How the size of character datatypes influences memory grants

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And how the engine tries to save you

About me

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20 + years experience with:

- MSSQL databases
- PowerShell addict

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Slides:

- https://bit.ly/3xRgiVv
- https://github.com/dbartv/BVernaillen-DemoDatype

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Conclusions

- Memory grants used for?
- Relation datatype & (initial) Memory Grant?
- Impact on the SQL instance?
- Impact Memory Grant Feedback?
- Remediations?

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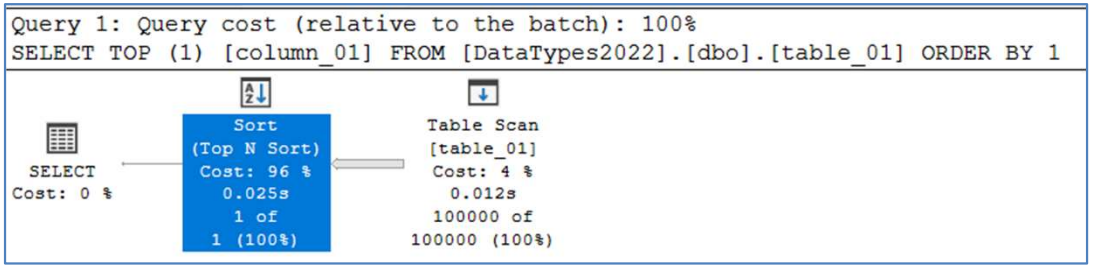
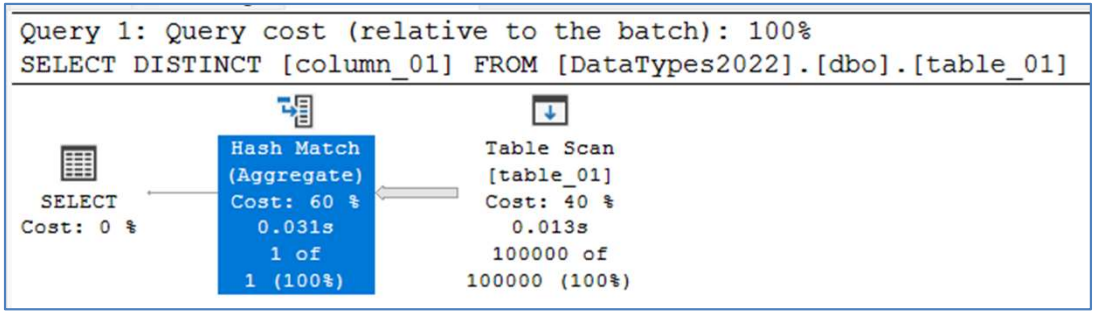
Memory grants

- Occur during query execution for the entire length of the execution
  - Sort operator (e.g. ORDER BY)



  - Hash operation
    - Join large input tables (missing index?)
    - Aggregates (SUM/AVG/MIN/…)
    - DISTINCT
    - UNION



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After execution

- **Actual execution plan**
  - Is generated after the query execution
  - Contains runtime information
    - Actual resource usage
    - Runtime warning
      - Contains both estimate and actual numbers

Memory Grant	10 MB
MemoryGrantInfo	
DesiredMemory	10664
GrantedMemory	10664
GrantWaitTime	0
IsMemoryGrantFeedbackA	NoFirstExecution
LastRequestedMemory	0
MaxQueryMemory	705456
MaxUsedMemory	10664
RequestedMemory	10664
RequiredMemory	512
SerialDesiredMemory	10664
SerialRequiredMemory	512

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During execution

- `sys.dm_exec_query_memory_grants`

```
SELECT [session_id]
      ,[requested_memory_kb]
      ,[granted_memory_kb]
      ,[used_memory_kb]
      ,[ideal_memory_kb]
      ,[ideal_memory_kb]
      ,[dop]
  FROM [master].[sys].[dm_exec_query_memory_grants]
```

Results | Messages

session_id	requested_memory_kb	granted_memory_kb	used_memory_kb	ideal_memory_kb	ideal_memory_kb	dop
74	600640	600640	10008	600640	600640	8

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Demo

- 4 Databases
- 5 tables
  - Char(1)
  - varchar(8)
  - varchar(80)
  - varchar(800)
  - varchar(8000)
- Each table has 12 columns
- Each 100.000 rows
- Each record is exactly 1 character

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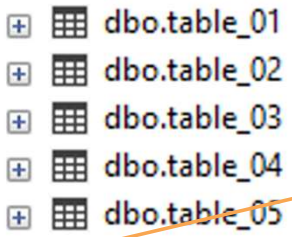

	table_name	name	name	max_length
1	table_01	column_01	char	1
2	table_02	column_01	varchar	8
3	table_03	column_01	varchar	80
4	table_04	column_01	varchar	800
5	table_05	column_01	varchar	8000

	column_01	column_02	column_03	column_04	column_05	column_06	column_07	column_08	column_09	column_10	column_11	column_12
1	A	B	C	D	E	F	G	H	I	J	K	L
2	A	B	C	D	E	F	G	H	I	J	K	L
3	A	B	C	D	E	F	G	H	I	J	K	L
4	A	B	C	D	E	F	G	H	I	J	K	L
5	A	B	C	D	E	F	G	H	I	J	K	L
6	A	B	C	D	E	F	G	H	I	J	K	L
7	A	B	C	D	E	F	G	H	I	J	K	L
8	A	B	C	D	E	F	G	H	I	J	K	L
9	A	B	C	D	E	F	G	H	I	J	K	L
10	A	B	C	D	E	F	G	H	I	J	K	L
11	A	B	C	D	E	F	G	H	I	J	K	L
12	A	B	C	D	E	F	G	H	I	J	K	L
13	A	B	C	D	E	F	G	H	I	J	K	L
14	A	B	C	D	E	F	G	H	I	J	K	L
15	A	B	C	D	E	F	G	H	I	J	K	L
16	A	B	C	D	E	F	G	H	I	J	K	L
17	A	B	C	D	E	F	G	H	I	J	K	L
18	A	B	C	D	E	F	G	H	I	J	K	L

Demo

- Is written in PowerShell to (try) to prevent demo failure(s) 🙏🙏🙏
  - Start XE session
  - Run queries
  - Stop XE session
  - Load plans in database ‘PlanUsageInfo’
  - Copy query to clipboard

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Oversized columns

- Mismatch between defined data type and actual data
- The truck is taking parking space from other people
- The truck is under utilized

Choose an appropriate size:

- Try to match character column length to the actual content

Memory grant feedback

- Since SQL 2017 (batch mode only)
  - Tries to remember previous executions
  - adjusts memory grants based on the previous execution.
- SQL 2019 also for row mode
- New feature in SQL 2022 => ONLY WHEN QUERY STORE IS ENABLED!!!!
  - Feedback is persisted in the query store
  - Feedback is calculated on multiple previous executions
  - Feedback survives:
    - Plan cache eviction
    - Server reboot

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No worries then?

A good database design

Memory grant feedback

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Bugs found:

- Feedback is not implemented immediately
- No indication in the query plan that the MG is adjusted through Query Store
- In this demo MGF fails when queries are executed in parallel

Conclusions:

- Memory grants are used for
  - Sort operations
  - Hash operations
- The optimizer assumes that on average your field is filled for 50%
- As the length of the data type grows, the (initial) memory grant grows.
- Memory Grant Feedback can reduce the impact
- What can we do?
  - Only use character datatypes when needed
  - Choose an appropriate length

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References

- https://sqlserverfast.com/epr/hash-match/
- https://sqlserverfast.com/epr/sort/
- https://techcommunity.microsoft.com/t5/azure-sql-blog/announcing-degree-of-parallelism-feedback-limited-preview/ba-p/3806924
- https://techcommunity.microsoft.com/t5/sql-server-blog/understanding-sql-server-memory-grant/ba-p/383595
- https://learn.microsoft.com/en-us/troubleshoot/sql/database-engine/performance/troubleshoot-memory-grant-issues
- https://learn.microsoft.com/en-us/sql/relational-databases/memory-management-architecture-guide?view=sql-server-ver16#memory-grant-considerations

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