# Modeling Runners' Times in the Cherry Blossom Race

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## 1 Introduction

The internet is a vast open resource for data, but internet data can be messy and difficult to wrangle. In this case study we collect data on participates of the Cherry Blossom Race from the Cherry Blossom Race website[1]. We find that there are a number of issues present in the data, including inconssitent web addressing formatting, inconsistent formatting, and missing data. We collect and clean this data to provide the Men's and Women's information in a format suitable for analysis.

## 2 Methods

### 2.1 Data

#### 2.1.1 Data Collection

In this case study, we collected data on participants in the Cherry Blossom Race. We scraped the data for Men and Woman from 1999 to 2012. The data was stored under the base address in the following form, where the year is between 1999 and 2012 and page is a specific page name.

`http://www.cherryblossom.org/results/<year>/<page>`

The specific addresses where the data is stored are given in table 1. While the structure follows `results/<year>` consistently, the page naming for each year is not consistent. In some cases, the names for the men's and women's pages are `men` and `women`, repectively. In other cases, a code is used such as `cb99m` and `cb99f` in 1999 for `men` and `women` repectively.

**Table 1. Web Page Pages**

| Year | Men's Pages | Women's Pages |
|---|---|---|
| 1999 | `results/1999/cb99m.html` | `results/1999/cb99f.html` |
| 2000 | `results/2000/Cb003m.htm` | `results/2000/Cb003f.htm` |

[1] See http://www.cherryblossom.org/.

| Year | Men's Pages | Women's Pages |
|---|---|---|
| 2001 | results/2001/oof_m.html | results/2001/oof_f.html |
| 2002 | results/2002/oofm.htm | results/2002/ooff.htm |
| 2003 | results/2003/CB03-M.HTM | results/2003/CB03-F.HTM |
| 2004 | results/2004/men.htm | results/2004/women.htm |
| 2005 | results/2005/CB05-M.htm | results/2005/CB05-F.htm |
| 2006 | results/2006/men.htm | results/2006/women.htm |
| 2007 | results/2007/men.htm | results/2007/women.ht |
| 2008 | results/2008/men.htm | results/2008/women.htm |
| 2009 | results/2009/09cucb-M.htm | results/2009/09cucb-F.htm |
| 2010 | results/2010/2010cucb10m-m.htm | results/2010/2010cucb10m-F.htm |
| 2011 | results/2011/2011cucb10m-m.htm | results/2011/2011cucb10m-F.htm |
| 2012 | results/2012/2012cucb10m-m.htm | results/2012/2012cucb10m-F.htm |

```
library(XML)
ubase = "http://www.cherryblossom.org/"
menURLs =
  c("results/1999/cb99m.html", "results/2000/Cb003m.htm", "results/2001/oof_m.html",
    "results/2002/oofm.htm", "results/2003/CB03-M.HTM",
    "results/2004/men.htm", "results/2005/CB05-M.htm",
    "results/2006/men.htm", "results/2007/men.htm",
    "results/2008/men.htm", "results/2009/09cucb-M.htm",
    "results/2010/2010cucb10m-m.htm",
    "results/2011/2011cucb10m-m.htm",
    "results/2012/2012cucb10m-m.htm")

urls = paste(ubase, menURLs, sep = "")

urls[1:3]
```

```
## [1] "http://www.cherryblossom.org/results/1999/cb99m.html"
## [2] "http://www.cherryblossom.org/results/2000/Cb003m.htm"
## [3] "http://www.cherryblossom.org/results/2001/oof_m.html"
```

```
extractResTable =
  # takes a list of websites from the cherry blossom race
  # a list of years corresponding to the year the result is for
  # and the gender of the participant
  # Retrieve data from web site,
  # find the preformatted text,
  # and write lines or return as a character vector.
  # returns a list of strings corrsponding to lines in the web url
```

```
  function(url = "http://www.cherryblossom.org/results/2009/09cucb-F.htm",
           year = 1999, sex = "male", file = NULL)
  {
    doc = htmlParse(url)

    if (year == 2000) {
      # Get preformatted text from 4th font element
      # The top file is ill formed so the <pre> search doesn't work.
      ff = getNodeSet(doc, "//font")
      txt = xmlValue(ff[[4]])
      els = strsplit(txt, "\r\n")[[1]]
    }
    else if (year == 2009 & sex == "male") {
      # Get preformatted text from <div class="Section1"> element
      # Each line of results is in a <pre> element
      div1 = getNodeSet(doc, "//div[@class='Section1']")
      pres = getNodeSet(div1[[1]], "//pre")
      els = sapply(pres, xmlValue)
      els = gsub("Â", "", els)
    }
    else if (year == 1999) {
      # Get preformatted text from <pre> elements
      pres = getNodeSet(doc, "//pre")
      txt = xmlValue(pres[[1]])
      els = strsplit(txt, "\n")[[1]]
    }
    else {
      # Get preformatted text from <pre> elements
      pres = getNodeSet(doc, "//pre")
      txt = xmlValue(pres[[1]])
      els = strsplit(txt, "\r\n")[[1]]
    }
    if (is.null(file)) return(els)
    # Write the lines as a text file.
    writeLines(els, con = file)
  }


years = 1999:2012
menTables = mapply(extractResTable, url = urls, year = years)
names(menTables) = years
sapply(menTables, length)
```

```
## 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
## 3193 3019 3627 3727 3951 4164 4335 5245 5283 5913 6659 6919 7019 7201
```

```
save(menTables, file = "CBMenTextTables.rda")
```

The data are successfully scraped from the urls that are given and we observe that the number of participants in the Cherry Blossom race has increased steadily from 1999 to 2012. We can use the `extractResTable` function to exptract all of the results, or to specify a single set of results.

```
men_2009<-extractResTable(url = urls[11], year = 2009, sex = 'male')
men_2009[1:10]
```

```
##  [1] " "
##  [2] "                 Credit Union Cherry Blossom Ten Mile Run"
##  [3] "                 Washington, DC     Sunday, April 5, 2009"
##  [4] " "
##  [5] "                           Official Male Results"
##  [6] " "
##  [7] "Place Div  /Tot   Num    Name                    Ag Hometown             Gun Tim Net Tim  Pace
##  [8] "===== =========== ====== ====================== == ==================== ======= =======  =====
##  [9] "    1     1/1420       1 Ridouane Harroufi      27 Morocco                45:56   45:56#  4:36
## [10] "    2     1/62         9 Feyisa Liesa           19 Ethiopia               45:58   45:58#  4:36
```

We observe the formatting of the text data, such as the use of the = character can be used to transform the lines of text into a a matrix. We will use this pattern to identify the boundary between the headering and the body of the data.

```
equals_idx<- grep('^===', men_2009)
equals_idx
```

```
## [1] 8
```

```
equals_idx2<- substr(men_2009, 1,3)
which(equals_idx2 == '===')
```

```
## [1] 8
```

```
spacerRow<- men_2009[equals_idx]
headerRow<- men_2009[equals_idx -1]
body<- men_2009[-(1:equals_idx)] # working with 2009 body
```

```
head(body)
```

```
## [1] "    1     1/1420       1 Ridouane Harroufi      27 Morocco                45:56   45:56#  4:36 "
## [2] "    2     1/62         9 Feyisa Liesa           19 Ethiopia               45:58   45:58#  4:36 "
## [3] "    3     1/1271      13 Silas Sang             31 Kenya                  45:59   45:59#  4:36 "
## [4] "    4     2/1420      29 Karim El Mabchour      26 Morocco                46:00   46:00#  4:36 "
## [5] "    5     3/1420      81 Stephen Chemlany       26 Kenya                  46:06   46:06#  4:37 "
## [6] "    6     1/399       83 Cosmas Koech Kimuati   23 Kenya                  46:08   46:08#  4:37 "
```

We can use the text above the = boundary as a header row to identify the columns names.

```
headerRow<- tolower(headerRow)
headerRow
```

```
## [1] "place div  /tot   num    name                    ag hometown             gun tim net tim  pace  "
```

Now that we have defined the column names, we are free to use the text structure, such as the spacing of column names and data, to identify datapoints. We will start with ag.

```
# looks for first match of given sequence
ageStart<- regexec('ag', headerRow, fixed = TRUE)
ageStart
```

```
## [[1]]
## [1] 49
## attr(,"match.length")
## [1] 2
## attr(,"useBytes")
## [1] TRUE
```

" 1 1/1420 1 Ridouane Harroufi 27 Morocco 45:56 45:56# 4:36 "

" 27 " " " " " " 26 M" " 26 " " 23 Ken"

```
age<- substr(body, start = 49, stop = 50)
head(age)
```

```
## [1] "27" "19" "31" "26" "26" "23"
```

```
summary(as.numeric(age))
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   10.00   29.00   35.00   37.37   44.00   85.00       2
```

We have successfully used the structure of the text data to identify an index location for `ag` data points. We can continue to use the spacing of text data to identify other data points.

```
#gregexpr looks for all matches of a given sequence
blankLocs<- gregexpr(' ', spacerRow)
blankLocs
```

```
## [[1]]
## [1]  6 18 25 48 51 72 80 89 95
## attr(,"match.length")
## [1] 1 1 1 1 1 1 1 1 1
```

```
searchLocs<- c(0,blankLocs[[1]])
searchLocs
```

```
##  [1]  0  6 18 25 48 51 72 80 89 95
```

The spacing indices will now be used in a funtion that can compile a matrix of data points across the entire list of tables.

```
values<- mapply(substr, list(body), start = searchLocs[-length(searchLocs)] +1, stop = searchLocs[-1] -
length(values)
```

```
## [1] 59859
```

```
head(values)
```

```
##      [,1]    [,2]          [,3]     [,4]                    [,5]
## [1,] "    1" "    1/1420 " " "     1" "Ridouane Harroufi     " "27"
## [2,] "    2" "    1/62   " " "     9" "Feyisa Liesa          " "19"
## [3,] "    3" "    1/1271 " " "    13" "Silas Sang            " "31"
## [4,] "    4" "    2/1420 " " "    29" "Karim El Mabchour     " "26"
## [5,] "    5" "    3/1420 " " "    81" "Stephen Chemlany      " "26"
## [6,] "    6" "    1/399  " " "    83" "Cosmas Koech Kimuati  " "23"
##      [,6]                    [,7]      [,8]       [,9]
## [1,] "Morocco             " " "  45:56" "  45:56#" " 4:36"
## [2,] "Ethiopia            " " "  45:58" "  45:58#" " 4:36"
## [3,] "Kenya               " " "  45:59" "  45:59#" " 4:36"
## [4,] "Morocco             " " "  46:00" "  46:00#" " 4:36"
## [5,] "Kenya               " " "  46:06" "  46:06#" " 4:37"
## [6,] "Kenya               " " "  46:08" "  46:08#" " 4:37"
```

A function `findColLocs` can be defined that uses these space indices to locate the begin points for data throughout the extracte text data.

```
findColLocs<- function(spacerRow){
  spaceLocs<- gregexpr(' ', spacerRow)[[1]]
  rowLength<- nchar(spacerRow)

  if (substring(spacerRow, rowLength, rowLength) != ' ')
    return( c(0, spaceLocs, rowLength +1))
  else return(c(0,spaceLocs))
}

locs_2012<- findColLocs(spacerRow)
length(locs_2012)
```

```
## [1] 10
```

```
locs_2012
```

```
##  [1]  0  6 18 25 48 51 72 80 89 95
```

`selectCols` is a tool that uses `findColLocs` to locate the data points for each column throughout the text for all of the race years.

```
selectCols =
function(colNames, headerRow, searchLocs)
{
  sapply(colNames,
         function(name, headerRow, searchLocs)
         {
           startPos = regexpr(name, headerRow)[[1]]
           if (startPos == -1)
             return( c(NA, NA) )

           index = sum(startPos >= searchLocs)
           c(searchLocs[index] + 1, searchLocs[index + 1] - 1)
         },
         headerRow = headerRow, searchLocs = searchLocs )
}
```

We can examine the results for validity with the summary function. Our functions have extracted almost all of the age data and may have identified some errors within the dataset.

```
searchLocs = findColLocs(spacerRow)
ageLoc = selectCols("ag", headerRow, searchLocs)
ages = mapply(substr, list(body),
```

```
              start = ageLoc[1,], stop = ageLoc[2, ])
summary(as.numeric(ages))
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   10.00   29.00   35.00   37.37   44.00   85.00       2
```

We can test the functionality of the tools we have assembled so far.

```
shortColNames = c("name", "home", "ag", "gun", "net", "time")
locCols = selectCols(shortColNames, headerRow, searchLocs)

#mapply forms a matrix after completion
Values = mapply(substr, list(body), start = locCols[1, ],
                stop = locCols[2, ])

class(Values)
```

```
## [1] "matrix" "array"
```

```
colnames(Values) = shortColNames
head(Values)
```

```
##      name                     home                   ag   gun       net
## [1,] "Ridouane Harroufi     " "Morocco             " "27" "  45:56" "  45:56#"
## [2,] "Feyisa Liesa          " "Ethiopia           " "19" "  45:58" "  45:58#"
## [3,] "Silas Sang            " "Kenya              " "31" "  45:59" "  45:59#"
## [4,] "Karim El Mabchour     " "Morocco            " "26" "  46:00" "  46:00#"
## [5,] "Stephen Chemlany      " "Kenya              " "26" "  46:06" "  46:06#"
## [6,] "Cosmas Koech Kimuati  " "Kenya              " "23" "  46:08" "  46:08#"
##      time
## [1,] NA
## [2,] NA
## [3,] NA
## [4,] NA
## [5,] NA
## [6,] NA
```

```
tail(Values)[ , 1:3]
```

```
##         name                     home                  ag
## [6646,] "John Sim            " "Fairfax VA         " "34"
## [6647,] "Kerry Kilman        " "Rockville MD       " "61"
```

```
## [6648,] "Edward Jefferson      " "Norfolk VA          " "75"
## [6649,] "Robert Smith          " "Comus MD           " "75"
## [6650,] "ine    "                  ""                    ""
## [6651,] "uideline"                 ""                    ""
```

To generalize this method, we define a function that combines the various processes we have used so far in the `extractVariables` function.

```
extractVariables =
  function(file, varNames =c("name", "home", "ag", "gun",
                             "net", "time"))
{
       # Find the index of the row with =s
  eqIndex = grep("^===", file)
       # Extract the two key rows and the data
  spacerRow = file[eqIndex]
  headerRow = tolower(file[ eqIndex - 1 ])
  body = file[ -(1 : eqIndex) ]

       # Obtain the starting and ending positions of variables
  searchLocs = findColLocs(spacerRow)
  locCols = selectCols(varNames, headerRow, searchLocs)

  Values = mapply(substr, list(body), start = locCols[1, ],
                  stop = locCols[2, ])
  colnames(Values) = varNames

  invisible(Values)
}
```

```
years = 1999:2012
menTables = mapply(extractResTable, url = urls, year = years)
names(menTables) = years
```

We now have a list of matrices. The original text data are in a much more machine readable format. Our number of rows for each matrix is equal to the number of original rows, minus the original text header.

```
menResMat = lapply(menTables, extractVariables)
length(menResMat)
```

```
## [1] 14
```

```
sapply(menResMat, nrow)
```

```
## 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
## 3190 3017 3622 3724 3948 4156 4327 5237 5276 5905 6651 6911 7011 7193
```

To perform statistical analyses on the numeric data, we must perform a datatype transformation.

```
age = as.numeric(menResMat[['2012']][ , 'ag'])

tail(age)
```

```
## [1] 41 39 56 35 NA 48
```

```
age = sapply(menResMat,
             function(x) as.numeric(x[ , 'ag']))
```

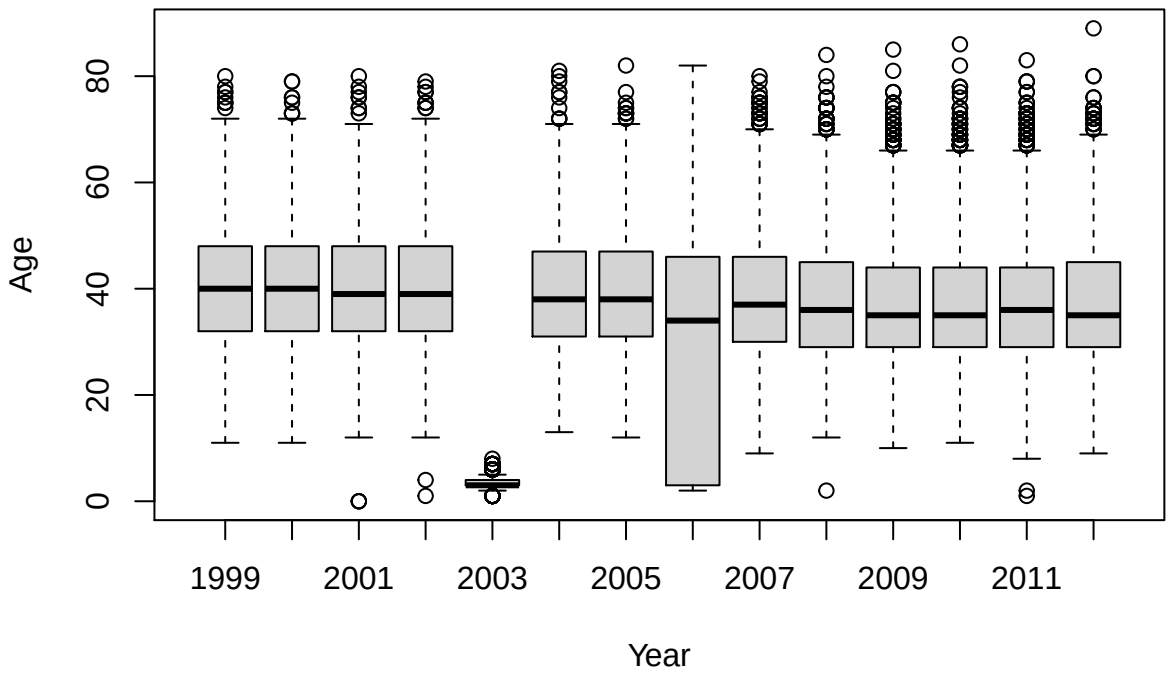
```
## Warning in FUN(X[[i]], ...): NAs introduced by coercion

## Warning in FUN(X[[i]], ...): NAs introduced by coercion

## Warning in FUN(X[[i]], ...): NAs introduced by coercion
```

There appears to be an anomoly in the process for the year 2003. After an examination of the original data table, we found that the spacing in the year 2003 data is not the same as the other years. We will adjust our `selectCols` function to capture the data for 2003.

```
boxplot(age, ylab = "Age", xlab = "Year")
```




```
selectCols = function(shortColNames, headerRow, searchLocs) {
  sapply(shortColNames, function(shortName, headerRow, searchLocs){
    startPos = regexpr(shortName, headerRow)[[1]]
    if (startPos == -1) return( c(NA, NA) )
    index = sum(startPos >= searchLocs)
    c(searchLocs[index] + 1, searchLocs[index + 1])
  }, headerRow = headerRow, searchLocs = searchLocs )
}
```

We also observe anomolies in the formatting of the year 2001. We introduce fixes and scrape the original tables once more to form the list of matrices called `menResMat`.

```
age2001 = age[["2001"]]

grep("^===", menResMat['2001'])
```

```
## integer(0)
```

```
badAgeIndex = which(is.na(age2001)) + 5
```

```
extractVariables =
function(file, varNames =c("name", "home", "ag", "gun",
                           "net", "time"))
{

  # Find the index of the row with =s
  eqIndex = grep("^===", file)
  # Extract the two key rows and the data
  spacerRow = file[eqIndex]
  headerRow = tolower(file[ eqIndex - 1 ])
  body = file[ -(1 : eqIndex) ]
       # Remove footnotes and blank rows
  footnotes = grep("^[[:blank:]]*(\\*|\\#)", body)
  if ( length(footnotes) > 0 ) body = body[ -footnotes ]
  blanks = grep("^[[:blank:]]*$", body)
  if (length(blanks) > 0 ) body = body[ -blanks ]


  # Obtain the starting and ending positions of variables
  searchLocs = findColLocs(spacerRow)
  locCols = selectCols(varNames, headerRow, searchLocs)

  Values = mapply(substr, list(body), start = locCols[1, ],
                  stop = locCols[2, ])
  colnames(Values) = varNames

  return(Values)
}

menResMat = lapply(menTables, extractVariables)
```

We must reformat the ag data to a numeric format for analysis.

```
age<- sapply(menResMat, function(x) as.numeric(x[, 'ag']))
```

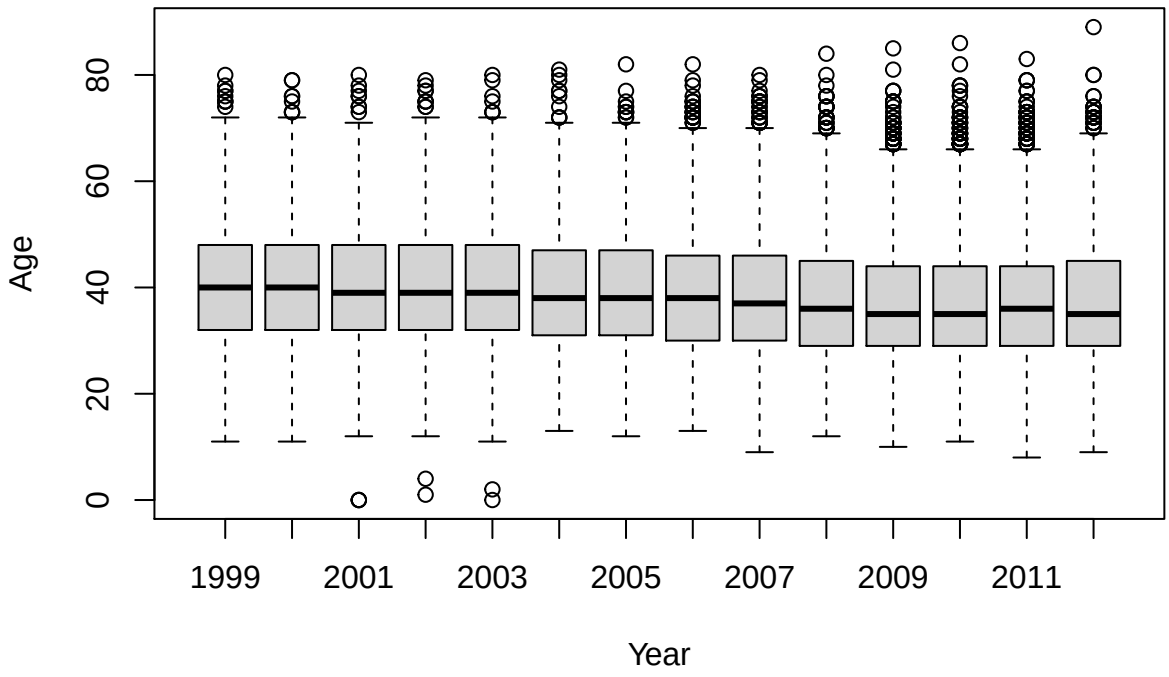
We can observe a mostly cleaned dataset with trace numbers of NA values across the 14 matrices.

```
sapply(age, function(x) sum(is.na(x)))
```

```
## 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
##    1    0    0    2    0    0   10    0    3    0    0    4    0    1
```

We will also observe the distributions of ag across each race. We can observe a few very young participants between 2001 and 2003. These may be errors and require a closer examination.

```
boxplot(age, ylab = "Age", xlab = "Year")
```




Many of these participants have an ag value of 0. There are very few of these values, so we will remove them from consideration.

```
young<- menResMat[['2001']][,'ag'] < 10
menResMat[['2001']]<- menResMat[['2001']][-c(young),]
y2002<- menResMat[['2002']][,'ag'] < 10
y2003<- menResMat[['2003']][,'ag'] < 10
menResMat[['2002']]<- menResMat[['2002']][-c(y2002),]
menResMat[['2003']]<- menResMat[['2003']][-c(y2003),]
y2002<- menResMat[['2002']][,'ag'] < 10
y2003<- menResMat[['2003']][,'ag'] < 10
```

To make the remaining analyses easier, we will transform the data structure from a list of matrices into a dataframe. To identify the data by year, we must add year vectors with lengths equal to the number of rows in each matrix.

```
menResDF = lapply(menResMat, data.frame)
```

```
col_1999 = rep(1999, nrow(menResDF$`1999`))

col_2000 = rep(2000, nrow(menResDF$`2000`))

col_2001 = rep(2001, nrow(menResDF$`2001`))

col_2002 = rep(2002, nrow(menResDF$`2002`))

col_2003 = rep(2003, nrow(menResDF$`2003`))

col_2004 = rep(2004, nrow(menResDF$`2004`))

col_2005 = rep(2005, nrow(menResDF$`2005`))

col_2006 = rep(2006, nrow(menResDF$`2006`))

col_2007 = rep(2007, nrow(menResDF$`2007`))

col_2008 = rep(2008, nrow(menResDF$`2008`))

col_2009 = rep(2009, nrow(menResDF$`2009`))

col_2010 = rep(2010, nrow(menResDF$`2010`))

col_2011 = rep(2011, nrow(menResDF$`2011`))

col_2012 = rep(2012, nrow(menResDF$`2012`))

cols = c(col_1999, col_2000, col_2001, col_2002, col_2003, col_2004, col_2005, col_2006, col_2007, col_
```

```
menResFinal = data.frame()
for (i in 1:length(names(menResDF))) {

  df<- menResDF[[i]]
  menResFinal = rbind(menResFinal, df)
}
menResFinal$Date<- cols
```

Our data is now in a much more convenient data structure.

```
menResFinal$ag = as.numeric(menResFinal$ag)
sum(is.na(menResFinal$ag))
```

```
## [1] 21
```

Combining the data into a single dataframe facilitates the cleaning of the columns containing the time data for each runner. These values are all still stored as characters and are in an HR:MIN:SEC format. We can separate the values and convert them all into a standard time format, minutes.

We define a function that converts the time into a minute format.

```
runTime = sapply(timePieces,
                 function(x) {
                   if (length(x) == 2) x[1] + x[2]/60
                   else 60*x[1] + x[2] + x[3]/60
                 })

summary(runTime)
```

```
##    Min. 1st Qu.  Median    Mean 3rd Qu.    Max.    NA's
##   45.25   77.21   86.63   87.55   96.75  170.83   48610
```

```
convertTime = function(time) {
  timePieces = strsplit(time, ":")
  timePieces = sapply(timePieces, as.numeric)
  sapply(timePieces, function(x) {
                       if (length(x) == 2) x[1] + x[2]/60
                       else 60*x[1] + x[2] + x[3]/60
                       })
}
```

We can combine these tools into a single function that will process the times. The end result will be a dataframe called menDF.

Finally, we find a few residual issues with the data from 2006 and clean that data and finalize our menDF dataframe.

```
sapply(menDF, function(x) sum(is.na(x$runTime)))
```

```
## 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
##    0    0    0    0    0    0    0 5232    0    0    0    0    0    0
```

```
separatorIdx = grep("^===", menTables[["2006"]])
separatorRow = menTables[['2006']][separatorIdx]
separatorRowX = paste(substring(separatorRow, 1, 63), " ",
                      substring(separatorRow, 65, nchar(separatorRow)),
                      sep = "")
menTables[['2006']][separatorIdx] = separatorRowX
```

```
menResMat = sapply(menTables, extractVariables)
menDF = mapply(createDF, menResMat, year = 1999:2012,
               sex = rep("M", 14), SIMPLIFY = FALSE)
```

With this process complete, we can simply re-use the functions on the women's data.

```
womenURLs =
  c("results/1999/cb99f.html", "results/2000/Cb003f.htm", "results/2001/oof_f.html",
    "results/2002/ooff.htm", "results/2003/CB03-F.HTM",
    "results/2004/women.htm", "results/2005/CB05-F.htm",
    "results/2006/women.htm", "results/2007/women.htm",
    "results/2008/women.htm", "results/2009/09cucb-F.htm",
    "results/2010/2010cucb10m-F.htm",
    "results/2011/2011cucb10m-F.htm",
    "results/2012/2012cucb10m-F.htm")

years = 1999:2012
urls = paste(ubase, womenURLs, sep = "")
womenTables = mapply(extractResTable, url = urls, year = years, sex='female')
names(womenTables) = years
sapply(womenTables, length)
```

```
## 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
## 2359 2169 2976 3338 3547 3907 4342 5445 5699 6405 8333 8863 9038 9737
```

We observe similar issues in the women's data that we did in the men's data for the year 2006.

```
separatorIdx = grep("^===", womenTables[["2006"]])
separatorRow = womenTables[['2006']][separatorIdx]
separatorRowX = paste(substring(separatorRow, 1, 63), " ",
                      substring(separatorRow, 65, nchar(separatorRow)),
                      sep = "")
womenTables[['2006']][separatorIdx] = separatorRowX

womenTables[['2001']][2:3] = womenTables[['2002']][2:3]

womenResMat = sapply(womenTables, extractVariables)
womenDF = mapply(createDF, womenResMat, year = 1999:2012,
               sex = rep("W", 14), SIMPLIFY = FALSE)
```

```
## Warning in data.frame(year = rep(year, nrow(Res)), sex = rep(sex, nrow(Res)), :
## NAs introduced by coercion
```

The ag column indicates a mostly successful data preprocessing scheme.

```
sapply(womenDF, function(x) sum(is.na(x$age)))
```

```
## 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
##    4    0    0    4    0    0    8    1    2    0    2    0    0    0
```

The runTime column is completely clean.

```
sapply(womenDF, function(x) sum(is.na(x$runTime)))
```

```
## 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012
##    0    0    0    0    0    0    0    0    0    0    0    0    0    0
```

Since there are so few NA values, we can safely remove them without affecting the results of the analysis.

```
menDF_complete = na.omit(menDF)
womenDF_complete = na.omit(womenDF)
```

We can combine the men's and women's data into a single dataframe for a complete analysis of the results over a 14 year period.

```
cherryblossom = data.frame()
for (i in 1:14) {

  df<- menDF_complete[[i]]
  cherryblossom = rbind(cherryblossom, df)
}
head(cherryblossom)
```

```
##   year sex                   name                home age  runTime
## 1 1999   M Worku Bikila           Ethiopia              28 46.98333
## 2 1999   M Lazarus Nyakeraka      Kenya                 24 47.01667
## 3 1999   M James Kariuki          Kenya                 27 47.05000
## 4 1999   M William Kiptum         Kenya                 28 47.11667
## 5 1999   M Joseph Kimani          Kenya                 26 47.51667
## 6 1999   M Josphat Machuka        Kenya                 25 47.55000
```

```
for (i in 1:14) {

  df<- womenDF_complete[[i]]
  cherryblossom = rbind(cherryblossom, df)
}
tail(cherryblossom)
```

```
##        year sex                    name                  home age  runTime
## 146036 2012   W Effie Harary             Long Branch NJ         39 152.1333
## 146037 2012   W Khristina Nava           Fort Meade MD          40 153.1833
## 146038 2012   W Geneva Dixon             Manassas Park VA       31 156.0500
## 146039 2012   W Veronica Eligan          Mitchellville MD       55 156.7500
## 146040 2012   W Denise Bobba             Herndon VA             40 156.9000
## 146041 2012   W Rashonna Waples          District Heights MD    38 170.9667
```

```
sum(is.na(cherryblossom))
```

```
## [1] 42
```

Our dataset is complete, clean, and ready for further analysis.

```
cherryblossom = na.omit(cherryblossom)
sum(is.na(cherryblossom))
```

```
## [1] 0
```

# 3 Conclusion

# A Code

```
The code is cooool
```