Estimate Scaling Parameter in SUCCOTASH

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Abstract

I look at SUCCOTASH using two other factor analysis methods. My "moderated factor analysis" seems to be getting closer to estimating π_0 for small sample sizes, but is still anticonservative and has worse MSE performance. The quasi-MLE factor analysis does not improve performance.

Results

```
library(knitr)
library(xtable)
library(dplyr)
```

```
## Warning: package 'dplyr' was built under R version 3.2.5
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##     filter, lag
```

```
## The following objects are masked from 'package:base':
##
##     intersect, setdiff, setequal, union
```

```
library(reshape2)
library(ggplot2)
```

To view a description of these simulations and the results when the variance was not-inflated, please see http://dcgerard.github.io/flash_sims/analysis/flashr_v_succ.pdf.

scale_succ_pca uses PCA, scale_succ_ModFA uses my moderated factor analysis, and QMLE uses quasi-maximum likelihood implemented in the package `cate`.

The moderated factor analysis seems to be getting closer to estimating π_0 accurately at smaller sample sizes, but is still anti-conservative, and performs worse in terms of MSE.

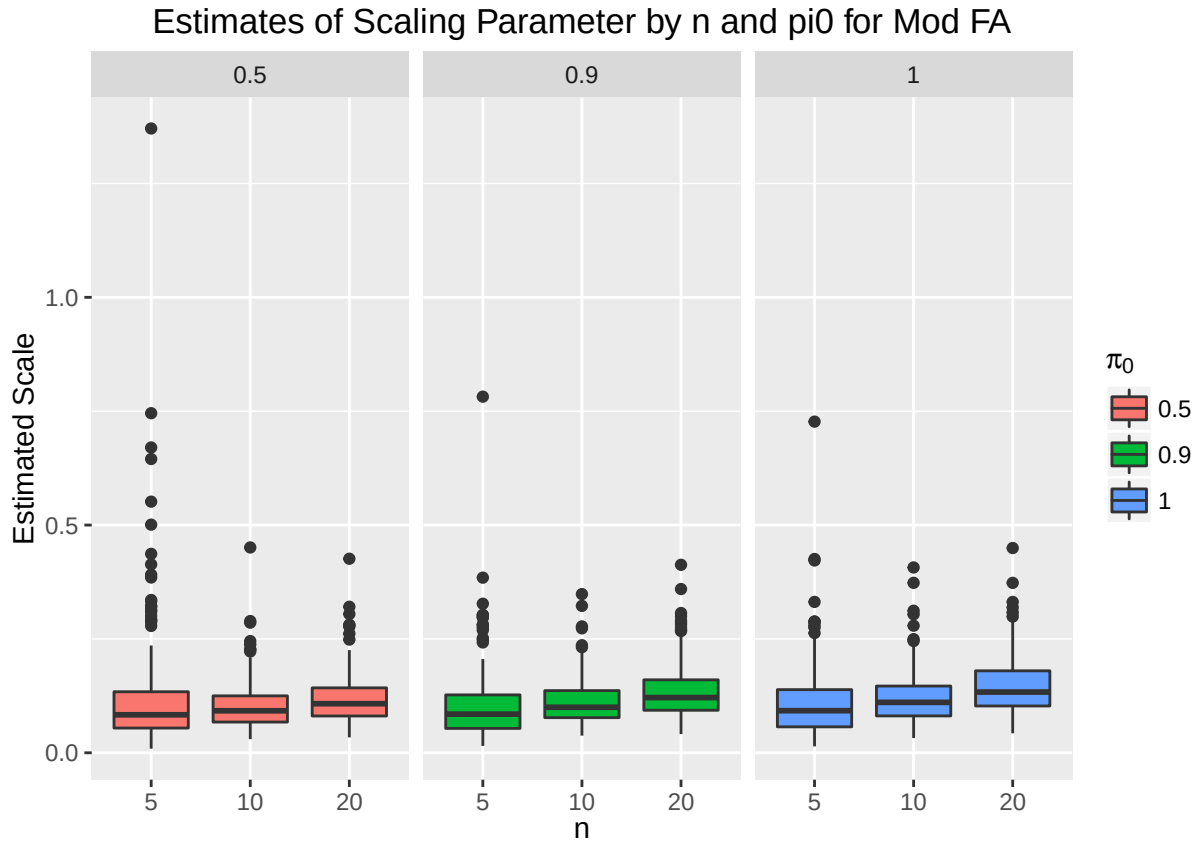
Quasi-mle seems to perform worse than PCA in terms of estimating π_0, and as well as PCA in terms of MSE and AUC.

The estimates of the scale parameter for QMLE are about where they were for PCA. Interestingly, the scale estimates when using the moderated factor analysis are close to 0.1. That is, SUCCOTASH shrinks the variances in this case.

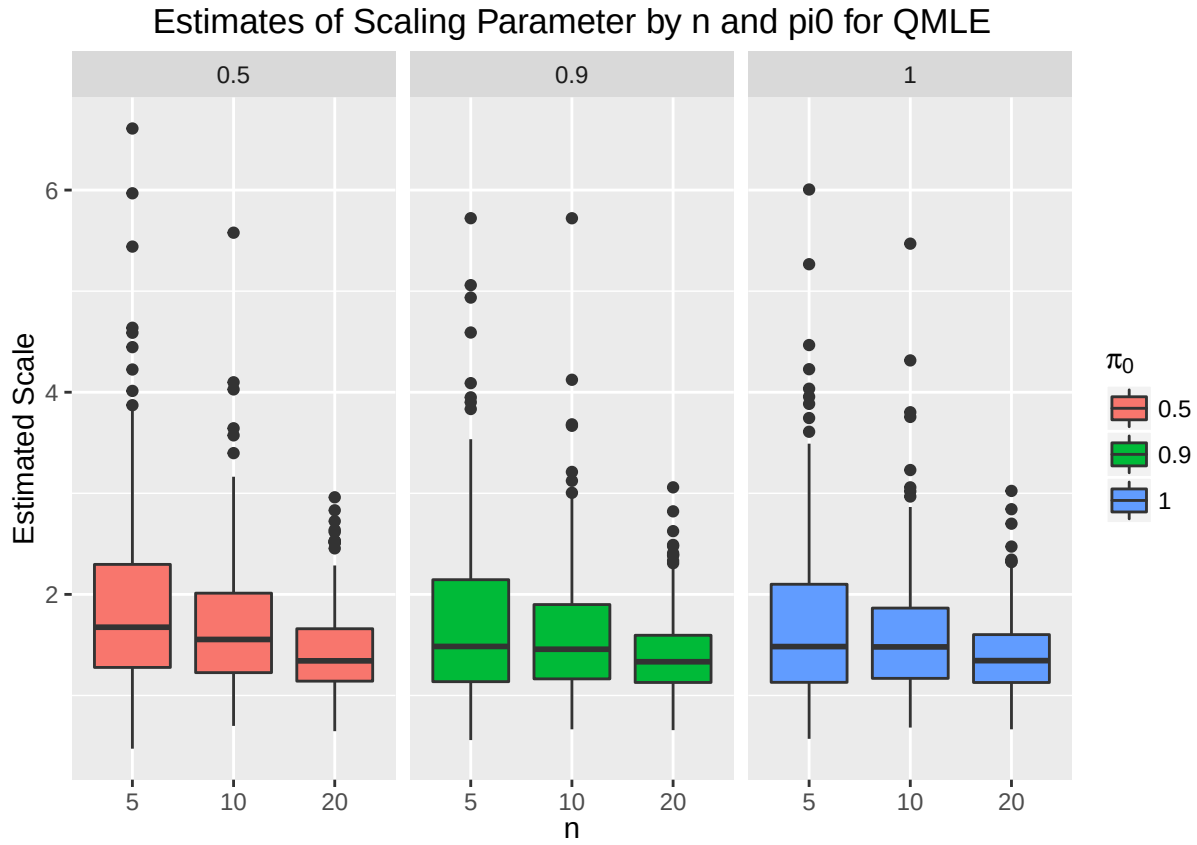
```
scale_est_mat <- tbl_df(read.csv("scale_est_ssuc_mc.csv", header = TRUE))
kable(cbind(aggregate(mod_fa ~ nullpi + nsamp, FUN = mean, data = scale_est_mat),
            aggregate(quasi_mle ~ nullpi + nsamp, FUN = mean,
                      data = scale_est_mat)$quasi_mle),
      col.names = c("$\\pi_0$", "$n$", "Mean Scale Mod FA", "Mean Scale QMLE"), digits = 2)
```

π_0	n	Mean Scale Mod FA	Mean Scale QMLE
0.5	5	0.13	1.91
0.9	5	0.11	1.73
1.0	5	0.11	1.73
0.5	10	0.10	1.71
0.9	10	0.11	1.62
1.0	10	0.12	1.60
0.5	20	0.12	1.44
0.9	20	0.13	1.40
1.0	20	0.15	1.40

```
ggplot(data = scale_est_mat, mapping = aes(x = factor(nsamp), y = mod_fa,
                                           fill = factor(nullpi))) +
    facet_grid(.~nullpi) +
    geom_boxplot() +
    xlab(expression(n)) + ylab("Estimated Scale") +
    scale_fill_discrete(name=expression(pi[0])) +
        ggtitle("Estimates of Scaling Parameter by n and pi0 for Mod FA")
```



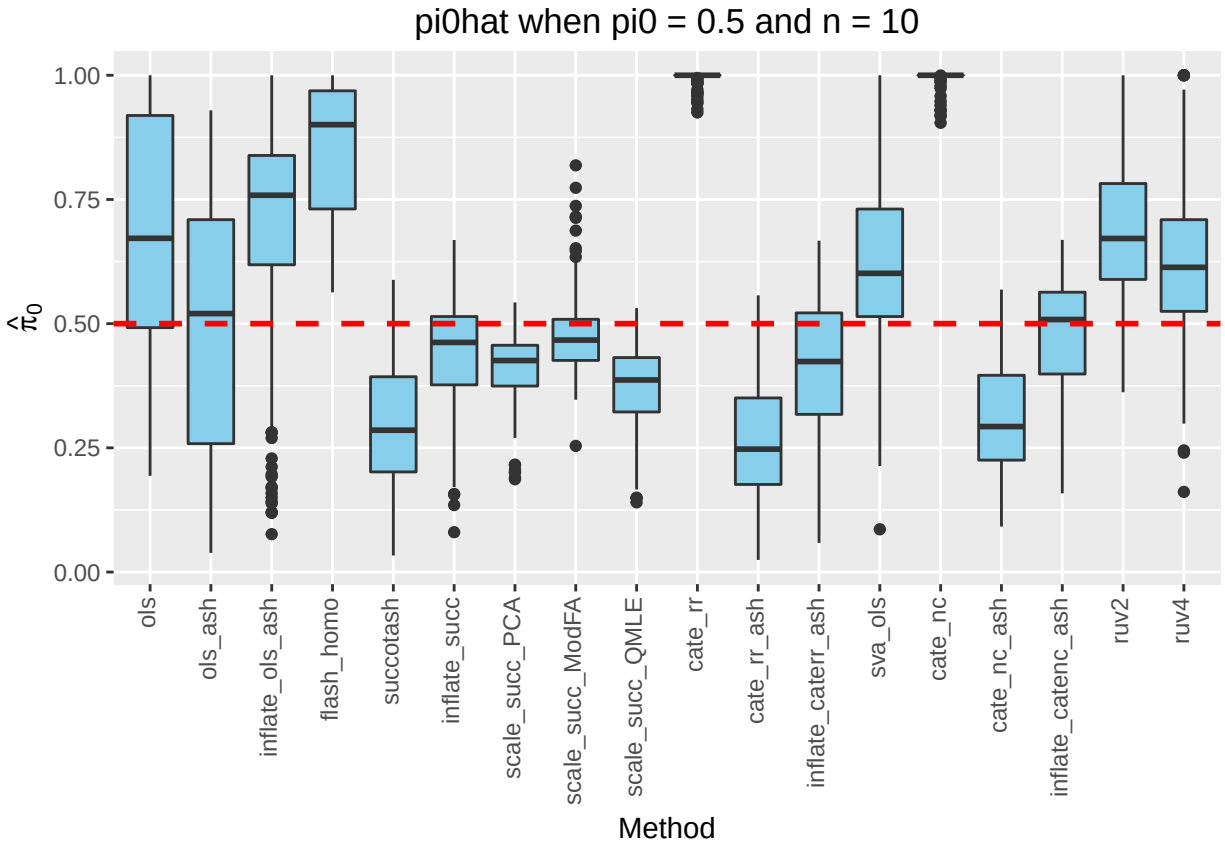

```
ggplot(data = scale_est_mat, mapping = aes(x = factor(nsamp), y = quasi_mle,
                                           fill = factor(nullpi))) +
    facet_grid(.~nullpi) +
    geom_boxplot() +
    xlab(expression(n)) + ylab("Estimated Scale") +
    scale_fill_discrete(name=expression(pi[0])) +
    ggtitle("Estimates of Scaling Parameter by n and pi0 for QMLE")
```

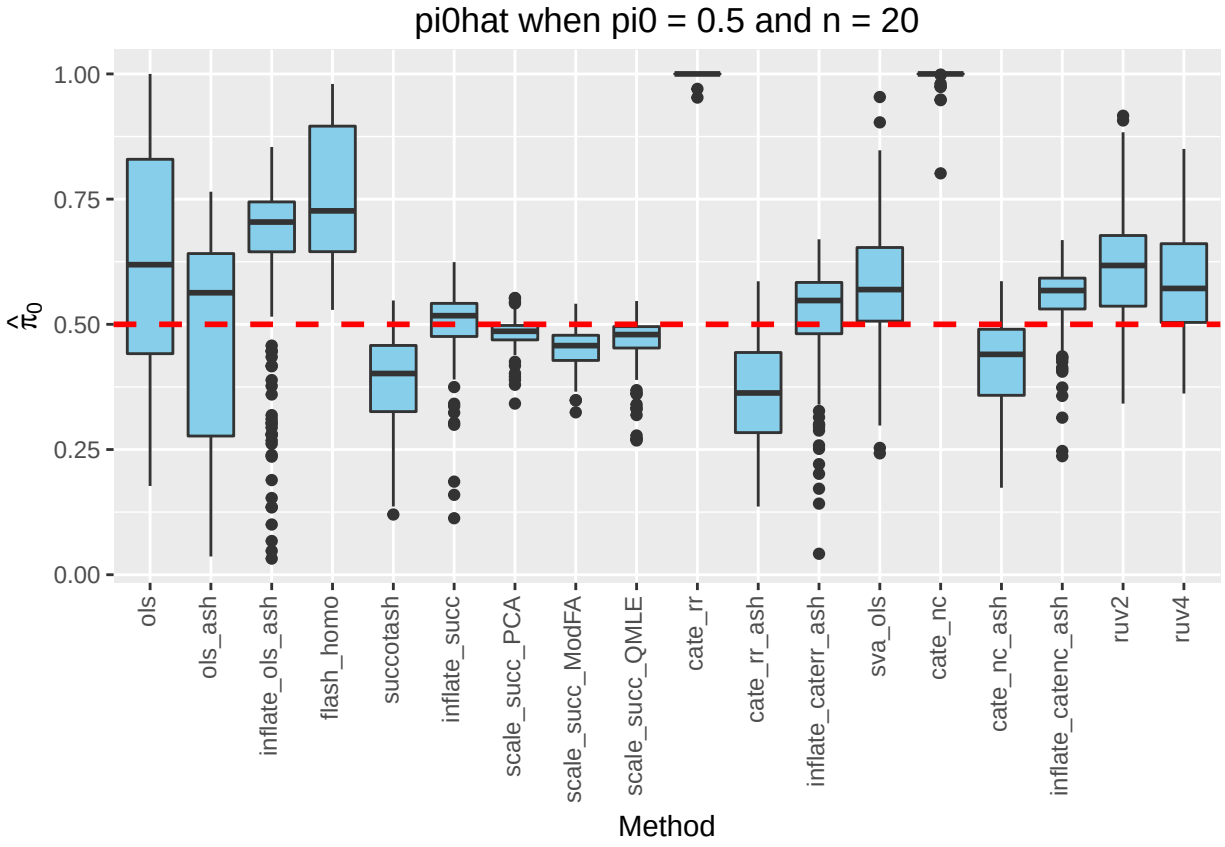


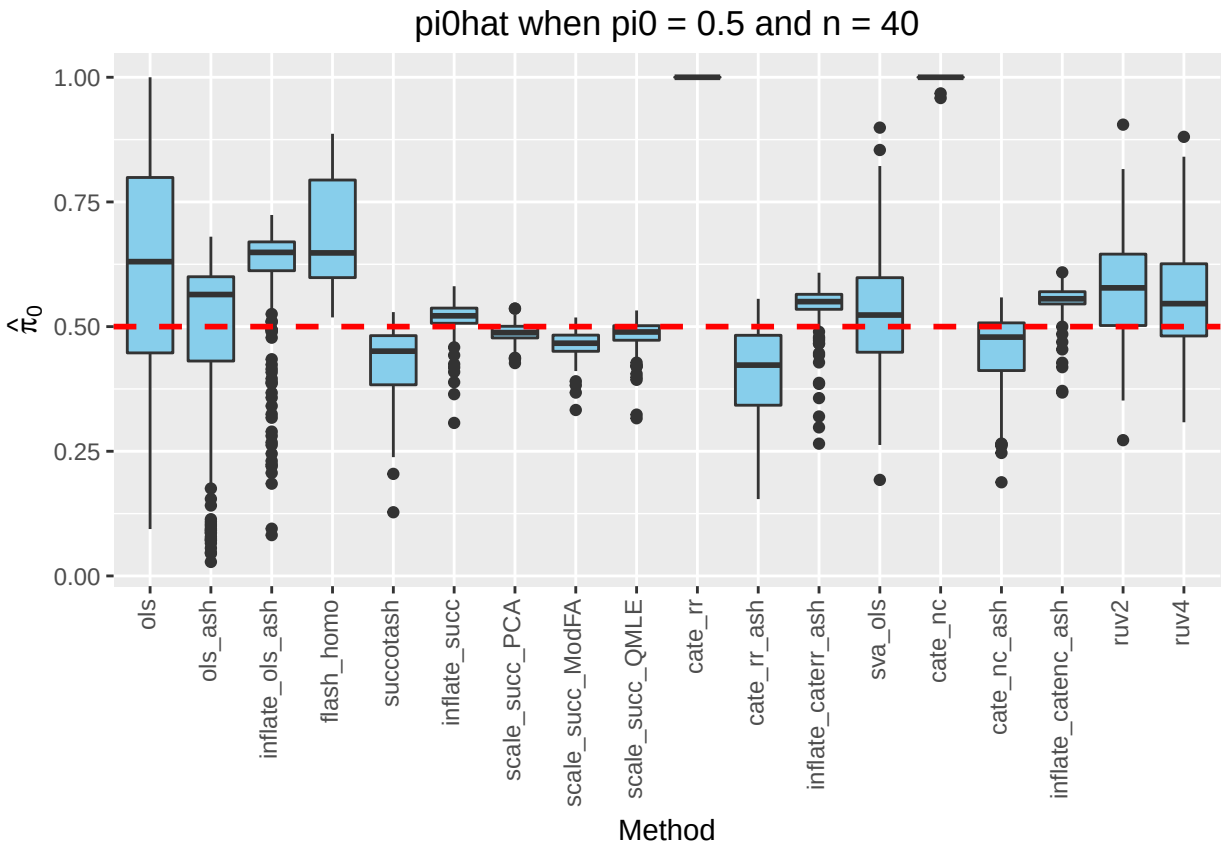
$\hat{\pi}_0$ Plots

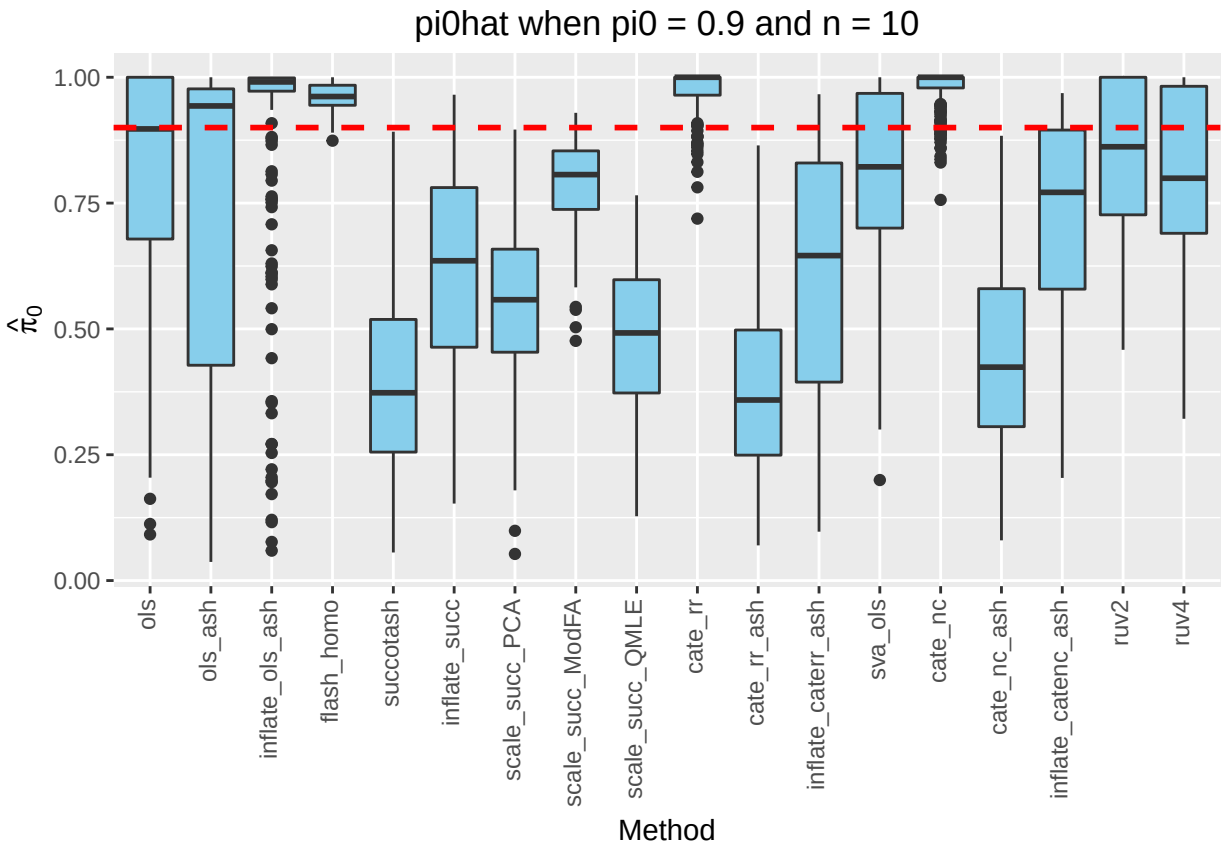
```
double_pi0 <- read.csv("../double_succ/pi0_mat.csv")
reg_pi0 <- read.csv("../flash_v_rest_using_package/pi0_mat.csv")
scale_pi0 <- read.csv("../succ_scaled/pi0_ssuc.csv")
scale_pi0_fa <- read.csv("pi0_ssuc_mc.csv")
reg_pi0$inflate_succ <- double_pi0$succotash
reg_pi0$inflate_caterr_ash <- double_pi0$cate_rr_ash
reg_pi0$inflate_catenc_ash <- double_pi0$cate_nc_ash
reg_pi0$inflate_ols_ash <- double_pi0$ols_ash
reg_pi0$scale_succ_PCA <- scale_pi0$scale_suc1
reg_pi0$scale_succ_ModFA <- scale_pi0_fa$mod_fa
reg_pi0$scale_succ_QMLE <- scale_pi0_fa$quasi_mle
reg_pi0 <- tbl_df(reg_pi0)
reg_pi0 <- reg_pi0[, c(1:2, 17, 3:4, 14, 18:20, 5:6, 15, 7:9, 16, 10:13)]
nsamp_seq <- unique(reg_pi0$nsamp)
nullpi_seq <- unique(reg_pi0$nullpi)
for (current_pi in nullpi_seq) {
    for (current_nsamp in nsamp_seq) {

        subdf <- select(
            filter(
                reg_pi0, nullpi == current_pi & nsamp == current_nsamp),
```

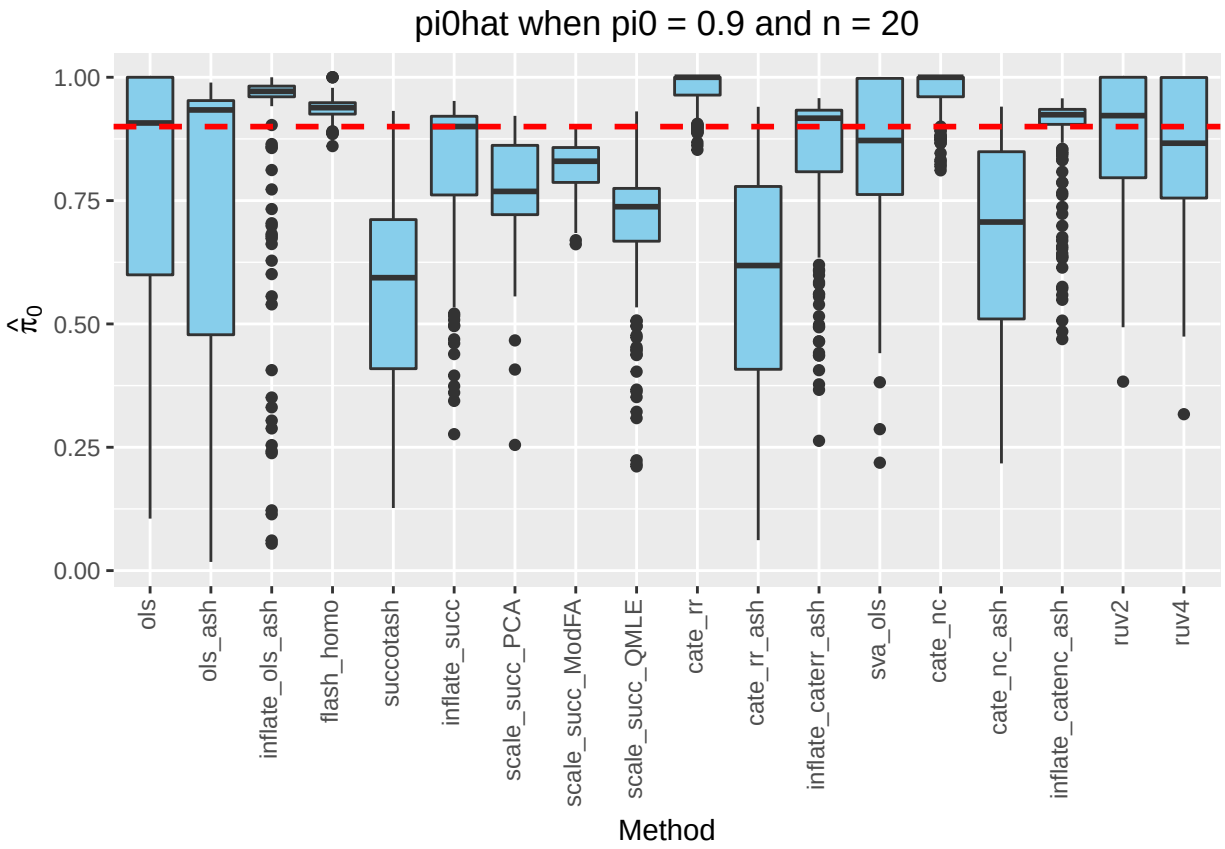
```
            -c(nsamp, nullpi)
        )

        melted_df <- melt(subdf, id.vars = NULL)

        p <- ggplot(data = melted_df, mapping = aes(x = variable, y = value)) +
            geom_boxplot(fill = I("skyblue")) +
            xlab(label = "Method") + ylab(label = expression(hat(pi)[0])) +
            geom_hline(yintercept = current_pi, color = I("red"), lty  = 2, lwd = 1) +
            ggtitle(paste("pi0hat when pi0 =", current_pi, "and n =", current_nsamp * 2)) +
            theme(axis.text.x = element_text(angle = 90, hjust = 1, vjust = 0.3))
        print(p)
    }
}
```

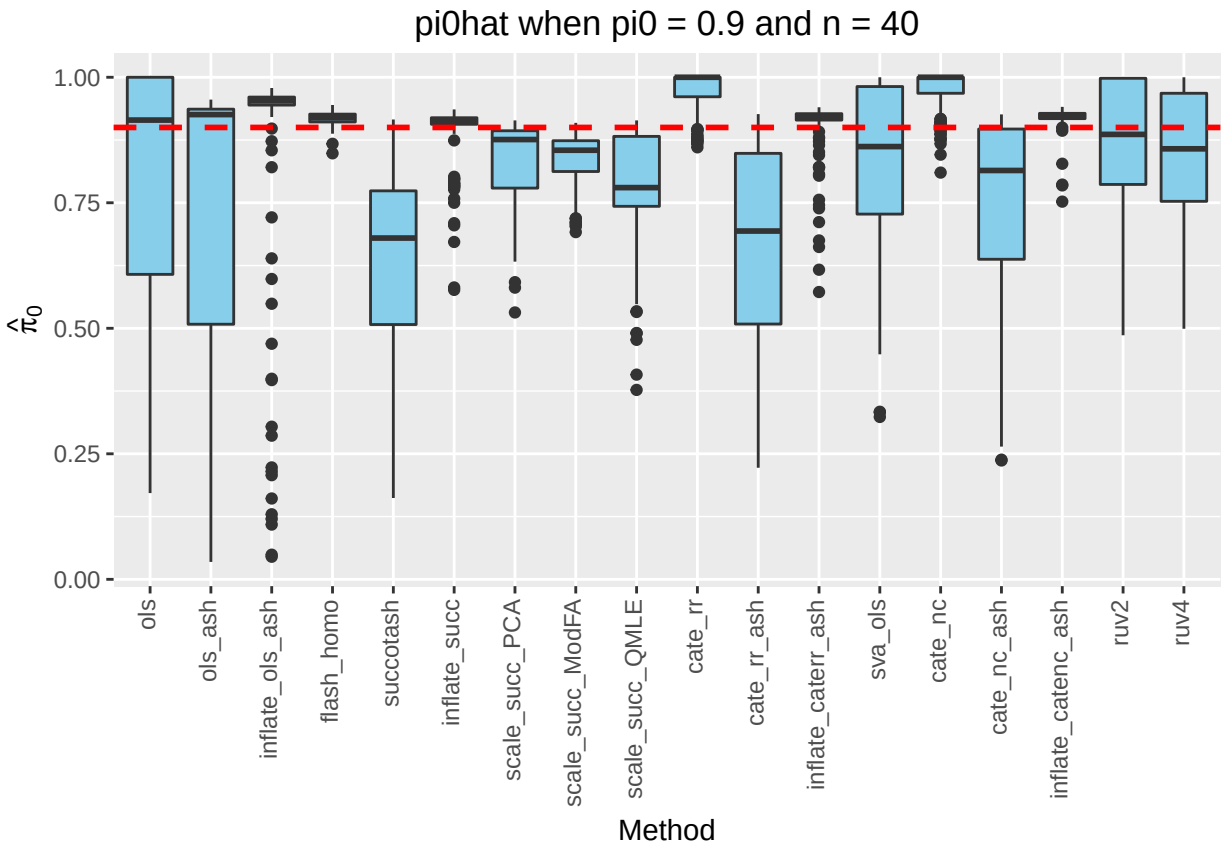

pi0hat when pi0 = 0.5 and n = 10
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

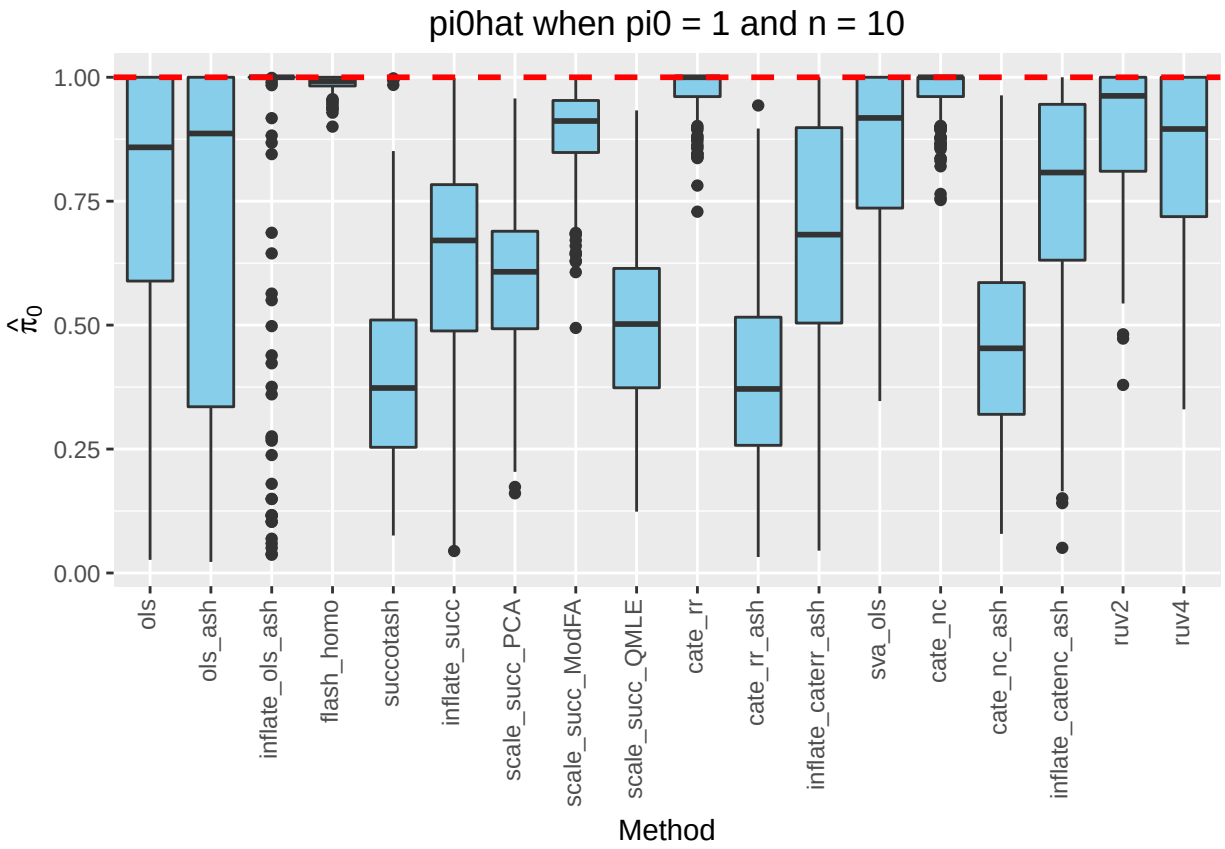

pi0hat when pi0 = 0.5 and n = 20
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

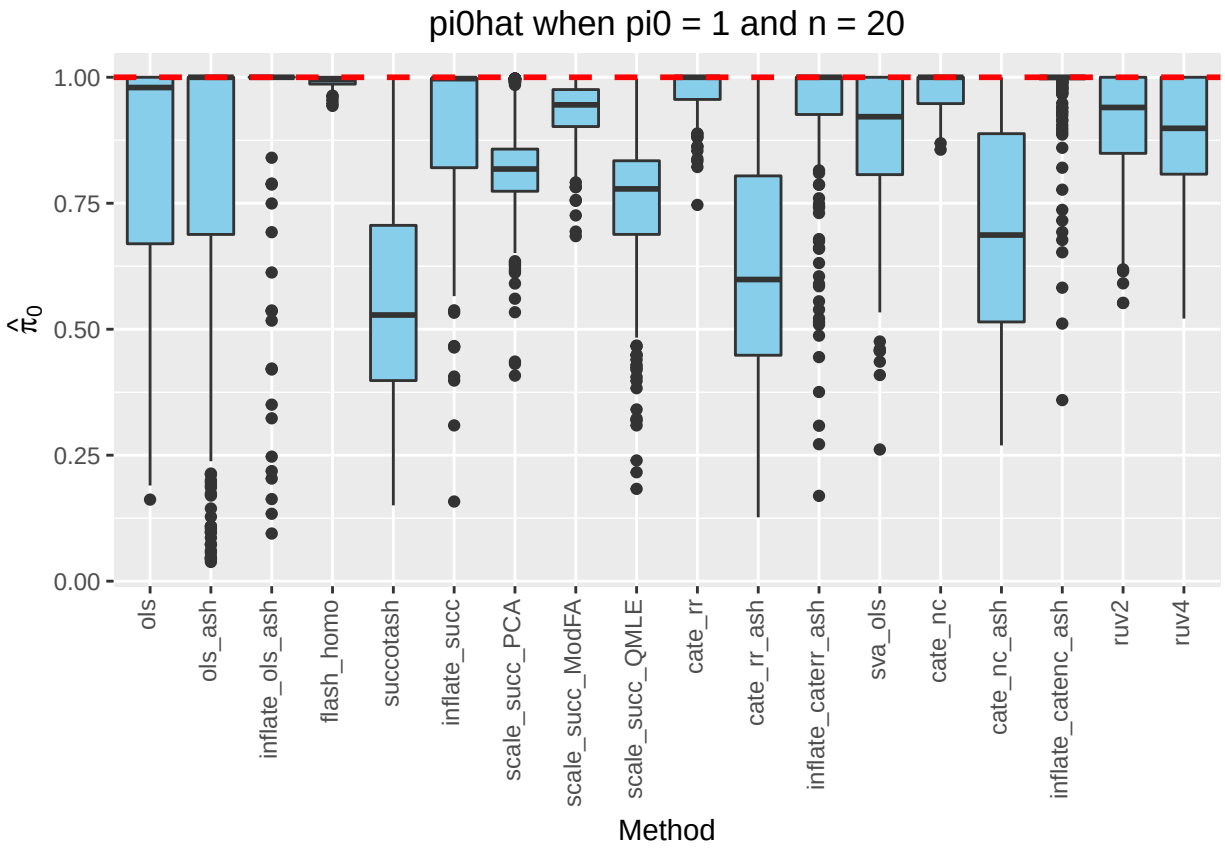

pi0hat when pi0 = 0.5 and n = 40
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

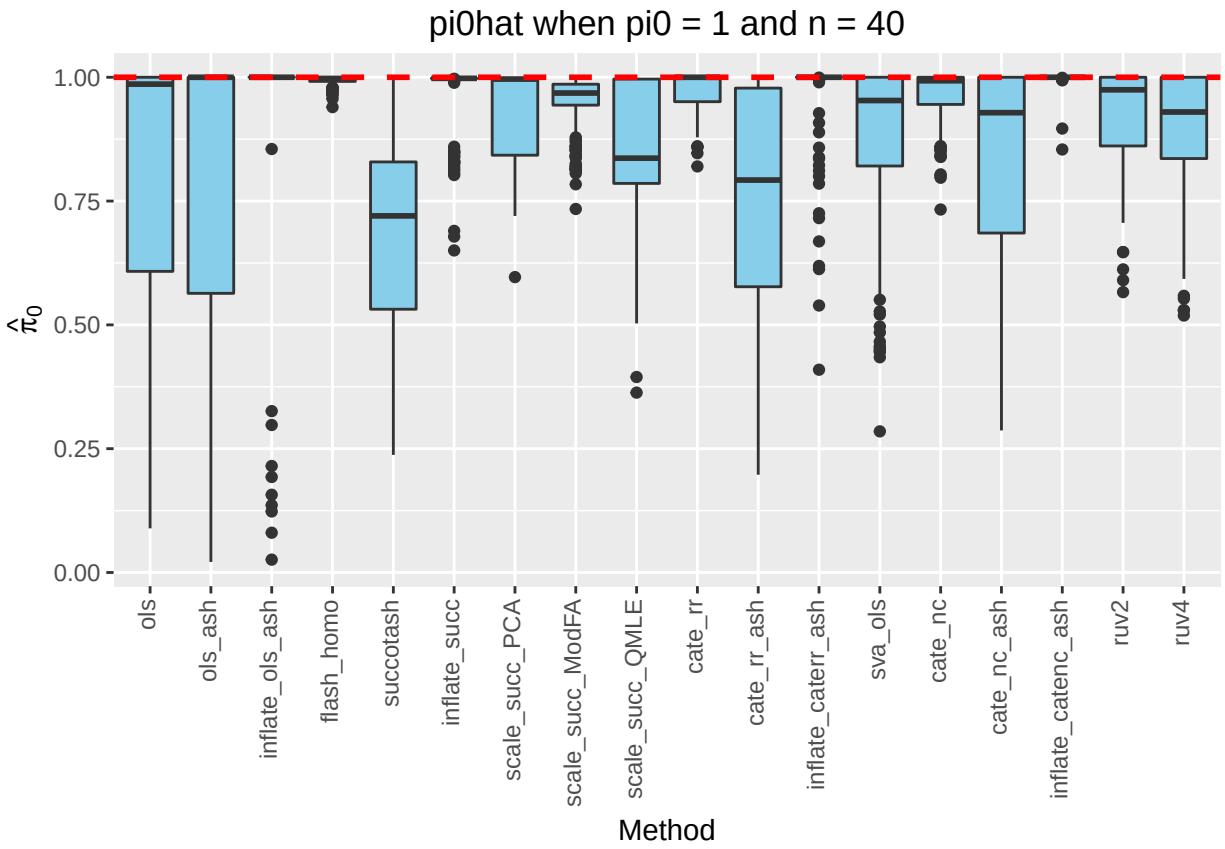

pi0hat when pi0 = 0.9 and n = 10
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


pi0hat when pi0 = 0.9 and n = 20
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


pi0hat when pi0 = 0.9 and n = 40
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


pi0hat when pi0 = 1 and n = 10
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

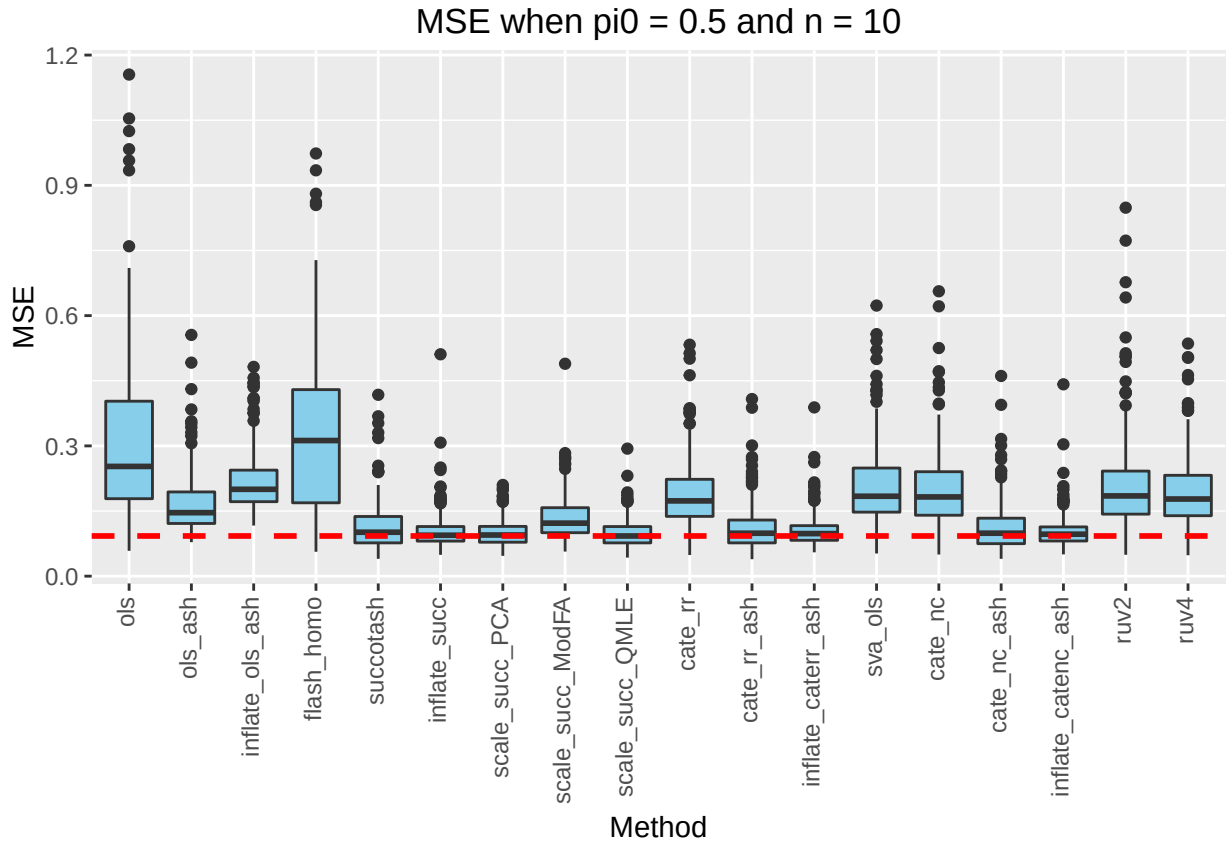

pi0hat when pi0 = 1 and n = 20
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method



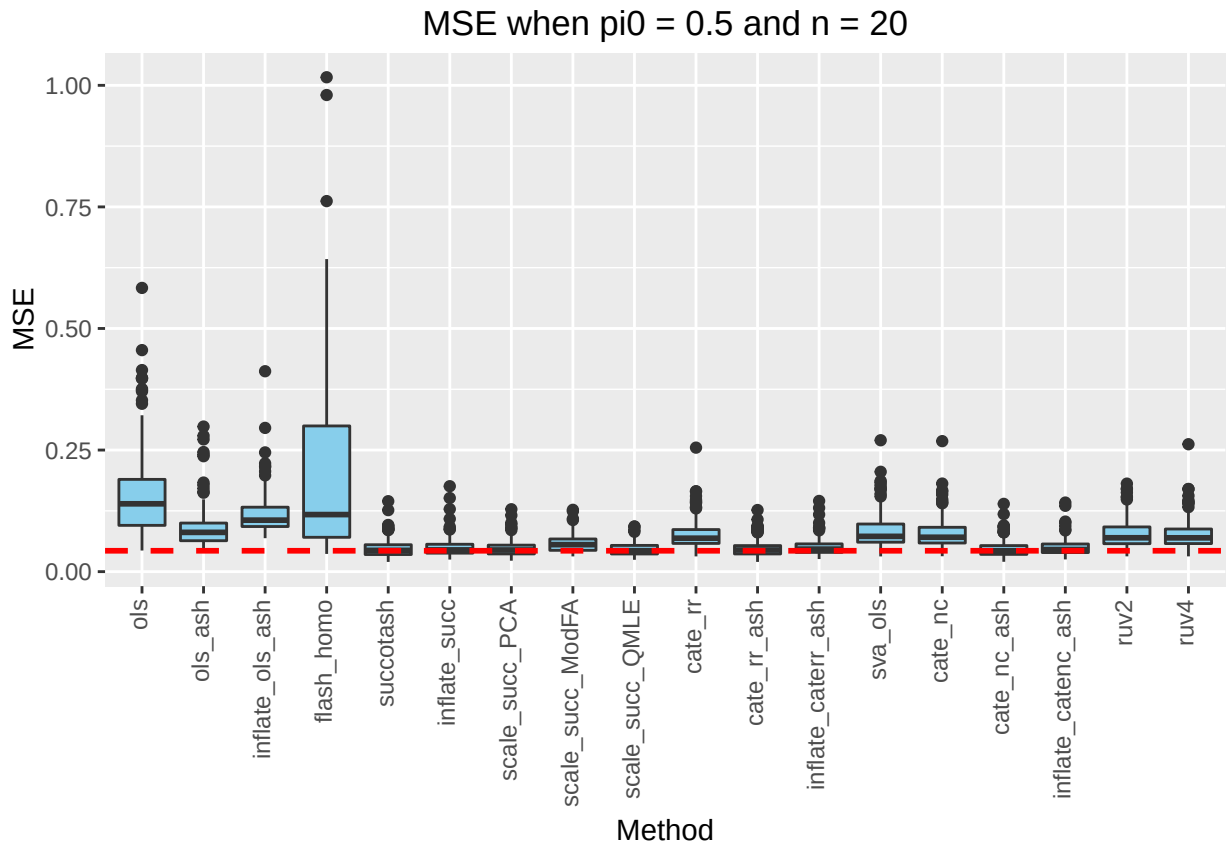
MSE Plots

```
double_mse <- read.csv("../double_succ/mse_mat.csv")
reg_mse <- read.csv("../flash_v_rest_using_package/mse_mat.csv")
scale_mse <- read.csv("../succ_scaled/mse_ssuc.csv")
scale_mse_fa <- read.csv("mse_ssuc_mc.csv")
reg_mse$inflate_succ <- double_mse$succotash
reg_mse$inflate_caterr_ash <- double_mse$cate_rr_ash
reg_mse$inflate_catenc_ash <- double_mse$cate_nc_ash
reg_mse$inflate_ols_ash <- double_mse$ols_ash
reg_mse$scale_succ_PCA <- scale_mse$scale_suc1
reg_mse$scale_succ_ModFA <- scale_mse_fa$mod_fa
reg_mse$scale_succ_QMLE <- scale_mse_fa$quasi_mle
reg_mse <- tbl_df(reg_mse)
reg_mse <- reg_mse[, c(1:2, 17, 3:4, 14, 18:20, 5:6, 15, 7:9, 16, 10:13)]
nsamp_seq <- unique(reg_mse$nsamp)
nullpi_seq <- unique(reg_mse$nullpi)
for (current_pi in nullpi_seq) {
    for (current_nsamp in nsamp_seq) {

        subdf <- select(
            filter(
                reg_mse, nullpi == current_pi & nsamp == current_nsamp),
```

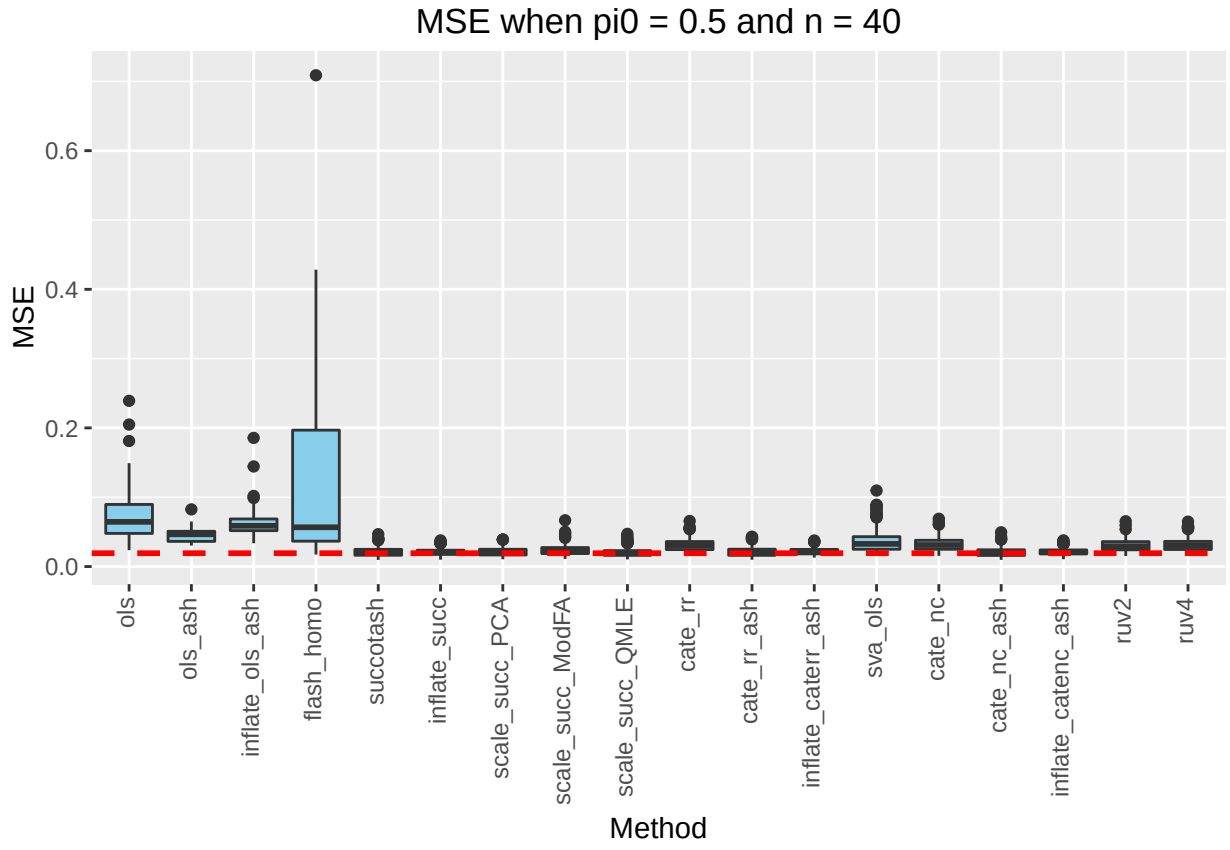
```
            -c(nsamp, nullpi)
        )

        hval <- min(apply(subdf, 2, median))

        melted_df <- melt(subdf, id.vars = NULL)

        p <- ggplot(data = melted_df, mapping = aes(x = variable, y = value)) +
            geom_boxplot(fill = I("skyblue")) +
            xlab(label = "Method") + ylab(label = "MSE") +
            geom_hline(yintercept = hval, color = I("red"), lty  = 2, lwd = 1) +
            ggtitle(paste("MSE when pi0 =", current_pi, "and n =", current_nsamp * 2)) +
            theme(axis.text.x = element_text(angle = 90, hjust = 1, vjust = 0.3))
        print(p)
    }
}
```

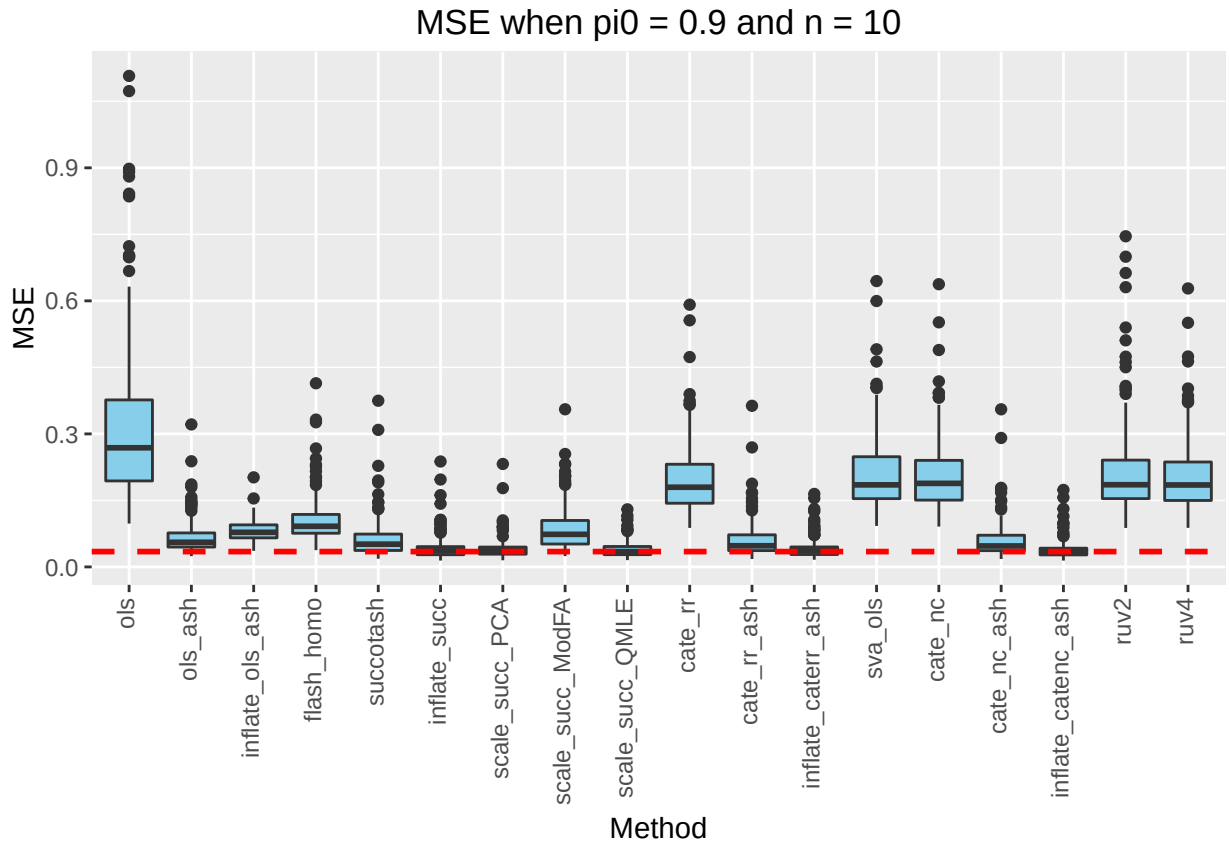



```
## Warning: Removed 5 rows containing non-finite values (stat_boxplot).
```

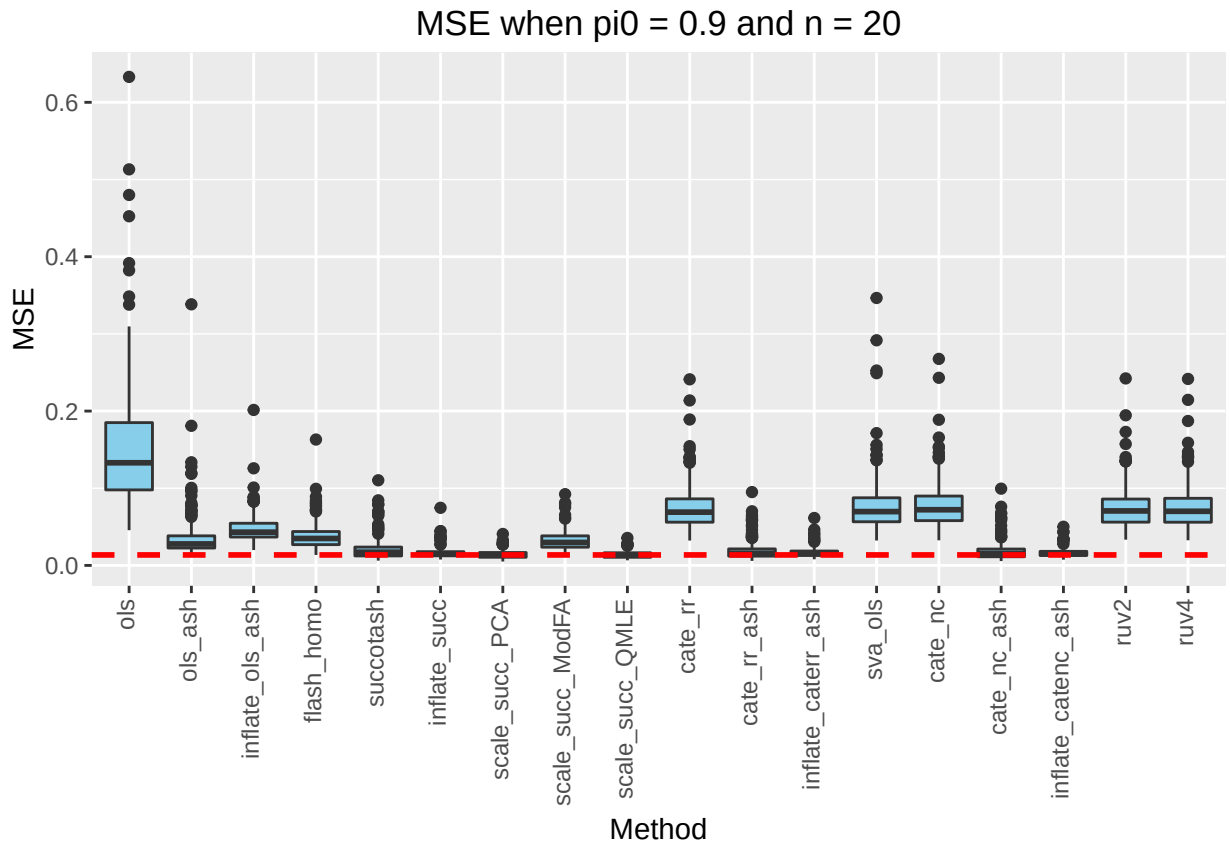



```
## Warning: Removed 203 rows containing non-finite values (stat_boxplot).
```

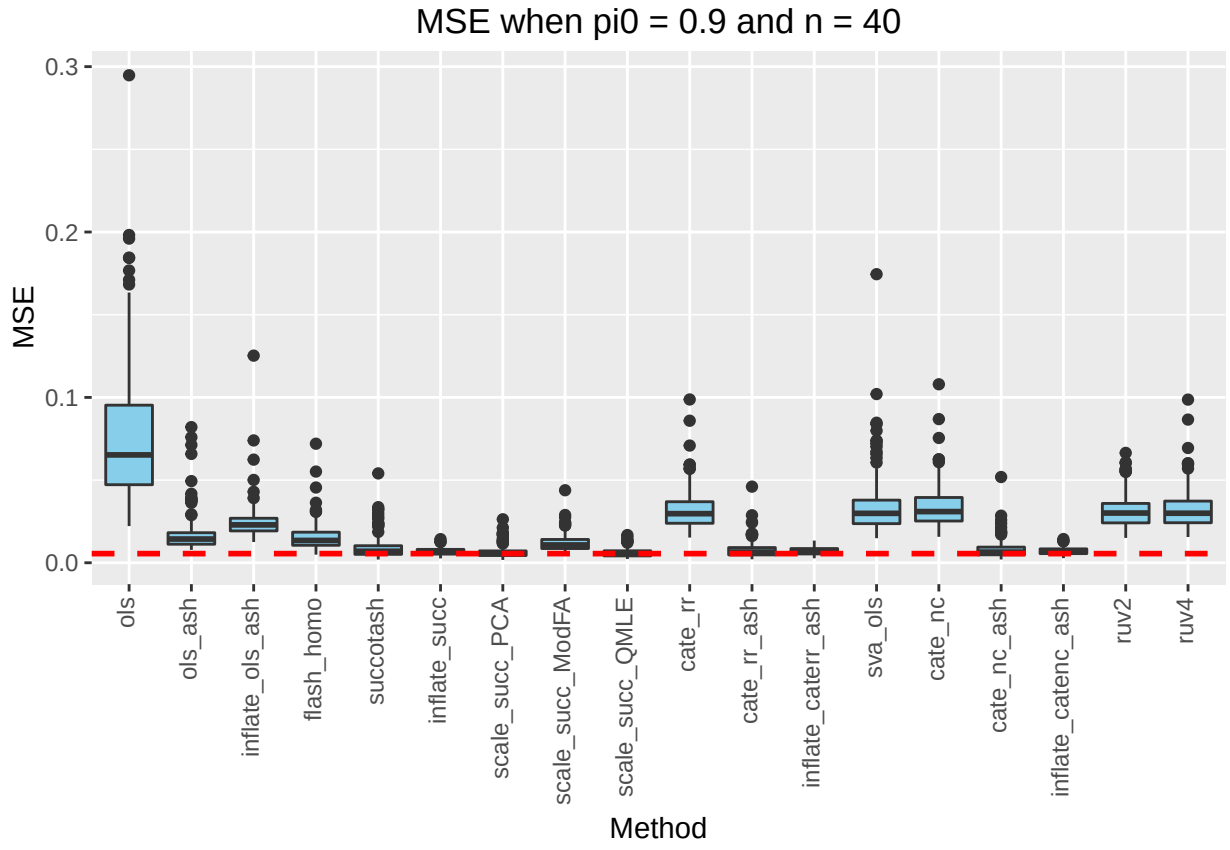

MSE when pi0 = 0.5 and n = 40
MSE
0.0
0.2
0.4
0.6
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

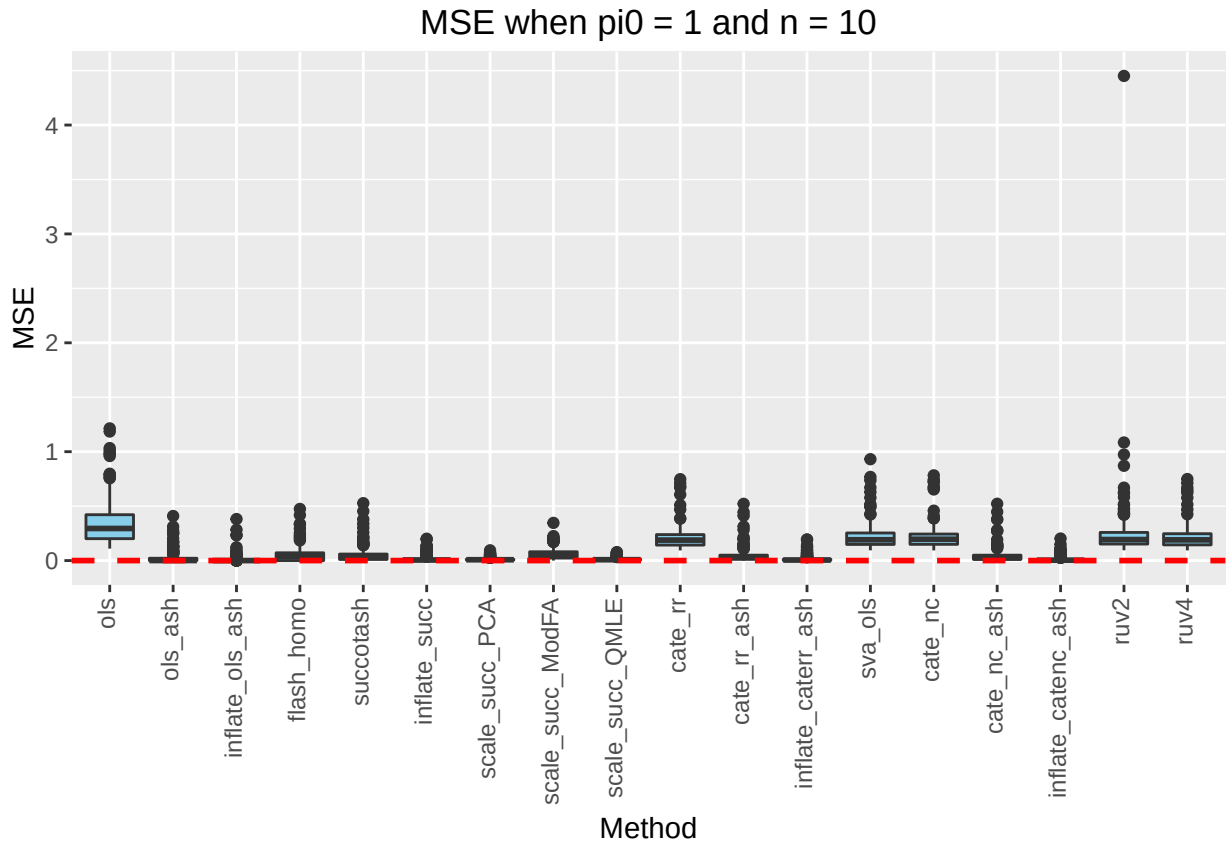

MSE when pi0 = 0.9 and n = 10
MSE
0.0
0.3
0.6
0.9
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

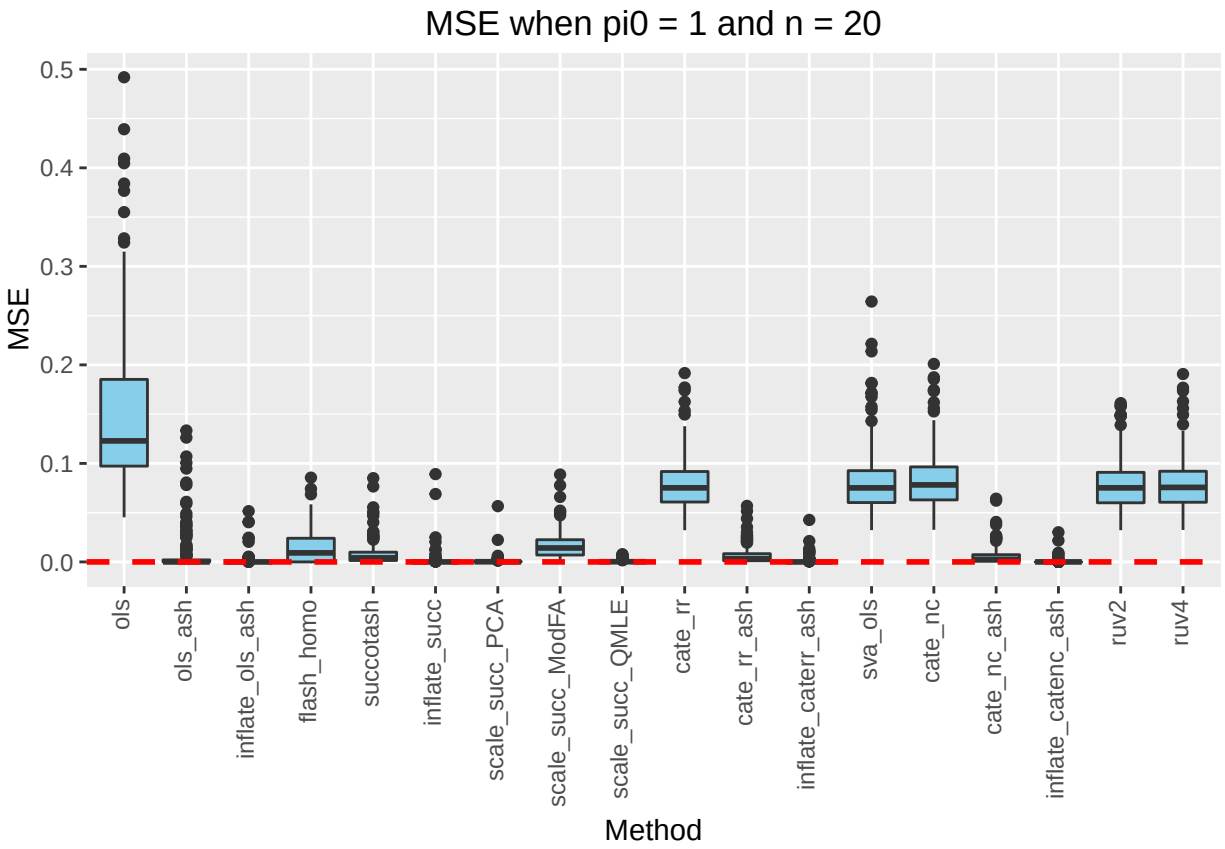
```
## Warning: Removed 1 rows containing non-finite values (stat_boxplot).
```

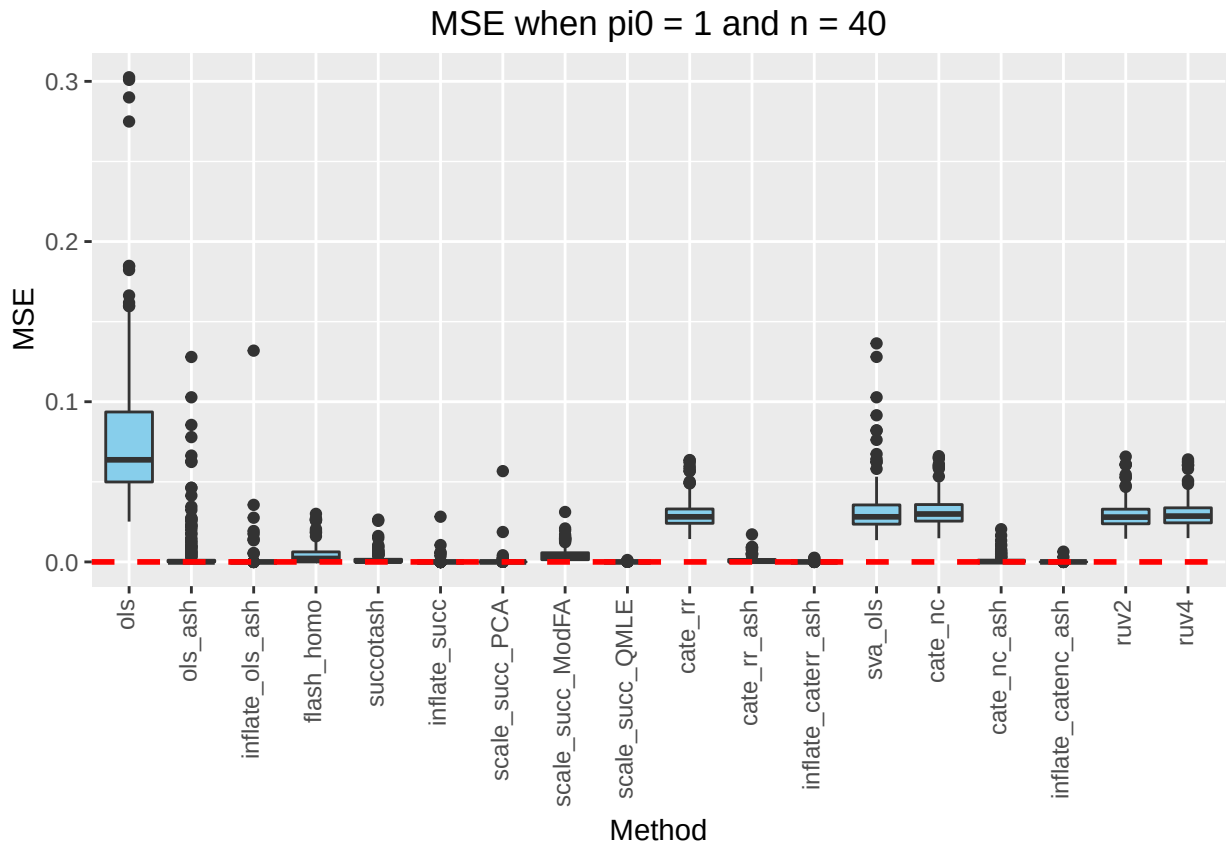



```
## Warning: Removed 89 rows containing non-finite values (stat_boxplot).
```


MSE when pi0 = 0.9 and n = 40
MSE
0.3
0.2
0.1
0.0
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


MSE when pi0 = 1 and n = 10
MSE
4
3
2
1
0
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

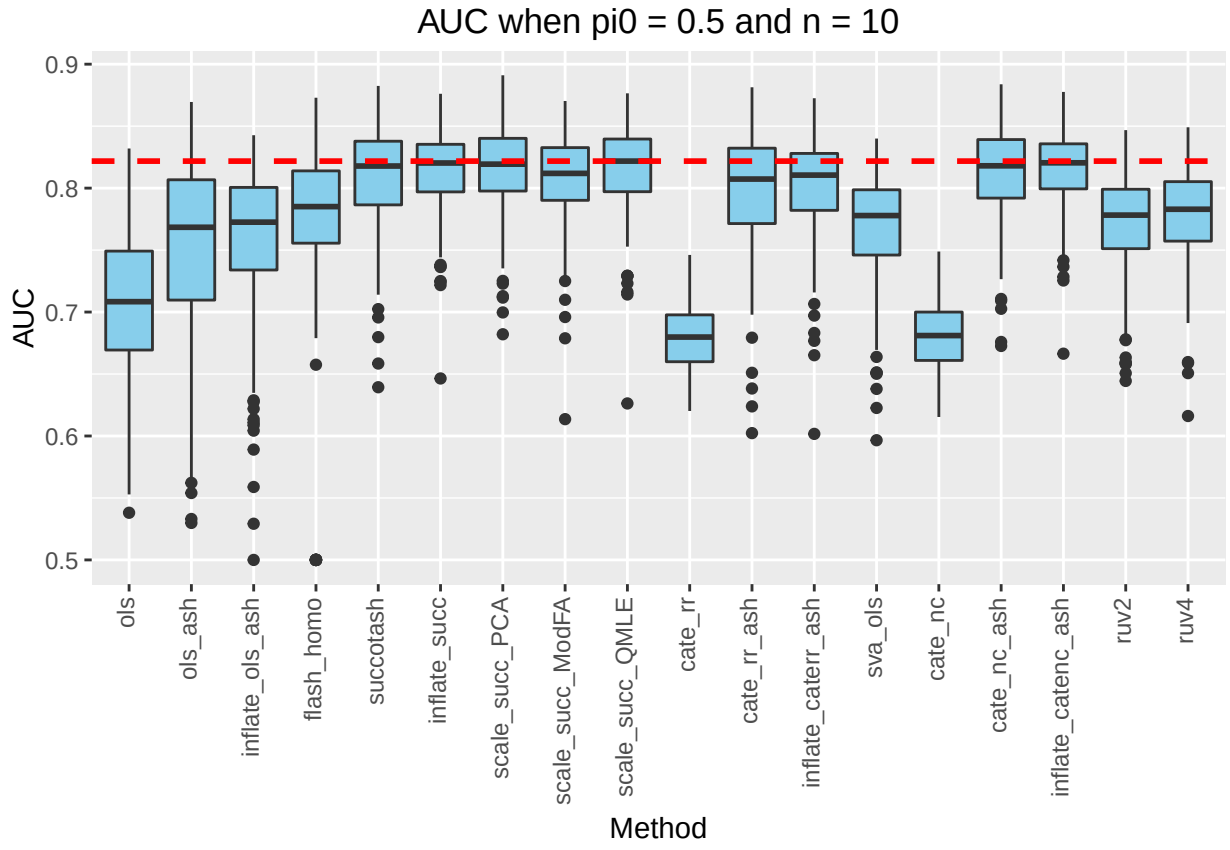

MSE when pi0 = 1 and n = 20
MSE
0.5
0.4
0.3
0.2
0.1
0.0
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

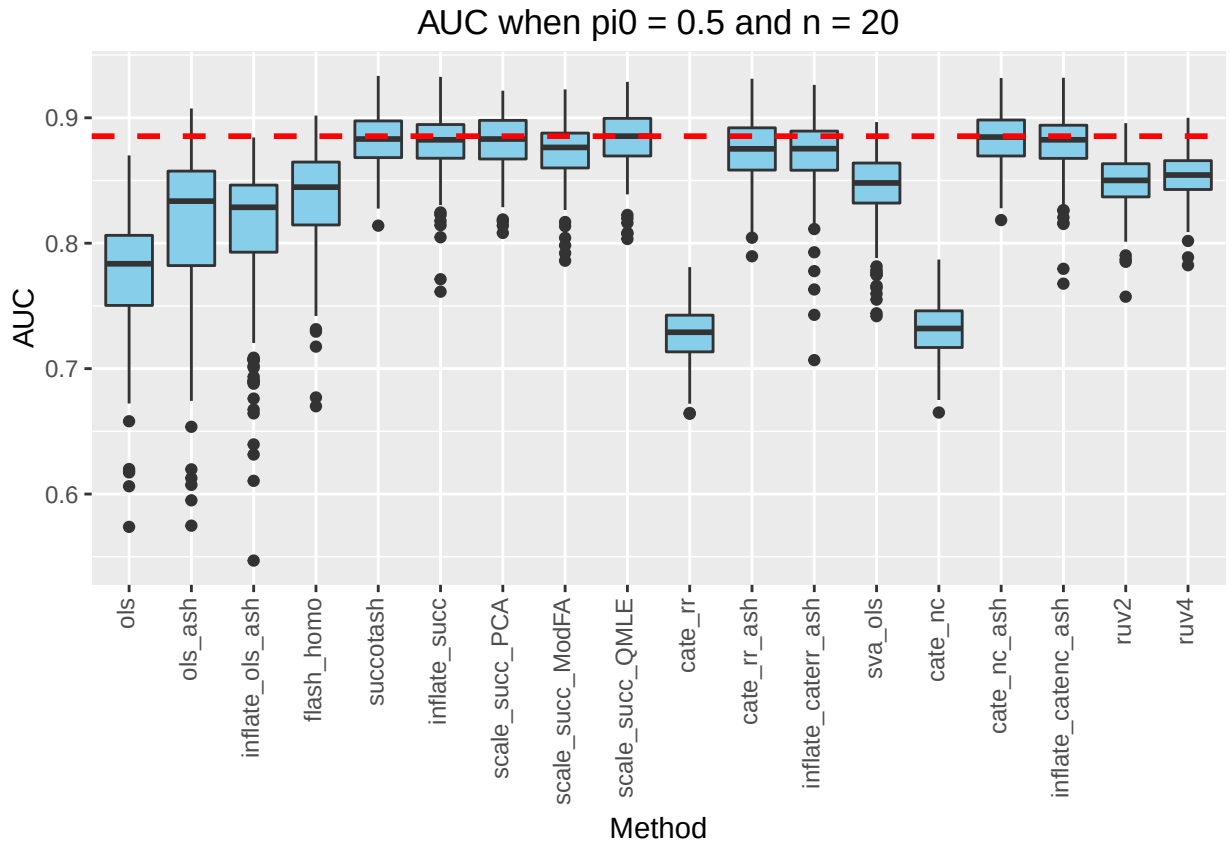


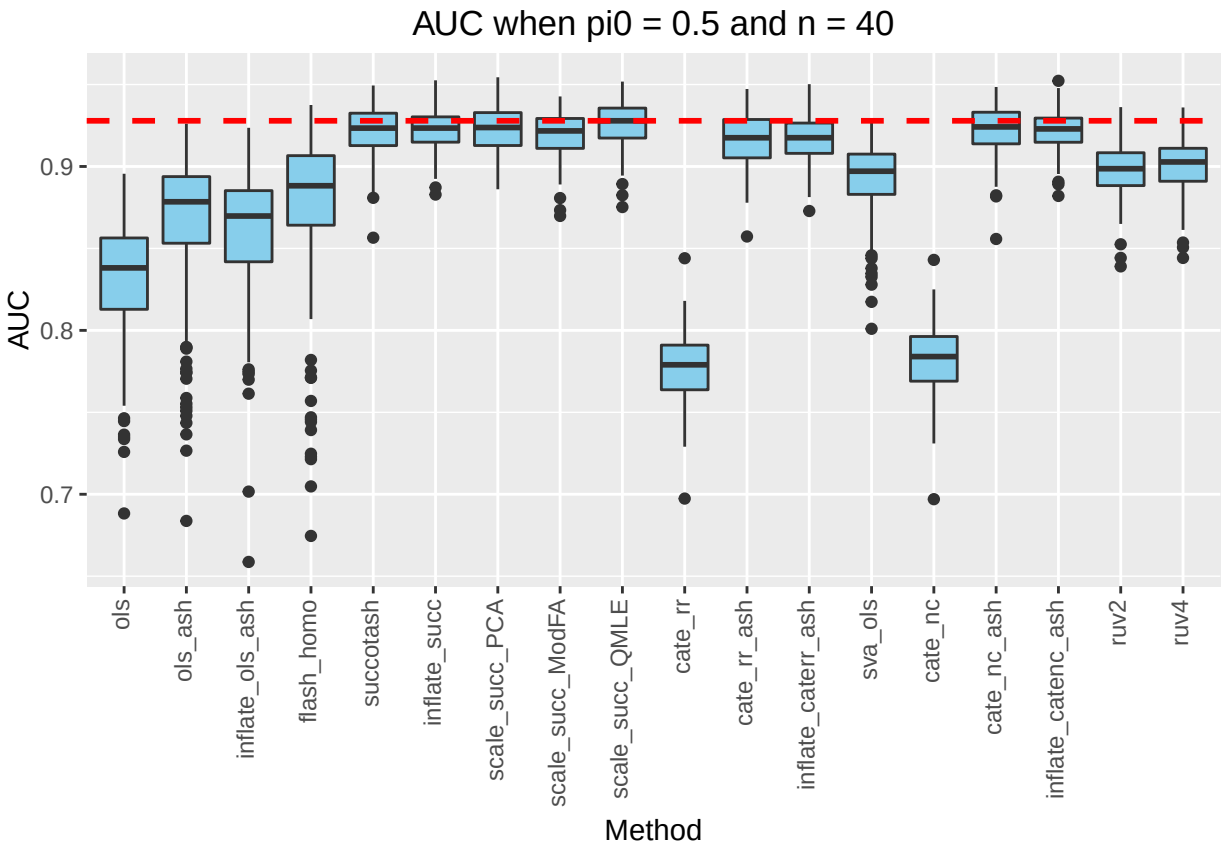
AUC Plots

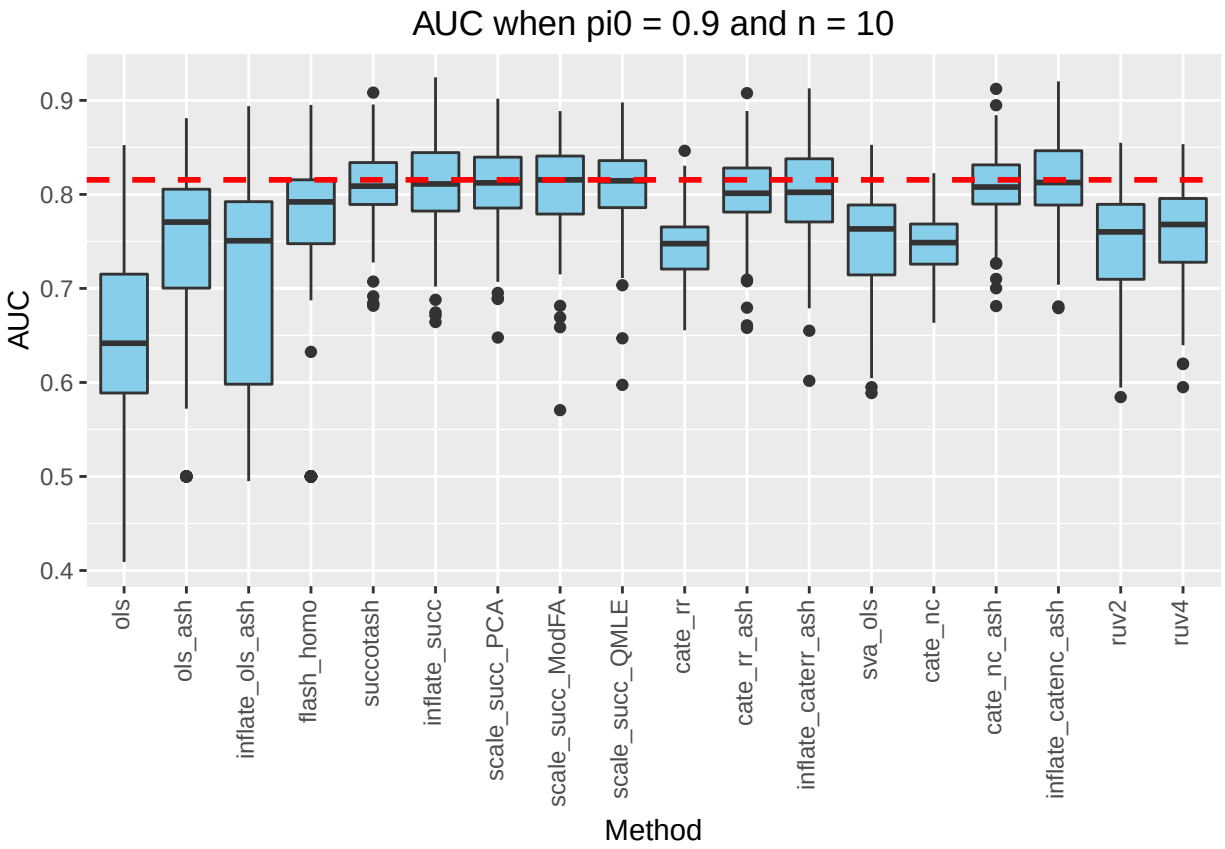
```
double_auc <- read.csv("../double_succ/auc_mat.csv")
reg_auc <- read.csv("../flash_v_rest_using_package/auc_mat.csv")
scale_auc <- read.csv("../succ_scaled/auc_ssuc.csv")
scale_auc_fa <- read.csv("auc_ssuc_mc.csv")
reg_auc$inflate_succ <- double_auc$succotash
reg_auc$inflate_caterr_ash <- double_auc$cate_rr_ash
reg_auc$inflate_catenc_ash <- double_auc$cate_nc_ash
reg_auc$inflate_ols_ash <- double_auc$ols_ash
reg_auc$scale_succ_PCA <- scale_auc$scale_suc1
reg_auc$scale_succ_ModFA <- scale_auc_fa$mod_fa
reg_auc$scale_succ_QMLE <- scale_auc_fa$quasi_mle
reg_auc <- tbl_df(reg_auc)
reg_auc <- reg_auc[, c(1:2, 17, 3:4, 14, 18:20, 5:6, 15, 7:9, 16, 10:13)]
nsamp_seq <- unique(reg_auc$nsamp)
nullpi_seq <- unique(reg_auc$nullpi)
for (current_pi in nullpi_seq) {
    for (current_nsamp in nsamp_seq) {

        subdf <- select(
            filter(
                reg_auc, nullpi == current_pi & nsamp == current_nsamp),
```

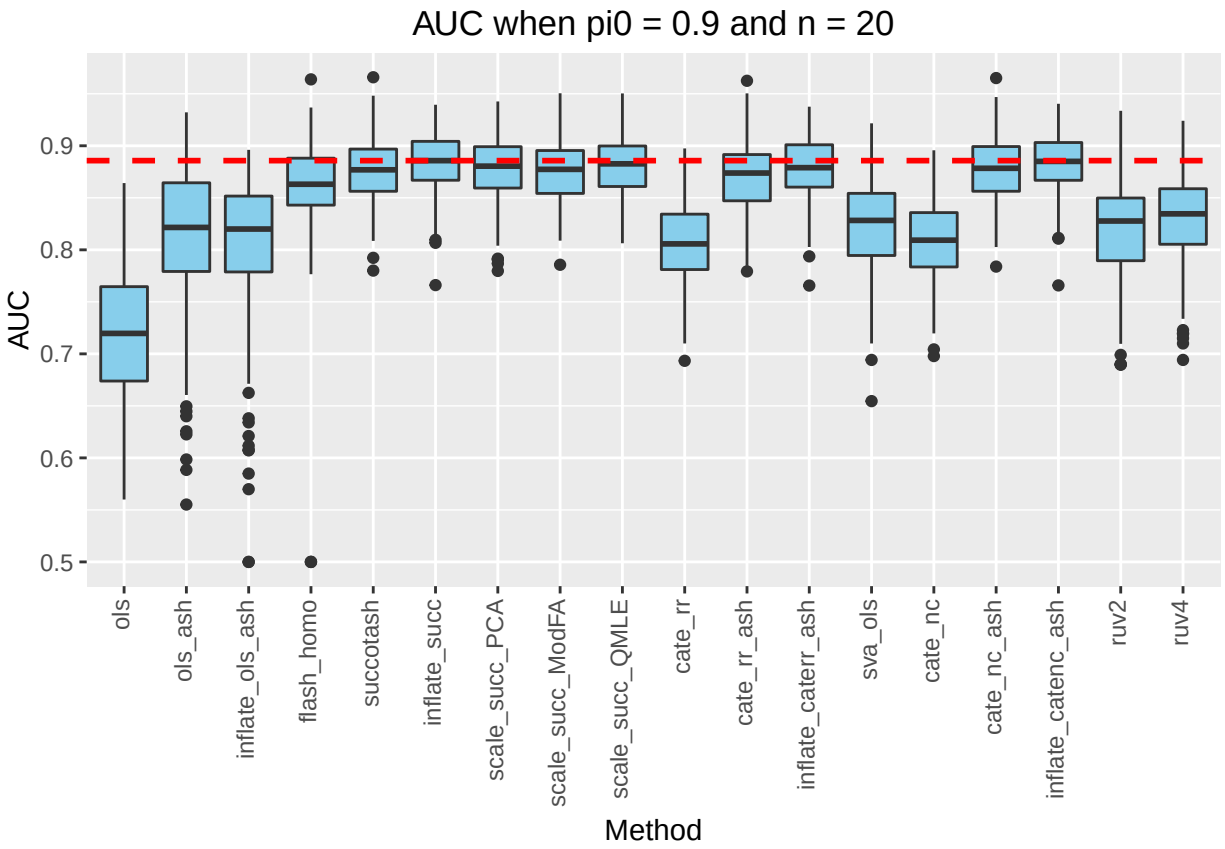
```
            -c(nsamp, nullpi)
        )

        hval <- max(apply(subdf, 2, median))

        melted_df <- melt(subdf, id.vars = NULL)

        p <- ggplot(data = melted_df, mapping = aes(x = variable, y = value)) +
            geom_boxplot(fill = I("skyblue")) +
            xlab(label = "Method") + ylab(label = "AUC") +
            geom_hline(yintercept = hval, color = I("red"), lty  = 2, lwd = 1) +
            ggtitle(paste("AUC when pi0 =", current_pi, "and n =", current_nsamp * 2)) +
            theme(axis.text.x = element_text(angle = 90, hjust = 1, vjust = 0.3))
        print(p)
    }
}
```

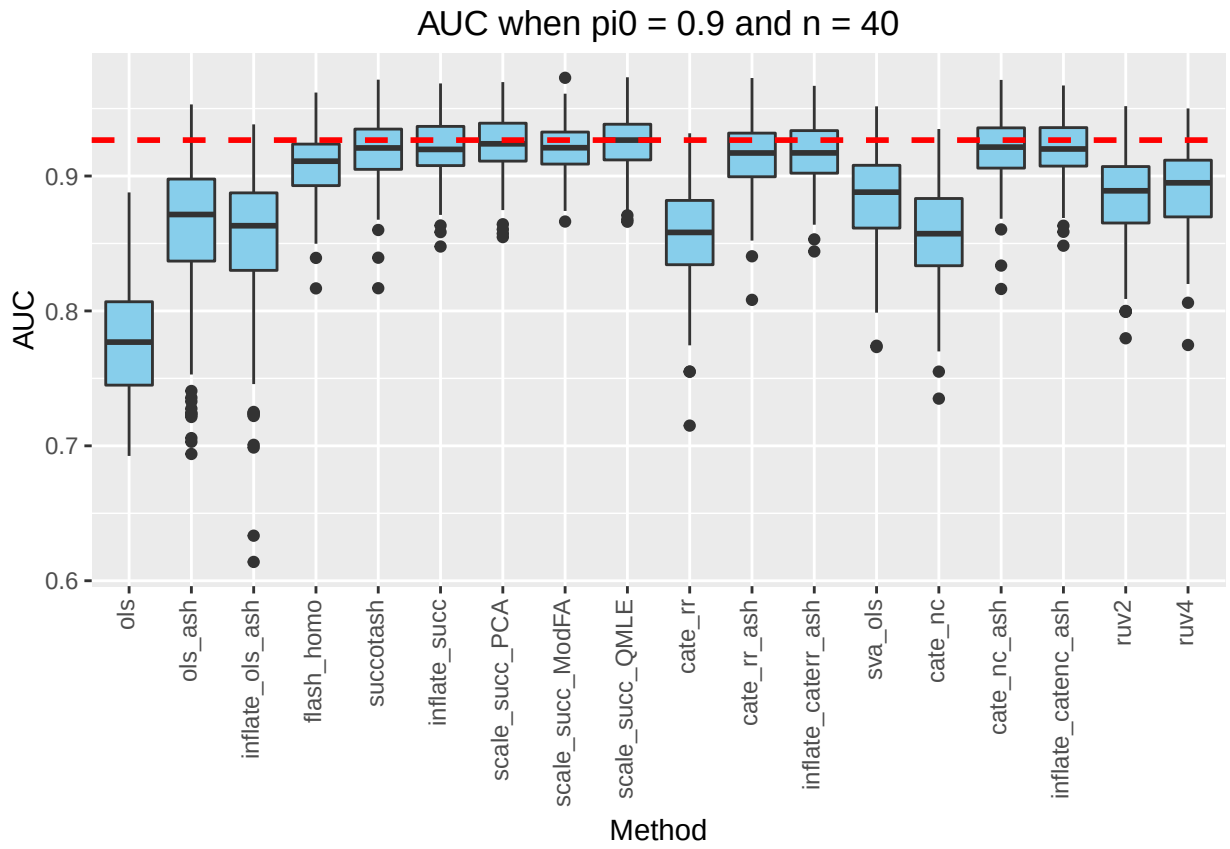

AUC when pi0 = 0.5 and n = 10
AUC
0.9
0.8
0.7
0.6
0.5
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


AUC when pi0 = 0.5 and n = 20
AUC
0.9
0.8
0.7
0.6
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


AUC when pi0 = 0.5 and n = 40
AUC
0.9
0.8
0.7
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


AUC when pi0 = 0.9 and n = 10
AUC
0.9
0.8
0.7
0.6
0.5
0.4
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


AUC when pi0 = 0.9 and n = 20
AUC
0.9
0.8
0.7
0.6
0.5
ols
ols_ash
inflate_ols_ash
flash_homo
succotash
inflate_succ
scale_succ_PCA
scale_succ_ModFA
scale_succ_QMLE
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method




```
sessionInfo()
```

```
## R version 3.2.4 Revised (2016-03-16 r70336)
## Platform: x86_64-w64-mingw32/x64 (64-bit)
## Running under: Windows 10 x64 (build 10586)
##
## locale:
## [1] LC_COLLATE=English_United States.1252
## [2] LC_CTYPE=English_United States.1252
## [3] LC_MONETARY=English_United States.1252
## [4] LC_NUMERIC=C
## [5] LC_TIME=English_United States.1252
##
## attached base packages:
## [1] stats     graphics  grDevices utils     datasets  methods   base
##
## other attached packages:
## [1] ggplot2_2.1.0  reshape2_1.4.1 dplyr_0.4.3    xtable_1.8-2
## [5] knitr_1.12.23
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.4       digest_0.6.9      assertthat_0.1
##  [4] grid_3.2.4        plyr_1.8.3        R6_2.1.2
##  [7] gtable_0.2.0      DBI_0.3.1         formatR_1.3
## [10] magrittr_1.5      scales_0.4.0      evaluate_0.8.3
## [13] highr_0.5.1       stringi_1.0-1     rmarkdown_0.9.5.9
```

```
## [16] labeling_0.3      tools_3.2.4       stringr_1.0.0
## [19] munsell_0.4.3     yaml_2.1.13       parallel_3.2.4
## [22] colorspace_1.2-6  htmltools_0.3.5
```