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

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
## Loading required package:  pkgmaker
## Loading required package:  registry
##
## Attaching package:  'pkgmaker'
## The following object is masked from 'package:base':
##
##    isNamespaceLoaded

##don't need doRNG here, but easier to keep it in

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

Function to pull out means and variances across simulations:

```
pullMeansVars <- function(pi0EstSim)
{
  ##pull out estimates at lambda=0.8, lambda=0.9, and final estimate
  pi0hat0.8 <- sapply(pi0EstSim, function(x){x[[1]]})
  pi0hat0.9 <- sapply(pi0EstSim, function(x){x[[2]]})
  pi0hatFinal <- sapply(pi0EstSim, function(x){x[[3]]})

  ##get means across simulations
  pi0hatMean0.8 <- rowMeans(pi0hat0.8)
  pi0hatMean0.9 <- rowMeans(pi0hat0.9)
  pi0hatMeanFinal <- rowMeans(pi0hatFinal)

  ##also get variances across simulations
  pi0hatVar0.8 <- apply(pi0hat0.8,1,var)
  pi0hatVar0.9 <- apply(pi0hat0.9,1,var)
  pi0hatVarFinal <- apply(pi0hatFinal,1,var)
```

```
  return(list(pi0hatMean0.8=pi0hatMean0.8,
              pi0hatMean0.9=pi0hatMean0.9,
              pi0hatMeanFinal=pi0hatMeanFinal,
              pi0hatVar0.8=pi0hatVar0.8,
              pi0hatVar0.9=pi0hatVar0.9,
              pi0hatVarFinal=pi0hatVarFinal))
}
```

Simulations are performed for a variety of alternative distributions:

```
altsGrid <- as.matrix(expand.grid(dist=c("z","t"),nrBlocks=c(10,20),corr=c(0.2,0.5,0.9)))
alts <- apply(altsGrid, 1, function(x){paste("alt",x[1],"large",x[2],x[3],sep="_")})
alts
```

```
##  [1] "alt_z_large_10_0.2" "alt_t_large_10_0.2"
##  [3] "alt_z_large_20_0.2" "alt_t_large_20_0.2"
##  [5] "alt_z_large_10_0.5" "alt_t_large_10_0.5"
##  [7] "alt_z_large_20_0.5" "alt_t_large_20_0.5"
##  [9] "alt_z_large_10_0.9" "alt_t_large_10_0.9"
## [11] "alt_z_large_20_0.9" "alt_t_large_20_0.9"
```

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="/"))

  pi0EstSim <- estimate_pi0x_sims(pValuesSims, tme)

  ##pull out means and variances of estimates at lambda=0.8, lambda=0.9, and final estimate
  pi0MeansVars <- pullMeansVars(pi0EstSim)

  ##save full results
  save(file=paste(alt,"simResults_pi0x_thresh_1_full.RData",sep="/"),
       list=c("pi0EstSim"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_thresh_1.RData",sep="/"),
       list=c("tme", "pi0", "pi0MeansVars"))
}
```

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="/"))
  splineMat <- ns(tme,df=3)

  ##--------linear fit-------##
  pi0EstSim.lin <- estimate_pi0x_sims(pValuesSims, tme)

  ##pull out means and variances of estimates at lambda=0.8, lambda=0.9, and final estimate
  pi0Lin.MeansVars <- pullMeansVars(pi0EstSim.lin)

  ##---------spline fit---------#
  pi0EstSim.spl <- estimate_pi0x_sims(pValuesSims, splineMat)

  ##pull out means and variances of estimates at lambda=0.8, lambda=0.9, and final estimate
  pi0Spl.MeansVars <- pullMeansVars(pi0EstSim.spl)

  ##save full results
  save(file=paste(alt,"simResults_pi0x_thresh_2_full.RData",sep="/"),
       list=c("pi0EstSim.lin","pi0EstSim.spl"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_thresh_2.RData",sep="/"),
       list=c("tme", "pi0", "pi0Lin.MeansVars", "pi0Spl.MeansVars"))
}
```

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="/"))

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

  linearMat <- cbind(tme1, m)
```

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

  ##--------linear fit-------##
  pi0EstSim.lin <- estimate_pi0x_sims(pValuesSims, linearMat)

  ##pull out means and variances of estimates at lambda=0.8, lambda=0.9, and final estimate
  pi0Lin.MeansVars <- pullMeansVars(pi0EstSim.lin)

  ##---------spline fit---------#
  pi0EstSim.spl <- estimate_pi0x_sims(pValuesSims, splineMat)

  ##pull out means and variances of estimates at lambda=0.8, lambda=0.9, and final estimate
  pi0Spl.MeansVars <- pullMeansVars(pi0EstSim.spl)

  ##save full results
  save(file=paste(alt,"simResults_pi0x_thresh_3_full.RData",sep="/"),
       list=c("pi0EstSim.lin","pi0EstSim.spl"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_thresh_3.RData",sep="/"),
       list=c("tme1", "tme2", "pi0", "pi0Lin.MeansVars", "pi0Spl.MeansVars"))
}
```

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="/"))

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

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

  ##--------linear fit-------##
  pi0EstSim.lin <- estimate_pi0x_sims(pValuesSims, linearMat)

  ##pull out means and variances of estimates at lambda=0.8, lambda=0.9, and final estimate
  pi0Lin.MeansVars <- pullMeansVars(pi0EstSim.lin)
```

```
  ##---------spline fit---------#
  pi0EstSim.spl <- estimate_pi0x_sims(pValuesSims, splineMat)

  ##pull out means and variances of estimates at lambda=0.8, lambda=0.9, and final estimate
  pi0Spl.MeansVars <- pullMeansVars(pi0EstSim.spl)

  ##save full results
  save(file=paste(alt,"simResults_pi0x_thresh_4_full.RData",sep="/"),
       list=c("pi0EstSim.lin","pi0EstSim.spl"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_thresh_4.RData",sep="/"),
       list=c("tme1", "tme2", "pi0", "pi0Lin.MeansVars", "pi0Spl.MeansVars"))
}
```

Session info:

```
devtools::session_info()

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

##  setting  value
##  version  R version 3.4.0 (2017-04-21)
##  system   x86_64, mingw32
##  ui       RTerm
##  language (EN)
##  collate  English_United States.1252
##  tz       America/New_York
##  date     2017-06-01

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

##  package    * version date       source
##  assertthat   0.2.0   2017-04-11 CRAN (R 3.4.0)
##  codetools    0.2-15  2016-10-05 CRAN (R 3.4.0)
##  colorspace   1.3-2   2016-12-14 CRAN (R 3.4.0)
##  DBI          0.6-1   2017-04-01 CRAN (R 3.4.0)
##  devtools     1.12.0  2016-12-05 CRAN (R 3.4.0)
##  digest       0.6.12  2017-01-27 CRAN (R 3.4.0)
##  doParallel * 1.0.10  2015-10-14 CRAN (R 3.4.0)
##  doRNG      * 1.6.6   2017-04-10 CRAN (R 3.4.0)
##  dplyr        0.5.0   2016-06-24 CRAN (R 3.4.0)
##  evaluate     0.10    2016-10-11 CRAN (R 3.4.0)
##  foreach    * 1.4.3   2015-10-13 CRAN (R 3.4.0)
##  ggplot2      2.2.1   2016-12-30 CRAN (R 3.4.0)
##  gtable       0.2.0   2016-02-26 CRAN (R 3.4.0)
```

```
##  highr        0.6     2016-05-09 CRAN (R 3.4.0)
##  iterators  * 1.0.8   2015-10-13 CRAN (R 3.4.0)
##  knitr      * 1.15.1  2016-11-22 CRAN (R 3.4.0)
##  lazyeval     0.2.0   2016-06-12 CRAN (R 3.4.0)
##  magrittr     1.5     2014-11-22 CRAN (R 3.4.0)
##  MASS       * 7.3-47  2017-02-26 CRAN (R 3.4.0)
##  memoise      1.1.0   2017-04-21 CRAN (R 3.4.0)
##  munsell      0.4.3   2016-02-13 CRAN (R 3.4.0)
##  pkgmaker   * 0.22    2014-05-14 CRAN (R 3.4.0)
##  plyr         1.8.4   2016-06-08 CRAN (R 3.4.0)
##  R6           2.2.0   2016-10-05 CRAN (R 3.4.0)
##  Rcpp         0.12.10 2017-03-19 CRAN (R 3.4.0)
##  registry   * 0.3     2015-07-08 CRAN (R 3.4.0)
##  reshape2     1.4.2   2016-10-22 CRAN (R 3.4.0)
##  rngtools   * 1.2.4   2014-03-06 CRAN (R 3.4.0)
##  scales       0.4.1   2016-11-09 CRAN (R 3.4.0)
##  stringi      1.1.5   2017-04-07 CRAN (R 3.4.0)
##  stringr      1.2.0   2017-02-18 CRAN (R 3.4.0)
##  swfdr      * 1.0.0   2017-04-25 Bioconductor
##  tibble       1.3.0   2017-04-01 CRAN (R 3.4.0)
##  withr        1.0.2   2016-06-20 CRAN (R 3.4.0)
##  xtable       1.8-2   2016-02-05 CRAN (R 3.4.0)
```