2 10 MERCER ST, Seattle, WA 98109
## 3 1001 FAIRVIEW AVE N Unit 1700A, SEATTLE, WA 98109
## 4 1225 1ST AVE, SEATTLE, WA 98101
## 5 18114 E VALLEY HWY, KENT, WA 98032
## 6 121 11TH AVE E, SEATTLE, WA 98102
```

Activity

The variable `Inspection_Date` is in the format "MM/DD/YYYY". In this question, we'll change the format using functions for strings.

1. How long is each character string in this variable?
2. Use `substr()` to extract the month of each entry and save it to an object called "months"
3. Use `substr()` to extract the year of each entry and save it to an object called "years"
4. Use `paste()` to combine each month and year, separated by an underscore (`_`). Save this as a new variable in the data called "Inspection_Date_Formatted"

Activity: My Answers

The variable `Inspection_Date` is in the format "MM/DD/YYYY". In this question, we'll change the format using functions for strings.

1.How long is each character string in this variable?

```r
table(nchar(restaurants$Inspection_Date))
```

```
## 
##     10 
## 258000
```

2.Use `substr()` to extract the month of each entry and save it to an object called "months"

3.Use `substr()` to extract the year of each entry and save it to an object called "years"

```r
months <- substr(restaurants$Inspection_Date,1,2)
years <- substr(restaurants$Inspection_Date,7,10)
```

Activity: My Answers

4.Use `paste()` to combine each month and year, separated by an underscore (`_`). Save this as a new variable in the data called "Inspection_Date_Formatted"

```
restaurants <- restaurants %>%
  mutate("Inspection_Date_Formatted"=paste(months,years,sep="_"))
restaurants %>%
  select(Inspection_Date,Inspection_Date_Formatted) %>%
  head(5)
```

```
## # A tibble: 5 × 2
##   Inspection_Date Inspection_Date_Formatted
##   <chr>           <chr>
## 1 <NA>            NA_NA
## 2 01/24/2017      01_2017
## 3 01/24/2017      01_2017
## 4 01/24/2017      01_2017
## 5 10/10/2016      10_2016
```

3. Strings in `stringr`

- `str_length()`
- `str_sub()`
- `str_c()`
- `str_to_upper()`, `str_to_lower()`, and `str_to_title()`
- `str_trim()`
- `str_detect()`
- `str_replace()`

`stringr`

`stringr` is yet another R package from the Tidyverse (like `ggplot2`, `dplyr`, `tidyr`, `lubridate`, `readr`).

It provides TONS of functions for working with strings:

- Some are equivalent/better versions of Base R functions
- Some can do *fancier* tricks with strings

Most `stringr` functions begin with "`str_`" to make RStudio auto-complete more useful.

We'll cover the basics today, but know there's much more out there!

```r
library(stringr)
```

Equivalencies: `str_length()`

`str_length()` is equivalent to `nchar()`:

```r
nchar("weasels")
```

```
## [1] 7
```

```r
str_length("weasels")
```

```
## [1] 7
```

Equivalencies: `str_sub()`

`str_sub()` is like `substr()`:

```r
str_sub("Washington", 2,4)
```

```
## [1] "ash"
```

`str_sub()` also lets you put in negative values to count backwards from the end (-1 is the end, -3 is third from end):

```r
str_sub("Washington", 4, -3)
```

```
## [1] "hingt"
```

Equivalencies: `str_c()`

`str_c()` ("string combine") is just like `paste()` but where the default is `sep = ""` (no space!)

```r
str_c(c("CSSS","STAT"),508)
```

```
## [1] "CSSS508" "STAT508"
```

```r
str_c(c("CSSS","STAT"),508,sep=" ")
```

```
## [1] "CSSS 508" "STAT 508"
```

```r
str_c(c("CSSS","STAT"),508,sep = " ",collapse = ", ")
```

```
## [1] "CSSS 508, STAT 508"
```

Changing Cases

`str_to_upper()`, `str_to_lower()`, `str_to_title()` convert cases, which is often a good idea to do before searching for values:

```
unique_cities <- unique(restaurants$City)
unique_cities %>% head()
```

```
## [1] "Seattle"  "SEATTLE"  "KENT"      "BELLEVUE" "KENMORE"  "Issaquah"
```

```
str_to_upper(unique_cities) %>% head()
```

```
## [1] "SEATTLE"  "SEATTLE"  "KENT"      "BELLEVUE" "KENMORE"  "ISSAQUAH"
```

```
str_to_lower(unique_cities) %>% head()
```

```
## [1] "seattle"  "seattle"  "kent"      "bellevue" "kenmore"  "issaquah"
```

```
str_to_title(unique_cities) %>% head()
```

```
## [1] "Seattle"  "Seattle"  "Kent"      "Bellevue" "Kenmore"  "Issaquah"
```

Whitespace: `str_trim()`

Extra leading or trailing whitespace is common in text data:

```
unique_names <- unique(restaurants$Name)
unique_names %>% head(3)
```

```
## [1] "@ THE SHACK, LLC "    "10 MERCER RESTAURANT"
## [3] "100 LB CLAM"
```

We can remove the whitespace using `str_trim()`:

```
str_trim(unique_names) %>% head(3)
```

```
## [1] "@ THE SHACK, LLC"     "10 MERCER RESTAURANT"
## [3] "100 LB CLAM"
```

Patterns!

It's common to want to see if a string satisfies a certain *pattern*.

We did this with numeric values earlier in this course!

```
cars %>% filter(speed < 5 | speed > 24)
```

```
##   speed dist
## 1     4    2
## 2     4   10
## 3    25   85
```

```
cars %>% filter(dist > 2 & dist <= 10)
```

```
##   speed dist
## 1     4   10
## 2     7    4
## 3     9   10
```

Patterns: `str_detect()`

We can do similar pattern-checking using `str_detect()`:

```
str_detect(string,pattern)
```

- `string` is the character string (or vector of strings) we want to examine
- `pattern` is the pattern that we're checking for inside `string`
- Output: TRUE/FALSE vector indicating if pattern was found

```
str_detect(string = c("Hello","my name","is Michael"),
           pattern = "m")
```

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

```
str_detect(string = c("Hello","my name","is Michael"),
           pattern = "M")
```

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

Results are case-sensitive!!

Patterns: `str_detect()`

We can test for more complex patterns using "|" and "&":

```
str_detect(string = c("Hello","my name","is Michael"),
           pattern = "m|M")
```

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

```
str_detect(string = c("Hello","my name","is Michael"),
           pattern = "m&M")
```

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

Note: Using "|" and "&" inside the pattern creates a **regular expression**. This is a fancy technique that we won't go into any more depth on. Still, it's helpful to know that there are more tools out there if you want to learn. Check out the links on our course website!

Patterns: `str_detect()`

Let's see which phone numbers are in the 206 area code:

```r
unique_phones <- unique(restaurants$Phone)
unique_phones %>% tail(4)
```

```
## [1] "(360) 698-0417" "(206) 525-7747" "(206) 390-9205"
## [4] "(425) 557-4474"
```

```r
str_detect(unique_phones,"206") %>% tail(4)
```

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

Replacement: `str_replace()`

What about if you want to replace a string with something else? Use `str_replace()`!

This function works very similarly to `str_detect()`, but with one extra argument:

```
str_replace(string, pattern, replacement)
```

- `replacement` is what `pattern` is substituted for.

```
str_replace(string="Hi, I'm Michael",
            pattern="Hi",replacement="Hello")
```

```
## [1] "Hello, I'm Michael"
```

Replacement: `str_replace()`

In the `Date` variable, let's replace each dash ("-") with an underscore ("_")

```r
dates <- restaurants$Date
dates %>% tail(3)
```

```
## [1] "2017-03-21" "2017-03-21" "2016-10-10"
```

```r
str_replace(dates,"-","_") %>% tail(3)
```

```
## [1] "2017_03-21" "2017_03-21" "2016_10-10"
```

Wait, what?

Replacement: `str_replace_all()`

`str_replace()` only changes the **first** instance of a pattern in each string!

If we want to replace **all** patterns, use `str_replace_all()`

```
dates <- restaurants$Date
dates %>% tail(3)
```

```
## [1] "2017-03-21" "2017-03-21" "2016-10-10"
```

```
str_replace_all(dates,"-","_") %>% tail(3)
```

```
## [1] "2017_03_21" "2017_03_21" "2016_10_10"
```

Quick Summary

We've seen lots of functions today!

Don't try to memorize them! Instead, use this page as a reference.

- Character Length: `nchar` and `str_length`
- Subsetting: `substr` and `str_sub`
- Combining: `paste` and `str_c`
- Case Changes: `str_to_upper()`, `str_to_lower()`, and `str_to_title()`
- Removing Whitespace: `str_trim`
- Pattern Detection/Replacement: `str_detect()` and `str_replace()`

Activity: Exploratory Analyses

Let's examine the coffee shops of King County!

1. Filter your data to only include rows in which the `Name` includes the word "coffee" (in any case!)
2. Create a new variable in your data which includes the length of the business name, after removing beginning/trailing whitespace.
3. Create a new variable in your data for the inspection year, *using a `stringr` function!*
4. Create side-by-side boxplots for the length of business name vs. year.
5. Calculate the maximum `Inspection_Score` by business and year.
6. Create a plot (you chose precisely what plot) using the variables Year, Maximum Score, and Business. Get creative!

Activity: My Solutions

1. Filter your data to only include rows in which the `Name` includes the word "coffee" (in any case!)

```
coffee <- restaurants
coffee$Name <- str_to_lower(coffee$Name)
coffee <- coffee %>% filter(str_detect(Name,"coffee"))
```

Activity: My Solutions

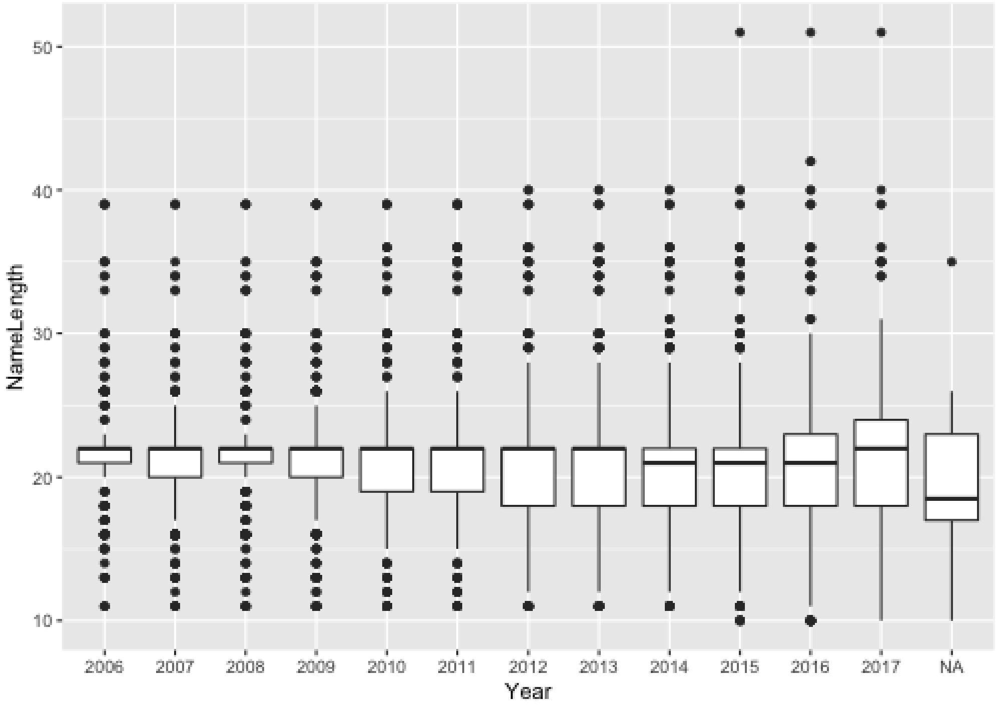
2.Create a new variable in your data which includes the length of the business name, after removing beginning/trailing whitespace.

```
coffee$NameLength <- str_length(str_trim(coffee$Name))
coffee$Year <- str_sub(coffee$Inspection_Date,-4,-1)
```

Activity: My Solutions

3.Create a new variable in your data for the inspection year.

```
library(ggplot2)
ggplot(coffee,aes(Year,NameLength))+geom_boxplot()
```



Activity: My Solutions

4.Calculate the maximum `Inspection_Score` by business and year.

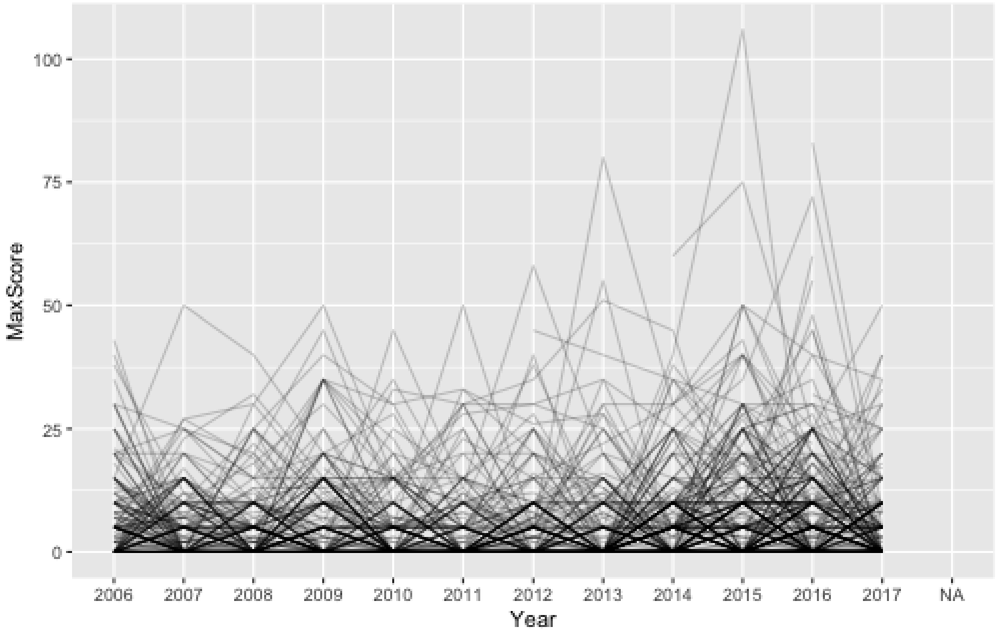
```
coffee_summary <- coffee %>% group_by(Name,Year) %>%
  summarize(MaxScore=max(Inspection_Score))
```

```
## `summarise()` has grouped output by 'Name'. You can override using
## the `.groups` argument.
```

Activity: My Solutions

5.Create a plot (you chose precisely what plot) using the variables Year, Maximum Score, and Business.

```
ggplot(coffee_summary,aes(Year,MaxScore,group=Name))+
  geom_line(alpha=.2)
```



Coming Up

- Remember: No homework due next week, and no lecture on Thanksgiving!
- Homework 7 is due tonight!
- Lab on Tuesday will be a review of past homework!
- Have a wonderful and restful Thanksgiving!!