Marginal differential expression

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Abstract

In this vignette we review the basic functions to perform a marginal differential expression analysis.

Packages

First, we need to load `Biobase` and `tami` with

```
library(Biobase)
library(tami)
```

or

```
pacman::p_load(Biobase,tami)
```

Data

The data set will be loaded from `tamidata` using

```
data(gse21942,package="tamidata")
```

The class (kind of data) of this data set is

```
class(gse21942)
```

```
[1] "ExpressionSet"
attr(,"package")
[1] "Biobase"
```

Additional information about the data set could be obtained with

```
help(gse21942,package="tamidata")
```

or just searching `gse21942` in the web.

The phenotipic variables contains the information about the samples. Their names are

```
varLabels(gse21942)
```

```
 [1] "Source.Name"
 [2] "Comment..Sample_description."
 [3] "Comment..Sample_source_name."
 [4] "Characteristics.Organism."
 [5] "Term.Source.REF"
 [6] "Term.Accession.Number"
 [7] "Characteristics.cell.type."
 [8] "Characteristics.disease.state."
 [9] "Term.Source.REF.1"
[10] "Term.Accession.Number.1"
[11] "Protocol.REF"
[12] "Term.Source.REF.2"
[13] "Protocol.REF.1"
[14] "Term.Source.REF.3"
[15] "Extract.Name"
[16] "Material.Type"
[17] "Protocol.REF.2"
```

```
[18] "Term.Source.REF.4"
[19] "Labeled.Extract.Name"
[20] "Label"
[21] "Protocol.REF.3"
[22] "Term.Source.REF.5"
[23] "Hybridization.Name"
[24] "Array.Design.REF"
[25] "Term.Source.REF.6"
[26] "Protocol.REF.4"
[27] "Term.Source.REF.7"
[28] "Protocol.REF.5"
[29] "Term.Source.REF.8"
[30] "Array.Data.File"
[31] "Comment..ArrayExpress.FTP.file."
[32] "Protocol.REF.6"
[33] "Term.Source.REF.9"
[34] "Normalization.Name"
[35] "Derived.Array.Data.File"
[36] "Comment..Derived.ArrayExpress.FTP.file."
[37] "FactorValue..DISEASE.STATE."
[38] "Term.Source.REF.10"
[39] "Term.Accession.Number.2"
[40] "GROUP"
```

The phenotipic variables can be obtained with

```
  pData(gse21942)
```

```
                Source.Name
GSM545846.CEL GSM545846 1
GSM545845.CEL GSM545845 1
GSM545844.CEL GSM545844 1
GSM545843.CEL GSM545843 1
GSM545842.CEL GSM545842 1
GSM545841.CEL GSM545841 1
GSM545840.CEL GSM545840 1
GSM545839.CEL GSM545839 1
GSM545838.CEL GSM545838 1
GSM545837.CEL GSM545837 1
GSM545836.CEL GSM545836 1
GSM545835.CEL GSM545835 1
GSM545834.CEL GSM545834 1
```

```
GSM545833.CEL GSM545833 1
GSM545832.CEL GSM545832 1
GSM545831.CEL GSM545831 1
GSM545830.CEL GSM545830 1
GSM545829.CEL GSM545829 1
GSM545828.CEL GSM545828 1
GSM545827.CEL GSM545827 1
GSM545826.CEL GSM545826 1
GSM545825.CEL GSM545825 1
GSM545824.CEL GSM545824 1
GSM545823.CEL GSM545823 1
GSM545822.CEL GSM545822 1
GSM545821.CEL GSM545821 1
GSM545820.CEL GSM545820 1
GSM545819.CEL GSM545819 1
GSM545818.CEL GSM545818 1
```

	Comment..Sample_description.
GSM545846.CEL	Gene expression data from MS patients
GSM545845.CEL	Gene expression data from MS patients
GSM545844.CEL	Gene expression data from MS patients
GSM545843.CEL	Gene expression data from MS patients
GSM545842.CEL	Gene expression data from MS patients
GSM545841.CEL	Gene expression data from MS patients
GSM545840.CEL	Gene expression data from MS patients
GSM545839.CEL	Gene expression data from MS patients
GSM545838.CEL	Gene expression data from MS patients
GSM545837.CEL	Gene expression data from MS patients
GSM545836.CEL	Gene expression data from MS patients
GSM545835.CEL	Gene expression data from MS patients
GSM545834.CEL	Gene expression data from MS patients
GSM545833.CEL	Gene expression data from MS patients
GSM545832.CEL	Gene expression data from controls representing the general population.
GSM545831.CEL	Gene expression data from controls representing the general population.
GSM545830.CEL	Gene expression data from controls representing the general population.
GSM545829.CEL	Gene expression data from controls representing the general population.
GSM545828.CEL	Gene expression data from controls representing the general population.
GSM545827.CEL	Gene expression data from controls representing the general population.
GSM545826.CEL	Gene expression data from controls representing the general population.
GSM545825.CEL	Gene expression data from controls representing the general population.
GSM545824.CEL	Gene expression data from controls representing the general population.
GSM545823.CEL	Gene expression data from controls representing the general population.
GSM545822.CEL	Gene expression data from controls representing the general population.
GSM545821.CEL	Gene expression data from controls representing the general population.

```
GSM545820.CEL Gene expression data from controls representing the general population.
GSM545819.CEL Gene expression data from controls representing the general population.
GSM545818.CEL Gene expression data from controls representing the general population.
                  Comment..Sample_source_name. Characteristics.Organism.
GSM545846.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545845.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545844.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545843.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545842.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545841.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545840.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545839.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545838.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545837.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545836.CEL peripheral blood mononuclear cells          Homo sapiens
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GSM545829.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545828.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545827.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545826.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545825.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545824.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545823.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545822.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545821.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545820.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545819.CEL peripheral blood mononuclear cells          Homo sapiens
GSM545818.CEL peripheral blood mononuclear cells          Homo sapiens
              Term.Source.REF                    Term.Accession.Number
GSM545846.CEL            EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
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GSM545844.CEL            EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545843.CEL            EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545842.CEL            EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545841.CEL            EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545840.CEL            EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545839.CEL            EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545838.CEL            EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
```

```
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GSM545836.CEL                EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545835.CEL                EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545834.CEL                EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
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GSM545826.CEL                EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
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GSM545821.CEL                EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545820.CEL                EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545819.CEL                EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
GSM545818.CEL                EFO http://purl.org/obo/owl/NCBITaxon#NCBITaxon_9606
                   Characteristics.cell.type. Characteristics.disease.state.
GSM545846.CEL peripheral blood mononuclear            multiple sclerosis
GSM545845.CEL peripheral blood mononuclear            multiple sclerosis
GSM545844.CEL peripheral blood mononuclear            multiple sclerosis
GSM545843.CEL peripheral blood mononuclear            multiple sclerosis
GSM545842.CEL peripheral blood mononuclear            multiple sclerosis
GSM545841.CEL peripheral blood mononuclear            multiple sclerosis
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GSM545839.CEL peripheral blood mononuclear            multiple sclerosis
GSM545838.CEL peripheral blood mononuclear            multiple sclerosis
GSM545837.CEL peripheral blood mononuclear            multiple sclerosis
GSM545836.CEL peripheral blood mononuclear            multiple sclerosis
GSM545835.CEL peripheral blood mononuclear            multiple sclerosis
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GSM545827.CEL peripheral blood mononuclear                       healthy
GSM545826.CEL peripheral blood mononuclear                       healthy
GSM545825.CEL peripheral blood mononuclear                       healthy
```

```
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GSM545823.CEL peripheral blood mononuclear                                healthy
GSM545822.CEL peripheral blood mononuclear                                healthy
GSM545821.CEL peripheral blood mononuclear                                healthy
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GSM545819.CEL peripheral blood mononuclear                                healthy
GSM545818.CEL peripheral blood mononuclear                                healthy
              Term.Source.REF.1 Term.Accession.Number.1 Protocol.REF
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GSM545844.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545843.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545842.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545841.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545840.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545839.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545838.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545837.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545836.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545835.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545834.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545833.CEL               EFO             EFO_0003885 P-GSE21942-2
GSM545832.CEL                                           P-GSE21942-2
GSM545831.CEL                                           P-GSE21942-2
GSM545830.CEL                                           P-GSE21942-2
GSM545829.CEL                                           P-GSE21942-2
GSM545828.CEL                                           P-GSE21942-2
GSM545827.CEL                                           P-GSE21942-2
GSM545826.CEL                                           P-GSE21942-2
GSM545825.CEL                                           P-GSE21942-2
GSM545824.CEL                                           P-GSE21942-2
GSM545823.CEL                                           P-GSE21942-2
GSM545822.CEL                                           P-GSE21942-2
GSM545821.CEL                                           P-GSE21942-2
GSM545820.CEL                                           P-GSE21942-2
GSM545819.CEL                                           P-GSE21942-2
GSM545818.CEL                                           P-GSE21942-2
              Term.Source.REF.2 Protocol.REF.1 Term.Source.REF.3
GSM545846.CEL                NA   P-GSE21942-3                NA
GSM545845.CEL                NA   P-GSE21942-3                NA
GSM545844.CEL                NA   P-GSE21942-3                NA
GSM545843.CEL                NA   P-GSE21942-3                NA
GSM545842.CEL                NA   P-GSE21942-3                NA
```

GSM545841.CEL		NA	P-GSE21942-3	NA
GSM545840.CEL		NA	P-GSE21942-3	NA
GSM545839.CEL		NA	P-GSE21942-3	NA
GSM545838.CEL		NA	P-GSE21942-3	NA
GSM545837.CEL		NA	P-GSE21942-3	NA
GSM545836.CEL		NA	P-GSE21942-3	NA
GSM545835.CEL		NA	P-GSE21942-3	NA
GSM545834.CEL		NA	P-GSE21942-3	NA
GSM545833.CEL		NA	P-GSE21942-3	NA
GSM545832.CEL		NA	P-GSE21942-3	NA
GSM545831.CEL		NA	P-GSE21942-3	NA
GSM545830.CEL		NA	P-GSE21942-3	NA
GSM545829.CEL		NA	P-GSE21942-3	NA
GSM545828.CEL		NA	P-GSE21942-3	NA
GSM545827.CEL		NA	P-GSE21942-3	NA
GSM545826.CEL		NA	P-GSE21942-3	NA
GSM545825.CEL		NA	P-GSE21942-3	NA
GSM545824.CEL		NA	P-GSE21942-3	NA
GSM545823.CEL		NA	P-GSE21942-3	NA
GSM545822.CEL		NA	P-GSE21942-3	NA
GSM545821.CEL		NA	P-GSE21942-3	NA
GSM545820.CEL		NA	P-GSE21942-3	NA
GSM545819.CEL		NA	P-GSE21942-3	NA
GSM545818.CEL		NA	P-GSE21942-3	NA
	Extract.Name	Material.Type	Protocol.REF.2	
GSM545846.CEL	GSM545846 extract 1	total RNA	P-GSE21942-4	
GSM545845.CEL	GSM545845 extract 1	total RNA	P-GSE21942-4	
GSM545844.CEL	GSM545844 extract 1	total RNA	P-GSE21942-4	
GSM545843.CEL	GSM545843 extract 1	total RNA	P-GSE21942-4	
GSM545842.CEL	GSM545842 extract 1	total RNA	P-GSE21942-4	
GSM545841.CEL	GSM545841 extract 1	total RNA	P-GSE21942-4	
GSM545840.CEL	GSM545840 extract 1	total RNA	P-GSE21942-4	
GSM545839.CEL	GSM545839 extract 1	total RNA	P-GSE21942-4	
GSM545838.CEL	GSM545838 extract 1	total RNA	P-GSE21942-4	
GSM545837.CEL	GSM545837 extract 1	total RNA	P-GSE21942-4	
GSM545836.CEL	GSM545836 extract 1	total RNA	P-GSE21942-4	
GSM545835.CEL	GSM545835 extract 1	total RNA	P-GSE21942-4	
GSM545834.CEL	GSM545834 extract 1	total RNA	P-GSE21942-4	
GSM545833.CEL	GSM545833 extract 1	total RNA	P-GSE21942-4	
GSM545832.CEL	GSM545832 extract 1	total RNA	P-GSE21942-4	
GSM545831.CEL	GSM545831 extract 1	total RNA	P-GSE21942-4	
GSM545830.CEL	GSM545830 extract 1	total RNA	P-GSE21942-4	
GSM545829.CEL	GSM545829 extract 1	total RNA	P-GSE21942-4	

```
GSM545828.CEL GSM545828 extract 1    total RNA   P-GSE21942-4
GSM545827.CEL GSM545827 extract 1    total RNA   P-GSE21942-4
GSM545826.CEL GSM545826 extract 1    total RNA   P-GSE21942-4
GSM545825.CEL GSM545825 extract 1    total RNA   P-GSE21942-4
GSM545824.CEL GSM545824 extract 1    total RNA   P-GSE21942-4
GSM545823.CEL GSM545823 extract 1    total RNA   P-GSE21942-4
GSM545822.CEL GSM545822 extract 1    total RNA   P-GSE21942-4
GSM545821.CEL GSM545821 extract 1    total RNA   P-GSE21942-4
GSM545820.CEL GSM545820 extract 1    total RNA   P-GSE21942-4
GSM545819.CEL GSM545819 extract 1    total RNA   P-GSE21942-4
GSM545818.CEL GSM545818 extract 1    total RNA   P-GSE21942-4
              Term.Source.REF.4 Labeled.Extract.Name  Label Protocol.REF.3
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GSM545845.CEL                NA        GSM545845 LE 1 biotin   P-GSE21942-5
GSM545844.CEL                NA        GSM545844 LE 1 biotin   P-GSE21942-5
GSM545843.CEL                NA        GSM545843 LE 1 biotin   P-GSE21942-5
GSM545842.CEL                NA        GSM545842 LE 1 biotin   P-GSE21942-5
GSM545841.CEL                NA        GSM545841 LE 1 biotin   P-GSE21942-5
GSM545840.CEL                NA        GSM545840 LE 1 biotin   P-GSE21942-5
GSM545839.CEL                NA        GSM545839 LE 1 biotin   P-GSE21942-5
GSM545838.CEL                NA        GSM545838 LE 1 biotin   P-GSE21942-5
GSM545837.CEL                NA        GSM545837 LE 1 biotin   P-GSE21942-5
GSM545836.CEL                NA        GSM545836 LE 1 biotin   P-GSE21942-5
GSM545835.CEL                NA        GSM545835 LE 1 biotin   P-GSE21942-5
GSM545834.CEL                NA        GSM545834 LE 1 biotin   P-GSE21942-5
GSM545833.CEL                NA        GSM545833 LE 1 biotin   P-GSE21942-5
GSM545832.CEL                NA        GSM545832 LE 1 biotin   P-GSE21942-5
GSM545831.CEL                NA        GSM545831 LE 1 biotin   P-GSE21942-5
GSM545830.CEL                NA        GSM545830 LE 1 biotin   P-GSE21942-5
GSM545829.CEL                NA        GSM545829 LE 1 biotin   P-GSE21942-5
GSM545828.CEL                NA        GSM545828 LE 1 biotin   P-GSE21942-5
GSM545827.CEL                NA        GSM545827 LE 1 biotin   P-GSE21942-5
GSM545826.CEL                NA        GSM545826 LE 1 biotin   P-GSE21942-5
GSM545825.CEL                NA        GSM545825 LE 1 biotin   P-GSE21942-5
GSM545824.CEL                NA        GSM545824 LE 1 biotin   P-GSE21942-5
GSM545823.CEL                NA        GSM545823 LE 1 biotin   P-GSE21942-5
GSM545822.CEL                NA        GSM545822 LE 1 biotin   P-GSE21942-5
GSM545821.CEL                NA        GSM545821 LE 1 biotin   P-GSE21942-5
GSM545820.CEL                NA        GSM545820 LE 1 biotin   P-GSE21942-5
GSM545819.CEL                NA        GSM545819 LE 1 biotin   P-GSE21942-5
GSM545818.CEL                NA        GSM545818 LE 1 biotin   P-GSE21942-5
              Term.Source.REF.5 Hybridization.Name Array.Design.REF
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```

```
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GSM545842.CEL                NA              GSM545842        A-AFFY-44
GSM545841.CEL                NA              GSM545841        A-AFFY-44
GSM545840.CEL                NA              GSM545840        A-AFFY-44
GSM545839.CEL                NA              GSM545839        A-AFFY-44
GSM545838.CEL                NA              GSM545838        A-AFFY-44
GSM545837.CEL                NA              GSM545837        A-AFFY-44
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GSM545833.CEL                NA              GSM545833        A-AFFY-44
GSM545832.CEL                NA              GSM545832        A-AFFY-44
GSM545831.CEL                NA              GSM545831        A-AFFY-44
GSM545830.CEL                NA              GSM545830        A-AFFY-44
GSM545829.CEL                NA              GSM545829        A-AFFY-44
GSM545828.CEL                NA              GSM545828        A-AFFY-44
GSM545827.CEL                NA              GSM545827        A-AFFY-44
GSM545826.CEL                NA              GSM545826        A-AFFY-44
GSM545825.CEL                NA              GSM545825        A-AFFY-44
GSM545824.CEL                NA              GSM545824        A-AFFY-44
GSM545823.CEL                NA              GSM545823        A-AFFY-44
GSM545822.CEL                NA              GSM545822        A-AFFY-44
GSM545821.CEL                NA              GSM545821        A-AFFY-44
GSM545820.CEL                NA              GSM545820        A-AFFY-44
GSM545819.CEL                NA              GSM545819        A-AFFY-44
GSM545818.CEL                NA              GSM545818        A-AFFY-44
              Term.Source.REF.6 Protocol.REF.4 Term.Source.REF.7 Protocol.REF.5
GSM545846.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545845.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545844.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545843.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545842.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545841.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545840.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545839.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545838.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545837.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545836.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545835.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545834.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
GSM545833.CEL                NA   P-GSE21942-6                NA   P-GSE21942-7
```

GSM545832.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545831.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545830.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545829.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545828.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545827.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545826.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545825.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545824.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545823.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545822.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545821.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545820.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545819.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7
GSM545818.CEL	NA	P-GSE21942-6	NA	P-GSE21942-7

	Term.Source.REF.8	Array.Data.File
GSM545846.CEL	NA	GSM545846.CEL
GSM545845.CEL	NA	GSM545845.CEL
GSM545844.CEL	NA	GSM545844.CEL
GSM545843.CEL	NA	GSM545843.CEL
GSM545842.CEL	NA	GSM545842.CEL
GSM545841.CEL	NA	GSM545841.CEL
GSM545840.CEL	NA	GSM545840.CEL
GSM545839.CEL	NA	GSM545839.CEL
GSM545838.CEL	NA	GSM545838.CEL
GSM545837.CEL	NA	GSM545837.CEL
GSM545836.CEL	NA	GSM545836.CEL
GSM545835.CEL	NA	GSM545835.CEL
GSM545834.CEL	NA	GSM545834.CEL
GSM545833.CEL	NA	GSM545833.CEL
GSM545832.CEL	NA	GSM545832.CEL
GSM545831.CEL	NA	GSM545831.CEL
GSM545830.CEL	NA	GSM545830.CEL
GSM545829.CEL	NA	GSM545829.CEL
GSM545828.CEL	NA	GSM545828.CEL
GSM545827.CEL	NA	GSM545827.CEL
GSM545826.CEL	NA	GSM545826.CEL
GSM545825.CEL	NA	GSM545825.CEL
GSM545824.CEL	NA	GSM545824.CEL
GSM545823.CEL	NA	GSM545823.CEL
GSM545822.CEL	NA	GSM545822.CEL
GSM545821.CEL	NA	GSM545821.CEL
GSM545820.CEL	NA	GSM545820.CEL

```
GSM545819.CEL                 NA   GSM545819.CEL
GSM545818.CEL                 NA   GSM545818.CEL
                                                                                Comment.
GSM545846.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545845.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545844.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545843.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545842.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545841.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545840.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545839.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545838.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545837.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545836.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545835.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545834.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545833.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545832.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545831.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545830.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545829.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545828.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545827.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545826.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545825.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545824.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545823.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545822.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545821.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545820.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545819.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545818.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
              Protocol.REF.6 Term.Source.REF.9         Normalization.Name
GSM545846.CEL    P-GSE21942-1                 NA GSM545846_sample_table.txt norm
GSM545845.CEL    P-GSE21942-1                 NA GSM545845_sample_table.txt norm
GSM545844.CEL    P-GSE21942-1                 NA GSM545844_sample_table.txt norm
GSM545843.CEL    P-GSE21942-1                 NA GSM545843_sample_table.txt norm
GSM545842.CEL    P-GSE21942-1                 NA GSM545842_sample_table.txt norm
GSM545841.CEL    P-GSE21942-1                 NA GSM545841_sample_table.txt norm
GSM545840.CEL    P-GSE21942-1                 NA GSM545840_sample_table.txt norm
GSM545839.CEL    P-GSE21942-1                 NA GSM545839_sample_table.txt norm
GSM545838.CEL    P-GSE21942-1                 NA GSM545838_sample_table.txt norm
GSM545837.CEL    P-GSE21942-1                 NA GSM545837_sample_table.txt norm
```

```
GSM545836.CEL    P-GSE21942-1                      NA GSM545836_sample_table.txt norm
GSM545835.CEL    P-GSE21942-1                      NA GSM545835_sample_table.txt norm
GSM545834.CEL    P-GSE21942-1                      NA GSM545834_sample_table.txt norm
GSM545833.CEL    P-GSE21942-1                      NA GSM545833_sample_table.txt norm
GSM545832.CEL    P-GSE21942-1                      NA GSM545832_sample_table.txt norm
GSM545831.CEL    P-GSE21942-1                      NA GSM545831_sample_table.txt norm
GSM545830.CEL    P-GSE21942-1                      NA GSM545830_sample_table.txt norm
GSM545829.CEL    P-GSE21942-1                      NA GSM545829_sample_table.txt norm
GSM545828.CEL    P-GSE21942-1                      NA GSM545828_sample_table.txt norm
GSM545827.CEL    P-GSE21942-1                      NA GSM545827_sample_table.txt norm
GSM545826.CEL    P-GSE21942-1                      NA GSM545826_sample_table.txt norm
GSM545825.CEL    P-GSE21942-1                      NA GSM545825_sample_table.txt norm
GSM545824.CEL    P-GSE21942-1                      NA GSM545824_sample_table.txt norm
GSM545823.CEL    P-GSE21942-1                      NA GSM545823_sample_table.txt norm
GSM545822.CEL    P-GSE21942-1                      NA GSM545822_sample_table.txt norm
GSM545821.CEL    P-GSE21942-1                      NA GSM545821_sample_table.txt norm
GSM545820.CEL    P-GSE21942-1                      NA GSM545820_sample_table.txt norm
GSM545819.CEL    P-GSE21942-1                      NA GSM545819_sample_table.txt norm
GSM545818.CEL    P-GSE21942-1                      NA GSM545818_sample_table.txt norm
                     Derived.Array.Data.File
GSM545846.CEL GSM545846_sample_table.txt
GSM545845.CEL GSM545845_sample_table.txt
GSM545844.CEL GSM545844_sample_table.txt
GSM545843.CEL GSM545843_sample_table.txt
GSM545842.CEL GSM545842_sample_table.txt
GSM545841.CEL GSM545841_sample_table.txt
GSM545840.CEL GSM545840_sample_table.txt
GSM545839.CEL GSM545839_sample_table.txt
GSM545838.CEL GSM545838_sample_table.txt
GSM545837.CEL GSM545837_sample_table.txt
GSM545836.CEL GSM545836_sample_table.txt
GSM545835.CEL GSM545835_sample_table.txt
GSM545834.CEL GSM545834_sample_table.txt
GSM545833.CEL GSM545833_sample_table.txt
GSM545832.CEL GSM545832_sample_table.txt
GSM545831.CEL GSM545831_sample_table.txt
GSM545830.CEL GSM545830_sample_table.txt
GSM545829.CEL GSM545829_sample_table.txt
GSM545828.CEL GSM545828_sample_table.txt
GSM545827.CEL GSM545827_sample_table.txt
GSM545826.CEL GSM545826_sample_table.txt
GSM545825.CEL GSM545825_sample_table.txt
GSM545824.CEL GSM545824_sample_table.txt
```

```
GSM545823.CEL GSM545823_sample_table.txt
GSM545822.CEL GSM545822_sample_table.txt
GSM545821.CEL GSM545821_sample_table.txt
GSM545820.CEL GSM545820_sample_table.txt
GSM545819.CEL GSM545819_sample_table.txt
GSM545818.CEL GSM545818_sample_table.txt
                                                                                Comment..De
GSM545846.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545845.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545844.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545843.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545842.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545841.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545840.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545839.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545838.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545837.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545836.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545835.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545834.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545833.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545832.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545831.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545830.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545829.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545828.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545827.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545826.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545825.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545824.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545823.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545822.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545821.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545820.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545819.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
GSM545818.CEL ftp://ftp.ebi.ac.uk/pub/databases/microarray/data/experiment/GEOD/E-GEOD-21942,
```

	FactorValue..DISEASE.STATE.	Term.Source.REF.10
GSM545846.CEL	multiple sclerosis	EFO
GSM545845.CEL	multiple sclerosis	EFO
GSM545844.CEL	multiple sclerosis	EFO
GSM545843.CEL	multiple sclerosis	EFO
GSM545842.CEL	multiple sclerosis	EFO
GSM545841.CEL	multiple sclerosis	EFO

```
GSM545840.CEL          multiple sclerosis                    EFO
GSM545839.CEL          multiple sclerosis                    EFO
GSM545838.CEL          multiple sclerosis                    EFO
GSM545837.CEL          multiple sclerosis                    EFO
GSM545836.CEL          multiple sclerosis                    EFO
GSM545835.CEL          multiple sclerosis                    EFO
GSM545834.CEL          multiple sclerosis                    EFO
GSM545833.CEL          multiple sclerosis                    EFO
GSM545832.CEL                        healthy
GSM545831.CEL                        healthy
GSM545830.CEL                        healthy
GSM545829.CEL                        healthy
GSM545828.CEL                        healthy
GSM545827.CEL                        healthy
GSM545826.CEL                        healthy
GSM545825.CEL                        healthy
GSM545824.CEL                        healthy
GSM545823.CEL                        healthy
GSM545822.CEL                        healthy
GSM545821.CEL                        healthy
GSM545820.CEL                        healthy
GSM545819.CEL                        healthy
GSM545818.CEL                        healthy
              Term.Accession.Number.2 GROUP
GSM545846.CEL           EFO_0003885       1
GSM545845.CEL           EFO_0003885       1
GSM545844.CEL           EFO_0003885       1
GSM545843.CEL           EFO_0003885       1
GSM545842.CEL           EFO_0003885       1
GSM545841.CEL           EFO_0003885       1
GSM545840.CEL           EFO_0003885       1
GSM545839.CEL           EFO_0003885       1
GSM545838.CEL           EFO_0003885       1
GSM545837.CEL           EFO_0003885       1
GSM545836.CEL           EFO_0003885       1
GSM545835.CEL           EFO_0003885       1
GSM545834.CEL           EFO_0003885       1
GSM545833.CEL           EFO_0003885       1
GSM545832.CEL                             0
GSM545831.CEL                             0
GSM545830.CEL                             0
GSM545829.CEL                             0
GSM545828.CEL                             0
```

```
GSM545827.CEL                           0
GSM545826.CEL                           0
GSM545825.CEL                           0
GSM545824.CEL                           0
GSM545823.CEL                           0
GSM545822.CEL                           0
GSM545821.CEL                           0
GSM545820.CEL                           0
GSM545819.CEL                           0
GSM545818.CEL                           0
```

The variable giving the condition is `FactorValue..DISEASE.STATE..`

```
pData(gse21942)[,"FactorValue..DISEASE.STATE."]
```

```
 [1] multiple sclerosis multiple sclerosis multiple sclerosis multiple sclerosis
 [5] multiple sclerosis multiple sclerosis multiple sclerosis multiple sclerosis
 [9] multiple sclerosis multiple sclerosis multiple sclerosis multiple sclerosis
[13] multiple sclerosis multiple sclerosis healthy            healthy
[17] healthy            healthy            healthy            healthy
[21] healthy            healthy            healthy            healthy
[25] healthy            healthy            healthy            healthy
[29] healthy
Levels: healthy multiple sclerosis
```

The absolute frequencies are

```
table(pData(gse21942)[,"FactorValue..DISEASE.STATE."])
```

```
          healthy multiple sclerosis
               15                 14
```

t-test for a given gene (row)

We choose the gene in row 698 in the expression matrix. The t-test comparing the means assuming a common variance can be applied using stats::t.test.

```
x0 = pData(gse21942)[,"FactorValue..DISEASE.STATE."]
y0 = exprs(gse21942)[698,]
```

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```r
t.test(y0 ~ x0,var.equal=TRUE)
```

```
    Two Sample t-test

data:  y0 by x0
t = 4.4829, df = 27, p-value = 0.0001222
alternative hypothesis: true difference in means between group healthy and group multiple scl
95 percent confidence interval:
 0.2135285 0.5739697
sample estimates:
        mean in group healthy mean in group multiple sclerosis
                     5.761981                        5.368232
```

t-tests for all genes

It can be used genefilter::rowttests.

```r
tt = genefilter::rowttests(gse21942,pData(gse21942)[,"FactorValue..DISEASE.STATE."])
```

```
Warning: replacing previous import 'utils::findMatches' by
'S4Vectors::findMatches' when loading 'AnnotationDbi'
```

The first rows can be seen with

```r
head(tt)
```

```
            statistic          dm     p.value
1007_s_at -2.29869931 -0.15981906 0.029492008
1053_at    3.44084102  0.20940361 0.001901206
117_at    -0.08505071 -0.01110444 0.932848609
121_at    -0.53362792 -0.02274832 0.597965094
1255_g_at -1.01536731 -0.04339509 0.318943716
1294_at   -1.05030996 -0.07873761 0.302886126
```

Note that tt is a data.frame.

```r
class(tt)
```

```
[1] "data.frame"
```

The column headed `statistic` is the statistic of the t-test assuming a common variance. The column `dm` is the difference of the sample means and the column headed `p.value` is the p-value of the t-test. These are the **raw p-values**.

We can evaluated how many genes are significant for a given threshold $\alpha = 0.05$.

```
tt[,"p.value"] < 0.001
```

The rows (in the expression matrix) of these genes are

```
which(tt[,"p.value"] < 0.001)
```

The rows for the minimum and maximum p-value can be found with

```
which.min(tt[,"p.value"])
```

```
[1] 37952
```

```
which.max(tt[,"p.value"])
```

```
[1] 52300
```

A summary of the p-values can be produced using

```
summary(tt[,"p.value"])
```

```
   Min. 1st Qu.  Median    Mean 3rd Qu.    Max.
0.00000 0.02348 0.20089 0.30861 0.55059 0.99999
```

A kernel estimator of the density of these p-values could be obtained with

```
pacman::p_load(ggplot2)
ggplot(tt, aes(x=p.value)) +  geom_density(adjust=1/5)
```
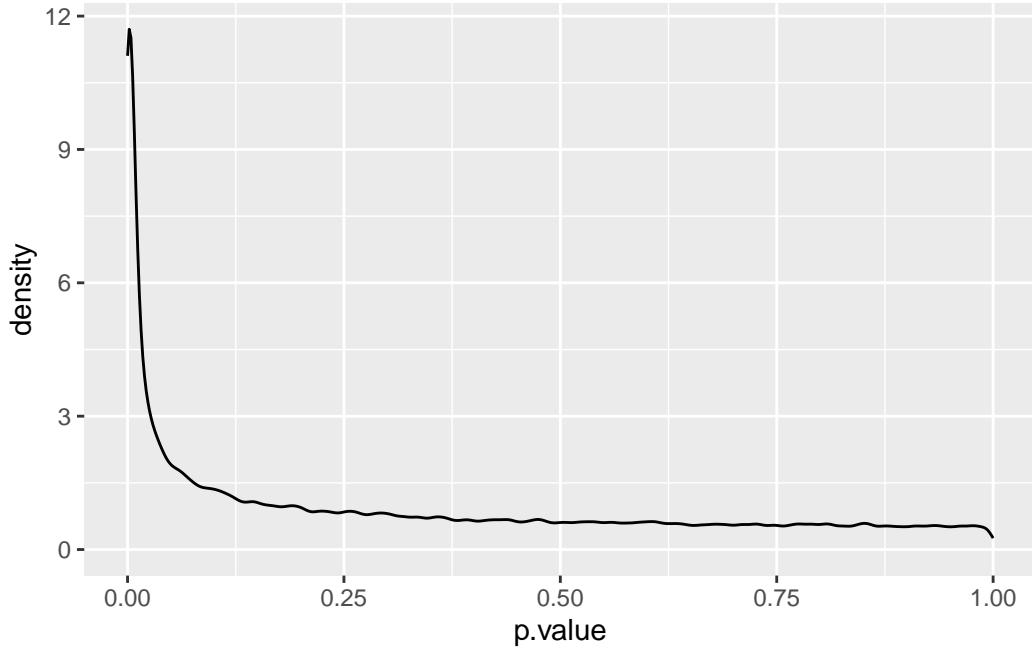
We can adjust the p-values using the Benjamini-Hochberg method

```
p_BH = p.adjust(tt[,"p.value"])
```

or using the Bonferroni correction.

```
p_Bonferroni = p.adjust(tt[,"p.value"])
```

Density estimators for Benjamini-Hochberg and Bonferroni adjusted p-values can be obtained with

```
df = data.frame(p_BH)
ggplot(df, aes(x=p_BH)) +  geom_density(adjust=1/5)
```
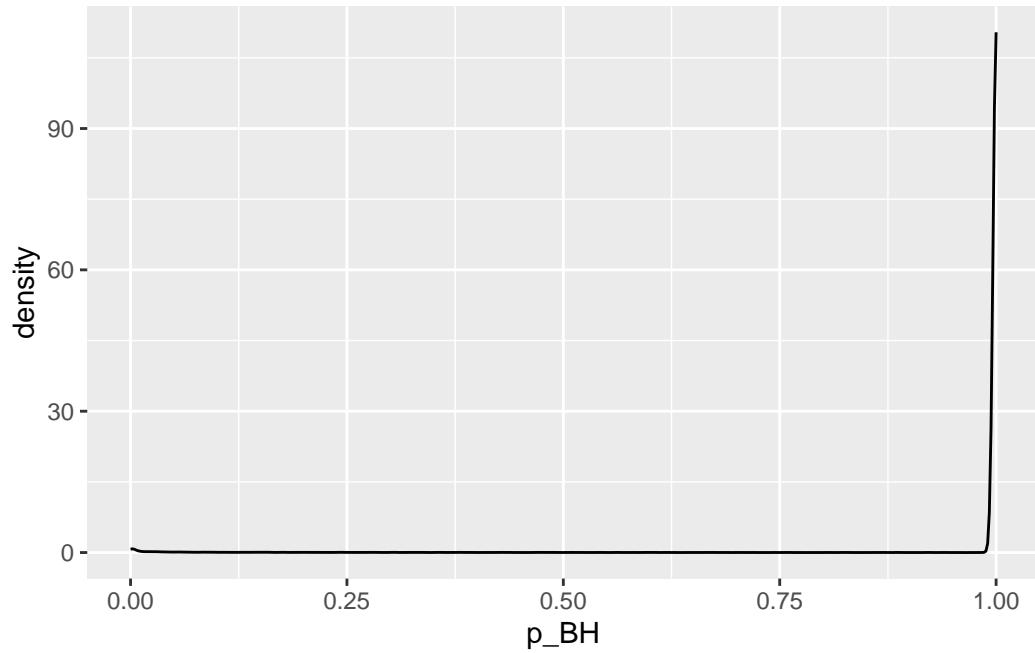
and

```
df = data.frame(p_Bonferroni)
ggplot(df, aes(x=p_Bonferroni)) +  geom_density(adjust=1/5)
```
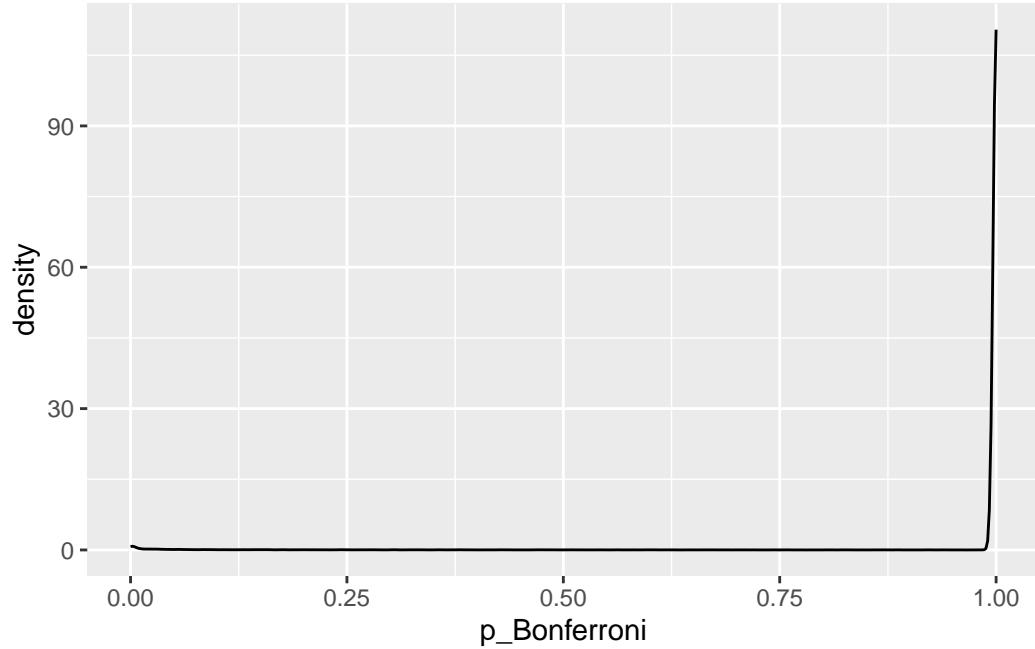
q-values

The q-values can be calculated using the package `qvalue`.

```
pacman::p_load(qvalue)
qval = qvalue(tt[,"p.value"])
```

Some plots for these q-values just calculated are obtained with

```
plot(qval)
```
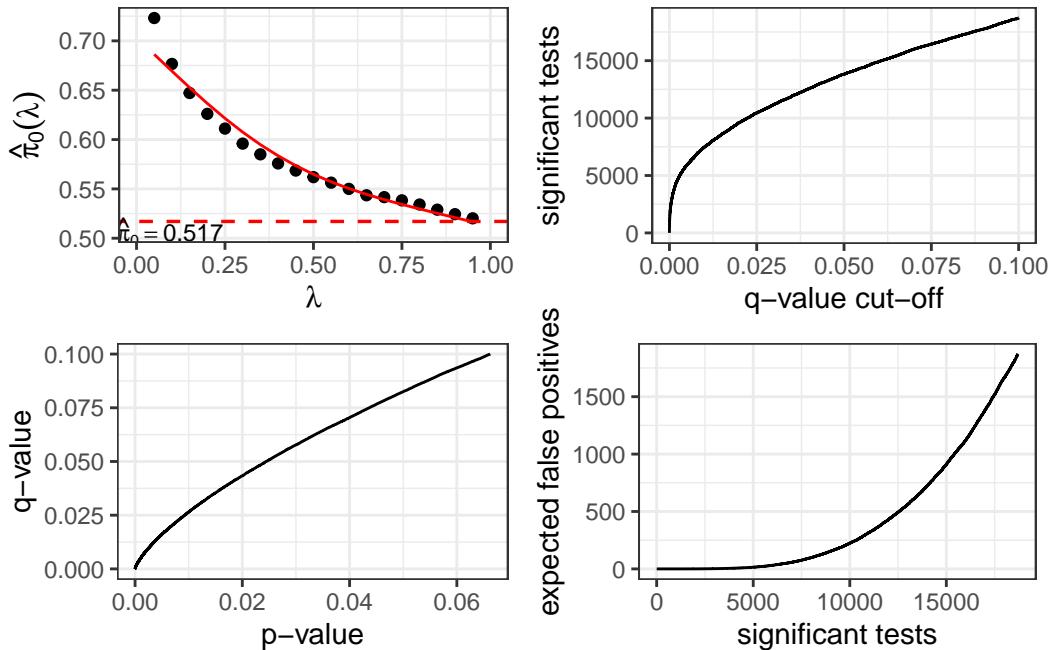

In particular the bottom-left plot shows the q-values against the raw p-values.

t-test using tami::dema

The function `tami::dema` performs a differential expression analysis in one step.

The first option is the usual t-test with a Benjamini-Hochberg correction.

```
x1 = tami::dema(x=gse21942,y="FactorValue..DISEASE.STATE.",test = rowt,
          correction = "BH",fdr=.0001,foutput = "gse21942_rowt")
```

A tidy report can be obtained using

```
x1_df = tidy(x1)
```

We have obtained a `data.frame`. The first rows can be obtained with

```
head(x1_df)
```

```
          PROBEID ENTREZID         ENSEMBL   SYMBOL         GO EVIDENCE
1171 1552312_a_at     4238 ENSG00000037749    MFAP3 GO:0005576      TAS
3614 1552660_a_at    55322 ENSG00000082213   C5orf22       <NA>     <NA>
3736 1552670_a_at    79660 ENSG00000173281   PPP1R3B GO:0000164      IEA
3792   1552675_at   150353 ENSG00000172404    DNAJB7 GO:0051087      IPI
4078 1552717_s_at   645455 ENSG00000276725  CEP170P1 GO:0005515      IPI
5331   1552867_at     <NA>            <NA>      <NA>       <NA>     <NA>
     ONTOLOGY statistic         rawp         adjp         qval
1171       CC  7.813037 2.115225e-08 5.511837e-06 2.847585e-06
3614     <NA>  7.165150 1.049814e-07 1.445808e-05 7.469493e-06
3736       CC  6.245573 1.110567e-06 6.876589e-05 3.552658e-05
3792       MF  7.307560 7.349016e-08 1.198296e-05 6.190769e-06
4078       MF  7.745471 2.493649e-08 6.254140e-06 3.231082e-06
5331     <NA>  6.211773 1.213190e-06 7.297158e-05 3.769937e-05
```

In particular, the results for the gene in row 698 previously considered are obtained with

```
x1_df[698,]
```

```
          PROBEID ENTREZID         ENSEMBL SYMBOL         GO EVIDENCE ONTOLOGY
531463 223585_x_at    25948 ENSG00000170852 KBTBD2 GO:0004842      IBA       MF
       statistic         rawp         adjp         qval
531463   8.41056 5.063783e-09 2.193817e-06 1.133394e-06
```

The same report in a html file is obtained with

```
glimpse(x1)
```

```
Warning: replacing previous import 'utils::findMatches' by
'S4Vectors::findMatches' when loading 'AnnotationForge'
```

```
Registered S3 method overwritten by 'GGally':
  method from
  +.gg   ggplot2
```

```
[1] "./reports/gse21942_rowt.html"
```

The html file just generated can be open with

```
browseURL(glimpse(x1))
```

Using moderated t-tests

We are use the moderated t-tests using the package `limma`. The test used in tami::dema have to be replaced by `rowtmod`.

```
x2 = dema(x=gse21942,y="FactorValue..DISEASE.STATE.",
          test = rowtmod,correction = "BH",
          fdr = .0001,foutput = "gse21942_rowtmod")
```

A `data.frame` with the results is obtained with

```
x2_df= tidy(x2)
```

The same report in a html file is obtained with

```
glimpse(x2)
```

```
[1] "./reports/gse21942_rowtmod.html"
```

We can open the file with

```
browseURL(glimpse(x2))
```

Comparing procedures

Let us assume that we have tested the differential expression using two procedures `rowt` and `rowtmod`. We want to compare the results obtained.

Note that the `data.frame`s generated using `tidy` provides information about those genes with a adjusted p-value lesser than the used `fdr`. If we want all genes in the study we have to set `fdr` to 1.

How many genes are called significant for a `fdr` equal to .0001 using `rowt`?

```
nrow(x1_df)
```

```
[1] 1044
```

And using `rowtmod`?

```
nrow(x2_df)
```

```
[1] 1563
```

We don't want to set previously given `fdr`'s. The `fdr` is set to 1 and the function `dema` is executed again for both procedures. Note that the values of each functions is saved in the same objects `x1` and `x2`.

```
x1 = dema(x=gse21942,y="FactorValue..DISEASE.STATE.",
          test = rowt,correction = "BH",
          fdr = 1,foutput = "gse21942_rowt")

x2 = dema(x=gse21942,y="FactorValue..DISEASE.STATE.",
          test = rowtmod,correction = "BH",
          fdr = 1,foutput = "gse21942_rowtmod")
```

The new `data.frame`s are generated.

```
x1_df= tidy(x1)
x2_df= tidy(x2)
```

What information contains these `data.frame`s just generated?

```
names(x1_df)
```

```
[1] "PROBEID"   "ENTREZID" "ENSEMBL"  "SYMBOL"   "GO"       "EVIDENCE"
[7] "ONTOLOGY"  "statistic" "rawp"     "adjp"     "qval"
```

They are different gene identifiers and the usual `statistic` of the test used (`rowt` or `rowtmod`), the raw p-value, the corresponding adjusted p-value (using the `correction` method for multiple testing) and the Storey's q-value.

Now we set a value for `fdr`

```
fdr0 = .000001
```

and the number of significant for each method would be

```
table(x1_df[,"adjp"] < fdr0)
```

```
FALSE   TRUE
54610     65
```

and

```
table(x2_df[,"adjp"] < fdr0)
```

```
FALSE   TRUE
54497    178
```

We can compare the results for both methods using

```
res1 = x1_df[,"adjp"] < fdr0
res2 = x2_df[,"adjp"] < fdr0
table(res1,res2)
```

```
        res2
res1     FALSE   TRUE
  FALSE  54496    114
  TRUE       1     64
```