Gianluca Hotz

SQL Server Database Engine 2017 Enhancements


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Who am I

Gianluca Hotz | @glhotz | ghotz@ugiss.org

Fondatore e Mentor SolidQ

- 20+ anni con SQL Server (dalla 4.21 nel 1996)
- Modellazione basi di dati, dimensionamento e amministrazione, sviluppo, ottimizzazione

Interessi

- Modello relazionale, architettura DBMS, alta disponibilità e Disaster Recovery

Community

- 20 anni Microsoft MVP SQL Server (dal 1998)
- Fondatore e presidente UGISS
  - User Group Italiano SQL Server (PASS Chapter)

Agenda

- Configuration
- Development — Demo First!
- In-Memory
- Administration — Demo First!
- HA & DR
- Performance
- Q&A

Configuration

Installation

Separate downloads

- SQL Server Management Studio 17.x (use it also for SQL 2016)
- SQL Server Data Tools
- **New in 2017: Reporting Services**

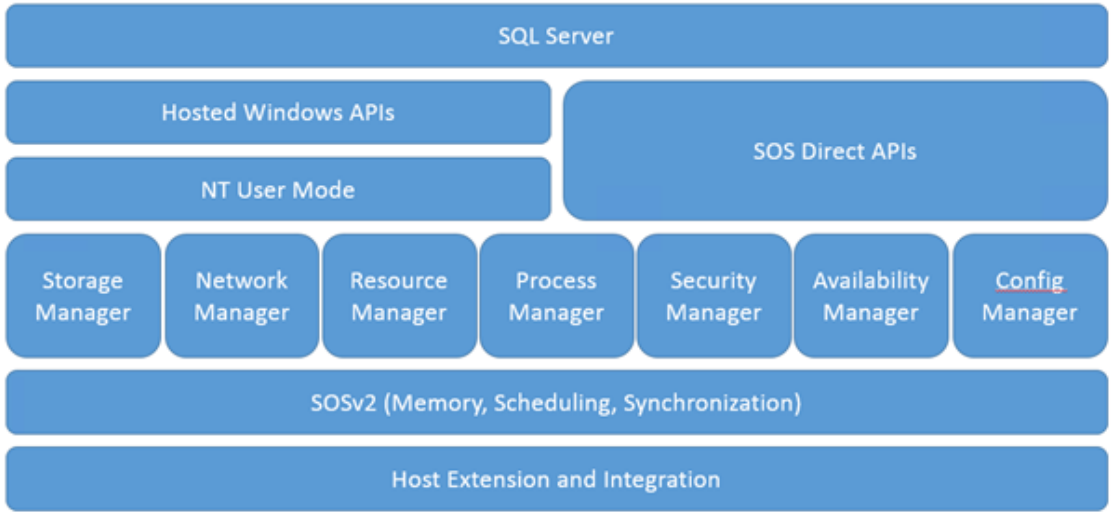
Tempdb configuration

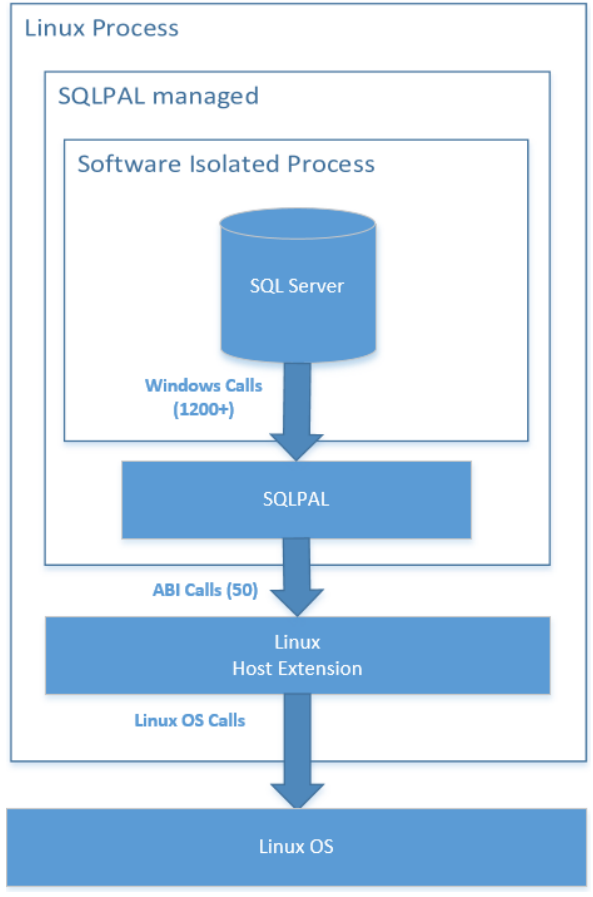
- Allows up to 256GB file size
- Warning if > 1GB and Instant File Initialization not enabled

Linux

- Easy: import repo GPG keys, register repository, apt-get update/install
- **mssql-conf** to script out installation (or to be used in a script installation)
- can use environment variables

SQL on Linux Architecture





SQL on Linux Supported Distro/Versions

Red Hat Enterprise Linux 7.3 or 7.4

Ubuntu Linux 16.04 LTS

Suse Linux Enterprise Server v12 SP2

Docker Engine 1.8+ on Linux, Mac, Windows

SQL on Linux Minimum Requirements

2 x core CPU 2Ghz (x64 only)

3,25 GB memory

6GB disk space (XFS or EXT4 file systems)

SQL on Linux Packages

mssql-tools

ODBC libraries
sqlcmd command-line querying tool
bcp for bulk import/export

mssql-server-agent

mssql-server-fts

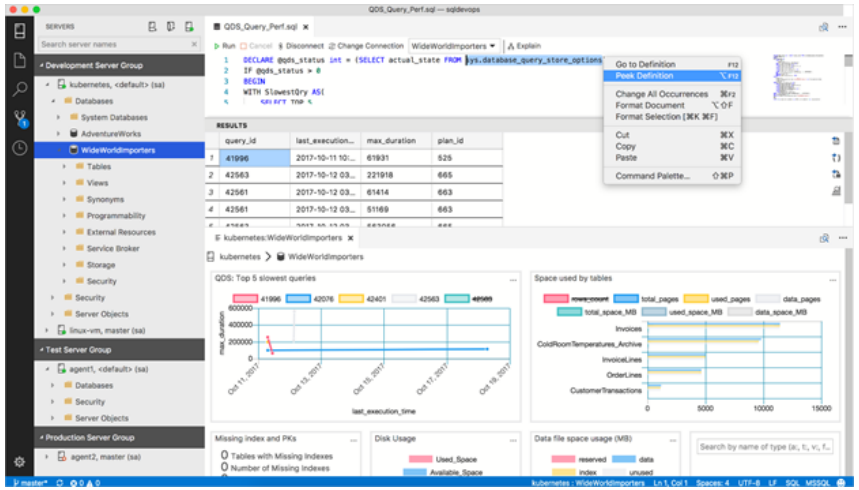
Full-Text indexing and Semantic Search (requires additional steps)

mssql-server-is

Tools

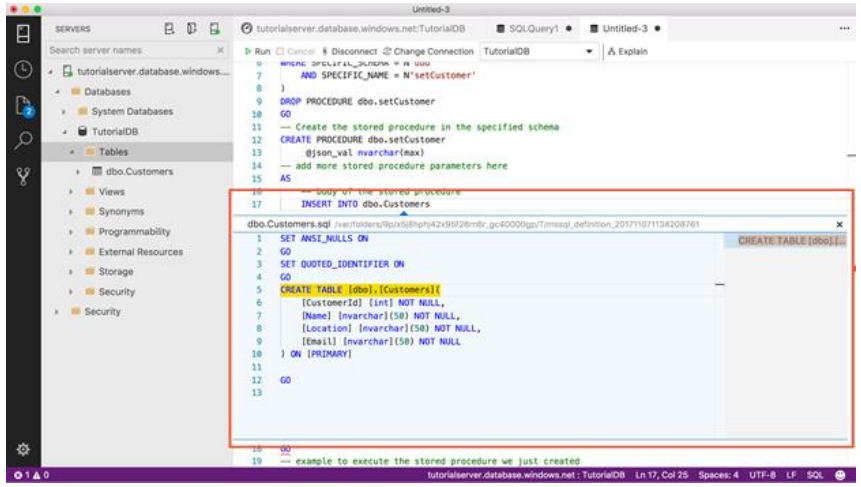
In Linux

- Configuration script **mssql-conf**
- T-SQL commands with **sqlcmd**



In Windows

- SQL Server Management Studio (SSMS)
- Visual Studio with SQL Server Data Tools (SSDT)
- Visual Studio Code with **mssql** extension
- PowerShell
- T-SQL commands with **sqlcmd**



Multi platform (Windows, Mac, Linux)

- SQL Operation Studio (preview)

CLR Strict Security

Code Access Security (CAS) in.NET Framework

- No more supported as security boundary
- Assembly with **PERMISSION_SET = SAFE** may access external resources, call unmanaged code, acquire sysadmin privileges

New configuration option “CLR Strict Security”

- Treats **SAFE/EXTERNAL ACCESS** as **UNSAFE**
- Requires assemblies to be signed and login with **UNSAFE ASSEMBLY** permission
  (database with TRUSTWORTHY ON owned by login with UNSAFE ASSEMBLY permission)
- Enabled by default can be disabled for backward compatibility (not recommended)

White-listing

- **sp_add_trusted_assembly**, **sp_drop_trusted_assembly**

Database Configuration

ALTER DATABASE SCOPED CONFIGURATION

- Clear procedure cache
- Cardinality estimation independent of compatibility level
- Parameter sniffing
- Query optimization hotfixes
- **New in 2017**: identity cache, turn off to avoid gaps (like Trace Flag 272)

DATABASE SCOPED CREDENTIAL

- Now a securable class supporting CONTROL, ALTER, REFERENCES, TAKE OWNERSHIP, VIEW DEFINITION

Development

Demo First!

Database Development

SELECT...INTO

Supports **ON** keyword to specify filegroup

New bulk access options

FORMAT = 'CSV'

Support for RFC 4180 in BULK INSERT and OPENROWSET

CREATE EXTERNAL DATA SOURCE ... TYPE = BLOB_STORAGE

Point to specific LOCATION URL

Use Shared Access Signatures (SAS) via CREDENTIAL

Temporal Tables

Support for **CASCADE DELETE** and **CASCADE UPDATE**

Retention Policy support

- Instead of custom cleanup script, stretch database or table partitioning
- Enabled at database level
  - ALTER DATABASE SET … **TEMPORAL_HISTORY_RETENTION ON**
- Specified per table
  - e.g. WITH(SYSTEM_VERSIONING = ON(… **HISTORY_RETENTION_PERIOD = 6 MONTHS**)
  - Support for DAYS, WEEKS, MONTHS, YEARS and INFINITE
  - Checked against column representing end of SYSTEM_TIME period

T-SQL Development

CONCAT_WS

Concatenate strings (columns/values) using first one as separator

TRANSLATE

Replaces set of characters in string with other set of character
e.g. **SELECT TRANSLATE('2*[3+4]/{7-2}', '[]{}', '()()');**

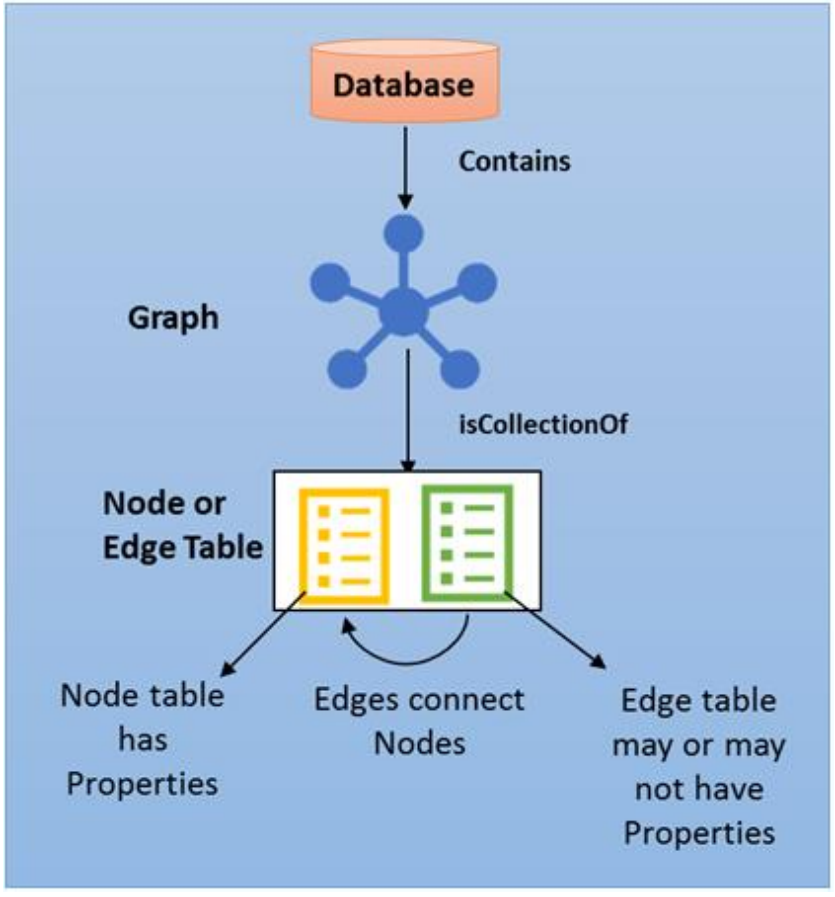
TRIM

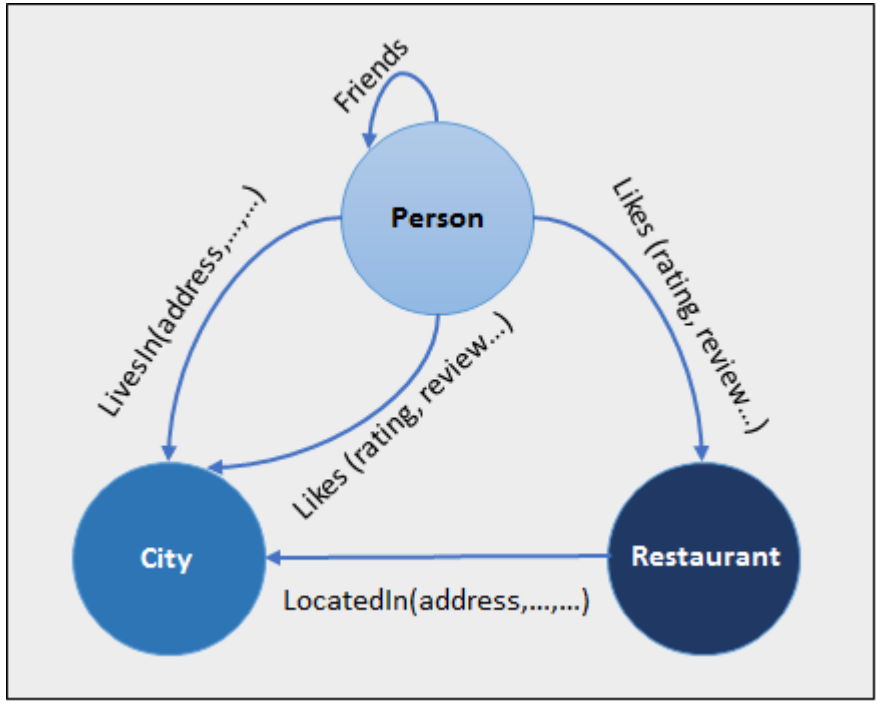
Finally!!!! ☺
Can trim a set of characters

STRING_AGG

Concatenates strings (rows) using separator

Graph Processing





Graph Processing Concepts

Node Table

Represent an entity

Edge Table

Represent many-to-many relationship
May have properties
Is directed, connects two nodes

MATCH T-SQL Command

Search condition for graph objects
Pattern matching and traversal

In-Memory

Columnstore Indexes in SQL Server 2017

Support for non-persisted computed column

Support for LOBs

- Clustered Columnstore only
- Already available also in Azure SQL Database (Premium)
- E.g. JSON data case
  - https://blogs.msdn.microsoft.com/sqlserverstorageengine/2017/02/09/json-data-in-clustered-column-store-indexes

Online non-clustered Columnstore index build/rebuild support

Feature summary for product releases

- https://docs.microsoft.com/en-us/sql/relational-databases/indexes/columnstore-indexes-what-s-new

Memory-Optimized Tables in SQL 2017

Support for computed columns

- Including indexes on computed columns

Support for **JSON** functions

- Both natively compiled T-SQL modules and check constraints

Increased support in natively compiled T-SQL modules

- **CROSS APPLY, CASE, TOP (N) WITH TIES, sp_spaceused, sp_rename**

Azure Storage support for memory-optimized files

- Including backup/restore

Performance

- Faster ALTER TABLE and bw-tree index rebuild during recovery
- Transaction-log REDO done in parallel

Administration

Demo First!

System Metadata

sys.dm_os_sys_info

Added **socket_count, cores_per_socket, numa_node_count**
Useful with VM

sys.dm_os_host_info

OS information on Windows/Linux

Undocumented

sys.dm_os_enumerate_fixed_drives
sys.dm_os_enumerate_filesystem(dir, pattern)
sys.dm_os_file_exists(dir_or_file)

Database Metadata

sys.dm_db_log_stats()

Summary info about t-log, useful for monitoring

sys.dm_db_file_space_usage

Added **modified_extent_page_count**
Useful to build smart backup solutions eg. differential if < 70-80%, full otherwise

sys.dm_tran_version_store_space_usage

Reserved space in pages/KB

sys.dm_db_stats_histogram(object, stat)

SQL Server 2017 / SQL Server 2016 SP1 CU2

DBCC CLONEDATABASE

Creates empty copy of database for troubleshooting

- No data but full schema
  - (constraints, type, t-sql modules, etc.)
- Statistics
- Non blocking
- Read only by default but can be changed
- Optionally **NO_STATISTICS**, **NO_QUERYSTORE**
- SQL Server 2012 SP4, 2014 SP2 CU3, 2016 SP1, 2017

USE HINT Query Option

Named hints instead of hard to remember trace flags

OPTION (USE HINT('DISABLE_PARAMETER_SNIFFING')) instead of **OPTION (QUERYTRACEON 4136)**

Doesn't require sysadmin permission!

Available in SQL Server 2017 / SQL Server 2016 SP1

List from **sys.dm_exec_valid_use_hints**

ASSUME_JOIN_PREDICATE_DEPENDS_ON_FILTERS	9476
ASSUME_MIN_SELECTIVITY_FOR_FILTER_ESTIMATES	4137, 9471
DISABLE_PARAMETER_SNIFFING	4136
DISABLE_OPTIMIZER_ROWGOAL	4138
DISABLE_OPTIMIZED_NESTED_LOOP	2340
ENABLE_HIST_AMENDMENT_FOR_ASC_KEYS	2389
ENABLE_QUERY_OPTIMIZER_HOTFIXES	4199
FORCE_DEFAULT_CARDINALITY_ESTIMATION	2312
FORCE_LEGACY_CARDINALITY_ESTIMATION	9481

Execution Plan Enhancements

- Shows query time statistics
  - CPU time and Elapsed time
  - SQL Server 2012 SP4, 2016 SP1, 2017, 2014 (TBD)
- Shows query-level Wait Stats!!
  - Top 10 wait stats
  - Also tracked in **sys.dm_exec_session_wait_stats**
  - SQL Server 2012 SP4, 2016 SP1, 2017 (compatibility 140!), 2014 (TBD)
- Shows query-Level Trace Flags
  - Including level: global, session or query
  - SQL Server 2012 SP4, 2014 SP2, 2016 SP1, 2017

Query execution profiling

sys.dm_exec_query_statistics_xml(session)

- Execution plan with transient, in-flight statistics
  - (e.g. row count, CPU)
- Available in SQL Server 2017 / SQL Server 2016 SP1
- Works both with standard and lightweight statistics profiling
  - E.g. execute **SET STATISTICS XML ON** before query to analyze

Query Store in SQL Server 2017

Wait Statistics integrated in Query Store!

sys.query_store_wait_stats

Organized in Wait Categories

ALTER DATABASE …
SET QUERY_STORE (WAIT_STATS_CAPTURE_MODE = ON)

Automatic Tuning

Automatic plan correction

- Automatically force last good plan when regression detected
- Minimum 10 CPU seconds improvement
- **sys.dm_db_tuning_recommendations** for manual corrections
- SQL Server 2017 and Azure SQL Database

Automatic index management

- Automatically **CREATE** and **DROP** indexes
- Verifies usage and performance improvements
- Azure SQL Database only (also automatic FORCE PLAN)

HA & DR

AlwaysOn FCI in newer releases

SQL Server 2016

- Group Managed Service Accounts (gMSA)
  - Managed directly by AD
  - Automatic password rotation

SQL Server 2017

- SQL Server on Linux support

AlwaysOn AG in SQL Server 2017

Cross database transactions supported (MSDTC)

Minimum number of (sync) replicas to commit

Clusterless support

CLUSTER_TYPE = NONE (e.g. read-only scale out replicas not used for HA)

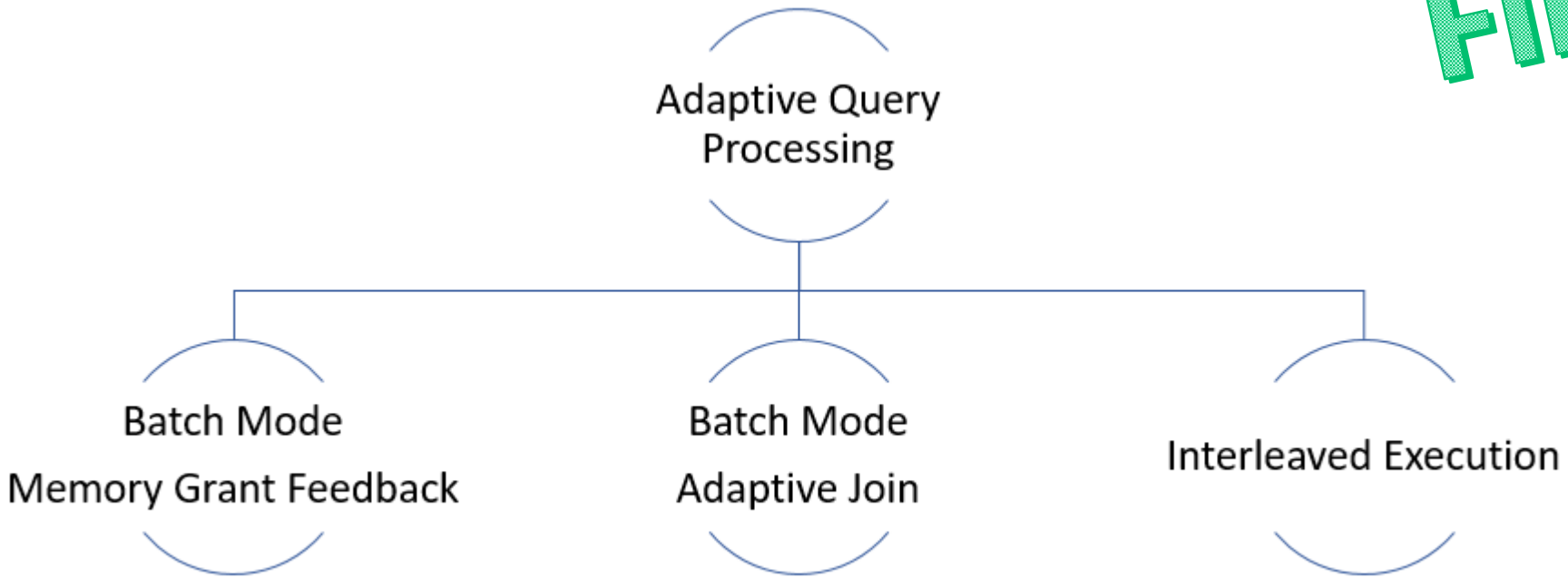
SQL Server on Linux support

CLUSTER_TYPE = EXTERNAL (Pacemaker)
CLUSTER_TYPE = NONE
Allows Windows-Linux cross-OS migrations

Performance

Adaptive Query Processing

Demo First!



Batch Memory Grant

Excessive Grant

Too much memory allocated vs. memory used
Impact: blocking, out-of-memory, reduced concurrency

Poor Grant

Not enough memory allocated resulting in data spill to tempdb
Impact: slow query, excessive disk usage (tempdb)

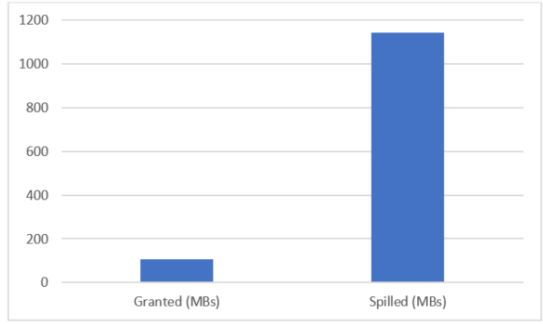
Grant increase

dynamic grants increase allocation too much
impact: server instability, unpredictable performance

Batch Mode Memory Grant Feedback

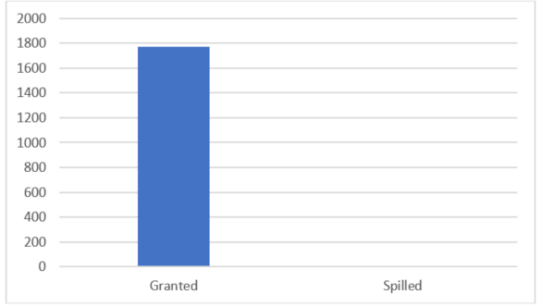
Post-execution evaluation

- Updates grant value for cached plan
- E.g. more memory if spilled, less if excessive grant



Parameter sensitive scenarios

- Some queries requires different plans with different grants
- Memory grant feedback will disable itself when unstable
  - **memory_grant_feedback_loop_disabled** extended event



Plan caching

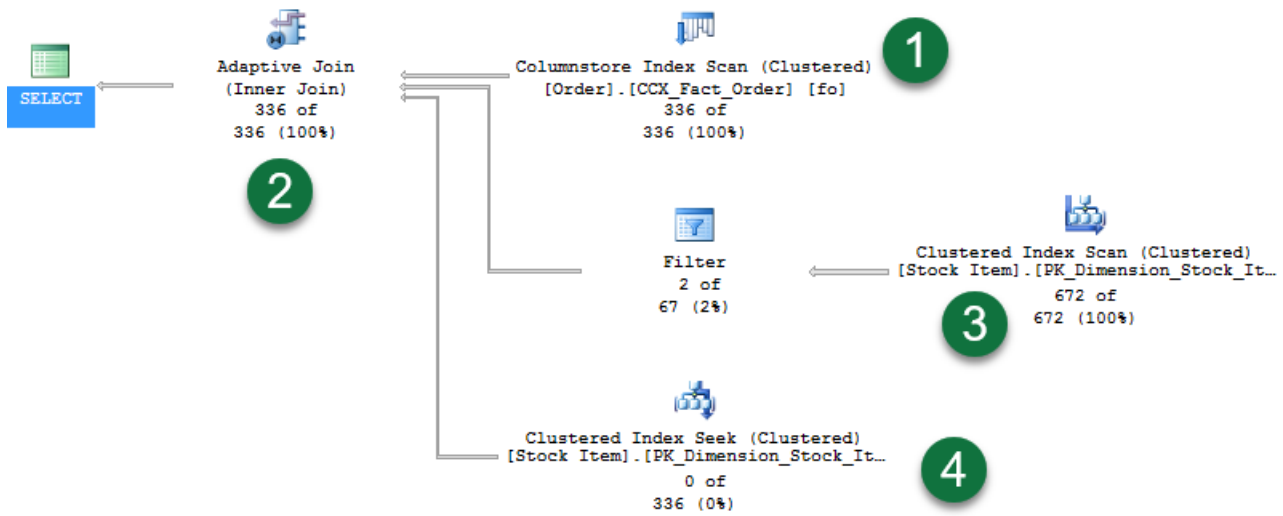
- Not persistent (i.e. not save in Query Store)
- OPTION(RECOMPILE) prevents caching and memory grant feedback

Batch mode adaptive joins

Scenario

- Nested loop algorithm better for small build join inputs
- Hash algorithm better for bigger inputs

Adaptive joins defer choice after first input scanned



Interleaved Execution

Problem with multi-statement table valued functions (MSTVFs)

- SQL Server <= 2012 optimize with cardinality = 1
- SQL Server 2014 & 2016 optimize with cardinality = 100

SQL Server >= 2017

- Start optimization
- Pause and executes MSTVFs if candidate
- Resume optimization with correct cardinality

Q&A