**SQL Server 2016 features:**

* **R Services**. New in SQL Server 2016, integrates the R programming language, used for statistical analysis, into SQL Server. Based on Microsoft's acquisition of Revolution Analytics.
* **PolyBase**. New in SQL Server 2016. Integrates SQL Server with external data either in Hadoop or in Azure Blob storage.
* Temporal tables, also new in SQL Server 2016, are history tables which record all data changes, complete with the date and time they occurred.
* the report rendering engine has been redesigned to support HTML5, meaning better support for modern web browsers including Edge, Chrome, Firefox and Safari. New chart types have been added, for Treemap and Sunburst charts. There is also a new mobile reports feature, based on Microsoft's acquisition of Datazen Software in early 2015.

**The master Database**

When a new database is created, entries corresponding to that database are also created in that master database to track the file structure and logical database structure of the new database

**The model Database**

The model database provides you a template for creating new databases. All the objects in the model databases are automatically copied to the new user database.

**The msdb Database**

. The SQL Server Agent service uses the msdb database to store scheduling information about jobs and alerts.

**The tempdb Database**

The tempdb database is used to store temporary tables generated automatically by SQL Server and the temporary tables created explicitly by the users. SQL Server uses the tempdb database to store the intermediate results of the queries when doing complex database operations. Whenever SQL Server restarts, the tempdb database is dropped and then recreated.

Normalization is a systematic approach of decomposing tables to eliminate data redundancy and undesirable characteristics like Insertion, Update and Deletion Anamolies.

Without Normalization, it becomes difficult to handle and update the database, without facing data loss. Insertion, Updation and Deletion Anamolies are very frequent if Database is not Normalized. To understand these anomalies let us take an example of **Student** table.

|  |  |  |  |
| --- | --- | --- | --- |
| **S\_id** | **S\_Name** | **S\_Address** | **Subject\_opted** |
| 401 | Adam | Noida | Bio |
| 402 | Alex | Panipat | Maths |
| 403 | Stuart | Jammu | Maths |
| 404 | Adam | Noida | Physics |

* **Updation Anamoly :** To update address of a student who occurs twice or more than twice in a table, we will have to update **S\_Address** column in all the rows, else data will become inconsistent.
* **Insertion Anamoly :** Suppose for a new admission, we have a Student id(S\_id), name and address of a student but if student has not opted for any subjects yet then we have to insert **NULL** there, leading to Insertion Anamoly.
* **Deletion Anamoly :** If (S\_id) 401 has only one subject and temporarily he drops it, when we delete that row, entire student record will be deleted along with it.

#### First Normal Form (1NF)

As per First Normal Form, no two Rows of data must contain repeating group of information i.e each set of column must have a unique value, such that multiple columns cannot be used to fetch the same row. Each table should be organized into rows, and each row should have a primary key that distinguishes it as unique.

**Student Table :**

|  |  |  |
| --- | --- | --- |
| **Student** | **Age** | **Subject** |
| Adam | 15 | Biology, Maths |
| Alex | 14 | Maths |
| Stuart | 17 | Maths |

In First Normal Form, any row must not have a column in which more than one value is saved, like separated with commas. Rather than that, we must separate such data into multiple rows.

**Student Table following 1NF will be :**

|  |  |  |
| --- | --- | --- |
| **Student** | **Age** | **Subject** |
| Adam | 15 | Biology |
| Adam | 15 | Maths |
| Alex | 14 | Maths |
| Stuart | 17 | Maths |

#### Second Normal Form (2NF)

As per the Second Normal Form there must not be any partial dependency of any column on primary key. It means that for a table that has concatenated primary key, each column in the table that is not part of the primary key must depend upon the entire concatenated key for its existence. If any column depends only on one part of the concatenated key, then the table fails **Second normal form**.

**New Student Table following 2NF will be :**

|  |  |
| --- | --- |
| **Student** | **Age** |
| Adam | 15 |
| Alex | 14 |
| Stuart | 17 |

In Student Table the candidate key will be **Student** column, because all other column i.e **Age** is dependent on it.

**New Subject Table introduced for 2NF will be :**

|  |  |
| --- | --- |
| **Student** | **Subject** |
| Adam | Biology |
| Adam | Maths |
| Alex | Maths |
| Stuart | Maths |

**Third Normal form** applies that every non-prime attribute of table must be dependent on primary key, or we can say that, there should not be the case that a non-prime attribute is determined by another non-prime attribute. So this *transitive functional dependency* should be removed from the table and also the table must be in **Second Normal form**.

Before

**Student\_Detail Table :**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Student\_id** | **Student\_name** | **DOB** | **Street** | **city** | **State** | **Zip** |

After

**New Student\_Detail Table :**

|  |  |  |  |
| --- | --- | --- | --- |
| **Student\_id** | **Student\_name** | **DOB** | **Zip** |

**Address Table :**

|  |  |  |  |
| --- | --- | --- | --- |
| **Zip** | **Street** | **city** | **state** |

CREATE TABLE employee   
( id number(5),   
name char(20),  
dept char(10),  
age number(2),  
salary number(10),  
location char(10),  
CONSTRAINT emp\_id\_pk PRIMARY KEY (id)  
);

CREATE TABLE employee  
( id number(5) PRIMARY KEY,  
name char(20),  
dept char(10),  
age number(2),  
mgr\_id number(5) REFERENCES employee(id),  
salary number(10),  
location char(10)   
);

CREATE TABLE employee  
( id number(5),  
name char(20) CONSTRAINT nm\_nn NOT NULL,  
dept char(10),  
age number(2),  
salary number(10),  
location char(10)   
);

Unique Key : A column(s) can have a null value but the values cannot be duplicated.

CREATE TABLE employee  
( id number(5) PRIMARY KEY,  
name char(20),  
dept char(10),  
age number(2),  
salary number(10),  
location char(10) UNIQUE   
);

**SQL Check Constraint :**

This constraint defines a business rule on a column. All the rows must satisfy this rule.

CREATE TABLE employee   
( id number(5) PRIMARY KEY,   
name char(20),   
dept char(10),   
age number(2),   
gender char(1) CHECK (gender in ('M','F')),   
salary number(10),   
location char(10)   
);

* **Data Definition Language (DDL)** - These SQL commands are used for creating, modifying, and dropping the structure of database objects. The commands are CREATE, ALTER, DROP, RENAME, and TRUNCATE.
* **Data Manipulation Language (DML)** - These SQL commands are used for storing, retrieving, modifying, and deleting data.   
  These Data Manipulation Language commands are: [SELECT](http://beginner-sql-tutorial.com/sql-select-statement.htm), [INSERT](http://beginner-sql-tutorial.com/sql-insert-statement.htm), [UPDATE](http://beginner-sql-tutorial.com/sql-update-statement.htm), and [DELETE](http://beginner-sql-tutorial.com/sql-delete-statement.htm).
* **Transaction Control Language (TCL)** - These SQL commands are used for managing changes affecting the data. These commands are COMMIT, ROLLBACK, and SAVEPOINT.
* **Data Control Language (DCL)** - These SQL commands are used for providing security to database objects. These commands are GRANT and REVOKE.

Commit Syntax

begin tran d  
update emp set empName ='D' where empid=11  
commit tran d

Rollback Syntax

begin tran t  
declare @id int;  
set @id=1;  
insert into emp values(@id,'d')  
if(@id<10)  
begin  
print ‘Error Message’;  
rollback tran t;  
end   
else  
begin  
print 'data is inserted'  
end

GRANT SELECT

on employee

to user1

WITH GRANT OPTION; //User 1 and grant select to user 2 on employee table

REVOKE privilege\_name   
ON object\_name   
FROM {user\_name |PUBLIC |role\_name}

Group functions are built-in SQL functions that operate on groups of rows and return one value for the entire group.

SELECT COUNT (\*) FROM employee WHERE dept = 'Electronics';

SELECT DISTINCT dept FROM employee;

SELECT MAX (salary) FROM employee;

SELECT MIN (salary) FROM employee;

SELECT AVG (salary) FROM employee;

SELECT SUM (salary) FROM employee;

LDF - Log files in SQL Server databases hold all the log information. (Transaction)

*.ndf* is usually recommended to denote secondary data files. It’s also possible to store the secondary data file in a separate physical drive than the one which primary data file is stored.

It points to the other files in the database. Therefore, every database has one primary data file. Also, all the data in the database objects (tables, stored procedures, views, triggers.. etc.) are stored in the primary data files.

The ORDER BY clause is used in a SELECT statement to sort results either in ascending or descending order.

SELECT name, salary, salary\*1.2 AS new\_salary   
FROM employee   
WHERE salary\*1.2 > 30000   
ORDER BY new\_salary DESC;

The SQL GROUP BY Clause is used along with the group functions to retrieve data grouped according to one or more columns.

SELECT dept, SUM (salary)   
FROM employee   
GROUP BY dept;

# SQL HAVING Clause

Having clause is used to filter data based on the group functions. This is similar to WHERE condition but is used with group functions.

SELECT dept, SUM (salary)   
FROM employee   
GROUP BY dept   
HAVING SUM (salary) > 25000

Views:

A VIEW is a virtual table, through which a selective portion of the data from one or more tables can be seen

## Basic Difference

1. Function must return a value but in Stored Procedure it is optional( Procedure can return zero or n values).
2. Functions can have only input parameters for it whereas Procedures can have input/output parameters .
3. Functions can be called from Procedure whereas Procedures cannot be called from Function.

## Advance Difference

1. Procedure allows SELECT as well as DML(INSERT/UPDATE/DELETE) statement in it whereas Function allows only SELECT statement in it.
2. Procedures can not be utilized in a SELECT statement whereas Function can be embedded in a SELECT statement.
3. Stored Procedures cannot be used in the SQL statements anywhere in the WHERE/HAVING/SELECT section whereas Function can be.
4. Functions that return tables can be treated as another rowset. This can be used in JOINs with other tables.
5. Inline Function can be though of as views that take parameters and can be used in JOINs and other Rowset operations.
6. Exception can be handled by try-catch block in a Procedure whereas try-catch block cannot be used in a Function.
7. We can go for Transaction Management in Procedure whereas we can't go in Function.

System Defined:

Scalar functions operates on a single value and returns a single value.

upper('dotnet') This will returns upper case of given string means 'DOTNET'

lower('DOTNET') This will returns lower case of given string means 'dotnet'

ltrim(' dotnet') This will remove the spaces from left hand side of 'dotnet' string.

Aggregate functions operates on a collection of values and returns a single value.

max() -This returns maximum value from a collection of values.

min() - This returns minimum value from a collection of values.

avg() - This returns average of all values in a collection.

count() - This returns no of counts from a collection of values.

User Defined System :

1. Scalar Function:
2. **Create function fnGetEmpFullName**
3. **(**
4. **@FirstName varchar(50),**
5. **@LastName varchar(50)**
6. **)**
7. **returns varchar(101)**
8. **As**
9. **Begin return (Select @FirstName + ' '+ @LastName);**
10. **end**

## 2. Inline Table-Valued Function

User defined inline table-valued function returns a table variable as a result of actions perform by function. The value of table variable should be derived from a single SELECT statement.

1. **--Create function to get employees**
2. **Create function fnGetEmployee()**
3. **returns Table**
4. **As**
5. **return (Select \* from Employee)**
6. **--Now call the above created function**
7. **Select \* from fnGetEmployee()**

## Multi-Statement Table-Valued Function

User defined multi-statement table-valued function returns a table variable as a result of actions perform by function. In this a table variable must be explicitly declared and defined whose value can be derived from a multiple sql statements.

1. **--Create function for EmpID,FirstName and Salary of Employee**
2. **Create function fnGetMulEmployee()**
3. **returns @Emp Table**
4. **(**
5. **EmpID int,**
6. **FirstName varchar(50),**
7. **Salary int**
8. **)**
9. **As**
10. **begin**
11. **Insert into @Emp Select e.EmpID,e.FirstName,e.Salary from Employee e;**
12. **--Now update salary of first employee**
13. **update @Emp set Salary=25000 where EmpID=1;**
14. **--It will update only in @Emp table not in Original Employee table**
15. **return**
16. **end**

CTE:

1. This is used to store result of a complex sub query for further use.
2. This is also used to create a recursive query.
3. **;With CTE1(Address, Name, Age)--Column names for CTE, which are optional**
4. **AS**
5. **(**
6. **SELECT Addr.Address, Emp.Name, Emp.Age from Address Addr**
7. **INNER JOIN EMP Emp ON Emp.EID = Addr.EID**
8. **)**
9. **SELECT \* FROM CTE1 --Using CTE**
10. **WHERE CTE1.Age > 50**
11. **ORDER BY CTE1.NAME**

## Temporary Tables

In SQL Server, temporary tables are created at run-time and you can do all the operations which you can do on a normal table. These tables are created inside Tempdb database.

### **Local Temp Table**

Local temp tables are only available to the SQL Server session or connection (means single user) that created the tables. These are automatically deleted when the session that created the tables has been closed. Local temporary table name is stared with single hash ("#") sign.

1. **CREATE TABLE *#LocalTemp***
2. **(**
3. **UserID int,**
4. **Name varchar(50),**
5. **Address varchar(150)**
6. **)**
7. **GO**
8. **insert into *#LocalTemp values ( 1, 'Shailendra','Noida');***
9. **GO**
10. **Select \* from *#LocalTemp***

### **Global Temp Table**

Global temp tables are available to all SQL Server sessions or connections (means all the user). These can be created by any SQL Server connection user and these are automatically deleted when all the SQL Server connections have been closed. Global temporary table name is stared with double hash ("##") sign.

1. **CREATE TABLE *##GlobalTemp***
2. **(**
3. **UserID int,**
4. **Name varchar(50),**
5. **Address varchar(150)**
6. **)**
7. **GO**
8. **insert into *##GlobalTemp values ( 1, 'Shailendra','Noida');***
9. **GO**
10. **Select \* from *##GlobalTemp***

## Table Variable

This acts like a variable and exists for a particular batch of query execution. It gets dropped once it comes out of batch. This is also created in the Tempdb database but not the memory. This also allows you to create primary key, identity at the time of Table variable declaration but not non-clustered index.

1. **GO**
2. **DECLARE @TProduct TABLE**
3. **(**
4. **SNo INT IDENTITY(1,1),**
5. **ProductID INT,**
6. **Qty INT**
7. **)**
8. **--Insert data to Table variable @Product**
9. **INSERT INTO @TProduct(ProductID,Qty)**
10. **SELECT DISTINCT ProductID, Qty FROM ProductsSales ORDER BY ProductID ASC**
11. **--Select data**
12. **Select \* from @TProduct**
13. **--Next batch**
14. **GO**
15. **Select \* from @TProduct --gives error in next batch**

**Derived Table:**Derived tables are the tables which are created on the fly with the help of the Select statement.

1. **SELECT**\* **FROM**
2. (SELECT e.Emp\_Id,e.EmployeeName,p.Project\_Name FROM dbo.Employee e
3. INNERJOIN
4. dbo.Project p
5. **ON**
6. e.Emp\_Id=p.Project\_Id)Tab
7. **WHERE** Tab.Emp\_Id%2=1

A subquery is a SELECT statement that is nested within another statement.

1. **SELECT**\* FROM dbo.Emp e
2. WHERE e.Id IN(**SELECT** e2.Emp\_Id fromdbo.Employee e2);

Views are virtual tables that are compiled at run time. The data associated with views are not physically stored in the view, but it is stored in the base tables of the view. A view can be made over one or more database tables. Generally we put those columns in view that we need to retrieve/query again and again. Once you have created the view, you can query view like as table.

1. **create VIEW vw\_Employee\_Test**
2. **AS**
3. **Select Emp\_ID ,Emp\_Name ,Emp\_Designation**
4. **From Employee\_Test**

Cursor is a database object to retrieve data from a result set one row at a time, instead of the T-SQL commands that operate on all the rows in the result set at one time.

## Life Cycle of Cursor

## Declare Cursor

A cursor is declared by defining the SQL statement that returns a result set.

## Open

A Cursor is opened and populated by executing the SQL statement defined by the cursor.

## Fetch

When cursor is opened, rows can be fetched from the cursor one by one or in a block to do data manipulation.

## Close

After data manipulation, we should close the cursor explicitly.

## Deallocate

Finally, we need to delete the cursor definition and released all the system resources associated with the cursor.

Joins

A Join condition is a part of the sql query that retrieves rows from two or more tables

Error Handling in SP

USE AdventureWorks2012;

GO

IF OBJECT\_ID('UpdateSales', 'P') IS NOT NULL

DROP PROCEDURE UpdateSales;

GO

CREATE PROCEDURE UpdateSales

  @SalesPersonID INT,

  @SalesAmt MONEY = 0

AS

BEGIN

  BEGIN TRY

    BEGIN TRANSACTION;

      UPDATE LastYearSales

      SET SalesLastYear = SalesLastYear + @SalesAmt

      WHERE SalesPersonID = @SalesPersonID;

    COMMIT TRANSACTION;

  END TRY

  BEGIN CATCH

    IF @@TRANCOUNT > 0

    ROLLBACK TRANSACTION;

    DECLARE @ErrorNumber INT = ERROR\_NUMBER();

    DECLARE @ErrorLine INT = ERROR\_LINE();

    DECLARE @ErrorMessage NVARCHAR(4000) = ERROR\_MESSAGE();

    DECLARE @ErrorSeverity INT = ERROR\_SEVERITY();

    DECLARE @ErrorState INT = ERROR\_STATE();

    PRINT 'Actual error number: ' + CAST(@ErrorNumber AS VARCHAR(10));

    PRINT 'Actual line number: ' + CAST(@ErrorLine AS VARCHAR(10));

    RAISERROR(@ErrorMessage, @ErrorSeverity, @ErrorState);

  END CATCH

END;

GO

* **ERROR\_NUMBER():** The number assigned to the error.
* **ERROR\_LINE():** The line number inside the routine that caused the error.
* **ERROR\_MESSAGE():** The error message text, which includes the values supplied for any substitutable parameters, such as times or object names.
* **ERROR\_SEVERITY():** The error’s severity.
* **ERROR\_STATE():** The error’s state number.
* **ERROR\_PROCEDURE():** The name of the stored procedure or trigger that generated the error.

|  |  |
| --- | --- |
| RAISEERROR | THROW |
| SQL Server 7.0 | SQL Server 2012 |
| It always generates new exception and results in the loss of the original exception details | To Re-THROW the original exception caught in the TRY Block, we can just specify the THROW statement without any parameters in the CATCH block. |
| RAISERROR (@ErMessage,               @ErSeverity,               @ErState ) | THROW |
| Statements after RAISEERROR are executed | Statements after THROW are not executed |
| The severity parameter specifies the severity of the exception. | There is no severity parameter. |
| With RAISERROR we can raise the System Exception | With THROW we can’t raise the System Exception. But when it used in CATCH BLOCK it can Re-THROW the system exception |

***NOWAIT will return error if the original table has (transaction) locked on it.***  
***NOLOCK will read the data irrespective of the (transaction) lock on it.***

SELECT ID, Col1

FROM First WITH (NOWAIT)

WHERE ID = 1

When SET ANSI\_NULLS is ON, a SELECT statement that uses WHERE column\_name = **NULL** returns zero rows even if there are null values in column\_name.

Trigger

A trigger is a special kind of a store procedure that executes in response to certain action on the table like insertion, deletion or updation of data. It is a database object which is bound to a table and is executed automatically. You can’t explicitly invoke triggers. The only way to do this is by performing the required action no the table that they are assigned to.

There are three action query types that you use in SQL which are INSERT, UPDATE and DELETE. So, there are three types of triggers and hybrids that come from mixing and matching the events and timings that fire them. Basically, triggers are classified into two main types:

1. After Triggers (For Triggers)
2. Instead Of Triggers

CREATE TRIGGER trgAfterInsert ON [dbo].[Employee\_Test]

FOR INSERT

AS

declare @empid int;

declare @empname varchar(100);

declare @empsal decimal(10,2);

declare @audit\_action varchar(100);

select @empid=i.Emp\_ID from inserted i;

select @empname=i.Emp\_Name from inserted i;

select @empsal=i.Emp\_Sal from inserted i;

set @audit\_action='Inserted Record -- After Insert Trigger.';

insert into Employee\_Test\_Audit

(Emp\_ID,Emp\_Name,Emp\_Sal,Audit\_Action,Audit\_Timestamp)

values(@empid,@empname,@empsal,@audit\_action,getdate());

PRINT 'AFTER INSERT trigger fired.'

GO

CREATE TRIGGER trgInsteadOfDelete ON [dbo].[Employee\_Test]

INSTEAD OF DELETE

AS

declare @emp\_id int;

declare @emp\_name varchar(100);

declare @emp\_sal int;

select @emp\_id=d.Emp\_ID from deleted d;

select @emp\_name=d.Emp\_Name from deleted d;

select @emp\_sal=d.Emp\_Sal from deleted d;

BEGIN

if(@emp\_sal>1200)

begin

RAISERROR('Cannot delete where salary > 1200',16,1);

ROLLBACK;

end

else

begin

delete from Employee\_Test where Emp\_ID=@emp\_id;

COMMIT;

insert into Employee\_Test\_Audit(Emp\_ID,Emp\_Name,Emp\_Sal,Audit\_Action,Audit\_Timestamp)

values(@emp\_id,@emp\_name,@emp\_sal,'Deleted -- Instead Of Delete Trigger.',getdate());

PRINT 'Record Deleted -- Instead Of Delete Trigger.'

end

END

GO

Coalesce –

. **It returns the first encountered Not Null Value from employee table.**

select id , name ,coalesce(Ph\_no,Alt\_no,Office\_no) as contact number from employee

## Clustered Index (CI)

A clustered index is something that reorganizes the way records in the table are physically stored. Therefore a table can have only one clustered index. The leaf nodes of a clustered index contain the data pages, by which I mean the key-value pair in the clustered index has the index key and the actual data value. Also remember, a clustered index will be created on a table by default the moment a primary key is created on the table. A clustered index is something like your train ticket B4/24, you know that you need to board coach B4 and sit on seat number 24. So this index physically leads you to your actual seat.

CREATE CLUSTERED INDEX CL\_ID ON SALES(ID);

## Non-Clustered Index (NCI)

A non-clustered index is a special type of index in which the logical order of the index does not match the physical stored order of the rows on disk. The leaf node of a non-clustered index does not consist of the data pages but a pointer to it. That goes to say that a non-clustered index can’t survive on its own - it needs a base to live on. A non-clustered index uses a clustered index (if defined) or the heap to build itself.

When a non-clustered index uses the heap, the leaf node (or the pointer) is a physical location of the data. When it uses a clustered index, the leaf node (or the pointer) is the clustered index key value and this key value in turn points to the actual data.

CREATE NONCLUSTERED INDEX NONCI\_PC ON SALES(ProductCode);

### **Row\_Number()**

This function will assign a unique id to each row returned from the query.

DECLARE @Table TABLE (

Col\_Value varchar(2)

)

INSERT INTO @Table (Col\_Value)

VALUES ('A'),('A'),('A'),('B'),('B'),('C'),('C');

SELECT

Col\_Value,

ROW\_NUMBER() OVER (ORDER BY Col\_Value) AS 'RowID'

FROM

@Table;

Output :

| **Col\_Value** | **RowID** |
| --- | --- |
| A | 1 |
| A | 2 |
| A | 3 |
| B | 4 |
| B | 5 |
| C | 6 |
| C | 7 |

Rank() - This function will assign a unique number to each distinct row, but it leaves a gap between the groups. Let me explain with a query, we will use the same query we used above with Rank().

SELECT

Col\_Value,

Rank() OVER (ORDER BY Col\_Value) AS 'RowID'

FROM

@Table;

Output :

| **Col\_Value** | **RowID** |
| --- | --- |
| A | 1 |
| A | 1 |
| A | 1 |
| B | 4 |
| B | 4 |
| C | 6 |
| C | 6 |

### **Dense\_Rank()**

This function is similar to Rank with only difference, this will not leave gaps between groups.

So if we use the same query used for Rank, then:

Hide   Copy Code

SELECT

Col\_Value,

DENSE\_RANK() OVER (ORDER BY Col\_Value) AS 'RowID'

FROM

@Table;

We will get:

| **Col\_Value** | **RowID** |
| --- | --- |
| A | 1 |
| A | 1 |
| A | 1 |
| B | 2 |
| B | 2 |
| C | 3 |
| C | 3 |