Midterm Project

Stat 133, Fall 2016, Prof. Sanchez

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Set Up: Packages and Functions

You will need to use the following packages: `"stringr"`, `"ggplot2"`, `"dplyr"`, and `"readr"`. You can also use any other packages. If you don't have any of the packages installed in your computer, install them first (outside this Rmd).

```
# use this code chunk to load all the packages that you will be using
# (do not include commands to install the packages)

library(stringr)
library(ggplot2)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'

## The following objects are masked from 'package:stats':
##
##     filter, lag

## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(readr)
```

To "import" the functions in your R script file, use the function `source()`

```
# source your functions
source("~/Desktop/STAT 133/stat133-my-repo/midterm_project/stat133-midterm-functions-template.R")
```

Import Raw Data in R

We are assuming that you already downloaded a copy of the CSV files with the raw data (you don't need to show the commands you used for this step):

- `womens-high-jump-raw.csv`
- `mens-high-jump-raw.csv`

Now, use the function `read_csv()` from the package `"readr"` to import the data sets in R.

```
# download.file(
#   url = 'https://raw.githubusercontent.com/ucb-stat133/stat133-fall-2016/master
#   /data/womens-high-jump-raw.csv',
#   destfile = '~/Desktop/STAT 133/stat133-my-repo/midterm_project/
#   womens-high-jump-raw.csv')

# read in womens-high-jump-raw.csv
womens_high_jump_raw = read_csv(
  '~/Desktop/STAT 133/stat133-my-repo/midterm_project/womens-high-jump-raw.csv',
  col_names = TRUE)
```

```
## Parsed with column specification:
## cols(
##   Height = col_character(),
##   Athlete = col_character(),
##   Date = col_character(),
##   Place = col_character()
## )
```

```
# check structure with str()
str(womens_high_jump_raw)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    56 obs. of  4 variables:
##  $ Height : chr  "1.46 m (4 ft 9 1/2 in)" "1.485 m (4 ft 10 1/2 in)" "1.485 m (4 ft 10 1/2 in)" "1.5
##  $ Athlete: chr  "Nancy Voorhees (USA)" "Elizabeth Stine (USA)" "Sophie Eliott-Lynn (GBR)" "Phyllis
##  $ Date   : chr  "20 May 1922" "26 May 1923" "6 August 1923" "11 July 1925" ...
##  $ Place  : chr  "Simsbury[1]" "Leonia[1]" "Brentwood[1]" "London[1]" ...
##  - attr(*, "spec")=List of 2
##   ..$ cols   :List of 4
##   .. ..$ Height : list()
##   .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
##   .. ..$ Athlete: list()
##   .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
##   .. ..$ Date   : list()
##   .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
##   .. ..$ Place  : list()
##   .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
##   ..$ default: list()
##   .. ..- attr(*, "class")= chr  "collector_guess" "collector"
##   ..- attr(*, "class")= chr "col_spec"
```

```
# download.file(
#   url = 'https://raw.githubusercontent.com/ucb-stat133/stat133-fall-2016/
#   master/data/mens-high-jump-raw.csv',
#   destfile = '~/Desktop/STAT 133/stat133-my-repo/midterm_project/
#   mens-high-jump-raw.csv')

# read in mens-high-jump-raw.csv
mens_high_jump_raw = read_csv(
  '~/Desktop/STAT 133/stat133-my-repo/midterm_project/mens-high-jump-raw.csv',
  col_names = TRUE)
```

```
## Parsed with column specification:
## cols(
##   Height = col_character(),
##   Athlete = col_character(),
##   Venue = col_character(),
##   Date = col_character()
## )
```

```
# check structure with str()
str(mens_high_jump_raw)
```

```
## Classes 'tbl_df', 'tbl' and 'data.frame':    40 obs. of  4 variables:
##  $ Height : chr  "2.00 m (6 ft 6 3/4 in)" "2.022 m (6 ft 7 5/8 in)" "2.038 m (6 ft 8 1/4 in)" "2.04 m
##  $ Athlete: chr  "George Horine (USA)" "Edward Beeson (USA)" "Harold Osborn (USA)" "Walter Marty (USA
##  $ Venue  : chr  "Palo Alto, California" "Berkeley, California" "Urbana, Illinois" "Fresno, Californi
##  $ Date   : chr  "18 May 1912[1]" "2 May 1914[3]" "27 May 1924[4]" "13 May 1933[1]" ...
##  - attr(*, "spec")=List of 2
##   ..$ cols   :List of 4
##   .. ..$ Height : list()
##   .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
##   .. ..$ Athlete: list()
##   .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
##   .. ..$ Venue  : list()
##   .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
##   .. ..$ Date   : list()
##   .. .. ..- attr(*, "class")= chr  "collector_character" "collector"
##   ..$ default: list()
##   .. ..- attr(*, "class")= chr  "collector_guess" "collector"
##   ..- attr(*, "class")= chr "col_spec"
```

Cleaning raw data of women's high jump world records

We'll start by cleaning the women's data set.

Column `Height`

To clean the contents of column `Height`, use your function to extract height values to generate a new **numeric** vector `height` with the values of meters:

```
# vector 'height' with numeric values of height in meters
height = extract_height(womens_high_jump_raw$Height)
```

Column `Athlete`

The column `Athlete` contains the name of the athlete, together with the country (inside parenthesis). Use your function to extract the athlete's name to create a new **character** vector `athlete`:

```
# vector 'athlete' with character values of athlete's name
athlete = extract_athlete(womens_high_jump_raw$Athlete)
```

Likewise, use your function to extract the country names to create a new **character** vector `country` that contains the initials of the countries:

```
# character vector 'country' with country abbreviations
country = extract_country(womens_high_jump_raw$Athlete)
```

Column `Date`

The column `Date` contains the dates when the records were established. From this column you have to create three new vectors: `day`, `month`, and `year`.

- Use your function to extract the day numbers to create a new **numeric** vector `day`:

```
# numeric vector 'day'
day = extract_day(womens_high_jump_raw$Date)
```

- Use your function to extract the month names to create a new **character** vector `month`:

```
# character vector 'month'
month = extract_month(womens_high_jump_raw$Date)
```

- Use your function to extract the year number to create a new **numeric** vector `year`:

```
# numeric vector 'year'
year = extract_year(womens_high_jump_raw$Date)
```

Likewise, use your function to reformat date to create a new vector `new_date` by reformatting the values in column `Date`:

```
# 'new_date' vector of class "Date"
new_date = reformat_date(womens_high_jump_raw$Date)
```

Column `Place`

Use your function to remove brackets—and the content inside them— to create a new character vector `city` from column `Place`:

```
# character vector 'city' with name of city
city = remove_brackets(womens_high_jump_raw$Place)
```

New vector `gender`

Create a **character** vector `gender` filled with `"female"` values, having length equal to the number of rows in the women's data set.

```
# vector 'gender'
gender = rep("female", nrow(womens_high_jump_raw))
```

New data frame `womens`

Use the vectors `height`, `athlete`, `gender`, `country`, `city`, `new_date`, `day`, `month`, and `year` to build a new data frame `womens`. The column corresponding to `new_date` should have name `"date"`. Do NOT convert character strings as factors:

```
# data frame 'womens'
womens = data.frame(
  height = height,
  athlete = athlete,
  gender = gender,
  country = country,
  city = city,
  date = new_date,
  day = day,
  month = month,
  year = year,
  stringsAsFactors = FALSE
)
```

Cleaning raw data of men's high jump world records

In this section you will clean the men's data set.

Column `Height`

To clean the contents of column `Height`, use your function to extract height values to generate a new **numeric** vector `height` with the values of meters:

```
# vector 'height' with numeric values of height in meters
height = extract_height(mens_high_jump_raw$Height)
```

Column `Athlete`

The column `Athlete` contains the name of the athlete, together with the country (inside parenthesis). Use your function to extract the athlete's name to create a new **character** vector `athlete`:

```
# vector 'athlete' with character values of athlete's name
athlete = extract_athlete(mens_high_jump_raw$Athlete)
```

Likewise, use your function to extract the country names to create a new **character** vector `country` that contains the initials of the countries:

```
# character vector 'country' with country abbreviations
country = extract_country(mens_high_jump_raw$Athlete)
```

Column `Venue`

The column `Venue` contains the name of the city where the record was established. As you can tell from the values in this column, some names contain more than just the name of the city (e.g. some include US State, some include name of country). Use your function to extract the name of the city in order to obtain a new **character** vector `city`:

```
# character vector 'city' with name of city
city = extract_city(mens_high_jump_raw$Venue)
```

Column `Date`

The column `Date` contains the dates when the records were established. As you can tell from the values in this column, they also contain extra characters (numbers inside brackets).

Use your function to remove brackets—and the content inside them— to create a new character vector `clean_date`:

```
# vector 'clean_date'
clean_date = remove_brackets(mens_high_jump_raw$Date)
```

Now take `clean_date` to create three new vectors: `day`, `month`, and `year`.

- Use your function to extract the day numbers to create a new **numeric** vector `day`:

```
# numeric vector 'day'
day = extract_day(clean_date)
```

- Use your function to extract the month names to create a new **character** vector `month`:

```
# character vector 'month'
month = extract_month(clean_date)
```

- Use your function to extract the year number to create a new **numeric** vector `year`:

```
# numeric vector 'year'
year = extract_year(clean_date)
```

Likewise, use your function to reformat date to create a new vector `new_date` by reformatting the values in column `Date`:

```
# 'new_date' vector of class "Date"
new_date = reformat_date(clean_date)
```

New vector `gender`

Create a **character** vector `gender` filled with `"male"` values, having length equal to the number of rows in the men's data set.

```
# vector 'gender'
gender = rep("male", nrow(mens_high_jump_raw))
```

New data frame `mens`

Use the vectors `height`, `athlete`, `gender`, `country`, `city`, `new_date`, `day`, `month`, and `year` to build a new data frame `mens`. The column corresponding to `new_date` should have name `"date"`. Do NOT convert character strings as factors:

```
# data frame 'mens'
mens = data.frame(
  height = height,
  athlete = athlete,
  gender = gender,
  country = country,
  city = city,
  date = new_date,
  day = day,
  month = month,
  year = year,
  stringsAsFactors = FALSE
)
```

Data Manipulation

Create a new data frame `records` by merging (or "stacking") the data frames `womens` and `mens`. Only the columns `gender` and `country` should be converted as R factors. Make sure that the column `date` is of class `"Date"`.

```
# new data frame 'records'
records = rbind(womens, mens)
records[,3] = factor(records[,3])
records[,4] = factor(records[,4])
```

Use functions in `"dplyr"` to compute the following frequency tables. Assign each table to its own object.

```
# number of records per country
# object: per_country
per_country = records %>%
  group_by(country) %>%
  summarise(records = n())

# invoke head() on per_country
head(per_country)
```

```
## # A tibble: 6 × 2
##   country records
##    <fctr>   <int>
```

```
## 1     AUT       1
## 2     BUL       5
## 3     CAN       2
## 4     CHN       4
## 5     CUB       3
## 6     FRG       4
```

```
# number of records per country in descending order
# object: per_country_desc
per_country_desc = per_country %>%
  arrange(desc(records))

# invoke head() on per_country_desc
head(per_country_desc)
```

```
## # A tibble: 6 × 2
##   country records
##    <fctr>   <int>
## 1     USA      24
## 2     URS      15
## 3     ROM      14
## 4     GDR       8
## 5     GBR       6
## 6     BUL       5
```

```
# number of records per year in descending order
# object: per_year_desc
per_year_desc = records %>%
  group_by(year) %>%
  summarise(records = n()) %>%
  arrange(desc(records))

# invoke head() on per_year_desc
head(per_year_desc)
```

```
## # A tibble: 6 × 2
##    year records
##   <dbl>   <int>
## 1  1961       7
## 2  1960       6
## 3  1958       5
## 4  1977       5
## 5  1983       5
## 6  1956       4
```

```
# number of records by gender
# object: by_gender
by_gender = records %>%
  group_by(gender) %>%
  summarise(records = n())

# invoke head() on by_gender
head(by_gender)
```

```
## # A tibble: 2 × 2
##   gender records
##   <fctr>   <int>
## 1 female      56
## 2   male      40
```

Here is one more challenge that involves some data wrangling with `year`. The objective is to compute the number of records per decade (regardless of gender):

```
# number of records per decade (1920-1929, 1930-1939, 1940-1949, etc)
# object: per_decade
per_year = records %>%
  group_by(year) %>%
  summarise(records = n()) %>%
  arrange(year)


intervals = seq(from = 1910, to = 2000, by = 10)
decade_records = integer(9)

for (i in 1:length(decade_records)){
  filtered_year = filter(per_year, year >= intervals[i] , year < intervals[i+1])
  filtered_records = filtered_year[,2]
  decade_records[i] = sum(filtered_records)
}

decade_names = c("1910-1919", "1920-1929", "1930-1939","1940-1949","1950-1959",
            "1960-1969","1970-1979","1980-1989","1990-1999")

per_decade = data.frame(
  decade = decade_names,
  records = decade_records,
  stringsAsFactors = FALSE
)
# invoke head() on per_decade
head(per_decade)
```

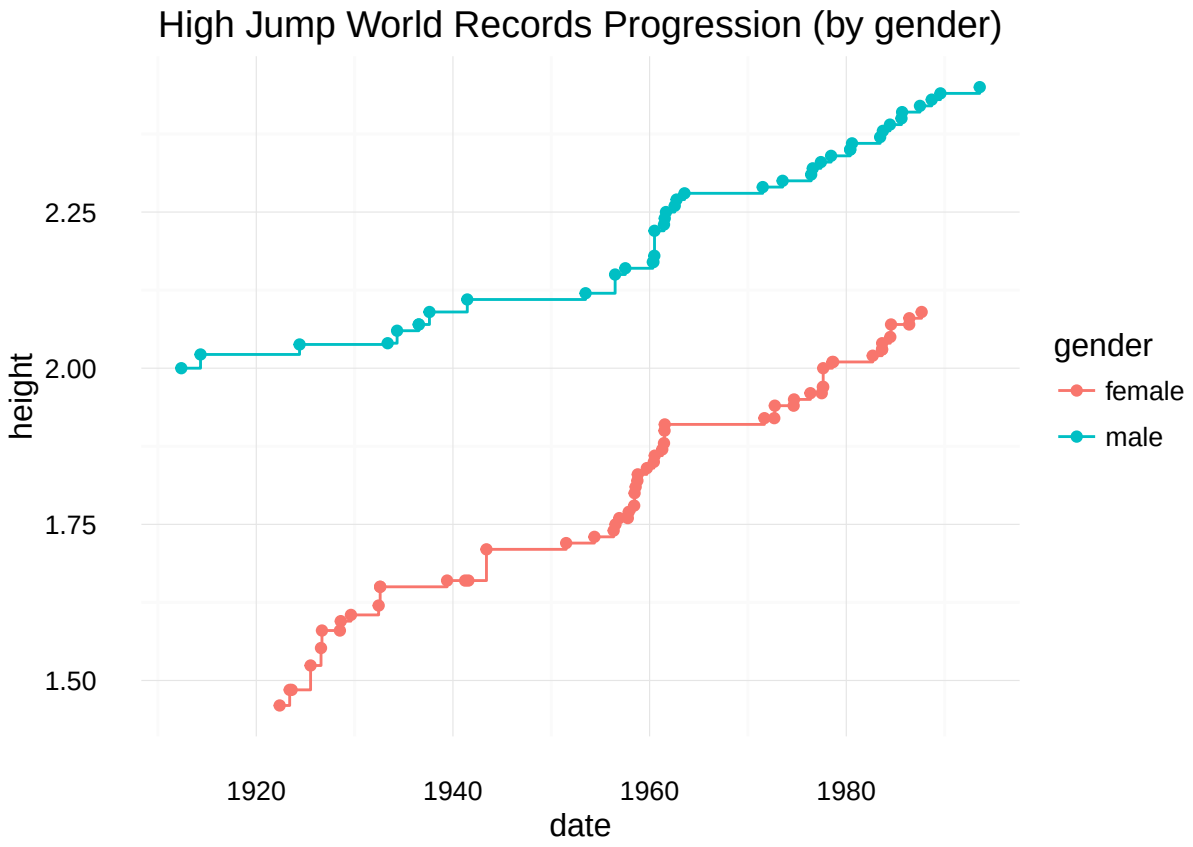
```
##      decade records
## 1 1910-1919       2
## 2 1920-1929      10
## 3 1930-1939       9
## 4 1940-1949       4
## 5 1950-1959      16
## 6 1960-1969      16
```

Data Visualization

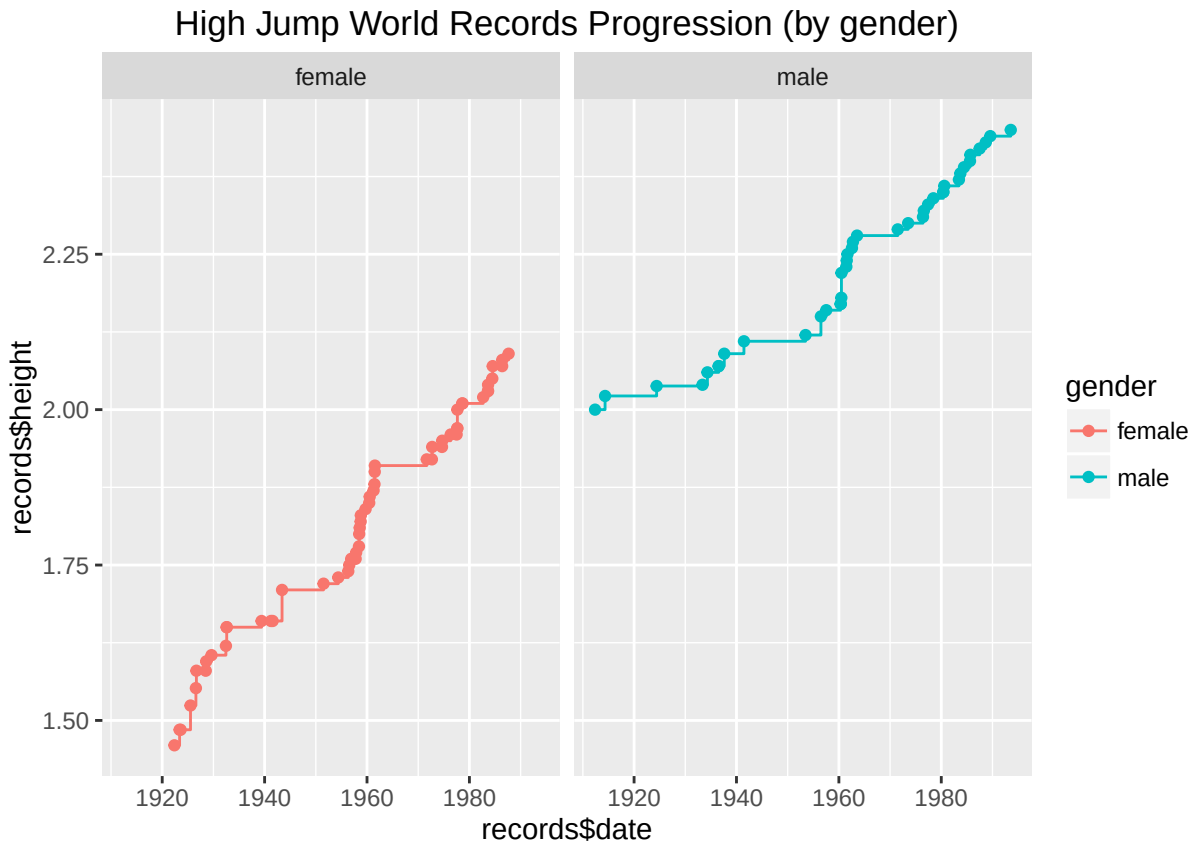
Use the `records` data frame, and functions in `"ggplot2"`, to create charts similar to those displayed in the PDF with the instructions for this project:

- Include a title on all graphics
- Include a description for each graphic

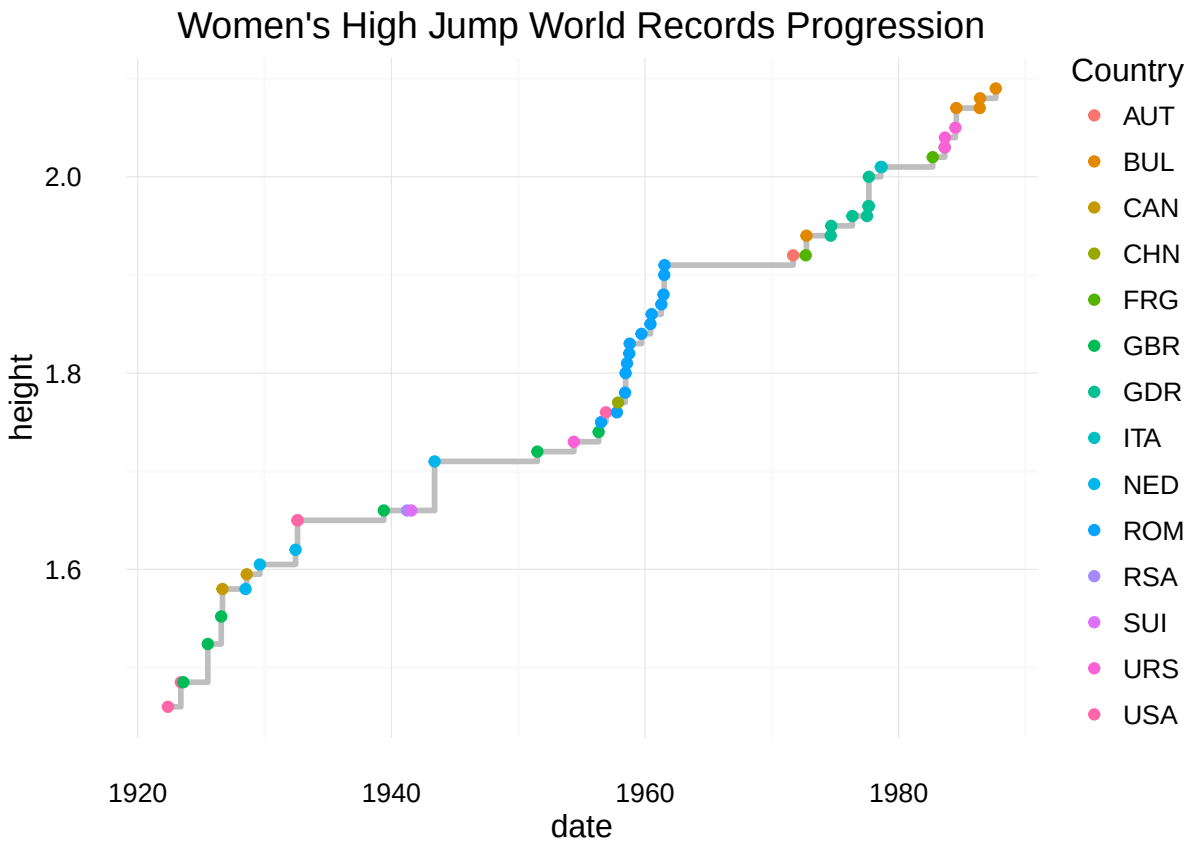
```
# step-line plot, with points, showing the progression of records
# (lines colored by gender)
# (the default ggplot color values are: '#00BFC4', '#F8766D')
date = records$date
height = records$height
gender = records$gender
ggplot(records, aes(x = date, y = height, group = gender)) +
  geom_point(aes(color = gender)) +
  ggtitle("High Jump World Records Progression (by gender)") +
  geom_step(aes(color = gender)) +
  theme_minimal()
```



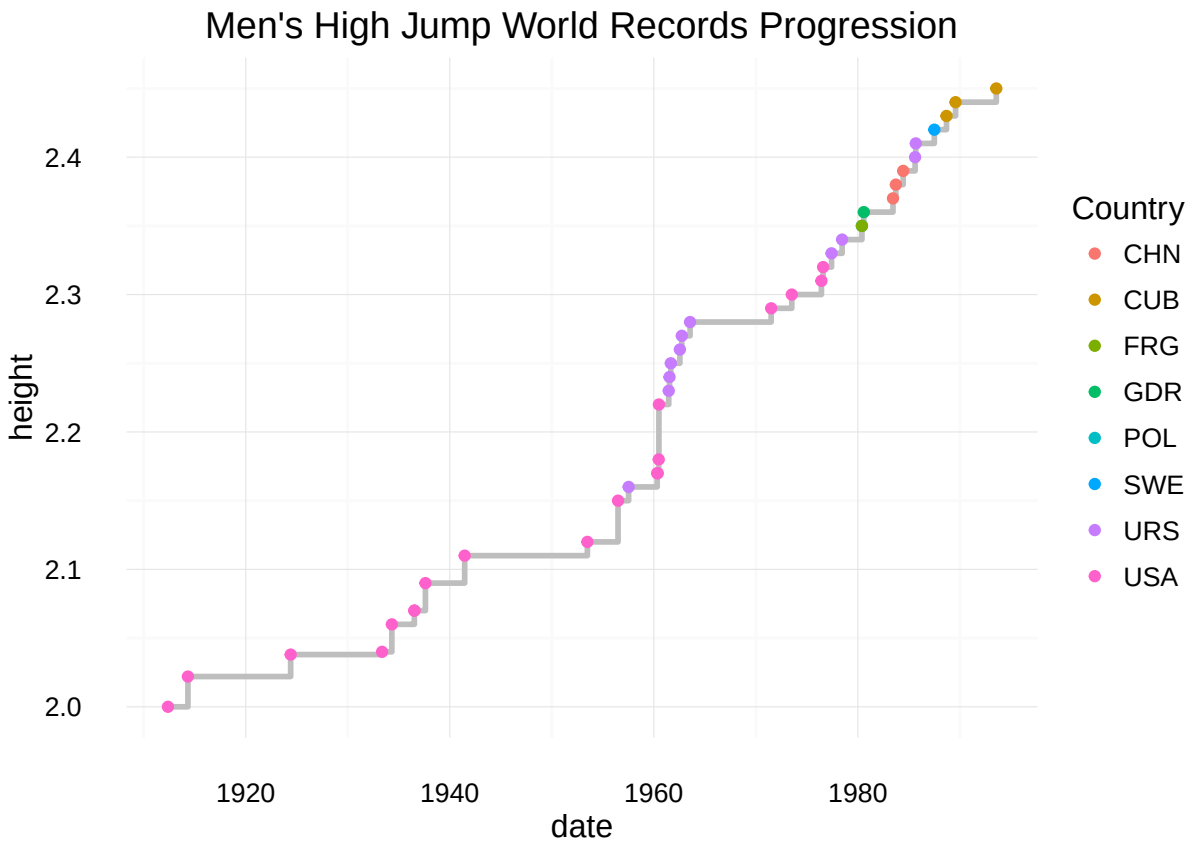

```
# step-line plot, with points, showing the progression of records
# (facetting by gender)
ggplot(records, aes(x = records$date, y = records$height)) +
  geom_point(aes(color = gender)) +
  geom_step(aes(color = gender)) +
  ggtitle("High Jump World Records Progression (by gender)") +
  facet_grid(~ gender)
```




```
# step-line plot, with points, showing the progression of women records
# (points colored by country)
womens = filter(records, gender == "female")
date = womens$date
height = womens$height
Country = womens$country
ggplot(womens, aes(x = date, y = height)) +
  geom_step(color = "gray", size = 1) +
  geom_point(aes(color = Country)) +
  ggtitle("Women's High Jump World Records Progression") +
  theme_minimal()
```




```
# step-line plot, with points, showing the progression of men records
# (points colored by country)
mens = filter(records, gender == "male")
date = mens$date
height = mens$height
Country = mens$country
ggplot(mens, aes(x = date, y = height)) +
  geom_step(color = "gray", size = 1) +
  geom_point(aes(color = Country)) +
  ggtitle("Men's High Jump World Records Progression") +
  theme_minimal()
```



Model Fitting

Now let's do some basic model fitting with a simple regression analysis.

Women's regression model

Subset the data `records` for those observations of gender `female`, and use the function `lm()` to compute a linear model by regressing `height` on `year`:

```
# Model for women
# regression of 'height' on 'year'
women = subset(records, gender == "female")
height = women$height
year = women$year
height_on_year_female = lm(height ~ year, data = women)
```

Use the object `"lm"` object in the previous step to compute a "prediction" of what the women's high jump world record could have been in years: 2000, 2004, 2008, 2012, and 2016.

```
# predictions for olympic years
years_for_prediction = data.frame(
  year = c(2000, 2004, 2008, 2012, 2016))
predict(height_on_year_female, years_for_prediction)
```

```
##        1        2        3        4        5
## 2.179933 2.214314 2.248695 2.283076 2.317457
```

Men's regression model

Subset the data `records` for those observations of gender `male`, and use the function `lm()` to compute a linear model by regressing `height` on `year`:

```
# Model for men
# regression of 'height' on 'year'
men = subset(records, gender == "male")
height = men$height
year = men$year
height_on_year_male = lm(height ~ year, data = men)
```

Use the object `"lm"` object in the previous step to compute a "prediction" of what the men's high jump world record could have been in years: 2000, 2004, 2008, 2012, and 2016.

```
# predictions for olympic years
years_for_prediction = data.frame(
  year = c(2000, 2004, 2008, 2012, 2016))
predict(height_on_year_male, years_for_prediction)
```

```
##        1        2        3        4        5
## 2.472384 2.496710 2.521036 2.545362 2.569688
```

Extra Credit

This part of the project is optional. If you provide a satisfactory solution, you will get extra credit.

Consider the first women's world record which is 1.46 meters. This value corresponds to "4 ft 9 1/2 in". Likewise, a height value of 2.04 meters can be expressed in US customary units as "6 ft 8 3/8 in".

The goal is to write a function that takes a height value (in meters), and which returns a character vector in US customary units. In other words, if you pass the value `1.46` to your function, the output will be the string `"4 ft 9 1/2 in"`.

You should be able to apply your function on the entire vector `height` to get the corresponding strings in US customary units. Your results should match the values in wikipedia's html tables.

Don't write a long function. You can use as many auxiliary short functions as necessary. All the functions must be well documented with a general description for the function's purpose, the arguments, and the output. Include these functions in the same `.R` script file with the other functions (those used to clean the columns of the raw data sets).

Your code should be accompanied with descriptions of how you approached this problem, and the decisions you made to implement it in that way.

```
# Code for testing
```