```r
N <- 700
Nsims <- 1000

maxFollow <- 84
cens.type <- "weibull"
##################### Forest search criteria
hr.threshold <- 1.25  # Initital candidates
hr.consistency <- 1  # Candidates for many splits

pconsistency.threshold <- 0.9
stop.threshold <- 0.95

maxk <- 2
nmin.fs <- 60
pstop_futile <- 0.7

# Limit timing for forestsearch
max.minutes <- 3
m1.threshold <- Inf  # Turning this off (Default)
# pconsistency.threshold<-0.70 # Minimum threshold (will choose max among
# subgroups satisfying)
fs.splits <- 400  # How many times to split for consistency
# vi is % factor is selected in cross-validation --> higher more important
vi.grf.min <- (-1) * 0.2  # This is default (to NOT exclude via VI)
# Null, turns off grf screening
d.min <- 10  # Min number of events for both arms (d0.min=d1.min=d.min)
# default=5

####################### Virtual twins analysis Counter-factual difference
####################### (C-E) >= vt.threshold Large values in favor of C
####################### (control)
vt.threshold <- 0.225  # For VT delta
treat.threshold <- 0

maxdepth <- 2
n.min <- 60
ntree <- 1000

# GRF criteria
dmin.grf <- 12  # For GRF delta
# Note: For CRT this represents dmin.grf/2 RMS for control (-dmin.grf/2 for
# treatment)
frac.tau <- 0.6

# For forestsearch algorithm use same as GRF
frac.tau_fs <- 0.6
dmin.grf_fs <- 12
maxdepth_fs <- 2

label.analyses <- c("FS1", "GRF", "VT(24)", "VT#(24)", "VT(36)", "VT#(36)", "GRF.60")
# Classification table names
est_names <- c("$FS_{g}$", "$FS_{lg}$", "$GRF$", "$GRF_{60}$", "$VT(24)$", "${VT}^{\\#}(24)$",
    "$VT(36)$", "${VT}^{\\#}(36)$")

outcome.name <- c("y.sim")
```

```r
event.name <- c("event.sim")
id.name <- c("id")
treat.name <- c("treat")

cox.formula.sim <- as.formula(paste("Surv(y.sim,event.sim)~treat"))
cox.formula.adj.sim <- as.formula(paste("Surv(y.sim,event.sim)~treat+v1+v2+v3+v4+v5"))

get.FS <- TRUE
get.VT <- TRUE
get.GRF <- TRUE

fl_prefix <- paste0("oc_sims=", Nsims, "_")

out.loc <- paste0("results/", fl_prefix)

# m1 -censoring adjustment
muC.adj <- log(1.5)

# 0, 3, or 5
n_add_noise <- 5

mindex <- "m4a"
file.index <- "v0B-4cuts"

z1_frac <- 0.25

if (mindex == "m4a") {
    k.z3 <- 1
    k.treat <- 0.9
    pH_super <- 0.125   # non-NULL re-defines z1_frac
}

if (mindex == "m4aB") {
    k.z3 <- 1
    k.treat <- 0.9
    pH_super <- 0.2   # non-NULL re-defines z1_frac
}

if (mindex == "m4b") {
    k.z3 <- 1
    k.treat <- 1.25
    pH_super <- 0.3   # non-NULL re-defines z1_frac
}

if (mindex == "m4c") {
    k.z3 <- 1
    k.treat <- 1.5
    pH_super <- 0.3   # non-NULL re-defines z1_frac
}

model.index <- paste0(mindex, "-Noise=", "")
model.index <- paste0(model.index, n_add_noise, "")

if (is.null(pH_super)) {
    # pH_check<-with(gbsg,mean(pgr<=quantile(pgr,c(z3_frac),1,0) &
```

```r
    # er<=quantile(er,z1_frac)))
    pH_check <- with(gbsg, mean(meno == 0 & er <= quantile(er, z1_frac)))
    cat("Underlying pH_super", c(pH_check), "\n")
}
# pH_super specified If pH_super then override z1_frac and find z1_frac to
# yield pH_super

if (!is.null(pH_super)) {
    # Approximate Z1 quantile to yield pH proportion
    z1_q <- uniroot(propH.obj4, c(0, 1), tol = 1e-04, pH.target = pH_super)$root
    # pH_check<-with(gbsg,mean(pgr<=quantile(pgr,c(z3_frac),1,0) &
    # er<=quantile(er,z1_q)))
    pH_check <- with(gbsg, mean(meno == 0 & er <= quantile(er, z1_q)))
    cat("pH", c(pH_check), "\n")
    rel_error <- (pH_super - pH_check)/pH_super
    if (abs(rel_error) >= 0.1)
        stop("pH_super approximation relative error exceeds 10%")
    z1_frac <- z1_q
    cat("Underlying pH_super", c(pH_check), "\n")
}

## pH 0.122449
## Underlying pH_super 0.122449

# Bootstrap on log(hr) scale converted to HR (est.loghr=TRUE & est.scale='hr')
est.loghr <- TRUE
est.scale <- "hr"
t.start.all <- proc.time()[3]

# Classification table names Note: within tab_tests (summary.VTFS) we rename so
# that denominator in ppv(hatH) is # hatH Manuscript section 3.2 will be
# updated accordingly

stat_names <- c("any(H)", "${sens}(\\hat{H})$", "${sens}(\\hat{H}^{C})$", "${ppv}(\\hat{H})$",
    "${ppv}(\\hat{H}^{C})$", "${avg}\\vert \\hat{H} \\vert$", "${min}\\vert \\hat{H} \\vert$",
    "${max}\\vert \\hat{H} \\vert$", "${avg}\\vert \\hat{H}^{C} \\vert$", "${min}\\vert \\hat{H}^{C} \\v
    "${max}\\vert \\hat{H}^{C} \\vert$")

if (!get.FS) est_names <- est_names[-c(1:3)]
```
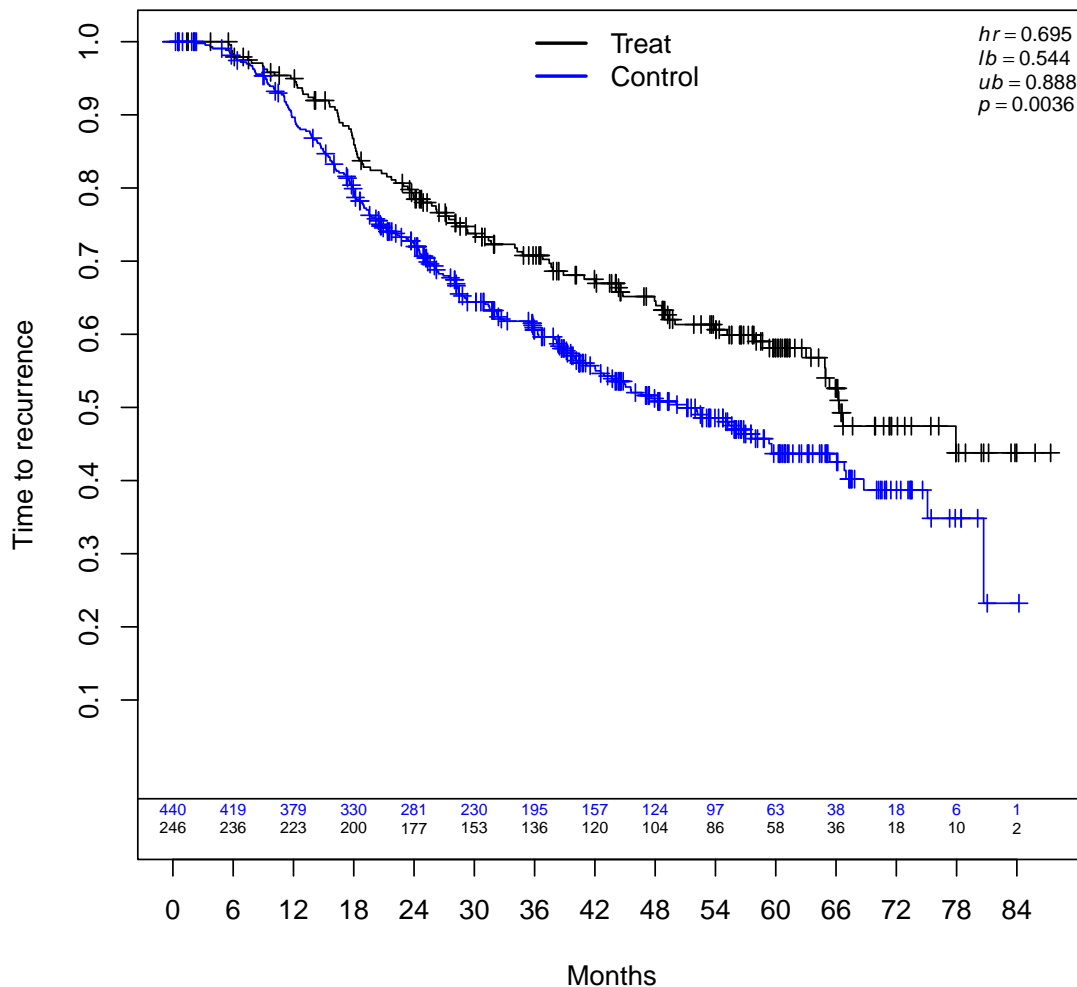
```r
mod.harm <- "null"
this.dgm <- get.dgm4.OC(mod.harm = mod.harm, N = N, k.treat = k.treat, model.index = model.index,
    sol_tol = 10^-8, hrH.target = hrH.target, cens.type = cens.type, out.loc = out.loc,
    file.index = file.index, details = TRUE, parms_torand = FALSE)
```

```
## Super-population empirical harm and non-harm hazard ratios= NA 0.701027
## Causal HR (empirical ITT)= 0.701027

dgm <- this.dgm$dgm
output.file <- this.dgm$out.file

if (!is.null(output.file) & !grepl(mod.harm, output.file)) stop("Wrong file name for mod.harm")

# Show first simulation ans1 <- oc_analyses_m4_FS4(1)

t.start <- proc.time()[3]
res <- foreach(sim = seq_len(Nsims), .options.future = list(seed = TRUE), .combine = "rbind",
    .errorhandling = "pass") %dofuture% {
    ans <- oc_analyses_m4FourCuts_FS4(sim)
    return(ans)
}

## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 49.01796 2
```

```
##    leaf.node control.mean control.size control.se depth
## 1          2         3.52        62.00       3.58     1
## 2          3        -4.64       638.00       1.13     1
## 11         4         4.01        80.00       2.80     2
## 3          6         5.46        61.00       3.60     2
## 4          7        -5.70       537.00       1.25     2
##   leaf.node control.mean control.size control.se depth
## 3         6         5.46        61.00       3.60     2
## GRF subgroup NOT found
## NO GRF cuts meeting delta(RMST): dmin.grf= 12
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## Default cuts included (1st 20)
## Categorical: z1 z2 z3 z4 z5 grade3
## # of candidate subgroup factors= 25
##  [1] "size <= 29.4"  "size <= 25"    "size <= 20"    "size <= 35"
##  [5] "noise1 <= 0"   "noise1 <= -0.6" "noise1 <= 0.7" "noise2 <= 0"
##  [9] "noise2 <= -0.8" "noise2 <= 0.7"  "noise3 <= 0"   "noise3 <= -0.7"
## [13] "noise3 <= 0.6"  "noise4 <= 0"    "noise4 <= -0.7" "noise4 <= 0.7"
## [17] "noise5 <= 0"    "noise5 <= -0.6" "noise5 <= 0.7" "z1"
## [21] "z2"             "z3"             "z4"            "z5"
## [25] "grade3"
## Number of factors evaluated= 25
## Confounders per grf screening q21 q16 q23 q9 q17 q4 q6 q11 q24 q22 q19 q8 q7 q14 q18 q25 q20 q13 q12
##           Factors Labels VI(grf)
## 21             z2    q21  0.1198
## 16  noise4 <= 0.7    q16  0.0876
## 23             z4    q23  0.0666
## 9  noise2 <= -0.8     q9  0.0574
## 17    noise5 <= 0    q17  0.0564
## 4       size <= 35     q4  0.0554
## 6  noise1 <= -0.6     q6  0.0461
## 11    noise3 <= 0    q11  0.0385
## 24             z5    q24  0.0377
## 22             z3    q22  0.0362
## 19  noise5 <= 0.7    q19  0.0344
## 8     noise2 <= 0     q8  0.0333
## 7   noise1 <= 0.7     q7  0.0313
## 14    noise4 <= 0    q14  0.0282
## 18 noise5 <= -0.6    q18  0.0272
## 25         grade3    q25  0.0267
## 20             z1    q20  0.0262
## 13  noise3 <= 0.6    q13  0.0259
## 12 noise3 <= -0.7    q12  0.0254
## 3       size <= 20     q3  0.0253
## 5     noise1 <= 0     q5  0.0244
## 10  noise2 <= 0.7    q10  0.0244
## 2       size <= 25     q2  0.0233
## 1    size <= 29.4     q1  0.0230
## 15 noise4 <= -0.7    q15  0.0194
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1275
## Approximately 5% of max_count met: minutes 0.002466667
## Approximately 10% of max_count met: minutes 0.0048
## Approximately 20% of max_count met: minutes 0.00885
```

```
## Approximately 33% of max_count met: minutes 0.0143
## Approximately 50% of max_count met: minutes 0.02125
## Approximately 75% of max_count met: minutes 0.03253333
## Approximately 90% of max_count met: minutes 0.03826667
## # of subgroups evaluated based on (up to) maxk-factor combinations 1275
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 58 83
## # of subgroups with sample size less than criteria 136
## # of subgroups meeting all criteria = 1117
## # of subgroups fitted (Cox model estimable) = 1117
## *Subgroup Searching Minutes=* 0.04188333
## Number of subgroups meeting HR threshold 2
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  2
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##     n  E d1    HR L(HR) q21.0 q21.1
## 1 82 31 19 1.49  0.72     0     0
## 2 86 41 24 1.31  0.70     0     0
## Consistency 0.7075
## Consistency 0.6075
## Subgroup Consistency Minutes= 0.04793333
## NO subgroup found (FS)
## Minutes forestsearch overall= 0.1108167
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 49.01796 2
##    leaf.node control.mean control.size control.se depth
## 1          2         3.52        62.00       3.58     1
## 2          3        -4.64       638.00       1.13     1
## 11         4         4.01        80.00       2.80     2
## 3          6         5.46        61.00       3.60     2
## 4          7        -5.70       537.00       1.25     2
##   leaf.node control.mean control.size control.se depth
## 3         6         5.46        61.00       3.60     2
## GRF subgroup NOT found
## NO GRF cuts meeting delta(RMST): dmin.grf= 12
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## CV lambda = 0.02832378
## 12 x 1 sparse Matrix of class "dgCMatrix"
##                 s0
## z1      0.06989458
## z2       .
## z3       .
## z4      0.48246098
## z5     -0.74548621
## size     .
## grade3   .
## noise1 -0.03624845
## noise2   .
## noise3   .
## noise4   .
## noise5   .
```

```
## Cox-LASSO selected: z1 z4 z5 noise1
## Cox-LASSO not selected: z2 z3 size grade3 noise2 noise3 noise4 noise5
## Default cuts included from Lasso:
## Categorical after Lasso: z1 z4 z5
## # of candidate subgroup factors= 22
##  [1] "size <= 29.4"  "size <= 25"    "size <= 20"    "size <= 35"
##  [5] "noise1 <= 0"   "noise1 <= -0.6" "noise1 <= 0.7"  "noise2 <= 0"
##  [9] "noise2 <= -0.8" "noise2 <= 0.7"  "noise3 <= 0"    "noise3 <= -0.7"
## [13] "noise3 <= 0.6"  "noise4 <= 0"    "noise4 <= -0.7" "noise4 <= 0.7"
## [17] "noise5 <= 0"    "noise5 <= -0.6" "noise5 <= 0.7"  "z1"
## [21] "z4"             "z5"
## Number of factors evaluated= 22
## Confounders per grf screening q16 q21 q9 q4 q17 q6 q22 q11 q7 q8 q19 q10 q14 q20 q13 q12 q5 q2 q18 q
##          Factors Labels VI(grf)
## 16  noise4 <= 0.7    q16  0.1003
## 21             z4    q21  0.0846
## 9  noise2 <= -0.8     q9  0.0733
## 4       size <= 35     q4  0.0661
## 17     noise5 <= 0    q17  0.0593
## 6  noise1 <= -0.6     q6  0.0527
## 22             z5    q22  0.0490
## 11     noise3 <= 0    q11  0.0463
## 7   noise1 <= 0.7     q7  0.0423
## 8      noise2 <= 0     q8  0.0400
## 19  noise5 <= 0.7    q19  0.0386
## 10  noise2 <= 0.7    q10  0.0365
## 14     noise4 <= 0    q14  0.0365
## 20             z1    q20  0.0350
## 13  noise3 <= 0.6    q13  0.0343
## 12 noise3 <= -0.7    q12  0.0338
## 5      noise1 <= 0     q5  0.0329
## 2       size <= 25     q2  0.0308
## 18 noise5 <= -0.6    q18  0.0294
## 3       size <= 20     q3  0.0283
## 1    size <= 29.4     q1  0.0263
## 15 noise4 <= -0.7    q15  0.0237
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 990
## Approximately 5% of max_count met: minutes 0.004383333
## Approximately 10% of max_count met: minutes 0.005716667
## Approximately 20% of max_count met: minutes 0.009733333
## Approximately 33% of max_count met: minutes 0.01348333
## Approximately 50% of max_count met: minutes 0.01908333
## Approximately 75% of max_count met: minutes 0.0273
## Approximately 90% of max_count met: minutes 0.03196667
## # of subgroups evaluated based on (up to) maxk-factor combinations 990
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 51 74
## # of subgroups with sample size less than criteria 118
## # of subgroups meeting all criteria = 851
## # of subgroups fitted (Cox model estimable) = 851
## *Subgroup Searching Minutes=* 0.03506667
## Number of subgroups meeting HR threshold 2
## Subgroup candidate(s) found (FS)
```

```
## # of candidate subgroups (meeting HR criteria) =  2
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##    n  E d1   HR L(HR) q16.0 q16.1
## 1 82 31 19 1.49  0.72     0     0
## 2 86 41 24 1.31  0.70     0     0
## Consistency 0.7075
## Consistency 0.6075
## Subgroup Consistency Minutes= 0.04836667
## NO subgroup found (FS)
## Minutes forestsearch overall= 0.09476667
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 50.12699 2
##   leaf.node control.mean control.size control.se depth
## 1         2        -4.38       459.00       1.29     1
## 2         3         2.57       241.00       1.72     1
## 3         4        -4.53       274.00       1.59     2
## 4         5         7.08       111.00       2.53     2
## 5         6        -5.59       255.00       1.74     2
## 6         7         8.16        60.00       3.56     2
##   leaf.node control.mean control.size control.se depth
## 6         7         8.16        60.00       3.56     2
## GRF subgroup found
## All splits
## [1] "size <= 27"     "size <= 23"     "noise5 <= 0.97"
## Terminating node at max.diff (sg.harm.id)
## [1] "noise5 <= 0.967882438461809"
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## Default cuts included (1st 20)
## Categorical: z1 z2 z3 z4 z5 grade3
## Factors per GRF: size <= 27 size <= 23 noise5 <= 0.97
## Initial GRF cuts included size <= 27 size <= 23 noise5 <= 0.97
## # of candidate subgroup factors= 29
##  [1] "size <= 27"     "size <= 23"     "noise5 <= 0.97" "size <= 29.9"
##  [5] "size <= 25"     "size <= 21"     "size <= 35"     "noise1 <= 0"
##  [9] "noise1 <= -0.7" "noise1 <= 0.7"  "noise2 <= 0"    "noise2 <= -0.7"
## [13] "noise2 <= 0.7"  "noise3 <= -0.1" "noise3 <= -0.7" "noise3 <= 0.6"
## [17] "noise4 <= -0.1" "noise4 <= 0"    "noise4 <= -0.8" "noise4 <= 0.6"
## [21] "noise5 <= 0"    "noise5 <= -0.7" "noise5 <= 0.8"  "z1"
## [25] "z2"             "z3"             "z4"             "z5"
## [29] "grade3"
## Number of factors evaluated= 29
## Confounders per grf screening q6 q11 q2 q23 q13 q21 q3 q16 q1 q28 q12 q14 q27 q10 q8 q25 q26 q15 q22
##            Factors Labels VI(grf)
## 6       size <= 21     q6  0.1014
## 11     noise2 <= 0    q11  0.0850
## 2       size <= 23     q2  0.0796
## 23   noise5 <= 0.8    q23  0.0432
## 13   noise2 <= 0.7    q13  0.0399
## 21     noise5 <= 0    q21  0.0389
## 3   noise5 <= 0.97     q3  0.0381
## 16   noise3 <= 0.6    q16  0.0347
## 1       size <= 27     q1  0.0344
## 28              z5    q28  0.0343
```

```
## 12 noise2 <= -0.7    q12  0.0336
## 14 noise3 <= -0.1    q14  0.0336
## 27             z4     q27  0.0331
## 10  noise1 <= 0.7     q10  0.0312
## 8      noise1 <= 0     q8  0.0291
## 25             z2     q25  0.0283
## 26             z3     q26  0.0274
## 15 noise3 <= -0.7     q15  0.0273
## 22 noise5 <= -0.7     q22  0.0264
## 9   noise1 <= -0.7     q9  0.0242
## 29          grade3    q29  0.0237
## 20  noise4 <= 0.6     q20  0.0232
## 7       size <= 35     q7  0.0231
## 24             z1     q24  0.0229
## 19 noise4 <= -0.8     q19  0.0219
## 4     size <= 29.9     q4  0.0182
## 18     noise4 <= 0    q18  0.0177
## 17 noise4 <= -0.1    q17  0.0161
## 5       size <= 25     q5  0.0096
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1711
## Approximately 5% of max_count met: minutes 0.005833333
## Approximately 10% of max_count met: minutes 0.009366667
## Approximately 20% of max_count met: minutes 0.02213333
## Approximately 33% of max_count met: minutes 0.0318
## Approximately 50% of max_count met: minutes 0.04475
## Approximately 75% of max_count met: minutes 0.06516667
## Approximately 90% of max_count met: minutes 0.07793333
## # of subgroups evaluated based on (up to) maxk-factor combinations 1711
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 88 100
## # of subgroups with sample size less than criteria 178
## # of subgroups meeting all criteria = 1494
## # of subgroups fitted (Cox model estimable) = 1494
## *Subgroup Searching Minutes=* 0.0846
## Number of subgroups meeting HR threshold 33
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  33
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##      n  E d1   HR L(HR) q6.0 q6.1 q11.0 q11.1 q2.0 q2.1 q23.0 q23.1 q13.0 q13.1
## 1   111 62 41 1.77  1.04    0    0     0     0    1    0     0     0     0     0
## 2    86 46 29 1.71  0.94    0    0     0     0    1    0     0     0     0     0
## 3    70 49 25 1.59  0.90    0    0     0     0    0    0     1     0     0     0
## 4    82 42 27 1.55  0.82    0    0     0     0    0    0     0     0     0     0
## 5    79 49 28 1.53  0.87    0    0     0     0    0    0     0     0     0     0
## 6    87 50 30 1.48  0.84    0    0     0     0    0    0     0     0     0     0
## 7   112 63 38 1.47  0.89    0    0     0     0    1    0     0     0     0     0
## 8   106 68 35 1.46  0.90    0    0     0     0    1    0     1     0     0     0
## 9    94 50 29 1.46  0.83    0    0     1     0    0    0     0     0     0     0
## 10   84 53 23 1.45  0.84    0    0     0     0    0    0     1     0     0     0
## Consistency 0.9775
## # of splits= 400
## Model, % Consistency Met= !{size <= 23} {size <= 27} 0.9775
## SG focus= hr
```

```
## Subgroup Consistency Minutes= 0.03136667
## Subgroup found (FS)
## Minutes forestsearch overall= 0.1343833
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 50.12699 2
##   leaf.node control.mean control.size control.se depth
## 1         2        -4.38       459.00       1.29     1
## 2         3         2.57       241.00       1.72     1
## 3         4        -4.53       274.00       1.59     2
## 4         5         7.08       111.00       2.53     2
## 5         6        -5.59       255.00       1.74     2
## 6         7         8.16        60.00       3.56     2
##   leaf.node control.mean control.size control.se depth
## 6         7         8.16        60.00       3.56     2
## GRF subgroup found
## All splits
## [1] "size <= 27"    "size <= 23"     "noise5 <= 0.97"
## Terminating node at max.diff (sg.harm.id)
## [1] "noise5 <= 0.967882438461809"
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## CV lambda = 0.01780769
## 12 x 1 sparse Matrix of class "dgCMatrix"
##                 s0
## z1      0.105318092
## z2     -0.164164016
## z3        .
## z4      0.665301094
## z5     -0.746687283
## size    0.003162630
## grade3  .
## noise1  0.007184574
## noise2 -0.023535977
## noise3  .
## noise4  .
## noise5  0.021153387
## Cox-LASSO selected: z1 z2 z4 z5 size noise1 noise2 noise5
## Cox-LASSO not selected: z3 grade3 noise3 noise4
## Default cuts included from Lasso:
## Categorical after Lasso: z1 z2 z4 z5
## Factors per GRF: size <= 27 size <= 23 noise5 <= 0.97
## Initial GRF cuts included size <= 27 size <= 23 noise5 <= 0.97
## Factors included per GRF (not in lasso) size <= 27 size <= 23 noise5 <= 0.97
## # of candidate subgroup factors= 27
##  [1] "size <= 27"    "size <= 23"     "noise5 <= 0.97" "size <= 29.9"
##  [5] "size <= 25"    "size <= 21"     "size <= 35"     "noise1 <= 0"
##  [9] "noise1 <= -0.7" "noise1 <= 0.7" "noise2 <= 0"    "noise2 <= -0.7"
## [13] "noise2 <= 0.7"  "noise3 <= -0.1" "noise3 <= -0.7" "noise3 <= 0.6"
## [17] "noise4 <= -0.1" "noise4 <= 0"    "noise4 <= -0.8" "noise4 <= 0.6"
## [21] "noise5 <= 0"    "noise5 <= -0.7" "noise5 <= 0.8"  "z1"
## [25] "z2"             "z4"             "z5"
## Number of factors evaluated= 27
## Confounders per grf screening q6 q11 q2 q23 q3 q13 q21 q27 q1 q16 q12 q25 q26 q8 q14 q10 q15 q9 q7 q
##           Factors Labels VI(grf)
```

```
## 6      size <= 21      q6  0.0914
## 11    noise2 <= 0     q11  0.0873
## 2      size <= 23      q2  0.0796
## 23  noise5 <= 0.8     q23  0.0489
## 3   noise5 <= 0.97     q3  0.0423
## 13  noise2 <= 0.7     q13  0.0423
## 21    noise5 <= 0     q21  0.0408
## 27            z5      q27  0.0395
## 1      size <= 27      q1  0.0382
## 16  noise3 <= 0.6     q16  0.0370
## 12 noise2 <= -0.7     q12  0.0362
## 25            z2      q25  0.0356
## 26            z4      q26  0.0351
## 8     noise1 <= 0      q8  0.0338
## 14 noise3 <= -0.1     q14  0.0337
## 10  noise1 <= 0.7     q10  0.0296
## 15 noise3 <= -0.7     q15  0.0282
## 9  noise1 <= -0.7      q9  0.0279
## 7      size <= 35      q7  0.0273
## 20  noise4 <= 0.6     q20  0.0254
## 22 noise5 <= -0.7     q22  0.0249
## 24            z1      q24  0.0245
## 19 noise4 <= -0.8     q19  0.0244
## 18    noise4 <= 0     q18  0.0206
## 4    size <= 29.9      q4  0.0182
## 17 noise4 <= -0.1     q17  0.0174
## 5      size <= 25      q5  0.0100
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1485
## Approximately 5% of max_count met: minutes 0.004266667
## Approximately 10% of max_count met: minutes 0.007183333
## Approximately 20% of max_count met: minutes 0.01481667
## Approximately 33% of max_count met: minutes 0.02423333
## Approximately 50% of max_count met: minutes 0.03758333
## Approximately 75% of max_count met: minutes 0.05561667
## Approximately 90% of max_count met: minutes 0.06548333
## # of subgroups evaluated based on (up to) maxk-factor combinations 1485
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 83 94
## # of subgroups with sample size less than criteria 159
## # of subgroups meeting all criteria = 1288
## # of subgroups fitted (Cox model estimable) = 1288
## *Subgroup Searching Minutes=* 0.07165
## Number of subgroups meeting HR threshold 27
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  27
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##       n  E d1   HR L(HR) q6.0 q6.1 q11.0 q11.1 q2.0 q2.1 q23.0 q23.1 q3.0 q3.1
## 1  111 62 41 1.77  1.04    0    0     0     0    1    0     0     0    0    0
## 2   86 46 29 1.71  0.94    0    0     0     0    1    0     0     0    0    0
## 3   70 49 25 1.59  0.90    0    0     0     0    0    0     1     0    0    0
## 4   82 42 27 1.55  0.82    0    0     0     0    0    0     0     0    0    0
## 5   87 50 30 1.48  0.84    0    0     0     0    0    0     0     0    0    0
## 6  112 63 38 1.47  0.89    0    0     0     0    1    0     0     0    0    0
```

```
## 7   106 68 35 1.46  0.90    0    0    0    0    1    0    1    0    0    0
## 8    94 50 29 1.46  0.83    0    0    1    0    0    0    0    0    0    0
## 9    84 53 23 1.45  0.84    0    0    0    0    0    0    1    0    0    0
## 10  76 43 25 1.43  0.78    0    0    0    0    0    0    0    0    0    0
## Consistency 0.9775
## # of splits= 400
## Model, % Consistency Met= !{size <= 23} {size <= 27} 0.9775
## SG focus= hr
## Subgroup Consistency Minutes= 0.03141667
## Subgroup found (FS)
## Minutes forestsearch overall= 0.1174667
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 48.57937 2
##   leaf.node control.mean control.size control.se depth
## 1          2         1.92       108.00       2.51     1
## 2          3        -5.69       592.00       1.20     1
## 3          4         7.18        84.00       2.86     2
## 4          5        -9.56       106.00       2.66     2
## 5          6        -6.00       496.00       1.30     2
##   leaf.node control.mean control.size control.se depth
## 3          4         7.18        84.00       2.86     2
## GRF subgroup found
## All splits
## [1] "size <= 20"     "z2 <= 0"        "noise2 <= 2.01"
## Terminating node at max.diff (sg.harm.id)
## [1] "z2 <= 0"
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## Default cuts included (1st 20)
## Categorical: z1 z2 z3 z4 z5 grade3
## Factors per GRF: size <= 20 z2 <= 0 noise2 <= 2.01
## Initial GRF cuts included size <= 20 z2 <= 0 noise2 <= 2.01
## # of candidate subgroup factors= 28
##  [1] "size <= 20"     "noise2 <= 2.01" "size <= 28.8"   "size <= 25"
##  [5] "size <= 35"     "noise1 <= -0.1" "noise1 <= 0"    "noise1 <= -0.7"
##  [9] "noise1 <= 0.6"  "noise2 <= 0"    "noise2 <= -0.7" "noise2 <= 0.7"
## [13] "noise3 <= 0"    "noise3 <= -0.7" "noise3 <= 0.7"  "noise4 <= 0"
## [17] "noise4 <= -0.1" "noise4 <= -0.7" "noise4 <= 0.6"  "noise5 <= 0"
## [21] "noise5 <= -0.6" "noise5 <= 0.7"  "z1"             "z2"
## [25] "z3"             "z4"             "z5"             "grade3"
## Number of factors evaluated= 28
## Confounders per grf screening q24 q5 q1 q10 q18 q27 q26 q20 q13 q4 q11 q21 q28 q12 q25 q6 q16 q8 q19
##            Factors Labels VI(grf)
## 24              z2    q24  0.2236
## 5       size <= 35     q5  0.0892
## 1       size <= 20     q1  0.0653
## 10      noise2 <= 0   q10  0.0504
## 18 noise4 <= -0.7    q18  0.0465
## 27              z5    q27  0.0397
## 26              z4    q26  0.0320
## 20      noise5 <= 0   q20  0.0289
## 13      noise3 <= 0   q13  0.0282
## 4       size <= 25     q4  0.0276
## 11 noise2 <= -0.7    q11  0.0256
```

```
## 21  noise5 <= -0.6     q21  0.0253
## 28            grade3    q28  0.0251
## 12   noise2 <= 0.7      q12  0.0235
## 25                z3    q25  0.0234
## 6   noise1 <= -0.1       q6  0.0230
## 16      noise4 <= 0     q16  0.0229
## 8   noise1 <= -0.7       q8  0.0226
## 19   noise4 <= 0.6      q19  0.0221
## 15   noise3 <= 0.7      q15  0.0215
## 3      size <= 28.8      q3  0.0207
## 7       noise1 <= 0      q7  0.0205
## 17  noise4 <= -0.1      q17  0.0201
## 22   noise5 <= 0.7      q22  0.0200
## 23                z1    q23  0.0194
## 9    noise1 <= 0.6       q9  0.0169
## 14  noise3 <= -0.7      q14  0.0158
## 2   noise2 <= 2.01       q2  0.0000
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1596
## Approximately 5% of max_count met: minutes 0.00455
## Approximately 10% of max_count met: minutes 0.008
## Approximately 20% of max_count met: minutes 0.01526667
## Approximately 33% of max_count met: minutes 0.02431667
## Approximately 50% of max_count met: minutes 0.03588333
## Approximately 75% of max_count met: minutes 0.05268333
## Approximately 90% of max_count met: minutes 0.0627
## # of subgroups evaluated based on (up to) maxk-factor combinations 1596
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 125 135
## # of subgroups with sample size less than criteria 202
## # of subgroups meeting all criteria = 1358
## # of subgroups fitted (Cox model estimable) = 1358
## *Subgroup Searching Minutes=* 0.0689
## Number of subgroups meeting HR threshold 3
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  3
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##     n  E  d1    HR L(HR) q24.0 q24.1 q5.0
## 1  84 40 25 1.91  1.00     1     0     0
## 2  94 45 26 1.35  0.75     0     0     0
## 3 107 53 29 1.30  0.76     0     0     0
## Consistency 0.9675
## # of splits= 400
## Model, % Consistency Met= !{z2} {size <= 20} 0.9675
## SG focus= hr
## Subgroup Consistency Minutes= 0.02998333
## Subgroup found (FS)
## Minutes forestsearch overall= 0.1129167
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 48.57937 2
##   leaf.node control.mean control.size control.se depth
## 1         2         1.92       108.00       2.51     1
## 2         3        -5.69       592.00       1.20     1
## 3         4         7.18        84.00       2.86     2
```

```
## 4          5          -9.56        106.00       2.66    2
## 5          6          -6.00        496.00       1.30    2
##   leaf.node control.mean control.size control.se depth
## 3          4           7.18         84.00        2.86    2
## GRF subgroup found
## All splits
## [1] "size <= 20"      "z2 <= 0"          "noise2 <= 2.01"
## Terminating node at max.diff (sg.harm.id)
## [1] "z2 <= 0"
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## CV lambda = 0.01121433
## 12 x 1 sparse Matrix of class "dgCMatrix"
##                  s0
## z1      0.2411784135
## z2     -0.3170179576
## z3      0.2830020629
## z4      0.6704133509
## z5     -0.7604110205
## size   -0.0001740549
## grade3   .
## noise1 -0.0016979619
## noise2   .
## noise3  0.0288498998
## noise4  0.0900180826
## noise5 -0.0961930750
## Cox-LASSO selected: z1 z2 z3 z4 z5 size noise1 noise3 noise4 noise5
## Cox-LASSO not selected: grade3 noise2
## Default cuts included from Lasso:
## Categorical after Lasso: z1 z2 z3 z4 z5
## Factors per GRF: size <= 20 z2 <= 0 noise2 <= 2.01
## Initial GRF cuts included size <= 20 z2 <= 0 noise2 <= 2.01
## Factors included per GRF (not in lasso) size <= 20 noise2 <= 2.01
## # of candidate subgroup factors= 27
##  [1] "size <= 20"      "noise2 <= 2.01" "size <= 28.8"   "size <= 25"
##  [5] "size <= 35"      "noise1 <= -0.1" "noise1 <= 0"    "noise1 <= -0.7"
##  [9] "noise1 <= 0.6"  "noise2 <= 0"     "noise2 <= -0.7" "noise2 <= 0.7"
## [13] "noise3 <= 0"     "noise3 <= -0.7" "noise3 <= 0.7"  "noise4 <= 0"
## [17] "noise4 <= -0.1" "noise4 <= -0.7" "noise4 <= 0.6"  "noise5 <= 0"
## [21] "noise5 <= -0.6" "noise5 <= 0.7"  "z1"             "z2"
## [25] "z3"              "z4"             "z5"
## Number of factors evaluated= 27
## Confounders per grf screening q24 q5 q1 q10 q18 q27 q26 q11 q12 q20 q13 q21 q25 q23 q6 q19 q4 q15 q1(
##            Factors Labels VI(grf)
## 24              z2    q24  0.2367
## 5        size <= 35    q5  0.0900
## 1        size <= 20    q1  0.0764
## 10     noise2 <= 0    q10  0.0550
## 18 noise4 <= -0.7    q18  0.0418
## 27              z5    q27  0.0385
## 26              z4    q26  0.0324
## 11 noise2 <= -0.7    q11  0.0298
## 12  noise2 <= 0.7    q12  0.0284
## 20     noise5 <= 0    q20  0.0270
```

```
## 13     noise3 <= 0     q13  0.0268
## 21 noise5 <= -0.6     q21  0.0262
## 25               z3     q25  0.0248
## 23               z1     q23  0.0239
## 6   noise1 <= -0.1      q6  0.0233
## 19  noise4 <= 0.6     q19  0.0233
## 4       size <= 25      q4  0.0227
## 15  noise3 <= 0.7     q15  0.0226
## 16     noise4 <= 0     q16  0.0216
## 8   noise1 <= -0.7      q8  0.0205
## 7       noise1 <= 0      q7  0.0203
## 9     noise1 <= 0.6      q9  0.0191
## 22  noise5 <= 0.7     q22  0.0185
## 3      size <= 28.8      q3  0.0172
## 17 noise4 <= -0.1     q17  0.0170
## 14 noise3 <= -0.7     q14  0.0162
## 2   noise2 <= 2.01      q2  0.0000
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1485
## Approximately 5% of max_count met: minutes 0.003983333
## Approximately 10% of max_count met: minutes 0.007316667
## Approximately 20% of max_count met: minutes 0.01383333
## Approximately 33% of max_count met: minutes 0.02183333
## Approximately 50% of max_count met: minutes 0.0323
## Approximately 75% of max_count met: minutes 0.049
## Approximately 90% of max_count met: minutes 0.05791667
## # of subgroups evaluated based on (up to) maxk-factor combinations 1485
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 120 130
## # of subgroups with sample size less than criteria 186
## # of subgroups meeting all criteria = 1263
## # of subgroups fitted (Cox model estimable) = 1263
## *Subgroup Searching Minutes=* 0.06343333
## Number of subgroups meeting HR threshold 3
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  3
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##      n  E  d1    HR L(HR) q24.0 q24.1 q5.0
## 1  84 40 25 1.91  1.00     1     0    0
## 2  94 45 26 1.35  0.75     0     0    0
## 3 107 53 29 1.30  0.76     0     0    0
## Consistency 0.9675
## # of splits= 400
## Model, % Consistency Met= !{z2} {size <= 20} 0.9675
## SG focus= hr
## Subgroup Consistency Minutes= 0.03168333
## Subgroup found (FS)
## Minutes forestsearch overall= 0.108

t.now <- proc.time()[3]
t.min <- (t.now - t.start)/60

print(table(res$analysis))

##
```

```
##     FSl    FSlg     GRF  GRF.60  VT(24)  VT(36) VT#(24) VT#(36)
##    1000    1000    1000    1000    1000    1000    1000    1000

check <- c(c(table(res$analysis)) - Nsims)
if (all(check != 0)) stop("All analyses not complete")

dgm_alt <- dgm
outres <- out.results(res = res, dgm = dgm, output.file = output.file, t.min = t.min,
    out_analysis = "FSl")

## [1] "results/oc_sims=1000_m4a-Noise=5_N=700_null_ktreat=0.9_v0B-4cuts.Rdata"
##      sim sizeH_true propH_true sizeHc_true propHc_true any.H size.H size.Hc
##    <int>      <num>      <num>       <int>       <num> <num>  <num>   <int>
## 1:     1          0          0         700           1     0      0     700
## 2:     1          0          0         700           1     0      0     700
## 3:     1          0          0         700           1     1     69     631
## 4:     1          0          0         700           1     0      0     700
## 5:     1          0          0         700           1     0      0     700
## 6:     1          0          0         700           1     0      0     700
##       ppv       npv specificity sensitivity found.1 found.2 found.both
##    <lgcl>     <num>       <num>       <num>   <int>   <int>      <num>
## 1:     NA 1.0000000           1          NA       0       0          0
## 2:     NA 1.0000000           1          NA       0       0          0
## 3:     NA 0.9014286           1           0      NA      NA         NA
## 4:     NA 1.0000000           1          NA      NA      NA         NA
## 5:     NA 1.0000000           1          NA       0       0          0
## 6:     NA 1.0000000           1          NA       0       0          0
##    found.al3 hr.H.true hr.Hc.true hr.H.hat hr.Hc.hat  b1.H  b2.H       b1.Hc
##        <num>    <lgcl>      <num>    <num>     <num> <num> <lgcl>       <num>
## 1:         0        NA  0.6155054       NA 0.6155054    NA     NA  0.00000000
## 2:         0        NA  0.6155054       NA 0.6155054    NA     NA  0.00000000
## 3:        NA        NA  0.6155054 2.406676 0.5325424    NA     NA -0.08296298
## 4:        NA        NA  0.6155054       NA 0.6155054    NA     NA  0.00000000
## 5:         0        NA  0.6155054       NA 0.6155054    NA     NA  0.00000000
## 6:         0        NA  0.6155054       NA 0.6155054    NA     NA  0.00000000
##         b2.Hc    p.cens analysis    taumax    hr.itt     l.itt     u.itt
##         <num>     <num>    <char>     <num>     <num>     <num>     <num>
## 1: -0.08552157 0.4642857      FSl 81.69660 0.6155054 0.5014207 0.755547
## 2: -0.08552157 0.4642857     FSlg 49.01796 0.6155054 0.5014207 0.755547
## 3: -0.16848455 0.4642857      GRF 81.69660 0.6155054 0.5014207 0.755547
## 4: -0.08552157 0.4642857   GRF.60 49.01796 0.6155054 0.5014207 0.755547
## 5: -0.08552157 0.4642857   VT(24) 81.69660 0.6155054 0.5014207 0.755547
## 6: -0.08552157 0.4642857  VT#(24) 81.69660 0.6155054 0.5014207 0.755547
##    hr.adj.itt l.adj.itt u.adj.itt l.H.true u.H.true l.Hc.true u.Hc.true
##         <num>     <num>     <num>   <lgcl>   <lgcl>     <num>     <num>
## 1:  0.5906047  0.480604 0.7257825       NA       NA 0.5014207  0.755547
## 2:  0.5906047  0.480604 0.7257825       NA       NA 0.5014207  0.755547
## 3:  0.5906047  0.480604 0.7257825       NA       NA 0.5014207  0.755547
## 4:  0.5906047  0.480604 0.7257825       NA       NA 0.5014207  0.755547
## 5:  0.5906047  0.480604 0.7257825       NA       NA 0.5014207  0.755547
## 6:  0.5906047  0.480604 0.7257825       NA       NA 0.5014207  0.755547
##      l.H.hat  u.H.hat  l.Hc.hat  u.Hc.hat
##        <num>    <num>     <num>     <num>
## 1:        NA       NA 0.5014207 0.7555470
## 2:        NA       NA 0.5014207 0.7555470
## 3: 1.043941 5.548289 0.4297038 0.6599928
```

```
## 4:         NA        NA 0.5014207 0.7555470
## 5:         NA        NA 0.5014207 0.7555470
## 6:         NA        NA 0.5014207 0.7555470
## Subgroup HRs: H, H^c, Causal= NA 0.701027 0.701027
## Simulations= 1000
## Avg censoring= 0.4613314
## Min,Max,Avg tau.max= 72.81026 83.95272 81.68616
## P(H) approximation at causal(Hrc), n=60, approx= 0.701027 0.03392115
## P(H) approximation at plim(Hrc), n=60, approx= 0.7071011 0.03573494
## Minutes,hours 14.61 0.2435
##                   FS1     FS1g      GRF  GRF.60   VT(24) VT#(24)   VT(36) VT#(36)
## any.H           0.370   0.340    0.710   0.380    0.040   0.010    0.050   0.020
## sensH             NaN     NaN      NaN     NaN      NaN     NaN      NaN     NaN
## sensHc          0.950   0.960    0.900   0.950    1.000   1.000    0.990   1.000
## ppH             0.000   0.000    0.000   0.000    0.000   0.000    0.000   0.000
## ppHc            1.000   1.000    1.000   1.000    1.000   1.000    1.000   1.000
## Avg(#H)        88.000  88.000   95.000  82.000   81.000  81.000   74.000  69.000
## minH           61.000  61.000   60.000  60.000   60.000  63.000   60.000  60.000
## maxH          276.000 276.000  233.000 172.000  152.000 120.000  115.000  96.000
## Avg(#Hc)      668.000 670.000  633.000 668.000  697.000 699.000  696.000 698.000
## minHc         424.000 424.000  467.000 528.000  548.000 580.000  585.000 604.000
## maxHc         700.000 700.000  700.000 700.000  700.000 700.000  700.000 700.000
## hat(H*)           NaN     NaN      NaN     NaN      NaN     NaN      NaN     NaN
## hat(hat[H])     1.892   1.894    1.717   1.553    1.411   1.398    1.280   1.483
## hat(Hc*)        0.748   0.749    0.723   0.719    0.734   0.755    0.717   0.750
## hat(hat[Hc])    0.661   0.662    0.635   0.651    0.679   0.698    0.674   0.697
## hat(H*)all        NaN     NaN      NaN     NaN      NaN     NaN      NaN     NaN
## hat(Hc*)all     0.707   0.707    0.707   0.707    0.707   0.707    0.707   0.707
## hat(ITT)all     0.707   0.707    0.707   0.707    0.707   0.707    0.707   0.707
## hat(ITTadj)all  0.666   0.666    0.666   0.666    0.666   0.666    0.666   0.666
```

```r
missC <- tab_tests(res = res)


pA <- as.character(round(outres$pAnyH.approx2, 4))
tabsim_missC <- get_tabsim(missC = missC, pA = pA, est_names = est_names, stat_names = stat_names,
    mod.harm = mod.harm, Nsims = Nsims)
```

```r
mod.harm <- "alt"
hrH.target <- 2

this.dgm <- get.dgm4.OC(mod.harm = mod.harm, N = N, k.treat = k.treat, model.index = model.index,
    sol_tol = 10^-8, hrH.target = hrH.target, cens.type = cens.type, out.loc = out.loc,
    file.index = file.index, details = TRUE, parms_torand = FALSE)
```
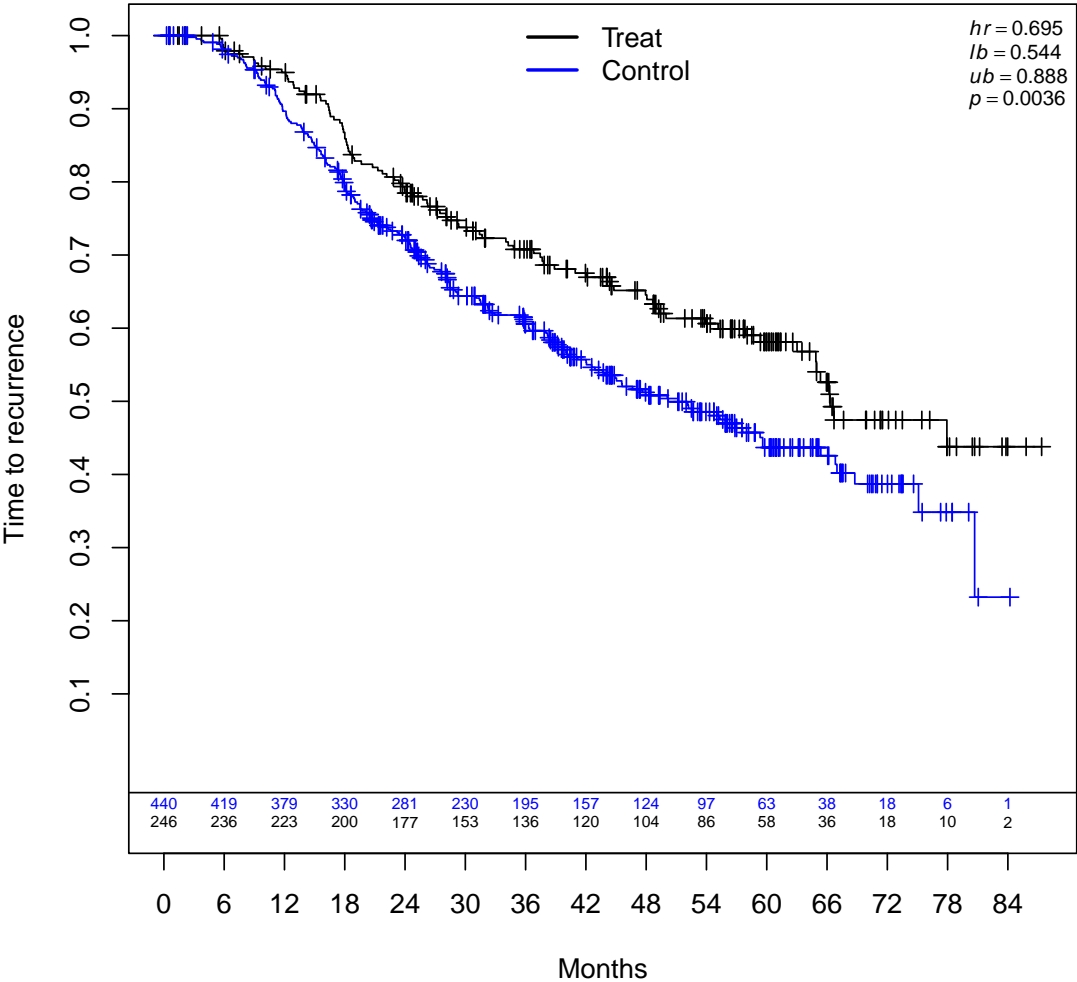
Table 1: Average classification rates: $avg|\hat{H}|$, $min|\hat{H}|$, and $max|\hat{H}|$, denote the average, minimum, and maximum of the number of subjects in the estimated subgroup $\hat{H}$ (analogously for $\hat{H}^c$). Note that under the null $sens(\hat{H})$ is undefined and $ppv(\hat{H}) = 0$.

	FS_g	FS_{lg}	GRF	GRF_{60}	$VT(24)$	$VT^{\#}(24)$	$VT(36)$	$VT^{\#}(36)$
Finding H								
any(H)	0.37	0.34	0.71	0.38	0.04	0.01	0.05	0.02
$sens(\hat{H})$	.	.	.	.	.	.	.	.
$sens(\hat{H}^C)$	0.95	0.96	0.9	0.95	1	1	0.99	1
$ppv(\hat{H})$	0	0	0	0	0	0	0	0
$ppv(\hat{H}^C)$	1	1	1	1	1	1	1	1
Size of H and H-complement								
$avg|\hat{H}|$	88	88	95	82	81	81	74	69
$min|\hat{H}|$	61	61	60	60	60	63	60	60
$max|\hat{H}|$	276	276	233	172	152	120	115	96
$avg|\hat{H}^C|$	668	670	633	668	697	699	696	698
$min|\hat{H}^C|$	424	424	467	528	548	580	585	604
$max|\hat{H}^C|$	700	700	700	700	700	700	700	700

Note: Number of simulations= 1000 .

Note: Probability approximation= 0.0357 .

```
## Super-population empirical harm and non-harm hazard ratios= 2.000007 0.6466405
## Causal HR (empirical ITT)= 0.7057463

dgm <- this.dgm$dgm
output.file <- this.dgm$out.file

if (!is.null(output.file) & !grepl(mod.harm, output.file)) stop("Wrong file name for mod.harm")

# Show first simulation ans1 <- oc_analyses_m4_FS4(2)

t.start <- proc.time()[3]
res <- foreach(sim = seq_len(Nsims), .options.future = list(seed = TRUE), .combine = "rbind",
    .errorhandling = "pass") %dofuture% {
    ans <- oc_analyses_m4FourCuts_FS4(sim)
    return(ans)
}

## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 48.86072 2
##   leaf.node control.mean control.size control.se depth
## 1         2        -4.41       509.00       1.23     1
## 2         3         2.52       191.00       2.29     1
## 3         4         2.33        95.00       2.91     2
## 4         5        -5.96       414.00       1.35     2
## 5         6         6.05       146.00       2.62     2
##   leaf.node control.mean control.size control.se depth
## 5         6         6.05       146.00       2.62     2
## GRF subgroup found
## All splits
## [1] "z1 <= 0"        "noise2 <= -0.95" "noise2 <= 0.71"
## Terminating node at max.diff (sg.harm.id)
## [1] "noise2 <= 0.705836025223127"
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## Default cuts included (1st 20)
## Categorical: z1 z2 z3 z4 z5 grade3
## Factors per GRF: z1 <= 0 noise2 <= -0.95 noise2 <= 0.71
## Initial GRF cuts included z1 <= 0 noise2 <= -0.95 noise2 <= 0.71
## # of candidate subgroup factors= 27
##  [1] "noise2 <= -0.95" "noise2 <= 0.71" "size <= 29.4"   "size <= 25"
##  [5] "size <= 20"      "size <= 35"     "noise1 <= 0"    "noise1 <= -0.6"
##  [9] "noise1 <= 0.7"   "noise2 <= 0"    "noise2 <= -0.8" "noise2 <= 0.7"
## [13] "noise3 <= 0"     "noise3 <= -0.7" "noise3 <= 0.6"  "noise4 <= 0"
## [17] "noise4 <= -0.7"  "noise4 <= 0.7"  "noise5 <= 0"    "noise5 <= -0.6"
## [21] "noise5 <= 0.7"   "z1"             "z2"             "z3"
## [25] "z4"              "z5"             "grade3"
## Number of factors evaluated= 27
## Confounders per grf screening q23 q24 q22 q1 q18 q19 q25 q26 q13 q6 q8 q16 q11 q21 q5 q10 q7 q27 q3 
##             Factors Labels VI(grf)
## 23                z2    q23  0.2083
## 24                z3    q24  0.1340
## 22                z1    q22  0.1165
## 1   noise2 <= -0.95     q1  0.0734
## 18    noise4 <= 0.7    q18  0.0531
## 19      noise5 <= 0    q19  0.0289
```

```
## 25                 z4   q25  0.0275
## 26                 z5   q26  0.0245
## 13     noise3 <= 0   q13  0.0232
## 6        size <= 35    q6  0.0222
## 8   noise1 <= -0.6    q8  0.0221
## 16     noise4 <= 0   q16  0.0208
## 11  noise2 <= -0.8   q11  0.0198
## 21   noise5 <= 0.7   q21  0.0196
## 5        size <= 20    q5  0.0187
## 10     noise2 <= 0   q10  0.0187
## 7       noise1 <= 0    q7  0.0182
## 27            grade3  q27  0.0176
## 3      size <= 29.4    q3  0.0174
## 4        size <= 25    q4  0.0174
## 9    noise1 <= 0.7    q9  0.0167
## 15   noise3 <= 0.6   q15  0.0161
## 14  noise3 <= -0.7   q14  0.0153
## 17  noise4 <= -0.7   q17  0.0146
## 2    noise2 <= 0.71   q2  0.0140
## 20  noise5 <= -0.6   q20  0.0116
## 12   noise2 <= 0.7   q12  0.0098
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1485
## Approximately 5% of max_count met: minutes 0.002866667
## Approximately 10% of max_count met: minutes 0.005483333
## Approximately 20% of max_count met: minutes 0.01076667
## Approximately 33% of max_count met: minutes 0.0167
## Approximately 50% of max_count met: minutes 0.02598333
## Approximately 75% of max_count met: minutes 0.03733333
## Approximately 90% of max_count met: minutes 0.04456667
## # of subgroups evaluated based on (up to) maxk-factor combinations 1485
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 77 104
## # of subgroups with sample size less than criteria 175
## # of subgroups meeting all criteria = 1279
## # of subgroups fitted (Cox model estimable) = 1279
## *Subgroup Searching Minutes=* 0.04916667
## Number of subgroups meeting HR threshold 29
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  29
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##      n  E d1    HR L(HR) q23.0 q23.1 q24.0 q24.1 q22.0 q22.1 q1.0 q1.1 q18.0
## 1   62 37 22 1.82  0.94     0     0     0     0     0     0    0    1    0
## 2   67 39 22 1.81  0.96     0     0     0     1     0     0    0    1    0
## 3   95 78 44 1.74  1.11     0     0     0     1     0     1    0    0    0
## 4   79 47 26 1.54  0.87     0     0     0     1     0     0    0    0    0
## 5   82 31 19 1.50  0.73     0     0     0     0     0     0    0    0    0
## 6   67 28 16 1.50  0.70     0     0     0     0     0     0    0    1    0
## 7   74 39 18 1.49  0.79     0     0     0     1     0     0    0    0    0
## 8   79 45 26 1.49  0.82     0     1     0     0     0     0    0    1    0
## 9   99 54 29 1.48  0.87     0     0     0     0     0     0    0    1    0
## 10 122 95 52 1.48  0.98     0     1     0     0     0     1    0    0    0
##     q18.1
## 1      0
```

```
## 2      0
## 3      0
## 4      0
## 5      0
## 6      0
## 7      0
## 8      0
## 9      1
## 10     0
## Consistency 0.925
## # of splits= 400
## Model, % Consistency Met= {noise2 <= -0.95} !{z5} 0.925
## Consistency 0.9325
## # of splits= 400
## Model, % Consistency Met= {z3} {noise2 <= -0.95} 0.9325
## Consistency 0.9675
## # of splits= 400
## Model, % Consistency Met= {z3} {z1} 0.9675
## SG focus= hr
## Subgroup Consistency Minutes= 0.0713
## Subgroup found (FS)
## Minutes forestsearch overall= 0.1311667
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 48.86072 2
##   leaf.node control.mean control.size control.se depth
## 1         2        -4.41       509.00       1.23     1
## 2         3         2.52       191.00       2.29     1
## 3         4         2.33        95.00       2.91     2
## 4         5        -5.96       414.00       1.35     2
## 5         6         6.05       146.00       2.62     2
##   leaf.node control.mean control.size control.se depth
## 5         6         6.05       146.00       2.62     2
## GRF subgroup found
## All splits
## [1] "z1 <= 0"        "noise2 <= -0.95" "noise2 <= 0.71"
## Terminating node at max.diff (sg.harm.id)
## [1] "noise2 <= 0.705836025223127"
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## CV lambda = 0.0313058
## 12 x 1 sparse Matrix of class "dgCMatrix"
##                s0
## z1       0.28876957
## z2        .
## z3       0.01851673
## z4       0.41993396
## z5      -0.71701803
## size      .
## grade3    .
## noise1  -0.02649584
## noise2    .
## noise3    .
## noise4    .
## noise5    .
```

```
## Cox-LASSO selected: z1 z3 z4 z5 noise1
## Cox-LASSO not selected: z2 size grade3 noise2 noise3 noise4 noise5
## Default cuts included from Lasso:
## Categorical after Lasso: z1 z3 z4 z5
## Factors per GRF: z1 <= 0 noise2 <= -0.95 noise2 <= 0.71
## Initial GRF cuts included z1 <= 0 noise2 <= -0.95 noise2 <= 0.71
## Factors included per GRF (not in lasso) noise2 <= -0.95 noise2 <= 0.71
## # of candidate subgroup factors= 25
##  [1] "noise2 <= -0.95" "noise2 <= 0.71"  "size <= 29.4"    "size <= 25"
##  [5] "size <= 20"      "size <= 35"      "noise1 <= 0"     "noise1 <= -0.6"
##  [9] "noise1 <= 0.7"   "noise2 <= 0"     "noise2 <= -0.8"  "noise2 <= 0.7"
## [13] "noise3 <= 0"     "noise3 <= -0.7"  "noise3 <= 0.6"   "noise4 <= 0"
## [17] "noise4 <= -0.7"  "noise4 <= 0.7"   "noise5 <= 0"     "noise5 <= -0.6"
## [21] "noise5 <= 0.7"   "z1"              "z3"              "z4"
## [25] "z5"
## Number of factors evaluated= 25
## Confounders per grf screening q23 q22 q1 q18 q6 q25 q24 q19 q8 q13 q21 q16 q7 q10 q5 q9 q11 q3 q15 q
##             Factors Labels VI(grf)
## 23               z3    q23  0.2546
## 22               z1    q22  0.1397
## 1   noise2 <= -0.95    q1  0.0837
## 18    noise4 <= 0.7   q18  0.0628
## 6         size <= 35    q6  0.0303
## 25               z5    q25  0.0299
## 24               z4    q24  0.0294
## 19     noise5 <= 0    q19  0.0270
## 8   noise1 <= -0.6     q8  0.0267
## 13     noise3 <= 0    q13  0.0254
## 21   noise5 <= 0.7    q21  0.0250
## 16       noise4 <= 0   q16  0.0238
## 7         noise1 <= 0    q7  0.0233
## 10       noise2 <= 0   q10  0.0221
## 5          size <= 20    q5  0.0211
## 9     noise1 <= 0.7     q9  0.0204
## 11   noise2 <= -0.8   q11  0.0198
## 3       size <= 29.4    q3  0.0191
## 15    noise3 <= 0.6   q15  0.0177
## 4          size <= 25    q4  0.0171
## 2     noise2 <= 0.71    q2  0.0170
## 14   noise3 <= -0.7   q14  0.0168
## 17   noise4 <= -0.7   q17  0.0167
## 12     noise2 <= 0.7   q12  0.0159
## 20   noise5 <= -0.6   q20  0.0146
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1275
## Approximately 5% of max_count met: minutes 0.002683333
## Approximately 10% of max_count met: minutes 0.005483333
## Approximately 20% of max_count met: minutes 0.0102
## Approximately 33% of max_count met: minutes 0.01546667
## Approximately 50% of max_count met: minutes 0.02366667
## Approximately 75% of max_count met: minutes 0.03571667
## Approximately 90% of max_count met: minutes 0.0422
## # of subgroups evaluated based on (up to) maxk-factor combinations 1275
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
```

```
## # of subgroups with events less than criteria: control, experimental 70 94
## # of subgroups with sample size less than criteria 155
## # of subgroups meeting all criteria = 1090
## # of subgroups fitted (Cox model estimable) = 1090
## *Subgroup Searching Minutes=* 0.04595
## Number of subgroups meeting HR threshold 26
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  26
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##       n  E d1   HR L(HR) q23.0 q23.1 q22.0 q22.1 q1.0 q1.1 q18.0 q18.1 q6.0 q6.1
## 1    62 37 22 1.82  0.94     0     0     0     0    0    1     0     0    0    0
## 2    67 39 22 1.81  0.96     0     1     0     0    0    1     0     0    0    0
## 3    95 78 44 1.74  1.11     0     1     0     1    0    0     0     0    0    0
## 4    79 47 26 1.54  0.87     0     1     0     0    0    0     0     0    0    0
## 5    82 31 19 1.50  0.73     0     0     0     0    0    0     0     0    0    0
## 6    67 28 16 1.50  0.70     0     0     0     0    0    1     0     0    0    0
## 7    74 39 18 1.49  0.79     0     1     0     0    0    0     0     0    0    0
## 8    99 54 29 1.48  0.87     0     0     0     0    0    1     0     1    0    0
## 9   100 80 41 1.47  0.94     0     0     0     1    0    0     0     0    0    0
## 10   72 39 25 1.43  0.74     0     1     0     0    0    0     1     0    0    0
## Consistency 0.925
## # of splits= 400
## Model, % Consistency Met= {noise2 <= -0.95} !{z5} 0.925
## Consistency 0.9325
## # of splits= 400
## Model, % Consistency Met= {z3} {noise2 <= -0.95} 0.9325
## Consistency 0.9675
## # of splits= 400
## Model, % Consistency Met= {z3} {z1} 0.9675
## SG focus= hr
## Subgroup Consistency Minutes= 0.07788333
## Subgroup found (FS)
## Minutes forestsearch overall= 0.13395
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 49.01446 2
##   leaf.node control.mean control.size control.se depth
## 1         2        -3.07       459.00       1.27     1
## 2         3         3.40       241.00       1.71     1
## 3         4        -6.70       129.00       2.28     2
## 4         5         4.26       203.00       1.96     2
## 5         6        -5.28       243.00       1.60     2
## 6         7         5.55       125.00       2.57     2
##   leaf.node control.mean control.size control.se depth
## 6         7         5.55       125.00       2.57     2
## GRF subgroup NOT found
## NO GRF cuts meeting delta(RMST): dmin.grf= 12
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## Default cuts included (1st 20)
## Categorical: z1 z2 z3 z4 z5 grade3
## # of candidate subgroup factors= 26
##  [1] "size <= 29.9"  "size <= 25"     "size <= 21"     "size <= 35"
##  [5] "noise1 <= 0"    "noise1 <= -0.7" "noise1 <= 0.7"  "noise2 <= 0"
##  [9] "noise2 <= -0.7" "noise2 <= 0.7"  "noise3 <= -0.1" "noise3 <= -0.7"
```

```
## [13] "noise3 <= 0.6"   "noise4 <= -0.1" "noise4 <= 0"     "noise4 <= -0.8"
## [17] "noise4 <= 0.6"   "noise5 <= 0"    "noise5 <= -0.7" "noise5 <= 0.8"
## [21] "z1"              "z2"             "z3"             "z4"
## [25] "z5"              "grade3"
## Number of factors evaluated= 26
## Confounders per grf screening q3 q21 q8 q23 q20 q22 q24 q10 q25 q18 q11 q9 q5 q13 q4 q12 q19 q1 q17 
##            Factors Labels VI(grf)
## 3       size <= 21     q3  0.1197
## 21              z1    q21  0.1170
## 8     noise2 <= 0     q8  0.0900
## 23              z3    q23  0.0858
## 20   noise5 <= 0.8    q20  0.0443
## 22              z2    q22  0.0436
## 24              z4    q24  0.0388
## 10   noise2 <= 0.7    q10  0.0369
## 25              z5    q25  0.0329
## 18     noise5 <= 0    q18  0.0313
## 11 noise3 <= -0.1    q11  0.0296
## 9  noise2 <= -0.7     q9  0.0285
## 5     noise1 <= 0     q5  0.0284
## 13  noise3 <= 0.6    q13  0.0271
## 4       size <= 35     q4  0.0244
## 12 noise3 <= -0.7    q12  0.0240
## 19 noise5 <= -0.7    q19  0.0234
## 1     size <= 29.9     q1  0.0228
## 17  noise4 <= 0.6    q17  0.0213
## 15    noise4 <= 0    q15  0.0209
## 26          grade3    q26  0.0206
## 7   noise1 <= 0.7     q7  0.0200
## 16 noise4 <= -0.8    q16  0.0199
## 2       size <= 25     q2  0.0177
## 6  noise1 <= -0.7     q6  0.0159
## 14 noise4 <= -0.1    q14  0.0154
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1378
## Approximately 5% of max_count met: minutes 0.003233333
## Approximately 10% of max_count met: minutes 0.006166667
## Approximately 20% of max_count met: minutes 0.01535
## Approximately 33% of max_count met: minutes 0.02416667
## Approximately 50% of max_count met: minutes 0.03583333
## Approximately 75% of max_count met: minutes 0.05271667
## Approximately 90% of max_count met: minutes 0.06145
## # of subgroups evaluated based on (up to) maxk-factor combinations 1378
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 71 70
## # of subgroups with sample size less than criteria 140
## # of subgroups meeting all criteria = 1213
## # of subgroups fitted (Cox model estimable) = 1213
## *Subgroup Searching Minutes=* 0.06713333
## Number of subgroups meeting HR threshold 68
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  68
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##      n  E d1   HR L(HR) q3.0 q3.1 q21.0 q21.1 q8.0 q8.1 q23.0 q23.1 q20.0 q20.1
```

```
## 1     88 63 35 3.59  2.13    0    0    0    1    0    0    0    1    0    0
## 2    117 78 42 2.03  1.29    0    0    0    1    0    0    0    0    0    0
## 3     88 56 29 1.87  1.11    0    0    0    1    0    0    0    0    0    0
## 4     91 54 25 1.82  1.07    0    0    0    1    1    0    0    0    0    0
## 5     71 46 26 1.77  0.98    0    0    0    0    0    0    0    1    0    0
## 6    131 82 40 1.67  1.08    0    0    0    1    0    0    0    0    0    0
## 7     70 49 25 1.66  0.94    0    0    0    0    0    0    0    0    1    0
## 8     67 31 17 1.62  0.80    0    0    0    0    0    0    0    1    0    0
## 9     89 59 28 1.61  0.96    0    0    0    1    0    0    0    0    0    0
## 10    80 56 29 1.60  0.94    0    0    0    1    0    0    0    0    0    0
## Consistency 1
## # of splits= 400
## Model, % Consistency Met= {z1} {z3} 1
## SG focus= hr
## Subgroup Consistency Minutes= 0.02801667
## Subgroup found (FS)
## Minutes forestsearch overall= 0.1105167
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 49.01446 2
##   leaf.node control.mean control.size control.se depth
## 1         2        -3.07       459.00       1.27     1
## 2         3         3.40       241.00       1.71     1
## 3         4        -6.70       129.00       2.28     2
## 4         5         4.26       203.00       1.96     2
## 5         6        -5.28       243.00       1.60     2
## 6         7         5.55       125.00       2.57     2
##   leaf.node control.mean control.size control.se depth
## 6         7         5.55       125.00       2.57     2
## GRF subgroup NOT found
## NO GRF cuts meeting delta(RMST): dmin.grf= 12
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## CV lambda = 0.01795345
## 12 x 1 sparse Matrix of class "dgCMatrix"
##                 s0
## z1      0.288629433
## z2     -0.101509769
## z3       .
## z4      0.603912320
## z5     -0.848116791
## size    0.002801471
## grade3  .
## noise1  .
## noise2 -0.028733702
## noise3  .
## noise4  .
## noise5  .
## Cox-LASSO selected: z1 z2 z4 z5 size noise2
## Cox-LASSO not selected: z3 grade3 noise1 noise3 noise4 noise5
## Default cuts included from Lasso:
## Categorical after Lasso: z1 z2 z4 z5
## # of candidate subgroup factors= 24
##  [1] "size <= 29.9"   "size <= 25"     "size <= 21"     "size <= 35"
##  [5] "noise1 <= 0"    "noise1 <= -0.7" "noise1 <= 0.7"  "noise2 <= 0"
```

```
##  [9] "noise2 <= -0.7" "noise2 <= 0.7"  "noise3 <= -0.1" "noise3 <= -0.7"
## [13] "noise3 <= 0.6"  "noise4 <= -0.1" "noise4 <= 0"     "noise4 <= -0.8"
## [17] "noise4 <= 0.6"  "noise5 <= 0"     "noise5 <= -0.7" "noise5 <= 0.8"
## [21] "z1"             "z2"              "z4"             "z5"
## Number of factors evaluated= 24
## Confounders per grf screening q3 q21 q8 q22 q20 q10 q24 q23 q18 q9 q5 q13 q11 q4 q12 q19 q16 q17 q1 q
##            Factors Labels VI(grf)
## 3      size <= 21      q3  0.1279
## 21             z1     q21  0.1184
## 8      noise2 <= 0     q8  0.0971
## 22             z2     q22  0.0746
## 20  noise5 <= 0.8     q20  0.0467
## 10  noise2 <= 0.7     q10  0.0426
## 24             z5     q24  0.0402
## 23             z4     q23  0.0392
## 18     noise5 <= 0     q18  0.0335
## 9  noise2 <= -0.7      q9  0.0323
## 5      noise1 <= 0      q5  0.0308
## 13  noise3 <= 0.6     q13  0.0306
## 11 noise3 <= -0.1     q11  0.0301
## 4      size <= 35      q4  0.0298
## 12 noise3 <= -0.7     q12  0.0272
## 19 noise5 <= -0.7     q19  0.0261
## 16 noise4 <= -0.8     q16  0.0256
## 17  noise4 <= 0.6     q17  0.0244
## 1     size <= 29.9     q1  0.0242
## 15     noise4 <= 0     q15  0.0230
## 6  noise1 <= -0.7      q6  0.0209
## 7   noise1 <= 0.7      q7  0.0195
## 2      size <= 25      q2  0.0180
## 14 noise4 <= -0.1     q14  0.0174
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1176
## Approximately 5% of max_count met: minutes 0.003833333
## Approximately 10% of max_count met: minutes 0.007983333
## Approximately 20% of max_count met: minutes 0.0143
## Approximately 33% of max_count met: minutes 0.02215
## Approximately 50% of max_count met: minutes 0.03003333
## Approximately 75% of max_count met: minutes 0.04355
## Approximately 90% of max_count met: minutes 0.05055
## # of subgroups evaluated based on (up to) maxk-factor combinations 1176
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 66 66
## # of subgroups with sample size less than criteria 124
## # of subgroups meeting all criteria = 1028
## # of subgroups fitted (Cox model estimable) = 1028
## *Subgroup Searching Minutes=* 0.05495
## Number of subgroups meeting HR threshold 50
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  50
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##      n  E d1   HR L(HR) q3.0 q3.1 q21.0 q21.1 q8.0 q8.1 q22.0 q22.1 q20.0 q20.1
## 1  117 78 42 2.03  1.29    0    0     0     1    0    0     0     1     0     0
## 2   88 56 29 1.87  1.11    0    0     0     1    0    0     0     0     0     0
```

```
## 3    91 54 25 1.82  1.07   0    0    0    1    1    0    0    0    0    0
## 4   131 82 40 1.67  1.08   0    0    0    1    0    0    0    0    0    0
## 5    70 49 25 1.66  0.94   0    0    0    0    0    0    0    0    1    0
## 6    89 59 28 1.61  0.96   0    0    0    1    0    0    0    0    0    0
## 7    80 56 29 1.60  0.94   0    0    0    1    0    0    0    0    0    0
## 8    89 43 27 1.60  0.86   0    0    0    0    0    0    0    0    0    0
## 9    85 48 25 1.58  0.90   0    0    0    1    0    0    0    0    0    0
## 10 136 94 46 1.58  1.05   0    0    0    1    0    0    0    0    0    0
## Consistency 1
## # of splits= 400
## Model, % Consistency Met= {z1} {z2} 1
## SG focus= hr
## Subgroup Consistency Minutes= 0.0306
## Subgroup found (FS)
## Minutes forestsearch overall= 0.0986
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 50.23146 2
##   leaf.node control.mean control.size control.se depth
## 1          2         3.76       108.00       2.71     1
## 2          3        -5.08       592.00       1.26     1
## 3          4         3.45       107.00       2.74     2
## 4          5        -6.86       294.00       1.78     2
## 5          6        -7.74       211.00       1.92     2
## 6          7         7.73        88.00       3.69     2
##   leaf.node control.mean control.size control.se depth
## 6          7         7.73        88.00       3.69     2
## GRF subgroup found
## All splits
## [1] "z3 <= 0"    "size <= 20" "z1 <= 0"
## Terminating node at max.diff (sg.harm.id)
## [1] "z1 <= 0"
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## Default cuts included (1st 20)
## Categorical: z1 z2 z3 z4 z5 grade3
## Factors per GRF: z3 <= 0 size <= 20 z1 <= 0
## Initial GRF cuts included z3 <= 0 size <= 20 z1 <= 0
## # of candidate subgroup factors= 27
##  [1] "size <= 20"    "size <= 28.8"  "size <= 25"    "size <= 35"
##  [5] "noise1 <= -0.1" "noise1 <= 0"   "noise1 <= -0.7" "noise1 <= 0.6"
##  [9] "noise2 <= 0"    "noise2 <= -0.7" "noise2 <= 0.7" "noise3 <= 0"
## [13] "noise3 <= -0.7" "noise3 <= 0.7" "noise4 <= 0"    "noise4 <= -0.1"
## [17] "noise4 <= -0.7" "noise4 <= 0.6" "noise5 <= 0"    "noise5 <= -0.6"
## [21] "noise5 <= 0.7"  "z1"            "z2"             "z3"
## [25] "z4"             "z5"            "grade3"
## Number of factors evaluated= 27
## Confounders per grf screening q22 q23 q4 q1 q9 q25 q27 q17 q26 q19 q24 q11 q18 q12 q20 q14 q10 q7 q5
##         Factors Labels VI(grf)
## 22            z1    q22  0.1097
## 23            z2    q23  0.0813
## 4      size <= 35    q4  0.0691
## 1      size <= 20    q1  0.0649
## 9     noise2 <= 0    q9  0.0608
## 25            z4    q25  0.0558
```

```
## 27          grade3    q27  0.0469
## 17 noise4 <= -0.7    q17  0.0449
## 26              z5    q26  0.0437
## 19    noise5 <= 0    q19  0.0354
## 24              z3    q24  0.0348
## 11  noise2 <= 0.7    q11  0.0288
## 18  noise4 <= 0.6    q18  0.0277
## 12    noise3 <= 0    q12  0.0272
## 20 noise5 <= -0.6    q20  0.0272
## 14  noise3 <= 0.7    q14  0.0244
## 10 noise2 <= -0.7    q10  0.0240
## 7  noise1 <= -0.7     q7  0.0235
## 5  noise1 <= -0.1     q5  0.0225
## 16 noise4 <= -0.1    q16  0.0215
## 21  noise5 <= 0.7    q21  0.0206
## 3       size <= 25     q3  0.0205
## 2     size <= 28.8     q2  0.0176
## 6       noise1 <= 0     q6  0.0174
## 8    noise1 <= 0.6     q8  0.0173
## 15    noise4 <= 0    q15  0.0168
## 13 noise3 <= -0.7    q13  0.0158
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1485
## Approximately 5% of max_count met: minutes 0.003366667
## Approximately 10% of max_count met: minutes 0.006683333
## Approximately 20% of max_count met: minutes 0.0131
## Approximately 33% of max_count met: minutes 0.02088333
## Approximately 50% of max_count met: minutes 0.03113333
## Approximately 75% of max_count met: minutes 0.0471
## Approximately 90% of max_count met: minutes 0.05565
## # of subgroups evaluated based on (up to) maxk-factor combinations 1485
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 68 76
## # of subgroups with sample size less than criteria 146
## # of subgroups meeting all criteria = 1311
## # of subgroups fitted (Cox model estimable) = 1311
## *Subgroup Searching Minutes=* 0.06075
## Number of subgroups meeting HR threshold 9
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  9
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##    n  E d1    HR L(HR) q22.0 q22.1 q23.0 q23.1 q4.0 q4.1 q1.0 q1.1 q9.0
## 1 88 68 36 1.85  1.14     0     1     0     0    0    0    0    0    0
## 2 84 41 25 1.78  0.95     0     0     1     0    0    0    0    1    0
## 3 96 63 37 1.50  0.90     0     1     0     0    0    0    0    0    0
## 4 94 47 27 1.36  0.76     0     0     0     0    0    0    0    1    0
## 5 87 65 33 1.32  0.81     0     1     0     0    0    0    0    0    0
## 6 97 69 33 1.30  0.80     0     1     0     0    0    0    0    0    0
## 7 90 65 31 1.29  0.79     0     1     0     0    0    0    0    0    0
## 8 76 48 25 1.29  0.73     0     1     0     0    0    0    0    0    0
## 9 85 55 30 1.26  0.74     0     0     0     0    0    0    0    0    0
## Consistency 0.975
## # of splits= 400
## Model, % Consistency Met= {z1} {z3} 0.975
```

```
## SG focus= hr
## Subgroup Consistency Minutes= 0.02623333
## Subgroup found (FS)
## Minutes forestsearch overall= 0.09886667
## FS: GRF stage for cut selection with dmin,tau= 12 0.6
## tau, maxdepth= 50.23146 2
##   leaf.node control.mean control.size control.se depth
## 1         2         3.76       108.00       2.71     1
## 2         3        -5.08       592.00       1.26     1
## 3         4         3.45       107.00       2.74     2
## 4         5        -6.86       294.00       1.78     2
## 5         6        -7.74       211.00       1.92     2
## 6         7         7.73        88.00       3.69     2
##   leaf.node control.mean control.size control.se depth
## 6         7         7.73        88.00       3.69     2
## GRF subgroup found
## All splits
## [1] "z3 <= 0"     "size <= 20" "z1 <= 0"
## Terminating node at max.diff (sg.harm.id)
## [1] "z1 <= 0"
## # of continuous/categorical characteristics 6 6
## Continuous characteristics: size noise1 noise2 noise3 noise4 noise5
## Categorical characteristics: z1 z2 z3 z4 z5 grade3
## CV lambda = 0.01166399
## 12 x 1 sparse Matrix of class "dgCMatrix"
##                 s0
## z1      0.43032177
## z2     -0.35901533
## z3      0.40313734
## z4      0.61783137
## z5     -0.74776389
## size    .
## grade3  .
## noise1  .
## noise2  .
## noise3  .
## noise4  0.09056499
## noise5 -0.09270525
## Cox-LASSO selected: z1 z2 z3 z4 z5 noise4 noise5
## Cox-LASSO not selected: size grade3 noise1 noise2 noise3
## Default cuts included from Lasso:
## Categorical after Lasso: z1 z2 z3 z4 z5
## Factors per GRF: z3 <= 0 size <= 20 z1 <= 0
## Initial GRF cuts included z3 <= 0 size <= 20 z1 <= 0
## Factors included per GRF (not in lasso) size <= 20
## # of candidate subgroup factors= 26
##  [1] "size <= 20"    "size <= 28.8"  "size <= 25"    "size <= 35"
##  [5] "noise1 <= -0.1" "noise1 <= 0"    "noise1 <= -0.7" "noise1 <= 0.6"
##  [9] "noise2 <= 0"    "noise2 <= -0.7" "noise2 <= 0.7" "noise3 <= 0"
## [13] "noise3 <= -0.7" "noise3 <= 0.7" "noise4 <= 0"    "noise4 <= -0.1"
## [17] "noise4 <= -0.7" "noise4 <= 0.6" "noise5 <= 0"    "noise5 <= -0.6"
## [21] "noise5 <= 0.7"  "z1"            "z2"            "z3"
## [25] "z4"            "z5"
## Number of factors evaluated= 26
## Confounders per grf screening q22 q23 q4 q9 q1 q25 q17 q26 q19 q24 q11 q18 q10 q12 q21 q20 q3 q14 q5
```

```
##              Factors Labels VI(grf)
## 22               z1     q22  0.1173
## 23               z2     q23  0.0864
## 4      size <= 35       q4  0.0690
## 9     noise2 <= 0       q9  0.0646
## 1      size <= 20       q1  0.0624
## 25               z4     q25  0.0608
## 17 noise4 <= -0.7    q17  0.0478
## 26               z5     q26  0.0419
## 19    noise5 <= 0     q19  0.0395
## 24               z3     q24  0.0389
## 11  noise2 <= 0.7    q11  0.0346
## 18  noise4 <= 0.6    q18  0.0316
## 10 noise2 <= -0.7    q10  0.0284
## 12    noise3 <= 0    q12  0.0260
## 21  noise5 <= 0.7    q21  0.0258
## 20 noise5 <= -0.6    q20  0.0256
## 3      size <= 25       q3  0.0236
## 14  noise3 <= 0.7    q14  0.0234
## 5  noise1 <= -0.1     q5  0.0226
## 7  noise1 <= -0.7     q7  0.0218
## 6     noise1 <= 0     q6  0.0199
## 13 noise3 <= -0.7    q13  0.0191
## 2     size <= 28.8    q2  0.0187
## 16 noise4 <= -0.1    q16  0.0180
## 8   noise1 <= 0.6     q8  0.0167
## 15    noise4 <= 0    q15  0.0156
## Number of possible configurations (<= maxk): maxk, # <= maxk 2 1378
## Approximately 5% of max_count met: minutes 0.003166667
## Approximately 10% of max_count met: minutes 0.006666667
## Approximately 20% of max_count met: minutes 0.01241667
## Approximately 33% of max_count met: minutes 0.02095
## Approximately 50% of max_count met: minutes 0.02898333
## Approximately 75% of max_count met: minutes 0.044
## Approximately 90% of max_count met: minutes 0.05183333
## # of subgroups evaluated based on (up to) maxk-factor combinations 1378
## % of all-possible combinations (<= maxk) 100
## k.max= 2
## Events criteria for control,exp= 10 10
## # of subgroups with events less than criteria: control, experimental 65 73
## # of subgroups with sample size less than criteria 132
## # of subgroups meeting all criteria = 1218
## # of subgroups fitted (Cox model estimable) = 1218
## *Subgroup Searching Minutes=* 0.0569
## Number of subgroups meeting HR threshold 8
## Subgroup candidate(s) found (FS)
## # of candidate subgroups (meeting HR criteria) =  8
## SGs (1st 10) meeting screening thresholds sorted by sg_focus= hr
##     n  E d1    HR L(HR) q22.0 q22.1 q23.0 q23.1 q4.0 q4.1 q9.0 q9.1
## 1 88 68 36 1.85  1.14      0     1     0     0    0    0    0    0
## 2 84 41 25 1.78  0.95      0     0     1     0    0    0    0    0
## 3 96 63 37 1.50  0.90      0     1     0     0    0    0    0    0
## 4 94 47 27 1.36  0.76      0     0     0     0    0    0    0    1
## 5 87 65 33 1.32  0.81      0     1     0     0    0    0    0    0
## 6 97 69 33 1.30  0.80      0     1     0     0    0    0    0    0
```

```
## 7 90 65 31 1.29  0.79       0     1      0      0     0     0     0     0
## 8 76 48 25 1.29  0.73       0     1      0      0     0     0     0     0
## Consistency 0.975
## # of splits= 400
## Model, % Consistency Met= {z1} {z3} 0.975
## SG focus= hr
## Subgroup Consistency Minutes= 0.0269
## Subgroup found (FS)
## Minutes forestsearch overall= 0.0953
```

```r
t.now <- proc.time()[3]
t.min <- (t.now - t.start)/60
```

```r
print(table(res$analysis))
```

```
##
##      FS1     FS1g     GRF   GRF.60   VT(24)   VT(36)  VT#(24)  VT#(36)
##     1000     1000     1000     1000     1000     1000     1000     1000
```

```r
check <- c(c(table(res$analysis)) - Nsims)
if (all(check != 0)) stop("All analyses not complete")
```

```r
dgm_alt <- dgm
```

```r
outres <- out.results(res = res, dgm = dgm, output.file = output.file, t.min = t.min,
    out_analysis = "FS1")
```

```
## [1] "results/oc_sims=1000_m4a-Noise=5_N=700_alt_ktreat=0.9_hrH=2_v0B-4cuts.Rdata"
##       sim sizeH_true propH_true sizeHc_true propHc_true any.H size.H size.Hc
##     <int>      <num>      <num>       <int>       <num> <num>  <num>   <int>
## ## 1:    1         95  0.1357143         605   0.8642857     1     95     605
## ## 2:    1         95  0.1357143         605   0.8642857     1     95     605
## ## 3:    1         95  0.1357143         605   0.8642857     1    181     519
## ## 4:    1         95  0.1357143         605   0.8642857     1    146     554
## ## 5:    1         95  0.1357143         605   0.8642857     0      0     700
## ## 6:    1         95  0.1357143         605   0.8642857     0      0     700
##          ppv       npv specificity sensitivity found.1 found.2 found.both
##        <num>     <num>       <num>       <num>   <num>   <num>      <num>
## ## 1: 1.0000000 1.0000000   1.0000000   1.0000000       0       0          0
## ## 2: 1.0000000 1.0000000   1.0000000   1.0000000       0       0          0
## ## 3: 0.6631579 0.8049587   0.9383430   0.3480663      NA      NA         NA
## ## 4: 0.7894737 0.8826446   0.9638989   0.5136986      NA      NA         NA
## ## 5: 0.0000000 1.0000000   0.8642857   0.0000000       0       0          0
## ## 6: 0.0000000 1.0000000   0.8642857   0.0000000       0       0          0
##     found.al3 hr.H.true hr.Hc.true hr.H.hat hr.Hc.hat       b1.H       b2.H
##         <num>     <num>      <num>    <num>     <num>      <num>      <num>
## ## 1:        0   1.74466  0.5577464 1.744660 0.5577464  0.0000000 -0.2553474
## ## 2:        0   1.74466  0.5577464 1.744660 0.5577464  0.0000000 -0.2553474
## ## 3:       NA   1.74466  0.5577464 1.459944 0.4959567 -0.2847159 -0.5400632
## ## 4:       NA   1.74466  0.5577464 1.269292 0.5300535 -0.4753683 -0.7307157
## ## 5:        0   1.74466  0.5577464       NA 0.6688550         NA         NA
## ## 6:        0   1.74466  0.5577464       NA 0.6688550         NA         NA
##         b1.Hc       b2.Hc    p.cens analysis    taumax    hr.itt     l.itt
##         <num>       <num>     <num>   <char>     <num>    <num>     <num>
## ## 1:  0.00000000 -0.08889407 0.4514286      FS1 81.43453 0.668855 0.5464683
```

```
## 2:   0.00000000 -0.08889407 0.4514286       FSlg 48.86072 0.668855 0.5464683
## 3: -0.06178971 -0.15068378 0.4514286        GRF 81.43453 0.668855 0.5464683
## 4: -0.02769288 -0.11658695 0.4514286     GRF.60 48.86072 0.668855 0.5464683
## 5:  0.11110856  0.02221450 0.4514286     VT(24) 81.43453 0.668855 0.5464683
## 6:  0.11110856  0.02221450 0.4514286    VT#(24) 81.43453 0.668855 0.5464683
##        u.itt hr.adj.itt l.adj.itt u.adj.itt l.H.true u.H.true l.Hc.true
##        <num>      <num>     <num>     <num>    <num>    <num>     <num>
## 1: 0.8186513  0.6827343 0.5565269 0.8375626 1.105971 2.752186 0.4437854
## 2: 0.8186513  0.6827343 0.5565269 0.8375626 1.105971 2.752186 0.4437854
## 3: 0.8186513  0.6827343 0.5565269 0.8375626 1.105971 2.752186 0.4437854
## 4: 0.8186513  0.6827343 0.5565269 0.8375626 1.105971 2.752186 0.4437854
## 5: 0.8186513  0.6827343 0.5565269 0.8375626 1.105971 2.752186 0.4437854
## 6: 0.8186513  0.6827343 0.5565269 0.8375626 1.105971 2.752186 0.4437854
##    u.Hc.true   l.H.hat  u.H.hat  l.Hc.hat  u.Hc.hat
##        <num>     <num>    <num>     <num>     <num>
## 1: 0.7009717 1.1059709 2.752186 0.4437854 0.7009717
## 2: 0.7009717 1.1059709 2.752186 0.4437854 0.7009717
## 3: 0.7009717 0.9876672 2.158051 0.3894210 0.6316379
## 4: 0.7009717 0.8574809 1.878877 0.4167659 0.6741357
## 5: 0.7009717        NA       NA 0.5464683 0.8186513
## 6: 0.7009717        NA       NA 0.5464683 0.8186513
## Subgroup HRs: H, H^c, Causal= 2.000007 0.6466405 0.7057463
## Simulations= 1000
## Avg censoring= 0.44999
## Min,Max,Avg tau.max= 74.465 83.95939 81.60594
## P(H) approximation at causal(H), n(sg)=60, approx= 2.000007 60 0.8283003
## P(H) approximation at causal(H), Avg(n(sg)), approx= 2.000007 89 0.8998777
## P(H) approximation at plim(H), Avg(n(sg)), approx= 2.127636 89 0.9289428
## Minutes,hours 11.9284 0.1988067
##                 FSl    FSlg     GRF  GRF.60  VT(24) VT#(24)  VT(36) VT#(36)
## any.H         0.950   0.900   0.960   0.730   0.390   0.460   0.360   0.480
## sensH         0.780   0.660   0.600   0.480   0.300   0.390   0.270   0.430
## sensHc        0.980   0.960   0.920   0.950   0.990   0.990   0.990   0.990
## ppH           0.780   0.650   0.530   0.430   0.290   0.380   0.270   0.420
## ppHc          0.970   0.950   0.940   0.930   0.910   0.920   0.910   0.930
## Avg(#H)      88.000  90.000 107.000 103.000  92.000  93.000  91.000  92.000
## minH         61.000  61.000  60.000  60.000  60.000  60.000  60.000  60.000
## maxH        220.000 220.000 327.000 228.000 171.000 178.000 185.000 171.000
## Avg(#Hc)    617.000 619.000 598.000 625.000 664.000 657.000 668.000 656.000
## minHc       480.000 480.000 373.000 472.000 529.000 522.000 515.000 529.000
## maxHc       700.000 700.000 700.000 700.000 700.000 700.000 700.000 700.000
## hat(H*)       2.164   2.183   2.148   2.206   2.398   2.371   2.421   2.399
## hat(hat[H])   2.252   2.181   1.985   1.904   2.142   2.190   2.161   2.270
## hat(Hc*)      0.653   0.654   0.652   0.647   0.656   0.651   0.649   0.651
## hat(hat[Hc])  0.653   0.654   0.641   0.647   0.668   0.656   0.662   0.654
## hat(H*)all    2.128   2.128   2.128   2.128   2.128   2.128   2.128   2.128
## hat(Hc*)all   0.651   0.651   0.651   0.651   0.651   0.651   0.651   0.651
## hat(ITT)all   0.754   0.754   0.754   0.754   0.754   0.754   0.754   0.754
## hat(ITTadj)all 0.742  0.742   0.742   0.742   0.742   0.742   0.742   0.742


missC <- tab_tests(res = res)


pA <- as.character(round(outres$pAnyH.approx2, 4))


tabsim_missC <- get_tabsim(missC = missC, pA = pA, est_names = est_names, stat_names = stat_names,
```

```
    mod.harm = mod.harm, Nsims = Nsims)
```

Table 2: Average classification rates: $avg|\hat{H}|$, $min|\hat{H}|$, and $max|\hat{H}|$, denote the average, minimum, and maximum of the number of subjects in the estimated subgroup $\hat{H}$ (analogously for $\hat{H}^c$). Note that under the null $sens(\hat{H})$ is undefined and $ppv(\hat{H}) = 0$.

	FS_g	FS_{lg}	GRF	GRF_{60}	$VT(24)$	$VT^{\#}(24)$	$VT(36)$	$VT^{\#}(36)$
Finding H								
any(H)	0.95	0.9	0.96	0.73	0.39	0.46	0.36	0.48
$sens(\hat{H})$	0.78	0.66	0.6	0.48	0.3	0.39	0.27	0.43
$sens(\hat{H}^C)$	0.98	0.96	0.92	0.95	0.99	0.99	0.99	0.99
$ppv(\hat{H})$	0.78	0.65	0.53	0.43	0.29	0.38	0.27	0.42
$ppv(\hat{H}^C)$	0.97	0.95	0.94	0.93	0.91	0.92	0.91	0.93
Size of H and H-complement								
$avg|\hat{H}|$	88	90	107	103	92	93	91	92
$min|\hat{H}|$	61	61	60	60	60	60	60	60
$max|\hat{H}|$	220	220	327	228	171	178	185	171
$avg|\hat{H}^C|$	617	619	598	625	664	657	668	656
$min|\hat{H}^C|$	480	480	373	472	529	522	515	529
$max|\hat{H}^C|$	700	700	700	700	700	700	700	700

Note: Number of simulations= 1000 .

Note: Probability approximation= 0.8999 .

```
t.done <- proc.time()[3]
t.min <- (t.done - t.start.all)/60
cat("Minutes and hours to finish", c(t.min, t.min/60), "\n")

## Minutes and hours to finish 26.85643 0.4476072

cat("Minutes and hours per 10,000 to finish", (10000/Nsims) * c(t.min, t.min/60),
    "\n")

## Minutes and hours per 10,000 to finish 268.5643 4.476072

# cat('Machine=',c(Sys.info()[[4]]),'\n') cat('Number of
# cores=',c(detectCores(logical = FALSE)),'\n')
require(benchmarkme)
my_system <- get_cpu()
my_ram <- get_ram()
cat("Running on system:", c(my_system$model_name), "\n")

## Running on system: AMD Ryzen Threadripper PRO 5995WX 64-Cores

cat("with number of cores and cpu/GB=", c(my_system$no_of_cores, round(c(my_ram)/10^9,
    0)), "\n")

## with number of cores and cpu/GB= 128 270
```