

# Converting a multidimensional index to a single unique id

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**Abstract:** This small note consider a mapping of a set of indexes into a unique id.

## 1 Assumptions

Consider a multidimensional index  $(i_1, \dots, i_m)$  where each index  $i_k$  belongs to a set of integers  $\{lb_k, \dots, ub_k\}$ . All combinations are valid, i.e. we have  $\prod_{k=1}^m |i_k|$  possible combinations of the indexes. If we enumerate all index combinations using the rule that index  $i_k$  is running before index  $i_q, k < q$  we get a matrix where each index combination may be given an unique id as illustrated below.

```
> dat <- expand.grid(i1 = 1:3, i2 = 0:1, i3 = 2:3)
> idStart <- 5
> dat <- cbind(id = idStart:(idStart + nrow(dat) - 1), dat)
> dat
```

	id	i1	i2	i3
1	5	1	0	2
2	6	2	0	2
3	7	3	0	2
4	8	1	1	2
5	9	2	1	2
6	10	3	1	2
7	11	1	0	3
8	12	2	0	3
9	13	3	0	3
10	14	1	1	3
11	15	2	1	3
12	16	3	1	3

Note  $id$  belongs to a sequence of integers starting from a given number  $id_s$ .

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## 2 Calculating the id

Given multidimensional index  $(i_1, \dots, i_m)$ , we can calculate the id using the following formula:

$$id = \sum_{k=2}^m \left( (i_k - lb_k) \prod_{j=1}^{k-1} |i_j| \right) + (i_1 - lb_1) + id_s$$

which using R can be found using the following function:

```
> getId <- function(idx, lb, lth, idStart = 0) {
+   m <- length(idx)
+   id <- 0
+   for (k in m:2) {
+     i <- idx[k]
+     id <- id + (idx[k] - lb[k]) * prod(lth[1:(k - 1)])
+     t <- which(dat$id == id)
+   }
+   id <- id + (idx[1] - lb[1]) + idStart
+   names(id) <- NULL
+   return(id)
+ }
> lb <- apply(dat, 2, min)[2:4]
> ub <- apply(dat, 2, max)[2:4]
> lth <- ub - lb + 1
> getId(idx = c(2, 1, 2), lb, lth, idStart)
```

```
[1] 9
```

## 3 Applications

An unique id might be useful e.g. when having multiple state variables in an Markov decision process. Here each state at a stage may be identified using the id.