```
## Load libraries
library(splines)
library(MASS)
library(FDRreg)

## Loading required package:  fda
## Warning:  package 'fda' was built under R version 3.3.3
## Loading required package:  Matrix
##
## Attaching package:  'fda'
## The following object is masked from 'package:graphics':
##
##    matplot
## Loading required package:  BayesLogit
## Warning:  package 'BayesLogit' was built under R version 3.3.2
## Loading required package:  mvtnorm
## Warning:  package 'mvtnorm' was built under R version 3.3.2

library(curl)

library(doParallel) ##to make cluster (on Windows)

## Loading required package:  foreach
## Loading required package:  iterators
## Loading required package:  parallel

library(foreach) ##to use foreach function that does the parallel processing
library(doRNG) ##for reproducible seeds when doing parallel processing

## Loading required package:  rngtools
## Warning:  package 'rngtools' was built under R version 3.3.2
## Loading required package:  pkgmaker
## Warning:  package 'pkgmaker' was built under R version 3.3.2
## Loading required package:  registry
## Warning:  package 'registry' was built under R version 3.3.2
##
## Attaching package:  'pkgmaker'
## The following object is masked from 'package:base':
##
##    isNamespaceLoaded

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

Define nulltype for Scott method:

```
nulltype <- "theoretical"
```

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")
```

1 Probability of being a false positive is flat

Perform estimation and save estimates:

```
for(alt in alts)
{
  load(paste(alt,"simResults_1.RData",sep="/"))
  ntest <- ncol(zValuesSims)

  pi0hatScottMat <- estimate_Scott_sims(zValuesSims, tme, nulltype)

  pi0hatScottMean <- colMeans(pi0hatScottMat[,1:ntest])
  pi0hatScottVar <- apply(pi0hatScottMat[,1:ntest],2,var)

  pi0hat.ScottMat <- pi0hatScottMat[,1:ntest]
  FDR.ScottMat <- pi0hatScottMat[,(ntest+1):(2*ntest)]

  ##save full results
  save(file=paste(alt,"simResults_pi0x_Scott_1_full.RData",sep="/"),
       list=c("pi0hat.ScottMat", "FDR.ScottMat"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_Scott_1.RData",sep="/"),
       list=c("tme", "pi0",
            "pi0hatScottMean","pi0hatScottVar"))
}

## Warning in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  NAs
introduced by coercion
## Error in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  (list)
object cannot be coerced to type 'double'
```

2 Probability of being a false positive is smooth in one variable

Perform estimation and save estimates:

```
for(alt in alts)
{
  load(paste(alt,"simResults_2.RData",sep="/"))
  ntest <- ncol(zValuesSims)

  splineMat <- ns(tme,df=3)

  ##--------linear fit-------##
  pi0hatScottMatFitLin <- estimate_Scott_sims(zValuesSims, tme, nulltype)

  pi0hatLin.ScottMean <- colMeans(pi0hatScottMatFitLin[,1:ntest])
  pi0hatLin.ScottVar <- apply(pi0hatScottMatFitLin[,1:ntest],2,var)

  pi0hat.Lin.ScottMat <- pi0hatScottMatFitLin[,1:ntest]
  FDR.Lin.ScottMat <- pi0hatScottMatFitLin[,(ntest+1):(2*ntest)]

  ##---------spline fit---------#
  pi0hatScottMatFitSpl <- estimate_Scott_sims(zValuesSims, splineMat, nulltype)

  pi0hatSpl.ScottMean <- colMeans(pi0hatScottMatFitSpl[,1:ntest])
  pi0hatSpl.ScottVar <- apply(pi0hatScottMatFitSpl[,1:ntest],2,var)

  pi0hat.Spl.ScottMat <- pi0hatScottMatFitSpl[,1:ntest]
  FDR.Spl.ScottMat <- pi0hatScottMatFitSpl[,(ntest+1):(2*ntest)]

  ##save full results
  save(file=paste(alt,"simResults_pi0x_Scott_2_full.RData",sep="/"),
       list=c("pi0hat.Lin.ScottMat", "FDR.Lin.ScottMat",
              "pi0hat.Spl.ScottMat", "FDR.Spl.ScottMat"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_Scott_2.RData",sep="/"),
       list=c("tme", "pi0",
              "pi0hatLin.ScottMean", "pi0hatLin.ScottVar",
              "pi0hatSpl.ScottMean", "pi0hatSpl.ScottVar"))
}
## Warning in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  NAs
introduced by coercion
## Warning in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  NAs
introduced by coercion
```

```
## Warning in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  NAs
introduced by coercion
## Warning in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  NAs
introduced by coercion
## Warning in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  NAs
introduced by coercion
## Error in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  (list)
object cannot be coerced to type ’double’
```

3 Probability of being a false positive is smooth in one variable within levels of second variable

Perform estimation and save estimates:

```
for(alt in alts)
{
  load(paste(alt,"simResults_3.RData",sep="/"))
  ntest <- ncol(zValuesSims)

  m <- model.matrix(~as.character(tme2))[,-1]

  linearMat <- cbind(tme1, m)
  splineMat <- cbind(ns(tme1,df=3), m)

  ##--------linear fit-------##
  pi0hatScottMatFitLin <- estimate_Scott_sims(zValuesSims, linearMat, nulltype)

  pi0hatLin.ScottMean <- colMeans(pi0hatScottMatFitLin[,1:ntest])
  pi0hatLin.ScottVar <- apply(pi0hatScottMatFitLin[,1:ntest],2,var)

  pi0hat.Lin.ScottMat <- pi0hatScottMatFitLin[,1:ntest]
  FDR.Lin.ScottMat <- pi0hatScottMatFitLin[,(ntest+1):(2*ntest)]

  ##---------spline fit---------#
  pi0hatScottMatFitSpl <- estimate_Scott_sims(zValuesSims, splineMat, nulltype)

  pi0hatSpl.ScottMean <- colMeans(pi0hatScottMatFitSpl[,1:ntest])
  pi0hatSpl.ScottVar <- apply(pi0hatScottMatFitSpl[,1:ntest],2,var)

  pi0hat.Spl.ScottMat <- pi0hatScottMatFitSpl[,1:ntest]
  FDR.Spl.ScottMat <- pi0hatScottMatFitSpl[,(ntest+1):(2*ntest)]

  ##save full results
  save(file=paste(alt,"simResults_pi0x_Scott_3_full.RData",sep="/"),
       list=c("pi0hat.Lin.ScottMat", "FDR.Lin.ScottMat",
              "pi0hat.Spl.ScottMat", "FDR.Spl.ScottMat"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_Scott_3.RData",sep="/"),
       list=c("tme1", "tme2", "pi0",
              "pi0hatLin.ScottMean", "pi0hatLin.ScottVar",
              "pi0hatSpl.ScottMean", "pi0hatSpl.ScottVar"))
}
```

4 Probability of being a false positive is smooth in one variable within levels of second variable - lower priors

Perform estimation and save estimates:

```
for(alt in alts)
{
  load(paste(alt,"simResults_4.RData",sep="/"))
  ntest <- ncol(zValuesSims)

  m <- model.matrix(~as.character(tme2))[,-1]

  linearMat <- cbind(tme1, m)
  splineMat <- cbind(ns(tme1,df=3), m)

  ##--------linear fit-------##
  pi0hatScottMatFitLin <- estimate_Scott_sims(zValuesSims, linearMat, nulltype)

  pi0hatLin.ScottMean <- colMeans(pi0hatScottMatFitLin[,1:ntest])
  pi0hatLin.ScottVar <- apply(pi0hatScottMatFitLin[,1:ntest],2,var)

  pi0hat.Lin.ScottMat <- pi0hatScottMatFitLin[,1:ntest]
  FDR.Lin.ScottMat <- pi0hatScottMatFitLin[,(ntest+1):(2*ntest)]

  ##---------spline fit---------#
  pi0hatScottMatFitSpl <- estimate_Scott_sims(zValuesSims, splineMat, nulltype)

  pi0hatSpl.ScottMean <- colMeans(pi0hatScottMatFitSpl[,1:ntest])
  pi0hatSpl.ScottVar <- apply(pi0hatScottMatFitSpl[,1:ntest],2,var)

  pi0hat.Spl.ScottMat <- pi0hatScottMatFitSpl[,1:ntest]
  FDR.Spl.ScottMat <- pi0hatScottMatFitSpl[,(ntest+1):(2*ntest)]

  ##save full results
  save(file=paste(alt,"simResults_pi0x_Scott_4_full.RData",sep="/"),
       list=c("pi0hat.Lin.ScottMat", "FDR.Lin.ScottMat",
              "pi0hat.Spl.ScottMat", "FDR.Spl.ScottMat"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_Scott_4.RData",sep="/"),
       list=c("tme1", "tme2", "pi0",
              "pi0hatLin.ScottMean", "pi0hatLin.ScottVar",
              "pi0hatSpl.ScottMean", "pi0hatSpl.ScottVar"))
}

## Warning in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  NAs
introduced by coercion
## Error in apply(as.matrix(pi0hatScottMat), 2, as.numeric):  (list)
object cannot be coerced to type 'double'
```

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     2017-06-13

## Packages --------------------------------------------------

##  package    * version date
##  assertthat   0.1     2013-12-06
##  BayesLogit * 0.6     2016-10-20
##  codetools    0.2-14  2015-07-15
##  colorspace   1.2-6   2015-03-11
##  curl       * 0.9.7   2016-04-10
##  DBI          0.4-1   2016-05-08
##  devtools     1.12.0  2016-06-24
##  digest       0.6.9   2016-01-08
##  doParallel * 1.0.10  2015-10-14
##  doRNG      * 1.6     2014-03-07
##  dplyr         0.4.3   2015-09-01
##  evaluate      0.10    2016-10-11
##  fda         * 2.4.4   2014-12-16
##  FDRreg      * 0.2-1   2017-05-03
##  foreach     * 1.4.3   2015-10-13
##  ggdendro      0.1-20  2016-04-27
##  ggplot2       2.2.1   2016-12-30
##  gridExtra     2.2.1   2016-02-29
##  gtable        0.2.0   2016-02-26
##  highr         0.6     2016-05-09
##  iterators   * 1.0.8   2015-10-13
##  knitr       * 1.15.1  2016-11-22
##  lattice       0.20-33 2015-07-14
##  lazyeval      0.2.0   2016-06-12
##  magrittr      1.5     2014-11-22
##  MASS        * 7.3-45  2016-04-21
##  Matrix      * 1.2-6   2016-05-02
##  memoise       1.0.0   2016-01-29
##  mosaic        0.14.4  2016-07-29
##  mosaicData    0.14.0  2016-06-17
##  munsell       0.4.3   2016-02-13
##  mvtnorm     * 1.0-6   2017-03-02
##  pkgmaker    * 0.22    2014-05-14
##  plyr          1.8.4   2016-06-08
##  R6            2.1.2   2016-01-26
##  Rcpp          0.12.10 2017-03-19
##  registry    * 0.3     2015-07-08
##  rngtools    * 1.2.4   2014-03-06
##  scales        0.4.1   2016-11-09
##  stringi       1.1.1   2016-05-27
##  stringr       1.0.0   2015-04-30
##  tibble        1.2     2016-08-26
##  tidyr         0.5.1   2016-06-14
##  withr         1.0.2   2016-06-20
##  xtable        1.8-2   2016-02-05
##  source
##  CRAN (R 3.3.1)
##  CRAN (R 3.3.2)
##  CRAN (R 3.3.1)
##  CRAN (R 3.3.1)
##  CRAN (R 3.3.1)
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##  CRAN (R 3.3.1)
##  CRAN (R 3.3.1)
##  CRAN (R 3.3.3)
##  Github (jgscott/FDRreg@8025d1a)
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##  CRAN (R 3.3.3)
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##  CRAN (R 3.3.1)
##  CRAN (R 3.3.0)
##  CRAN (R 3.3.1)
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##  CRAN (R 3.3.1)
##  CRAN (R 3.3.2)
##  CRAN (R 3.3.1)
##  CRAN (R 3.3.1)
##  CRAN (R 3.3.1)
```