Data Structures in R: Arrays and Factors

Stat 133 with Gaston Sanchez

Data Types & Vectors recap

Data Types (primitives)

```
1L       # integer
2.5      # double (real)
TRUE     # logical
"hello"  # character
1 + 3i   # complex
```

Fundamental concepts

Atomic objects

Coercion

Subsetting or Bracket Notation `[index]`

Vectorization

Recycling

Atomic objects

Atomic: all elements must be of the same data type.

In other words: you cannot have an atomic object containing elements of different types.

Matrices and Arrays

single data type

dimensions

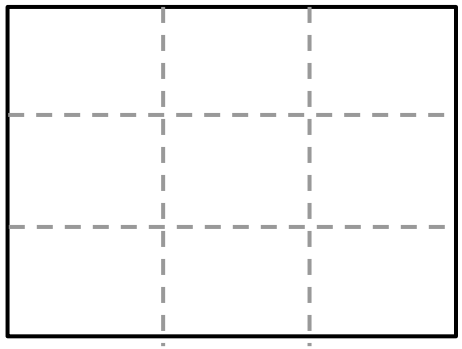
1D

Vector

Atomic objects

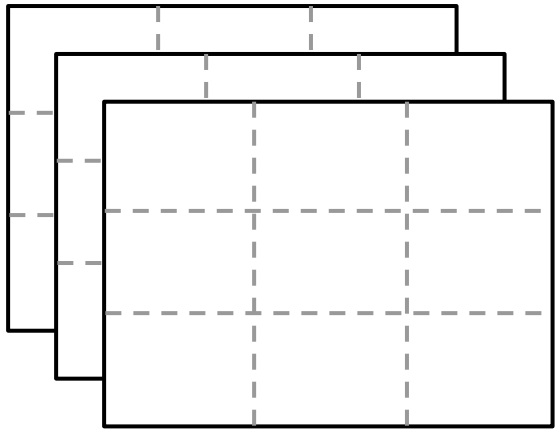
2D

Matrix



nD

Array



Arrays and matrices

You can transform a vector in an n-dimensional array by giving it a **dimensions** attribute

```
x <- 1:8

dim(x) <- c(2, 4)
```

Arrays and matrices

The **dimensions** attribute is a numeric vector with as many elements as desired dimensions

```
x <- 1:8

dim(x) <- c(2, 2, 2)
```

In practice, we don't really create matrices and arrays via dim()

Arrays and matrices

To have more control about how a matrix is filled, we use the function **matrix()**

```
a <- 1:8

A <- matrix(a, nrow = 2, ncol = 4)
```

About R matrices

R stores matrices as vectors.

Which means that matrices are also **atomic**.

Matrices in R are stored **column-major** (i.e. by columns).

This is like Fortran, Matlab, and Julia, but not like C or Python (e.g. numpy).

Arrays and matrices

If you want to fill a matrix by rows use

byrow = TRUE

```
b <- 1:8

B <- matrix(a, nrow = 2, ncol = 4,
            byrow = TRUE)
```

dimensions

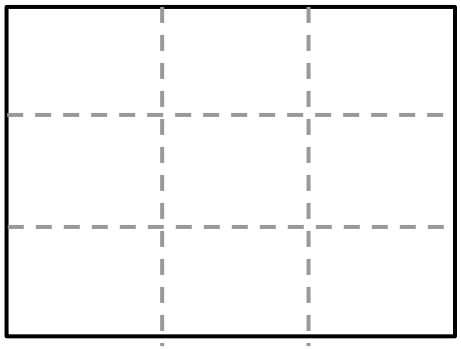
Vector

1D

object[i]

Matrix

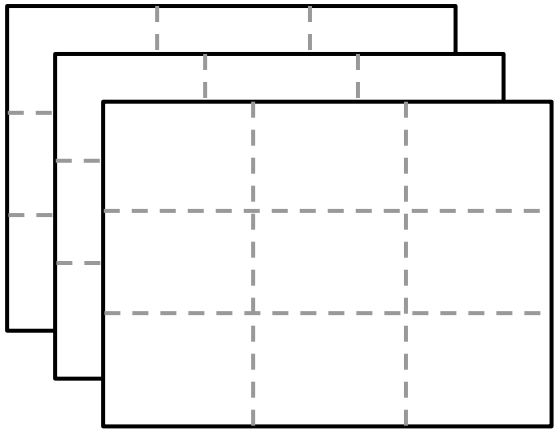
2D



object[i,j]

Array

nD



object[i,j,k]

object[i,j,k,l]

So far

Vectors, matrices, and arrays are atomic objects (they can only store one type of data)

Many operations in R need atomic structures to make sure all values are of the same mode

In real life, however, many datasets contain multiple types of information

R provides other data structures for this purpose

Factors

R factors

Another data structure in R are **factors**

A factor is designed to handle categorical data

The name “factor” comes from “Analysis of Variance” (ANOVA) terminology

R factors

To create a factor, typically you pass a vector to the function **`factor()`**

```
size <- c("sm", "md", "lg", "md")

size <- factor(size)
```

About R factors

Factors are excellent for working with categorical data, especially data with an “ordinal” scale

Factors are **internally stored as vectors of integers**

Factors behave a lot like vectors

But factors have their own special properties

Codification issues

Codification

It is very common that we (humans) codify information (e.g. data, variables) in many interesting ways

It can make completely sense to us

But not necessarily to the computer

Binary scale variable

Example	R mode
`TRUE, FALSE`	logical
`0, 1`	numeric
`"yes", "no"`	character
`yes, no`	factor

Nominal scale variable

Example	R mode
`1, 2, 3`	numeric
`"blue", "white", "red"`	character
`blue, white, red`	factor

Odinal scale variable

Example	R mode
`1, 2, 3`	numeric
`"small", "medium", "large"`	character
`small, medium, large`	factor

Interval / Ratio scale variables in R

Example	R mode
`1.1, -2.5, 100`	numeric
`1/4, pi, exp(1)`	numeric

Missing Values

Example	R mode
`NA`	logical
`-999`	numeric
`-99999`	numeric
`"?"`	character
`" "`	character
`"na"`	character

Next

single data type *multiple data types*

dimensions

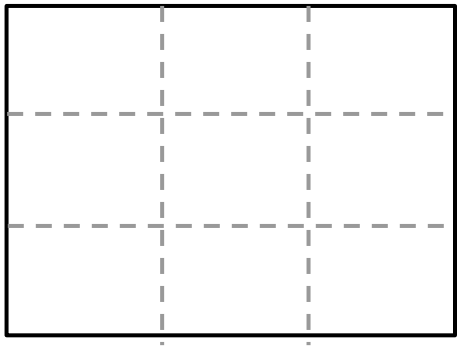
1D

Vector

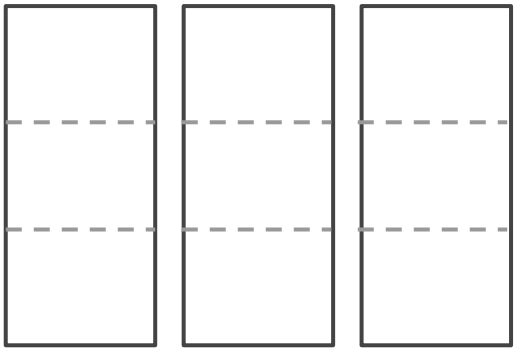
List

2D

Matrix



Data Frame



non-atomic structures

nD

Array