

# Package ‘blima’

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**Type** Package

**Title** Tools for the preprocessing and analysis of the Illumina microarrays on the detector (bead) level

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**Author** Vojtěch Kulvait

**Maintainer** Vojtěch Kulvait <kulvait@gmail.com>

**Description** Package blima includes several algorithms for the preprocessing of Illumina microarray data. It focuses to the bead level analysis and provides novel approach to the quantile normalization of the vectors of unequal lengths. It provides variety of the methods for background correction including background subtraction, RMA like convolution and background outlier removal. It also implements variance stabilizing transformation on the bead level. There are also implemented methods for data summarization. It also provides the methods for performing T-tests on the detector (bead) level and on the probe level for differential expression testing.

**License** GPL-3

**LazyLoad** yes

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**LinkingTo** Rcpp

**Suggests** xtable, blimaTestingData, BiocStyle, illuminaHumanv4.db, lumi, knitr

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---

|               |                                                                                                             |
|---------------|-------------------------------------------------------------------------------------------------------------|
| blima-package | <i>Package for the preprocessing and analysis of the Illumina microarrays on the detector (bead) level.</i> |
|---------------|-------------------------------------------------------------------------------------------------------------|

---

## Description

Package blima includes several algorithms for the preprocessing of Illumina microarray data. It focuses to the bead level analysis and provides novel approach to the quantile normalization of the vectors of unequal lengths. It provides variety of the methods for background correction including background subtraction, RMA like convolution and background outlier removal. It also implements variance stabilizing transformation on the bead level. There are also implemented methods for data summarization. It provides the methods for performing T-tests on the detector (bead) level and on the probe level for differential expression testing.

## Details

The DESCRIPTION file: This package was not yet installed at build time.

Index: This package was not yet installed at build time.

## Author(s)

Vojtěch Kulvait Maintainer: Vojtěch Kulvait <kulvait@gmail.com>

---

|                        |                       |
|------------------------|-----------------------|
| aggregateAndPreprocess | <i>Aggregate data</i> |
|------------------------|-----------------------|

---

## Description

This function is not intended to direct use. It helps perform work of doProbeTTests function. For each probe it prints mean and sd of an quality.

## Usage

```
aggregateAndPreprocess(x, quality = "qua", transformation = NULL)
```

## Arguments

|                |                                                                                                                                                                                                                            |
|----------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| x              | Two column matrix to agregate with columns "ProbeID" and quality.                                                                                                                                                          |
| quality        | Quality to analyze, default is "qua".                                                                                                                                                                                      |
| transformation | Function of input data trasformation, default is NULL. Any function which for input value returns transformed value may be supplied. T-test then will be evaluated on transformed data, consider use log2TranformPositive. |

## Value

Some return value

**Author(s)**

Vojtěch Kulvait

---

backgroundCorrect      *Data background correction.*


---

**Description**

Background correction procedure selecting beads with background Intensity  $I_b$   $|mean - I_b| > k * SD(I_{bs})$  for exclusion.

**Usage**

```
backgroundCorrect(b, normalizationMod = NULL, channelBackground = "GrnB",
  k = 3, channelBackgroundFilter = "bgf", channelAndVector = NULL)
```

**Arguments**

**b**                      List of beadLevelData objects (or single object).

**normalizationMod**                      NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes.

**channelBackground**                      Name of channel to normalize.

**k**                      Parameter of method stringency (default is 3).

**channelBackgroundFilter**                      Filtered beads will have weight 0 and non filtered weight 1.

**channelAndVector**                      Represents vector to bitwise multiple to the channelBackgroundFilter vector.

**Author(s)**

Vojtěch Kulvait

**Examples**

```
if(require("blimaTestingData") && interactive())
{
  #To perform background correction on blimatesting object for two groups. Background correction is followed by
  data(blimatesting)
  #Prepare logical vectors corresponding to conditions A and E.
  groups1 = "A";
  groups2 = "E";
  sampleNames = list()
  c = list()
  for(i in 1:length(blimatesting))
  {
    p = pData(blimatesting[[i]]@experimentData$phenoData)
    c[[i]] = p$Group %in% c(groups1, groups2);
    sampleNames[[i]] = p$Name
  }
}
```

```

    }
    #Background correction and quantile normalization followed by testing including log2TransformPositive trans
    blimatesting = backgroundCorrect(blimatesting, normalizationMod=c, channelBackgroundFilter="bgf")
    blimatesting = nonPositiveCorrect(blimatesting, normalizationMod=c, channelCorrect="GrnF", channelBackgro
  }else
  {
    print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager
  }

```

---

backgroundCorrectSingleArray

*Data background correction.*


---

## Description

Background correction procedure selecting beads with background Intensity  $I_b$   $|mean - I_b| > k * SD(I_{bs})$  for exclusion, internal.

## Usage

```
backgroundCorrectSingleArray(b, normalizationMod = NULL, channelBackground = "GrnB",
                             k = 3, channelBackgroundFilter = "bgf", channelAndVector = NULL)
```

## Arguments

|                         |                                                                                                                                                                                              |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| b                       | List of beadLevelData objects (or single object).                                                                                                                                            |
| normalizationMod        | NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes. |
| channelBackground       | Name of channel to normalize.                                                                                                                                                                |
| k                       | Parameter of method stringency (default is 3).                                                                                                                                               |
| channelBackgroundFilter | Filtered beads will have weight 0 and non filtered weight 1.                                                                                                                                 |
| channelAndVector        | Represents vector to bitwise multiple to the channelBackgroundFilter vector.                                                                                                                 |

## Author(s)

Vojtěch Kulvait

---

backgroundChannelSubtract

*Background channel subtraction*


---

## Description

Function to subtract one channel from another producing new channel. Standard graphic subtraction.

## Usage

```
backgroundChannelSubtract(b, normalizationMod = NULL, channelSubtractFrom = "GrnF",
  channelSubtractWhat = "GrnB", channelResult = "Grn")
```

## Arguments

**b** List of beadLevelData objects (or single object).

**normalizationMod** NULL for performing on all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes.

**channelSubtractFrom** Name of channel to subtract from.

**channelSubtractWhat** Name of channel to subtract.

**channelResult** Result channel, if this channel exists it will be overwritten.

## Author(s)

Vojtěch Kulvait

## Examples

```
if(require("blimaTestingData") && interactive())
{
  #To perform background correction on blimatesting object for two groups. Background correction is followed by
  data(blimatesting)
  #Prepare logical vectors corresponding to conditions A and E.
  groups1 = "A";
  groups2 = "E";
  sampleNames = list()
  c = list()
  for(i in 1:length(blimatesting))
  {
    p = pData(blimatesting[[i]]@experimentData$phenoData)
    c[[i]] = p$Group %in% c(groups1, groups2);
    sampleNames[[i]] = p$Name
  }
  #Background correction and quantile normalization followed by testing including log2TransformPositive trans
  blimatesting = backgroundCorrect(blimatesting, normalizationMod=c, channelBackgroundFilter="bgf")
  blimatesting = nonPositiveCorrect(blimatesting, normalizationMod=c, channelCorrect="GrnF", channelBackgro
}else
```

```
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager::install('blimaTestingData')")
}
```

---

backgroundChannelSubtractSingleArray

*Background channel subtraction*


---

## Description

INTERNAL FUNCTION Correction for positive values only

## Usage

```
backgroundChannelSubtractSingleArray(b, normalizationMod = NULL,
  channelSubtractFrom = "GrnF", channelSubtractWhat = "GrnB",
  channelResult = "Grn")
```

## Arguments

**b** List of beadLevelData objects (or single object).

**normalizationMod** NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes.

**channelSubtractFrom** Name of channel to subtract from.

**channelSubtractWhat** Name of channel to subtract.

**channelResult** Result channel, if this channel exists it will be overwritten.

## Author(s)

Vojtěch Kulvait

---

channelExistsIntegrityWithLogicalVectorList

*Internal function*


---

## Description

Test existence of channel slot based on vector list

## Usage

```
channelExistsIntegrityWithLogicalVectorList(b, spotsToCheck = NULL,
  slotToCheck, action = c("returnText", "warn", "error"))
```

**Arguments**

|              |                                                                                                                                               |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| b            | List of beadLevelData objects.                                                                                                                |
| spotsToCheck | NULL for check all spots from b. Otherwise specifies logical vector of the length equals to the number of arrays in b with TRUE for checking. |
| slotToCheck  | Slot name to check                                                                                                                            |
| action       | What type of action is required in case of invalid object structure. Either return text different from TRUE, warn or error.                   |

**Author(s)**

Vojtěch Kulvait

---

|                |                          |
|----------------|--------------------------|
| checkIntegrity | <i>Internal function</i> |
|----------------|--------------------------|

---

**Description**

Check integrity of the list of beadLevelData objects or single beadLevelData object returns waslist.

**Usage**

```
checkIntegrity(b, action = c("warn", "error"))
```

**Arguments**

|        |                                                                                                                             |
|--------|-----------------------------------------------------------------------------------------------------------------------------|
| b      | List of beadLevelData objects or single.                                                                                    |
| action | What type of action is required in case of invalid object structure. Either return text different from TRUE, warn or error. |

**Value**

Returns value if the object was list or not before calling this function.

**Author(s)**

Vojtěch Kulvait

---

`checkIntegrityLogical` *Internal function*

---

**Description**

Check integrity of the list of logical objects, internal.

**Usage**

```
checkIntegrityLogical(xx, b, action = c("returnText", "warn",  
  "error"))
```

**Arguments**

|                     |                                                                                                                                                                      |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>xx</code>     | List of logical objects compatible with a list <code>b</code> .                                                                                                      |
| <code>b</code>      | List of <code>beadLevelData</code> objects.                                                                                                                          |
| <code>action</code> | What type of action is required in case of invalid object structure. Either return text different from <code>TRUE</code> , <code>warn</code> or <code>error</code> . |

**Author(s)**

Vojtěch Kulvait

---

`checkIntegrityOfListOfBeadLevelDataObjects`  
*Internal function*

---

**Description**

Check integrity of the list of `beadLevelData` objects, internal.

**Usage**

```
checkIntegrityOfListOfBeadLevelDataObjects(listb, action = c("returnText",  
  "warn", "error"))
```

**Arguments**

|                     |                                                                                                                                                                      |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>listb</code>  | List of <code>beadLevelData</code> objects.                                                                                                                          |
| <code>action</code> | What type of action is required in case of invalid object structure. Either return text different from <code>TRUE</code> , <code>warn</code> or <code>error</code> . |

**Author(s)**

Vojtěch Kulvait

---

```
checkIntegrityOfSingleBeadLevelDataObject
```

*Internal function*

---

### Description

Check integrity of single beadLevelData object, internal.

### Usage

```
checkIntegrityOfSingleBeadLevelDataObject(b, action = c("returnText",
  "warn", "error"))
```

### Arguments

|        |                                                                                                                             |
|--------|-----------------------------------------------------------------------------------------------------------------------------|
| b      | beadLevelData object.                                                                                                       |
| action | What type of action is required in case of invalid object structure. Either return text different from TRUE, warn or error. |

### Author(s)

Vojtěch Kulvait

---

```
chipArrayStatistics
```

*Statistics of beadLevelData*

---

### Description

This function returns table with statistics of single beadLevelData object indexed by order of spots. It prints number of beads on each array spot mean foreground intensity and optionally mean background intensity, mean number of beads in probe set and unbiased estimate of standard deviations of these parameters. Optionally you can also obtain percentage of removed beads within excludedOnSDMultiple multiple of standard deviations from the background value.

### Usage

```
chipArrayStatistics(b, includeBeadStatistic = TRUE, channelForeground = "GrnF",
  channelBackground = "GrnB", includeBackground = TRUE, excludedOnSDMultiple = NA)
```

### Arguments

|                      |                                              |
|----------------------|----------------------------------------------|
| b                    | Single beadLevelData object.                 |
| includeBeadStatistic | Include number of beads per probe in output. |
| channelForeground    | Name of channel of foreground.               |
| channelBackground    | Name of channel of background.               |

includeBackground

Whether to output background data.

excludedOnSDMultiple

If positive number, print how much percents of the background lies more than excludedOnSDMultiple multipliers of standard deviation estimate away from background mean.

## Author(s)

Vojtěch Kulvait

## Examples

```
if(require("blimaTestingData") && interactive())
{
  #To print basic statistic data about blimatesting[[1]] object.
  data(blimatesting)
  array1stats = chipArrayStatistics(blimatesting[[1]], includeBeadStatistic=TRUE,
    excludedOnSDMultiple=3)
  array1pheno = pData(blimatesting[[1]]@experimentData$phenoData)
  array1stats = data.frame(array1pheno$Name, array1stats)
  colnames(array1stats)[1] <- "Array";
  print(array1stats);
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager::install('blimaTestingData')")
}
```

---

createSummarizedMatrix

*Summarized value matrix.*

---

## Description

This function creates summarized matrix of values of certain type.

## Usage

```
createSummarizedMatrix(b, spotsToProcess = NULL, quality = "qua",
  channelInclude = "bgf", annotationTag = NULL)
```

## Arguments

|                |                                                                                                                                                                                                                                                                                                 |
|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| b              | List of beadLevelData objects (or single object).                                                                                                                                                                                                                                               |
| spotsToProcess | NULL for processing all spots in b. Otherwise specifies logical vector of the length equals to the number of arrays in b.                                                                                                                                                                       |
| quality        | Quality to matrice.                                                                                                                                                                                                                                                                             |
| channelInclude | This field allows user to set channel with weights which have to be from 0,1. All zero weighted items are excluded from summarization. You can turn this off by setting this NULL. This option may be used together with backgroundCorrect method or/and with beadarray QC (defaults to "bgf"). |
| annotationTag  | Tag from annotation file which to use in resulting matrix as colname.                                                                                                                                                                                                                           |

**Author(s)**

Vojtěch Kulvait

**Examples**

```
if(require("blimaTestingData") && require("illuminaHumanv4.db") && interactive())
{
  #Create summarization of nonnormalized data from GrnF column.
  data(blimetesting)
  blimatesting = bacgroundCorrect(blimetesting, channelBackgroundFilter="bgf")
  blimatesting = nonPositiveCorrect(blimetesting, channelCorrect="GrnF", channelBackgroundFilter="bgf", cha
  #Prepare logical vectors corresponding to conditions A(groups1Mod), E(groups2Mod) and both(processingMod).
  nonnormalized = createSummarizedMatrix(blimetesting, quality="GrnF", channelInclude="bgf",
    annotationTag="Name")
  head(nonnormalized)
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager")
}
```

---

doAction

*Internal function*


---

**Description**

Performs action of certain type

**Usage**

```
doAction(message, action = c("returnText", "warn", "error"))
```

**Arguments**

|         |                                                                                                                             |
|---------|-----------------------------------------------------------------------------------------------------------------------------|
| message | Text message.                                                                                                               |
| action  | What type of action is required in case of invalid object structure. Either return text different from TRUE, warn or error. |

**Author(s)**

Vojtěch Kulvait

---

|               |                                     |
|---------------|-------------------------------------|
| doProbeTTests | <i>T-test for probe level data.</i> |
|---------------|-------------------------------------|

---

## Description

This function does aggregated probe level t-tests on the data provided by the object `beadLevelData` from package `beadarray`.

## Usage

```
doProbeTTests(b, c1, c2, quality = "qua", channelInclude = "bgf",
  correction = "BY", transformation = NULL)
```

## Arguments

|                             |                                                                                                                                                                                                                                                                                                               |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>b</code>              | List of <code>beadLevelData</code> objects (or single object).                                                                                                                                                                                                                                                |
| <code>c1</code>             | List of logical vectors of data to assign to the first group (or single vector).                                                                                                                                                                                                                              |
| <code>c2</code>             | List of logical vectors of data to assign to the second group (or single vector).                                                                                                                                                                                                                             |
| <code>quality</code>        | Quality to analyze, default is "qua".                                                                                                                                                                                                                                                                         |
| <code>channelInclude</code> | This field allows user to set channel with weights which have to be 0,1. All zero weighted items are excluded from t-test. You can turn this off by setting this NULL. This option may be used together with <code>backgroundCorrect</code> method or/and with <code>beadarray</code> QC (defaults to "bgf"). |
| <code>correction</code>     | Multiple testing adjustment method as defined by <code>p.adjust</code> function, default is "BY".                                                                                                                                                                                                             |
| <code>transformation</code> | Function of input data trasformation, default is NULL. Any function which for input value returns transformed value may be supplied. T-test then will be evaluated on transformed data, consider use <code>log2TranformPositive</code> .                                                                      |

## Author(s)

Vojtěch Kulvait

## Examples

```
if(require("blimaTestingData") && require("illuminaHumanv4.db") && interactive())
{
  #To perform background correction, variance stabilization and quantile normalization then test on probe level
  data(blimatesting)
  #Prepare logical vectors corresponding to conditions A(groups1Mod), E(groups2Mod) and both(processingMod).
  groups1 = "A";
  groups2 = "E";
  sampleNames = list()
  groups1Mod = list()
  groups2Mod = list()
  processingMod = list()
  for(i in 1:length(blimatesting))
  {
    p = pData(blimatesting[[i]]@experimentData$phenoData)
    groups1Mod[[i]] = p$Group %in% groups1;
    groups2Mod[[i]] = p$Group %in% groups2;
```

```

        processingMod[[i]] = p$Group %in% c(groups1, groups2);
        sampleNames[[i]] = p$Name
    }
    #Background correction and quantile normalization followed by testing including log2TransformPositive trans
    blimatesting = backgroundCorrect(blimatesting, normalizationMod =processingMod, channelBackgroundFilter="bg
    blimatesting = nonPositiveCorrect(blimatesting, normalizationMod=processingMod, channelCorrect="GrnF", ch
    blimatesting = varianceBeadStabilise(blimatesting, normalizationMod = processingMod,
        quality="GrnF", channelInclude="bgf", channelOutput="vst")
    blimatesting = quantileNormalize(blimatesting, normalizationMod = processingMod,
        channelNormalize="vst", channelOutput="qua", channelInclude="bgf")
    beadTest = doTTests(blimatesting, groups1Mod, groups2Mod, "qua", "bgf")
    probeTest = doProbeTTests(blimatesting, groups1Mod, groups2Mod, "qua", "bgf")
    adrToSymbol <- merge(toTable(illuminaHumanv4ARRAYADDRESS), toTable(illuminaHumanv4SYMBOLREANNOTATED))
    adrToSymbol <- adrToSymbol[,c("ArrayAddress", "SymbolReannotated")]
    colnames(adrToSymbol) <- c("Array_Address_Id", "Symbol")
    probeTestID = probeTest[, "ProbeID"]
    beadTestID = beadTest[, "ProbeID"]
    probeTestFC = abs(probeTest[, "mean1"]-probeTest[, "mean2"])
    beadTestFC = abs(beadTest[, "mean1"]-beadTest[, "mean2"])
    probeTestP = probeTest[, "adjustedp"]
    beadTestP = beadTest[, "adjustedp"]
    probeTestMeasure = (1-probeTestP)*probeTestFC
    beadTestMeasure = (1-beadTestP)*beadTestFC
    probeTest = cbind(probeTestID, probeTestMeasure)
    beadTest = cbind(beadTestID, beadTestMeasure)
    colnames(probeTest) <- c("ArrayAddressID", "difexPL")
    colnames(beadTest) <- c("ArrayAddressID", "difexBL")
    tocmp <- merge(probeTest, beadTest)
    tocmp = merge(tocmp, adrToSymbol, by.x="ArrayAddressID", by.y="Array_Address_Id")
    tocmp = tocmp[, c("ArrayAddressID", "Symbol", "difexPL", "difexBL")]
    sortPL = sort(-tocmp[, "difexPL"], index.return=TRUE)$ix
    sortBL = sort(-tocmp[, "difexBL"], index.return=TRUE)$ix
    beadTop10 = tocmp[sortBL[1:10],]
    probeTop10 = tocmp[sortPL[1:10],]
    print(beadTop10)
    print(probeTop10)
} else
{
    print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager
}

```

doTTests

*T-test for bead (detector) level data.*

## Description

This function does t-tests on the data provided by the object `beadLevelData` from package `beadarray`.

## Usage

```
doTTests(b, c1, c2, quality = "qua", channelInclude = "bgf",
        correction = "BY", transformation = NULL)
```

## Arguments

|                             |                                                                                                                                                                                                                                                                                     |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>b</code>              | List of beadLevelData objects (or single object).                                                                                                                                                                                                                                   |
| <code>c1</code>             | List of logical vectors of data to assign to the first group (or single vector).                                                                                                                                                                                                    |
| <code>c2</code>             | List of logical vectors of data to assign to the second group (or single vector).                                                                                                                                                                                                   |
| <code>quality</code>        | Quality to analyze, default is "qua".                                                                                                                                                                                                                                               |
| <code>channelInclude</code> | This field allows user to set channel with weights which have to be 0,1. All zero weighted items are excluded from t-test. You can turn this off by setting this NULL. This option may be used together with backgroundCorrect method or/and with beadarray QC (defaults to "bgf"). |
| <code>correction</code>     | Multiple testing adjustment method as defined by p.adjust function, default is "BY".                                                                                                                                                                                                |
| <code>transformation</code> | Function of input data trasformation, default is NULL. Any function which for input value returns transformed value may be supplied. T-test then will be evaluated on transformed data, consider use log2TransformPositive.                                                         |

## Author(s)

Vojtěch Kulvait

## Examples

```
if(require("blimaTestingData") && require("illuminaHumanv4.db") && interactive())
{
  #To perform background correction, variance stabilization and quantile normalization then test on probe level
  data(blimatesting)
  #Prepare logical vectors corresponding to conditions A(groups1Mod), E(groups2Mod) and both(processingMod).
  groups1 = "A";
  groups2 = "E";
  sampleNames = list()
  groups1Mod = list()
  groups2Mod = list()
  processingMod = list()
  for(i in 1:length(blimatesting))
  {
    p = pData(blimatesting[[i]]@experimentData$phenoData)
    groups1Mod[[i]] = p$Group %in% groups1;
    groups2Mod[[i]] = p$Group %in% groups2;
    processingMod[[i]] = p$Group %in% c(groups1, groups2);
    sampleNames[[i]] = p$Name
  }
  #Background correction and quantile normalization followed by testing including log2TransformPositive trans
  blimatesting = backgroundCorrect(blimatesting, normalizationMod =processingMod, channelBackgroundFilter="bgf")
  blimatesting = nonPositiveCorrect(blimatesting, normalizationMod=processingMod, channelCorrect="GrnF", channelOutput="vst")
  blimatesting = varianceBeadStabilise(blimatesting, normalizationMod = processingMod,
    quality="GrnF", channelInclude="bgf", channelOutput="vst")
  blimatesting = quantileNormalize(blimatesting, normalizationMod = processingMod,
    channelNormalize="vst", channelOutput="qua", channelInclude="bgf")
  beadTest = doTTests(blimatesting, groups1Mod, groups2Mod, "qua", "bgf")
  probeTest = doProbeTTests(blimatesting, groups1Mod, groups2Mod, "qua", "bgf")
  adrToSymbol <- merge(toTable(illuminaHumanv4ARRAYADDRESS), toTable(illuminaHumanv4SYMBOLREANNOTATED))
  adrToSymbol <- adrToSymbol[,c("ArrayAddress", "SymbolReannotated")]
  colnames(adrToSymbol) <- c("Array_Address_Id", "Symbol")
  probeTestID = probeTest[, "ProbeID"]
}
```

```

beadTestID = beadTest[, "ProbeID"]
probeTestFC = abs(probeTest[, "mean1"] - probeTest[, "mean2"])
beadTestFC = abs(beadTest[, "mean1"] - beadTest[, "mean2"])
probeTestP = probeTest[, "adjustedp"]
beadTestP = beadTest[, "adjustedp"]
probeTestMeasure = (1 - probeTestP) * probeTestFC
beadTestMeasure = (1 - beadTestP) * beadTestFC
probeTest = cbind(probeTestID, probeTestMeasure)
beadTest = cbind(beadTestID, beadTestMeasure)
colnames(probeTest) <- c("ArrayAddressID", "difexPL")
colnames(beadTest) <- c("ArrayAddressID", "difexBL")
tocmp <- merge(probeTest, beadTest)
tocmp = merge(tocmp, adrToSymbol, by.x="ArrayAddressID", by.y="Array_Address_Id")
tocmp = tocmp[, c("ArrayAddressID", "Symbol", "difexPL", "difexBL")]
sortPL = sort(-tocmp[, "difexPL"], index.return=TRUE)$ix
sortBL = sort(-tocmp[, "difexBL"], index.return=TRUE)$ix
beadTop10 = tocmp[sortBL[1:10],]
probeTop10 = tocmp[sortPL[1:10],]
print(beadTop10)
print(probeTop10)
} else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager::install('blimaTestingData')")
}

```

---

filterBg

*Bg correct vector*


---

### Description

Background correction procedure selecting beads with background Intensity  $I_b$   $|mean - I_b| > k * SD(I_b)$  for exclusion, internal.

### Usage

```
filterBg(x, k = 3)
```

### Arguments

|   |                                                |
|---|------------------------------------------------|
| x | Vector to correct                              |
| k | Parameter of method stringency (default is 3). |

### Author(s)

Vojtěch Kulvait

---

|               |                                              |
|---------------|----------------------------------------------|
| getNextVector | <i>Support probe and bead level testing.</i> |
|---------------|----------------------------------------------|

---

**Description**

Internal function supporting probe and bead level testing.

**Usage**

```
getNextVector(what, from, length)
```

**Arguments**

|        |                                             |
|--------|---------------------------------------------|
| what   | Two column sorted matrix with probe values. |
| from   | Index to start on                           |
| length | nrow(what)                                  |

**Author(s)**

Vojtěch Kulvait

---

|                      |                             |
|----------------------|-----------------------------|
| initMeanDistribution | <i>initMeanDistribution</i> |
|----------------------|-----------------------------|

---

**Description**

This is internal function not intended to direct use which initializes mean distribution.

**Usage**

```
initMeanDistribution(srt, prvku)
```

**Arguments**

|       |                                     |
|-------|-------------------------------------|
| srt   | vector of sorted values             |
| prvku | number of items in meanDistribution |

**Author(s)**

Vojtěch Kulvait

---

|              |                                                         |
|--------------|---------------------------------------------------------|
| insertColumn | <i>Internal function to support chipArrayStatistics</i> |
|--------------|---------------------------------------------------------|

---

**Description**

Internal

**Usage**

```
insertColumn(matrix, column, name)
```

**Arguments**

|        |                            |
|--------|----------------------------|
| matrix | Object to insert column to |
| column | Column to insert           |
| name   | Name of column to assign.  |

**Author(s)**

Vojtěch Kulvait

---

|                         |                                  |
|-------------------------|----------------------------------|
| interpolateSortedVector | <i>Interpolate sorted vector</i> |
|-------------------------|----------------------------------|

---

**Description**

Interpolates given sorted vector to the vector of different length. It does not sort input vector thus for unsorted vectors do not guarantee functionality. Internal function.

**Usage**

```
interpolateSortedVector(vector, newSize)
```

**Arguments**

|         |                                |
|---------|--------------------------------|
| vector  | Sorted vector to interpolate.  |
| newSize | Size of the vector to produce. |

**Author(s)**

Vojtěch Kulvait

---

```
interpolateSortedVectorRcpp_  
    interpolateSortedVectorRcpp
```

---

**Usage**

```
interpolateSortedVectorRcpp_(vector, newSize)
```

**Arguments**

```
vector  
newSize
```

**Author(s)**

```
Vojtěch Kulvait
```

---

```
log2TransformPositive  Log2 transform of numbers >1.
```

---

**Description**

Transformation function are popular in beadarray package. Here this is similar concept. This function allow user to perform log transformation before doing t-tests.

**Usage**

```
log2TransformPositive(x)
```

**Arguments**

```
x                Number to transform.
```

**Value**

This function returns logarithm of base 2 for numbers  $\geq 1$  and zero for numbers  $< 1$ .

**Author(s)**

```
Vojtěch Kulvait
```

## Examples

```

if(require("blimaTestingData") && require("illuminaHumanv4.db") && interactive())
{
  #To perform background correction, quantile normalization and then bead level t-test on log data run. Vst is not used
  data(blimatesting)
  #Prepare logical vectors corresponding to conditions A(groups1Mod), E(groups2Mod) and both(c).
  groups1 = "A";
  groups2 = "E";
  sampleNames = list()
  groups1Mod = list()
  groups2Mod = list()
  c = list()
  for(i in 1:length(blimatesting))
  {
    p = pData(blimatesting[[i]]@experimentData$phenoData)
    groups1Mod[[i]] = p$Group %in% groups1;
    groups2Mod[[i]] = p$Group %in% groups2;
    c[[i]] = p$Group %in% c(groups1, groups2);
    sampleNames[[i]] = p$Name
  }
  #Background correction and quantile normalization followed by testing including log2TransformPositive transformation
  blimatesting = backgroundCorrect(blimatesting, normalizationMod=c, channelBackgroundFilter="bgf")
  blimatesting = nonPositiveCorrect(blimatesting, normalizationMod=c, channelCorrect="GrnF", channelBackgroundFilter="bgf")
  blimatesting = quantileNormalize(blimatesting, normalizationMod=c, channelNormalize="GrnF", channelOutput="log2")
  beadTest <- doTTests(blimatesting, groups1Mod, groups2Mod,
    transformation=log2TransformPositive, quality="qua", channelInclude="bgf")
  symbol2address <- merge(toTable(illuminaHumanv4ARRAYADDRESS), toTable(illuminaHumanv4SYMBOLREANNOTATED))
  symbol2address <- symbol2address[,c("SymbolReannotated", "ArrayAddress") ]
  colnames(symbol2address) <- c("Symbol", "ArrayAddressID")
  beadTest = merge(beadTest, symbol2address, by.x="ProbeID", by.y="ArrayAddressID")
  beadTestID = beadTest[,c("ProbeID", "Symbol")]
  beadTestFC = abs(beadTest[, "mean1"]-beadTest[, "mean2"])
  beadTestP = beadTest[, "adjustedp"]
  beadTestMeasure = (1-beadTestP)*beadTestFC
  beadTest = cbind(beadTestID, beadTestMeasure)
  colnames(beadTest) <- c("ArrayAddressID", "Symbol", "difexBL")
  sortBL = sort(-beadTest[, "difexBL"], index.return=TRUE)$ix
  beadTop10 = beadTest[sortBL[1:10],]
  print(beadTop10)
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager::install('blimaTestingData')")
}

```

---

meanDistribution

*Produce sorted double vector with mean distribution.*

---

## Description

This function processes arrays in the object `beadLevelData` from package `beadarray` and returns sorted double vector. The vector has length `prvku`. And the distribution of this vector is a "mean" of all distributions of `distributionChannel` quantity in arrays. In case that probe numbers are different from `prvku` it does some averaging.

**Usage**

```
meanDistribution(b, normalizationMod = NULL, distributionChannel = "Grn",
  channelInclude = NULL, prvku)
```

**Arguments**

**b** Object beadLevelData from package beadarray or list of these objects

**normalizationMod** NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes (defaults to NULL).

**distributionChannel** Channel to do mean distribution from (defaults to "Grn").

**channelInclude** This field allows user to set channel with weights which have to be in 0,1. All zero weighted items are excluded from quantile normalization and the value assigned to such probes is a close to value which would be assigned to them if not being excluded. You can turn this off by setting this NULL. This option may be used together with bacgroundCorrect method or/and with beadarray QC (defaults to NULL).

**prvku** Number of items in a resulting double vector. Prvku must not be more than minimal number of included items in any distributionChannel.

**Author(s)**

Vojtěch Kulvait

---

nonParametricEstimator

*INTERNAL FUNCTION Xie background correct.*

---

**Description**

INTERNAL This function is not intended for direct use. Background correction according to non parametric estimator in Xie, Yang, Xinlei Wang, and Michael Story. "Statistical Methods of Background Correction for Illumina BeadArray Data." Bioinformatics 25, no. 6 (March 15, 2009): 751-57. doi:10.1093/bioinformatics/btp040. The method is applied on the bead level.

**Usage**

```
nonParametricEstimator(toCorrectAll, toCorrectNeg)
```

**Arguments**

**toCorrectAll**

**toCorrectNeg**

**Author(s)**

Vojtěch Kulvait

---

|                    |                             |
|--------------------|-----------------------------|
| nonPositiveCorrect | <i>Correct non positive</i> |
|--------------------|-----------------------------|

---

## Description

Correction for positive values only

## Usage

```
nonPositiveCorrect(b, normalizationMod = NULL, channelCorrect = "GrnF",
  channelBackgroundFilter = "bgf", channelAndVector = NULL)
```

## Arguments

|                         |                                                                                                                                                                                              |
|-------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| b                       | List of beadLevelData objects (or single object).                                                                                                                                            |
| normalizationMod        | NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes. |
| channelCorrect          | Name of channel to correct.                                                                                                                                                                  |
| channelBackgroundFilter | Filtered beads will have weight 0 and non filtered weight 1.                                                                                                                                 |
| channelAndVector        | Represents vector to bitwise multiple to the channelBackgroundFilter vector.                                                                                                                 |

## Author(s)

Vojtěch Kulvait

## Examples

```
if(require("blimaTestingData") && interactive())
{
  #To perform background correction on blimatesting object for two groups. Background correction is followed by
  data(blimatesting)
  #Prepare logical vectors corresponding to conditions A and E.
  groups1 = "A";
  groups2 = "E";
  sampleNames = list()
  c = list()
  for(i in 1:length(blimatesting))
  {
    p = pData(blimatesting[[i]]@experimentData$phenoData)
    c[[i]] = p$Group %in% c(groups1, groups2);
    sampleNames[[i]] = p$Name
  }
  #Background correction and quantile normalization followed by testing including log2TransformPositive trans
  blimatesting = backgroundCorrect(blimatesting, normalizationMod=c, channelBackgroundFilter="bgf")
  blimatesting = nonPositiveCorrect(blimatesting, normalizationMod=c, channelCorrect="GrnF", channelBackgro
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager
}
```

---

```
nonPositiveCorrectSingleArray
      Correct non positive
```

---

**Description**

INTERNAL FUNCTION Correction for positive values only

**Usage**

```
nonPositiveCorrectSingleArray(b, normalizationMod = NULL, channelCorrect = "GrnF",
      channelBackgroundFilter = "bgf", channelAndVector = NULL)
```

**Arguments**

**b** List of beadLevelData objects (or single object).

**normalizationMod** NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes.

**channelCorrect** Name of channel to correct.

**channelBackgroundFilter** Filtered beads will have weight 0 and non filtered weight 1.

**channelAndVector** Represents vector to bitwise multiple to the channelBackgroundFilter vector.

**Author(s)**

Vojtěch Kulvait

---

```
numberOfDistributionElements
      Internal
```

---

**Description**

Internal function

**Usage**

```
numberOfDistributionElements(b, normalizationMod = NULL, channelInclude = NULL)
```

**Arguments**

**b** Object beadLevelData from package beadarray or list of these objects

**normalizationMod** NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes.

**channelInclude**

**Author(s)**

Vojtěch Kulvait

---

`performXieCorrection`    *INTERNAL FUNCTION Xie background correct.*

---

**Description**

INTERNAL This function is not intended for direct use. Background correction according to non parametric estimator in Xie, Yang, Xinlei Wang, and Michael Story. "Statistical Methods of Background Correction for Illumina BeadArray Data." *Bioinformatics* 25, no. 6 (March 15, 2009): 751-57. doi:10.1093/bioinformatics/btp040. ###The method is applied on the bead level.

**Usage**

```
performXieCorrection(value, alpha, mu, sigma)
```

**Arguments**

value  
alpha  
mu  
sigma

**Author(s)**

Vojtěch Kulvait

---

`plotBackgroundImageAfterCorrection`  
                                  *Plot background image after correction*

---

**Description**

This function plots image of background distribution versus to foreground after background subtraction.

**Usage**

```
plotBackgroundImageAfterCorrection(b, index, channelForeground = "GrnF",  
                                  channelBackground = "GrnB", SDMultiple = 3, includePearson = FALSE)
```

**Arguments**

**b** Single beadLevelData object.  
**index** Index of spot to generate.  
**channelForeground** Name of channel of foreground.  
**channelBackground** Name of channel of background.  
**SDMultiple** Correct on this level.  
**includePearson** Include Pearson correlation.

**Author(s)**

Vojtěch Kulvait

**Examples**

```

if(require("blimaTestingData") && interactive())
{
  #Write background images after correction. This function prints graph for condition D4. Call dev.off() to close plot.
  data(blimatesting)
  p = pData(blimatesting[[2]]@experimentData$phenoData)
  index = base::match("D4", p$Name)
  plotBackgroundImageAfterCorrection(blimatesting[[2]], index)
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager::install('blimaTestingData')")
}

```

---

plotBackgroundImageBeforeCorrection

*Plot background image before correction*

---

**Description**

This function plots image of background distribution versus to foreground before background subtraction.

**Usage**

```

plotBackgroundImageBeforeCorrection(b, index, channelForeground = "GrnF",
  channelBackground = "GrnB", includePearson = FALSE)

```

**Arguments**

**b** Single beadLevelData object.  
**index** Index of spot to generate.  
**channelForeground** Name of channel of foreground.  
**channelBackground** Name of channel of background.  
**includePearson** Include Pearson correlation.

**Author(s)**

Vojtěch Kulvait

**Examples**

```

if(require("blimaTestingData") && interactive())
{
  #Write background images before correction. This function prints graph for condition D4. Call dev.off() to clear
  data(blimetesting)
  p = pData(blimetesting[[2]]@experimentData$phenoData)
  index = base::match("D4", p$Name)
  plotBackgroundImageBeforeCorrection(blimetesting[[2]], index)
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager::install('blimaTestingData')")
}

```

quantileNormalize

*Bead level quantile normalization.***Description**

This function does quantile normalization of object beadLevelData from package beadarray.

**Usage**

```

quantileNormalize(b, normalizationMod = NULL, channelNormalize = "Grn",
  channelOutput = "qua", channelInclude = NULL, dst)

```

**Arguments**

|                         |                                                                                                                                                                                                                                                                                                                                                                                                                       |
|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>b</b>                | Object beadLevelData from package beadarray or list of these objects                                                                                                                                                                                                                                                                                                                                                  |
| <b>normalizationMod</b> | NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes.                                                                                                                                                                                                                          |
| <b>channelNormalize</b> | Name of channel to normalize.                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>channelOutput</b>    | Name of output normalized channel.                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>channelInclude</b>   | This field allows user to set channel with weights which have to be in 0,1. All zero weighted items are excluded from quantile normalization and the value assigned to such probes is a close to value which would be assigned to them if not being excluded. You can turn this off by setting this NULL. This option may be used together with backgroundCorrect method or/and with beadarray QC (defaults to NULL). |
| <b>dst</b>              | User can specify sorted vector which represents distribution that should be assigned to items.                                                                                                                                                                                                                                                                                                                        |

**Author(s)**

Vojtěch Kulvait

## Examples

```

if(require("blimaTestingData") && interactive())
{
  #To perform background correction, variance stabilization and quantile normalization.
  data(blimatesting)
  #Prepare logical vectors corresponding to conditions A(groups1Mod), E(groups2Mod) and both(c).
  groups1 = "A";
  groups2 = "E";
  sampleNames = list()
  processingMod = list()
  for(i in 1:length(blimatesting))
  {
    p = pData(blimatesting[[i]]@experimentData$phenoData)
    processingMod[[i]] = p$Group %in% c(groups1, groups2);
    sampleNames[[i]] = p$Name
  }
  #Background correction and quantile normalization followed by testing including log2TransformPositive trans
  blimatesting = backgroundCorrect(blimatesting, normalizationMod = processingMod, channelBackgroundFilter="b
  blimatesting = nonPositiveCorrect(blimatesting, normalizationMod = processingMod, channelCorrect="GrnF", c
  blimatesting = varianceBeadStabilise(blimatesting, normalizationMod = processingMod,
    quality="GrnF", channelInclude="bgf", channelOutput="vst")
  blimatesting = quantileNormalize(blimatesting, normalizationMod = processingMod,
    channelNormalize="vst", channelOutput="qua", channelInclude="bgf")
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager
}

```

---

readToVector

Support doTTests function.

---

## Description

Internal function supporting doTTests function.

## Usage

```
readToVector(what, from, length, quality)
```

## Arguments

|         |                   |
|---------|-------------------|
| what    | Item to read.     |
| from    | From index.       |
| length  | Length of vector. |
| quality | Column.           |

## Author(s)

Vojtěch Kulvait

---

selectedChannelTransform  
*Channel transformation*

---

## Description

Function to transform channel data.

## Usage

```
selectedChannelTransform(b, normalizationMod = NULL, channelTransformFrom,
  channelResult, transformation = NULL)
```

## Arguments

|                             |                                                                                                                                                                                                                            |
|-----------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>b</b>                    | List of beadLevelData objects (or single object).                                                                                                                                                                          |
| <b>normalizationMod</b>     | NULL for performing on all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes.                                  |
| <b>channelTransformFrom</b> | Name of channel to transform.                                                                                                                                                                                              |
| <b>channelResult</b>        | Result channel, if this channel exists it will be overwritten.                                                                                                                                                             |
| <b>transformation</b>       | Function of input data trasformation, default is NULL. Any function which for input value returns transformed value may be supplied. T-test then will be evaluated on transformed data, consider use log2TranformPositive. |

## Author(s)

Vojtěch Kulvait

## Examples

```
if(require("blimaTestingData") && interactive())
{
  #To perform background correction on blimatesting object for two groups. Background correction is followed by
  data(blimatesting)
  #Prepare logical vectors corresponding to conditions A and E.
  groups1 = "A";
  groups2 = "E";
  sampleNames = list()
  c = list()
  for(i in 1:length(blimatesting))
  {
    p = pData(blimatesting[[i]]@experimentData$phenoData)
    c[[i]] = p$Group %in% c(groups1, groups2);
    sampleNames[[i]] = p$Name
  }
  #Background correction and quantile normalization followed by testing including log2TransformPositive trans
  blimatesting = bacgroundCorrect(blimatesting, normalizationMod=c, channelBackgroundFilter="bgf")
  blimatesting = nonPositiveCorrect(blimatesting, normalizationMod=c, channelCorrect="GrnF", channelBackgro
}else
```

```
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager::install('blimaTestingData')")
}
```

---

selectedChannelTransformSingleArray  
*Channel transformation*

---

### Description

Function to transform channel data.

### Usage

```
selectedChannelTransformSingleArray(b, normalizationMod = NULL,
  channelTransformFrom, channelResult, transformation)
```

### Arguments

**b** List of beadLevelData objects (or single object).

**normalizationMod** NULL for performing on all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes.

**channelTransformFrom** Name of channel to transform.

**channelResult** Result channel, if this channel exists it will be overwritten.

**transformation** Function of input data trasformation, default is NULL. Any function which for input value returns transformed value may be supplied. T-test then will be evaluated on transformed data, consider use log2TranformPositive.

### Author(s)

Vojtěch Kulvait

---

singleArrayNormalize *Bead level quantile normalization.*

---

### Description

This function does quantile normalization of object beadLevelData from package beadarray. Internal function not intended to direct use. Please use quantileNormalize.

### Usage

```
singleArrayNormalize(b, normalizationMod = NULL, channelNormalize = "Grn",
  channelOutput = "qua", channelInclude = NULL, dst)
```

**Arguments**

|                  |                                                                                                                                                                                                                                                                                                                                                                                                                      |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| b                | Object beadLevelData from package beadarray                                                                                                                                                                                                                                                                                                                                                                          |
| normalizationMod | NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b.                                                                                                                                                                                                                                                                                         |
| channelNormalize | Name of channel to normalize.                                                                                                                                                                                                                                                                                                                                                                                        |
| channelOutput    | Name of output normalized channel.                                                                                                                                                                                                                                                                                                                                                                                   |
| channelInclude   | This field allows user to set channel with weights which have to be in 0,1. All zero weighted items are excluded from quantile normalization and the value assigned to such probes is a close to value which would be assigned to them if not being excluded. You can turn this off by setting this NULL. This option may be used together with bacgroundCorrect method or/and with beadarray QC (defaults to NULL). |
| dst              | This field must be sorted. It is a distribution of values to assign to ports. By default this distribution is computed using meanDistribution function.                                                                                                                                                                                                                                                              |

**Author(s)**

Vojtěch Kulvait

---

singleChannelExistsIntegrityWithLogicalVector  
*Internal function*

---

**Description**

Test existence of channel slot based on logical list

**Usage**

```
singleChannelExistsIntegrityWithLogicalVector(b, spotsToCheck = NULL,
  slotToCheck, action = c("returnText", "warn", "error"))
```

**Arguments**

|              |                                                                                                                                               |
|--------------|-----------------------------------------------------------------------------------------------------------------------------------------------|
| b            | single beadLevelData object                                                                                                                   |
| spotsToCheck | NULL for check all spots from b. Otherwise specifies logical vector of the length equals to the number of arrays in b with TRUE for checking. |
| slotToCheck  | Slot name to check                                                                                                                            |
| action       | What type of action is required in case of invalid object structure. Either return text different from TRUE, warn or error.                   |

**Author(s)**

Vojtěch Kulvait

---

```
singleCheckIntegrityLogicalVector
```

*Internal function*

---

**Description**

Check integrity of the logical object, internal.

**Usage**

```
singleCheckIntegrityLogicalVector(xx, b, action = c("returnText",
  "warn", "error"))
```

**Arguments**

|        |                                                                                                                             |
|--------|-----------------------------------------------------------------------------------------------------------------------------|
| xx     | Logical object compatible with b.                                                                                           |
| b      | Single beadLevelData object.                                                                                                |
| action | What type of action is required in case of invalid object structure. Either return text different from TRUE, warn or error. |

**Author(s)**

Vojtěch Kulvait

---

```
singleNumberOfDistributionElements
```

*Internal*

---

**Description**

Internal function

**Usage**

```
singleNumberOfDistributionElements(b, normalizationMod = NULL,
  channelInclude = NULL)
```

**Arguments**

|                  |                                                                                                                                                                                              |
|------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| b                | Object beadLevelData from package beadarray                                                                                                                                                  |
| normalizationMod | NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes. |
| channelInclude   |                                                                                                                                                                                              |

**Author(s)**

Vojtěch Kulvait

---

updateMeanDistribution

*updateMeanDistribution*


---

### Description

This is internal function not intended to direct use. Updates mean distribution.

### Usage

```
updateMeanDistribution(meanDistribution, srt, arraysUsed)
```

### Arguments

meanDistribution

srt                      vector of sorted values

arraysUsed              number of arrays allready used to create distribution

### Author(s)

Vojtěch Kulvait

---

varianceBeadStabilise    *Bead level VST.*


---

### Description

This function does variance stabilising step on bead level.

### Usage

```
varianceBeadStabilise(b, normalizationMod = NULL, quality = "qua",
  channelInclude = "bgf", channelOutput = "vst")
```

### Arguments

b                      List of beadLevelData objects (or single object).

normalizationMod      NULL for normalization of all input b. Otherwise specifies logical vector of the length equal to the number of arrays in b or list of such vectors if b is a list of beadLevelData classes.

quality                Quality to analyze, default is "qua".

channelInclude        This field allows user to set channel with weights which have to be in 0,1. All zero weighted items are excluded from t-test. You can turn this off by setting this NULL. This option may be used together with bacgroundCorrect method or/and with beadarray QC (defaults to "bgf").

channelOutput        Output from VST.

**Author(s)**

Vojtěch Kulvait

**Examples**

```

if(require("blimaTestingData") && interactive())
{
  #To perform background correction, variance stabilization and quantile normalization.
  data(blimatesting)
  #Prepare logical vectors corresponding to conditions A(groups1Mod), E(groups2Mod) and both(c).
  groups1 = "A";
  groups2 = "E";
  sampleNames = list()
  processingMod = list()
  for(i in 1:length(blimatesting))
  {
    p = pData(blimatesting[[i]]@experimentData$phenoData)
    processingMod[[i]] = p$Group %in% c(groups1, groups2);
    sampleNames[[i]] = p$Name
  }
  #Background correction and quantile normalization followed by testing including log2TransformPositive trans
  blimatesting = bacgroundCorrect(blimatesting, normalizationMod = processingMod, channelBackgroundFilter="b
  blimatesting = nonPositiveCorrect(blimatesting, normalizationMod = processingMod, channelCorrect="GrnF", c
  blimatesting = varianceBeadStabilise(blimatesting, normalizationMod = processingMod,
    quality="GrnF", channelInclude="bgf", channelOutput="vst")
  blimatesting = quantileNormalize(blimatesting, normalizationMod = processingMod,
    channelNormalize="vst", channelOutput="qua", channelInclude="bgf")
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager
}

```

---

varianceBeadStabiliseSingleArray  
*Bead level VST.*

---

**Description**

This function is not intended to direct use it takes single beadLevelData object and do bead level variance stabilisation.

**Usage**

```

varianceBeadStabiliseSingleArray(b, normalizationMod = NULL,
  quality = "qua", channelInclude = "bgf", channelOutput = "vst")

```

**Arguments**

|                  |                                                                                                                              |
|------------------|------------------------------------------------------------------------------------------------------------------------------|
| b                | Object beadLevelData.                                                                                                        |
| normalizationMod | NULL for normalization of all input b. Otherwise specifies logical vector of the length equals to the number of arrays in b. |
| quality          | Quality to analyze, default is "qua".                                                                                        |

- channelInclude This field allows user to set channel with weights which have to be in 0,1. All zero weighted items are excluded from t-test. You can turn this off by setting this NULL. This option may be used together with backgroundCorrect method or/and with beadarray QC (defaults to "bgf").
- channelOutput Output from VST.

**Author(s)**

Vojtěch Kulvait

---

vstFromLumi

---

*Function from LGPL lumi package 2.16.0*


---

**Description**

This function is derived from copy and paste of lumi::vst function. Since lumi package has extensive imports I decided to hardcode this function to the blima instead of importing lumi package.

**Usage**

```
vstFromLumi(u, std, nSupport = min(length(u), 500), backgroundStd = NULL,
           lowCutoff = 1/3)
```

**Arguments**

- u The mean of probe beads
- std The standard deviation of the probe beads
- nSupport Something for c3 guess.
- backgroundStd Estimate the background variance c3. Input should be variance according to article, not SD.
- lowCutoff Something for c3 guess.

**Author(s)**

authors are Pan Du, Simon Lin, the function was edited by Vojtěch Kulvait

**References**

<http://www.bioconductor.org/packages/release/bioc/html/lumi.html>

---

writeBackgroundImages *Write Background Images*


---

## Description

This function writes images with background distribution according to foreground before and after background subtraction.

## Usage

```
writeBackgroundImages(b, spotsToGenerate = NULL, imageType = c("jpg",
  "png", "eps"), channelForeground = "GrnF", channelBackground = "GrnB",
  SDMultiple = 3, includePearson = FALSE, outputDir = getwd(),
  width = 505, height = 505)
```

## Arguments

|                   |                                                                                                                                                                       |
|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| b                 | Single beadLevelData object.                                                                                                                                          |
| spotsToGenerate   | NULL for generate images for all spots from b. Otherwise specifies logical vector of the length equals to the number of arrays in b with TRUE for images to generate. |
| imageType         | Type of images produced, either jpg, png or eps                                                                                                                       |
| channelForeground | Name of channel of foreground.                                                                                                                                        |
| channelBackground | Name of channel of background.                                                                                                                                        |
| SDMultiple        | Correct on this level.                                                                                                                                                |
| includePearson    | Include Pearson correlation.                                                                                                                                          |
| outputDir         | Directory where to output images.                                                                                                                                     |
| width             | Width of image (default 505 fits well for 86mm 150dpi illustration in Bioinformatics journal:)                                                                        |
| height            | Height of image                                                                                                                                                       |

## Author(s)

Vojtěch Kulvait

## Examples

```
if(require("blimaTestingData") && interactive())
{
  #Write background images before and after correction for background into /tmp directory. This function creates
  data(blimatesting)
  p = pData(blimatesting[[2]]@experimentData$phenoData)
  spotsToGenerate = p$Group %in% "D";
  writeBackgroundImages(blimatesting[[2]], imageType="jpg", spotsToGenerate=spotsToGenerate, includePearson=includePearson)
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager::install('blimaTestingData')")
}
```

---

|                      |                                |
|----------------------|--------------------------------|
| xieBackgroundCorrect | <i>Xie background correct.</i> |
|----------------------|--------------------------------|

---

## Description

Background correction according to non parametric estimator in Xie, Yang, Xinlei Wang, and Michael Story. "Statistical Methods of Background Correction for Illumina BeadArray Data." *Bioinformatics* 25, no. 6 (March 15, 2009): 751-57. doi:10.1093/bioinformatics/btp040.###The method is applied on the bead level.

## Usage

```
xieBackgroundCorrect(b, normalizationMod = NULL, negativeArrayAddresses,
                     channelCorrect, channelResult, channelInclude = NULL)
```

## Arguments

|                        |                                                                                                                                                                                                                                                                                                |
|------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| b                      | List of beadLevelData objects (or single object).                                                                                                                                                                                                                                              |
| normalizationMod       | NULL for processing all spots in b. Otherwise specifies logical vector of the length equals to the number of arrays in b.                                                                                                                                                                      |
| negativeArrayAddresses | Vector of addresses of negative control probes on array                                                                                                                                                                                                                                        |
| channelCorrect         | Slot to perform convolution correction.                                                                                                                                                                                                                                                        |
| channelResult          | Result channel, if this channel exists it will be overwritten.                                                                                                                                                                                                                                 |
| channelInclude         | This field allows user to set channel with weights which have to be from 0,1. All zero weighted items are excluded from summarization. You can turn this off by setting this NULL. This option may be used together with backgroundCorrect method or/and with beadarray QC (defaults to NULL). |

## Author(s)

Vojtěch Kulvait

## Examples

```
if(require("blimaTestingData") && exists("annotationHumanHT12V4") && interactive())
{
  #Create vector of negative array addresses.
  negAdr = unique(annotationHumanHT12V4$Controls[annotationHumanHT12V4$Controls$Reporter_Group_Name=="negative"])
  #Create summarization of nonnormalized data from GrnF column.
  data(blimatesting)
  blimatesting = backgroundCorrect(blimatesting, channelBackgroundFilter="bgf")
  blimatesting = nonPositiveCorrect(blimatesting, channelCorrect="GrnF", channelBackgroundFilter="bgf", channelInclude="Name")
  blimatesting = xieBackgroundCorrect(blimatesting, negativeArrayAddresses=negAdr, channelCorrect="GrnF", channelInclude="Name")
  #Prepare logical vectors corresponding to conditions A(groups1Mod), E(groups2Mod) and both(processingMod).
  xiecorrected = createSummarizedMatrix(blimatesting, quality="GrnFXIE", channelInclude="bgf",
    annotationTag="Name")
  head(xiecorrected)
}else
{
  print("To run this example, please install blimaTestingData package from bioconductor by running BiocManager::install('blimaTestingData')")
}
```

---

`xieBacgroundCorrectSingleArray`*INTERNAL FUNCTION Xie background correct.*

---

**Description**

INTERNAL This function is not intended for direct use. Background correction according to non parametric estimator in Xie, Yang, Xinlei Wang, and Michael Story. "Statistical Methods of Background Correction for Illumina BeadArray Data." *Bioinformatics* 25, no. 6 (March 15, 2009): 751-57. doi:10.1093/bioinformatics/btp040. The method is applied on the bead level.

**Usage**

```
xieBacgroundCorrectSingleArray(b, normalizationMod = NULL, negativeArrayAddresses,  
channelCorrect, channelResult, channelInclude = NULL)
```

**Arguments**

|                                     |                                                                                                                                                                                                                                                                                                                         |
|-------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <code>b</code>                      | Single beadLevelData object.                                                                                                                                                                                                                                                                                            |
| <code>normalizationMod</code>       | NULL for processing all spots in <code>b</code> . Otherwise specifies logical vector of the length equals to the number of arrays in <code>b</code> .                                                                                                                                                                   |
| <code>negativeArrayAddresses</code> | Vector of addresses of negative control probes on array                                                                                                                                                                                                                                                                 |
| <code>channelCorrect</code>         | Slot to perform convolution correction.                                                                                                                                                                                                                                                                                 |
| <code>channelResult</code>          | Result channel, if this channel exists it will be overwritten.                                                                                                                                                                                                                                                          |
| <code>channelInclude</code>         | This field allows user to set channel with weights which have to be from 0,1. All zero weighted items are excluded from summarization. You can turn this off by setting this NULL. This option may be used together with <code>bacgroundCorrect</code> method or/and with <code>beadarray QC</code> (defaults to NULL). |

**Author(s)**

Vojtěch Kulvait

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