DB storage architectures:

Rows and Columns

COS 518: *Advanced Computer Systems*
Lecture 8

Michael Freedman

Basic row-based storage

8	32	4	2	4	= 50
Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	

Basic row-based storage

	8	32	4	2	4	= 50
0	Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	
50	Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	
100	Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	
150	Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	

Basic row-based storage

	8	32	4	2	4	= 50
0	Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	
50	Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	
100	Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	
150	Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	

READ 32 bytes at positions (0 + 8), (50 + 8), (100 + 8), (150 + 8)

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Row-based storage: variable lengths

8	0 - 255	4	2	4	= 18 - 273
Id BIGINT	URL VARCHAR(255)	Size INT	Code SMALLINT	Fetched DATE	

How do you walk through all the URLs?
No longer at fixed offsets

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Row-based storage: variable lengths

8	0 - 255	4	2	4	= 18 - 273
Id BIGINT	URL VARCHAR(255)	Size INT	Code SMALLINT	Fetched DATE	

- Data stored in fixed-sized pages on disk
  - E.g., typically 8K in PostgreSQL
  - Page includes metadata and actual data items
  - Items = indexes, data rows

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Row-based storage: variable lengths

Table 63-2. Overall Page Layout

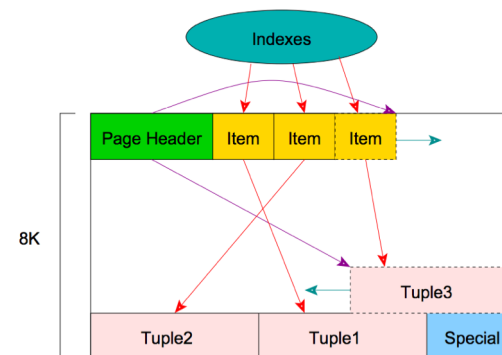| Item	Description
PageHeaderData	24 bytes long. Contains general information about the page, including free space pointers.
ItemIdData	Array of (offset,length) pairs pointing to the actual items. 4 bytes per item.
Free space	The unallocated space. New item pointers are allocated from the start of this area, new items from the end.
Items	The actual items themselves.
Special space	Index access method specific data. Different methods store different data. Empty in ordinary tables.

https://www.postgresql.org/docs/9.5/static/storage-page-layout.html

ItemIdData: [58, 101), (102, 290), (291, 59)]

	Id BIGINT	URL VARCHAR(255)	Size INT	Code SMALLINT	Fetched DATE
58	Id BIGINT	URL VARCHAR(255)	Size INT	Code SMALLINT	Fetched DATE
102	Id BIGINT	URL VARCHAR(255)	Size INT	Code SMALLINT	Fetched DATE
291	Id BIGINT	URL VARCHAR(255)	Size INT	Code SMALLINT	Fetched DATE

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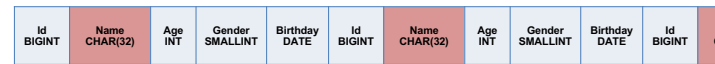# Row-based storage: variable lengths

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Types of database workloads

- OLTP = OnLine Transaction Processing
  - Write-heavy
  - Transactions

- OLAP = OnLine Analytical Processing
  - Read-heavy
  - Analytical scans or "rollups" along column
    - "SELECT AVG(latency) FROM system
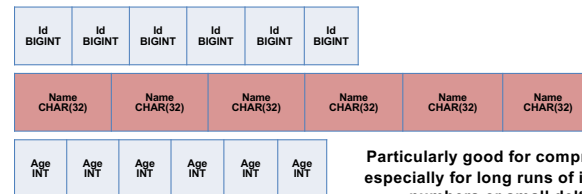   WHERE time > now() – interval("1h")

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Comparison of disk layouts

- Row-oriented layout

Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	Id BIGINT	Name CHAR(32)	Age INT	Gender SMALLINT	Birthday DATE	Id BIGINT	

- Column-oriented layout

Id BIGINT	Id BIGINT	Id BIGINT	Id BIGINT	Id BIGINT	Id BIGINT

Name CHAR(32)	Name CHAR(32)	Name CHAR(32)	Name CHAR(32)	Name CHAR(32)	Name CHAR(32)

Age INT	Age INT	Age INT	Age INT	Age INT	Age INT

Particularly good for compression, especially for long runs of identical numbers or small deltas

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Good discussion of benefits of columns...

C-Store: A Column-oriented DBMS

Mike Stonebraker[*], Daniel J. Abadi[*], Adam Batkin[+], Xuedong Chen[†], Mitch Cherniack[+], Miguel Ferreira[*], Edmond Lau[*], Amerson Lin[*], Sam Madden[*], Elizabeth O'Neil[†], Pat O'Neil[†], Alex Rasin[‡], Nga Tran[+], Stan Zdonik[‡]

| [*]MIT CSAIL Cambridge, MA | [+]Brandeis University Waltham, MA | [†]UMass Boston Boston, MA | [‡]Brown University Providence, RI |

http://db.csail.mit.edu/projects/cstore/vldb.pdf

Column-Stores vs. Row-Stores: How Different Are They Really?

| Daniel J. Abadi Yale University New Haven, CT, USA dna@cs.yale.edu | Samuel R. Madden MIT Cambridge, MA, USA madden@csail.mit.edu | Nabil Hachem AvantGarde Consulting, LLC Shrewsbury, MA, USA nhachem@agdba.com |

http://db.csail.mit.edu/projects/cstore/abadi-sigmod08.pdf

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