

# Package ‘AffyTiling’

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**Title** Easy extraction of individual probes in Affymetrix tiling arrays

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**Depends** R (>= 2.6)

**Imports** affxparser, affy (>= 1.16), stats, utils, preprocessCore

**LinkingTo**

**Suggests**

**Description** This package provides easy, fast functions for the extraction and annotation of individual probes from Affymetrix tiling arrays.

**License** GPL (>= 2)

**Collate** AssociateWithInterval.R AssociateWithGenes.R parseBPMAP.R  
AnalyzeTilingCelFiles.R TilingCelFiles2Probesets.R

**biocViews** Microarray, Preprocessing

**LazyLoad** yes

**NeedsCompilation** yes

## R topics documented:

AnalyzeTilingCelFiles . . . . .	2
AssociateWithGenes . . . . .	3
AssociateWithInterval . . . . .	4
Einter . . . . .	5
KG . . . . .	6
KnownGenes . . . . .	6
parseBPMAP . . . . .	7
TilingCelFiles2Probesets . . . . .	8

<b>Index</b>	<b>10</b>
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AnalyzeTilingCelFiles *Background correction and RNA normalization for CEL files from an Affymetrix tiling array.*

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### Description

AnalyzeTilingCelFiles extracts intensity data from a group of CEL files and returns annotated intensities using information from a BMAP file. Options can be set to limit the analysis to certain genomic features or regions of interest, thus requiring less memory and computing time.

By default, performs background correction, quantile normalization, and log<sub>2</sub> transform. This can be disabled by setting ReturnRawIntensities to TRUE, if raw intensity values are desired.

This function returns a matrix, where rows represent probes and columns represent the following values: –Unique probe ID –Probe start position (in genomic coordinates) –Chromosome –Sequence –Intensity for sample 1 –Intensity for sample 2 ... –Intensity for sample N

### Usage

```
AnalyzeTilingCelFiles(CEL_filenames, BMAP_filename, outfile=NULL, iID=NULL, iCHR=NULL, iSTART=N
```

### Arguments

CEL\_filenames A character vector of the path to all CEL file(s) in the analysis.

BMAP\_filename The path to the BMAP file which describes the arrays specified in the cel files.

outfile If specified, the function writes a tab-separated table of normalized intensities.

iID Vector of IDs for each interval specified.

iCHR Vector of chromosomes for each interval.

iSTART Integer vector of the interval start.

iEND Integer vector of the interval end.

makeUniqueID If TRUE (default), returns a column of unique identifiers for each probe, of the form: chr-start.

readOnlyNCBI If TRUE (default), returns ONLY probes that target NCBI sequences, TIGR and Affymetrix controls are ignored.

readProbeSeq If TRUE, returns the first 25 bp of the probe sequence.

IgnoreBmapCelPlatformMismatch  
If TRUE, ignores a mismatch between BMAP and CEL platforms. (EXPERT ONLY!)

ReturnRawIntensities  
If TRUE, returns raw intensity values associated with the specified regions. Otherwise (default) performs RMA-like processing of data using the affy package. Processing includes background correction, quantile normalization, and a log<sub>2</sub> transform.

**Author(s)**

Charles Danko

**Examples**

```
## Note that executing the following example requires .bmap and .cel files in the working directory.
## If these files do not, the program will not execute.

## Get the file names in the current working directory.
CEL_NAMES <- dir(pattern=".CEL|.cel");
BPMAP      <- dir(pattern=".bmap");

## If files are found in the current working directory ... start the analysis!!
if( (NROW(CEL_NAMES) > 0) & (NROW(BPMAP) > 0) ) {
  AnalyzeTilingCelFiles(CEL_NAMES, BPMAP, outfilename="NormalizedData.tsv");
}
```

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AssociateWithGenes	<i>Associates a vector of probe positions with the nearest input transcription start site.</i>
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**Description**

Associates a vector of probes, with known genomic positions, to the nearest transcription start site (TSS).

If argument D is specified, returns ALL genes with a TSS < D bp from pID. Otherwise, the nearest gene is returned for each probe.

Returns vector composed of the following columns: ProbeID – Unique probe ID. GeneID – Gene/transcript ID. pgDistance – Distance between ProbeID and GeneID TSS; Positive values indicate upstream of the TSS. Negative values indicate downstream.

**Usage**

```
AssociateWithGenes(kgID, kgCHR, kgSTR, kgSTART, kgEND, pID, pCHR, pMID, D=NULL)
```

**Arguments**

kgID	Vector of gene IDs, one for each transcription start site.
kgCHR	Vector of gene chromosomes, in the format "chr1", "chr2", ..., "chrX", "chrY".
kgSTR	Vector of strand: "+" for a gene on the "+1" strand, "-" for the "-1" strand.
kgSTART	Vector of start positions for each the transcript relative to the chromosome, NOT the start of transcription.
kgEND	Vector of end positions for each the transcript relative to the chromosome.
pID	Vector of UniqueIDs for each probe being evaluated.
pCHR	Vector of chromosomes, in the format "chr1", "chr2", ..., "chrX", "chrY".

pMID            Vector of start positions, one for each of the probes being annotated.  
 D                Threshold distance: if specified, returns all genes with a TSS < D bp from pMID.  
 Otherwise the nearest gene is returned for each probe.

### Author(s)

Charles Danko

### Examples

```
data(KnownGenes)

## Calculate the gene nearest to each probe in Einter data frame.
NearestGenes <- AssociateWithGenes(KG[,1], KG[,2], KG[,3], KG[,4], KG[,5],
  Einter[,1], Einter[,3], (as.integer(Einter[,2])+13))

## Returns all genes within 1 Kb of each probe in Einter.
## Probes that do not have a gene within 1 Kb are not returned.
NearestGenes <- AssociateWithGenes(KG[,1], KG[,2], KG[,3], KG[,4], KG[,5],
  Einter[,1], Einter[,3], (as.integer(Einter[,2])+13), D=1000)
```

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AssociateWithInterval    *Returns index of association between a probe and a set of genomic intervals.*

---

### Description

Takes four vectors representing a unique ID, chromosome, start, and end of non-overlapping regions of interest (e.g. known genes, CpG islands, etc.). Two additional vectors representing the chromosome and start position of probes in a tiling array.

One additional argument (optional) specifies the length of the probes. This can be either a vector with one length for each probe, or a scalar if all probes are the same length. If this argument is not specified, probes are assumed to be 25bp in length.

Returns a vector representing the unique ID of the interval in which each probe can be found. Values of NA are returned for probes that are located in any of the given genomic intervals.

### Usage

```
AssociateWithInterval(fID, fCHR, fSTART, fEND, pCHR, pSTART, pLENGTH)
```

### Arguments

fID                Vector of unique IDs, representing each interval searched.  
 fCHR              Vector of chromosomes, one for each interval searched.  
 fSTART            Vector of start positions, one for each interval searched.  
 fEND              Vector of end positions, one for the each interval searched.

pCHR Vector of chromosomes, one for each probes being annotated.  
 pSTART Vector of start positions, one for each of the probes being annotated.  
 pLENGTH Vector or scalar representing probe length. Default is 25bp for each probe.

**Author(s)**

Charles Danko

**Examples**

```
data(KnownGenes)

## Returns probes that fall inside known genes.
Interval <- AssociateWithInterval( KG[,1], KG[,2], KG[,4], KG[,5], Einter[,3], as.integer(Einter[,2]) )
```

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Einter *Sample intensities for human promoter tiling array.*

---

**Description**

Einter is a data frame consisting of 3 position information columns (Unique ID, Start position of probe, Chromosome) and normalized intensity data from 4 samples. Data is given for the first 3Mb of human chromosomes 1-3.

From the Affymetrix human promoter tiling array v02-3.

Full description is given below...

UniqueID A unique ID for each probe.

START The start position of each probe.

CHR The chromosome of each probe.

X19.103.10009.CEL Normalized, Log-2 transformed intensities for sample X19.103.10009.

X19.104.10013.CEL Normalized, Log-2 transformed intensities for sample X19.104.10013.

X19.107.10027.CEL Normalized, Log-2 transformed intensities for sample X19.107.10027.

X19.104.10013.CEL Normalized, Log-2 transformed intensities for sample X19.104.10013.

**Usage**

```
data(KnownGenes)
```

**Format**

data frame

**Source**

Unpublished data, courtesy of Yanli Zhang and Frank Middleton.

---

KG *Position of known genes in the first 2 Mb of human chromosome 1-3.*

---

**Description**

A data frame with 146 observations on the following 5 variables.

name Gene IDs.

chrom Chromosomes.

strand Strand.

txStart Transcription start.

txEnd Transcription end

**Usage**

```
data(KnownGenes)
```

**Format**

data frame

**Source**

The UCSC genome browser (<http://genome.ucsc.edu>).

---

KnownGenes *Sample intensities for human promoter tiling array.*

---

**Description**

KnownGenes is an RData file intended to illustrate the uses of the AffyTiling package! Full description is given below...

Einter Sample intensity values taken from human chromosome 1.

KG Information on gene positions in the first 1MB of human chromosome 1.

**Usage**

```
data(KnownGenes)
```

**Format**

data frame

**Source**

Unpublished data, courtesy of Yanli Zhang and Frank Middleton.

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parseBPMAP	<i>Returns information from a BPMAP file for select probes in an Affymetrix tiling array.</i>
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## Description

parseBPMAP takes as input the path to an Affymetrix BPMAP file, and data on any genomic intervals of particular interest to the analysis.

Returns a matrix, where rows represent each probe on the tiling array and columns representing the following information: "UniqueID" – A unique ID for each probeset of the form: "Chromosome-Start" (if makeUniqueID == TRUE) "CHR" – Chromosome on which the probe is located "Start" – Genomic position in the BPMAP file "PMX" – X index of the spot on the tiling array "PMY" – Y index of the spot on the tiling array "SEQ" – Sequence of the probe (if readProbeSeq == TRUE) "iID" – The ID of the interval in which this probe is located (if an interval was passed)

Note that passing a region of interest returns only probes in that genomic region. If no region is specified, information is returned for all probes on the tiling array.

## Usage

```
parseBPMAP(filename, iID=NULL, iCHR=NULL, iSTART=NULL, iEND=NULL, recordIntervalIDs = FALSE, makeUniqueID = FALSE, readOnlyNCBI = TRUE, seqIndices = NULL, readProbeSeq = FALSE, verbose = 0)
```

## Arguments

filename	The path to the BPMAP file which describes the arrays specified in the cel files.
iID	Vector of IDs for each interval specified.
iCHR	Vector of chromosomes for each interval.
iSTART	Integer vector of the interval start.
iEND	Integer vector of the interval end.
recordIntervalIDs	If TRUE, returns a column of the interval ID corresponding to each probe. Requires use of interval data.
makeUniqueID	If TRUE (default), returns a column of unique identifiers for each probe, of the form: "chr"- "start"
readOnlyNCBI	If TRUE (default), returns ONLY probes that target NCBI sequences, TIGR and Affymetrix controls are ignored.
seqIndices	If specified, reads only given portions of the BPMAP file (Expert ONLY).
readProbeSeq	If TRUE, returns the first 25 bp of the probe sequence.
verbose	if >= 1, returns varying amounts of output in the R window.

## Author(s)

Charles Danko

**Examples**

```
## Note that executing the following example requires a .bmap file in the working directory.
## If one does not exist, the program will not execute.

## Identify a .bmap file in the current working directory.
BPMAP <- dir(pattern=".bmap");

## If one or more .bmap file are present in the current working directory
## returns a list representation of information in the first .bmap file.
if( NROW(BPMAP) > 0 ) {
  parseBPMAP(BPMAP[0]);
}
```

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**TilingCelFiles2Probesets**

*Background correction and RNA normalization for CEL files from an Affymetrix tiling array.*

---

**Description**

TilingCelFiles2Probesets extracts intensity data from a group of CEL files and returns annotated intensities using information from a BMAP file. Options can be set to limit the analysis to certain genomic features or regions of interest, thus requiring less memory and computing time.

Returns a matrix, where rows represent probe sets and columns represent the following: –Unique probeset ID ("chromosome-first probe START position-last probe END position") –Probe start position (in genomic coordinates) –Chromosome –Average normalized intensity for sample 1 –Average normalized intensity for sample 2 ... –Average normalized intensity for sample N

Note that unlike AnalyzeTilingCelFiles, this function reports only 1 average value for all probes in each interval.

**Usage**

```
TilingCelFiles2Probesets(CEL_filenames, BMAP_filename, outfilename=NULL, iID=NULL, iCHR, iSTART, iEND)
```

**Arguments**

CEL_filenames	A character vector of the path to all CEL file(s) in the analysis.
BMAP_filename	The path to the BMAP file which describes the arrays specified in the cel files.
outfilename	If specified, the function writes a tab-separated table of normalized intensities.
iID	Vector of IDs for each interval specified. If NULL (default) creates a unique ID for each interval of the form: "CHR-START-END".
iCHR	Vector of chromosomes for each interval.
iSTART	Integer vector of the interval start.
iEND	Integer vector of the interval end.
IgnoreBmapCelPlatformMismatch	If TRUE, ignores a mismatch between BMAP and CEL platforms. (EXPERT ONLY!)

**Author(s)**

Charles Danko

**Examples**

```
## Note that executing the following example requires .bmap and .cel files in the working directory.
## If these files do not, the program will not execute.

## Creates a sample interval of the first 1MB of chromosome 1-3.
## This function will return a single value for each interval.
iCHR <- c("chr1", "chr2", "chr3")
iSTART <- rep(1, 3)
iEND <- iSTART + 1e+06

## Get the file names in the current working directory.
CEL_NAMES <- dir(pattern=".CEL|.cel");
BPMAP      <- dir(pattern=".bmap");

## If files are found in the current working directory ... start the analysis!!
if( (NROW(CEL_NAMES) > 0) & (NROW(BPMAP) > 0) ) {
  TilingCelFiles2Probesets(CEL_NAMES, BPMAP, outfilename="NormalizedData.tsv", IID=NULL, iCHR=iCHR, iSTART=iSTART
}
```

# Index

## \*Topic **datasets**

Einter, [5](#)

KG, [6](#)

KnownGenes, [6](#)

## \*Topic **data**

AnalyzeTilingCelFiles, [2](#)

AssociateWithGenes, [3](#)

AssociateWithInterval, [4](#)

parseBPMAP, [7](#)

TilingCelFiles2Probesets, [8](#)

AnalyzeTilingCelFiles, [2](#)

AssociateWithGenes, [3](#)

AssociateWithInterval, [4](#)

Data used to demonstrate AffyTiling.

(KnownGenes), [6](#)

Einter, [5](#)

gene positions (KG), [6](#)

intensities (Einter), [5](#)

KG, [6](#)

KnownGenes, [6](#)

parseBPMAP, [7](#)

TilingCelFiles2Probesets, [8](#)