```r
# ***********************************************************************
# *** Introduction to R: Lists and Arrays ******************************
# ***********************************************************************

# ***********************************************************************
# *** Exercise 01: BigTen Sports Lists
# Use the provided vector data to create BigTen lists with school name, info on
# graduation and acceptance rates, last 5 years of enrollments and a list of
# school sponsored men's sports, together with the count of sports.
# https://en.wikipedia.org/wiki/Big_Ten_Conference#Sports
# The enrollment history must be a 2-column data frame with school years 2018-19
# down to 2014-15. Make sure to adequately name all the list elements as well as
# the data contained within the elements.
# ***********************************************************************
school <- c("Illinois","Indiana","Iowa","Maryland","Michigan","Michigan State",
            "Minnesota","Nebraska","Northwestern","Ohio State","Penn State",
            "Purdue","Rutgers","Wisconsin")
men_sports <- c("Baseball","Basketball","Cross
Country","Football","Golf","Gymnastics",
                "Ice Hockey","Lacrosse","Soccer","Swimming & Diving","Tennis",
                "Track & Field (indoor)","Track & Field (outdoor)","Wrestling")
grad_rate <- c(0.85, 0.77, 0.74, 0.85, 0.92, 0.80, 0.80,
               0.68, 0.94, 0.83, 0.85, 0.78, 0.80, 0.87)
accept <- c(0.62, 0.77, 0.83, 0.47, 0.23, 0.78, 0.52,
            0.8, 0.08, 0.52, 0.56, 0.58, 0.6, 0.52)

# Data on last 5 years of total school enrollments
acd_years <- c("2018-19","2017-18","2016-17","2015-16","2014-15")
IL_enroll <- c(49702, 48216, 46951, 45842, 45140)
IN_enroll <- c(43503, 43710, 49695, 48514, 46416)
IA_enroll <- c(31656, 32166, 32011, 30844, 29970)
MD_enroll <- c(41200, 40521, 39083, 38140, 37610)
MI_enroll <- c(46716, 46002, 44718, 43651, 43625)
ST_enroll <- c(50351, 50019, 50340, 50538, 50081)
MN_enroll <- c(50734, 51848, 51579, 50678, 51147)
NE_enroll <- c(25820, 26079, 25897, 25260, 25006)
NW_enroll <- c(22127, 22008, 21823, 21655, 21554)
OH_enroll <- c(61170, 59837, 59482, 58663, 58322)
PA_enroll <- c(46810, 47119, 47789, 47307, 47040)
PD_enroll <- c(44474, 42699, 41513, 40472, 39752)
RG_enroll <- c(50254, 49577, 50146, 49428, 48378)
WI_enroll <- c(43463, 42977, 42582, 42716, 42598)

# Create the data frame of enrollments in all schools used
# to build the Big Ten master list

### data frame more as a matrix

enroll_df <- data.frame(IL_enroll, IN_enroll, IA_enroll, MD_enroll, MI_enroll,
                        ST_enroll, MN_enroll, NE_enroll, NW_enroll, OH_enroll,
                        PA_enroll, PD_enroll, RG_enroll, WI_enroll)
### why organized in this way?
### row function
### Column represent attributes of the entities


row.names(enroll_df) <- acd_years

enroll_df

# 1. Examine the enrollment data frame by accessing Minnesota's enrollment
# for 2016-17 academic year.

enroll_df[3,7]
#Alternatively we can use row and column name
enroll_df["2016-17","MN_enroll"]
# Using row and column names

# ***********************************************************************
# Data on each of the Big Ten sports sponsored by the school
IL_men_sports <- c('Baseball','Basketball','Cross
Country','Football','Golf','Gymnastics',
                   'Tennis','Track & Field (indoor)','Track & Field
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                                   (outdoor)','Wrestling')
72   IN_men_sports <- c('Baseball','Basketball','Cross Country','Football','Golf','Soccer',
73                      'Swimming & Diving','Tennis','Track & Field (indoor)',
74                      'Track & Field (outdoor)','Wrestling')
75   IA_men_sports <- c('Baseball','Basketball','Cross
     Country','Football','Golf','Gymnastics',
76                      'Swimming & Diving','Tennis','Track & Field (indoor)',
77                      'Track & Field (outdoor)','Wrestling')
78   MD_men_sports <- c('Baseball','Basketball','Football','Golf','Lacrosse','Soccer',
79                      'Track & Field (outdoor)','Wrestling')
80   MI_men_sports <- c('Baseball','Basketball','Cross
     Country','Football','Golf','Gymnastics',
81                      'Ice Hockey','Lacrosse','Soccer','Swimming & Diving','Tennis',
82                      'Track & Field (indoor)','Track & Field (outdoor)','Wrestling')
83   ST_men_sports <- c('Baseball','Basketball','Cross Country','Football','Golf','Ice
     Hockey',
84                      'Soccer','Swimming & Diving','Tennis','Track & Field (indoor)',
85                      'Track & Field (outdoor)','Wrestling')
86   MN_men_sports <- c('Baseball','Basketball','Cross
     Country','Football','Golf','Gymnastics',
87                      'Ice Hockey','Swimming & Diving','Tennis','Track & Field (indoor)',
88                      'Track & Field (outdoor)','Wrestling')
89   NE_men_sports <- c('Baseball','Basketball','Cross
     Country','Football','Golf','Gymnastics',
90                      'Tennis','Track & Field (indoor)','Track & Field
                        (outdoor)','Wrestling')
91   NW_men_sports <- c('Baseball','Basketball','Football','Golf','Soccer','Swimming &
     Diving',
92                      'Tennis','Wrestling')
93   OH_men_sports <- c('Baseball','Basketball','Cross
     Country','Football','Golf','Gymnastics',
94                      'Ice Hockey','Lacrosse','Soccer','Swimming & Diving','Tennis',
95                      'Track & Field (indoor)','Track & Field (outdoor)','Wrestling')
96   PA_men_sports <- c('Baseball','Basketball','Cross
     Country','Football','Golf','Gymnastics',
97                      'Ice Hockey','Lacrosse','Soccer','Swimming & Diving','Tennis',
98                      'Track & Field (indoor)','Track & Field (outdoor)','Wrestling')
99   PD_men_sports <- c('Baseball','Basketball','Cross
     Country','Football','Golf','Swimming & Diving',
100                     'Tennis','Track & Field (indoor)','Track & Field
                        (outdoor)','Wrestling')
101  RG_men_sports <- c('Baseball','Basketball','Cross
     Country','Football','Golf','Lacrosse','Soccer',
102                     'Track & Field (indoor)','Track & Field (outdoor)','Wrestling')
103  WI_men_sports <- c('Basketball','Cross Country','Football','Golf','Ice
     Hockey','Soccer',
104                     'Swimming & Diving','Tennis','Track & Field (indoor)',
105                     'Track & Field (outdoor)','Wrestling')
106
107  # Create the list of sports in all schools used to build the Big `Ten master list`
108  # Unlike the enrollment data frame, this cannot be a data frame, because different
     schools
109  # will have different sports and different number of sports.
110  men_sports_list <- list(IL_men_sports, IN_men_sports, IA_men_sports, MD_men_sports,
111                          MI_men_sports, ST_men_sports, MN_men_sports, NE_men_sports,
112                          NW_men_sports, OH_men_sports, PA_men_sports, PD_men_sports,
113                          RG_men_sports, WI_men_sports)
114
115
116  class(men_sports_list)
117
118  # 2. Examine the men's sports list by accessing Minnesota's list (actually a vector)
119  # of sports and then retrieve men's hockey.
120  men_sports_list[[7]]     # Again, the result is a vector
121  class(men_sports_list[[7]])
122  men_sports_list[[7]][[7]]  # So, it is easy to retrieve men's ice hockey element
123  men_sports_list[[7]][7]
124  #Vector is a list, vector has to have a same data type
125
126
127  # *************************************************************************
128  # Build a master list of all Big Ten schools
129  big_ten_list <- list()
```

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      #repeated 14 times
130
      for(i in 1:14){
131
        #School = give a name 'school
132
                            #Name of the school    School[7]: "Minnesota"
133
        big_ten_list[[i]] <- list(School=school[i],
134
                                  #grad=grad_rate[7], acpt=accept[7] : graduation rate and
135
                                  acceptance rate of Minnesota
136

                                  Info=c(grad=grad_rate[i], acpt=accept[i]),
137
                                  #Get me all the rows of the ith column
138
                                  Enrollment=enroll_df[,i],
139
                                  #List of all the minnesota men's sorts
140
                                  Men_Sports=men_sports_list[[i]],
141
                                  #Number of sports in minnesota
142
                                  Total_Sports=length(men_sports_list[[i]]))
143
        names(big_ten_list[[i]]$Enrollment) <- acd_years
144

145
      }
146

147
      #Not jut about the sport
148
      big_ten_list
149
      #How many school
150
      length(big_ten_list)
151
      #We named it so we can use $
152
      #this is why it is beneficial to name it
153

154
      big_ten_list[[7]]$Info[]
155
      big_ten_list[[7]]$Info[[2]]
156

157
      #List of men's sport in minnesota
158
      big_ten_list[[7]]$Men_Sports[]
159
      #7 element of the men sport is ice hockey
160
      big_ten_list[[7]]$Men_Sports[7]
161

162
      # 3. Examine the master BigTen list by accessing all the Minnesota related elements.
163

164

165
      # ****************************************************************************
166
      # *** Exercise 02: Big Ten Enrollment Array
167
      # Use the BigTen enrollment data for the 5 given academic years and broken
168
      # by the US World News ranking and the geographical region, to assemble a
169
      # 3D enrollment array. The 3 rows of zero's represent the fact that there
170
      # are no Northeast schools in Low, High or Top10 ranking categories.
171
      # Use the array to retrieve the enrollment of highly ranked midwest schools
172
      # in 2016-17 academic year.
173
      # ****************************************************************************
174
      sel_years <- c("2014-15","2015-16","2016-17","2017-18","2018-19")
175
      us_rank <- c("Low","Mod","High","Top10")
176
      sch_region <- c("MDW","NE")
177
      enroll_array <- array(
178
        c(25006,  25260,  25897,  26079,  25820,    # Low-MDW
179
          275688, 279709, 284620, 280279, 281888,   # Mod-MDW
180
          131363, 132209, 134251, 137195, 139881,   # High-MDW
181
          21554,  21655,  21823,  22008,  22127,    # Top10-MDW
182
          0, 0,   0, 0,   0,
183
          133028, 134875, 137018, 137217, 138264,   # Mod-NE
184
          0, 0,   0, 0,   0,
185
          0, 0,   0, 0,   0
186
        ),
187
        #dimension
188
        dim=c(5,4,2),
189
        #Why have to be list?
190
        #Each elemen have different length
191
        dimnames = list(sel_years, us_rank, sch_region)
192
      )
193
      enroll_array
194

195
      # 4.What is the 2016-17 midwest enrollment of highly ranked schools? What is the
196
      2016-17 midwest enrollment of highly ranked schools?

197

198
      enroll_array[3,3,1]
199
200
```

```r
201    enroll_array["2016-17","High","MDW"]
202
203
204    #5 What is th total midest enrollment of highly ranked schools?
205    #empty means all : all years
206    enroll_array[,3,1]
207
208
209    enroll_array[,"High","MDW"]
210    sum(enroll_array[,3,1])
211
212
213    #What is the total 2016-17 midwest enrollment?
214
215    enroll_array[3,,1]
216    enroll_array["2016-17",,"MDW"]
217
```