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Data Warehouse Optimization – report

1. Aim of the laboratory

The aim of the task is to show issues concerning various physical cube models and aggregation design.

2. Preliminary assumptions

Size of the database (data warehouse): 247 MB

Number of Rows: 500 000

Testing environment:
- Microsoft SQL Server Management Studio 20
- Visual Studio Enterprise 2022
- SQL Server Profiler 18
- about PC:

  ○ 16GB RAM
  ○ Windows 11
  ○ Processor - Intel(R) Core(TM) i5-1035G1 CPU @ 1.00GHz 1.19 GHz

	MOLAP		ROPAP		HOLAP	
	Aggr	No Aggr	Aggr	No Aggr	Aggr	No Aggr
Querying speed (for 3 different queries)	**30**	**34.7**	**109.3**	**366.2**	**110.7**	**113**
	5.7	**25.7**	**116.2**	**197.7**	**4.8**	**111**
	43.8	**46.5**	**124**	**127.3**	**127**	**108.7**
Processing time	**5 s**	**5 s**	**1 s**	**1 s**	**1 s**	**1 s**
Total size	**16.18 MB**	**16.07 MB**	**3.80 MB**	**3.80 MB**	**3.92 MB**	**3.80 MB**

3. Testing

Testing query execution times for different models, with and without defined aggregations. Testing cube processing times in the same testing settings.
Brief description of the queries:

1. (one with aggregations on dates)

```
--1. Compare the number of appointments near-the-holidays days in current and previous
month? (Query with Aggregations on Dates)

WITH MEMBER [Measures].[Before Holiday Day] AS
    Aggregate(
        [Date].[Date].CurrentMember.PrevMember
    )
SELECT
    {[Measures].[Appointment Count]} ON COLUMNS,
    NON EMPTY
    {
        [Date].[Year-Month-Hierarchy].[Year].&[2023].Children,
        [Date].[Year-Month-Hierarchy].[Month].Members
    } ON ROWS
FROM [Appointify Warehouse]
```

Times for **MOLAP** with **NO AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	30
Query Cube End	Appointif...	28
Query Cube End	Appointif...	30
Query Cube End	Appointif...	29
Query Cube End	Appointif...	28
Query Cube End	Appointif...	30
Query Cube End	Appointif...	28
Query Cube End	Appointif...	29
Query Cube End	Appointif...	26
Query Cube End	Appointif...	56

Times for **MOLAP** with **AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	61
Query Cube End	Appointif...	27
Query Cube End	Appointif...	37
Query Cube End	Appointif...	29
Query Cube End	Appointif...	28
Query Cube End	Appointif...	28
Query Cube End	Appointif...	3
Query Cube End	Appointif...	30
Query Cube End	Appointif...	28
Query Cube End	Appointif...	29

Times for **ROLAP** with **NO AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	317
Query Cube End	Appointif...	96
Query Cube End	Appointif...	103
Query Cube End	Appointif...	100
Query Cube End	Appointif...	110
Query Cube End	Appointif...	97
Query Cube End	Appointif...	102
Query Cube End	Appointif...	2517
Query Cube End	Appointif...	116
Query Cube End	Appointif...	104

Times for **ROLAP** with **AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	176
Query Cube End	Appointif...	98
Query Cube End	Appointif...	103
Query Cube End	Appointif...	96
Query Cube End	Appointif...	91
Query Cube End	Appointif...	97
Query Cube End	Appointif...	102
Query Cube End	Appointif...	99
Query Cube End	Appointif...	104
Query Cube End	Appointif...	127

Times for **HOLAP** with **NO AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	170
Query Cube End	Appointif...	111
Query Cube End	Appointif...	115
Query Cube End	Appointif...	108
Query Cube End	Appointif...	98
Query Cube End	Appointif...	100
Query Cube End	Appointif...	107
Query Cube End	Appointif...	113
Query Cube End	Appointif...	103
Query Cube End	Appointif...	105

Times for **HOLAP** with **AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	119
Query Cube End	Appointif...	105
Query Cube End	Appointif...	133
Query Cube End	Appointif...	99
Query Cube End	Appointif...	105
Query Cube End	Appointif...	98
Query Cube End	Appointif...	111
Query Cube End	Appointif...	110
Query Cube End	Appointif...	120
Query Cube End	Appointif...	107

2. (one for particular dimension attribute)

```
--2. How effective are promo codes? (Query for a Particular Dimension Attribute)

SELECT
    {[Measures].[Appointment Count]} ON COLUMNS,
    [Junk].[Promo Code Usage Hierarchy].[Is Promo Code Used].MEMBERS ON ROWS
FROM [Appointify Warehouse]
```

Times for **MOLAP** with **NO AGGREGATIONS**

EventClass	Duration	DatabaseName
Query Cube End	45	Appointif...
Query Cube End	25	Appointif...
Query Cube End	26	Appointif...
Query Cube End	21	Appointif...
Query Cube End	20	Appointif...
Query Cube End	26	Appointif...
Query Cube End	25	Appointif...
Query Cube End	23	Appointif...
Query Cube End	22	Appointif...
Query Cube End	24	Appointif...

Times for **MOLAP** with **AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	33
Query Cube End	Appointif...	4
Query Cube End	Appointif...	4
Query Cube End	Appointif...	2
Query Cube End	Appointif...	2
Query Cube End	Appointif...	3
Query Cube End	Appointif...	3
Query Cube End	Appointif...	2
Query Cube End	Appointif...	2
Query Cube End	Appointif...	2

Times for **ROLAP** with **NO AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	252
Query Cube End	Appointif...	843
Query Cube End	Appointif...	103
Query Cube End	Appointif...	110
Query Cube End	Appointif...	121
Query Cube End	Appointif...	114
Query Cube End	Appointif...	99
Query Cube End	Appointif...	122
Query Cube End	Appointif...	110
Query Cube End	Appointif...	103

Times for **ROLAP** with **AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	147
Query Cube End	Appointif...	131
Query Cube End	Appointif...	111
Query Cube End	Appointif...	105
Query Cube End	Appointif...	108
Query Cube End	Appointif...	95
Query Cube End	Appointif...	9344
Query Cube End	Appointif...	127
Query Cube End	Appointif...	106
Query Cube End	Appointif...	116

While calculating ROLAP with AGGREGATION we come a cross an outlier with duration equal 9344. Therefore, we calculated mean without this value.

Times for **HOLAP** with **NO AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	156
Query Cube End	Appointif...	113
Query Cube End	Appointif...	116
Query Cube End	Appointif...	92
Query Cube End	Appointif...	87
Query Cube End	Appointif...	120
Query Cube End	Appointif...	116
Query Cube End	Appointif...	94
Query Cube End	Appointif...	112
Query Cube End	Appointif...	104

Times for **HOLAP** with **AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	21
Query Cube End	Appointif...	4
Query Cube End	Appointif...	2
Query Cube End	Appointif...	3
Query Cube End	Appointif...	3
Query Cube End	Appointif...	4
Query Cube End	Appointif...	2
Query Cube End	Appointif...	2
Query Cube End	Appointif...	3
Query Cube End	Appointif...	4

3. (general one)

```
--3. Which services are most popular? (General Query)

SELECT
    {[Measures].[Appointment Count]} ON COLUMNS,
        TOPCOUNT(
    [Service Type].[Service ID].Members,
        10,
        [Measures].[Appointment Count]
        ) ON ROWS
FROM [Appointify Warehouse]
```

Times for **MOLAP** with **NO AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	52
Query Cube End	Appointif...	36
Query Cube End	Appointif...	49
Query Cube End	Appointif...	44
Query Cube End	Appointif...	48
Query Cube End	Appointif...	38
Query Cube End	Appointif...	57
Query Cube End	Appointif...	46
Query Cube End	Appointif...	35
Query Cube End	Appointif...	60

Times for **MOLAP** with **AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	77
Query Cube End	Appointif...	42
Query Cube End	Appointif...	37
Query Cube End	Appointif...	35
Query Cube End	Appointif...	55
Query Cube End	Appointif...	33
Query Cube End	Appointif...	41
Query Cube End	Appointif...	37
Query Cube End	Appointif...	48
Query Cube End	Appointif...	36

Times for **ROLAP** with **NO AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	180
Query Cube End	Appointif...	107
Query Cube End	Appointif...	142
Query Cube End	Appointif...	116
Query Cube End	Appointif...	112
Query Cube End	Appointif...	116
Query Cube End	Appointif...	112
Query Cube End	Appointif...	154
Query Cube End	Appointif...	119
Query Cube End	Appointif...	115

Times for **ROLAP** with **AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	169
Query Cube End	Appointif...	121
Query Cube End	Appointif...	122
Query Cube End	Appointif...	109
Query Cube End	Appointif...	121
Query Cube End	Appointif...	109
Query Cube End	Appointif...	117
Query Cube End	Appointif...	115
Query Cube End	Appointif...	112
Query Cube End	Appointif...	145

Times for **HOLAP** with **NO AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	120
Query Cube End	Appointif...	113
Query Cube End	Appointif...	111
Query Cube End	Appointif...	137
Query Cube End	Appointif...	122
Query Cube End	Appointif...	116
Query Cube End	Appointif...	127
Query Cube End	Appointif...	113
Query Cube End	Appointif...	7
Query Cube End	Appointif...	121

Times for **HOLAP** with **AGGREGATIONS**

EventClass	DatabaseName	Duration
Query Cube End	Appointif...	178
Query Cube End	Appointif...	117
Query Cube End	Appointif...	126
Query Cube End	Appointif...	130
Query Cube End	Appointif...	123
Query Cube End	Appointif...	110
Query Cube End	Appointif...	116
Query Cube End	Appointif...	116
Query Cube End	Appointif...	139
Query Cube End	Appointif...	115

4.   Assessment

MOLAP:

Querying Speed: MOLAP is consistently faster with aggregations than without. This is because MOLAP stores all its data and aggregations directly in the cube, allowing quick data retrieval.

Processing Time: Remains constant at 5 seconds, indicating that MOLAP's processing is not heavily impacted by whether aggregations are used or not.

Total Size: Slightly larger with aggregations, but the difference is minimal, reflecting the overhead of storing aggregation data.

ROLAP:

Querying Speed: Dramatically slower without aggregations. This slowdown occurs because ROLAP has to query the relational database each time, which is slower without pre-computed aggregations.

Processing Time: Faster at 1 second. ROLAP processes quickly because it doesn't store the data within the cube; it stays in the relational database.

Total Size: Smallest among all models because it doesn't store data within the cube itself.

HOLAP:

Querying Speed: Similar performance with and without aggregations. HOLAP benefits from having aggregations pre-stored, but detailed data still requires accessing the relational database, which evens out the performance gains.

Processing Time: Consistent at 1 second, indicating efficient handling of both detailed and aggregated data.

Total Size: Marginally larger with aggregations, suggesting minimal storage of aggregated data in the cube.

Conclusions:

We run all the queries **10** times for accurate results. And cleared the caches after each execution.

Clear Cache:

```
<ClearCache xmlns="http://schemas.microsoft.com/analysisservices/2003/engine">
    <Object>
        <DatabaseID>AppointifyWarehouse</DatabaseID>
    </Object>
</ClearCache>
```

MOLAP provides the best performance for queries due to pre-stored data and aggregations, making it suitable for environments where query speed is crucial.

ROLAP There was not that significat difference between agregatinos.

HOLAP offers a balance between MOLAP and ROLAP, with moderate query speeds and minimal storage overhead, making it ideal for scenarios where both storage and speed are considerations.