```
## 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        0.05000000 0.001951840
## Scott     0.89954500 1.000000000
## Scott_emp 0.84046627 0.958894729
## Storey    0.05250000 0.001906795
## BH        0.03916667 0.001445886
##                  FDR         TPR
## BL        0.04833333 0.001550654
## Scott     0.92632500 1.000000000
## Scott_emp 0.85904596 0.979518293
## Storey    0.04833333 0.001166801
## BH        0.04083333 0.001093272
##                  FDR         TPR
## BL        0.06500000 0.001552679
## Scott     0.92632500 1.000000000
## Scott_emp 0.86603128 0.983138218
## Storey    0.04833333 0.001166801
## BH        0.04083333 0.001093272
##                  FDR         TPR
## BL        0.05166667 0.002146207
```

```
## Scott     0.94856500 1.000000000
## Scott_emp 0.88903011 0.975174083
## Storey    0.05416667 0.001876110
## BH        0.05416667 0.001876110
##                 FDR         TPR
## BL        0.06166667 0.002519005
## Scott     0.94856500 1.000000000
## Scott_emp 0.89436435 0.975948408
## Storey    0.05416667 0.001876110
## BH        0.05416667 0.001876110
##                 FDR         TPR
## BL        0.06439110 0.121715055
## Scott     0.56734500 1.000000000
## Scott_emp         NA          NA
## Storey    0.05058619 0.054040383
## BH        0.03372985 0.003338835
##                 FDR         TPR
## BL        0.07921145 0.154448402
## Scott     0.56734500 1.000000000
## Scott_emp         NA          NA
## Storey    0.05058619 0.054040383
## BH        0.03372985 0.003338835
## [1] ""
## [1] "alt_chisq_large_3_3"
##                 FDR       TPR
## BL        0.05341275 0.3082754
## Scott     0.89954500 1.0000000
## Scott_emp 0.83455914 0.9534077
## Storey    0.05395371 0.3058190
## BH        0.04834402 0.2958929
##                 FDR       TPR
## BL        0.05273820 0.2840034
## Scott     0.92632500 1.0000000
## Scott_emp 0.89601798 0.9848436
## Storey    0.05331255 0.2750067
## BH        0.04994776 0.2671000
##                 FDR       TPR
## BL        0.05371318 0.2917129
## Scott     0.92632500 1.0000000
## Scott_emp 0.89921827 0.9862607
## Storey    0.05331255 0.2750067
## BH        0.04994776 0.2671000
##                 FDR       TPR
## BL        0.05853321 0.2482776
## Scott     0.94856500 1.0000000
```

```
## Scott_emp 0.92393598 0.9833760
## Storey    0.05435515 0.2402515
## BH        0.05345426 0.2342449
##                 FDR       TPR
## BL        0.05922928 0.2521774
## Scott     0.94856500 1.0000000
## Scott_emp 0.92992403 0.9872291
## Storey    0.05435515 0.2402515
## BH        0.05345426 0.2342449
##                 FDR       TPR
## BL        0.05118123 0.5230945
## Scott     0.56734500 1.0000000
## Scott_emp 0.55922911 0.9876498
## Storey    0.04740946 0.5168515
## BH        0.02763305 0.4450779
##                 FDR       TPR
## BL        0.05461861 0.5269882
## Scott     0.56734500 1.0000000
## Scott_emp 0.55938095 0.9879333
## Storey    0.04740946 0.5168515
## BH        0.02763305 0.4450779
## [1] ""
## [1] "alt_chisq_large"
##                 FDR       TPR
## BL        0.04999166 0.5116271
## Scott     0.89954500 1.0000000
## Scott_emp 0.85499169 0.9866320
## Storey    0.04807658 0.5093932
## BH        0.04360780 0.4965026
##                 FDR       TPR
## BL        0.04842959 0.4826783
## Scott     0.92632500 1.0000000
## Scott_emp 0.89350245 0.9956366
## Storey    0.04794688 0.4709166
## BH        0.04416100 0.4630599
##                 FDR       TPR
## BL        0.04980752 0.4891368
## Scott     0.92632500 1.0000000
## Scott_emp 0.89981779 0.9958737
## Storey    0.04794688 0.4709166
## BH        0.04416100 0.4630599
##                 FDR       TPR
## BL        0.04982625 0.4429267
## Scott     0.94856500 1.0000000
## Scott_emp 0.93759610 0.9968405
```

```
## Storey    0.04945105 0.4308903
## BH        0.04750937 0.4247327
##                 FDR       TPR
## BL        0.05343757 0.4477006
## Scott     0.94856500 1.0000000
## Scott_emp 0.93871022 0.9970987
## Storey    0.04945105 0.4308903
## BH        0.04750937 0.4247327
##                 FDR       TPR
## BL        0.05117916 0.7162476
## Scott     0.56734500 1.0000000
## Scott_emp         NA        NA
## Storey    0.04720856 0.7109875
## BH        0.02806396 0.6514715
##                 FDR       TPR
## BL        0.05304052 0.7186921
## Scott     0.56734500 1.0000000
## Scott_emp         NA        NA
## Storey    0.04720856 0.7109875
## BH        0.02806396 0.6514715
## [1] ""
## [1] "alt_chisq_small_3_3"
##                 FDR         TPR
## BL        0.07255556 0.008662193
## Scott     0.89954500 1.000000000
## Scott_emp 0.87999760 0.828279461
## Storey    0.06255556 0.008607753
## BH        0.05888889 0.008374021
##                 FDR         TPR
## BL        0.05023611 0.008586545
## Scott     0.92632500 1.000000000
## Scott_emp 0.89619368 0.846103979
## Storey    0.05173611 0.008006679
## BH        0.04717262 0.007586995
##                 FDR         TPR
## BL        0.05000000 0.008293118
## Scott     0.92632500 1.000000000
## Scott_emp 0.89988621 0.854578203
## Storey    0.05173611 0.008006679
## BH        0.04717262 0.007586995
##                 FDR         TPR
## BL        0.06483333 0.006838517
## Scott     0.94856500 1.000000000
## Scott_emp 0.92600045 0.866727088
## Storey    0.06400000 0.006218365
```

```
## BH        0.05700000 0.006132158
##                  FDR         TPR
## BL        0.06783333 0.007019064
## Scott     0.94856500 1.000000000
## Scott_emp 0.92979346 0.871091193
## Storey    0.06400000 0.006218365
## BH        0.05700000 0.006132158
##                  FDR        TPR
## BL        0.04950210 0.01796875
## Scott     0.56734500 1.00000000
## Scott_emp 0.50328614 0.76300489
## Storey    0.04616745 0.01708028
## BH        0.04014459 0.01370930
##                  FDR        TPR
## BL        0.05071834 0.01861373
## Scott     0.56734500 1.00000000
## Scott_emp 0.50865336 0.76917650
## Storey    0.04616745 0.01708028
## BH        0.04014459 0.01370930
## [1] ""
## [1] "alt_chisq_small"
##                  FDR        TPR
## BL        0.04004960 0.03061533
## Scott     0.89954500 1.00000000
## Scott_emp 0.86026833 0.82968421
## Storey    0.04045833 0.03034135
## BH        0.03320833 0.02941577
##                  FDR        TPR
## BL        0.05630159 0.02278873
## Scott     0.92632500 1.00000000
## Scott_emp 0.87909221 0.85122456
## Storey    0.04892063 0.02190392
## BH        0.04917063 0.02159655
##                  FDR        TPR
## BL        0.05931349 0.02393050
## Scott     0.92632500 1.00000000
## Scott_emp 0.87939675 0.85768769
## Storey    0.04892063 0.02190392
## BH        0.04917063 0.02159655
##                  FDR        TPR
## BL        0.05141667 0.02219645
## Scott     0.94856500 1.00000000
## Scott_emp 0.91166974 0.86748302
## Storey    0.04350000 0.02133745
## BH        0.04241667 0.02065111
```

```
##                  FDR        TPR
## BL        0.05492857 0.02277200
## Scott     0.94856500 1.00000000
## Scott_emp 0.91179832 0.87218359
## Storey    0.04350000 0.02133745
## BH        0.04241667 0.02065111
##                  FDR        TPR
## BL        0.03691339 0.07375251
## Scott     0.56734500 1.00000000
## Scott_emp 0.49794845 0.81903682
## Storey    0.03407316 0.07139827
## BH        0.02713549 0.06080670
##                  FDR        TPR
## BL        0.03810798 0.07585683
## Scott     0.56734500 1.00000000
## Scott_emp 0.50116659 0.82100183
## Storey    0.03407316 0.07139827
## BH        0.02713549 0.06080670
## [1] ""
## [1] "alt_t_large"
##                  FDR       TPR
## BL        0.05694322 0.1568195
## Scott     0.21318158 0.5541295
## Scott_emp 0.23355335 0.5690983
## Storey    0.05502398 0.1521425
## BH        0.04843184 0.1360035
##                  FDR       TPR
## BL        0.04758411 0.1298639
## Scott     0.20666280 0.6446058
## Scott_emp 0.23836783 0.6547283
## Storey    0.05003389 0.1159324
## BH        0.04376258 0.1056487
##                  FDR       TPR
## BL        0.04684918 0.1381427
## Scott     0.21059922 0.6481542
## Scott_emp 0.24491670 0.6564942
## Storey    0.05003389 0.1159324
## BH        0.04376258 0.1056487
##                  FDR        TPR
## BL        0.06157486 0.09408780
## Scott     0.26809184 0.54633052
## Scott_emp 0.30985967 0.54678563
## Storey    0.05885497 0.08178553
## BH        0.05406091 0.07572923
##                  FDR        TPR
```

```
## BL        0.06793054 0.10008271
## Scott     0.27303889 0.55172785
## Scott_emp 0.31285257 0.55322423
## Storey    0.05885497 0.08178553
## BH        0.05406091 0.07572923
##                 FDR       TPR
## BL        0.05037590 0.5249882
## Scott     0.09297654 0.7286749
## Scott_emp 0.02794174 0.4441566
## Storey    0.04730285 0.5195930
## BH        0.02865974 0.4033814
##                 FDR       TPR
## BL        0.05370492 0.5302949
## Scott     0.09341767 0.7295840
## Scott_emp 0.02791136 0.4459875
## Storey    0.04730285 0.5195930
## BH        0.02865974 0.4033814
## [1] ""
## [1] "alt_t_small"
##                 FDR         TPR
## BL        0.07666667 0.001796208
## Scott     0.46003063 0.084206265
## Scott_emp 0.44188776 0.092857085
## Storey    0.07666667 0.001587584
## BH        0.07666667 0.001442703
##                FDR         TPR
## BL        0.0695000 0.002768259
## Scott     0.4350775 0.109824245
## Scott_emp 0.4586776 0.109720375
## Storey    0.0645000 0.002569000
## BH        0.0645000 0.002127544
##                 FDR         TPR
## BL        0.06866667 0.003141470
## Scott     0.43719049 0.113951357
## Scott_emp 0.45507707 0.114398647
## Storey    0.06450000 0.002569000
## BH        0.06450000 0.002127544
##                FDR         TPR
## BL        0.0800000 0.002108632
## Scott     0.5973022 0.077811564
## Scott_emp 0.5829466 0.087765854
## Storey    0.0800000 0.001976403
## BH        0.0800000 0.001833283
##                FDR         TPR
## BL        0.0875000 0.002392134
```

```
## Scott     0.5985801 0.080186866
## Scott_emp 0.5906203 0.090968579
## Storey    0.0800000 0.001976403
## BH        0.0800000 0.001833283
##                 FDR         TPR
## BL        0.03968398 0.007356401
## Scott     0.15038108 0.139461815
## Scott_emp 0.10558269 0.080552475
## Storey    0.03345734 0.006592882
## BH        0.03394053 0.004757086
##                 FDR         TPR
## BL        0.04676884 0.007917570
## Scott     0.15049087 0.140696001
## Scott_emp 0.10630426 0.081639298
## Storey    0.03345734 0.006592882
## BH        0.03394053 0.004757086
## [1] ""
## [1] "alt_z_large"
##                 FDR       TPR
## BL        0.04987169 0.5099702
## Scott     0.05244247 0.5094888
## Scott_emp 0.06590108 0.4974688
## Storey    0.04876093 0.5081392
## BH        0.04406380 0.4969158
##                 FDR       TPR
## BL        0.05394619 0.4852853
## Scott     0.05662850 0.6350251
## Scott_emp 0.08085186 0.6134574
## Storey    0.05266540 0.4764023
## BH        0.04925492 0.4695397
##                 FDR       TPR
## BL        0.05598406 0.4929255
## Scott     0.05947830 0.6354941
## Scott_emp 0.08295914 0.6149134
## Storey    0.05266540 0.4764023
## BH        0.04925492 0.4695397
##                 FDR       TPR
## BL        0.05793651 0.4509699
## Scott     0.05913016 0.6032959
## Scott_emp 0.09943899 0.5786749
## Storey    0.05419544 0.4400385
## BH        0.05084388 0.4337851
##                 FDR       TPR
## BL        0.05922129 0.4560561
## Scott     0.05995634 0.6085792
```

```
## Scott_emp 0.10140147 0.5817328
## Storey    0.05419544 0.4400385
## BH        0.05084388 0.4337851
##                  FDR       TPR
## BL        0.04975254 0.7164064
## Scott     0.04919670 0.7184060
## Scott_emp 0.02377998 0.6062543
## Storey    0.04688963 0.7117715
## BH        0.02780684 0.6542942
##                  FDR       TPR
## BL        0.05236504 0.7196263
## Scott     0.05005387 0.7189591
## Scott_emp 0.02437117 0.6071701
## Storey    0.04688963 0.7117715
## BH        0.02780684 0.6542942
## [1] ""
## [1] "alt_z_small"
##                  FDR        TPR
## BL        0.05589881 0.03188285
## Scott     0.05472817 0.02781127
## Scott_emp 0.11215185 0.04569293
## Storey    0.05257738 0.03140774
## BH        0.05023214 0.03007326
##                  FDR        TPR
## BL        0.05159939 0.02579223
## Scott     0.05107520 0.05045846
## Scott_emp 0.12884809 0.08113511
## Storey    0.05039105 0.02505514
## BH        0.04993651 0.02460052
##                  FDR        TPR
## BL        0.05366685 0.02658068
## Scott     0.05124190 0.05472064
## Scott_emp 0.14262377 0.08537738
## Storey    0.05039105 0.02505514
## BH        0.04993651 0.02460052
##                  FDR        TPR
## BL        0.08272024 0.02489327
## Scott     0.03682341 0.04283833
## Scott_emp 0.14819768 0.06681714
## Storey    0.07434524 0.02444456
## BH        0.06934524 0.02414950
##                  FDR        TPR
## BL        0.07876190 0.02544827
## Scott     0.05355177 0.04614136
## Scott_emp 0.15242393 0.06958799
```

```
## Storey    0.07434524 0.02444456
## BH        0.06934524 0.02414950
##                  FDR        TPR
## BL        0.04015670 0.07674906
## Scott     0.04033579 0.08216187
## Scott_emp 0.02783462 0.04714461
## Storey    0.03735624 0.07474051
## BH        0.03112061 0.06375623
##                  FDR        TPR
## BL        0.04066081 0.07849420
## Scott     0.04331698 0.08378698
## Scott_emp 0.03722637 0.05262702
## Storey    0.03735624 0.07474051
## BH        0.03112061 0.06375623
```

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)
```