

# Primitive array operations in the `gRbase` package

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```
> library(gRbase)
```

## 1 Introduction

This note describes some operations on arrays in R. These operations have been implemented to facilitate implementation of graphical models and Bayesian networks in R.

### 1.1 Arrays in R

The documentation of R states the following about arrays:

An array in R can have one, two or more dimensions. It is simply a vector which is stored with additional attributes giving the dimensions (attribute "dim") and optionally names for those dimensions (attribute "dimnames").

A two-dimensional array is the same thing as a matrix.

One-dimensional arrays often look like vectors, but may be handled differently by some functions.

Hence the defining characteristic of an array is that it is a vector with a dim attribute. For example

```
> ## 1-dimensional array
> ##
> x1 <- 1:8
> dim(x1) <- 8
> x1

[1] 1 2 3 4 5 6 7 8

> is.array(x1)

[1] TRUE

> is.matrix(x1)

[1] FALSE

> ## 2-dimensional array (matrix)
> ##
> x2 <- 1:8
> dim(x2) <- c(2,4)
> x2

      [,1] [,2] [,3] [,4]
[1,]    1    3    5    7
[2,]    2    4    6    8

> is.array(x2)

[1] TRUE

> is.matrix(x2)

[1] TRUE

> ## 3-dimensional array
> ##
> x3 <- array(1:8, dim=c(2,2,2))
> x3

, , 1

      [,1] [,2]
[1,]    1    3
[2,]    2    4

, , 2

      [,1] [,2]
[1,]    5    7
[2,]    6    8

> is.array(x3)

[1] TRUE

> is.matrix(x3)

[1] FALSE
```

## 1.2 Terminology

Consider a set  $\Delta = \{\delta_1, \dots, \delta_K\}$  of  $|\Delta| = K$  factors where the factor  $\delta_k$  has levels  $I_k$ . The cross product  $I = I_1 \times \dots \times I_K$  defines an array where  $i = (i_1, \dots, i_K) \in I$  is a cell. It is the convention

here that the first factor varies fastest. To each cell  $i \in I$  there is often a value  $f(i)$ .

As shown above, an array is implemented as a vector  $x$  of length  $L = |I|$ , that is  $x \equiv (f(i), i \in I)$ . In practice  $x$  is indexed by an entry  $e$  as  $x[e]$  for  $e = 1, \dots, L$ .

The factor levels  $(I_1, \dots, I_K)$  are denoted `flevels` in the code below. As an example we take the following:

```
> flevels <- c(2,3,2,4)
```

## 2 cell2entry() and entry2cell()

The map from a cell to the corresponding entry is provided by `cell2entry()`. The reverse operation, going from an entry to a cell (which is much less needed) is provided by `entry2cell()`.

```
> cell2entry(c(1,1,1,1), flevels)
[1] 1
> entry2cell(1, flevels)
[1] 1 1 1 1
> cell2entry(c(2,1,2,1), flevels)
[1] 8
> entry2cell(8, flevels)
[1] 2 1 2 1
```

## 3 nextCell() and nextCellMarg()

Given a cell, say  $i = (1, 1, 2, 1)$  we often want to find the next cell in the table following the convention that the first factor varies fastest, that is  $(2, 1, 2, 1)$ . This is provided by `nextCell()`. Notice the result of finding the next cell to the final cell.

```
> nextCell(c(1,1,2,1), flevels)
[1] 2 1 2 1
> nextCell(c(2,3,2,4), flevels)
NULL
```

Given  $A \subset \Delta$  and a cell  $i_A \in I_A$  consider the cells  $I(i_A) = \{j \in I | j_A = i_A\}$ . For example, the cells satisfying that factor 2 is at level 1. Given such a cell, say  $(2, 1, 1, 2)$  we often want to find the next cell also satisfying this constraint following the convention that the first factor varies fastest, that is  $(1, 1, 2, 2)$ . This is provided by `nextCellMarg()`.

```
> nextCellMarg(c(1,3,2,1), margset=c(2,3), flevels)
[1] 2 3 2 1
> nextCellMarg(c(2,3,2,1), margset=c(2,3), flevels)
[1] 1 3 2 2
```

## 4 margcell2entry()

Given  $A \subset \Delta$  and a cell  $i_A \in I_A$ . This cell defines a slice of the original array, namely the cells  $I(i_A) = \{j \in I \mid j_A = i_A\}$ . We often want to find the entries in  $x$  for the cells  $I(i_A)$ . This is provided by `margcell2entry()`. To be specific, we may want the entries for the cells  $(*, 1, 2, *)$  or  $(2, 2, *, *)$ :

```
> margcell2entry(margcell=c(1,2), margset=c(2,3), flevels)
[1] 7 8 19 20 31 32 43 44
> margcell2entry(margcell=c(2,2), margset=c(1,2), flevels)
[1] 4 10 16 22 28 34 40 46
```

## 5 Factorial grids

Using the operations above we can obtain the combinations of the factors as a matrix:

```
> ff <- factgrid(flevels)
> head(ff)
      [,1] [,2] [,3] [,4]
[1,]    1    1    1    1
[2,]    2    1    1    1
[3,]    1    2    1    1
[4,]    2    2    1    1
[5,]    1    3    1    1
[6,]    2    3    1    1
> tail(ff)
      [,1] [,2] [,3] [,4]
[43,]    1    1    2    4
[44,]    2    1    2    4
[45,]    1    2    2    4
[46,]    2    2    2    4
[47,]    1    3    2    4
[48,]    2    3    2    4
> ff <- factgrid(flevels, margcell=c(1,2), margset=c(2,3))
> ff
      [,1] [,2] [,3] [,4]
[1,]    1    1    2    1
[2,]    2    1    2    1
[3,]    1    1    2    2
[4,]    2    1    2    2
[5,]    1    1    2    3
[6,]    2    1    2    3
[7,]    1    1    2    4
[8,]    2    1    2    4
```