Stat 243, Fall 2016, Manipulating Strings

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Strings Manipulation

The purpose of this lab is to work with regular expressions and string manipulations in R. The packages required to complete the work are: `"XML"`, `"stringr"`, and `"ggplot2"`.

```
library(XML)
library(stringr)
library(ggplot2)
```

Data

You will be working with the data set for the *Men's high jump world record progression*, available in wikipedia:

https://en.wikipedia.org/wiki/Men%27s_high_jump_world_record_progression

Height	Athlete	Venue	Date
2.00 m (6 ft 6¾ in)	George Horine (USA)	Palo Alto, California	18 May 1912[1]
2.022 m (6 ft 7⅝ in)	Edward Beeson (USA)	Berkeley, California	2 May 1914[3]
2.038 m (6 ft 8¼ in)	Harold Osborn (USA)	Urbana, Illinois	27 May 1924[4]
2.04 m (6 ft 8⅜ in)	Walter Marty (USA)	Fresno, California	13 May 1933[1]
2.06 m (6 ft 9⅛ in)	Walter Marty (USA)	Palo Alto, California	28 April 1934[1]
2.07 m (6 ft 9½ in)	Cornelius Johnson (USA)	New York	12 July 1936[1]
2.07 m (6 ft 9½ in)	Dave Albritton (USA)	New York	12 July 1936[1]

Figure 1: screenshot of the html table

Let's start by downloading the html file of the wikipedia page. To do this, we will use the function `paste0()` to assemble the address of the webpage. We can create a base url `wiki`, and then a separate string with the part that has to do with the Men's high jump work record:

```
# Download a copy of the HTML file,
wiki = "https://en.wikipedia.org/wiki/"
mens_high_jump = "Men%27s_high_jump_world_record_progression"

wiki_mhj = paste0(wiki, mens_high_jump)
```

```
download.file(wiki_mhj, "mens-high-jump.html")
```

Once you've downloaded the html content in the file `mens-high-jump.html`, you can use the function `readHTMLTable()` (from "XML") to read the tables:

```
# read in tables with readHTMLTable()
tbls <- readHTMLTable("mens-high-jump.html")

# how many html tables?
length(tbls)
```

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

```
# dimension of tables?
lapply(tbls, dim)
```

```
## $`NULL`
## [1] 40  4
##
## $`NULL`
## [1] 6 2
```

As ou can tell, `tbls` contains two HTML tables. Inspecting their dimensions, you should see that it is the first table the one that we are interested in. So let's re-read just the first table, and tell R to not convert strings as factors:

```
# the first table is the good one
dat <- readHTMLTable("mens-high-jump.html",
                     which = 1,
                     stringsAsFactors = FALSE)
```

Data Cleaning

The main goal is to clean the downloaded data frame in order to produce another data frame with columns:

- `height` (in meters)
- `name` (name of athlete)
- `first_name` (first name of athlete)
- `last_name` (last name of athlete)
- `country` (country abbreviation)
- `date` (in format `"%d %B %Y"`)
- `day` (number of day)
- `month` (abbreviated name, e.g. `Jan`, `Apr`, `Dec`)
- `year` (number of year)

Regex

Here's a table with some of the common regex patterns:

Pattern	Description
`abc`	letters
`123`	digits
`.`	any chracter
`\\.`	period
`[abd]`	only a, b, or c
`[^abc]`	not a, b, nor c
`[a-z]`	characters a to z
`[0-9]`	numbers 0 to 9
`{m}`	m repetitions
`{m,n}`	m to n repetitions
`*`	zero or more repetitions
`+`	one or more repetitions
`?`	optional character
`\\d`	any digit
`\\D`	any Non-digit
`\\w`	any alphanumeric character
`\\W`	any non-alphanumeric character
`\\s`	any whitespace
`\\S`	any Non-whitespace
`^a`	starts with a
`b$`	ends with b

Extracting meters

The column `Height` contains a character string with the record expressed both in meters and feet-inches. We want to extract only the value associated to meters.

My suggestion is to always start small. In this case, we can get a subset of values on which we can play:

```
tmp <- head(dat$Height)
tmp
```

```
## [1] "2.00 m (6 ft 6 ¾ in)"  "2.022 m (6 ft 7 5/8 in)"
## [3] "2.038 m (6 ft 8 ¼ in)" "2.04 m (6 ft 8 3/8 in)"
## [5] "2.06 m (6 ft 9 1/8 in)"  "2.07 m (6 ft 9 ½ in)"
```

With the values in `tmp`, let's try to match the value of meters.

Meters: Option 1. One possibility is to use `str_split()` to **split** the vector using `"m"` as the pattern to separate the values.

```
str_split(tmp, "m")
```

```
## [[1]]
## [1] "2.00 "            " (6 ft 6 ¾ in)"
##
## [[2]]
## [1] "2.022 "           " (6 ft 7 5/8 in)"
##
## [[3]]
## [1] "2.038 "           " (6 ft 8 ¼ in)"
##
## [[4]]
## [1] "2.04 "            " (6 ft 8 3/8 in)"
##
## [[5]]
## [1] "2.06 "            " (6 ft 9 1/8 in)"
##
## [[6]]
## [1] "2.07 "            " (6 ft 9 ½ in)"
```

The output is a list in which each element has two values: the character numbers of the meters, and the characters inside parenthesis of feet-inches.

Then we can use `sapply()` to loop over the list, and retrieve the first element:

```
tmp_split <- str_split(tmp, "m")
sapply(tmp_split, function(x) x[1])
```

```
## [1] "2.00 "  "2.022 " "2.038 " "2.04 "  "2.06 "  "2.07 "
```

Finally, we need to remove the extra spaces at the end of each string. One option to do this is with `str_trim()`. The last step consists in converting the characters into a numeric vector:

```
tmp_meters <- sapply(tmp_split, function(x) x[1])
str_trim(tmp_meters)
```

```
## [1] "2.00"  "2.022" "2.038" "2.04"  "2.06"  "2.07"
```

```
# and
as.numeric(str_trim(tmp_meters))
```

```
## [1] 2.000 2.022 2.038 2.040 2.060 2.070
```

Meters: Option 2. Another alternative to extract the height value of meters, is to use a regular expression that matches those values. Here is my solution with the pattern `"2\\.[0-9][0-9]+"`:

```r
# height in meters
str_extract(tmp, "2\\.[0-9][0-9]+")
```

```
## [1] "2.00"  "2.022" "2.038" "2.04"  "2.06"  "2.07"
```

The pattern `"2\\.[0-9][0-9]+"` indicates: match a `2`, followed by a dot `\\.`, followed by any number `[0-9]`, followed by one or more occurrances of another number `[0-9]+`.

```r
# numeric vector of height (in meters)
height <- as.numeric(str_extract(dat$Height, "2\\.[0-9][0-9]+"))
```

Extracting Athlete Name

The second task involves extracting the name of the athlete. If you inspect the column `Athlete`, you will see that all its values are formed with the first name, the last name, and the country inside parenthesis:

```r
ath <- head(dat$Athlete)
ath
```

```
## [1] "George Horine (USA)"     "Edward Beeson (USA)"
## [3] "Harold Osborn (USA)"     "Walter Marty (USA)"
## [5] "Walter Marty (USA)"      "Cornelius Johnson (USA)"
```

Work with the sample vector `ath` and try to `str_extract()` the first name. You can experiment with the *word* pattern `"\\w+"` (i.e. one or more alphanumeric characters):

```r
# your code (for first name)
```

Now use the patterns *word* `"\\w+"` and whitespace `\\s` to attempt extracting the athlete's full name (first and last names):

```r
# your code for the full name
```

How would you extract just the last name?

```r
# your code for the last name
```

Country

Next to the athlete's name we have the athelete's country (inside parentheses). To match parenthesis, you must escape them: `"\\("` and `"\\)"`.

Here's one pattern that matches zero or more characters inside parentheses:

```
str_extract(ath, "\\(.*\\)")
```

```
## [1] "(USA)" "(USA)" "(USA)" "(USA)" "(USA)" "(USA)"
```

To be more specific about the type of characters inside parenthesis, we can use a character class with three upper case letters:

```
str_extract(ath, "\\([A-Z][A-Z][A-Z]\\)")
```

```
## [1] "(USA)" "(USA)" "(USA)" "(USA)" "(USA)" "(USA)"
```

Since the pattern `"[A-Z]"` is repeated three times, we can specify that with a counter:

```
str_extract(ath, "\\([A-Z]{3}\\)")
```

```
## [1] "(USA)" "(USA)" "(USA)" "(USA)" "(USA)" "(USA)"
```

All of the options described above are able to math the country abbreviations, but they also match the parentheses.

Instead of specifying a regex pattern, we can use the function `str_sub()`. This function requires two indices: one for the `start` position, and the other one for the `end` position. For instance, if you want to substring the first three characters in the vector `ath`, simple specify:

```
str_sub(ath, start = 1, end = 3)
```

```
## [1] "Geo" "Edw" "Har" "Wal" "Wal" "Cor"
```

A very nice feature of `str_sub()` is that it allows you to specify negative indices. Here's how to get the last five characters:

```
str_sub(ath, start = -5)
```

```
## [1] "(USA)" "(USA)" "(USA)" "(USA)" "(USA)" "(USA)"
```

Find out how to play with `start` and `end` in order to get just the abbreviated country name (without the parenthesis)

```
# your code to str_sub() country name
```

Date

The date values are in the column `Date`:

```
dts <- head(dat$Date)
dts
```

```
## [1] "18 May 1912[1]"   "2 May 1914[3]"    "27 May 1924[4]"
## [4] "13 May 1933[1]"   "28 April 1934[1]" "12 July 1936[1]"
```

In addition to the date, there is also one or more numbers inside square brackets. To "remove" these brackets we will use `str_replace()` and a pattern that matches the brackets. Keep in mind that brackets are metacharacters; you must escape them if you want to match them: `"\\["` and `"\\]"`.

Let's start with the pattern `"\\[[0-9]\\]"`, that is, an open bracket, followed by a number, followed by a closing bracket:

```
str_replace(dts, "\\[[0-9]\\]", "")
```

```
## [1] "18 May 1912"   "2 May 1914"    "27 May 1924"   "13 May 1933"
## [5] "28 April 1934" "12 July 1936"
```

For the first six elements, the pattern works. But there are some rows that contain more than one number inside brackets:

```
str_replace(dat$Date[10:13], "\\[[0-9]\\]", "")
```

```
## [1] "27 June 1953[5]" "29 June 1956[6]" "13 July 1957"    "30 April 1960"
```

This means that we need to **repeat** the pattern. To do that, we surround the pattern with parenthesis, and we append a `"+"` to indicate one or more occurrances:

```
str_replace(dat$Date[10:13], "(\\[[0-9]\\])+", "")
```

```
## [1] "27 June 1953"  "29 June 1956"  "13 July 1957"  "30 April 1960"
```

```
# vector of dates
dates <- str_replace(dat$Date, "(\\[[0-9]\\])+", "")
```

Your turn: With the `dates` vector, extract in separate vectors the values of day, month name, and year:

```
# your code for days, months, and years
```

Finally, use the function `as.Date()` to format the vector `dates` as a vector of class `"Date"`. Use the format `""%d %B %Y"`:

```
# your code to format dates
```

Clean Data Frame

Assuming that you have created vectors for all the cleaned components, you should be able to create a data frame `high_jump`, for instance:

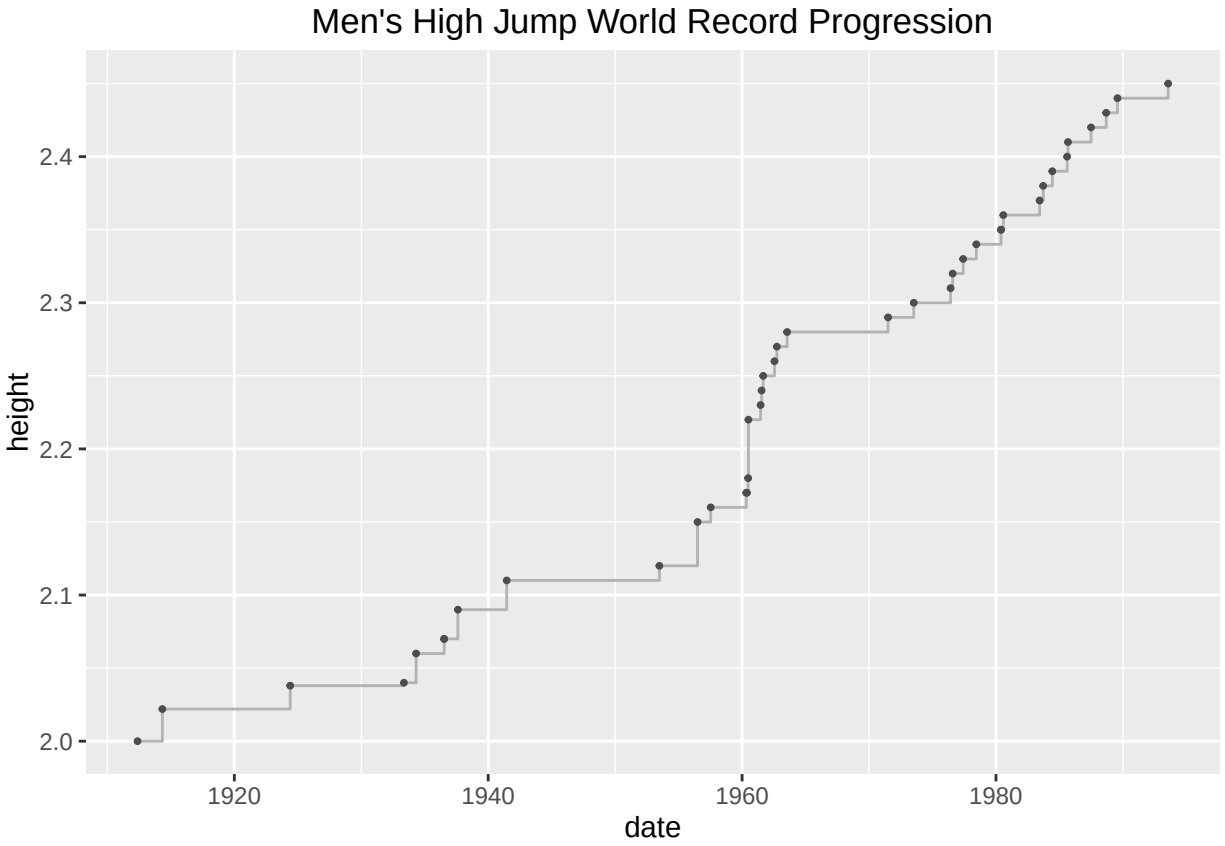
```
# clean data frame
high_jump <- data.frame(
  height = height,
  first_name = first_name,
  last_name = last_name,
  country = country,
  date = dates,
  day = day,
  month = month,
  year = year
)
```

```
##   height first_name last_name country       date day month year
## 1  2.000     George    Horine     USA 1912-05-18  18   May 1912
## 2  2.022     Edward    Beeson     USA 1914-05-02   2   May 1914
## 3  2.038     Harold    Osborn     USA 1924-05-27  27   May 1924
## 4  2.040     Walter     Marty     USA 1933-05-13  13   May 1933
## 5  2.060     Walter     Marty     USA 1934-04-28  28   Apr 1934
## 6  2.070  Cornelius   Johnson     USA 1936-07-12  12   Jul 1936
```

Plot of record progression

With the data frame `high_jump`, we can use the package `"ggplot2"` to plot a step-line chart that shows the progression over time:

```
ggplot(data = high_jump, aes(x = date, y = height)) +
  geom_step(color = "gray70") +
  geom_point(size = 0.7, color = "gray30") +
  ggtitle("Men's High Jump World Record Progression")
```



Use the column `country` as an *aesthetic* attribute to colored the points with ggplot.

```
# your code to add color of points based on 'country'
```

Exporting Clean Data

Use one of the writing table functions (e.g. `read.table()`) to export the data frame `high_jump` in an external file (e.g. CSV file)

```
# your code to save high_jump in a field-separated format file
```

Solutions at the end of this document

Solutions

```
# numeric vector of height (in meters)
height <- as.numeric(str_extract(dat$Height, "2\\.[0-9][0-9]+"))

# all athlete names are in the form "First Last"
# we can extract them using the word "\\w"
first_last = str_extract(dat$Athlete, "\\w+\\s\\w+")

# athlete first name
first_name = str_extract(first_last, "^\\w+")

# athlete last name
last_name = str_extract(first_last, "\\w+$")

# country
country = str_sub(dat$Athlete, -4, -2)

# dates
dates <- str_replace(dat$Date, "(\\[[0-9]\\])+", "")

# extracting day
day = as.numeric(str_extract(dates, "^[0-9]+"))

# extracting month
month = str_trim(str_extract(dates, "\\D+"))
month = str_sub(month, 1, 3)

# extracting year
year = as.numeric(str_extract(dates, "\\d+$"))

# reformat `dates`
dates <- as.Date(dates, "%d %B %Y")
```

```
# clean data frame
high_jump <- data.frame(
  height = height,
  first_name = first_name,
  last_name = last_name,
  country = country,
  date = dates,
  day = day,
  month = month,
  year = year
)
```

```r
# step line with colored points based on country
ggplot(data = high_jump, aes(x = date, y = height)) +
  geom_step(color = "gray70") +
  geom_point(size = 0.8, aes(color = country)) +
  ggtitle("Men's High Jump World Record Progression")
```