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

## Error in library(swfdr):  there is no package called '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
## 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

##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:

```
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 $x^{5/4}$

Perform estimation and save estimates (use splines!):

```
for(alt in alts)
{
  load(paste(alt,"simResults_9.RData",sep="/"))

  splineMat <- ns(tme,df=3)

  pi0EstSim <- estimate_pi0x_sims(pValuesSims, splineMat)

  ##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_9_full.RData",sep="/"),
       list=c("pi0EstSim"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_thresh_9.RData",sep="/"),
       list=c("tme", "pi0", "pi0MeansVars"))
}
```

2 Probability of being a false positive is $x^{3/2}$

Perform estimation and save estimates (use splines!):

```
for(alt in alts)
{
  load(paste(alt,"simResults_10.RData",sep="/"))

  splineMat <- ns(tme,df=3)

  pi0EstSim <- estimate_pi0x_sims(pValuesSims, splineMat)

  ##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_10_full.RData",sep="/"),
       list=c("pi0EstSim"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_thresh_10.RData",sep="/"),
       list=c("tme", "pi0", "pi0MeansVars"))
}
```

3 Probability of being a false positive is quadratic

Perform estimation and save estimates (use splines!):

```
for(alt in alts)
{
  load(paste(alt,"simResults_11.RData",sep="/"))

  splineMat <- ns(tme,df=3)

  pi0EstSim <- estimate_pi0x_sims(pValuesSims, splineMat)

  ##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_11_full.RData",sep="/"),
       list=c("pi0EstSim"))

  ##save summary results
```

```
  save(file=paste(alt,"simResults_pi0x_thresh_11.RData",sep="/"),
       list=c("tme", "pi0", "pi0MeansVars"))
}
```

4 Probability of being a false positive is cubic

Perform estimation and save estimates (use splines!):

```
for(alt in alts)
{
  load(paste(alt,"simResults_12.RData",sep="/"))

  splineMat <- ns(tme,df=3)

  pi0EstSim <- estimate_pi0x_sims(pValuesSims, splineMat)

  ##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_12_full.RData",sep="/"),
       list=c("pi0EstSim"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_thresh_12.RData",sep="/"),
       list=c("tme", "pi0", "pi0MeansVars"))
}
```

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     2018-08-29

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

```
##  package    * version date       source
##  codetools    0.2-14  2015-07-15 CRAN (R 3.3.1)
##  devtools     1.12.0  2016-06-24 CRAN (R 3.3.3)
##  digest       0.6.12  2017-01-27 CRAN (R 3.3.3)
##  doParallel * 1.0.10  2015-10-14 CRAN (R 3.3.1)
##  doRNG      * 1.6     2014-03-07 CRAN (R 3.3.1)
##  evaluate     0.10    2016-10-11 CRAN (R 3.3.1)
##  foreach    * 1.4.3   2015-10-13 CRAN (R 3.3.1)
##  highr        0.6     2016-05-09 CRAN (R 3.3.1)
##  iterators  * 1.0.8   2015-10-13 CRAN (R 3.3.0)
##  knitr      * 1.17    2017-08-10 CRAN (R 3.3.3)
##  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)
##  pkgmaker   * 0.22    2014-05-14 CRAN (R 3.3.2)
##  registry   * 0.3     2015-07-08 CRAN (R 3.3.2)
##  rngtools   * 1.2.4   2014-03-06 CRAN (R 3.3.2)
##  stringi      1.1.1   2016-05-27 CRAN (R 3.3.0)
##  stringr      1.2.0   2017-02-18 CRAN (R 3.3.3)
##  withr        1.0.2   2016-06-20 CRAN (R 3.3.1)
##  xtable       1.8-2   2016-02-05 CRAN (R 3.3.1)
```