Microsoft

SQL Server Statistics Structure

Module 6

Learning Units covered in this Module

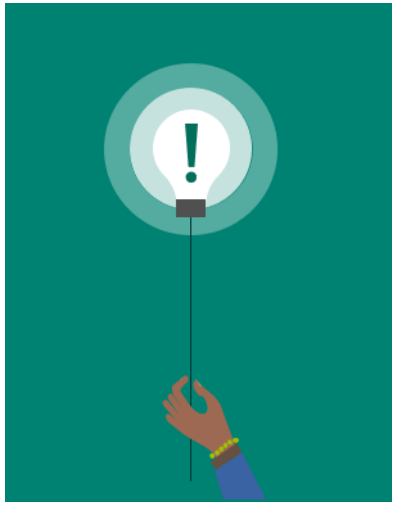
- Lesson 1: SQL Server Statistics Internals
- Lesson 2: SQL Server Statistics Maintenance

Lesson 1: SQL Server Statistics Internals

Objectives

After completing this learning, you will be able to:

- Understand statistics, and to retrieve their contents.
- Review database options used to control statistics creation and update.
- Use different methods to read statistics information.



SQL Server statistics

What are the statistics?

Statistics contain statistical information about distribution of values in one or more columns of a table or index.

It is stored as binary large objects (BLOBs).

It is used by the Query Optimizer (QO) to estimate the *cardinality*, or number of rows, in the query result, and enable the creation of high-quality query plans.

Statistics are created:

- Intrinsically when indexes are created.
- Manually by using CREATE STATISTICS command.
- Automatically, to support WHERE clauses (if AUTO_CREATE_STATISTICS in ON).

Statistics components

Density Vector

Density is information about the number of duplicates in each column or combination of columns

•Used when query predicate contains variable
WHERE col = @variable
or when a stored procedure uses query on a modified parameter:
WHERE col = @local_variable

Histogram

A **histogram** measures the frequency of occurrence for each distinct value in a data set.

•Used when query predicate contains
WHERE col = 'literal'
or when a stored procedure uses a query on a parameter
WHERE col = @parameter

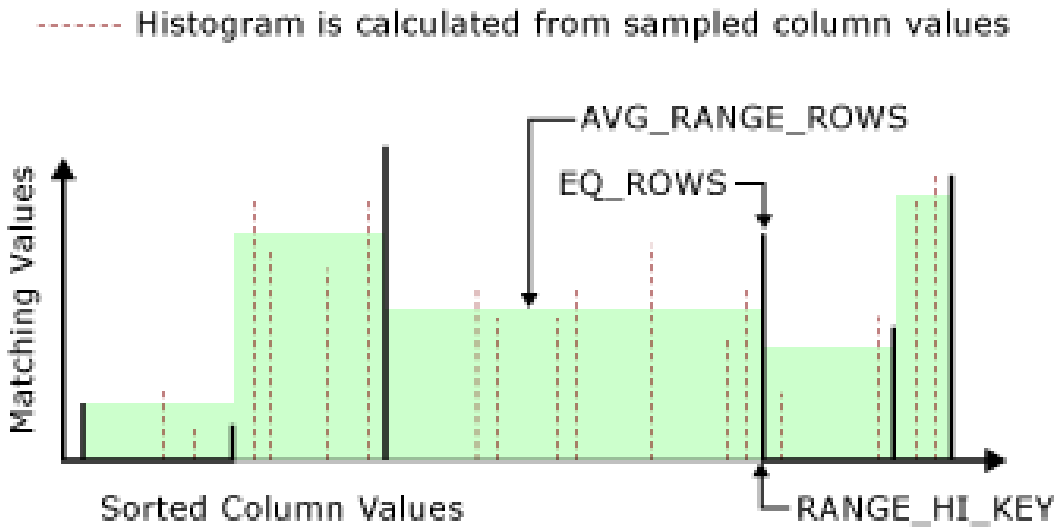
Statistics components

Histogram

It is computed from the values in the leftmost key column of the statistics object.

Data is selected from table or view in one of two ways:

- Statistically sampling rows.
  Data shown contains estimates of rows and distinct values.
- Performing a full scan of all rows.
  Data shown contains actual numbers.



Showing Statistics

```
DBCC SHOW_STATISTICS ('Sales.SalesOrderDetail', 'IX_SalesOrderDetail_ProductID')
WITH STAT_HEADER, HISTOGRAM
```

Results | Messages

Name	Updated	Rows	Rows Sampled	Steps	Density	Average key length	String Index	Fil
IX_SalesOrderDetail_ProductID	Nov 7 2012 6:44PM	121317	121317	200	0.0078125	12	NO	N

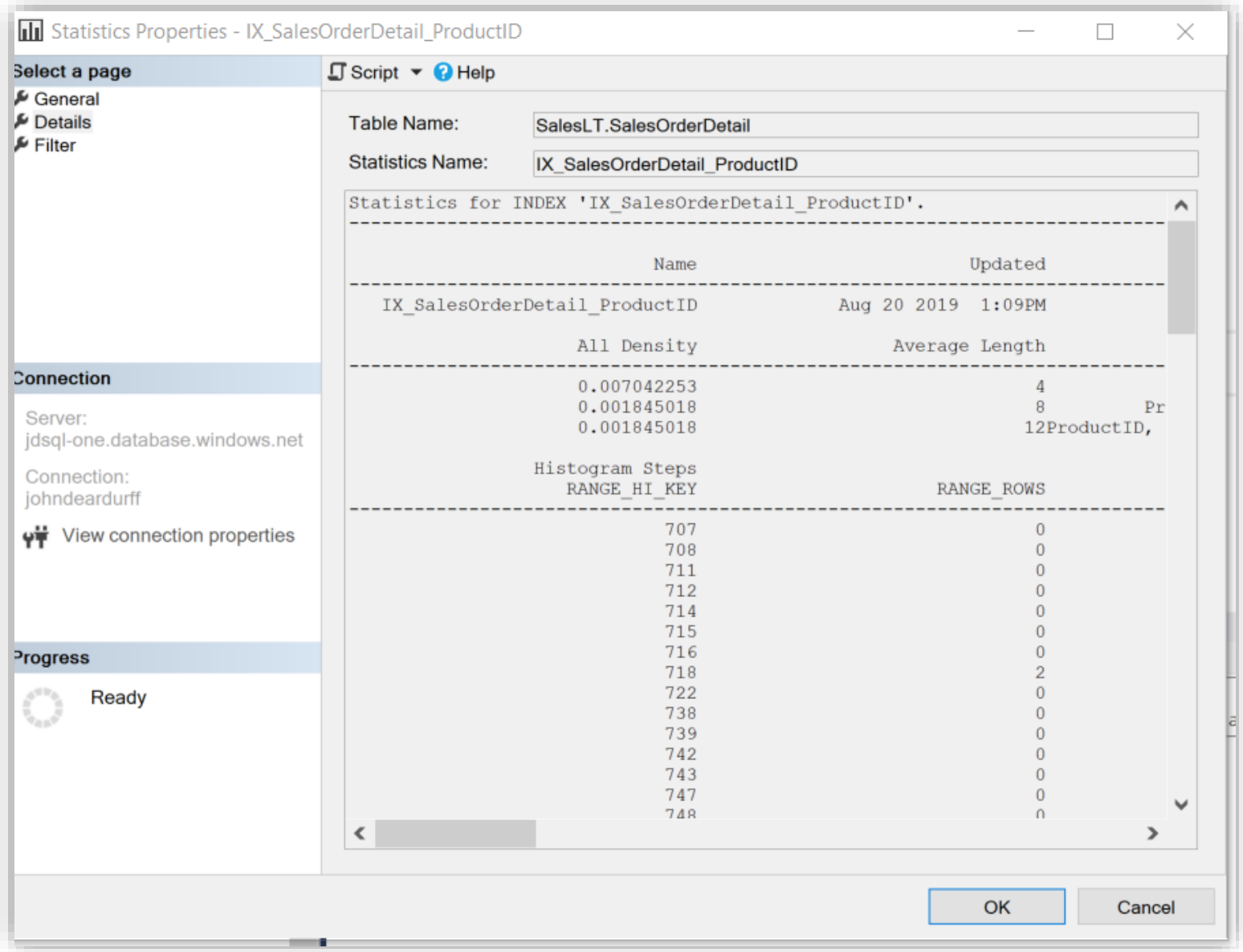
RANGE_HI_KEY	RANGE_ROWS	EQ_ROWS	DISTINCT_RANGE_ROWS	AVG_RANGE_ROWS
730	0	288	0	1
732	0	130	0	1
738	154	600	2	77
741	167	94	1	167
742	0	288	0	1

```
SELECT
    ProductID, RecordCount = COUNT(*)
FROM Sales.SalesOrderDetail
WHERE
    ProductID >= 732 AND
    ProductID <= 738
GROUP BY ProductID
```

Results | Messages

ProductID	RecordCount
732	130
733	44
736	110
738	600

Showing Statistics



Automatically created statistics

Database options that affects automatic statistics creation and update

AUTO_CREATE_STATISTICS

AUTO_UPDATE_STATISTICS

AUTO_UPDATE_STATISTICS_ASYNC

INCREMENTAL

Use the defaults unless you NEED to do otherwise.

Do not enable auto-create statistics on SharePoint content database.

The small sample rate of AUTO_UPDATE_STATISTICS can cause some workloads to choose sub-optimal execution plans.

Manually created Statistics

For most queries, the query optimizer generates necessary statistics for a high-quality query plan.

In a few cases, additional statistics is needed to improve query performance.

```
CREATE STATISTICS ContactPromotion1
ON Person.Person (BusinessEntityID, LastName, EmailPromotion)
```

Filtered Statistics

May help address statistics quality issues for large tables with uneven data distributions.

Update threshold on filtered statistics is based on overall table threshold and *not* the filter predicate.

Filtered Statistics will not be used when RECOMPILE hint is missing.

```
CREATE STATISTICS ContactPromotion1
ON Person.Person (BusinessEntityID, LastName, EmailPromotion)
WHERE EmailPromotion = 2
```

Incremental statistics

Introduced in SQL Server 2014.

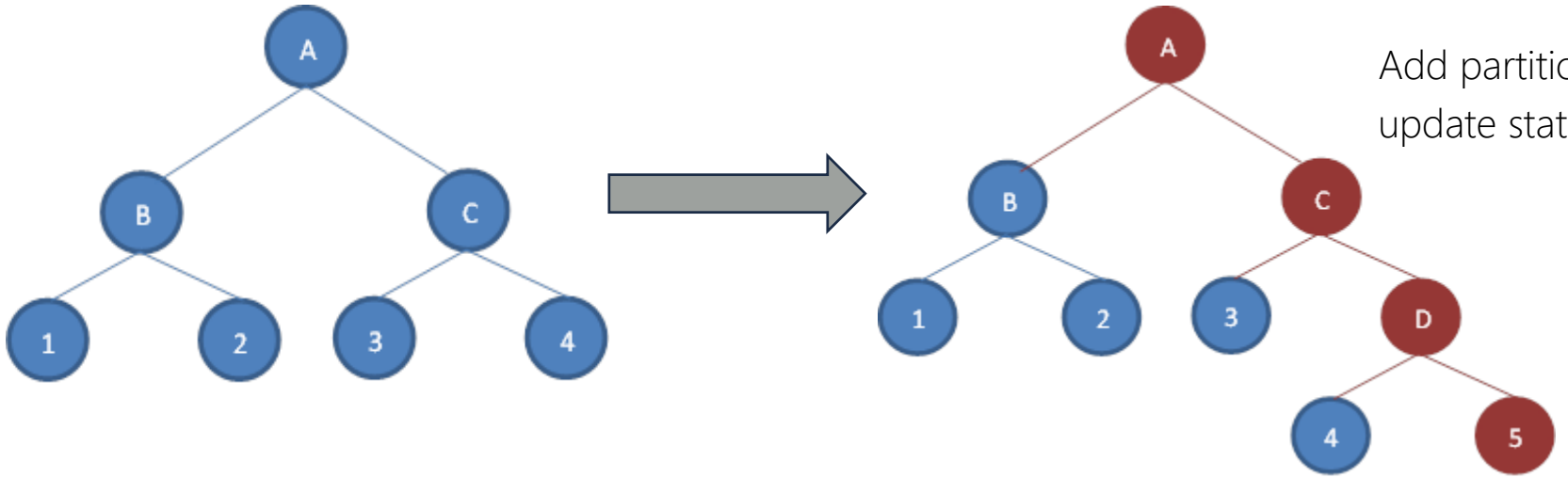
The incremental option creates and stores statistics on a per partition basis.

It allows to update statistics for a single partition. reducing maintenance times and eliminating the need to scan all partitions to get data to calculate statistics.

Partition level statistics are merged into a global statistic.

Per-Partition Statistics are not available for query optimization and the cardinality estimator still uses global table stats for query optimization.

Create Incremental Statistics on a four partition table



Add partition 5 and update statistics

Available tools to review statistics

	Metadata	Last Update Date	Sampling Rate	Row Mod Counter	Density Vector	Histogram
sys.stats	X					
STATS_DATE()		X				
sys.dm_db_stats_properties (object_id, stats_id)		X	X	X		
sys.dm_db_incremental_stats_properties (object_id, stats_id)		X	X	X		
sys.dm_db_stats_histogram (object_id, stats_id)						X
SQL Server Mgt Studio	X	X	X		X	X
DBCC SHOW_STATISTICS		X	X	X	X	X

Demonstration

Exploring statistics

Questions?

Knowledge Check

What is the density vector, and how does it differ from the histogram?

When would filtered statistics be a good option?

Explain incremental statistics?

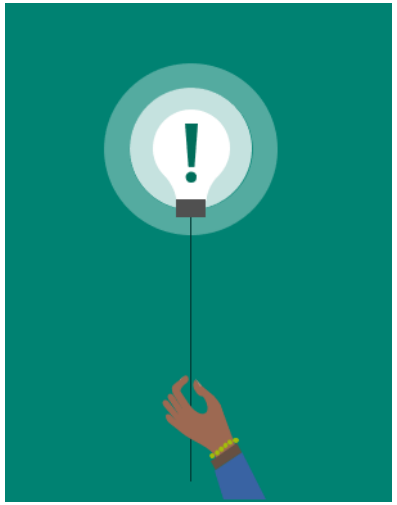
Is it possible to have an index with no statistics associated?

Lesson 2: SQL Server Statistics Maintenance

Objectives

After completing this learning, you will be able to:

- Describe the importance of updating statistics on a regular basis.
- Differentiate between manual and automatic update statistics methods.
- Understand when automatic statistics updates occur.



Why update statistics?

Up-to-date statistics are crucial for generating optimal query plans and to ensure excellent performance.

Data changes over time and a statistic created hours/days/weeks ago can not represent correctly data distribution.

Updating statistics ensures that queries compile with up-to-date statistics.

However, when updating statistics consider that:

- It causes queries to recompile.
- It can use TempDB to sort the sample of rows for building statistics.

Manual statistics update

UPDATE STATISTICS

sp_updatestats

Automatic statistics update

Using ALTER INDEX

- When an index is rebuilt, all data is read, and index statistics are updated with a sample of 100%.
- Statistics are not created or updated by scanning all the rows in the table for partitioned indexes. Instead, the default sampling algorithm is used.
- Reorganizing an index does not update statistics.

Automatic statistics update

AUTO_UPDATE_STATISTICS database option

AUTO_UPDATE_STATISTICS is ON by default on all new databases.

SQL Server fires statistics updates if a query is executed and it considers the statics might be out of date considering the tracked changes on column.

AUTO_UPDATE_STATISTICS_ASYNC is OFF	AUTO_UPDATE_STATISTICS_ASYNC is ON
The query executing is suspended until statistics are updated and a new plan is created. This can create performance issues as the process to update statistics can take a long time on big indexes.	The query is executed using existing statistics and statistics are updated as asynchronous operation. It can be useful in scenarios where synchronous statistics update take a long time.

Automatic statistics update

AUTO_UPDATE_STATISTICS threshold calculation

SQL Server 2014 or databases with compatibility level 120 or lower:

	Threshold calculation
Permanent Table	If n <= 500, RecompilationThreshold(RT) = 500 If n > 500, RT = 500 + 0.20 * n
Temp Table	If n < 6, RT = 6 If 6 <= n <= 500, RT = 500 If n > 500, RT = 500 + 0.20 * n
Table Variable	No statistics, unless Trace flag 2453 enabled Trace flag 2453 allows a table variable to trigger recompile when enough number of rows are changed
Incremental statistics	To update global stat: 500 + 20% of average partition size (non-empty) To update per-partition stat: 20% data change based on average partition size

The previous formula is a linear function, so the biggest the table, the lower the probability that statistics are automatically updated, leading to potential performance problems.

Automatic statistics threshold

In SQL Server 2016 and later the following formula is used:

RT = SQRT (1000 * #rows)

Rows	Old formula	New Formula
1,000	**700**	1,000
10,000	**2,500**	3,162
20,000	4,500	4,472
30,000	6,500	**5,477**
50,000	10,500	**7,071**
100,000	20,500	**10,000**

The new formula can be enabled in SQL 2008 R2 SP1 and later by using Trace Flag 2371.

TF23711 can be used in SQL Server 2016+ for databases with compatibility level 120 or lower.

Automatic statistics update

Disabling automatic updates (AUTO_UPDATE_STATISTICS) for specific indexes

To control when statistics are updated on a table basis.

Auto update statistics can be disabled in three ways:

Using the option NORECOMPUTE in the CREATE STATISTICS and UPDATE STATISTICS commands.

Using the option (STATISTICS_NORECOMPUTE = ON) in the CREATE INDEX and ALTER INDEX ... REBUILD commands.

Executing the stored procedure sp_autostats.

Automatic statistics updates can be reenabled, using the sp_autostats or by executing UPDATE STATISTICS without the NORECOMPUTE option.

Performance Monitor Counters

Execution Statistics

SQL Errors\Errors/sec

- Error types must be investigated and possibly resolved.

SQL Statistics\Batch Requests/sec

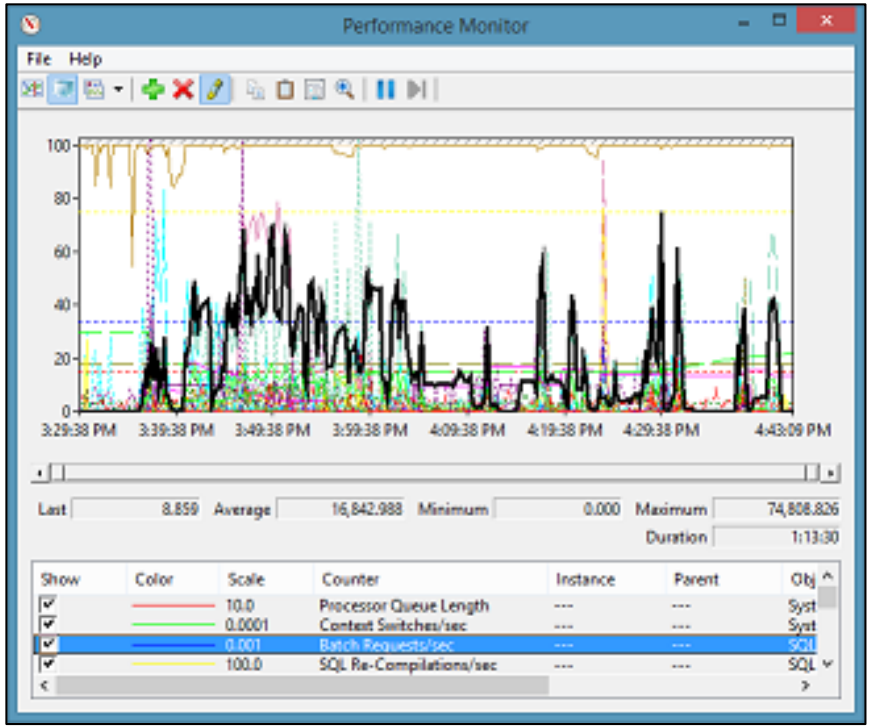
- Batch Requests > 1000 indicates busy server.

SQL Statistics\SQL Compilations/sec

- A high number can be an indicator of ad hoc queries, this must be cross referenced with ad hoc plans in the plan cache.

SQL Statistics\SQL Recompilations/sec

- If high determine recompilation reason with Xevent session. Usually stale statistics, Temp table usage and option WITH Recompile.



Statistics Update

- Observing Automatic statistics update
- Updating Statistics by executing ALTER INDEX

Questions?

Knowledge Check

Does an INDEX REORG update its statistics?

What is the % of data sampled used to update statistics when ALTER INDEX … REBUILD is executed?

Is it possible to disable auto updates for a particular statistic?

What is the formula for the auto update statistics threshold in SQL Server 2106+ (compatibility 130+)?