

MiChip

Jonathon Blake

October 29, 2019

Contents

1	Introduction	1
2	Reading the Hybridization Files	1
3	Removing Unwanted Rows and Correcting for Flags	2
4	Summarizing Intensities	3
5	Plotting Functions	3
6	Normalization	3
7	Writing Output Files	3
8	Combination of processes	5

1 Introduction

MiChip is a microarray platform using locked oligonucleotides for the analysis of the expression of microRNAs in a variety of species [Castoldi et al. \(2008\)](#). The MiChip library provides a set of functions for loading data from several MiChip hybridizations, flag correction, filtering and summarizing the data. The data is then packaged as a Bioconductor *ExpressionSet* object where it can easily be further analyzed with the Bioconductor toolset <http://www.bioconductor.org/>.

First load the library.

```
> library(MiChip)
```

2 Reading the Hybridization Files

MiChip is scanned as a single colour cy3 hybridization and the output is gridded using Genepix software. To load the data from a set of MiChip hybridization Genepix files into bioconductor, use the *parseRawData()* method.

```
> datadir <-system.file("extdata", package="MiChip")
> defaultRawData <- parseRawData(datadir)
```

```
2 files found
```

```
Dealing with file B_676.gpr
```

```
Dealing with file B_677.gpr
```

The defaults are current directory "." And the ".gpr" file extension. Loading data from a directory other than the current directory requires sending the directory to the method e.g. `otherDirectoryData <- parseRawData(datadir="/myDemoDir", pat=".gpr")`.

All files in the directory with the matching extension will be parsed and combined into an `ExpressionSet` containing all features on the chip with the background subtracted intensity from the scanner and quality flags. All hybridizations in the directory should be of the same type otherwise an error will be thrown.

3 Removing Unwanted Rows and Correcting for Flags

Due to the spotting configuration of MiChip and the probes supplied in the Exiqon probe library there are several data points which can be removed from the data set before analysis. Some of the spots on the chip are empty, others contain various controls and probes relating to microRNAs from different species possibly not relevant to the analysis in at hand. To remove data from these points use the `removeUnwantedRows()` method. This takes an array of strings and removes rows containing any of these strings in the gene name annotation of the data.

Remove all empty spots from data set

```
> noEmptiesDataSet <- removeUnwantedRows(defaultRawData, c("Empty"))
```

```
Raw Data 4608
Number of filters 1
Filtering special case empties
Filtered Data 4504
```

Use the helper method to produce the standard set of data rows for human MiChip experiments

```
> humanDataSet <- standardRemoveRows(defaultRawData)
```

```
Raw Data 4608
Number of filters 13
Filtering special case empties
Filtered Data 1118
```

Flags for the MiChip hybridizations are 0 for passes and negative values for spots that are marked absent. Data points with flag values less than zero are set to NA using the `correctForFlags` method.

```
> flagCorrectedDataSet <- correctForFlags(humanDataSet)
```

```
B_676 had 55 bad flags from 1118 data points
B_677 had 54 bad flags from 1118 data points
```

Positive but low intensities may lead to readings near background being taken as positive. Therefore an intensity cutoff can be sent to the `correctForFlags()` to set all the intensities under a set value to NA.

```
> flagCorrectedDataSet <- correctForFlags(humanDataSet, intensityCutoff = 50)
```

```
B_676 had 55 bad flags and 77 values below cutoff from 1118 data points
B_677 had 54 bad flags and 86 values below cutoff from 1118 data points
```

4 Summarizing Intensities

The MiChip probes are spotted in either duplicate or quadruplicate on the array. The individual readings of the data can be combined to give a single intensity value. The combined intensity is taken as the median of the individual intensities, omitting NAs. A minimum length for the acceptable number of present values is supplied to prevent features with only a low number of positive calls being accepted. Summarized intensities where the median absolute deviation is greater than the median intensity can be set to NA on the grounds of being too variable. This is done by setting the `madAdjust` argument to `TRUE`.

```
> summedData <- summarizeIntensitiesAsMedian(flagCorrectedDataSet,minSumlength = 0, madAdjust=FALSE)
```

5 Plotting Functions

MiChip contains two functions for plotting intensity data, both are wrappers for standard plotting functions. The data however produced is written to a file allowing intensity plots and box plots to be produced automatically.

```
> plotIntensitiesScatter(exprs(summedData), NULL, "MiChipDemX", "SummarizedScatter")
```

File saved to `/tmp/RtmpMo4t50/Rbuild654f568e0f/MiChip/vignettes/MiChipDemX_SummarizedScatter.jpg`

Figure 1 shows scatter plots of the intensities of the hybridizations.

```
> boxplotData(exprs(summedData), "MiChipDemX", "Summarized")
```

File saved to `/tmp/RtmpMo4t50/Rbuild654f568e0f/MiChip/vignettes/MiChipDemX_Summarized.jpg`

	used (Mb)	gc trigger (Mb)	max used (Mb)
Ncells	658570 35.2	1295287 69.2	1295287 69.2
Vcells	1362909 10.4	8388608 64.0	4481468 34.2

Figure 2 shows boxplots of the summarized intensity data.

6 Normalization

The major advantage of the MiChip library is to parse MiChip hybridization data sets into an *ExpressionSet* so that existing methods for normalization and hybridization within Bioconductor can be used. Median normalization per chip is implemented in the MiChip.

```
> mednormedData <- normalizePerChipMedian(summedData)
```

7 Writing Output Files

The `outputAnnotatedDataMatrix()` method combines the annotation and expression data from an *ExpressionSet*. This produces a tab delimited file containing data annotation in the left hand columns and expression data in the right for distribution or analysis with other applications.

```
> outputAnnotatedDataMatrix(mednormedData, "MiChipDemo", "medNormedIntensity", "exprs")
```

File saved to `/tmp/RtmpMo4t50/Rbuild654f568e0f/MiChip/vignettes/MiChipDemo_medNormedIntensity.txt`

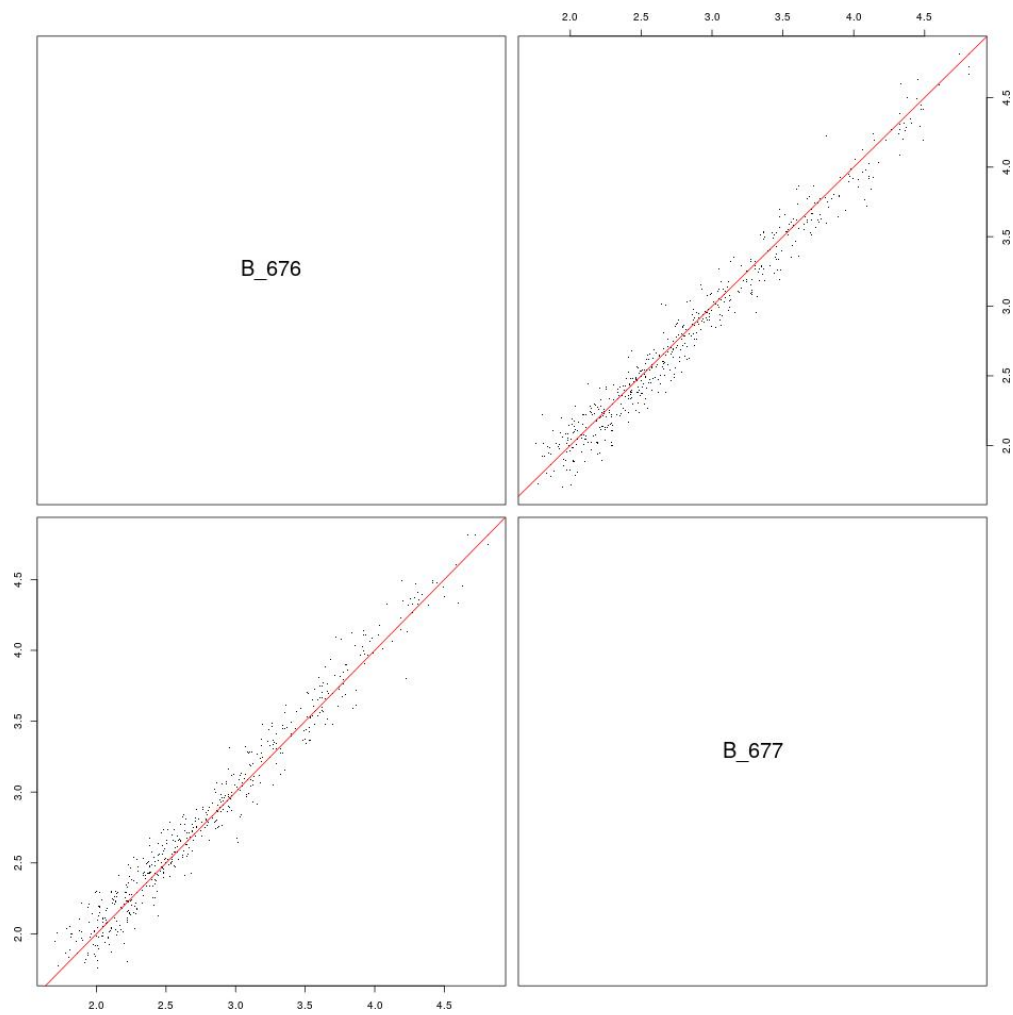


Figure 1: Scatterplots of pairwise intensities per hybridization

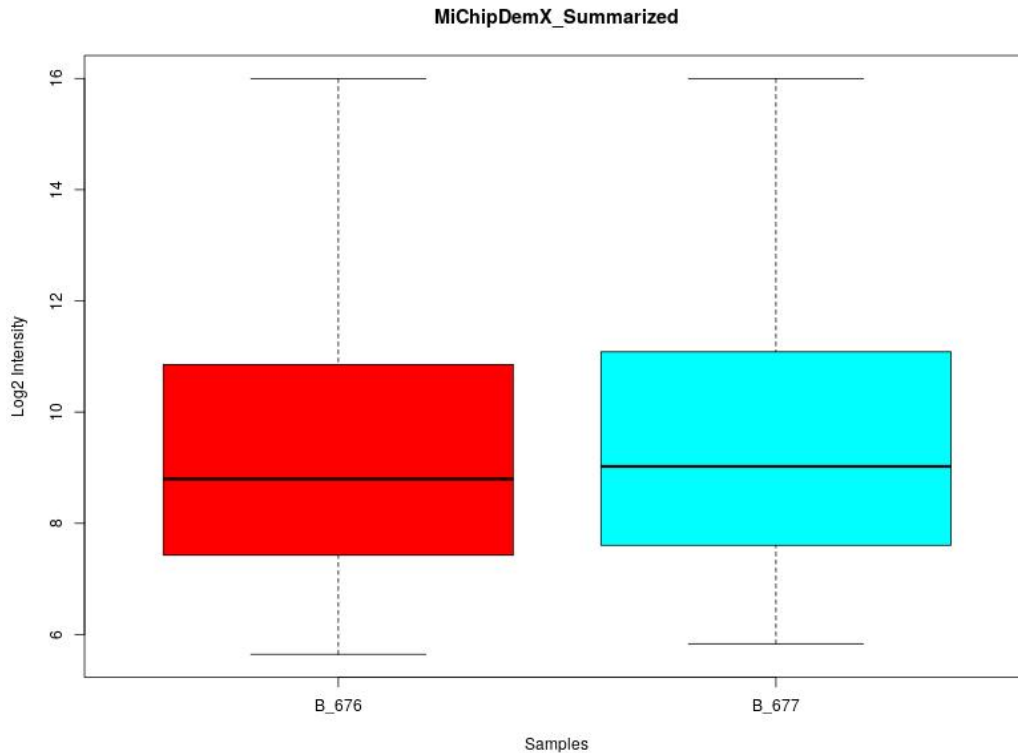


Figure 2: Boxplot of Summarized Intensity Data

8 Combination of processes

The MiChip library has been developed to automate and simplify the analysis of MiChip hybridizations and provide a basis for incorporating the MiChip into analysis pipelines. A worked example of the analysis from file parsing to median normalization of the expression data is given in the workedExampleMedian-Normalization method.

```
> datadir <-system.file("extdata", package="MiChip")
> myNormedEset <- workedExampleMedianNormalize("NormedDemo", intensityCutoff = 50,datadir)

2 files found
Dealing with file B_676.gpr
Dealing with file B_677.gpr
Raw Data 4608
Number of filters 13
Filtering special case empties
Filtered Data 1118
File saved to /tmp/RtmpMo4t50/Rbuildd654f568e0f/MiChip/vignettes/NormedDemo_FilteredData.txt
B_676 had 55 bad flags and 77 values below cutoff from 1118 data points
B_677 had 54 bad flags and 86 values below cutoff from 1118 data points
File saved to /tmp/RtmpMo4t50/Rbuildd654f568e0f/MiChip/vignettes/NormedDemo_FlagCorrected.jpg
File saved to /tmp/RtmpMo4t50/Rbuildd654f568e0f/MiChip/vignettes/NormedDemo_FlagCorrectedIntensity.txt
File saved to /tmp/RtmpMo4t50/Rbuildd654f568e0f/MiChip/vignettes/NormedDemo_Summarized.jpg
File saved to /tmp/RtmpMo4t50/Rbuildd654f568e0f/MiChip/vignettes/NormedDemo_summarizedIntensity.txt
```

File saved to /tmp/RtmpMo4t50/Rbuildd654f568e0f/MiChip/vignettes/NormedDemo_SummarizedScatter.jpg
File saved to /tmp/RtmpMo4t50/Rbuildd654f568e0f/MiChip/vignettes/NormedDemo_Median Normalized.jpg
File saved to /tmp/RtmpMo4t50/Rbuildd654f568e0f/MiChip/vignettes/NormedDemo_MedNormedScatter.jpg
File saved to /tmp/RtmpMo4t50/Rbuildd654f568e0f/MiChip/vignettes/NormedDemo_medNormedIntensity.tx

References

- M. Castoldi, S. Schmidt, V. Benes, M. W. Hentze, and M. U. Muckenthaler. michip: an array-based method for microRNA expression profiling using locked nucleic acid capture probes. *Nature Protocols*, 3(2):321–329, 2008. 1
- M. Castoldi, S. Schmidt, V. Benes, M Noerholm, A. E. Kulozik, M. W. Hentze, and M. U. Muckenthaler. A sensitive array for microRNA expression profiling (michip) based on locked nucleic acids (lna). *RNA*, 12(5):913–920, 2006.