Subsetting & data structures

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2. Data structures
    1. Basic data types
    2. Vectors, matrices & arrays
    3. Lists & data.frames

Subsetting

Key to efficient use of R is mastering subsetting.

Take one minute to recall the 5 basic types of subsetting

blank	include all
integer	**+ve**: include **-ve**: exclude
logical	include TRUEs
character	lookup by name

Integer subsetting

```r
# Nothing
str(diamonds[, ])

# Positive integers & nothing
diamonds[1:6, ]  # same as head(diamonds)
diamonds[, 1:4]  # watch out!

# Two positive integers in rows & columns
diamonds[1:10, 1:4]

# Repeating input repeats output
diamonds[c(1,1,1,2,2), 1:4]

# Negative integers drop values
diamonds[-(1:53900), -1]
```

```
# Useful technique: Order by one or more columns
diamonds[order(diamonds$x), ]

# Useful technique: Combine two tables
carats <- data.frame(table(carat = diamonds$carat))
mtch <- match(diamonds$carats, carats$carats)
diamonds$carat_count <- carats$Freq[mtch]
```

Logical subsetting

```r
# The most complicated to understand, but
# the most powerful. Lets you extract a
# subset defined by some characteristic of
# the data
x_big <- diamonds$x > 10

head(x_big)
sum(x_big)
mean(x_big)
table(x_big)

diamonds$x[x_big]
diamonds[x_big, ]
```

```
small <- diamonds[diamonds$carat < 1, ]
lowqual <- diamonds[diamonds$clarity
  %in% c("I1", "SI2", "SI1"), ]

# Comparison functions:
# < > <= >= != == %in%

# Boolean operators: & | !
small <- diamonds$carat < 1 &
  diamonds$price > 500
lowqual <- diamonds$colour == "D" |
  diamonds$cut == "Fair"
```

Your turn

Select the diamonds that have:

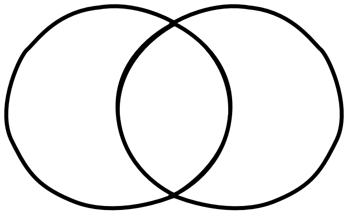
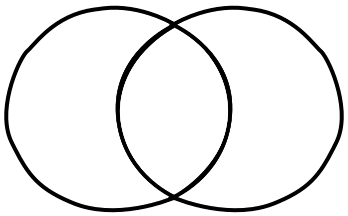
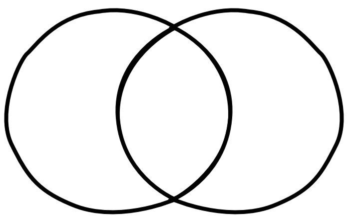
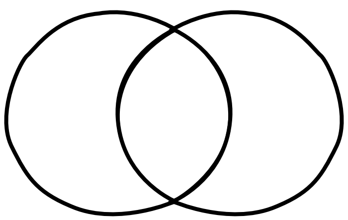
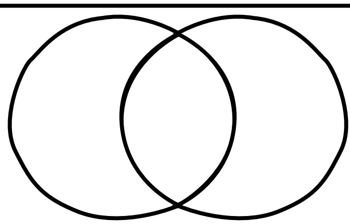
Equal x and y dimensions.

Depth between 55 and 70.

Carat smaller than the mean.

Cost more than $10,000 per carat.

Are of good quality or better.

	A
	B
	A | B
	A & B
	A & !B

Easy to select first n

```r
a <- seq(0, 100, by = 2)
b <- seq(0, 100, by = 3)

intersect(a, b)  # divisible by 2 and 3
union(a, b)      # divisible by 2 or 3
setdiff(a, b)    # divisible by 2, but not 3
setdiff(b, a)    # divisible by 3, but not 2
setdiff(union(a, b), intersect(a, b))
# divisible by either, but not both
```

which() converts from logical to numeric

```
A <- rep(c(F, T), length = 100)
B <- rep(c(F, F, T), length = 100)

A & B      # divisible by 2 and 3
A | B      # divisible by 2 or 3
A & !B     # divisible by 2, but not 3
B & !A     # divisible by 3, but not 2
xor(A, B) # divisible by either, but not both
(A | B) & !(A & B)  # same thing
```

Character subsetting

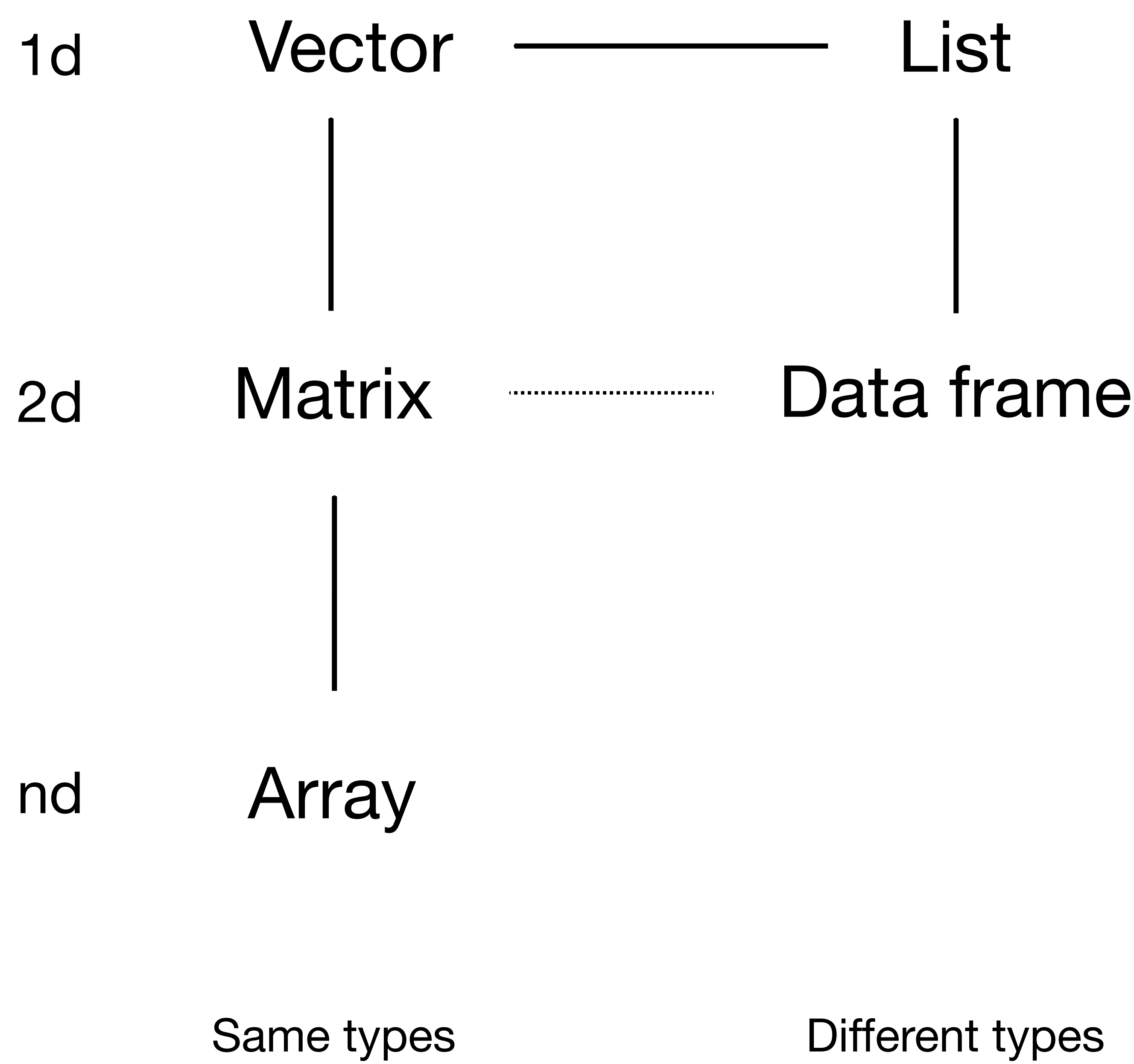
```
# Matches by names
diamonds[1:5, c("carat", "cut", "color")]

# Useful technique: change labelling
c("Fair" = "C", "Good" = "B", "Very Good" = "B+",
"Premium" = "A", "Ideal" = "A+")[diamonds$cut]

# Can also be used to collapse levels
table(c("Fair" = "C", "Good" = "B", "Very Good" =
"B", "Premium" = "A", "Ideal" = "A")[diamonds$cut])

# (see ?cut for continuous to discrete equivalent)
```

Your turn

In the mpg dataset, create a new variable giving the origin of the manufacturer: Europe, America or Asia.

Data structures

Take two minutes to come up with
the 5 basic data structures


1d
Vector
List
2d
Matrix
Data frame
nd
Array
Same types
Different types

str()

character

numeric

logical

```
as.character(c(T, F))
as.character(seq_len(5))
as.logical(c(0, 1, 100))
as.logical(c("T", "F", "a"))
as.numeric(c("A", "100"))
as.numeric(c(T, F))
```

When vectors of different types occur in an expression, they will be automatically coerced to the same type: character > numeric > logical

`mode()`

`names()` Optional, but useful

`length()` A scalar is a vector of length 1

Technically, these are all **atomic** vectors

Your turn

Experiment with automatic coercion.
What is happening in the following cases?

```
104 & 2 < 4

mean(diamonds$cut == "Good")

diamonds$color == "D" | "E" | "F"
```

Matrix (2d)
Array (>2d)

Just like a vector. Has `mode()` and `length()`.

Create with `matrix()` or `array()`, or from a vector by setting `dim()`

`as.vector()` converts back to a vector

```
a <- seq_len(12)
dim(a) <- c(1, 12)
dim(a) <- c(4, 3)
dim(a) <- c(2, 6)
dim(a) <- c(3, 2, 2)
```

```
a <- 1:10
b <- 11:20
```

```
cbind(a, b)
rbind(a, b)
```

```r
# What's the difference between a & b?
a <- matrix(x, 4, 3)
b <- array(x, c(4, 3))

# What's the difference between x & y
y <- matrix(x, 12)
```

List

Is also a vector (so has mode, length and names), but is different in that it can store any other vector inside it (including lists).

```
c(1, 2, c(3, 4))
list(1, 2, list(3, 4))

c("a", T, 1:3)
list("a", T, 1:3)
```

Use `unlist()` to convert to a vector. Use `as.list()` to convert a vector to a list.

```
a <- list(1:3, 1:5)
unlist(a)
as.list(a)

b <- list(1:3, "a", "b")
unlist(b)
```

Technically a **recursive** vector

Data frame

List of vectors, each of the same length. (Cross between list and matrix)

Different to matrix in that each column can have a different type

```
data.frame(
  a = 1:10,
  b = letters[1:10]
)
```

```
load(url("http://had.co.nz/stat405/data/quiz.rdata"))

# What is a?  What is b?
# How are they different?  How are they similar?
# How can you turn a in to b?
# How can you turn b in to a?

# What are c, d, and e?
# How are they different?  How are they similar?
# How can you turn one into another?

# What is f?
# How can you extract the first element?
# How can you extract the first value in the first
# element?
```

```r
# a is numeric vector, containing the numbers 1 to 10
# b is a list of numeric scalars
# they contain the same values, but in a different format
identical(a[1], b[[1]])
identical(a, unlist(b))
identical(b, as.list(a))

# c is a named list
# d is a data.frame
# e is a numeric matrix
# From most to least general: c, d, e
identical(c, as.list(d))
identical(d, as.data.frame(c))
identical(e, data.matrix(d))
```

```
# f is a list of matrices of different dimensions

f[[1]]
f[[1]][1, 2]
```

1d	names()	length()	c()
2d	colnames() rownames()	ncol() nrow()	cbind() rbind()
nd	dimnames()	dim()	abind() (special package)

```
# What does these subsetting operations do?
# Why do they work?  (Remember to use str)
diamonds[1]
diamonds[[1]]
diamonds["cut"]
diamonds[["cut"]]
diamonds$cut

# How are these subsetting operations different?
a <- matrix(1:12, 4, 3)
a[, 1]
a[, 1, drop = FALSE]
a[1, ]
a[1, , drop = FALSE]
```

Vectors	`x[1:4]`	—
Matrices Arrays	`x[1:4, ]` `x[, 2:3, ]`	`x[1:4, , drop = F]`
Lists	`x[[1]]` `x$name`	`x[1]`