

Online on-demand Project Support



SQL Server Performance

Optimierung für Entwickler



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Motivation

- Übersicht
- Grundlagen
- Wichtiges

- Spaß

Zeitliche Planung

9:00 Uhr bis 17:00 Uhr

Mittagessen

12:00 Uhr bis 13:00 Uhr

Agenda

- Praktische Tipps
- Tabellendesign
- Versteckte Bremsen
- Ad hoc vs. Procedures & Co.
- Tabellen und deren Indizes

- Tools
 - Hilfreiche Helferlein

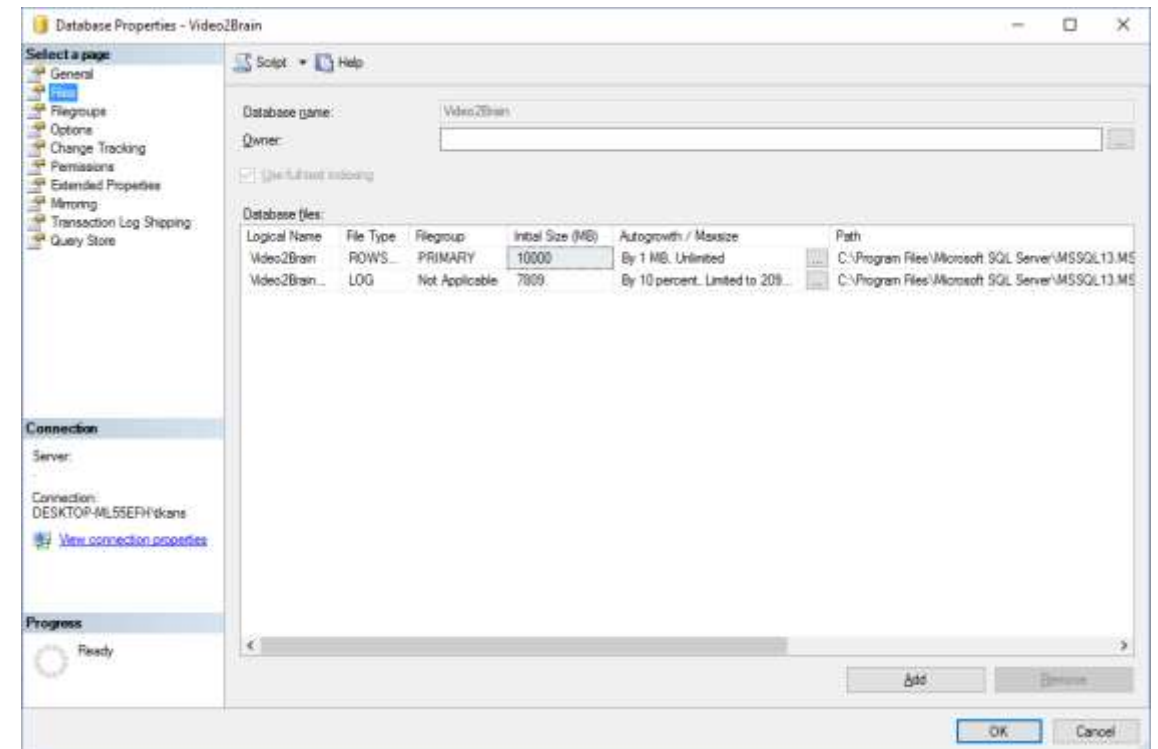


Grundlagen



Datenbankdimensionierung

- Größe (voraus-)planen
- Automatische Vergrößerung
- Aufteilung auf mehrere Dateien



Demo

Tabellendesign – die größten Sünden

- Datentypen
- Unicode oder nicht Unicode?
- Berechnete Spalten
- BLOBs
- NULLable
- Redundante Daten

Weniger Arbeit für CPU und I/O System
plus effizientere RAM-Ausnutzung!

Der richtige Datentyp

- DATE/ TIME statt DATETIME etc.
- BIT statt CHAR(1)
- TINYINT, SMALLINT, INT, BIGINT statt DECIMAL(n,0)
- CHAR statt VARCHAR(1)
- ...



<https://docs.microsoft.com/en-us/sql/t-sql/data-types/data-types-transact-sql?view=sql-server-2017>

Unicode oder nicht Unicode?

- Erhöhter Speicherbedarf
- Besonders Sortierung aufwendiger



[https://technet.microsoft.com/de-de/library/ms189617\(v=sql.105\).aspx](https://technet.microsoft.com/de-de/library/ms189617(v=sql.105).aspx)


Berechnete Spalten

- Sparen Speicherplatz, kosten Performancen
- Können persistiert werden

Nullable

- „Leere Felder“ als Nullable markieren
- Effizientere Verarbeitung und Speicherung

Blobs (Big large Objects)

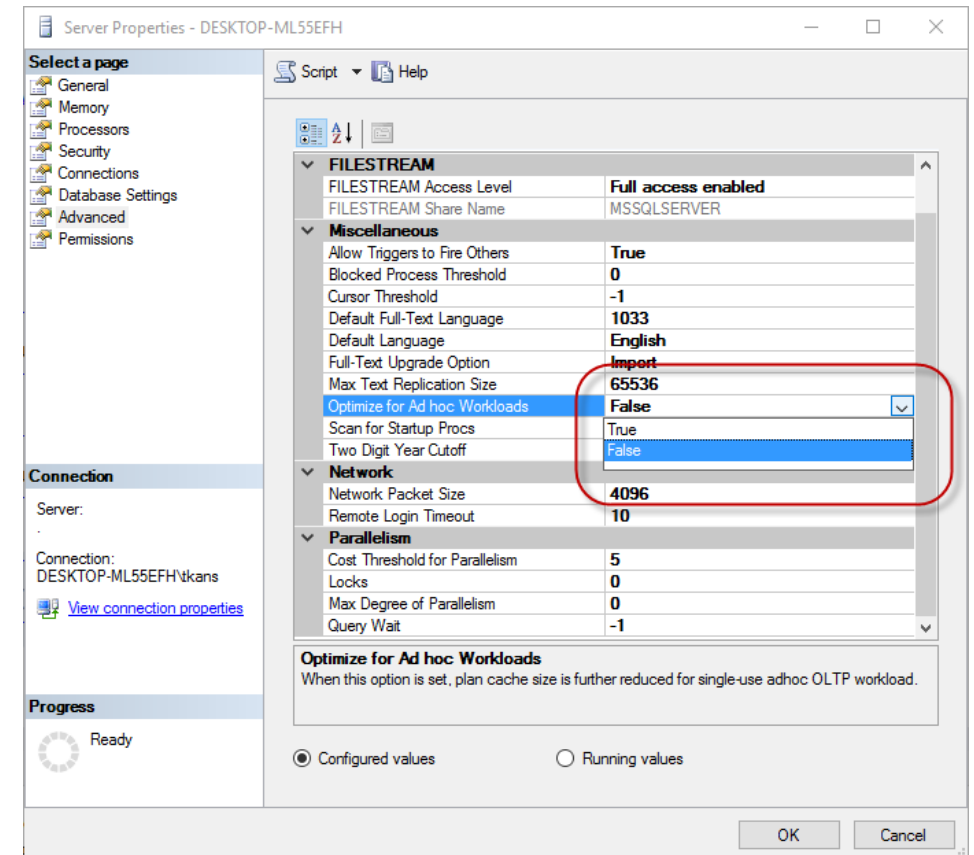
- (N) VARCHAR (MAX) , TEXT 
 - Out-of-Row-Storage mittels Pointer
 - Jede NOT NULL-Spalte min. 24 Bytes
- Komplize von „SELECT *“

Versteckte Bremsen

- Trigger
- Check Constraints
- Unnötiges Lesen von (statischen) Inhalten
- SELECT N+1

Ad hoc vs. Prozeduren & Co.

- Ad-hoc-Abfragen
 - flexibel
 - oftmals langsamer
- Prozeduren & Co.
 - starrer
 - Ausführungspläne



Indizes

A photograph of a street scene in Naples, Italy. The image shows a row of colorful buildings. On the left is a yellow building with red accents and a 'KARAOKE' sign. In the center is a green building with white window frames and a 'CIAO NAPOLI' sign. To the right is a grey building with arched windows. A semi-transparent blue banner with the word 'Indizes' is overlaid across the middle of the image.

Primary Key?

Jeder Primary Key ist ein Index

Jedoch:

Ein Index ist nicht zwangsläufig ein Primary Key

Wichtige Arten von Indizes

- Kein Index (Heap)
- Clustered Index
- Non Clustered Index
- Clustered ColumnStore Index
- Hash Index (Range Index)

Heap

- Tabelle, die keinen Clustered Index besitzt
- Kann Non Clustered Index besitzen

Clustered Index

- Legt die physikalische Reihenfolge der Zeilen fest („Der CI ist die Tabelle, die Tabelle ist der CI“)
- Es kann nur einen CI geben
- Max. Größe 900 Bytes

Non Clustered Index

- „Standard“-Index
- Max. 999 pro Tabelle
- Max. Größe pro Index 1.700 Bytes
- Benötigt zusätzlichen Speicher

Clustered Columnstore Index

- Hohe Kompression
- Ab 2016: sekundäre Indizes möglich

Hash Index (Range Index)

- Nur für Memoy Optimized Tables
- Tabelle wird beim Start der Datenbank ins RAM geladen
- Hash Index/Range Index
- Abweichendes Transaktionsverhalten (!)

Sonstige Arten von Indizes

- XML-Index
- Volltext-Index
- Räumlicher Index
 - Geometry und Geography



Index Prüfstand

Mengengerüst

- 10 Mio. Zeilen (dbo . ProduktverzeichnisQuelle)
- Recovery Mode Simple
- Datenbank ausreichend dimensioniert (~80% frei)
- Importieren (alle Zeilen)



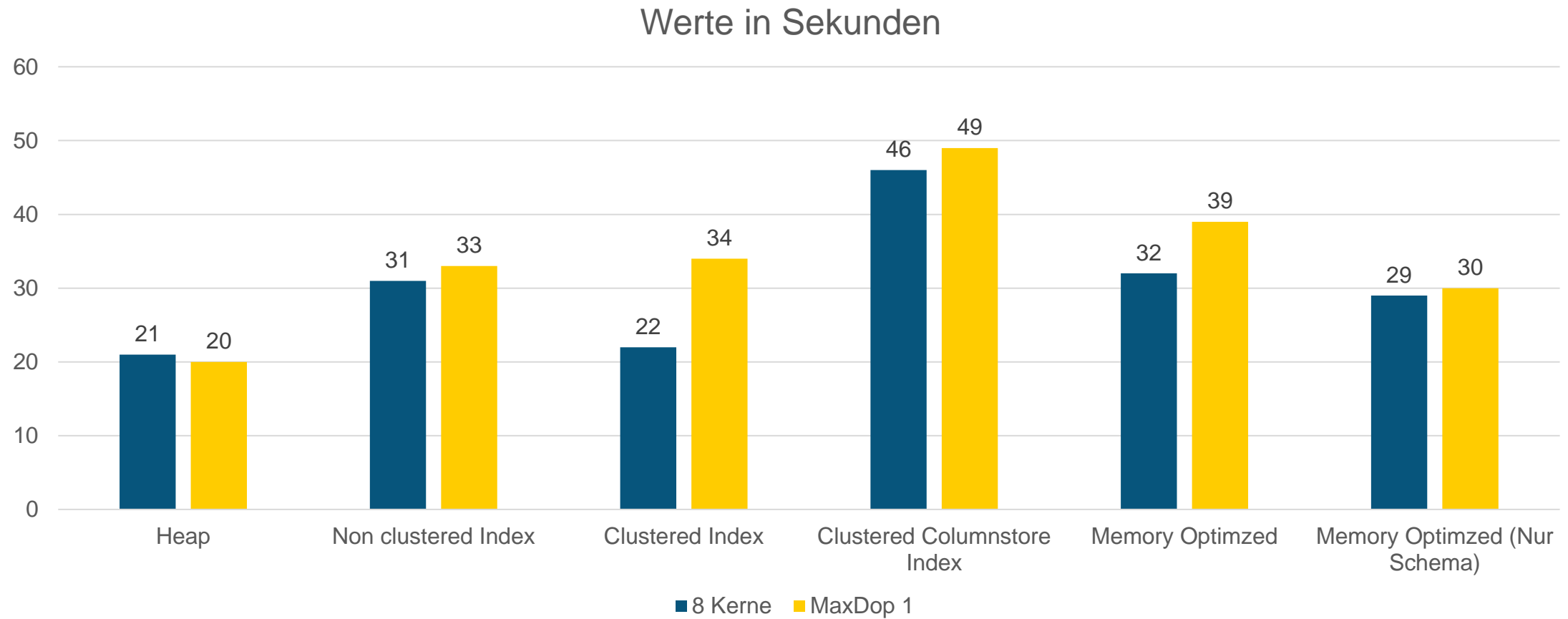
02 Indizes\01 IndexSetup.sql



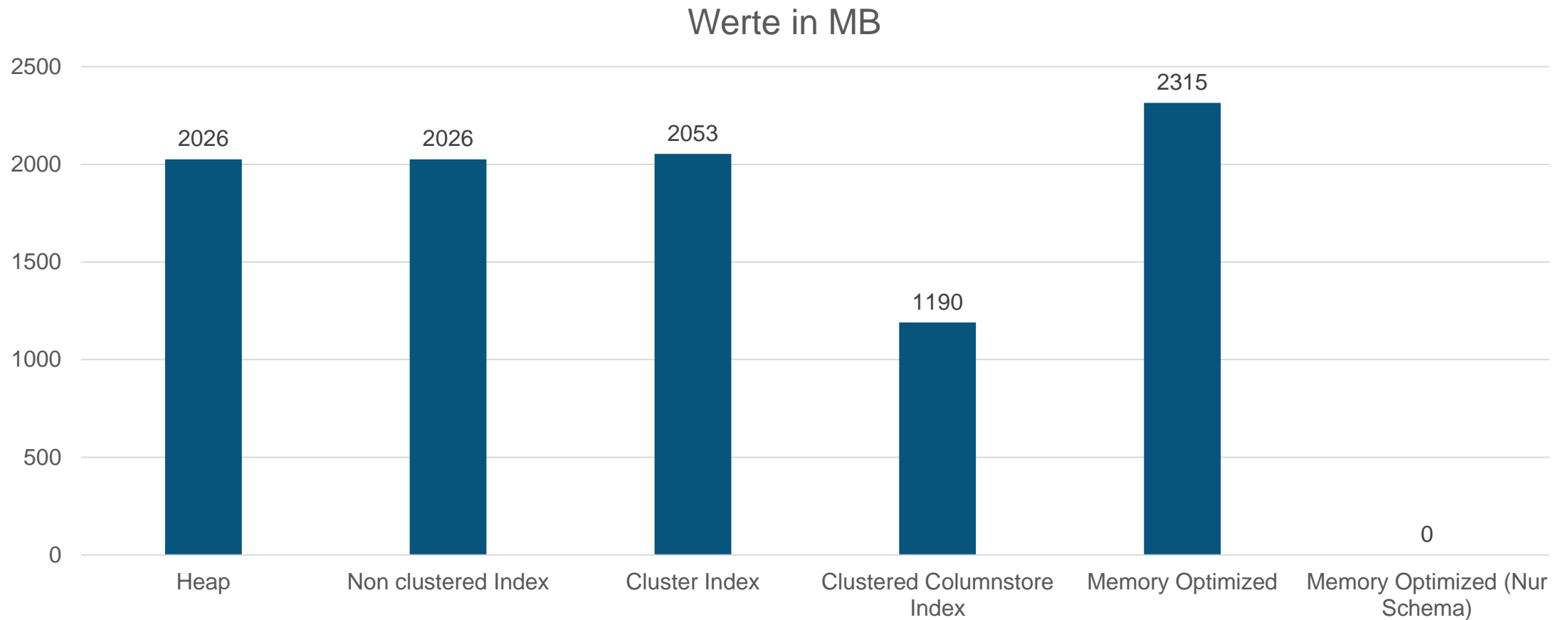
02 Indizes\02 Insert.sql

INSERT-Performance

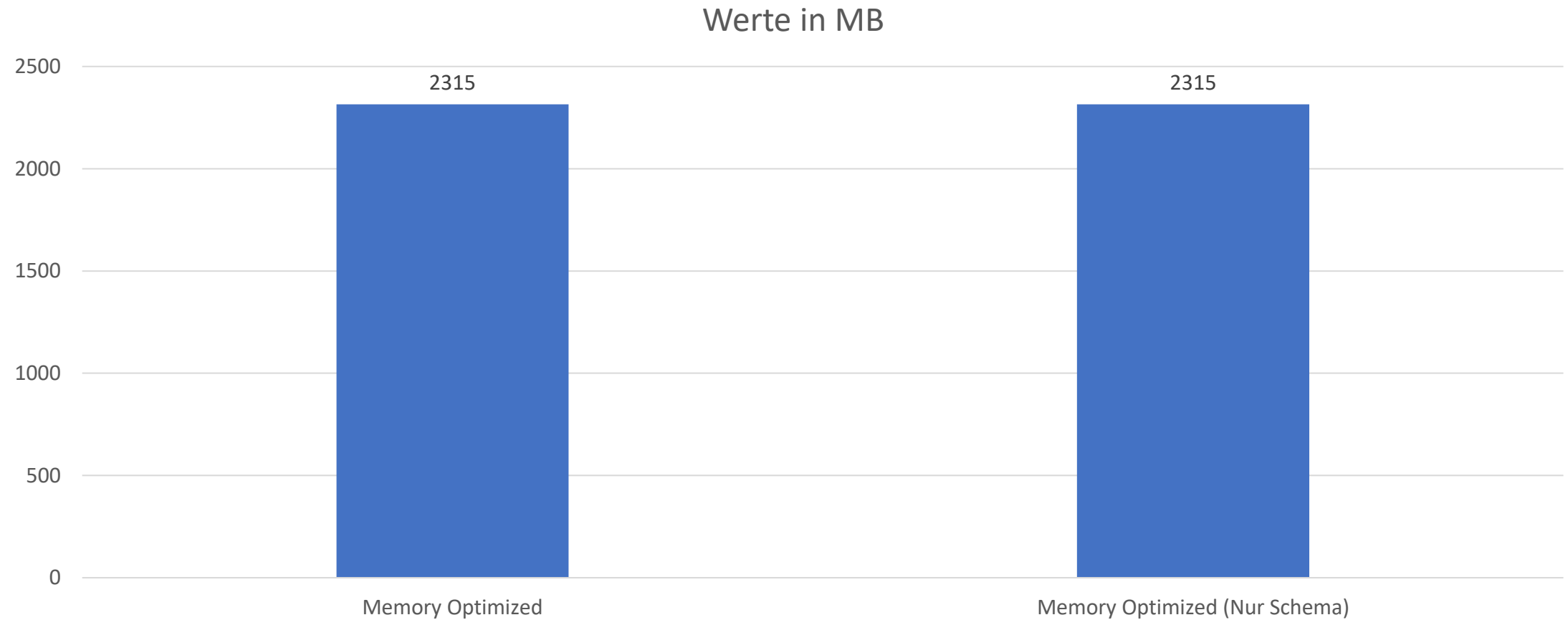
Insert-Performance (10 Mio Zeilen)



Speicherbedarf auf I/O System



Speicherbedarf im RAM



SELECT-Performance

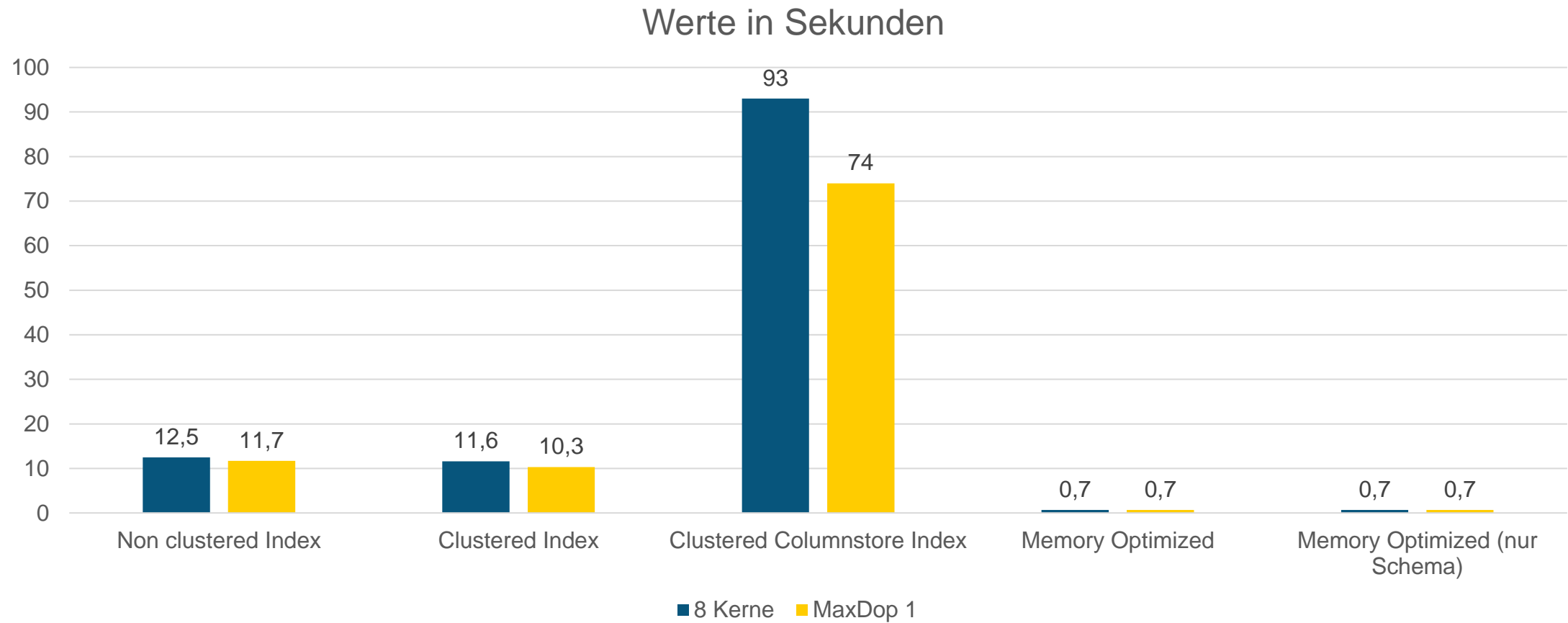


02 Indizes\03a Select.sql
02 Indizes\03b Select MaxDop.sql

Warum ohne Heap?

- Schon 10.000 Selects dauern 1.504 Sekunden (ca. 25 Minuten)
- Wie lange dauern dann 100.000?

SELECT-Performance (100.000 Zeilen zufällig)



Was beeinflusst das Ergebnis?

- Parallelisierung (MAXDOP)
- Breite der Zeilen (Bytes)
I/O System
- Netzwerk (Bei Rückgabe)

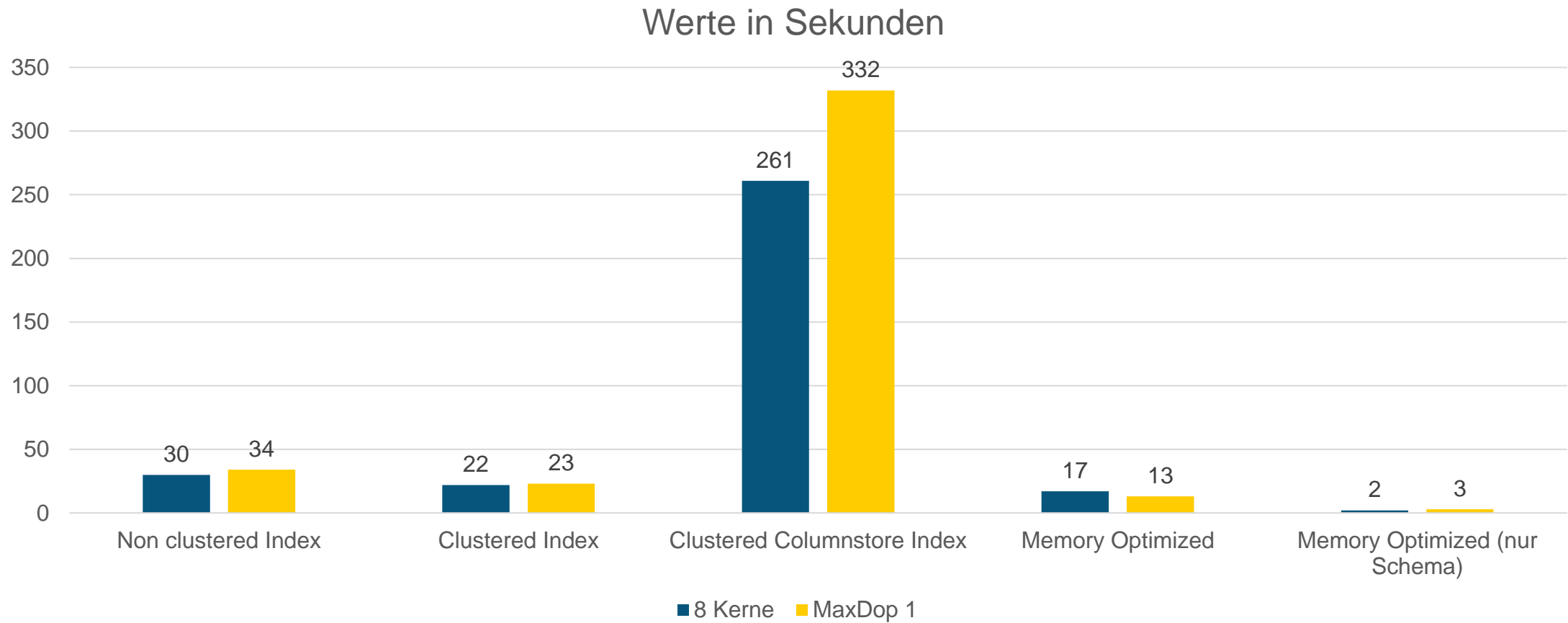
UPDATE-Performance

Demo

02 Indizes\04a Update.sql

02 Indizes\04b Update MaxDop.sql

Update-Performance (100.000 Zeilen zufällig)



Clustered Columnstore Index

Deltastore ist angewachsen (B-Tree)

```
SELECT * FROM sys.column_store_row_groups WHERE OBJECT_ID =  
OBJECT_ID('dbo.ProduktverzeichnisClusteredColumnstoreIndex');
```

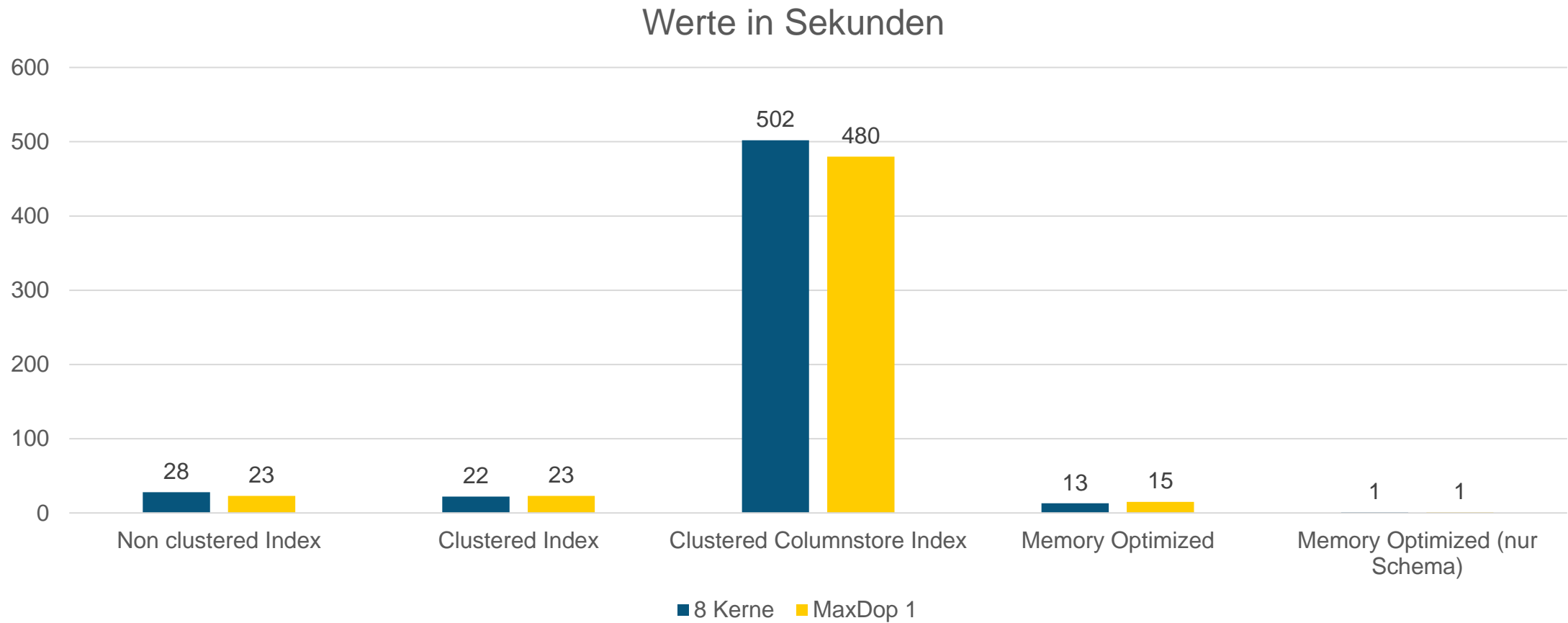
Results Messages										
	object_id	index_id	partition_number	row_group_id	delta_store_hobt_id	state	state_description	total_rows	deleted_rows	size_in_bytes
1	1301579675	1	1	62	72057594044416000	1	OPEN	90392	NULL	NULL
2	1301579675	1	1	61	NULL	3	COMPRESSED	42849	380	795162
3	1301579675	1	1	60	NULL	3	COMPRESSED	200916	1745	3979710
4	1301579675	1	1	59	NULL	3	COMPRESSED	243875	2115	4830004
5	1301579675	1	1	58	NULL	3	COMPRESSED	29186	218	544470
6	1301579675	1	1	57	NULL	3	COMPRESSED	214725	1818	4252916
7	1301579675	1	1	56	NULL	3	COMPRESSED	243908	2134	4830272
8	1301579675	1	1	55	NULL	3	COMPRESSED	15350	121	289444
9	1301579675	1	1	54	NULL	3	COMPRESSED	228461	2040	4524576
10	1301579675	1	1	53	NULL	3	COMPRESSED	243812	2091	4828880
11	1301579675	1	1	52	NULL	3	COMPRESSED	1688	17	31714
12	1301579675	1	1	51	NULL	3	COMPRESSED	242015	2121	4793684
13	1301579675	1	1	50	NULL	3	COMPRESSED	231971	2063	4594512
14	1301579675	1	1	49	NULL	3	COMPRESSED	11028	95	2150770

DELETE-Performance

Demo

02 Indizes\05a Delete.sql
02 Indizes\05b Delete MaxDop.sql

Delete-Performance (100.000 Zeilen zufällig)



Best Practices

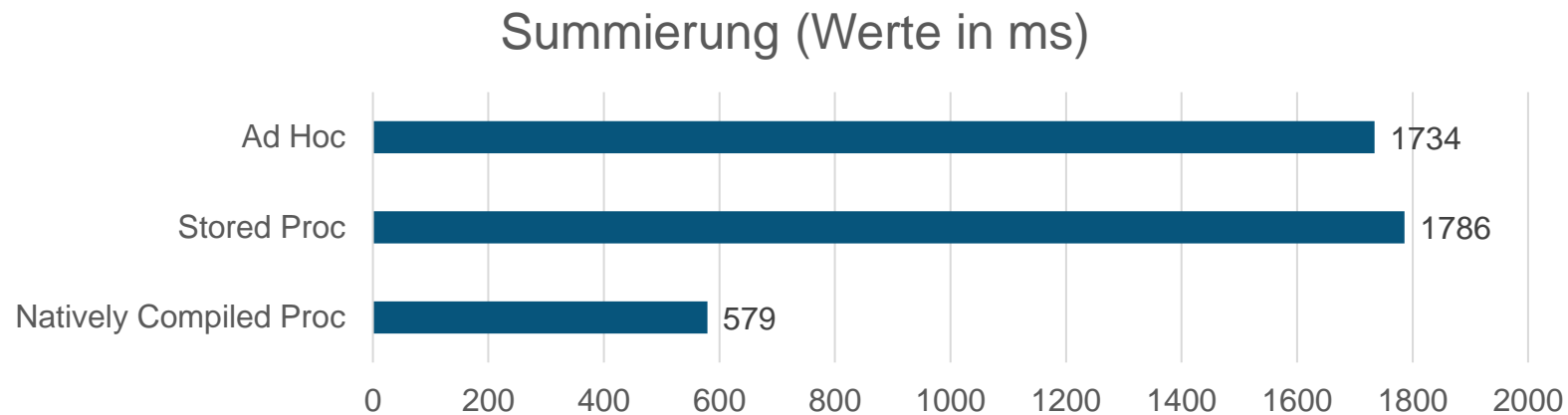
- Clustered Index
Häufigster Zugriff (Primary Key)
- Non Clustered Index
Häufige Zugriffe (Suchen)
- Clustered Columnstore Index
Große Zeilenanzahl und statische Daten (historische Daten)
- Memory Optimized (Schema Only)
Schnelle Erfassung/Zwischenergebnisse
Bei viel RAM eine Option

The image shows three bronze statues of dwarves, known as 'Prozeduren' (Procedures), located on a cobblestone street in Prague. The statue on the left is a dwarf with a large, pointed hat and a beard, holding a small object in its hand. The middle statue is a dwarf with a beard and a headlamp on its forehead, holding a small object. The statue on the right is a dwarf with a beard and a headlamp on its forehead, holding a small object. The statues are set against a background of a red brick wall and a cobblestone street. A dark blue horizontal band with the word 'Prozeduren' in white text is overlaid on the image.

Prozeduren

Natively Compiled Procedures

- Nur für Memory Optimized Tables
- T-SQL wird in C übersetzt
- Viele Funktionalitäten fehlen (noch), d.h. viele Einschränkungen





02 Indizes\ 06 Sum Natively Comp Proc.sql



Indizes anlegen und verwalten



Indizes anlegen

- Non Clustered Index
 - Filtered
 - Included
 - Unique
- Clustered Index
 - Unique
- Clustered ColumnStore Index

Index-Wartung

- ALTER INDEX...REORGANIZE
 - ALTER INDEX...REBUILD
 - CREATE INDEX WITH DROP_EXISTING
-
- Fragmentierung < 10% oder < 1000 Seiten: Nichts!
 - Fragmentierung 10%-30%: REORGANIZE
 - Fragmentierung >30%: REBUILD

Index-Verwendung

- `sys.dm_db_index_usage_stats`
 - Seek => Suche mittels Index
 - Scan => Durchlaufen des Index
 - Lookup => i.d.R. Joins
- `sys.dm_db_missing_index_details`

Demo

04 Tools\01a DMV Indizes.sql

04 Tools\01b DMV Indizes.sql



Ab SQL Server 2017

Automatic Tuning

-- Einschalten

```
ALTER DATABASE CURRENT SET AUTOMATIC_TUNING =  
    AUTO | INHERIT | CUSTOM;
```

-- Einschalten

```
ALTER DATABASE CURRENT SET AUTOMATIC_TUNING  
(  
    FORCE_LAST_GOOD_PLAN = ON,  
    CREATE_INDEX = DEFAULT,  
    DROP_INDEX = OFF  
);
```



<https://docs.microsoft.com/en-us/azure/sql-database/sql-database-automatic-tuning-enable>

Demo

A fluffy brown dog is seen from behind, standing in a grassy field. The dog's fur is thick and curly. The field is green with some patches of brown earth. In the background, there are some trees and a fence. A dark blue banner with white text is overlaid across the middle of the image.

Statistics, Ausführungspläne & Co

Statistics Time/ IO

- SET STATISTICS TIME ON/ OFF;
 - CPU Time => verbrauchte CPU-Zeit
 - Elapsed Time => gemessene Zeit
- SET STATISTICS IO ON/ OFF;
 - Physical Read => Zugriff auf I/O System
 - Logical Read => Zugriff auf I/O System **oder** Buffer



04 Tools\02 Set Statistics.sql

Client Statistics

Ausführungsstatistiken im SSMS anzeigen



	Trial 2	Trial 1	Average
Client Execution Time	12:38:47	12:38:39	
Query Profile Statistics			
Number of INSERT, DELETE and UPDATE statements	0	→ 0	→ 0.0000
Rows affected by INSERT, DELETE, or UPDATE statement...	0	→ 0	→ 0.0000
Number of SELECT statements	4	→ 4	→ 4.0000
Rows returned by SELECT statements	2	→ 2	→ 2.0000
Number of transactions	0	→ 0	→ 0.0000
Network Statistics			
Number of server roundtrips	2	→ 2	→ 2.0000
TDS packets sent from client	2	→ 2	→ 2.0000
TDS packets received from server	2	→ 2	→ 2.0000
Bytes sent from client	328	↑ 324	→ 326.0000
Bytes received from server	1669	↑ 1666	→ 1667.5000
Time Statistics			
Client processing time	3	→ 3	→ 3.0000
Total execution time	152	↓ 173	→ 162.5000
Wait time on server replies	149	↓ 170	→ 159.5000

Demo

Ausführungspläne & Live Statistics

Grafische Anzeige im SSMS

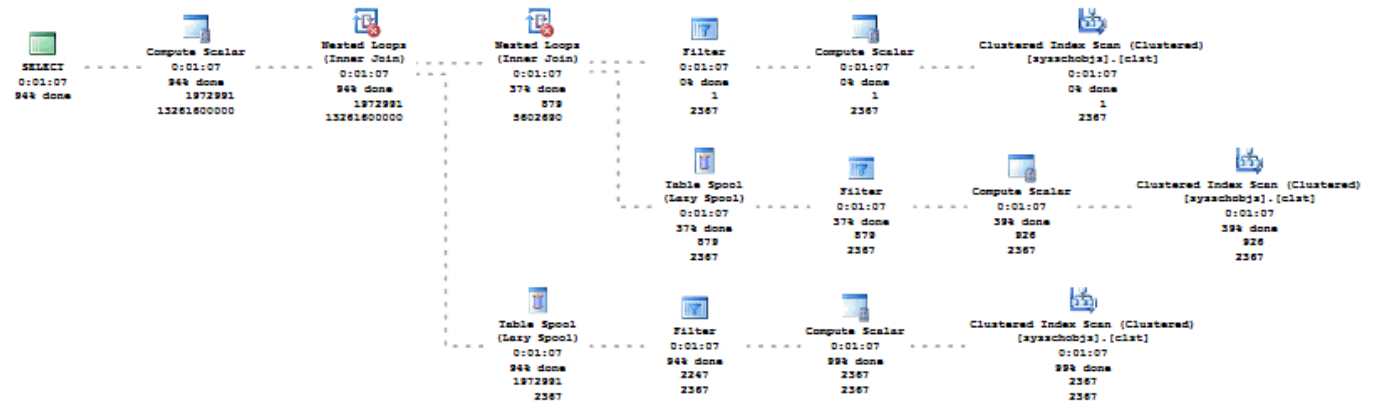
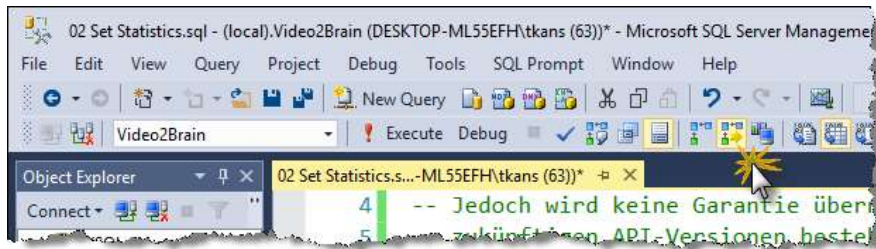
- Geschätzter AP => wahrscheinlicher AP bei der **nächsten** Ausführung
- Tatsächlicher AP => der verwendete AP nach Ausführung

The screenshot displays the Microsoft SQL Server Enterprise Manager (SSMS) interface. The top menu bar includes File, Edit, View, Query, Project, Debug, Tools, SQL Prompt, Window, and Help. The toolbar contains icons for New Query, Open, Save, Execute, and others. The Object Explorer on the left shows the 'Video2Brain' database. The main window displays the 'Execution plan' tab for a query. The query text is: `SELECT * FROM [dbo].[ProduktverzeichnisHeap] WHERE IDENTITYCOL = 23423`. Below the query text, a message indicates a missing index: `Missing Index (Impact 99.9835): CREATE NONCLUSTERED INDEX [<Name of Missing Index, sysname,>] ON [dbo].[ProduktverzeichnisHeap] (IDENTITYCOL) INCLUDE ([...])`. The execution plan diagram shows a 'Table Scan' operation on '[ProduktverzeichnisHeap]' with a cost of 99%, followed by a 'Parallelism (Gather Streams)' operation with a cost of 1%, and finally a 'SELECT' operation with a cost of 0%.

Demo

Live Query

- Echtzeit-Ausführungsplan während der Ausführung
- Alternativer Start via Activity Monitor
 - Trace Flag 7412



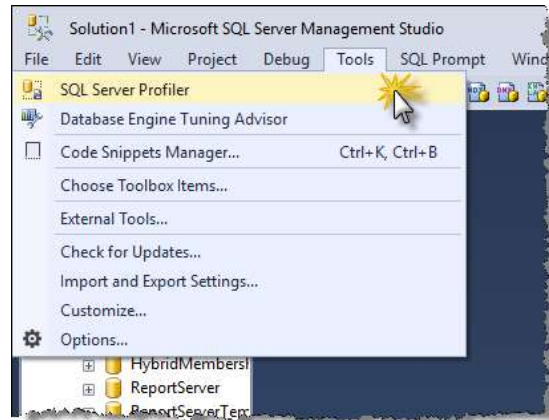
Demo

A large, rounded rock formation, possibly a natural arch or a pile of boulders, stands prominently in the center of the frame. The rocks are light brown and have smooth, weathered surfaces. The background shows a vast, flat desert floor with sparse, low-lying vegetation. In the distance, there are low, hazy mountains under a clear, bright blue sky. A dark blue horizontal band is superimposed over the middle of the image, containing the title text in white.

SQL Server Profiler & DB Tuning Advisor

SQL Server Profiler

Aufzeichnung aller SQL-Server-Abfragen



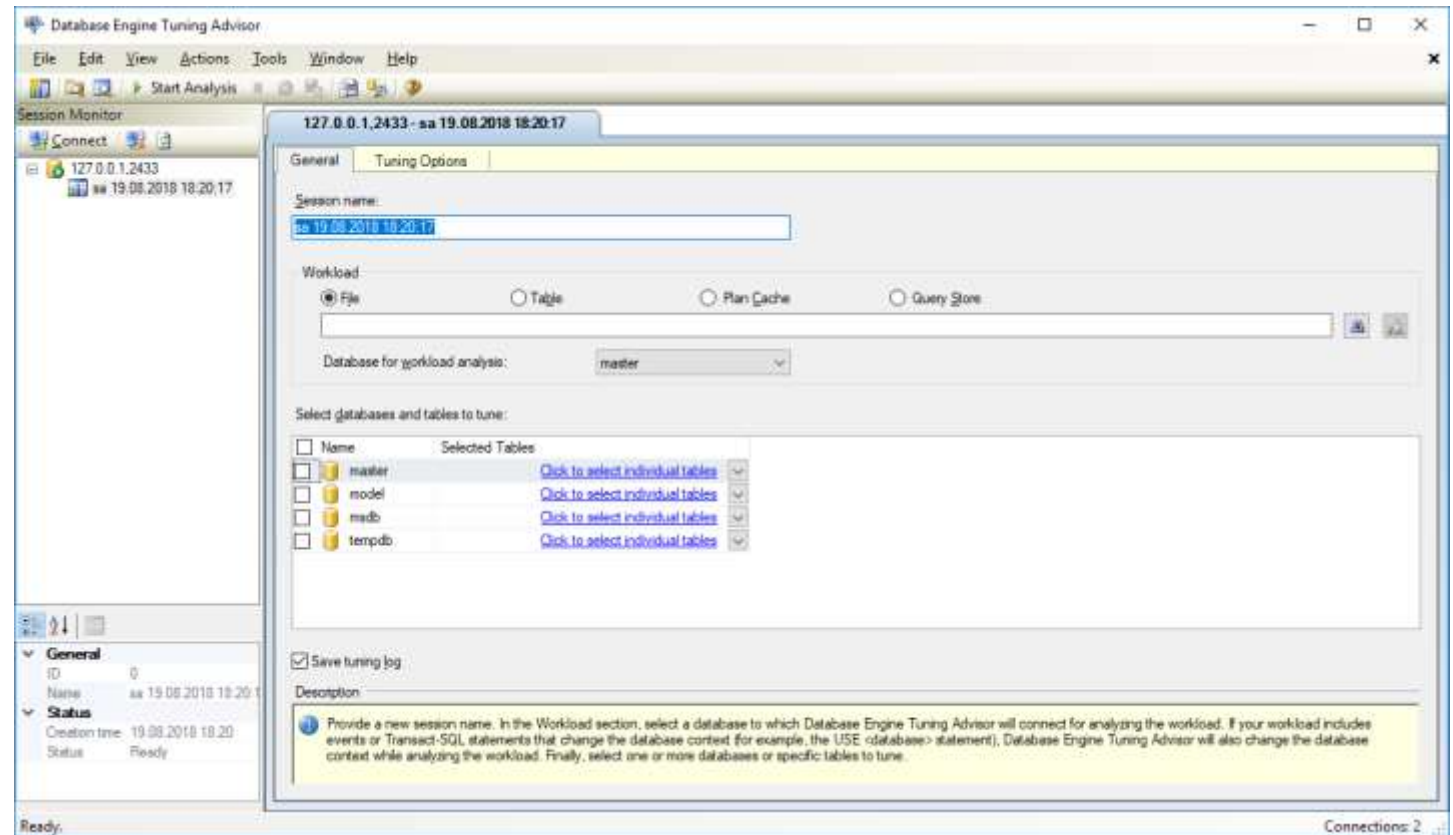
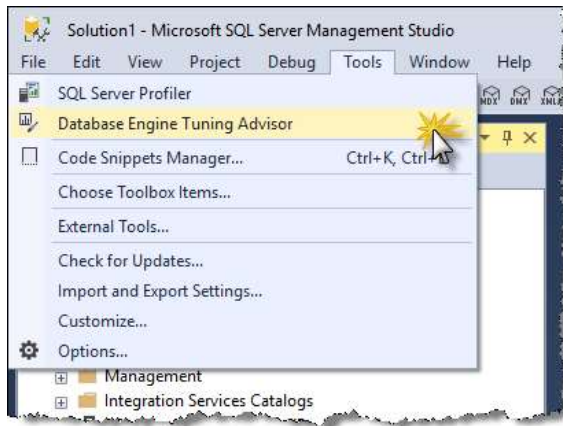
A screenshot of the SQL Server Profiler interface. The main window displays a table of trace events. The table has columns for EventClass, TextData, ApplicationName, NTUserName, LoginName, CPU, Reads, Writes, Duration, ClientProcessID, SPID, StartTime, and EndTime. The trace shows various events including 'Trace Start', 'ExistingConnection', 'Audit Login', 'SQL:BatchStarting', 'SQL:BatchCompleted', 'SQL:BatchStarting', 'SQL:BatchCompleted', 'SQL:BatchStarting', 'SQL:BatchCompleted', 'SQL:BatchStarting', 'SQL:BatchCompleted', 'Audit Login', 'SQL:BatchStarting', 'SQL:BatchCompleted', and 'Audit Logout'. The 'TextData' column contains the SQL queries being executed, such as 'SELECT SYSTEM_USER', 'SELECT SERVERPROPERTY('EngineEditio...', and 'SET ROWCOUNT 0 SET TEXTSIZE 2147483...'. The 'ApplicationName' column shows 'Microsoft SQ...', 'NTUserName' shows 'tkansy@...', and 'LoginName' shows 'Micros...'. The 'CPU', 'Reads', 'Writes', and 'Duration' columns show the performance metrics for each query. The 'ClientProcessID' and 'SPID' columns show the process and session IDs. The 'StartTime' and 'EndTime' columns show the execution time of each query.

EventClass	TextData	ApplicationName	NTUserName	LoginName	CPU	Reads	Writes	Duration	ClientProcessID	SPID	StartTime	EndTime
Trace Start											2017-02-03 12:12:27...	
ExistingConnection	-- network protocol: LPC set quote...	Microsoft SQ...	tkansy@...	Micros...					15832	51	2017-02-03 13:14:47...	
Audit Login	-- network protocol: LPC set quote...	Microsoft SQ...	tkansy@...	Micros...					15832	57	2017-02-03 13:14:28...	
SQL:BatchStarting	SELECT SYSTEM_USER	Microsoft SQ...	tkansy@...	Micros...					15832	57	2017-02-03 13:14:28...	
SQL:BatchCompleted	SELECT SYSTEM_USER	Microsoft SQ...	tkansy@...	Micros...	0	0	0	0	15832	57	2017-02-03 13:14:28...	2017-02-03 13:14:28...
SQL:BatchStarting	SELECT SERVERPROPERTY('EngineEditio...	Microsoft SQ...	tkansy@...	Micros...					15832	57	2017-02-03 13:14:28...	
SQL:BatchCompleted	SELECT SERVERPROPERTY('EngineEditio...	Microsoft SQ...	tkansy@...	Micros...	0	0	0	0	15832	57	2017-02-03 13:14:28...	2017-02-03 13:14:28...
SQL:BatchStarting	SET ROWCOUNT 0 SET TEXTSIZE 2147483...	Microsoft SQ...	tkansy@...	Micros...					15832	57	2017-02-03 13:14:28...	
SQL:BatchCompleted	SET ROWCOUNT 0 SET TEXTSIZE 2147483...	Microsoft SQ...	tkansy@...	Micros...	0	0	0	0	15832	57	2017-02-03 13:14:28...	2017-02-03 13:14:28...
SQL:BatchStarting	select @@spid; select SERVERPROPER...	Microsoft SQ...	tkansy@...	Micros...					15832	57	2017-02-03 13:14:28...	
SQL:BatchCompleted	select @@spid; select SERVERPROPER...	Microsoft SQ...	tkansy@...	Micros...	0	0	0	0	15832	57	2017-02-03 13:14:28...	2017-02-03 13:14:28...
Audit Login	-- network protocol: LPC set quote...	Microsoft SQ...	tkansy@...	Micros...					15832	63	2017-02-03 13:14:28...	
SQL:BatchStarting	DECLARE @edition sysname; SET @edit...	Microsoft SQ...	tkansy@...	Micros...					15832	63	2017-02-03 13:14:28...	
SQL:BatchCompleted	DECLARE @edition sysname; SET @edit...	Microsoft SQ...	tkansy@...	Micros...	0	0	0	0	15832	63	2017-02-03 13:14:28...	2017-02-03 13:14:28...
Audit Logout		Microsoft SQ...	tkansy@...	Micros...	0	0	0	0	15832	63	2017-02-03 13:14:28...	2017-02-03 13:14:28...

Demo

Database Engine Tuning Advisor

(Schlechte?) Tipps für Indizes



Demo



Ab SQL Server 2016

Query Store

Historische Query-Performance-Daten zur Analyse

- SQL Server (Re-)Start übergreifend
- Kumulierte Daten

Demo

Fragen?

Links



<http://dotnetconsulting.eu/blog/>



[@Tkansy](https://twitter.com/Tkansy)



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www.dotnetconsulting.eu