THE #RDATATABLE PACKAGE

for fast, flexible and memory efficient data wrangling

Arun Srinivasan

CO-DEVELOPER, DATA.TABLE

USER TOULOUSE, JUL'19

@ARUN_SRINIV

~ A YEAR BEFORE

- Homepage: http://r-datatable.com, 50 contributors
- Since 2006 on CRAN, >40 releases so far
- Does not depend/import any other packages
- >7700 unit tests, ~93% coverage (using covr)
- >600 packages import/depend/suggest data.table
- ~18.3 packages per month since Jan'18
- 10th most starred R package on Github (METACRAN)
- >7400 questions on StackOverflow

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TALK OVERVIEW

- Introduce data.table's syntax / general form with simple examples

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EXAMPLE 1

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2:	1	b	2	11
3:	1	c	3	12
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for each value of **id**

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Group 1

id:1	valA
	1
	2
	3
	4
	7
	9

Group 2

id:2	valA
	5
	6
	8

EXAMPLE 1 CONTD ...

	id	code	valA	valB
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	id	valA
1:	1	26
2:	2	19

```
DT[, .(valA=sum(valA)), by=id]
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EXAMPLE 2

	id	code	valA	valB
1:	1	c	1	10
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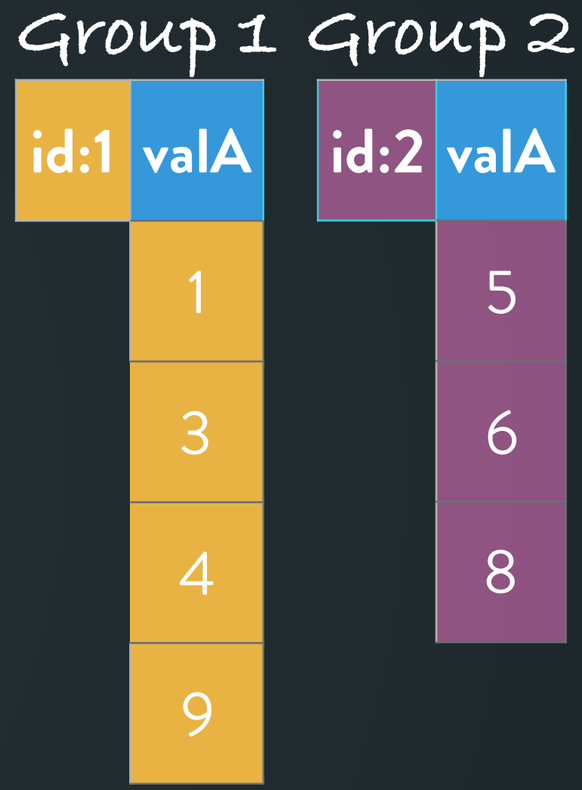


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DT[code != "b", .(valA=sum(valA)), by=id]
```

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	id	code	valA	valB
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GENERAL FORM

```
DT[code != "b", .(valA=sum(valA)), by=id]
```

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

i: On which rows

j: What to do?

by: Grouped by what?

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.SD AND .SDCOLS

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DT[code != "b", lapply(.SD, sum), by=id,
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```

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Group 1

id:1	code	valA	valB
	c	1	10
	c	3	12
	c	4	13
	c	9	18

Group 2

id:2	code	valA	valB
	a	5	14
	a	6	15
	a	8	17

Subset of Data

```
DT[code != "b", lapply(.SD, sum), by=id,
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```

.SD AND .SDCOLS

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Subset *of* **D**ata

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.SD AND .SDCOLS CONTD ...

	id	code	valA	valB
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Get **sum of each of val**

cols for each **id where**

code != "b"

	id	valA	valB
1:	1	17	53
2:	2	19	46

```
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.SD AND .SDCOLS CONTD ...

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DT[code != "b", lapply(.SD, sum), by=id,
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```

New vignette in devel version 1.12.3: vignette("datatable-sd-usage")

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HOW TO BE PERFORMANT?

```
DT[code != "b", .(valA=sum(valA)), by=id]
```

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

i	j	by
On which rows	What to do?	Grouped by what?

No shortcuts ... Optimise every single stage

OPTIMISATIONS IN 'I'

Auto indexing:

```
dt <- data.table(x=sample(1e5, 2e8, TRUE), y=runif(2e8))
```

200 million rows, 2 cols, ~3GB

OPTIMISATIONS IN 'I'

Auto indexing:

`dt <- data.table(x=sample(1e5, 2e8, TRUE), y=runif(2e8))` 200 million rows, 2 cols, ~3GB	
Run 1: `dt[x %in% 1000:2000]`	4.9s
Run 2: Reuses **index** built during 1st run	.6s
	run time

Optimised for == and *%in%*

TODO: Other operators

OPTIMISATIONS IN 'I'

Parallel subsets (columns are processed in parallel):

```
dt <- setDT(lapply(1:20, function(x) sample(100, 5e7, TRUE)))
```

50 million rows, 20 cols, all Integers, ~3.7GB

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Parallel subsets (columns are processed in parallel):

`dt <- setDT(lapply(1:20, function(x) sample(100, 5e7, TRUE)))` 50 million rows, 20 cols, all Integers, ~3.7GB	
Parallel (default): `dt[V1 > 50L]`	.59s
Sequential: with `setDTthreads(1L)`	1.01s
	run time

Every bit of optimisation matters

(1.7x speedup on 2 threads)

OPTIMISATIONS IN ‘BY’

Radix order has been parallelised recently:

```
dt <- data.table(x=sample(1e5, 2e8, TRUE), y=runif(2e8))
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OPTIMISATIONS IN 'BY'

Radix order has been parallelised recently:

`dt <- data.table(x=sample(1e5, 2e8, TRUE), y=runif(2e8))` 200 million rows, 2 cols, ~3GB	
`dt[, .N, by=x]` (with 2 threads)	5.43s
Using 1 thread with `setDTthreads(1L)`	10.42s
	run time

~1.92x speedup

OPTIMISATIONS IN 'J'

GForce: sum, min, max, mean, median, head, tail etc.

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dt <- setDT(lapply(1:20, function(x) sample(100, 5e7, TRUE)))
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GForce: sum, min, max, mean, median, head, tail etc.

`dt <- setDT(lapply(1:20, function(x) sample(100, 5e7, TRUE)))` 50 million rows, 20 cols, ~3.7GB	
`dt[, lapply(.SD, mean), by=V1]`	2.8s
`dt[, lapply(.SD, base::mean), by=V1]`	6.8s
	run time

MORE FUNCTIONALITIES

nafill:

	V1	V2	V3	V4
1:	1	c	NA	10
2:	2	b	2	NA
3:	NA	c	3	NA
4:	1	NA	4	NA
5:	2	NA	5	14

```
nafill(DT, “locf”)
```

```
setnafill(DT, “locf”)
```

	V1	V2	V3	V4
1:	1	c	NA	10
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nafill(DT, "locf")
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Operates in parallel across cols, see ?nafill

	V1	V2	V3	V4
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4:	1	c	4	10
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MORE FUNCTIONALITIES

nafill:

```
dt <- setDT(lapply(1:20, function(x) sample(c(NA, 1:10), 5e7, TRUE)))
```

50 million rows, 20 cols, ~3.7GB

MORE FUNCTIONALITIES

nafill:

`dt <- setDT(lapply(1:20, function(x) sample(c(NA, 1:10), 5e7, TRUE)))`

50 million rows, 20 cols, ~3.7GB

	run time
`nafill(dt, "locf") # 2 threads`	1.1s
`nafill(dt, "locf") # 1 thread`	2.7s

Can also be used with 'by', e.g.,

```
DT[, if (cond) nafill(.SD, "locf") else .SD, by=col]
```

MORE FUNCTIONALITIES

froll: frollsum, frollmean

	V1	V2	V3
1:	1	6	11
2:	2	7	12
3:	3	8	13
4:	4	9	14
5:	5	10	15

```
setDT(frollsum(DT, 3))
```

Operates in parallel across cols, see ?froll

	V1	V2	V3
1:	NA	NA	NA
2:	NA	NA	NA
3:	6	21	36
4:	9	24	39
5:	12	27	42

MORE FUNCTIONALITIES

coalesce:

	x	y	z
1:	11	NA	11
2:	NA	12	NA
3:	13	5	1
4:	NA	NA	14
5:	15	NA	NA
6:	NA	NA	NA

```
coalesce(DT)
```

11	12	13	14	15	NA

Operates in parallel, see ?coalesce

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- Auto indexing improvements in ‘i’ for other operators could be a great feature to add.
- More performance might be squeezed out of (parallel) radix ordering for grouping operations by handling special cases more efficiently.
- Several new compute functionalities are being added. They can be hooked in ‘j’ via GForce for quicker group-by operations.
- New vignettes added and several bugs fixed.

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  - **Renkun-ken** and a few others for active dev testing and reporting

THANKS TO

- CRAN team, Github CI/R developers for providing the means to catch and fix issues quickly

THANKS TO

- **Michael Chirico** for active contributions on documentations, R-code and recently C-code too! CJ() has been moved to C and parallelised.
- Michael has also written a much requested vignette on .SD usage. Please check out vignette("datatable-sd-usage") from v1.2.3+

THANKS TO

- **Jan** has implemented several recent functionalities - coalsce, nafill, frollmean, frollsum etc. in C/OpenMP
- A lot other contributors that I've not been able to mention by name (see: https://github.com/Rdatatable/data.table/graphs/contributors)
- And of course, **Matt** for steering this ship for over 13 years :-) (fread, fwrite, parallel radix ordering etc.)

THANKS TO

you for your attention …

Questions?