

Messina E3: Messina vs ? on APCI

March 30, 2015

1 Preparation

```
library(plyr)
library(ggplot2)

## Loading required package: methods

library(messina)

## Loading required package: survival
## Loading required package: splines

library(maxstat)
library(doMC)

## Loading required package: foreach
## Loading required package: iterators
## Loading required package: parallel

paropts = list(.options.multicore = list(preschedule = FALSE))
```

2 Data preparation

```
load("../biosurv/data/07_data_for_SIS.rda")
APGI.x = x.diag_dsd
APGI.y = y.diag_dsd
APGI.samps = samps.diag_dsd
APGI.feats = data.frame(symbol = rownames(APGI.x))

temp = NA
temp = ls()
rm(list = temp[!(temp %in% c("APGI.x", "APGI.y", "APGI.samps", "APGI.feats"))])

load("../biosurv/data/15_validation.rda")
rm(GSE28735.lingex, GSE21501.lingex)
GSE28735.x = GSE28735.gex
GSE21501.x = GSE21501.gex
GSE28735.feats = GSE28735.feats
GSE21501.feats = GSE21501.feats
rm(GSE28735.gex, GSE21501.gex, GSE28735.feats, GSE21501.feats)
```

```

load("../biosurv/data/validation/tcga-clin-gex.20141118.rda")
TCGA.x = data.merged$paad$gex$Illuminahiseq_rnaseqv2
rownames(TCGA.x) = gsub("\\|.*", "", rownames(TCGA.x))
TCGA.x = TCGA.x[rownames(TCGA.x) != "?",]
TCGA.x = log2(TCGA.x + 1)
temp.time = as.numeric(as.character(data.merged$paad$clin$days_to_death))
temp.time[is.na(temp.time)] = as.numeric(as.character(data.merged$paad$clin$days_to_last_followup[is.na(
TCGA.y = Surv(temp.time, data.merged$paad$clin$vital_status == "Dead")
TCGA.feats = data.frame(symbol = rownames(TCGA.x))
rm(data.merged)

keepMostVariableGeneMeasurement = function(gex, feats, ids)
{
  sds = apply(gex, 1, sd, na.rm = TRUE)
  perm = order(-sds)
  gex = gex[perm,,drop = FALSE]
  feats = feats[perm,,drop = FALSE]
  ids = ids[perm]
  drop = duplicated(ids) | is.null(ids)
  gex = gex[!drop,,drop = FALSE]
  feats = feats[!drop,,drop = FALSE]
  ids = ids[!drop]
  list(gex = gex, feats = feats, ids = ids)
}

# Now moved to the validation function
# regularizeX = function(x)
# {
#   require(robustbase)
#   location = apply(x, 1, median, na.rm = TRUE)
#   scale = apply(x, 1, scaleTau2, na.rm = TRUE)
#   (x - location) / scale
# }

temp = keepMostVariableGeneMeasurement(APGI.x, APGI.feats, APGI.feats$symbol)
APGI.x = temp$gex
APGI.feats = temp$feats
temp = keepMostVariableGeneMeasurement(GSE28735.x, GSE28735.feats, GSE28735.feats$Gene.symbol)
GSE28735.x = temp$gex
GSE28735.feats = temp$feats
temp = keepMostVariableGeneMeasurement(GSE21501.x, GSE21501.feats, GSE21501.feats$Gene.symbol)
GSE21501.x = temp$gex
GSE21501.feats = temp$feats

GSE28735.y = Surv(GSE28735.samp$time, GSE28735.samp$event)
GSE21501.y = Surv(GSE21501.samp$time, GSE21501.samp$event)

# APGI.xreg = regularizeX(APGI.x)
# GSE28735.xreg = regularizeX(GSE28735.x) # This one validated for survsigs
# GSE21501.xreg = regularizeX(GSE21501.x)

```

```

# Temporary testing measure. Probably will be used in real application, but somewhat defeats
# the whole purpose of Messina for testing, so should be removed when comparing vs other methods.
# temp.sel = apply(APGI.x, 1, sd) >= 1 & grepl("^D", rownames(APGI.x))
# APCI.x = APCI.x[temp.sel,,drop = FALSE]
# APCI.feats = APCI.feats[temp.sel,,drop = FALSE]

# messinaSurv(APGI.x, APCI.y, messinaSurvObj.CoxCoef(round(log(2), 3)), parallel = TRUE, silent = FALSE)
# messinaSurv(APGI.x, APCI.y, messinaSurvObj.Tau(0.6), parallel = TRUE, silent = FALSE, seed = 20150321)
# messinaSurv(APGI.x, APCI.y, messinaSurvObj.RelTau(0.7), parallel = TRUE, silent = FALSE, seed = 20150321)

registerDoMC(32)

library(plyr)
APGI.messina.cc2 = messinaSurv(APGI.x, APCI.y, messinaSurvObj.CoxCoef(round(log(2), 3)), parallel = TRUE)

## Performance bootstrapping...
## Final training...

APGI.messina.cc3 = messinaSurv(APGI.x, APCI.y, messinaSurvObj.CoxCoef(round(log(3), 3)), parallel = TRUE)

## Performance bootstrapping...
## Final training...

APGI.messina.tau6 = messinaSurv(APGI.x, APCI.y, messinaSurvObj.Tau(0.6), parallel = TRUE, silent = FALSE)

## Performance bootstrapping...
## Final training...

APGI.messina.tau7 = messinaSurv(APGI.x, APCI.y, messinaSurvObj.Tau(0.7), parallel = TRUE, silent = FALSE)

## Performance bootstrapping...
## Final training...

APGI.messina = APCI.messina.cc2
APGI.maxstat = alply(APGI.x, 1, function(x1) {
  data = data.frame(time = APCI.y[,1], event = APCI.y[,2], x = x1)
  test = try(maxstat.test(Surv(time, event) ~ x, data = data, smethod = "LogRank", pmethod = "HL"))
  result = list(p.value = NA, threshold = NA)
  if (class(test) != "try-error")
  {
    result$p.value = test$p.value
    result$threshold = test$estimate
  }
  result
}, .parallel = TRUE)

print(dim(APGI.x))

## [1] 13000 110

hist(APGI.messina@fits@summary$margin, main = "", xlab = "")

hist(APGI.messina@fits@summary$margin[APGI.messina@fits@summary$passed == TRUE], main = "", xlab = "")

```

```

sum(APGI.messina@fits@summary$passed == TRUE)
## [1] 159

mean(APGI.messina@fits@summary$passed == TRUE)
## [1] 0.01223

sum(APGI.messina@fits@summary$margin >= 1)
## [1] 11

mean(APGI.messina@fits@summary$margin >= 1)
## [1] 0.0008462

sum(APGI.messina@fits@summary$margin >= 1 & APGI.messina@fits@summary$passed == TRUE)
## [1] 8

mean(APGI.messina@fits@summary$margin >= 1 & APGI.messina@fits@summary$passed == TRUE)
## [1] 0.0006154

hist(sapply(APGI.maxstat, function(x) x$p.value), main = "", xlab = "")

hist(log10(sapply(APGI.maxstat, function(x) x$p.value)), main = "", xlab = "")

sum(sapply(APGI.maxstat, function(x) x$p.value) < 0.05, na.rm = TRUE)
## [1] 413

sum(sapply(APGI.maxstat, function(x) x$p.value) < 0.05, na.rm = TRUE) / length(APGI.maxstat)
## [1] 0.03177

APGI.messina
## An object of class MessinaSurvResult
##
## Problem type:survival
## Parameters:
##   An object of class MessinaParameters
##   13000 features, 110 samples.
##   Objective type: survival [messinaSurvObj.CoxCoef(coxcoef_threshold = 0.693)].
##   Minimum group fraction: 0.1
##   Training fraction: 0.8
##   Number of bootstraps: 50
##   Random seed: 20150321
##
## Summary of results:
##   An object of class MessinaFits
##   159 / 13000 features passed performance requirements (1.22%)
##   Top features:
##           Passed Requirements Classifier Type Threshold Value Direction
## KRT6A           TRUE           Threshold           9.503           1

```

```
## ANGPTL4      TRUE      Threshold      8.900      1
## KRT6C        TRUE      Threshold      7.458      1
## IGFBP1       TRUE      Threshold      7.070      1
## FGG          TRUE      Threshold      8.585      1
## LYNX1        TRUE      Threshold      7.020      1
## PPY          TRUE      Threshold     11.931     -1
## LOX          TRUE      Threshold      7.686      1
## DCBLD2       TRUE      Threshold     10.959      1
## CDA          TRUE      Threshold      8.205      1
##             Margin
## KRT6A      3.9988
## ANGPTL4    2.7155
## KRT6C      2.3334
## IGFBP1     1.4736
## FGG        1.3648
## LYNX1      1.3442
## PPY        1.0981
## LOX        1.0514
## DCBLD2     0.9851
## CDA        0.9712
```

```
comb.feats = data.frame(symbol = intersect(GSE28735.feats$Gene.symbol, TCGA.feats$symbol))
comb.x = cbind(GSE28735.x[match(comb.feats$symbol, GSE28735.feats$Gene.symbol),], TCGA.x[match(comb.feats$symbol, TCGA.feats$symbol),])
comb.y = Surv(c(GSE28735.y[,1]/12*365.25, TCGA.y[,1]), c(GSE28735.y[,2], TCGA.y[,2]))
```

```
print(dim(APGI.x))
## [1] 13000  110

print(dim(GSE28735.x))
## [1] 4022   42

print(dim(GSE21501.x))
## [1] 3908  102

print(dim(TCGA.x))
## [1] 20502   58

print(dim(comb.x))
## [1] 3742  100

print(length(intersect(APGI.feats$symbol, GSE28735.feats$Gene.symbol)))
## [1] 2899

print(length(intersect(APGI.feats$symbol, GSE21501.feats$Gene.symbol)))
## [1] 2545

print(length(intersect(APGI.feats$symbol, TCGA.feats$symbol)))
## [1] 11936

print(length(intersect(APGI.feats$symbol, comb.feats$symbol)))
## [1] 2889
```

```

doValidation = function(train.features, train.x, train.threshold, train.merit, min_merit, test.features,
{
  require(robustbase)

  sel.merit = train.merit >= min_merit
  sel.val_avail = train.features %in% test.features
  sel = sel.merit & sel.val_avail
  if (!all(sel.merit) && !all(!sel.merit) && !all(sel.val_avail) && !all(!sel.val_avail))
  {
    print(fisher.test(table(sel.merit, sel.val_avail)))
  }

  val.train.features = train.features[sel]
  val.train.x = train.x[sel,,drop=FALSE]
  val.train.threshold = train.threshold[sel]
  val.train.merit = train.merit[sel]
  val.perm = match(val.train.features, test.features)
  val.test.features = test.features[val.perm]
  val.test.x = test.x[val.perm,,drop=FALSE]

  stopifnot(val.test.features == val.train.features)

  # Translate the threshold on the training x to an approximate equivalent
  # on the test x, by normalization
  locscale.train = apply(val.train.x, 1, function(x) scaleTau2(x[!is.na(x)], mu.too = TRUE))
  loc.train = locscale.train[1,]
  scale.train = locscale.train[2,]

  locscale.test = apply(val.test.x, 1, function(x) scaleTau2(x[!is.na(x)], mu.too = TRUE))
  loc.test = locscale.test[1,]
  scale.test = locscale.test[2,]

  val.test.threshold = (val.train.threshold - loc.train) / scale.train * scale.test + loc.test

  val.chisq = mapply(function(row_index, threshold) {
    if (is.na(threshold)) { return(NA) }
    x = val.test.x[row_index,]
    xd = x > threshold
    xd = xd[!is.na(xd)]
    if (length(xd) == 0 || all(xd) || all(!xd)) { return(NA) }
    fit = survdiff(test.y ~ xd)
    fit$chisq
  }, 1:length(val.test.threshold), val.test.threshold)

  val.abs.hr = sqrt(val.chisq*4/sum(test.y[,2]))

  result = data.frame(merit = val.train.merit, threshold.train = val.train.threshold, threshold.test = val.test.threshold,
rownames(result) = val.test.features
result = result[order(-result$merit),]
result
}

# debug(doValidation)

```

```

val.GSE28735.messina = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$

##
## Fisher's Exact Test for Count Data
##
## data: table(sel.merit, sel.val_avail)
## p-value = 0.01671
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
## 1.13 37.46
## sample estimates:
## odds ratio
## 5.814

val.GSE28735.maxstat = doValidation(as.character(APGI.feats$symbol), APCI.x, sapply(APCI.maxstat, functi

##
## Fisher's Exact Test for Count Data
##
## data: table(sel.merit, sel.val_avail)
## p-value < 2.2e-16
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
## 2.431 3.653
## sample estimates:
## odds ratio
## 2.982

val.GSE21501.messina = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$

##
## Fisher's Exact Test for Count Data
##
## data: table(sel.merit, sel.val_avail)
## p-value = 7.261e-05
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
## 3.701 1290.528
## sample estimates:
## odds ratio
## 28.83

val.GSE21501.maxstat = doValidation(as.character(APGI.feats$symbol), APCI.x, sapply(APCI.maxstat, functi

##
## Fisher's Exact Test for Count Data
##
## data: table(sel.merit, sel.val_avail)
## p-value = 1.805e-10
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
## 1.649 2.540
## sample estimates:
## odds ratio
## 2.051

```

```

val.TCGA.messina = doValidation(as.character(APGI.feats$symbol), APGI.x, APGI.messina@fits@summary$thresh

##
## Fisher's Exact Test for Count Data
##
## data: table(sel.merit, sel.val_avail)
## p-value = 1
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
## 0.152 Inf
## sample estimates:
## odds ratio
## Inf

val.TCGA.maxstat = doValidation(as.character(APGI.feats$symbol), APGI.x, sapply(APGI.maxstat, function(x)

##
## Fisher's Exact Test for Count Data
##
## data: table(sel.merit, sel.val_avail)
## p-value = 0.08234
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
## 0.961 2.318
## sample estimates:
## odds ratio
## 1.46

val.comb.messina = doValidation(as.character(APGI.feats$symbol), APGI.x, APGI.messina@fits@summary$thresh

##
## Fisher's Exact Test for Count Data
##
## data: table(sel.merit, sel.val_avail)
## p-value = 0.01646
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
## 1.136 37.631
## sample estimates:
## odds ratio
## 5.84

val.comb.maxstat = doValidation(as.character(APGI.feats$symbol), APGI.x, sapply(APGI.maxstat, function(x)

##
## Fisher's Exact Test for Count Data
##
## data: table(sel.merit, sel.val_avail)
## p-value < 2.2e-16
## alternative hypothesis: true odds ratio is not equal to 1
## 95 percent confidence interval:
## 2.418 3.633
## sample estimates:
## odds ratio
## 2.965

```



```
print(val.GSE28735.messina)
```

```
##          merit threshold.train threshold.test  chisq abs.hr
## KRT6A    3.999           9.503           4.754 1.6382 0.4753
## ANGPTL4  2.716           8.900           3.754 0.6709 0.3042
## FGG      1.365           8.585          13.796    NA    NA
## PPY      1.098          11.931           4.068 2.5368 0.5915
## LOX      1.051           7.686           6.841 0.4943 0.2611
```

```
print(val.GSE21501.messina)
```

```
##          merit threshold.train threshold.test  chisq abs.hr
## KRT6A    3.999           9.503           3.3849 0.2333 0.11891
## ANGPTL4  2.716           8.900           0.7529 0.1246 0.08691
## KRT6C    2.333           7.458          40.3387    NA    NA
## IGFBP1   1.474           7.070          -4.0458 2.3645 0.37856
## FGG      1.365           8.585           9.7976    NA    NA
## PPY      1.098          11.931           3.8380 0.3419 0.14395
## LOX      1.051           7.686          -0.5062 0.1867 0.10636
```

```
print(val.TCGA.messina)
```

```
##          merit threshold.train threshold.test  chisq abs.hr
## KRT6A    3.999           9.503           3.656 1.4483 0.5838
## ANGPTL4  2.716           8.900           3.336 0.2310 0.2331
## KRT6C    2.333           7.458          16.773    NA    NA
## IGFBP1   1.474           7.070           3.788    NA    NA
## FGG      1.365           8.585          10.219    NA    NA
## LYNX1    1.344           7.020           3.998    NA    NA
## PPY      1.098          11.931           3.969 0.3139 0.2718
## LOX      1.051           7.686           3.602 0.3011 0.2662
```

```
print(val.comb.messina)
```

```
##          merit threshold.train threshold.test  chisq abs.hr
## KRT6A    3.999           9.503           4.029 0.039744 0.05879
## ANGPTL4  2.716           8.900           3.359 0.066278 0.07592
## FGG      1.365           8.585          12.497    NA    NA
## PPY      1.098          11.931           4.015 1.971306 0.41403
## LOX      1.051           7.686           3.810 0.003568 0.01761
```

```
print(val.GSE28735.maxstat)
```

```
##          merit threshold.train threshold.test  chisq abs.hr
## ANGPTL4  4.835           8.356           3.527 1.217e+00 0.40975
## KRT6A    4.450           8.915           4.503 2.180e+00 0.54832
## LOX      4.225           7.502           6.609 5.419e-01 0.27339
## PYGL     3.837           8.829           7.074 2.251e+00 0.55715
## ST6GAL1  3.803           9.542           6.145 1.230e+00 0.41191
## FAM189A2 3.630           6.455           4.052 3.197e-03 0.02100
## KLHL5    3.511           8.978           6.464 2.728e+00 0.61346
## ADM      3.394           8.820           4.730 1.088e+00 0.38741
## E2F7     3.373           6.507           3.854 4.938e+00 0.82532
## SMOX     3.165           7.190           4.852 2.650e-02 0.06045
## KIF20A   3.123           7.250           3.584 2.396e+00 0.57493
## CAPN6    3.073           6.516           4.094 7.537e-01 0.32243
```

## IL20RB	2.994	6.505	3.492	6.901e-01	0.30852
## P4HA1	2.882	9.080	7.426	3.618e-02	0.07064
## FYN	2.854	8.079	6.086	5.064e-01	0.26428
## AURKA	2.850	7.727	3.628	5.199e-01	0.26779
## TCEA3	2.791	8.955	4.898	3.547e+00	0.69941
## LOXL4	2.778	7.628	3.985	4.353e-03	0.02450
## LDHA	2.744	11.922	9.716	6.056e-01	0.28901
## CKAP2L	2.693	7.047	3.898	3.238e+00	0.66834
## PPY	2.628	11.966	4.074	2.537e+00	0.59153
## TREM1	2.588	6.546	5.146	3.641e-01	0.22411
## PLOD1	2.541	10.492	5.802	6.070e-02	0.09150
## CDC20	2.506	8.806	4.385	7.903e-01	0.33017
## PFKP	2.483	9.183	5.636	7.701e-02	0.10307
## ERRFI1	2.364	10.222	8.463	2.657e-02	0.06054
## RGS5	2.303	8.665	6.941	1.157e-01	0.12634
## TPX2	2.283	7.213	4.613	2.342e+00	0.56834
## P4HA2	2.267	9.209	6.579	2.345e+00	0.56868
## SLC15A1	2.242	6.716	5.053	4.828e-01	0.25805
## DPY19L1	2.227	9.183	6.364	3.403e-02	0.06851
## MME	2.227	6.441	4.645	1.425e-01	0.14019
## ATF7IP2	2.212	7.139	5.793	4.623e-02	0.07986
## PAEP	2.186	6.304	5.022	2.214e-01	0.17473
## EPHX2	2.173	7.223	3.637	7.331e-01	0.31800
## KYNU	2.169	7.161	5.370	9.540e-04	0.01147
## FOXM1	2.166	6.884	4.573	5.998e+00	0.90954
## NAMPT	2.159	7.988	10.049	3.699e-01	0.22588
## PLOD2	2.155	10.451	7.593	3.300e+00	0.67467
## UPP1	2.130	9.094	4.411	1.248e+00	0.41484
## KCTD10	2.119	7.907	6.094	3.352e-04	0.00680
## ZNF185	2.105	7.420	3.933	1.060e+00	0.38235
## EDIL3	2.105	6.400	8.217	5.409e-03	0.02731
## NEK2	2.103	8.167	4.426	5.032e-01	0.26344
## LCP1	2.100	8.702	6.629	6.413e+00	0.94049
## GAPDH	2.086	11.336	9.814	1.951e+00	0.51882
## ARSD	2.085	9.970	6.440	2.866e+00	0.62874
## KIF2C	2.080	6.839	3.953	3.629e+00	0.70749
## ENO2	2.069	7.557	5.422	3.748e-02	0.07190
## COL12A1	2.052	8.689	8.314	5.723e-02	0.08884
## VSNL1	2.052	6.712	4.221	2.337e-03	0.01796
## ENTHD1	2.044	6.345	3.130	1.851e-01	0.15977
## CADPS2	2.043	7.892	5.795	3.026e+00	0.64603
## ASPM	1.993	7.916	5.271	9.366e-02	0.11366
## ASAP1	1.993	9.917	7.260	4.509e-02	0.07886
## SPATA18	1.952	7.197	5.264	2.207e+00	0.55180
## KRT18	1.943	12.487	7.917	6.325e-01	0.29538
## POLQ	1.938	6.758	3.609	5.093e+00	0.83813
## FAM3D	1.933	9.474	6.136	2.076e+00	0.53516
## CD109	1.929	6.370	5.959	2.207e-01	0.17446
## UBE2C	1.927	9.305	5.228	1.843e+00	0.50417
## OCLN	1.922	7.722	7.186	5.277e-01	0.26980
## WNK2	1.915	6.293	3.922	2.774e+00	0.61854
## TGFBI	1.912	12.180	8.229	2.750e+00	0.61587
## SPOCK1	1.903	8.915	5.387	7.009e+00	0.98323
## CD300A	1.885	6.707	5.248	1.331e-01	0.13548

## RAVR2	1.856	7.583	5.856	7.799e-01	0.32798
## P2RY8	1.856	7.349	4.024	1.079e-02	0.03858
## A4GNT	1.846	6.439	3.549	1.023e+00	0.37571
## RIMKLB	1.825	7.221	6.093	7.238e-03	0.03160
## ADAM23	1.824	6.394	4.155	7.598e-03	0.03237
## FST	1.820	7.155	4.557	1.088e+00	0.38730
## CA8	1.819	6.429	3.264	1.650e+00	0.47710
## CEP55	1.819	7.985	4.831	1.431e+00	0.44426
## IL1A	1.813	6.266	2.599	1.460e-01	0.14191
## ANLN	1.811	7.020	4.871	3.439e+00	0.68875
## DCBLD2	1.806	10.689	8.544	7.788e+00	1.03647
## PLA2G10	1.795	9.726	4.000	4.374e+00	0.77673
## KLHL13	1.791	6.430	3.543	6.677e-01	0.30348
## STAG3L4	1.784	6.532	4.970	3.087e-01	0.20636
## GOLM1	1.777	6.547	8.986	NA	NA
## F3	1.770	9.228	7.930	4.135e-02	0.07552
## NTS	1.760	6.317	2.643	1.702e+00	0.48451
## TPI1	1.759	10.890	6.342	4.913e-01	0.26033
## PTGES	1.757	7.540	4.722	7.838e-06	0.00104
## IGV10RY-1	1.755	11.809	7.375	2.201e-03	0.01742
## SNAI2	1.753	8.469	6.705	7.687e-02	0.10297
## NFIA	1.727	7.914	5.845	1.255e+00	0.41606
## COL7A1	1.726	8.066	4.932	2.645e+00	0.60395
## FGD6	1.724	6.426	6.617	9.292e-01	0.35800
## MCM4	1.721	7.948	5.209	1.214e+00	0.40916
## TUBA1C	1.720	11.899	6.920	1.285e-02	0.04210
## MELK	1.713	7.288	4.752	2.117e+00	0.54039
## C5orf46	1.700	6.858	2.836	NA	NA
## COL17A1	1.700	10.742	6.042	7.886e-01	0.32980
## PDLIM7	1.691	8.030	6.383	6.057e-01	0.28905
## PTTG1	1.674	9.067	4.939	1.004e+00	0.37213
## DSG2	1.663	10.999	7.174	6.084e+00	0.91609
## COL1A2	1.658	12.989	11.330	1.470e+00	0.45034
## SYNE2	1.657	8.782	7.637	1.589e-01	0.14803
## SERPINH1	1.646	10.187	6.735	2.134e+00	0.54256
## PHLDA1	1.643	9.269	6.348	1.132e+00	0.39517
## CTSE	1.642	11.677	9.666	1.154e+00	0.39904
## ADH1A	1.635	8.432	4.306	3.482e+00	0.69297
## WEE1	1.635	7.480	7.084	1.675e+00	0.48070
## CHEK1	1.623	6.501	4.403	2.718e+00	0.61232
## GSDMC	1.618	6.409	3.565	4.329e+00	0.77272
## SLC2A1	1.615	10.218	7.422	3.749e-03	0.02274
## SERPINB3	1.614	6.324	2.770	1.020e-02	0.03752
## DHRS9	1.609	8.430	4.046	2.091e-01	0.16984
## PPP1R3C	1.597	8.282	5.976	3.812e+00	0.72507
## FLRT3	1.596	9.224	5.713	3.404e+00	0.68522
## CCNB2	1.594	7.685	4.108	1.338e+00	0.42967
## CORO1A	1.593	8.375	5.960	4.792e-03	0.02571
## RHOF	1.591	6.800	4.881	5.617e-01	0.27835
## GRAMD3	1.587	7.707	5.612	7.763e-03	0.03272
## IL33	1.583	7.299	4.397	2.122e-03	0.01711
## AQP1	1.577	7.146	5.848	7.817e-02	0.10384
## VEGFA	1.573	7.090	6.212	1.095e-02	0.03887
## ANGPTL2	1.563	9.897	5.866	1.308e+00	0.42483

## SEMA4A	1.562	7.304	4.697	1.226e-01	0.13004
## GCNT1	1.562	8.263	6.462	2.802e-01	0.19661
## CCL19	1.560	9.155	6.111	2.032e-01	0.16742
## CACHD1	1.555	6.709	5.075	4.289e-03	0.02432
## NCAPG	1.544	7.323	5.149	4.495e-01	0.24900
## FCGR2B	1.536	7.007	4.506	2.784e-02	0.06197
## BOC	1.528	6.805	5.509	3.207e+00	0.66507
## CNIH3	1.513	6.461	4.149	9.764e-01	0.36699
## IL1R2	1.508	8.252	5.522	3.305e+00	0.67523
## ITGA5	1.505	8.100	5.330	7.701e-02	0.10307
## ITM2A	1.504	9.660	5.222	7.935e-01	0.33084
## SLC9A9	1.502	7.348	6.777	2.790e-02	0.06203
## TM4SF19	1.496	6.269	4.532	1.245e+00	0.41442
## JAG1	1.488	9.130	8.263	4.872e+00	0.81979
## FN1	1.486	6.406	11.169	2.450e-02	0.05813
## NRP2	1.484	6.606	8.615	NA	NA
## TNNI2	1.480	6.303	4.497	3.223e-01	0.21086
## APOL1	1.469	6.456	7.103	6.062e-02	0.09144
## KANK4	1.468	7.979	4.247	2.105e-01	0.17040
## RFX2	1.463	6.427	5.086	5.510e-01	0.27568
## DSC2	1.458	6.704	7.468	8.154e+00	1.06049
## KRT17	1.449	10.862	6.923	1.492e+00	0.45370
## ANKLE2	1.448	7.795	6.781	1.866e+00	0.50736
## PRC1	1.445	8.324	5.413	2.803e+00	0.62174
## PPP2R2C	1.443	6.859	3.662	4.825e+00	0.81578
## KIF18A	1.440	6.472	3.550	1.717e+00	0.48658
## NDRG2	1.438	8.691	6.250	2.768e+00	0.61792
## LONRF2	1.437	6.411	4.445	4.865e-01	0.25904
## SEMA3A	1.432	7.328	6.924	1.541e+00	0.46100
## ARHGAP26	1.426	6.622	7.091	3.126e+00	0.65660
## ZBED2	1.424	6.267	4.047	1.361e+00	0.43327
## PCF11	1.422	6.970	5.972	5.690e+00	0.88589
## IGJ	1.420	9.761	10.380	1.711e-02	0.04857
## RGS16	1.419	6.813	5.669	4.387e+00	0.77790
## HRASLS2	1.418	7.346	3.576	1.641e-01	0.15045
## AHCYL2	1.417	8.620	7.190	4.483e+00	0.78637
## TLE4	1.417	8.089	5.644	1.763e-02	0.04932
## CDA	1.416	6.859	4.461	1.855e-01	0.15997
## DNASE1	1.415	6.346	3.864	6.021e-01	0.28818
## DKK1	1.413	9.728	5.287	1.032e+00	0.37731
## CD38	1.405	7.104	6.298	7.484e-01	0.32128
## MALL	1.405	10.388	6.245	3.778e-01	0.22828
## GIMAP2	1.400	7.313	5.276	2.303e+00	0.56357
## GPC3	1.399	7.457	6.106	8.675e-01	0.34592
## SH3RF1	1.391	8.535	6.363	4.798e+00	0.81349
## DUOXA2	1.384	7.261	4.065	3.746e+00	0.71877
## FRMD6	1.379	9.411	7.018	1.674e+00	0.48046
## KNTC1	1.365	7.209	5.133	2.333e+00	0.56731
## TMSB10	1.364	13.721	10.239	9.794e-01	0.36754
## KPNA2	1.356	6.543	6.121	6.968e-01	0.31002
## CST6	1.354	8.451	4.027	1.272e+00	0.41878
## CCNB1	1.353	7.364	5.563	3.176e-01	0.20931
## CD79A	1.350	7.991	4.204	1.653e+00	0.47746
## RAP1GAP	1.346	9.590	3.821	2.320e-01	0.17889

```
## CENPF      1.346      7.209      5.142 5.130e-01 0.26601
## SOD2       1.341      8.755      7.349      NA      NA
## MIF        1.334     12.328      7.195 2.992e-01 0.20314
## GBE1       1.331      7.564      6.499 1.296e+00 0.42285
## MEOX1      1.331      6.748      4.334 3.263e-02 0.06709
## KIF14      1.322      6.914      3.835 3.222e+00 0.66666
## TRNP1      1.319     10.665      5.963 4.984e-03 0.02622
## FGG        1.319      8.010     10.996      NA      NA
## MUC16      1.312      6.930      3.937 1.296e-01 0.13368
## DYNC2H1    1.312      7.510      6.309 4.117e+00 0.75355
## MMP10      1.307      6.412      2.984 6.057e-01 0.28904
## LETM2      1.306      6.642      4.413 6.681e-01 0.30356
```

```
print(val.GSE21501.maxstat)
```

```
##      merit threshold.train threshold.test      chisq      abs.hr
## ANGPTL4 4.835      8.356      0.19587 6.865e-01 0.203971
## KRT6A   4.450      8.915      2.97484 2.615e-02 0.039811
## LOX     4.225      7.502     -0.79221 1.058e+00 0.253245
## KRT6C   4.215      6.392      5.59238      NA      NA
## ST6GAL1 3.803      9.542      0.78319 5.739e-01 0.186504
## FAM189A2 3.630      6.455      0.28808 7.248e-01 0.209584
## ADM     3.394      8.820     -1.66023 7.681e+00 0.682307
## E2F7    3.373      6.507     -2.26972 1.101e+01 0.816993
## CAPN6   3.073      6.516      0.58777 1.934e+00 0.342376
## IL20RB  2.994      6.505      0.27819 2.890e+00 0.418499
## FGF13   2.837      6.400     -0.33980 2.197e+00 0.364889
## TCEA3   2.791      8.955      0.67789 4.561e+00 0.525732
## LOXL4   2.778      7.628      0.96728 4.499e-01 0.165118
## TMEM26  2.688      6.692      0.77037 4.695e-02 0.053341
## BIRC5   2.643      7.334     -1.61111 4.021e+00 0.493655
## CD70    2.632      6.748     -0.60306 5.035e-01 0.174694
## PPY     2.628     11.966      3.85564 7.804e-01 0.217485
## TREM1   2.588      6.546      2.12235 4.167e+00 0.502511
## IGFBP1  2.466      7.076     -4.02812 1.675e+00 0.318579
## ERFFI1  2.364     10.222      0.59119 1.790e+01 1.041655
## RGS5    2.303      8.665      4.26999 5.369e+00 0.570428
## PHACTR3 2.275      6.884      1.98393 1.343e+00 0.285312
## MME     2.227      6.441     -1.58576 2.189e-01 0.115175
## PRDM16  2.206      6.605      3.97296 1.839e+00 0.333875
## PAEP    2.186      6.304      0.77117 4.242e-01 0.160333
## EPHX2   2.173      7.223      0.03016 4.564e-01 0.166306
## KYNU    2.169      7.161     -1.99673 3.795e-01 0.151662
## NAMPT   2.159      7.988      0.11528 1.970e+00 0.345539
## PLOD2   2.155     10.451      0.06961 8.655e-02 0.072425
## EDIL3   2.105      6.400      4.24471 1.304e+00 0.281169
## NEK2    2.103      8.167     -1.80395 4.750e+00 0.536570
## LCP1    2.100      8.702     -1.84614 2.896e+00 0.418967
## COL12A1 2.052      8.689      1.83301 3.053e-01 0.136032
## VSNL1   2.052      6.712     -1.64740 1.529e-01 0.096261
## ENTHD1  2.044      6.345      1.75682 2.632e-01 0.126309
## PCDH20  2.003      7.551      3.99419 1.354e+00 0.286499
## ASPM    1.993      7.916     -0.07079 1.759e+00 0.326534
## CATSPER1 1.956      6.371      0.89696 1.486e+00 0.300113
```

## KRT18	1.943	12.487	0.25249	1.552e+00	0.306688
## FAM3D	1.933	9.474	5.30834	6.346e+00	0.620176
## CD109	1.929	6.370	-0.49431	4.737e-01	0.169441
## UBE2C	1.927	9.305	-1.15748	2.006e+00	0.348648
## OCLN	1.922	7.722	2.27334	3.056e+00	0.430370
## TGFBI	1.912	12.180	1.17508	7.810e-02	0.068799
## SPOCK1	1.903	8.915	-0.07385	3.241e-02	0.044319
## P2RY2	1.899	6.885	2.53729	5.626e-01	0.184657
## RAVR2	1.856	7.583	0.05711	4.701e-01	0.168793
## P2RY8	1.856	7.349	0.52845	1.882e+00	0.337727
## A4GNT	1.846	6.439	3.40057	8.431e-01	0.226048
## APOA4	1.823	6.333	-1.04560	3.747e-01	0.150698
## CEP55	1.819	7.985	-0.77283	1.442e-03	0.009348
## IL1A	1.813	6.266	-0.13329	2.483e-02	0.038792
## ANLN	1.811	7.020	-2.66571	1.547e-01	0.096836
## DCBLD2	1.806	10.689	0.63766	4.607e+00	0.528400
## PLA2G10	1.795	9.726	3.52033	1.519e-01	0.095962
## GOLM1	1.777	6.547	4.36321	3.484e+00	0.459532
## F3	1.770	9.228	3.33470	7.961e-01	0.219662
## NTS	1.760	6.317	-5.02906	1.450e+00	0.296467
## SNAI2	1.753	8.469	0.96462	2.333e+00	0.376030
## COL7A1	1.726	8.066	-0.65725	1.243e+00	0.274511
## FGD6	1.724	6.426	1.00560	2.874e-02	0.041738
## NFIX	1.713	9.904	1.57937	1.036e+00	0.250572
## C5orf46	1.700	6.858	1.16807	5.466e+00	0.575554
## COL17A1	1.700	10.742	4.24593	2.682e-01	0.127500
## VSTM2L	1.679	7.078	2.67464	2.975e-01	0.134266
## COL1A2	1.658	12.989	3.96788	4.629e-03	0.016750
## SERPINH1	1.646	10.187	0.16779	4.575e+00	0.526550
## CTSE	1.642	11.677	7.26038	3.184e+00	0.439271
## TNFRSF6B	1.638	7.634	3.32680	6.004e-01	0.190757
## ADH1A	1.635	8.432	2.32552	1.282e+00	0.278749
## CHEK1	1.623	6.501	-3.47669	7.154e-02	0.065844
## SLC2A1	1.615	10.218	-0.52907	5.130e-01	0.176320
## SERPINB3	1.614	6.324	0.71096	4.767e-01	0.169980
## DHRS9	1.609	8.430	1.56562	2.307e+00	0.373911
## PPP1R3C	1.597	8.282	0.52826	8.428e-05	0.002260
## FLRT3	1.596	9.224	3.15856	2.789e+00	0.411136
## CCNB2	1.594	7.685	-0.56249	1.099e+00	0.258023
## CXCR5	1.589	6.681	7.98854	NA	NA
## IL33	1.583	7.299	4.11799	2.212e-02	0.036611
## AQP1	1.577	7.146	3.32621	1.330e-01	0.089783
## TNFRSF17	1.573	7.032	12.81828	NA	NA
## VEGFA	1.573	7.090	-0.39754	2.750e-01	0.129105
## GCNT1	1.562	8.263	1.40450	6.109e-02	0.060848
## CCL19	1.560	9.155	5.98546	9.945e-01	0.245510
## ADRA1B	1.546	6.285	0.12758	3.060e+00	0.430671
## CAV2	1.540	8.562	1.61441	2.749e+00	0.408156
## FCGR2B	1.536	7.007	1.56740	9.048e-01	0.234173
## MRAP2	1.532	7.684	0.29126	2.912e-01	0.132852
## CCL3L3	1.524	6.799	1.79960	1.696e+00	0.320563
## CNIH3	1.513	6.461	0.57543	1.041e+00	0.251233
## IL1R2	1.508	8.252	3.85019	2.006e-01	0.110265
## ITM2A	1.504	9.660	-0.78323	1.336e+00	0.284577

##	SLC9A9	1.502	7.348	3.46665	9.579e-02	0.076192
##	FN1	1.486	6.406	0.04531	3.830e-01	0.152356
##	SOX8	1.486	7.496	0.79012	5.370e-03	0.018041
##	NRP2	1.484	6.606	5.28797	NA	NA
##	TNNI2	1.480	6.303	-1.30119	7.253e+00	0.662984
##	HES1	1.479	8.112	1.10294	4.000e-01	0.155700
##	KCNH2	1.476	6.778	0.69336	2.375e+00	0.379430
##	APOL1	1.469	6.456	0.79884	2.381e-02	0.037989
##	KANK4	1.468	7.979	1.54307	1.052e-01	0.079839
##	KRT17	1.449	10.862	1.84873	3.034e+00	0.428807
##	PPP2R2C	1.443	6.859	-0.11054	1.115e-01	0.082189
##	KIF18A	1.440	6.472	-2.19452	1.770e-01	0.103563
##	LONRF2	1.437	6.411	-1.25358	1.612e+00	0.312580
##	SEMA3A	1.432	7.328	0.13548	6.067e-01	0.191751
##	ARHGAP26	1.426	6.622	1.86500	5.095e-01	0.175719
##	ZBED2	1.424	6.267	2.24266	7.387e-01	0.211587
##	SPOCD1	1.422	6.904	1.25823	5.807e+00	0.593238
##	IGJ	1.420	9.761	1.21379	3.078e-01	0.136571
##	RGS16	1.419	6.813	1.94034	2.366e-01	0.119752
##	HRASLS2	1.418	7.346	4.41621	2.843e-01	0.131273
##	AHCYL2	1.417	8.620	1.74374	4.884e+00	0.544052
##	DNASE1	1.415	6.346	0.03199	5.313e-02	0.056746
##	DKK1	1.413	9.728	0.52018	1.947e+00	0.343491
##	CD38	1.405	7.104	2.18938	7.635e-01	0.215108
##	MALL	1.405	10.388	3.83833	5.231e-01	0.178049
##	FGF18	1.397	6.280	1.94601	3.342e-03	0.014232
##	ZNF365	1.390	7.180	2.32667	3.166e-01	0.138525
##	FRMD6	1.379	9.411	1.01822	1.170e-02	0.026633
##	TK1	1.375	8.114	-1.37859	4.348e+00	0.513363
##	CST6	1.354	8.451	4.65564	2.530e-01	0.123838
##	CD79A	1.350	7.991	2.33695	7.925e-02	0.069304
##	RAP1GAP	1.346	9.590	0.53578	8.878e-03	0.023196
##	CENPF	1.346	7.209	-2.07887	2.536e+00	0.392078
##	SOD2	1.341	8.755	-0.40747	6.928e-01	0.204903
##	MEOX1	1.331	6.748	0.96369	5.732e-01	0.186382
##	KIF14	1.322	6.914	-1.85459	3.210e-01	0.139485
##	TRNP1	1.319	10.665	3.20514	9.527e-04	0.007599
##	FGG	1.319	8.010	6.42581	NA	NA
##	CBX1	1.317	6.644	0.09649	4.679e-01	0.168403
##	MUC16	1.312	6.930	-1.13833	1.513e-01	0.095769
##	DYNC2H1	1.312	7.510	0.47423	6.089e-03	0.019209
##	GATA6	1.310	6.470	3.72622	2.664e+00	0.401788
##	MMP10	1.307	6.412	1.44298	3.202e-02	0.044051

```
print(val.TCGA.maxstat)
```

##	merit	threshold.train	threshold.test	chisq	abs.hr	
##	ANGPTL4	4.835	8.356	3.2506	8.573e-02	0.142030
##	B3GALTL	4.586	6.747	3.1744	4.692e-01	0.332277
##	KRT6A	4.450	8.915	3.5365	2.464e+00	0.761458
##	LOX	4.225	7.502	3.5709	6.397e-01	0.387968
##	KRT6C	4.215	6.392	3.9993	NA	NA
##	PFKFB4	4.140	7.004	3.0053	3.090e-01	0.269623
##	CIDEC	3.851	7.623	3.0437	2.472e-01	0.241173

## PYGL	3.837	8.829	3.4693	2.323e+00	0.739303
## ST6GAL1	3.803	9.542	3.6540	4.597e-02	0.104006
## FAM189A2	3.630	6.455	2.8347	6.560e-01	0.392865
## RPIA	3.527	7.988	3.2886	1.041e+00	0.494966
## KLHL5	3.511	8.978	3.4314	8.833e-01	0.455900
## LYNX1	3.490	6.603	3.5629	3.300e+01	2.786522
## TRAPPC2	3.466	8.229	3.2071	5.559e-01	0.361659
## ZNF565	3.451	6.532	2.8439	9.433e-01	0.471122
## ADM	3.394	8.820	3.0578	1.290e+00	0.550837
## E2F7	3.373	6.507	2.8931	3.369e+00	0.890337
## KTI12	3.278	7.949	3.1614	1.803e+00	0.651319
## UFC1	3.264	9.787	3.5679	1.613e-01	0.194826
## HJURP	3.180	6.967	3.1594	2.203e+00	0.719982
## SMOX	3.165	7.190	3.2938	2.054e-01	0.219816
## KIF20A	3.123	7.250	3.1635	8.137e-01	0.437564
## ELMOD3	3.075	7.298	3.2690	2.506e-01	0.242803
## NACC2	3.073	6.578	2.7790	3.077e-02	0.085091
## CAPN6	3.073	6.516	3.1289	3.945e+00	0.963493
## IL20RB	2.994	6.505	2.6696	6.952e-01	0.404444
## CARHSP1	2.993	10.451	3.5607	2.610e+00	0.783592
## P4HA1	2.882	9.080	3.5537	8.216e-01	0.439679
## FYN	2.854	8.079	3.5020	2.393e-01	0.237278
## AURKA	2.850	7.727	3.1350	1.347e+00	0.562947
## FGF13	2.837	6.400	2.8910	2.202e-02	0.071977
## TCEA3	2.791	8.955	3.2703	1.672e+00	0.627186
## LOXL4	2.778	7.628	3.2741	1.007e+00	0.486752
## LDHA	2.744	11.922	3.8200	1.032e-01	0.155810
## SLAMF9	2.730	6.346	1.9189	2.350e+00	0.743553
## GOLPH3L	2.729	7.859	3.4711	1.324e-01	0.176470
## DEFB123	2.716	6.326	NaN	NA	NA
## SLC30A3	2.696	6.399	1.5633	2.190e+00	0.717762
## CKAP2L	2.693	7.047	3.0517	5.679e+00	1.155938
## TMEM26	2.688	6.692	2.8280	5.494e-05	0.003595
## BIRC5	2.643	7.334	3.1152	1.436e+00	0.581364
## IFT140	2.638	6.438	3.3541	3.296e-03	0.027850
## CD70	2.632	6.748	2.6457	3.625e-03	0.029205
## PPY	2.628	11.966	3.9751	3.139e-01	0.271774
## LRRFIP2	2.624	7.861	3.4000	5.492e-01	0.359463
## TREM1	2.588	6.546	3.0622	8.990e-01	0.459927
## LYRM1	2.548	9.343	3.2709	5.861e-03	0.037136
## PLOD1	2.541	10.492	3.6442	6.590e-01	0.393765
## ATP50	2.538	11.228	3.6003	7.877e-01	0.430499
## CDC20	2.506	8.806	3.2186	4.668e-01	0.331426
## ARHGEF19	2.486	6.695	3.1074	2.975e+00	0.836710
## PFKP	2.483	9.183	3.5533	2.849e-01	0.258895
## AURKB	2.470	6.963	3.0300	1.073e+00	0.502561
## IGFBP1	2.466	7.076	3.7990	NA	NA
## VPS29	2.464	9.524	3.3949	1.012e-01	0.154339
## PHF21A	2.423	8.261	3.3828	1.254e-01	0.171748
## PDCD2L	2.416	7.446	2.9782	4.223e-01	0.315233
## FAH	2.413	7.260	3.2812	6.847e-02	0.126932
## PLIN3	2.391	11.237	3.6267	2.658e-01	0.250069
## SLC15A4	2.382	9.055	3.4043	1.492e+00	0.592598
## NOTCH1	2.378	7.822	3.4138	6.490e+00	1.235773

##	ERRFI1	2.364	10.222	3.7131	2.452e+00	0.759630
##	RFX4	2.360	6.318	0.6094	3.735e+00	0.937419
##	RGS5	2.303	8.665	3.6868	2.529e+00	0.771462
##	COL5A3	2.294	6.444	3.3676	2.353e+00	0.744144
##	PTPRM	2.289	7.564	3.4899	1.177e+00	0.526291
##	SOBP	2.285	7.318	3.2145	1.427e+00	0.579445
##	TPX2	2.283	7.213	3.4056	5.839e+00	1.172127
##	PHACTR3	2.275	6.884	2.7109	4.422e+00	1.020010
##	P4HA2	2.267	9.209	3.5563	8.348e-01	0.443197
##	IKBIP	2.252	6.947	3.3099	1.815e-01	0.206659
##	DHRS11	2.249	7.620	3.0378	2.263e+00	0.729748
##	SLC15A1	2.242	6.716	3.2639	2.503e-01	0.242659
##	BMS1	2.234	9.010	3.4895	4.549e-02	0.103453
##	DPY19L1	2.227	9.183	3.5265	1.193e-01	0.167516
##	MME	2.227	6.441	3.1336	1.430e+00	0.580049
##	ARMC7	2.218	7.589	3.2933	1.957e-03	0.021460
##	ATF7IP2	2.212	7.139	3.2603	1.696e+00	0.631663
##	PRDM16	2.206	6.605	3.2494	1.055e-01	0.157519
##	TRIM54	2.197	8.060	3.1774	2.177e+00	0.715766
##	PAEP	2.186	6.304	3.5895	NA	NA
##	TM9SF3	2.181	9.973	3.8034	7.033e-01	0.406800
##	TARBP2	2.175	6.959	3.2777	1.864e+00	0.662262
##	EPHX2	2.173	7.223	3.1924	1.516e-04	0.005973
##	SGSM1	2.171	6.631	2.9490	2.006e-02	0.068698
##	KYNU	2.169	7.161	3.1598	8.082e-01	0.436070
##	FOXMI	2.166	6.884	3.3186	3.181e-01	0.273580
##	NAMPT	2.159	7.988	3.6866	5.716e-01	0.366727
##	PLOD2	2.155	10.451	3.5670	2.931e-01	0.262627
##	TTC13	2.144	7.827	3.3152	6.849e-01	0.401449
##	UPP1	2.130	9.094	3.3237	9.579e-02	0.150132
##	KCTD10	2.119	7.907	3.5420	5.250e-01	0.351483
##	ZNF185	2.105	7.420	3.2864	1.071e+00	0.502018
##	EDIL3	2.105	6.400	3.5273	3.943e+00	0.963201
##	KCNQ3	2.104	6.635	2.5387	7.679e-01	0.425055
##	NEK2	2.103	8.167	3.1637	1.973e-01	0.215456
##	LCP1	2.100	8.702	3.5387	9.984e-03	0.048469
##	CFL1	2.088	12.385	3.9427	4.260e-01	0.316604
##	GAPDH	2.086	11.336	4.0228	1.957e+00	0.678555
##	ARSD	2.085	9.970	3.6909	5.880e-01	0.371959
##	PGBD3	2.085	6.454	2.9488	1.496e-01	0.187636
##	KIF2C	2.080	6.839	3.2058	4.434e-01	0.322993
##	ENO2	2.069	7.557	3.4295	1.791e+00	0.649226
##	ABLIM1	2.063	9.734	3.6850	1.090e+00	0.506472
##	RFC5	2.053	7.876	3.1563	2.165e+00	0.713759
##	COL12A1	2.052	8.689	3.7775	5.110e-01	0.346739
##	VSNL1	2.052	6.712	2.9368	7.472e-01	0.419295
##	ENTHD1	2.044	6.345	2.9963	3.341e-01	0.280367
##	CADPS2	2.043	7.892	3.3495	7.356e-02	0.131561
##	GARS	2.035	10.140	3.5755	1.141e+00	0.518191
##	SCYL2	2.021	8.564	3.4991	2.646e-01	0.249525
##	PCDH20	2.003	7.551	3.5025	NA	NA
##	ARFGAP3	2.001	8.794	3.5346	1.388e-01	0.180722
##	ASPM	1.993	7.916	3.3218	6.506e+00	1.237243
##	ASAP1	1.993	9.917	3.5695	1.304e+00	0.553869

## RPS4X	1.964	11.441	3.9567	9.396e-01	0.470206
## CATSPER1	1.956	6.371	2.4825	2.207e-01	0.227857
## SPATA18	1.952	7.197	3.2489	1.300e-01	0.174924
## GLOD5	1.944	6.455	2.9064	NA	NA
## KRT18	1.943	12.487	3.8944	9.596e-01	0.475165
## POLQ	1.938	6.758	2.9372	3.382e-01	0.282094
## FAM3D	1.933	9.474	3.6956	5.202e-01	0.349841
## CD109	1.929	6.370	3.4720	2.027e+00	0.690548
## UBE2C	1.927	9.305	3.2822	6.069e-01	0.377876
## OCLN	1.922	7.722	3.4377	7.736e-01	0.426651
## IRF2BP1	1.915	7.100	3.3272	1.025e-01	0.155301
## WNK2	1.915	6.293	3.3750	3.541e-01	0.288642
## TGFBI	1.912	12.180	3.8654	7.781e+00	1.353089
## RPL22	1.904	7.535	3.8000	7.946e-01	0.432385
## SPOCK1	1.903	8.915	3.5262	7.123e+00	1.294646
## ABHD5	1.902	6.876	3.3126	1.184e+00	0.527738
## P2RY2	1.899	6.885	2.9708	1.667e+00	0.626317
## GATC	1.896	6.590	2.8045	3.130e-01	0.271389
## FAIM2	1.891	6.411	3.0889	2.126e-01	0.223650
## DYNLL2	1.887	7.492	3.4929	3.124e+00	0.857392
## CD300A	1.885	6.707	3.2155	4.593e-02	0.103952
## GAB2	1.881	7.897	3.4618	2.567e+00	0.777131
## SPATS2	1.870	7.594	3.3907	3.015e+00	0.842265
## BAMBI	1.869	8.351	3.1289	8.300e-01	0.441922
## RAVR2	1.856	7.583	3.3692	4.196e-01	0.314207
## P2RY8	1.856	7.349	3.4846	NA	NA
## ACTR6	1.854	8.483	3.2930	1.554e+00	0.604611
## STAT5B	1.852	6.899	3.5432	1.469e+00	0.587841
## A4GNT	1.846	6.439	4.1193	NA	NA
## PQBP1	1.842	8.110	3.4243	2.566e-02	0.077710
## CGB5	1.839	6.293	2.1368	1.209e+00	0.533442
## TMEM91	1.839	7.342	2.8389	1.924e-02	0.067285
## SEPW1	1.835	10.598	3.7110	1.520e-01	0.189133
## EIF2AK3	1.832	7.163	3.4123	6.456e-03	0.038977
## RIMKLB	1.825	7.221	3.3330	7.642e-02	0.134092
## ADAM23	1.824	6.394	3.1013	3.619e+00	0.922777
## APOA4	1.823	6.333	1.1187	2.832e-01	0.258131
## FST	1.820	7.155	2.9354	1.577e-01	0.192604
## CA8	1.819	6.429	2.9970	4.371e-01	0.320695
## CEP55	1.819	7.985	3.2909	1.853e+00	0.660291
## IL1A	1.813	6.266	2.3296	3.748e-01	0.296967
## ANLN	1.811	7.020	3.2911	2.084e+00	0.700274
## DCBLD2	1.806	10.689	3.6675	1.241e+00	0.540286
## PLA2G10	1.795	9.726	2.9673	3.689e+00	0.931728
## KLHL13	1.791	6.430	2.8886	9.688e-01	0.477455
## ATP5G1	1.786	9.631	3.3717	1.065e-01	0.158287
## STAG3L4	1.784	6.532	2.9777	2.411e-03	0.023820
## GOLM1	1.777	6.547	3.9934	3.130e-01	0.271389
## FAM120AOS	1.776	8.186	3.4890	3.801e-01	0.299062
## OAZ1	1.771	13.408	3.8313	1.149e+00	0.519866
## F3	1.770	9.228	3.6677	1.306e-01	0.175272
## SSBP1	1.769	10.404	3.4807	4.902e+00	1.074000
## CDK2	1.768	7.675	3.3169	4.595e+00	1.039748
## NTS	1.760	6.317	2.1570	1.333e-01	0.177128

## EXOSC8	1.760	8.069	3.2073	2.864e+00	0.820929
## TPI1	1.759	10.890	3.7702	3.363e-01	0.281299
## PTGES	1.757	7.540	3.2485	6.087e+00	1.196743
## SNAI2	1.753	8.469	3.4439	4.045e+00	0.975574
## TUBA1B	1.753	12.783	3.9004	2.600e-01	0.247341
## TMEM169	1.751	6.319	2.6845	8.908e-01	0.457812
## NMB	1.750	7.677	3.0834	2.543e-02	0.077360
## DLEU2L	1.730	6.438	1.4591	2.510e-01	0.243015
## NFIA	1.727	7.914	3.4562	4.141e-01	0.312152
## COL7A1	1.726	8.066	3.5331	1.415e+00	0.576970
## FGD6	1.724	6.426	3.4307	1.327e-01	0.176734
## MCM4	1.721	7.948	3.4194	3.085e+00	0.851936
## TUBA1C	1.720	11.899	3.7057	8.785e-01	0.454660
## FOXS1	1.718	7.298	3.1583	3.589e+00	0.918911
## TIMM13	1.713	6.409	3.5505	5.202e-01	0.349841
## NFIX	1.713	9.904	3.5989	2.572e-01	0.245994
## MELK	1.713	7.288	3.0206	1.295e+00	0.551965
## SLC25A46	1.712	7.935	3.3419	1.689e+00	0.630326
## TRIB3	1.710	7.122	3.1145	1.058e-01	0.157806
## KLC1	1.709	7.622	3.5027	2.145e-02	0.071045
## TOB2	1.709	7.447	3.6045	7.112e-01	0.409081
## OBFC1	1.706	9.217	3.3905	4.077e-03	0.030972
## C5orf46	1.700	6.858	2.3104	1.826e+00	0.655543
## COL17A1	1.700	10.742	3.6286	3.295e+00	0.880553
## POLR3B	1.699	7.293	3.1060	4.297e-02	0.100550
## PPP4C	1.699	9.693	3.5507	6.037e-01	0.376880
## KCTD11	1.698	6.786	3.3416	1.220e-02	0.053583
## PDLIM7	1.691	8.030	3.5801	3.449e-01	0.284874
## XP01	1.681	9.811	3.7021	1.323e+00	0.558032
## RPA2	1.681	9.943	3.4610	1.183e+00	0.527666
## VSTM2L	1.679	7.078	3.2831	1.323e+01	1.764412
## ATP6V1E2	1.679	6.546	2.7694	3.848e-01	0.300899
## GABPB1	1.676	6.984	3.2742	8.025e-02	0.137415
## FRMD8	1.676	9.351	3.5294	7.264e-01	0.413428
## PTTG1	1.674	9.067	3.1726	6.096e-01	0.378737
## DERA	1.666	9.876	3.3371	2.186e+00	0.717239
## DSG2	1.663	10.999	3.7350	5.492e-03	0.035949
## FER	1.659	6.659	2.9500	1.287e+00	0.550215
## COL1A2	1.658	12.989	4.1898	4.774e-01	0.335168
## SYNE2	1.657	8.782	3.7798	1.771e+00	0.645537
## TTC39B	1.653	6.774	3.0458	3.997e-02	0.096982
## GINS2	1.647	7.556	3.0632	1.103e+00	0.509499
## SERPINH1	1.646	10.187	3.7895	2.717e+00	0.799492
## PHLDA1	1.643	9.269	3.6421	2.007e+00	0.687157
## CTSE	1.642	11.677	4.0112	1.076e+00	0.503110
## APOM	1.642	6.378	2.4521	1.841e-01	0.208154
## TNFRSF6B	1.638	7.634	3.4588	1.304e-01	0.175139
## ADH1A	1.635	8.432	2.0811	3.883e+00	0.955813
## WEE1	1.635	7.480	3.3728	1.980e+00	0.682477
## SERTAD2	1.633	8.744	3.3991	3.244e-01	0.276278
## A4GALT	1.632	7.607	3.3175	2.700e+00	0.797073
## CHEK1	1.623	6.501	2.9954	2.896e+00	0.825527
## GSDMC	1.618	6.409	2.7840	1.252e+01	1.716380
## PHOSPHO2	1.615	7.216	2.8894	4.778e-01	0.335309

##	SLC2A1	1.615	10.218	3.6658	2.558e-01	0.245342
##	AKR1A1	1.614	10.293	3.6156	2.043e+00	0.693248
##	SERPINB3	1.614	6.324	2.4993	3.611e-01	0.291477
##	DHRS9	1.609	8.430	3.1080	8.923e-01	0.458209
##	MARCKSL1	1.603	10.942	3.7662	4.572e-02	0.103721
##	GFPT1	1.602	9.027	3.7192	5.682e-01	0.365642
##	PPP1R3C	1.597	8.282	3.2787	1.401e-01	0.181559
##	FLRT3	1.596	9.224	3.4412	8.624e+00	1.424499
##	CCNB2	1.594	7.685	3.1023	2.564e+00	0.776753
##	CORO1A	1.593	8.375	3.6365	0.000e+00	0.000000
##	RHOF	1.591	6.800	3.5103	8.463e-01	0.446251
##	CXCR5	1.589	6.681	5.4576	NA	NA
##	GRAMD3	1.587	7.707	3.3124	1.174e+00	0.525599
##	SASH3	1.583	7.268	3.5271	0.000e+00	0.000000
##	IL33	1.583	7.299	3.6988	NA	NA
##	TSTD1	1.581	8.076	3.2918	2.819e-01	0.257566
##	COX4I2	1.578	6.452	2.5804	1.407e+00	0.575305
##	AQP1	1.577	7.146	3.7407	3.122e+00	0.857117
##	TNFRSF17	1.573	7.032	7.4590	NA	NA
##	VEGFA	1.573	7.090	3.5544	3.458e-01	0.285265
##	EMILIN2	1.572	7.921	3.2903	4.992e-01	0.342728
##	CSNK1D	1.568	8.679	3.6515	5.638e-02	0.115178
##	ANGPTL2	1.563	9.897	3.6227	3.061e+00	0.848679
##	SPAG9	1.563	8.322	3.6142	1.919e-01	0.212508
##	SEMA4A	1.562	7.304	3.3571	7.670e-01	0.424825
##	GCNT1	1.562	8.263	3.5100	4.923e-02	0.107626
##	CCL19	1.560	9.155	3.8134	NA	NA
##	RNF149	1.557	10.704	3.5503	7.575e-01	0.422181
##	CAMK1G	1.556	7.801	2.8927	3.130e-01	0.271389
##	CACHD1	1.555	6.709	3.2188	4.548e-02	0.103442
##	FAM169B	1.552	6.268	2.1272	1.453e+00	0.584794
##	SYN2	1.552	6.331	2.6110	1.833e+00	0.656755
##	ADRA1B	1.546	6.285	2.1524	6.290e+00	1.216557
##	NCAPG	1.544	7.323	3.1988	4.007e-02	0.097094
##	OSBPL5	1.543	7.918	3.4081	1.661e-02	0.062517
##	CAV2	1.540	8.562	3.6245	8.222e-01	0.439837
##	TRAPPC6A	1.540	8.912	3.3258	2.175e-01	0.226243
##	VPS35	1.539	10.444	3.6960	6.849e-01	0.401449
##	FCGR2B	1.536	7.007	3.1525	3.158e-01	0.272586
##	C19orf47	1.536	6.652	3.2430	1.438e-01	0.183921
##	MRAP2	1.532	7.684	3.1330	1.103e+00	0.509517
##	MRPS33	1.532	9.331	3.3606	7.158e-02	0.129778
##	BOC	1.528	6.805	3.6609	3.130e-01	0.271389
##	CCL3L3	1.524	6.799	0.7756	1.376e+00	0.568924
##	MCM10	1.521	6.595	2.8382	1.840e+00	0.658027
##	SLC22A4	1.520	6.613	2.7837	1.846e-02	0.065908
##	ITPKB	1.519	7.192	3.4426	3.062e-02	0.084883
##	CNIH3	1.513	6.461	3.0495	2.842e+00	0.817696
##	PLAGL2	1.510	7.073	3.3044	4.281e-03	0.031737
##	IL1R2	1.508	8.252	3.1741	1.933e+00	0.674380
##	STC2	1.507	7.442	3.3382	2.482e-04	0.007642
##	ITGA5	1.505	8.100	3.6009	1.259e+00	0.544304
##	ITM2A	1.504	9.660	3.4624	1.643e-01	0.196617
##	SLC9A9	1.502	7.348	3.3847	NA	NA

## RSAD1	1.500	6.717	3.3316	2.884e-02	0.082381
## RANBP10	1.499	7.007	3.3615	9.914e-01	0.482992
## RGAG4	1.497	6.348	3.2581	8.273e-02	0.139519
## TM4SF19	1.496	6.269	2.1759	1.526e-01	0.189505
## MECP2	1.495	6.370	3.4877	8.243e+00	1.392690
## RGS14	1.490	6.541	3.4589	2.506e-01	0.242803
## SCT	1.490	6.268	1.9659	7.850e-01	0.429767
## RAB11FIP4	1.490	6.362	3.4024	2.042e+00	0.693151
## GLTP	1.489	10.014	3.4471	2.688e-01	0.251504
## JAG1	1.488	9.130	3.7151	1.140e+00	0.517873
## FN1	1.486	6.406	4.1583	1.094e+00	0.507401
## SOX8	1.486	7.496	2.9507	1.771e+00	0.645480
## NRP2	1.484	6.606	3.9807	NA	NA
## C16orf59	1.483	6.608	3.0110	NA	NA
## TNNI2	1.480	6.303	2.4835	3.190e+00	0.866368
## HES1	1.479	8.112	3.4743	1.145e-01	0.164164
## KCNH2	1.476	6.778	3.5749	0.000e+00	0.000000
## FAM20B	1.475	9.647	3.5856	6.189e-01	0.381599
## POC1A	1.473	7.413	2.9964	7.401e-01	0.417296
## RBM47	1.472	10.429	3.6613	1.269e-03	0.017282
## APOL1	1.469	6.456	3.7246	8.069e-02	0.137787
## KANK4	1.468	7.979	3.1972	3.089e+00	0.852566
## ADAMTS7	1.467	6.317	3.1483	1.054e+00	0.497924
## LCNL1	1.467	6.408	2.2455	0.000e+00	0.000000
## RFX2	1.463	6.427	3.3350	NA	NA
## DSC2	1.458	6.704	3.5360	4.807e-02	0.106354
## PTPN21	1.457	6.447	3.3866	5.584e-01	0.362487
## CCDC121	1.454	6.453	2.8292	4.352e-02	0.101190
## KRT17	1.449	10.862	3.7948	1.167e+00	0.524061
## ANKLE2	1.448	7.795	3.5327	8.997e-03	0.046009
## ZSCAN16	1.445	7.056	2.9421	3.290e-01	0.278245
## PRC1	1.445	8.324	3.3555	7.716e-01	0.426097
## PPP2R2C	1.443	6.859	3.1352	9.240e-01	0.466263
## CCDC90B	1.440	9.441	3.3297	1.109e+00	0.510862
## KIF18A	1.440	6.472	2.9976	1.531e+00	0.600248
## XPA	1.439	7.021	3.1874	6.163e-01	0.380798
## NDRG2	1.438	8.691	3.5555	2.986e+00	0.838269
## LONRF2	1.437	6.411	3.1302	4.640e+00	1.044914
## KIAA0513	1.433	7.095	3.3885	8.800e+00	1.438917
## SEMA3A	1.432	7.328	3.3191	2.982e+00	0.837583
## ARHGAP26	1.426	6.622	3.5689	6.208e-01	0.382204
## ZBED2	1.424	6.267	2.6404	9.202e-02	0.147144
## SNORA68	1.423	6.324	NaN	NA	NA
## PCF11	1.422	6.970	3.4366	7.438e-01	0.418331
## SPOCD1	1.422	6.904	3.1989	6.114e-02	0.119945
## IGJ	1.420	9.761	3.8954	6.425e-01	0.388814
## RGS16	1.419	6.813	3.3425	1.120e+00	0.513269
## DCUN1D5	1.419	7.784	3.1239	2.984e-01	0.264975
## HRASLS2	1.418	7.346	3.1936	4.853e-01	0.337908
## AHCYL2	1.417	8.620	3.6455	2.709e-01	0.252452
## TLE4	1.417	8.089	3.4041	6.532e-01	0.392041
## CDA	1.416	6.859	3.0503	7.147e-01	0.410084
## PTGER1	1.416	6.400	1.7094	1.127e-03	0.016286
## DNASE1	1.415	6.346	2.8686	1.812e-01	0.206457

## DKK1	1.413	9.728	3.5504	6.462e+00	1.233034
## CCNI	1.410	12.338	3.7065	1.898e+00	0.668194
## ZNF788	1.406	6.627	2.8865	2.915e+00	0.828111
## CIB1	1.405	11.636	3.5823	1.276e-01	0.173254
## CD38	1.405	7.104	3.5357	NA	NA
## MALL	1.405	10.388	3.6083	2.075e+00	0.698798
## MRPL24	1.403	9.794	3.4134	3.915e-02	0.095974
## GIMAP2	1.400	7.313	3.2329	1.574e-01	0.192432
## PTPRCAP	1.400	7.459	3.4644	0.000e+00	0.000000
## GPC3	1.399	7.457	3.5336	NA	NA
## FGF18	1.397	6.280	2.3996	5.912e+00	1.179396
## SH3RF1	1.391	8.535	3.6129	3.130e-01	0.271389
## P4HTM	1.391	8.083	3.3394	4.300e-02	0.100585
## ZXDA	1.390	6.544	2.7996	4.335e-02	0.101001
## ZNF365	1.390	7.180	3.0792	5.040e-01	0.344382
## PTTG3P	1.389	8.174	1.3959	2.946e-02	0.083250
## DUOXA2	1.384	7.261	3.1782	5.090e-01	0.346085
## PPP1R10	1.384	7.704	3.5441	1.649e+00	0.622812
## TMED1	1.381	9.202	3.3875	1.928e+00	0.673559
## HAUS4	1.380	8.015	3.3994	5.073e-01	0.345498
## FRMD6	1.379	9.411	3.6192	3.917e+00	0.960074
## TK1	1.375	8.114	3.3818	1.019e-01	0.154873
## PRKRA	1.369	9.033	3.3912	6.142e+00	1.202155
## PIWIL2	1.366	6.375	2.6387	6.065e+00	1.194548
## KNTC1	1.365	7.209	3.2118	5.172e-01	0.348844
## PRMT7	1.364	6.754	3.3088	1.487e+00	0.591449
## TMSB10	1.364	13.721	3.9436	4.097e+00	0.981826
## CNFN	1.364	6.450	1.9003	1.866e-01	0.209518
## MID1	1.362	7.791	3.3494	7.003e-01	0.405927
## SPIN4	1.362	7.786	3.0949	5.783e-02	0.116648
## HSCB	1.362	6.783	3.0437	4.520e-03	0.032611
## CRYZL1	1.361	7.822	3.2180	7.182e-02	0.129996
## MCCC1	1.359	7.845	3.3359	3.093e-01	0.269770
## KPNA2	1.356	6.543	3.3935	6.906e-03	0.040310
## LMF1	1.356	6.510	3.3279	8.111e-01	0.436848
## CST6	1.354	8.451	3.2431	1.109e-01	0.161542
## CCNB1	1.353	7.364	3.3303	5.580e-01	0.362330
## WDR61	1.352	8.848	3.3552	1.219e-01	0.169356
## CD79A	1.350	7.991	3.4026	3.533e-01	0.288315
## RAP1GAP	1.346	9.590	3.5257	7.116e-01	0.409185
## CENPF	1.346	7.209	3.4310	1.761e+00	0.643672
## SOD2	1.341	8.755	3.6848	1.821e-02	0.065458
## SPEF1	1.335	6.303	1.5753	2.478e-03	0.024147
## MIF	1.334	12.328	3.6243	9.961e-04	0.015309
## GBE1	1.331	7.564	3.3502	2.602e+00	0.782409
## MEOX1	1.331	6.748	3.1246	2.389e+00	0.749702
## KIF14	1.322	6.914	3.0420	5.273e-01	0.352235
## TRNP1	1.319	10.665	3.5686	3.309e-01	0.279039
## FGG	1.319	8.010	8.4072	NA	NA
## CBX1	1.317	6.644	3.4502	9.520e-01	0.473279
## C1QTNF6	1.314	7.167	3.3009	1.953e-02	0.067794
## MUC16	1.312	6.930	3.1071	1.980e+00	0.682496
## DYNC2H1	1.312	7.510	3.4248	4.562e+00	1.036084
## CDCA5	1.312	7.784	3.1680	1.464e+00	0.587001

```
## GATA6      1.310      6.470      3.4487 5.841e-01 0.370721
## MMP10      1.307      6.412      2.8272 5.747e-01 0.367722
## LETM2      1.306      6.642      3.1564 4.691e+00 1.050626
## ANGEL2     1.301      8.493      3.3331 3.981e+00 0.967808
```

```
print(val.comb.maxstat)
```

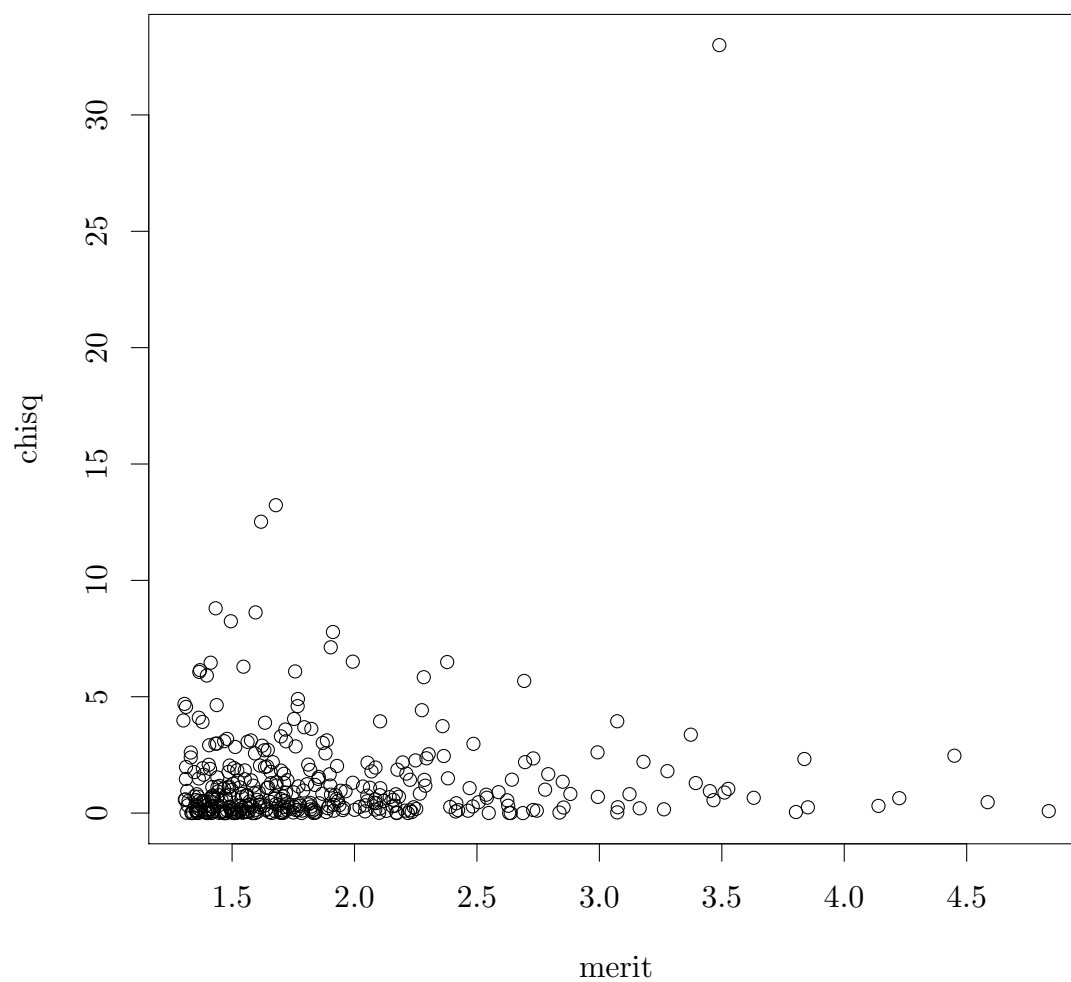
```
##      merit threshold.train threshold.test      chisq      abs.hr
## ANGPTL4 4.835      8.356      3.210 0.0004978 0.006579
## KRT6A   4.450      8.915      3.844 0.1986036 0.131415
## LOX     4.225      7.502      3.674 0.7779826 0.260097
## PYGL    3.837      8.829      3.749 0.0035678 0.017614
## ST6GAL1 3.803      9.542      3.897 0.0035678 0.017614
## FAM189A2 3.630      6.455      3.141 0.1145970 0.099825
## KLHL5   3.511      8.978      3.436 0.3554151 0.175800
## ADM     3.394      8.820      2.480      NA      NA
## E2F7    3.373      6.507      3.226 2.0068826 0.417746
## SMOX     3.165      7.190      3.061      NA      NA
## KIF20A   3.123      7.250      3.215 9.8111520 0.923658
## CAPN6    3.073      6.516      3.026 3.8052088 0.575228
## IL20RB   2.994      6.505      2.897 2.9543186 0.506850
## P4HA1    2.882      9.080      3.664 0.3896693 0.184077
## FYN      2.854      8.079      3.627 0.0035678 0.017614
## AURKA    2.850      7.727      3.251 2.3172761 0.448890
## TCEA3    2.791      8.955      2.794      NA      NA
## LOXL4    2.778      7.628      3.277 0.3821183 0.182285
## LDHA     2.744     11.922      3.593      NA      NA
## CKAP2L   2.693      7.047      3.391 5.7916593 0.709664
## PPY      2.628     11.966      4.021 1.9713060 0.414026
## TREM1    2.588      6.546      3.178 0.0007441 0.008044
## PLOD1    2.541     10.492      3.522      NA      NA
## CDC20    2.506      8.806      3.501 0.0187455 0.040374
## PFKP     2.483      9.183      3.236      NA      NA
## ERFFI1   2.364     10.222      3.697 0.8531713 0.272376
## RGS5     2.303      8.665      3.744 0.2652384 0.151869
## TPX2     2.283      7.213      3.573 2.6441369 0.479505
## P4HA2    2.267      9.209      3.663 0.0253982 0.046995
## SLC15A1  2.242      6.716      3.477 0.0144333 0.035427
## DPY19L1  2.227      9.183      3.721 0.0035678 0.017614
## MME      2.227      6.441      3.198 1.0129642 0.296789
## ATF7IP2  2.212      7.139      3.843 0.0117813 0.032007
## PAEP     2.186      6.304      6.323 0.0004239 0.006071
## EPHX2    2.173      7.223      3.219 0.0086576 0.027438
## KYNU     2.169      7.161      2.993 0.8499361 0.271859
## FOXM1    2.166      6.884      3.573 0.0187455 0.040374
## NAMPT    2.159      7.988      3.765 0.0055932 0.022054
## PLOD2    2.155     10.451      3.540 1.4408075 0.353960
## UPP1     2.130      9.094      3.431 0.0119443 0.032228
## KCTD10   2.119      7.907      3.504 0.1981721 0.131272
## ZNF185   2.105      7.420      2.953 0.2493545 0.147251
## EDIL3    2.105      6.400      4.043 0.0035678 0.017614
## NEK2     2.103      8.167      3.437 0.0269672 0.048425
## LCP1     2.100      8.702      3.003      NA      NA
## GAPDH    2.086     11.336      4.025 1.6997840 0.384457
```

## ARSD	2.085	9.970	4.143	0.0035678	0.017614
## KIF2C	2.080	6.839	3.346	4.1336140	0.599537
## ENO2	2.069	7.557	3.319	0.6803431	0.243229
## COL12A1	2.052	8.689	3.651	0.1334730	0.107733
## VSNL1	2.052	6.712	3.189	0.3629304	0.177649
## ENTHD1	2.044	6.345	3.456	1.2111259	0.324523
## CADPS2	2.043	7.892	3.059	NA	NA
## ASPM	1.993	7.916	3.672	0.7472457	0.254908
## ASAP1	1.993	9.917	3.743	0.0035678	0.017614
## SPATA18	1.952	7.197	3.612	0.0035678	0.017614
## KRT18	1.943	12.487	3.907	0.1040003	0.095097
## POLQ	1.938	6.758	3.104	3.1628186	0.524431
## FAM3D	1.933	9.474	4.640	0.8060879	0.264754
## CD109	1.929	6.370	3.608	0.6577033	0.239148
## UBE2C	1.927	9.305	3.709	0.0387531	0.058050
## OCLN	1.922	7.722	3.772	0.0035678	0.017614
## WNK2	1.915	6.293	3.616	0.0147675	0.035835
## TGFBI	1.912	12.180	4.166	0.0035678	0.017614
## SPOCK1	1.903	8.915	3.713	0.0012165	0.010285
## CD300A	1.885	6.707	2.896	0.2493545	0.147251
## RAVR2	1.856	7.583	3.603	0.0035678	0.017614
## P2RY8	1.856	7.349	3.669	0.0038305	0.018251
## A4GNT	1.846	6.439	3.903	0.1930676	0.129570
## RIMKLB	1.825	7.221	3.626	0.0035678	0.017614
## ADAM23	1.824	6.394	3.503	0.1240432	0.103857
## FST	1.820	7.155	3.631	0.0777217	0.082210
## CA8	1.819	6.429	3.051	0.0207083	0.042435
## CEP55	1.819	7.985	3.585	0.2196926	0.138216
## IL1A	1.813	6.266	2.414	3.2140638	0.528662
## ANLN	1.811	7.020	3.296	2.9263997	0.504450
## DCBLD2	1.806	10.689	4.054	0.0035678	0.017614
## PLA2G10	1.795	9.726	2.891	6.1589803	0.731822
## KLHL13	1.791	6.430	2.972	1.1928161	0.322061
## STAG3L4	1.784	6.532	3.123	0.0035678	0.017614
## GOLM1	1.777	6.547	4.739	0.0035678	0.017614
## F3	1.770	9.228	3.714	0.0299218	0.051009
## NTS	1.760	6.317	2.615	1.2101170	0.324388
## TPI1	1.759	10.890	3.769	0.1625755	0.118899
## PTGES	1.757	7.540	3.135	1.4880021	0.359710
## SNAI2	1.753	8.469	3.661	0.0465868	0.063648
## NFIA	1.727	7.914	3.435	0.9401856	0.285929
## COL7A1	1.726	8.066	4.218	0.0035678	0.017614
## FGD6	1.724	6.426	3.383	0.0365754	0.056396
## MCM4	1.721	7.948	3.516	0.5868460	0.225898
## TUBA1C	1.720	11.899	3.793	0.0193417	0.041011
## MELK	1.713	7.288	3.073	0.6315674	0.234348
## C5orf46	1.700	6.858	2.286	1.4935441	0.360380
## COL17A1	1.700	10.742	3.743	0.8917474	0.278466
## PDLIM7	1.691	8.030	3.542	1.6147019	0.374712
## PTTG1	1.674	9.067	3.255	0.1179884	0.101291
## DSG2	1.663	10.999	3.707	0.3781192	0.181328
## COL1A2	1.658	12.989	4.359	0.0035678	0.017614
## SYNE2	1.657	8.782	3.997	0.0035678	0.017614
## SERPINH1	1.646	10.187	3.821	0.0767611	0.081700

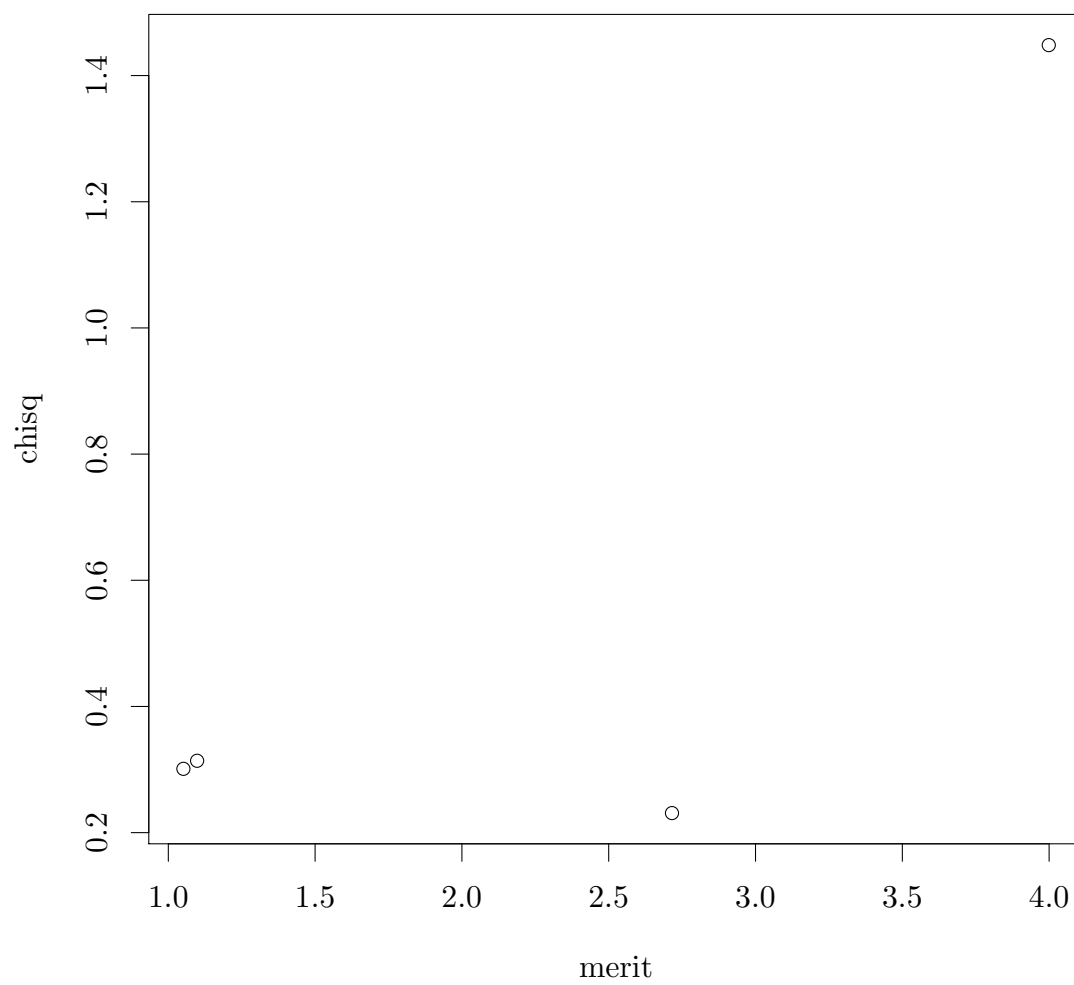
##	PHLDA1	1.643	9.269	3.609	0.7263754	0.251323
##	CTSE	1.642	11.677	4.511	0.1313074	0.106855
##	ADH1A	1.635	8.432	2.255	5.7185177	0.705168
##	WEE1	1.635	7.480	3.472	0.0051318	0.021124
##	CHEK1	1.623	6.501	2.964	2.0411068	0.421293
##	GSDMC	1.618	6.409	3.172	1.9526594	0.412064
##	SLC2A1	1.615	10.218	3.468	0.6944135	0.245731
##	SERPINB3	1.614	6.324	2.609	0.7094777	0.248382
##	DHRS9	1.609	8.430	3.057	0.1852770	0.126929
##	PPP1R3C	1.597	8.282	3.707	0.0035678	0.017614
##	FLRT3	1.596	9.224	4.159	0.0365977	0.056413
##	CCNB2	1.594	7.685	3.093	1.5509773	0.367243
##	CORO1A	1.593	8.375	4.110	0.1313074	0.106855
##	RHOF	1.591	6.800	4.028	0.1766016	0.123922
##	GRAMD3	1.587	7.707	3.244	0.5462400	0.217943
##	IL33	1.583	7.299	3.943	0.0767047	0.081670
##	AQP1	1.577	7.146	3.665	4.3477251	0.614868
##	VEGFA	1.573	7.090	3.251	NA	NA
##	ANGPTL2	1.563	9.897	3.893	0.0035678	0.017614
##	SEMA4A	1.562	7.304	3.776	0.0035678	0.017614
##	GCNT1	1.562	8.263	4.202	0.0035678	0.017614
##	CCL19	1.560	9.155	4.688	0.4375669	0.195062
##	CACHD1	1.555	6.709	3.451	0.0035678	0.017614
##	NCAPG	1.544	7.323	3.496	0.3771344	0.181092
##	FCGR2B	1.536	7.007	2.674	0.2493545	0.147251
##	BOC	1.528	6.805	4.264	1.0965857	0.308796
##	CNIH3	1.513	6.461	3.359	0.3495024	0.174332
##	IL1R2	1.508	8.252	3.348	0.1222745	0.103114
##	ITGA5	1.505	8.100	3.339	NA	NA
##	ITM2A	1.504	9.660	3.937	2.7945851	0.492958
##	SLC9A9	1.502	7.348	4.240	0.5297471	0.214628
##	TM4SF19	1.496	6.269	2.413	1.0614479	0.303809
##	JAG1	1.488	9.130	3.880	0.0035678	0.017614
##	FN1	1.486	6.406	4.287	0.9023623	0.280118
##	NRP2	1.484	6.606	5.636	0.0289729	0.050193
##	TNNI2	1.480	6.303	2.624	0.2263211	0.140286
##	APOL1	1.469	6.456	3.585	0.7158484	0.249495
##	KANK4	1.468	7.979	3.566	0.0143186	0.035286
##	RFX2	1.463	6.427	4.172	0.0290013	0.050218
##	DSC2	1.458	6.704	3.648	0.0348408	0.055042
##	KRT17	1.449	10.862	4.109	0.0035678	0.017614
##	ANKLE2	1.448	7.795	3.476	0.8543086	0.272558
##	PRC1	1.445	8.324	3.444	0.3926359	0.184776
##	PPP2R2C	1.443	6.859	3.277	0.3334814	0.170289
##	KIF18A	1.440	6.472	3.101	1.8010981	0.395749
##	NDRG2	1.438	8.691	3.463	3.9168427	0.583605
##	LONRF2	1.437	6.411	2.928	2.4085775	0.457648
##	SEMA3A	1.432	7.328	4.192	0.0227839	0.044511
##	ARHGAP26	1.426	6.622	3.754	0.0035678	0.017614
##	ZBED2	1.424	6.267	2.992	1.5608576	0.368411
##	PCF11	1.422	6.970	3.221	NA	NA
##	IGJ	1.420	9.761	4.703	0.0035678	0.017614
##	RGS16	1.419	6.813	3.285	0.4896111	0.206337
##	HRASLS2	1.418	7.346	3.407	0.0139895	0.034878

##	AHCYL2	1.417	8.620	4.069	0.0035678	0.017614
##	TLE4	1.417	8.089	3.660	0.0035678	0.017614
##	CDA	1.416	6.859	3.104	0.9922819	0.293744
##	DNASE1	1.415	6.346	3.262	0.0396133	0.058691
##	DKK1	1.413	9.728	4.178	1.0779753	0.306165
##	CD38	1.405	7.104	5.417	0.1183433	0.101443
##	MALL	1.405	10.388	3.522	0.9229104	0.283290
##	GIMAP2	1.400	7.313	3.256	0.2906574	0.158980
##	GPC3	1.399	7.457	4.365	0.8516055	0.272126
##	SH3RF1	1.391	8.535	3.939	0.0035678	0.017614
##	DUOXA2	1.384	7.261	3.159	0.1074942	0.096682
##	FRMD6	1.379	9.411	3.892	0.0035678	0.017614
##	KNTC1	1.365	7.209	3.297	0.2084770	0.134642
##	TMSB10	1.364	13.721	3.928	1.7809633	0.393531
##	KPNA2	1.356	6.543	3.098	NA	NA
##	CST6	1.354	8.451	3.637	0.0206769	0.042403
##	CCNB1	1.353	7.364	3.535	0.0035678	0.017614
##	CD79A	1.350	7.991	3.860	0.4292865	0.193208
##	RAP1GAP	1.346	9.590	3.507	0.9101503	0.281325
##	CENPF	1.346	7.209	3.636	0.2196926	0.138216
##	SOD2	1.341	8.755	3.332	NA	NA
##	MIF	1.334	12.328	3.756	0.0033418	0.017047
##	GBE1	1.331	7.564	3.393	1.1336603	0.313973
##	MEOX1	1.331	6.748	3.342	0.0774991	0.082092
##	KIF14	1.322	6.914	3.173	2.7780473	0.491497
##	TRNP1	1.319	10.665	3.917	0.0035678	0.017614
##	FGG	1.319	8.010	10.080	NA	NA
##	MUC16	1.312	6.930	3.052	2.2390182	0.441245
##	DYNC2H1	1.312	7.510	3.561	0.0035678	0.017614
##	MMP10	1.307	6.412	2.883	0.0371326	0.056824
##	LETM2	1.306	6.642	3.934	0.0431692	0.061269

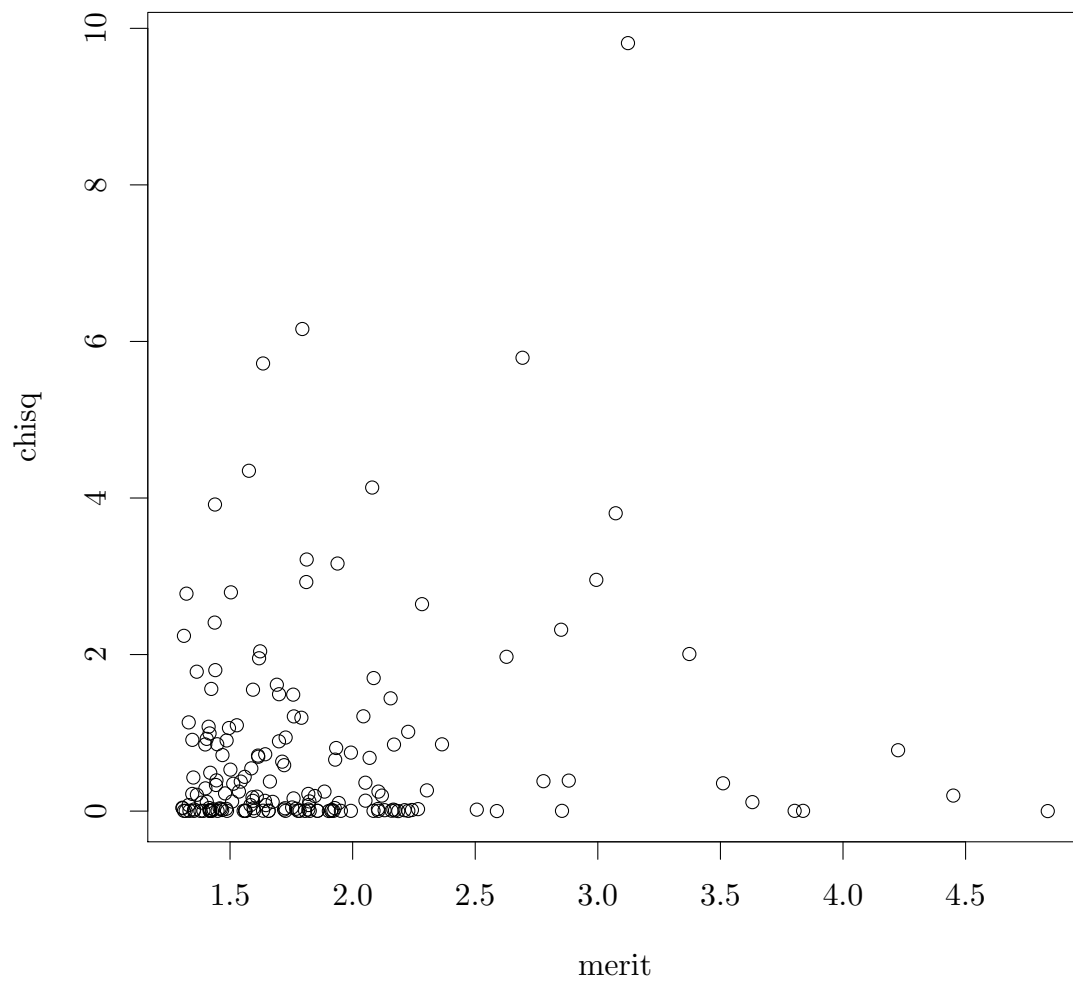
```
plot(chisq ~ merit, val.TCGA.maxstat)
```



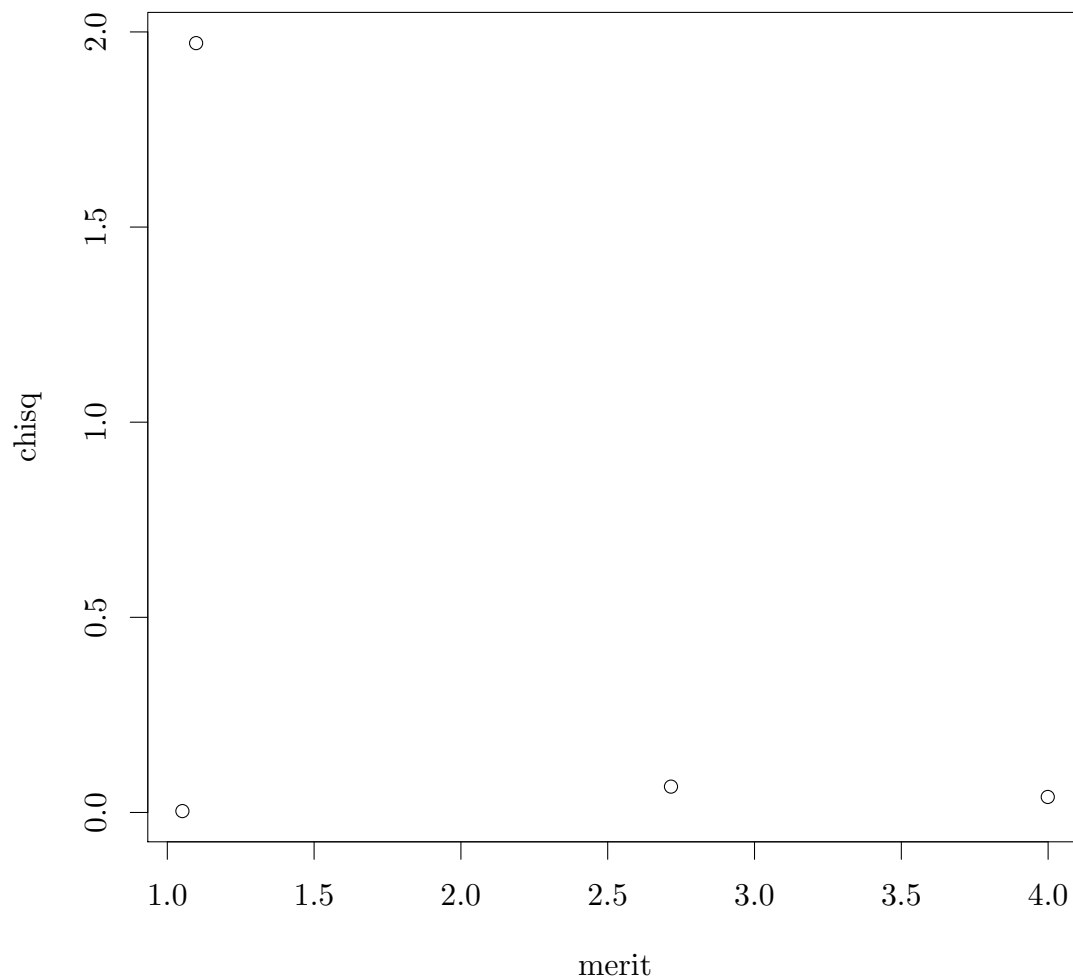
```
plot(chisq ~ merit, val.TCGA.messina)
```



```
plot(chisq ~ merit, val.comb.maxstat)
```



```
plot(chisq ~ merit, val.comb.messina)
```



```
library(messina)
library(ggplot2)
# library(doMC)
# registerDoMC(4)
# temp.fit.messina = messinaSurv(APGI.x[c("KRT6A", "ANGPTL4", "KRT6C"),], APGI.y, messinaSurvObj.CoxCoe
print(APGI.messina)

## An object of class MessinaSurvResult
##
## Problem type:survival
## Parameters:
##   An object of class MessinaParameters
##   13000 features, 110 samples.
##   Objective type: survival [messinaSurvObj.CoxCoef(coxcoef_threshold = 0.693)].
##   Minimum group fraction: 0.1
##   Training fraction: 0.8
##   Number of bootstraps: 50
##   Random seed: 20150321
##
## Summary of results:
##   An object of class MessinaFits
##   159 / 13000 features passed performance requirements (1.22%)
##   Top features:
```

```

##           Passed Requirements Classifier Type Threshold Value Direction
## KRT6A                TRUE      Threshold          9.503          1
## ANGPTL4              TRUE      Threshold          8.900          1
## KRT6C                TRUE      Threshold          7.458          1
## IGFBP1              TRUE      Threshold          7.070          1
## FGG                 TRUE      Threshold          8.585          1
## LYNX1               TRUE      Threshold          7.020          1
## PPY                 TRUE      Threshold         11.931         -1
## LOX                 TRUE      Threshold          7.686          1
## DCBLD2              TRUE      Threshold         10.959          1
## CDA                 TRUE      Threshold          8.205          1
##           Margin
## KRT6A          3.9988
## ANGPTL4        2.7155
## KRT6C          2.3334
## IGFBP1         1.4736
## FGG            1.3648
## LYNX1          1.3442
## PPY            1.0981
## LOX            1.0514
## DCBLD2         0.9851
## CDA            0.9712

pdf("07_E3_best.pdf", height = 10, width = 10)
# plot(APGI.messina, indices = 1:3)
# plot(APGI.messina, indices = 1:3, bootstrap_type = "ci")

i = which(rownames(APGI.messina@fits@summary) == "KRT6A")
print(messina::messinaSurvObjPlot(APGI.messina, i) + geom_rug(aes(x = x), data = data.frame(x = APCI.x)))
## Warning: Removed 2 rows containing missing values (geom_path).

print(messina::messinaSurvKMplot(y = APCI.y, group = (APCI.x["KRT6A",] > APCI.messina@fits@summary$threshold))
print(messina::messinaSurvKMplot(y = APCI.y, group = (APCI.x["KRT6A",] > APCI.messina@fits@summary$threshold))
print(messina::messinaSurvKMplot(y = APCI.y, group = (APCI.x["KRT6A",] > APCI.messina@fits@summary$threshold))

i = which(rownames(APGI.messina@fits@summary) == "ANGPTL4")
print(messina::messinaSurvObjPlot(APGI.messina, i) + geom_rug(aes(x = x), data = data.frame(x = APCI.x)))
## Warning: Removed 2 rows containing missing values (geom_path).

print(messina::messinaSurvKMplot(y = APCI.y, group = (APCI.x["ANGPTL4",] > APCI.messina@fits@summary$threshold))
print(messina::messinaSurvKMplot(y = APCI.y, group = (APCI.x["ANGPTL4",] > APCI.messina@fits@summary$threshold))
print(messina::messinaSurvKMplot(y = APCI.y, group = (APCI.x["ANGPTL4",] > APCI.messina@fits@summary$threshold))

i = which(rownames(APGI.messina@fits@summary) == "KRT6C")
print(messina::messinaSurvObjPlot(APGI.messina, i) + geom_rug(aes(x = x), data = data.frame(x = APCI.x)))
## Warning: Removed 2 rows containing missing values (geom_path).

print(messina::messinaSurvKMplot(y = APCI.y, group = (APCI.x["KRT6C",] > APCI.messina@fits@summary$threshold))
print(messina::messinaSurvKMplot(y = APCI.y, group = (APCI.x["KRT6C",] > APCI.messina@fits@summary$threshold))
print(messina::messinaSurvKMplot(y = APCI.y, group = (APCI.x["KRT6C",] > APCI.messina@fits@summary$threshold))

dev.off()

## pdf
## 2

```

```

val.GSE28735.messina = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$
val.GSE28735.maxstat = doValidation(as.character(APGI.feats$symbol), APCI.x, sapply(APGI.maxstat, functi
val.GSE21501.messina = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$
val.GSE21501.maxstat = doValidation(as.character(APGI.feats$symbol), APCI.x, sapply(APGI.maxstat, functi
val.TCGA.messina = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$thre
val.TCGA.maxstat = doValidation(as.character(APGI.feats$symbol), APCI.x, sapply(APGI.maxstat, function(x
val.comb.messina = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$thre
val.comb.maxstat = doValidation(as.character(APGI.feats$symbol), APCI.x, sapply(APGI.maxstat, function(x
val.GSE28735.messina2 = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$
val.GSE21501.messina2 = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$
val.TCGA.messina2 = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$thre
val.comb.messina2 = doValidation(as.character(APGI.feats$symbol), APCI.x, APCI.messina@fits@summary$thre

print(val.GSE28735.messina[val.GSE28735.messina$merit >= 1,])

##          merit threshold.train threshold.test  chisq abs.hr
## KRT6A      3.999          9.503          4.754 1.6382 0.4753
## ANGPTL4    2.716          8.900          3.754 0.6709 0.3042
## FGG        1.365          8.585         13.796      NA      NA
## PPY        1.098         11.931          4.068 2.5368 0.5915
## LOX        1.051          7.686          6.841 0.4943 0.2611

print(val.GSE21501.messina[val.GSE21501.messina$merit >= 1,])

##          merit threshold.train threshold.test  chisq abs.hr
## KRT6A      3.999          9.503          3.3849 0.2333 0.11891
## ANGPTL4    2.716          8.900          0.7529 0.1246 0.08691
## KRT6C      2.333          7.458         40.3387      NA      NA
## IGFBP1     1.474          7.070         -4.0458 2.3645 0.37856
## FGG        1.365          8.585          9.7976      NA      NA
## PPY        1.098         11.931          3.8380 0.3419 0.14395
## LOX        1.051          7.686         -0.5062 0.1867 0.10636

print(val.TCGA.messina[val.TCGA.messina$merit >= 1,])

##          merit threshold.train threshold.test  chisq abs.hr
## KRT6A      3.999          9.503          3.656 1.4483 0.5838
## ANGPTL4    2.716          8.900          3.336 0.2310 0.2331
## KRT6C      2.333          7.458         16.773      NA      NA
## IGFBP1     1.474          7.070          3.788      NA      NA
## FGG        1.365          8.585         10.219      NA      NA
## LYNX1      1.344          7.020          3.998      NA      NA
## PPY        1.098         11.931          3.969 0.3139 0.2718
## LOX        1.051          7.686          3.602 0.3011 0.2662

print(val.comb.messina[val.comb.messina$merit >= 1,])

##          merit threshold.train threshold.test  chisq abs.hr
## KRT6A      3.999          9.503          4.029 0.039744 0.05879
## ANGPTL4    2.716          8.900          3.359 0.066278 0.07592
## FGG        1.365          8.585         12.497      NA      NA
## PPY        1.098         11.931          4.015 1.971306 0.41403
## LOX        1.051          7.686          3.810 0.003568 0.01761

print(val.GSE28735.messina2[val.GSE28735.messina2$merit >= 1,])

```



```
##      merit threshold.train threshold.test   chisq abs.hr
## KRT6A  3.999           9.503           4.754 1.638186 0.47535
## ANGPTL4 2.716           8.900           3.754 0.670894 0.30420
## DHRS9   1.468           8.965           4.404 0.007037 0.03116
## FGG     1.365           8.585          13.796      NA      NA
## PPY     1.098          11.931           4.068 2.536840 0.59153
## LOX     1.051           7.686           6.841 0.494314 0.26112
## IL20RB  1.043           6.971           4.060 0.435502 0.24509
```

```
print(val.GSE21501.messina2[val.GSE21501.messina2$merit >= 1,])
```

```
##      merit threshold.train threshold.test   chisq abs.hr
## KRT6A  3.999           9.503           3.3849 0.2333 0.11891
## ANGPTL4 2.716           8.900           0.7529 0.1246 0.08691
## KRT6C   2.333           7.458          40.3387      NA      NA
## IGFBP1  1.474           7.070          -4.0458 2.3645 0.37856
## DHRS9   1.468           8.965           1.9614 3.9596 0.48988
## FGG     1.365           8.585           9.7976      NA      NA
## PPY     1.098          11.931           3.8380 0.3419 0.14395
## LOX     1.051           7.686          -0.5062 0.1867 0.10636
## IL20RB  1.043           6.971           1.7140 0.6682 0.20124
```

```
print(val.TCGA.messina2[val.TCGA.messina2$merit >= 1,])
```

```
##      merit threshold.train threshold.test   chisq abs.hr
## KRT6A  3.999           9.503           3.656 1.4483 0.5838
## ANGPTL4 2.716           8.900           3.336 0.2310 0.2331
## KRT6C   2.333           7.458          16.773      NA      NA
## CIDECE  2.269           8.021           3.192 2.0245 0.6902
## IGFBP1  1.474           7.070           3.788      NA      NA
## DHRS9   1.468           8.965           3.203 0.1557 0.1914
## FGG     1.365           8.585          10.219      NA      NA
## LYNX1   1.344           7.020           3.998      NA      NA
## PPY     1.098          11.931           3.969 0.3139 0.2718
## LOX     1.051           7.686           3.602 0.3011 0.2662
## IL20RB  1.043           6.971           2.975 4.0928 0.9813
```

```
print(val.comb.messina2[val.comb.messina2$merit >= 1,])
```

```
##      merit threshold.train threshold.test   chisq abs.hr
## KRT6A  3.999           9.503           4.029 0.039744 0.05879
## ANGPTL4 2.716           8.900           3.359 0.066278 0.07592
## DHRS9   1.468           8.965           3.237 0.023762 0.04546
## FGG     1.365           8.585          12.497      NA      NA
## PPY     1.098          11.931           4.015 1.971306 0.41403
## LOX     1.051           7.686           3.810 0.003568 0.01761
## IL20RB  1.043           6.971           3.407 1.555023 0.36772
```

```
print(val.GSE28735.messina2[1:25,])
```

```
##      merit threshold.train threshold.test   chisq abs.hr
## KRT6A  3.9988           9.503           4.754 1.638186 0.47535
## ANGPTL4 2.7155           8.900           3.754 0.670894 0.30420
## DHRS9   1.4685           8.965           4.404 0.007037 0.03116
## FGG     1.3648           8.585          13.796      NA      NA
```

```
## PPY      1.0981      11.931      4.068 2.536840 0.59153
## LOX      1.0514      7.686      6.841 0.494314 0.26112
## IL20RB   1.0429      6.971      4.060 0.435502 0.24509
## DCBLD2   0.9851     10.959      8.809 4.573332 0.79423
## CDA      0.9712      8.205      5.484 5.578617 0.87719
## PYGL     0.9394      8.707      6.968 1.675156 0.48068
## TCEA3    0.8598      9.056      4.960 6.722756 0.96295
## DKK1     0.7932     10.123      5.601 4.468957 0.78512
## SERPINB3 0.7304      7.502      8.703 0.434203 0.24472
## CAV1     0.7152     10.833      6.383 1.861383 0.50670
## UBE2C    0.7069      9.361      5.275 1.842838 0.50417
## UPP1     0.6954      9.363      4.612 2.009762 0.52651
## COL17A1  0.6772     10.850      6.112 0.916987 0.35564
## NEK2     0.6470      8.382      4.655 3.762606 0.72040
## TGFBI    0.6440     11.519      7.745 1.997784 0.52493
## PHLDA1   0.6227      9.838      6.666 1.301754 0.42374
## CDC20    0.6035      9.036      4.516 1.048897 0.38036
## FGB      0.5720      6.942      4.373 0.482299 0.25792
## SPOCK1   0.5481      8.806      5.282 5.432086 0.86559
## KLHL5    0.5450      9.040      6.523 1.858889 0.50636
## KCTD10   0.5421      8.313      6.391 0.954290 0.36280
```

```
print(val.GSE21501.messina2[1:25,])
```

```
##          merit threshold.train threshold.test  chisq  abs.hr
## KRT6A    3.9988          9.503          3.3849 0.2333 0.11891
## ANGPTL4  2.7155          8.900          0.7529 0.1246 0.08691
## KRT6C    2.3334          7.458         40.3387      NA      NA
## IGFBP1   1.4736          7.070         -4.0458 2.3645 0.37856
## DHRS9    1.4685          8.965          1.9614 3.9596 0.48988
## FGG      1.3648          8.585          9.7976      NA      NA
## PPY      1.0981         11.931          3.8380 0.3419 0.14395
## LOX      1.0514          7.686         -0.5062 0.1867 0.10636
## IL20RB   1.0429          6.971          1.7140 0.6682 0.20124
## DCBLD2   0.9851         10.959          0.8818 5.1370 0.55797
## TCEA3    0.8598          9.056          0.8150 3.8451 0.48274
## DKK1     0.7932         10.123          1.0495 1.5160 0.30311
## SERPINB3 0.7304          7.502          9.8687      NA      NA
## CAV1     0.7152         10.833         -0.4123 0.3670 0.14913
## UBE2C    0.7069          9.361         -1.0727 2.2779 0.37156
## COL17A1  0.6772         10.850          4.3181 0.1625 0.09925
## NEK2     0.6470          8.382         -1.4027 1.7177 0.32265
## TGFBI    0.6440         11.519          0.4992 0.1565 0.09738
## FGB      0.5720          6.942          4.3258 1.5532 0.30681
## PHACTR3  0.5493          6.744          1.8219 1.4980 0.30131
## SPOCK1   0.5481          8.806         -0.2239 0.1803 0.10452
## F3       0.5411          9.489          3.6157 2.2244 0.36717
## TMEM158  0.5410         10.672          2.4477 0.7650 0.21532
## ADM      0.4839          8.850         -1.6351 3.8843 0.48519
## ERRFI1   0.4786         10.269          0.6604 16.4916 0.99975
```

```
print(val.TCGA.messina2[1:25,])
```

```
##          merit threshold.train threshold.test  chisq  abs.hr
## KRT6A    3.9988          9.503          3.656 1.4483 0.58375
```

##	ANGPTL4	2.7155	8.900	3.336	0.2310	0.23314
##	KRT6C	2.3334	7.458	16.773	NA	NA
##	CIDEA	2.2689	8.021	3.192	2.0245	0.69018
##	IGFBP1	1.4736	7.070	3.788	NA	NA
##	DHRS9	1.4685	8.965	3.203	0.1557	0.19137
##	FGG	1.3648	8.585	10.219	NA	NA
##	LYNX1	1.3442	7.020	3.998	NA	NA
##	PPY	1.0981	11.931	3.969	0.3139	0.27177
##	LOX	1.0514	7.686	3.602	0.3011	0.26619
##	IL20RB	1.0429	6.971	2.975	4.0928	0.98133
##	DCBLD2	0.9851	10.959	3.702	0.4372	0.32074
##	CDA	0.9712	8.205	3.461	1.6185	0.61711
##	PYGL	0.9394	8.707	3.452	3.7715	0.94202
##	TCEA3	0.8598	9.056	3.289	1.6718	0.62719
##	DKK1	0.7932	10.123	3.661	NA	NA
##	SERPINB3	0.7304	7.502	6.685	NA	NA
##	CAV1	0.7152	10.833	3.700	0.7929	0.43194
##	UBE2C	0.7069	9.361	3.293	4.1776	0.99145
##	UPP1	0.6954	9.363	3.369	0.0271	0.07985
##	COL17A1	0.6772	10.850	3.644	3.8883	0.95650
##	NEK2	0.6470	8.382	3.223	2.0679	0.69754
##	TGFBI	0.6440	11.519	3.793	9.1433	1.46676
##	PHLDA1	0.6227	9.838	3.699	0.2173	0.22611
##	CDC20	0.6035	9.036	3.264	1.0556	0.49836

```
print(val.comb.messina2[1:25,])
```

##		merit	threshold.train	threshold.test	chisq	abs.hr
##	KRT6A	3.9988	9.503	4.029	0.039744	0.05879
##	ANGPTL4	2.7155	8.900	3.359	0.066278	0.07592
##	DHRS9	1.4685	8.965	3.237	0.023762	0.04546
##	FGG	1.3648	8.585	12.497	NA	NA
##	PPY	1.0981	11.931	4.015	1.971306	0.41403
##	LOX	1.0514	7.686	3.810	0.003568	0.01761
##	IL20RB	1.0429	6.971	3.407	1.555023	0.36772
##	DCBLD2	0.9851	10.959	4.201	0.003568	0.01761
##	CDA	0.9712	8.205	4.503	0.042036	0.06046
##	PYGL	0.9394	8.707	3.652	0.003568	0.01761
##	TCEA3	0.8598	9.056	2.882	NA	NA
##	DKK1	0.7932	10.123	4.422	1.830767	0.39900
##	SERPINB3	0.7304	7.502	7.088	0.062874	0.07394
##	CAV1	0.7152	10.833	4.066	0.003568	0.01761
##	UBE2C	0.7069	9.361	3.757	0.038753	0.05805
##	UPP1	0.6954	9.363	3.623	0.133938	0.10792
##	COL17A1	0.6772	10.850	3.799	1.218751	0.32554
##	NEK2	0.6470	8.382	3.602	1.057385	0.30323
##	TGFBI	0.6440	11.519	3.851	1.315357	0.33820
##	PHLDA1	0.6227	9.838	3.846	0.003568	0.01761
##	CDC20	0.6035	9.036	3.671	0.076721	0.08168
##	FGB	0.5720	6.942	4.752	0.140356	0.11048
##	SPOCK1	0.5481	8.806	3.649	0.242147	0.14511
##	KLHL5	0.5450	9.040	3.478	1.047763	0.30184
##	KCTD10	0.5421	8.313	3.652	0.003568	0.01761

```
print(val.GSE28735.maxstat[val.GSE28735.maxstat$merit >= -log10(0.01),])
```

##	merit	threshold.train	threshold.test	chisq	abs.hr
## ANGPTL4	4.835	8.356	3.527	1.2172131	0.40975
## KRT6A	4.450	8.915	4.503	2.1797169	0.54832
## LOX	4.225	7.502	6.609	0.5418944	0.27339
## PYGL	3.837	8.829	7.074	2.2505118	0.55715
## ST6GAL1	3.803	9.542	6.145	1.2301143	0.41191
## FAM189A2	3.630	6.455	4.052	0.0031968	0.02100
## KLHL5	3.511	8.978	6.464	2.7284225	0.61346
## ADM	3.394	8.820	4.730	1.0881259	0.38741
## E2F7	3.373	6.507	3.854	4.9383591	0.82532
## SMOX	3.165	7.190	4.852	0.0264970	0.06045
## KIF20A	3.123	7.250	3.584	2.3964258	0.57493
## CAPN6	3.073	6.516	4.094	0.7537046	0.32243
## IL20RB	2.994	6.505	3.492	0.6900670	0.30852
## P4HA1	2.882	9.080	7.426	0.0361759	0.07064
## FYN	2.854	8.079	6.086	0.5063749	0.26428
## AURKA	2.850	7.727	3.628	0.5199047	0.26779
## TCEA3	2.791	8.955	4.898	3.5465208	0.69941
## LOXL4	2.778	7.628	3.985	0.0043526	0.02450
## LDHA	2.744	11.922	9.716	0.6055617	0.28901
## CKAP2L	2.693	7.047	3.898	3.2384237	0.66834
## PPY	2.628	11.966	4.074	2.5368403	0.59153
## TREM1	2.588	6.546	5.146	0.3641295	0.22411
## PLOD1	2.541	10.492	5.802	0.0607022	0.09150
## CDC20	2.506	8.806	4.385	0.7903335	0.33017
## PFKP	2.483	9.183	5.636	0.0770144	0.10307
## ERRFI1	2.364	10.222	8.463	0.0265727	0.06054
## RGS5	2.303	8.665	6.941	0.1157263	0.12634
## TPX2	2.283	7.213	4.613	2.3417950	0.56834
## P4HA2	2.267	9.209	6.579	2.3446584	0.56868
## SLC15A1	2.242	6.716	5.053	0.4827903	0.25805
## DPY19L1	2.227	9.183	6.364	0.0340304	0.06851
## MME	2.227	6.441	4.645	0.1424883	0.14019
## ATF7IP2	2.212	7.139	5.793	0.0462345	0.07986
## PAEP	2.186	6.304	5.022	0.2213571	0.17473
## EPHX2	2.173	7.223	3.637	0.7331425	0.31800
## KYNU	2.169	7.161	5.370	0.0009540	0.01147
## FOXM1	2.166	6.884	4.573	5.9976088	0.90954
## NAMPT	2.159	7.988	10.049	0.3699184	0.22588
## PLOD2	2.155	10.451	7.593	3.3000992	0.67467
## UPP1	2.130	9.094	4.411	1.2476835	0.41484
## KCTD10	2.119	7.907	6.094	0.0003352	0.00680
## ZNF185	2.105	7.420	3.933	1.0598714	0.38235
## EDIL3	2.105	6.400	8.217	0.0054087	0.02731
## NEK2	2.103	8.167	4.426	0.5031598	0.26344
## LCP1	2.100	8.702	6.629	6.4127584	0.94049
## GAPDH	2.086	11.336	9.814	1.9514902	0.51882
## ARSD	2.085	9.970	6.440	2.8660524	0.62874
## KIF2C	2.080	6.839	3.953	3.6289488	0.70749
## ENO2	2.069	7.557	5.422	0.0374754	0.07190
## COL12A1	2.052	8.689	8.314	0.0572269	0.08884
## VSNL1	2.052	6.712	4.221	0.0023373	0.01796
## ENTHD1	2.044	6.345	3.130	0.1850704	0.15977
## CADPS2	2.043	7.892	5.795	3.0258048	0.64603

```
print(val.GSE21501.maxstat[val.GSE21501.maxstat$merit >= -log10(0.01),])
```

##	merit	threshold.train	threshold.test	chisq	abs.hr
## ANGPTL4	4.835	8.356	0.19587	0.68647	0.20397
## KRT6A	4.450	8.915	2.97484	0.02615	0.03981
## LOX	4.225	7.502	-0.79221	1.05819	0.25324
## KRT6C	4.215	6.392	5.59238	NA	NA
## ST6GAL1	3.803	9.542	0.78319	0.57393	0.18650
## FAM189A2	3.630	6.455	0.28808	0.72477	0.20958
## ADM	3.394	8.820	-1.66023	7.68147	0.68231
## E2F7	3.373	6.507	-2.26972	11.01337	0.81699
## CAPN6	3.073	6.516	0.58777	1.93415	0.34238
## IL20RB	2.994	6.505	0.27819	2.88983	0.41850
## FGF13	2.837	6.400	-0.33980	2.19688	0.36489
## TCEA3	2.791	8.955	0.67789	4.56051	0.52573
## LOXL4	2.778	7.628	0.96728	0.44986	0.16512
## TMEM26	2.688	6.692	0.77037	0.04695	0.05334
## BIRC5	2.643	7.334	-1.61111	4.02097	0.49365
## CD70	2.632	6.748	-0.60306	0.50354	0.17469
## PPY	2.628	11.966	3.85564	0.78045	0.21749
## TREM1	2.588	6.546	2.12235	4.16653	0.50251
## IGFBP1	2.466	7.076	-4.02812	1.67463	0.31858
## ERFFI1	2.364	10.222	0.59119	17.90323	1.04165
## RGS5	2.303	8.665	4.26999	5.36891	0.57043
## PHACTR3	2.275	6.884	1.98393	1.34315	0.28531
## MME	2.227	6.441	-1.58576	0.21888	0.11518
## PRDM16	2.206	6.605	3.97296	1.83929	0.33387
## PAEP	2.186	6.304	0.77117	0.42416	0.16033
## EPHX2	2.173	7.223	0.03016	0.45635	0.16631
## KYNU	2.169	7.161	-1.99673	0.37952	0.15166
## NAMPT	2.159	7.988	0.11528	1.97005	0.34554
## PLOD2	2.155	10.451	0.06961	0.08655	0.07243
## EDIL3	2.105	6.400	4.24471	1.30442	0.28117
## NEK2	2.103	8.167	-1.80395	4.75048	0.53657
## LCP1	2.100	8.702	-1.84614	2.89631	0.41897
## COL12A1	2.052	8.689	1.83301	0.30533	0.13603
## VSNL1	2.052	6.712	-1.64740	0.15289	0.09626
## ENTHD1	2.044	6.345	1.75682	0.26324	0.12631
## PCDH20	2.003	7.551	3.99419	1.35435	0.28650

```
print(val.TCGA.maxstat[val.TCGA.maxstat$merit >= -log10(0.01),])
```

##	merit	threshold.train	threshold.test	chisq	abs.hr
## ANGPTL4	4.835	8.356	3.2506	8.573e-02	0.142030
## B3GALTL	4.586	6.747	3.1744	4.692e-01	0.332277
## KRT6A	4.450	8.915	3.5365	2.464e+00	0.761458
## LOX	4.225	7.502	3.5709	6.397e-01	0.387968
## KRT6C	4.215	6.392	3.9993	NA	NA
## PFKFB4	4.140	7.004	3.0053	3.090e-01	0.269623
## CIDEA	3.851	7.623	3.0437	2.472e-01	0.241173
## PYGL	3.837	8.829	3.4693	2.323e+00	0.739303
## ST6GAL1	3.803	9.542	3.6540	4.597e-02	0.104006
## FAM189A2	3.630	6.455	2.8347	6.560e-01	0.392865
## RPIA	3.527	7.988	3.2886	1.041e+00	0.494966
## KLHL5	3.511	8.978	3.4314	8.833e-01	0.455900

## LYNX1	3.490	6.603	3.5629	3.300e+01	2.786522
## TRAPPC2	3.466	8.229	3.2071	5.559e-01	0.361659
## ZNF565	3.451	6.532	2.8439	9.433e-01	0.471122
## ADM	3.394	8.820	3.0578	1.290e+00	0.550837
## E2F7	3.373	6.507	2.8931	3.369e+00	0.890337
## KTI12	3.278	7.949	3.1614	1.803e+00	0.651319
## UFC1	3.264	9.787	3.5679	1.613e-01	0.194826
## HJURP	3.180	6.967	3.1594	2.203e+00	0.719982
## SMOX	3.165	7.190	3.2938	2.054e-01	0.219816
## KIF20A	3.123	7.250	3.1635	8.137e-01	0.437564
## ELMOD3	3.075	7.298	3.2690	2.506e-01	0.242803
## NACC2	3.073	6.578	2.7790	3.077e-02	0.085091
## CAPN6	3.073	6.516	3.1289	3.945e+00	0.963493
## IL20RB	2.994	6.505	2.6696	6.952e-01	0.404444
## CARHSP1	2.993	10.451	3.5607	2.610e+00	0.783592
## P4HA1	2.882	9.080	3.5537	8.216e-01	0.439679
## FYN	2.854	8.079	3.5020	2.393e-01	0.237278
## AURKA	2.850	7.727	3.1350	1.347e+00	0.562947
## FGF13	2.837	6.400	2.8910	2.202e-02	0.071977
## TCEA3	2.791	8.955	3.2703	1.672e+00	0.627186
## LOXL4	2.778	7.628	3.2741	1.007e+00	0.486752
## LDHA	2.744	11.922	3.8200	1.032e-01	0.155810
## SLAMF9	2.730	6.346	1.9189	2.350e+00	0.743553
## GOLPH3L	2.729	7.859	3.4711	1.324e-01	0.176470
## DEFB123	2.716	6.326	NaN	NA	NA
## SLC30A3	2.696	6.399	1.5633	2.190e+00	0.717762
## CKAP2L	2.693	7.047	3.0517	5.679e+00	1.155938
## TMEM26	2.688	6.692	2.8280	5.494e-05	0.003595
## BIRC5	2.643	7.334	3.1152	1.436e+00	0.581364
## IFT140	2.638	6.438	3.3541	3.296e-03	0.027850
## CD70	2.632	6.748	2.6457	3.625e-03	0.029205
## PPY	2.628	11.966	3.9751	3.139e-01	0.271774
## LRRFIP2	2.624	7.861	3.4000	5.492e-01	0.359463
## TREM1	2.588	6.546	3.0622	8.990e-01	0.459927
## LYRM1	2.548	9.343	3.2709	5.861e-03	0.037136
## PLOD1	2.541	10.492	3.6442	6.590e-01	0.393765
## ATP50	2.538	11.228	3.6003	7.877e-01	0.430499
## CDC20	2.506	8.806	3.2186	4.668e-01	0.331426
## ARHGEF19	2.486	6.695	3.1074	2.975e+00	0.836710
## PFKP	2.483	9.183	3.5533	2.849e-01	0.258895
## AURKB	2.470	6.963	3.0300	1.073e+00	0.502561
## IGFBP1	2.466	7.076	3.7990	NA	NA
## VPS29	2.464	9.524	3.3949	1.012e-01	0.154339
## PHF21A	2.423	8.261	3.3828	1.254e-01	0.171748
## PDCD2L	2.416	7.446	2.9782	4.223e-01	0.315233
## FAH	2.413	7.260	3.2812	6.847e-02	0.126932
## PLIN3	2.391	11.237	3.6267	2.658e-01	0.250069
## SLC15A4	2.382	9.055	3.4043	1.492e+00	0.592598
## NOTCH1	2.378	7.822	3.4138	6.490e+00	1.235773
## ERFFI1	2.364	10.222	3.7131	2.452e+00	0.759630
## RFX4	2.360	6.318	0.6094	3.735e+00	0.937419
## RGS5	2.303	8.665	3.6868	2.529e+00	0.771462
## COL5A3	2.294	6.444	3.3676	2.353e+00	0.744144
## PTPRM	2.289	7.564	3.4899	1.177e+00	0.526291

## SOBP	2.285	7.318	3.2145	1.427e+00	0.579445
## TPX2	2.283	7.213	3.4056	5.839e+00	1.172127
## PHACTR3	2.275	6.884	2.7109	4.422e+00	1.020010
## P4HA2	2.267	9.209	3.5563	8.348e-01	0.443197
## IKBIP	2.252	6.947	3.3099	1.815e-01	0.206659
## DHRS11	2.249	7.620	3.0378	2.263e+00	0.729748
## SLC15A1	2.242	6.716	3.2639	2.503e-01	0.242659
## BMS1	2.234	9.010	3.4895	4.549e-02	0.103453
## DPY19L1	2.227	9.183	3.5265	1.193e-01	0.167516
## MME	2.227	6.441	3.1336	1.430e+00	0.580049
## ARMC7	2.218	7.589	3.2933	1.957e-03	0.021460
## ATF7IP2	2.212	7.139	3.2603	1.696e+00	0.631663
## PRDM16	2.206	6.605	3.2494	1.055e-01	0.157519
## TRIM54	2.197	8.060	3.1774	2.177e+00	0.715766
## PAEP	2.186	6.304	3.5895	NA	NA
## TM9SF3	2.181	9.973	3.8034	7.033e-01	0.406800
## TARBP2	2.175	6.959	3.2777	1.864e+00	0.662262
## EPHX2	2.173	7.223	3.1924	1.516e-04	0.005973
## SGSM1	2.171	6.631	2.9490	2.006e-02	0.068698
## KYNU	2.169	7.161	3.1598	8.082e-01	0.436070
## FOXM1	2.166	6.884	3.3186	3.181e-01	0.273580
## NAMPT	2.159	7.988	3.6866	5.716e-01	0.366727
## PLOD2	2.155	10.451	3.5670	2.931e-01	0.262627
## TTC13	2.144	7.827	3.3152	6.849e-01	0.401449
## UPP1	2.130	9.094	3.3237	9.579e-02	0.150132
## KCTD10	2.119	7.907	3.5420	5.250e-01	0.351483
## ZNF185	2.105	7.420	3.2864	1.071e+00	0.502018
## EDIL3	2.105	6.400	3.5273	3.943e+00	0.963201
## KCNQ3	2.104	6.635	2.5387	7.679e-01	0.425055
## NEK2	2.103	8.167	3.1637	1.973e-01	0.215456
## LCP1	2.100	8.702	3.5387	9.984e-03	0.048469
## CFL1	2.088	12.385	3.9427	4.260e-01	0.316604
## GAPDH	2.086	11.336	4.0228	1.957e+00	0.678555
## ARSD	2.085	9.970	3.6909	5.880e-01	0.371959
## PGBD3	2.085	6.454	2.9488	1.496e-01	0.187636
## KIF2C	2.080	6.839	3.2058	4.434e-01	0.322993
## ENO2	2.069	7.557	3.4295	1.791e+00	0.649226
## ABLIM1	2.063	9.734	3.6850	1.090e+00	0.506472
## RFC5	2.053	7.876	3.1563	2.165e+00	0.713759
## COL12A1	2.052	8.689	3.7775	5.110e-01	0.346739
## VSNL1	2.052	6.712	2.9368	7.472e-01	0.419295
## ENTHD1	2.044	6.345	2.9963	3.341e-01	0.280367
## CADPS2	2.043	7.892	3.3495	7.356e-02	0.131561
## GARS	2.035	10.140	3.5755	1.141e+00	0.518191
## SCYL2	2.021	8.564	3.4991	2.646e-01	0.249525
## PCDH20	2.003	7.551	3.5025	NA	NA
## ARFGAP3	2.001	8.794	3.5346	1.388e-01	0.180722

```
print(val.comb.maxstat[val.comb.maxstat$merit >= -log10(0.01),])
```

##	merit	threshold.train	threshold.test	chisq	abs.hr
## ANGPTL4	4.835	8.356	3.210	0.0004978	0.006579
## KRT6A	4.450	8.915	3.844	0.1986036	0.131415
## LOX	4.225	7.502	3.674	0.7779826	0.260097

## PYGL	3.837	8.829	3.749	0.0035678	0.017614
## ST6GAL1	3.803	9.542	3.897	0.0035678	0.017614
## FAM189A2	3.630	6.455	3.141	0.1145970	0.099825
## KLHL5	3.511	8.978	3.436	0.3554151	0.175800
## ADM	3.394	8.820	2.480	NA	NA
## E2F7	3.373	6.507	3.226	2.0068826	0.417746
## SMOX	3.165	7.190	3.061	NA	NA
## KIF20A	3.123	7.250	3.215	9.8111520	0.923658
## CAPN6	3.073	6.516	3.026	3.8052088	0.575228
## IL20RB	2.994	6.505	2.897	2.9543186	0.506850
## P4HA1	2.882	9.080	3.664	0.3896693	0.184077
## FYN	2.854	8.079	3.627	0.0035678	0.017614
## AURKA	2.850	7.727	3.251	2.3172761	0.448890
## TCEA3	2.791	8.955	2.794	NA	NA
## LOXL4	2.778	7.628	3.277	0.3821183	0.182285
## LDHA	2.744	11.922	3.593	NA	NA
## CKAP2L	2.693	7.047	3.391	5.7916593	0.709664
## PPY	2.628	11.966	4.021	1.9713060	0.414026
## TREM1	2.588	6.546	3.178	0.0007441	0.008044
## PLOD1	2.541	10.492	3.522	NA	NA
## CDC20	2.506	8.806	3.501	0.0187455	0.040374
## PFKP	2.483	9.183	3.236	NA	NA
## ERIFI1	2.364	10.222	3.697	0.8531713	0.272376
## RGS5	2.303	8.665	3.744	0.2652384	0.151869
## TPX2	2.283	7.213	3.573	2.6441369	0.479505
## P4HA2	2.267	9.209	3.663	0.0253982	0.046995
## SLC15A1	2.242	6.716	3.477	0.0144333	0.035427
## DPY19L1	2.227	9.183	3.721	0.0035678	0.017614
## MME	2.227	6.441	3.198	1.0129642	0.296789
## ATF7IP2	2.212	7.139	3.843	0.0117813	0.032007
## PAEP	2.186	6.304	6.323	0.0004239	0.006071
## EPHX2	2.173	7.223	3.219	0.0086576	0.027438
## KYNU	2.169	7.161	2.993	0.8499361	0.271859
## FOXM1	2.166	6.884	3.573	0.0187455	0.040374
## NAMPT	2.159	7.988	3.765	0.0055932	0.022054
## PLOD2	2.155	10.451	3.540	1.4408075	0.353960
## UPP1	2.130	9.094	3.431	0.0119443	0.032228
## KCTD10	2.119	7.907	3.504	0.1981721	0.131272
## ZNF185	2.105	7.420	2.953	0.2493545	0.147251
## EDIL3	2.105	6.400	4.043	0.0035678	0.017614
## NEK2	2.103	8.167	3.437	0.0269672	0.048425
## LCP1	2.100	8.702	3.003	NA	NA
## GAPDH	2.086	11.336	4.025	1.6997840	0.384457
## ARSD	2.085	9.970	4.143	0.0035678	0.017614
## KIF2C	2.080	6.839	3.346	4.1336140	0.599537
## ENO2	2.069	7.557	3.319	0.6803431	0.243229
## COL12A1	2.052	8.689	3.651	0.1334730	0.107733
## VSNL1	2.052	6.712	3.189	0.3629304	0.177649
## ENTHD1	2.044	6.345	3.456	1.2111259	0.324523
## CADPS2	2.043	7.892	3.059	NA	NA

```

# detCurve(list(
#   "Messina GSE28735" = val.GSE28735.messina,
#   "Messina GSE21501" = val.GSE21501.messina,

```



```
# "Messina TCGA" = val.TCGA.messina,
# "Messina GSE28735 NC" = val.GSE28735.messina2,
# "Messina GSE21501 NC" = val.GSE21501.messina2,
# "Messina TCGA NC" = val.TCGA.messina2,
# "maxstat GSE28735" = val.GSE28735.maxstat,
# "maxstat GSE21501" = val.GSE21501.maxstat,
# "maxstat TCGA" = val.TCGA.maxstat)) + theme_bw()
```

```
detCurve = function(val_list, alpha = 0.05, relative = FALSE, dataonly = FALSE)
{
  if (is.null(names(val_list)))
  {
    names(val_list) = paste("Method", 1:length(val_list), sep = " ")
  }

  val_list_annotated = lapply(val_list, function(val) {
    val$merit[is.na(val$merit)] = -1
    val = val[order(-val$merit),]
    val$val = pchisq(val$chisq, df = 1, lower.tail = FALSE) < alpha
    val$val[is.na(val$chisq)] = FALSE
    val$cum_val = cumsum(val$val)
    val$cum_nonval = cumsum(!val$val)
    total_val = sum(val$val)
    total_nonval = sum(!val$val)
    val$rate_val = val$cum_val / total_val
    val$rate_nonval = val$cum_nonval / total_nonval
    val
  })

  val_list_combined = do.call(rbind, val_list_annotated)
  val_list_combined$Curve = rep(names(val_list), sapply(val_list, nrow))

  if (dataonly) { return(val_list_combined) }
  if (!relative)
  {
    nval = sapply(val_list_annotated, function(v) sum(v$val))
    null_slopes = data.frame(Curve = names(nval), intercept = 0, slope = nval)

    theplot = ggplot(val_list_combined, aes(x = rate_nonval, y = cum_val, colour = Curve)) +
      geom_line(lwd = 2) +
      xlab("Non-validation rate") +
      ylab("Total validated") +
      geom_abline(aes(intercept = intercept, slope = slope, colour = Curve), null_slop
    }
  }
  else
  {
    theplot = ggplot(val_list_combined, aes(x = rate_nonval, y = rate_val, colour = Curve)) +
      geom_line(lwd = 2) +
      xlab("Non-validation rate") +
      ylab("Validation rate") +
      geom_abline(intercept = 0, slope = 1, linetype = "dashed", lwd = 1.5) +
      xlim(0, 1) + ylim(0, 1)
  }
}
```

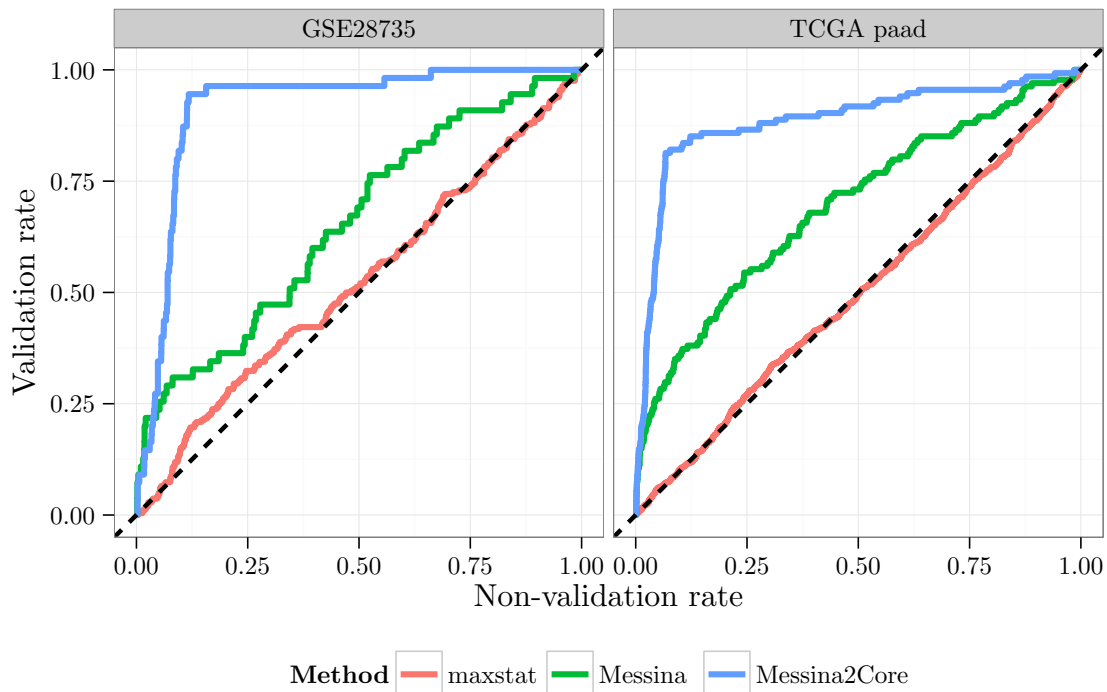
```

    theplot
  }

# detCurve(list(Messina = val.GSE28735.messina, maxstat = val.GSE28735.maxstat, MessinaCore = val.GSE28735.messina2),
# detCurve(list(Messina = val.GSE28735.messina, maxstat = val.GSE28735.maxstat, MessinaCore = val.GSE28735.messina2),
# detCurve(list(Messina = val.GSE21501.messina, maxstat = val.GSE21501.maxstat, MessinaCore = val.GSE21501.messina2),
# detCurve(list(Messina = val.GSE21501.messina, maxstat = val.GSE21501.maxstat, MessinaCore = val.GSE21501.messina2),
# detCurve(list(Messina = val.TCGA.messina, maxstat = val.TCGA.maxstat, MessinaCore = val.TCGA.messina2),
# detCurve(list(Messina = val.TCGA.messina, maxstat = val.TCGA.maxstat, MessinaCore = val.TCGA.messina2),
# detCurve(list(Messina = val.comb.messina, maxstat = val.comb.maxstat, MessinaCore = val.comb.messina2),
# detCurve(list(Messina = val.comb.messina, maxstat = val.comb.maxstat, MessinaCore = val.comb.messina2),

dat1 = detCurve(list(Messina = val.GSE28735.messina, maxstat = val.GSE28735.maxstat, Messina2Core = val.GSE28735.messina2),
dat2 = detCurve(list(Messina = val.TCGA.messina, maxstat = val.TCGA.maxstat, Messina2Core = val.TCGA.messina2),
data = as.data.frame(rbind(cbind(dat1, Cohort = "GSE28735"), cbind(dat2, Cohort = "TCGA paad")))
ggplot(data, aes(x = rate_nonval, y = rate_val, colour = Curve)) +
  geom_line(lwd = 2) +
  xlab("Non-validation rate") +
  ylab("Validation rate") +
  geom_abline(intercept = 0, slope = 1, linetype = "dashed", lwd = 1.5) +
  xlim(0, 1) + ylim(0, 1) + coord_fixed() +
  theme_bw() + labs(colour = "Method") +
  facet_wrap(~ Cohort) + theme(legend.position = "bottom")

```



```

# plot(APGI.messina, indices = 1, sort_features = TRUE)
# plot(APGI.messina, indices = which(APGI.featsfsymbol == "IL20RB"), sort_features = FALSE)
val.GSE28735.messina2["IL20RB",]

##          merit threshold.train threshold.test  chisq abs.hr
## IL20RB  1.043           6.971           4.06 0.4355 0.2451

il20rb.TCGA.xc = TCGA.x["IL20RB",] > val.TCGA.messina2["IL20RB",]$threshold.test

```

```

survdif(TCGA.y ~ il20rb.TCGA.xc)

## Call:
## survdiff(formula = TCGA.y ~ il20rb.TCGA.xc)
##
##               N Observed Expected (O-E)^2/E (O-E)^2/V
## il20rb.TCGA.xc=FALSE 43      10   13.31    0.825    4.09
## il20rb.TCGA.xc=TRUE  15       7    3.69    2.978    4.09
##
##  Chisq= 4.1  on 1 degrees of freedom, p= 0.0431

il20rb.TCGA.fit = survfit(TCGA.y ~ il20rb.TCGA.xc)
print(il20rb.TCGA.fit)

## Call: survfit(formula = TCGA.y ~ il20rb.TCGA.xc)
##
##               records n.max n.start events median 0.95LCL 0.95UCL
## il20rb.TCGA.xc=FALSE   43   43     43     10   665     480     NA
## il20rb.TCGA.xc=TRUE   15   15     15      7   460     334     NA

plot(il20rb.TCGA.fit, col = c("red", "green"))

```

