

# goProfiles

April 19, 2009

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CD4Ids

*Entrez identifiers for CD4-TCells example*

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## Description

This dataset contains the entrez identifiers `CD4EntrezIds` and their associated GO Terms `CD4GOTermsFrame` and `CD4GOTermsList` corresponding to the list of differentially expressed genes in a study by Henkel et al.

## Usage

```
data(CD4Ids)
```

## Source

Hengel, R.L. and Thaker, V. and Pavlick, M.V. and Metcalf, J.A. and Dennis, G. Jr. and Yang, J. and Lempicki, R.A. and Sereti, I. and Lane, H.C. (2003). L-selectin (CD62L) expression distinguishes small resting memory CD4+ T cells that preferentially respond to recall antigen. *J. Immunol.*, 170, 28-32. (2003)

## Examples

```
data(CD4Ids)
```

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GOTermsList

*Functions to create and manage lists of GO terms associated with a vector of 'Entrez' identifiers*

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## Description

These functions prepare data to be processed by the 'basicProfile' function. To create a profile a set of GO terms belonging to one or more ontologies is needed. The terms belonging to each gene must be given separately so that they can be counted. This function queries the environment 'GOENTREZID2GO' with the vector of Entrez terms and formats the output into a list whose components -one per Entrez term- contain the most specific GO identifiers associated with this term.

**Usage**

```
GOTermsList(LLids, onto = "any", evid = "any", na.rm = FALSE, orgPkg )
getAncestorsLst(GOtermslist, onto, unique.ancestor=TRUE, na.rm=TRUE, combine=TRUE)
getGOLevel(onto, level)
```

**Arguments**

LLids	Character vector of Entrez (formerly Locuslink identifiers)
onto	ontology to be queried using the genes list
evid	type of evidence supporting the selected GO Terms
na.rm	flag indicating if those ids returning NA must be removed from the output
orgPkg	Organism annotation package ('org.Xx.eg.db') required to obtain the GO terms associated with the Entrez identifiers
GOTermslist	List produced by a call to function GOTermsList
unique.ancestor	Flag to remove repeated ancestor identifiers
combine	Flag to combine ancestors
level	GO level at which the profile is built

**Details**

During the call to this function there may appear two types of NAs.

By one side if a name is not mapped in LocusLink this yields an NA that must be eliminated because nothing can be found through LL about this name

By another side if a gene is identified in LL but yields NA it seems to mean that it is not mapped in the GO

This may be eliminated but it may be worth the pity to keep track of them and to put these terms in an 'Seemingly unannotated' category. In the case that its number was very high it might suggest reviewing the list or reconsidering the results.

**Value**

A list whose components -one per Entrez term- are character vectors with the most specific GO identifiers associated with this term

**Author(s)**

Alex Sanchez

**See Also**

getAncestorsLst

**Examples**

```
#data(CD4Ids)
#simpleLLids<- as.character(c(2189,5575,5569,11)) #1 is not a Locuslink identifier
#simpleGOlist<- GOTermsList (simpleLLids, orgPkg="org.Hs.eg.db")
#print(simpleGOlist.CC<-GOTermsList (simpleLLids,"CC", orgPkg="org.Hs.eg.db"))
#print(simpleGOlist.IEA<-GOTermsList (simpleLLids,evid="IEA",na.rm=TRUE, orgPkg="org.Hs.eg.db"))
```

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basicProfile	<i>Builds basic functional profile</i>
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### Description

Compute basic functional profile for a given list of genes/GO identifiers, a given ontology at a given level of the GO

### Usage

```
basicProfile(genelist, idType = "Entrez", onto = "ANY", level = 2, orgPackage=NULL,
             ord = TRUE, multilevels = NULL, empty.cats = TRUE, cat.names = TRUE, na.rm = TRUE)
```

### Arguments

genelist	List of genes on which the Profile has to be based
idType	Type of identifiers for the genes. May be 'Entrez' (default), BiocProbes or GoTermsFrame (see details below).
onto	Ontology on which the profile has to be built
level	Level of the ontology at which the profile has to be built
orgPackage	Name of a Bioconductor's organism annotations package ('org.Xx-eg-db'). This field must be provided if the gene list passed to the function is either a character vector of 'Entrez' (NCBI) identifiers or a character vector of probe names
anotPackage	Name of Bioconductor's microarray annotations package. This field must be provided if the gene list passed to the function is a character vector of probe names
ord	Set to 'TRUE' if the profile has to appear ordered by the category names
multilevels	If it is not NULL it must be a vector of GO categories that defines the level at where the profile is built
empty.cats	Set to 'TRUE' if empty categories should appear in the profile
cat.names	Set to 'TRUE' if the profile has to contain the names of categories
na.rm	Set to 'TRUE' if NAs should be removed

### Details

The function admits three types of entries: Entrez ('Entrez'), Bioconductor probe set names ('BioCprobes') or a special type of data frames ('GoTermsFrames'). If the identifier type are 'BioCprobes' then an annotation package name must be provided too.

### Value

An object of class GOProfile (one or more data frames in a list named by the ontologies)

### Author(s)

Alex Sanchez

## References

Sanchez-Pla, A., Salicru, M. and Ocana, J. Statistical methods for the analysis of high-throughput data based on functional profiles derived from the gene ontology. *Journal of Statistical Planning and Inference*, Volume 137, Issue 12, Pages 3975-3989, 2007

## See Also

expandedProfile

## Examples

```
data(CD4Ids)
CD4.MF.Profiles <-basicProfile(geneList=CD4LLids, onto='MF', level=2, orgPackage="org.Hs.
print(CD4.MF.Profiles)
```

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compSummary	<i>This function returns a brief summary of the comparison between two (expanded) profiles.</i>
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## Description

Function to return a brief summary of the comparison between two (expanded) profiles.

## Usage

```
compSummary(l, decs = 6)
```

## Arguments

l	A list of comparison results as returned by a call to <code>compareGeneLists</code>
decs	Number of decimal places to use in the output

## Value

A data frame with the summarized results of each comparison. The values contained are: `Sqr.Eucl.Dist`: The squared euclidean distance, `Standard Err`: The standard error estimate, `pValue` p value of the test, `low conf.int` Lower value for the desired confidence interval, `up conf.int` Upper value for the desired confidence interval.

## Author(s)

Alex Sanchez

## Examples

```
data(sampleProfiles)
comparedMF <-compareGOProfiles (pn=expandedWelsh01[['MF']],
                               qm = expandedSingh01[['MF']],
                               pqn0= commonExpandedWelsh01Singh01[['MF']])
print(comparedMF)
print(compSummary(comparedMF))
```

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compareGOProfiles *Comparison of lists of genes through their functional profiles*

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## Description

Compare two samples of genes in terms of their GO profiles `pn` and `qm`. Both samples may share a common subsample of genes, with GO profile `pqn0`. 'compareGOProfiles' implements some inferential procedures based on asymptotic properties of the squared euclidean distance between the contracted versions of `pn` and `qm`

## Usage

```
compareGOProfiles(pn, qm = NULL, pqn0 = NULL, n = ngenes(pn), m = ngenes(qm), n0 = ngenes(pqn0),
  ab.approx = "asymptotic", confidence = 0.95, nsims = 10000, simplify = T, ...)
```

## Arguments

<code>pn</code>	an object of class <code>ExpandedGOProfile</code> representing one or more "sample" expanded GO profiles for a fixed ontology (see the 'Details' section)
<code>qm</code>	an object of class <code>ExpandedGOProfile</code> representing one or more "sample" expanded GO profiles for a fixed ontology (see the 'Details' section)
<code>pqn0</code>	an object of class <code>ExpandedGOProfile</code> representing one or more "sample" expanded GO profiles for a fixed ontology (see the 'Details' section)
<code>n</code>	a numeric vector with the number of genes profiled in each column of <code>pn</code> . This parameter is included to allow the possibility of exploring the consequences of varying sample sizes, other than the true sample size in <code>pn</code> .
<code>m</code>	a numeric vector with the number of genes profiled in each column of <code>qm</code> .
<code>n0</code>	a numeric vector with the number of genes profiled in each column of <code>pqn0</code> .
<code>method</code>	the approximation method to the sampling distribution under the null hypothesis specifying that the samples <code>pn</code> and <code>qm</code> come from the same population. See the 'Details' section below
<code>confidence</code>	the confidence level of the confidence interval in the result
<code>ab.approx</code>	the approximation used for computing 'a' and 'b' coefficients (see details)
<code>nsims</code>	some inferential methods require a simulation step; the number of simulation replicates is specified with this parameter
<code>simplify</code>	should the result be simplified, if possible? See the 'Details' section
<code>...</code>	Other arguments needed

## Details

An object of S3 class 'ExpandedGOProfile' is, essentially, a 'data.frame' object with each column representing the relative frequencies in all observed node combinations, resulting from profiling a set of genes, for a given and fixed ontology. The `row.names` attribute codifies the node combinations and each `data.frame` column (say, each profile) has an attribute, 'ngenes', indicating the number of profiled genes. The arguments 'pn', 'qm' and 'pqn0' are compared in a column by column wise, recycling columns, if necessary, in order to perform `max(ncol(pn),ncol(qm),ncol(pqn0))` comparisons (each comparison resulting in an object of class 'GOProfileHtest', an specialization of 'htest'). In order to be properly compared, these arguments are expanded by row, according to their row names.

That is, the data arguments can have unequal row numbers. Then, they are expanded adding rows with zero frequencies, in order to make them comparable.

In the  $i$ -th comparison ( $i$  from 1 to  $\max(\text{ncol}(\text{pn}), \text{ncol}(\text{qm}), \text{ncol}(\text{pqn0}))$ ), the parameters  $n$ ,  $m$  and  $n0$  are included to allow the possibility of exploring the consequences of varying sample sizes, other than the true sample sizes included as an attribute in  $\text{pn}$ ,  $\text{qm}$  and  $\text{pqn0}$ .

When  $\text{qm} = \text{NULL}$ , the genes profiled in  $\text{pn}$  are compared with a subsample of them, those profiled in  $\text{pqn0}$  (compare a set of genes with a restricted subset, e.g. those overexpressed under a disease). In this case we take  $\text{qm} = \text{pqn0}$ . When  $\text{pqn0} = \text{NULL}$ , two profiles with no genes in common are compared.

Let  $P_n$  and  $Q_m$  correspond to the contracted functional profiles (the total counts or relative frequencies of hits in each one of the  $s$  GO categories being compared) obtained from  $\text{pn}$  and  $\text{qm}$ . If  $P$  stands for the "population" profile originating the sample profile  $P_n[j]$ ,  $Q$  for the profile originating  $Q_m[j]$  and  $d(\cdot)$  for the squared euclidean distance, if  $P \neq Q$ , the distribution of  $\sqrt{nm/(n+m)}(d(P_n[j], Q_m[j]) - d(P, Q))/\text{se}(d)$  is approximately standard normal,  $N(0,1)$ . This provides the basis for the confidence interval in the result field `icDistance`. When  $P=Q$ , the asymptotic distribution of  $(nm/(n+m)) d(P_n[j], Q_m[j])$  corresponds to the distribution of a mixture of independent chi-square random variables, each one with one degree of freedom. The sampling distribution under  $H_0 P=Q$  may be directly computed from this distribution (approximating it by simulation) (`method="lcombChisq"`) or by a chi-square approximation to it, based on two correcting constants  $a$  and  $b$  (`method="chi-square"`). These constants are chosen to equate the first two moments of both distributions (the linear combination of chi-square random variables distribution and the approximating chi-square distribution). When `method="chi-square"`, the returned test statistic value is the chi-square approximation  $(n d(\text{pn}[j], \text{qm}[j]) - b) / a$ . Then, the result field 'parameter' is a vector containing the 'a' and 'b' values and the number of degrees of freedom, 'df'. Otherwise, the returned test statistic value is  $(nm/(n+m)) d(P_n[j], Q_m[j])$  and 'parameter' contains the coefficients of the linear combination of chi-squares.

## Value

A list containing  $\max(\text{ncol}(\text{pn}), \text{ncol}(\text{qm}), \text{ncol}(\text{pqn0}))$  objects of class 'GOProfileHtest', directly inheriting from 'htest' or a single 'GOProfileHtest' object if  $\max(\text{ncol}(\text{pn}), \text{ncol}(\text{qm}), \text{ncol}(\text{pqn0})) == 1$  and `simplify == T`. Each object of class 'GOProfileHtest' has the following fields:

<code>profilePn</code>	the first contracted profile to compute the squared Euclidean distance
<code>profileQm</code>	the second contracted profile to compute the squared Euclidean distance
<code>statistic</code>	test statistic; its meaning depends on the value of "method", see the 'Details' section.
<code>parameter</code>	parameters of the sample distribution of the test statistic, see the 'Details' section.
<code>p.value</code>	associated p-value to test the null hypothesis of profiles equality.
<code>conf.int</code>	asymptotic confidence interval for the squared euclidean distance. Its attribute "conf.level" contains its nominal confidence level.
<code>estimate</code>	squared euclidean distance between the contracted profiles. Its attribute "se" contains its standard error estimate.
<code>method</code>	a character string indicating the method used to perform the test.
<code>data.name</code>	a character string giving the names of the data.
<code>alternative</code>	a character string describing the alternative hypothesis (always 'true squared Euclidean distance between the contracted profiles is greater than zero')

**Author(s)**

Jordi Ocana

**References**

Sanchez-Pla, A., Salicru M. and Ocana, J. Statistical methods for the analysis of highthroughput data based on functional profiles derived from the gene ontology. *Journal of Statistical Planning and Inference*, 2007.

**See Also**

fitGOProfile, equivalentGOProfiles

**Examples**

```
data(sampleProfiles)
comparedMF <-compareGOProfiles (pn=expandedWelsh01[['MF']],
                               qm = expandedSingh01[['MF']],
                               pqn0= commonExpandedWelsh01Singh01[['MF']])
print(comparedMF)
print(compSummary(comparedMF))
```

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compareGeneLists     *Compares two lists of genes by building (expanded) profiles and comparing them*

---

**Description**

This function wraps all the needed steps to compare two lists of genes following the methodology developed by Sanchez, Salicru and Ocan\textasciitildea (2007)

**Usage**

```
compareGeneLists(genelist1, genelist2, idType = "Entrez", onto = "ANY",
                 level = 2, orgPackage,
                 method = "lcombChisq", ab.approx = "asymptotic", confidence = 0.95, compareFunc)
```

**Arguments**

genelist1	First gene set to be compared
genelist2	Second gene set to be compared
idType	Type of identifiers for the genes. May be 'Entrez' (default), BiocProbes or GoTermsFrame. See the 'Details' section below
onto	Ontology on which the profile has to be built
level	Level of the ontology at which the profile has to be built
orgPackage	Name of a Bioconductor's organism annotations package ('org.Xx-eg-db')
method	The approximation method to the sampling distribution under the null hypothesis specifying that the samples pn and qm come from the same population. See the 'Details' section below

confidence	The confidence level of the confidence interval in the result
ab.approx	The approximation used for computing 'a' and 'b' coefficients (see details)
compareFunction	Allows to use 'fitGOProfile' (sample vs population) or 'compareGOProfiles' (sample1 vs sample2)
...	Other arguments for the methods 'basicProfile' or 'compareGoProfiles'

**Value**

The result of the comparison is a list with a variable number of arguments, depending for which ontologies has been performed the comparison. Each list member is an object of class 'htest' corresponding to the output of the function `compareGOProfiles`

**Author(s)**

Alex Sanchez

**References**

Sanchez-Pla, A., Salicru, M. and Ocana, J. Statistical methods for the analysis of high-throughput data based on functional profiles derived from the gene ontology. *Journal of Statistical Planning and Inference*, 2007

**See Also**

[compareGOProfiles](#), [basicProfile](#)

**Examples**

```
data(prostateIds)
prostateCompared<- compareGeneLists (welsh01EntrezIDs[1:500],
singh01EntrezIDs[1:500], level=2, onto='MF', orgPackage="org.Hs.eg.db")
print (prostateCompared)
print (compSummary (prostateCompared))
```

---

`compareProfilesLists`

*Compares two of expanded profiles*

---

**Description**

This function compares two lists (“sensu R lists”) of expanded profiles by successive calls to function `compareGOProfiles` following the methodology developed by Sanchez, Salicru and Ocan\textasciitildea (2007)

**Usage**

```
compareProfilesLists(expanded1, expanded2, common.expanded=NULL, relationType,
method = "lcombChisq", ab.approx = "asymptotic", confidence = 0.95, ...)
```



**Arguments**

expanded1	First expanded profile to be compared
expanded2	Second expanded profile to be compared
common.expanded	Expanded profile made from the genes appearing in both lists of genes
relationType	Type of relation between gene lists compared through the expanded profiles. It can be INCLUSION, INTERSECTION or DISJOINT
method	The approximation method to the sampling distribution under the null hypothesis specifying that the samples pn and qm come from the same population. See the 'Details' section below
confidence	The confidence level of the confidence interval in the result
ab.approx	The approximation used for computing 'a' and 'b' coefficients (see details)
...	Other arguments for the methods 'basicProfile' or 'compareGoProfiles'

**Value**

The result of the comparison is a list with a variable number of arguments, depending for which ontologies has been performed the comparison. Each list member is an object of class 'hstest' corresponding to the output of the function `compareGOProfiles`

**Author(s)**

Alex Sanchez

**References**

Sanchez-Pla, A., Salicru, M. and Ocana, J. Statistical methods for the analysis of high-throughput data based on functional profiles derived from the gene ontology. *Journal of Statistical Planning and Inference*, 2007

**See Also**

[compareGeneLists](#), [expandedProfile](#)

**Examples**

```
require(goProfiles)
data(sampleProfiles)
comparedMF<- compareProfilesLists (expandedWelsh01, expandedSingh01, relationType="DISJOINT")
print(comparedMF)
print(compSummary(comparedMF))
```

---

 conversionFunctions

*Functions to transform/convert objects between different types*


---

### Description

These functions transform data from one classtype into another, or pack simple processes such as compute the profiles needed for one annotations package.

### Usage

```

as.GOTerms.frame(myGOTermsList, na.rm=TRUE)
as.GOTerms.list(genelist, probeType, orgPackage=NULL, anotPkg=NULL, onto="any",
BioCpack2EntrezIDS(anotPkg, na.rm=FALSE)
BioCpack2Profiles(anotPkg, orgPackage, level=2, na.rm=FALSE, expanded=FALSE)
BioCprobes2Entrez(probeslist , anotPkg, na.rm=TRUE)
GOTermsFrame2GOTermsList(myGOTermsFrame, evid=FALSE)

```

### Arguments

myGOTermsList	GOTermsList object to transform
myGOTermsFrame	GOTermsFrame object to transform
genelist	List of genes (Entrez Ids) to transform
evid	Type of evidence supporting the selected GO Terms
na.rm	Flag indicating if those ids returning NA must be removed from the output
probeType	Type of probes to transform into Entrez Ids
probeslist	List of probes to transform into Entrez Ids
orgPackage	Name of the organism ('org.Xx.eg.db') annotation package
anotPkg	Name of the chip annotation package
level	GO level at which the profile is built
onto	ontology
expanded	Flag to decide if an expanded profile has to be computed

### Details

Not yet available

### Value

Every function returns a transformed object or a list of computed profiles

### Author(s)

Alex Sanchez

**Examples**

```
data(CD4Ids)
myGOTermsList <- GOTermsList(CD4LLids[1:5], orgPkg="org.Hs.eg.db")
myGOTermsFrame<- as.GOTerms.frame(myGOTermsList, na.rm=TRUE)
GOTermsFrame2GOTermsList(myGOTermsFrame, evid=FALSE)
```

---

drosophila

*Entrez identifiers for genes related with an eye mutation in drosophila*


---

**Description**

Entrez identifiers for genes related with an eye mutation in drosophila.

ostrinIds List of genes in Entrez, generated by Ostrin et al.

michaudIds List of genes in Entrez, generated by Michaud et al.

drosophilaIds List of Drosophila genes in Entrez.

**Usage**

```
data(drosophila)
```

**Format**

Each dataset is a character vector with a different number of elements which (should) correspond to valid Entrez identifiers

**Examples**

```
data(drosophila)
```

---

equivSummary

*This function returns a brief summary of the equivalence test between two profiles.*


---

**Description**

Function to return a brief summary of the equivalence test between two profiles. If In its current version it is better that `equivalentGOProfiles` is called with option `simplify` set to `FALSE` before `equivSummary` can be used

**Usage**

```
equivSummary(l, decs = 6)
```

**Arguments**

`l` A list of comparison results as returned by a call to `compareGenelists`  
`decs` Number of decimal places to use in the output

**Value**

A data frame with the summarized results of each comparison. The values contained are: `Sqr.Eucl.Dist`: The squared euclidean distance, `Standard Err`: The standard error estimate, `pValue` p value of the equivalence test, `up.conf.intUpper` value for the desired confidence interval. `d0` Threshold value for equivalence test. `Equivalent?` Numerical value set to 1 if profiles can be considered equivalent and to zero if they cannot.

**Author(s)**

Alex Sanchez

**Examples**

```
data(sampleProfiles)
comparedMF <-compareGOProfiles (pn=expandedWelsh01[['MF']],
                               qm = expandedSingh01[['MF']],
                               pqn0= commonExpandedWelsh01Singh01[['MF']])
equivMF<- equivalentGOProfiles(comparedMF)
print(equivSummary(equivMF, decs=5))
```

---

equivalentGOProfiles

*Are two lists of genes equivalent in terms of their Gene Ontology profiles?*

---

**Description**

Performs an equivalence test based on the squared Euclidean distance between the Gene Ontology profiles of two lists of genes. Equivalence is declared if the upper limit `d.sup` of a one-sided confidence interval `[0, d.sup]` for the distance is lesser than the equivalence limit `d0`.

**Usage**

```
equivalentGOProfiles(goObject, ...)
## S3 method for class 'GOProfileHtest':
equivalentGOProfiles(goObject, equivEpsilon = 0.05, d0 = NULL, confidence = NULL)
## S3 method for class 'list':
equivalentGOProfiles(goObject, ...)
## S3 method for class 'ExpandedGOProfile':
equivalentGOProfiles(goObject, qm=NULL, pqn0=NULL,
                     n = ngenes(goObject), m = ngenes(qm), n0 = ngenes(pqn0),
                     confidence = 0.95,
                     equivEpsilon = 0.05, d0 = NULL,
                     simplify = FALSE, ...)
## Default S3 method:
equivalentGOProfiles(goObject, ...)
```

**Arguments**

<code>goObject</code>	an object related to GO profiles or comparisons between them
<code>qm</code>	an expanded GO profile, i.e. and object of class 'ExpandedGOProfile'
<code>pqn0</code>	an expanded GO profile, i.e. and object of class 'ExpandedGOProfile'
<code>n</code>	a numeric vector with the number of genes profiled in each column of <code>goObject</code> . This parameter is included to allow the possibility of exploring the consequences of varying sample sizes, other than the true sample size in <code>goObject</code> .
<code>m</code>	a numeric vector with the number of genes profiled in each column of <code>qm</code> .
<code>n0</code>	a numeric vector with the number of genes profiled in each column of <code>pqn0</code> .
<code>confidence</code>	the nominal confidence level of the one-sided confidence interval on the distance
<code>d0</code>	a positive value specifying the equivalence limit
<code>equivEpsilon</code>	a positive value used to compute 'd0' if it is not directly available
<code>simplify</code>	should the result be simplified, if possible? See the 'Details' section
<code>...</code>	further arguments, typically the same than to 'compareGOProfiles'

**Details**

An object of S3 class "ExpandedGOProfile" is, essentially, a "data.frame" object with each column representing the relative frequencies in all observed node combinations, resulting from profiling a set of genes, for a given and fixed ontology. The 'row.names' attribute codifies the node combinations and each "data.frame" column (say, each profile) has an attribute, 'ngenest', indicating the number of profiled genes.

In the 'ExpandedGOProfile' interface, the arguments 'goObject', 'qm' and 'pqn0' are compared in a column by column wise, recycling columns, if necessary, in order to perform  $\max(\text{ncol}(\text{goObject}), \text{ncol}(\text{qm}), \text{ncol}(\text{pqn0}))$  equivalence tests (each test resulting in an object of class 'htest'). In order to be properly tested, these arguments are expanded by row, according to their row names. That is, the data arguments can have unequal row numbers. Then, they are expanded adding rows with zero frequencies, in order to make them comparable. In the *i*-th comparison (*i* from 1 to  $\max(\text{ncol}(\text{goObject}), \text{ncol}(\text{qm}), \text{ncol}(\text{pqn0}))$ ), the parameters *n*, *m* and *n0* are included to allow the possibility of exploring the consequences of varying sample sizes, other than the true sample sizes included as an attribute in `goObject`, `qm` and `pqn0`. When `qm = NULL`, the genes profiled in `goObject` are compared with a subsample of them, those profiled in `pqn0` (is there equivalence between a set of genes and a restricted subset, e.g. those overexpressed under a disease, in terms of their profiles?). When `pqn0 = NULL`, an equivalence test between two profiles with no genes in common is performed.

In the 'GOProfileHtest' interface, the one-sided confidence interval for the squared Euclidean distance is computed from the distance and its standard error stored in the corresponding fields of the argument `goObject`, itself typically an object of class 'GOProfileHtest' resulting from a call to 'compareGOProfiles' with `simplify=T`.

In the 'list' interface, the argument `goObject` is intended to be a list of objects of class 'GOProfileHtest' typically resulting from a call to 'compareGOProfiles' with `simplify=F`. The call to the method is iterated along the list, and the one-sided confidence interval for the squared Euclidean distance is computed from the distance and its standard error stored in the corresponding fields of all the members of the list.

In the default interface, the 'goObject' argument is previously converted into an object of class 'ExpandedGOProfile' and then this interface is used.

If the argument 'd0' is not provided it is computed as  $d0 < -s * \text{equivEpsilon}^2$ , where 's' stands for the number of non empty GO nodes in any of the GO profiles being compared.

**Value**

In the 'ExpandedGOProfile' and 'list' interfaces, the result is a list of objects of class "htest" or a single "htest" object if there is only one object in the list and `simplify == T`. In the other interfaces, the result is a single "htest" object. Each one of these "htest" objects has the following fields:

<code>statistic</code>	test statistic, $(\text{distance} - d_0) / \text{se}$
<code>parameter</code>	$d_0$ and the sample sizes (number of genes) $n$ and $m$
<code>p.value</code>	associated p-value to test the null hypothesis of profiles inequivalence
<code>conf.int</code>	asymptotic one-sided confidence interval for the squared euclidean distance. Its attribute "conf.level" contains its nominal confidence level.
<code>estimate</code>	squared euclidean distance between the contracted profiles. Its attribute "se" contains its standard error estimate
<code>data.name</code>	a character string giving the names of the data
<code>alternative</code>	a character string describing the alternative hypothesis (always 'Equivalence or similarity, true squared Euclidean distance between the contracted profiles is less than $d_0$ ')

**Author(s)**

Jordi Ocana

**See Also**

'compareGOProfiles'

**Examples**

```
data(sampleProfiles)
comparedMF <- compareGOProfiles (pn=expandedWelsh01[['MF']],
                                qm = expandedSingh01[['MF']],
                                pqn0= commonExpandedWelsh01Singh01[['MF']])
equivMF<- equivalentGOProfiles(comparedMF)
print(equivSummary(equivMF, decs=5))
```

---

<code>expandedLevel</code>	<i>Function to create expanded levels which can contain GO Terms at different GO levels</i>
----------------------------	---

---

**Description**

This function, combined with function `expandTerm`, allows to create mixed levels which can contain terms belonging to different GO levels. Specifically one can take one (or several, but one by one) term at a given GO level and expand it into its children terms using function `expandTerm` and then combine them into a new level using this function.

**Usage**

```
expandedLevel(LevelTerms, Term2Expand, onto)
expandTerm(GOTerm, onto)
```

**Arguments**

LevelTerms	Other terms which have not been expanded, and will be combined with the expanded ones
Term2Expand	The GO term which will be substituted by its children terms
GOTerm	The GO term which will be substituted by its children terms
onto	The ontology ('MF','BP','CC')

**Value**

The value returned is the vector combining the original terms with the children of the term that had to be expanded.

**Author(s)**

Alex Sanchez

**Examples**

```
got<-toTable(GOTERM)[,2:3]
desc<-function(s) got[got[,1]==s,2]
MFLevel2<-getGOLevel("MF",2)
bindingLevel2<-MFLevel2[2]
bindingLevel3 <- expandTerm(bindingLevel2,"MF")
print(descbindingLevel3<-as.matrix(sapply(bindingLevel3,desc )))
mixedLevel<-c(MFLevel2[-2],bindingLevel3)
print(mixedLevel<-as.matrix(sapply(mixedLevel,desc )))
```

---

expandedProfile      *Builds expanded profiles*

---

**Description**

Expanded profiles are used mainly for comparison of profiles based on the theory developed by Sanchez et al (2007) (see references)

**Usage**

```
expandedProfile(genelist, idType = "Entrez", onto = "ANY", level = 2, orgPackage=
  multilevels = NULL, ord = TRUE, na.rm = TRUE, percentage = TRUE)
```

**Arguments**

genelist	List of genes on which the Profile has to be based
idType	Type of identifiers for the genes. Use 'Entrez' preferably
onto	Ontology on which the profile has to be built
level	Level of the ontology at which the profile has to be built
orgPackage	Name of a Bioconductor's organism annotations package ('org.Xx-eg-db'). This field must be provided if the gene list passed to the function is either a character vector of 'Entrez' (NCBI) identifiers or a character vector of probe names

anotPackage	Name of Bioconductor annotations package. This field must be provided if the gene list passed to the function is a character vector of probe names
ord	Set to 'TRUE' if the profile has to appear ordered by the category names
multilevels	If it is not NULL it must be a vector of GO categories that defines the level at where the profile is built
na.rm	Set to 'TRUE' if NAs should be removed
percentage	Set to 'TRUE' if the profile must be built using percentages

### Details

The function admits three types of entries: Entrez ('Entrez'), Bioconductor probe set names ('BioCprobes') or a special type of data frames ('GOTermsFrames'). If the identifier type are 'BioCprobes' then an annotation package name must be provided too.

### Value

An object of class GOProfile containing an expanded profile

### Author(s)

Alex Sanchez

### References

Sanchez-Pla, A., Salicru, M. and Ocana, J. Statistical methods for the analysis of high-throughput data based on functional profiles derived from the gene ontology. Journal of Statistical Planning and Inference, Volume 137, Issue 12, Pages 3975-3989, 2007.

### See Also

basicProfile

### Examples

```
data(CD4Ids)
CD4.Expanded <-expandedProfile(geneList=CD4LLids, onto='MF', level=2, orgPackage="org.Hs.
```

---

fitGOProfile	<i>Does a "sample" GO profile 'pn', observed in a sample of 'n' genes, fit a "population" or "model" p0?</i>
--------------	--

---

### Description

'fitGOProfile' implements some inferential procedures to solve the preceding question. These procedures are based on asymptotic properties of the squared euclidean distance between the contracted versions of pn and p0

### Usage

```
fitGOProfile(pn, p0, n = ngenes(pn), method = "lcombChisq", ab.approx = "asympto
```



**Arguments**

<code>pn</code>	an object of class <code>ExpandedGOProfile</code> representing one or more "sample" expanded GO profiles for a fixed ontology (see the 'Details' section)
<code>p0</code>	an object of class <code>ExpandedGOProfile</code> representing one or more "population" or "theoretical" expanded GO profiles (see also the 'Details' section)
<code>n</code>	a numeric vector with the number of genes profiled in each column of <code>pn</code> . This parameter is included to allow the possibility of exploring the consequences of varying sample sizes, other than the true sample size in <code>pn</code>
<code>method</code>	the approximation method to the sampling distribution under the null hypothesis " $p = p0$ ", where <code>p</code> is the 'true' population profile originating each column of <code>pn</code> . See the 'Details' section below
<code>ab.approx</code>	the method used to compute the constants 'a' and 'b' described in the paper. See the 'Details' section
<code>confidence</code>	the confidence level of the confidence interval in the result
<code>nsims</code>	some inferential methods require a simulation step; the number of simulation replicates is specified with this parameter
<code>simplify</code>	should the result be simplified, if possible? See the 'Details' section

**Details**

An object of class 'ExpandedGOProfile' is, essentially, a 'data.frame' object with each column representing the relative frequencies in all observed node combinations, resulting from profiling a set of genes, for a given and fixed ontology. The `row.names` attribute codifies the node combinations and each data.frame column (say, each profile) has an attribute, 'ngenes', indicating the number of profiled genes. (Actually, the 'ngenes' attribute of each 'p0' column is ignored and is taken as if it were infinite, 'Inf'.) The arguments 'pn' and 'p0' are compared in a column by column wise, recycling columns, if necessary, in order to perform  $\max(\text{ncol}(\text{pn}), \text{ncol}(\text{p0}))$  comparisons (each comparison resulting in an object of class 'htest'). In order to be properly compared, 'pn' and 'p0' are expanded by row, according to their row names. That is, both arguments can have unequal row numbers. Then, they are expanded adding rows with zero frequencies, in order to make them comparable.

In the  $i$ -th comparison ( $i$  from 1 to  $\max(\text{ncol}(\text{pn}), \text{ncol}(\text{p0}))$ ), if `p` stands for the profile originating the sample profile `pn[,i]` and `d(.)` for the squared euclidean distance, if  $p \neq p0[,i]$ , the distribution of  $\sqrt{n}(d(\text{pn}[,i], p0[,i]) - d(p, p0[,i]))/se$  is approximately standard normal,  $N(0,1)$ . This provides the basis for the confidence interval in the result field `conf.int`. When  $p = p0[,i]$ , the asymptotic distribution of  $n d(\text{pn}[,i], p0[,i])$  is the distribution of a linear combination of independent chi-square random variables, each one with one degree of freedom. This sampling distribution may be directly computed (approximating it by simulation, `method="lcombChisq"`) or approximated by a chi-square distribution, based on two correcting constants `a` and `b` (`method="chi-square"`). These constants are chosen to equate the first two moments of both distributions (the distribution of a linear combination of chi square variables and the approximating chi-square distribution). When `method="chi-square"`, the returned test statistic value is the chi-square approximation  $(n d(\text{pn}, p0) - b) / a$ . Then, the result field 'parameter' is a vector containing the 'a' and 'b' values and the number of degrees of freedom, 'df'. Otherwise, the returned test statistic value is  $n d(\text{pn}, p0)$  and 'parameter' contains the coefficients of the linear combination of chi-squares

**Value**

A list containing  $\max(\text{ncol}(\text{pn}), \text{ncol}(\text{p0}))$  objects of class 'htest', or a single 'htest' object if  $\text{ncol}(\text{pn}) == 1$  and  $\text{ncol}(\text{p0}) == 1$  and `simplify == T`. Each 'htest' object has the following fields:

statistic	test statistic; its meaning depends on the value of "method", see the 'Details' section
parameter	parameters of the sample distribution of the test statistic, see the 'Details' section
p.value	associated p-value to test the null hypothesis "pn[,i] is a random sample taken from p0[,i]"
conf.int	asymptotic confidence interval for the squared euclidean distance. Its attribute "conf.level" contains its nominal confidence level
estimate	squared euclidean distance between the contracted pn and p0 profiles. Its attribute "se" contains its standard error estimate
method	a character string indicating the method used to perform the test
data.name	a character string giving the names of the data
alternative	a character string describing the alternative hypothesis

**Author(s)**

Jordi Ocana

**References**

Sanchez-Pla, A., Salicru, M. and Ocana, J. Statistical methods for the analysis of high-throughput data based on functional profiles derived from the gene ontology. *Journal of Statistical Planning and Inference*, 2007.

**See Also**

compareGOProfiles

**Examples**

```
data(sampleProfiles)
comparedMF <-fitGOProfile(pn=expandedWelsh01[['MF']],
                        p0 = expandedSingh01[['MF']])
print(comparedMF)
print(compSummary(comparedMF))
```

---

goProfiles-package *Performs Gene Ontology based analysis using Functional Profiles.*

---

**Description**

Performs Gene Ontology based analysis for gene sets or other type of biological identifiers which can be annotated in the Gene Ontology.

**Details**

Package: goProfiles  
 Type: Package  
 Version: 1.0  
 Date: 2007-06-12  
 License: GPL

**Author(s)**

Alex Sanchez and Jordi Ocana

**References**

Sanchez-Pla, A., Salicru M. and J.Ocana. Statistical methods for the analysis of high-throughput data based on functional profiles derived from the gene ontology. Journal of Statistical Planning and Inference, 2007.

**See Also**

goTools, Gostat, ontoTools, and other Bioconductor packages for GO based analysis

---

hugoIds

*Entrez Identifiers obtained from the Human Genome Organization*

---

**Description**

Entrez identifiers obtained from the Human Genome Organization. They correspond to the column named 'Entrez Gene Id (mapped)' in the 'All data' table in the Hugo Genome Nomenclature web site (<http://www.genenames.org/index.html>)

**Usage**

```
data(hugoIds)
```

**References**

[http://www.genenames.org/cgi-bin/hgnc\\_downloads.cgi](http://www.genenames.org/cgi-bin/hgnc_downloads.cgi)

**Examples**

```
data(hugoIds)
```

---

`mergeProfilesLists` *Combines two lists of profiles into one*

---

**Description**

Combines two lists of profiles, that is two lists with three components, 'MF', 'BP', 'CC' into a single one.

**Usage**

```
mergeProfilesLists(profilesList1, profilesList2, emptyCats = F, profNames = NULL)
```

**Arguments**

profilesList1	First list to combine
profilesList2	Second list to combine
emptyCats	Boolean. Set to TRUE if there are empty categories that should be accounted for in any of the profiles
profNames	Names for the profiles (optional). If missing they are set to 'Frequency-1', 'Frequency-2', etc.

**Value**

A list of profiles with more than one column each.

**Author(s)**

Alex Sanchez

**Examples**

```
data(sampleProfiles)
merged<-mergeProfilesLists (basicSingh01, basicWelsh01, profNames=c('Welsh','Singh'))
```

---

omimIds

---

*Entrez identifiers for disease-related genes in the OMIM database*


---

**Description**

Entrez identifiers for several lists of genes related with human disease.

diseaseIds contains the Entrez identifiers corresponding to disease-related genes found in the OMIM database. This list has been manually curated by Nuria Lopez-Bigas et al. who kindly provided it to us.

morbiditymapIds contains the Entrez identifiers for all the genes in the morbiditymap table. This list would correspond to disease-related genes if there had been no manual curation, as in the previous list ('diseaseIds')

dominantIds contains the Entrez identifiers for dominant genes after manual curation by Nuria Lopez-Bigas who has kindly allowed us to include them in the package.

recessiveIds contains the Entrez identifiers for recessive genes after manual curation by Nuria Lopez-Bigas who has kindly allowed us to include them in the package.

dominantIdsEBI contains the Entrez identifiers for dominant genes in the EBI version of the OMIM database recovered using SRS with the term 'dominant' in the KEYWORDS field.

recessiveIdsEBI contains the Entrez identifiers for recessive genes in the EBI version of the OMIM database recovered using SRS with the term 'recessive' in the KEYWORDS field.

dominantIdsNCBI contains the Entrez identifiers for dominant genes in the NCBI version of the OMIM database recovered using ENTREZ with the term 'dominant' in the CLINICAL field.

recessiveIdsNCBI contains the Entrez identifiers for recessive genes in the NCBI version of the OMIM database recovered using ENTREZ with the term 'recessive' in the CLINICAL field.

## Usage

```
data(omimIds)
```

## Format

Each dataset is a character vector with a different number of elements which (should) correspond to valid Entrez identifiers

## Details

Lopez-Bigas et al. analyzed the distribution of functional categories in genes causing disease in human. They did several comparisons which can also be done using `goProfiles`. In order to perform these comparisons we first tried to obtain the same lists of genes using standard database browsers, such as 'SRS', at the European Bioinformatics Institute, or 'Entrez', at the National Center for Biotechnological Information. Curiously both approaches provided very different lists so we asked the authors for their data and they kindly provided them to us. In order to facilitate the use of functions included in `goProfiles` we have trimmed the list of recessive and dominant genes so that (i) They become exclusive (no gene belongs to both lists) (2) They are both included in the `diseaseIds` list. This eliminated 39 genes (out of 639) from the list of recessive genes and 52 genes (out of 414) from the list of dominant genes

## References

Lopez-Bigas, N., Blencowe, B.J. and Ouzounis, C.A., Highly consistent patterns for inherited human diseases at the molecular level, *Bioinformatics*, 2006, 22 (3), 269-277.

## Examples

```
data(omimIds)
```

---

`plotProfiles`      *Plot functional profiles*

---

## Description

Plots basic functional profiles created with the 'basicProfile' instruction. If several profiles have to be plot together they must be first merged using the 'mergeProfiles' function. The labels of the Y-axis of the plots are the descriptions of the GO Terms. If the label is longer than 20 characters it is truncated and ended by three dots.

## Usage

```
plotProfiles(aProf, aTitle = "Functional Profile", anOnto = NULL, percentage = F,  
HORIZVERT = TRUE, legendText = NULL, colores = c("white", "red"), multiplePlots
```

**Arguments**

aProf	Functional profile to plot
aTitle	Title for the figures
anOnto	Ontology (to appear in the title)
percentage	Plot absolute or relative frequencies (not summing to 100)
HORIZVERT	Plot horizontal or vertical bars
legendText	Text of the legend for the plot
colores	Colors to be used
multiplePlots	Plot all profiles for a given dataset in one figure
multipleWindows	Open a new window after each plot
labelWidth	Width of Y axis labels (Names of GO categories) in the plot
...	Other graphical parameters that should be passed for plotting

**Value**

The plot

**Author(s)**

Alex Sanchez

**Examples**

```
data(sampleProfiles)
plotProfiles(basicWelsh01[['MF']], 'Functional profiles for Welsh dataset', percentage=TRUE)
merged<-mergeProfilesLists (basicSingh01, basicWelsh01, profNames=c('Welsh', 'Singh'))
plotProfiles(merged, percentage=TRUE, multiplePlots=TRUE, labelWidth=30)
```

---

printProfiles      *Print functional profiles*

---

**Description**

Prints basic functional profiles created with the 'basicProfile' instruction. Allows for several formatting operations such as truncating long labels, removing empty categories or choosing between absolute or relative frequencies. If several profiles have to be printed together they must be first merged using the 'mergeProfiles' function.

**Usage**

```
printProfiles(aProf, aTitle = "Functional Profile", anOnto = NULL, percentage =
  Width=25, emptyCats=FALSE)
```

**Arguments**

aProf	Functional profile to plot
aTitle	Title for the figures
anOnto	Ontology (to appear in the title)
percentage	Plot absolute or relative frequencies (not summing to 100)
Width	Maximum width for the description of GO categories
emptyCats	Set to 'TRUE' if empty categories should appear in the profile

**Value**

The printout

**Author(s)**

Alex Sanchez

**Examples**

```
data(sampleProfiles)
printProfiles(basicWelsh01[['MF']], 'Functional profiles for Welsh dataset', anOnto='MF',
printProfiles(basicWelsh01, 'Functional profiles for Welsh dataset', anOnto='MF', percentage
merged<-mergeProfilesLists (basicSingh01, basicWelsh01, profNames=c('Welsh', 'Singh'))
printProfiles(merged, percentage=TRUE, emptyCats=TRUE)
```

---

prostateIds

*Prostate cancer-related genes*

---

**Description**

Entrez identifiers for genes related with Prostate Cancer selected from two datasets analyzed by Welsh et al. (2001) and Singh et al. (2002) respectively. The genes have been selected from freely available datasets in the internet using a standard workflow for selecting differentially expressed genes. The dataset contains 4 character vectors, each corresponding to the entrez identifiers of the genes selected at a 5% and 1% significance level from the Welsh and Singh dataset respectively.

welsh05EntrezIDs List of genes selected from Welsh et al. study at a 0.05 significance level.

welsh01EntrezIDs List of genes selected from Welsh et al. study at a 0.01 significance level.

singh05EntrezIDs List of genes selected from Singh et al. study at a 0.05 significance level.

singh01EntrezIDs List of genes selected from Singh et al. study at a 0.01 significance level.

**Usage**

```
data(prostateIds)
```

**Format**

Each dataset is a character vector with a different number of elements which (should) correspond to valid Entrez identifiers

**Source**

John B. Welsh, Lisa M. Sapinoso, Andrew I. Su, Suzanne G. Kern, Jessica Wang-Rodriguez, Christopher A. Moskaluk, Jr. Frierson, Henry F., and Garret M. Hampton. Analysis of Gene Expression Identifies Candidate Markers and Pharmacological Targets in Prostate Cancer. *Cancer Res*, 61(16):5974-5978, 2001.

Singh, Dinesh and Febbo, Phillip G and Ross, Kenneth and Jackson, Donald G and Manola, Judith and Ladd, Christine and Tamayo, Pablo and Renshaw, Andrew A and D'Amico, Anthony V and Richie, Jerome P and Lander, Eric S and Loda, Massimo and Kantoff, Philip W and Golub, Todd R and Sellers, William R. Gene expression correlates of clinical prostate cancer behavior. *Cancer Cell*, 2002, Mar., 1(2) 203-209, 2002.

**Examples**

```
data(prostateIds)
```

---

sampleProfiles	<i>Sample Profiles computed on some datasets in the package</i>
----------------	---

---

**Description**

This dataset contains some basic and expanded sample profiles computed on some of the datasets in the package. They are intended to be used in examples of profile manipulation, without having to re-compute the profiles each time the example is checked. The prefix of the object indicates if it is a 'basic' or an 'expanded' profile, whereas the name can be clearly associated to some of the datasets available in the package.

`basicWelsh01` Basic (contracted) profile made from `Welsh01EntrezIds` dataset with default parameters.

`basicSingh01` Basic (contracted) profile made from `Singh01EntrezIds` dataset with default parameters.

`basicCD4` Basic (contracted) profile made from `CD4LLids` dataset with default parameters.

`basicHugo` Basic (contracted) profile made from `hugoIds` dataset with default parameters.

`expandedWelsh01` Expanded profile made from `Welsh01EntrezIds` dataset with default parameters.

`expandedSingh01` Expanded profile made from `Singh01EntrezIds` dataset with default parameters.

`commonExpandedWelsh01Singh01` Expanded profile made from common genes in `Welsh01EntrezIds` and `Singh01EntrezIds` dataset with default parameters.

`expandedCD4` Expanded profile made from `CD4LLids` dataset with default parameters.

`expandedHugo` Expanded profile made from `hugoIds` dataset with default parameters.

**Usage**

```
data(sampleProfiles)
```



**Examples**

```
data(sampleProfiles)
```

# Index

- \*Topic **datasets**
  - CD4Ids, 1
  - drosophila, 11
  - hugoIds, 19
  - omimIds, 20
  - prostateIds, 23
  - sampleProfiles, 24
- \*Topic **hplot**
  - plotProfiles, 21
  - printProfiles, 22
- \*Topic **htest**
  - basicProfile, 3
  - compareGeneLists, 7
  - compareGOProfiles, 5
  - compareProfilesLists, 8
  - compSummary, 4
  - equivalentGOProfiles, 12
  - equivSummary, 11
  - expandedProfile, 15
  - fitGOProfile, 16
- \*Topic **manip**
  - conversionFunctions, 10
  - expandedLevel, 14
  - GOTermsList, 1
- \*Topic **package**
  - goProfiles-package, 18
- \*Topic **utilities**
  - mergeProfilesLists, 19
  
- as.GOTerms.frame
  - (*conversionFunctions*), 10
- as.GOTerms.list
  - (*conversionFunctions*), 10
  
- basicCD4 (*sampleProfiles*), 24
- basicHugo (*sampleProfiles*), 24
- basicProfile, 3, 8
- basicSingh01 (*sampleProfiles*), 24
- basicWelsh01 (*sampleProfiles*), 24
- BioCpack2EntrezIDS
  - (*conversionFunctions*), 10
- BioCpack2Profiles
  - (*conversionFunctions*), 10
  
- BioCprobes2Entrez
  - (*conversionFunctions*), 10
  
- CD4GOTermsFrame (*CD4Ids*), 1
- CD4GOTermsList (*CD4Ids*), 1
- CD4Ids, 1
- CD4LLids (*CD4Ids*), 1
- commonExpandedWelsh01Singh01
  - (*sampleProfiles*), 24
- compareGeneLists, 7, 9
- compareGOProfiles, 5, 8
- compareProfilesLists, 8
- compSummary, 4
- conversionFunctions, 10
  
- diseaseIds (*omimIds*), 20
- dominantIds (*omimIds*), 20
- dominantIdsEBI (*omimIds*), 20
- dominantIdsNCBI (*omimIds*), 20
- drosophila, 11
- drosophilaIds (*drosophila*), 11
  
- equivalentGOProfiles, 12
- equivSummary, 11
- expandedCD4 (*sampleProfiles*), 24
- expandedHugo (*sampleProfiles*), 24
- expandedLevel, 14
- expandedProfile, 9, 15
- expandedSingh01 (*sampleProfiles*), 24
- expandedWelsh01 (*sampleProfiles*), 24
- expandTerm (*expandedLevel*), 14
  
- fitGOProfile, 16
  
- getAncestorsLst (*GOTermsList*), 1
- getGOLevel (*GOTermsList*), 1
- goProfiles (*goProfiles-package*), 18
- goProfiles-package, 18
- GOTermsFrame2GOTermsList
  - (*conversionFunctions*), 10
- GOTermsList, 1

hugoIds, [19](#)

mergeProfilesLists, [19](#)

michaudIds (*drosophila*), [11](#)

morbidmapIds (*omimIds*), [20](#)

omimIds, [20](#)

ostrinIds (*drosophila*), [11](#)

plotProfiles, [21](#)

printProfiles, [22](#)

prostateIds, [23](#)

recessiveIds (*omimIds*), [20](#)

recessiveIdsEBI (*omimIds*), [20](#)

recessiveIdsNCBI (*omimIds*), [20](#)

sampleProfiles, [24](#)

singh01EntrezIDs (*prostateIds*), [23](#)

singh05EntrezIDs (*prostateIds*), [23](#)

welsh01EntrezIDs (*prostateIds*), [23](#)

welsh05EntrezIDs (*prostateIds*), [23](#)