TP 2 estimation des effectifs en populations fermées avec données simulées

On charge le package `RMark` qui appelle le logiciel Mark depuis `R`. On charge aussi le package `secr` qui permet d'implémenter le test de `closure`.

```
library(RMark)
library(secr)
```

Simulation des données

On construit une fonction qui va nous permettre de simuler des données selon une population fermée avec un certain nombre d'occasions, deux groupes (mâles et femelles par exemple), un effet du comportement sur la détection, et des effets temps.

```
sim.closedCR <- function(n_ind, n_occ, prob_first_capt, prob_recapt, filename){
  # if one group only
  if (length(prob_first_capt) == 1 & length(prob_recapt) == 1){
  y <- matrix(0, nrow = n_ind, ncol = n_occ)
              for (i in 1:n_ind){
                for (j in 1:n_occ){
                  # if first occasion of the study, then apply prob_first_capt
                  if (j == 1) y[i,j] <- rbinom(1, 1, prob_first_capt)
                  # if not first occasion of the study, and no previous capture, then apply prob_first_
                  if (j > 1 & sum(y[i, 1:(j-1)]) == 0) y[i,j] <- rbinom(1, 1, prob_first_capt)
                  # if not first occasion of the study, and a previous capture occurred, then apply pro
                  if (j > 1 & sum(y[i, 1:(j-1)]) > 0) y[i,j] <- rbinom(1, 1, prob_recapt)
                }
              }
              # get rid of individuals never captured
              mat <- data.frame(ch = y[apply(y, 1, sum) > 0,])
              res <- paste0(as.vector(t(tidyr::unite(mat, col = "ch", sep = ""))), " 1;")
              write.table(res,
                          row.names = FALSE,
                          col.names = FALSE,
                          quote = FALSE,
                          file = filename)
  }
  # if one group only
  if (length(prob_first_capt) > 1 | length(prob_recapt) > 1){
  # group 1
  y <- matrix(0, nrow = n_ind[1], ncol = n_occ)
              for (i in 1:n_ind[1]){
                for (j in 1:n_occ){
                  # if first occasion of the study, then apply prob_first_capt
```

```
                if (j == 1) y[i,j] <- rbinom(1, 1, prob_first_capt[1])
                # if not first occasion of the study, and no previous capture, then apply prob_first_
                if (j > 1 & sum(y[i, 1:(j-1)]) == 0) y[i,j] <- rbinom(1, 1, prob_first_capt[1])
                # if not first occasion of the study, and a previous capture occurred, then apply pro
                if (j > 1 & sum(y[i, 1:(j-1)]) > 0) y[i,j] <- rbinom(1, 1, prob_recapt[1])
              }
            }
  y1 <- y
  # group 2
  y <- matrix(0, nrow = n_ind[2], ncol = n_occ)
            for (i in 1:n_ind[2]){
              for (j in 1:n_occ){
                # if first occasion of the study, then apply prob_first_capt
                if (j == 1) y[i,j] <- rbinom(1, 1, prob_first_capt[2])
                # if not first occasion of the study, and no previous capture, then apply prob_first_
                if (j > 1 & sum(y[i, 1:(j-1)]) == 0) y[i,j] <- rbinom(1, 1, prob_first_capt[2])
                # if not first occasion of the study, and a previous capture occurred, then apply pro
                if (j > 1 & sum(y[i, 1:(j-1)]) > 0) y[i,j] <- rbinom(1, 1, prob_recapt[2])
              }
            }
  y2 <- y
  # get rid of individuals never captured
  mat1 <- data.frame(ch = y1[apply(y1, 1, sum) > 0,])
  mat2 <- data.frame(ch = y2[apply(y2, 1, sum) > 0,])
  res1 <- paste0(as.vector(t(tidyr::unite(mat1, col = "ch", sep = ""))), " 1 0;")
  res2 <- paste0(as.vector(t(tidyr::unite(mat2, col = "ch", sep = ""))), " 0 1;")
  res <- c(res1, res2)
  write.table(res,
              row.names = FALSE,
              col.names = FALSE,
              quote = FALSE,
              file = filename)
  }
res
}
```

Simulation avec un groupe.

```
sim.closedCR(n_ind = 500,
             n_occ = 6,
             prob_first_capt = 0.7,
             prob_recapt = 0.2,
             filename = "dat/sim.un.groupe.inp")
```

```
##   [1] "110010 1;" "010000 1;" "010010 1;" "100010 1;" "011000 1;" "100001 1;"
##   [7] "001000 1;" "110001 1;" "010000 1;" "100001 1;" "000010 1;" "100010 1;"
##  [13] "101100 1;" "011000 1;" "000100 1;" "100110 1;" "010111 1;" "000100 1;"
##  [19] "100100 1;" "101110 1;" "100000 1;" "100000 1;" "101000 1;" "100000 1;"
##  [25] "100010 1;" "011000 1;" "100101 1;" "100010 1;" "100000 1;" "100000 1;"
##  [31] "010000 1;" "110000 1;" "001001 1;" "100001 1;" "010011 1;" "100000 1;"
##  [37] "110000 1;" "010001 1;" "101000 1;" "010001 1;" "100010 1;" "100001 1;"
##  [43] "001010 1;" "100110 1;" "101000 1;" "100000 1;" "001011 1;" "010101 1;"
##  [49] "100000 1;" "001001 1;" "100001 1;" "110000 1;" "110001 1;" "100001 1;"
```

```
##  [55] "001010 1;" "010011 1;" "101010 1;" "101000 1;" "010000 1;" "000100 1;"
##  [61] "100100 1;" "110000 1;" "100001 1;" "100000 1;" "000100 1;" "101100 1;"
##  [67] "100011 1;" "010100 1;" "001001 1;" "100000 1;" "100100 1;" "101100 1;"
##  [73] "100100 1;" "100100 1;" "110001 1;" "110100 1;" "100010 1;" "100000 1;"
##  [79] "010000 1;" "100010 1;" "100001 1;" "110000 1;" "010110 1;" "100001 1;"
##  [85] "100000 1;" "100000 1;" "100000 1;" "101000 1;" "110000 1;" "000100 1;"
##  [91] "100101 1;" "101010 1;" "100010 1;" "110000 1;" "100000 1;" "100000 1;"
##  [97] "101001 1;" "100010 1;" "010010 1;" "110000 1;" "010000 1;" "010000 1;"
## [103] "100000 1;" "010000 1;" "010000 1;" "110001 1;" "100000 1;" "000100 1;"
## [109] "010100 1;" "100000 1;" "111000 1;" "100000 1;" "001000 1;" "100000 1;"
## [115] "001010 1;" "100001 1;" "100000 1;" "100000 1;" "000100 1;" "000010 1;"
## [121] "001000 1;" "100101 1;" "110110 1;" "100011 1;" "100000 1;" "100000 1;"
## [127] "101100 1;" "110000 1;" "100010 1;" "010010 1;" "111001 1;" "100000 1;"
## [133] "100011 1;" "001100 1;" "110000 1;" "010010 1;" "001000 1;" "100000 1;"
## [139] "101100 1;" "100001 1;" "000100 1;" "011001 1;" "111000 1;" "100000 1;"
## [145] "010001 1;" "100011 1;" "001000 1;" "101000 1;" "100000 1;" "010000 1;"
## [151] "100010 1;" "100000 1;" "101100 1;" "011010 1;" "100000 1;" "100000 1;"
## [157] "100000 1;" "001000 1;" "100100 1;" "100010 1;" "110000 1;" "010000 1;"
## [163] "111110 1;" "100100 1;" "111100 1;" "100000 1;" "100000 1;" "100100 1;"
## [169] "100000 1;" "100000 1;" "100110 1;" "100010 1;" "011100 1;" "010000 1;"
## [175] "000011 1;" "110100 1;" "111001 1;" "100101 1;" "110000 1;" "101000 1;"
## [181] "000100 1;" "101001 1;" "101101 1;" "101011 1;" "110000 1;" "010010 1;"
## [187] "100000 1;" "100100 1;" "100100 1;" "010000 1;" "010000 1;" "100000 1;"
## [193] "100000 1;" "100010 1;" "110101 1;" "011000 1;" "000110 1;" "100101 1;"
## [199] "111110 1;" "100011 1;" "100011 1;" "100000 1;" "100000 1;" "100100 1;"
## [205] "110000 1;" "101010 1;" "100010 1;" "110000 1;" "010010 1;" "110001 1;"
## [211] "101000 1;" "100000 1;" "001011 1;" "010000 1;" "110000 1;" "100110 1;"
## [217] "001000 1;" "100000 1;" "001000 1;" "100110 1;" "100011 1;" "100000 1;"
## [223] "100100 1;" "010000 1;" "101000 1;" "100010 1;" "100100 1;" "001001 1;"
## [229] "001000 1;" "100100 1;" "010110 1;" "010000 1;" "110000 1;" "010100 1;"
## [235] "100001 1;" "100100 1;" "100000 1;" "110001 1;" "100000 1;" "001000 1;"
## [241] "100000 1;" "101101 1;" "110010 1;" "100001 1;" "100000 1;" "101000 1;"
## [247] "100001 1;" "101001 1;" "110000 1;" "010000 1;" "100100 1;" "010000 1;"
## [253] "111000 1;" "101000 1;" "100100 1;" "100100 1;" "001000 1;" "010000 1;"
## [259] "011000 1;" "111001 1;" "101000 1;" "111010 1;" "100001 1;" "100000 1;"
## [265] "010000 1;" "010010 1;" "111000 1;" "100000 1;" "010000 1;" "100110 1;"
## [271] "010000 1;" "110001 1;" "100010 1;" "101000 1;" "110000 1;" "010000 1;"
## [277] "100000 1;" "101001 1;" "100010 1;" "010000 1;" "100000 1;" "110000 1;"
## [283] "100000 1;" "100000 1;" "110000 1;" "100000 1;" "100100 1;" "100000 1;"
## [289] "100001 1;" "101000 1;" "100000 1;" "010000 1;" "111000 1;" "111000 1;"
## [295] "010000 1;" "010101 1;" "010000 1;" "100100 1;" "010000 1;" "100000 1;"
## [301] "110000 1;" "110000 1;" "010000 1;" "100000 1;" "101100 1;" "110000 1;"
## [307] "100000 1;" "010000 1;" "011000 1;" "001010 1;" "000100 1;" "011100 1;"
## [313] "000001 1;" "000111 1;" "100000 1;" "010100 1;" "010010 1;" "010001 1;"
## [319] "100001 1;" "100010 1;" "100000 1;" "110000 1;" "010000 1;" "100000 1;"
## [325] "110001 1;" "001001 1;" "100000 1;" "100100 1;" "010100 1;" "100000 1;"
## [331] "001010 1;" "111000 1;" "100010 1;" "100000 1;" "101000 1;" "110001 1;"
## [337] "100100 1;" "100000 1;" "100000 1;" "010000 1;" "001000 1;" "101100 1;"
## [343] "100011 1;" "010010 1;" "100101 1;" "101000 1;" "100000 1;" "100000 1;"
## [349] "100101 1;" "100100 1;" "010001 1;" "010100 1;" "011101 1;" "100001 1;"
## [355] "000110 1;" "010000 1;" "100000 1;" "010010 1;" "000110 1;" "010001 1;"
## [361] "100000 1;" "010000 1;" "000010 1;" "101100 1;" "000100 1;" "100000 1;"
## [367] "101000 1;" "100100 1;" "011000 1;" "000010 1;" "001000 1;" "100101 1;"
## [373] "010000 1;" "100000 1;" "010000 1;" "101000 1;" "010000 1;" "100000 1;"
```

```
## [379] "011100 1;" "101000 1;" "010000 1;" "100001 1;" "100111 1;" "001000 1;"
## [385] "010000 1;" "101010 1;" "100010 1;" "001000 1;" "100001 1;" "110010 1;"
## [391] "100100 1;" "100100 1;" "110000 1;" "010000 1;" "001100 1;" "110001 1;"
## [397] "001001 1;" "100000 1;" "000010 1;" "010100 1;" "101100 1;" "110001 1;"
## [403] "100000 1;" "100000 1;" "100100 1;" "100000 1;" "100000 1;" "100010 1;"
## [409] "100100 1;" "110000 1;" "011100 1;" "100100 1;" "100010 1;" "011000 1;"
## [415] "100011 1;" "100100 1;" "110000 1;" "101000 1;" "100001 1;" "000100 1;"
## [421] "100010 1;" "100101 1;" "110000 1;" "100110 1;" "001101 1;" "110100 1;"
## [427] "100010 1;" "110000 1;" "100001 1;" "101100 1;" "111001 1;" "010100 1;"
## [433] "110000 1;" "110010 1;" "100000 1;" "100000 1;" "010000 1;" "110000 1;"
## [439] "010110 1;" "110000 1;" "101000 1;" "100000 1;" "110110 1;" "100000 1;"
## [445] "110010 1;" "011010 1;" "100100 1;" "001110 1;" "100000 1;" "100010 1;"
## [451] "100010 1;" "100000 1;" "101000 1;" "010000 1;" "001000 1;" "011001 1;"
## [457] "100001 1;" "111001 1;" "010010 1;" "110001 1;" "110010 1;" "100010 1;"
## [463] "100100 1;" "101000 1;" "100100 1;" "100001 1;" "101000 1;" "100001 1;"
## [469] "010000 1;" "010000 1;" "011000 1;" "110001 1;" "100100 1;" "100000 1;"
## [475] "100000 1;" "100000 1;" "100110 1;" "100000 1;" "100000 1;" "100000 1;"
## [481] "100100 1;" "100000 1;" "010000 1;" "110000 1;" "010101 1;" "100000 1;"
## [487] "001011 1;" "000010 1;" "100001 1;" "010000 1;" "100000 1;" "100000 1;"
## [493] "110000 1;" "100100 1;" "100000 1;" "010010 1;" "100101 1;" "111001 1;"
## [499] "101001 1;" "100001 1;"
```

Simulation avec deux groupes.

```
sim.closedCR(n_ind = c(200, 300),
             n_occ = 6,
             prob_first_capt = c(0.7, 0.7),
             prob_recapt = c(0.2, 0.6),
             filename = "dat/sim.deux.groupes.inp")
```

```
##   [1] "010010 1 0;" "100000 1 0;" "100000 1 0;" "101000 1 0;" "100111 1 0;"
##   [6] "100000 1 0;" "100000 1 0;" "100001 1 0;" "010000 1 0;" "010001 1 0;"
##  [11] "101100 1 0;" "010000 1 0;" "100010 1 0;" "100000 1 0;" "100000 1 0;"
##  [16] "110011 1 0;" "101000 1 0;" "100110 1 0;" "100000 1 0;" "100001 1 0;"
##  [21] "110010 1 0;" "100000 1 0;" "110001 1 0;" "011000 1 0;" "001011 1 0;"
##  [26] "010000 1 0;" "110010 1 0;" "100101 1 0;" "100110 1 0;" "110000 1 0;"
##  [31] "100101 1 0;" "010001 1 0;" "110001 1 0;" "100001 1 0;" "010101 1 0;"
##  [36] "100011 1 0;" "100000 1 0;" "010011 1 0;" "100000 1 0;" "011000 1 0;"
##  [41] "000100 1 0;" "100010 1 0;" "100000 1 0;" "001000 1 0;" "100000 1 0;"
##  [46] "100000 1 0;" "110000 1 0;" "110010 1 0;" "110000 1 0;" "100010 1 0;"
##  [51] "110000 1 0;" "111000 1 0;" "100110 1 0;" "100000 1 0;" "100000 1 0;"
##  [56] "100000 1 0;" "110000 1 0;" "111010 1 0;" "010000 1 0;" "100000 1 0;"
##  [61] "010000 1 0;" "100000 1 0;" "110000 1 0;" "100000 1 0;" "110010 1 0;"
##  [66] "001000 1 0;" "100000 1 0;" "100101 1 0;" "100000 1 0;" "010000 1 0;"
##  [71] "010000 1 0;" "100000 1 0;" "110000 1 0;" "111001 1 0;" "010000 1 0;"
##  [76] "100110 1 0;" "100011 1 0;" "111000 1 0;" "100000 1 0;" "100000 1 0;"
##  [81] "100110 1 0;" "010010 1 0;" "100010 1 0;" "101110 1 0;" "100000 1 0;"
##  [86] "100010 1 0;" "100100 1 0;" "100000 1 0;" "100010 1 0;" "100010 1 0;"
##  [91] "100001 1 0;" "100010 1 0;" "100001 1 0;" "001000 1 0;" "111011 1 0;"
##  [96] "100100 1 0;" "100010 1 0;" "101100 1 0;" "001101 1 0;" "101010 1 0;"
## [101] "011001 1 0;" "001000 1 0;" "001001 1 0;" "100010 1 0;" "100000 1 0;"
## [106] "100110 1 0;" "100000 1 0;" "100010 1 0;" "111000 1 0;" "100000 1 0;"
## [111] "100000 1 0;" "100001 1 0;" "100000 1 0;" "110100 1 0;" "000100 1 0;"
```

```
## [116] "100001 1 0;" "100001 1 0;" "100001 1 0;" "010000 1 0;" "101001 1 0;"
## [121] "010000 1 0;" "100000 1 0;" "100010 1 0;" "100010 1 0;" "101000 1 0;"
## [126] "111000 1 0;" "101000 1 0;" "101000 1 0;" "100000 1 0;" "101010 1 0;"
## [131] "100001 1 0;" "100000 1 0;" "010100 1 0;" "010000 1 0;" "110110 1 0;"
## [136] "100000 1 0;" "010010 1 0;" "100000 1 0;" "011001 1 0;" "100000 1 0;"
## [141] "110001 1 0;" "001100 1 0;" "100011 1 0;" "100100 1 0;" "010000 1 0;"
## [146] "110000 1 0;" "100011 1 0;" "100010 1 0;" "100010 1 0;" "010000 1 0;"
## [151] "001000 1 0;" "100000 1 0;" "100100 1 0;" "100000 1 0;" "101001 1 0;"
## [156] "101000 1 0;" "001010 1 0;" "100000 1 0;" "010100 1 0;" "100110 1 0;"
## [161] "101011 1 0;" "010000 1 0;" "010001 1 0;" "010110 1 0;" "001010 1 0;"
## [166] "010000 1 0;" "010000 1 0;" "011001 1 0;" "110000 1 0;" "100110 1 0;"
## [171] "111011 1 0;" "100011 1 0;" "100100 1 0;" "010000 1 0;" "001000 1 0;"
## [176] "100001 1 0;" "001001 1 0;" "001010 1 0;" "101000 1 0;" "110000 1 0;"
## [181] "110000 1 0;" "010000 1 0;" "100000 1 0;" "100110 1 0;" "100000 1 0;"
## [186] "100001 1 0;" "100000 1 0;" "010000 1 0;" "101100 1 0;" "001000 1 0;"
## [191] "100000 1 0;" "100010 1 0;" "100000 1 0;" "101000 1 0;" "101100 1 0;"
## [196] "011100 1 0;" "010000 1 0;" "100101 1 0;" "111000 1 0;" "100001 1 0;"
## [201] "010111 0 1;" "101110 0 1;" "100111 0 1;" "111010 0 1;" "110111 0 1;"
## [206] "100101 0 1;" "001110 0 1;" "101000 0 1;" "110110 0 1;" "001111 0 1;"
## [211] "110001 0 1;" "111010 0 1;" "011111 0 1;" "100101 0 1;" "010110 0 1;"
## [216] "101111 0 1;" "111010 0 1;" "110110 0 1;" "110110 0 1;" "111111 0 1;"
## [221] "110101 0 1;" "111001 0 1;" "011111 0 1;" "110101 0 1;" "111100 0 1;"
## [226] "010110 0 1;" "111011 0 1;" "011101 0 1;" "011100 0 1;" "001100 0 1;"
## [231] "101111 0 1;" "110000 0 1;" "001000 0 1;" "111101 0 1;" "110111 0 1;"
## [236] "111110 0 1;" "101101 0 1;" "000111 0 1;" "010111 0 1;" "101101 0 1;"
## [241] "110111 0 1;" "101010 0 1;" "001110 0 1;" "011111 0 1;" "111111 0 1;"
## [246] "110010 0 1;" "100001 0 1;" "111111 0 1;" "100001 0 1;" "011111 0 1;"
## [251] "000101 0 1;" "110011 0 1;" "111010 0 1;" "011111 0 1;" "001100 0 1;"
## [256] "111111 0 1;" "101000 0 1;" "110011 0 1;" "100100 0 1;" "101101 0 1;"
## [261] "100101 0 1;" "100101 0 1;" "101100 0 1;" "101011 0 1;" "110101 0 1;"
## [266] "101110 0 1;" "110000 0 1;" "110011 0 1;" "011101 0 1;" "101011 0 1;"
## [271] "111011 0 1;" "011100 0 1;" "111011 0 1;" "111101 0 1;" "101000 0 1;"
## [276] "110101 0 1;" "100111 0 1;" "111110 0 1;" "010110 0 1;" "111001 0 1;"
## [281] "111101 0 1;" "110001 0 1;" "100110 0 1;" "001000 0 1;" "111011 0 1;"
## [286] "111111 0 1;" "111111 0 1;" "110101 0 1;" "010011 0 1;" "101000 0 1;"
## [291] "111110 0 1;" "101111 0 1;" "111110 0 1;" "100110 0 1;" "110100 0 1;"
## [296] "101010 0 1;" "111101 0 1;" "010101 0 1;" "100101 0 1;" "011101 0 1;"
## [301] "110101 0 1;" "011111 0 1;" "101100 0 1;" "101101 0 1;" "001111 0 1;"
## [306] "001010 0 1;" "111111 0 1;" "111011 0 1;" "110110 0 1;" "111100 0 1;"
## [311] "111010 0 1;" "100101 0 1;" "011001 0 1;" "001111 0 1;" "110110 0 1;"
## [316] "111111 0 1;" "110111 0 1;" "111101 0 1;" "100000 0 1;" "111010 0 1;"
## [321] "101001 0 1;" "011101 0 1;" "111011 0 1;" "111011 0 1;" "111000 0 1;"
## [326] "111100 0 1;" "111101 0 1;" "111111 0 1;" "011011 0 1;" "010110 0 1;"
## [331] "111111 0 1;" "101010 0 1;" "111000 0 1;" "101001 0 1;" "011111 0 1;"
## [336] "110100 0 1;" "111010 0 1;" "110011 0 1;" "100110 0 1;" "110110 0 1;"
## [341] "101110 0 1;" "100010 0 1;" "110110 0 1;" "111101 0 1;" "111111 0 1;"
## [346] "110101 0 1;" "011111 0 1;" "010001 0 1;" "011100 0 1;" "101110 0 1;"
## [351] "001110 0 1;" "110111 0 1;" "101000 0 1;" "100111 0 1;" "111110 0 1;"
## [356] "111111 0 1;" "010111 0 1;" "100000 0 1;" "101111 0 1;" "111011 0 1;"
## [361] "011101 0 1;" "100011 0 1;" "010000 0 1;" "011111 0 1;" "111111 0 1;"
## [366] "100111 0 1;" "001100 0 1;" "100101 0 1;" "011000 0 1;" "110111 0 1;"
## [371] "111011 0 1;" "011101 0 1;" "100111 0 1;" "110010 0 1;" "110100 0 1;"
## [376] "010110 0 1;" "101011 0 1;" "110001 0 1;" "011001 0 1;" "010101 0 1;"
## [381] "100110 0 1;" "010111 0 1;" "101111 0 1;" "100111 0 1;" "011010 0 1;"
```

```
## [386] "010000 0 1;" "011101 0 1;" "011101 0 1;" "101110 0 1;" "111010 0 1;"
## [391] "101111 0 1;" "100111 0 1;" "100100 0 1;" "010100 0 1;" "110111 0 1;"
## [396] "111101 0 1;" "011010 0 1;" "111011 0 1;" "110110 0 1;" "110100 0 1;"
## [401] "110111 0 1;" "111111 0 1;" "111110 0 1;" "110011 0 1;" "010100 0 1;"
## [406] "010011 0 1;" "011110 0 1;" "111011 0 1;" "010110 0 1;" "111111 0 1;"
## [411] "111101 0 1;" "100011 0 1;" "110110 0 1;" "010001 0 1;" "100011 0 1;"
## [416] "110110 0 1;" "011100 0 1;" "011100 0 1;" "001111 0 1;" "011111 0 1;"
## [421] "101101 0 1;" "111011 0 1;" "100110 0 1;" "100101 0 1;" "111110 0 1;"
## [426] "010110 0 1;" "111101 0 1;" "010100 0 1;" "101011 0 1;" "111110 0 1;"
## [431] "111110 0 1;" "111101 0 1;" "110101 0 1;" "110011 0 1;" "010010 0 1;"
## [436] "101000 0 1;" "111001 0 1;" "110011 0 1;" "110011 0 1;" "101010 0 1;"
## [441] "110100 0 1;" "011001 0 1;" "011011 0 1;" "010100 0 1;" "011111 0 1;"
## [446] "111001 0 1;" "110111 0 1;" "110011 0 1;" "111111 0 1;" "001111 0 1;"
## [451] "010101 0 1;" "010111 0 1;" "111011 0 1;" "111011 0 1;" "101011 0 1;"
## [456] "101001 0 1;" "101111 0 1;" "111110 0 1;" "110101 0 1;" "000110 0 1;"
## [461] "111111 0 1;" "111000 0 1;" "111111 0 1;" "101011 0 1;" "011010 0 1;"
## [466] "010110 0 1;" "111001 0 1;" "010001 0 1;" "101011 0 1;" "111011 0 1;"
## [471] "101010 0 1;" "111111 0 1;" "010100 0 1;" "101011 0 1;" "111111 0 1;"
## [476] "110011 0 1;" "101101 0 1;" "111111 0 1;" "100010 0 1;" "111001 0 1;"
## [481] "111001 0 1;" "100001 0 1;" "111011 0 1;" "101101 0 1;" "100111 0 1;"
## [486] "100110 0 1;" "110110 0 1;" "110100 0 1;" "100100 0 1;" "001101 0 1;"
## [491] "101101 0 1;" "011101 0 1;" "101011 0 1;" "111001 0 1;" "100011 0 1;"
## [496] "111001 0 1;" "111111 0 1;" "101111 0 1;" "011111 0 1;" "101111 0 1;"
```

Ajustement un groupe

Package

```
library(RMark)
```

Lecture et formatage des données

On commence par lire les données qui se trouvent dans le répertoire dat/

```
mouse <- convert.inp("dat/sim.un.groupe.inp",
                     group.df = NULL,
                     covariates = NULL)
```

On regarde les 10 premières lignes du fichier.

```
head(mouse)
```

```
##       ch freq
## 1 110010    1
## 2 010000    1
## 3 010010    1
## 4 100010    1
## 5 011000    1
## 6 100001    1
```

Les 10 dernières lignes.

```
tail(mouse)
```

```
##         ch freq
## 495 100000    1
## 496 010010    1
## 497 100101    1
## 498 111001    1
## 499 101001    1
## 500 100001    1
```

On fait les tests de fermeture. Pour cela, il nous faut d'abord convertir les données au format requis pour utiliser le package secr qui fait ces tests. Le formatage consiste à mettre un espace entre les colonnes de capture.

```
library(secr)
mouse_secr <- unRMarkInput(mouse)
```

On peut utiliser la fonction summary de R pour obtenir un résumé des données.

```
summary(mouse_secr)
```

```
## Object class       capthist
##
## Counts by occasion
##              1   2   3   4   5   6 Total
## n          342 177 117 118 103 103   960
## u          342 100  34  16   7   1   500
## f          180 202  98  18   2   0   500
## M(t+1)     342 442 476 492 499 500   500
## losses       0   0   0   0   0   0     0
## detections 342 177 117 118 103 103   960
```

Test de l'hypothèse de fermeture

On fait enfin les tests. Par défaut, seul le test d'Otis est fait. En rajoutant l'option "SB = TRUE", on fait aussi le test de Stanley et Burnham.

```
closure.test(mouse_secr, SB = TRUE)
```

```
## $Otis
##  statistic         p
##   1.223896 0.8895042
##
## $Xc
##  statistic df            p
##   65.61094  8 3.653722e-11
##
## $NRvsJS
##  statistic df            p
```

```
##   62.75445  4 7.643886e-13
##
## $NMvsJS
##  statistic df         p
##   4.520202  4 0.3401588
##
## $MtvsNR
##  statistic df         p
##   2.856493  4 0.5821209
##
## $MtvsNM
##  statistic df            p
##   61.09074  4 1.710965e-12
##
## $compNRvsJS
##   Occasion Chisquare df           p
## 1        2 39.188650  1 3.847704e-10
## 2        3 14.860536  1 1.157596e-04
## 3        4  5.154957  1 2.318011e-02
## 4        5  3.550304  1 5.953454e-02
##
## $compNMvsJS
##   Occasion Chisquare df          p
## 1        2 3.8403466  1 0.05003318
## 2        3 0.1828602  1 0.66892667
## 3        4 0.1795814  1 0.67173323
## 4        5 0.3174133  1 0.57316629
```

Une première série de modèles

Pour utiliser RMark, on passe par 3 étapes : la préparation des données, la définition des modèles et l'ajustement à proprement parler.

On commence par préparer les données.

```
mouse.proc <- process.data(mouse,
                           begin.time = 1,
                           model = "FullHet")
mouse.ddl <- make.design.data(mouse.proc)
```

On définit les modèles que l'on souhaite ajuster grâce à une fonction R qui fait 3 choses : spéficication des effets, création d'une liste des modèles à ajuster et préparation pour envoi à Mark. Par défaut, Mark considère un effet comportement et distingue une probabilité de capture c et une autre de recapture p. On utilise "share = TRUE" pour fusionner ces deux paramètres en une seule probabilité de capture.

```
run.mouse <- function() {

## On specifie les effets

  # M0 : p constant dans le temps
  p.dot <- list(formula =  ~ 1, share = TRUE)
  # Mb : p (recapture) different de c (premiere capture) et constants dans le temps
  p.dot.behav <- list(formula =  ~ 1)
```

```
  # Mt : p varie selon la session (dans le temps)
  p.time <- list(formula =  ~ time, share = TRUE)
  # Mh : p est heterogene entre individu
  p.h <- list(formula = ~ mixture, share = TRUE)
  # Mtb
  p.time.behav <- list(formula =  ~ time)
  # Mbh
  p.h.behav <- list(formula =  ~ mixture)
  # Mth
  p.h.time <- list(formula = ~ time + mixture, share = TRUE)
  # Mtbh
  p.h.time.behav <- list(formula =  ~ mixture + time)

## On construit la liste des modeles
  mouse.model.list <- create.model.list("FullHet")

## On prépare le tout pour envoi a Mark
  mouse.results <- mark.wrapper(mouse.model.list,
                                data = mouse.proc,
                                ddl = mouse.ddl)

## On retourne les resultats
  return(mouse.results)
}
```

On fait tourner tous les modèles d'un coup.

```
mouse.results <- run.mouse()
```

```
##
## Output summary for FullHet model
## Name : pi(~1)p(~1)c()f0(~1)
##
## Npar :  3  (unadjusted=2)
## -2lnL:  -1582.743
## AICc :  -1576.735  (unadjusted=-1578.7394)
##
## Beta
##                     estimate        se           lcl           ucl
## pi:(Intercept) -0.0001106151 0.0000000 -0.0001106151 -0.0001106151
## p:(Intercept)  -0.9795549000 0.0484902 -1.0745958000 -0.8845141000
## f0:(Intercept)  4.4557801000 0.1499537  4.1618708000  4.7496893000
##
##
## Real Parameter pi
##
##
## mixture:1 0.4999723
##
##
## Real Parameter p
##
##                   1         2         3         4         5         6
```

```
## mixture:1 0.2729801 0.2729801 0.2729801 0.2729801 0.2729801 0.2729801
## mixture:2 0.2729801 0.2729801 0.2729801 0.2729801 0.2729801 0.2729801
##
##
## Real Parameter c
##
##                   2         3         4         5         6
## mixture:1 0.2729801 0.2729801 0.2729801 0.2729801 0.2729801
## mixture:2 0.2729801 0.2729801 0.2729801 0.2729801 0.2729801
##
##
## Real Parameter f0
##
##         1
##  86.12331
##
## Output summary for FullHet model
## Name : pi(~1)p(~1)c(~1)f0(~1)
##
## Npar :  4  (unadjusted=3)
## -2lnL:  -1990.395
## AICc :  -1982.382  (unadjusted=-1984.3873)
##
## Beta
##                      estimate        se           lcl           ucl
## pi:(Intercept)  1.775695e-05 0.0000000  1.775695e-05  1.775695e-05
## p:(Intercept)   6.939848e-01 0.0803403  5.365179e-01  8.514517e-01
## c:(Intercept)  -1.359303e+00 0.0522710 -1.461754e+00 -1.256852e+00
## f0:(Intercept) -2.026618e+00 6.7106022 -1.517940e+01  1.112616e+01
##
##
## Real Parameter pi
##
##
## mixture:1 0.5000044
##
##
## Real Parameter p
##
##                   1         2         3         4         5         6
## mixture:1 0.6668528 0.6668528 0.6668528 0.6668528 0.6668528 0.6668528
## mixture:2 0.6668528 0.6668528 0.6668528 0.6668528 0.6668528 0.6668528
##
##
## Real Parameter c
##
##                   2         3         4         5         6
## mixture:1 0.2043536 0.2043536 0.2043536 0.2043536 0.2043536
## mixture:2 0.2043536 0.2043536 0.2043536 0.2043536 0.2043536
##
##
## Real Parameter f0
##
##          1
```

```
##  0.1317805
##
## Output summary for FullHet model
## Name : pi(~1)p(~mixture)c()f0(~1)
##
## Npar :  4  (unadjusted=2)
## -2lnL:  -1582.743
## AICc :  -1574.73  (unadjusted=-1578.7394)
##
## Beta
##                    estimate           se          lcl         ucl
## pi:(Intercept) -16.4064290 1721.1256000 -3389.812700 3356.999900
## p:(Intercept)   -0.6424946  254.3466900  -499.162020  497.877030
## p:mixture2      -0.3370604  254.3467000  -498.856600  498.182480
## f0:(Intercept)   4.4557801    0.1499537     4.161871    4.749689
##
##
## Real Parameter pi
##
##
## mixture:1 7.495115e-08
##
##
## Real Parameter p
##
##                    1         2         3         4         5         6
## mixture:1 0.3446828 0.3446828 0.3446828 0.3446828 0.3446828 0.3446828
## mixture:2 0.2729801 0.2729801 0.2729801 0.2729801 0.2729801 0.2729801
##
##
## Real Parameter c
##
##                    2         3         4         5         6
## mixture:1 0.3446828 0.3446828 0.3446828 0.3446828 0.3446828
## mixture:2 0.2729801 0.2729801 0.2729801 0.2729801 0.2729801
##
##
## Real Parameter f0
##
##         1
##  86.12331
##
## Output summary for FullHet model
## Name : pi(~1)p(~mixture)c(~1)f0(~1)
##
## Npar :  5  (unadjusted=3)
## -2lnL:  -1992.19
## AICc :  -1982.17  (unadjusted=-1986.1824)
##
## Beta
##                   estimate         se         lcl         ucl
## pi:(Intercept)  -1.854659  0.7856544   -3.394542  -0.3147767
## p:(Intercept)   11.717758 88.7756480 -162.282520 185.7180300
## p:mixture2     -11.165995 88.7753470 -185.165680 162.8336900
```

```
## c:(Intercept)   -1.359307  0.0522711   -1.461759  -1.2568561
## f0:(Intercept) -20.406903  0.0000000  -20.406903 -20.4069030
##
##
## Real Parameter pi
##
##
## mixture:1 0.1353268
##
##
## Real Parameter p
##
##                    1         2         3         4         5         6
## mixture:1 0.9999919 0.9999919 0.9999919 0.9999919 0.9999919 0.9999919
## mixture:2 0.6345444 0.6345444 0.6345444 0.6345444 0.6345444 0.6345444
##
##
## Real Parameter c
##
##                    2         3         4         5         6
## mixture:1 0.2043529 0.2043529 0.2043529 0.2043529 0.2043529
## mixture:2 0.2043529 0.2043529 0.2043529 0.2043529 0.2043529
##
##
## Real Parameter f0
##
##             1
##  1.372128e-09
##
## Output summary for FullHet model
## Name : pi(~1)p(~time + mixture)c()f0(~1)
##
## Npar :  9  (unadjusted=8)
## -2lnL:  -1931.017
## AICc :  -1912.956  (unadjusted=-1914.9686)
##
## Beta
##                      estimate           se           lcl           ucl
## pi:(Intercept) -6.268713e+00 6445.9950000 -12640.419000 12627.8820000
## p:(Intercept)   4.375407e-01    3.6675605     -6.750878     7.6259595
## p:time2        -1.216717e+00    0.1269836     -1.465605    -0.9678293
## p:time3        -1.775243e+00    0.1372669     -2.044286    -1.5062001
## p:time4        -1.764487e+00    0.1370116     -2.033030    -1.4959442
## p:time5        -1.933609e+00    0.1413222     -2.210601    -1.6566176
## p:time6        -1.933609e+00    0.1413222     -2.210601    -1.6566175
## p:mixture2     -6.130668e-07    3.6731703     -7.199415     7.1994133
## f0:(Intercept)  4.140002e+00    0.1705101      3.805802     4.4742018
##
##
## Real Parameter pi
##
##
## mixture:1 0.0018911
##
```

```
##
## Real Parameter p
##
##                   1         2         3         4         5         6
## mixture:1 0.6076729 0.3144974 0.2078881 0.2096649 0.1830126 0.1830126
## mixture:2 0.6076727 0.3144973 0.2078880 0.2096648 0.1830125 0.1830126
##
##
## Real Parameter c
##
##                   2         3         4         5         6
## mixture:1 0.3144974 0.2078881 0.2096649 0.1830126 0.1830126
## mixture:2 0.3144973 0.2078880 0.2096648 0.1830125 0.1830126
##
##
## Real Parameter f0
##
##         1
##  62.80294
##
## Output summary for FullHet model
## Name : pi(~1)p(~mixture + time)c(~1)f0(~1)
##
## Npar :  10  (unadjusted=6)
## -2lnL:  -1996.138
## AICc :  -1976.064  (unadjusted=-1984.1096)
##
## Beta
##                    estimate          se           lcl          ucl
## pi:(Intercept)    2.8047973    0.000000     2.8047973    2.8047973
## p:(Intercept)     0.7791757    0.000000     0.7791757    0.7791757
## p:mixture2       -0.1194923    0.000000    -0.1194923   -0.1194923
## p:time2          -0.2269884    0.000000    -0.2269884   -0.2269884
## p:time3          -0.4229131    0.000000    -0.4229131   -0.4229131
## p:time4          -0.0774885    0.000000    -0.0774885   -0.0774885
## p:time5           1.1762125    0.000000     1.1762125    1.1762125
## p:time6          19.9330580 2320.387400 -4528.0263000 4567.8924000
## c:(Intercept)    -1.3593029    0.052271    -1.4617541   -1.2568516
## f0:(Intercept) -20.3518240 2216.026900 -4363.7646000 4323.0610000
##
##
## Real Parameter pi
##
##
## mixture:1 0.9429345
##
##
## Real Parameter p
##
##                   1         2         3         4         5 6
## mixture:1 0.6855024 0.6346429 0.5881354 0.6685617 0.8760330 1
## mixture:2 0.6591893 0.6065170 0.5589176 0.6415723 0.8624626 1
##
##
```

```
## Real Parameter c
##
##                   2         3         4         5         6
## mixture:1 0.2043536 0.2043536 0.2043536 0.2043536 0.2043536
## mixture:2 0.2043536 0.2043536 0.2043536 0.2043536 0.2043536
##
##
## Real Parameter f0
##
##             1
##  1.449824e-09
##
## Output summary for FullHet model
## Name : pi(~1)p(~time)c()f0(~1)
##
## Npar :  8
## -2lnL:  -1931.017
## AICc :  -1916.979
##
## Beta
##                      estimate se           lcl           ucl
## pi:(Intercept) -0.0004161478  0 -0.0004161478 -0.0004161478
## p:(Intercept)   0.4375396000  0  0.4375396000  0.4375396000
## p:time2        -1.2167164000  0 -1.2167164000 -1.2167164000
## p:time3        -1.7752427000  0 -1.7752427000 -1.7752427000
## p:time4        -1.7644864000  0 -1.7644864000 -1.7644864000
## p:time5        -1.9336087000  0 -1.9336087000 -1.9336087000
## p:time6        -1.9336087000  0 -1.9336087000 -1.9336087000
## f0:(Intercept)  4.1400021000  0  4.1400021000  4.1400021000
##
##
## Real Parameter pi
##
##
## mixture:1 0.499896
##
##
## Real Parameter p
##
##                   1         2        3         4         5         6
## mixture:1 0.6076726 0.3144973 0.207888 0.2096649 0.1830125 0.1830125
## mixture:2 0.6076726 0.3144973 0.207888 0.2096649 0.1830125 0.1830125
##
##
## Real Parameter c
##
##                   2        3         4         5         6
## mixture:1 0.3144973 0.207888 0.2096649 0.1830125 0.1830125
## mixture:2 0.3144973 0.207888 0.2096649 0.1830125 0.1830125
##
##
## Real Parameter f0
##
##         1
```

```
##  62.80295
##
## Output summary for FullHet model
## Name : pi(~1)p(~time)c(~1)f0(~1)
##
## Npar :  9  (unadjusted=6)
## -2lnL:  -1996.138
## AICc :  -1978.077  (unadjusted=-1984.1096)
##
## Beta
##                      estimate           se           lcl           ucl
## pi:(Intercept)  5.768517e-04    0.0000000  5.768517e-04  5.768517e-04
## p:(Intercept)   7.722158e-01    0.0961927  5.836782e-01  9.607535e-01
## p:time2        -2.274887e-01    0.1910352 -6.019177e-01  1.469403e-01
## p:time3        -4.239100e-01    0.2834284 -9.794297e-01  1.316097e-01
## p:time4        -7.906680e-02    0.4435719 -9.484678e-01  7.903341e-01
## p:time5         1.173699e+00    1.0733637 -9.300942e-01  3.277492e+00
## p:time6         2.966013e+01  596.5942900 -1.139665e+03  1.198985e+03
## c:(Intercept)  -1.359303e+00    0.0522710 -1.461754e+00 -1.256852e+00
## f0:(Intercept) -1.858181e+01 1770.1054000 -3.487988e+03  3.450825e+03
##
##
## Real Parameter pi
##
##
## mixture:1 0.5001442
##
##
## Real Parameter p
##
##               1         2         3         4         5 6
## mixture:1 0.684 0.6329114 0.5862067 0.6666671 0.8750005 1
## mixture:2 0.684 0.6329114 0.5862067 0.6666671 0.8750005 1
##
##
## Real Parameter c
##
##                   2         3         4         5         6
## mixture:1 0.2043536 0.2043536 0.2043536 0.2043536 0.2043536
## mixture:2 0.2043536 0.2043536 0.2043536 0.2043536 0.2043536
##
##
## Real Parameter f0
##
##             1
##  8.511775e-09
```

On examine les résultats.

```
mouse.results
```

```
##                                 model npar      AICc   DeltaAICc       weight
## 2             pi(~1)p(~1)c(~1)f0(~1)    4 -1982.382   0.0000000 4.858271e-01
## 4        pi(~1)p(~mixture)c(~1)f0(~1)    5 -1982.170   0.2114845 4.370775e-01
```

```
## 8           pi(~1)p(~time)c(~1)f0(~1)    9 -1978.077   4.3045451 5.646270e-02
## 6 pi(~1)p(~mixture + time)c(~1)f0(~1)   10 -1976.064   6.3179476 2.063274e-02
## 7             pi(~1)p(~time)c()f0(~1)    8 -1914.969  67.4133888 1.116478e-15
## 5   pi(~1)p(~time + mixture)c()f0(~1)    9 -1912.956  69.4254451 0.000000e+00
## 1               pi(~1)p(~1)c()f0(~1)    3 -1576.735 405.6465551 0.000000e+00
## 3          pi(~1)p(~mixture)c()f0(~1)    4 -1574.730 407.6519000 0.000000e+00
##    Deviance
## 2  62.85688
## 4  61.06174
## 8  57.11456
## 6  57.11455
## 7 122.23546
## 5 122.23546
## 1 470.50882
## 3 470.50882
```

Le nom des modèles n'est pas limpide. On fait le lien entre la première colonne qui donne le numéro du modèle, et la liste des modèles qu'on a définie au-dessus.

```
names(mouse.results)
```

```
## [1] "p.dot"          "p.dot.behav"    "p.h"            "p.h.behav"
## [5] "p.h.time"       "p.h.time.behav" "p.time"         "p.time.behav"
## [9] "model.table"
```

Par exemple, si l'on veut afficher les résultats du modèle M_0, il s'agit du modèle 1 "p.dot". On peut afficher la probabilité de détection avec l'intervalle de confiance associé. Ce sont exactement les valeurs utilisées pour simuler les données.

```
mouse.results$p.dot.behav$results$real
```

```
##              estimate        se       lcl       ucl fixed note
## pi g1 m1    0.5000044 0.0000000 0.5000044 0.5000044
## p g1 t1 m1  0.6668528 0.0178484 0.6310020 0.7008716
## c g1 t2 m1  0.2043536 0.0084989 0.1881992 0.2215163
## f0 g1 a0 t1 0.1317805 0.8843265 0.0028453 6.1034118
```

On obtient aussi une estimation de l'effectif. Pile sur la cible!

```
mouse.results$p.dot.behav$results$derived
```

```
## $`N Population Size`
##   estimate      lcl      ucl
## 1 500.1318 500.0028 506.1034
```

Ajustement deux groupes

Lecture et formatage des données

On commence par lire les données qui se trouvent dans le répertoire dat/

```
mouse <- convert.inp("dat/sim.deux.groupes.inp",
                     group.df = data.frame(sex = c("M","F")),
                     covariates = NULL)
```

On regarde les 10 premières lignes du fichier.

```
head(mouse)
```

```
##         ch freq sex
## 1:1 010010    1   M
## 1:2 100000    1   M
## 1:3 100000    1   M
## 1:4 101000    1   M
## 1:5 100111    1   M
## 1:6 100000    1   M
```

Les 10 dernières lignes.

```
tail(mouse)
```

```
##           ch freq sex
## 2:495 100011    1   F
## 2:496 111001    1   F
## 2:497 111111    1   F
## 2:498 101111    1   F
## 2:499 011111    1   F
## 2:500 101111    1   F
```

On fait les tests de fermeture. Pour cela, il nous faut d'abord convertir les données au format requis pour utiliser le package secr qui fait ces tests. Le formatage consiste à mettre un espace entre les colonnes de capture.

```
library(secr)
mouse_secr <- unRMarkInput(mouse)
```

On peut utiliser la fonction summary de R pour obtenir un résumé des données.

```
summary(mouse_secr)
```

```
## Object class       capthist
##
## Counts by occasion
##              1   2   3   4   5   6 Total
## n          363 266 228 228 234 233  1552
## u          363 102  30   5   0   0   500
## f           80 101 119 109  69  22   500
## M(t+1)     363 465 495 500 500 500   500
## losses       0   0   0   0   0   0     0
## detections 363 266 228 228 234 233  1552
##
## Individual covariates
##  sex
##  F:300
##  M:200
```

Test de l'hypothèse de fermeture

On fait enfin les tests. Par défaut, seul le test d'Otis est fait. En rajoutant l'option "SB = TRUE", on fait aussi le test de Stanley et Burnham.

```
closure.test(mouse_secr, SB = TRUE)
```

```
## $Otis
##  statistic p
##   5.727195 1
##
## $Xc
##  statistic df p
##   147.3957  7 0
##
## $NRvsJS
##  statistic df            p
##   38.48874  3 2.227184e-08
##
## $NMvsJS
##  statistic df           p
##   67.32622  4 8.31557e-14
##
## $MtvsNR
##  statistic df p
##    108.907  4 0
##
## $MtvsNM
##  statistic df p
##   80.06952  3 0
##
## $compNRvsJS
##   Occasion Chisquare df           p
## 1        2 20.055009  1 7.52462e-06
## 2        3 14.967549  1 1.09376e-04
## 3        4  3.466185  1 6.26356e-02
## 4        5        NA NA          NA
##
## $compNMvsJS
##   Occasion Chisquare df            p
## 1        2  8.575405  1 3.407341e-03
## 2        3 17.109268  1 3.528967e-05
## 3        4 32.360599  1 1.280568e-08
## 4        5  9.280944  1 2.315501e-03
```

Modèles avec le sexe

Pour utiliser RMark, on passe par 3 étapes : la préparation des données, la définition des modèles et l'ajustement à proprement parler.

On commence par préparer les données.

```
mouse.proc <- process.data(mouse,
                           begin.time = 1,
                           model = "FullHet",
                           groups = "sex")
mouse.ddl <- make.design.data(mouse.proc)
```

On définit les modèles que l'on souhaite ajuster grâce à une fonction R qui fait 3 choses : spéficication des effets, création d'une liste des modèles à ajuster et préparation pour envoi à Mark. Par défaut, Mark considère un effet comportement et distingue une probabilité de capture c et une autre de recapture p. On utilise "share = TRUE" pour fusionner ces deux paramètres en une seule probabilité de capture.

```
run.mouse <- function() {

## On specifie les effets

  # M0 : p constant dans le temps
  p.dot <- list(formula =  ~ 1, share = TRUE)
  # Mb : p (recapture) different de c (premiere capture) et constants dans le temps
  p.dot.behav <- list(formula =  ~ 1)
  # Mt : p varie selon la session (dans le temps)
  p.time <- list(formula =  ~ time, share = TRUE)
  # Mh : p est heterogene entre individu
  p.h <- list(formula = ~ mixture, share = TRUE)
  # Mtb
  p.time.behav <- list(formula =  ~ time)
  # Mbh
  p.h.behav <- list(formula =  ~ mixture)
  # Mth
  p.h.time <- list(formula = ~ time + mixture, share = TRUE)
  # Mtbh
  p.h.time.behav <- list(formula =  ~ mixture + time)
  # Mbsex - modele selon lequel on a simule les donnees
  p.sex.behav <- list(p = list(formula = ~ sex),
                      c = list(formula = ~ sex))

## On construit la liste des modeles
  mouse.model.list <- create.model.list("FullHet")

## On prépare le tout pour envoi a Mark
  mouse.results <- mark.wrapper(mouse.model.list,
                                data = mouse.proc,
                                ddl = mouse.ddl)

## On retourne les resultats
  return(mouse.results)
}
```

On fait tourner tous les modèles d'un coup.

```
mouse.results <- run.mouse()
```

```
##
```

```
## Output summary for FullHet model
## Name : pi(~1)p(~1)c()f0(~1)
##
## Npar :  3
## -2lnL:  -407.9639
## AICc :  -401.9559
##
## Beta
##                      estimate        se           lcl           ucl
## pi:(Intercept) -2.240395e-06 0.0000000 -2.240395e-06 -2.240395e-06
## p:(Intercept)   4.590260e-02 0.0379740 -2.852640e-02  1.203316e-01
## f0:(Intercept)  1.052263e+00 0.4785276  1.143491e-01  1.990177e+00
##
##
## Real Parameter pi
## Group:sexF
##
## mixture:1 0.4999994
##
## Group:sexM
##
## mixture:1 0.4999994
##
##
## Real Parameter p
## Group:sexF
##                   1         2         3         4         5         6
## mixture:1 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736
## mixture:2 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736
##
## Group:sexM
##                   1         2         3         4         5         6
## mixture:1 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736
## mixture:2 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736
##
##
## Real Parameter c
## Group:sexF
##                   2         3         4         5         6
## mixture:1 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736
## mixture:2 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736
##
## Group:sexM
##                   2         3         4         5         6
## mixture:1 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736
## mixture:2 0.5114736 0.5114736 0.5114736 0.5114736 0.5114736
##
##
## Real Parameter f0
## Group:sexF
##         1
##  2.864126
##
## Group:sexM
```

```
##         1
##  2.864126
##
## Output summary for FullHet model
## Name : pi(~1)p(~1)c(~1)f0(~1)
##
## Npar :  4  (unadjusted=2)
## -2lnL:  -578.6289
## AICc :  -570.6156  (unadjusted=-574.62491)
##
## Beta
##                      estimate           se           lcl           ucl
## pi:(Intercept)  9.501776e-04    0.0000000  9.501776e-04  9.501776e-04
## p:(Intercept)   1.038460e+00    0.0874627  8.670332e-01  1.209887e+00
## c:(Intercept)  -1.891108e-01    0.0416816 -2.708067e-01 -1.074150e-01
## f0:(Intercept) -1.628484e+01 2590.9667000 -5.094580e+03  5.062010e+03
##
##
## Real Parameter pi
## Group:sexF
##
## mixture:1 0.5002375
##
## Group:sexM
##
## mixture:1 0.5002375
##
##
## Real Parameter p
## Group:sexF
##                   1         2         3         4         5         6
## mixture:1 0.7385528 0.7385528 0.7385528 0.7385528 0.7385528 0.7385528
## mixture:2 0.7385528 0.7385528 0.7385528 0.7385528 0.7385528 0.7385528
##
## Group:sexM
##                   1         2         3         4         5         6
## mixture:1 0.7385528 0.7385528 0.7385528 0.7385528 0.7385528 0.7385528
## mixture:2 0.7385528 0.7385528 0.7385528 0.7385528 0.7385528 0.7385528
##
##
## Real Parameter c
## Group:sexF
##                   2         3         4         5         6
## mixture:1 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
## mixture:2 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
##
## Group:sexM
##                   2         3         4         5         6
## mixture:1 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
## mixture:2 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
##
##
## Real Parameter f0
## Group:sexF
```

```
##             1
##  8.464195e-08
##
## Group:sexM
##             1
##  8.464195e-08
##
## Output summary for FullHet model
## Name : pi(~1)p(~mixture)c()f0(~1)
##
## Npar :  4
## -2lnL:  -460.7611
## AICc :  -452.7477
##
## Beta
##                   estimate        se       lcl        ucl
## pi:(Intercept) -0.1716211 0.4255716 -1.005742  0.6624993
## p:(Intercept)  -0.7948595 0.2487662 -1.282441 -0.3072776
## p:mixture2      1.3965581 0.1527522  1.097164  1.6959524
## f0:(Intercept)  2.5162378 0.3740521  1.783096  3.2493799
##
##
## Real Parameter pi
## Group:sexF
##
## mixture:1 0.4571997
##
## Group:sexM
##
## mixture:1 0.4571997
##
##
## Real Parameter p
## Group:sexF
##                   1         2         3         4         5         6
## mixture:1 0.3111262 0.3111262 0.3111262 0.3111262 0.3111262 0.3111262
## mixture:2 0.6460448 0.6460448 0.6460448 0.6460448 0.6460448 0.6460448
##
## Group:sexM
##                   1         2         3         4         5         6
## mixture:1 0.3111262 0.3111262 0.3111262 0.3111262 0.3111262 0.3111262
## mixture:2 0.6460448 0.6460448 0.6460448 0.6460448 0.6460448 0.6460448
##
##
## Real Parameter c
## Group:sexF
##                   2         3         4         5         6
## mixture:1 0.3111262 0.3111262 0.3111262 0.3111262 0.3111262
## mixture:2 0.6460448 0.6460448 0.6460448 0.6460448 0.6460448
##
## Group:sexM
##                   2         3         4         5         6
## mixture:1 0.3111262 0.3111262 0.3111262 0.3111262 0.3111262
## mixture:2 0.6460448 0.6460448 0.6460448 0.6460448 0.6460448
```

```
##
##
## Real Parameter f0
## Group:sexF
##         1
##  12.38193
##
## Group:sexM
##         1
##  12.38193
##
## Output summary for FullHet model
## Name : pi(~1)p(~mixture)c(~1)f0(~1)
##
## Npar :  5  (unadjusted=3)
## -2lnL:  -578.6289
## AICc :  -568.6089  (unadjusted=-572.6209)
##
## Beta
##                      estimate           se           lcl         ucl
## pi:(Intercept) -3.832845e+00  763.6227100 -1500.5334000 1492.867700
## p:(Intercept)   1.038456e+00    1.5510497    -2.0016010    4.078514
## p:mixture2      2.153045e-06    1.5821054    -3.1009244    3.100929
## c:(Intercept)  -1.891109e-01    0.0416816    -0.2708067   -0.107415
## f0:(Intercept) -1.868005e+01 4363.1229000 -8570.4012000 8533.041100
##
##
## Real Parameter pi
## Group:sexF
##
## mixture:1 0.0211892
##
## Group:sexM
##
## mixture:1 0.0211892
##
##
## Real Parameter p
## Group:sexF
##                    1         2         3         4         5         6
## mixture:1 0.7385520 0.7385520 0.7385520 0.7385520 0.7385520 0.7385520
## mixture:2 0.7385525 0.7385525 0.7385525 0.7385525 0.7385525 0.7385525
##
## Group:sexM
##                    1         2         3         4         5         6
## mixture:1 0.7385520 0.7385520 0.7385520 0.7385520 0.7385520 0.7385520
## mixture:2 0.7385525 0.7385525 0.7385525 0.7385525 0.7385525 0.7385525
##
##
## Real Parameter c
## Group:sexF
##                    2         3         4         5         6
## mixture:1 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
## mixture:2 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
```

```
##
## Group:sexM
##                   2         3         4         5         6
## mixture:1 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
## mixture:2 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
##
##
## Real Parameter f0
## Group:sexF
##             1
##  7.715348e-09
##
## Group:sexM
##             1
##  7.715348e-09
##
## Output summary for FullHet model
## Name : pi(~1)p(~time + mixture)c()f0(~1)
##
## Npar :  9
## -2lnL:  -584.9233
## AICc :  -566.8631
##
## Beta
##                   estimate        se        lcl        ucl
## pi:(Intercept) -0.1729354 0.3809512 -0.9195999  0.5737290
## p:(Intercept)   0.1204300 0.2522950 -0.3740682  0.6149281
## p:time2        -0.8915985 0.1382829 -1.1626330 -0.6205641
## p:time3        -1.2246423 0.1393626 -1.4977930 -0.9514916
## p:time4        -1.2246423 0.1393626 -1.4977931 -0.9514916
## p:time5        -1.1717351 0.1391071 -1.4443851 -0.8990851
## p:time6        -1.1805384 0.1391474 -1.4532674 -0.9078094
## p:mixture2      1.4827279 0.1492878  1.1901237  1.7753321
## f0:(Intercept)  2.4346760 0.3768382  1.6960731  3.1732790
##
##
## Real Parameter pi
## Group:sexF
##
## mixture:1 0.4568736
##
## Group:sexM
##
## mixture:1 0.4568736
##
##
## Real Parameter p
## Group:sexF
##                   1         2         3         4         5         6
## mixture:1 0.5300712 0.3162264 0.2489515 0.2489515 0.2589746 0.2572887
## mixture:2 0.8324593 0.6707456 0.5935150 0.5935150 0.6062134 0.6041099
##
## Group:sexM
##                   1         2         3         4         5         6
```

```
## mixture:1 0.5300712 0.3162264 0.2489515 0.2489515 0.2589746 0.2572887
## mixture:2 0.8324593 0.6707456 0.5935150 0.5935150 0.6062134 0.6041099
##
##
## Real Parameter c
## Group:sexF
##                   2         3         4         5         6
## mixture:1 0.3162264 0.2489515 0.2489515 0.2589746 0.2572887
## mixture:2 0.6707456 0.5935150 0.5935150 0.6062134 0.6041099
##
## Group:sexM
##                   2         3         4         5         6
## mixture:1 0.3162264 0.2489515 0.2489515 0.2589746 0.2572887
## mixture:2 0.6707456 0.5935150 0.5935150 0.6062134 0.6041099
##
##
## Real Parameter f0
## Group:sexF
##         1
##  11.41212
##
## Group:sexM
##         1
##  11.41212
##
## Output summary for FullHet model
## Name : pi(~1)p(~mixture + time)c(~1)f0(~1)
##
## Npar :  10  (unadjusted=4)
## -2lnL:  -584.9797
## AICc :  -564.9061  (unadjusted=-576.96639)
##
## Beta
##                    estimate           se           lcl          ucl
## pi:(Intercept)  -3.3083223    0.0000000    -3.3083223   -3.3083223
## p:(Intercept)    1.0732363    0.0000000     1.0732363    1.0732363
## p:mixture2      -0.1023447    0.0000000    -0.1023447   -0.1023447
## p:time2          0.0954572    0.0000000     0.0954572    0.0954572
## p:time3          0.8178623    0.0000000     0.8178623    0.8178623
## p:time4         14.4232390 1198.6618000 -2334.9539000 2363.8004000
## p:time5         -2.4938750  867.0260400 -1701.8650000 1696.8772000
## p:time6         -2.4933016    0.0000000    -2.4933016   -2.4933016
## c:(Intercept)   -0.1891109    0.0416816    -0.2708067   -0.1074150
## f0:(Intercept) -18.5076910 1973.9098000 -3887.3709000 3850.3555000
##
##
## Real Parameter pi
## Group:sexF
##
## mixture:1 0.0352868
##
## Group:sexM
##
## mixture:1 0.0352868
```

```
##
##
## Real Parameter p
## Group:sexF
##                   1         2         3         4         5         6
## mixture:1 0.7452119 0.7629088 0.8688807 0.9999998 0.1945615 0.1946513
## mixture:2 0.7252972 0.7439019 0.8567744 0.9999998 0.1790226 0.1791069
##
## Group:sexM
##                   1         2         3         4         5         6
## mixture:1 0.7452119 0.7629088 0.8688807 0.9999998 0.1945615 0.1946513
## mixture:2 0.7252972 0.7439019 0.8567744 0.9999998 0.1790226 0.1791069
##
##
## Real Parameter c
## Group:sexF
##                   2         3         4         5         6
## mixture:1 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
## mixture:2 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
##
## Group:sexM
##                   2         3         4         5         6
## mixture:1 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
## mixture:2 0.4528627 0.4528627 0.4528627 0.4528627 0.4528627
##
##
## Real Parameter f0
## Group:sexF
##             1
##  9.166681e-09
##
## Group:sexM
##             1
##  9.166681e-09
##
## Output summary for FullHet model
## Name : pi(~1)p(~sex)c(~sex)f0(~1)
##
## Npar :  6  (unadjusted=4)
## -2lnL:  -966.0421
## AICc :  -954.014  (unadjusted=-958.02875)
##
## Beta
##                    estimate           se           lcl          ucl
## pi:(Intercept)    0.0033911    0.0000000     0.0033911    0.0033911
## p:(Intercept)     1.0593913    0.1137924     0.8363581    1.2824245
## p:sexM           -0.0515330    0.1778971    -0.4002113    0.2971453
## c:(Intercept)     0.4667456    0.0549931     0.3589591    0.5745320
## c:sexM           -1.7960330    0.0976890    -1.9875034   -1.6045627
## f0:(Intercept) -15.8941430 1289.1855000 -2542.6977000 2510.9094000
##
##
## Real Parameter pi
## Group:sexF
```

```
##
## mixture:1 0.5008478
##
## Group:sexM
##
## mixture:1 0.5008478
##
##
## Real Parameter p
## Group:sexF
##                   1         2         3         4         5         6
## mixture:1 0.7425742 0.7425742 0.7425742 0.7425742 0.7425742 0.7425742
## mixture:2 0.7425742 0.7425742 0.7425742 0.7425742 0.7425742 0.7425742
##
## Group:sexM
##                   1         2         3         4         5         6
## mixture:1 0.7326008 0.7326008 0.7326008 0.7326008 0.7326008 0.7326008
## mixture:2 0.7326008 0.7326008 0.7326008 0.7326008 0.7326008 0.7326008
##
##
## Real Parameter c
## Group:sexF
##                   2         3         4         5         6
## mixture:1 0.6146132 0.6146132 0.6146132 0.6146132 0.6146132
## mixture:2 0.6146132 0.6146132 0.6146132 0.6146132 0.6146132
##
## Group:sexM
##                   2         3         4         5         6
## mixture:1 0.2092772 0.2092772 0.2092772 0.2092772 0.2092772
## mixture:2 0.2092772 0.2092772 0.2092772 0.2092772 0.2092772
##
##
## Real Parameter f0
## Group:sexF
##             1
##  1.251012e-07
##
## Group:sexM
##             1
##  1.251012e-07
##
## Output summary for FullHet model
## Name : pi(~1)p(~time)c()f0(~1)
##
## Npar :  8  (unadjusted=7)
## -2lnL:  -522.8609
## AICc :  -506.8128  (unadjusted=-508.82351)
##
## Beta
##                     estimate        se           lcl           ucl
## pi:(Intercept)  7.186387e-05 0.0000000  7.186387e-05  7.186387e-05
## p:(Intercept)   9.408148e-01 0.1006365  7.435672e-01  1.138062e+00
## p:time2        -8.324523e-01 0.1334688 -1.094051e+00 -5.708535e-01
## p:time3        -1.134339e+00 0.1337461 -1.396482e+00 -8.721970e-01
```

```
## p:time4        -1.134340e+00 0.1337461 -1.396482e+00 -8.721971e-01
## p:time5        -1.086440e+00 0.1336122 -1.348320e+00 -8.245599e-01
## p:time6        -1.094410e+00 0.1336322 -1.356329e+00 -8.324911e-01
## f0:(Intercept)  8.506645e-01 0.5369129 -2.016848e-01  1.903014e+00
##
##
## Real Parameter pi
## Group:sexF
##
## mixture:1 0.500018
##
## Group:sexM
##
## mixture:1 0.500018
##
##
## Real Parameter p
## Group:sexF
##                   1         2         3         4         5         6
## mixture:1 0.7192642 0.5270641 0.4517693 0.4517693 0.4636579 0.4616765
## mixture:2 0.7192642 0.5270641 0.4517693 0.4517693 0.4636579 0.4616765
##
## Group:sexM
##                   1         2         3         4         5         6
## mixture:1 0.7192642 0.5270641 0.4517693 0.4517693 0.4636579 0.4616765
## mixture:2 0.7192642 0.5270641 0.4517693 0.4517693 0.4636579 0.4616765
##
##
## Real Parameter c
## Group:sexF
##                   2         3         4         5         6
## mixture:1 0.5270641 0.4517693 0.4517693 0.4636579 0.4616765
## mixture:2 0.5270641 0.4517693 0.4517693 0.4636579 0.4616765
##
## Group:sexM
##                   2         3         4         5         6
## mixture:1 0.5270641 0.4517693 0.4517693 0.4636579 0.4616765
## mixture:2 0.5270641 0.4517693 0.4517693 0.4636579 0.4616765
##
##
## Real Parameter f0
## Group:sexF
##         1
##  2.341202
##
## Group:sexM
##         1
##  2.341202
##
## Output summary for FullHet model
## Name : pi(~1)p(~time)c(~1)f0(~1)
##
## Npar :  9  (unadjusted=4)
## -2lnL:  -584.9797
```

```
## AICc :  -566.9195  (unadjusted=-576.96639)
##
## Beta
##                       estimate           se           lcl           ucl
## pi:(Intercept) -3.895778e-04    0.0000000 -3.895778e-04 -3.895778e-04
## p:(Intercept)   9.744603e-01    0.1002710  7.779292e-01  1.170991e+00
## p:time2         9.523930e-02    0.2200707 -3.360992e-01  5.265778e-01
## p:time3         8.172817e-01    0.4933412 -1.496671e-01  1.784231e+00
## p:time4         1.596888e+01 2665.8469000 -5.209091e+03  5.241029e+03
## p:time5        -1.379205e+00  595.5265700 -1.168611e+03  1.165853e+03
## p:time6        -1.379424e+00  758.4192800 -1.487881e+03  1.485122e+03
## c:(Intercept)  -1.890951e-01    0.0416815 -2.707909e-01 -1.073993e-01
## f0:(Intercept) -1.935493e+01 7070.5828000 -1.387770e+04  1.383899e+04
##
##
## Real Parameter pi
## Group:sexF
##
## mixture:1 0.4999026
##
## Group:sexM
##
## mixture:1 0.4999026
##
##
## Real Parameter p
## Group:sexF
##                   1         2         3 4         5         6
## mixture:1 0.7260076 0.7445398 0.8571407 1 0.4001729 0.4001204
## mixture:2 0.7260076 0.7445398 0.8571407 1 0.4001729 0.4001204
##
## Group:sexM
##                   1         2         3 4         5         6
## mixture:1 0.7260076 0.7445398 0.8571407 1 0.4001729 0.4001204
## mixture:2 0.7260076 0.7445398 0.8571407 1 0.4001729 0.4001204
##
##
## Real Parameter c
## Group:sexF
##                   2         3         4         5         6
## mixture:1 0.4528666 0.4528666 0.4528666 0.4528666 0.4528666
## mixture:2 0.4528666 0.4528666 0.4528666 0.4528666 0.4528666
##
## Group:sexM
##                   2         3         4         5         6
## mixture:1 0.4528666 0.4528666 0.4528666 0.4528666 0.4528666
## mixture:2 0.4528666 0.4528666 0.4528666 0.4528666 0.4528666
##
##
## Real Parameter f0
## Group:sexF
##             1
##  3.928807e-09
##
```

```
## Group:sexM
##             1
##  3.928807e-09
```

On examine les résultats.

```
mouse.results
```

```
##                                 model npar      AICc DeltaAICc weight Deviance
## 7          pi(~1)p(~sex)c(~sex)f0(~1)    6 -954.0140    0.0000      1 115.0620
## 2              pi(~1)p(~1)c(~1)f0(~1)    4 -570.6156  383.3985      0 502.4752
## 4        pi(~1)p(~mixture)c(~1)f0(~1)    5 -568.6089  385.4052      0 502.4752
## 9           pi(~1)p(~time)c(~1)f0(~1)    9 -566.9195  387.0945      0 496.1244
## 5   pi(~1)p(~time + mixture)c()f0(~1)    9 -566.8631  387.1509      0 496.1808
## 6 pi(~1)p(~mixture + time)c(~1)f0(~1)   10 -564.9061  389.1079      0 496.1244
## 8             pi(~1)p(~time)c()f0(~1)    8 -506.8128  447.2012      0 558.2432
## 3          pi(~1)p(~mixture)c()f0(~1)    4 -452.7477  501.2663      0 620.3430
## 1               pi(~1)p(~1)c()f0(~1)    3 -401.9559  552.0581      0 673.1402
```

Le nom des modèles n'est pas limpide. On fait le lien entre la première colonne qui donne le numéro du modèle, et la liste des modèles qu'on a définie au-dessus.

```
names(mouse.results)
```

```
##  [1] "p.dot"          "p.dot.behav"    "p.h"            "p.h.behav"
##  [5] "p.h.time"       "p.h.time.behav" "p.sex.behav"    "p.time"
##  [9] "p.time.behav"   "model.table"
```

Par exemple, si l'on veut afficher les résultats du modèle M_0, il s'agit du modèle 1 "p.dot". On peut afficher la probabilité de détection avec l'intervalle de confiance associé. On retrouve les valeurs utilisées pour simuler les données.

```
mouse.results$p.sex.behav$results$real
```

```
##                 estimate           se          lcl          ucl fixed note
## pi gF m1    5.008478e-01 0.0000000000 5.008478e-01 0.5008478000
## p gF t1 m1  7.425742e-01 0.0217523000 6.976976e-01 0.7828622000
## p gM t1 m1  7.326008e-01 0.0267875000 6.769613e-01 0.7817467000
## c gF t2 m1  6.146132e-01 0.0130259000 5.887885e-01 0.6398082000
## c gM t2 m1  2.092772e-01 0.0133608000 1.842917e-01 0.2366675000
## f0 gF a0 t1 1.251012e-07 0.0001612787 7.511164e-11 0.0002083607
```

On obtient aussi une estimation de l'effectif. Pile sur la cible!

```
mouse.results$p.sex.behav$results$derived
```

```
## $`N Population Size`
##   estimate lcl      ucl
## 1      300 300 300.0002
## 2      200 200 200.0002
```

Nettoyage

On supprime les fichiers temporaires.

```
rm(list = ls(all = TRUE))
cleanup(ask = FALSE)
```