Tensors and lists

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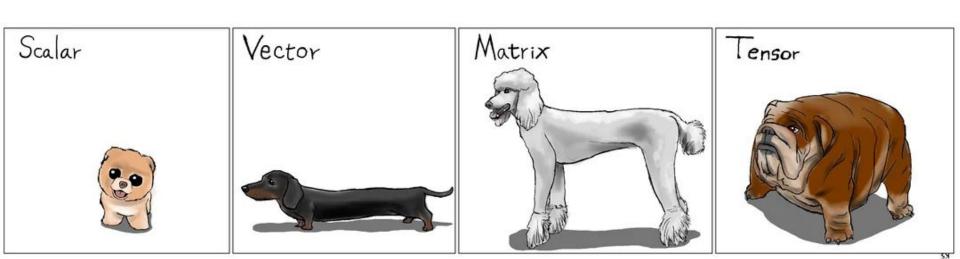
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Unit 2: Mathematical models and simulations

Tensors and lists

- Lecture Worksheet

Tensors



Say we have a floor design for an office, each cell represents a room

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Now with 3 dimensions, we can specify which floor you're on

```
> array(NA, dim = c(4,4,2))
                                   , , 2
, , 1
                                         [,1] [,2] [,3] [,4]
      [,1] [,2] [,3] [,4]
                                   [1,]
                                                NA
                                           NA
                                                      NA
                                                            NA
[1,]
       NA
             NA
                   NA
                         NA
                                   [2,]
                                           NA
                                                NA
                                                      NA
                                                            NA
[2,]
                         NA
       NA
             NA
                   NA
                                   [3,]
                                           NA
                                                NA
                                                      NA
                                                            NA
[3,]
                         NA
       NA
             NA
                   NΑ
                                   [4,]
                                           NA
                                                 NA
                                                      NA
                                                            NA
[4,]
       NΑ
             NA
                   NA
                         NA
```

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```
Adding another dimension, what
> array(NA, dim = c(4, 4, 2, 2))
                                                          building you're in
                                              , , 1, 2
, , 1, 1
                                                    [,1] [,2] [,3] [,4]
     [,1] [,2] [,3] [,4]
                                              [1,]
                                                      NA
                                                           NA
                                                                 NA
                                                                      NA
[1,]
       NA
                  NA
                        NA
             NA
                                              [2,]
                                                      NA
                                                           NA
                                                                 NA
                                                                      NA
[2,]
                        NA
       NA
             NA
                  NA
                                              [3,]
                                                      NA
                                                           NA
                                                                      NA
[3,]
       NA
                        NA
             NA
                                              [4,]
                                                      NA
                                                           NA
                                                                 NA
                                                                      NA
[4,]
       NA
             NA
                  NA
                        NA
                                              , , 2, 2
, , 2, 1
                                                    [,1] [,2] [,3] [,4]
     [,1] [,2] [,3] [,4]
                                              [1,]
                                                      NA
                                                           NA
                                                                 NA
                                                                      NA
[1,]
       NA
             NA
                  NA
                        NA
                                              [2,]
                                                                 NA
                                                                      NA
                                                      NA
                                                           NA
[2,]
       NA
             NA
                  NA
                        NA
                                              [3,]
                                                                      NA
                                                      NA
                                                           NA
[3,]
       NA
             NA
                  NA
                        NA
                                              [4,]
                                                      NA
                                                           NA
                                                                 NA
                                                                      NA
[4,]
       NA
             NA
                  NA
                        NA
```

NA

```
> array(NA, dim = c(4, 4, 2, 2, 2))
                                            , , 1, 1, 2
, , 1, 1, 1
                                                 [,1] [,2] [,3] [,4]
    [,1] [,2] [,3] [,4]
                                            [1,] NA
          NA
                                                  NA
                                                       NA
                                                           NA
          NA
              NA
                                            [3,]
                                                  NA
                                                       NA
                                                           NA
      NA
          NA
              NA
                                            [4,] NA NA NA NA
     NA NA NA NA
                                            , , 2, 1, 2
, , 2, 1, 1
                                                 [,1] [,2] [,3] [,4]
    [,1] [,2] [,3] [,4]
                                                  NA
                                                           NA
      NA
          NA
                                            [3,] NA
                                                       NA
                                                           NA NA
          NA
                                            [4,] NA NA NA NA
      NA
         NA
                                            , , 1, 2, 2
, , 1, 2, 1
                                                 [,1] [,2] [,3] [,4]
    [,1] [,2] [,3] [,4]
          NA
              NA
      NA
          NA
              NA
                                                  NA
                                                           NA
      NA
          NA
                                            [4,] NA
                                                      NA NA NA
          NA
              NA NA
                                            , , 2, 2, 2
, , 2, 2, 1
                                                 [,1] [,2] [,3] [,4]
    [,1] [,2] [,3] [,4]
                                            [1,] NA
                                                           NA
[1,] NA
          NA
              NA NA
      NA
          NA
              NA
                                                  NA
                                                       NA
                                                           NA
      NA
          NA
                                            [4,] NA NA NA NA
              NA
```

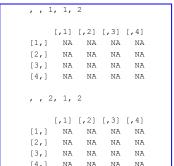
Even further, which city block you're in

Control

> array(NA, dim = c(4,4,2,2,2)), , 1, 1, 1 [,1] [,2] [,3] [,4] NA Rep 1 , , 2, 1, 1 [,1] [,2] [,3] [,4] NA NA NA NA

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

Treatment



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

Let's think about how this could be used in science

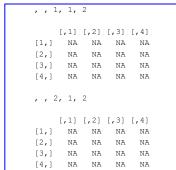
Rep 2

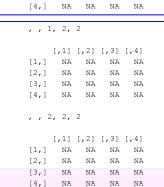
NA NA Brian Kissmer NA NA NA NA Week 5

N = 20> array(NA, dim = c(4,4,2,2,2)), , 1, 1, 1 [,1] [,2] [,3] [,4] NA Rep 1 , , 2, 1, 1 [,1] [,2] [,3] [,4] NA NA NA NA

NA NA NA NA

N = 200





Let's think about how this could be used in science with one example

Rep 2

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Week 5

Lists

- Lists are like more flexible versions of tensors
- Rather than a matrix of the same size comprising the first two dimensions, anything can be added to a list

Lists

```
> list(c("job", "cat"), 3, rbinom(15, 25, .3), matrix(NA, 5, 5))
[[1]]
[1] "job" "cat"
[[2]]
[1] 3
[[3]]
 [1] 11 9 7 10 4 9 7 10 8 6 9 5 10 6 9
[[4]]
     [,1] [,2] [,3] [,4] [,5]
[1,]
            NA
                 NA
                           NA
                      NA
[2,]
            NA
                 NA
                      NA
                           NA
[3,1
            NA
                NA
                      NA
                           NA
[4,]
                           NΑ
            NA
                 NA
                      NA
[5,]
            NA
                      NA
                           NA
```

Lists are great when you have multiple data types associated with an object. Let's make a list with some more realistic data

Lists

```
mylist <- list(c("Brian"), 27, matrix(runif(25, 0, 1), 5, 5))
names(mylist) <- c("Name", "Age", "Homework submission")</pre>
> mylist
$Name
[1] "Brian"
$Age
[1] 27
$`Homework submission`
          [,1]
                           [,3] [,4]
[1,] 0.1513382 0.52659008 0.88076411 0.2372297 0.8014296
[2,] 0.2818117 0.06078222 0.50837063 0.6864904 0.1462821
[3,] 0.6667052 0.96903886 0.33749500 0.2258184 0.8227174
[4,] 0.9773836 0.12023713 0.89433463 0.3184946 0.3309978
```

[5,] 0.5827397 0.08836330 0.03197163 0.1739838 0.3741694

Lists are great when you have multiple data types associated with an object. Let's make a list with some more realistic data

Worksheet

Head to today's worksheet for practice with tensors and lists!

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Week 5