KULENDAYZ

4.-6. SEP 2025
OSIJEK CROATIA

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JSON in the world of MSSQL

github.com/matesic-damir/presentations

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AD 2018 - Leading Data Events in Croatia

AD 2019 - Introduced SQL/Data Saturday in Croatia

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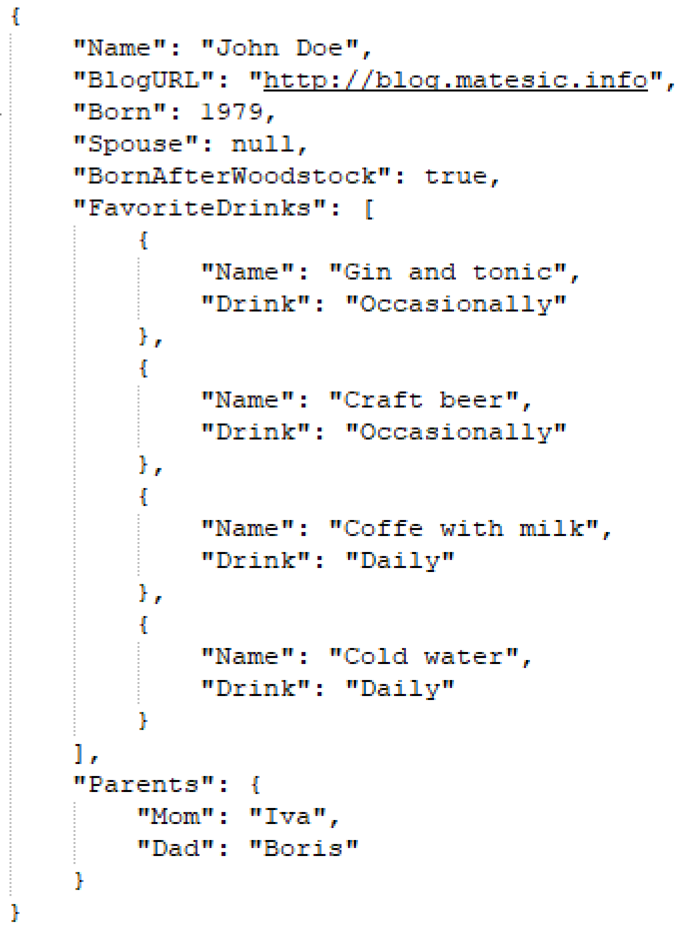
Storing JSON in a SQL Database

JSON 1/2

- JavaScript **O**bject **N**otation
- language in depended
- open standard format
- simple and very popular
- JSON objects are human readable lists of key-value pairs.



```
{
    "Name": "John Doe",
    "BlogURL": "http://blog.matesic.info",
    "Born": 1979,
    "Spouse": null,
    "BornAfterWoodstock": true,
    "FavoriteDrinks": [
        {
            "Name": "Gin and tonic",
            "Drink": "Occasionally"
        },
        {
            "Name": "Craft beer",
            "Drink": "Occasionally"
        },
        {
            "Name": "Coffe with milk",
            "Drink": "Daily"
        },
        {
            "Name": "Cold water",
            "Drink": "Daily"
        }
    ],
    "Parents": {
        "Mom": "Iva",
        "Dad": "Boris"
    }
}
```

JSON 2/2

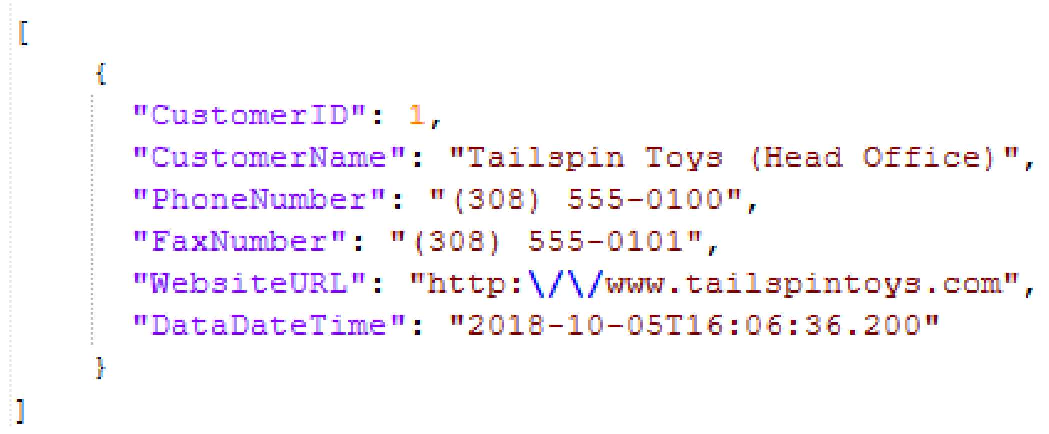
Supported data types:

- **String** - escaped Unicode text surrounded by double quotes
- **Number** - double-precision float
- **Boolean** - true/false written in lowercase
- **null** - represents a null value

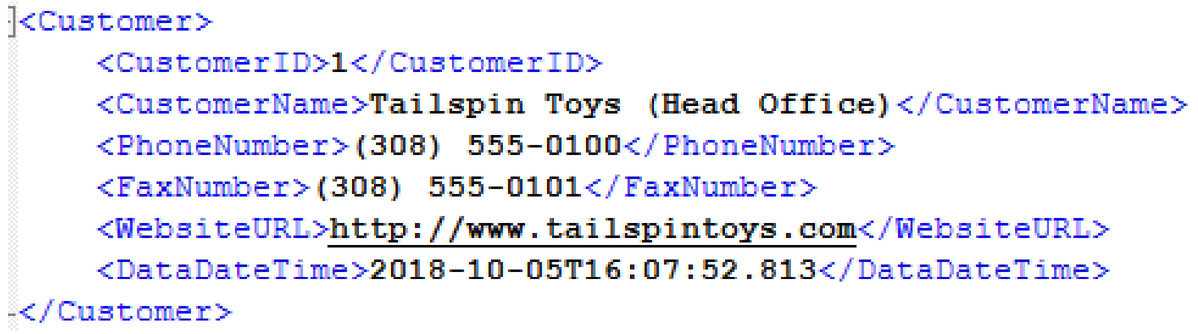
Escaping rules

- Quotation mark (") -> \"
- Reverse solidus (\) -> \\
- Solidus (/) -> \/
- Backspace -> \b
- Form feed -> \f
- New line -> \n
- Carriage return -> \r
- Horizontal tab -> \t
- Control characters (0-31) -> **\u**<code> (e.g. CHAR(0) -> **\u**0000)

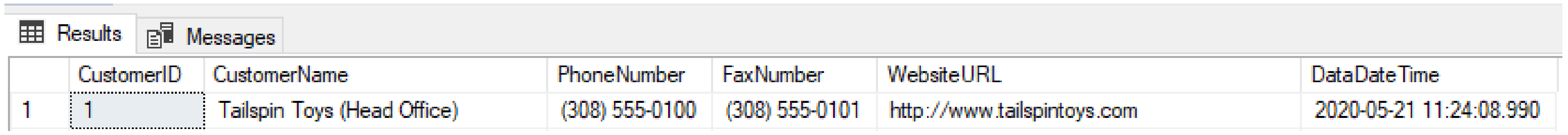
JSON VS XML



```
[
    {
        "CustomerID": 1,
        "CustomerName": "Tailspin Toys (Head Office)",
        "PhoneNumber": "(308) 555-0100",
        "FaxNumber": "(308) 555-0101",
        "WebsiteURL": "http:\/\/www.tailspintoys.com",
        "DataDateTime": "2018-10-05T16:06:36.200"
    }
]
```



```
<Customer>
    <CustomerID>1</CustomerID>
    <CustomerName>Tailspin Toys (Head Office)</CustomerName>
    <PhoneNumber>(308) 555-0100</PhoneNumber>
    <FaxNumber>(308) 555-0101</FaxNumber>
    <WebsiteURL>http://www.tailspintoys.com</WebsiteURL>
    <DataDateTime>2018-10-05T16:07:52.813</DataDateTime>
</Customer>
```



Results | Messages

	CustomerID	CustomerName	PhoneNumber	FaxNumber	WebsiteURL	DataDateTime
1	1	Tailspin Toys (Head Office)	(308) 555-0100	(308) 555-0101	http://www.tailspintoys.com	2020-05-21 11:24:08.990

JSON VS XML

- arrays and objects
- can store only data
- less verbose and easier to read
- less data
- SQL:
  - NVARCHAR -> COMPRESS ?!?!
  - index problem
  - Recently -> JSON data type

- tree structure
- can store more complex data types
- can store additional information’s
- more robust
- SQL:
  - native XML data type

MS SQL 2016

SQL 2 JSON

Pretty much like creating XML data (FOR XML) -> **FOR JSON**

Two modes supported:

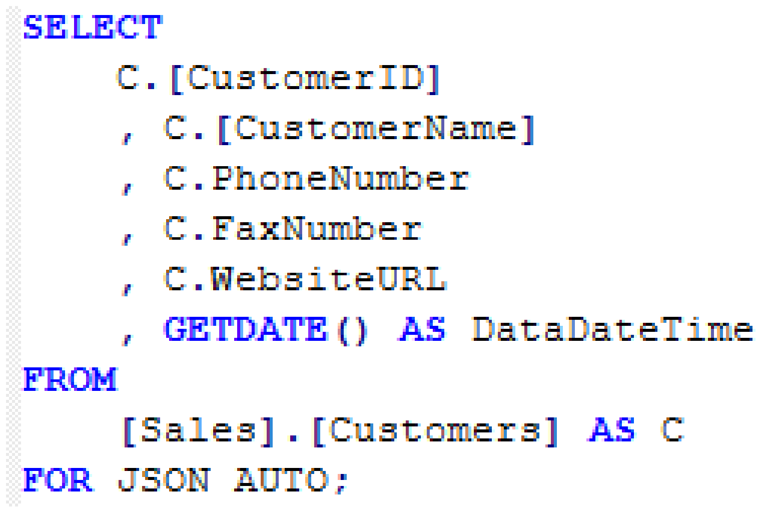
- **FOR JSON AUTO**
- **FOR JSON PATH**

Additional options

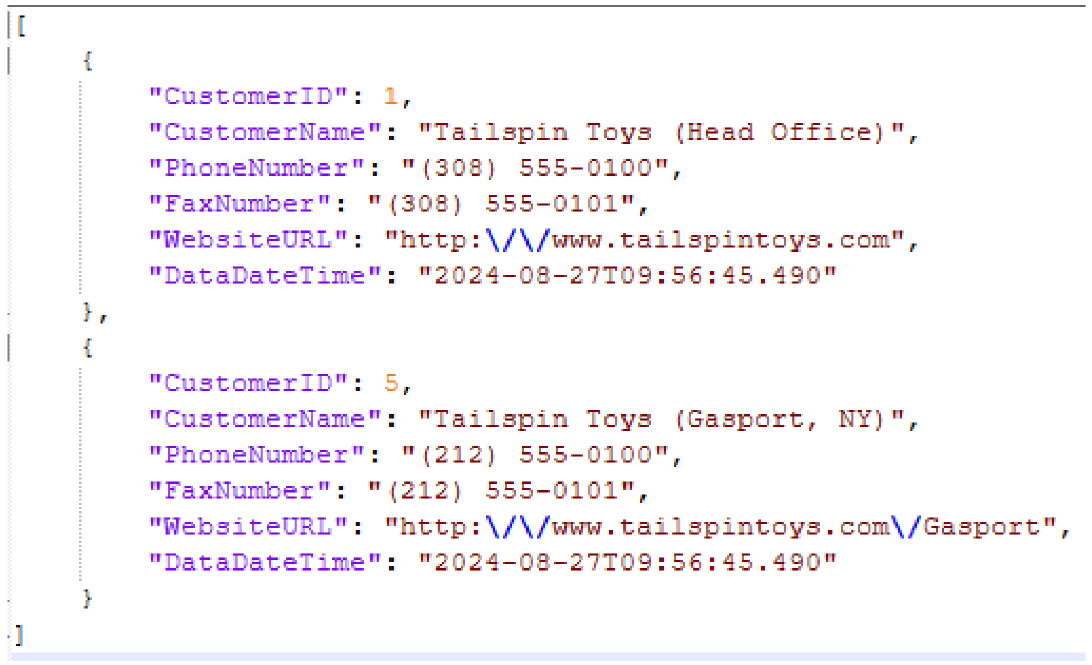
- **INCLUDE_NULL_VALUES**
- **ROOT**
- **WITHOUT_ARRAY_WRAPPER**

SQL 2 JSON – data conversion

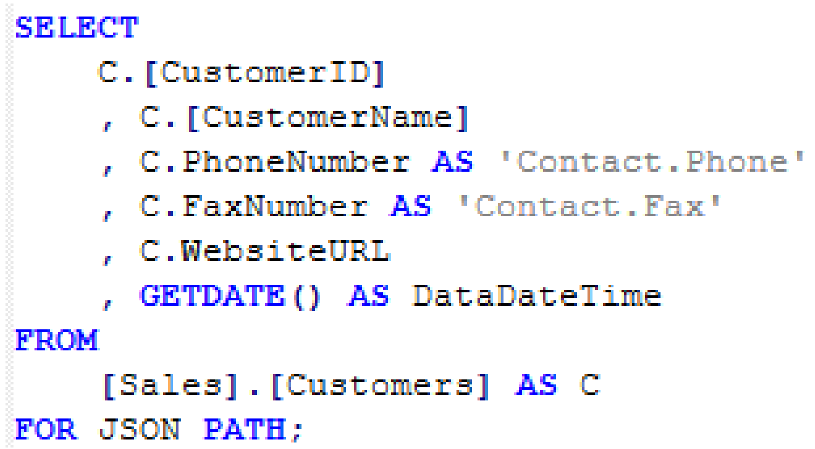
Source data type	Destination data type
Char, Varchar, Nchar, NVarchar, Text, Ntext, Date, DateTime, DateTime2, DateTimeOffset, Time, UniqueIdentifier, Smallmoney, Money, XML, HierarchyId, Sql_Variant	String
Tinyint, Smallint, Int, Bigint, Decimal, Float, Numeric	Number
Bit	Boolean
Binary, Varbinary, Image, Rowversion, Timestamp	Base 64 encoded string
null	null
geography, geometry, and CLR-based user defined data types	**not supported**



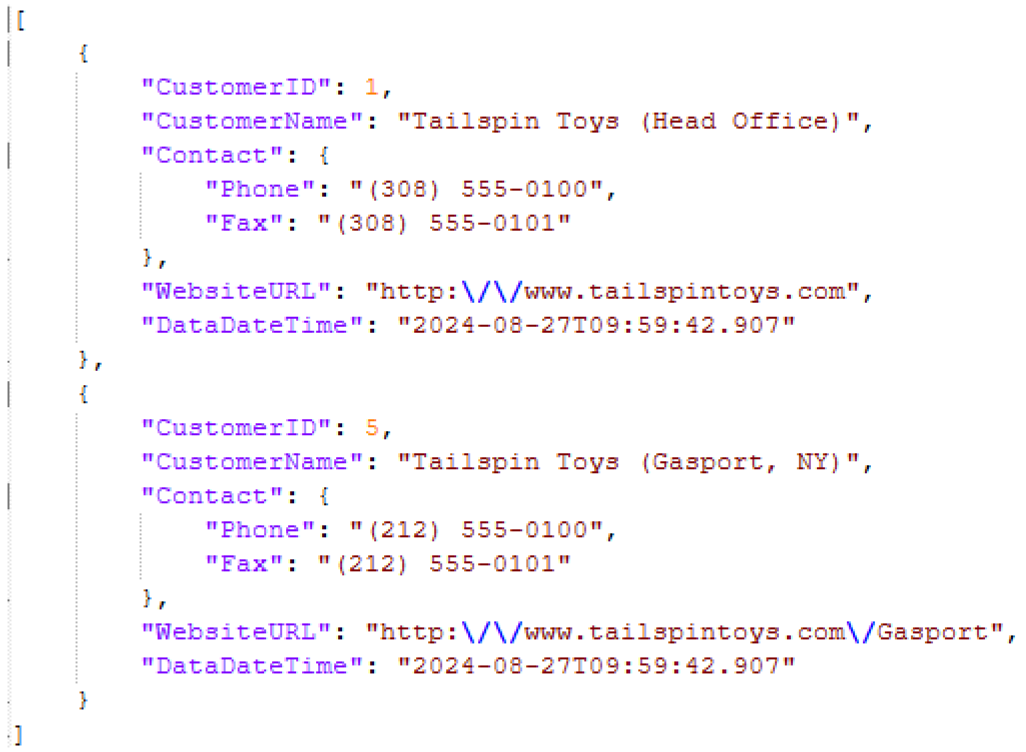
```sql
SELECT
    C.[CustomerID]
  , C.[CustomerName]
  , C.PhoneNumber
  , C.FaxNumber
  , C.WebsiteURL
  , GETDATE() AS DataDateTime
FROM
    [Sales].[Customers] AS C
FOR JSON AUTO;
```



```json
[
    {
        "CustomerID": 1,
        "CustomerName": "Tailspin Toys (Head Office)",
        "PhoneNumber": "(308) 555-0100",
        "FaxNumber": "(308) 555-0101",
        "WebsiteURL": "http:\/\/www.tailspintoys.com",
        "DataDateTime": "2024-08-27T09:56:45.490"
    },
    {
        "CustomerID": 5,
        "CustomerName": "Tailspin Toys (Gasport, NY)",
        "PhoneNumber": "(212) 555-0100",
        "FaxNumber": "(212) 555-0101",
        "WebsiteURL": "http:\/\/www.tailspintoys.com\/Gasport",
        "DataDateTime": "2024-08-27T09:56:45.490"
    }
]
```



```sql
SELECT
    C.[CustomerID]
  , C.[CustomerName]
  , C.PhoneNumber AS 'Contact.Phone'
  , C.FaxNumber AS 'Contact.Fax'
  , C.WebsiteURL
  , GETDATE() AS DataDateTime
FROM
    [Sales].[Customers] AS C
FOR JSON PATH;
```



```json
[
    {
        "CustomerID": 1,
        "CustomerName": "Tailspin Toys (Head Office)",
        "Contact": {
            "Phone": "(308) 555-0100",
            "Fax": "(308) 555-0101"
        },
        "WebsiteURL": "http:\/\/www.tailspintoys.com",
        "DataDateTime": "2024-08-27T09:59:42.907"
    },
    {
        "CustomerID": 5,
        "CustomerName": "Tailspin Toys (Gasport, NY)",
        "Contact": {
            "Phone": "(212) 555-0100",
            "Fax": "(212) 555-0101"
        },
        "WebsiteURL": "http:\/\/www.tailspintoys.com\/Gasport",
        "DataDateTime": "2024-08-27T09:59:42.907"
    }
]
```

JSON 2 SQL

OPENJSON

rowset function (table-valued function)

Two types of return tables:

- **Default schema**
- **Explicit schema**

OPENJSON – default schema

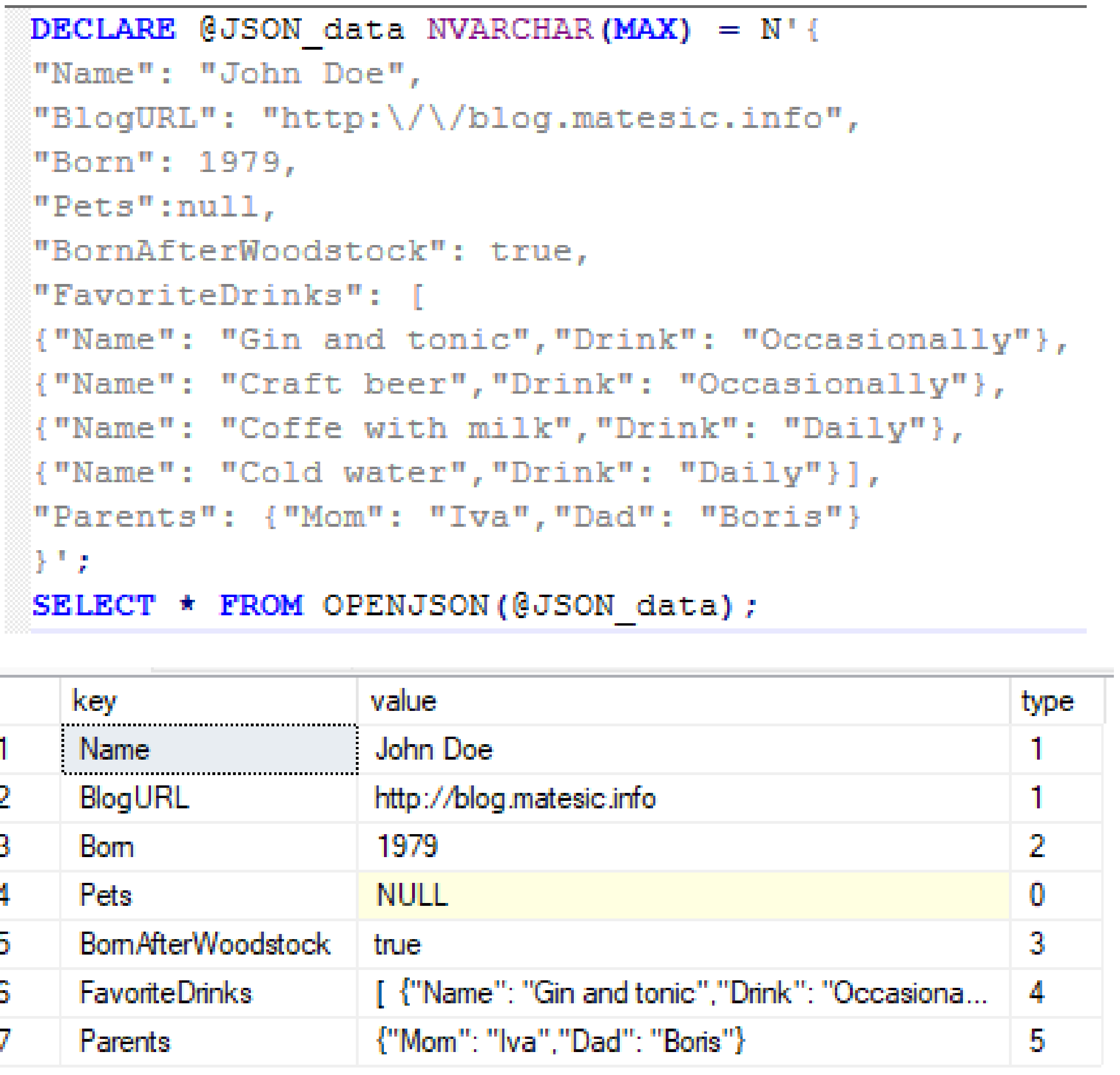
OPENJSON (Expression, [Path])

- **Expression** – JSON object in Unicode text format
- **Path** – optional argument to specify a fragment (sub-node) of the input expression

Return - table result with three columns

- **Key**
- **Value**
- **Type**

0 -> null	**1 -> string**	**2 -> int**	**3 -> true/false**	**4 -> array**	**5 -> object**



```
DECLARE @JSON_data NVARCHAR(MAX) = N'{
"Name": "John Doe",
"BlogURL": "http:\/\/blog.matesic.info",
"Born": 1979,
"Pets":null,
"BornAfterWoodstock": true,
"FavoriteDrinks": [
{"Name": "Gin and tonic","Drink": "Occasionally"},
{"Name": "Craft beer","Drink": "Occasionally"},
{"Name": "Coffe with milk","Drink": "Daily"},
{"Name": "Cold water","Drink": "Daily"}],
"Parents": {"Mom": "Iva","Dad": "Boris"}
}';
SELECT * FROM OPENJSON(@JSON_data);
```

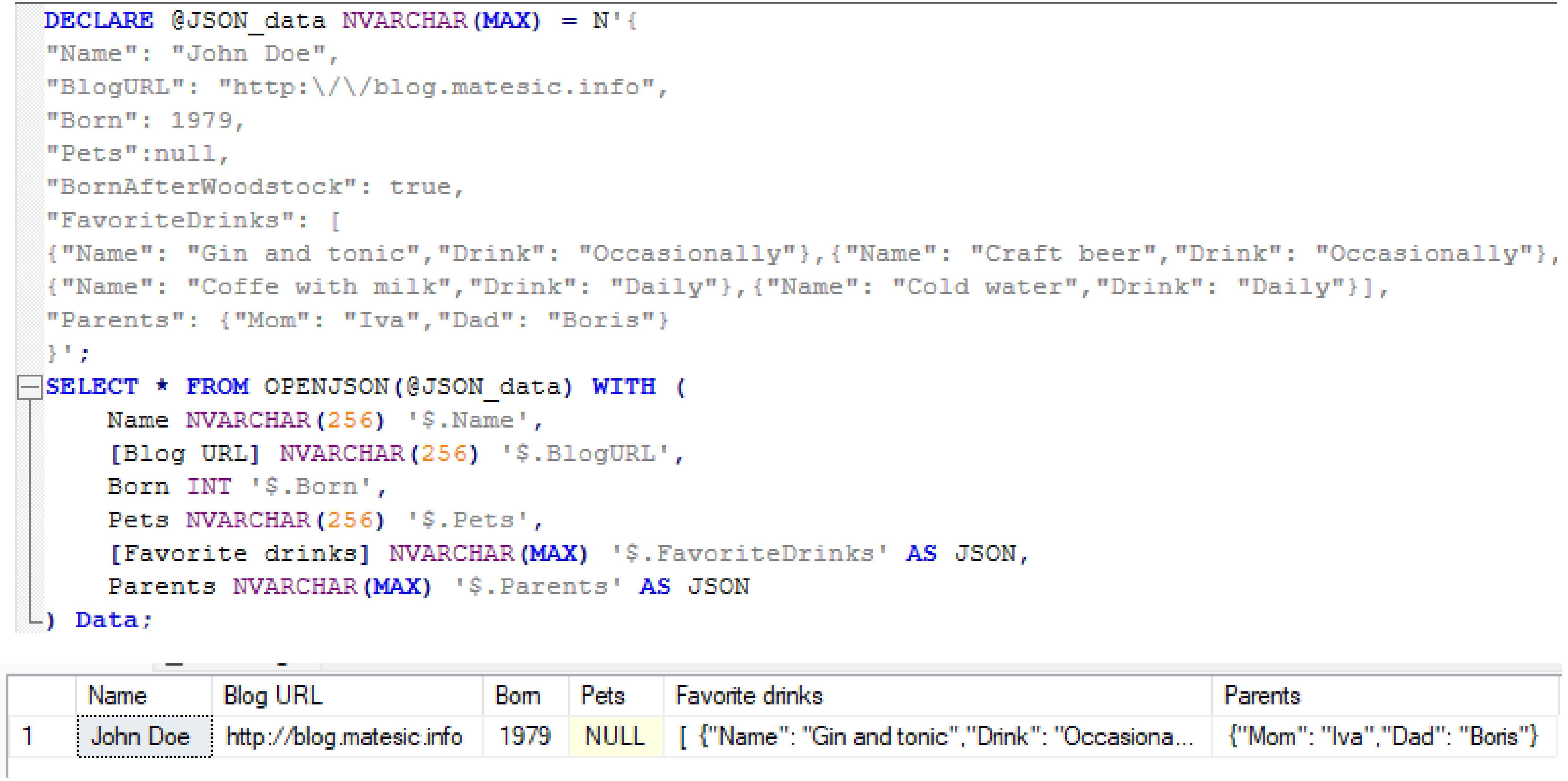
	key	value	type
1	Name	John Doe	1
2	BlogURL	http://blog.matesic.info	1
3	Born	1979	2
4	Pets	NULL	0
5	BornAfterWoodstock	true	3
6	FavoriteDrinks	[{"Name": "Gin and tonic","Drink": "Occasiona...	4
7	Parents	{"Mom": "Iva","Dad": "Boris"}	5

OPENJSON – explicit schema

```
OPENJSON (Expression, [Path])
[ WITH (
    columnName dataType [columnPath] [AS JSON]
    [, columnName dataType [columnPath] [AS JSON] ]
  ) ]
```

- **columnName** – Name of the output column
- **dataType** – Data type of the output column
- **columnPath** – Optional argument to specify a fragment (sub-node) of the column
- **AS JSON** – Optional argument to specify that the referenced property contains an inner JSON object or array. If used, the column must be NVARCHAR(MAX) data type

WITH keyword - at least one column must be specified!!!



```
DECLARE @JSON_data NVARCHAR(MAX) = N'{
"Name": "John Doe",
"BlogURL": "http:\/\/blog.matesic.info",
"Born": 1979,
"Pets":null,
"BornAfterWoodstock": true,
"FavoriteDrinks": [
{"Name": "Gin and tonic","Drink": "Occasionally"},{"Name": "Craft beer","Drink": "Occasionally"},
{"Name": "Coffe with milk","Drink": "Daily"},{"Name": "Cold water","Drink": "Daily"}],
"Parents": {"Mom": "Iva","Dad": "Boris"}
}';
SELECT * FROM OPENJSON(@JSON_data) WITH (
    Name NVARCHAR(256) '$.Name',
    [Blog URL] NVARCHAR(256) '$.BlogURL',
    Born INT '$.Born',
    Pets NVARCHAR(256) '$.Pets',
    [Favorite drinks] NVARCHAR(MAX) '$.FavoriteDrinks' AS JSON,
    Parents NVARCHAR(MAX) '$.Parents' AS JSON
) Data;
```

	Name	Blog URL	Born	Pets	Favorite drinks	Parents
1	John Doe	http://blog.matesic.info	1979	NULL	[{"Name": "Gin and tonic","Drink": "Occasiona...	{"Mom": "Iva","Dad": "Boris"}

JSON_VALUE

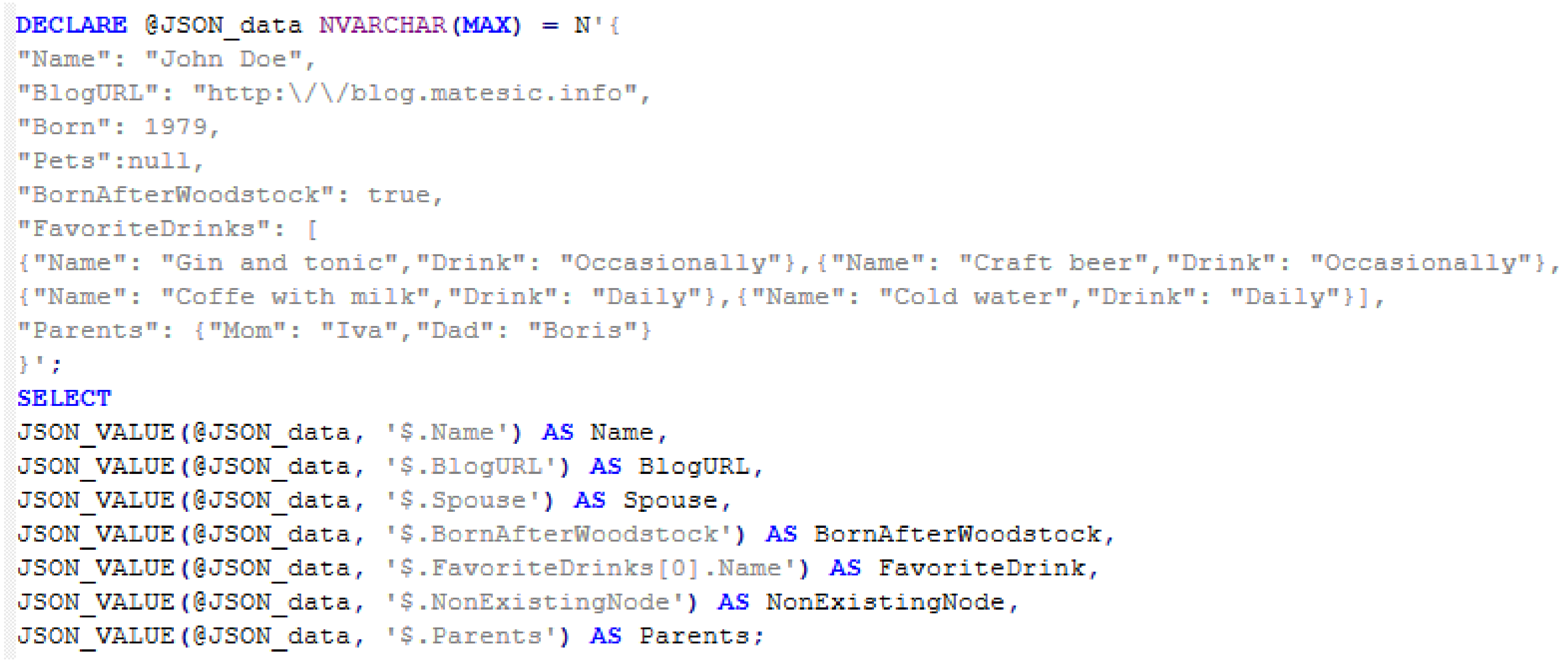
extracts a scalar value (primitive data type) from a JSON string

JSON_VALUE (Expression, [Path])

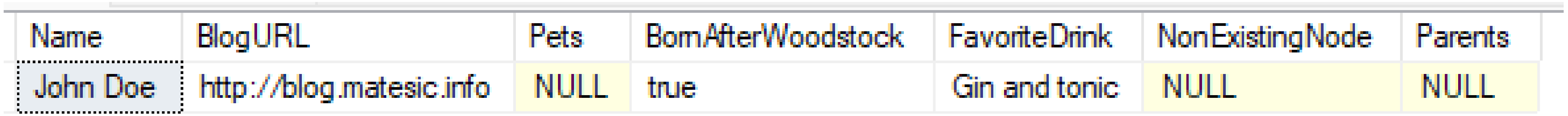
- **Expression** – JSON object in Unicode text format
- **Path** – optional argument to specify a fragment (sub-node) of the input expression

Return – result of nvarchar(4000) data type with the same collation as in the input expression.

Can be used in SELECT, WHERE, and ORDER BY clauses



```
DECLARE @JSON_data NVARCHAR(MAX) = N'{
"Name": "John Doe",
"BlogURL": "http:\/\/blog.matesic.info",
"Born": 1979,
"Pets":null,
"BornAfterWoodstock": true,
"FavoriteDrinks": [
{"Name": "Gin and tonic","Drink": "Occasionally"},{"Name": "Craft beer","Drink": "Occasionally"},
{"Name": "Coffe with milk","Drink": "Daily"},{"Name": "Cold water","Drink": "Daily"}],
"Parents": {"Mom": "Iva","Dad": "Boris"}
}';
SELECT
JSON_VALUE(@JSON_data, '$.Name') AS Name,
JSON_VALUE(@JSON_data, '$.BlogURL') AS BlogURL,
JSON_VALUE(@JSON_data, '$.Spouse') AS Spouse,
JSON_VALUE(@JSON_data, '$.BornAfterWoodstock') AS BornAfterWoodstock,
JSON_VALUE(@JSON_data, '$.FavoriteDrinks[0].Name') AS FavoriteDrink,
JSON_VALUE(@JSON_data, '$.NonExistingNode') AS NonExistingNode,
JSON_VALUE(@JSON_data, '$.Parents') AS Parents;
```



Name	BlogURL	Pets	BornAfterWoodstock	FavoriteDrink	NonExistingNode	Parents
John Doe	http://blog.matesic.info	NULL	true	Gin and tonic	NULL	NULL

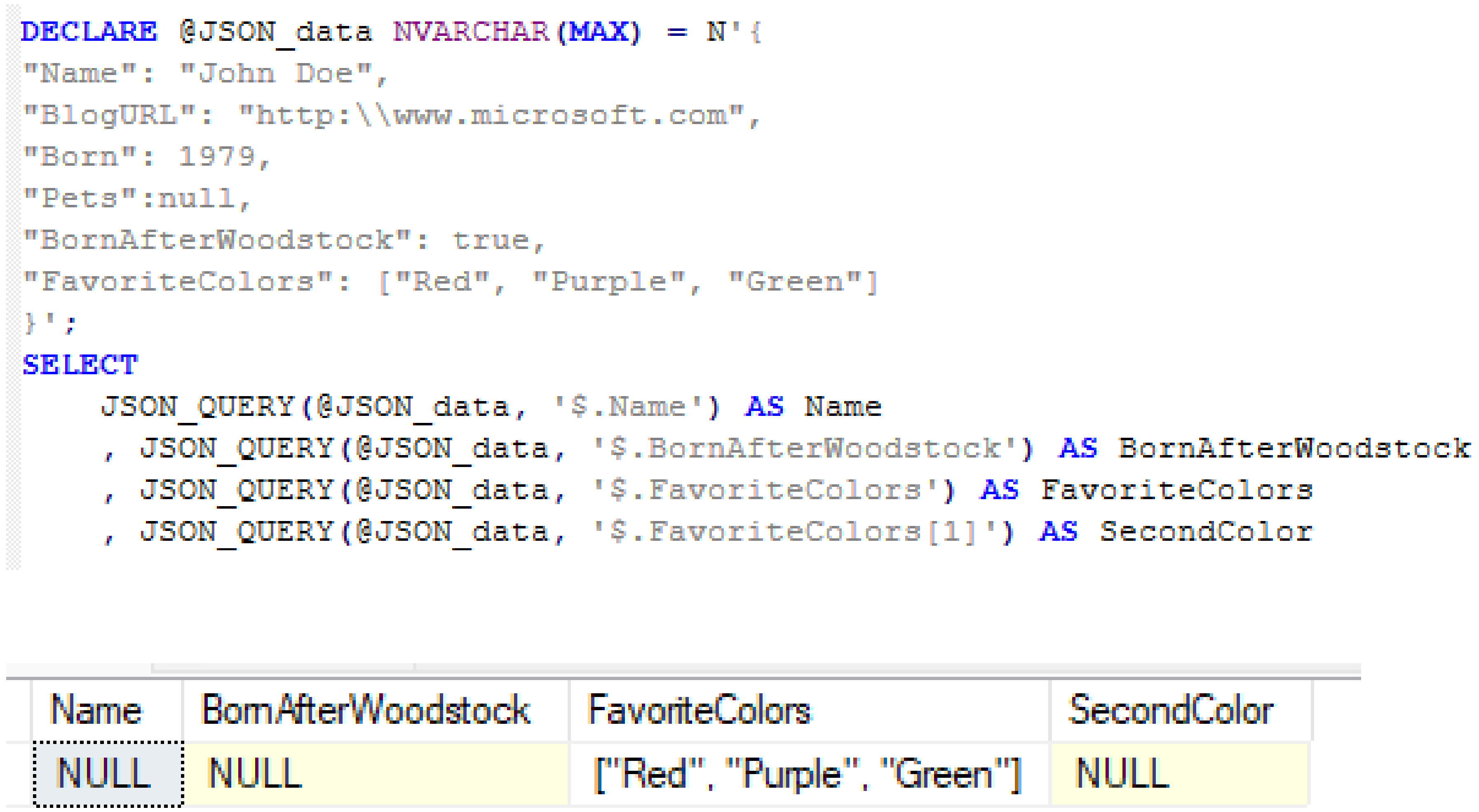
JSON_QUERY

extract a JSON fragment or to get a complex value (object or array)

JSON_QUERY (Expression, [Path])

- **Expression** – JSON object in Unicode text format
- **Path** – optional argument to specify a fragment (sub-node) of the input expression

Return – nvarchar(max) if the input string is defined as (n)varchar(max); otherwise -> nvarchar(4000)



```
DECLARE @JSON_data NVARCHAR(MAX) = N'{
"Name": "John Doe",
"BlogURL": "http:\\www.microsoft.com",
"Born": 1979,
"Pets":null,
"BornAfterWoodstock": true,
"FavoriteColors": ["Red", "Purple", "Green"]
}';
SELECT
    JSON_QUERY(@JSON_data, '$.Name') AS Name
    , JSON_QUERY(@JSON_data, '$.BornAfterWoodstock') AS BornAfterWoodstock
    , JSON_QUERY(@JSON_data, '$.FavoriteColors') AS FavoriteColors
    , JSON_QUERY(@JSON_data, '$.FavoriteColors[1]') AS SecondColor
```

Name	BornAfterWoodstock	FavoriteColors	SecondColor
NULL	NULL	["Red", "Purple", "Green"]	NULL

Modifying JSON data

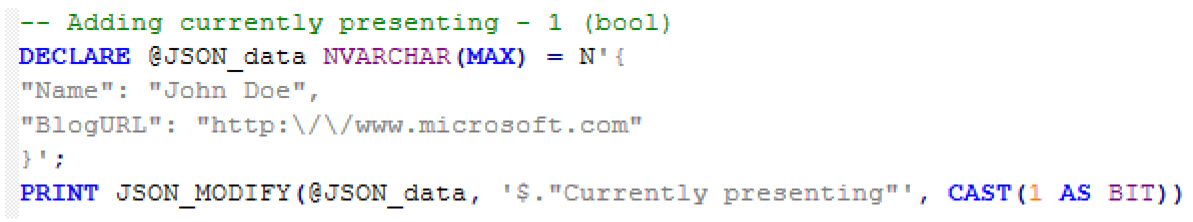
JSON_MODIFY (expression , path , newValue)

- **Expression** – JSON object in Unicode text format
- **Path** – A JSON path expression that specifies the property to update
- **newValue** – The new value for the property specified by path

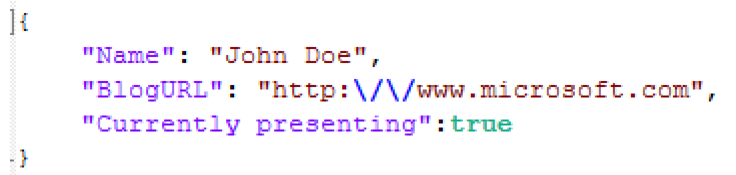
Return - updated JSON string

Adding, Removing, Updating JSON property

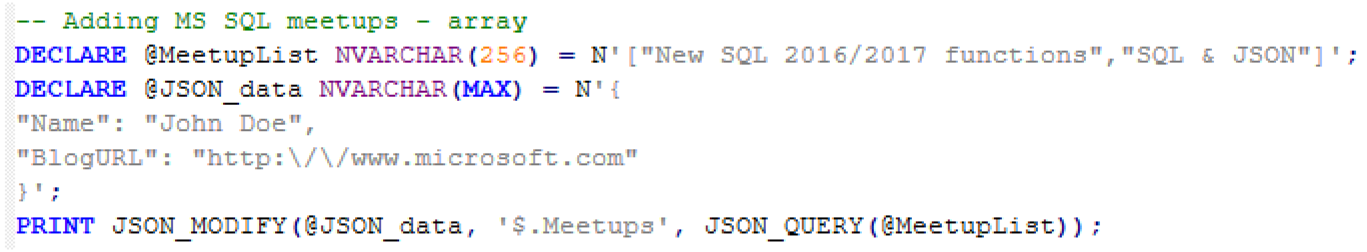
Multiple changes



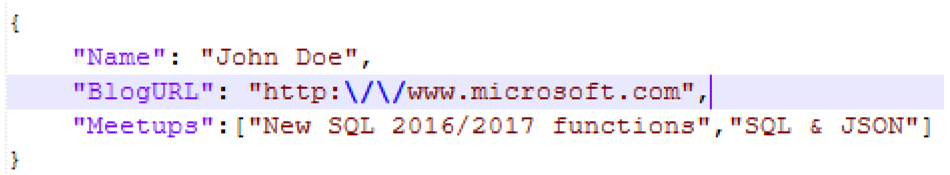
```sql
-- Adding currently presenting - 1 (bool)
DECLARE @JSON_data NVARCHAR(MAX) = N'{
"Name": "John Doe",
"BlogURL": "http:\/\/www.microsoft.com"
}';
PRINT JSON_MODIFY(@JSON_data, '$."Currently presenting"', CAST(1 AS BIT))
```



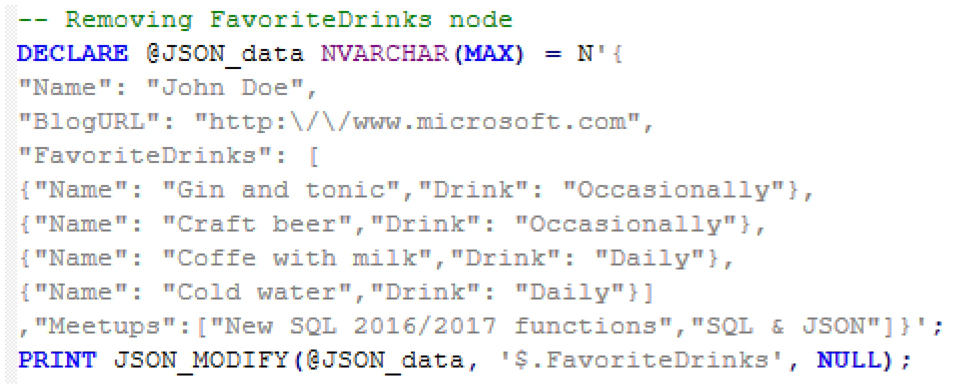
```
{
    "Name": "John Doe",
    "BlogURL": "http:\/\/www.microsoft.com",
    "Currently presenting":true
}
```



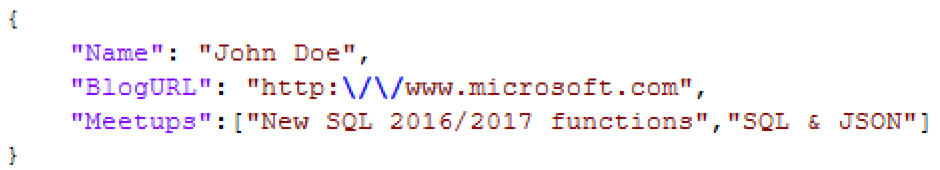
```sql
-- Adding MS SQL meetups - array
DECLARE @MeetupList NVARCHAR(256) = N'["New SQL 2016/2017 functions","SQL & JSON"]';
DECLARE @JSON_data NVARCHAR(MAX) = N'{
"Name": "John Doe",
"BlogURL": "http:\/\/www.microsoft.com"
}';
PRINT JSON_MODIFY(@JSON_data, '$.Meetups', JSON_QUERY(@MeetupList));
```



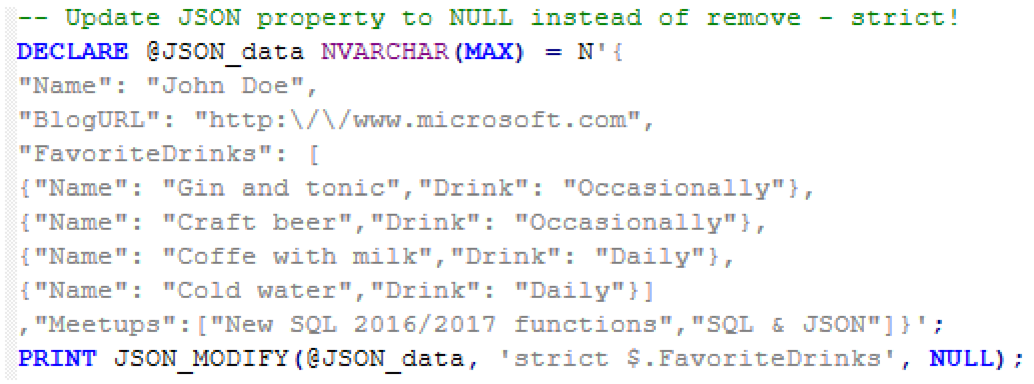
```
{
    "Name": "John Doe",
    "BlogURL": "http:\/\/www.microsoft.com",
    "Meetups":["New SQL 2016/2017 functions","SQL & JSON"]
}
```



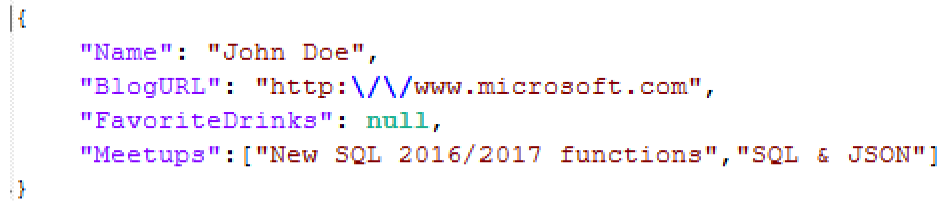
```sql
-- Removing FavoriteDrinks node
DECLARE @JSON_data NVARCHAR(MAX) = N'{
"Name": "John Doe",
"BlogURL": "http:\/\/www.microsoft.com",
"FavoriteDrinks": [
{"Name": "Gin and tonic","Drink": "Occasionally"},
{"Name": "Craft beer","Drink": "Occasionally"},
{"Name": "Coffe with milk","Drink": "Daily"},
{"Name": "Cold water","Drink": "Daily"}]
,"Meetups":["New SQL 2016/2017 functions","SQL & JSON"]}';
PRINT JSON_MODIFY(@JSON_data, '$.FavoriteDrinks', NULL);
```



```
{
    "Name": "John Doe",
    "BlogURL": "http:\/\/www.microsoft.com",
    "Meetups":["New SQL 2016/2017 functions","SQL & JSON"]
}
```



```sql
-- Update JSON property to NULL instead of remove - strict!
DECLARE @JSON_data NVARCHAR(MAX) = N'{
"Name": "John Doe",
"BlogURL": "http:\/\/www.microsoft.com",
"FavoriteDrinks": [
{"Name": "Gin and tonic","Drink": "Occasionally"},
{"Name": "Craft beer","Drink": "Occasionally"},
{"Name": "Coffe with milk","Drink": "Daily"},
{"Name": "Cold water","Drink": "Daily"}]
,"Meetups":["New SQL 2016/2017 functions","SQL & JSON"]}';
PRINT JSON_MODIFY(@JSON_data, 'strict $.FavoriteDrinks', NULL);
```



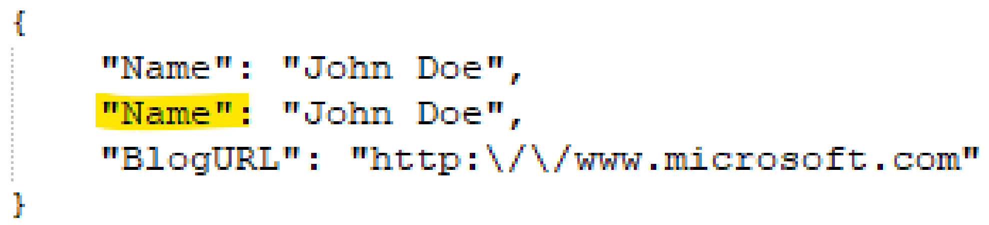
```
{
    "Name": "John Doe",
    "BlogURL": "http:\/\/www.microsoft.com",
    "FavoriteDrinks": null,
    "Meetups":["New SQL 2016/2017 functions","SQL & JSON"]
}
```

ISJSON

To JSON or not to JSON ?

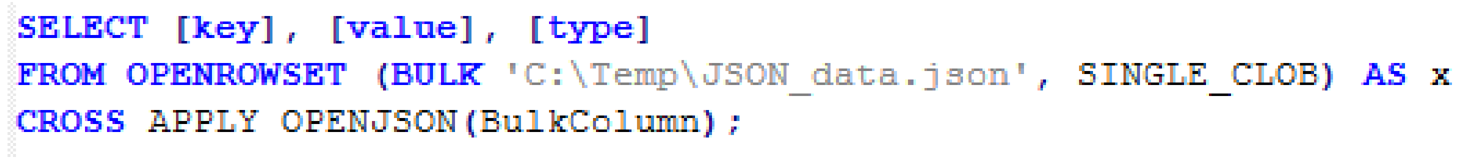
ISJSON (expression)

- **Expression** – The string to test
- Return – int
  - - 1 - string contains valid JSON
  - - 0 - string is not valid JSON
  - - NULL - input expression is NULL

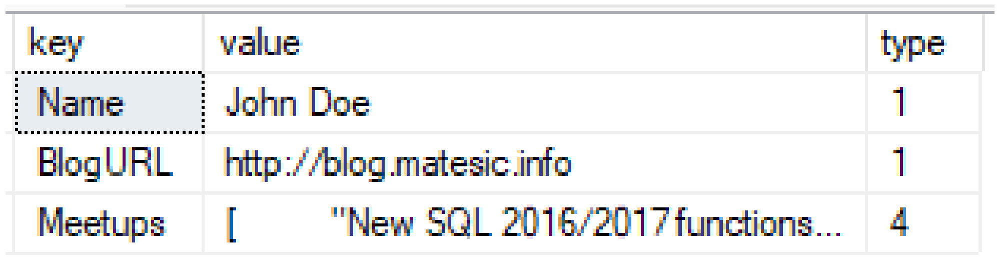


```
{
    "Name": "John Doe",
    "Name": "John Doe",
    "BlogURL": "http:\/\/www.microsoft.com"
}
```

T&T – Import JSON from a file

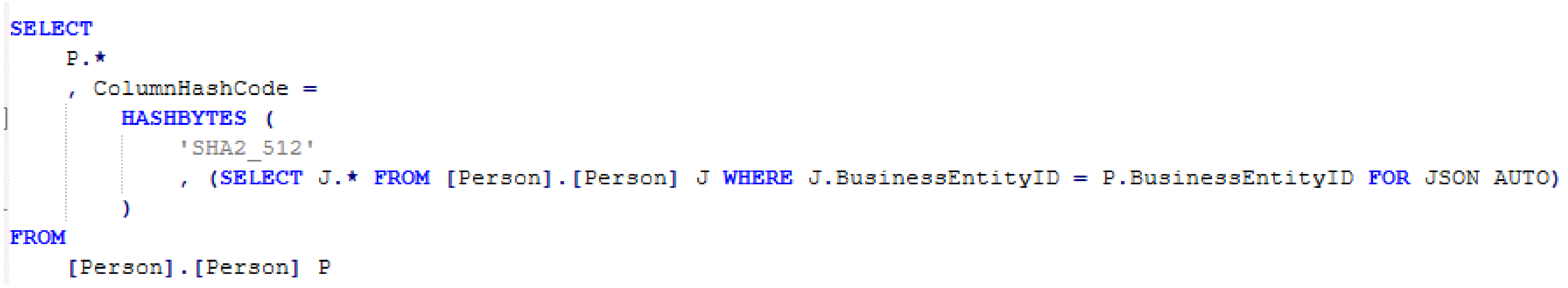


```
SELECT [key], [value], [type]
FROM OPENROWSET (BULK 'C:\Temp\JSON_data.json', SINGLE_CLOB) AS x
CROSS APPLY OPENJSON(BulkColumn);
```

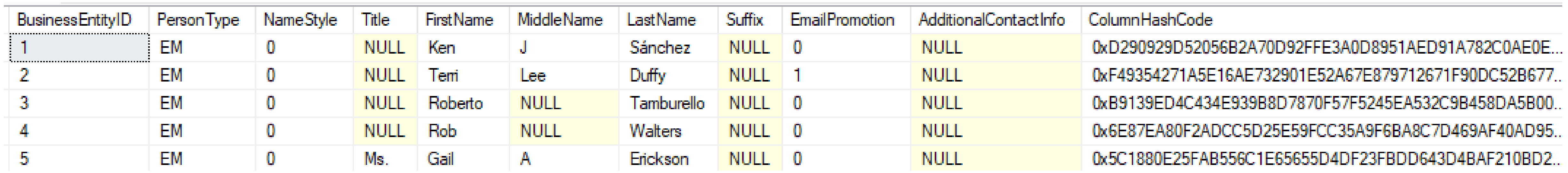


key	value	type
Name	John Doe	1
BlogURL	http://blog.matesic.info	1
Meetups	["New SQL 2016/2017 functions...	4

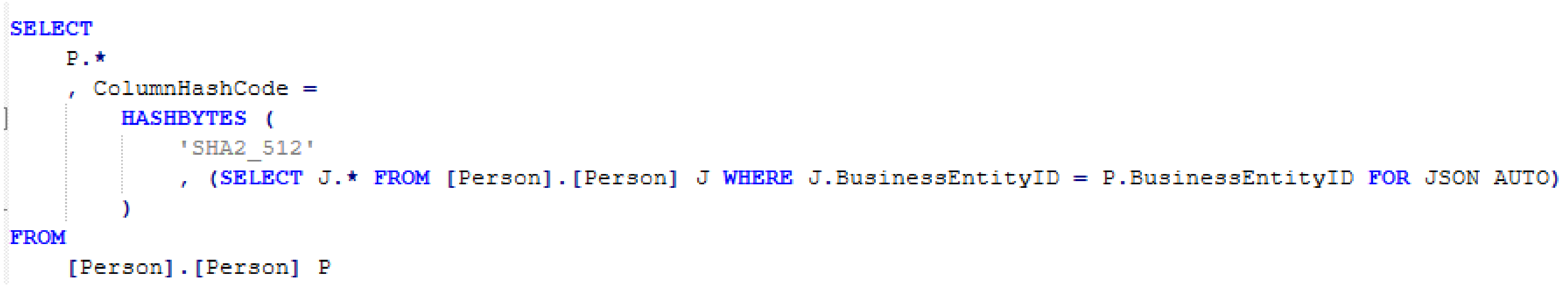
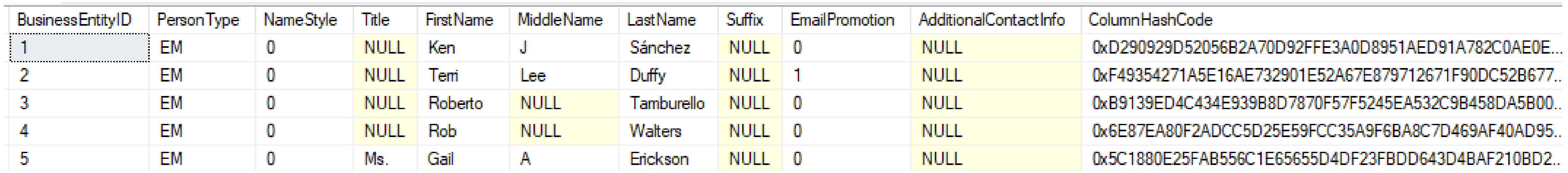
T&T – Compare records with hash



```sql
SELECT
    P.*
    , ColumnHashCode =
        HASHBYTES (
            'SHA2_512'
            , (SELECT J.* FROM [Person].[Person] J WHERE J.BusinessEntityID = P.BusinessEntityID FOR JSON AUTO)
        )
FROM
    [Person].[Person] P
```

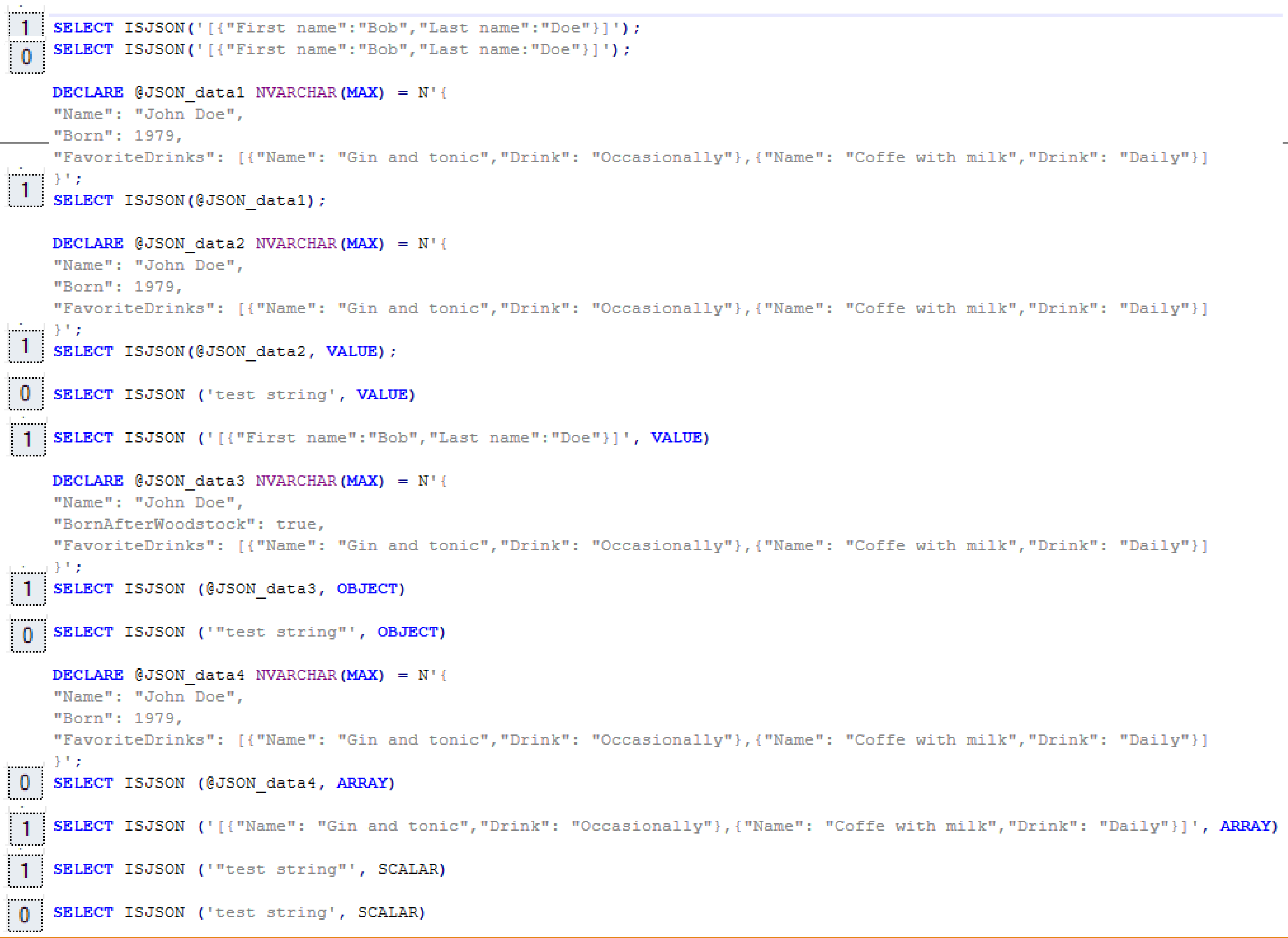


BusinessEntityID	PersonType	NameStyle	Title	FirstName	MiddleName	LastName	Suffix	EmailPromotion	AdditionalContactInfo	ColumnHashCode
1	EM	0	NULL	Ken	J	Sánchez	NULL	0	NULL	0xD290929D52056B2A70D92FFE3A0D8951AED91A782C0AE0E...
2	EM	0	NULL	Terri	Lee	Duffy	NULL	1	NULL	0xF49354271A5E16AE732901E52A67E879712671F90DC52B677...
3	EM	0	NULL	Roberto	NULL	Tamburello	NULL	0	NULL	0xB9139ED4C434E939B8D7870F57F5245EA532C9B458DA5B00...
4	EM	0	NULL	Rob	NULL	Walters	NULL	0	NULL	0x6E87EA80F2ADCC5D25E59FCC35A9F6BA8C7D469AF40AD95...
5	EM	0	Ms.	Gail	A	Erickson	NULL	0	NULL	0x5C1880E25FAB556C1E65655D4DF23FBDD643D4BAF210BD2...

MS SQL 2022

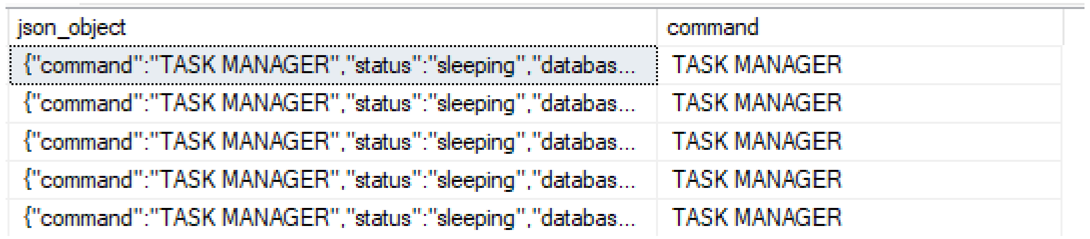
ISJSON



```
1 SELECT ISJSON('[{"First name":"Bob","Last name":"Doe"}]');
0 SELECT ISJSON('[{"First name":"Bob","Last name:"Doe"}]');

  DECLARE @JSON_data1 NVARCHAR(MAX) = N'{
  "Name": "John Doe",
  "Born": 1979,
  "FavoriteDrinks": [{"Name": "Gin and tonic","Drink": "Occasionally"},{"Name": "Coffe with milk","Drink": "Daily"}]
  }';
1 SELECT ISJSON(@JSON_data1);

  DECLARE @JSON_data2 NVARCHAR(MAX) = N'{
  "Name": "John Doe",
  "Born": 1979,
  "FavoriteDrinks": [{"Name": "Gin and tonic","Drink": "Occasionally"},{"Name": "Coffe with milk","Drink": "Daily"}]
  }';
1 SELECT ISJSON(@JSON_data2, VALUE);

0 SELECT ISJSON ('test string', VALUE)

1 SELECT ISJSON ('[{"First name":"Bob","Last name":"Doe"}]', VALUE)

  DECLARE @JSON_data3 NVARCHAR(MAX) = N'{
  "Name": "John Doe",
  "BornAfterWoodstock": true,
  "FavoriteDrinks": [{"Name": "Gin and tonic","Drink": "Occasionally"},{"Name": "Coffe with milk","Drink": "Daily"}]
  }';
1 SELECT ISJSON (@JSON_data3, OBJECT)

0 SELECT ISJSON ('"test string"', OBJECT)

  DECLARE @JSON_data4 NVARCHAR(MAX) = N'{
  "Name": "John Doe",
  "Born": 1979,
  "FavoriteDrinks": [{"Name": "Gin and tonic","Drink": "Occasionally"},{"Name": "Coffe with milk","Drink": "Daily"}]
  }';
0 SELECT ISJSON (@JSON_data4, ARRAY)

1 SELECT ISJSON ('[{"Name": "Gin and tonic","Drink": "Occasionally"},{"Name": "Coffe with milk","Drink": "Daily"}]', ARRAY)

1 SELECT ISJSON ('"test string"', SCALAR)

0 SELECT ISJSON ('test string', SCALAR)
```

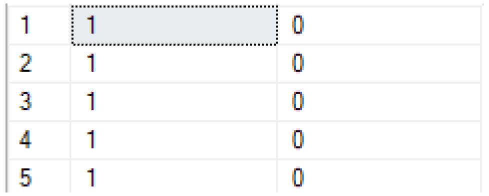
JSON_PATH_EXISTS

```sql
DROP TABLE IF EXISTS sql_requests_table_json_object;
GO
SELECT JSON_OBJECT('command': r.command, 'status': r.status, 'database_id': r.database_id, 'wait_type': r.wait_type, 'wait_resource': r.wait_resource, 'user': s.is_user_process) as json_object, r.command
INTO sql_requests_table_json_object
FROM sys.dm_exec_requests r
JOIN sys.dm_exec_sessions s
ON r.session_id = s.session_id
ORDER BY r.session_id;
GO
SELECT * FROM sql_requests_table_json_object;
GO
```



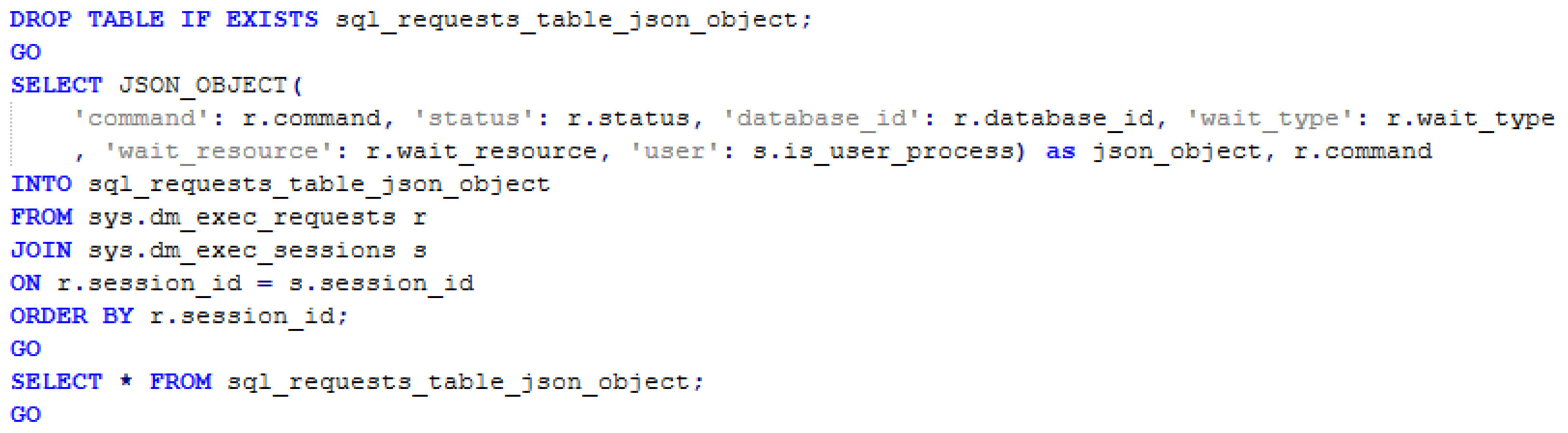
json_object	command
{"command":"TASK MANAGER","status":"sleeping","databas...	TASK MANAGER
{"command":"TASK MANAGER","status":"sleeping","databas...	TASK MANAGER
{"command":"TASK MANAGER","status":"sleeping","databas...	TASK MANAGER
{"command":"TASK MANAGER","status":"sleeping","databas...	TASK MANAGER
{"command":"TASK MANAGER","status":"sleeping","databas...	TASK MANAGER

```sql
SELECT
    JSON_PATH_EXISTS(json_object, '$.status')
    , JSON_PATH_EXISTS(command, '$.status')
FROM sql_requests_table_json_object;
```

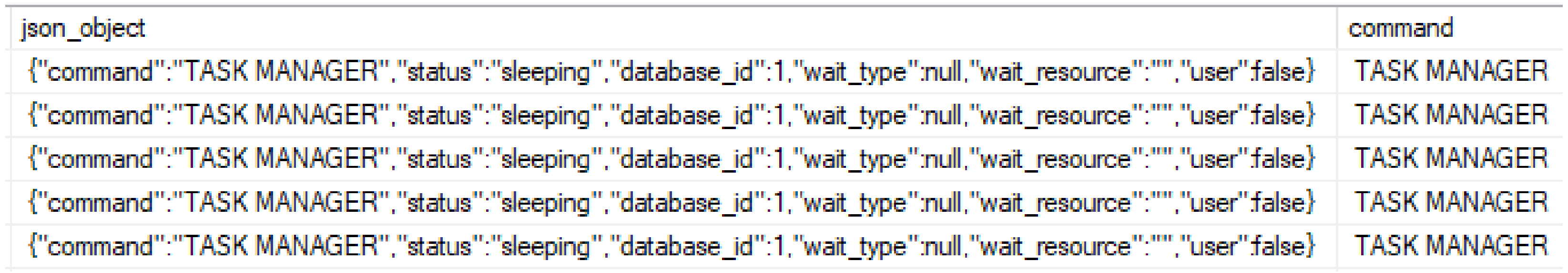


1	1	0
2	1	0
3	1	0
4	1	0
5	1	0

JSON_OBJECT



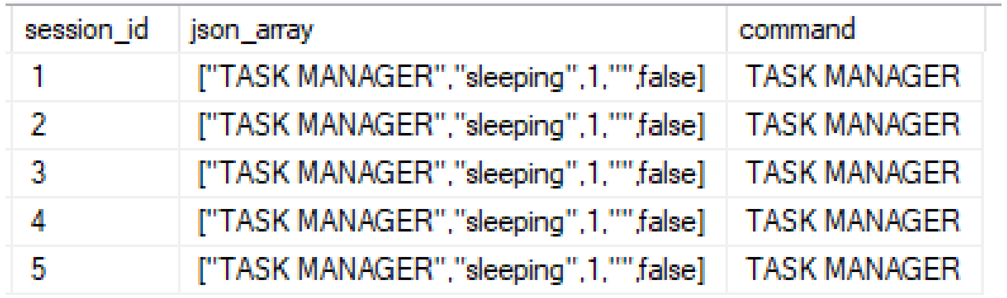
```sql
DROP TABLE IF EXISTS sql_requests_table_json_object;
GO
SELECT JSON_OBJECT(
    'command': r.command, 'status': r.status, 'database_id': r.database_id, 'wait_type': r.wait_type
    , 'wait_resource': r.wait_resource, 'user': s.is_user_process) as json_object, r.command
INTO sql_requests_table_json_object
FROM sys.dm_exec_requests r
JOIN sys.dm_exec_sessions s
ON r.session_id = s.session_id
ORDER BY r.session_id;
GO
SELECT * FROM sql_requests_table_json_object;
GO
```



json_object	command
{"command":"TASK MANAGER","status":"sleeping","database_id":1,"wait_type":null,"wait_resource":"","user":false}	TASK MANAGER
{"command":"TASK MANAGER","status":"sleeping","database_id":1,"wait_type":null,"wait_resource":"","user":false}	TASK MANAGER
{"command":"TASK MANAGER","status":"sleeping","database_id":1,"wait_type":null,"wait_resource":"","user":false}	TASK MANAGER
{"command":"TASK MANAGER","status":"sleeping","database_id":1,"wait_type":null,"wait_resource":"","user":false}	TASK MANAGER
{"command":"TASK MANAGER","status":"sleeping","database_id":1,"wait_type":null,"wait_resource":"","user":false}	TASK MANAGER

JSON_ARRAY

```sql
DROP TABLE IF EXISTS sql_requests_json_array;
GO
SELECT r.session_id, JSON_ARRAY(r.command, r.status, r. database_id, r.wait_type, r.wait_resource, s.is_user_process) as json_array, r.command
INTO sql_requests_json_array
FROM sys.dm_exec_requests r
JOIN sys.dm_exec_sessions s
ON r.session_id = s.session_id
ORDER BY r.session_id;
GO
SELECT * FROM sql_requests_json_array;
GO
```



session_id	json_array	command
1	["TASK MANAGER","sleeping",1,"",false]	TASK MANAGER
2	["TASK MANAGER","sleeping",1,"",false]	TASK MANAGER
3	["TASK MANAGER","sleeping",1,"",false]	TASK MANAGER
4	["TASK MANAGER","sleeping",1,"",false]	TASK MANAGER
5	["TASK MANAGER","sleeping",1,"",false]	TASK MANAGER

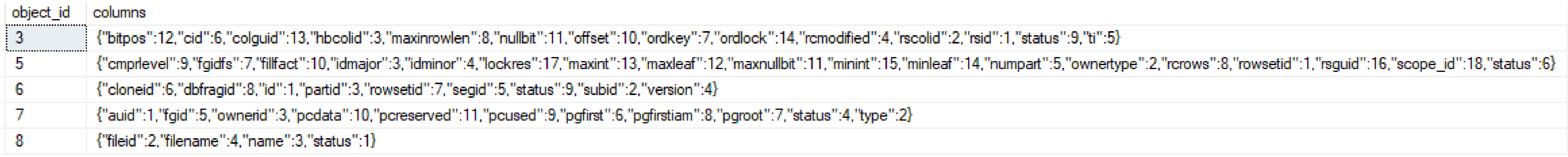
MS SQL 2025

JSON_OBJECTAGG

Constructs a JSON object from an aggregation of SQL data or columns

The key/value pairs can be specified as input values, column, variable references

```sql
SELECT TOP(5) c.object_id, JSON_OBJECTAGG(c.name:c.column_id) AS columns
FROM sys.columns AS c
GROUP BY c.object_id;
```

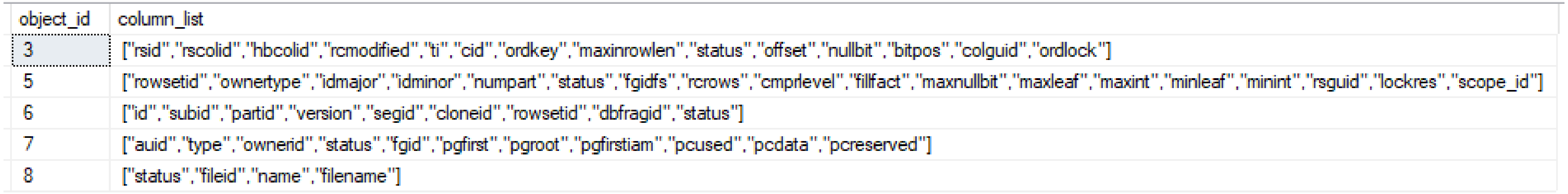


object_id	columns
3	{"bitpos":12,"cid":6,"colguid":13,"hbcolid":3,"maxinrowlen":8,"nullbit":11,"offset":10,"ordkey":7,"ordlock":14,"rcmodified":4,"rscolid":2,"rsid":1,"status":9,"ti":5}
5	{"cmprlevel":9,"fgidfs":7,"fillfact":10,"idmajor":3,"idminor":4,"lockres":17,"maxint":13,"maxleaf":12,"maxnullbit":11,"minint":15,"minleaf":14,"numpart":5,"ownertype":2,"rcrows":8,"rowsetid":1,"rsguid":16,"scope_id":18,"status":6}
6	{"cloneid":6,"dbfragid":8,"id":1,"partid":3,"rowsetid":7,"segid":5,"status":9,"subid":2,"version":4}
7	{"auid":1,"fgid":5,"ownerid":3,"pcdata":10,"pcreserved":11,"pcused":9,"pgfirst":6,"pgfirstiam":8,"pgroot":7,"status":4,"type":2}
8	{"fileid":2,"filename":4,"name":3,"status":1}

JSON_ARRAYAGG

Constructs a JSON array from an aggregation of SQL data or columns

```sql
SELECT TOP(5) c.object_id, JSON_ARRAYAGG(c.name ORDER BY c.column_id) AS column_list
FROM sys.columns AS c
GROUP BY c.object_id;
```



object_id	column_list
3	["rsid","rscolid","hbcolid","rcmodified","ti","cid","ordkey","maxinrowlen","status","offset","nullbit","bitpos","colguid","ordlock"]
5	["rowsetid","ownertype","idmajor","idminor","numpart","status","fgidfs","rcrows","cmprlevel","fillfact","maxnullbit","maxleaf","maxint","minleaf","minint","rsguid","lockres","scope_id"]
6	["id","subid","partid","version","segid","cloneid","rowsetid","dbfragid","status"]
7	["auid","type","ownerid","status","fgid","pgfirst","pgroot","pgfirstiam","pcused","pcdata","pcreserved"]
8	["status","fileid","name","filename"]

JSON data type & Index

```
column_name JSON [NOT NULL | NULL]
[CHECK(constraint_expression)]
[DEFAULT(default_expression)]
```

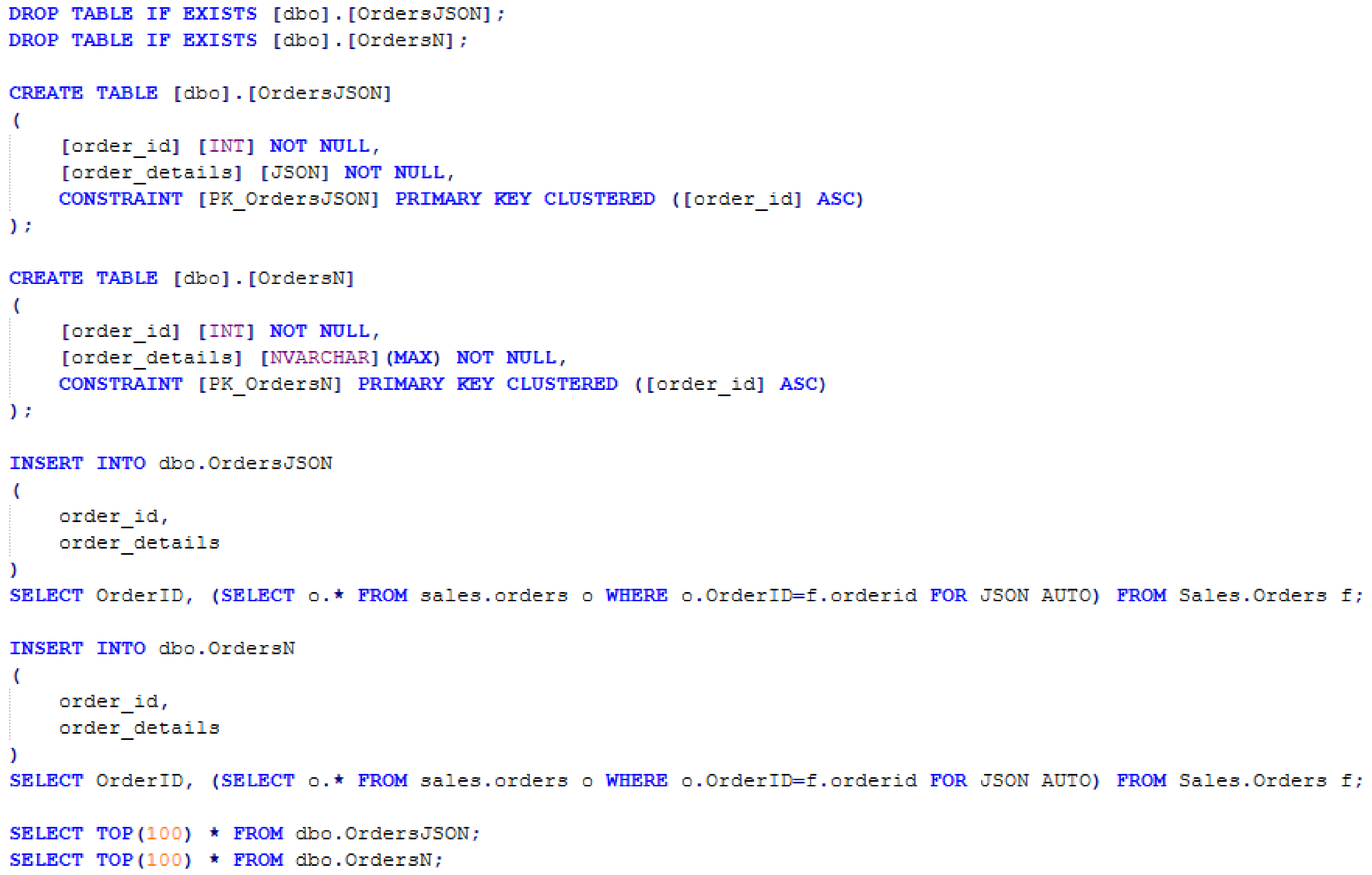
```
CREATE JSON INDEX name ON table_name
(json_column_name)
  [ FOR ( sql_json_path [ , ...n ] ) ]
  [ WITH ( <json_index_option> [ , ...n ] ) ]
  [ ON { filegroup_name | "default" } ]
[ ; ]
```

JSON data type & Index

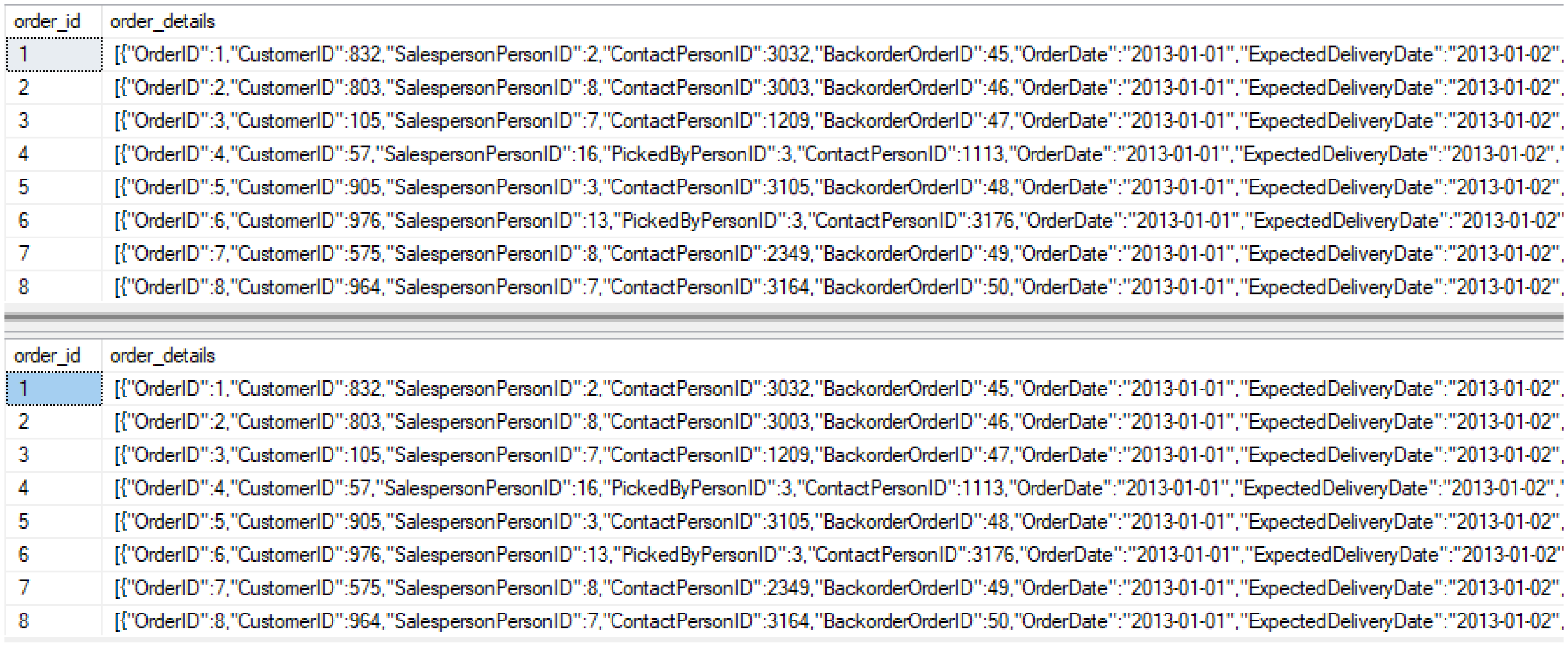
The new native JSON data type that stores JSON documents in a native binary format

The JSON type provides a high-fidelity storage of JSON documents optimized for easy querying and manipulation, and provides the following benefits over storing JSON data in VARCHAR or NVARCHAR:

- More efficient reads, as the document is already parsed
- More efficient writes, as the query can update individual values without accessing the entire document
- More efficient storage, optimized for compression
- No change in compatibility with existing code

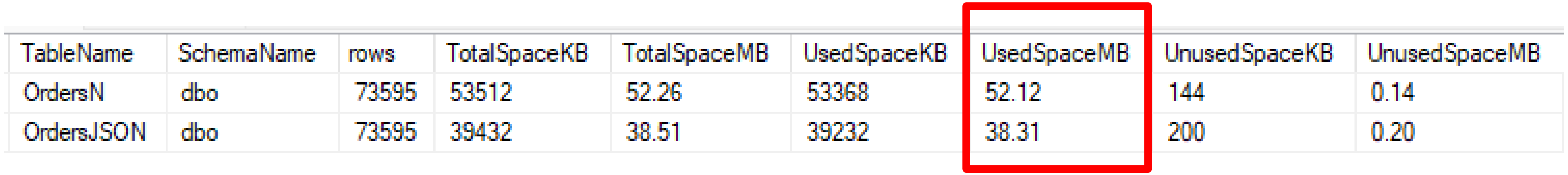


```sql
DROP TABLE IF EXISTS [dbo].[OrdersJSON];
DROP TABLE IF EXISTS [dbo].[OrdersN];

CREATE TABLE [dbo].[OrdersJSON]
(
    [order_id] [INT] NOT NULL,
    [order_details] [JSON] NOT NULL,
    CONSTRAINT [PK_OrdersJSON] PRIMARY KEY CLUSTERED ([order_id] ASC)
);

CREATE TABLE [dbo].[OrdersN]
(
    [order_id] [INT] NOT NULL,
    [order_details] [NVARCHAR](MAX) NOT NULL,
    CONSTRAINT [PK_OrdersN] PRIMARY KEY CLUSTERED ([order_id] ASC)
);

INSERT INTO dbo.OrdersJSON
(
    order_id,
    order_details
)
SELECT OrderID, (SELECT o.* FROM sales.orders o WHERE o.OrderID=f.orderid FOR JSON AUTO) FROM Sales.Orders f;

INSERT INTO dbo.OrdersN
(
    order_id,
    order_details
)
SELECT OrderID, (SELECT o.* FROM sales.orders o WHERE o.OrderID=f.orderid FOR JSON AUTO) FROM Sales.Orders f;

SELECT TOP(100) * FROM dbo.OrdersJSON;
SELECT TOP(100) * FROM dbo.OrdersN;
```



order_id	order_details
1	[{"OrderID":1,"CustomerID":832,"SalespersonPersonID":2,"ContactPersonID":3032,"BackorderOrderID":45,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
2	[{"OrderID":2,"CustomerID":803,"SalespersonPersonID":8,"ContactPersonID":3003,"BackorderOrderID":46,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
3	[{"OrderID":3,"CustomerID":105,"SalespersonPersonID":7,"ContactPersonID":1209,"BackorderOrderID":47,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
4	[{"OrderID":4,"CustomerID":57,"SalespersonPersonID":16,"PickedByPersonID":3,"ContactPersonID":1113,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02","
5	[{"OrderID":5,"CustomerID":905,"SalespersonPersonID":3,"ContactPersonID":3105,"BackorderOrderID":48,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
6	[{"OrderID":6,"CustomerID":976,"SalespersonPersonID":13,"PickedByPersonID":3,"ContactPersonID":3176,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02"
7	[{"OrderID":7,"CustomerID":575,"SalespersonPersonID":8,"ContactPersonID":2349,"BackorderOrderID":49,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
8	[{"OrderID":8,"CustomerID":964,"SalespersonPersonID":7,"ContactPersonID":3164,"BackorderOrderID":50,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",

order_id	order_details
1	[{"OrderID":1,"CustomerID":832,"SalespersonPersonID":2,"ContactPersonID":3032,"BackorderOrderID":45,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
2	[{"OrderID":2,"CustomerID":803,"SalespersonPersonID":8,"ContactPersonID":3003,"BackorderOrderID":46,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
3	[{"OrderID":3,"CustomerID":105,"SalespersonPersonID":7,"ContactPersonID":1209,"BackorderOrderID":47,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
4	[{"OrderID":4,"CustomerID":57,"SalespersonPersonID":16,"PickedByPersonID":3,"ContactPersonID":1113,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02","
5	[{"OrderID":5,"CustomerID":905,"SalespersonPersonID":3,"ContactPersonID":3105,"BackorderOrderID":48,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
6	[{"OrderID":6,"CustomerID":976,"SalespersonPersonID":13,"PickedByPersonID":3,"ContactPersonID":3176,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02"
7	[{"OrderID":7,"CustomerID":575,"SalespersonPersonID":8,"ContactPersonID":2349,"BackorderOrderID":49,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",
8	[{"OrderID":8,"CustomerID":964,"SalespersonPersonID":7,"ContactPersonID":3164,"BackorderOrderID":50,"OrderDate":"2013-01-01","ExpectedDeliveryDate":"2013-01-02",



TableName	SchemaName	rows	TotalSpaceKB	TotalSpaceMB	UsedSpaceKB	UsedSpaceMB	UnusedSpaceKB	UnusedSpaceMB
OrdersN	dbo	73595	53512	52.26	53368	52.12	144	0.14
OrdersJSON	dbo	73595	39432	38.51	39232	38.31	200	0.20

```sql
SELECT
    JSON_VALUE(order_details, '$[0].CustomerID') AS CustomerID,
    COUNT(*) AS Cnt
FROM [dbo].[OrdersJSON]
WHERE JSON_VALUE(order_details, '$[0].CustomerID') = 1050
GROUP BY JSON_VALUE(order_details, '$[0].CustomerID')
ORDER BY CustomerID;
```

```
Table 'Worktable'. Scan count 0, logical reads 0
Table 'OrdersJSON'. Scan count 1, logical reads 4904

 SQL Server Execution Times:
   CPU time = 172 ms,  elapsed time = 169 ms.
```

```sql
SELECT
    JSON_VALUE(order_details, '$[0].CustomerID') AS CustomerID,
    COUNT(*) AS Cnt
FROM [dbo].[OrdersN]
WHERE JSON_VALUE(order_details, '$[0].CustomerID') = 1050
GROUP BY JSON_VALUE(order_details, '$[0].CustomerID')
ORDER BY CustomerID;
```

```
Table 'OrdersN'. Scan count 5, logical reads 7005
Table 'Worktable'. Scan count 0, logical reads 0

 SQL Server Execution Times:
   CPU time = 372 ms,  elapsed time = 95 ms.
```

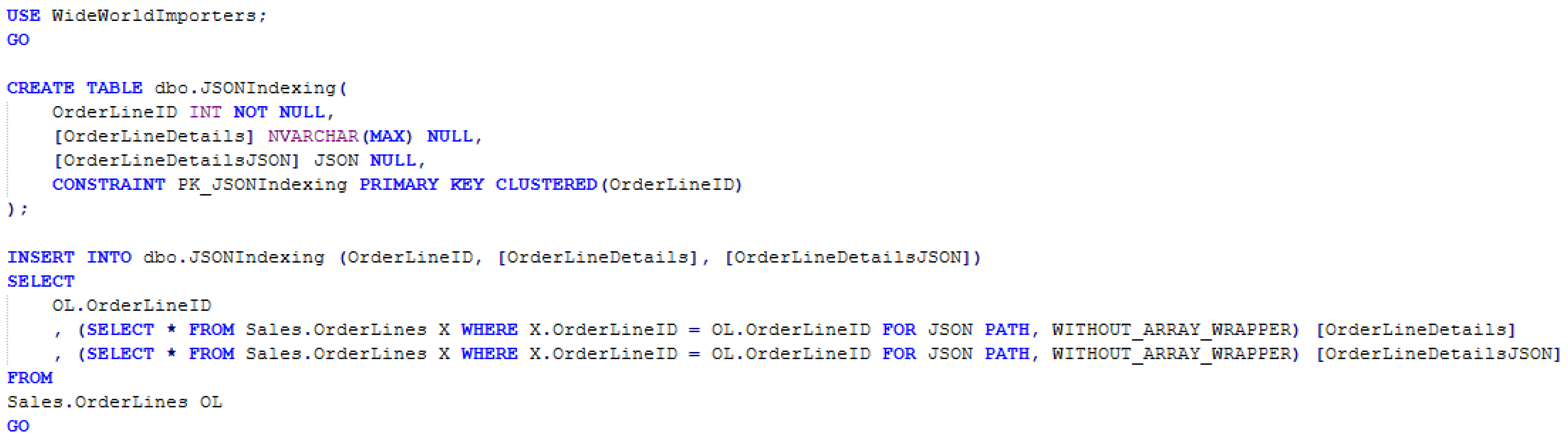
```sql
SELECT *
FROM [dbo].[OrdersJSON] O
    CROSS APPLY
    OPENJSON(O.order_details)
    WITH
    (
        OrderID INT '$.OrderID',
        OrderDate DATE '$.OrderDate'
    ) F
WHERE F.OrderDate = '2013-01-25';
```

```
Table 'OrdersJSON'. Scan count 1, logical reads 4904

SQL Server Execution Times:
   CPU time = 1563 ms,  elapsed time = 1588 ms.
```

```sql
SELECT *
FROM [dbo].[OrdersN] O
    CROSS APPLY
    OPENJSON(O.order_details)
    WITH
    (
        OrderID INT '$.OrderID',
        OrderDate DATE '$.OrderDate'
    ) F
WHERE F.OrderDate = '2013-01-25';
```

```
Table 'OrdersN'. Scan count 1, logical reads 6671

SQL Server Execution Times:
   CPU time = 593 ms,  elapsed time = 583 ms.
```

T&T – Indexing JSON data



```
USE WideWorldImporters;
GO

CREATE TABLE dbo.JSONIndexing(
    OrderLineID INT NOT NULL,
    [OrderLineDetails] NVARCHAR(MAX) NULL,
    [OrderLineDetailsJSON] JSON NULL,
    CONSTRAINT PK_JSONIndexing PRIMARY KEY CLUSTERED(OrderLineID)
);

INSERT INTO dbo.JSONIndexing (OrderLineID, [OrderLineDetails], [OrderLineDetailsJSON])
SELECT
    OL.OrderLineID
    , (SELECT * FROM Sales.OrderLines X WHERE X.OrderLineID = OL.OrderLineID FOR JSON PATH, WITHOUT_ARRAY_WRAPPER) [OrderLineDetails]
    , (SELECT * FROM Sales.OrderLines X WHERE X.OrderLineID = OL.OrderLineID FOR JSON PATH, WITHOUT_ARRAY_WRAPPER) [OrderLineDetailsJSON]
FROM
Sales.OrderLines OL
GO
```

Total rows 1 000 000, Size approx 1GB

```
SELECT [OrderLineID] FROM dbo.JSONIndexing
WHERE JSON_VALUE([OrderLineDetails],'$.StockItemID') = '164';
```

1. NO INDEX, QUERY ON NVARCHAR(MAX)

	Logical reads	CPU Time (ms)
1. No index, VCHAR	144.443	17.503

2. COMPUTED COLUMN WITH INDEX (SQL 2016)

	Logical reads	CPU Time (ms)
1. No index, VCHAR	144.443	17.503
2. Computed + Index, VARCHAR	14	0

```
ALTER TABLE dbo.JSONIndexing
ADD
  StockItemID AS
  JSON_VALUE([OrderLineDetails],'$.StockItemID');
GO

CREATE INDEX IDX_StockItemID ON
  dbo.JSONIndexing(StockItemID);
GO
```

3. NO INDEX, QUERY ON JSON (SQL 2025)

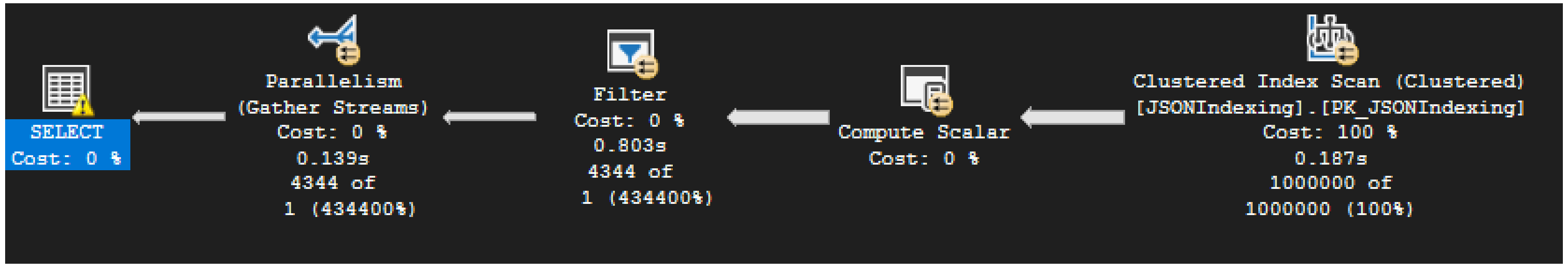
	Logical reads	CPU Time (ms)
1. No idx, VCHAR	144.443	17.503
2. Computed + Index, VARCHAR	14	0
3. No idx, JSON	145.115	8.033

4. JSON INDEX (*), QUERY ON JSON (SQL 2025)

```
CREATE JSON INDEX IX_JSON
   ON dbo.JSONIndexing(
       [OrderLineDetailsJSON]
   )
   FOR ('$')
   WITH (DATA_COMPRESSION=PAGE);
GO
```

	Logical reads	CPU Time (ms)
1. No idx, VCHAR	144.443	17.503
2. Computed + Index, VARCHAR	14	0
3. No idx, JSON	145.115	8.033
4. Index (*) on JSON	145.039	8.313

No index used!!!



4.1. JSON INDEX (*), QUERY ON JSON (SQL 2025)

```
SELECT
       *
FROM
       dbo.JSONIndexing
WITH
       (INDEX(IX_JSON))
WHERE JSON_VALUE([OrderLineDetailsJSON]
,'$.StockItemID') = '164';
```

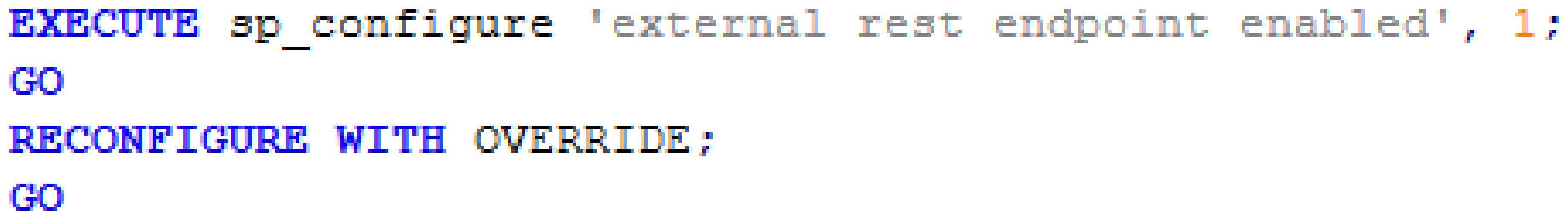
	Logical reads	CPU Time (ms)
1. No idx, VCHAR	144.443	17.503
2. Computed + Index, VARCHAR	14	0
3. No idx, JSON	145.115	8.033
4. Index (*) on JSON	145.039	8.313
4.1. Index (*) on JSON	147.250	2.482

5. JSON INDEX, QUERY ON JSON (SQL 2025)

```
CREATE JSON INDEX IX_JSON
   ON dbo.JSONIndexing(
       [OrderLineDetailsJSON]
   )
   FOR ('$.StockItemID')
   WITH (DATA_COMPRESSION=PAGE);
GO
```

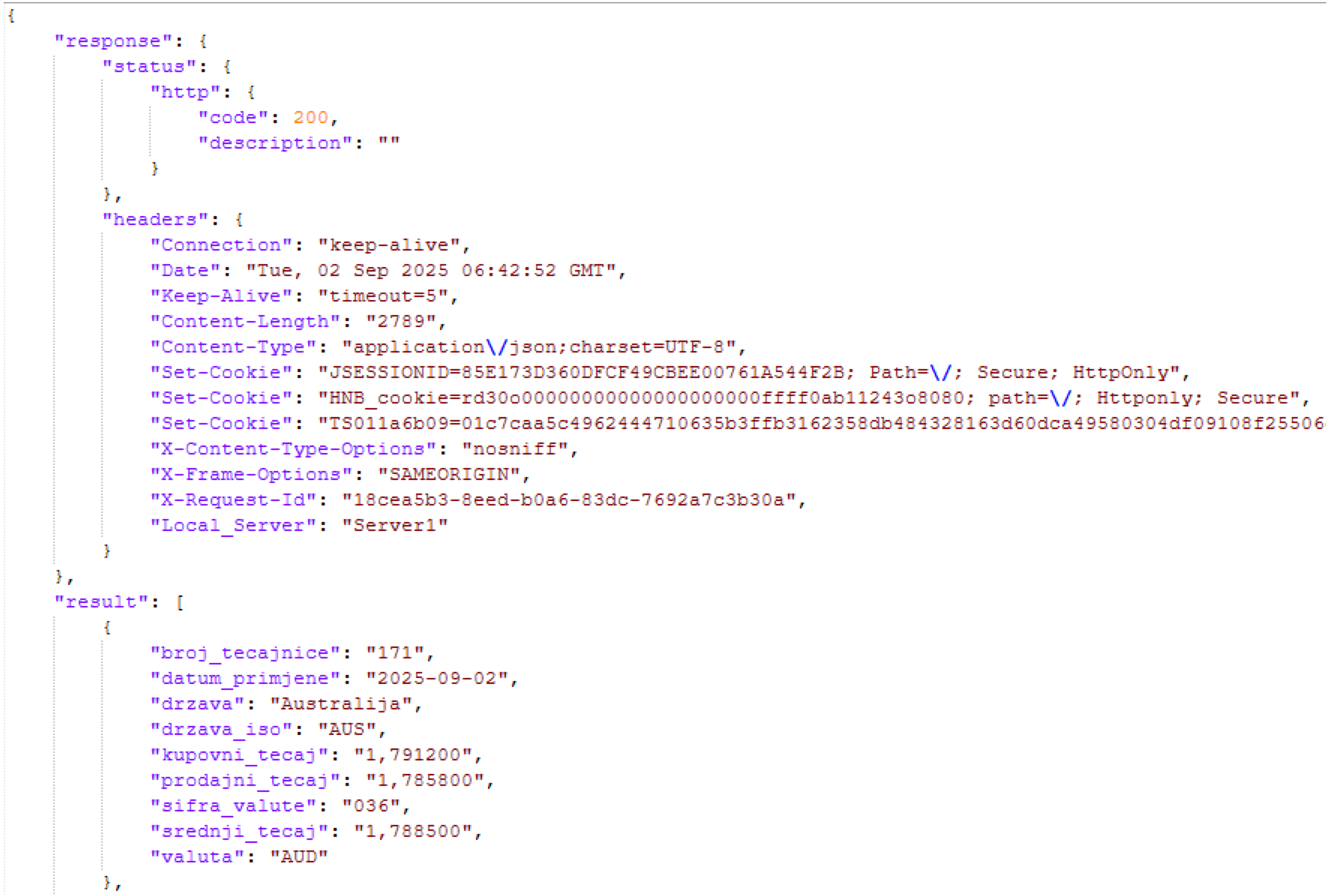
	Logical reads	CPU Time (ms)
1. No index, VCHAR	144.443	17.503
2. Computed + Index, VARCHAR	**14**	**0**
3. No index, JSON	145.115	8.033
4. Index (*) on JSON	145.039	8.313
4.1. Index (*) on JSON	**147.250**	**2.482**
5. Index on JSON	144.815	7.996
5.1. Index on JSON	147.184	2.346

sp_invoke_external_rest_endpoint



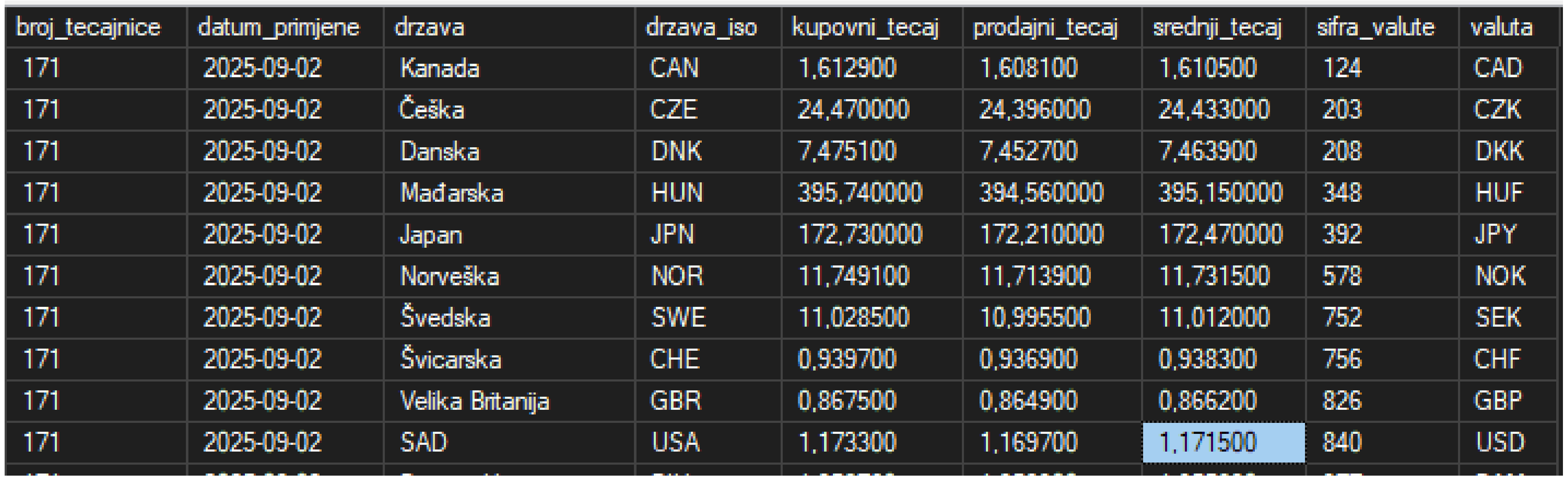
```sql
EXECUTE sp_configure 'external rest endpoint enabled', 1;
GO
RECONFIGURE WITH OVERRIDE;
GO
```

```sql
DECLARE @ret AS INT, @response AS NVARCHAR (MAX);
EXECUTE
    @ret = sp_invoke_external_rest_endpoint
    @url = N'https://api.hnb.hr/tecajn-eur/v3',
    @method = 'GET',
    @response = @response OUTPUT;

SELECT @ret AS ReturnCode,
       @response AS Response;
```



```
{
    "response": {
        "status": {
            "http": {
                "code": 200,
                "description": ""
            }
        },
        "headers": {
            "Connection": "keep-alive",
            "Date": "Tue, 02 Sep 2025 06:42:52 GMT",
            "Keep-Alive": "timeout=5",
            "Content-Length": "2789",
            "Content-Type": "application\/json;charset=UTF-8",
            "Set-Cookie": "JSESSIONID=85E173D360DFCF49CBEE00761A544F2B; Path=\/; Secure; HttpOnly",
            "Set-Cookie": "HNB_cookie=rd30o00000000000000000000ffff0ab11243o8080; path=\/; Httponly; Secure",
            "Set-Cookie": "TS011a6b09=01c7caa5c4962444710635b3ffb3162358db484328163d60dca49580304df09108f25506
            "X-Content-Type-Options": "nosniff",
            "X-Frame-Options": "SAMEORIGIN",
            "X-Request-Id": "18cea5b3-8eed-b0a6-83dc-7692a7c3b30a",
            "Local_Server": "Server1"
        }
    },
    "result": [
        {
            "broj_tecajnice": "171",
            "datum_primjene": "2025-09-02",
            "drzava": "Australija",
            "drzava_iso": "AUS",
            "kupovni_tecaj": "1,791200",
            "prodajni_tecaj": "1,785800",
            "sifra_valute": "036",
            "srednji_tecaj": "1,788500",
            "valuta": "AUD"
        },
```

```sql
SELECT
    broj_tecajnice
    , datum_primjene
    , drzava
    , drzava_iso
    , kupovni_tecaj
    , prodajni_tecaj
    , srednji_tecaj
    , sifra_valute
    , valuta
FROM OPENJSON(@response, '$.result') WITH (
    broj_tecajnice INT '$.broj_tecajnice'
    , datum_primjene DATE '$.datum_primjene'
    , drzava NVARCHAR(256) '$.drzava'
    , drzava_iso VARCHAR(3) '$.drzava_iso'
    , kupovni_tecaj VARCHAR(256) '$.kupovni_tecaj'
    , prodajni_tecaj VARCHAR(256) '$.prodajni_tecaj'
    , srednji_tecaj VARCHAR(256) '$.srednji_tecaj'
    , sifra_valute VARCHAR(3) '$.sifra_valute'
    , valuta VARCHAR(3) '$.valuta'
)
```



broj_tecajnice	datum_primjene	drzava	drzava_iso	kupovni_tecaj	prodajni_tecaj	srednji_tecaj	sifra_valute	valuta
171	2025-09-02	Kanada	CAN	1,612900	1,608100	1,610500	124	CAD
171	2025-09-02	Češka	CZE	24,470000	24,396000	24,433000	203	CZK
171	2025-09-02	Danska	DNK	7,475100	7,452700	7,463900	208	DKK
171	2025-09-02	Mađarska	HUN	395,740000	394,560000	395,150000	348	HUF
171	2025-09-02	Japan	JPN	172,730000	172,210000	172,470000	392	JPY
171	2025-09-02	Norveška	NOR	11,749100	11,713900	11,731500	578	NOK
171	2025-09-02	Švedska	SWE	11,028500	10,995500	11,012000	752	SEK
171	2025-09-02	Švicarska	CHE	0,939700	0,936900	0,938300	756	CHF
171	2025-09-02	Velika Britanija	GBR	0,867500	0,864900	0,866200	826	GBP
171	2025-09-02	SAD	USA	1,173300	1,169700	1,171500	840	USD

SLOW DOWN

THANK YOU!