```
## Load libraries
library(splines)
library(MASS)
library(xtable)
library(qvalue)

##Source functions
source("../functions.R")
```

Simulations are performed for a variety of alternative distributions:

```
alts <- c("alt_beta","alt_chisq_large_3_3","alt_chisq_large",
          "alt_chisq_small_3_3","alt_chisq_small",
          "alt_t_large","alt_t_small",
          "alt_z_large",
          "alt_z_small")
```

Make FDR-TPR table:

```
for(alt in alts)
{
  ##For each simulation, get the FDR-TPR table: (BL = Boca-Leek method)
  scen1 <- scen2a <- scen2b <- scen3a <- scen3b <- NULL

  ##-------------------Set 1----------------##

  ##Load p-values and £\pi_0(x)£ estimates for the simulations:
  for(l in listSimRes(alt, 1))
  {
    load(l)
  }

  ##Get BH and Storey q-values for each simulation:
  qValuesSimsBH <- getQValuesSimsBH(pValuesSims)
  qValuesSimsStorey <- getQValuesSimsStorey(pValuesSims)

  ##Get estimated FDR for each simulation for the final estimates
  FDRreg <- getFDRregSims(pi0EstSim, qValuesSimsBH)

  ##get FDR-TPR table
  scen1 <- estFDR.TPR(FDR.BL = FDRreg,
                      FDR.BH = qValuesSimsBH, FDR.Storey = qValuesSimsStorey,
                      FDR.Scott = FDR.ScottMat, FDR.Scott_emp = FDR.ScottMat_emp, nullHypSi

  ##-------------------Set 2----------------##
```

```r
##Load p-values and £\pi_0(x)£ estimates for the simulations:
for(l in listSimRes(alt, 2))
{
  load(l)
}

##Get BH and Storey q-values for each simulation:
qValuesSimsBH <- getQValuesSimsBH(pValuesSims)
qValuesSimsStorey <- getQValuesSimsStorey(pValuesSims)

##--------Linear fit-------##

##Get estimated FDR for each simulation for the final estimates
FDRreg <- getFDRregSims(pi0EstSim.lin, qValuesSimsBH)

##get FDR-TPR table
scen2a <- estFDR.TPR(FDR.BL = FDRreg,
                     FDR.BH = qValuesSimsBH, FDR.Storey = qValuesSimsStorey,
                     FDR.Scott = FDR.Lin.ScottMat, FDR.Scott_emp = FDR.Lin.ScottMat_emp, r

##--------Spline fit-------##

##Get estimated FDR for each simulation for the final estimates
FDRreg <- getFDRregSims(pi0EstSim.spl, qValuesSimsBH)

##get FDR-TPR table
scen2b <- estFDR.TPR(FDR.BL = FDRreg,
                     FDR.BH = qValuesSimsBH, FDR.Storey = qValuesSimsStorey,
                     FDR.Scott = FDR.Spl.ScottMat, FDR.Scott_emp = FDR.Spl.ScottMat_emp, r

##--------------------Set 3----------------##

##Load p-values and £\pi_0(x)£ estimates for the simulations:
for(l in listSimRes(alt, 3))
{
  load(l)
}

##Get BH and Storey q-values for each simulation:
qValuesSimsBH <- getQValuesSimsBH(pValuesSims)
qValuesSimsStorey <- getQValuesSimsStorey(pValuesSims)

##--------Linear fit-------##

##Get estimated FDR for each simulation for the final estimates
```

```r
FDRreg <- getFDRregSims(pi0EstSim.lin, qValuesSimsBH)

##get FDR-TPR table
scen3a <- estFDR.TPR(FDR.BL = FDRreg,
                     FDR.BH = qValuesSimsBH, FDR.Storey = qValuesSimsStorey,
                     FDR.Scott = FDR.Lin.ScottMat, FDR.Scott_emp = FDR.Lin.ScottMat_emp, r

##--------Spline fit-------##

##Get estimated FDR for each simulation for the final estimates
FDRreg <- getFDRregSims(pi0EstSim.spl, qValuesSimsBH)

##get FDR-TPR table
scen3b <- estFDR.TPR(FDR.BL = FDRreg,
                     FDR.BH = qValuesSimsBH, FDR.Storey = qValuesSimsStorey,
                     FDR.Scott = FDR.Spl.ScottMat, FDR.Scott_emp = FDR.Spl.ScottMat_emp, r

##-------------------Set 4----------------##

##Load p-values and £\pi_0(x)£ estimates for the simulations:
for(l in listSimRes(alt, 4))
{
  load(l)
}

##Get BH and Storey q-values for each simulation:
qValuesSimsBH <- getQValuesSimsBH(pValuesSims)
qValuesSimsStorey <- getQValuesSimsStorey(pValuesSims)

##--------Linear fit-------##

##Get estimated FDR for each simulation:
##first pull out just the final estimates
pi0_final <- lapply(pi0EstSim.lin, function(x){x[[3]]})

FDRreg <- t(mapply(function(q,pi0){q*pi0}, data.frame(t(qValuesSimsBH)), pi0_final, SIMPLI

##get FDR-TPR table
scen4a <- estFDR.TPR(FDR.BL = FDRreg,
                     FDR.BH = qValuesSimsBH, FDR.Storey = qValuesSimsStorey,
                     FDR.Scott = FDR.Lin.ScottMat, FDR.Scott_emp = FDR.Lin.ScottMat_emp, r

##--------Spline fit-------##

##Get estimated FDR for each simulation:
```

```
  ##first pull out just the final estimates
  pi0_final <- lapply(pi0EstSim.spl, function(x){x[[3]]})

  FDRreg <- t(mapply(function(q,pi0){q*pi0}, data.frame(t(qValuesSimsBH)), pi0_final, SIMPLI

  ##get FDR-TPR table
  scen4b <- estFDR.TPR(FDR.BL = FDRreg,
                       FDR.BH = qValuesSimsBH, FDR.Storey = qValuesSimsStorey,
                       FDR.Scott = FDR.Spl.ScottMat, FDR.Scott_emp = FDR.Spl.ScottMat_emp, r

  print("")
  print(alt)
  print(scen1)
  print(scen2a)
  print(scen2b)
  print(scen3a)
  print(scen3b)
  print(scen4a)
  print(scen4b)

  save(list=c("scen1","scen2a","scen2b","scen3a","scen3b","scen4a","scen4b"),
       file=paste(alt,"FDR_TPR_sims.RData",sep="/"))
}
```

```
## [1] ""
## [1] "alt_beta"
##                  FDR          TPR
## BL        0.03700000 0.0001801052
## Scott     0.90014850 1.0000000000
## Scott_emp 0.90016181 1.0000000000
## Storey    0.03700000 0.0001801052
## BH        0.03616667 0.0001551536
##                  FDR          TPR
## BL        0.03083333 0.0002035583
## Scott     0.92587700 1.0000000000
## Scott_emp 0.92587700 1.0000000000
## Storey    0.03083333 0.0001565015
## BH        0.03000000 0.0001565015
##                  FDR          TPR
## BL        0.03083333 0.0002237986
## Scott     0.92587700 1.0000000000
## Scott_emp 0.92587700 1.0000000000
## Storey    0.03083333 0.0001565015
## BH        0.03000000 0.0001565015
##                 FDR          TPR
## BL        0.0400000 0.0001256615
```

```
## Scott     0.9486415 1.0000000000
## Scott_emp 0.9486404 1.0000000000
## Storey    0.0350000 0.0001155809
## BH        0.0350000 0.0001052928
##                FDR          TPR
## BL        0.0450000 0.0001360565
## Scott     0.9486415 1.0000000000
## Scott_emp 0.9486404 1.0000000000
## Storey    0.0350000 0.0001155809
## BH        0.0350000 0.0001052928
##                 FDR          TPR
## BL        0.04398119 0.0122282933
## Scott     0.56870950 1.0000000000
## Scott_emp         NA           NA
## Storey    0.04766879 0.0050416009
## BH        0.02459040 0.0003102373
##                 FDR          TPR
## BL        0.05013933 0.0199943022
## Scott     0.56870950 1.0000000000
## Scott_emp         NA           NA
## Storey    0.04766879 0.0050416009
## BH        0.02459040 0.0003102373
## [1] ""
## [1] "alt_chisq_large_3_3"
##                 FDR       TPR
## BL        0.05038802 0.2974263
## Scott     0.90014850 1.0000000
## Scott_emp 0.90014850 1.0000000
## Storey    0.05043161 0.2974229
## BH        0.04532031 0.2874058
##                 FDR       TPR
## BL        0.04910648 0.2800230
## Scott     0.92587700 1.0000000
## Scott_emp 0.92587700 1.0000000
## Storey    0.04994228 0.2708622
## BH        0.04687084 0.2649899
##                 FDR       TPR
## BL        0.04868581 0.2838509
## Scott     0.92587700 1.0000000
## Scott_emp 0.92587700 1.0000000
## Storey    0.04994228 0.2708622
## BH        0.04687084 0.2649899
##                 FDR       TPR
## BL        0.05249217 0.2426240
## Scott     0.94864150 1.0000000
```

```
## Scott_emp 0.94864150 1.0000000
## Storey    0.05198538 0.2359225
## BH        0.04961398 0.2321865
##                 FDR       TPR
## BL        0.05231222 0.2442294
## Scott     0.94864150 1.0000000
## Scott_emp 0.94864150 1.0000000
## Storey    0.05198538 0.2359225
## BH        0.04961398 0.2321865
##                 FDR       TPR
## BL        0.04720523 0.5182180
## Scott     0.56870950 1.0000000
## Scott_emp 0.57075714 1.0000000
## Storey    0.04694086 0.5167668
## BH        0.02841505 0.4475972
##                 FDR       TPR
## BL        0.04735480 0.5187015
## Scott     0.56870950 1.0000000
## Scott_emp 0.57075714 1.0000000
## Storey    0.04694086 0.5167668
## BH        0.02841505 0.4475972
## [1] ""
## [1] "alt_chisq_large"
##                 FDR       TPR
## BL        0.04992740 0.5065315
## Scott     0.90014850 1.0000000
## Scott_emp 0.90014850 1.0000000
## Storey    0.04982659 0.5064742
## BH        0.04507402 0.4956380
##                 FDR       TPR
## BL        0.04892529 0.4820037
## Scott     0.92587700 1.0000000
## Scott_emp 0.92587700 1.0000000
## Storey    0.04960789 0.4717792
## BH        0.04569686 0.4635510
##                 FDR       TPR
## BL        0.04847870 0.4858638
## Scott     0.92587700 1.0000000
## Scott_emp 0.92587700 1.0000000
## Storey    0.04960789 0.4717792
## BH        0.04569686 0.4635510
##                 FDR       TPR
## BL        0.05014062 0.4395577
## Scott     0.94864150 1.0000000
## Scott_emp 0.94864150 1.0000000
```

```
## Storey    0.04997196 0.4321289
## BH        0.04782477 0.4269699
##                 FDR       TPR
## BL        0.05037074 0.4417391
## Scott     0.94864150 1.0000000
## Scott_emp 0.94864150 1.0000000
## Storey    0.04997196 0.4321289
## BH        0.04782477 0.4269699
##                 FDR       TPR
## BL        0.04773427 0.7113716
## Scott     0.56870950 1.0000000
## Scott_emp         NA        NA
## Storey    0.04758025 0.7101354
## BH        0.02844283 0.6515505
##                 FDR       TPR
## BL        0.04793122 0.7117650
## Scott     0.56870950 1.0000000
## Scott_emp         NA        NA
## Storey    0.04758025 0.7101354
## BH        0.02844283 0.6515505
## [1] ""
## [1] "alt_chisq_small_3_3"
##                 FDR         TPR
## BL        0.05588352 0.004374358
## Scott     0.90014850 1.000000000
## Scott_emp 0.90013166 1.000000000
## Storey    0.05644930 0.004364696
## BH        0.05568821 0.004258809
##                 FDR         TPR
## BL        0.05896284 0.003786449
## Scott     0.92587700 1.000000000
## Scott_emp 0.92591616 1.000000000
## Storey    0.06412951 0.003686268
## BH        0.06329618 0.003610690
##                 FDR         TPR
## BL        0.05983189 0.003879890
## Scott     0.92587700 1.000000000
## Scott_emp 0.92591616 1.000000000
## Storey    0.06412951 0.003686268
## BH        0.06329618 0.003610690
##                 FDR         TPR
## BL        0.06390079 0.003364668
## Scott     0.94864150 1.000000000
## Scott_emp 0.94862814 1.000000000
## Storey    0.06681746 0.003286853
```

```
## BH        0.06688690 0.003235488
##                 FDR         TPR
## BL        0.06348413 0.003384324
## Scott     0.94864150 1.000000000
## Scott_emp 0.94862814 1.000000000
## Storey    0.06681746 0.003286853
## BH        0.06688690 0.003235488
##                 FDR        TPR
## BL        0.03648377 0.01570084
## Scott     0.56870950 1.00000000
## Scott_emp 0.56868434 1.00000000
## Storey    0.03600993 0.01558154
## BH        0.02954534 0.01292525
##                 FDR        TPR
## BL        0.03661985 0.01575204
## Scott     0.56870950 1.00000000
## Scott_emp 0.56868434 1.00000000
## Storey    0.03600993 0.01558154
## BH        0.02954534 0.01292525
## [1] ""
## [1] "alt_chisq_small"
##                 FDR        TPR
## BL        0.04675710 0.02310579
## Scott     0.90014850 1.00000000
## Scott_emp 0.90015455 1.00000000
## Storey    0.04640441 0.02299092
## BH        0.04323486 0.02215884
##                 FDR        TPR
## BL        0.05160792 0.01912256
## Scott     0.92587700 1.00000000
## Scott_emp 0.92588838 1.00000000
## Storey    0.05194276 0.01862739
## BH        0.05123292 0.01821753
##                 FDR        TPR
## BL        0.05200295 0.01940442
## Scott     0.92587700 1.00000000
## Scott_emp 0.92588838 1.00000000
## Storey    0.05194276 0.01862739
## BH        0.05123292 0.01821753
##                 FDR        TPR
## BL        0.04856758 0.01534389
## Scott     0.94864150 1.00000000
## Scott_emp 0.94865685 1.00000000
## Storey    0.04826934 0.01473764
## BH        0.04830979 0.01457395
```

```
##                  FDR        TPR
## BL         0.04836514 0.01556766
## Scott      0.94864150 1.00000000
## Scott_emp  0.94865685 1.00000000
## Storey     0.04826934 0.01473764
## BH         0.04830979 0.01457395
##                  FDR        TPR
## BL         0.03562998 0.07186136
## Scott      0.56870950 1.00000000
## Scott_emp  0.56869849 1.00000000
## Storey     0.03593538 0.07158702
## BH         0.02926360 0.06111337
##                  FDR        TPR
## BL         0.03603455 0.07195040
## Scott      0.56870950 1.00000000
## Scott_emp  0.56869849 1.00000000
## Storey     0.03593538 0.07158702
## BH         0.02926360 0.06111337
## [1] ""
## [1] "alt_t_large"
##                  FDR       TPR
## BL         0.05156920 0.1413328
## Scott      0.21679671 0.5533824
## Scott_emp  0.20788838 0.5322975
## Storey     0.05121535 0.1410240
## BH         0.04662848 0.1262586
##                  FDR       TPR
## BL         0.04558570 0.1147426
## Scott      0.19981528 0.6569400
## Scott_emp  0.19936003 0.6536347
## Storey     0.04917543 0.1024570
## BH         0.04485754 0.0924984
##                  FDR       TPR
## BL         0.04453287 0.1204800
## Scott      0.20190300 0.6574039
## Scott_emp  0.20148230 0.6542250
## Storey     0.04917543 0.1024570
## BH         0.04485754 0.0924984
##                  FDR        TPR
## BL         0.04927168 0.06773425
## Scott      0.24681300 0.62460353
## Scott_emp  0.26803101 0.63730172
## Storey     0.05217810 0.05971629
## BH         0.05211931 0.05492284
##                  FDR        TPR
```

```
## BL        0.04832136 0.07005785
## Scott     0.24797626 0.62612967
## Scott_emp 0.26928622 0.63907431
## Storey    0.05217810 0.05971629
## BH        0.05211931 0.05492284
##                 FDR       TPR
## BL        0.04813761 0.5182922
## Scott     0.09326501 0.7284492
## Scott_emp 0.01222393 0.2850707
## Storey    0.04787731 0.5164582
## BH        0.02891815 0.4019615
##                 FDR       TPR
## BL        0.04814676 0.5189370
## Scott     0.09331981 0.7286028
## Scott_emp 0.01229413 0.2856909
## Storey    0.04787731 0.5164582
## BH        0.02891815 0.4019615
## [1] ""
## [1] "alt_t_small"
##                 FDR          TPR
## BL        0.05908333 0.0002976598
## Scott     0.45893701 0.0823723693
## Scott_emp 0.46207348 0.0843754947
## Storey    0.05908333 0.0002976598
## BH        0.05541667 0.0002730119
##                FDR          TPR
## BL        0.0787500 0.0003075512
## Scott     0.4521543 0.1041067228
## Scott_emp 0.4755499 0.1065859670
## Storey    0.0787500 0.0002873627
## BH        0.0787500 0.0002873627
##                FDR          TPR
## BL        0.0787500 0.0003406773
## Scott     0.4448529 0.1073669015
## Scott_emp 0.4698458 0.1095127177
## Storey    0.0787500 0.0002873627
## BH        0.0787500 0.0002873627
##                FDR          TPR
## BL        0.0812500 0.0003495909
## Scott     0.5596357 0.0909046758
## Scott_emp 0.5872793 0.0968826080
## Storey    0.0812500 0.0003391307
## BH        0.0812500 0.0003391307
##                FDR          TPR
## BL        0.0812500 0.0003391307
```

```
## Scott     0.5556546 0.0926080382
## Scott_emp 0.5822775 0.0990048380
## Storey    0.0812500 0.0003391307
## BH        0.0812500 0.0003391307
##                 FDR         TPR
## BL        0.03667280 0.003062926
## Scott     0.15113673 0.137568917
## Scott_emp 0.09503206 0.064570231
## Storey    0.03634225 0.003003643
## BH        0.02929753 0.001736907
##                 FDR         TPR
## BL        0.03612316 0.003091762
## Scott     0.15129686 0.137680075
## Scott_emp 0.09485720 0.064694333
## Storey    0.03634225 0.003003643
## BH        0.02929753 0.001736907
## [1] ""
## [1] "alt_z_large"
##                 FDR       TPR
## BL        0.04975513 0.5064633
## Scott     0.04994533 0.5063831
## Scott_emp 0.05887183 0.5209223
## Storey    0.04954030 0.5065332
## BH        0.04491480 0.4957233
##                 FDR       TPR
## BL        0.04925271 0.4841525
## Scott     0.05241358 0.6388865
## Scott_emp 0.05298246 0.6289395
## Storey    0.04925485 0.4730709
## BH        0.04617947 0.4660183
##                 FDR       TPR
## BL        0.04907004 0.4882848
## Scott     0.05196910 0.6397282
## Scott_emp 0.05264251 0.6295905
## Storey    0.04925485 0.4730709
## BH        0.04617947 0.4660183
##                 FDR       TPR
## BL        0.04918503 0.4417890
## Scott     0.05248772 0.6023499
## Scott_emp 0.05464651 0.5930179
## Storey    0.04907765 0.4346142
## BH        0.04666994 0.4296511
##                 FDR       TPR
## BL        0.04917346 0.4440387
## Scott     0.05218686 0.6061170
```

```
## Scott_emp 0.05430511 0.5965718
## Storey    0.04907765 0.4346142
## BH        0.04666994 0.4296511
##                  FDR       TPR
## BL        0.04774741 0.7129065
## Scott     0.04959447 0.7180685
## Scott_emp 0.02297804 0.6217568
## Storey    0.04752174 0.7118180
## BH        0.02844312 0.6531338
##                  FDR       TPR
## BL        0.04788445 0.7132579
## Scott     0.04961257 0.7183181
## Scott_emp 0.02298978 0.6220703
## Storey    0.04752174 0.7118180
## BH        0.02844312 0.6531338
## [1] ""
## [1] "alt_z_small"
##                  FDR        TPR
## BL        0.04486098 0.02275498
## Scott     0.04181064 0.02182907
## Scott_emp 0.03203863 0.01589514
## Storey    0.04421373 0.02270703
## BH        0.04282583 0.02177593
##                  FDR        TPR
## BL        0.04882152 0.01999052
## Scott     0.04091324 0.04702477
## Scott_emp 0.03728488 0.04155173
## Storey    0.04962363 0.01940610
## BH        0.04817092 0.01904258
##                  FDR        TPR
## BL        0.04868542 0.02023837
## Scott     0.04166507 0.05009867
## Scott_emp 0.03829508 0.04363148
## Storey    0.04962363 0.01940610
## BH        0.04817092 0.01904258
##                  FDR        TPR
## BL        0.04687381 0.01587448
## Scott     0.04201984 0.03616332
## Scott_emp 0.04856121 0.03356878
## Storey    0.04824859 0.01545078
## BH        0.04668075 0.01515060
##                  FDR        TPR
## BL        0.04338471 0.01610611
## Scott     0.04204644 0.03750369
## Scott_emp 0.04870215 0.03469725
```

```
## Storey    0.04824859 0.01545078
## BH        0.04668075 0.01515060
##                  FDR        TPR
## BL        0.035943462 0.07244075
## Scott     0.039218383 0.07809887
## Scott_emp 0.005162502 0.01789073
## Storey    0.035856909 0.07225321
## BH        0.028526820 0.06169256
##                  FDR        TPR
## BL        0.036039835 0.07261939
## Scott     0.039458323 0.07821824
## Scott_emp 0.004775125 0.01799370
## Storey    0.035856909 0.07225321
## BH        0.028526820 0.06169256
```

Session info:

```
devtools::session_info()
```

```
## Session info -------------------------------------------------
```

```
##  setting  value
##  version  R version 3.3.1 (2016-06-21)
##  system   x86_64, mingw32
##  ui       RTerm
##  language (EN)
##  collate  English_United States.1252
##  tz       America/New_York
##  date     2017-06-14
```

```
## Packages -----------------------------------------------------
```

```
##  package    * version date       source
##  assertthat   0.1     2013-12-06 CRAN (R 3.3.1)
##  colorspace   1.2-6   2015-03-11 CRAN (R 3.3.1)
##  devtools     1.12.0  2016-06-24 CRAN (R 3.3.3)
##  digest       0.6.9   2016-01-08 CRAN (R 3.3.1)
##  evaluate     0.10    2016-10-11 CRAN (R 3.3.1)
##  ggplot2      2.2.1   2016-12-30 CRAN (R 3.3.3)
##  gtable       0.2.0   2016-02-26 CRAN (R 3.3.1)
##  highr        0.6     2016-05-09 CRAN (R 3.3.1)
##  knitr      * 1.15.1  2016-11-22 CRAN (R 3.3.1)
##  lazyeval     0.2.0   2016-06-12 CRAN (R 3.3.1)
##  magrittr     1.5     2014-11-22 CRAN (R 3.3.1)
##  MASS       * 7.3-45  2016-04-21 CRAN (R 3.3.1)
##  memoise      1.0.0   2016-01-29 CRAN (R 3.3.1)
##  munsell      0.4.3   2016-02-13 CRAN (R 3.3.1)
```

```
##  plyr         1.8.4   2016-06-08 CRAN (R 3.3.1)
##  qvalue     * 2.4.2   2016-05-16 Bioconductor
##  Rcpp         0.12.10 2017-03-19 CRAN (R 3.3.3)
##  reshape2     1.4.1   2014-12-06 CRAN (R 3.3.1)
##  scales       0.4.1   2016-11-09 CRAN (R 3.3.3)
##  stringi      1.1.1   2016-05-27 CRAN (R 3.3.0)
##  stringr      1.0.0   2015-04-30 CRAN (R 3.3.1)
##  tibble       1.2     2016-08-26 CRAN (R 3.3.2)
##  withr        1.0.2   2016-06-20 CRAN (R 3.3.1)
##  xtable     * 1.8-2   2016-02-05 CRAN (R 3.3.1)
```