Data Structures in R: Data Frames

Stat 133 by Gaston Sanchez

Lists reminder

single data type *multiple data types*

dimensions

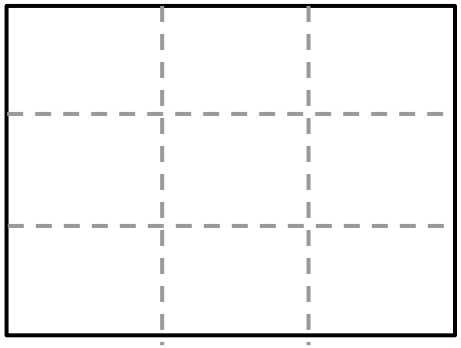
1D

Vector

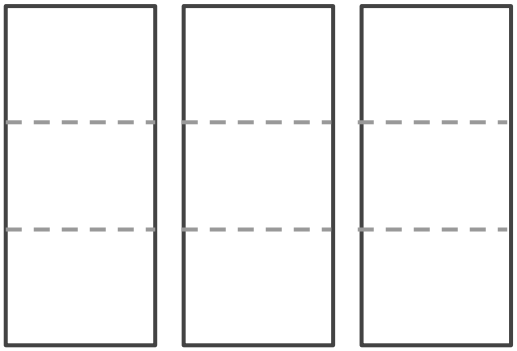
List

2D

Matrix



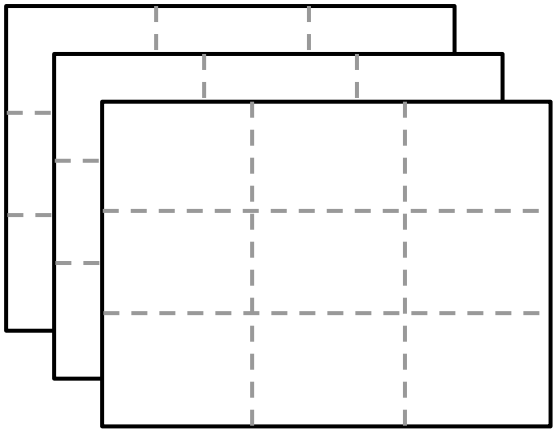
Data Frame



non-atomic structures

nD

Array



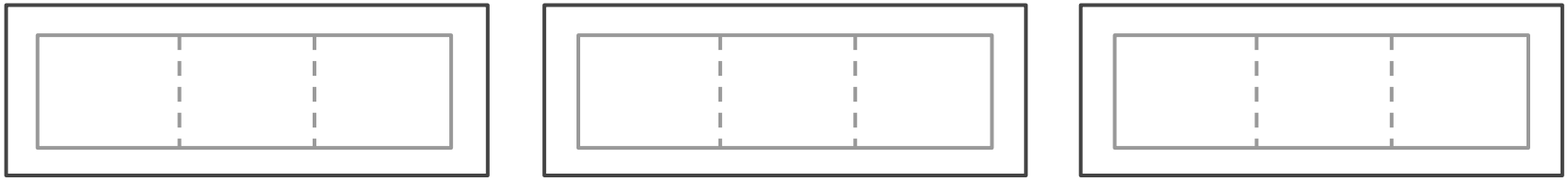
R lists

A list is the most general data structure in R

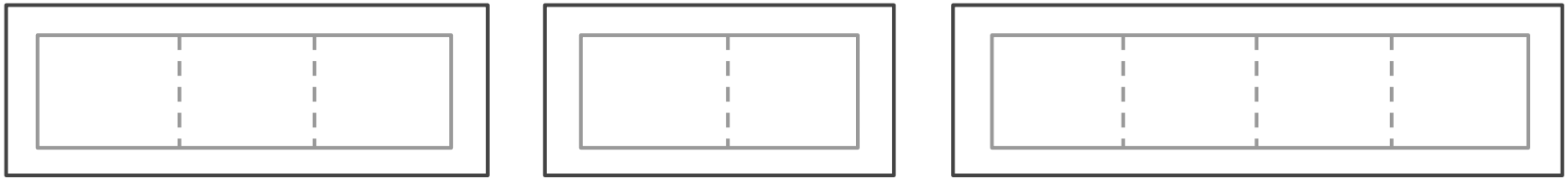
Lists can contain any other type of data structure

Lists can even contain other lists

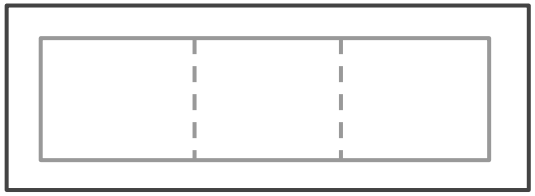
List of Vectors (of equal length)



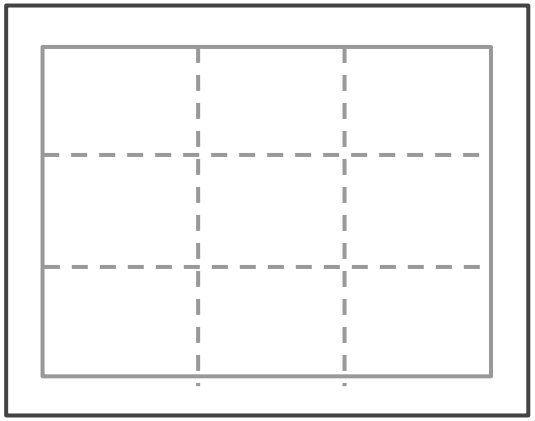
List of Vectors (of different length)



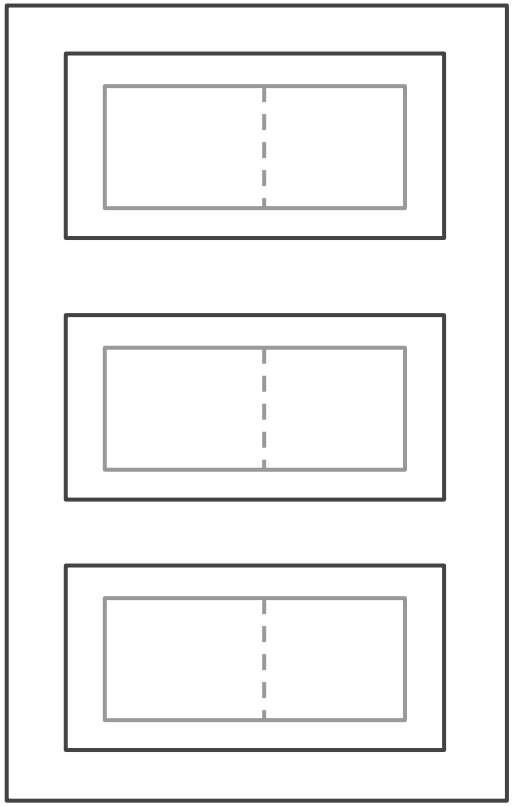
List of various objects



vector

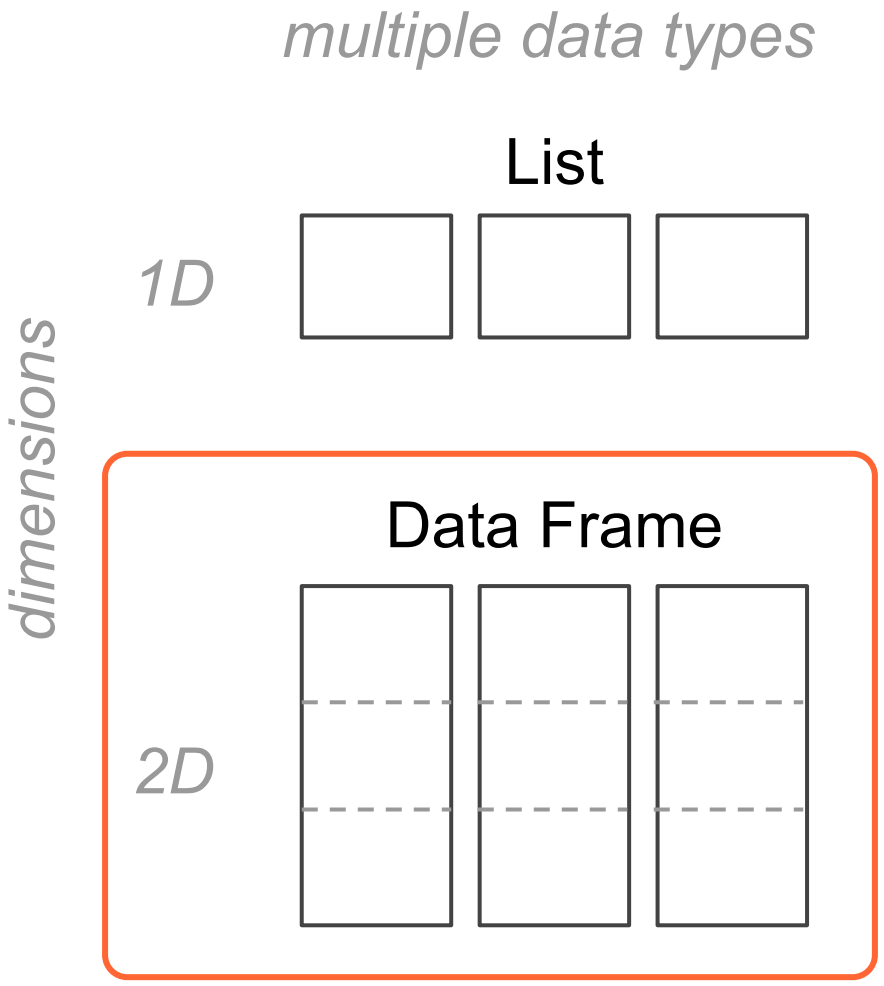


matrix



Other lists

Data Frames


multiple data types
List
1D
dimensions
Data Frame
2D

R data frames

A data.frame is the primary data structure that R provides for handling tabular data sets

Creating a data frame

```
# data frame

df <- data.frame(
  name = c('Anakin', 'Padme', 'Luke', 'Leia'),
  gender = c('male', 'female', 'male', 'female'),
  height = c(1.88, 1.65, 1.72, 1.50),
  weight = c(84, 45, 77, 49)
)
```

R data frames

R data frames are special kinds of lists

Stored in R as a list of vectors (or factors)

Columns are typically atomic structures

But since a data frame is a list, you can mix different types of columns

Data frames are NOT matrices but they behave a lot like matrices

There's a bunch of functions to inspect a data.frame object

Function	Description
`str()`	structure
`head()`	First rows
`tail()`	Last rows
`summary()`	Descriptive statistics
`dim()`	Dimensions (# rows, # columns)
`nrow()`	Number of rows
`ncol()`	Number of columns
`names()`	Column names
`colnames()`	Column names
`rownames()`	Row names
`dimnames()`	List with row and column names

Functions to inspect a data frame

```
# display structure
str(airquality)

# display structure but showing
# few elements
str(airquality, vec.len = 1)
```

Functions to inspect a data frame

```
# first n rows
head(airquality, n = 5)

# last n rows
tail(airquality, n = 5)
```

Functions to inspect a data frame

```
# column summaries
summary(airquality)

# memory size
object.size(airquality)

# attributes
attributes(airquality)
```

Functions to inspect a data frame

```
# data frame dimensions
dim(airquality)

# number of rows
nrow(airquality)

# number of columns
ncol(airquality)
```

Functions to inspect a data frame

```
# row names
rownames(airquality)

# column names
colnames(airquality)

# column names
names(airquality)
```

Functions to inspect a data frame

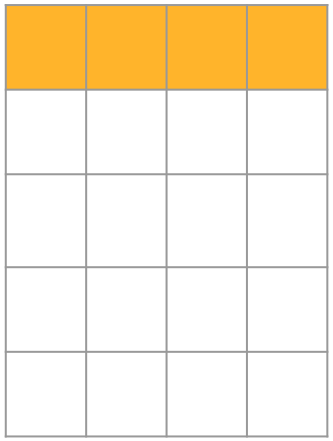
```
# object class ('data.frame')
class(airquality)

# check if object is data.frame
is.data.frame(airquality)

# data.frame is also a list
is.list(airquality)
```

Basic manipulation of Data Frames

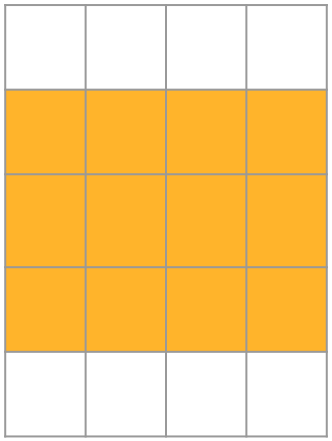
Working with data frames

There are many ways in which the elements of a data.frame can be accessed (i.e. retrieved, selected)

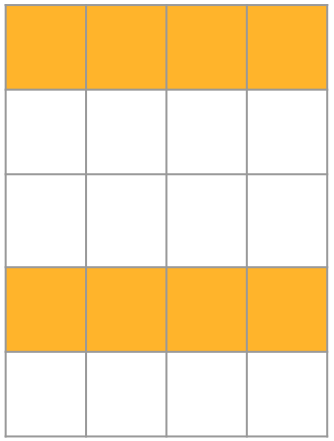
Accessing Rows



one single row

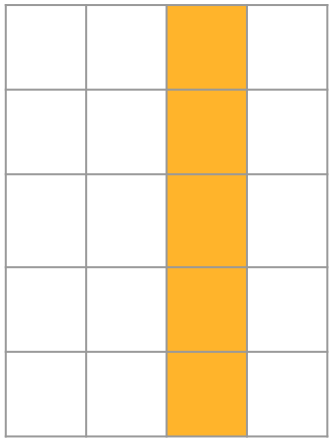


consecutive rows

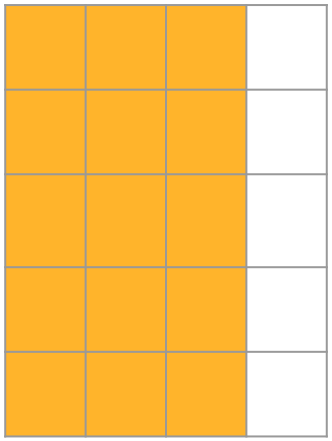


separate rows

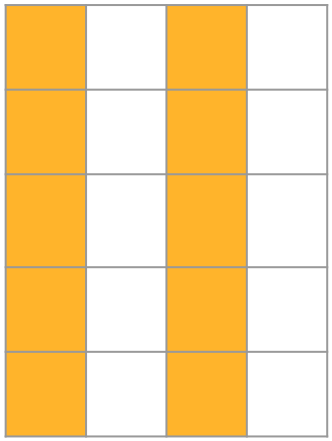
Accessing Columns



one single column

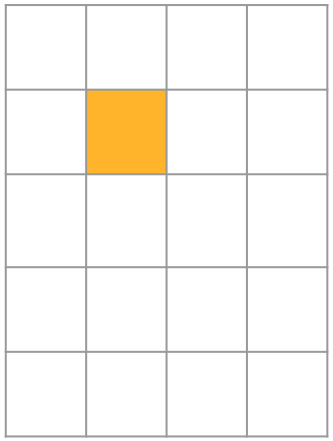


consecutive columns

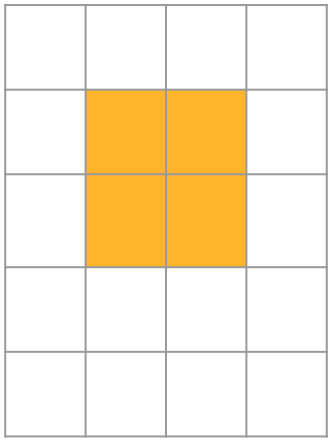


separate columns

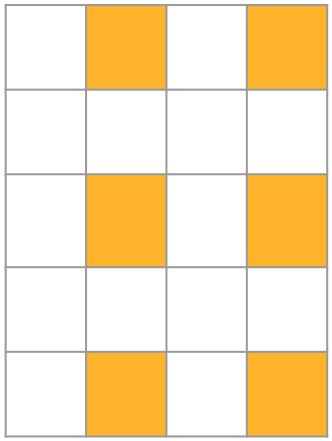
Accessing Cells



one single cell



consecutive cells



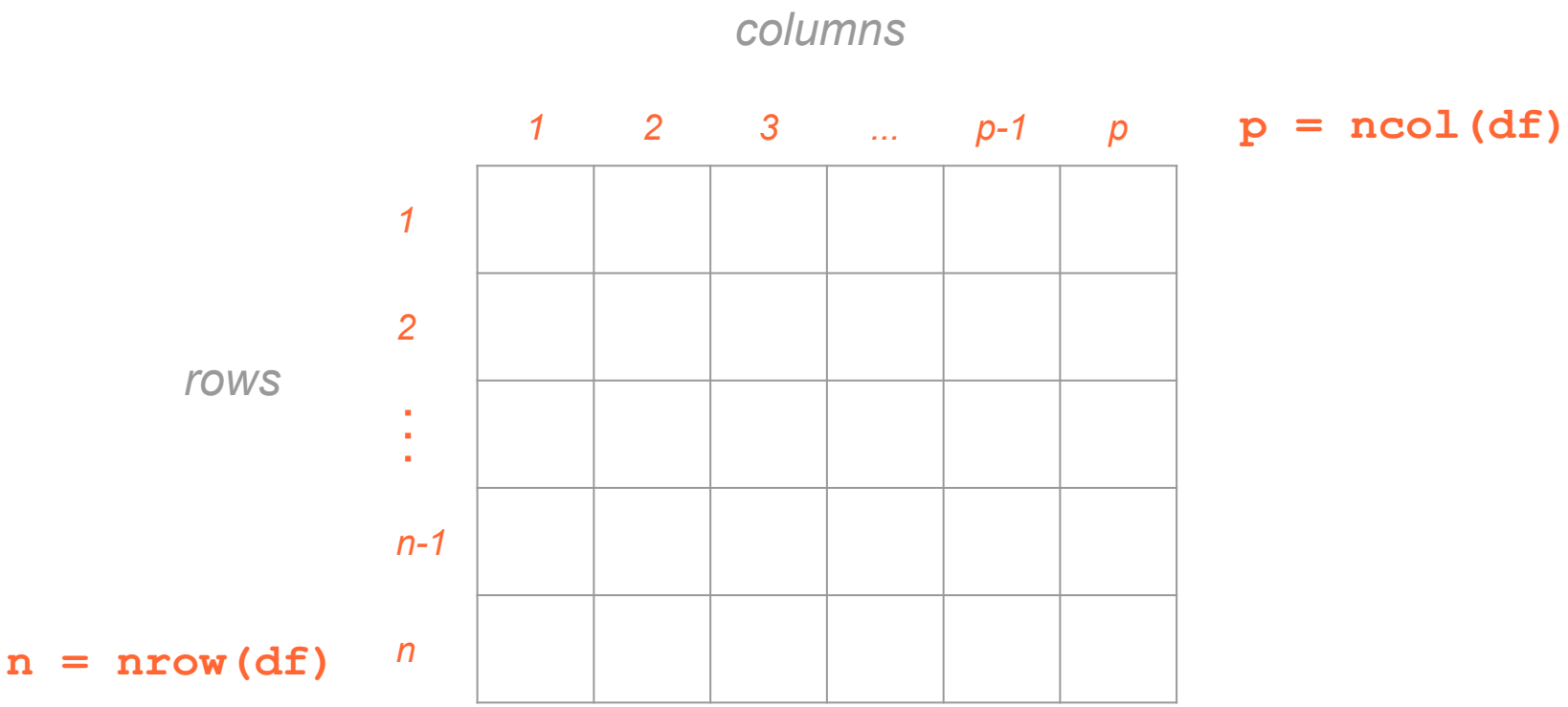
separate cells

Data frame `airquality` *(first 10 rows)*

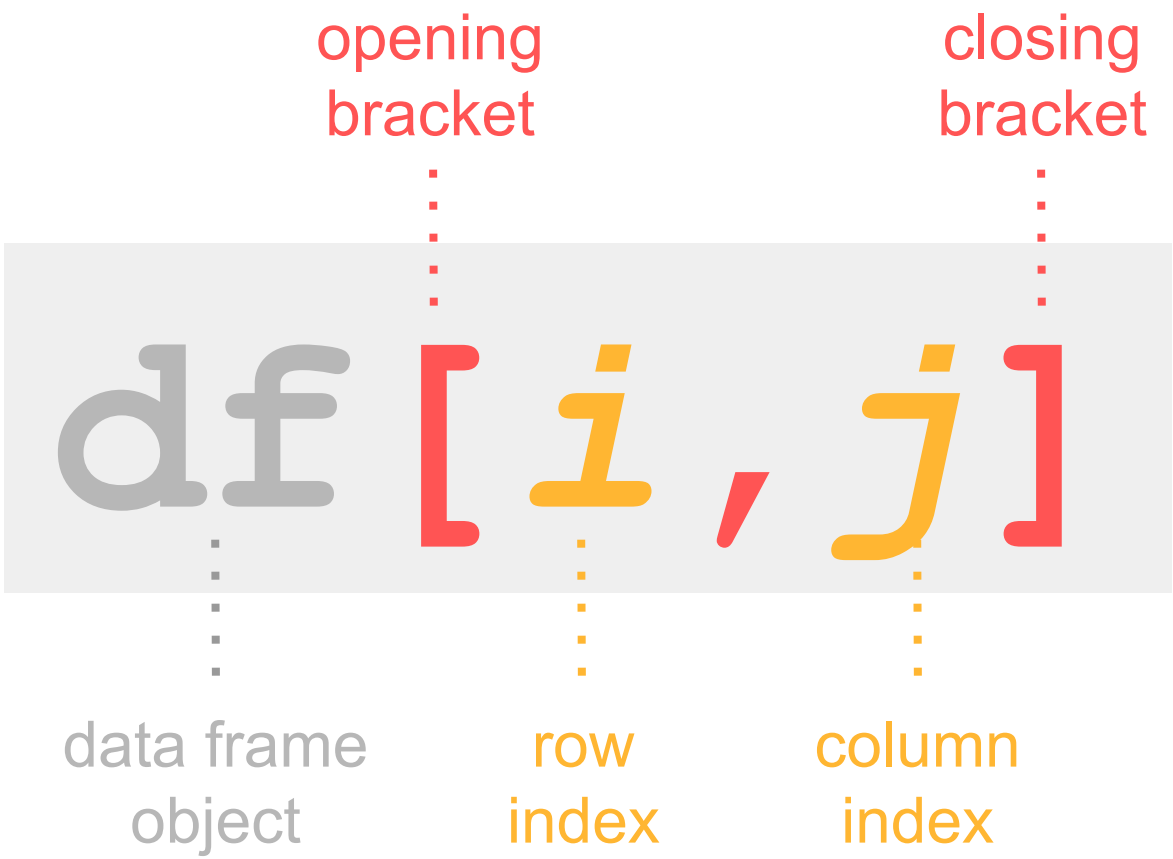
	Ozone	Solar.R	Wind	Temp	Month	Day
1	41	190	7.4	67	5	1
2	36	118	8.0	72	5	2
3	12	149	12.6	74	5	3
4	18	313	11.5	62	5	4
5	NA	NA	14.3	56	5	5
6	28	NA	14.9	66	5	6
7	23	299	8.6	65	5	7
8	19	99	13.8	59	5	8
9	8	19	20.1	61	5	9
10	NA	194	8.6	69	5	10

Retrieving elements via Index Values

Numeric Indices in a data frame

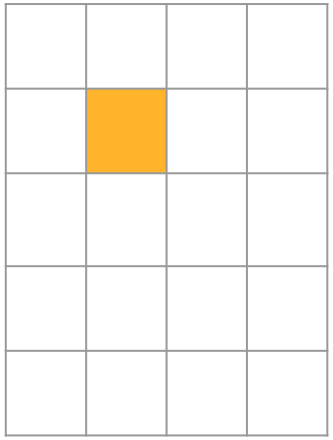


Bracket Notation



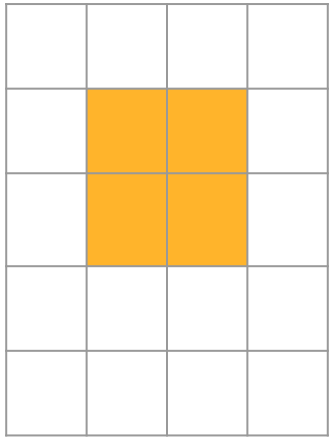
Retrieving Cells

`df[2,2]`



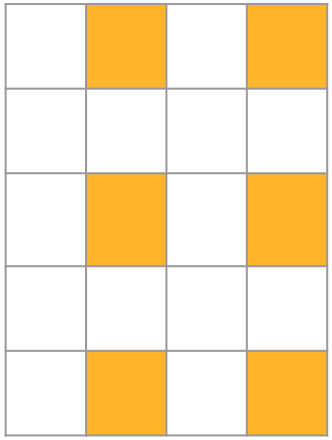
one single cell

`df[2:3,2:3]`



consecutive cells

`df[c(1,3,5), c(2,4)]`



separated cells

Retrieving Cells

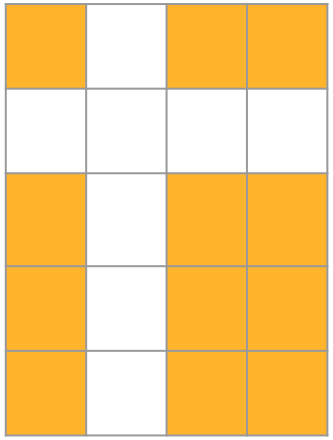
```
# first cell 1,1
airquality[1,1]

# cell 9,6
airquality[9,6]

# last cell
airquality[153,6]
```

Retrieving Cells

```
# various adjacent cells
airquality[1:5,4:6]

# various adjacent cells
#(permuted order)
airquality[5:1,6:4]

# non-adjacent cells
airquality[c(1,50,100),c(3,5)]
```

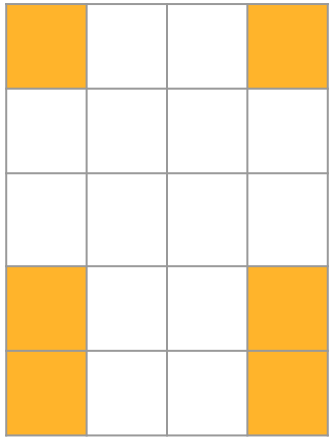
Retrieving Cells (excluding indices)

```
df[-2,-2]
```



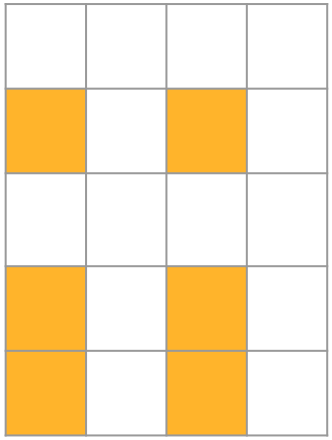
one single cell

```
df[-(2:3),
   -(2:3)]
```



consecutive cells

```
df[-c(1,3),
   -c(2,4)]
```



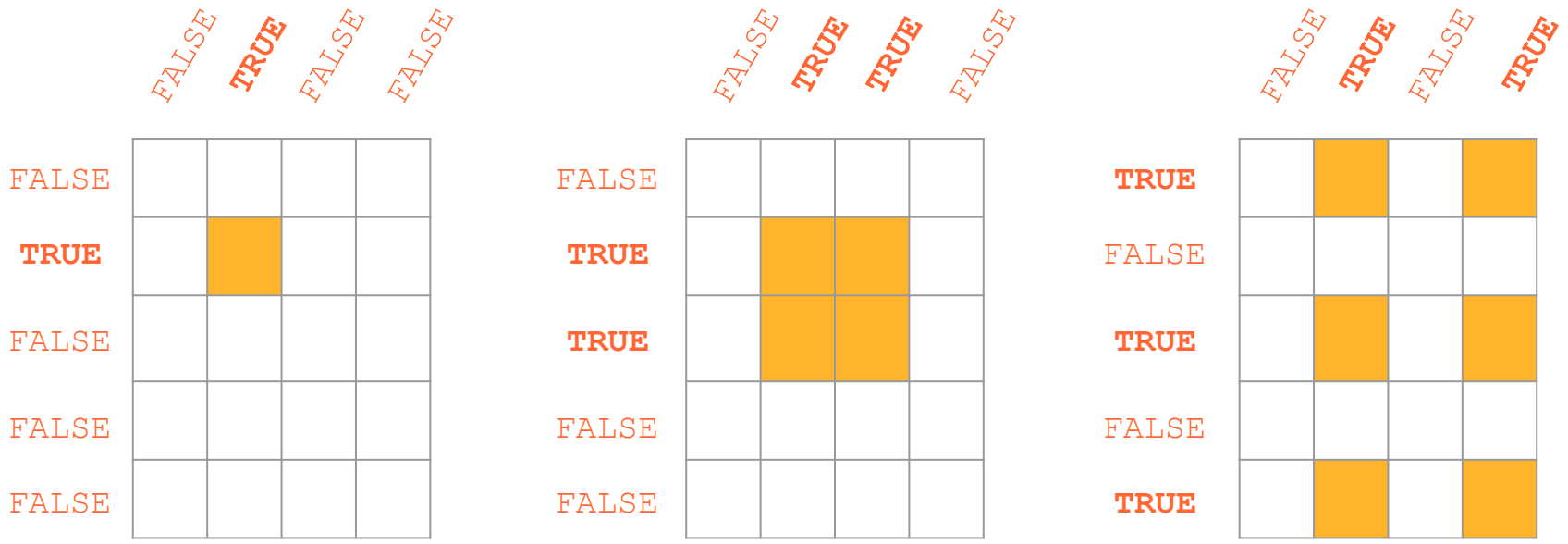
separated cells

Retrieving Cells (excluding indices)

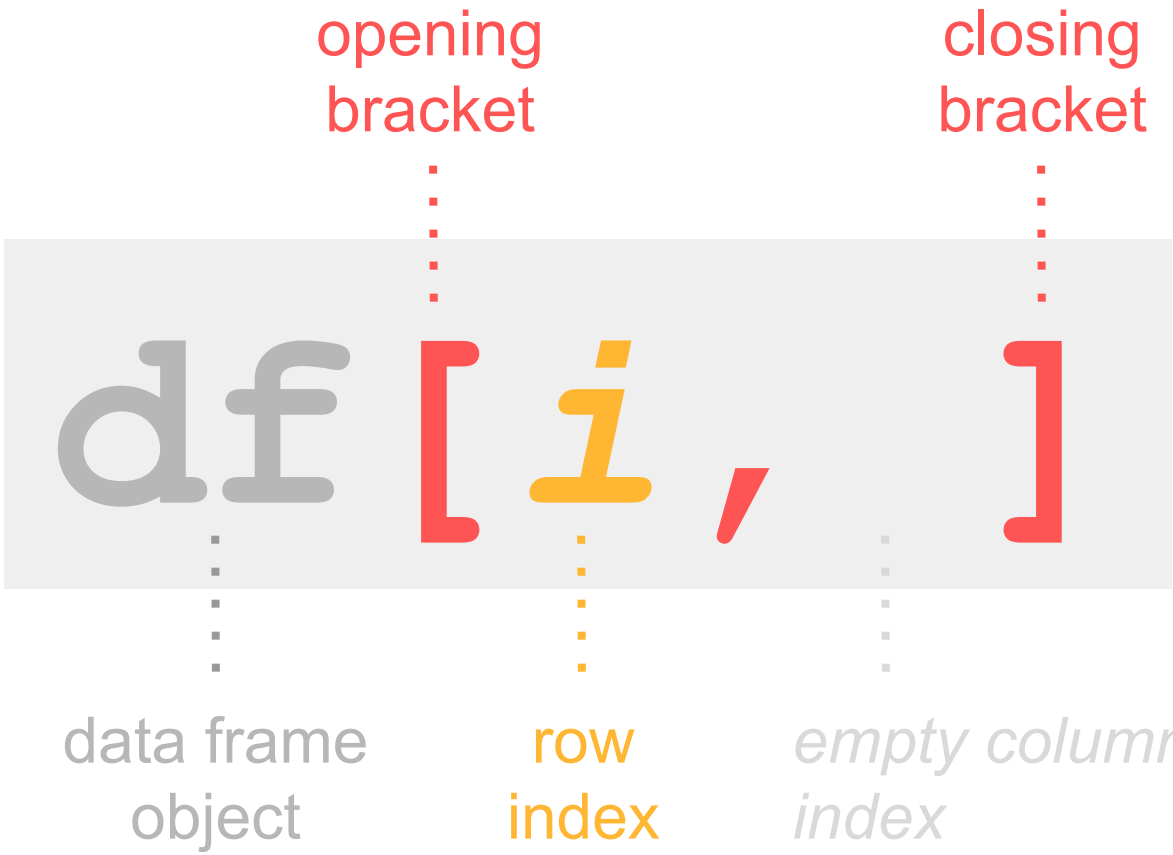
```
# various adjacent cells
airquality[-(1:5),-(4:6)]

# non-adjacent cells
airquality[-c(1,50,100),-c(3,5)]
```

Accessing Cells via Logical Subscripts

```
df[ilog,jlog]
```

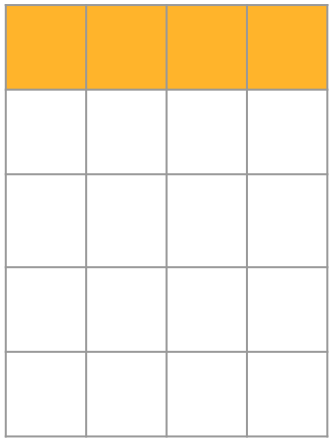


Bracket Notation: retrieving rows



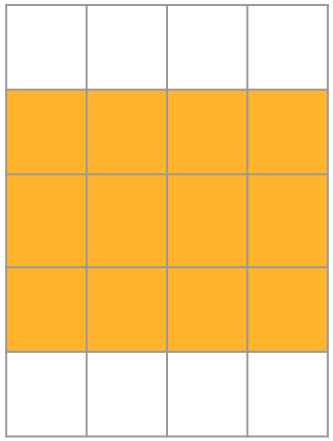
Retrieving Rows

```
df[1, ]
```



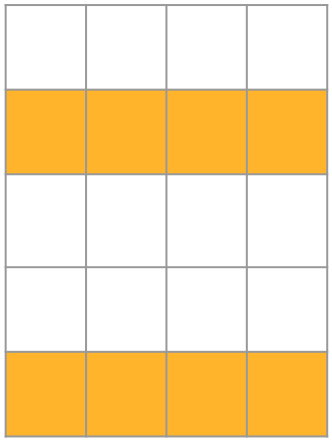
one single row

```
df[2:4, ]
```



consecutive rows

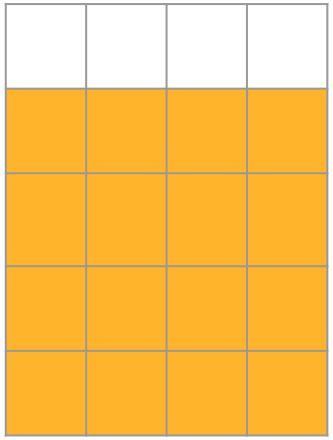
```
df[c(2,5), ]
```



separate rows

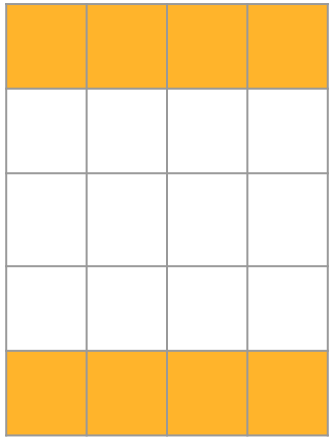
Retrieving Rows (excluding indices)

```
df[-1, ]
```



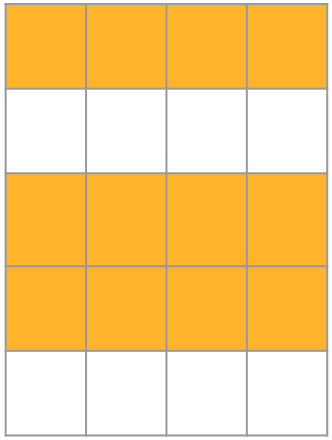
one single row

```
df[-(2:4), ]
```



consecutive rows

```
df[-c(2,5), ]
```



separate rows

Retrieving Rows

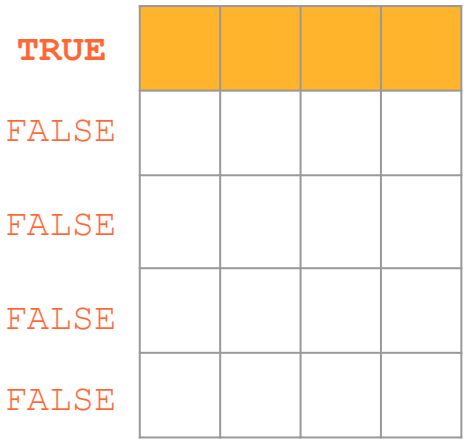
```
# first row
airquality[1, ]

# rows from 3 to 7
airquality[3:7, ]

# rows 1, 3, 5, 7
airquality[c(1,3,5,7), ]
```

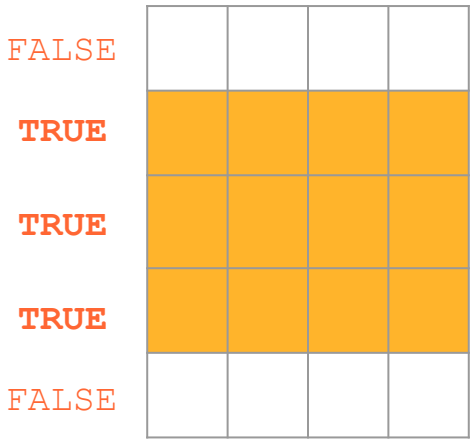
Retrieving Rows (excluding indices)

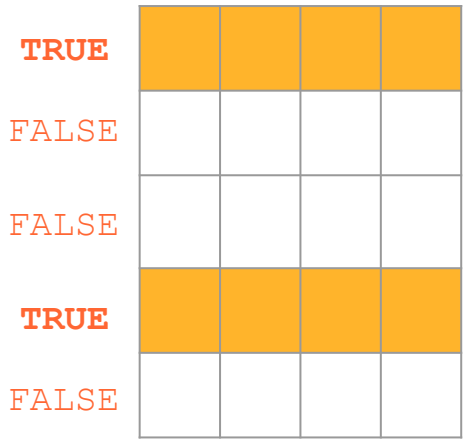
```
# all rows except first one
airquality[-1, ]

# rows except from 3 to 7
airquality[-(3:7), ]

# all rows but 1, 3, 5, 7
airquality[-c(1,3,5,7), ]
```

Accessing Rows via Logical Subscripts

```
df[logical, ]
```







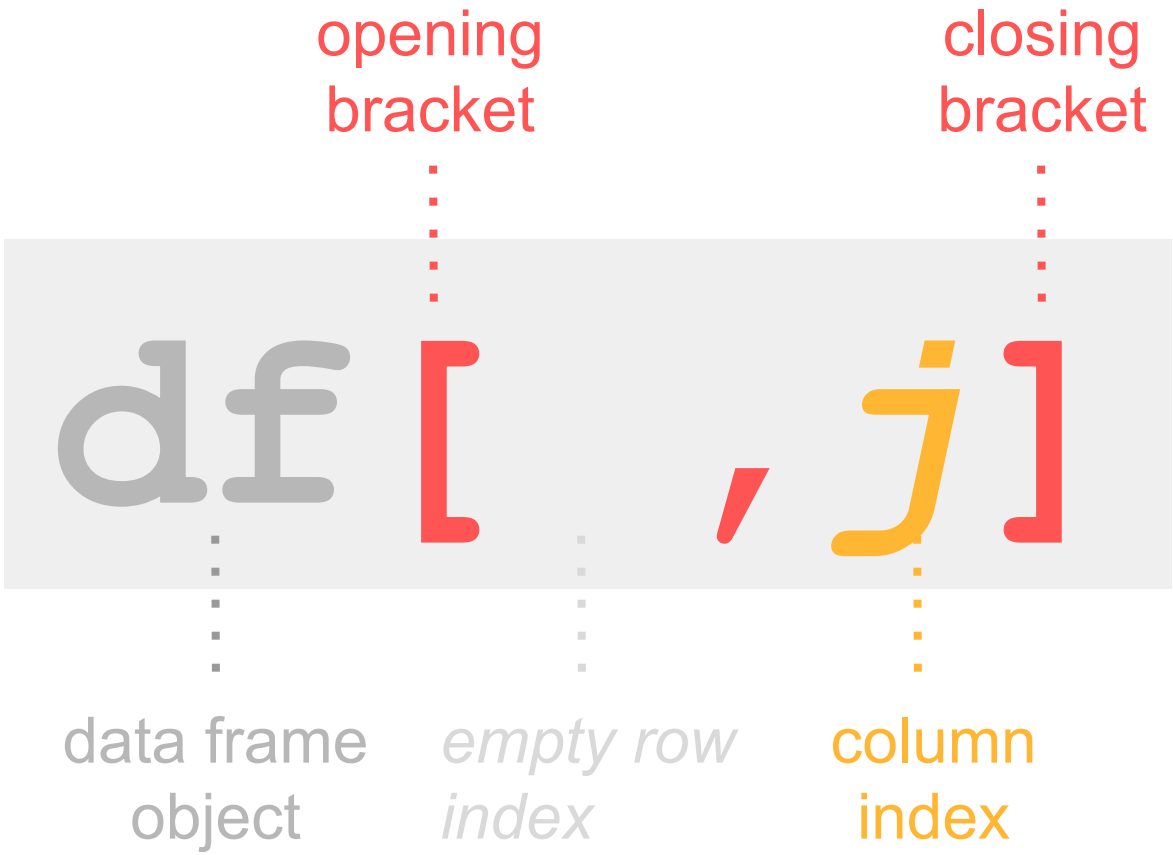
Retrieving Rows (logical indexing)

```
# records with Month 5
airquality[airquality$Month==5, ]

# records of 1st day of month
airquality[airquality$Day==1, ]
```

Retrieving Rows (logical indexing)

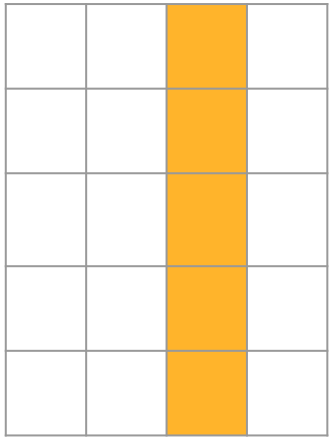
```
# vector matching odd numbers
odds = rep(c(TRUE, FALSE),
  length = nrow(airquality))

# odd rows
airquality[odds, ]

# even rows (logical negation)
airquality[!odds, ]
```

Bracket Notation: retrieving columns



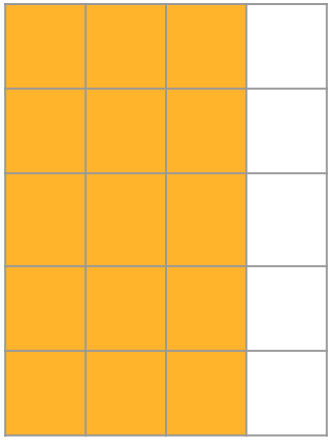
Retrieving Columns

`df[ ,3]`



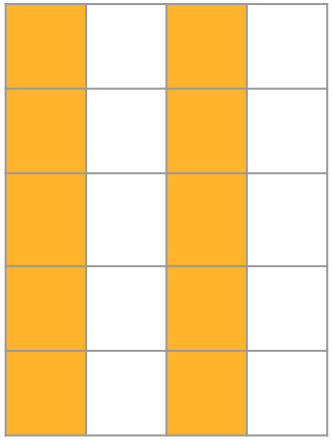
one single column

`df[ ,1:3]`



consecutive columns

`df[ ,c(1,3)]`



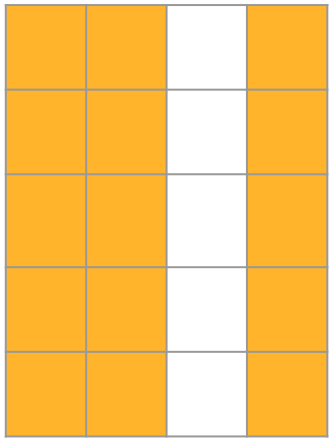
separate columns

Retrieving Columns

```
# first column
airquality[ ,1]

# columns from 1 to 3
airquality[ ,1:3]

# columns 2, 4, 6
airquality[ ,c(2,4,6)]
```

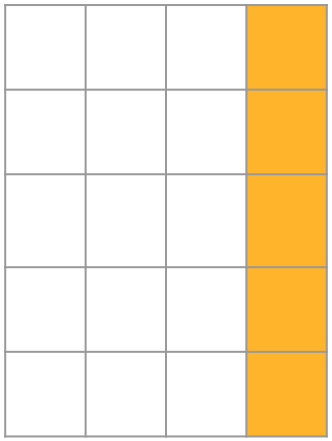
Retrieving Columns (excluding indices)

```
df[ ,-3]
```



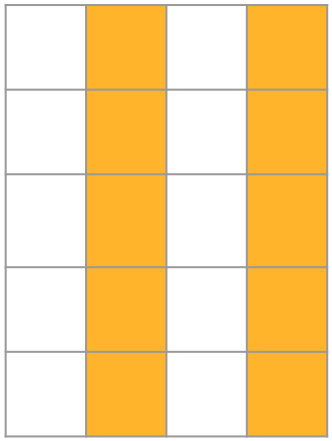
one single column

```
df[ ,-(1:3)]
```



consecutive columns

```
df[ ,-c(1,3)]
```



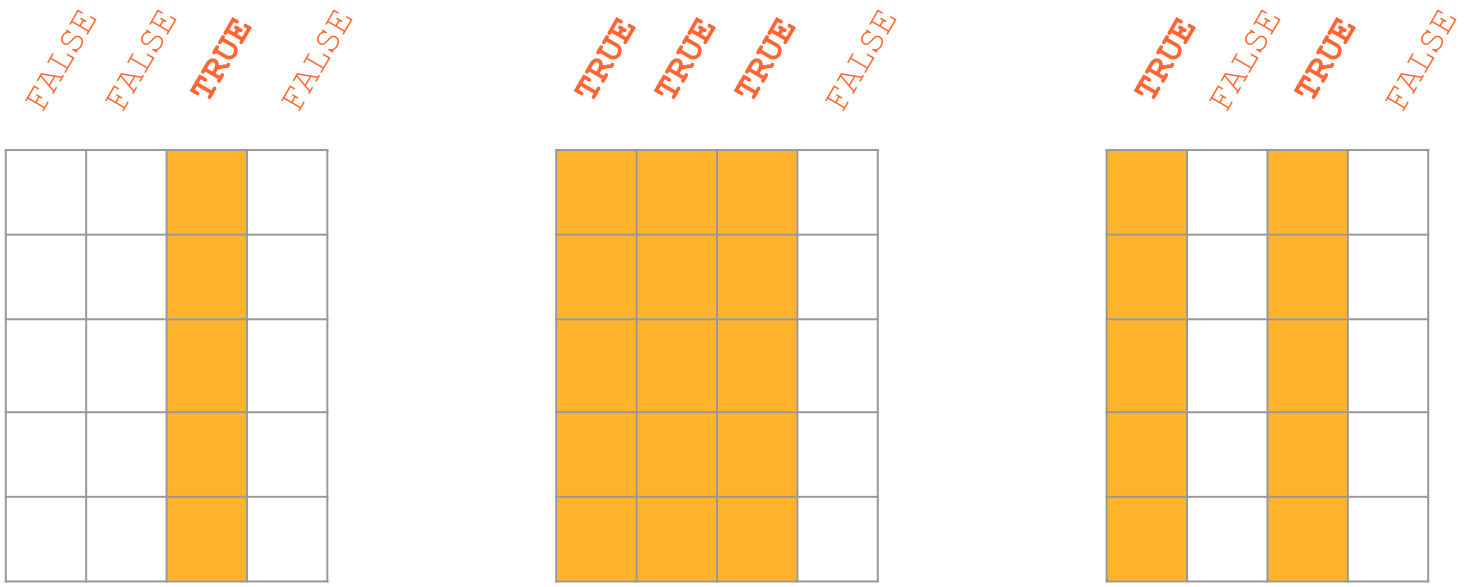
separate columns

Retrieving Columns (excluding indices)

```
# excluding first column
airquality[ ,-1]

# columns except 1 to 3
airquality[ ,-(1:3)]

# all columns but 2, 4, 6
airquality[ ,-c(2,4,6)]
```

Accessing Columns via Logical Subscripts

```
df[ ,logical]
```



Retrieving Columns (logical indexing)

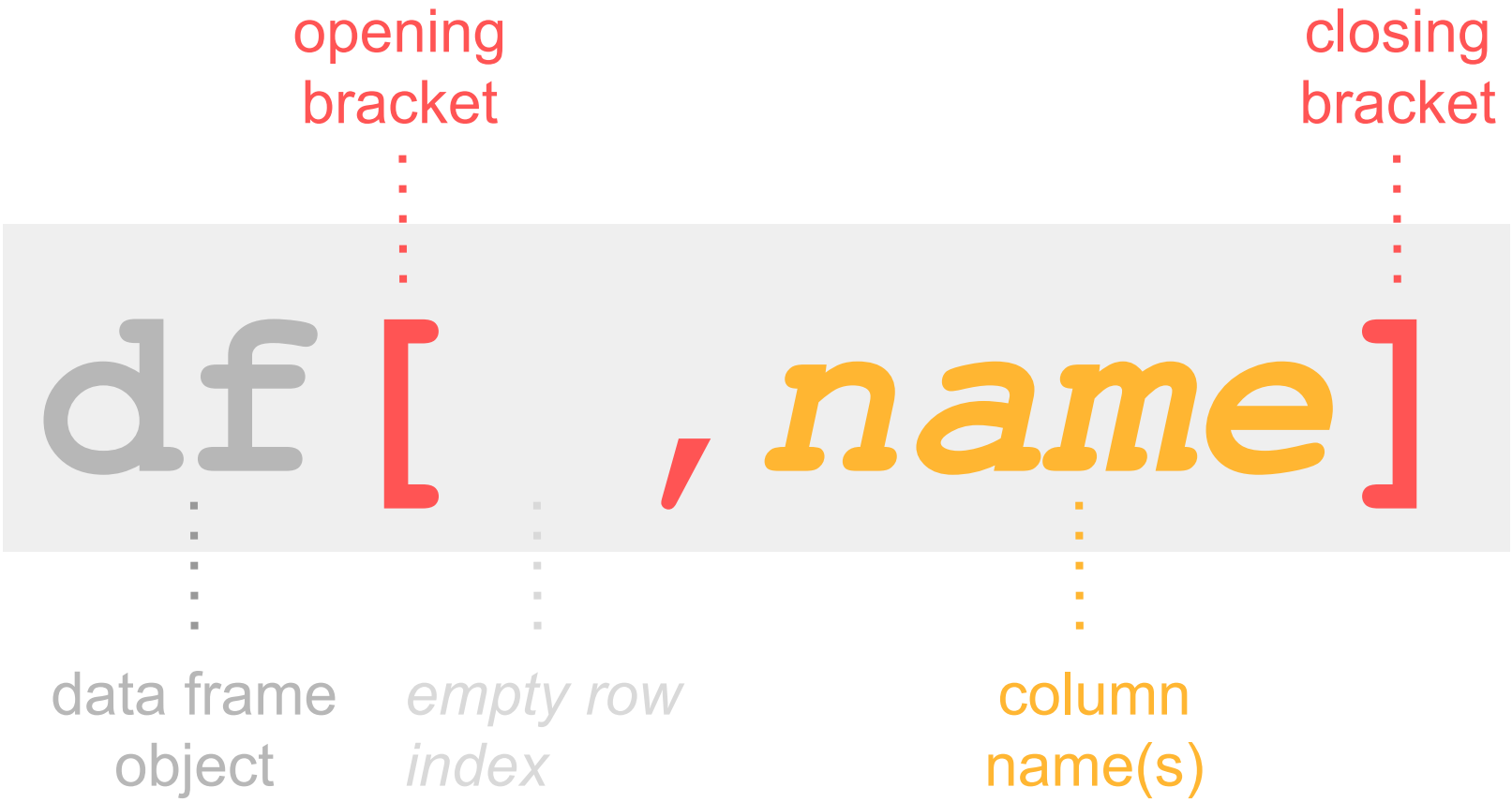
```
# look for these names
these = c('Day', 'Wind', 'Rain',
          'Temp', 'XY', 'Snow')

# query logical selection
Q = names(airquality) %in% these

# selecting corresponding columns
airquality[ ,Q]
```

Retrieving Columns (logical indexing)

```
# logical vector
cols3 = c(rep(TRUE, 3),
          rep(FALSE, 3))

# first 3 columns
airquality[ ,cols3]

# last 3 columns (logical neg)
airquality[ ,!cols3]
```

More options to access columns

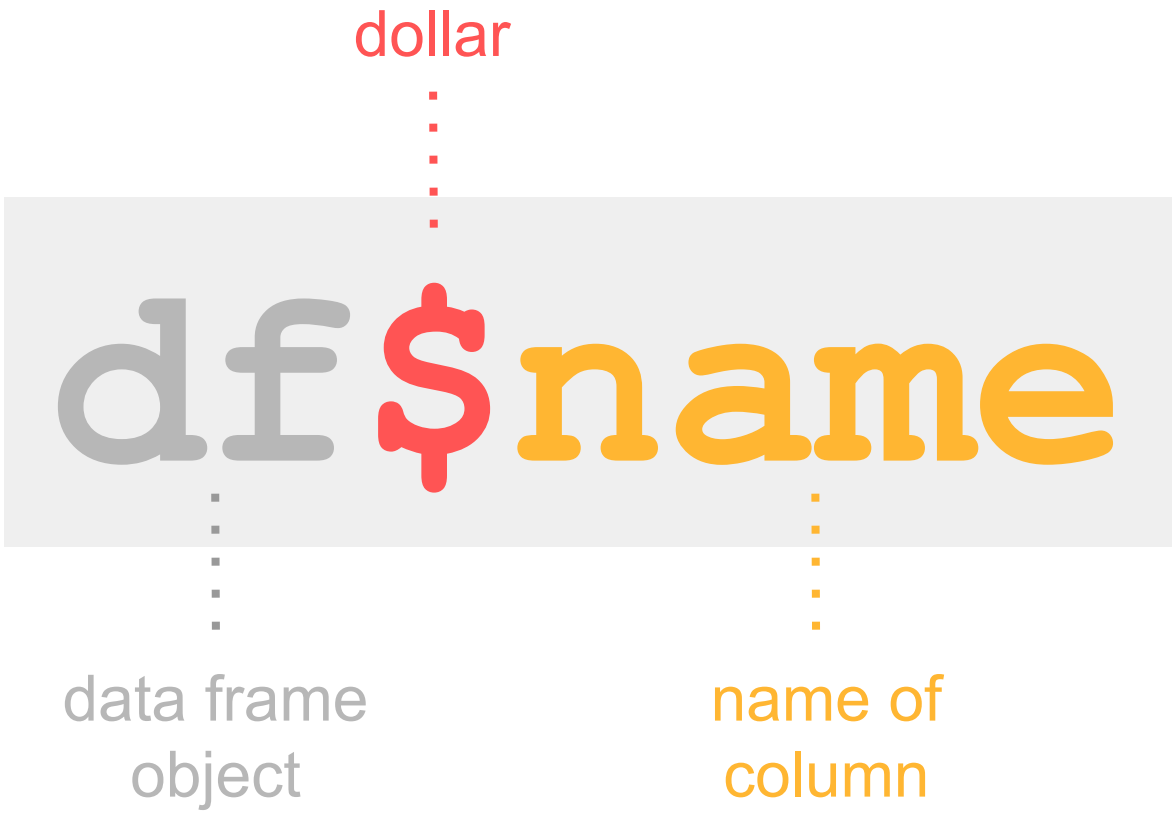
Bracket Notation: retrieving columns via names



Retrieving Columns (using names)

```
# column Ozone
airquality[ ,"Ozone"]

# columns Wind and Temp
airquality[ ,c("Wind","Temp")]
```

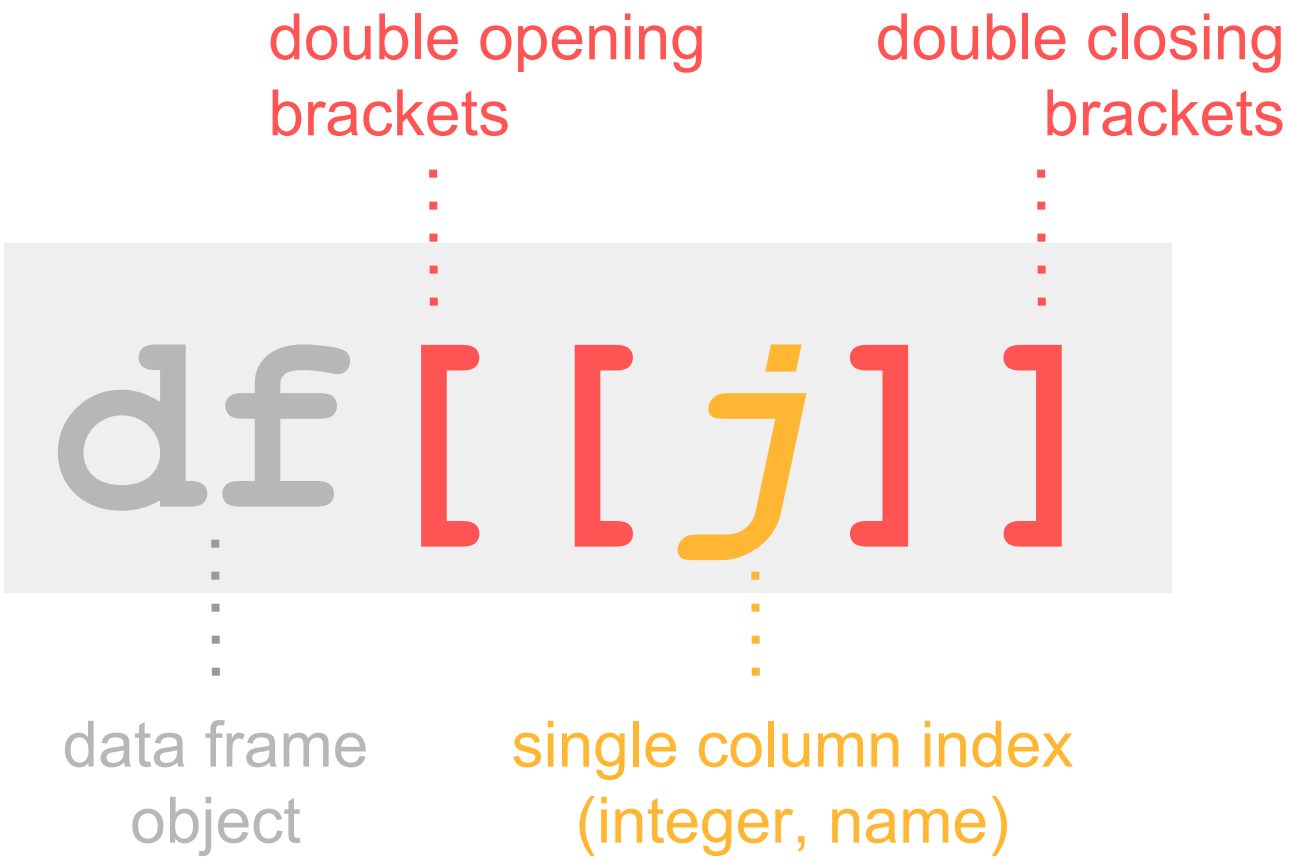
Dollar Notation: retrieving columns via names



Accessing One Column

```
# column Ozone
airquality$Ozone

# equivalently
airquality$"Ozone"

# equivalently
airquality$'Ozone'
```

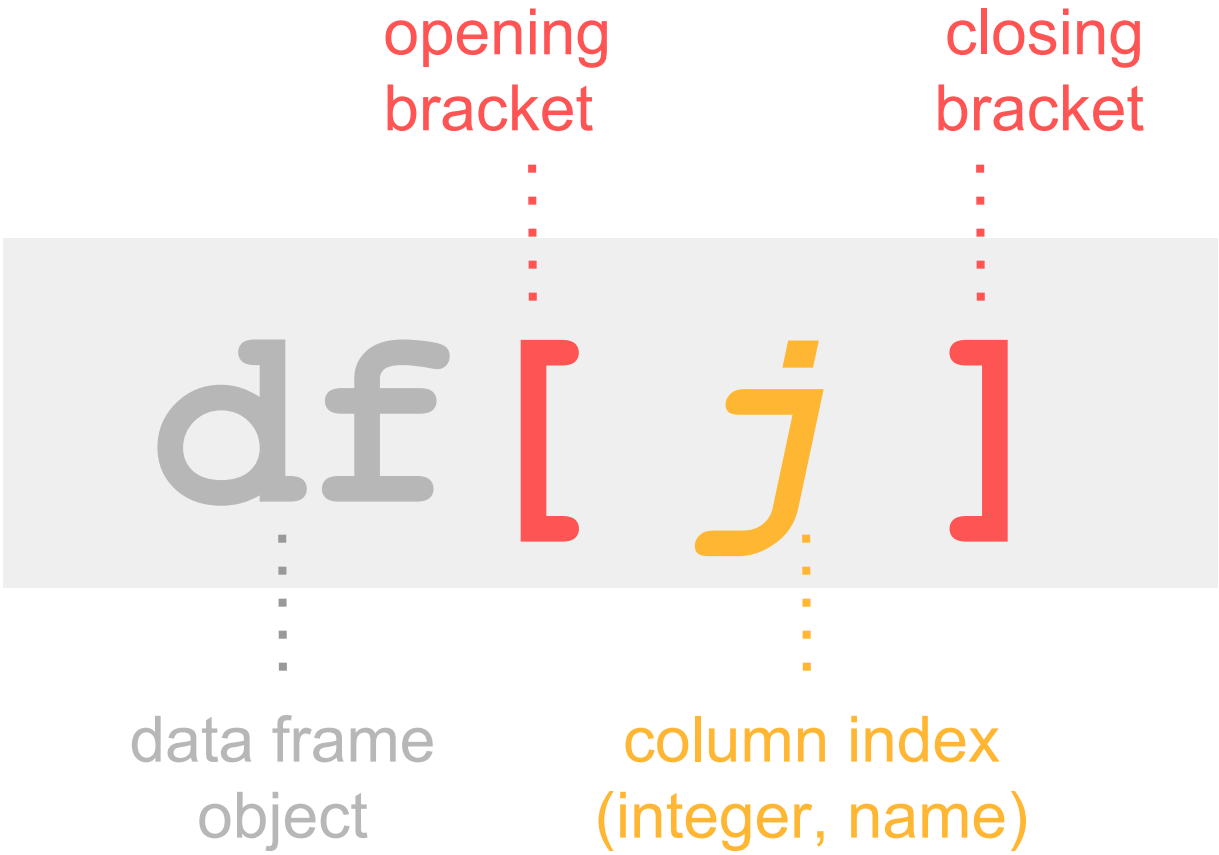
Selecting columns with double brackets



Accessing One Column

```
# first column
airquality[[1]]

# column Wind
airquality[["Wind"]]
```

Selecting columns with vector notation



Accessing Columns with vector notation

```
# first column
airquality[1]

# columns from 1 to 3
airquality[1:3]

# columns 2, 4, 6
airquality[c(2,4,6)]
```

Be careful when using this type of syntax since it may create confusion for other users reading your code

Accessing Columns with `list` syntax

```
# column Ozone
airquality["Ozone"]

# columns Ozone and Wind
airquality[c("Ozone","Wind")]
```

Be careful when using this type of syntax since it may create confusion for other users reading your code

Argument `drop` when selecting one column

```
df[i, j, drop= TRUE
               FALSE ]
```

drop

TRUE (default) returns result into a vector

FALSE keeps values as a column

Use `drop` to keep result as a column

```
# first column
airquality[ ,1,drop=FALSE]

# column Ozone
airquality[ ,"Ozone",drop=FALSE]
```