Package ‘monoreg’

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getcmat

A matrix of point process configurations in p-dimensional covariate space

Description

This function returns a matrix where the rows correspond to each possible point process specification in p-dimensional covariate space; this may be helpful in specifying the argument `settozero` in the functions `monoreg` and `monosurv`.

Usage

```
getcmat(p)
```

Arguments

- `p` Number of covariate axes.

Value

A zero-one matrix with $2^p - 1$ rows and $p$ columns.

Author(s)

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monoreg

Bayesian monotonic regression

Description

This function implements an extended version of the Bayesian monotonic regression procedure for continuous outcomes described in Saarela & Arjas (2011), allowing for multiple additive monotonic components. The simulated example below replicates the one in the reference.

Usage

```
monoreg(niter=15000, burnin=5000, adapt=5000, refresh=10, thin=5, 
birthdeath=10, seed=1, rhoa=0.1, rhob=0.1, deltai=0.1, 
range=2.0, predict, include, response, offset=NULL, 
axes, covariates, settozero, package)
```
Arguments

- **niter**: Total number of MCMC iterations.
- **burnin**: Number of iterations used for burn-in period.
- **adapt**: Number of iterations used for adapting Metropolis-Hastings proposals.
- **refresh**: Interval for producing summary output of the state of the MCMC sampler.
- **thin**: Interval for saving the state of the MCMC sampler.
- **birthdeath**: Number of birth-death proposals attempted at each iteration.
- **seed**: Seed for the random generator.
- **rhoa**: Shape parameter of a Gamma hyperprior for the Poisson process rate parameters.
- **rhob**: Scale parameter of a Gamma hyperprior for the Poisson process rate parameters.
- **deltai**: Range for a uniform proposal for the function level parameters.
- **drange**: Allowed range for the monotonic function components.
- **predict**: Indicator vector for the observations for which absolute risks are calculated (not included in the likelihood expression).
- **include**: Indicator vector for the observations to be included in the likelihood expression.
- **response**: Vector of response variable values.
- **offset**: Vector of offset terms to be included in the linear predictor (optional).
- **axes**: A matrix where the columns specify the covariate axes in the non-parametrically specified regression functions. Each variable here must be scaled to zero-one interval.
- **covariates**: A matrix of additional covariates to be included in the linear predictor of the events of interest. Must include at least a vector of ones to specify an intercept term.
- **settozero**: A zero-one matrix specifying the point process construction. Each row represents a point process, while columns correspond to the columns of the argument axes, indicating whether the column is one of the dimensions specifying the domain of the point process. (See function `getmat`.)
- **package**: An integer vector specifying the additive component into which each point process (row) specified in argument `settozero` is placed.

Value

A list with elements

- **steptotal**: A sample of total number of points in the marked point process construction.
- **steps**: A sample of the number of points used per each additive component.
- **rho**: A sample of the Poisson process rate parameters (one per each point process specified).
- **loglik**: A sample of log-likelihood values.
- **beta**: A sample of regression coefficients for the variables specified in the argument `covariates`. 
phi A sample of non-parametric regression function levels for each observation specified in the argument predict.

pred A sample of predicted means for each observation specified in the argument predict.

sigma A sample of residual standard error parameters.

Author(s)
Olli Saarela <olli.saarela@utoronto.ca>

References

Examples
## Not run:
library(monoreg)
set.seed(1)
# nobs <- 1000
nobs <- 50
sigma <- 0.01
x1 <- runif(nobs)
x2 <- runif(nobs)
# 6 different monotonic regression surfaces:
# mu <- sqrt(x1)
mu <- 0.5 * x1 + 0.5 * x2
# mu <- pmin(x1, x2)
# mu <- 0.25 * x1 + 0.25 * x2 + 0.5 * (x1 + x2 > 1.0)
# mu <- 0.25 * x1 + 0.25 * x2 + 0.5 * (pmax(x1, x2) > 0.5)
# mu <- ifelse((x1 - 1.0)^2 + (x2 - 1.0)^2 < 1.0, sqrt(1.0 - (x1 - 1.0)^2 - (x2 - 1.0)^2), 0.0)
y <- rnorm(nobs, mu, sigma)

# results <- monoreg(niter=15000, burnin=5000, adapt=5000, refresh=10,
results <- monoreg(niter=5000, burnin=2500, adapt=2500, refresh=10,
  thin=5, birthdeath=10, seed=1, rhoa=0.1, rhob=0.1,
deltai=0.1, drange=2.0, predict=rep(1.0, nobs),
  include=rep(1.0, nobs), response=y, offset=NULL,
  axes=cbind(x1,x2), covariates=rep(1.0, nobs),
  settozero=getcmat(2), package=rep(1,3))

# pdf(file.path(getwd(), 'pred3d.pdf'), width=6.0, height=6.0, paper='special')
op <- par(mar=c(2,2,0,0), oma=c(0,0,0,0), mgp=c(2.5,1,0), cex=0.75)
pred <- colMeans(results$pred)
idx <- order(pred, decreasing=TRUE)

tr <- persp(z=matrix(c(NA,NA,NA,NA), 2, 2), xlim=c(0,1),
  ylim=c(0,1), ylim=c(0,1),
  xlab="x1", ylab="x2", zlab="mu",
  theta=30, phi=30, col="blue",
  shade=0.5, expand=0.5, ticktype="detailed",
  axes=FALSE, box=FALSE, type="n")

# draw the points
points(tr$x, tr$y, pch=19, col="red", cex=0.5)

# draw the lines
lines(tr$x[idx], tr$y[idx], col="blue")
monosurv

Bayesian monotonic regression for time-to-event outcomes

Description

This function implements an extended version of the Bayesian monotonic regression procedure described in Saarela & Arjas (2011), allowing for multiple additive monotonic components, and time-to-event outcomes through case-base sampling. Logistic/multinomial regression is fitted if no time variable is present. The extension and its applications, including estimation of absolute risks, are described in Saarela & Arjas (2015). The example below does logistic regression; for an example of modeling a time-to-event outcome, please see the documentation for the dataset risks.

Usage

monosurv(niter=15000, burnin=5000, adapt=5000, refresh=10, thin=5, birthdeath=10, timevar=0, seed=1, rhoa=0.1, rhob=0.1, years=NULL, deltai=0.1, drange=2.0, predict, include, casestatus, sprob=NULL, offset=NULL, tstart=NULL, axes, covariates, ccovariates=NULL, settozero, package, cr=NULL)

Arguments

niter Total number of MCMC iterations.
burnin Number of iterations used for burn-in period.
adapt Number of iterations used for adapting Metropolis-Hastings proposals.
refresh Interval for producing summary output of the state of the MCMC sampler.
thin Interval for saving the state of the MCMC sampler.
birthdeath Number of birth-death proposals attempted at each iteration.
timevar Number identifying the column in argument axes representing a time variable. Zero if no time variable is present, in which case a logistic/multinomial regression is fitted (instead of a hazard regression).
seed
Seed for the random generator.

rhoa
Shape parameter of a Gamma hyperprior for the Poisson process rate parameters.

rhob
Scale parameter of a Gamma hyperprior for the Poisson process rate parameters.

years
Time period over which absolute risks are calculated (on a time scale scaled to zero-one interval; optional).

deltai
Range for a uniform proposal for the function level parameters.

drange
Allowed range for the monotonic function components, on log-rate/log-odds scale.

predict
Indicator vector for the observations for which absolute risks are calculated (not included in the likelihood expression).

include
Indicator vector for the observations to be included in the likelihood expression.

casestatus
An integer vector indicating the case status (0=censoring, 1=event of interest, 2=competing event).

sprob
Vector of sampling probabilities/rates for each person/person-moment (optional).

offset
Vector of offset terms to be included in the linear predictor of the events of interest (optional).

tstart
Vector of entry times on a time scale scaled to zero-one interval (optional).

axes
A matrix where the columns specify the covariate axes in the non-parametrically specified regression functions. Each variable here must be scaled to zero-one interval.

covariates
A matrix of additional covariates to be included in the linear predictor of the events of interest. Must include at least a vector of ones to specify an intercept term.

ccovariates
A matrix of additional covariates to be included in the linear predictor of the competing events (optional).

setzero
A zero-one matrix specifying the point process construction. Each row represents a point process, while columns correspond to the columns of the argument axes, indicating whether the column is one of the dimensions specifying the domain of the point process. (See function getmat.)

package
An integer vector specifying the additive component into which each point process (row) specified in argument setzero is placed.

cr
A zero-one vector indicating the additive components to be placed in the linear predictor of the competing causes (optional).

Value
A list with elements

steptotal
A sample of total number of points in the marked point process construction.

steps
A sample of the number of points used per each additive component.

rho
A sample of the Poisson process rate parameters (one per each point process specified).
loglik  A sample of log-likelihood values.
beta   A sample of regression coefficients for the variables specified in the argument covariates.
betac  A sample of regression coefficients for the variables specified in the argument ccovariates.
phi    A sample of non-parametric regression function levels for each observation specified in the argument predict.
risk   A sample of absolute risks of the event of interest for each observation specified in the argument predict.
crisk  A sample of absolute risks of the competing event for each observation specified in the argument predict.

Author(s)
Olli Saarela <olli.saarela@utoronto.ca>

References

Examples
## Not run:
library(monoreg)
set.seed(1)
# nobs <- 1000
nobs <- 50
x1 <- runif(nobs)
x2 <- runif(nobs)
# 6 different monotonic regression surfaces:
# mu <- sqrt(x1)
mu <- 0.5 * x1 + 0.5 * x2
# mu <- pmin(x1, x2)
# mu <- 0.25 * x1 + 0.25 * x2 + 0.5 * (x1 + x2 > 1.0)
# mu <- 0.25 * x1 + 0.25 * x2 + 0.5 * (pmax(x1, x2) > 0.5)
# mu <- ifelse((x1 - 1.0)^2 + (x2 - 1.0)^2 < 1.0, sqrt(1.0 - (x1 - 1.0)^2 - (x2 - 1.0)^2), 0.0)
y <- rbinom(nobs, 1, mu)
# results <- monosurv(niter=15000, burnin=5000, adapt=5000, refresh=10,
results <- monosurv(niter=5000, burnin=2500, adapt=2500, refresh=10,
                   thin=5, birthdeath=10, seed=1,
rhoa=0.1, rhob=0.1, deltain=0.5, drange=10.0,
predict=rep(1.0, nobs), include=rep(1.0, nobs),
casestatus=y, axes=cbind(x1,x2), covariates=rep(1.0, nobs),
                   rhoa=0.1, rhob=0.1, deltain=0.5, drange=10.0,
predict=rep(1.0, nobs), include=rep(1.0, nobs),
casestatus=y, axes=cbind(x1,x2), covariates=rep(1.0, nobs),
                   thin=5, birthdeath=10, seed=1,
ordmonoreg

Bayesian monotonic regression

Description
This function implements the non-parametric Bayesian monotonic regression procedure for ordinal outcomes described in Saarela, Rohrbeck & Arjas (2023).

Usage
ordmonoreg(niter=15000, burnin=5000, adapt=5000, refresh=10, thin=20, birthdeath=1, logit=FALSE, gam=FALSE, seed=1, rhoa=0.1, rhob=0.1, deltai=0.5, dlower=0, dupper=1, invprob=1.0, dc=0.0, predict, include, outcome, axes, covariates=NULL, cluster=NULL, ncluster=NULL, settozero)

Arguments
niter Total number of MCMC iterations.
burnin Number of iterations used for burn-in period.
adapt Number of iterations used for adapting Metropolis-Hastings proposals.
refresh Interval for producing summary output of the state of the MCMC sampler.
thin Interval for saving the state of the MCMC sampler.
ordmonoreg

birthdeath  Number of birth-death proposals attempted at each iteration.
logit  Indicator for fitting the model on logit scale.
gam  Indicator for fitting non-monotonic generalized additive models for covariate effects.
seed  Seed for the random generator.
rhoa  Shape parameter of a Gamma hyperprior for the Poisson process rate parameters.
rhob  Scale parameter of a Gamma hyperprior for the Poisson process rate parameters.
deltai  Range for a uniform proposal for the function level parameters.
dlower  Lower bound for the allowed range for the monotonic function.
dupper  Upper bound for the allowed range for the monotonic function.
invprob  Probability with which to propose keeping the original direction of monotonicity.
dc  First parameter of the conditional beta prior to counter spiking behaviour near the origin - 1.
predict  Indicator vector for the observations for which absolute risks are calculated (not included in the likelihood expression).
include  Indicator vector for the observations to be included in the likelihood expression.
outcome  Vector of outcome variable values.
axes  A matrix where the columns specify the covariate axes in the non-parametrically specified regression functions. Each variable here must be scaled to zero-one interval.
covariates  A matrix of additional covariates to be included in the linear predictor of the events of interest (optional).
cluster  A vector of indicators for cluster membership, numbered from 0 to ncluster-1 (optional).
ncluster  Number of clusters (optional).
settozero  A zero-one matrix specifying the point process construction. Each row represents a point process, while columns correspond to the columns of the argument axes, indicating whether the column is one of the dimensions specifying the domain of the point process. (See function getmat.)

Value

A list with elements

steptotal  A sample of total number of points in the marked point process construction.
steps  A sample of the number of points used per each additive component.
rho  A sample of the Poisson process rate parameters (one per each point process specified).
loglik  A sample of log-likelihood values.
tau  A sample of random intercept variances.
alpha  A sample of random intercepts.
beta   A sample of regression coefficients for the variables specified in the argument covariates.
lambda A sample of non-parametric regression function levels for each observation specified in the argument predict.
pred   A sample of predicted means for each observation specified in the argument predict.
sigmasq A sample of autoregressive prior variances.

Author(s)
Olli Saarela <olli.saarela@utoronto.ca>, Christian Rohrbeck <cr777@bath.ac.uk>

References

Examples

library(monoreg)
expit <- function(x) {1/(1+exp(-x))}
logit <- function(p) {log(p)-log(1-p)}
set.seed(1)
# nobs <- 500
nobs <- 200
x <- sort(runif(nobs))
ngrid <- 100
xgrid <- seq(1/ngrid, (ngrid-1)/ngrid, by=1/ngrid)
ngrid <- length(xgrid)
ncat <- 4
beta <- 0.75
disc <- c(Inf, Inf, 0.75, 0.5)
gamma <- c(0,0,0.25,0.5)
surv <- matrix(NA, nobs, ncat)
cdf <- matrix(NA, nobs, ncat)
cols <- c('black','red','blue','green')
for (i in 1:ncat) {
  surv[,i] <- expit(logit((ncat-(i-1))/ncat) + beta * x +
    gamma[i] * (x > disc[i]) - gamma[i] * (x < disc[i]))
  if (i==1)
    plot(x, surv[,i], type='l', col=cols[i], ylim=c(0,1), lwd=2, ylab='S')
  else
    lines(x, surv[,i], col=cols[i], lwd=2)
}
head(surv)

for (i in 1:ncat) {
  if (i<ncat)
    cdf[,i] <- 1.0 - surv[,i+1]
else
cdf[,i] <- 1.0
if (0) {
  if (i==1)
    plot(x, cdf[,i], type='l', col=cols[i], ylim=c(0,1), lwd=2, ylab='F')
else
  lines(x, cdf[,i], col=cols[i], lwd=2)
}
}
head(cdf)

u <- runif(nobs)
y <- rep(NA, nobs)
for (i in 1:nobs)
  y[i] <- findInterval(u[i], cdf[i,]) + 1
table(y)

xwindow <- 0.1/2
mw <- matrix(NA, nobs, ncat)
grid <- sort(x)
for (i in 1:nobs) {
  idx <- (x > grid[i] - xwindow) & (x < grid[i] + xwindow)
  for (j in 1:ncat)
    mw[i,j] <- sum(y[idx] >= j)/sum(idx)
}
for (j in 1:ncat) {
  lines(grid, mw[,j], lty='dashed', col=cols[j])
}

# results <- ordomonoreg(niter=15000, burnin=5000, adapt=5000, refresh=10, thin=5,
results <- ordomonoreg(niter=3000, burnin=1000, adapt=1000, refresh=10, thin=4,
birthdeath=1, logit=FALSE, gam=FALSE, seed=1, rhoa=0.1, rhob=0.1,
deltai=0.2, dlower=0, dupper=1, invprob=1.0, dc=0.0,
predict=c(rep(0,nobs),rep(1,ngrid)),
include=c(rep(1,nobs),rep(0,ngrid)),
outcome=c(y, rep(1,ngrid)),
axes=c(x, xgrid), covariates=NULL, cluster=NULL, ncluster=NULL,
settozero=getcmat(1))

s <- results$lambda
dim(s)
lines(xgrid, colMeans(subset(s, s[,1]==0),2:(ngrid+1)))
lines(xgrid, colMeans(subset(s, s[,1]==1),2:(ngrid+1)), col='red')
lines(xgrid, colMeans(subset(s, s[,1]==2),2:(ngrid+1)), col='blue')
lines(xgrid, colMeans(subset(s, s[,1]==3),2:(ngrid+1)), col='green')
legend('bottomright', legend=c(expression(P(Y>=1)), expression(P(Y>=2)),
expression(P(Y>=3)), expression(P(Y>=4))), lwd=2, col=cols)

## Absolute risks from 7 survival models

risks
Description
This example dataset includes time-to-event outcomes and absolute risks for reproducing the ROC curves in Figure 3 of Saarela & Arjas (2015), please see the example code below.

Usage
data(risks)

Format
A data frame containing the elements

- **tstop** Age at the end of the follow-up (scaled to zero-one interval)
- **censvar** Case status (0=censoring, 1=CVD event, 2=other death).
- **tstart** Age at the start of the follow-up (scaled to zero-one interval).
- **model1** Absolute risk from model 1.
- **model2** Absolute risk from model 2.
- **model3** Absolute risk from model 3.
- **model4** Absolute risk from model 4.
- **model5** Absolute risk from model 5.
- **model6** Absolute risk from model 6.
- **model7** Absolute risk from model 7.

References

Examples
```r
## Not run:
rm(list=ls())
library(monoreg)
library(eha)

# Read the example data:
data(risks)
ftime <- (risks$tstop - risks$tstart)/max(risks$tstop - risks$tstart)
ftime <- ifelse(ftime == 0, ftime + 0.00001, ftime)
censvar <- risks$censvar
case <- censvar == 1
dcase <- censvar == 2
a <- risks$tstart
a2 <- a^2
nobs <- nrow(risks)

# Fit a simple parametric model to remove the effect of baseline age:
```
wmodel <- weibreg(Surv(ftime, case) ~ a + a2, shape=1)
summary(wmodel)

wcoef <- c(coef(wmodel), 0.0)
wlp <- crossprod(t(cbind(a, a2)), wcoef[1:(length(wcoef)-2)])
wpar <- exp(wcoef[length(wcoef)-1]:length(wcoef))

whaz <- function(x, bz) {
}

chint <- function(x, bz) {
  return(exp(bz) * (x / wpar[1])^wpar[2])
}
croot <- function(x, bz, c) {
  return(chint(x, bz) - c)
}

# Age-matched case-base sample for model validation:

set.seed(1)
crate <- chint(ftime, wlp)
csrate <- cumsum(crate)
m <- sum(case) * 10
persons <- rep(1:nobs, rmultinom(1, m, crate/sum(crate)))
moments <- rep(NA, m)
for (i in 1:m) {
  u <- runif(1, 0.0, crate[persons[i]])
  moments[i] <- uniroot(croot, c(0.0, ftime[persons[i]]), c=u,
                       bz=wlp[persons[i]])$root
}

plot(ecdf(risks$tstart[case]), pch=20, col="red")
plot(ecdf(risks$tstart[persons]), pch=20, col="blue", add=TRUE)

rate <- whaz(moments, wlp[persons])
mrate <- mean(rate)

d <- c(rep(0, m), rep(1, sum(censvar == 1)), rep(2, sum(censvar == 2)), censvar)
mom <- c(moments, ftime[censvar == 1], ftime[censvar == 2], rep(1.0, nobs))
per <- c(persons, (1:nobs)[censvar == 1], (1:nobs)[censvar == 2], 1:nobs)

include <- rep(c(1,0), c(m + sum(censvar == 1) + sum(censvar == 2), nobs))
predict <- as.numeric(include)

offset <- log(sum(crate)/(m * whaz(mom, wlp[per])))
moffset <- rep(log(sum(crate)/(m * mrate)), length(mom))

sprob <- 1/exp(offset)
msprob <- 1/exp(moffset)

stz <- getcmat(2)
settozero <- rbind(stz[1,], stz[1,], stz[2:3,], stz[2:3,])
package <- 1:nrow(settozero)
cr <- c(1,0,rep(1,2),rep(0,2))
# Fit models removing the age effect:

```r
agecir <- matrix(NA, nobs, 7)
for (i in 1:7) {
  agecir[,i] <- as.numeric(colMeans(
    monosurv(niter=15000, burnin=5000, adapt=5000, refresh=10, thin=5,
    birthdeath=10, timevar=1, seed=1, rhoa=0.1, rhob=0.1,
    years=1.0, deltai=0.1, drange=6.0, predict=predict, include=include,
    casestatus=d, sprob=msprob, offset=NULL, tstart=NULL,
    axes=cbind(mom, risks[per,paste('Var', i, sep='Var')]),
    covariates=rep(1.0, length(per)), ccovariates=rep(1.0, length(per)),
    settozero=settozero, package=package, cr=cr)$risk))
  print(i)
}
```

# Fit models without removing the age effect:

```r
cir <- matrix(NA, nobs, 7)
for (i in 1:7) {
  cir[,i] <- as.numeric(colMeans(
    monosurv(niter=15000, burnin=5000, adapt=5000, refresh=10, thin=5,
    birthdeath=10, timevar=1, seed=1, rhoa=0.1, rhob=0.1,
    years=1.0, deltai=0.1, drange=6.0, predict=predict, include=include,
    casestatus=d, sprob=msprob, offset=NULL, tstart=NULL,
    axes=cbind(mom, risks[per,paste('model', i, sep='')]),
    covariates=rep(1.0, length(per)), ccovariates=rep(1.0, length(per)),
    settozero=settozero, package=package, cr=cr)$risk))
  print(i)
}
```

# Calculate ROC curves:

```r
for (i in 1:7) {
  probs <- as.numeric(risks[,paste('Var', 'model', i, sep='Var')])
  cutoffs <- sort(unique(probs), decreasing=TRUE)
  truepos <- rep(NA, length(cutoffs))
  falsepos <- rep(NA, length(cutoffs))
  auc <- rep(0.0, length(cutoffs))
  for (j in 1:length(cutoffs)) {
    ind <- as.numeric(probs > cutoffs[j])
    truepos[j] <- sum(ind * agecir[,i])/sum(agecir[,i])
    falsepos[j] <- sum(ind * (1.0 - agecir[,i]))/sum(1.0 - agecir[,i])
    if (j > 1)
      auc[j] = (truepos[j] + truepos[j-1]) * (falsepos[j] - falsepos[j-1])
  }
  auc <- cumsum(auc) * 0.5
  roc <- cbind(cutoffs, truepos, falsepos, auc)
  save(roc, file=paste('ageroc', i, sep=''))
}
```

for (i in 1:7) {
  probs <- as.numeric(risks[,paste('model', i, sep='')])
cutoffs <- sort(unique(probs), decreasing=TRUE)
truepos <- rep(NA, length(cutoffs))
falsepos <- rep(NA, length(cutoffs))
auc <- rep(0.0, length(cutoffs))
for (j in 1:length(cutoffs)) {
  ind <- as.numeric(probs > cutoffs[j])
  truepos[j] <- sum(ind * cir[,i]) / sum(cir[,i])
  falsepos[j] <- sum(ind * (1.0 - cir[,i])) / sum(1.0 - cir[,i])
  if (j > 1)
    auc[j] <- (truepos[j] + truepos[j-1]) * (falsepos[j] - falsepos[j-1])
}
auc <- cumsum(auc) * 0.5
roc <- cbind(cutoffs, truepos, falsepos, auc)
save(roc, file=paste('/quotesingle.Var', i, 'quotesingle.Var', sep=''))

# Plot ROC curves:

# postscript(file.path(getwd(), 'rocs.eps'), paper='special', width=10, height=5,
# horizontal=FALSE)
op <- par(cex=1, mar=c(3.75,3.75,0.25,0.25), mfrow=c(1,2), mgp=c(2.5,1,0))
plot(1, xlim=c(0,1), ylim=c(0,1), type='n', xlab='False positive fraction',
     ylab='True positive fraction')
abline(0, 1, lty='dashed')
cols=c('darkgray', 'red', 'blue', 'darkgreen', 'orange', 'purple', 'magenta')
aucs <- NULL
for (i in 1:7) {
  load(file=paste('rocr', i, sep=''))
aucs <- c(aucs, max(roc[,4]))
  lines(roc[,3], roc[,2], type='s', lwd=2, col=cols[i])
  for (j in c(0.05,0.1,0.15,0.2)) {
    tp <- approx(roc[,1], roc[,2], xout=j)$y
    fp <- approx(roc[,1], roc[,3], xout=j)$y
    idx <- nobs - findInterval(j,sort(roc[,1]))
    points(fp, tp, col=cols[i], pch=20)
    if (i == 1)
      text(fp, tp-0.015, labels=j, pos=4, offset=0.25, col=cols[i], cex=0.9)
  }
  legend('bottomright', legend=paste('Model ', 1:7, '; AUC=',
    format(round(aucs, 3), nsmall=3, scientific=FALSE), sep=''),
    col=cols, lty=rep('solid',7), lwd=rep(2,7))
}

# Plot ROC curves:

plot(1, xlim=c(0,1), ylim=c(0,1), type='n', xlab='False positive fraction',
     ylab='True positive fraction')
abline(0, 1, lty='dashed')
cols=c('darkgray', 'red', 'blue', 'darkgreen', 'orange', 'purple', 'magenta')
aucs <- NULL
for (i in 1:7) {
  load(file=paste('ageroc', i, sep=''))
aucs <- c(aucs, max(roc[,4]))
lines(roc[,3], roc[,2], type='s', lwd=2, col=cols[i])
for (j in c(0.05,0.1,0.15,0.2)) {
  tp <- approx(roc[,1], roc[,2], xout=j)$y
  fp <- approx(roc[,1], roc[,3], xout=j)$y
  idx <- nobs - findInterval(j, sort(roc[,1]))
  points(fp, tp, col=cols[i], pch=20)
  if (i == 1)
    text(fp, tp-0.015, labels=j, pos=4, offset=0.25, col=cols[i], cex=0.9)
}
legend('bottomright', legend=paste('Model ', 1:7, '; AUC=',
                                   format(round(aucs, 3), nsmall=3, scientific=FALSE), sep=''),
       col=cols, lty=rep('solid', 7), lwd=rep(2,7))
par(op)
# dev.off()

## End(Not run)
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