

```

## 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")

options(warn=1)

```

Define nulltype for Scott method:

```
nulltype <- "empirical"
```

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)
{
  print(alt)

  load(paste(alt,"simResults_1.RData",sep="/"))
  ntest <- ncol(zValuesSims)

  pi0hatScottMat_emp <- estimate_Scott_sims(zValuesSims, tme, nulltype)

  pi0hatScottMean_emp <- colMeans(pi0hatScottMat_emp[,1:ntest])
  pi0hatScottVar_emp <- apply(pi0hatScottMat_emp[,1:ntest],2,var)

  pi0hat.ScottMat_emp <- pi0hatScottMat_emp[,1:ntest]
  FDR.ScottMat_emp <- pi0hatScottMat_emp[, (ntest+1):(2*ntest)]

  ##save full results
  save(file=paste(alt,"simResults_pi0x_Scott_emp_1_full.RData",sep="/"),
        list=c("pi0hat.ScottMat_emp", "FDR.ScottMat_emp"))

  ##save summary results
  save(file=paste(alt,"simResults_pi0x_Scott_emp_1.RData",sep="/"),
        list=c("tme", "pi0",
                "pi0hatScottMean_emp","pi0hatScottVar_emp"))
}
```

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

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

Perform estimation and save estimates:

```
for(alt in alts)
{
  print(alt)

  load(paste(alt,"simResults_2.RData",sep="/"))
  ntest <- ncol(zValuesSims)

  ##-----linear fit-----##
  print("linear")
  pi0hatScottMat_empFitLin <- estimate_Scott_sims(zValuesSims, tme, nulltype)

  pi0hatLin.ScottMean_emp <- colMeans(pi0hatScottMat_empFitLin[,1:ntest])
  pi0hatLin.ScottVar_emp <- apply(pi0hatScottMat_empFitLin[,1:ntest],2,var)

  pi0hat.Lin.ScottMat_emp <- pi0hatScottMat_empFitLin[,1:ntest]
  FDR.Lin.ScottMat_emp <- pi0hatScottMat_empFitLin[, (ntest+1):(2*ntest)]

  ##-----spline fit-----#
  print("spline")
  splineMat <- ns(tme,df=3)

  pi0hatScottMat_empFitSpl <- estimate_Scott_sims(zValuesSims, splineMat, nulltype)

  pi0hatSpl.ScottMean_emp <- colMeans(pi0hatScottMat_empFitSpl[,1:ntest])
  pi0hatSpl.ScottVar_emp <- apply(pi0hatScottMat_empFitSpl[,1:ntest],2,var)
```

```

pi0hat.Spl.ScottMat_emp <- pi0hatScottMat_empFitSpl[,1:ntest]
FDR.Spl.ScottMat_emp <- pi0hatScottMat_empFitSpl[, (ntest+1):(2*ntest)]

##save full results
save(file=paste(alt,"simResults_pi0x_Scott_emp_2_full.RData",sep="/"),
      list=c("pi0hat.Lin.ScottMat_emp", "FDR.Lin.ScottMat_emp",
             "pi0hat.Spl.ScottMat_emp", "FDR.Spl.ScottMat_emp"))

##save summary results
save(file=paste(alt,"simResults_pi0x_Scott_emp_2.RData",sep="/"),
      list=c("tme", "pi0",
             "pi0hatLin.ScottMean_emp", "pi0hatLin.ScottVar_emp",
             "pi0hatSpl.ScottMean_emp", "pi0hatSpl.ScottVar_emp"))
}

## [1] "alt_z_large_10_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_10_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_20_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_20_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_10_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_10_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_20_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_20_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_10_0.9"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_10_0.9"
## [1] "linear"
## [1] "spline"

```

```
## [1] "alt_z_large_20_0.9"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_20_0.9"
## [1] "linear"
## [1] "spline"
```

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)
{
  print(alt)

  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-----##
  print("linear")
  pi0hatScottMat_empFitLin <- estimate_Scott_sims(zValuesSims, linearMat, nulltype)

  pi0hatLin.ScottMean_emp <- colMeans(pi0hatScottMat_empFitLin[,1:ntest])
  pi0hatLin.ScottVar_emp <- apply(pi0hatScottMat_empFitLin[,1:ntest],2,var)

  pi0hat.Lin.ScottMat_emp <- pi0hatScottMat_empFitLin[,1:ntest]
  FDR.Lin.ScottMat_emp <- pi0hatScottMat_empFitLin[, (ntest+1):(2*ntest)]

  ##-----spline fit-----#
  print("spline")
  pi0hatScottMat_empFitSpl <- estimate_Scott_sims(zValuesSims, splineMat, nulltype)

  pi0hatSpl.ScottMean_emp <- colMeans(pi0hatScottMat_empFitSpl[,1:ntest])
  pi0hatSpl.ScottVar_emp <- apply(pi0hatScottMat_empFitSpl[,1:ntest],2,var)

  pi0hat.Spl.ScottMat_emp <- pi0hatScottMat_empFitSpl[,1:ntest]
  FDR.Spl.ScottMat_emp <- pi0hatScottMat_empFitSpl[, (ntest+1):(2*ntest)]
}
```

```

##save full results
save(file=paste(alt,"simResults_pi0x_Scott_emp_3_full.RData",sep="/"),
      list=c("pi0hat.Lin.ScottMat_emp", "FDR.Lin.ScottMat_emp",
             "pi0hat.Spl.ScottMat_emp", "FDR.Spl.ScottMat_emp"))

##save summary results
save(file=paste(alt,"simResults_pi0x_Scott_emp_3.RData",sep="/"),
      list=c("tme", "pi0",
             "pi0hatLin.ScottMean_emp", "pi0hatLin.ScottVar_emp",
             "pi0hatSpl.ScottMean_emp", "pi0hatSpl.ScottVar_emp"))
}

## [1] "alt_z_large_10_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_10_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_20_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_20_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_10_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_10_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_20_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_20_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_10_0.9"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_10_0.9"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_20_0.9"
## [1] "linear"
## [1] "spline"

```

```
## [1] "alt_t_large_20_0.9"
## [1] "linear"
## [1] "spline"
```

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)
{
  print(alt)

  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-----##
  print("linear")
  pi0hatScottMat_empFitLin <- estimate_Scott_sims(zValuesSims, linearMat, nulltype)

  ##if only have 2 columns, make everything NULL (this means there was an error in every sim)
  if(ncol(pi0hatScottMat_empFitLin) > 2)
  {
    pi0hatLin.ScottMean_emp <- colMeans(pi0hatScottMat_empFitLin[, 1:ntest])
    pi0hatLin.ScottVar_emp <- apply(pi0hatScottMat_empFitLin[, 1:ntest], 2, var)

    pi0hat.Lin.ScottMat_emp <- pi0hatScottMat_empFitLin[, 1:ntest]
    FDR.Lin.ScottMat_emp <- pi0hatScottMat_empFitLin[, (ntest+1):(2*ntest)]
  } else {
    pi0hatLin.ScottMean_emp <- pi0hatLin.ScottVar_emp <-
      pi0hat.Lin.ScottMat_emp <- FDR.Lin.ScottMat_emp <- NULL
  }

  ##-----spline fit-----#
  print("spline")
  pi0hatScottMat_empFitSpl <- estimate_Scott_sims(zValuesSims, splineMat, nulltype)
```

```

##if only have 2 columns, make everything NULL (this means there was an error in every si
if(ncol(pi0hatScottMat_empFitLin) > 2)
{
  pi0hatSpl.ScottMean_emp <- colMeans(pi0hatScottMat_empFitSpl[,1:nTest])
  pi0hatSpl.ScottVar_emp <- apply(pi0hatScottMat_empFitSpl[,1:nTest],2,var)

  pi0hat.Spl.ScottMat_emp <- pi0hatScottMat_empFitSpl[,1:nTest]
  FDR.Spl.ScottMat_emp <- pi0hatScottMat_empFitSpl[(nTest+1):(2*nTest)]
} else {
  pi0hatSpl.ScottMean_emp <- pi0hatSpl.ScottVar_emp <-
  pi0hat.Spl.ScottMat_emp <- FDR.Spl.ScottMat_emp <- NULL
}

##save full results
save(file=paste(alt,"simResults_pi0x_Scott_emp_4_full.RData",sep="/"),
      list=c("pi0hat.Lin.ScottMat_emp", "FDR.Lin.ScottMat_emp",
            "pi0hat.Spl.ScottMat_emp", "FDR.Spl.ScottMat_emp"))

##save summary results
save(file=paste(alt,"simResults_pi0x_Scott_emp_4.RData",sep="/"),
      list=c("tme", "pi0",
            "pi0hatLin.ScottMean_emp", "pi0hatLin.ScottVar_emp",
            "pi0hatSpl.ScottMean_emp", "pi0hatSpl.ScottVar_emp"))
}

## [1] "alt_z_large_10_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_10_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_20_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_20_0.2"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_10_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_10_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_20_0.5"
## [1] "linear"
## [1] "spline"

```



```
## [1] "alt_t_large_20_0.5"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_10_0.9"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_10_0.9"
## [1] "linear"
## [1] "spline"
## [1] "alt_z_large_20_0.9"
## [1] "linear"
## [1] "spline"
## [1] "alt_t_large_20_0.9"
## [1] "linear"
## [1] "spline"
```

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 2017-06-01

## 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)
## CRAN (R 3.3.1)
## CRAN (R 3.3.3)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)

```

```
## CRAN (R 3.3.3)
## Github (jgscott/FDRreg@8025d1a)
## CRAN (R 3.3.1)
## CRAN (R 3.3.3)
## CRAN (R 3.3.3)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
## CRAN (R 3.3.0)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
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## CRAN (R 3.3.2)
## CRAN (R 3.3.2)
## CRAN (R 3.3.1)
## CRAN (R 3.3.1)
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## CRAN (R 3.3.2)
## CRAN (R 3.3.2)
## CRAN (R 3.3.2)
## CRAN (R 3.3.3)
## CRAN (R 3.3.0)
## 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)
```