

Using the basket Package

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The “basket” package is an R package that can be applied to conduct basket trial designs based on the MEM method. One can use the package to perform the exact or MCMC computation of the operating characteristics of different scenarios. The posterior probabilities, HPD boundaries, effective sample sizes (ESS), mean and median estimations can be calculated With this package using the MEM method. After the basket trial is completed, one can use the package conduct the MEM analysis with the observed outcomes. Density of each basket and the exchangeability can be plotted using the package. The package includes the following main functions:

- `mem_full_bayes_exact`
- `mem_full_bayes_mcmc`
- `summary`
- `update_result`
- `plot_density`
- `plot_posterior_exchangeability`
- `plot_all_exchangeability`

`mem_full_bayes_exact()` function

This function conducts the exact computation based on the MEM method.

```
library(basket)
data(vemu_wide)
baskets <- 1:5
vemu_wide1 <- vemu_wide[baskets,]
# Full Bayes exact method
exact_res <- mem_full_bayes_exact(responses = vemu_wide1$responders,
                                size = vemu_wide1$evaluable,
                                name = vemu_wide1$baskets, p0=rep(0.15, length(basket)))
#> [1] "#### Cluster Assignment: 1"
#> [1] 2 3 4
#> [1] "CRC (vemu)" "CRC (vemu+cetu)" "Bile Duct"
#> [1] "#### Cluster Assignment: 2"
#> [1] 1 5
#> [1] "NSCLC" "ECD or LCH"
```

The output “exact_res” is a list including three components: call, basketwise, clusterwise.

The “call” is the exact call including parameters for the function.

```
print(exact_res$call)
#> mem_full_bayes_exact(responses = vemu_wide1$responders, size = vemu_wide1$evaluable,
#> name = vemu_wide1$baskets, p0 = rep(0.15, length(basket)))
```

The “basketwise” includes all results of the basketwise analyses.

```
print(exact_res$basketwise$PEP)
#>
#> NSCLC NSCLC CRC (vemu) CRC (vemu+cetu) Bile Duct ECD or LCH
#> NSCLC 1 0.0007372476 6.586685e-05 0.09118478 0.928129459
#> CRC (vemu) NA 1.0000000000 9.237235e-01 0.76921374 0.001272453
#> CRC (vemu+cetu) NA NA 1.000000e+00 0.79134284 0.000163091
```

```

#> Bile Duct      NA      NA      NA 1.00000000 0.099968871
#> ECD or LCH     NA      NA      NA      NA 1.000000000
print(exact_res$basketwise$MAP)
#>      NSCLC CRC (vemu) CRC (vemu+cetu) Bile Duct ECD or LCH
#> NSCLC      1      0      0      0      1
#> CRC (vemu)  0      1      1      1      0
#> CRC (vemu+cetu) 0      1      1      1      0
#> Bile Duct  0      1      1      1      0
#> ECD or LCH  1      0      0      0      1
print(exact_res$basketwise$post.prob)
#>      NSCLC      CRC (vemu) CRC (vemu+cetu)      Bile Duct
#> 0.99973003 0.02228797 0.01695701 0.15655229
#>      ECD or LCH
#> 0.99937485
print(exact_res$basketwise$HPD)
#>      NSCLC      CRC (vemu) CRC (vemu+cetu)      Bile Duct ECD or LCH
#> lower 0.2564416 0.0000150714 0.00261162 0.001423002 0.2529839
#> upper 0.5903820 0.1268641693 0.12448533 0.343617974 0.5986269
print(exact_res$basketwise$ESS)
#>      NSCLC      CRC (vemu) CRC (vemu+cetu)      Bile Duct
#> 33.73238 41.20234 42.57151 40.39913
#>      ECD or LCH
#> 33.45118
print(exact_res$basketwise$mean_est)
#>      NSCLC      CRC (vemu) CRC (vemu+cetu)      Bile Duct
#> 0.42198814 0.05378763 0.05377999 0.09461882
#>      ECD or LCH
#> 0.41938223
print(exact_res$basketwise$median_est)
#>      NSCLC      CRC (vemu) CRC (vemu+cetu)      Bile Duct
#> 0.41979605 0.04587528 0.04685210 0.05984761
#>      ECD or LCH
#> 0.41732553

```

The “clusterwise” includes all results of the clusterwise analyses.

```

print(exact_res$clusterwise$cluster)
#> [[1]]
#> [1] "CRC (vemu)"      "CRC (vemu+cetu)" "Bile Duct"
#>
#> [[2]]
#> [1] "NSCLC"      "ECD or LCH"
print(exact_res$clusterwise$post.prob)
#>      Cluster 1 Cluster 2
#> 0.15 0.06486667 0.9996
print(exact_res$clusterwise$HPD)
#>      Cluster 1 Cluster 2
#> Lower Bound 0.0004014445 0.2565271
#> Upper Bound 0.1761279038 0.5929280
print(exact_res$clusterwise$ESS)
#> Cluster 1 Cluster 2
#> 30.41333 31.62072
print(exact_res$clusterwise$mean_est)
#> Cluster 1 Cluster 2

```

```
#> 0.06739548 0.42068518
print(exact_res$clusterwise$median_est)
#> Cluster 1 Cluster 2
#> 0.05018346 0.41858398
```

mem_full_bayes_mcmc() function

This function conducts the MCMC computation based on the MEM method.

```
baskets <- 1:6
vemu_wide2 <- vemu_wide[baskets,]

MHResult1 <- mem_full_bayes_mcmc(responses = vemu_wide2$responders,
                                size = vemu_wide2$evaluable,
                                name=c("NSCLC ", "CRC.v ", "CRC.vc", " BD ", "ED.LH ", " ATC "),
                                p0 = c(0.15, 0.15, 0.15, 0.2, 0.15, 0.15), Initial = NA)

#> [1] "#### Cluster Assignment: 1"
#> [1] 2 3 4
#> [1] "CRC.v " "CRC.vc" " BD "
#> [1] "#### Cluster Assignment: 2"
#> [1] 1 5 6
#> [1] "NSCLC " "ED.LH " " ATC "
```

The output of the MCMC method “MHResult1” is a list including three components: call, basketwise, clusterwise.

```
print(MHResult1$call)
#> mem_full_bayes_mcmc(responses = vemu_wide2$responders, size = vemu_wide2$evaluable,
#> name = c("NSCLC ", "CRC.v ", "CRC.vc", " BD ", "ED.LH ",
#> " ATC "), p0 = c(0.15, 0.15, 0.15, 0.2, 0.15, 0.15),
#> Initial = NA)

print(MHResult1$basketwise$PEP)
#> NSCLC CRC.v CRC.vc BD ED.LH ATC
#> NSCLC 1.0000 0.0013 0.0000 0.1685 0.9370 0.9085
#> CRC.v 0.0013 1.0000 0.9460 0.7218 0.0030 0.0381
#> CRC.vc 0.0000 0.9460 1.0000 0.7041 0.0000 0.0139
#> BD 0.1685 0.7218 0.7041 1.0000 0.1827 0.4377
#> ED.LH 0.9370 0.0030 0.0000 0.1827 1.0000 0.9124
#> ATC 0.9085 0.0381 0.0139 0.4377 0.9124 1.0000
print(MHResult1$basketwise$MAP)
#> NSCLC CRC.v CRC.vc BD ED.LH ATC
#> NSCLC 1 0 0 0 1 1
#> CRC.v 0 1 1 1 0 0
#> CRC.vc 0 1 1 1 0 0
#> BD 0 1 1 1 0 0
#> ED.LH 1 0 0 0 1 1
#> ATC 1 0 0 0 1 1
print(MHResult1$basketwise$post.prob)
#> NSCLC CRC.v CRC.vc BD ED.LH ATC
#> 1.0000 0.0253 0.0166 0.2235 0.9995 0.9954
print(MHResult1$basketwise$HPD)
#> NSCLC CRC.v CRC.vc BD ED.LH
#> Lower Bound 0.2467614 0.0003721994 0.001025824 0.004948796 0.2418332
#> Upper Bound 0.5519280 0.1262331834 0.120540034 0.387087910 0.5486360
```

```

#>          ATC
#> Lower Bound 0.2131869
#> Upper Bound 0.5420350
print(MHResult1$basketwise$ESS)
#>      NSCLC      CRC.v      CRC.vc      BD      ED.LH      ATC
#> 38.090890 52.776421 56.020480 9.803425 37.664711 31.845339
print(MHResult1$basketwise$mean_est)
#>      NSCLC      CRC.v      CRC.vc      BD      ED.LH      ATC
#> 0.39674201 0.05463994 0.05235777 0.12991978 0.39444144 0.37321698
print(MHResult1$basketwise$median_est)
#>      NSCLC      CRC.v      CRC.vc      BD      ED.LH      ATC
#> 0.39364114 0.04703820 0.04548292 0.08336069 0.39219950 0.37206424

print(MHResult1$clusterwise$cluster)
#> [[1]]
#> [1] "CRC.v " "CRC.vc" " BD "
#>
#> [[2]]
#> [1] "NSCLC " "ED.LH " " ATC "
print(MHResult1$clusterwise$post.prob)
#>      Cluster 1 Cluster 2
#> 0.15 0.10963333 0.9983000
#> 0.2 0.07756667 0.9913667
print(MHResult1$clusterwise$HPD)
#>      Cluster 1 Cluster 2
#> Lower Bound 8.852201e-07 0.2292339
#> Upper Bound 2.812484e-01 0.5466789
print(MHResult1$clusterwise$ESS)
#> Cluster 1 Cluster 2
#> 11.55675 34.94048
print(MHResult1$clusterwise$mean_est)
#> Cluster 1 Cluster 2
#> 0.07897249 0.38813348
print(MHResult1$clusterwise$median_est)
#> Cluster 1 Cluster 2
#> 0.05440386 0.38653401

```

summary() function

Summarize the operating characteristics from the result (basketwise or clusterwise)

```

summary(exact_res$basketwise)
#>      NSCLC      CRC (vemv) CRC (vemv+cetu)      Bile Duct ECD or LCH
#> Post.Prob 0.9997300 2.228797e-02      0.01695701 0.156552290 0.9993749
#> HPD LB    0.2564416 1.507140e-05      0.00261162 0.001423002 0.2529839
#> HPD HB    0.5903820 1.268642e-01      0.12448533 0.343617974 0.5986269
#> ESS       33.7323756 4.120234e+01      42.57151265 40.399126070 33.4511756
#> Mean      0.4219881 5.378763e-02      0.05377999 0.094618820 0.4193822
#> Median    0.4197960 4.587528e-02      0.04685210 0.059847607 0.4173255
summary(exact_res$clusterwise)
#>      Cluster 1 Cluster 2
#> Post.Prob 0.15 6.486667e-02 0.9996000

```

```
#> HPD LB      4.014445e-04  0.2565271
#> HPD HB      1.761279e-01  0.5929280
#> ESS         3.041333e+01 31.6207193
#> Mean        6.739548e-02  0.4206852
#> Median      5.018346e-02  0.4185840
```

update_result() function

Update the result with the new threshold value p0 and the alternative parameter.

```
exact_resNew <- update_result(exact_res, 0.25)
```

```
summary(exact_res$basketwise)
#>           NSCLC   CRC (vemu) CRC (vemu+cetu)   Bile Duct ECD or LCH
#> Post.Prob  0.9997300 2.228797e-02    0.01695701 0.156552290 0.9993749
#> HPD LB     0.2564416 1.507140e-05    0.00261162 0.001423002 0.2529839
#> HPD HB     0.5903820 1.268642e-01    0.12448533 0.343617974 0.5986269
#> ESS       33.7323756 4.120234e+01    42.57151265 40.399126070 33.4511756
#> Mean       0.4219881 5.378763e-02    0.05377999 0.094618820 0.4193822
#> Median     0.4197960 4.587528e-02    0.04685210 0.059847607 0.4173255
summary(exact_resNew$basketwise)
#>           NSCLC   CRC (vemu) CRC (vemu+cetu)   Bile Duct ECD or LCH
#> Post.Prob  0.9800814 1.816233e-03    2.860321e-04 0.096965046 0.9778063
#> HPD LB     0.2564416 1.507140e-05    2.611620e-03 0.001423002 0.2529839
#> HPD HB     0.5903820 1.268642e-01    1.244853e-01 0.343617974 0.5986269
#> ESS       33.7323756 4.120234e+01    4.257151e+01 40.399126070 33.4511756
#> Mean       0.4219881 5.378763e-02    5.377999e-02 0.094618820 0.4193822
#> Median     0.4197960 4.587528e-02    4.685210e-02 0.059847607 0.4173255
```

plot functions

Plot the density and the exchangeability

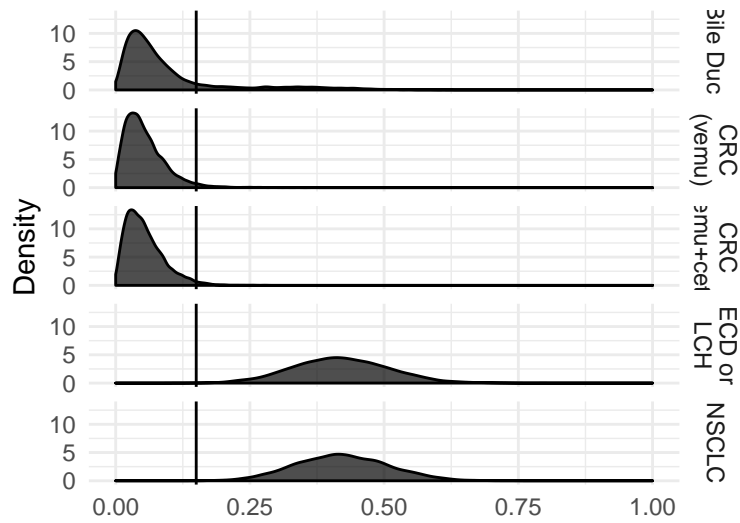
```
library(extrafont)
```

```
font_import()
```

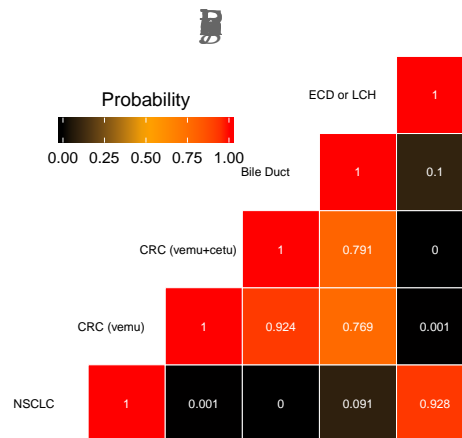
```
#> Importing fonts may take a few minutes, depending on the number of fonts and the speed of the system
#> Continue? [y/n]
```

```
loadfonts(device = "pdf", quiet=TRUE)
```

```
plot_density(exact_res$basketwise)
```

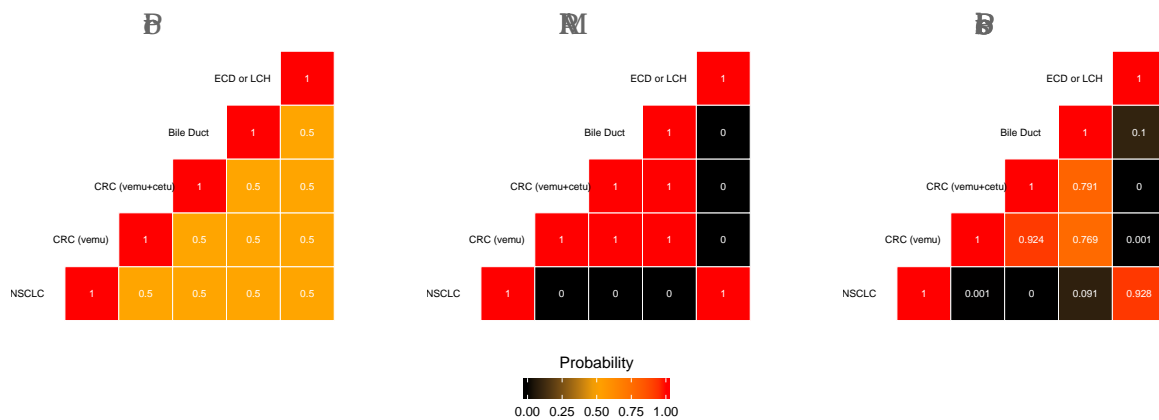


```
plot_posterior_exchangeability(exact_res$basketwise,
                              text_size=2.5, basket_name_hoffset=-0.2)
```



Plot prior, likelihood, and posterior probability.

```
plot_all_exchangeability(exact_res$basketwise, c("PRIOR", "MAP", "PEP"),
                        text_size=2.5, basket_name_hoffset=-0.2)
```



```
plot_all_exchangeability(exact_res$basketwise, c("MAP", "PEP"),
  text_size=3, basket_name_hoffset=-0.2)
```

