mmap + indexing

crazy big data, crazy fast

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The Problem

Data is unlimited
Memory is finite

... and R uses a memory model

The Options

Get more memory

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expensive and limited

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Use an external data store

Oracle, MySQL, sqlite, Postgresql, Berkeley DB, Redis, voltDB,Vertica, monetDB, ...

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What if we changed how R sees your data instead?

mmap

OS system call

very low level API - you see what the C call sees

virtually map files into memory on demand

similar (but different) to the R packages *ff* and *bigmemory*

mmap

mmap	R	C	bytes
raw()	raw	unsigned char	1
char()	raw	char	1
uchar()	raw	unsigned char	1
int8()	integer	signed char	1
uint8()	integer	unsigned char	1
int16()	integer	signed short	2
uint16()	integer	unsigned short	2
int24()	integer	three byte int	3
uint24()	integer	unsigned three byte int	3
int32()	integer	int	4
integer()	integer	int	4
real32()	double	single precision float	4
real64()	double	double precision float	8
double()	double	double precision float	8
cplx()	complex	complex	16
complex()	complex	complex	16
char(n)	character	fixed-width ascii	n+1
character(n)	character	fixed-width ascii	n+1
struct(...)	list	struct of above types	variable

mmap

```
> # 2-byte (int16)
> # 4-byte (int32 or integer)
> # 8-byte float (real64 or double)

> record.type <- struct(short=int16(),int=int32(),double=real64())
> record.type
struct: (short) integer(0)
        (int) integer(0)
        (double) double(0)
> nbytes(record.type) # 14 bytes in total
[1] 14

> m <- mmap(tmp, record.type)
> m[1]
$short
[1] 1

$int
[1] 366214

$double
[1] -1.382365
```

indexing

provide database style indexing and search tools
for R based data objects

column store + binary search + bitmap indexing + mmap

indexing

extend data.frame to use indexes (fast searching)

build in support for disk-based access (unlimited data)

R interface (painfully simple)

indexing

the interface

create_index

load_index

[

vertical partitions

LZO compression

indexing

WAH bitmap compression

binary search

language agnostic storage

the technology

horizontal partitions

bitmap indexing

column store

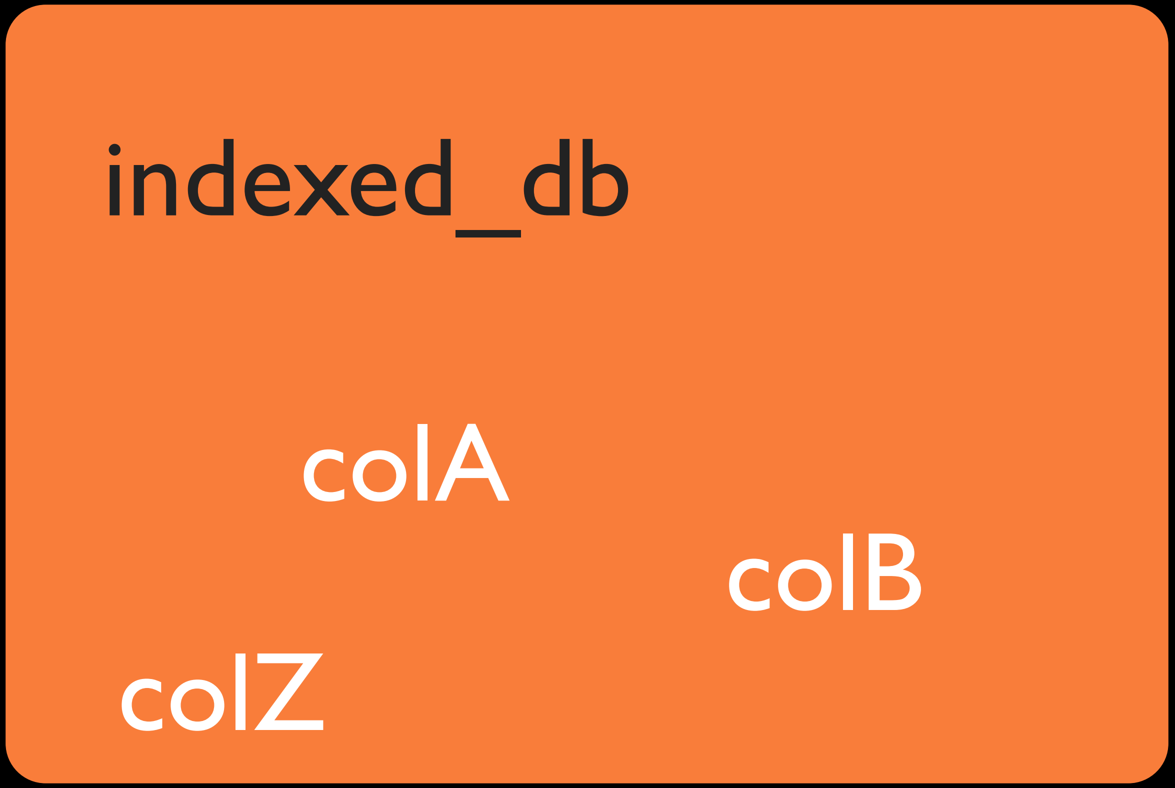
networked

query optimization

caching

mmap + indexing

indexed_db
is an
environment



indexed_db

colA

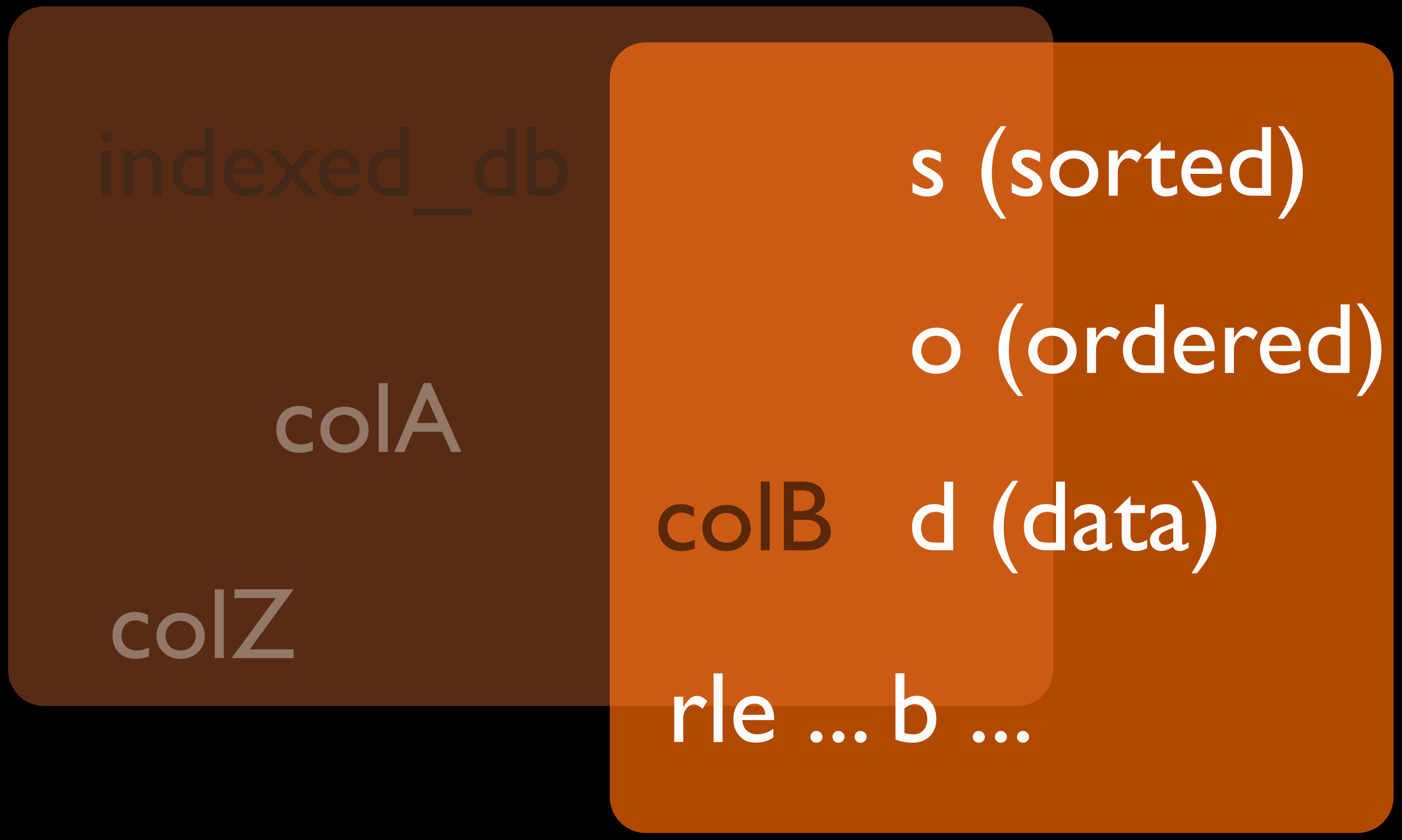
colB

colZ

colA - Z are
“columns”
of your data

“columns” are really objects (lists) in the environment

mmap + indexing



indexed_db

colA

colZ

colB

s (sorted)

o (ordered)

d (data)

rle ... b ...

lists contain the mmap objects to data on disk(s)

mmap + indexing

2 steps

create_index

any column or vector of data

returns the “indexed” environment

e.g.

```
Z <- rnorm(1e6)
db <- create_index(Z)
rm(Z)
```

[

use subsetting to magically extract data from disk using index (fast and friendly)

fancy *j* evaluation included

e.g.

```
db[Z < 0]
db[Z > 1 & Z < -3, Z]
db[Z < -3, mean(Z)]
```

mmap + indexing

Real World Example

67,000,000 equity option contracts
14+ columns

```
> system.time( db[symbols=="AAPL"] )
   user  system elapsed
  0.012   0.000   0.012

> db[symbols=="AAPL"]
91428 hits
```

ia

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