

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

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

## Warning: package 'doParallel' was built under R version 3.3.2
## 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
```

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))
}

```

## 1 Probability of being a false positive as a linear function of time

Load simulations and (re)define some variables:

```

load("simResults_1.RData")

nSims <- length(pValuesSims)
ntest <- length(pValuesSims[[1]])

##sequence of lambdas
lambdas <- round(seq(0.05, 0.95, 0.05),2)
which.0.8 <- which(lambdas==0.8)
which.0.9 <- which(lambdas==0.9)
which.0.8

## [1] 16

which.0.9

## [1] 18

## Set up the time vector and the probability of being null
tme <- seq(-1,2,length=ntest)
pi0 <- 1/4*tme+1/2

```

Perform estimation and save estimates:

```

cl<-makeCluster(8) ##specify number of cores less than or equal to number of cores on your
registerDoParallel(cl)

pi0EstSim <- foreach(sim = 1:nSims, .packages=c("swfdr")) %dornrg% {
  res <- lm_pi0(pValuesSims[[sim]], lambda=lambdas, X=tme,
               smooth.df=3, threshold=FALSE);
  res.pi0.lambda <- res$pi0.lambda;
  list(res.pi0.lambda[,which.0.8],
       res.pi0.lambda[,which.0.9],
       res$pi0)}

```

```

##close the cluster
stopCluster(cl)

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

##save results
save(file="simResults_pi0x_noThresh_1.RData",
      list=c("tme", "pi0", "pi0MeansVars"))

```

## 2 Probability of being a false positive as a smooth function of time

Load simulations and (re)define some variables:

```

load("simResults_2.RData")

nSims <- length(pValuesSims)
ntest <- length(pValuesSims[[1]])

##sequence of lambdas
lambdas <- round(seq(0.05, 0.95, 0.05),2)
which.0.8 <- which(lambdas==0.8)
which.0.9 <- which(lambdas==0.9)
which.0.8

## [1] 16

which.0.9

## [1] 18

## Set up the time vector and the probability of being null
tme <- seq(-1,2,length=ntest)
pi0 <- pnorm(tme)

splineMat <- ns(tme,df=3)

```

Perform estimation and save estimates:

```

cl<-makeCluster(8) ##specify number of cores less than or equal to number of cores on your
registerDoParallel(cl)

```

```

pi0EstSim.lin <- foreach(sim = 1:nSims, .packages=c("swfdr")) %dorn% {
  res <- lm_pi0(pValuesSims[[sim]], lambda=lambdas, X=tme,
               smooth.df=3, threshold=FALSE);
  res.pi0.lambda <- res$pi0.lambda;
  list(res.pi0.lambda[,which.0.8],
       res.pi0.lambda[,which.0.9],
       res$pi0)}

##close the cluster
stopCluster(cl)

cl<-makeCluster(8) ##specify number of cores less than or equal to number of cores on your
registerDoParallel(cl)

pi0EstSim.spl <- foreach(sim = 1:nSims, .packages=c("swfdr")) %dorn% {
  res <- lm_pi0(pValuesSims[[sim]], lambda=lambdas, X=splineMat,
               smooth.df=3, threshold=FALSE);
  res.pi0.lambda <- res$pi0.lambda;
  list(res.pi0.lambda[,which.0.8],
       res.pi0.lambda[,which.0.9],
       res$pi0)}

##close the cluster
stopCluster(cl)

##pull out means and variances of estimates at lambda=0.8, lambda=0.9, and final estimate
pi0Lin.MeansVars <- pullMeansVars(pi0EstSim.lin)
pi0Spl.MeansVars <- pullMeansVars(pi0EstSim.spl)

##save results
save(file="simResults_pi0x_noThresh_2.RData",
     list=c("tme", "pi0", "pi0Lin.MeansVars", "pi0Spl.MeansVars"))

```

### 3 Probability of being a false positive as a sine + step function

Load simulations and (re)define some variables:

```

load("simResults_3.RData")

nSims <- length(pValuesSims)
ntest <- length(pValuesSims[[1]])

```

```

##sequence of lambdas
lambdas <- round(seq(0.05, 0.95, 0.05),2)
which.0.8 <- which(lambdas==0.8)
which.0.9 <- which(lambdas==0.9)
which.0.8

## [1] 16

which.0.9

## [1] 18

## Set up the time vector and the probability of being null
tme1 <- seq(-1*pi,2*pi,length=ntest)
tme2 <- rep(1:0, each=ntest/2)

pi0 <- 1/4*sin(tme1) + tme2/4 + 1/2
range(pi0)

## [1] 0.2500028 0.9999972

splineMat3 <- cbind(ns(tme1,df=3), tme2)
splineMat20 <- cbind(ns(tme1,df=20), tme2)

```

Perform estimation and save estimates:

```

cl<-makeCluster(8) ##specify number of cores less than or equal to number of cores on your system
registerDoParallel(cl)

pi0EstSim3 <- foreach(sim = 1:nSims, .packages=c("swfdr")) %dorng% {
  res <- lm_pi0(pValuesSims[[sim]], lambda=lambdas, X=splineMat3,
               smooth.df=3, threshold=FALSE);
  res.pi0.lambda <- res$pi0.lambda;
  list(res.pi0.lambda[,which.0.8],
       res.pi0.lambda[,which.0.9],
       res$pi0)}

##close the cluster
stopCluster(cl)

cl<-makeCluster(8) ##specify number of cores less than or equal to number of cores on your system
registerDoParallel(cl)

pi0EstSim20 <- foreach(sim = 1:nSims, .packages=c("swfdr")) %dorng% {
  res <- lm_pi0(pValuesSims[[sim]], lambda=lambdas, X=splineMat20,
               smooth.df=3, threshold=FALSE);

```

```

res.pi0.lambda <- res$pi0.lambda;
list(res.pi0.lambda[,which.0.8],
      res.pi0.lambda[,which.0.9],
      res$pi0)}

##close the cluster
stopCluster(cl)

##pull out means and variances of estimates at lambda=0.8, lambda=0.9, and final estimate
pi0_3.MeanVars <- pullMeansVars(pi0EstSim3)
pi0_20.MeanVars <- pullMeansVars(pi0EstSim20)

##save results
save(file="simResults_pi0x_noThresh_3.RData",
      list=c("tme1", "tme2", "pi0",
             "pi0_3.MeanVars", "pi0_20.MeanVars"))

```

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 2017-01-01

## 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 3.3.1)
## digest 0.6.9 2016-01-08 CRAN (R 3.3.1)
## doParallel * 1.0.10 2015-10-14 CRAN (R 3.3.2)
## doRNG * 1.6 2014-03-07 CRAN (R 3.3.1)
## evaluate 0.10 2016-10-11 CRAN (R 3.3.2)
## 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 * 1.15.1 2016-11-22 CRAN (R 3.3.2)
## 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 3.3.1) |
| ## | registry | * 0.3    | 2015-07-08 | CRAN (R 3.3.1) |
| ## | rngtools | * 1.2.4  | 2014-03-06 | CRAN (R 3.3.1) |
| ## | stringi  | 1.1.1    | 2016-05-27 | CRAN (R 3.3.0) |
| ## | stringr  | 1.0.0    | 2015-04-30 | CRAN (R 3.3.1) |
| ## | swfdr    | * 0.99.0 | 2016-12-09 | local          |
| ## | withr    | 1.0.2    | 2016-06-20 | CRAN (R 3.3.1) |
| ## | xtable   | 1.8-2    | 2016-02-05 | CRAN (R 3.3.1) |