

An Introduction to the bigmemoryExtras Package

Peter M. Haverty

April 11, 2014

1 Introduction

This package defines a "BigMatrix" ReferenceClass which adds safety and convenience features to the file-backed `big.matrix` class from the `bigmemory` package. `BigMatrix` protects against segfaults by monitoring and gracefully restoring the connection to on-disk data. We provide utilities for using `BigMatrix`-derived classes as `assayData` matrices within the `Biobase` package's `eSet` family of classes. `BigMatrix` provides some optimizations related to attaching to, and indexing into, file-backed matrices with `dimnames`. Additionally, the package provides a "BigMatrixFactor" class, a file-backed matrix with factor properties.

```
> library(bigmemoryExtras)
> data.file = file.path(tempdir(),"bigmat","ds")
> x = matrix(1:9,ncol=3,dimnames=list(letters[1:3],LETTERS[1:3]))
> ds = BigMatrix(x,data.file)
> ds[,1] = 3:1
> ds[,1]
```

```
a b c
3 2 1
```

2 Re-attaching to on-disk data as necessary

When a `big.matrix` object is attached to its on-disk data, an external pointer is used to connect the R object to a C++ data structure. When a `big.matrix` object is not attached, like when it is loaded from an `RData` file, this pointer is `nil`. Any access to this `nil` pointer will crash R. The `bigmemoryExtras` package provides a `BigMatrix` class that prevents such a crash by controlling access to the external pointer. Additionally, `BigMatrix` objects remember the location of their on-disk components and automatically re-attach themselves as necessary.

This kind of thing would be helpful if you, for example, chose to save your new `BigMatrix` object to disk for later use. You might save your object using R's built in `save` or `saveRDS` functions.

```
> ds$backingfile

[1] "/tmp/Rtmp28GzGM/bigmat/ds"

> saveRDS(ds,file=file.path(tempdir(),"foo.rds"))
> new.ds = readRDS(file=file.path(tempdir(),"foo.rds"))
> new.ds[1:2,2:3]

  B C
a 4 7
b 5 8
```

3 S4 Style Access

The BigMatrix class uses R's Reference Class system. Any change to the matrix portion of the data has on-disk side effects, so it seems natural that any other changes to the object should have the same behavior. In order to give BigMatrix the same API as a base matrix or big.matrix class, certain S4-style methods are provided. ReferenceClass objects are relatively new to R and unfamiliar to many users, so you may want to review the ReferenceClasses help page.

```
> nrow(ds)

[1] 3

> ds$nrow()

[1] 3

> ncol(ds)

[1] 3

> ds$ncol()

[1] 3

> dim(ds)

[1] 3 3

> ds$dim()

[1] 3 3

> dimnames(ds)

[[1]]
[1] "a" "b" "c"

[[2]]
[1] "A" "B" "C"

> ds$dimnames()

[[1]]
[1] "a" "b" "c"

[[2]]
[1] "A" "B" "C"

> length(ds)

[1] 9

> ds$length()

[1] 9
```

4 BigMatrixFactor

The `bignmemoryExtras` package adds a “`BigMatrixFactor`” class to provide a means to store large matrices of characters. On the file system, these are stored as the C type `char` or `int` (8 or 32 bits), depending on the number of levels in the factor. Subsetting a `BigMatrixFactor` returns a factor. If more than one column is returned, the returned object is a factor matrix.

```
> data.file = file.path(tempdir(),"bigmat","fs")
> x = matrix( c(rep("AA",5),rep("BB",4)) ,ncol=3,dimnames=list(letters[1:3],LETTERS[1:3]))
> fs = BigMatrixFactor(x,data.file,levels=c("AA","BB"))
> fs[,]

  A  B  C
a AA AA BB
b AA AA BB
c AA BB BB
Levels: AA BB

> as(fs,"matrix")

  A  B  C
a AA AA BB
b AA AA BB
c AA BB BB
Levels: AA BB

> fs$levels

[1] "AA" "BB"

> levels(fs)

[1] "AA" "BB"

> fs[, 2]

  a  b  c
AA AA BB
Levels: AA BB

> fs[, 2:3]

  B  C
a AA BB
b AA BB
c BB BB
Levels: AA BB
```

5 Use with Biobase and eSet-derived Classes

Either class can be used as an `assayDataElement` in the `assayData` slot of the familiar BioConductor `eSet`-derived classes. We provide utility functions to deal with relocated `BigMatrix` files and to attach all of an `eSet`'s `BigMatrix` `assayDataElements`. Of course, you can also just let them attach themselves as necessary.

```

> library(Biobase)
> eset = ExpressionSet()
> assayDataElement(eset,"exprs") = ds
> exprs(eset)[1:2,2:3]

      B C
a 4 7
b 5 8

> new.dir = file.path(tempdir(),"newbigmat")
> dir.create(new.dir,showWarnings=FALSE)
> file.copy(ds$backingfile, new.dir)

[1] TRUE

> updateAssayDataElementPaths( assayData(eset), new.dir )
> assayDataElement(eset,"exprs")$backingfile

[1] "/tmp/Rtmp28GzGM/newbigmat/ds"

> attachAssayDataElements( eset )
>

```