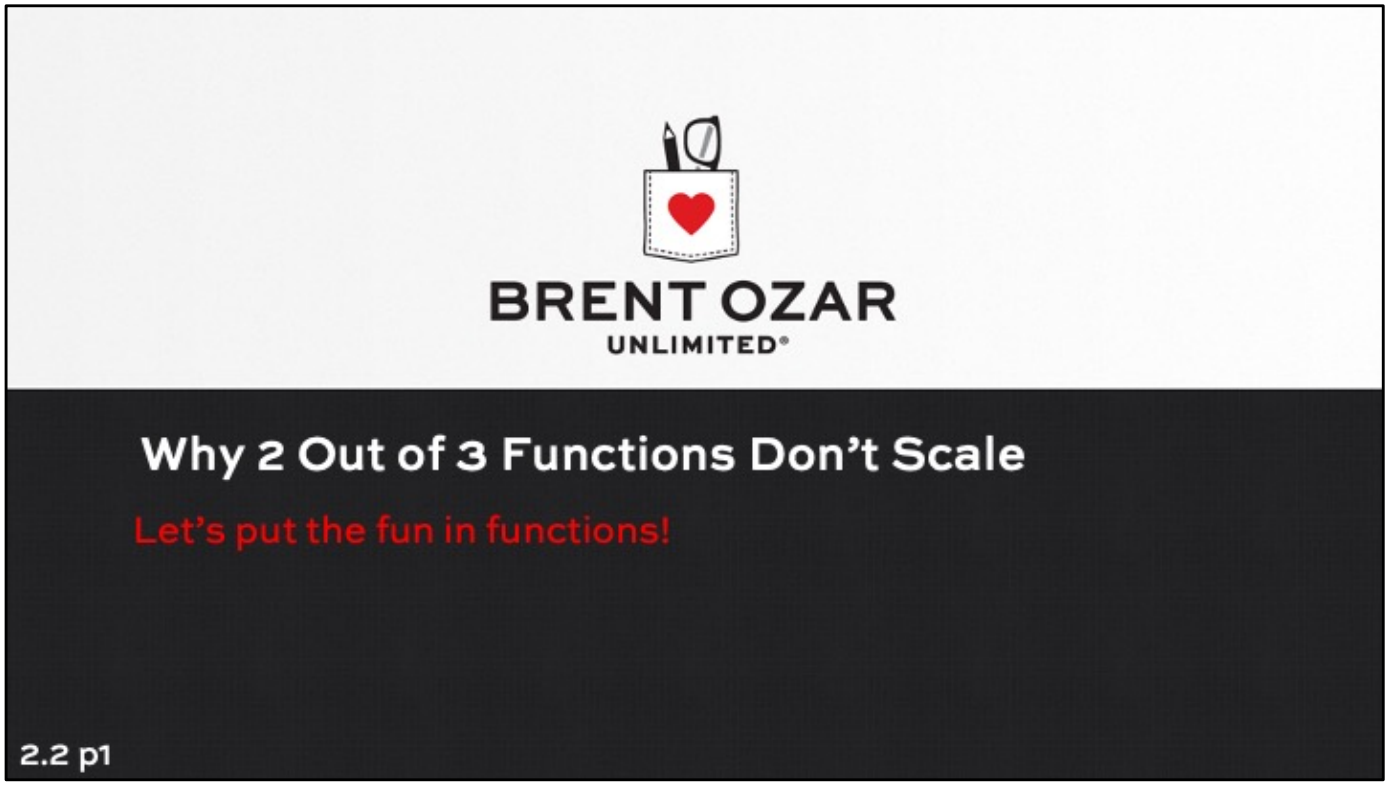


Agenda

Bad functions:

- Scalar user-defined functions
- Multi-statement table-valued functions
- Functions in table definitions

Not-so-bad functions:

- SQL Server 2019's Froid technology
- Inline table-valued functions
- CTE and OUTER APPLY

How to find & fix the bad ones

Developers are taught to reuse code

Functions are helpful to:

- Encapsulate code and package it for easier reuse
- Make it more test-friendly
- Don't repeat yourself (DRY)

All that stuff is true in app languages,
and functions don't get a performance overhead there either.

2.2 p4

Your functions are no good here

- The most important takeaway is that SQL is set-based, and calculating values row by row is painful
- Same applies to cursors, they're almost always performance killers, but that's another issue.
- WHILE loops have similar performance problems, and often get used in functions for splitting strings, padding strings, removing characters, putting names in proper case, etc.

2.2 p5

Built-in system functions can be bad, too

- Usually (but not always) have bad row estimations
- Which leads to query plans that scan rather than seek
- Can sometimes lead to dramatically higher CPU use

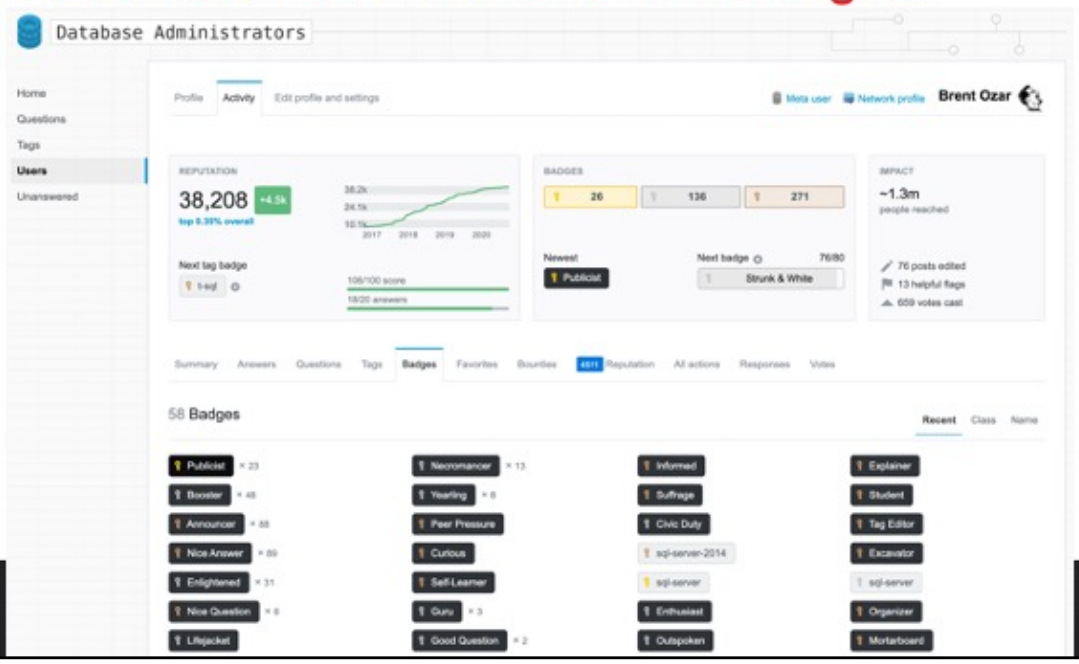
Examples:

- WHERE UPPER(DisplayName) = 'BRENT'
- WHERE LTRIM(RTRIM(DisplayName)) = 'BRENT'
- WHERE ISNULL(DisplayName, '') = 'BRENT'

But in this class, I'm specifically talking about user-defined functions: ones we created.

2.2 p6

StackOverflow users can earn badges.



2.2 p8

We want to count badges for each user.

Code goals:

- When we show a user's info, we often want to show their # of badges
- Ideally, we code this just once, and it's reusable

2.2 p9

The scalar function version

```
-- Scalar Function
CREATE FUNCTION dbo.ScalarFunction ( @uid INT )
RETURNS BIGINT
    WITH RETURNS NULL ON NULL INPUT,
         SCHEMABINDING
AS
    BEGIN
        DECLARE @BCount BIGINT;
        SELECT  @BCount = COUNT_BIG(*)
        FROM    dbo.Badges AS b
        WHERE   b.UserId = @uid
        GROUP BY b.UserId;
        RETURN @BCount;
    END;
```

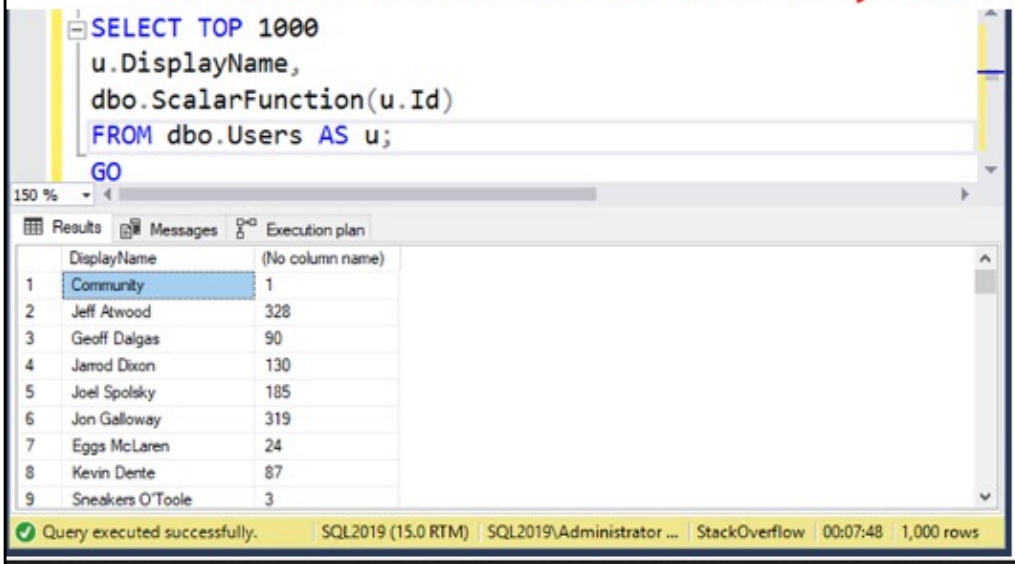
2.2 p10

How you call it

```
SELECT TOP 1000
u.DisplayName,
dbo.ScalarFunction(u.Id)
FROM dbo.Users AS u
```

2.2 p11

It takes ~8 minutes to return 1,000 rows.



```
SELECT TOP 1000
u.DisplayName,
dbo.ScalarFunction(u.Id)
FROM dbo.Users AS u;
GO
```

150 %

Results | Messages | Execution plan

	DisplayName	(No column name)
1	Community	1
2	Jeff Atwood	328
3	Geoff Dalgas	90
4	Jarrod Dixon	130
5	Joel Spolsky	185
6	Jon Galloway	319
7	Eggs McLaren	24
8	Kevin Dente	87
9	Sneakers O'Toole	3

Query executed successfully. | SQL2019 (15.0 RTM) | SQL2019\Administrator ... | StackOverflow | 00:07:48 | 1,000 rows

2.2 p12

When a query is this slow, you wanna see what tables it read from.

But SET STATISTICS IO ON completely lies: it doesn't show anything that scalar functions do.

```
SELECT TOP 1000
u.DisplayName,
dbo.ScalarFunction(u.Id)
FROM dbo.Users AS u;
```

150 %

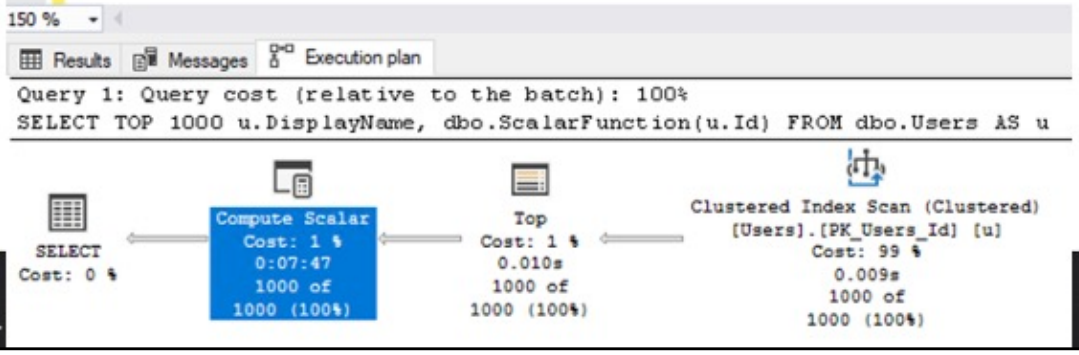
Results | Messages | Execution plan

```
SQL Server parse and compile time:
   CPU time = 0 ms, elapsed time = 0 ms.

 SQL Server Execution Times:
   CPU time = 0 ms,  elapsed time = 0 ms.
SQL Server parse and compile time:
   CPU time = 0 ms, elapsed time = 2 ms.

(1000 rows affected)
Table 'Users'. Scan count 1, logical reads 69, physical reads 0,

(1 row affected)

 SQL Server Execution Times:
   CPU time = 1861215 ms,  elapsed time = 467866 ms.
SQL Server parse and compile time:
   CPU time = 0 ms, elapsed time = 0 ms.
```

2.2 p13

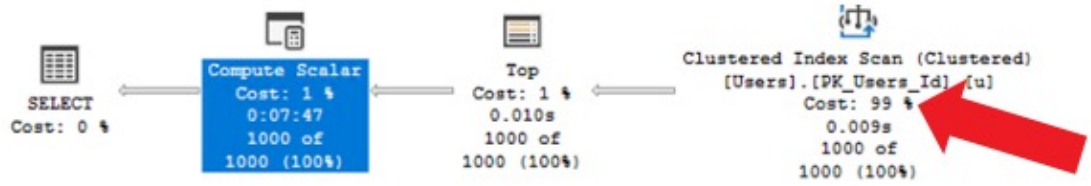
What about the query plan? It gets worse.

```
SELECT TOP 1000
u.DisplayName,
dbo.ScalarFunction(u.Id)
FROM dbo.Users AS u;
GO
```



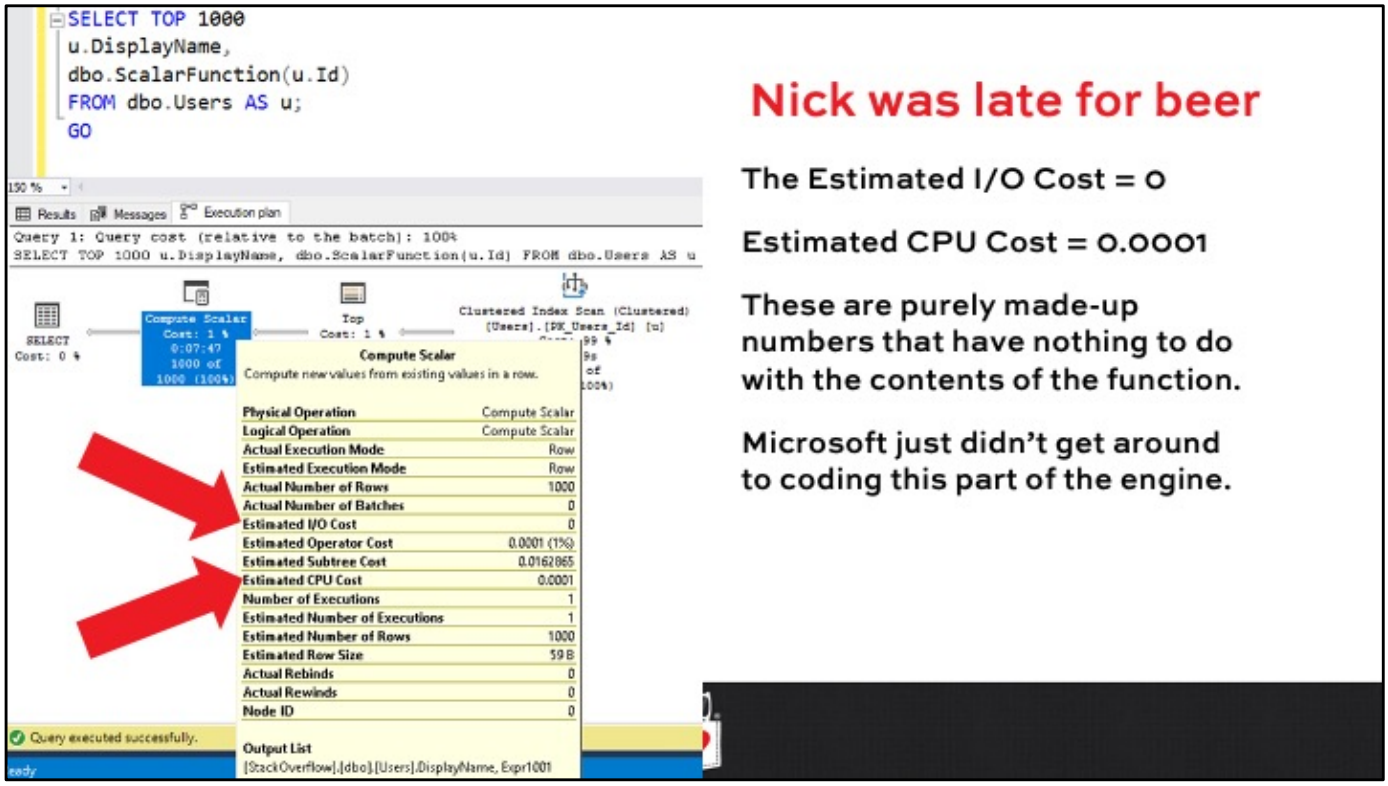
2.2 p14

What about the query plan? It gets worse.



SQL Server implies the clustered index scan is 99% of the cost, and that the Compute Scalar was just 1%.

That's because the estimated costs for scalars is completely made up.



Nick was late for beer

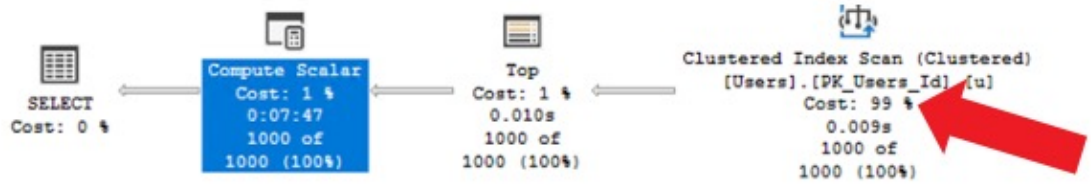
The Estimated I/O Cost = 0

Estimated CPU Cost = 0.0001

These are purely made-up numbers that have nothing to do with the contents of the function.

Microsoft just didn't get around to coding this part of the engine.

What about the query plan? It gets worse.

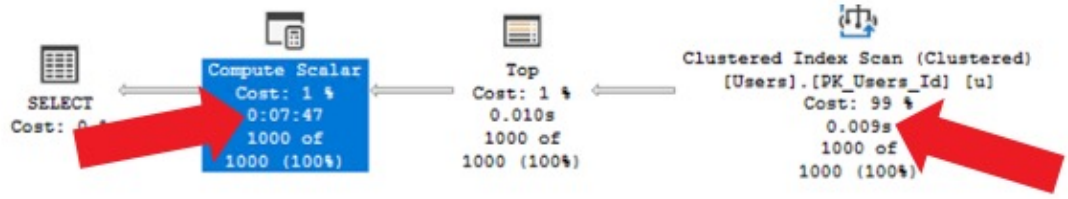


SQL Server implies the clustered index scan is 99% of the cost, and that the Compute Scalar was just 1%.

That's because the estimated costs for scalars is completely made up.

You have to do some detective work.

If you look closely at the completion times for each operator:

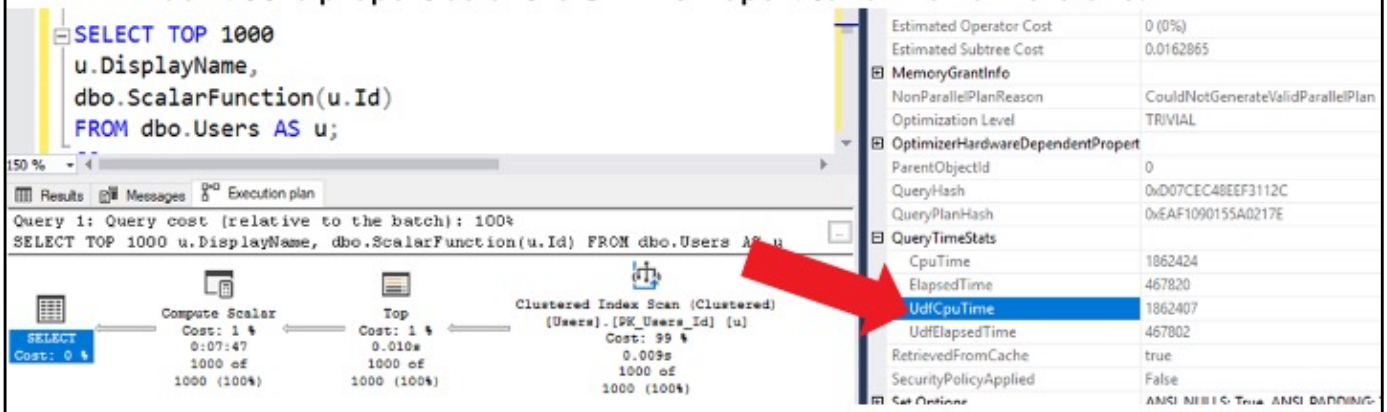


The table scan finished 0.009 seconds into the query.

The Compute Scalar finished 7 minutes, 47 seconds in.

Another way to spot it

Look at the properties of the SELECT operator on newer versions:



UdfCpuTime, UdfElapsedTime show how much time was spent inside user-defined functions.

But my favorite way is sp_BlitzCache.

```
sp_BlitzCache
```

Results | Messages

	Database	Cost	Query Text	Query Type	Warnings	# Executions	Total CPU (ms)	Avg CPU (ms)	Total Duration (ms)	Avg Duration (ms)
1	StackOverflow	0.0162065	SELECT TOP 1000 u.DisplayName, dbo.ScalarFu...	Statement	Long Running Query, Downlevel CE, Forced Serialization, Plan created last 4hrs, Low Cost High CPU	1	1862309	1862309	467866	467866
2	StackOverflow	135.252	CREATE FUNCTION dbo.ScalarFunction (@uid I...	Procedure or Function: [dbo].[ScalarFunction]	Missing Indexes (1), Parallel, Parameter Sniffing, Downlevel CE, Plan created last 4hrs	1000	1862274	1862	467787	467
3	StackOverflow	135.252	SELECT @@Count = COUNT_BIG(*) FROM ...	Statement (parent [dbo].[ScalarFunction])	Missing Indexes (1), Parallel, Parameter Sniffing, Downlevel CE, Plan created last 4hrs	1000	1862239	1862	467752	467

#1 query is the SELECT TOP 1000, which calls the function.

The SELECT's CPU & duration *includes the function's work.*

Now look at the #2 query: it's the function.

The function's CPU time and duration is almost the entire time that the SELECT query worked. That's your big sign.

2.2 p20

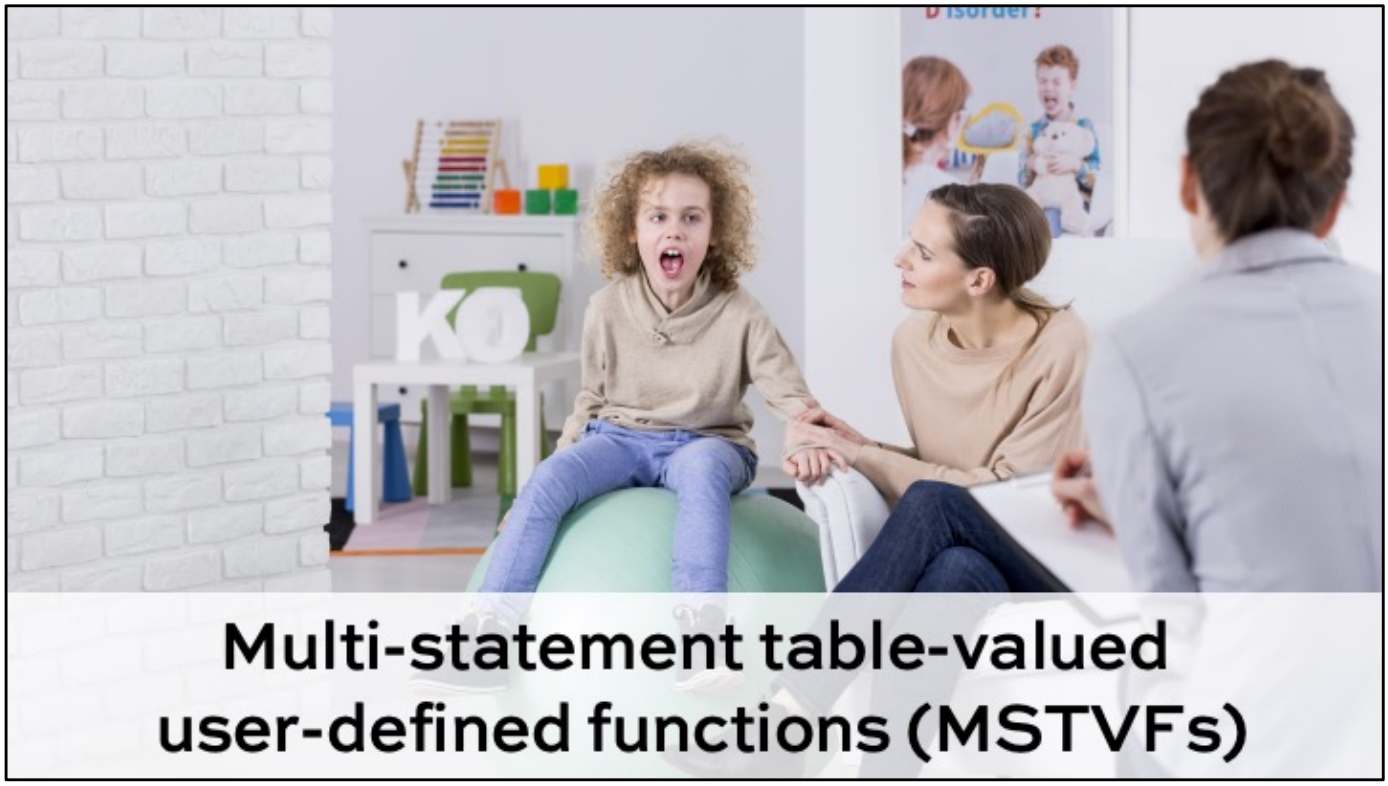
Scalar round up

The bad:

- Runs once per row
- Cost isn't added to the total query cost
- No info from STATISTICS IO, not much in the plan
- Inhibits parallelism, too: BrentOzar.com/go/serialudf

The good:

This section is intentionally left blank



MSTVFs use table variables to store data.

Which means all modifications are serial, and

Your estimates will be really low (unless you recompile), and

You won't get column statistics (so SQL won't know how joins will go)

2.2 p23

How you build it

```
-- Multi Statement Table Valued Function
CREATE FUNCTION dbo.MultiStatementTVF ( @uid INT )
RETURNS @Out TABLE ( BadgeCount BIGINT )
    WITH SCHEMABINDING
AS
    BEGIN
        INSERT  INTO @Out(BadgeCount)
        SELECT  COUNT_BIG(*) AS BadgeCount
        FROM    dbo.Badges AS b
        WHERE   b.UserId = @uid
        GROUP BY b.UserId;
      RETURN;
    END;
```

2.2 p24

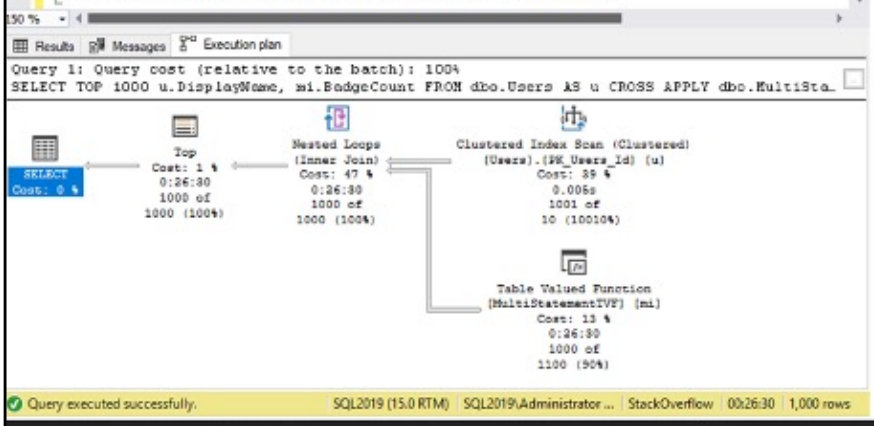
How you call it

```
SELECT TOP 1000
u.DisplayName,
mi.BadgeCount
FROM dbo.Users AS u
CROSS APPLY dbo.MultiStatementTVF(u.Id) AS mi
```

2.2 p25

Now up to 26.5 minutes.

```
SELECT TOP 1000
u.DisplayName,
mi.BadgeCount
FROM dbo.Users AS u
CROSS APPLY dbo.MultiStatementTVF(u.Id) AS mi;
```



2.2 p26

Now up to 26.5 minutes.

```
SELECT TOP 1000
u.DisplayName,
mi.BadgeCount
FROM dbo.Users AS u
CROSS APPLY dbo.MultiStatementTVF(u.Id) AS mi;
```

Query executed successfully. SQL2019 (15.0 RTM) | SQL2019\Administrator ... | StackOverflow | 00:26:30 | 1,000 rows

2.2 p27

What's STATISTICS IO say this time?

```
SELECT TOP 1000
u.DisplayName,
mi.BadgeCount
FROM dbo.Users AS u
CROSS APPLY dbo.MultiStatementTVF(u.Id) AS mi;
```

150 %

Results | Messages | Execution plan

```
SQL Server parse and compile time:
   CPU time = 0 ms, elapsed time = 0 ms.

 SQL Server Execution Times:
   CPU time = 0 ms,  elapsed time = 0 ms.
SQL Server parse and compile time:
   CPU time = 3 ms, elapsed time = 3 ms.

(1000 rows affected)
Table '#B1482DC7'. Scan count 1001, logical reads 1001, physical reads 0,
Table 'Users'. Scan count 1, logical reads 69, physical reads 0, page ser

(1 row affected)
```

150 %

Query executed successfully. | SQL2019 (15.0 RTM) | SQL2019\Administrator ... | StackOverflow | 00:26:30 | 1,000 rows

2.2 p28

What's STATISTICS IO say this time?

```
SELECT TOP 1000
u.DisplayName,
mi.BadgeCount
FROM dbo.Users AS u
CROSS APPLY dbo.MultiStatementTVF(u.Id) AS mi;
```

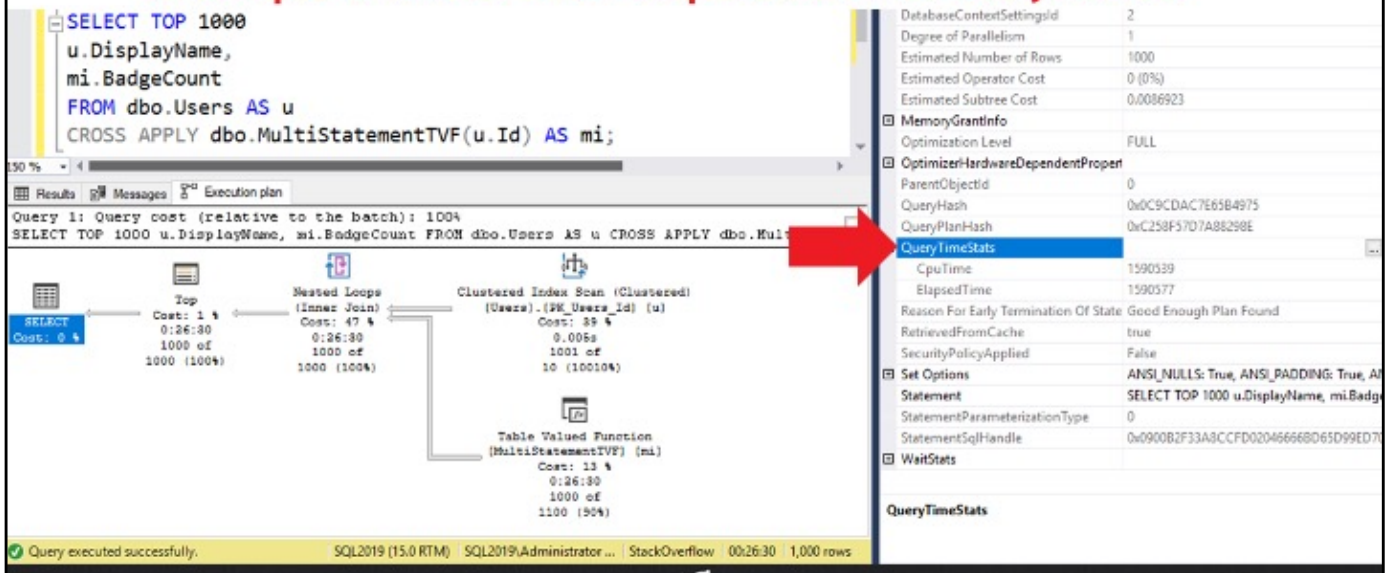

```
Table '#B1482DC7'. Scan count 1001, logical reads 1001, physical reads 0,
Table 'Users'. Scan count 1, logical reads 69, physical reads 0, page ser

(1 row affected)
```

150 %

Query executed successfully. SQL2019 (15.0 RTM) SQL2019\Administrator ... StackOverflow 00:26:30 1,000 rows

2.2 p29

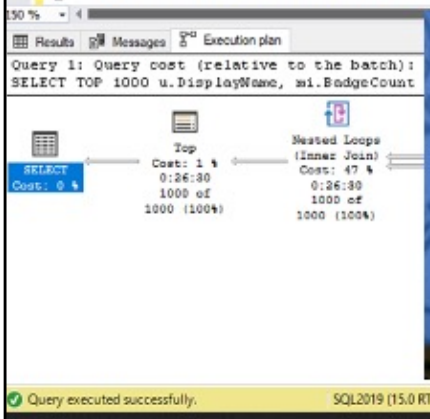
UdfCpuTime or UdfElapsedTime? No, none.



2.2 p30

UdfCpuTime or UdfElapsedTime? No, none.

```
SELECT TOP 1000
u.DisplayName,
mi.BadgeCount
FROM dbo.Users AS u
CROSS APPLY dbo.MultiStatementTVF(u.Id) AS mi;
```

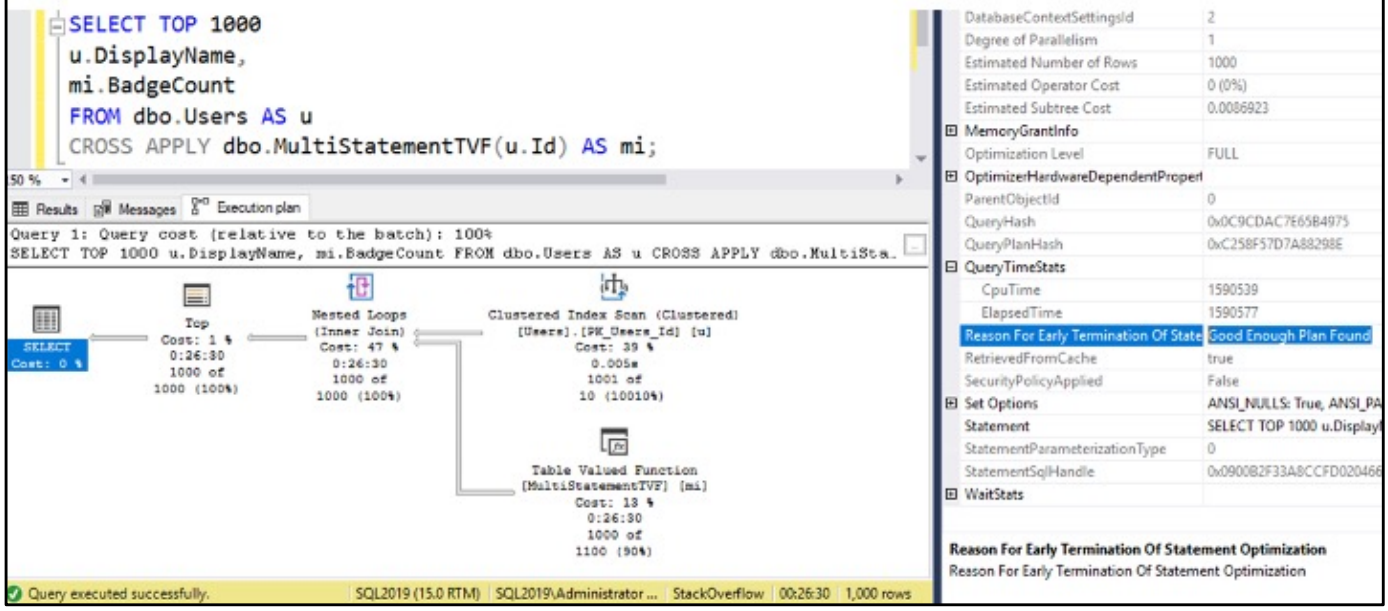


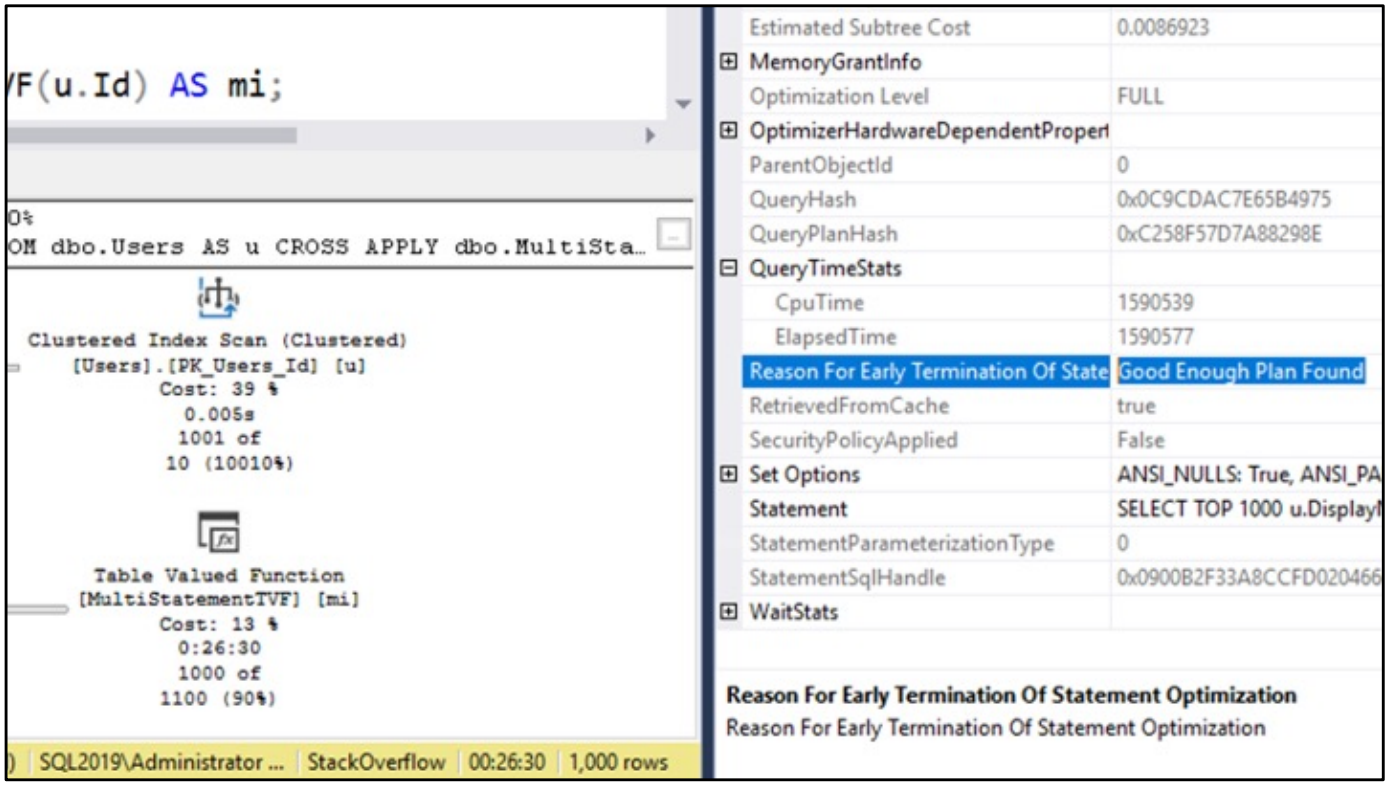
DatabaseContextSettingsId	2
Degree of Parallelism	1
Estimated Number of Rows	1000
Estimated Operator Cost	0 (0%)
Estimated Subtree Cost	0.0086923
MemoryGrantInfo	
Optimization Level	FULL
OptimizerHardwareDependentPropert	
ParentObjectId	0
QueryHash	0x0C9CDAC7E65B4975
QueryPlanHash	0xC258F57D7A88298E
QueryTimeStats	
CpuTime	1590539
ElapsedTime	1590577
Reason For Early Termination Of State	Good Enough Plan Found
RetrievedFromCache	true
SecurityPolicyApplied	False
Set Options	ANSI_NULLS: True, ANSI_PADDING: True, A
Statement	SELECT TOP 1000 u.DisplayName, mi.Badg
StatementParameterizationType	0
StatementSqlHandle	0x0900B2F33A8CCFD020466668D65D99ED7
WaitStats	

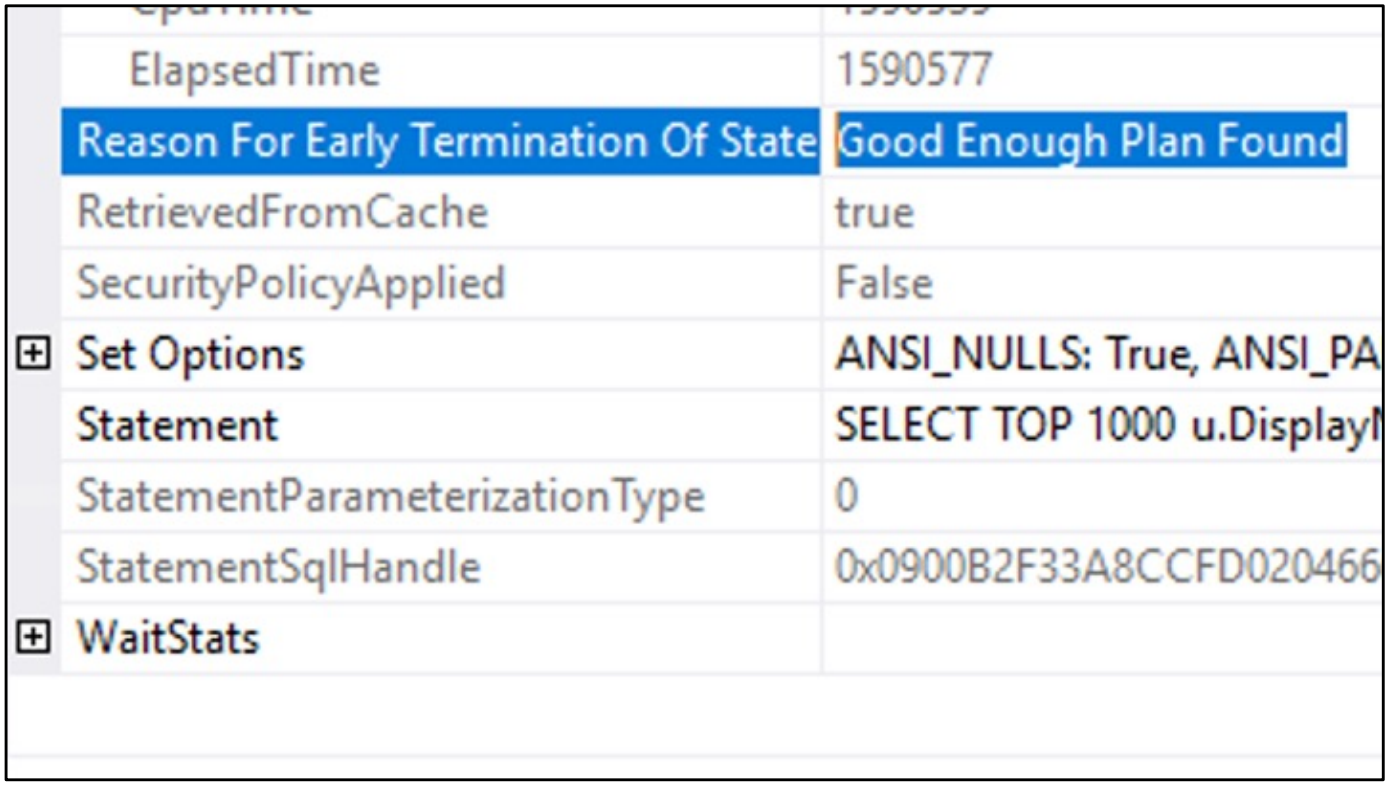
QueryTimeStats

2.2 p31

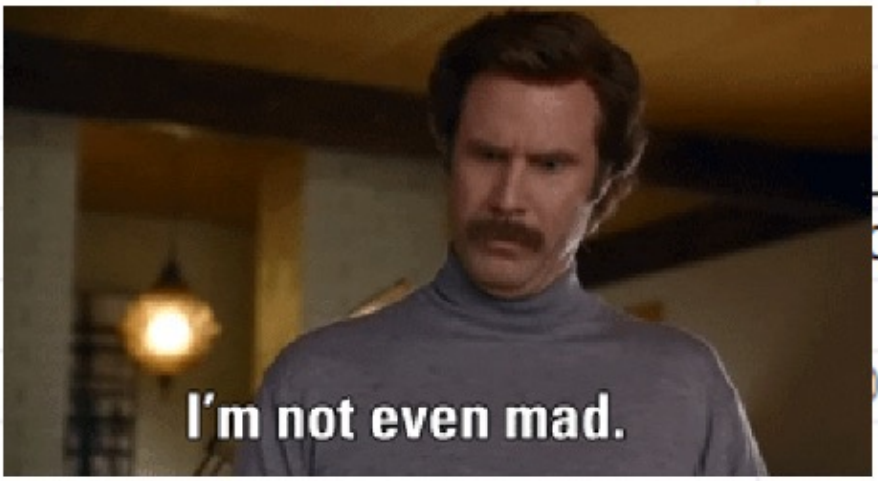
But the best part...







ElapsedTime	1590577
Reason For Early Termination Of State	Good Enough Plan Found



_NULLS: True, ANSI_PA

CT TOP 1000 u.Display

0B2F33A8CCFD020466

MSTVF round up

The bad:

- Table variable guarantees at least a serial zone in the plan
- Takes several times longer than a scalar
- Some information in the execution plan, but misleading
- Some information in STATISTICS IO, but also misleading

The good:

- They get just a little better in SQL Server 2017.

Scalar functions can be used in more places

- Computed columns
- Check constraints

Using them in either of these makes

ALL QUERIES AGAINST THE TABLE SERIAL

This includes maintenance like index rebuilds, CHECKDB.

Blogs to prove it

Still Serial After All These Years:

https://www.brentozar.com/archive/2016/01/still-serial-after-all-these-years/

Scalar Functions In Computed Columns:

https://www.brentozar.com/archive/2016/01/another-reason-why-scalar-functions-in-computed-columns-is-a-bad-idea/

Scalar Functions In Check Constraints:

https://www.brentozar.com/archive/2016/04/another-hidden-parallelism-killer-scalar-udfs-check-constraints/

After a decade, Microsoft saw the light.

When Microsoft started hosting your databases in Azure SQL DB, they suddenly realized how CPU-intensive functions were. Go figure.

SQL Server 2019 can inline some scalar functions:
https://docs.microsoft.com/en-us/sql/relational-databases/user-defined-functions/scalar-udf-inlining

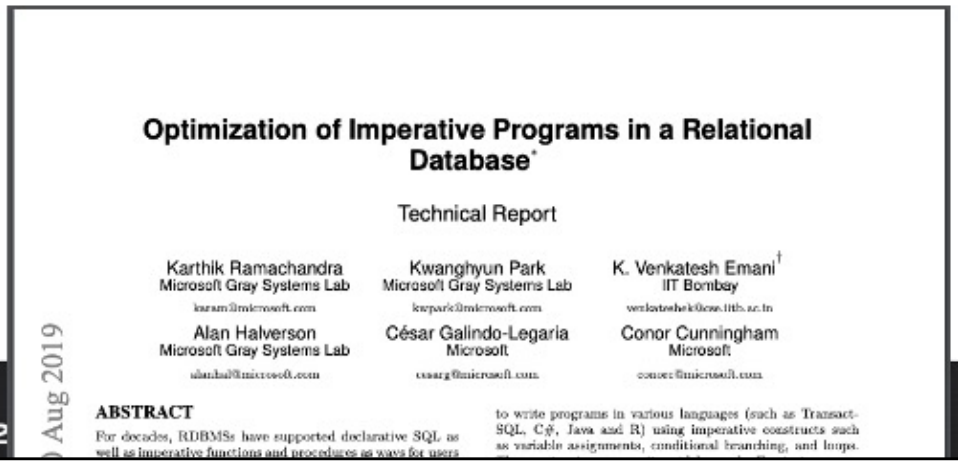
There are a lot of limitations, so not all functions will inline:

- Can't call time-dependent functions like GETDATE()
- The UDF can't have table variables or TVPs
- The UDF can't be referenced in a GROUP BY or ORDER BY
- The UDF can't be used in a computed column, check constraint, or partitioned function

This stuff is amazeballs complicated

White paper about the internals: https://arxiv.org/pdf/1712.00498

Possibly extensible to C#, Java, R, Python hosted in SQL Server



Optimization of Imperative Programs in a Relational Database*

Technical Report

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Conor Cunningham, Microsoft, conorc@microsoft.com

ABSTRACT

For decades, RDBMSs have supported declarative SQL as well as imperative functions and procedures as ways for users to write programs in various languages (such as Transact-SQL, C#, Java and R) using imperative constructs such as variable assignments, conditional branching, and loops.

2.2 p42

Will your functions be a good fit?

Set up a SQL Server 2019 server, restore your databases into it

Check the is_inlineable column in sys.sql_modules:

That doesn't mean it'll actually get inlined:
the decision is made at compile time, based on the query calling the UDF

```
/* Will SQL Server 2019 help? */
ALTER DATABASE CURRENT SET COMPATIBILITY_LEVEL = 150;
GO
SELECT * FROM sys.sql_modules WHERE definition LIKE '%Function%';
```

150 %

Results | Messages | Execution plan

	object_id	definition	is_inlineable	u
1	789577851	CREATE FUNCTION [dbo].[fn_UserHasVoted] (@UserId INT, @PostId INT) RETURNS BIT WITH RET...	1	1
2	805577908	CREATE FUNCTION dbo.ScalarFunction (@uid INT) RETURNS BIGINT WITH RETURNS NULL ON NU...	1	1
3	821577965	CREATE FUNCTION [dbo].[InlineTVF] (@uid INT) RETURNS TABLE WITH SCHEMABINDING AS ...	1	1
4	834102012	CREATE PROC dbo.usp_Q89582 AS BEGIN DECLARE @padStr NVARCHAR(64) = NCHAR (8199) + N...	0	1
5	837578022	CREATE FUNCTION dbo.MultiStatementTVF (@uid INT) RETURNS @Out TABLE (BadgeCount BIGINT) ...	0	1
6	1522104463	CREATE FUNCTION [dbo].[AcceptedAnswerPercentageRate] (@UserId INT) RETURNS FLOAT WIT...	1	1
7	1650104919	CREATE FUNCTION dbo.RelatedPosts (@PostId INT) RETURNS @Out TABLE (PostId BIGINT) AS ...	0	1
8	1986106116	CREATE FUNCTION dbo.IsTagBanned (@PostId INT) RETURNS TINYINT WITH RETURNS NULL O...	1	1

2.2 p43

There are a huge list of limitations

https://docs.microsoft.com/en-us/sql/relational-databases/user-defined-functions/scalar-udf-inlining

A scalar T-SQL UDF can be inlined if all of the following conditions are true:

- The UDF is written using the following constructs:
  - `DECLARE`, `SET`: Variable declaration and assignments.
  - `SELECT`: SQL query with single/multiple variable assignments [1].
  - `IF`/`ELSE`: Branching with arbitrary levels of nesting.
  - `RETURN`: Single or multiple return statements.
  - `UDF`: Nested/recursive function calls [2].
  - Others: Relational operations such as `EXISTS`, `ISNULL`.
- The UDF does not invoke any intrinsic function that is either time-dependent (such as `GETDATE()`) or has side effects [3] (such as `NEWSEQUENTIALID()`).

- The UDF does not reference table variables or table-valued parameters.
- The query invoking a scalar UDF does not reference a scalar UDF call in its `GROUP BY` clause.
- The query invoking a scalar UDF in its select list with `DISTINCT` clause does not have `ORDER BY` clause.
- The UDF is not used in `ORDER BY` clause.
- The UDF is not natively compiled (interop is supported).
- The UDF is not used in a computed column or a check constraint definition.
- The UDF does not reference user-defined types.
- There are no signatures added to the UDF.
- The UDF is not a partition function.
- The UDF does not contain references to Common Table Expressions (CTEs).
- The UDF does not contain references to intrinsic functions that may alter the results when inlined (such as `@@ROWCOUNT`) [4].
- The UDF does not contain aggregate functions being passed as parameters to a scalar UDF [4].
- The UDF does not reference built-in views (such as `OBJECT_ID`) [4].
- The UDF does not reference XML methods [5].
- The UDF does not contain a SELECT with `ORDER BY` without a `TOP 1` clause [5].
- The UDF does not contain a SELECT query that performs an assignment in conjunction with the `ORDER BY` clause (such as `SELECT @x = @x + 1 FROM table1 ORDER BY col1`) [5].
- The UDF does not contain multiple RETURN statements [6].
- The UDF is not called from a RETURN statement [6].
- The UDF does not reference the `STRING_AGG` function [6].
- The UDF does not reference remote tables [7].
- The UDF-calling query does not use `GROUPING SETS`, `CUBE`, or `ROLLUP` [7].
- The UDF-calling query does not contain a variable that is used as a UDF parameter for assignment (for example, `SELECT @y = 2, @x = UDF(@y)`)[7].

Microsoft keeps adding more limitations

Since SQL Server 2019 released, most of the Cumulative Updates have removed inline function support for more and more functions:

https://support.microsoft.com/en-us/help/4538581/fix-scalar-udf-inlining-issues-in-sql-server-2019

2.2 p46

This cumulative update also **blocks** inlining in the following scenarios:

- If the UDF references certain intrinsic functions (for example, @@ROWCOUNT) that may alter the results when inlined (added in Microsoft SQL Server 2019 CU2)
- When aggregate functions are passed as parameters to a scalar UDF (added in Microsoft SQL Server 2019 CU2)
- If the UDF references built-in views (for example: OBJECT_ID) (added in Microsoft SQL Server 2019 CU2)
- If the UDF uses XML methods (added in Microsoft SQL Server 2019 CU4)
- If the UDF contains a SELECT with ORDER BY without a "TOP 1" (added in Microsoft SQL Server 2019 CU4)
- If the SELECT query performs an assignment in conjunction with the ORDER BY clause (for example, SELECT @x = @x +1 FROM table ORDER BY *column_name) (added in Microsoft SQL Server 2019 CU4)*
- If the UDF contains multiple RETURN statements (added in Microsoft SQL Server 2019 CU5)
- If the UDF is called from a RETURN statement (added in Microsoft SQL Server 2019 CU5)
- If the UDF references the STRING_AGG function (added in Microsoft SQL Server 2019 CU5)
- If the UDF definition references remote tables (added in Microsoft SQL Server 2019 CU6)
- If the UDF-calling query uses GROUPING SETS, CUBE, or ROLLUP (added in Microsoft SQL Server 2019 CU6)
- If the UDF-calling query contains a variable that is used as a UDF parameter for assignment (for example, SELECT @y=2, @x=UDF(@y)) (added in Microsoft SQL Server 2019 CU6)

Let's try our ScalarFunction example

It used to take ~8 minutes. In 2019 compat level: 2 minutes!

```
SELECT TOP 1000
u.DisplayName,
dbo.ScalarFunction(u.Id)
FROM dbo.Users AS u;
```

150 %

Results | Messages | Execution plan

	DisplayName	(No column name)
1	Community	1
2	Jeff Atwood	328
3	Geoff Dalgas	90
4	Jarrod Dixon	130
5	Joel Spolsky	185

Query executed successfully. | SQL2019 (15.0 RTM) | SQL2019\Administrator ... | StackOverflow | 00:01:56 | 1,000 rows

STATISTICS IO now shows what's going on

```
SELECT TOP 1000
u.DisplayName,
dbo.ScalarFunction(u.Id)
FROM dbo.Users AS u;
GO
```

But it's not good: that's a hell of a lot of reads.

150 %

Results | Messages | Execution plan

```
SQL Server parse and compile time:
   CPU time = 0 ms, elapsed time = 0 ms.

 SQL Server Execution Times:
   CPU time = 0 ms,  elapsed time = 0 ms.
SQL Server parse and compile time:
   CPU time = 4 ms, elapsed time = 4 ms.

(1000 rows affected)
Table 'Worktable'. Scan count 1000, logical reads 83182561, physical re
Table 'Badges'. Scan count 1, logical reads 168260, physical reads 0, p
Table 'Users'. Scan count 1, logical reads 69, physical reads 0, page s

(1 row affected)

 SQL Server Execution Times:
   CPU time = 116157 ms,  elapsed time = 116255 ms.
```

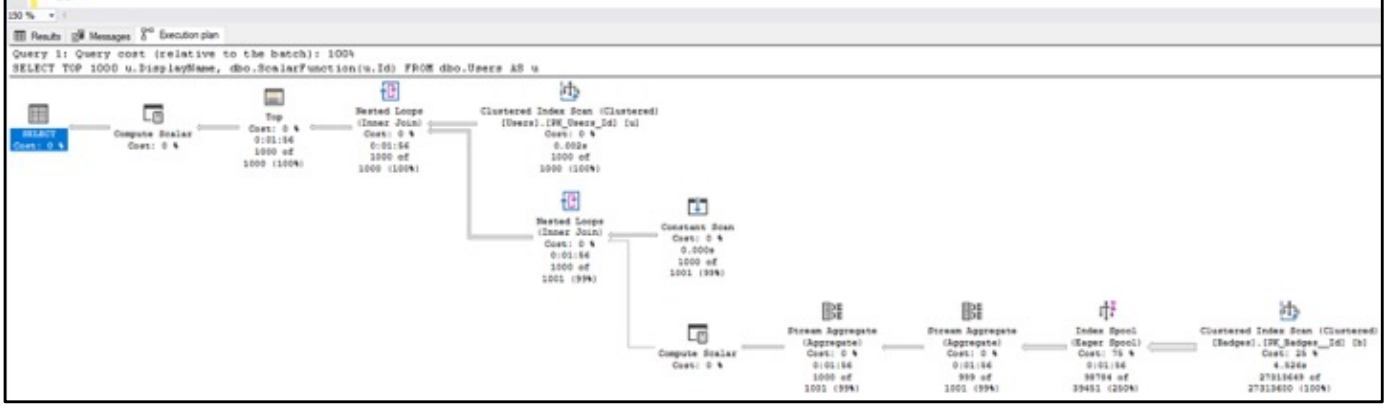
2.2 p49

The plan shows what's up, too.

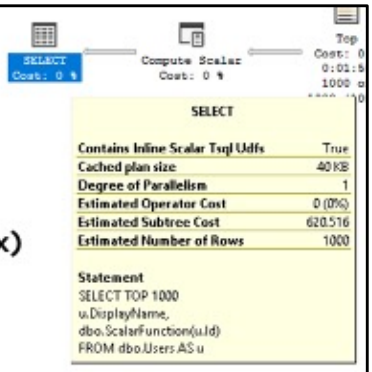
The Badges table now shows up, but...

We get an Index Spool (Eager Spool) and no parallelism.

```
SELECT TOP 1000
u.DisplayName,
dbo.ScalarFunction(u.Id)
FROM dbo.Users AS u;
GO
```



What went wrong



SQL Server 2019 inlined the function, but:

- Chose an index spool plan (that didn't suggest an index)
- Only used a single CPU core
  (whereas 2017 let the function itself go parallel)
- And it wasn't due to low query cost either

If inlining doesn't work out for your function (some go slower), you can use WITH INLINE = OFF at the function level:

```
CREATE OR ALTER FUNCTION dbo.discount_price(@price DECIMAL(12,2), @discount DECIMAL(12,2))
RETURNS DECIMAL (12,2)
WITH INLINE = OFF
AS
BEGIN
    RETURN @price * (1 - @discount);
END
```

2.2 p51

And you can still do way better yourself.

2.2 p52

If you're facing MSTVFs that look like this:

```
-- Multi Statement Table Valued Function
CREATE FUNCTION dbo.MultiStatementTVF ( @uid INT )
RETURNS @Out TABLE ( BadgeCount BIGINT )
    WITH SCHEMABINDING
AS
    BEGIN
        INSERT  INTO @Out(BadgeCount)
        SELECT  COUNT_BIG(*) AS BadgeCount
        FROM    dbo.Badges AS b
        WHERE   b.UserId = @uid
        GROUP BY b.UserId;
      RETURN;
    END;
```

2.2 p54

And you call them like this:

```
SELECT TOP 1000
u.DisplayName,
mi.BadgeCount
FROM dbo.Users AS u
CROSS APPLY dbo.MultiStatementTVF(u.Id) AS mi
```

2.2 p55

Then they'll fly if you make 'em look like this:

```
-- Inline Table Valued Function
CREATE FUNCTION dbo.InlineTVF ( @uid INT )
RETURNS TABLE
    WITH SCHEMABINDING
AS
RETURN
    SELECT  COUNT_BIG(*) AS BadgeCount
    FROM    dbo.Badges AS b
    WHERE   b.UserId = @uid
    GROUP BY b.UserId;
```

2.2 p56

Single-statement inline TVFs

If you can write it with a single SELECT, then SQL Server can inline it just like it was a view.

The good: you only have to change the function's contents, but not the way you call the function. The callers stay the same.

The bad: complex MSTVFs can turn into a hell of CASEs.

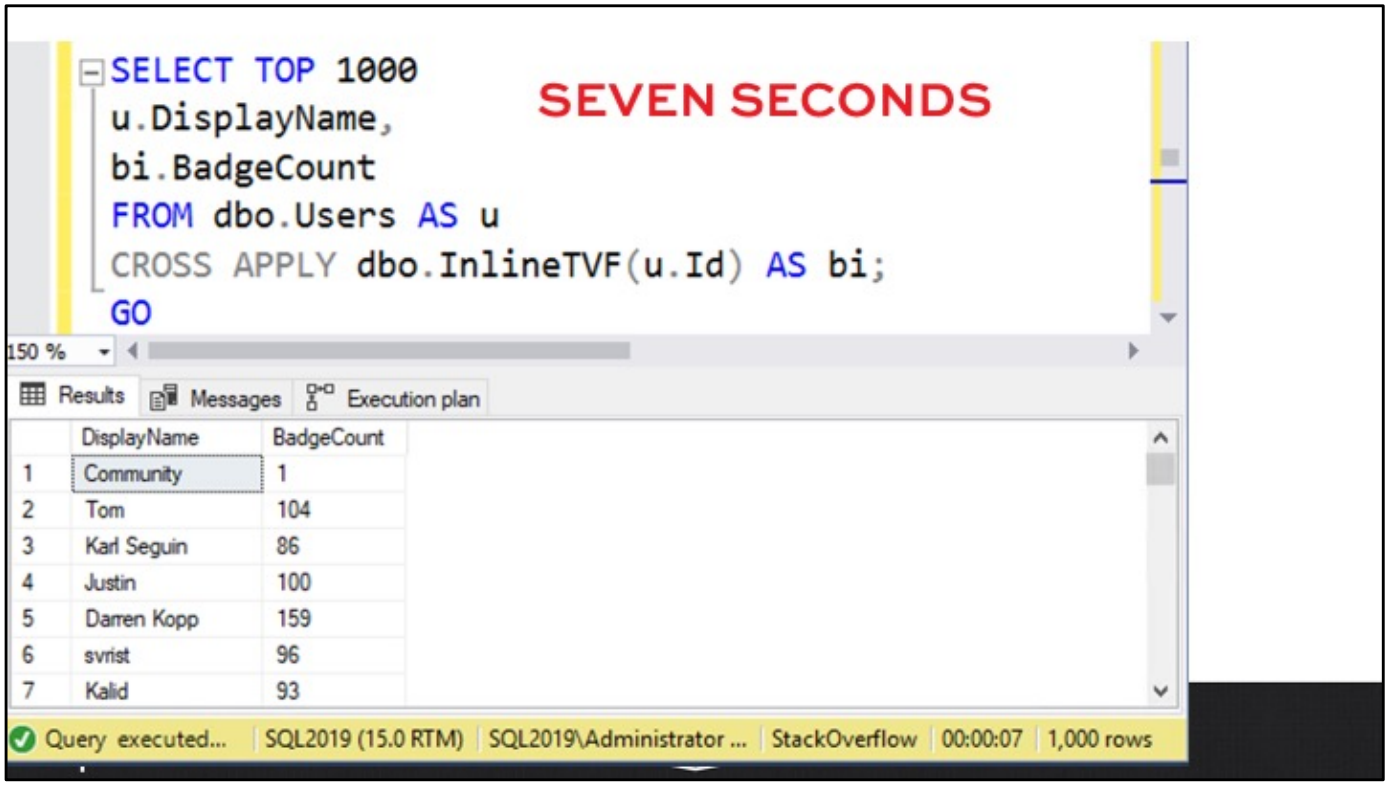
The ugly: if you can't get it into one statement, it won't perform. Your only options are things like stored procedures.

2.2 p57

lol.exe is terminating unexpectedly

```
SELECT TOP 1000
u.DisplayName,
bi.BadgeCount
FROM dbo.Users AS u
CROSS APPLY dbo.InlineTVF(u.Id) AS bi
```

2.2 p58

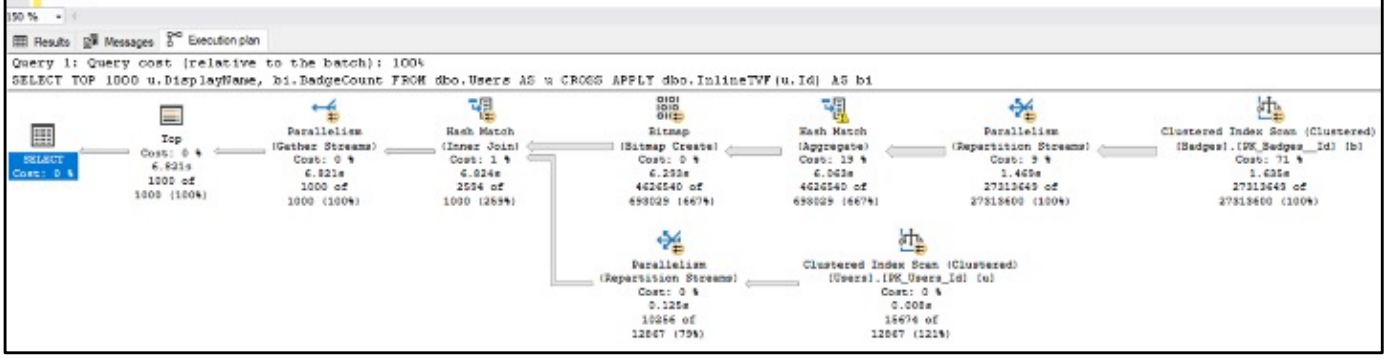


The plan gets way better

We get parallelism, and no index spool.

And if you tuned indexes, you could do even better.

```
SELECT TOP 1000
u.DisplayName,
bi.BadgeCount
FROM dbo.Users AS u
CROSS APPLY dbo.InlineTVF(u.Id) AS bi;
GO
```



So many good benefits here

Parallelism

One call to the function

Done in seconds, not minutes

Accurate STATISTICS IO

Accurate query cost

2.2 p61

CROSS APPLY would work too

```
SELECT TOP  1000
            u.DisplayName ,
            bca.BadgeCount
FROM    dbo.Users AS u
CROSS APPLY ( SELECT b.UserId ,
              COUNT_BIG(*) AS BadgeCount
              FROM      dbo.Badges AS b
              WHERE     u.Id = b.UserId
              GROUP BY  b.UserId
            ) bca;
```

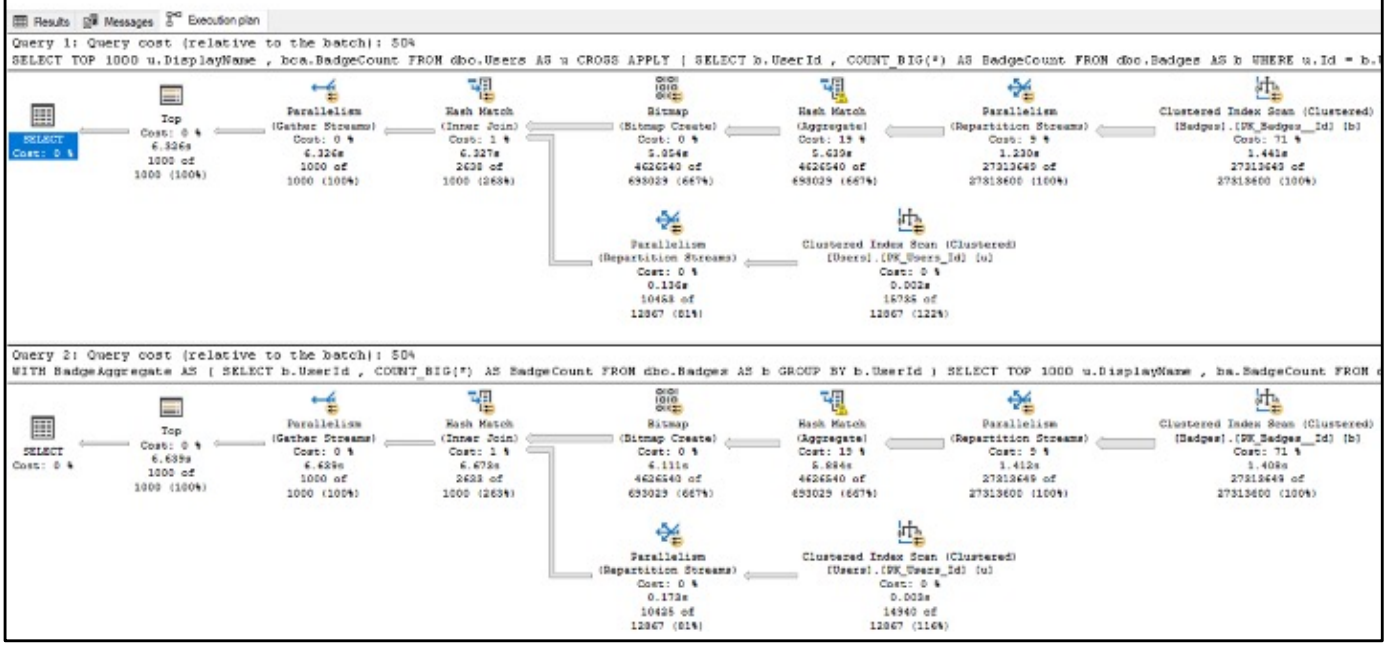
2.2 p62

As would a CTE

```
WITH BadgeAggregate AS
( SELECT b.UserId ,
  COUNT_BIG(*) AS BadgeCount
  FROM     dbo.Badges AS b
  GROUP BY b.UserId )
SELECT TOP 1000
        u.DisplayName ,
        ba.BadgeCount
FROM    dbo.Users AS u
JOIN    BadgeAggregate AS ba
ON      ba.UserId = u.Id;
```

2.2 p63

Same plan, same costs, etc.



But if you're facing scalar functions...

```
-- Scalar Function
CREATE FUNCTION dbo.ScalarFunction ( @uid INT )
RETURNS BIGINT
    WITH RETURNS NULL ON NULL INPUT,
         SCHEMABINDING
AS
    BEGIN
        DECLARE @BCount BIGINT;
        SELECT  @BCount = COUNT_BIG(*)
        FROM    dbo.Badges AS b
        WHERE   b.UserId = @uid
        GROUP BY b.UserId;
        RETURN @BCount;
    END;
```

2.2 p65

SQL Server 2017 & prior can't inline these.

Even if they only have one statement, they won't go inline.

That means you HAVE to get rid of them altogether, not just tune them.

Which is problematic since you have to touch every query that has 'em.

Thus the excitement about SQL Server 2019.

2.2 p66

Find queries executed frequently

```
EXEC sp_BlitzCache @SortOrder = 'xpm'
GO
EXEC sp_BlitzCache @SortOrder = 'executions'

/* Sorts your plan cache by highest executions per
minute or executions.

When this is high, it's sometimes a sign of row-by-
row functions being called, as we saw.

http://www.brentozar.com/blitzcache/ */
```

2.2 p68

Or you can rip through code...

```
/*You can look for bad functions like this*/

SELECT  SCHEMA_NAME(o.schema_id) AS [schema_name], o.name, o.type_desc
FROM    sys.objects AS o
WHERE   o.type IN ('FN', N'TF')
        AND o.is_ms_shipped = 0;

/*Plug the names in here to search stored proc text*/

SELECT  obj.name ,
        sc.text
FROM    sys.objects obj
INNER JOIN sys.syscomments sc
ON      sc.id = obj.object_id
WHERE   obj.type = 'P'
        AND sc.text LIKE '% FUNCTION NAME %'
```

2.2 p69

Recap

Functions sound like a great idea at first

- Code reusability is a best practice everywhere else

But right now, functions cause problems in SQL Server

- Serializing execution
- Row by row execution

Inline table valued functions reduce these issues

- Treated like a view or CTE rather than a separate procedural task