PIACENZA EDITION

DelphiDay

italian conference

Park Hotel - Piacenza 6, 7 Giugno 2023

T-SQL performance

Tips & Tricks

Slide and demos: https://bit.ly/3WBxPt3

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AGENDA

- ➔ SARGable predicates
  - ➔ NULLs
  - ➔ Dynamic sorting
- ➔ Query mode execution
- ➔ Join order
- ➔ Temp table cache contention

SARGable predicates

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The definition of SARGable

Wikipedia (en.wikipedia.org/wiki/Sargable) defines **SARGability** in this way:

> In relational databases, a condition (or predicate) in a query is said to be sargable if the DBMS engine can take advantage of an index to speed up the execution of the query. The term is derived from a contraction of **Search ARGument ABLE**

The definition of SARGable

A query failing to be sargable is known as a non-sargable query and typically has a negative effect on query time, so one of the steps in query optimization is to convert them to be sargable. The effect is similar to searching for a specific term in a book that has no index, beginning at page one each time, instead of jumping to a list of specific pages identified in an index

SARGable predicates

- ➔ SARGable means that the predicate can be evaluated/executed using a Seek
- ➔ Predicates

✗ <expression><operator><expression>

✓ <column><operator><expression>

Demo

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Query mode processing

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Row mode execution

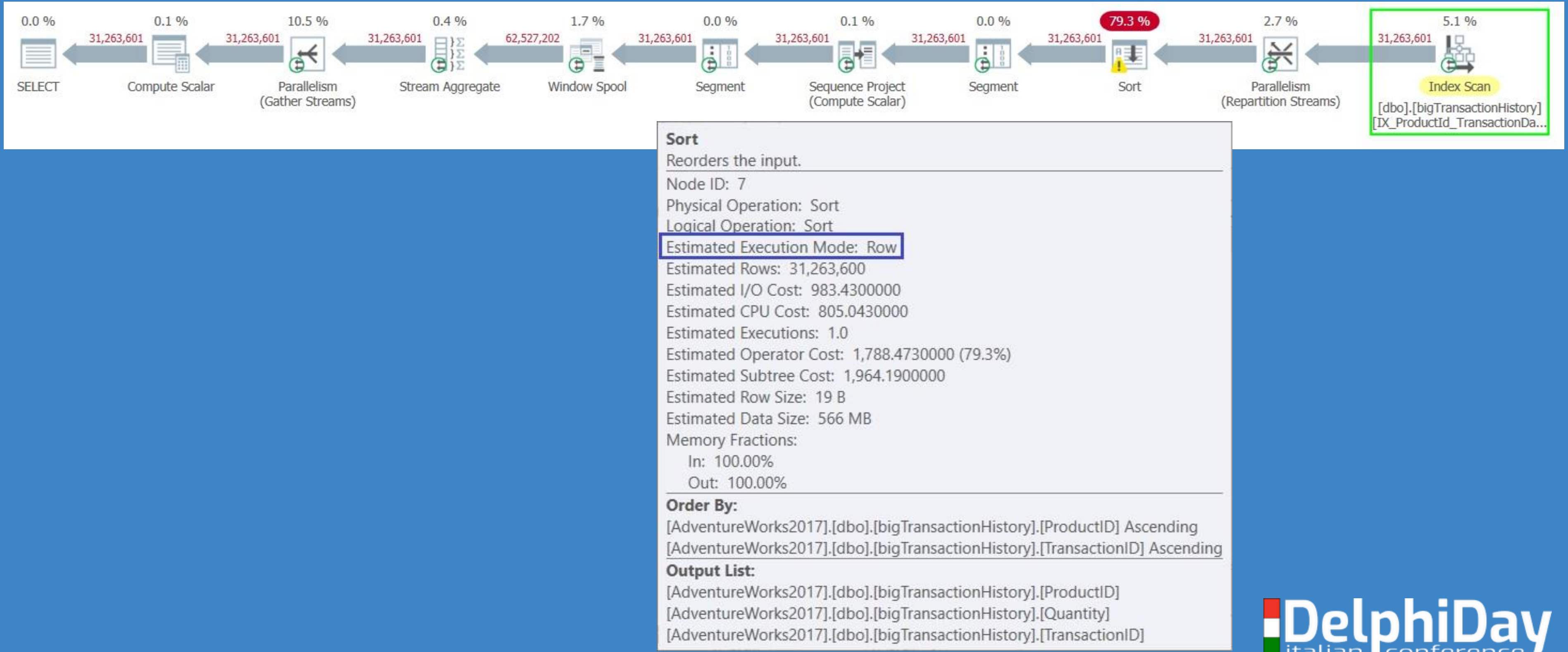
- Row mode execution is a query processing method used with traditional RDBMS tables, where data is stored in row format
- When a query is executed and accesses data in row store tables, the execution tree operators and child operators read each required row, across all the columns specified in the table schema

Row mode execution

➔ From each row that is read, SQL Server retrieves the columns that are required for the result set, as referenced by a SELECT statement, JOIN predicate, or filter predicate

https://docs.microsoft.com/sql/relational-databases/query-processing-architecture-guide?view=sql-server-ver15#row-mode-execution

Row mode execution



Sort
Reorders the input.

Node ID: 7
Physical Operation: Sort
Logical Operation: Sort
Estimated Execution Mode: Row
Estimated Rows: 31,263,600
Estimated I/O Cost: 983.4300000
Estimated CPU Cost: 805.0430000
Estimated Executions: 1.0
Estimated Operator Cost: 1,788.4730000 (79.3%)
Estimated Subtree Cost: 1,964.1900000
Estimated Row Size: 19 B
Estimated Data Size: 566 MB
Memory Fractions:
In: 100.00%
Out: 100.00%

Order By:
[AdventureWorks2017].[dbo].[bigTransactionHistory].[ProductID] Ascending
[AdventureWorks2017].[dbo].[bigTransactionHistory].[TransactionID] Ascending

Output List:
[AdventureWorks2017].[dbo].[bigTransactionHistory].[ProductID]
[AdventureWorks2017].[dbo].[bigTransactionHistory].[Quantity]
[AdventureWorks2017].[dbo].[bigTransactionHistory].[TransactionID]

Batch mode execution

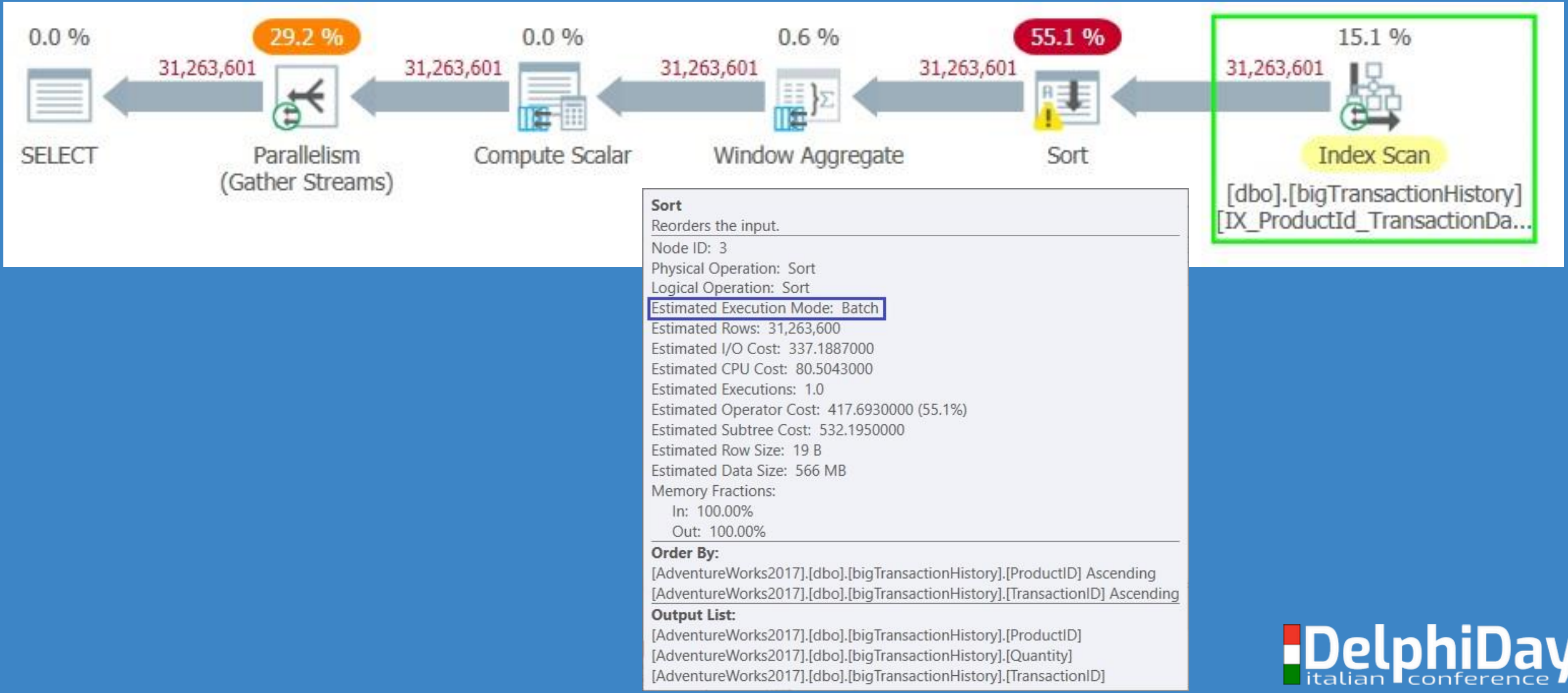
- ➔ Batch mode execution is a query processing method used to process multiple rows together, query operators process data more efficiently
- ➔ Each column within a batch is stored as a vector in a separate area of memory, so batch mode processing is vector-based

Batch mode execution

➔ Batch mode processing operates on compressed data when possible and eliminates the exchange operator used by row mode execution. The result is better parallelism and faster performance

https://docs.microsoft.com/sql/relational-databases/query-processing-architecture-guide?view=sql-server-ver15#batch-mode-execution

Batch mode execution



Sort
Reorders the input.

Node ID: 3
Physical Operation: Sort
Logical Operation: Sort
Estimated Execution Mode: Batch
Estimated Rows: 31,263,600
Estimated I/O Cost: 337.1887000
Estimated CPU Cost: 80.5043000
Estimated Executions: 1.0
Estimated Operator Cost: 417.6930000 (55.1%)
Estimated Subtree Cost: 532.1950000
Estimated Row Size: 19 B
Estimated Data Size: 566 MB
Memory Fractions:
In: 100.00%
Out: 100.00%

Order By:
[AdventureWorks2017].[dbo].[bigTransactionHistory].[ProductID] Ascending
[AdventureWorks2017].[dbo].[bigTransactionHistory].[TransactionID] Ascending

Output List:
[AdventureWorks2017].[dbo].[bigTransactionHistory].[ProductID]
[AdventureWorks2017].[dbo].[bigTransactionHistory].[Quantity]
[AdventureWorks2017].[dbo].[bigTransactionHistory].[TransactionID]

Columnstore and query mode execution

- ➔ SQL Server 2012 introduced a new feature to accelerate analytical workloads: columnstore indexes
- ➔ SQL Server expanded the use cases and improved the performance of columnstore indexes in each subsequent release
- ➔ SQL Server 2016 enables the creation of empty filtered columnstore indexes

Columnstore and query mode execution

- ➔ Up to SQL Server 2017 batch mode processing requires a columnstore index to be enabled
- ➔ Starting with SQL Server 2019 (15.x) and in Azure SQL Database, batch mode execution no longer requires columnstore indexes, the feature is called Batch mode on rowstore!

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Demo

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Join order

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Join order

- ➔ Query Optimizer must find the optimal sequence of joins between the tables used in the query, it defines the join order
- ➔ Finding the optimal join order is one of the most difficult problems in query optimization and it has be done within the available time

Join order

- ➔ Does the Query Optimizer analyze all possible join orders?
- ➔ No, it doesn't! ☹
- ➔ It finds a balance between the optimization time and the quality of the resulting plan

Join order

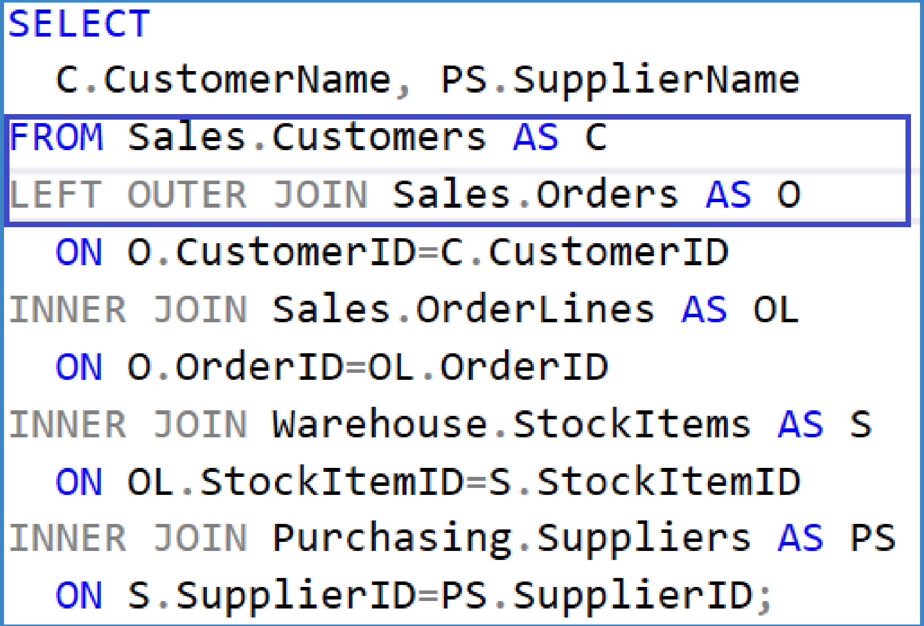
Please, consider this query…

```
SELECT
  C.CustomerName, PS.SupplierName
FROM Sales.Customers AS C
INNER JOIN Sales.Orders AS O
  ON O.CustomerID=C.CustomerID
INNER JOIN Sales.OrderLines AS OL
  ON O.OrderID=OL.OrderID
INNER JOIN Warehouse.StockItems AS S
  ON OL.StockItemID=S.StockItemID
INNER JOIN Purchasing.Suppliers AS PS
  ON S.SupplierID=PS.SupplierID;
```

Supplier-Customer that have joint activity

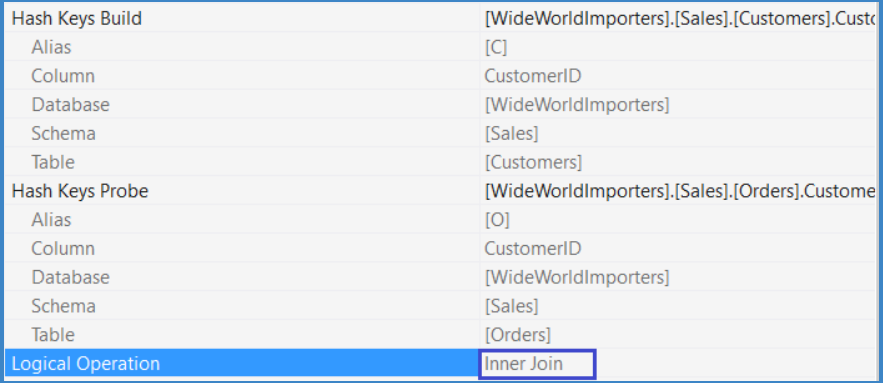
Now imagine, you want to preserve customers who have no orders…

Join order



```sql
SELECT
  C.CustomerName, PS.SupplierName
FROM Sales.Customers AS C
LEFT OUTER JOIN Sales.Orders AS O
  ON O.CustomerID=C.CustomerID
INNER JOIN Sales.OrderLines AS OL
  ON O.OrderID=OL.OrderID
INNER JOIN Warehouse.StockItems AS S
  ON OL.StockItemID=S.StockItemID
INNER JOIN Purchasing.Suppliers AS PS
  ON S.SupplierID=PS.SupplierID;
```

Query optimizer has detected a contradiction...



Hash Keys Build	[WideWorldImporters].[Sales].[Customers].Custo
Alias	[C]
Column	CustomerID
Database	[WideWorldImporters]
Schema	[Sales]
Table	[Customers]
Hash Keys Probe	[WideWorldImporters].[Sales].[Orders].Custome
Alias	[O]
Column	CustomerID
Database	[WideWorldImporters]
Schema	[Sales]
Table	[Orders]
Logical Operation	Inner Join

Demo

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Temp table cache contention

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Tempdb

- ➔ It stores
  - ➔ User objects
  - ➔ Work objects (worktable for Sort and Spool, etc.)
  - ➔ Version Store (Row Versioning)
- ➔ It's always recreated after SQL Server restart
- ➔ It uses simple recovery model
- ➔ One tempdb for the entire instance = It's a bottleneck by design!

User objects in tempdb

- Local temporary tables
  - Prefix “#”, Scope limited to the local session
  - Auto dropped after the session is closed
- Global temporary tables
  - Prefix “##”, Visible in all sessions
  - Auto dropped after the session is closed
- Table variables
- Tables returned from the “Table Valued Functions”

Creating a temp table on tempdb means

- ➔ Reading the SGAM page (2:1:3) to find an extent with free space
  - ➔ An exclusive latch is active during the update
- ➔ Reading the PFS page (2:1:1) to find a free page within the extent
  - ➔ An exclusive latch is active during the update
- ➔ A PAGELATCH_* wait type occurs
  - ➔ Resources have the form 2:x:x
  - ➔ 2:1:1, 2:1:2 and 2:1:3

Temp table cache contention

- ➔ Temp table caching helped address metadata contention by allowing us to reuse tables
- ➔ Cache a temp table object
  - ➔ When you delete that table SQL Server doesn’t actually drop the metadata
  - ➔ SQL Server keeps a cache of all the temporary objects that are used through a stored procedure and then it reuses the metadata for those objects

Demo

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Summary

- ➔ One of the steps in the query optimization process is to convert non-sargable predicates to sargable predicates
  - ➔ Pay attention to NULLs
- ➔ SQL Server 2016 enables the creation of empty filtered columnstore indexes that you can use to enable batch mode execution in the OLTP scenarios without maintenance costs on columnstore indexes

Summary

- ➔ The logical join ordering is determined by the order of ON clauses
- ➔ If you have a query that uses more than one table always use aliases for all tables

Resources

- ➔ Sargable predicates and NULLs in SQL Server
  - ➔ https://segovoni.medium.com/sargable-predicates-and-null-values-in-sql-server-c43ec3d8b108
- ➔ Query mode execution
  - ➔ https://segovoni.medium.com/sql-server-query-mode-execution-and-columnstore-indexes-fa05152c0753
  - ➔ https://bit.ly/3Hmcyuf
- ➔ Thinking Big (Adventure) by Adam Machanic
  - ➔ http://dataeducation.com/thinking-big-adventure
- ➔ Session materials on GitHub
  - ➔ https://bit.ly/3WBxPt3

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THANK YOU

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