

# Day 2 – 01 Explore Data (Exercises – Solutions)

## Seminar practice worksheet

Use this key after attempting `scripts/01_explore_data_exercises.Rmd`. The code chunks mirror the TODOs but include one possible solution for each task.

### 1. Load and preview the dataset

```
input_path <- file.path('..', 'data', 'dataset2_subset_long.csv')
long_df <- read.csv(input_path, stringsAsFactors = FALSE, check.names = FALSE)
cat('Rows:', nrow(long_df), '\nColumns:', ncol(long_df), '\n')

## Rows: 3072 \nColumns: 7 \n

head(long_df)

##                                     Genome      snp_id Position     value mouse_id day
## 1 Akkermansia_muciniphila_YL44 239840-C-G  239840 0.000000   1683   0
## 2 Akkermansia_muciniphila_YL44 241793-A-G  241793 0.049587   1683   0
## 3 Akkermansia_muciniphila_YL44 355328-A-T  355328 0.138182   1683   0
## 4 Akkermansia_muciniphila_YL44 356291-C-A  356291 0.000000   1683   0
## 5 Akkermansia_muciniphila_YL44 2351445-C-T 2351445 0.000000   1683   0
## 6 Bacteroides_caecimuris_I48 1601848-T-C  1601848 0.041609   1683   0
##   treatment_group
## 1          Control
## 2          Control
## 3          Control
## 4          Control
## 5          Control
## 6          Control
```

### 2. Enumerate genomes and SNPs

```
unique(long_df$Genome)

## [1] "Akkermansia_muciniphila_YL44" "Bacteroides_caecimuris_I48"
## [3] "Turicimonas_muris_YL45"

table(long_df$Genome)

##
## Akkermansia_muciniphila_YL44    Bacteroides_caecimuris_I48
##                               320                           1216
## Turicimonas_muris_YL45
##                               1536

tapply(long_df$snp_id, long_df$Genome, function(x) length(unique(x)))
```

```

## Akkermansia_muciniphila_YL44      Bacteroides_caecimuris_I48
##                               5                      19
##       Turicimonas_muris_YL45
##                               24

```

### 3. Summaries by genome

```

sample_values <- long_df$value[1:10]
summary(sample_values)

##      Min. 1st Qu. Median   Mean 3rd Qu.   Max.
## 0.00000 0.00000 0.00000 0.03426 0.04759 0.13818

aggregate(value ~ Genome, data = long_df, function(x) summary(x))

##                                     Genome value.Min. value.1st Qu. value.Median value.Mean
## 1 Akkermansia_muciniphila_YL44 0.0000000 0.0000000 0.0523090 0.1741893
## 2 Bacteroides_caecimuris_I48 0.0000000 0.0000000 0.0338305 0.1485411
## 3 Turicimonas_muris_YL45    0.0000000 0.0000000 0.2649125 0.4312851
##   value.3rd Qu. value.Max.
## 1     0.2714463 0.8712450
## 2     0.2679232 0.9912180
## 3     0.9090910 1.0000000

```

### 4. Focus on Turicimonas

```

turicimonas_df <- long_df[long_df$Genome == 'Turicimonas_muris_YL45', ]
cat('Rows for Turicimonas:', nrow(turicimonas_df), '\n')

```

```

## Rows for Turicimonas: 1536 \n
head(turicimonas_df)

##           Genome      snp_id Position   value mouse_id day
## 25 Turicimonas_muris_YL45 362534-G-A 362534 1.000000 1683  0
## 26 Turicimonas_muris_YL45 1063346-G-A 1063346 0.741935 1683  0
## 27 Turicimonas_muris_YL45 1135479-G-A 1135479 0.000000 1683  0
## 28 Turicimonas_muris_YL45 1364256-G-A 1364256 0.406250 1683  0
## 29 Turicimonas_muris_YL45 1376518-G-A 1376518 0.000000 1683  0
## 30 Turicimonas_muris_YL45 1392383-G-A 1392383 0.461538 1683  0
##   treatment_group
## 25          Control
## 26          Control
## 27          Control
## 28          Control
## 29          Control
## 30          Control

table(turicimonas_df$mouse_id, turicimonas_df$day)

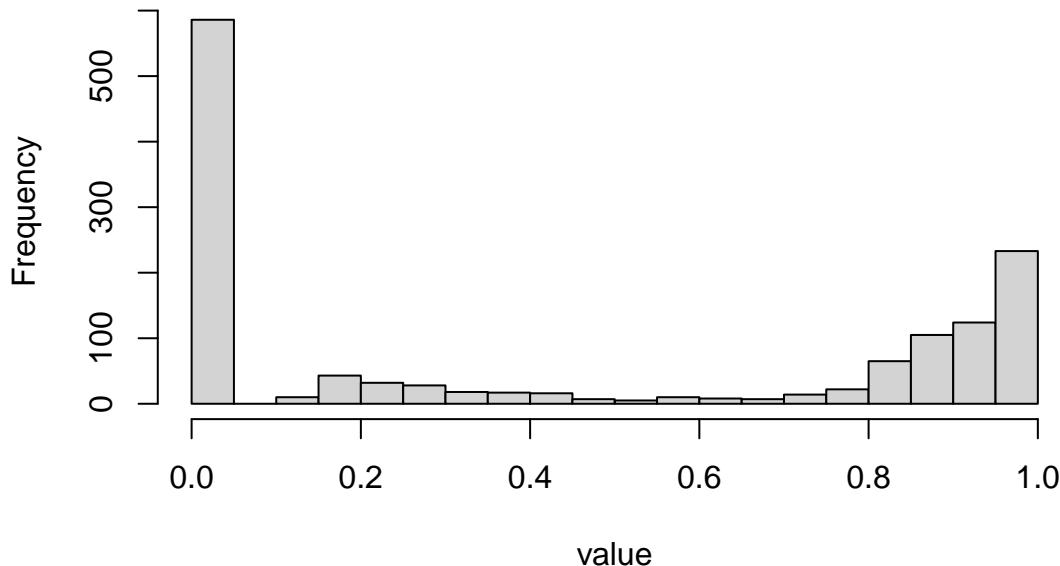
##
##      0  4  9 14 18 23 30 37 44 49 53 58 63 67 72 79
## 1683 24 24 24 24 24 24 24 24 24 24 24 24 24 24 24 24
## 1688 24 24 24 24 24 24 24 24 24 24 24 24 24 24 24 24
## 1692 24 24 24 24 24 24 24 24 24 24 24 24 24 24 24 24
## 1699 24 24 24 24 24 24 24 24 24 24 24 24 24 24 24 24

```

## 5. Allele-frequency focus (Turicimonas vs all genomes)

```
turicimonas_values <- long_df$value[long_df$Genome == 'Turicimonas_muris_YL45']  
hist(turicimonas_values, breaks = 20, main = 'Turicimonas AF', xlab = 'value')
```

**Turicimonas AF**

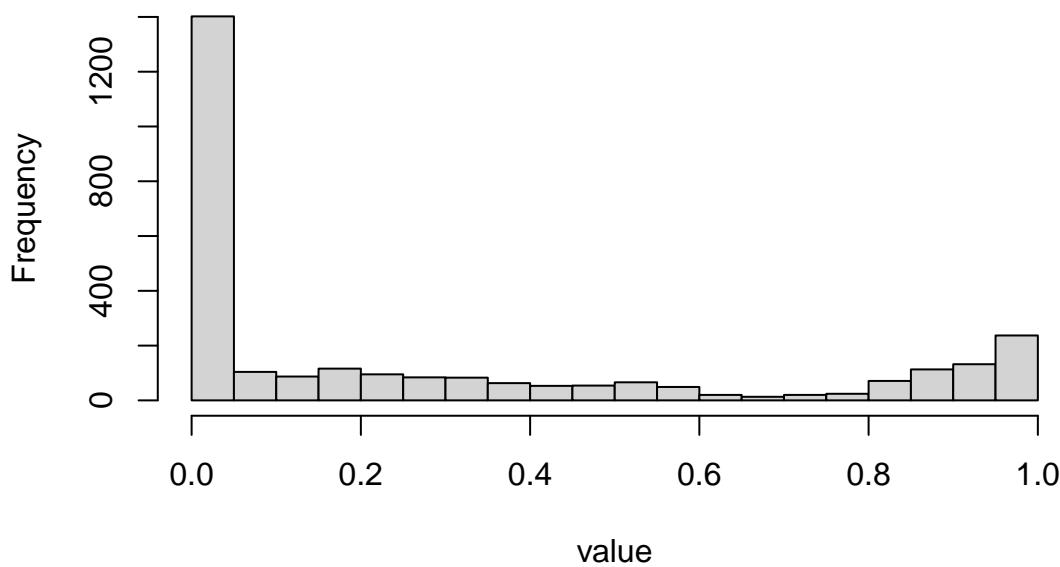


```
summary(turicimonas_values)
```

```
##      Min. 1st Qu. Median      Mean 3rd Qu.      Max.    NA's  
## 0.0000 0.0000 0.2649 0.4313 0.9091 1.0000     186
```

```
hist(long_df$value, breaks = 30, main = 'All genomes AF', xlab = 'value')
```

**All genomes AF**



```

summary(long_df$value)

##      Min. 1st Qu. Median     Mean 3rd Qu.     Max.    NA's
## 0.00000 0.00000 0.06438 0.28365 0.51995 1.00000     186

```

## 6. Missing values

```

na_total <- sum(is.na(long_df$value))
na_total

## [1] 186
na_by_mouse_day <- with(long_df, tapply(value, list(mouse_id, day), function(x) sum(is.na(x))))
na_by_mouse_day

##      0   4   9  14  18  23  30  37  44  49  53  58  63  67  72  79
## 1683  0   1   0   1   3   2   1   0   0   2   0   1   0   0   0   0   1
## 1688 15   1   0   1   0   0   0   0   0   0   0   0   0   0   0   0   1
## 1692  0  24  24   0  24  20   6   0   1   8  16   0   0   6   0   0
## 1699  0   0  24   0   1   0   0   0   1   0   0   0   1   0   0   0

```

In this dataset the counts are all zero, so no genome (including Turicimonas) introduces missing allele-frequency entries.

## 7. Treatment groups

```

unique(long_df$treatment_group)

## [1] "Control"      "Ciprofloxacin" "Tetracyclin"   "Vancomycin"
table(long_df$treatment_group)

##
##   Ciprofloxacin      Control      Tetracyclin      Vancomycin
##       768           768           768           768

table(long_df$mouse_id, long_df$treatment_group)

##
##   Ciprofloxacin Control Tetracyclin Vancomycin
## 1683          0     768          0         0
## 1688          768          0         0         0
## 1692          0     0     768         0
## 1699          0     0         0     768

long_df[long_df$day == 30, c('mouse_id', 'treatment_group')]

##
##   mouse_id treatment_group
## 193     1683      Control
## 194     1683      Control
## 195     1683      Control
## 196     1683      Control
## 197     1683      Control
## 198     1683      Control
## 199     1683      Control
## 200     1683      Control
## 201     1683      Control

```

```
## 202      1683      Control
## 203      1683      Control
## 204      1683      Control
## 205      1683      Control
## 206      1683      Control
## 207      1683      Control
## 208      1683      Control
## 209      1683      Control
## 210      1683      Control
## 211      1683      Control
## 212      1683      Control
## 213      1683      Control
## 214      1683      Control
## 215      1683      Control
## 216      1683      Control
## 217      1683      Control
## 218      1683      Control
## 219      1683      Control
## 220      1683      Control
## 221      1683      Control
## 222      1683      Control
## 223      1683      Control
## 224      1683      Control
## 225      1683      Control
## 226      1683      Control
## 227      1683      Control
## 228      1683      Control
## 229      1683      Control
## 230      1683      Control
## 231      1683      Control
## 232      1683      Control
## 233      1683      Control
## 234      1683      Control
## 235      1683      Control
## 236      1683      Control
## 237      1683      Control
## 238      1683      Control
## 239      1683      Control
## 240      1683      Control
## 961       1688  Ciprofloxacin
## 962       1688  Ciprofloxacin
## 963       1688  Ciprofloxacin
## 964       1688  Ciprofloxacin
## 965       1688  Ciprofloxacin
## 966       1688  Ciprofloxacin
## 967       1688  Ciprofloxacin
## 968       1688  Ciprofloxacin
## 969       1688  Ciprofloxacin
## 970       1688  Ciprofloxacin
## 971       1688  Ciprofloxacin
## 972       1688  Ciprofloxacin
## 973       1688  Ciprofloxacin
## 974       1688  Ciprofloxacin
## 975       1688  Ciprofloxacin
```

```
## 976      1688  Ciprofloxacin
## 977      1688  Ciprofloxacin
## 978      1688  Ciprofloxacin
## 979      1688  Ciprofloxacin
## 980      1688  Ciprofloxacin
## 981      1688  Ciprofloxacin
## 982      1688  Ciprofloxacin
## 983      1688  Ciprofloxacin
## 984      1688  Ciprofloxacin
## 985      1688  Ciprofloxacin
## 986      1688  Ciprofloxacin
## 987      1688  Ciprofloxacin
## 988      1688  Ciprofloxacin
## 989      1688  Ciprofloxacin
## 990      1688  Ciprofloxacin
## 991      1688  Ciprofloxacin
## 992      1688  Ciprofloxacin
## 993      1688  Ciprofloxacin
## 994      1688  Ciprofloxacin
## 995      1688  Ciprofloxacin
## 996      1688  Ciprofloxacin
## 997      1688  Ciprofloxacin
## 998      1688  Ciprofloxacin
## 999      1688  Ciprofloxacin
## 1000     1688  Ciprofloxacin
## 1001     1688  Ciprofloxacin
## 1002     1688  Ciprofloxacin
## 1003     1688  Ciprofloxacin
## 1004     1688  Ciprofloxacin
## 1005     1688  Ciprofloxacin
## 1006     1688  Ciprofloxacin
## 1007     1688  Ciprofloxacin
## 1008     1688  Ciprofloxacin
## 1729     1692   Tetracyclin
## 1730     1692   Tetracyclin
## 1731     1692   Tetracyclin
## 1732     1692   Tetracyclin
## 1733     1692   Tetracyclin
## 1734     1692   Tetracyclin
## 1735     1692   Tetracyclin
## 1736     1692   Tetracyclin
## 1737     1692   Tetracyclin
## 1738     1692   Tetracyclin
## 1739     1692   Tetracyclin
## 1740     1692   Tetracyclin
## 1741     1692   Tetracyclin
## 1742     1692   Tetracyclin
## 1743     1692   Tetracyclin
## 1744     1692   Tetracyclin
## 1745     1692   Tetracyclin
## 1746     1692   Tetracyclin
## 1747     1692   Tetracyclin
## 1748     1692   Tetracyclin
## 1749     1692   Tetracyclin
```

```
## 1750    1692    Tetracyclin
## 1751    1692    Tetracyclin
## 1752    1692    Tetracyclin
## 1753    1692    Tetracyclin
## 1754    1692    Tetracyclin
## 1755    1692    Tetracyclin
## 1756    1692    Tetracyclin
## 1757    1692    Tetracyclin
## 1758    1692    Tetracyclin
## 1759    1692    Tetracyclin
## 1760    1692    Tetracyclin
## 1761    1692    Tetracyclin
## 1762    1692    Tetracyclin
## 1763    1692    Tetracyclin
## 1764    1692    Tetracyclin
## 1765    1692    Tetracyclin
## 1766    1692    Tetracyclin
## 1767    1692    Tetracyclin
## 1768    1692    Tetracyclin
## 1769    1692    Tetracyclin
## 1770    1692    Tetracyclin
## 1771    1692    Tetracyclin
## 1772    1692    Tetracyclin
## 1773    1692    Tetracyclin
## 1774    1692    Tetracyclin
## 1775    1692    Tetracyclin
## 1776    1692    Tetracyclin
## 2497    1699    Vancomycin
## 2498    1699    Vancomycin
## 2499    1699    Vancomycin
## 2500    1699    Vancomycin
## 2501    1699    Vancomycin
## 2502    1699    Vancomycin
## 2503    1699    Vancomycin
## 2504    1699    Vancomycin
## 2505    1699    Vancomycin
## 2506    1699    Vancomycin
## 2507    1699    Vancomycin
## 2508    1699    Vancomycin
## 2509    1699    Vancomycin
## 2510    1699    Vancomycin
## 2511    1699    Vancomycin
## 2512    1699    Vancomycin
## 2513    1699    Vancomycin
## 2514    1699    Vancomycin
## 2515    1699    Vancomycin
## 2516    1699    Vancomycin
## 2517    1699    Vancomycin
## 2518    1699    Vancomycin
## 2519    1699    Vancomycin
## 2520    1699    Vancomycin
## 2521    1699    Vancomycin
## 2522    1699    Vancomycin
## 2523    1699    Vancomycin
```

```
## 2524    1699    Vancomycin
## 2525    1699    Vancomycin
## 2526    1699    Vancomycin
## 2527    1699    Vancomycin
## 2528    1699    Vancomycin
## 2529    1699    Vancomycin
## 2530    1699    Vancomycin
## 2531    1699    Vancomycin
## 2532    1699    Vancomycin
## 2533    1699    Vancomycin
## 2534    1699    Vancomycin
## 2535    1699    Vancomycin
## 2536    1699    Vancomycin
## 2537    1699    Vancomycin
## 2538    1699    Vancomycin
## 2539    1699    Vancomycin
## 2540    1699    Vancomycin
## 2541    1699    Vancomycin
## 2542    1699    Vancomycin
## 2543    1699    Vancomycin
## 2544    1699    Vancomycin
```

## 8. Stretch idea (optional)

```
day30 <- long_df[long_df$day == 30, ]
medians_day30 <- tapply(day30$value, day30$Genome, median, na.rm = TRUE)
medians_day30

## Akkermansia_muciniphila_YL44    Bacteroides_caecimuris_I48
##                               0.124955                      0.030887
##       Turicimonas_muris_YL45
##                               0.250000

medians_day30[which.max(medians_day30)]
```

```
## Turicimonas_muris_YL45
##                           0.25
```

Feel free to compare your answers with these outputs, then proceed to `scripts/02_simple_heatmap.Rmd`.