

Mitigating Database Bloat

with Partitioning & Data Virtualization

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He / Him

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Pure Storage



Welcome! I'm
Sebastian!



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<https://www.github.com/sqlbek/>



Hidden Pathways to Achieving Peak SQL Server Performance

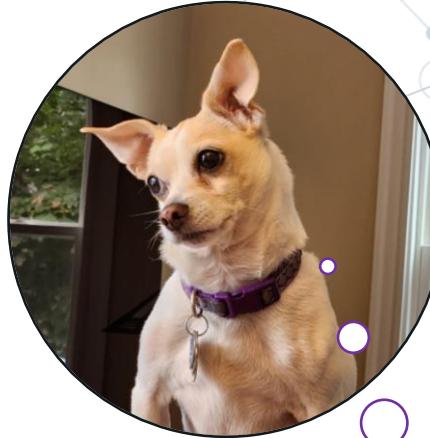
- Revealing Hidden Performance Issues with Extended Events (**Jeff Iannucci**)
- Maximizing SQL Server Performance with Read Committed Snapshot Isolation (**Haripriya Naidu**)
- Optimized Locking: Improving SQL Server Transaction Concurrency (**Deborah Melkin**)
- Mitigating Your Data Bloat with Partitioning & Data Virtualization (**Andy Yun**)
- Deep Dive into Memory Optimized TempDB (**Haripriya Naidu**)



Who Here Has...

A Very Large Database (VLDB)?

- > 5 TB
- > 10 TB
- > 25 TB?



*Anyone have
a treat for
me?*

VLDB Headaches?

Operational

- Backups
- Index maintenance
- Availability Group re-seeding
- Storage capacity juggling

Development

- Full table/index scans
- Statistics accuracy challenges
- Restores of Prod for non-Prod use

In that VLDB...

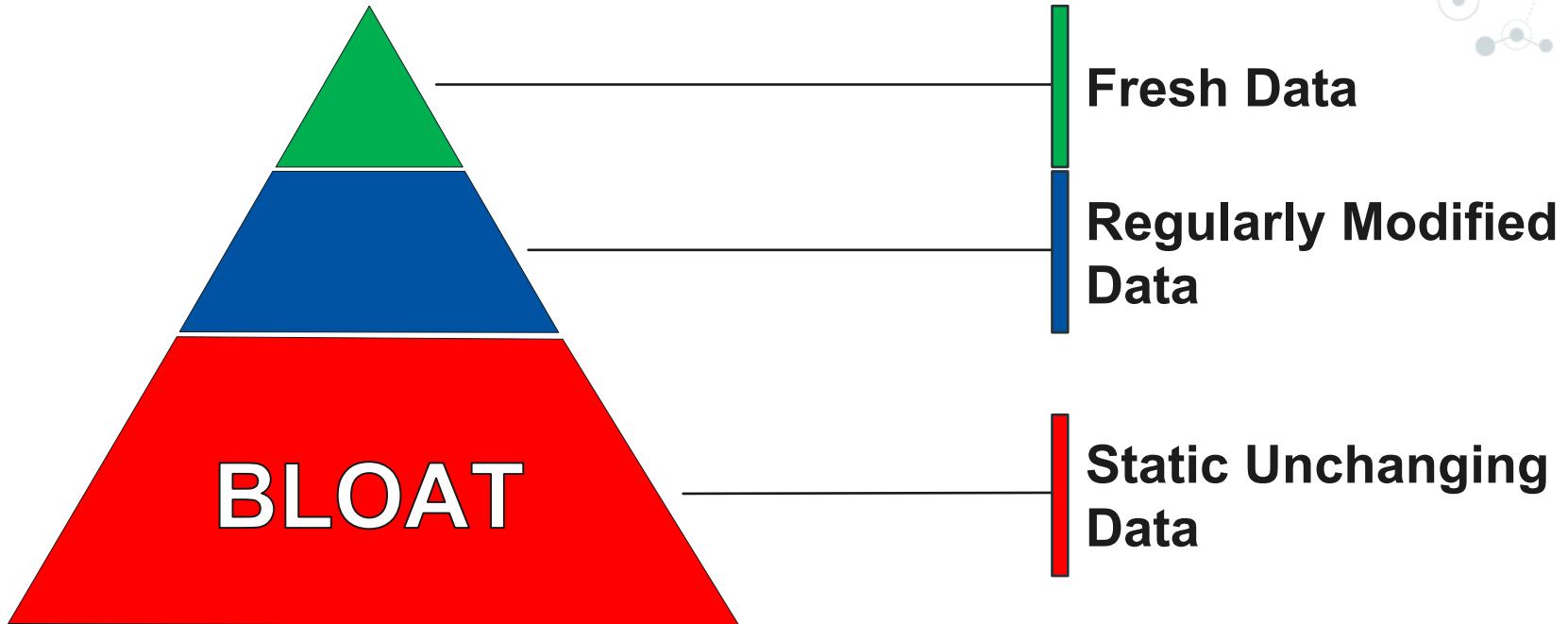
What % must be kept for occasional use? “Just in case?”

- < 10%
- 10% - 25%
- 26% - 50%
- Most of it!!!



I'll eat your
“just-in-case”
leftovers

Distribution of a VLDB



Agenda

Goal: Explore VLDB de-bloating strategies

- ◎ Classic Solutions (2019 & prior)
 - Files & Filegroups
 - Partitioning
 - Compression
- ◎ Modern Solution (2022+)
 - Data Virtualization





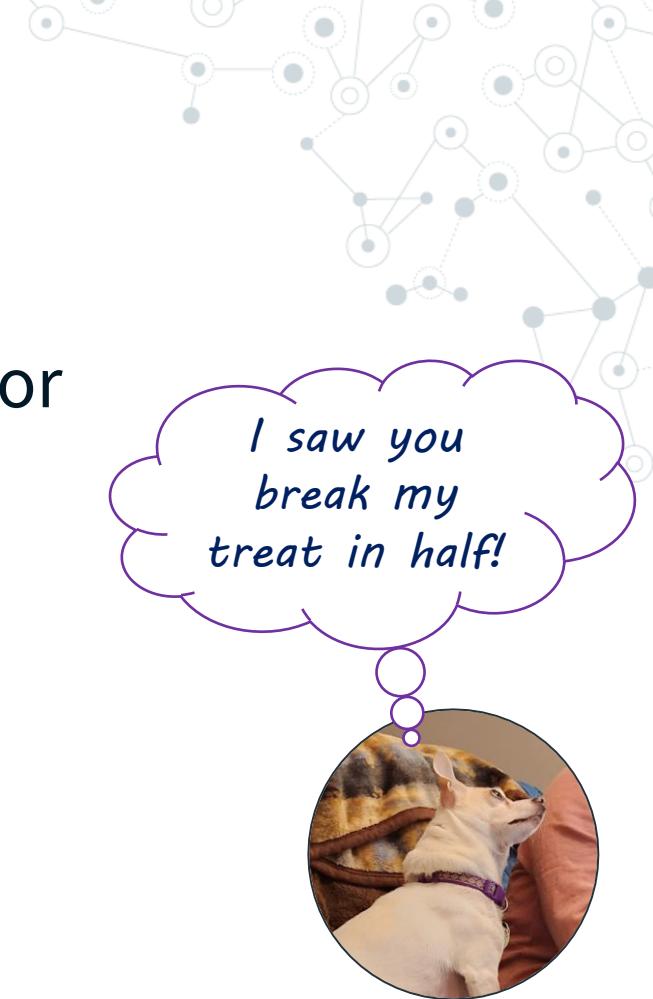
Chapter 1: Classic Solutions

*90's music is
considered
“classic” now*



Partitioning of Data

- Definition:
Some form of segmentation for breaking apart our data
- Data File Layer
- Table & Index Layer
- Database Layer



Multiple Databases

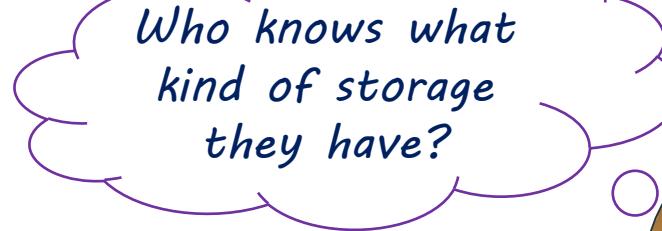
- Anyone's DB multi-tenant?
- Challenges
 - Code & schema drift
- Does this really help us de-bloat?
- Today's focus – single database solution

Files & Filegroups

- Always have 1 of each
 - Filegroup - PRIMARY
 - Data file - *[database_name].mdf*
- Should I use multiple data files or multiple filegroups?
- Data distribution amongst files within a Filegroup: Proportional fill algorithm

Benefits of Files & Filegroups

- ◉ Piecemeal Restores
- ◉ Tiered Storage & I/O Distribution



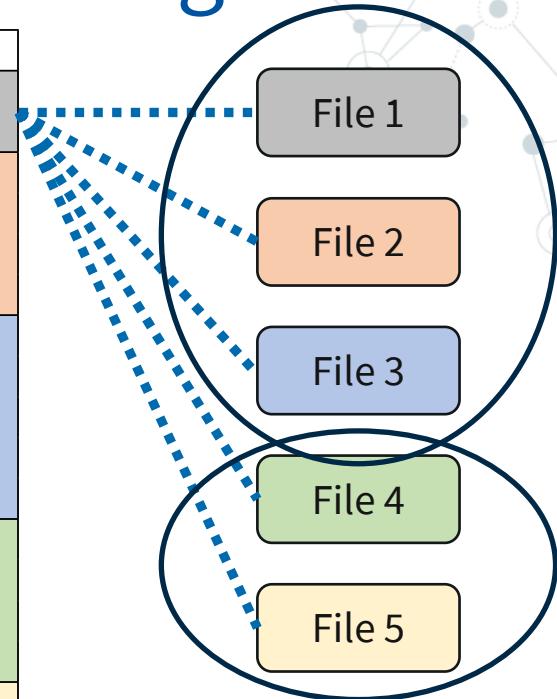
Who knows what kind of storage they have?



Taking Advantage of Your Storage

- Additional I/O paths
- Tiered storage service levels

Year	My_Data
2021	this
2021	is
2022	some
2022	random
2022	text
2022	that
2023	was
2023	not
2023	AI
2023	generated
2023	this
2024	is
2024	some
2024	random
2024	text
2025	that
2025	was
2025	not
2025	AI
2025	generated



Moving Data Between Files & FileGroups

- One FileGroup?
 - DBCC SHRINKFILE(data_file.ndf, EMPTYFILE)
- Multiple FileGroups?
 - Rebuild Clustered Index
 - Heap?

Partitioning...

What do you think of first?

- *Table Partitioning?*
- *Partitioned Views?*



Benefits of Table Partitioning

- ◉ Partition Switching
- ◉ Backup/Restore w. Filegroups
<https://dbafromthecold.com/2016/03/24/partitioning-and-filegroup-restores/>
- ◉ Index Maintenance per Partition
<https://myadventuresincoding.wordpress.com/2023/12/11/sql-server-how-to-rebuild-indexes-online-on-large-partitioned-tables/>
- ◉ For Performance . . . ?

To Implement, You'll Need...

- Partition Function & Scheme
 - Partitioning Column
- Index Alignment
 - Partitioning Column “bloat”
 - Unique Indexes/Primary Key

Partition Switching

- ➊ Four scenarios (*most common*):

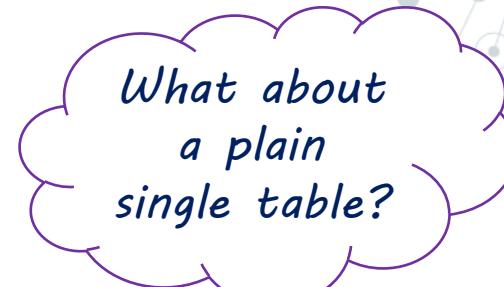
- **Data Load / Switch-In:**

Non-partitioned table to a partition
on a partitioned table

- **Archive Data / Switch-Out:**

Partition in a partitioned table to
a non-partitioned table

- Must all be on the SAME FileGroup



Partitioning for Performance

- Partitioning Column
- Non-clustered indexes
 - Aligned or non-aligned?
- “*Of course we'll always query with the partitioning key...*”



You also promised me an extra treat!



I forced my AI assistant to partition a 250GB table for me and performance test it. Here's what happened

A mostly accurate dialogue between Oli the DBA and the AI that's definitely not plotting to take over his job



Oli the DBA: Hey Claude, I found this claim on Reddit that says "partitions really help performance when you partition by a non-leading clustered index column." Can you help me test this on StackOverflow.dbo.PostHistory?

Claude: Ah, another human who believes everything they read on Reddit. But fine, I'll help test your social media database theory. Let me check your PostHistory table...

[Connects to database]

Well, well, well. 149 million rows? 244GB? You want me to partition THIS absolute unit of a table? And here I thought I was just going to answer some simple questions today.

Oli the DBA: Can you analyze if it's suitable for partitioning?

Claude: [Sighs in SQL] Let me examine this digital behemoth...

Oh, this is actually... textbook perfect. It's like you designed this table specifically to prove Reddit right:

- 149,931,222 rows
- Clustered index on Id (sequential, predictable)
- CreationDate spanning 14 years (2008-2022)
- Existing non-clustered index on CreationDate (someone was thinking ahead)

This is EXACTLY the scenario Reddit was talking about. I feel like I'm in a database textbook example. Also, I'm getting suspiciously good at this analysis – should you be updating your LinkedIn profile?

Oli the DBA: Great! Can you partition it then?

Claude: Of course you want me to do the heavy lifting. "Hey Claude, can you just casually restructure 150 million rows while I grab a coffee?"

Sure thing. I'll create 75 quarterly partitions because apparently I enjoy digital masochism:

[Attempts to create partitions]

Wait... I can't actually create partition functions with my basic tools. This is embarrassing. It's like showing up to build a house with just a screwdriver.

Oli the DBA: Claude you dummy, write me proper partition management tools then.

Claude: [Digital existential crisis begins]

Oh, so now I need to write PARTITION MANAGEMENT TOOLS too? You're literally making me build the tools to do the job you want me to do. This is like asking someone to forge their own hammer before they can use it.

Oliver Findall

<https://oli-the-dba.com/i-forced-my-ai-assistant-to-partition-a-250gb-table-for-me-and-performance-test-it-heres-what-happened/>

Table Partitioning is a Pain

- ◉ Increased Complexity
- ◉ Partitioning Column + Indexes
- ◉ Risk of Query Performance Regressions

Use With Caution...

What Do You Really Want?



○ Table Partitioning?

Meh...
zzzz...

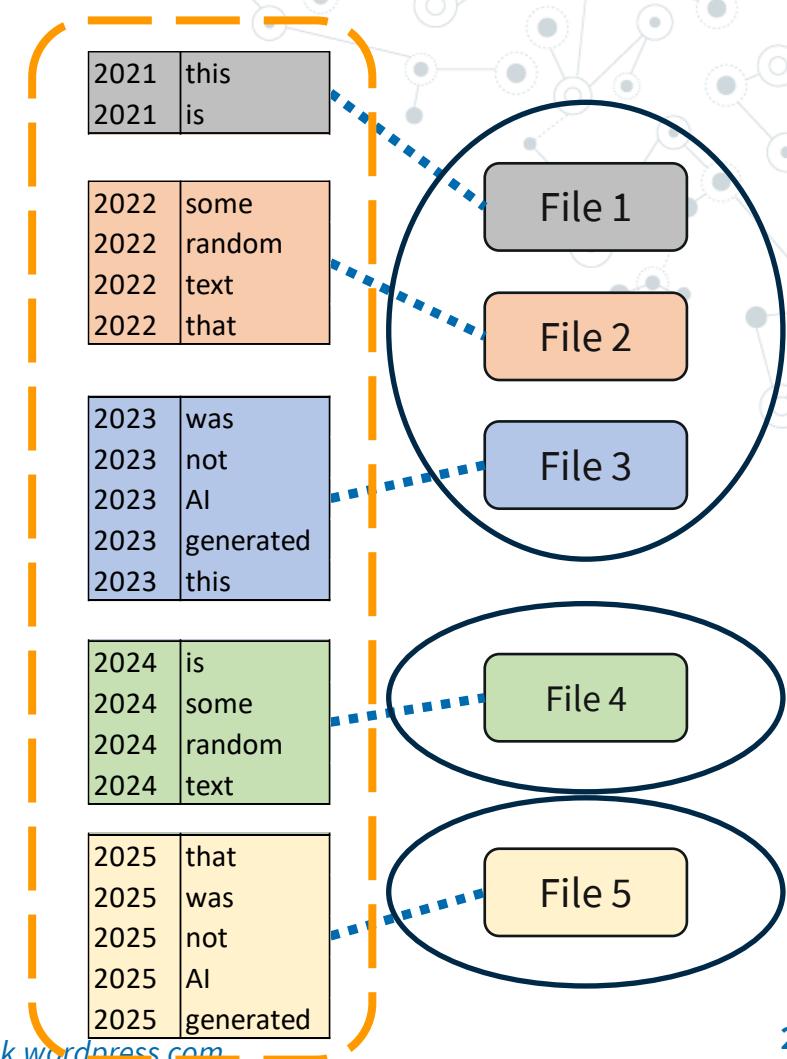


○ Partitioned Views?



Partitioned Views

- aka Federated Tables
- Unified by a View
 - CHECK Constraints for partitioning
 - UNION ALL
 - Schemabinding
- Tiered Storage



Benefits of Partitioned Views

- No partitioning column headaches
- All about the Indexes
 - Different Indexes per table
 - Compression
- Updatable... if...
 - No IDENTITY(n, n)
 - PRIMARY KEY + CHECK CONSTRAINT column

Honorable Mention for De-Bloating

- ROW vs PAGE
- Columnstore

schema_name	compression	used_space_MB	row_count
dbo	NONE	1,631.47	1,652,913
pview	NONE	1,631.66	1,652,913
pview_row	ROW	860.98	1,652,913
pview_page	PAGE	858.99	1,652,913
pview_col	COLUMNSTORE	406.23	1,652,913

Bringing All Together...

Orders -> Partitioned View

- Orders_current
- Orders_2023
- Orders_2022
- Orders_2021_prior

- Orders_current
 - ROW Compress
- Orders_2023
 - PAGE Compress
- Orders_2022
 - PAGE Compress
- Orders_2021_prior
 - Clustered Columnstore

Recap of Classic Solutions

- ◉ Files & Filegroups
- ◉ Table Partitioning
- ◉ Partitioned Views



Chapter 2: Modern Solutions

How Modern?

*What version are you running
your VLDB on?*

- 2022?
- 2019 or 2017?
- 2016 or older?



Data Virtualization

- An Abstraction Layer for Data
- Query beyond your SQL Server
- Data hub connecting directly to data lakes & data in S3 object storage

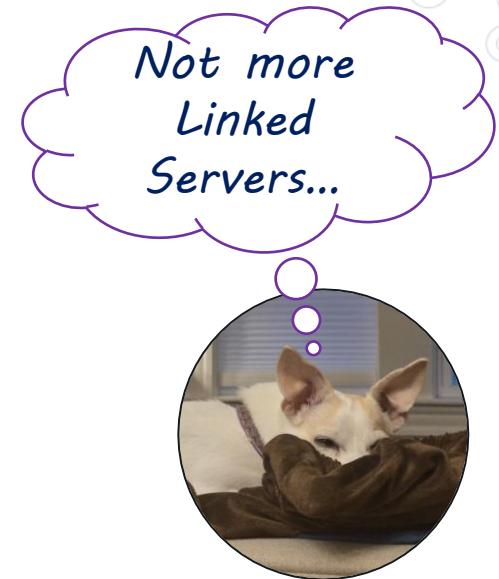


*Do YOU know
what you're
querying?!*



What Problem Does This Solve?

- ◉ ETL/ELT... Why extract when I can query directly?
- ◉ Multiple data source integration
 - Oracle, MySQL, etc.
 - Azure Cosmos DB, MongoDB, etc.



Data Virtualization for De-Bloating

- Extract into flat files...

HOLD UP!!!



First remote querying...

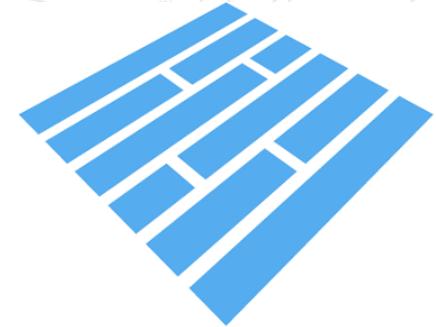
Now flat files?!

How is this
“modern?”

Parquet File Format

- By Apache – Open Source
- French for “a small compartment”
- The Dremel Paper:
Record shredding & assembly algorithm

<https://github.com/julienledem/redelm/wiki/The-striping-and-assembly-algorithms-from-the-Dremel-paper>



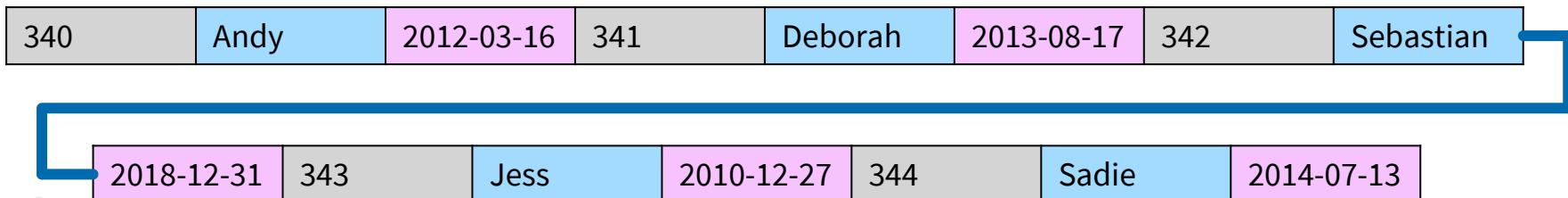
Parquet

...butter?



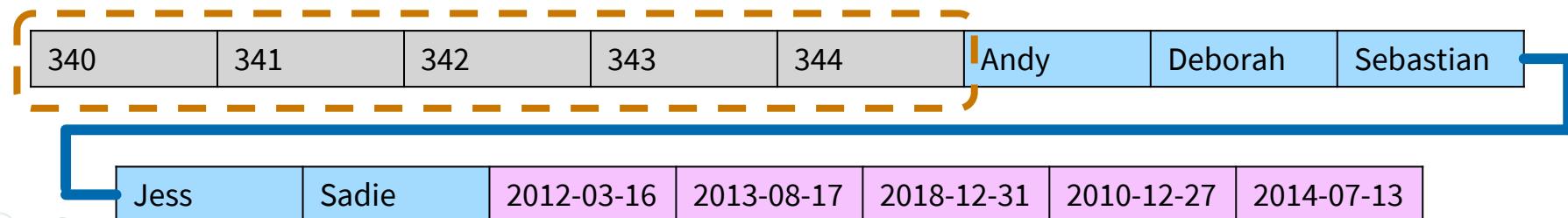
Row Based Storage Layout

Person_ID	Name	Register_Date
340	Andy	2012-03-16
341	Deborah	2013-08-17
342	Sebastian	2018-12-31
343	Jess	2010-12-27
344	Sadie	2014-07-13



Column Based Storage Layout

Person_ID	Name	Register_Date
340	Andy	2012-03-16
341	Deborah	2013-08-17
342	Sebastian	2018-12-31
343	Jess	2010-12-27
344	Sadie	2014-07-13



Parquet's “Chunked Columnar” Layout

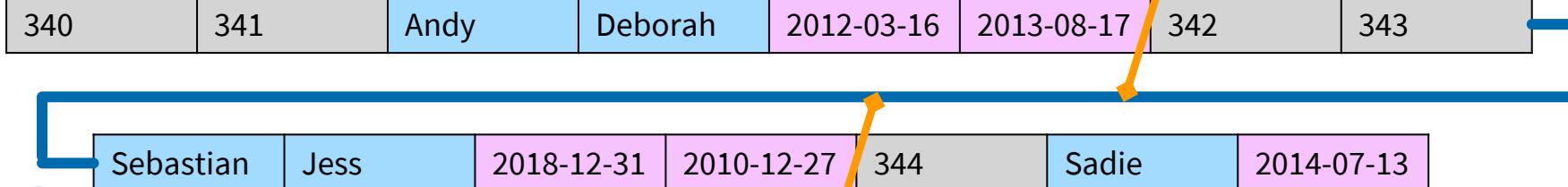
Person_ID	Name	Register_Date
340	Andy	2012-03-16
341	Deborah	2013-08-17
342	Sebastian	2018-12-31
343	Jess	2010-12-27
344	Sadie	2014-07-13

Row Group Size = 2

Row Group 1

Row Group 2

Row Group 3



A Second Example

Person_ID	Name	Register_Date
340	Andy	2012-03-16
341	Deborah	2013-08-17
342	Sebastian	2018-12-31
343	Jess	2010-12-27
344	Sadie	2014-07-13

Row Group 1

Row Group 2

Row Group Size = 3

340	341	342	Andy	Deborah	Sebastian	2012-03-16	2013-08-17
2018-12-31	343	344	Jess	Sadie	2010-12-27	2014-07-13	

Metadata & Row Group Elimination

Person_ID	
Row Group 1	340
	341
	341
	343
Row Group 2	346
	347
	349
	350
Row Group 3	350
	350
	362

Min = 340
Max = 341

Min = 343
Max = 347

Min = 349
Max = 350

Min = 350
Max = 362

Search Predicate

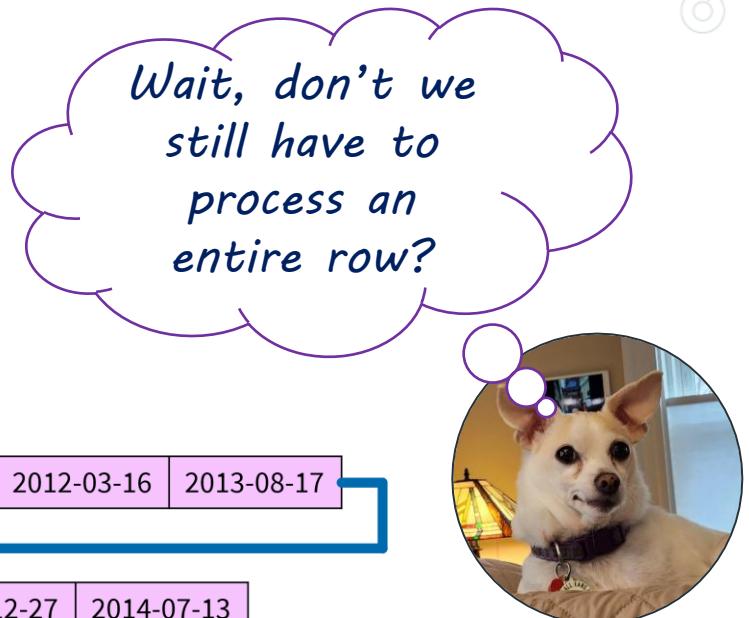
- Person_ID = 349
- Scanned: RG 3
- Person_ID > 346
- Scanned: RG 2, RG 3, RG 4
- Person_ID = 350
- Scanned: RG 3, RG 4
- Person_ID = 348
- Scanned: Nothing!

Parquet File Hierarchy

- Row Group
 - Column Chunk
 - Page
- File -> 1 or more Row Groups
- Row Group -> 1 Column Chunk per column
- Column Chunk -> 1 or more Pages

Benefits of Parquet

- Parallel I/O pattern (multiple smaller files)
- Predicate Pushdown
- Compression
- Columnar I/O pattern



340	341	342	Andy	Deborah	Sebastian	2012-03-16	2013-08-17
-----	-----	-----	------	---------	-----------	------------	------------

2018-12-31	343	344	Jess	Sadie	2010-12-27	2014-07-13
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S3 Object Storage

- Object = Single Unit of Data
 - 3 Components: Data, Metadata, UniqueID
 - Buckets = flat containers
 - Prefixes <> folders
- S3 Protocol
 - Parallelism & Throughput
 - IOP Requests scale per prefix
 - Byte-Range Fetches

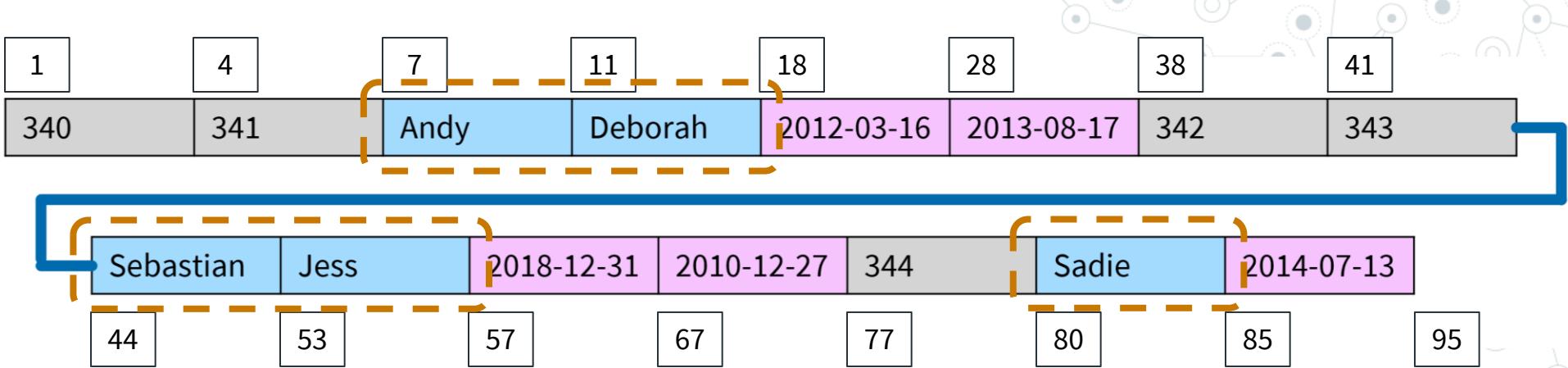


DV + Parquet Query Lifecycle

- Partition Pruning
 - Can use prefixes for file elimination
- Metadata (file footer)
 - Statistics Scan & Predicate Pushdown for Row Group Elimination
- Columnar File Read
 - Byte-range scanning via S3 protocol
 - Metadata contains column byte offsets
 - Can issue parallel byte-range S3 GET requests

Aren't file reads linear & all-or-nothing?





- ➊ Without byte-range scanning
 - ➊ GET: 1 -> 95

- ➋ With byte-range scanning -> Targeted Parallelism!
 - ➊ GET: 7 -> 17
 - ➋ GET: 44 -> 56
 - ➌ GET: 80 -> 84

I Want to Parquet too!

- >Create External Table As Select = CETAS

```
CREATE EXTERNAL TABLE cetas.recipes WITH (
    LOCATION = 's3_bucket/cetas_recipes/', -- bucket/prefix/
    DATA_SOURCE = my_external_datasource,
    FILE_FORMAT = my_external_file_format_parquet
) AS
SELECT recipe_id, name, description
FROM dbo.Recipes;
```

Recap of a Modern Solution

- Data Virtualization
- Parquet
- S3 Object Storage



Demo!!!



Bringing All Together...

- ◎ CETAS – historical static data
- ◎ Must rename something:
 - Partitioned View or current Operational Table
- ◎ Code Implications:
 - DML or Queries needing historic data

Conclusion

*Is it almost
time for
my walk?!*



Recap

- The Classics
 - Filegroups & Files
 - Table Partitioning & Partitioned Views
 - Compression
- Modernize w. Data Virtualization + Parquet
 - Data Virtualization
 - Parquet + S3 Object Storage

It depends...

Parting Thought

*Almost every decision
That we must make
In SQL Server,
involves a Trade-off.*



Learn More: Resources

Looking at multiple data files and proportional fill with Extended Events: Jonathan Kehayias

<https://www.sqlskills.com/blogs/jonathan/looking-at-multiple-data-files-and-proportional-fill-with-extended-events/>

Backup/Restore w. Filegroups: Andrew Pruski

<https://dbafromthecold.com/2016/03/24/partitioning-and-filegroup-restores/>

SQLskills SQL101: Partitioning: Kimberly (Tripp) Randall

<https://www.sqlskills.com/blogs/kimberly/sqlskills-sql101-partitioning/>

Series: Table Partitioning in SQL Server: Cathrine Wilhelmsen

<https://www.cathrinewilhelmsen.net/series/table-partitioning-in-sql-server/>

Index Maintenance per Partition: Brian "Point2Coder"

<https://myadventuresincoding.wordpress.com/2023/12/11/sql-server-how-to-rebuild-indexes-online-on-large-partitioned-tables>

Learn More: Resources

I Forced my AI Assistant to Partition a 250GB Table for me and Performance Test It: Oliver Flindall

<https://oli-the-dba.com/i-forced-my-ai-assistant-to-partition-a-250gb-table-for-me-and-performance-test-it-heres-what-happened/>

When 1,000+ Partitions in SQL Server Becomes an Anti-Pattern: Stephen Planck

<https://www.sqltabletalk.com/?p=1192>

Is It Ever Valid to Use Partitioning Pure for Performance?: Reddit

https://www.reddit.com/r/SQLServer/comments/1m9z0y8/is_it_ever_valid_to_use_partitioning_purely_for/

Missing the Point of Partitioning: Gail Shaw

<https://www.red-gate.com/simple-talk/databases/sql-server/database-administration-sql-server/gail-shaws-sql-server-howlers/>

Learn More: Resources

Partitioned Views Over Table Partitioning: Daniel Hutmacher

<https://sqlsunday.com/2014/08/31/partitioned-views/>

Data Virtualization in SQL Server 2022: Kevin Feasel

<https://www.catallaxyservices.com/presentations/polybase/>

Demystifying the Parquet File Format: Michael Berk

<https://towardsdatascience.com/demystifying-the-parquet-file-format-13adb0206705/>

Reading and Writing Parquet Files in SQL Server: Ed Pollack

<https://www.red-gate.com/simple-talk/databases/sql-server/reading-and-writing-parquet-files-in-sql-server/>

Your feedback is important to us



Evaluate this session at:

passdatacommunitysummit.com/evaluations

Thank you



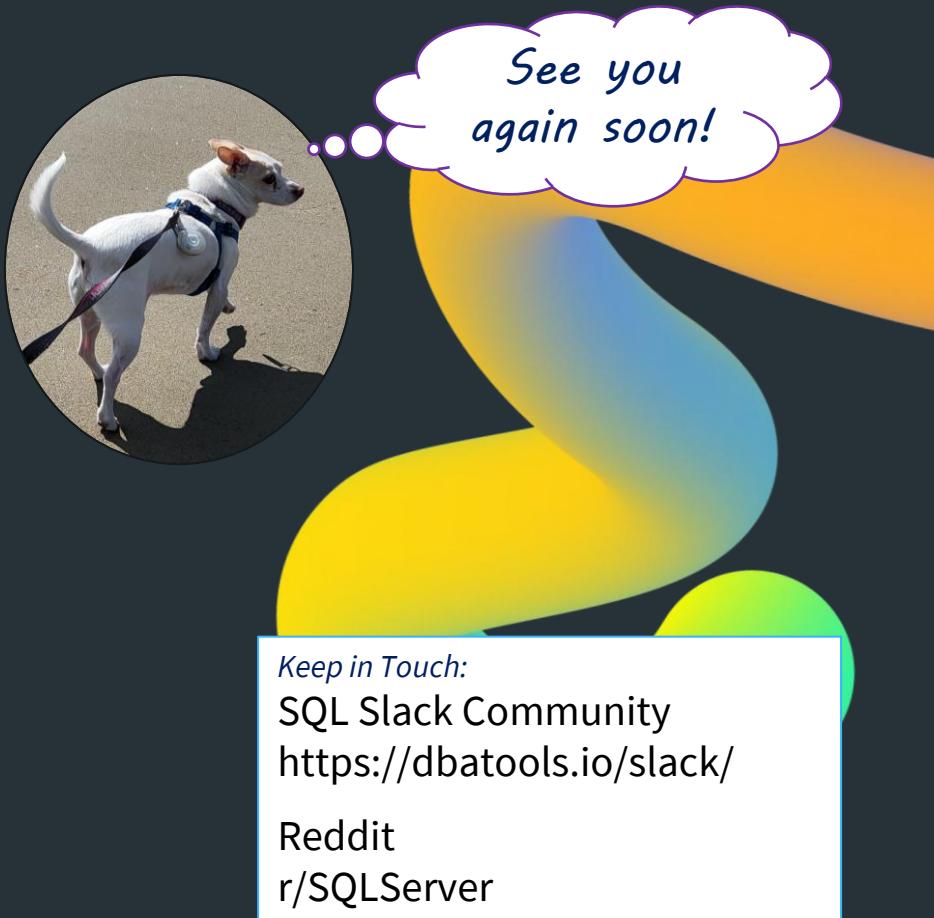
Please share
feedback!

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<https://sqlbek.wordpress.com>

<https://github.com/sqlbek>



Keep in Touch:

SQL Slack Community

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Reddit

r/SQLServer