

HowTo BGX

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1 Introduction

This vignette describes how to use *bgx*, a C++ implementation of a Bayesian hierarchical integrated approach to the modelling and analysis of Affymetrix GeneChip arrays. The model and methodology is described in Hein et al, 2005.

There are two ways to run *bgx*: (1) through R and (2) as a standalone binary. Both ways make use of probe level GeneChip data, which you must obtain as GeneChip CEL files.

2 Reading in the CEL files

When you load *bgx*, several required packages from the Bioconductor¹ project are automatically loaded.

```
> library(bgx)
```

The *affy* package allows you to read CEL files into an **AffyBatch** object. This can be achieved by changing your working directory to wherever the CEL files are stored and executing:

```
> aData <- ReadAffy()
```

This will read in the CEL files in alphabetical order and save the data in the **aData** object. Alternatively, you can specify the specific files you would like to read in by adding their paths to the argument list, for example:

```
> aData <- ReadAffy("CEL/choe/chipC-rep1.CEL", "CEL/choe/chipS-rep2.CEL")
```

¹<http://bioconductor.org>

3 Running BGX through R

A basic execution of the program can be performed by simply passing an `AffyBatch` object as a single parameter to the `bgx` function and saving the result in an `ExpressionSet` object. The result will hold array-specific gene expression values and their corresponding standard errors in `assayData(eset)$exprs` and `assayData(eset)$se.exprs` respectively.

```
> eset <- bgx(aData)
```

A more elaborate scenario would involve splitting the arrays into a number of conditions using the *samplesets* argument²; specifying which genes to analyse with the *genes* argument; specifying whether to take into account probe affinity with *probeAff*; setting the number of burn-in and post burn-in runs with the *burnin* and *iter* arguments respectively; setting the set of parameters to save with the *output* argument³; and specifying where to save the runs with *rundir*. Execute `help(bgx)` in R for a full explanation of all the parameters.

As an example, let us analyse the `Dilution` data set and save the results in the current working directory ("."):

```
> library(affydata)
> library(hgu95av2cdf)
> data(Dilution)
> eset <- bgx(Dilution, samplesets = c(2, 2), probeAff = FALSE,
+   burnin = 2048, iter = 8192, genes = c(12500:12599), output = "all")
```

The `eset` object will contain gene expression information for each gene under each condition (not necessarily each array). You may obtain the gene expression measure using the `exprs` function. For instance:

```
> exprs(eset)[10:40, ]
```

| | condition 1 | condition 2 |
|----------|-------------|-------------|
| 947_at | 6.55138 | 6.26038 |
| 948_s_at | 4.81587 | 4.51607 |
| 949_s_at | 4.84355 | 4.63399 |
| 950_at | 4.56655 | 4.31742 |
| 951_at | 2.43563 | 2.72552 |
| 952_at | 2.00411 | 2.53086 |

²Note that if your `AffyBatch` object contains information on the experimental design in the `phenoData` slot, you do not need to use the *samplesets* argument.

³*output* can be set to either "minimal", "trace" or "all". See the documentation for an explanation of what these levels mean

| | | |
|----------|---------|---------|
| 953_g_at | 5.32531 | 4.90937 |
| 954_s_at | 6.37378 | 6.07759 |
| 955_at | 6.62420 | 6.35586 |
| 956_at | 7.00169 | 6.71399 |
| 957_at | 4.63236 | 4.33294 |
| 958_s_at | 5.56037 | 5.18119 |
| 959_at | 1.47410 | 1.40060 |
| 960_g_at | 5.25870 | 4.96330 |
| 961_at | 2.04249 | 1.34850 |
| 962_at | 2.36443 | 1.57513 |
| 963_at | 4.60603 | 4.34192 |
| 964_at | 4.29928 | 4.09498 |
| 965_at | 1.57227 | 2.06872 |
| 966_at | 4.41798 | 4.10954 |
| 967_g_at | 4.90560 | 4.61491 |
| 968_i_at | 2.43029 | 3.71769 |
| 969_s_at | 4.85067 | 4.55694 |
| 970_r_at | 6.31518 | 6.17359 |
| 971_s_at | 2.44516 | 2.49688 |
| 973_at | 4.46834 | 4.12362 |
| 974_at | 2.86450 | 2.29705 |
| 975_at | 4.32882 | 4.10482 |
| 976_s_at | 3.67115 | 2.81030 |
| 977_s_at | 4.93549 | 4.60938 |
| 978_at | 2.83836 | 2.19194 |

Run `help(ExpressionSet)` in R for more information.

Note that *samplesets* should be set to an array specifying the number of replicates in each condition. If set to (3,2), `bgx` will treat the first three arrays read into R as replicates under condition 1 and the next two as replicates under condition 2. You should make sure that all condition 1 files are read in first and all condition 2 files are read in second by `ReadAffy()`. You may check the order of the samples in your `AffyBatch` object by using the `sampleNames` function:

```
> sampleNames(Dilution)
```

```
[1] "20A" "20B" "10A" "10B"
```

4 Running BGX as a standalone binary

Occasionally it may be useful to run `bgx` as a standalone binary from the command line⁴. In this case, you should use the `standalone.bgx` function instead of the `bgx` function. It takes the same arguments as `bgx`, with the addition of `dirname`, which should specify where you would like to save the input files required by the standalone binary.

```
aData <- ReadAffy() # Read in 6 arrays across two conditions
                  # in alphabetical order
standalone.bgx(aData, samplesets=c(3,3), genes=c(1:650,1000:1200),
  burnin=16384, iter=65536, output="minimal",
  dirname="input-choe3replicates")
```

Once you have saved the input files, you should locate the binary, make sure it is executable⁵, and pass the path to the newly created `infile.txt` file as a single argument. For example:

```
./bgx ../input-choe3replicates/infile.txt
```

5 Detailed analysis of the output

If you wish to analyse the output in detail, you should first read the output into a list as follows:

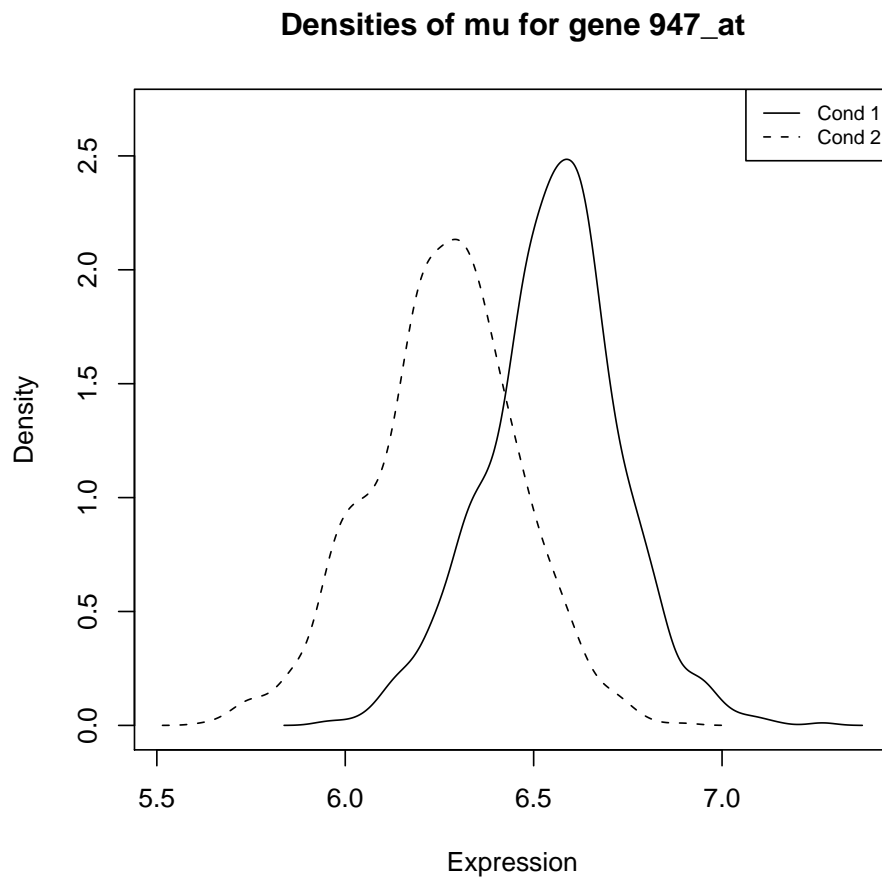
```
> bgxOutput <- readOutput.bgx("run.1")
```

You may then pass the `bgxOutput` object to any of several analysis functions. For instance, to view the gene expression distributions under the various conditions for gene 10, you could do:

```
> plotExpressionDensity(bgxOutput, gene = 10)
```

⁴You can compile it by tweaking 'src/Makefile.standalone' to your specifications and running 'make -f Makefile.standalone' from the 'src' directory.

⁵Under Unix-like environments, you can type `chmod +x bgx` at the command prompt to do this.



In order to get a list of ranked differential expression values, you could do:

```
> rankedGeneList <- rankByDE(bgxOutput)
> print(rankedGeneList[1:25, ])
```

| | Position | DiffExpression |
|---------------------------|----------|----------------|
| 955_at | 18 | 33.222281 |
| AFFX-HSAC07/X00351_5_at | 83 | 31.507561 |
| AFFX-HUMGAPDH/M33197_5_at | 90 | 29.928834 |
| 956_at | 19 | 28.704045 |
| 941_at | 4 | 27.843495 |
| 947_at | 10 | 25.893534 |
| AFFX-HSAC07/X00351_M_at | 85 | 25.126291 |
| AFFX-HUMGAPDH/M33197_M_at | 92 | 24.585403 |
| 954_s_at | 17 | 22.634570 |
| 953_g_at | 16 | 22.067209 |
| 958_s_at | 21 | 20.690656 |
| AFFX-hum_alu_at | 87 | 20.199556 |

| | | |
|-----------------------------|----|-----------|
| AFFX-HUMGAPDH/M33197_3_at | 88 | 19.762552 |
| 946_at | 9 | 19.069500 |
| AFFX-BioDn-3_at | 70 | 16.881780 |
| AFFX-HUMISGF3A/M97935_MB_at | 97 | 13.474122 |
| 982_at | 44 | 12.165461 |
| 977_s_at | 39 | 12.136329 |
| 960_g_at | 23 | 11.765490 |
| 942_at | 5 | 11.391190 |
| AFFX-HUMISGF3A/M97935_3_at | 94 | 10.783033 |
| AFFX-HUMISGF3A/M97935_MA_at | 96 | 9.935485 |
| 969_s_at | 32 | 8.037317 |
| AFFX-HSAC07/X00351_3_at | 81 | 8.016859 |
| 967_g_at | 30 | 7.957880 |

Run `help(analysis.bgx)` for more detailed usage instructions on the analysis functions.