tutorial uRos 2018

Jaap Walhout

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Overview

https://github.com/jaapwalhout/data.table-tutorial-uros2018

Overview

1. Introduction
2. Fast read & write
3. Syntax
4. Basic operations (filtering rows & selecting columns)
5. Summarizing
6. Adding / updating variables
7. Joining datasets
8. Reshaping data

Special symbols: .N + .SD + .I

Special operator: :=

Introduction

Developers: Matt Dowle, Arun Srinivasan, Jan Gorecki, Michael Chirico,
Pasha Stetsenko, Tom Short, Steve Lianoglou, Eduard Antonyan,
Markus Bonsch, Hugh Parsonage

Since 2006 on CRAN, > 35 releases so far

678 packages import/depend/suggest **data.table** (543 CRAN + 135 Bioconductor)

Homepage: http://r-datatable.com

Introduction

Why use data.table?

Pros:

- speed
- memory efficiency
- coding flexibility
- beautiful syntax
- non-equi joins

Cons:

- ‘different’ syntax

Fast read & write

50 million rows / 10 columns / ± 4GB

fread("datafile.csv")

```
            expr     time
data.table_fread     15.6
  readr_read_csv     92.6
   base_read.csv    559.9
```

fwrite(DT, "datafile.csv")

```
            expr     time
data.table_fread     32.6
  readr_read_csv    102.2
   base_read.csv    201.9
```

times in seconds

Syntax: data.table == enhanced data.frame

Three main enhancements:

1. Column names can be used as variables inside [....]
2. Because they are variables, we can use column names to calculate stuff inside [....]
3. An additional grouping argument: by

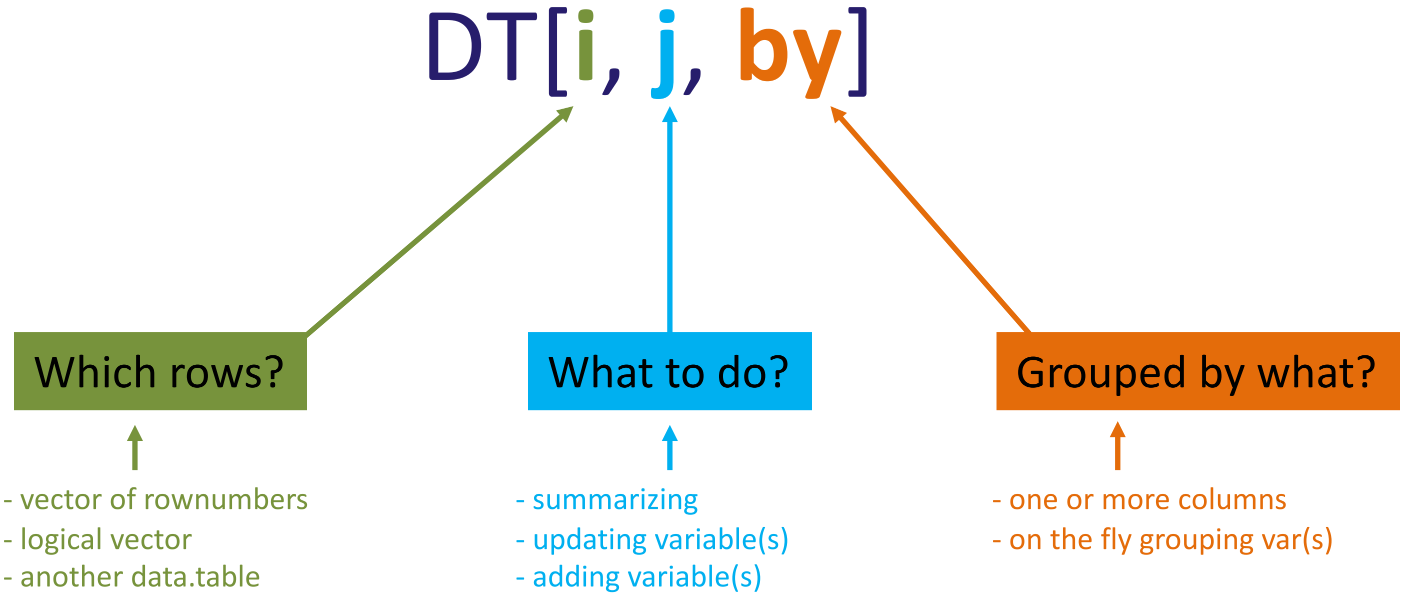
Syntax: dataframe refresher

Columnar data structure: 2D – rows and columns

- subset rows	df[df$id == "01",]
- select columns	df[, "val1"]
- subset rows & select columns	df[df$id == "01", "val1"]

- that’s about it ….

Syntax: general form



DT[i, j, by]

Which rows?

- vector of rownumbers
- logical vector
- another data.table

What to do?

- summarizing
- updating variable(s)
- adding variable(s)

Grouped by what?

- one or more columns
- on the fly grouping var(s)

Syntax: general form

DT[i, j, by]

```
data.table:    i                j           by
      SQL:  where    select | update    group by
```

Example data

build in **iris** dataset:

```
irisDT <- as.data.table(iris)
```

Filtering rows & selecting columns

syntax: DT[**i**, **j**, **by**]

subset rows

```
irisDT[Species == "setosa", ]
```

select columns

```
irisDT[, Petal.Width]
irisDT[, .(Petal.Width)]
```

subset rows & select columns

```
irisDT[Species == "setosa", Petal.Width]
irisDT[Species == "setosa", .(Petal.Width)]
```

Filtering rows & selecting columns

subset rows

```
irisDT[Petal.Width >= 1 & Petal.Width <= 2)]

irisDT[between(Petal.Width, 1, 2)]

irisDT[Petal.Width %between% c(1, 2)]
```

select columns

```
irisDT[, .(Species, Sepal.Length)]
```

Exercise 1

Open the file **ex1.R**

subset rows : get only the rows with a day lower than or equal to 10

select columns : select only the Month column and make sure you get a data.table back

subset rows & select columns : get only the Wind & Temp columns for the rows with a day higher than 5 and lower than or equal to 10

Exercise 1 - solutions

syntax: DT[**i**, **j**, **by**]

subset rows	:	air[Day <= 10]
select columns	:	air[, .(Month)]
subset rows & select columns	:	air[between(Day, 5, 10), .(Wind, Temp)]

Summarizing

1. Counts
2. Aggregating
3. Group by

Counts

syntax: DT[**i**, **j**, **by**]	special symbol: **.N**
count	`irisDT[Species == "setosa", .N]`

count distinct	`irisDT[, uniqueN(Species)]`
	`irisDT[Petal.Width < 0.9, uniqueN(Species)]`
	`uniqueN(irisDT, by = "Species")`

Aggregating

syntax: DT[**i**, **j**, **by**]

Simple aggregation: irisDT[, .(count = .N, average = mean(Petal.Width))]

Including filtering: irisDT[Petal.Width < 0.9, .(count = .N, average = mean(Petal.Width))]

Group by

syntax: DT[**i**, **j**, **by**]

```
irisDT[, .N, by = Species]

irisDT[, .(average = mean(Petal.Width)), by = Species]

irisDT[Sepal.Length < 5.3, .(average = mean(Petal.Width)), by = Species]

irisDT[, .(average = mean(Petal.Width)), by = .(Species, logi = Sepal.Length < 5.3)]
```

Group by

special symbol: **.SD**

SD = **S**ubset of **D**ata

- a data.table by itself
- holds data of current goup as defined in by
- when no by, .SD applies to whole data.table
- allows for calculations on multiple columns

Group by

special symbol: **.SD**

```
irisDT[, lapply(.SD, mean), by = Species]
```

```
irisDT[Sepal.Length < 5.3, lapply(.SD, mean), by = Species]
```

Group by

special symbol: **.SD**

special symbol: **.SDcols**

```
irisDT[, lapply(.SD, mean), by = Species, .SDcols = 1:2]

irisDT[, lapply(.SD, mean), by = Species, .SDcols = grep("Length", names(irisDT))]
```

Order of execution

DT[i, j, by]

DT[1, 3, 2]

Exercise 2

Open the file **ex2.R**

- Count the number of days per month
- Calculate the average Wind speed by month for only those days that have an ozone value
- Calculate the mean temperature for the odd and even days for each month

Exercise 2 - solutions

syntax: DT[**i**, **j**, **by**]

Count the number of days per month

```
air[, .N, by = Month]
```

Calculate the average Wind speed by month for only those days that have an ozone value

```
air[!is.na(Ozone), mean(Wind), by = Month]
```

Calculate the mean temperature for the odd and even days for each month

```
air[, mean(Temp)
    , by = .(Month, odd = Day %% 2)]
```

Updating, adding & deleting variables

special operator: **:=**

- updates a data.table in place (by reference)
- can be used to:
  - update existing column(s)
  - add new column(s)
  - delete column(s)
- you don’t need **<-**

Updating variables

special operator: **:=**

```
irisDT[, Sepal.Length := Sepal.Length * 2]
```

```
irisDT[, `:=` (Sepal.Length = Sepal.Length * 2,
               Petal.Width = Petal.Width / 2)]
```

Updating variables by group

special operator: **:=**

```
irisDT[, Sepal.Length := Sepal.Length * uniqueN(Sepal.Width) / .N, by = Species]
```

```
irisDT[, `:=` (Sepal.Length = Sepal.Length * uniqueN(Sepal.Width),
               Petal.Width = Petal.Width / .N)
       , by = Species]
```

Adding variables

special operator: **:=** special symbol: **.I**

```
irisDT[, rownumber := .I]

irisDT[, Sepal.Area := Sepal.Length * Sepal.Width]

irisDT[, `:=` (Sepal.Area = Sepal.Length * Sepal.Width,
               Petal.Area = Petal.Length * Petal.Width)]
```

Adding variables by group

special operator: **:=**

```
irisDT[, Total.Sepal.Area := sum(Sepal.Area), by = Species]
```

```
irisDT[, `:=` (Total.Sepal.Area = sum(Sepal.Area),
               Total.Petal.Area = sum(Petal.Area))
        , by = Species]
```

Deleting variables

special operator: **:=**

```
irisDT[, Sepal.Length := NULL]

irisDT[, (1:4) := NULL]

irisDT[, grep("Length", names(irisDT)) := NULL]
```

Exercise 3

Open the file **ex3.R**

- Change the Wind column from miles per hour to kilometers per hour (1 mph = 1.6 kmh)
- Calculate a new **chill** variable (Wind * Temperature)
- Calculate the average chill by month and add that as a new variable
- Remove the **Ozone** and **Solar.R** columns

Exercise 3 - solutions

syntax: DT[**i**, j, **by**]

Change the Wind column from miles per hour to kilometers per hour (1 mph = 1.6 kmh)	air[, Wind := Wind * 1.6]
Calculate a new **chill** variable (Wind * Temperature)	air[, chill := Wind * Temp]

Exercise 3 - solutions

syntax: DT[**i**, **j**, **by**]

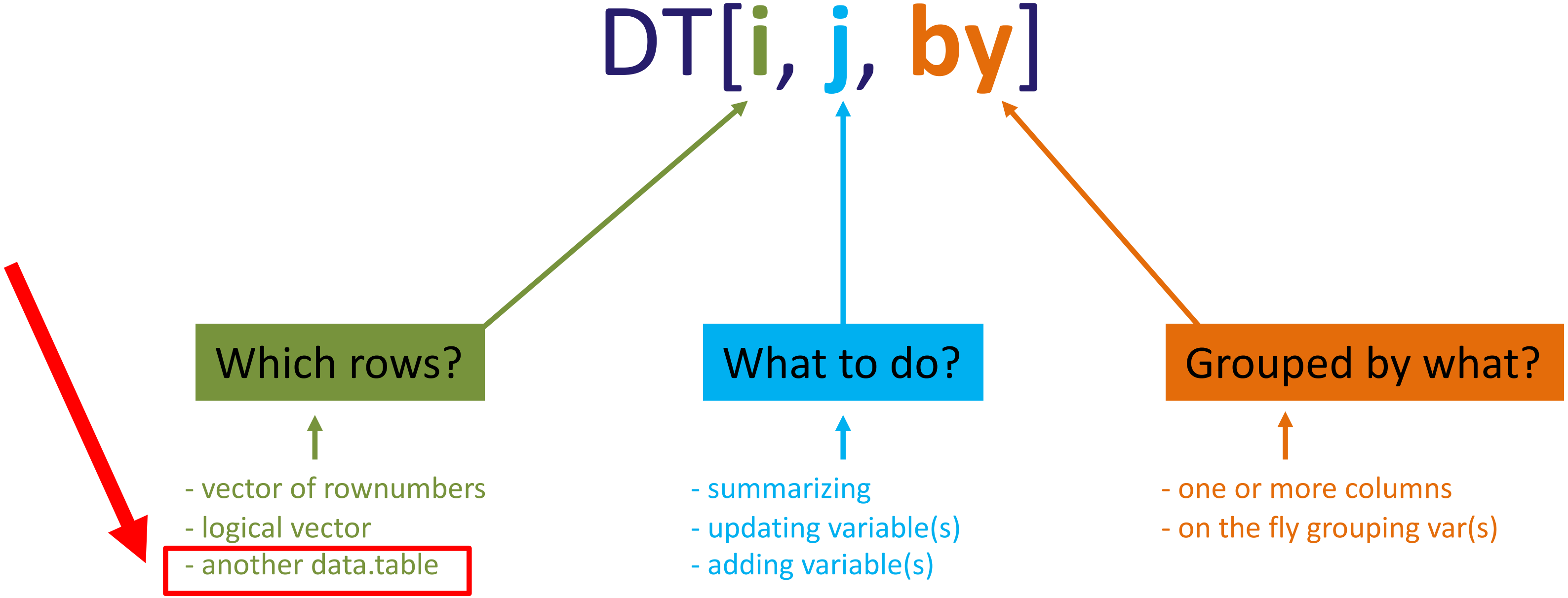
Calculate the average chill by month and add that as a new variable

```
air[, mean.chill := mean(chill)
      , by = Month]
```

Remove the **Ozone** and **Solar.R** columns

```
air[, c("Ozone ", "Solar.R ") := NULL]
air[, (1:2) := NULL]
```

Joining datasets



DT[i, j, by]

Which rows?

- vector of rownumbers
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Joining datasets

Example data

```
irisDT <- as.data.table(iris)

irisH <- data.table(Species = c("setosa","versicolor","virginica"),
                    Species.full = c("Iris setosa","Iris versicolor","Iris virginica"),
                    height = 1:3,
                    soil = c("mud","rock","sand"))
```

Joining datasets

syntax: DT[**i**, **on**, **j**, **by**]

```
irisDT[irisH, on = .(Species)]

irisDT[irisH, on = "Species"]

irisDT[irisH, on = .(Species = Spec, other_col)]
```

Joining datasets

syntax: DT[**i**, **on**, **j**, **by**]

```
irisDT[irisH, on = .(Species), Species.full := Species.full]

irisDT[irisH
        , on = .(Species)
        , `:=` (Species.full = Species.full, height = height, soil = soil)]

irisDT[irisH
        , on = .(Species)
        , `:=` (Species.full = i.Species.full, height = i.height, soil = i.soil)]
```

Joining & chaining

syntax: DT[**i**, **on**, **j**, **by**]

like %>% from the tidyverse, you can also chain data.table operations together

```
irisDT[ … ][ … ][ … ]
```

```
irisDT[irisH, on = .(Species), Species.full := Species.full
         ][, median(Sepal.Length), by = Species.full]
```

Exercise 4

Open the file **ex4.R**

- Use a join to add the month name from 'airmonths' to 'air'
- Use a join to add both the month name and the month abbreviation from 'airmonths' to 'air'
- Use a join to add the month name from 'airmonths' to 'air’; then use chaining to calculate the median Wind speed for each month name

Exercise 4 - solutions

syntax: DT[**i**, **on**, **j**, **by**]

Use a join to add the month name from 'airmonths' to 'air'

```
air[airmonths, on = .(Month)
    , Month_name := Month_name][]
```

Use a join to add both the month name and the month abbreviation from 'airmonths' to 'air'

```
air[airmonths, on = .(Month)
    , `:=` (Month_name = Month_name,
            Month_abb = Month_abb)][]
```

Exercise 4 - solutions

Use a join to add the month name from 'airmonths' to 'air’; then use chaining to calculate the median Wind speed for each month name

```
air[airmonths, on = .(Month)
   , Month_name := Month_name
   ][, median(Wind), by = Month_name]
```

Reshaping data

From wide to long:

```
irisMelted <- melt(irisDT, id = "Species")
```

```
melt(data, id.vars, measure.vars,
        variable.name = "variable",
        value.name = "value",
        na.rm = FALSE,
        variable.factor = TRUE,
        value.factor = FALSE)
```

See also: ?melt

Reshaping data

From long to wide: dcast(irisMelted, Species ~ variable)

```
dcast(data, formula,
        fun.aggregate = NULL, sep = "_", ...,
        margins = NULL, subset = NULL,
        fill = NULL, drop = TRUE,
        value.var = guess(data))
```

See also: ?dcast

What else is there to discover?

more joins:	non-equi joins + rolling joins
more special symbols:	.BY + .GRP
special grouping functions:	rowid + rleid
set* functions:	setkey + setorder + setcolorder + setnames + ...
and even more:	frank + shift + CJ + tstrsplit + ...

Want to learn more?

Overview of getting started vignettes

Datacamp’s data.table course (paid)

StackOverflow [data.table] tag (> 7700 questions)

The End

Thank you for your attention!