Fisher's Exact Test of Independence

When to use it
Null hypothesis
How the test works

See the *Handbook* for information on these topics.

Post-hoc tests

For the following example of post-hoc pairwise testing, we'll use the *fisher.multcomp* function from the package *RVAideMemoire* to make the task easier. Then we'll use *pairwise.table* in the native *stats* package as an alternative.

Post-hoc pairwise Fisher's exact tests with RVAideMemoire

```
### --------------------------------------------------------------
### Post-hoc example, Fisher's exact test, p. 79
### --------------------------------------------------------------

Input =("
Frequency  Damaged  Undamaged
Daily       1        24
Weekly      5        20
Monthly    14        11
Quarterly  11        14
")

Matriz = as.matrix(read.table(textConnection(Input),
                   header=TRUE,
                   row.names=1))

Matriz

fisher.test(Matriz,
            alternative="two.sided")

   p-value = 0.0001228
   alternative hypothesis: two.sided
```

```
library(rcompanion)

PT = pairwiseNominalIndependence(Matriz,
                                 fisher = TRUE,
                                 gtest  = FALSE,
                                 chisq  = FALSE,
                                 digits = 3)

PT

           Comparison p.Fisher p.adj.Fisher
1      Daily : Weekly 0.189000     0.227000
2     Daily : Monthly 0.000102     0.000612
3   Daily : Quarterly 0.001920     0.005760
4    Weekly : Monthly 0.018600     0.037200
5  Weekly : Quarterly 0.128000     0.192000
6 Monthly : Quarterly 0.572000     0.572000


library(rcompanion)

cldList(comparison = PT$Comparison,
        p.value    = PT$p.adj.Fisher,
        threshold  = 0.05)

      Group Letter MonoLetter
1     Daily      a         a
2    Weekly     ab        ab
3   Monthly      c         c
4 Quarterly     bc        bc

   Summary of results

   Frequency  Damaged  Letter
   Daily        4%     a
   Weekly     20%      ab
   Quarterly  44%       bc
   Monthly    56%        c

   Groups sharing a letter are not significantlt different (alpha = 0.05)
```

#   #   #

Assumptions

See the *Handbook* for information on this topic.

Examples

Examples of Fisher's exact test with data in a matrix

```
### --------------------------------------------------------------
### Chipmunk example, Fisher's exact test, p. 80
### --------------------------------------------------------------
```

```
Input =("
Distance    Trill  No.trill
 10m        16      8
 100m        3     18
")

Matriz = as.matrix(read.table(textConnection(Input),
                   header=TRUE,
                   row.names=1))

Matriz

fisher.test(Matriz,
            alternative="two.sided")

   p-value = 0.0006862
```

\#   \#   \#

```
### --------------------------------------------------------------
### Drosophila example, Fisher’s exact test, p. 81
### --------------------------------------------------------------

Input =("
Variation             Synonymous  Replacement
 'Polymorphisms'      43          2
 'Fixed differences'  17          7
")

Matriz = as.matrix(read.table(textConnection(Input),
                   header=TRUE,
                   row.names=1))

Matriz

fisher.test(Matriz,
            alternative="two.sided")


   p-value = 0.006653
```

\#   \#   \#

```
### --------------------------------------------------------------
### King penguin example, Fisher’s exact test, p. 81
### --------------------------------------------------------------

Input =("
 Site     Alive  Dead
 Lower    43     7
 Middle   44     6
 Upper    49     1
")

Matriz = as.matrix(read.table(textConnection(Input),
                   header=TRUE,
                   row.names=1))
```

```
Matriz

fisher.test(Matriz,
            alternative="two.sided")

   p-value = 0.08963
   alternative hypothesis: two.sided
```

# # #

```
### --------------------------------------------------------------
### Moray eel example, Fisher’s exact test, pp. 81-82
### --------------------------------------------------------------

Input =("

 Site     G.moringa  G.vicinus
 Grass    127        116
 Sand      99         67
 Border   264        161
")

Matriz = as.matrix(read.table(textConnection(Input),
                   header=TRUE,
                   row.names=1))

Matriz

fisher.test(Matriz,
            alternative="two.sided")

   p-value = 0.04438
   alternative hypothesis: two.sided
```

# # #

```
### --------------------------------------------------------------
### Herons example, Fisher’s exact test, p. 82
### --------------------------------------------------------------

Input =("
 Site          Heron  Egret
 Vegetation    15     8
 Shoreline     20     5
 Water         14     7
 Structures     6     1
")

Matriz = as.matrix(read.table(textConnection(Input),
                   header=TRUE,
                   row.names=1))

Matriz

fisher.test(Matriz,
            alternative="two.sided")
```

```
p-value = 0.5491
alternative hypothesis: two.sided
```

# # #

Graphing the results

Graphing is discussed above in the “Chi-square Test of Independence” section.

Similar tests – McNemar’s test

Care is needed in setting up the data for McNemar’s test. For a before-and-after test, the contingency table is set-up as before and after as row and column headings, or vice-versa. Note that the total observations in the contingency table is equal to the number of experimental units. That is, in the following example there are 62 men, and the sum of the counts in the contingency table is 62. If you set up the table incorrectly, you might end with double this number, and this will not yield the correct results.

McNemar’s test with data in a matrix

```
### --------------------------------------------------------------
### Dysfunction example, McNemar test, pp. 82-83
### --------------------------------------------------------------

Input =("
 Row         After.no  After.yes
 Before.no    46        10
 Before.yes    0         6
")

Matriz = as.matrix(read.table(textConnection(Input),
                   header=TRUE,
                   row.names=1))

Matriz

mcnemar.test(Matriz, correct=FALSE)

   McNemar's chi-squared = 10, df = 1, p-value = 0.001565
```

# # #

McNemar’s test with data in a data frame

```
### --------------------------------------------------------------
### Dysfunction example, McNemar test, pp. 82-83
###    Example using cross-tabulation
### --------------------------------------------------------------

Input =("
ED.before  ED.after  Count
 no         no        46
 no         yes       10
 yes        no         0
 yes        yes        6
")
```

```
")

Data = read.table(textConnection(Input),header=TRUE)

Data.xtabs = xtabs(Count ~ ED.before + ED.after, data=Data)

Data.xtabs

            ED.after
   ED.before   no   yes
          no   46    10
          yes   0     6

mcnemar.test(Data.xtabs, correct=FALSE)

   McNemar's chi-squared = 10, df = 1, p-value = 0.001565
```

# # #

How to do the test

Fisher's exact test with data as a data frame

```
### --------------------------------------------------------------
### Chipmunk example, Fisher's exact test, SAS example, p. 83
###      Example using cross-tabulation
### --------------------------------------------------------------

Input =("
Distance    Sound   Count
 10m        trill   16
 10m        notrill  8
 100m       trill    3
 100m       notrill 18
")

Data = read.table(textConnection(Input), header=TRUE)

Data.xtabs = xtabs(Count ~ Distance + Sound, data=Data)

Data.xtabs

           Sound
   Distance notrill trill
       100m      18     3
       10m        8    16

summary(Data.xtabs)


### Fisher's exact test of independence

fisher.test(Data.xtabs,
            alternative="two.sided")

   p-value = 0.0006862
```

# # #

```
### --------------------------------------------------------------
### Bird example, Fisher's exact test, SAS example, p. 84
###      Example using cross-tabulation
### --------------------------------------------------------------

Input =("

Bird    Substrate   Count
 heron  vegetation  15
 heron  shoreline   20
 heron  water       14
 heron  structures   6
 egret  vegetation   8
 egret  shoreline    5
 egret  water        7
 egret  structures   1
")

Data = read.table(textConnection(Input), header=TRUE)

Data.xtabs = xtabs(Count ~ Bird + Substrate, data=Data)

Data.xtabs

          Substrate
   Bird    shoreline structures vegetation water
     egret         5          1          8     7
     heron        20          6         15    14


summary(Data.xtabs)


### Fisher's exact test of independence

fisher.test(Data.xtabs,
            alternative="two.sided")

   p-value = 0.5491
   alternative hypothesis: two.sided
```

# # #

Power analysis

To calculate power or required samples, follow examples in the "Chi-square Test of Independence" section.

There, the result was

```
   N = 1640.537     # Total observations
```

compared with the value in the *Handbook* of N_{total} = 1523 for this section.