Inflate Variance in ASH with CATE

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Abstract

This is the same setup as [here] except I also added a scenario of CATE + ASH while estimating a variance inflation parameter.

Results

```
library(knitr)
library(xtable)
library(dplyr)
library(reshape2)
library(ggplot2)
```

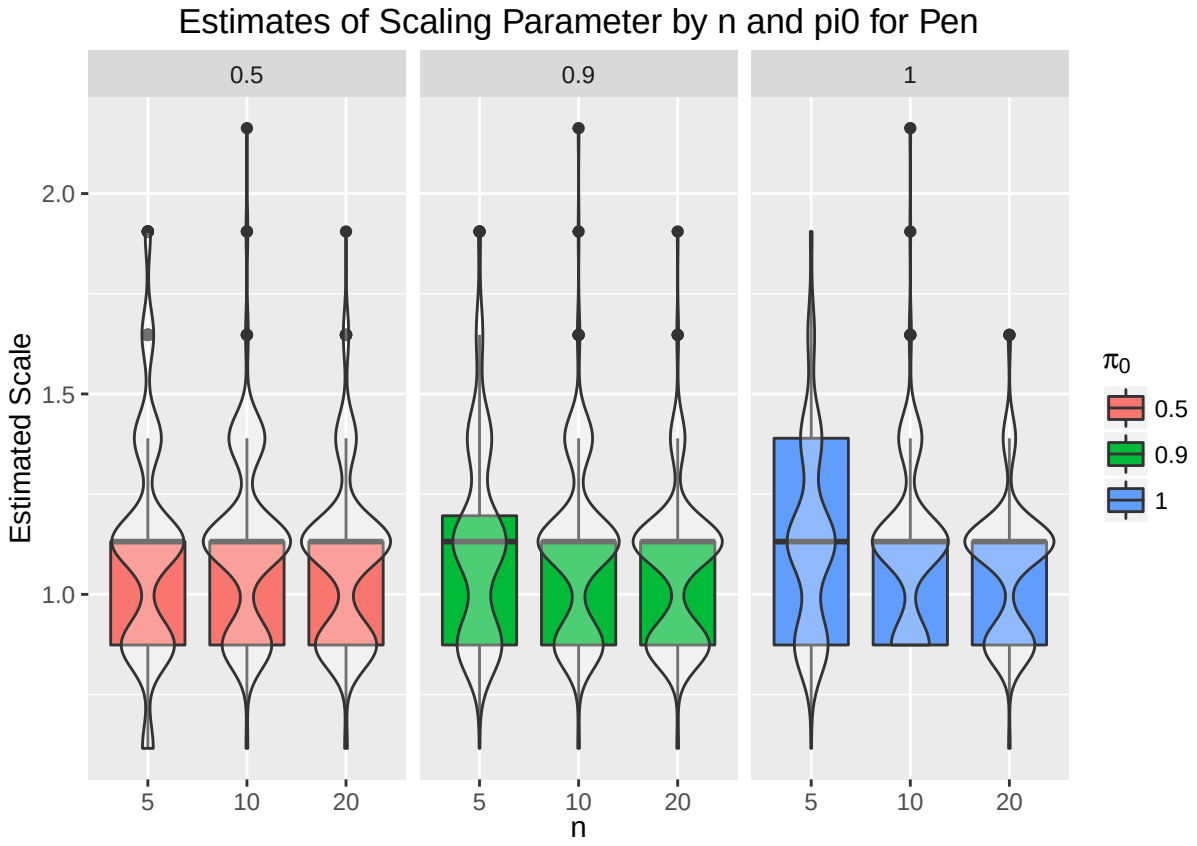
To view a description of these simulations and the results when the variance was not-inflated, please see http://dcgerard.github.io/flash_sims/analysis/flashr_v_succ.pdf.

As inflating the variance of CATE then using ASH worked very well, I tried to estimating this variance inflation when using CATE to estimate the surrogate variables. The pipeline was

1. Use CATE to get the $\hat{\beta}_i$'s and $\hat{s}_i$'s.
2. Use ASH with data $\hat{\beta}_i$ and standard devitiations $\lambda\hat{s}_i$, where λ varies on a grid of 20 from 0.1 to 4.
3. Choose the ASH output with the largest log-likelihood.

This method worked really poorly in terms of estimating π_0, but actually worked better in terms of MSE and AUC. It never does better than SUCCOTASH with the variance inflation parameter, though. It basically has the same performance as SVA + ASH.

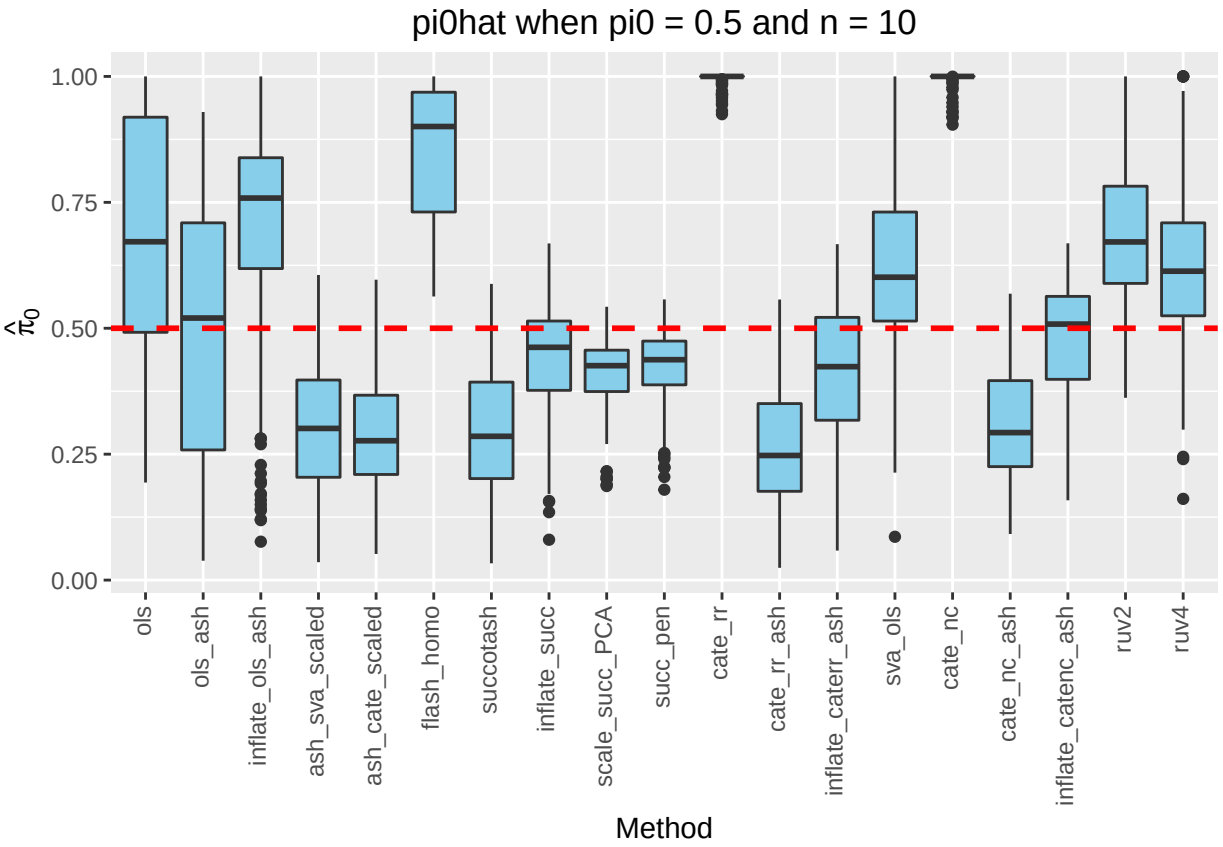
```
scale_mat_ash <- read.csv("scale_est_cateash_mc.csv")
ggplot(data = scale_mat_ash, mapping = aes(x = factor(nsamp), y = post_inflate,
                                           fill = factor(nullpi))) +
    facet_grid(.~nullpi) +
    geom_boxplot() + geom_violin(fill = I("white"), alpha = 0.3) +
    xlab(expression(n)) + ylab("Estimated Scale") +
    scale_fill_discrete(name=expression(pi[0])) +
        ggtitle("Estimates of Scaling Parameter by n and pi0 for Pen")
```

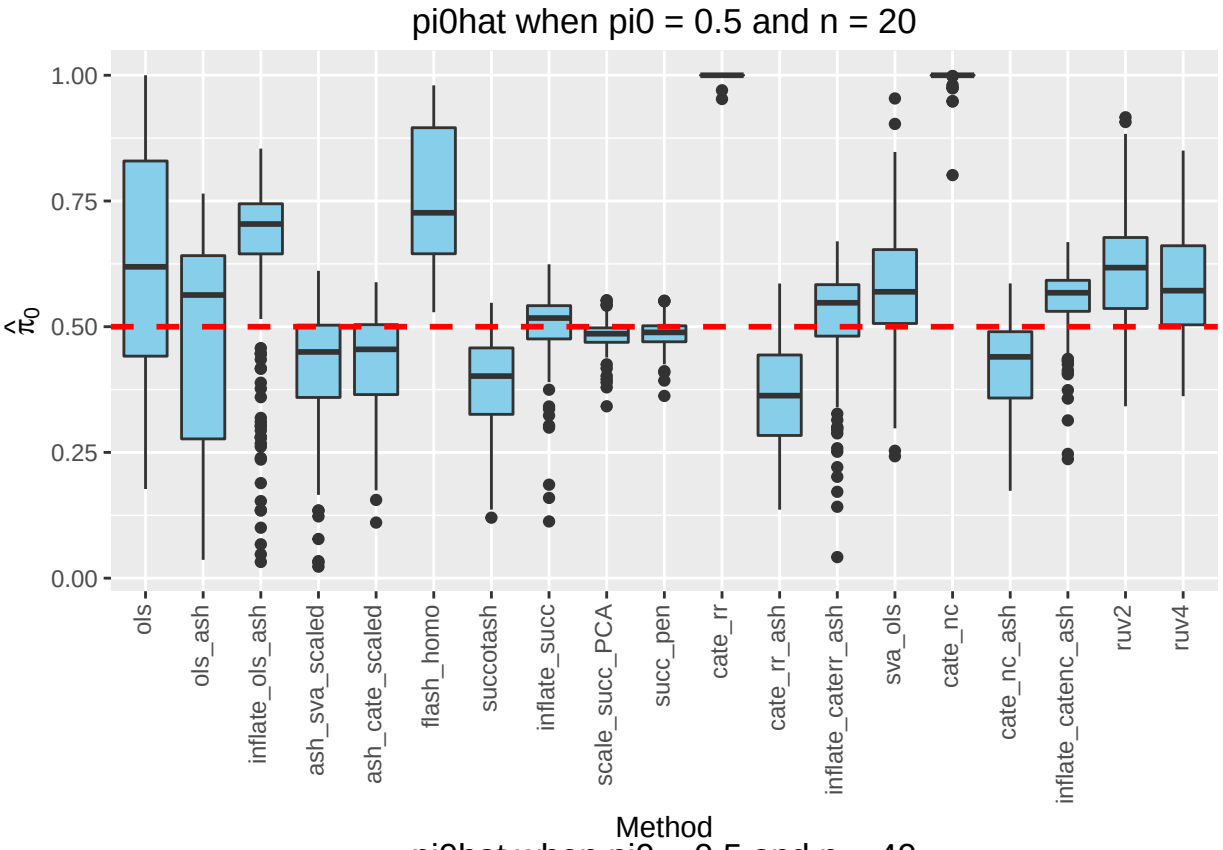


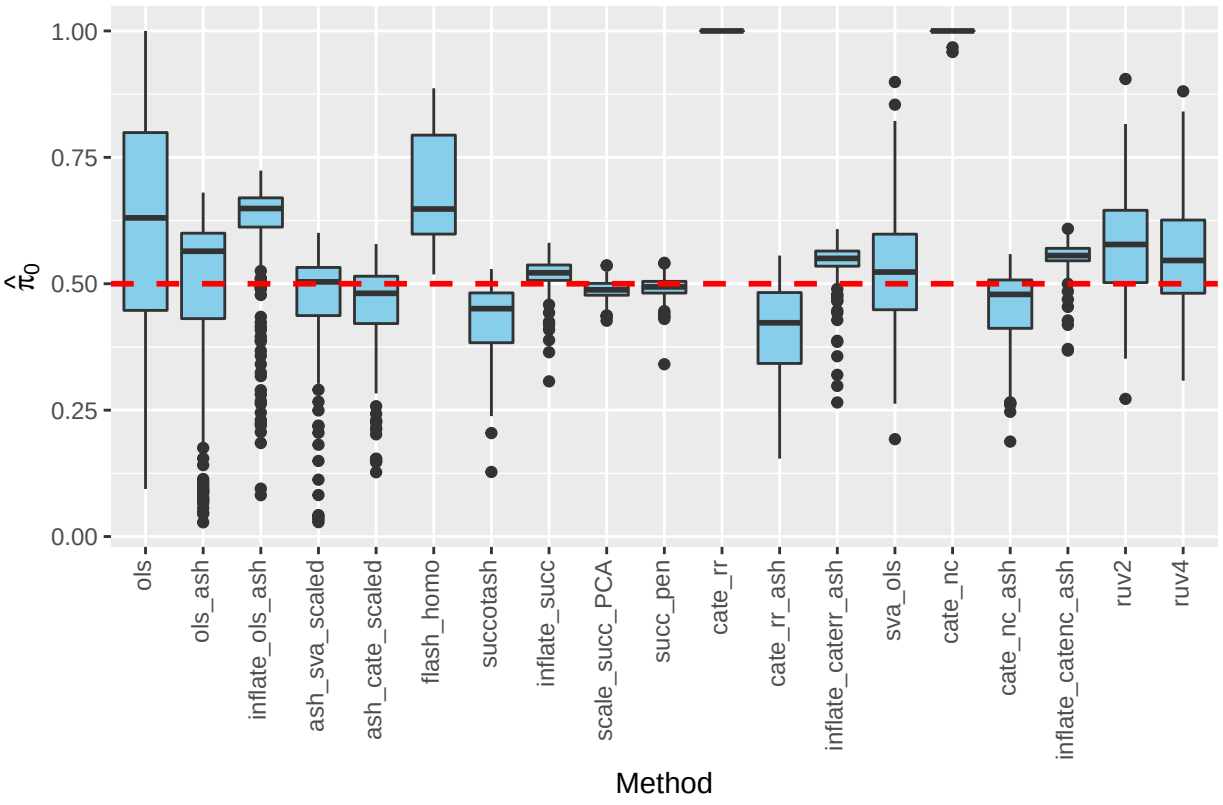
$\hat{\pi}_0$ Plots

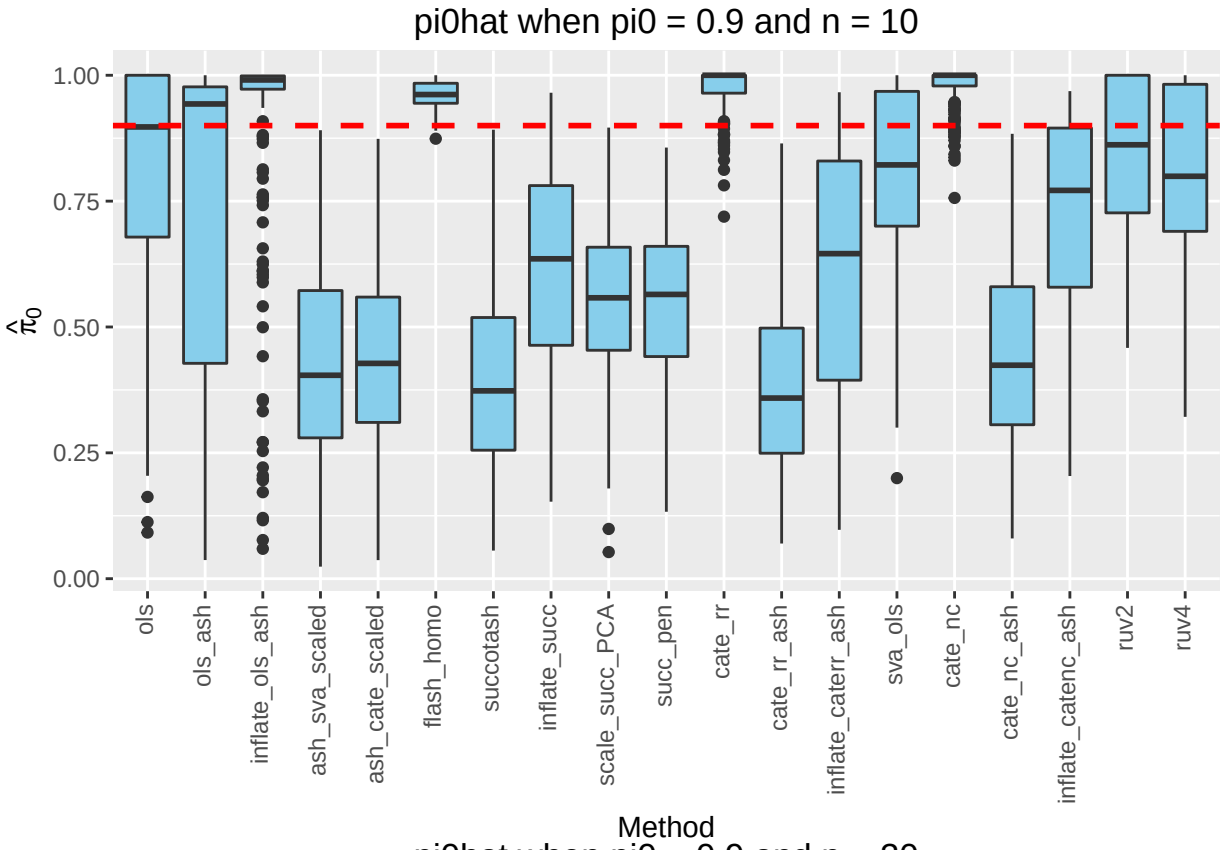
```
double_pi0 <- read.csv("../double_succ/pi0_mat.csv")
reg_pi0 <- read.csv("../flash_v_rest_using_package/pi0_mat.csv")
scale_pi0 <- read.csv("../succ_scaled/pi0_ssuc.csv")
scale_pi0_pen <- read.csv("../succ_scaled_pen/pi0_ssuc_mc.csv")
ash_sva <- read.csv("../scaled_ashr/pi0_svaash_mc.csv")
ash_cate <- read.csv("pi0_cateash_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$succ_pen <- scale_pi0_pen$post_inflate
reg_pi0$ash_sva_scaled <- ash_sva$post_inflate
reg_pi0$ash_cate_scaled <- ash_cate$post_inflate
reg_pi0 <- tbl_df(reg_pi0)
reg_pi0 <- reg_pi0[, c(1:2, 17, 20, 21, 3:4, 14, 18:19, 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) {
```

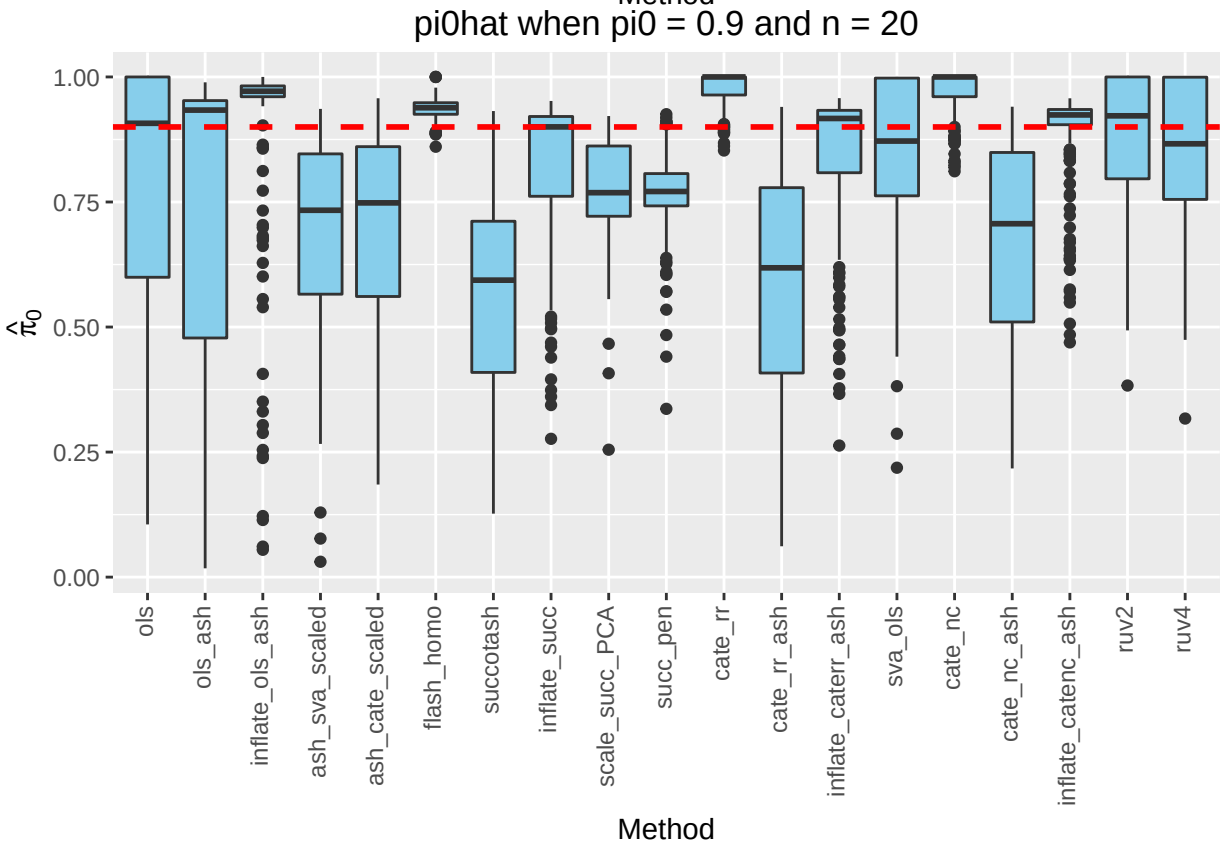
```
        subdf <- select(
            filter(
                reg_pi0, nullpi == current_pi & nsamp == current_nsamp),
            -c(nsamp, nullpi)
        )

        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)
    }
}
```

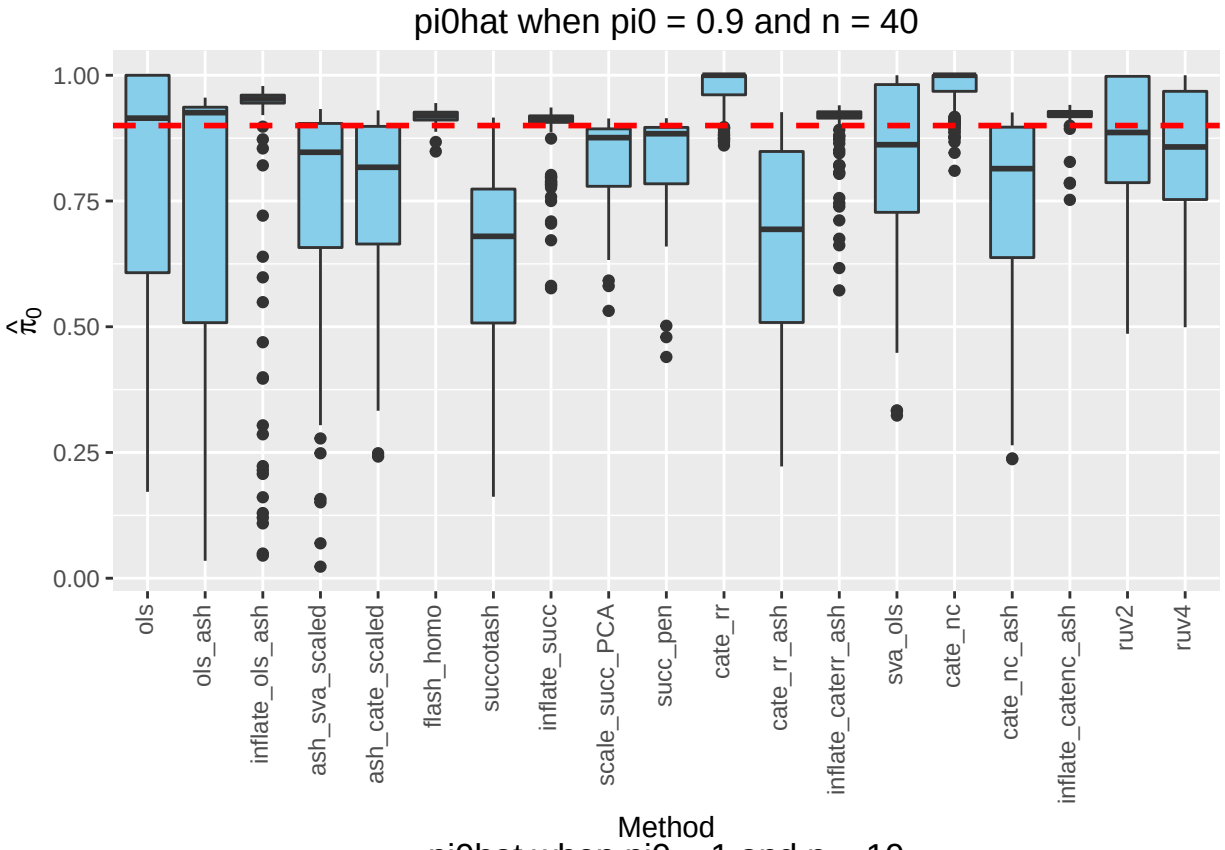


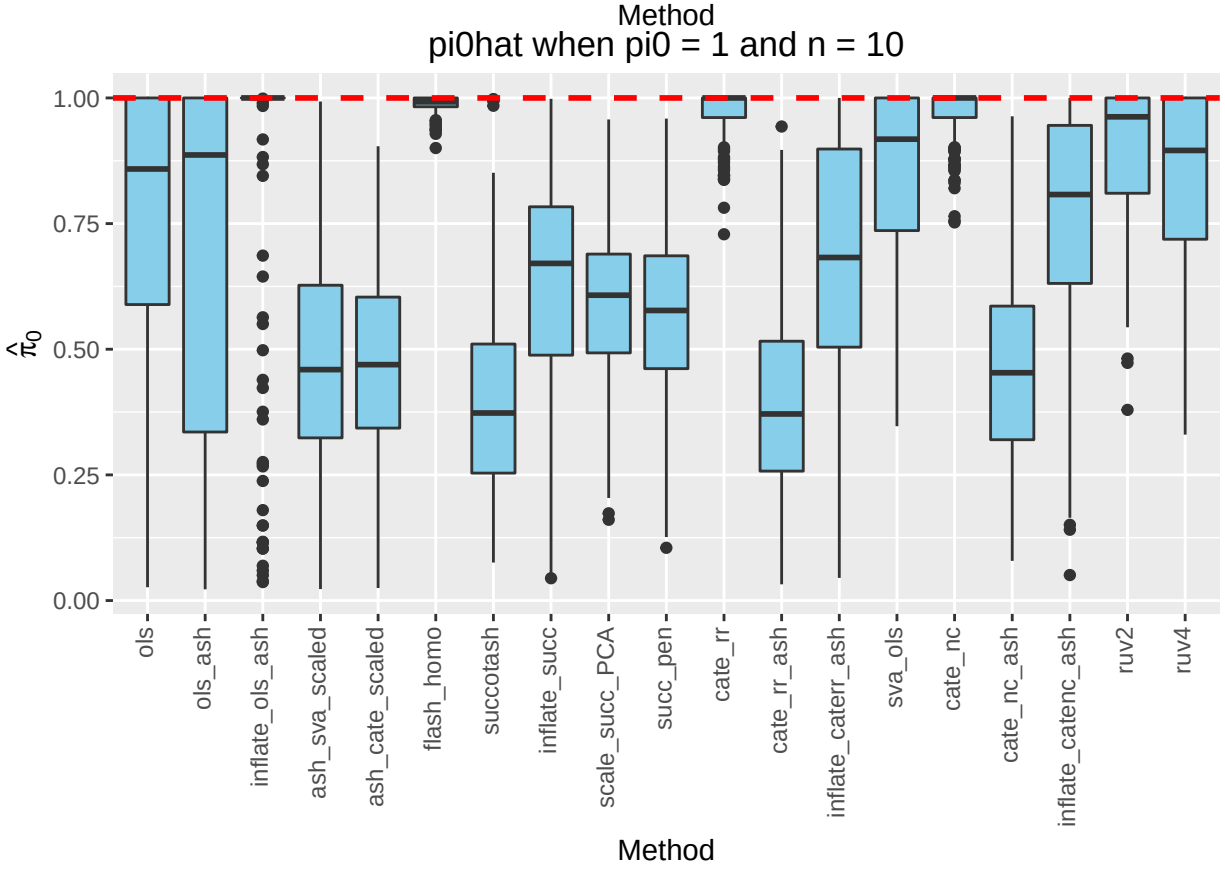

pi0hat when pi0 = 0.5 and n = 20
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

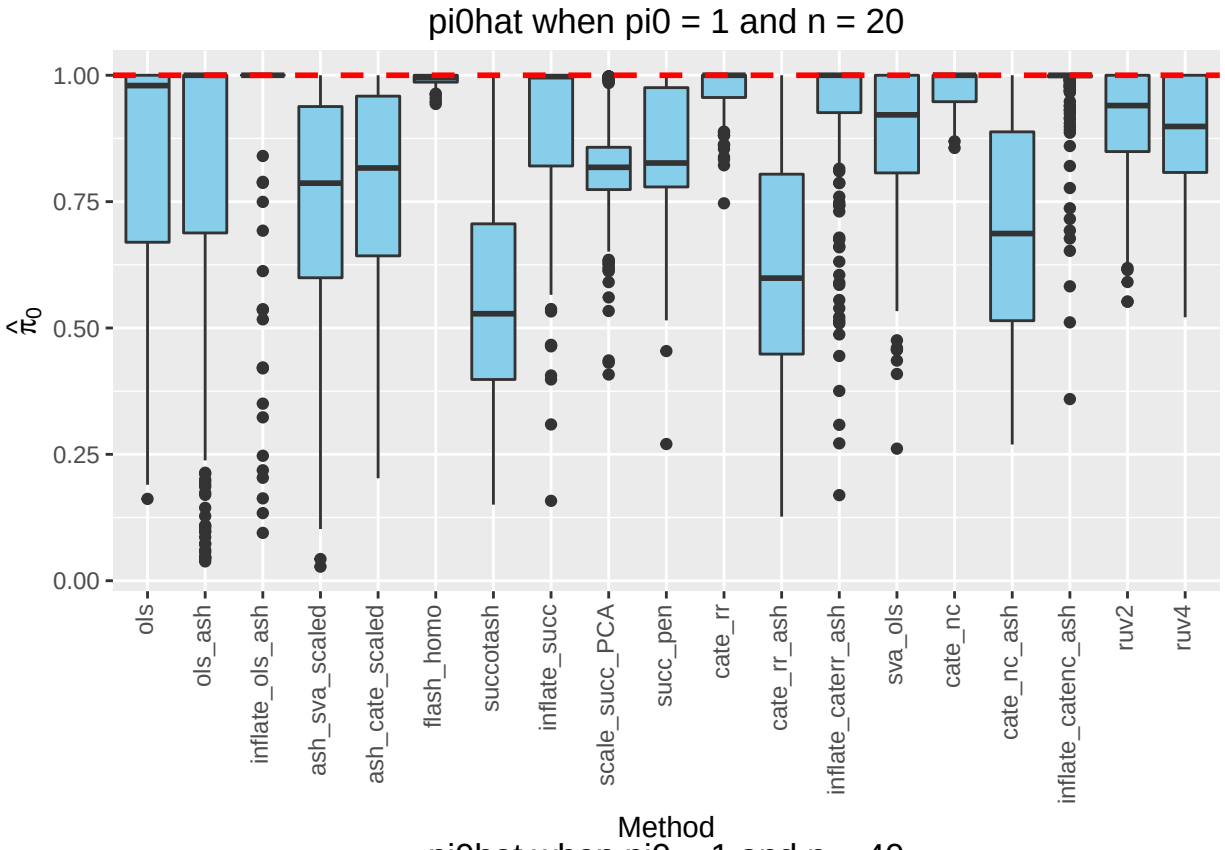

pi0hat when pi0 = 0.5 and n = 40
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

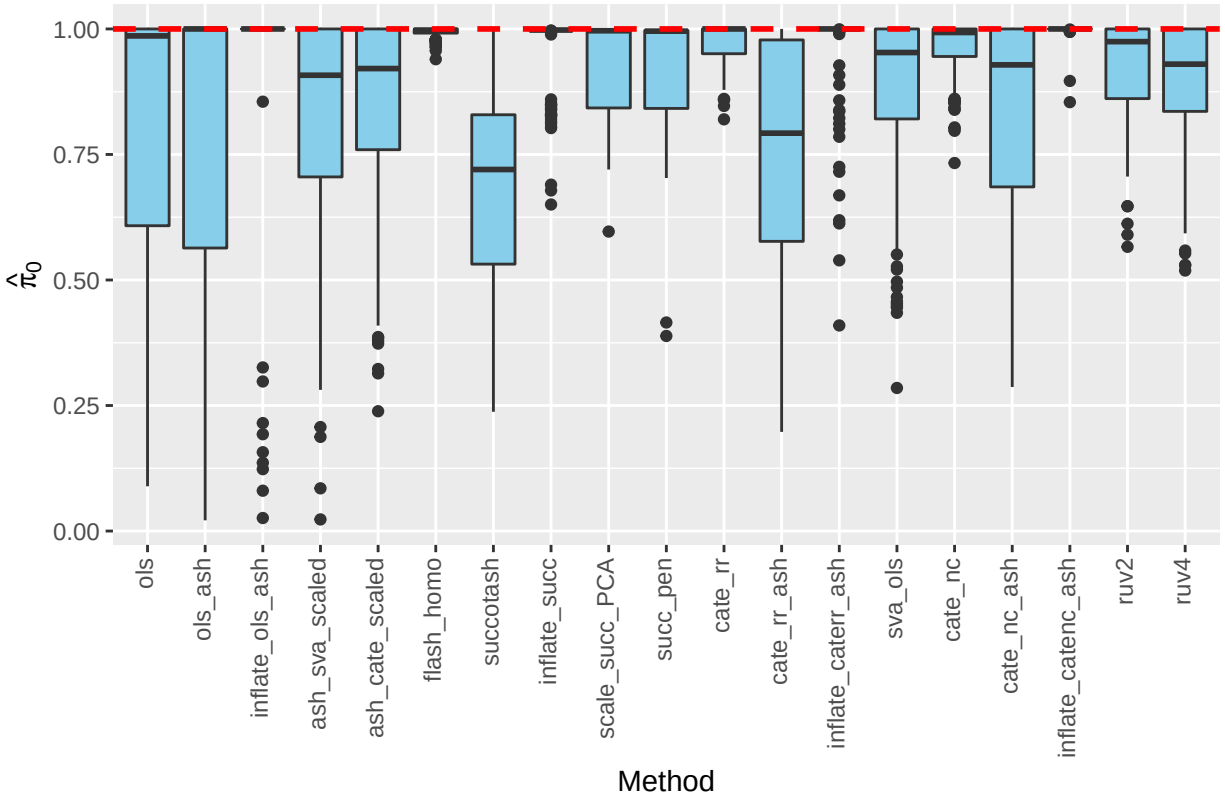

pi0hat when pi0 = 0.9 and n = 10
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


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
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
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
$\hat{\pi}_0$
1.00
0.75
0.50
0.25
0.00
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

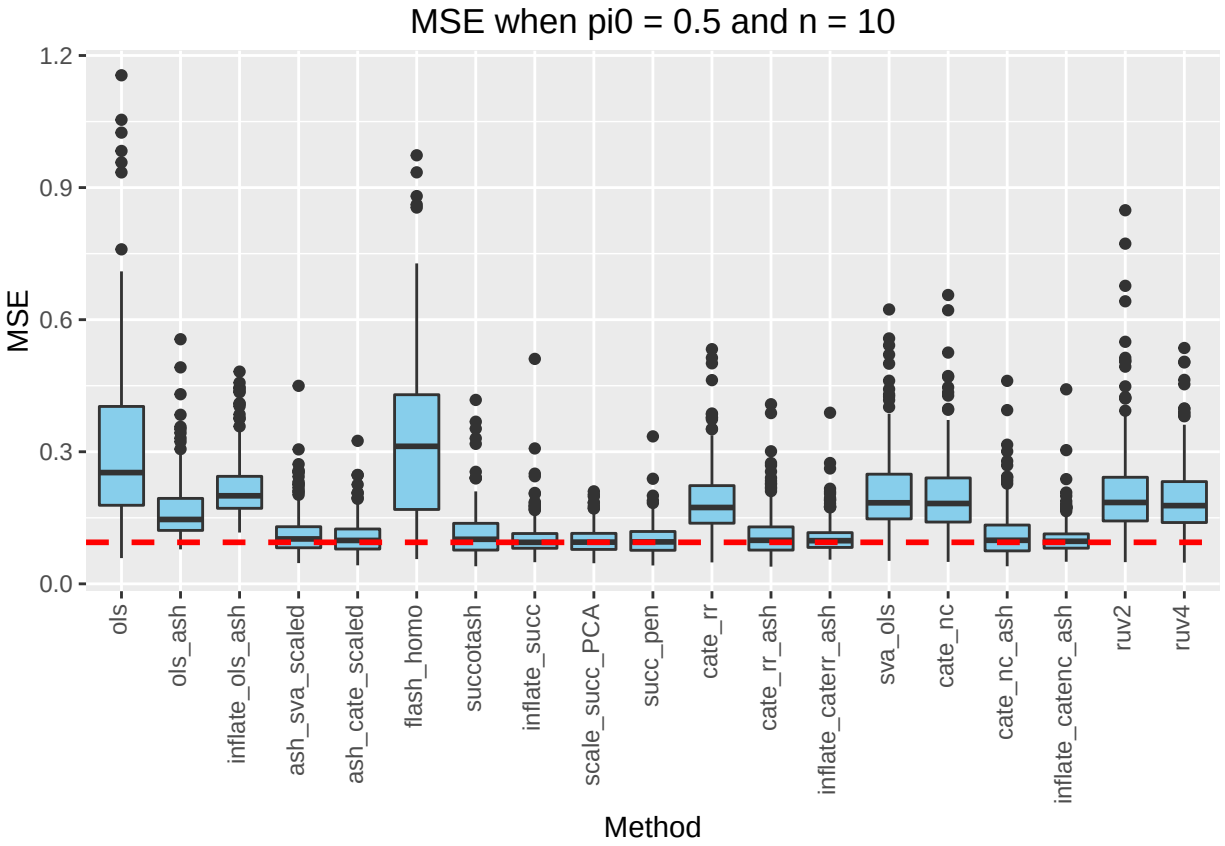

pi0hat when pi0 = 1 and n = 10
$\hat{\pi}_0$
1.00
0.75
0.50
0.25
0.00
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


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
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

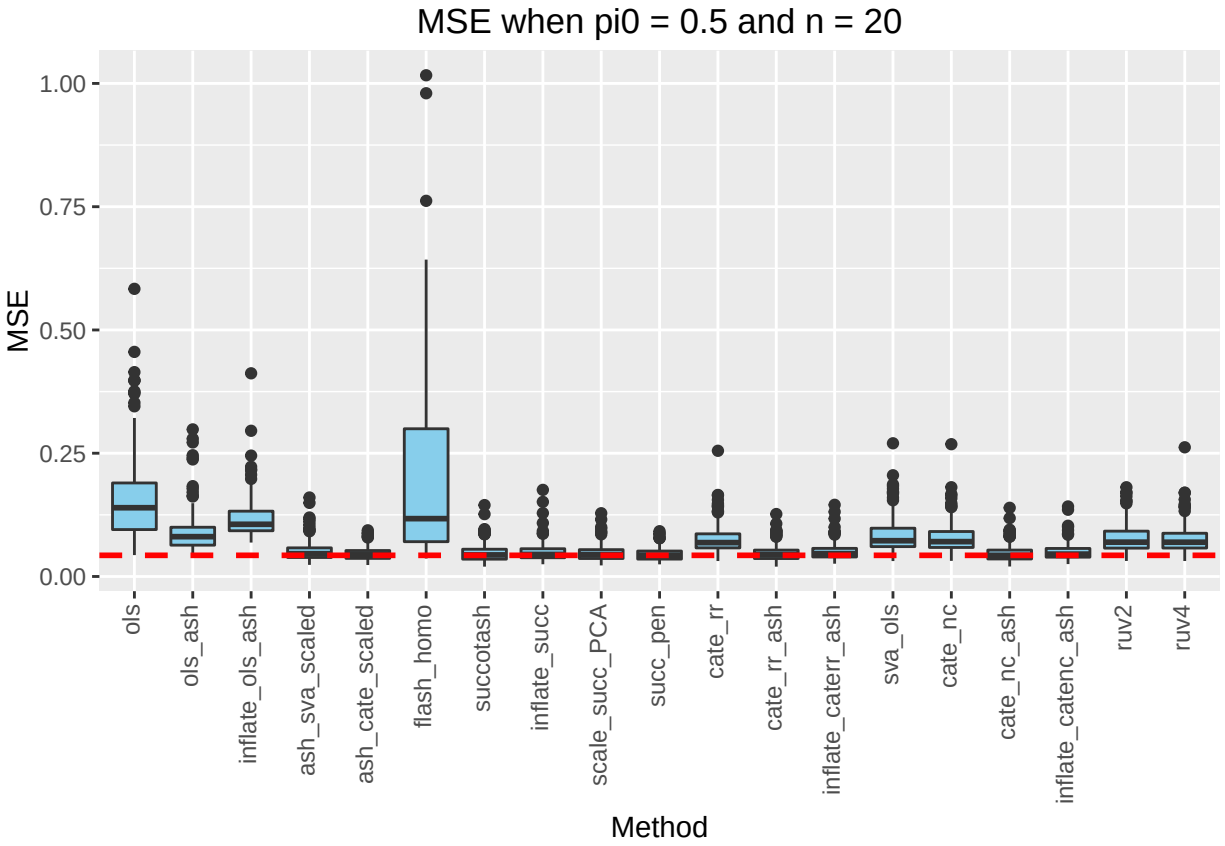

pi0hat when pi0 = 1 and n = 40
1.00
0.75
0.50
0.25
0.00
$\hat{\pi}_0$
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

MSE Plots

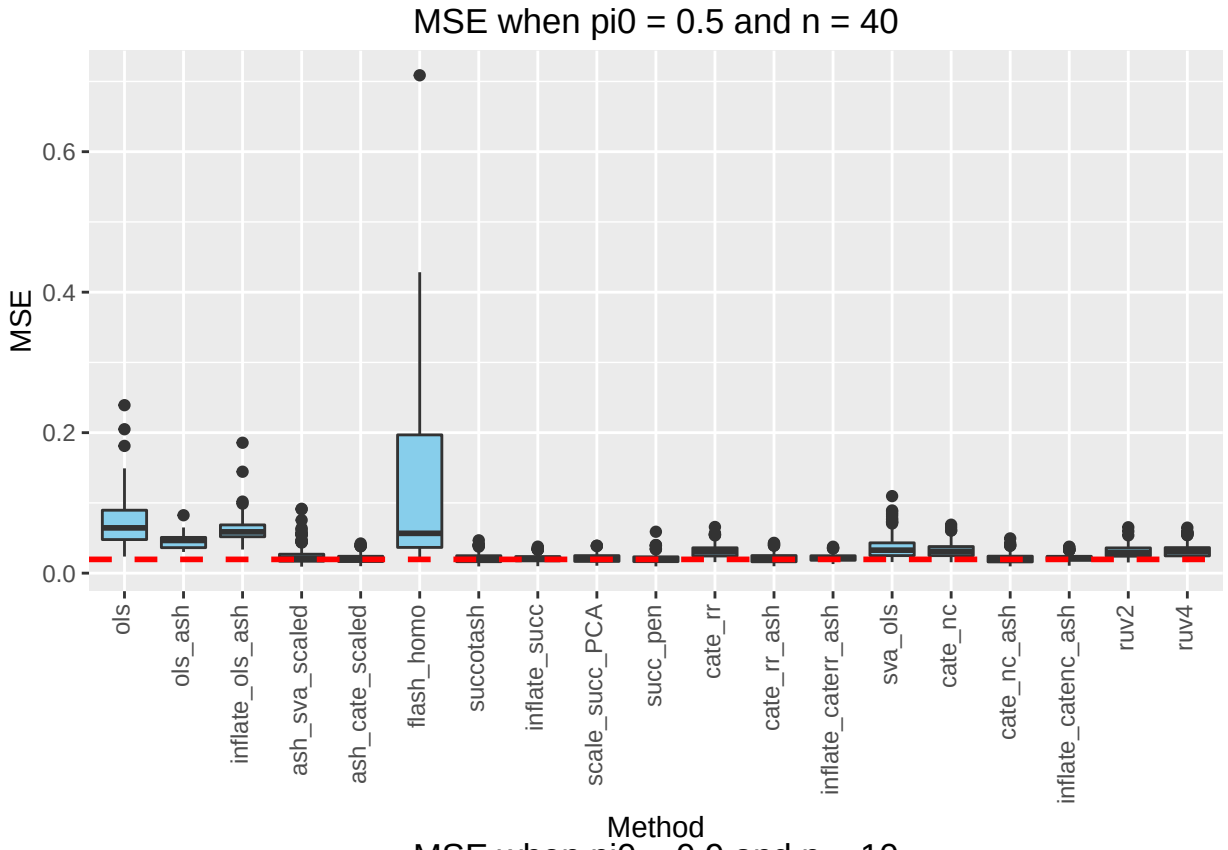
```
double_mse <- read.csv("../double_succ/mse_mat.csv")
reg_mse <- read.csv("../flash_v_rest_using_package/mse_mat.csv")
scale_mse <- read.csv("../succ_scaled/mse_ssuc.csv")
scale_mse_pen <- read.csv("../succ_scaled_pen/mse_ssuc_mc.csv")
ash_sva <- read.csv("../scaled_ashr/mse_svaash_mc.csv")
ash_cate <- read.csv("mse_cateash_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$succ_pen <- scale_mse_pen$post_inflate
reg_mse$ash_sva_scaled <- ash_sva$post_inflate
reg_mse$ash_cate_scaled <- ash_cate$post_inflate
reg_mse <- tbl_df(reg_mse)
reg_mse <- reg_mse[, c(1:2, 17, 20, 21, 3:4, 14, 18:19, 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)
    }
}
```

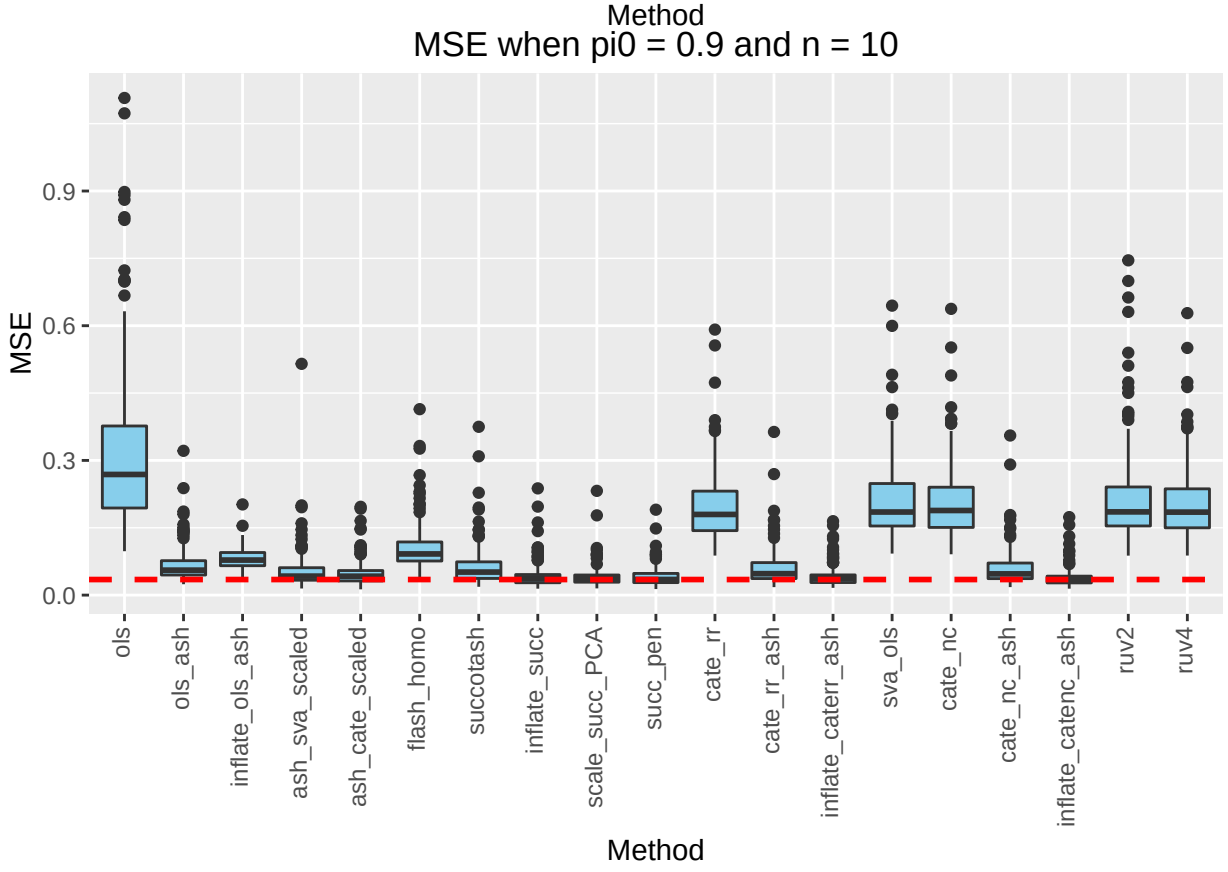



```
## Warning: Removed 5 rows containing non-finite values (stat_boxplot).
```

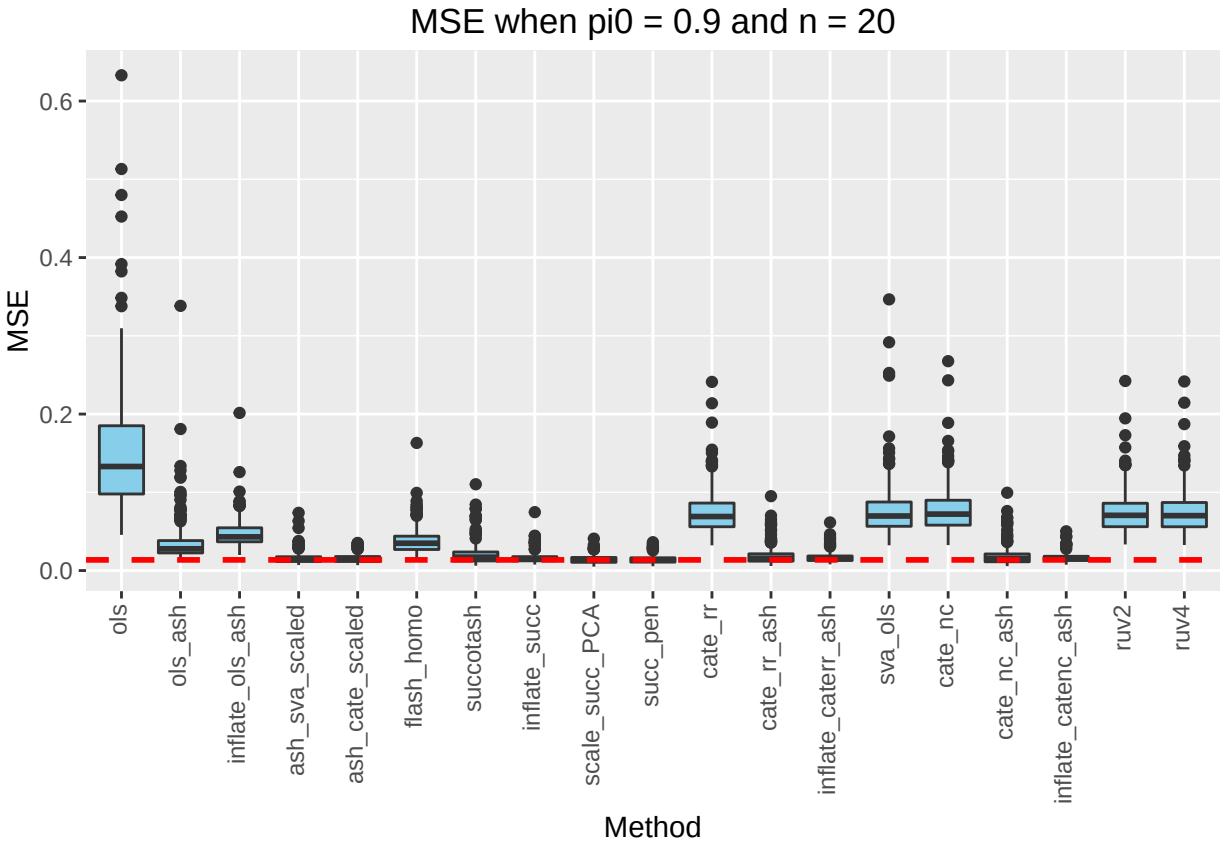



```
## Warning: Removed 203 rows containing non-finite values (stat_boxplot).
```

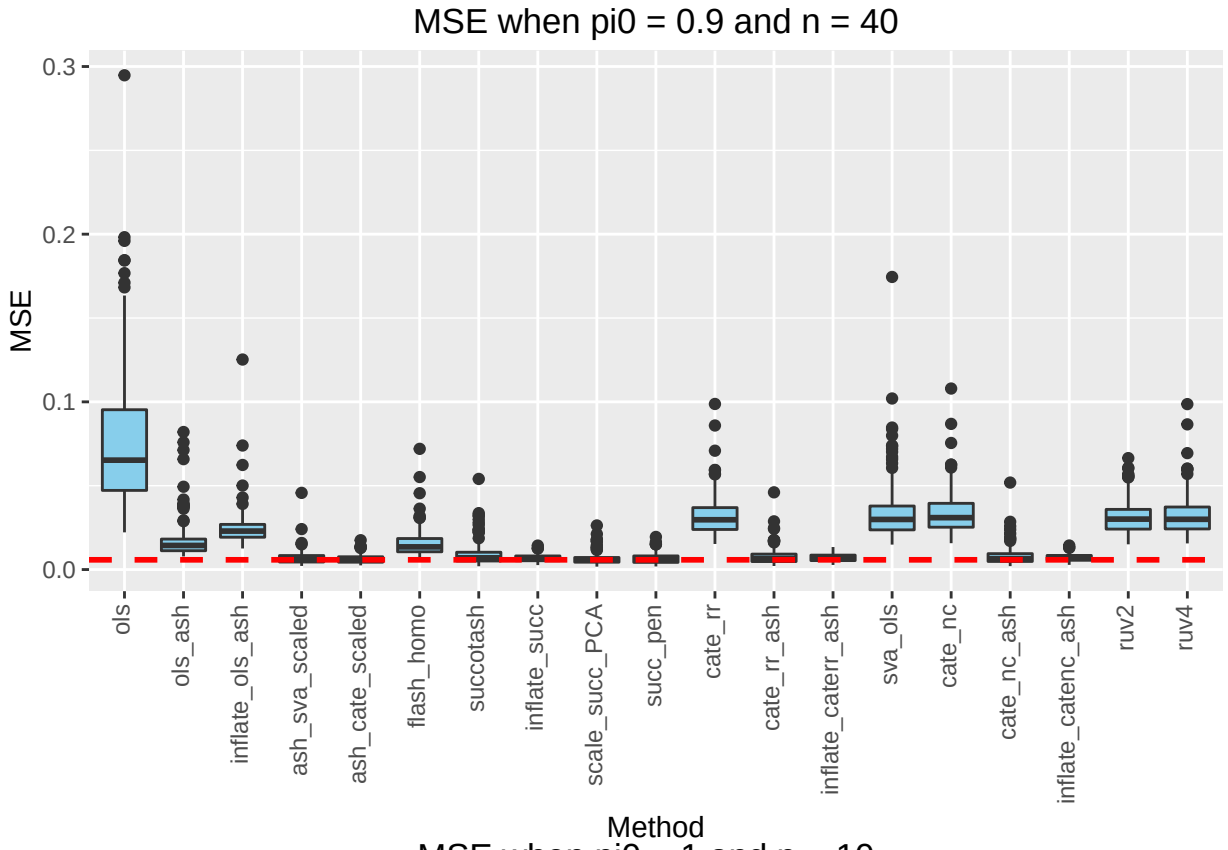


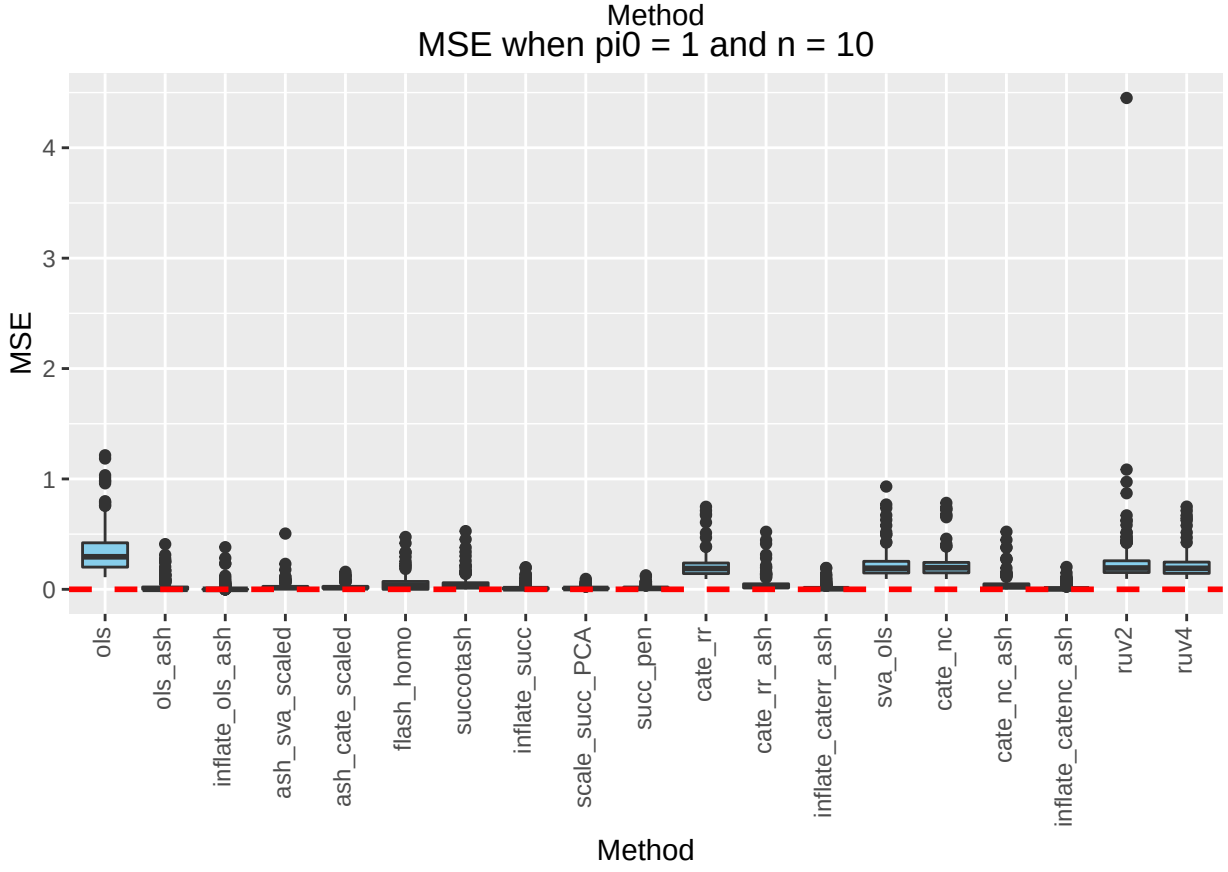


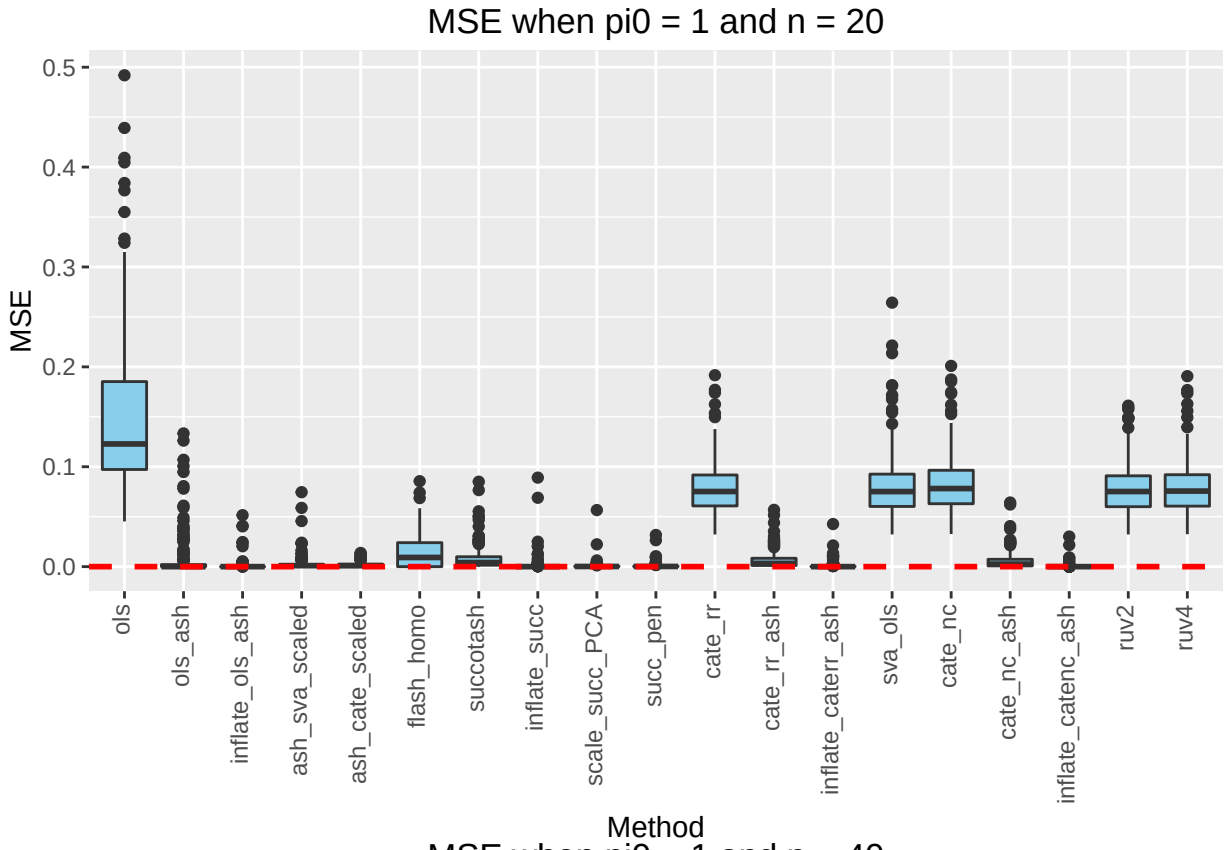

```
## Warning: Removed 1 rows containing non-finite values (stat_boxplot).
```

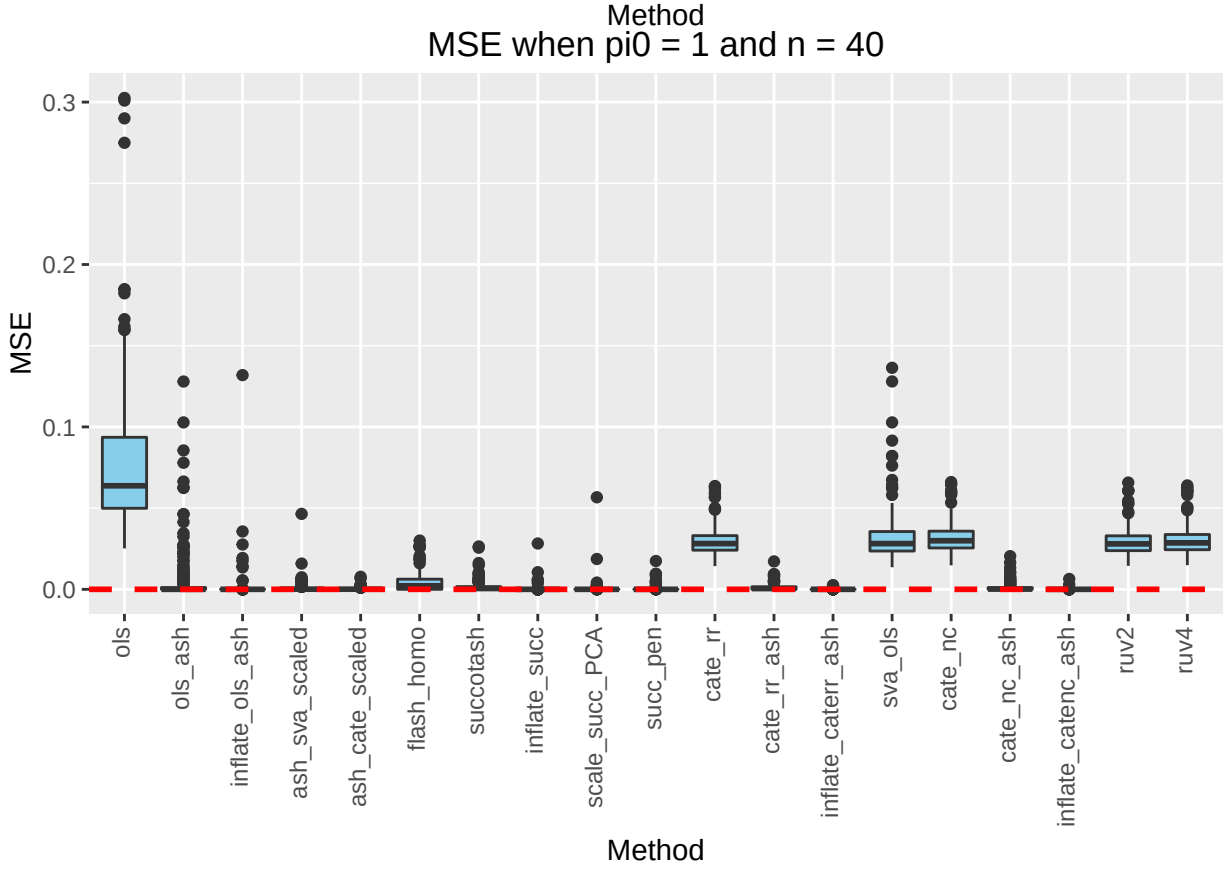



```
## Warning: Removed 89 rows containing non-finite values (stat_boxplot).
```


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

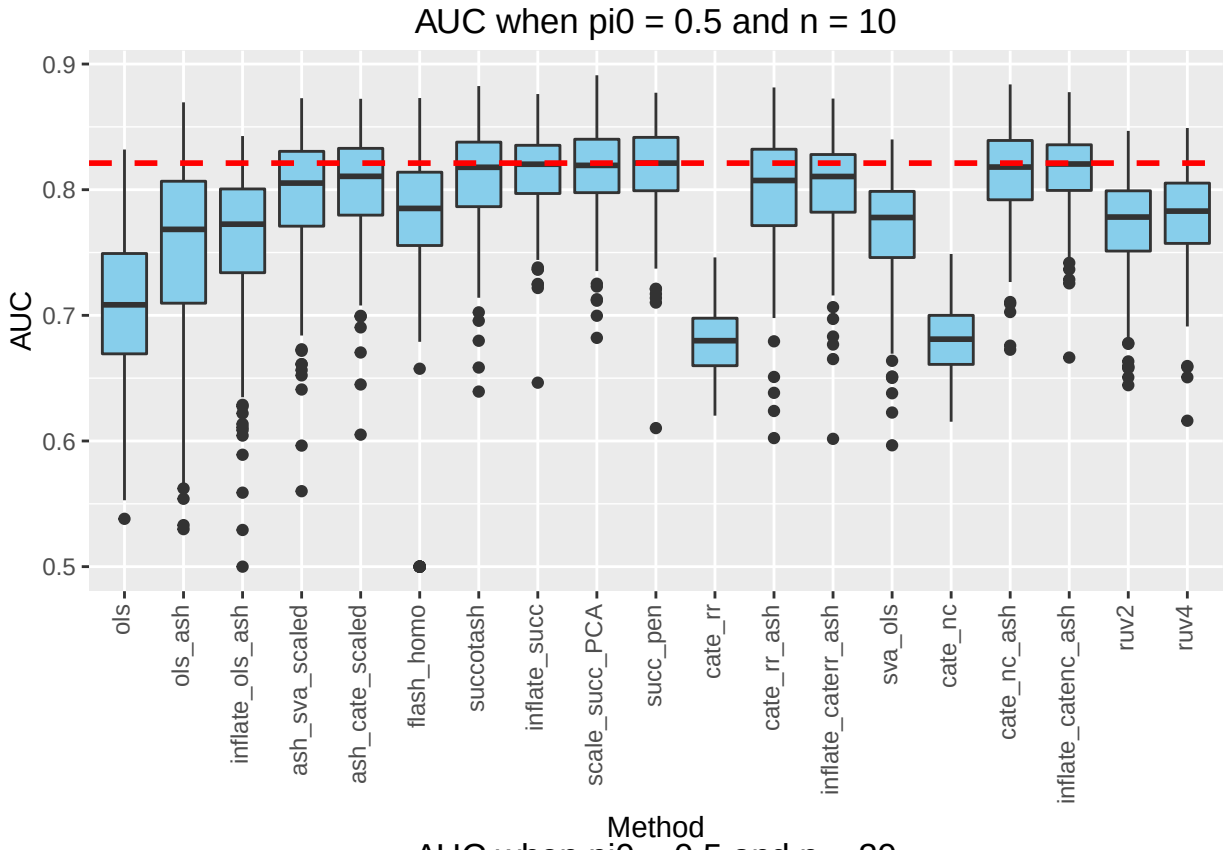

MSE when pi0 = 1 and n = 10
MSE
4
3
2
1
0
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

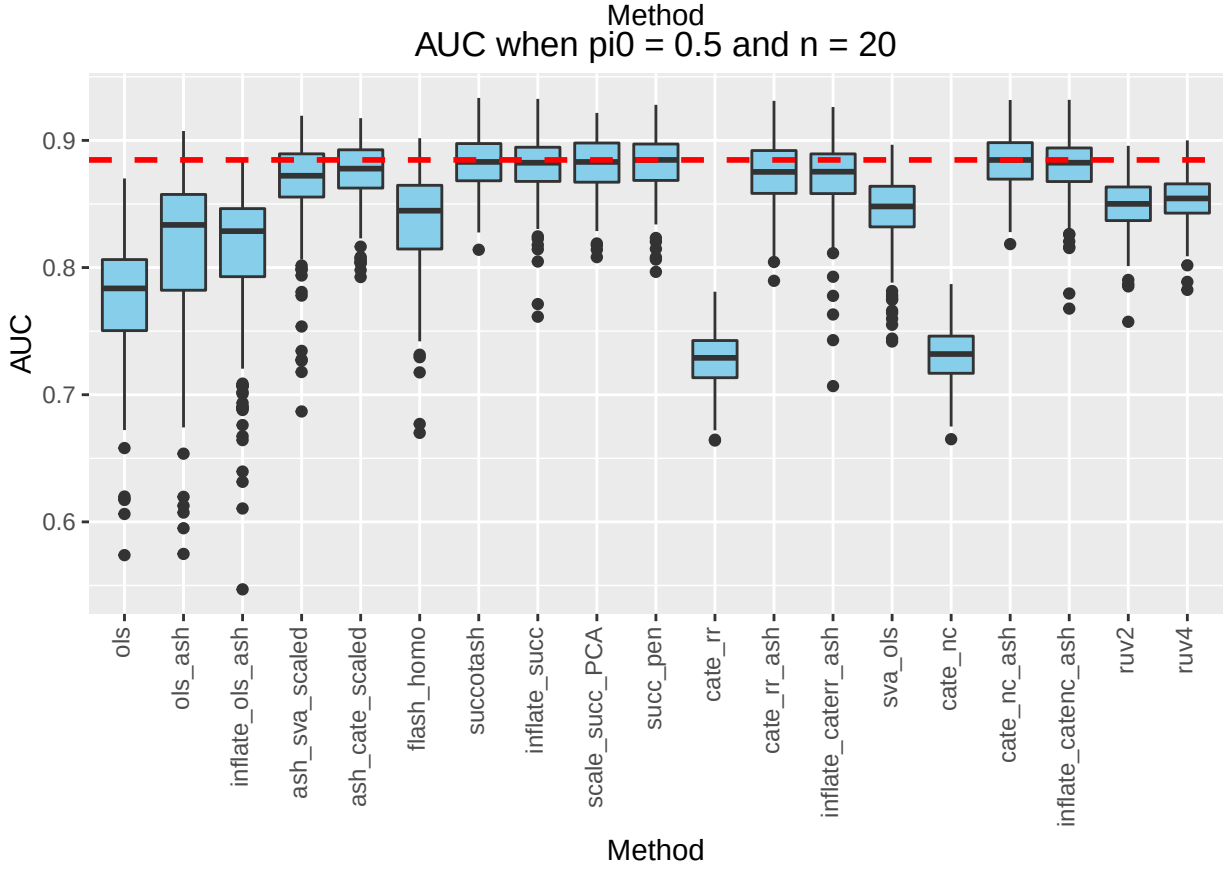

MSE when pi0 = 1 and n = 20
MSE
0.5
0.4
0.3
0.2
0.1
0.0
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

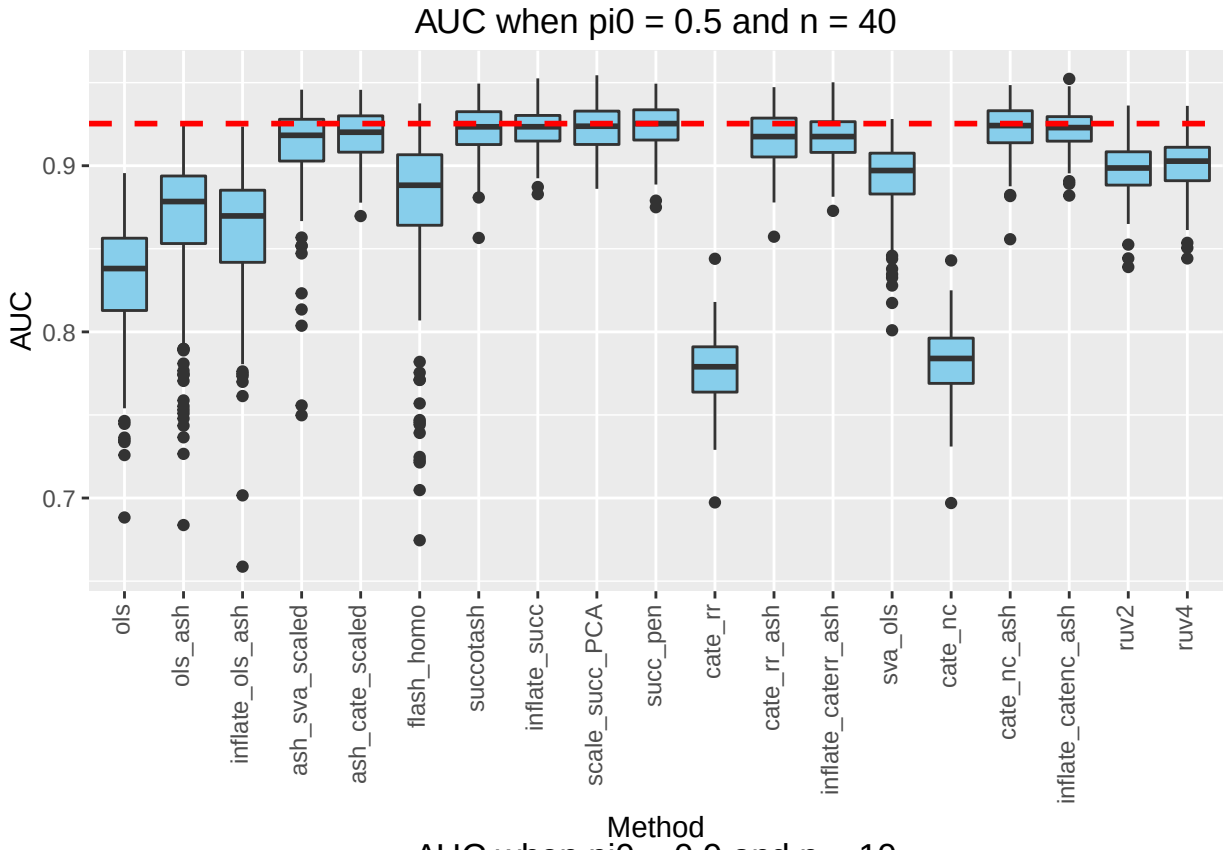

MSE when pi0 = 1 and n = 40
MSE
0.3
0.2
0.1
0.0
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

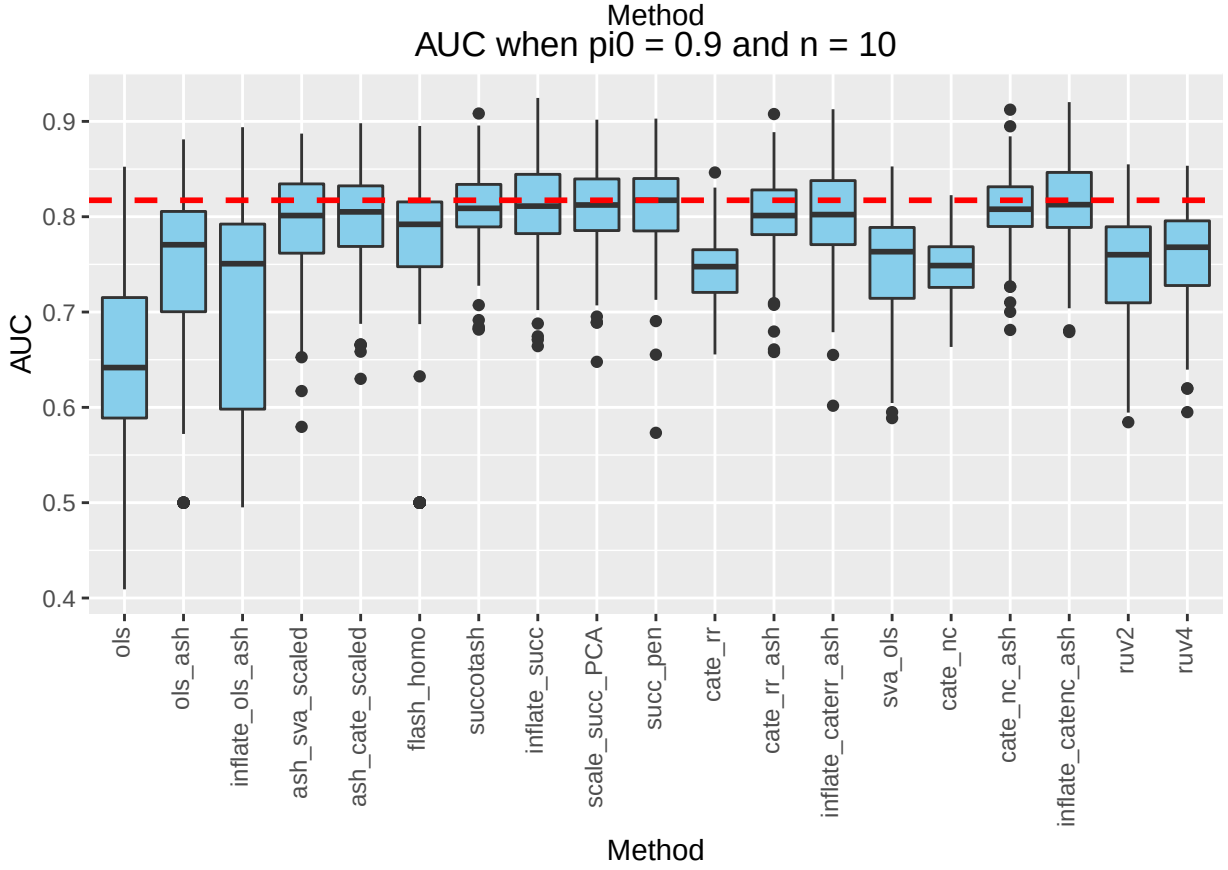
AUC Plots

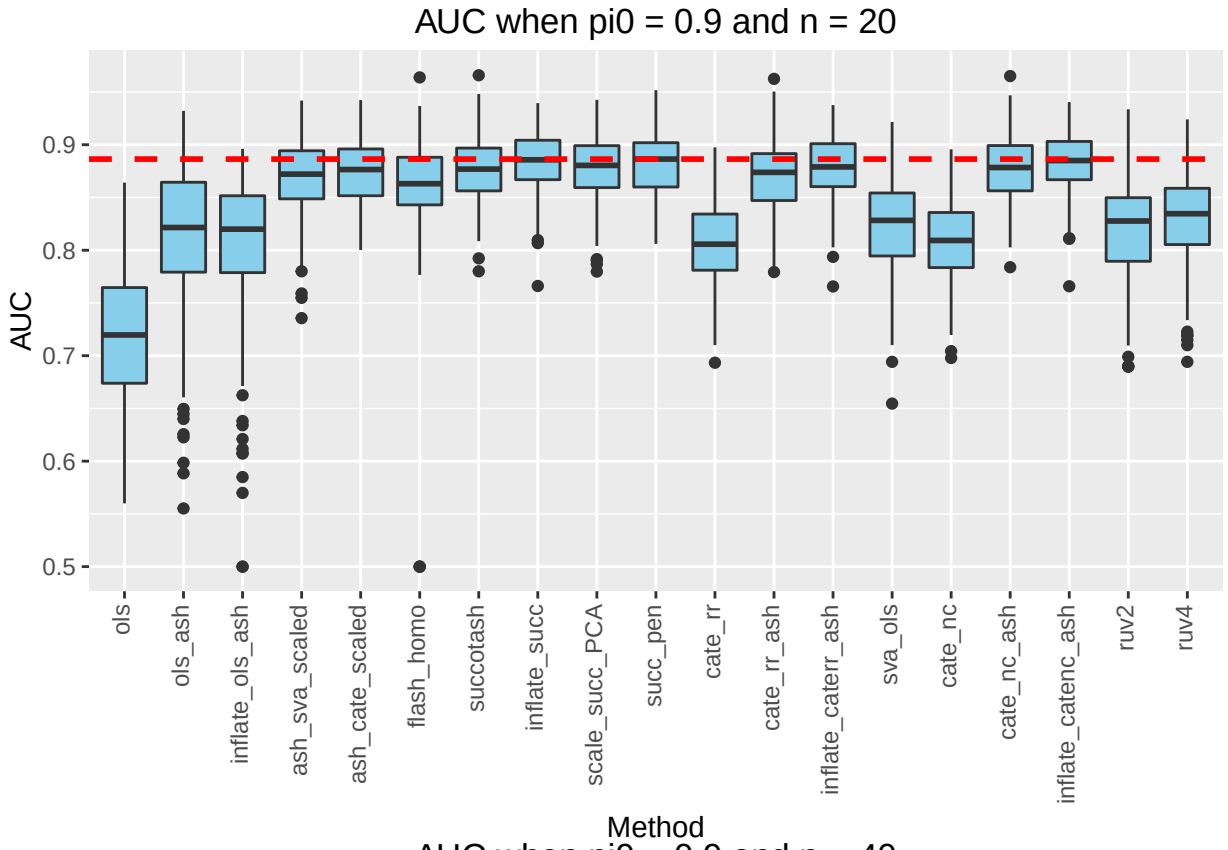
```
double_auc <- read.csv("../double_succ/auc_mat.csv")
reg_auc <- read.csv("../flash_v_rest_using_package/auc_mat.csv")
scale_auc <- read.csv("../succ_scaled/auc_ssuc.csv")
scale_auc_pen <- read.csv("../succ_scaled_pen/auc_ssuc_mc.csv")
ash_sva <- read.csv("../scaled_ashr/auc_svaash_mc.csv")
ash_cate <- read.csv("auc_cateash_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$succ_pen <- scale_auc_pen$post_inflate
reg_auc$ash_sva_scaled <- ash_sva$post_inflate
reg_auc$ash_cate_scaled <- ash_cate$post_inflate
reg_auc <- tbl_df(reg_auc)
reg_auc <- reg_auc[, c(1:2, 17, 20, 21, 3:4, 14, 18:19, 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)
    }
}
```

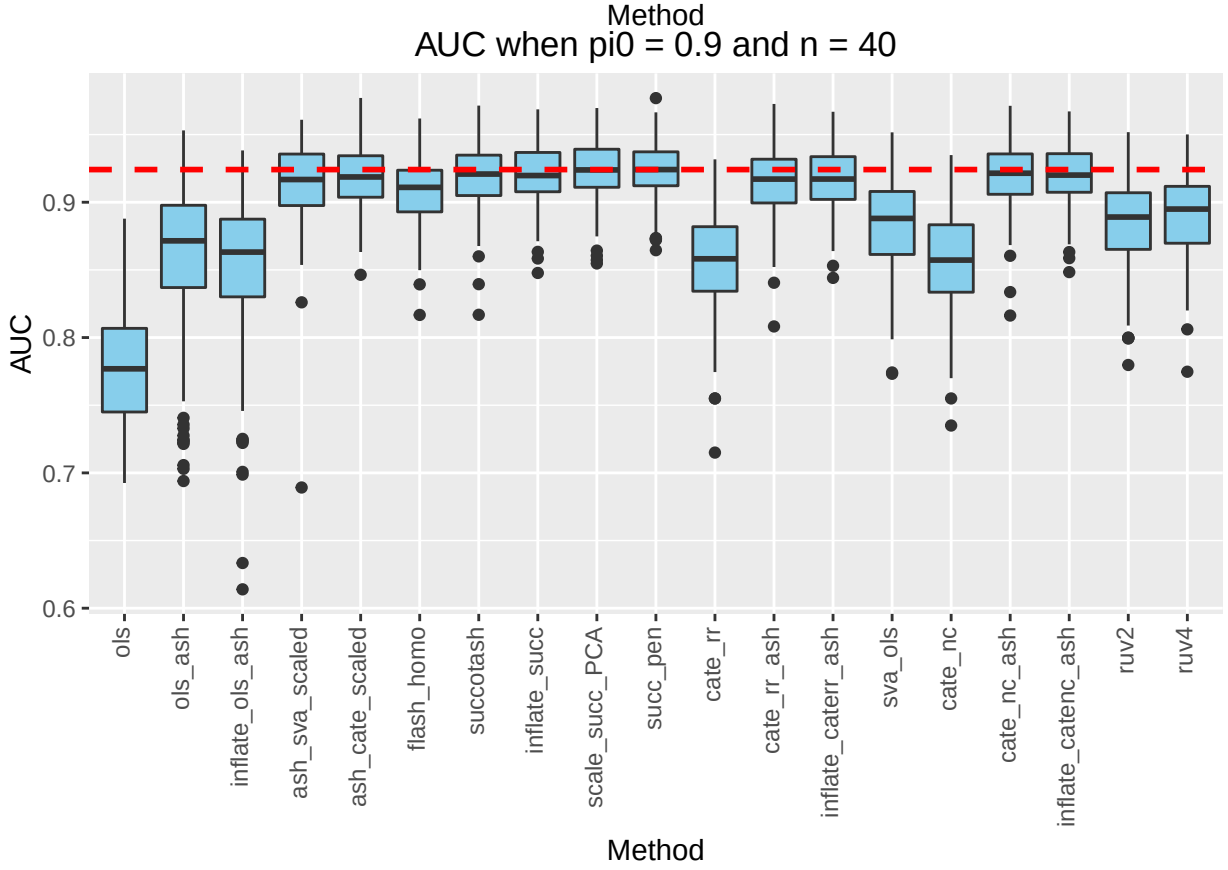

AUC when pi0 = 0.5 and n = 10
AUC
0.9
0.8
0.7
0.6
0.5
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method


AUC when pi0 = 0.5 and n = 20
AUC
0.9
0.8
0.7
0.6
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
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
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
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
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
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
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
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 = 40
AUC
0.9
0.8
0.7
0.6
ols
ols_ash
inflate_ols_ash
ash_sva_scaled
ash_cate_scaled
flash_homo
succotash
inflate_succ
scale_succ_PCA
succ_pen
cate_rr
cate_rr_ash
inflate_caterr_ash
sva_ols
cate_nc
cate_nc_ash
inflate_catenc_ash
ruv2
ruv4
Method

```r
sessionInfo()
```

```
## R version 3.2.5 (2016-04-14)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 14.04.4 LTS
##
## locale:
##  [1] LC_CTYPE=en_US.UTF-8       LC_NUMERIC=C
##  [3] LC_TIME=en_US.UTF-8        LC_COLLATE=en_US.UTF-8
##  [5] LC_MONETARY=en_US.UTF-8    LC_MESSAGES=en_US.UTF-8
##  [7] LC_PAPER=en_US.UTF-8       LC_NAME=C
##  [9] LC_ADDRESS=C               LC_TELEPHONE=C
## [11] LC_MEASUREMENT=en_US.UTF-8 LC_IDENTIFICATION=C
##
## 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_1.12.26
##
## loaded via a namespace (and not attached):
##  [1] Rcpp_0.12.2      magrittr_1.5     munsell_0.4.3    colorspace_1.2-6
##  [5] R6_2.1.1         stringr_1.0.0    plyr_1.8.3       tools_3.2.5
##  [9] parallel_3.2.5   grid_3.2.5       gtable_0.2.0     DBI_0.3.1
## [13] htmltools_0.3.5  yaml_2.1.13      lazyeval_0.1.10  assertthat_0.1
## [17] digest_0.6.9     formatR_1.3      codetools_0.2-14 evaluate_0.8.3
## [21] rmarkdown_0.9.6  labeling_0.3     stringi_1.0-1    compiler_3.2.5
## [25] scales_0.4.0
```