flashtpx: Simulation Run 3

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Overview

This is the third simulation run of *flashtpx* without the non-negative constraint. The main idea is to try and replicate the results for the `FitGoM()` in CountClust or `topics()` model in the maptpx package due to Matt Taddy.

Without the non-negative constraint, *flashtpx* is basically applying *flash* with the covariance matrix for the data estimated from the GoM or topic model fitting on the counts data. Here we apply *flashtpx* on the counts data generated from a chosen simulation design and then interpret the results and compare the results to the PMA model fitting.

Simulation Design

We load the packages and the functions we need to perform the model.

```r
library(ashr)
library(irlba)
library(PMA)
source("../R/flash.R")
```

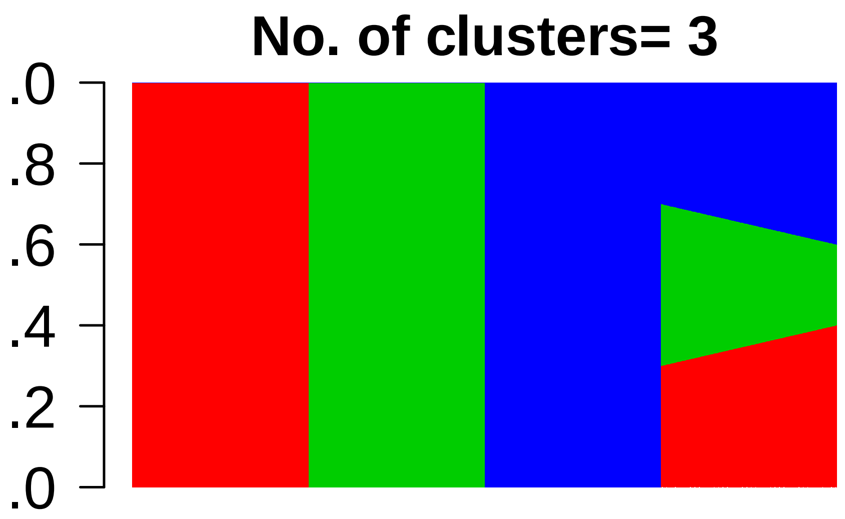
In the first two simulation runs, we considered $K = 2$, here we consider the model with $K = 3$.

Again as in first simulation run, we take samples in batches of size 200. The first 200 samples are from cluster 1, next 200 from cluster 2, next 200 from cluster 3 and the final 200 are proportionally allocated to the three clusters. More clear presentation of the omega matrix or membership matrix can be obtained from the Structure plot below.

```
n.out <- 200
omega_sim <- rbind(cbind(rep(1, n.out), rep(0,
    n.out), rep(0, n.out)), cbind(rep(0, n.out),
    rep(1, n.out), rep(0, n.out)), cbind(rep(0,
    n.out), rep(0, n.out), rep(1, n.out)), cbind(seq(0.3,
    0.4, length.out = n.out), seq(0.4, 0.2, length.out = n.out),
    1 - seq(0.3, 0.4, length.out = n.out) - seq(0.4,
        0.2, length.out = n.out)))

K <- dim(omega_sim)[2]

par(mar = c(2, 2, 2, 2))
barplot(t(omega_sim), col = 2:(K + 1), axisnames = F,
    space = 0, border = NA, main = paste("No. of clusters=",
        K), las = 1, ylim = c(0, 1), cex.axis = 1.5,
    cex.main = 1.4)
```



Assume there are 100 genes we have observed. Lets see how the clusters look by defining the cluster frequency matrix below.

```
freq <- rbind(c(0.1, 0.2, rep(0.7/98, 98)), c(rep(0.7/98,
    98), 0.1, 0.2), c(rep(0.4/49, 49), 0.1, 0.2,
    rep(0.3/49, 49)))

str(freq)
```

```
##  num [1:3, 1:100] 0.1 0.00714 0.00816 0.2 0.00714 ...
```

We now generate the counts data given the above membership probability and the cluster distribution matrices.

```
counts <- t(do.call(cbind, lapply(1:dim(omega_sim)[1],
    function(x) rmultinom(1, 1000, prob = omega_sim[x,
        ] %*% freq))))
dim(counts)
```

```
## [1] 800 100
```

We next fit a standard topic model with $K = 2$.

```
topic.fit <- maptpx::topics(counts, K = 3)
```

```
##
## Estimating on a 800 document collection.
## Fitting the 3 topic model.
## log posterior increase: 19369.6, 10.2, 0.7, 0.2, done.
```

```
omega <- topic.fit$omega
theta <- topic.fit$theta
```

Brief methods overview

Under the standard topic model, we have

$$c_{ng} \sim Poi(c_{n+} \sum_{k=1}^{K} \omega_{nk}\theta_{kg})$$

Let us define

$$\lambda_{ng} = c_{n+} \sum_{k=1}^{K} \omega_{nk}\theta_{kg}$$

Under the normal model, if λ_{ng} is large, we can assume

$$c_{ng} \sim N(\lambda_{ng}, \lambda_{ng})$$

which is equivalent to saying

$$c_{ng} = \lambda_{ng} + e_{ng} \qquad e_{ng} \sim N(0, \lambda_{ng})$$

For applying *flash*, we first estimate the λ in the variance using topic model estimate (we call this λ to be $\lambda^{\star}$).

to guard against the odd possibility that for some n and g, this estimate $\lambda^{\star}$ could be 0, we replace such cases as of now with a small value 0.0001.

In this example model we have considered $c_{n+} = 1000$.

```
lambda_star <- 1000 * (omega %*% t(theta))
lambda_star[lambda_star == 0] <- 1e-04
dim(lambda_star)
```

```
## [1] 800 100
```

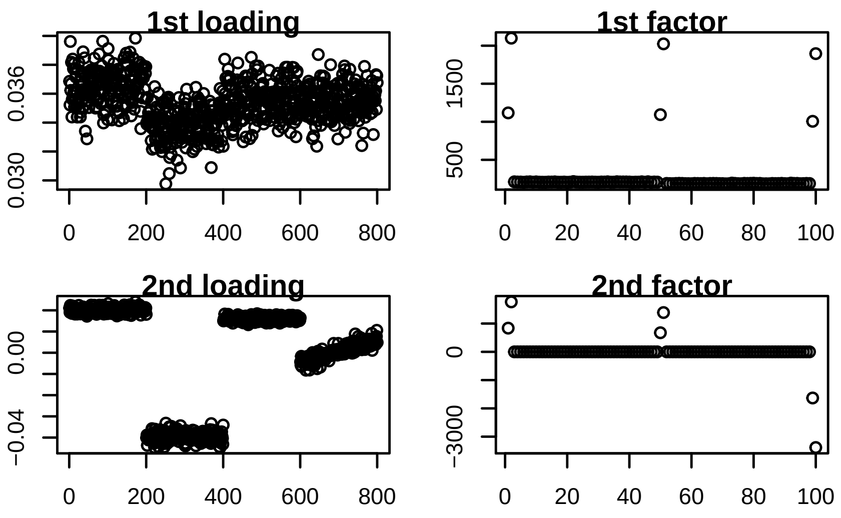
FLASH model fitting

flash then fits the model

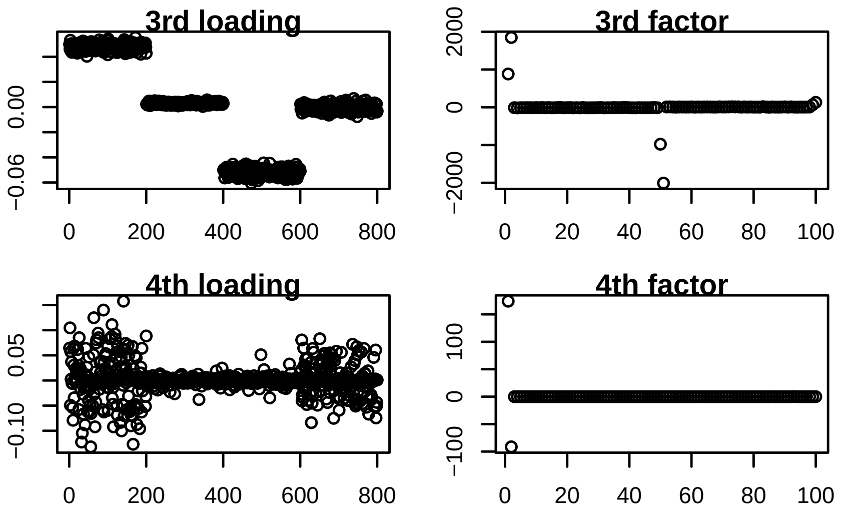
$$c_{ng} = \sum_{k=1}^{K} l_{nk} f_{kg} + e_{ng} \qquad e_{ng} \sim N(0, \lambda^{\star}_{ng})$$

```
g1 = suppressMessages(flash(counts, sigmae2_true = lambda_star))
f = g1$f
l = g1$l
res = counts - l %*% t(f)
# g_new = flash(res,nonnegative =
# TRUE,sigmae2_true = lambda)
g2 = suppressMessages(flash(res, sigmae2_true = lambda_star))
l = g2$l
f = g2$f
res = res - l %*% t(f)
g3 = suppressMessages(flash(res, sigmae2_true = lambda_star))
l = g3$l
f = g3$f
res = res - l %*% t(f)
g4 = suppressMessages(flash(res, sigmae2_true = lambda_star))
l = g4$l
f = g4$f
res = res - l %*% t(f)
g5 = suppressMessages(flash(res, sigmae2_true = lambda_star))
l = g5$l
f = g5$f
res = res - l %*% t(f)
g6 = suppressMessages(flash(res, sigmae2_true = lambda_star))
l = g6$l
f = g6$f
par(mfrow = c(2, 2))
par(cex = 0.6)
par(mar = c(3, 3, 0.8, 0.8), oma = c(1, 1, 1,
    1))
plot(g1$l, main = "1st loading")
plot(g1$f, main = "1st factor")
```

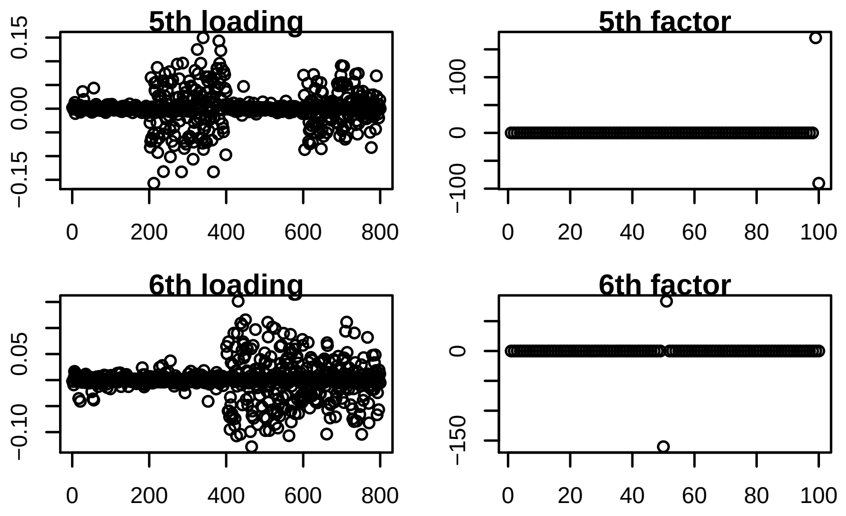
```r
plot(g2$l, main = "2nd loading")
plot(g2$f, main = "2nd factor")
```



```r
plot(g3$l, main = "3rd loading")
plot(g3$f, main = "3rd factor")
plot(g4$l, main = "4th loading")
plot(g4$f, main = "4th factor")
```



```r
plot(g5$l, main = "5th loading")
plot(g5$f, main = "5th factor")
plot(g6$l, main = "6th loading")
plot(g6$f, main = "6th factor")
```



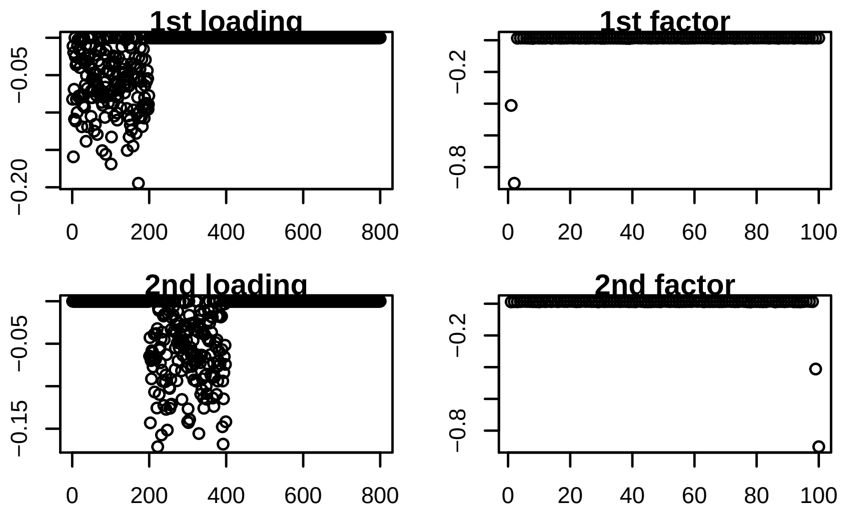
PMA model fitting

We compare the output of *flash* with that of the `PMD()` function of the package PMA. We use their default settings for shrinkage.

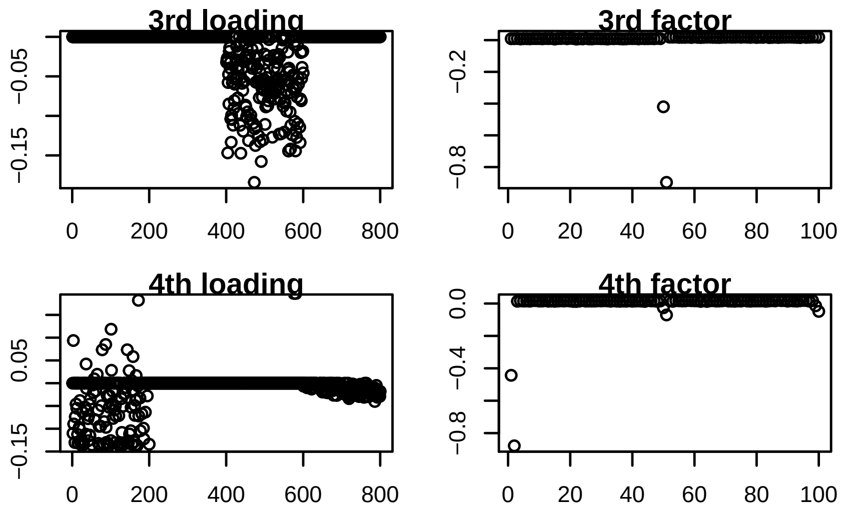
```
out <- PMD(counts, K = 6)
```

```
## 12345
## 12345
## 12345
## 1234567891011
## 1234567891011
## 123456789
```

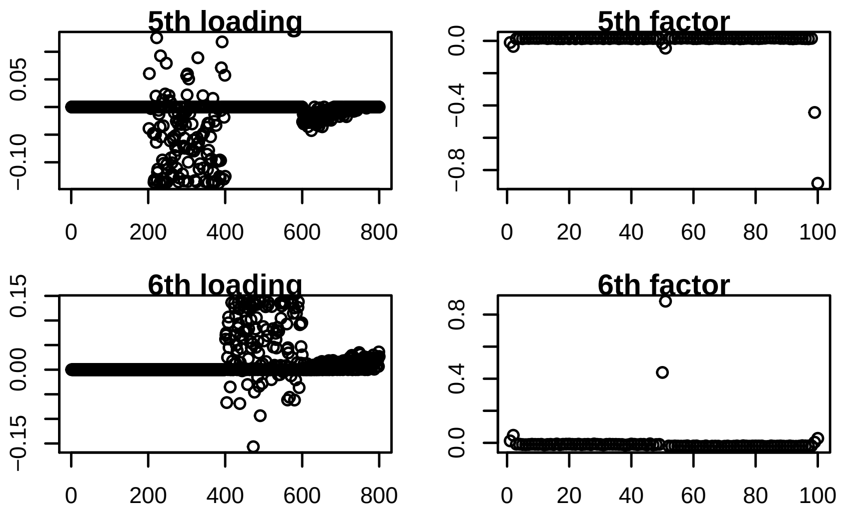
```
par(mfrow = c(2, 2))
par(cex = 0.6)
par(mar = c(3, 3, 0.8, 0.8), oma = c(1, 1, 1,
    1))
plot(out$u[, 1], main = "1st loading")
plot(out$v[, 1], main = "1st factor")
plot(out$u[, 2], main = "2nd loading")
plot(out$v[, 2], main = "2nd factor")
```



```r
plot(out$u[, 3], main = "3rd loading")
plot(out$v[, 3], main = "3rd factor")
plot(out$u[, 4], main = "4th loading")
plot(out$v[, 4], main = "4th factor")
```



```r
plot(out$u[, 5], main = "5th loading")
plot(out$v[, 5], main = "5th factor")
plot(out$u[, 6], main = "6th loading")
plot(out$v[, 6], main = "6th factor")
```



```
sessionInfo()
```

```
## R version 3.2.4 (2016-03-10)
## Platform: x86_64-apple-darwin13.4.0 (64-bit)
## Running under: OS X 10.10.5 (Yosemite)
##
## locale:
## [1] en_US.UTF-8/en_US.UTF-8/en_US.UTF-8/C/en_US.UTF-8/en_US.UTF-8
##
## attached base packages:
## [1] stats     graphics  grDevices utils
## [5] datasets  methods   base
##
## other attached packages:
## [1] Rcpp_0.12.4   PMA_1.0.9     impute_1.44.0
## [4] plyr_1.8.3    irlba_2.0.0   Matrix_1.2-4
## [7] ashr_1.0.8
##
## loaded via a namespace (and not attached):
##  [1] knitr_1.12.3      magrittr_1.5
##  [3] MASS_7.3-43       doParallel_1.0.10
##  [5] pscl_1.4.9        SQUAREM_2014.8-1
##  [7] lattice_0.20-33   foreach_1.4.3
##  [9] stringr_1.0.0     tools_3.2.4
## [11] parallel_3.2.4    grid_3.2.4
## [13] maptpx_1.9-2      htmltools_0.3
## [15] iterators_1.0.8   assertthat_0.1
## [17] yaml_2.1.13       digest_0.6.9
## [19] formatR_1.2.1     codetools_0.2-14
## [21] slam_0.1-32       evaluate_0.8
## [23] rmarkdown_0.9.2   stringi_1.0-1
## [25] truncnorm_1.0-7   tufte_0.2
```