

# Package ‘ssize’

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**Title** Estimate Microarray Sample Size

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**Description** Functions for computing and displaying sample size information for gene expression arrays.

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**Depends** gdata, xtable

**License** LGPL

**biocViews** Microarray, DifferentialExpression

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|        |                                                                    |
|--------|--------------------------------------------------------------------|
| exp.sd | <i>Example baseline variability for gene expression experiment</i> |
|--------|--------------------------------------------------------------------|

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## Description

Example baseline variability for gene expression experiment

## Usage

data(exp.sd)

**Format**

Vector of 12,625 standard deviations of gene expression data normalized via the RMA method (ie on log2 scale) with names from Affymetrix probe set IDs.

**Examples**

```
data(exp.sd)

hist(exp.sd, prob=TRUE)
lines(density(exp.sd), col="red", lwd=2)
```

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|     |                                                                                                               |
|-----|---------------------------------------------------------------------------------------------------------------|
| pow | <i>Compute and plot power, required sample-size, or detectible effect size for gene expression experiment</i> |
|-----|---------------------------------------------------------------------------------------------------------------|

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**Description**

Compute and plot power, required sample-size, or detectible effect size for gene expression experiment

**Usage**

```
pow(sd, n, delta, sig.level, alpha.correct = "Bonferonni")
power.plot(x, xlab = "Power", ylab = "Proportion of Genes with Power >= x",
  marks = c(0.7, 0.8, 0.9), ...)

ssize(sd, delta, sig.level, power, alpha.correct = "Bonferonni")
ssize.plot(x, xlab = "Sample Size (per group)",
  ylab = "Proportion of Genes Needing Sample Size <= n",
  marks = c(2, 3, 4, 5, 6, 8, 10, 20), ...)

delta(sd, n, power, sig.level, alpha.correct = "Bonferonni")
delta.plot(x, xlab = "Fold Change",
  ylab = "Proportion of Genes with Power >= 80% at Fold Change=delta",
  marks = c(1.5, 2, 2.5, 3, 4, 6, 10), ...)
```

**Arguments**

|               |                                                                                           |
|---------------|-------------------------------------------------------------------------------------------|
| sd            | Vector of standard deviations for control samples, *on the log2 scale*                    |
| n             | Number of observations (per group)                                                        |
| delta         | Hypothetical True difference in expression, on the log2 scale.                            |
| sig.level     | Significance level (Type I error probability)                                             |
| power         | Power                                                                                     |
| alpha.correct | Type of correction for multiple comparison. One of "Bonferonni" or "None".                |
| x             | Vector of powers generated by pow                                                         |
| xlab, ylab    | x and y axis labels                                                                       |
| marks         | Powers at which percent of genes achieving the specified cutoff is annotated on the plot. |
| ...           | Additional graphical parameters                                                           |

## Details

The `pow` function computes power for each element of a gene expression experiment using an vector of estimated standard deviations. The power is computed separately for each gene, with an optional correction to the significance level for multiple comparison. The `power.plot` function generates a cumulative power plot illustrating the fraction and number of genes achieve a given power for the specified sample size, significance level, and delta.

Periods are printed for every 10 calculations so that the user can see that the computation is proceeding.

## Value

`pow` returns a vector containing the power for each standard deviation.

## Note

This code was intended to be used with data are on the  $\log_2$  scale, in which case the delta can be set to becomes  $\log_2(\text{fold-change})$ .

## Author(s)

Gregory R. Warnes <greg@warnes.net>

## References

Warnes GR and Fasheng Li Warnes GR and Liu P, "Sample Size Selection for Microarray Experiments" submitted to *Biometrics*.

Warnes GR and Fasheng Li, "Sample Size Selection for Microarray based Gene Expression Studies," Talk, "2003 FDA/Industry Statistics Workshop: From Theory to Regulatory Acceptance", American Statistical Association, Bethesda, MD, Sept 18-19, 2003. <http://www.warnes.net/Research/PresentationFolder/SampleSize.pdf>

## See Also

[ssize](#), [ssize.plot](#), [delta](#), [delta.plot](#)

## Examples

```
library(gdata) # for nobs()

data(exp.sd)

# Histogram of the standard deviations

hist(exp.sd, n=20, col="cyan", border="blue", main="",
      xlab="Standard Deviation (for data on the log scale)")
dens <- density(exp.sd)
lines(dens$x, dens$y*par("usr")[4]/max(dens$y), col="red", lwd=2)

title("Histogram of Standard Deviations")

# 1) What is the power if using 6 patients 3 measurements assuming
#    Delta=1.0, Alpha=0.05 and Observed SDs?
#
```

```

n=6; fold.change=2.0; power=0.8; sig.level=0.05;
#
all.power <- pow(sd=exp.sd, n=n, delta=log2(fold.change),
                sig.level=sig.level)

power.plot(all.power, lwd=2, col="blue")
xmax <- par("usr")[2]-0.05; ymax <- par("usr")[4]-0.05
legend(x=xmax, y=ymax,
       legend= strsplit( paste("n=",n," ",
                                "fold change=",fold.change," ",
                                "alpha=", sig.level, " ",
                                "# genes=", nobs(exp.sd), sep=''), " ", " ")[[1]],
       xjust=1, yjust=1, cex=1.0)
title("Power to Detect 2-Fold Change")

# 2) What is necessary sample size for 80% power using 3 measurements/patient
# assuming Delta=1.0, Alpha=0.05 and Observed SDs?
#
all.size <- ssize(sd=exp.sd, delta=log2(fold.change),
                 sig.level=sig.level, power=power)
ssize.plot(all.size, lwd=2, col="magenta", xlim=c(1,20))
xmax <- par("usr")[2]-1; ymin <- par("usr")[3] + 0.05
legend(x=xmax, y=ymin,
       legend= strsplit( paste("fold change=",fold.change," ",
                                "alpha=", sig.level, " ",
                                "power=",power," ",
                                "# genes=", nobs(exp.sd), sep=''), " ", " ")[[1]],
       xjust=1, yjust=0, cex=1.0)
title("Sample Size to Detect 2-Fold Change")

# 3) What is necessary fold change to achieve 80% power using 3
# measurements/patient assuming n=6, Delta=1.0, Alpha=0.05 and Observed
# SDs?
#
all.delta <- delta(sd=exp.sd, power=power, n=n,
                 sig.level=sig.level)
delta.plot(all.delta, lwd=2, col="magenta", xlim=c(1,10))
xmax <- par("usr")[2]-1; ymin <- par("usr")[3] + 0.05
legend(x=xmax, y=ymin,
       legend= strsplit( paste("n=",n," ",
                                "alpha=", sig.level, " ",
                                "power=",power," ",
                                "# genes=", nobs(exp.sd), sep=''), " ", " ")[[1]],
       xjust=1, yjust=0, cex=1.0)
title("Fold Change to Achieve 80% Power")

```

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power.t.test.FDR

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*Power calculations for one and two sample t tests using FDR correction*


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## Description

Compute power of test, or determine parameters to obtain target power.

**Usage**

```
power.t.test.FDR(sd=1, n=NULL, delta=NULL,
                 FDR.level=0.05,
                 pi0,
                 power=NULL,
                 type=c("two.sample", "one.sample", "paired"),
                 alternative=c("two.sided", "one.sided") )
```

**Arguments**

|             |                                                                                  |
|-------------|----------------------------------------------------------------------------------|
| sd          | Standard deviation                                                               |
| n           | Number of observations (per group)                                               |
| delta       | True difference in means                                                         |
| FDR.level   | False Discovery Rate (expected ratio of false discoveries among all discoveries) |
| pi0         | Proportion of true null hypotheses (fraction of tests that with no difference)   |
| power       | Power of test (1 minus Type II error probability)                                |
| type        | Type of t test                                                                   |
| alternative | One- or two-sided test                                                           |

**Details**

Exactly one of the parameters n, delta, power, sd, and FDR.level must be passed as NULL, and that parameter is determined from the others. Notice that the last two have non-NULL defaults so NULL must be explicitly passed if you want to compute them.

**Value**

Object of class "power.htest", a list of the arguments (including the computed one) augmented with method and note elements.

**Note**

uniroot is used to solve power equation for unknowns, so you may see errors from it, notably about inability to bracket the root when invalid arguments are given.

**Author(s)**

Peng Liu, based on power.t.test code by Peter Dalgaard, which in turn is based on previous work by Claus Ekstrøm

**See Also**

[t.test](#), [uniroot](#)

**Examples**

```
## Compute power given sd, n, delta, FDR & pi.0
power.t.test.FDR(sd=1, n=5, delta=2, FDR.level=0.05, pi0=0.95,
                 power=NULL, type="two.sample", alternative="two.sided")

## Compute power
power.t.test.FDR(n=20, delta=1, FDR=0.05, pi0=0.75)
```

```
power.t.test.FDR(n=29, delta=1, FDR=0.05, pi0=0.75)

## compute n
power.t.test.FDR(n=NULL, sd=1, power=.90, delta=1, FDR=0.05, pi0=0.975)
power.t.test.FDR(n=NULL, sd=1, power=.90, delta=1, FDR=0.05, pi0=0.975,
                  alt="one.sided")

## compute sd
power.t.test.FDR(sd=NULL, n=29, power=.90, delta=1, FDR=0.05, pi0=0.975)

## compute FDR level
power.t.test.FDR(sd=1, n=29, power=.90, delta=1, FDR=NULL, pi0=0.975)
```

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