

# Object Oriented Microarray and Proteomics Analysis (OOMPA)

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## 1 Introduction

OOMPA is a suite of object-oriented tools for processing and analyzing large biological data sets, such as those arising from mRNA expression microarrays or mass spectrometry proteomics.

This vignette documents the base package, *oompaBase*. A critical (but invisible to the user) feature of the *oompaBase* package is that it defines a `class union` allowing you to use “numeric” or “NULL” objects in the design of an S4 class. More interesting user-visible features include alternative color schemes and vectorized matrix operations to speed the computation of row-by-row means, variances, and t-tests.

## 2 Getting Started

You invoke the package in the usual way:

```
> library(oompaBase)
```

## 3 Color Schemes

To illustrate the various color schemes, we first create a structured matrix:

```
> mat <- matrix(1:1024, ncol = 1)
```

The following code is used to generate Figure 1.

```
> opar <- par(mfrow = c(5, 1), mai = c(0.3, 0.5, 0.2, 0.2))
> image(mat, col = redgreen(64), main = "redgreen")
> image(mat, col = jetColors(128), main = "jetColors")
> image(mat, col = blueyellow(32), main = "blueyellow")
> image(mat, col = redscale(64), main = "redscale")
> image(mat, col = bluescale(64), main = "bluescale")
> par(opar)
```

## 4 Row-by-row Matrix Operations

We now want to illustrate the “matrix operations” that allow for rapid computation of row-by-row means, variances, and t-tests.

We start by creating a slightly more interesting matrix full of random data. First, we make the variance larger in the second half (by column) of the data than in the first half.

```
> ng <- 10000
> ns <- 50
> dat <- matrix(rnorm(ng * ns, 0, rep(c(1, 2), each = 25)), ncol = ns,
+   byrow = TRUE)
```

Next, we shift the mean for the first 500 “genes” (rows).

```
> dat[1:500, 1:25] <- dat[1:500, 1:25] + 2
```

In order to compute t-tests, we also assign arbitrary labels separating the “sample columns” into two groups.

```
> clas <- factor(rep(c("Good", "Bad"), each = 25))
```

Here we compute the row-by-row means.

```
> a0 <- proc.time()
> myMean <- matrixMean(dat)
> used0 <- proc.time() - a0
```

For comparison purposes, we perform the same computation using `apply`.

```
> a1 <- proc.time()
> mm <- apply(dat, 1, mean)
> used1 <- proc.time() - a1
```

The results are the same, to within round-off error.

```
> summary(as.vector(myMean - mm))
```

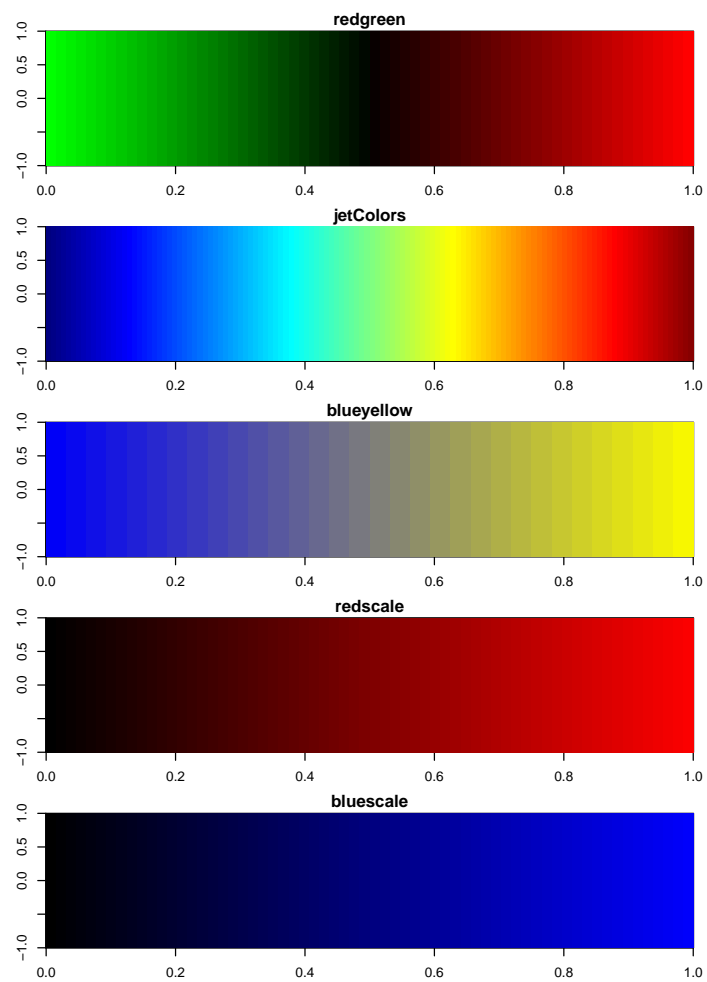


Figure 1: Five color schemes.

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
-8.882e-16	-2.776e-17	0.000e+00	4.561e-19	2.776e-17	1.110e-15

There is a measurable (although not really user-perceptible) difference in the time for the two methods.

```
> used0
```

user	system	elapsed
0.003	0.001	0.003

```
> used1
```

user	system	elapsed
0.264	0.005	0.281

Here we compute the variances using two different methods.

```
> a0 <- proc.time()
> myVar <- matrixVar(dat, myMean)
> a1 <- proc.time()
> vv <- apply(dat, 1, var)
> a2 <- proc.time()
```

Again, the values are the same:

```
> summary(as.vector(myVar - vv))
```

Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
-3.997e-15	-4.441e-16	0.000e+00	3.780e-19	4.441e-16	4.441e-15

However, the time savings is substantially larger.

```
> a1 - a0
```

user	system	elapsed
0.005	0.001	0.009

```
> a2 - a1
```

user	system	elapsed
0.543	0.004	0.623

Not surprisingly, there is an even bigger time savings when computing (equal variance) t-statistics.

```
> t0 <- proc.time()
> myT <- matrixT(dat, clas)
> t1 <- proc.time()
> tt <- sapply(1:nrow(dat), function(i) {
+   t.test(dat[i, clas == "Bad"], dat[i, clas == "Good"], var.equal = T)$statistic
+ })
> t2 <- proc.time()
```

```

> summary(as.vector(tt - myT))

      Min.      1st Qu.      Median      Mean      3rd Qu.      Max.
-6.217e-15 -1.110e-16  0.000e+00  9.987e-18  1.110e-16  6.217e-15

> t1 - t0

      user  system elapsed
0.035    0.006    0.049

> t2 - t1

      user  system elapsed
5.891    0.035    6.300

```