`SQL (Structured Query Language) :

SQL is a standard language for accessing and manipulating databases.

What is SQL?

- SQL stands for Structured Query Language
- SQL lets you access and manipulate databases
- SQL became a standard of the American National Standards Institute (ANSI) in 1986, and of the International Organization for Standardization (ISO) in 1987

What Can SQL do?

- SQL can execute queries against a database
- SQL can retrieve data from a database
- SQL can insert records in a database
- SQL can update records in a database
- SQL can delete records from a database
- SQL can create new databases
- SQL can create new tables in a database
- SQL can create stored procedures in a database
- SQL can create views in a database
- SQL can set permissions on tables, procedures, and views

Using SQL in Your Web Site

To build a web site that shows data from a database, you will need:

- An RDBMS database program (i.e. MS Access, SQL Server, MySQL)
- To use a server-side scripting language, like PHP or ASP
- To use SQL to get the data you want
- To use HTML / CSS to style the page

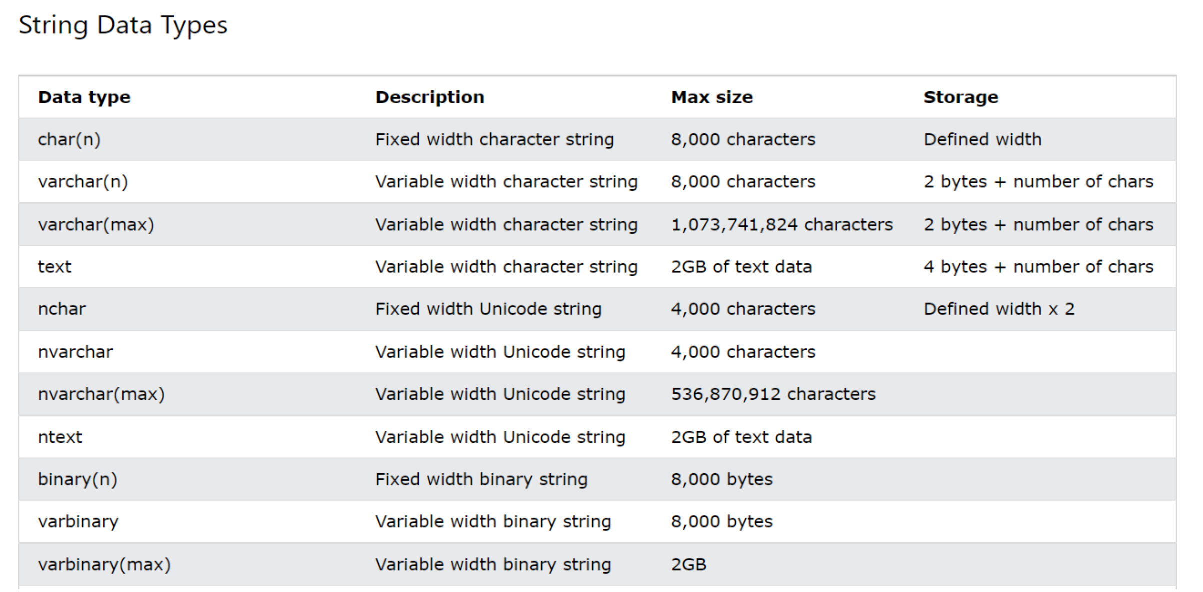
What is Data :

Data is nothing but information about anything.

DataTypes :

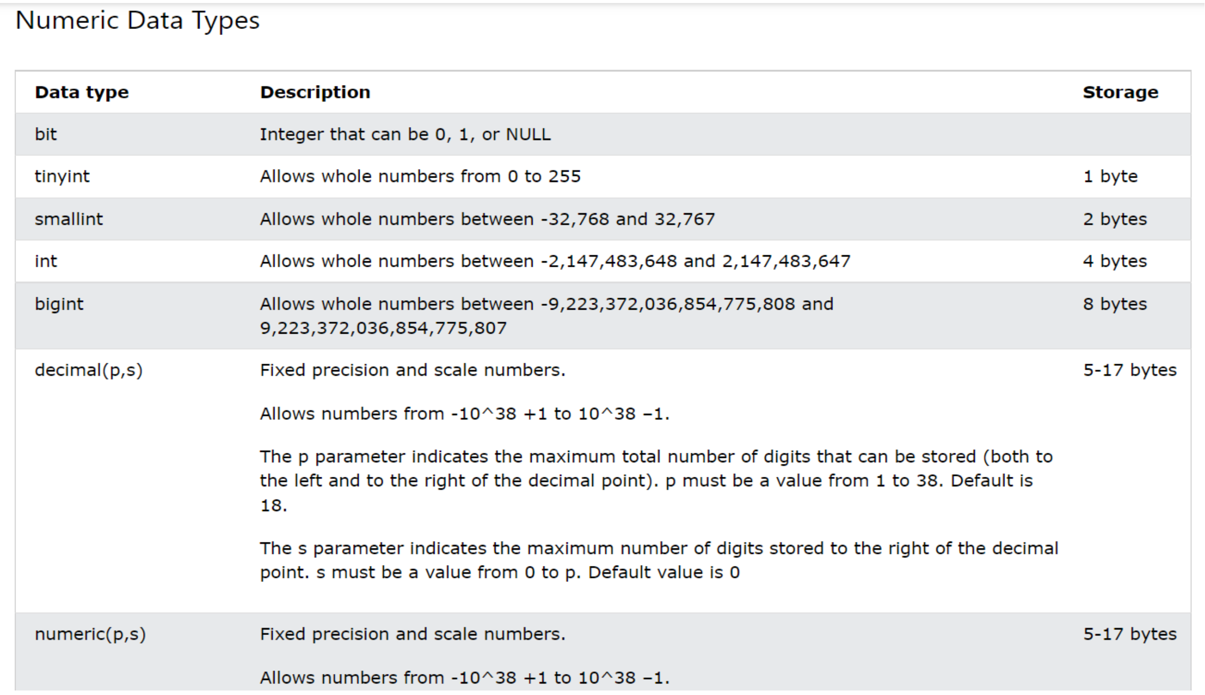
A data type is an attribute that specifies the type of data that the object can hold: integer data, character data, monetary data, date and time data, binary strings, and so on. SQL Server supplies a set of system data types that define all the types of data that can be used with SQL Server.

Link : ://www.w https 3schools.com/sql/sql_datatypes.asp



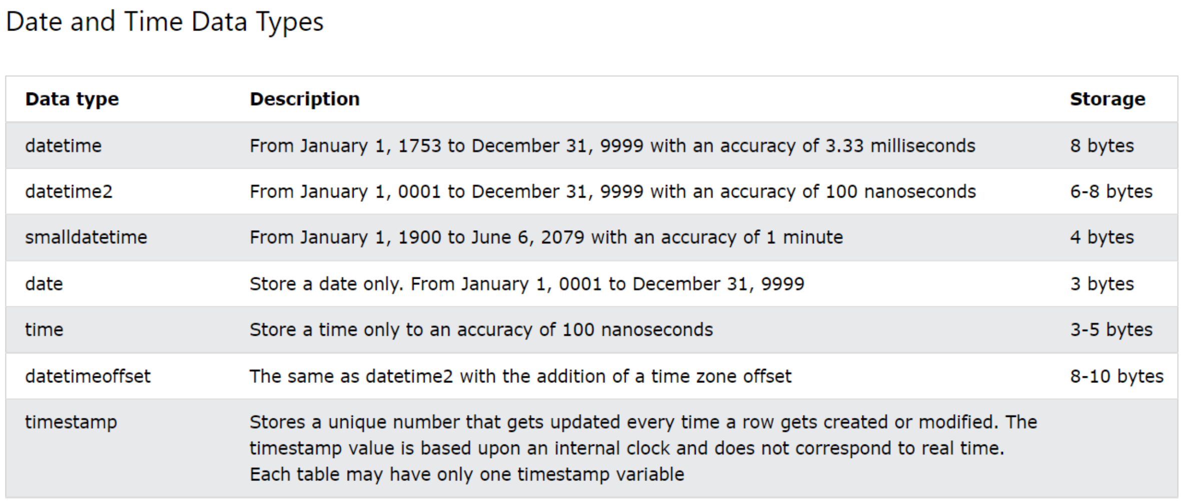
String Data Types

Data type	Description	Max size	Storage
char(n)	Fixed width character string	8,000 characters	Defined width
varchar(n)	Variable width character string	8,000 characters	2 bytes + number of chars
varchar(max)	Variable width character string	1,073,741,824 characters	2 bytes + number of chars
text	Variable width character string	2GB of text data	4 bytes + number of chars
nchar	Fixed width Unicode string	4,000 characters	Defined width x 2
nvarchar	Variable width Unicode string	4,000 characters	
nvarchar(max)	Variable width Unicode string	536,870,912 characters	
ntext	Variable width Unicode string	2GB of text data	
binary(n)	Fixed width binary string	8,000 bytes	
varbinary	Variable width binary string	8,000 bytes	
varbinary(max)	Variable width binary string	2GB	



Numeric Data Types

Data type	Description	Storage
bit	Integer that can be 0, 1, or NULL	
tinyint	Allows whole numbers from 0 to 255	1 byte
smallint	Allows whole numbers between -32,768 and 32,767	2 bytes
int	Allows whole numbers between -2,147,483,648 and 2,147,483,647	4 bytes
bigint	Allows whole numbers between -9,223,372,036,854,775,808 and 9,223,372,036,854,775,807	8 bytes
decimal(p,s)	Fixed precision and scale numbers. Allows numbers from -10^38 +1 to 10^38 –1. The p parameter indicates the maximum total number of digits that can be stored (both to the left and to the right of the decimal point). p must be a value from 1 to 38. Default is 18. The s parameter indicates the maximum number of digits stored to the right of the decimal point. s must be a value from 0 to p. Default value is 0	5-17 bytes
numeric(p,s)	Fixed precision and scale numbers. Allows numbers from -10^38 +1 to 10^38 –1.	5-17 bytes



Date and Time Data Types

Data type	Description	Storage
datetime	From January 1, 1753 to December 31, 9999 with an accuracy of 3.33 milliseconds	8 bytes
datetime2	From January 1, 0001 to December 31, 9999 with an accuracy of 100 nanoseconds	6-8 bytes
smalldatetime	From January 1, 1900 to June 6, 2079 with an accuracy of 1 minute	4 bytes
date	Store a date only. From January 1, 0001 to December 31, 9999	3 bytes
time	Store a time only to an accuracy of 100 nanoseconds	3-5 bytes
datetimeoffset	The same as datetime2 with the addition of a time zone offset	8-10 bytes
timestamp	Stores a unique number that gets updated every time a row gets created or modified. The timestamp value is based upon an internal clock and does not correspond to real time. Each table may have only one timestamp variable	

What Is a Database?

A database is an organized collection of structured information, or data, typically stored electronically in a computer system. A database is usually controlled by a database management system (DBMS). Together, the data and the DBMS, along with the applications that are associated with them, are referred to as a database system, often shortened to just database.

Data within the most common types of databases in operation today is typically modelled in rows and columns in a series of tables to make processing and data querying efficient. The data can then be easily accessed, managed, modified, updated, controlled, and organized. Most databases use structured query language (SQL) for writing and querying data.

RDBMS

RDBMS stands for Relational Database Management System.

RDBMS is the basis for SQL, and for all modern database systems such as MS SQL Server, IBM DB2, Oracle, MySQL, and Microsoft Access.

The data in RDBMS is stored in database objects called tables. A table is a collection of related data entries and it consists of columns and rows

TABLE :

Every table is broken up into smaller entities called fields. The fields in the Customers table consist of CustomerID, CustomerName, ContactName, Address, City, PostalCode and Country. A field is a column in a table that is designed to maintain specific information about every record in the table.

Table can have only 1024 columns.

A record, also called a row, is each individual entry that exists in a table. For example, there are 91 records in the above Customers table. A record is a horizontal entity in a table.

A column is a vertical entity in a table that contains all information associated with a specific field in a table.

Connecting to SQL Server

SQL Server Management Studio (SSMS), is the client tool that can be used to write and execute SQL queries. To connect to the SQL Server Management Studio

1. Click Start
2. Select All Programs
3. Select Microsoft SQL Server 2005, 2008, or 2008 R2 (Depending on the version installed)
4. Select SQL Server Management Studio

You will now see, Connect to Server window.

1. Select Database Engine as the Server Type. The other options that you will see here are Analysis Services (SSAS), Reporting Services (SSRS) and Integration Services (SSIS).

Server type = Database Engine

2. Next you need to specify the Server Name. Here we can specify the name or the server or IP Address. If you have SQL Server installed on your local machine, you can specify, (local) or just . (Period) or 127.0.0.1

Server name = (local)

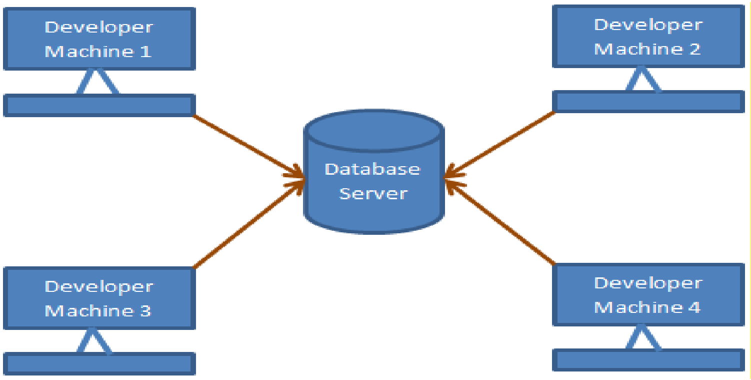
3. Now select Authentication. The options available here, depends on how you have installed SQL Server. During installation, if you have chosen mixed mode authentication, you will have both Windows Authentication and SQL Server Authentication. Otherwise, you will just be able to connect using windows authentication.

4. If you have chosen Windows Authentication, you don't have to enter user name and password, otherwise enter the user's name and password and click connect.

You should now be connected to SQL Server→ New Query

SSMS is a client tool and not the Server by itself. Usually database server (SQL Server), will be on a dedicated machine, and developers connect to the server using SSMS from their respective local (development) computers.

Developer Machines 1,2,3 and 4 connects to the database server using SSMS.

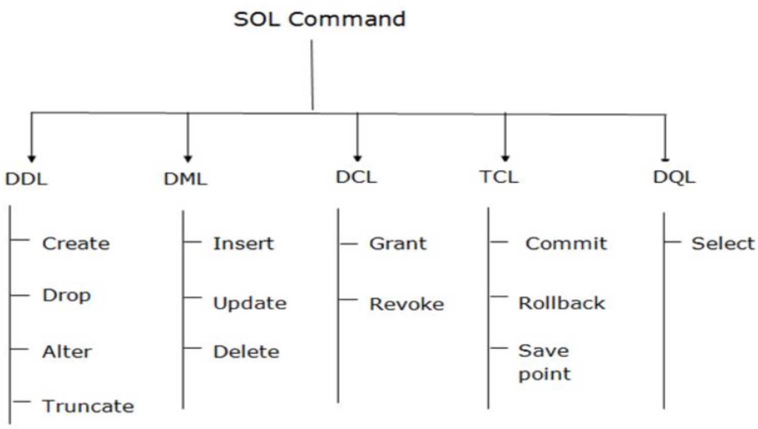


SQL Commands

- SQL commands are instructions. It is used to communicate with the database. It is also used to perform specific tasks, functions, and queries of data.
- SQL can perform various tasks like create a table, add data to tables, drop the table, modify the table, set permission for users.

Types of SQL Commands

There are five types of SQL commands: DDL, DML, DCL, TCL, and DQL.



1. Data Definition Language (DDL)

- DDL changes the structure of the table like creating a table, deleting a table, altering a table, etc.

- All the command of DDL are auto-committed that means it permanently save all the changes in the database.

Here are some commands that come under DDL:

- CREATE
- ALTER
- DROP
- TRUNCATE

a. CREATE: It is used to create a new table/database/stored procedure/views in the database.

Syntax:

CREATE TABLE **TABLE_NAME** (COLUMN_NAME DATATYPES[,....]);

CREATE Procedure **Proc_Name**

Create Database **Database_Name**

Exam: CREATE TABLE EMPLOYEE(EmpId int, Name VARCHAR(20), Email VARCHAR(100), DOB DATE);

b. ALTER: It is used to alter the structure of the database. This change could be either to modify the characteristics of an existing attribute or probably to add a new attribute.

Syntax: This command is used to modify structure of existing database object like Table/Proc/Function etc

To add a new column in the table

ALTER TABLE table_name ADD column_name COLUMN-definition;
Exam : ALTER TABLE STU_DETAILS ADD(ADDRESS VARCHAR2(20));

c. DROP: It is used to delete both the structure and record stored in the table.

Syntax : DROP TABLE table_name;
Drop Database Database_Name,
Drop Proc Proc_Name
Example: DROP TABLE EMPLOYEE;

d. TRUNCATE: It is used to delete all the rows from the table and free the space containing the table.

Syntax : TRUNCATE TABLE table_name;
Example : TRUNCATE TABLE EMPLOYEE;

2. Data Manipulation Language

- DML commands are used to modify the database. It is responsible for all form of changes in the database.
- The command of DML is not auto-committed that means it can't permanently save all the changes in the database. They can be rollback.

Here are some commands that come under DML:

- INSERT
- UPDATE
- DELETE

a. INSERT: The INSERT statement is a SQL query. It is used to insert data into the row of a table.

Syntax:

```
INSERT INTO TABLE_NAME (col1, col2, col3,.... col N)
VALUES (value1, value2, value3, .... valueN);
```

OR

```
INSERT INTO TABLE_NAME
VALUES (value1, value2, value3, .... valueN);
```

Example:

```
INSERT INTO javatpoint (Author, Subject) VALUES ("Sonoo", "DBMS");
```

b. UPDATE: This command is used to update or modify the value of a column in the table.

Syntax:

```
UPDATE table_name SET [column_name1= value1,...column_nameN = valueN] [WHERE CONDITION]
```

For example:

```
UPDATE students
SET User_Name = 'Sonoo'
WHERE Student_Id = '3'
```

c. DELETE: It is used to remove one or more row from a table.

Syntax:

1. DELETE FROM table_name [WHERE condition];

For example:

```
DELETE FROM javatpoint WHERE Author="Sonoo";
```

3. Data Control Language

DCL commands are used to grant and take back authority from any database user. Here are some commands that come under DCL:

- Grant
- Revoke

a. Grant: It is used to give user access privileges to a database.

Example
GRANT SELECT, UPDATE ON MY_TABLE TO SOME_USER, ANOTHER_USER;

b. Revoke: It is used to take back permissions from the user.

Example
REVOKE SELECT, UPDATE ON MY_TABLE FROM USER1, USER2;

4. Transaction Control Language

TCL commands can only use with DML commands like INSERT, DELETE and UPDATE only.
These operations are automatically committed in the database that's why they cannot be used while creating tables or dropping them.

Here are some commands that come under TCL:

- COMMIT
- ROLLBACK
- SAVEPOINT

a. Commit: Commit command is used to save all the transactions to the database.

Syntax: COMMIT;

Example:
DELETE FROM CUSTOMERS WHERE AGE = 25;
COMMIT;

b. Rollback: Rollback command is used to undo transactions that have not already been saved to the database.

Syntax: ROLLBACK;
Example:
DELETE FROM CUSTOMERS WHERE AGE = 25;
ROLLBACK;

c. SAVEPOINT: It is used to roll the transaction back to a certain point without rolling back the entire transaction.

Syntax:
SAVEPOINT SAVEPOINT_NAME;

5. Data Query Language

DQL is used to fetch the data from the database TABLE.
It uses only one command:

a. **SELECT:** This is the same as the projection operation of relational algebra. It is used to select the attribute based on the condition described by WHERE clause.

Syntax:
SELECT Columns FROM TABLES
WHERE conditions;
For example: SELECT emp_name FROM employee WHERE age > 20;

SQL Constraints

SQL constraints are used to specify rules for data in a table.

Constraints are used to limit the type of data that can go into a table. This ensures the accuracy and reliability of the data in the table. If there is any violation between the constraint and the data action, the action is aborted.

Constraints can be column level or table level. Column level constraints apply to a column, and table level constraints apply to the whole table.

The following constraints are commonly used in SQL:

- NOT NULL - Ensures that a column cannot have a NULL value
- UNIQUE - Ensures that all values in a column are different (more than one UK, can accept only one null)
- PRIMARY KEY - A combination of a NOT NULL and UNIQUE. Uniquely identifies each row in a table (only 1 PK per table)
- FOREIGN KEY - Prevents actions that would destroy links between tables
- CHECK - Ensures that the values in a column satisfies a specific condition
- DEFAULT - Sets a default value for a column if no value is specified

NOTE : Constraints can be added to column while table creation or we can add constraint to column after creating table using Alter Table command.

Syntax : Alter Table Table_Name
Add Constraint Constraint_Name Constraint_Defination

SQL AUTO INCREMENT Field

Auto-increment allows a unique number to be generated automatically when a new record is inserted into a table.

Often this is the primary key field that we would like to be created automatically every time a new record is inserted.

The following SQL statement defines the "Personid" column to be an auto-increment primary key field in the "Persons" table:

```
CREATE TABLE Persons (
   Personid int IDENTITY(1,1) PRIMARY KEY,
   LastName varchar(255) NOT NULL,
   FirstName varchar(255),
   Age int);
```

The MS SQL Server uses the IDENTITY keyword to perform an auto-increment feature.

In the example above, the starting value for IDENTITY is 1, and it will increment by 1 for each new record.

Tip: To specify that the "Personid" column should start at value 10 and increment by 5, change it to IDENTITY(10,5).

To insert a new record into the "Persons" table, we will NOT have to specify a value for the "Personid" column (a unique value will be added automatically):

```
INSERT INTO Persons (FirstName,LastName)
VALUES ('Lars','Monsen');
```

The SQL statement above would insert a new record into the "Persons" table. The "Personid" column would be assigned a unique value. The "FirstName" column would be set to "Lars" and the "LastName" column would be set to "Monsen".

https://www.w3schools.com/sql/sql_ref_sqlserver.asp

The SQL SELECT Statement

The SELECT statement is used to select data from a database.
The data returned is stored in a result table, called the result-set.

SELECT Syntax

```
SELECT column1, column2, ...
FROM table_name;
```

Here, column1, column2, ... are the field names of the table you want to select data from. If you want to select all the fields available in the table, use the following syntax:

```
Select * From Table_Name
```

SELECT Column Example

The following SQL statement selects the "CustomerName" and "City" columns from the "Customers" table:

Example

```
SELECT CustomerName, City FROM Customers;
```

Use of TOP and DISTINCT in SQL SERVER

TOP Clause:

TOP is mainly used to limit the result of query in terms of number or percentage of the result from database. It selects result limits to TOP from N numbers of data from ordered rows by using *ORDER BY* statement otherwise it selects undefined order data. *TOP* can be used in statements *SELECT*, *UPDATE*, *DELETE*, *INSERT*, or *MERGE* statement.

Syntax:

```
SELECT TOP <expression> [PERCENT]

FROM  <table_name>

ORDER BY  <column_name>
```

You can use clauses like *WHERE*, *JOIN*, *HAVING* and *GROUP BY* with *SELECT* statement.

Using *TOP* in constant value:

Constant value to return the top 10.

```
SELECT TOP 10 First_Name, Salary FROM EmployeeDb

ORDER BY  First_Name,Salary DESC
```

TOP* to return *PERCENT* of *ROWS

Returns percent of total results of rows:

```
SELECT TOP 1 PERCENT First_Name, Salary FROM EmployeeDb

ORDER BY First_Name DESC
```

DISTINCT clause

It selects only different value which eliminates duplicate record form the result. It only operates on single column and can be used in COUNT, AVG, MAX, etc. while using DISTINCT on column with multiple NULL values, it returns only one NULL as it treats multiple NULL as one distinct value. DINSTINT cannot be operated on multiple columns.

In single column:

Syntax:

```
SELECT DINTINCT <column_name> FROM <table_name>
```

It returns distinct values from the specified column.

```
SELECT DISTINCT  First_Name FROM  EmployeeDb ORDER BY   First_Name
```

Use of *DISTINCT* and *TOP*

Implementation of DISTINCT and TOP in a column. It also cannot be operated on multiple columns.

Example:

```
SELECT DISTINCT TOP 10 First_Name FROM EmployeeDb ORDER BY First_Name
```

The SQL WHERE Clause

The WHERE clause is used to filter records.
It is used to extract only those records that fulfil a specified condition.

WHERE Syntax

```
SELECT column1, column2, ...
FROM table_name
WHERE condition;
```

Note: The WHERE clause is not only used in SELECT statements, it is also used in UPDATE, DELETE, etc.!

WHERE Clause Example

The following SQL statement selects all the customers from the country "Mexico", in the "Customers" table:

Example

```
SELECT * FROM Customers
WHERE Country='Mexico';
```

Text Fields vs. Numeric Fields

SQL requires single quotes around text values (most database systems will also allow double quotes).

However, numeric fields should not be enclosed in quotes:

Example

```
SELECT * FROM Customers
WHERE CustomerID=1;
```

Operators in The WHERE Clause

The following operators can be used in the WHERE clause:

=	Equal		
<	Less than	>	Greater than
<=	Less than equal to	>=	Greater than equal to
<>	Not Equal to		

Between – Between a certain range
Like - Search for a pattern
In - To specify multiple possible values for a column

SQL Wildcard Characters

A wildcard character is used to substitute one or more characters in a string.
Wildcard characters are used with the LIKE operator. The LIKE operator is used in a WHERE clause to search for a specified pattern in a column.

Wildcard Characters in SQL Server

Symbol	**Description**	**Example**

%	Represents zero or more characters	bl% finds bl, black, blue, and blob
_	Represents a single character	h_t finds hot, hat, and hit
[]	Represents any single character within the brackets	h[oa]t finds hot and hat, but not hit
^	Represents any character not in the brackets	h[^oa]t finds hit, but not hot and hat
-	Represents any single character within the specified range	c[a-b]t finds cat and cbt

All the wildcards can also be used in combinations!

Here are some examples showing different LIKE operators with '%' and '_' wildcards:

LIKE Operator	Description
WHERE CustomerName LIKE 'a%'	Finds any values that starts with "a"
WHERE CustomerName LIKE '%a'	Finds any values that ends with "a"
WHERE CustomerName LIKE '%or%'	Finds any values that have "or" in any position
WHERE CustomerName LIKE '_r%'	Finds any values that have "r" in the second position
WHERE CustomerName LIKE 'a__%'	Finds any values that starts with "a" and are at least 3 characters in length
WHERE ContactName LIKE 'a%o'	Finds any values that starts with "a" and ends with "o"

The SQL ORDER BY Keyword

The ORDER BY keyword is used to sort the result-set in ascending or descending order.
The ORDER BY keyword sorts the records in ascending order by default. To sort the records in descending order, use the DESC keyword.

ORDER BY Syntax

```
SELECT column1, column2, ...
FROM table_name
ORDER BY column1, column2, ... ASC|DESC;
```

ORDER BY Example

The following SQL statement selects all customers from the "Customers" table, sorted by the "Country" column:

Example

```
SELECT * FROM Customers
ORDER BY Country; Order by clause can be used with several columns also.
```

SQL Aliases

SQL aliases are used to give a table, or a column in a table, a temporary name.
Aliases are often used to make column names more readable.
An alias only exists for the duration of that query.
An alias is created with the AS keyword.

```
SELECT column_name AS alias_name
FROM table_name;
```

SQL Server Functions

SQL Server has many built-in functions.
This reference contains string, numeric, date, conversion, and some advanced functions in SQL Server.

SQL Server String Functions

Function	Description
CHARINDEX	Returns the position of a substring in a string
CONCAT	Adds two or more strings together
Concat with +	Adds two or more strings together
DATALENGTH	Returns the number of bytes used to represent an expression
DIFFERENCE	Compares two SOUNDEX values, and returns an integer value
FORMAT	Formats a value with the specified format
LEFT	Extracts a number of characters from a string (starting from left)
LEN	Returns the length of a string
LOWER	Converts a string to lower-case
LTRIM	Removes leading spaces from a string
NCHAR	Returns the Unicode character based on the number code
PATINDEX	Returns the position of a pattern in a string
QUOTENAME	Returns a Unicode string with delimiters added to make the string a valid SQL Server delimited identifier
REPLACE	Replaces all occurrences of a substring within a string, with a new substring
REPLICATE	Repeats a string a specified number of times
REVERSE	Reverses a string and returns the result
RIGHT	Extracts a number of characters from a string (starting from right)
RTRIM	Removes trailing spaces from a string
SOUNDEX	Returns a four-character code to evaluate the similarity of two strings
SPACE	Returns a string of the specified number of space characters
STR	Returns a number as string
STUFF	Deletes a part of a string and then inserts another part into the string, starting at a specified position
SUBSTRING	Extracts some characters from a string
TRANSLATE	Returns the string from the first argument after the characters specified in the second argument are translated into the characters specified in the third argument.
TRIM	Removes leading and trailing spaces (or other specified characters) from a string
UNICODE	Returns the Unicode value for the first character of the input expression
UPPER	Converts a string to upper-case

1.ASCII - Return the ASCII value of the first character in "Shivraj":

SELECT ASCII('Shivraj') AS NumCodeOfFirstChar FROM Customers

2.CHAR - The CHAR() function returns the character based on the ASCII code.

Syntax : CHAR(*code*)

Example : SELECT CHAR(65) AS CodeToCharacter;

3.The **CHARINDEX()** function searches for a substring in a string, and returns the position.

If the substring is not found, this function returns 0.

Note: This function performs a case-insensitive search.

Syntax : CHARINDEX(*substring*, *string*, *start*)

Example : SELECT CHARINDEX('a', 'Amit') as 'xyz'

4.The **CONCAT()** function adds two or more strings together.

CONCAT(*string1*, *string2*, *....*, *string_n*) WE CAN USE + ALSO

Syntax : SELECT CONCAT('Shivraj',' ','Wankar') AS FullName

Example : SELECT ('Shivraj'+' '+'Wankar') AS FullName -- Concat using Plus(+) sign

5.The **DATALENGTH()** function returns the number of bytes used to represent an expression.

Note: The **DATALENGTH()** function counts both leading and trailing spaces when calculating the length of the expression.

Syntax : DATALENGTH(*expression*)

Example : SELECT DATALENGTH('Shivraj') AS CharacterLength

7. The **SOUNDEX()** function accepts a string and converts it to a four-character code based on how the string sounds when it is spoken.

8. The **DIFFERENCE()** function compares two SOUNDEX values, and returns an integer. The integer value indicates the match for the two SOUNDEX values, from 0 to 4.

0 indicates weak or no similarity between the SOUNDEX values. 4 indicates strong similarity or identically SOUNDEX values.

9. The **LEN()** function returns the length of a string.

Syntax : LEN(*string*)

Example : SELECT LEN(' W3Schools.com ');

Note: Trailing spaces at the end of the string is not included when calculating the length. However, leading spaces at the start of the string is included when calculating the length.

10. The **LOWER()** function converts a string to lower-case.

Syntax : **LOWER(*text*)**

Example : SELECT lower('Shivraj') AS CharacterLength

11. The **UPPER()** function converts a string to lower-case.

Syntax : Upper(Text)

SELECT upper('Shivraj') AS CharacterLength

12. The **RIGHT()** function extracts a number of characters from a string (starting from right).

And The **LEFT()** function extracts a number of characters from a string (starting from left).

Syntax : **RIGHT(*string*, *number_of_chars*) and Left(*string*, *number_of_chars*)**

Example : **SELECT** LEFT(**Name**,**3**),**Name**, right(**Name**,**2**) **FROM Departments**

13. The **LTRIM()** function removes leading spaces from a string.

The **RTRIM()** function removes trailing spaces from a string.

The **TRIM()** function removes the space character OR other specified characters from the start or end of a string.

By default, the TRIM() function removes leading and trailing spaces from a string.

Syntax : **TRIM([*characters* FROM]*string*) or LTRIM([*characters* FROM]*string*)**

Example : SELECT trim('   SQL Tutorial!   ') AS TrimmedString;

SELECT REPLACE('SQL Tutorial SQL SERVER', 'SQL', 'HTML');

14. The **REPLACE()** function replaces all occurrences of a substring within a string, with a new substring.

Note: The search is case-insensitive.

Syntax : **REPLACE(*string*, *old_string*, *new_string*)**

Example : SELECT REPLACE(LASTNAME,'WANKAR','Jadhav') AS ReplacedLastName,LastName,FirstName,Age FROM Persons

15. The **REPLICATE()** function repeats a string a specified number of times.

Syntax : **REPLICATE(*string, integer*)**

Example : SELECT REPLICATE(CustomerName, 2)FROM Customers;

16. The **SUBSTRING()** function extracts some characters from a string.

Syntax : **SUBSTRING(*string*, *start*, *length*)**

Example : SELECT SUBSTRING(NAME,1,8),NAME FROM Departments

17. **The STUFF()** function deletes a part of a string and then inserts another part into the string, starting at a specified position.

Syntax : **STUFF(*string*, *start*, *length*, *new_string*)**

Example : SELECT STUFF('SQL Tutorial!', 13, 1, ' is fun!');

18. The **PATINDEX()** function returns the position of a pattern in a string.

If the pattern is not found, this function returns 0.

Note: The search is case-insensitive and the first position in string is 1.

Syntax : **PATINDEX(*%pattern%*, *string*)**

Example : SELECT PATINDEX('%schools%', 'W3Schools.com');

SELECT PATINDEX('%s%com%', 'W3Schools.com');

Note : This are the some of the commonly used string functions. For all the other string function visit below url.

https://www.w3schools.com/sql/

SQL Server Math/Numeric Functions

Function	Description
ABS	Returns the absolute value of a number
AVG	Returns the average value of an expression
CEILING	Returns the smallest integer value that is >= a number
COUNT	Returns the number of records returned by a select query
FLOOR	Returns the largest integer value that is <= to a number
LOG	Returns the natural logarithm of a number, or the logarithm of a number to a specified base
MAX	Returns the maximum value in a set of values
MIN	Returns the minimum value in a set of values
POWER	Returns the value of a number raised to the power of another number
RADIANS	Converts a degree value into radians

RAND	Returns a random number (0 and 1)
ROUND	Rounds a number to a specified number of decimal places
SIGN	Returns the sign of a number
SQRT	Returns the square root of a number
SQUARE	Returns the square of a number
SUM	Calculates the sum of a set of values

Some Important / commonly used Aggregate functions in SQL Server :

1. The **ABS()** function returns the absolute value of a number.

Exa - SELECT Abs(-243.5) AS AbsNum;

2. **The AVG()** function returns the average value of an expression.

Note: NULL values are ignored.

Syntax : AVG(*expression*)

Example : SELECT AVG(Price) AS AveragePrice FROM Products;

3. The **COUNT()** function returns the number of records returned by a select query.

Note: NULL values are not counted.

Syntax : **COUNT*(expression*)**

Example : SELECT COUNT(ProductID) AS NumberOfProducts FROM Products;

4. The **SUM()** function calculates the sum of a set of values.

Note: NULL values are ignored.

Syntax : SUM(*expression*)

Example : SELECT SUM(Quantity) AS TotalItemsOrdered FROM OrderDetails;

5. The **MIN()** function returns the minimum value in a set of values.

Syntax : MIN(*expression*)

Example : SELECT MIN(Price) AS SmallestPrice FROM Products;

6. The **MAX()** function returns the maximum value in a set of values.

Syntax : Max(*expression*)

Example : SELECT MAX(Price) AS LargestPrice FROM Products;

7. The **CEILING()** function returns the smallest integer value that is larger than or equal to a number.

Syntax : **CEILING(*number*)**

Example : **SELECT CEILING(25.1) AS CeilValue; -- Returns 26**

8. The **FLOOR()** function returns the largest integer value that is smaller than or equal to a number.

Syntax : **FLOOR(*number*)**

Example : **SELECT FLOOR(25.1) AS CeilValue; -- Returns 25**

9. The **ROUND()** function rounds a number to a specified number of decimal places.

Syntax : **ROUND(*number*, *decimals*, *operation*)**

Example : SELECT ROUND(235.415, 1, 2) AS RoundValue;

10. The **RAND()** function returns a random number between 0 (inclusive) and 1 (exclusive).

Syntax : **RAND(*seed*)**

Example : SELECT RAND()

SQUARE (Number) - **Returns the square of the given number.**

Example:
Select SQUARE(9) -- Returns 81

SQRT (Number) - **SQRT stands for Square Root. This function returns the square root of the given value.**

Example:
Select SQRT(81) -- Returns 9

The SQL GROUP BY Statement

The GROUP BY statement groups rows that have the same values into summary rows, like "find the number of customers in each country".

The GROUP BY statement is often used with aggregate functions (COUNT(), MAX(), MIN(), SUM(), AVG()) to group the result-set by one or more columns.

Syntax :

```
SELECT column_name(s)
FROM table_name
WHERE condition
GROUP BY column_name(s)
ORDER BY column_name(s);
```

```
        Example : SELECT COUNT(CustomerID), Country
                  FROM Customers
                  GROUP BY Country;
```

The SQL HAVING Clause

The HAVING clause was added to SQL because the WHERE keyword cannot be used with aggregate functions.

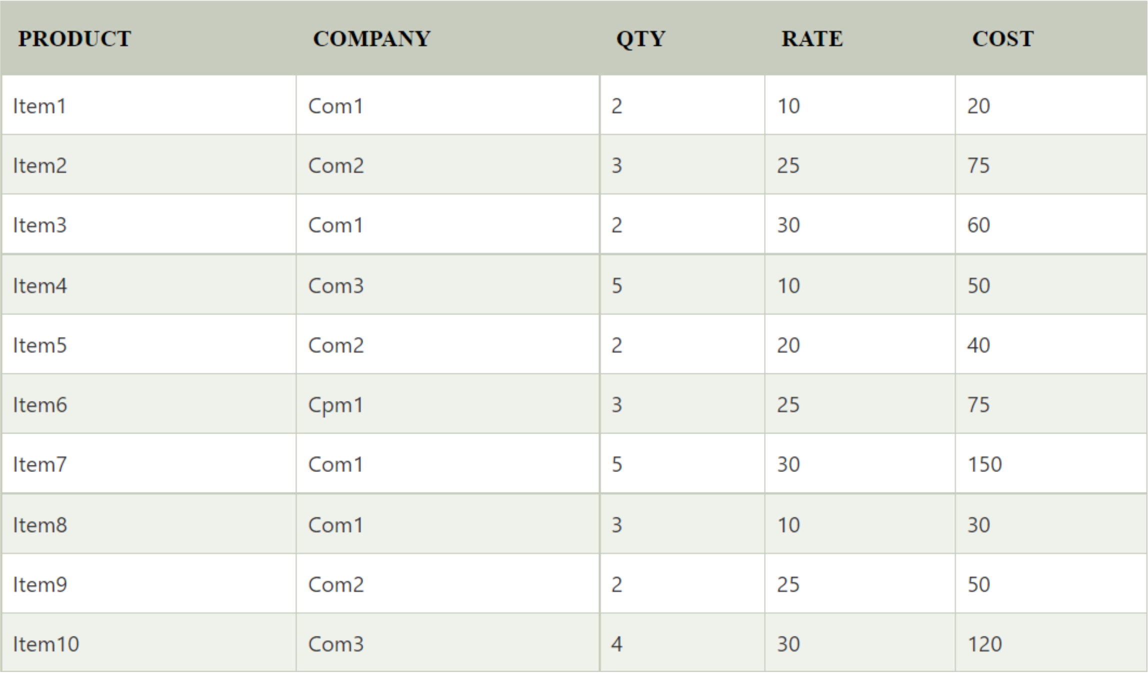
Having Syntax :

```
SELECT column_name(s)
FROM table_name
WHERE condition
GROUP BY column_name(s)
HAVING condition
ORDER BY column_name(s);
```

Refer below table for Aggregate function and Group by:

Table : PRODUCT_MAST

Structure : ProductMasterId int primary key identity column, Product varchar(15), Company varchar(15), Quantity int, Rate int, Cost int



PRODUCT	COMPANY	QTY	RATE	COST
Item1	Com1	2	10	20
Item2	Com2	3	25	75
Item3	Com1	2	30	60
Item4	Com3	5	10	50
Item5	Com2	2	20	40
Item6	Cpm1	3	25	75
Item7	Com1	5	30	150
Item8	Com1	3	10	30
Item9	Com2	2	25	50
Item10	Com3	4	30	120

1. SELECT COUNT(*) FROM PRODUCT_MAST

2. SELECT COUNT(*) FROM PRODUCT_MAST WHERE RATE>=20
3. SELECT COUNT(DISTINCT COMPANY) FROM PRODUCT_MAST
4. SELECT COMPANY, COUNT(*) FROM PRODUCT_MAST GROUP BY COMPANY
5. SELECT COMPANY, COUNT(*) FROM PRODUCT_MAST GROUP BY COMPANY
   HAVING COUNT(*)>2

1. SELECT SUM(COST) FROM PRODUCT_MAST
2. SELECT SUM(COST) FROM PRODUCT_MAST WHERE QTY>3;
3. SELECT SUM(COST) FROM PRODUCT_MAST WHERE QTY>3 GROUP BY COMPANY
4. SELECT COMPANY, SUM(COST) FROM PRODUCT_MAST GROUP BY COMPANY
   HAVING SUM(COST)>=170;

1. SELECT AVG(COST) FROM PRODUCT_MAST
2. SELECT MAX(RATE) FROM PRODUCT_MAST
3. SELECT MIN(RATE) FROM PRODUCT_MAST

Table for Exercise with Sample Data TableName - EmpSalary

employeenumber	**lastname**	**level**	**annual_salary**	**department**
1056	Patterson	10	10000	Finance
1076	Firrel	5	7000	Marketing
1088	Patterson	10	12500	Finance
1102	Bondur	2	5000	Human Resources
1143	Bow	2	5000	Sales
1165	Jennings	2	5000	Sales
1166	Thompson	10	10000	Marketing

1. Find employeenumber, Name & Max salary from above table
   SELECT EmployeeNo, LastName, Max(AnnualSalary) AS MaxSalaary from EmpSalary Group by AnnualSalary,EmployeeNo, LastName

2. Find employeenumber, Name & min salary from above table
   SELECT EmployeeNo, LastName, MIN(AnnualSalary) AS MaxSalaary from EmpSalary Group by AnnualSalary,EmployeeNo, LastName

3. Find employeenumber, Name & average salary from above table
   SELECT EmployeeNo, LastName, AVG(AnnualSalary) AS MaxSalaary from EmpSalary Group by AnnualSalary,EmployeeNo, LastName

4. Find Count of employeenumber with respect to salary (Hint – Group by column salary)
   SELECT count(EmployeeNo) EmployeeCount,AnnualSalary from EmpSalary group by AnnualSalary

5. Find average salary consumed by each department

```
select avg (AnnualSalary)  as AvgSalaryByDept, Department from EmpSalary GROUP BY Department
```

6. Find sum of salary for each level in above table

```
SELECT SUM(AnnualSalary) AS SumOfSalary, Level  FROM EmpSalary GROUP BY Level
```

7. Find count of employee whose average salary greater that 7000

```
SELECT Count(EmployeeNo) AS EmpCount, AVG(ANNUALSALARY) AvgSalary FROM EmpSalary Group BY AnnualSalary  HAVING AVG(ANNUALSALARY)>7000
```

8. Find departments whose sum of salary greater that 10000

```
SELECT SUM(ANNUALSALARY) TotalSalary, Department FROM EmpSalary Group BY Department HAVING SUM(ANNUALSALARY)>10000
```

SQL Server Date Functions :

Function	Description
CURRENT_TIMESTAMP	Returns the current date and time
DATEADD	Adds a time/date interval to a date and then returns the date
DATEDIFF	Returns the difference between two dates
DATEFROMPARTS	Returns a date from the specified parts (year, month, and day values)
DATENAME	Returns a specified part of a date (as string)
DATEPART	Returns a specified part of a date (as integer)
DAY	Returns the day of the month for a specified date
GETDATE	Returns the current database system date and time
GETUTCDATE	Returns the current database system UTC date and time
ISDATE	Checks an expression and returns 1 if it is a valid date, otherwise 0
MONTH	Returns the month part for a specified date (a number from 1 to 12)
SYSDATETIME	Returns the date and time of the SQL Server
YEAR	Returns the year part for a specified date

Below four Date functions used to find/fetch current date & time

1. The **CURRENT_TIMESTAMP** function returns the current date and time, in a 'YYYY-MM-DD hh:mm:ss.mmm' format.

```
SELECT CURRENT_TIMESTAMP
```

2. The **GETDATE()** function returns the current database system date and time, in a 'YYYY-MM-DD hh:mm:ss.mmm' format.

```
SELECT GETDATE()
```

3. The **GETUTCDATE()** function returns the current database system UTC date and time, in a 'YYYY-MM-DD hh:mm:ss.mmm' format.

```
SELECT GETUTCDATE()
```

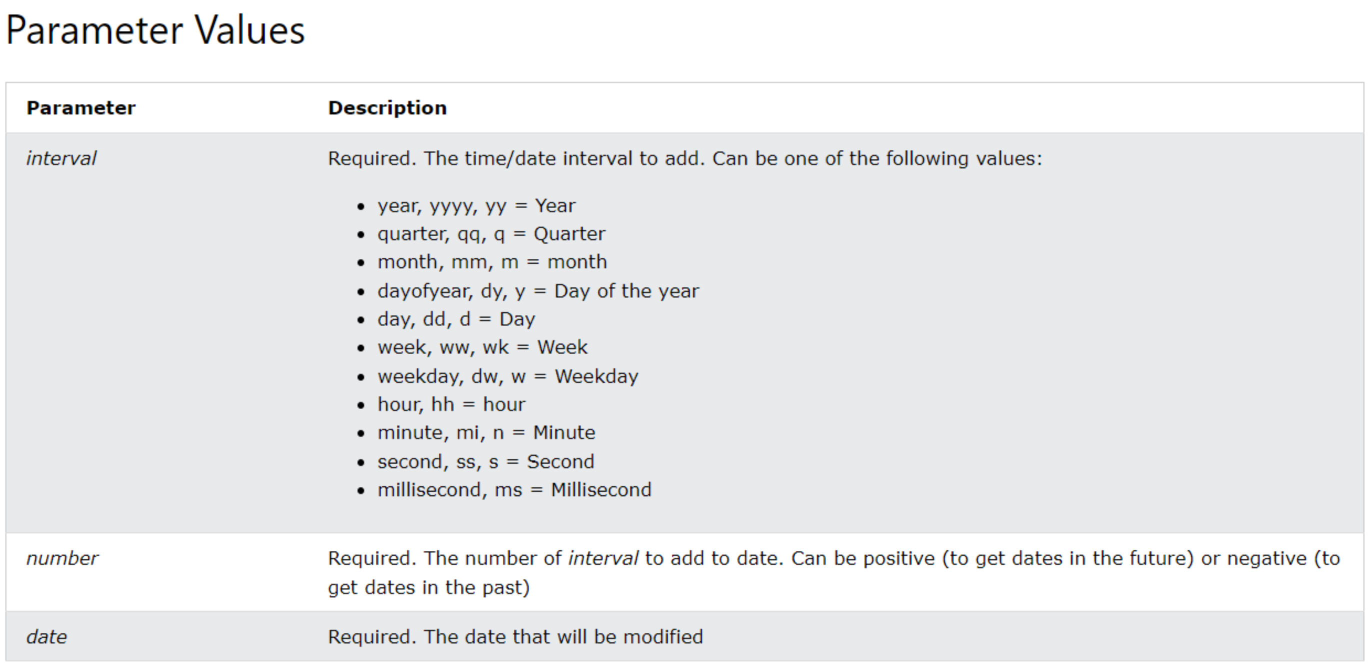
4. The **SYSDATETIME()** function returns the date and time of the computer where the SQL Server is running.

```
SELECT SYSDATETIME()
```

Other Date functions in sql server :

5. The **DATEADD()** function adds a time/date interval to a date and then returns the date.

Syntax : Select DATEADD(*interval*, *number*, *date*)



Parameter Values

Parameter	Description
interval	Required. The time/date interval to add. Can be one of the following values: • year, yyyy, yy = Year • quarter, qq, q = Quarter • month, mm, m = month • dayofyear, dy, y = Day of the year • day, dd, d = Day • week, ww, wk = Week • weekday, dw, w = Weekday • hour, hh = hour • minute, mi, n = Minute • second, ss, s = Second • millisecond, ms = Millisecond
number	Required. The number of *interval* to add to date. Can be positive (to get dates in the future) or negative (to get dates in the past)
date	Required. The date that will be modified

Example :

```
SELECT DATEADD(year, 1, '2017/08/25') AS YearAdd;        ----It will add 1 year to date
SELECT DATEADD(month, 2, '2017/08/25') AS DateAdd;       ----It will add 2 months to date
SELECT DATEADD(month, -2, '2017/08/25') AS DateAdd;      ----It will add -2 months to date i.e. 2015
```

6. The **DATEDIFF()** function returns the difference between two dates.

Syntax : Select DATEDIFF(*interval*, *date1*, *date2*)

Example :

```
SELECT DATEDIFF(month, '2017/08/25', '2011/08/25') AS DateDiff;   -- Displays diff between given dates in month
SELECT DATEDIFF(hour, '2017/08/25 07:00', '2017/08/25 12:45') AS DateDiff; --Diff in Hours
```

7. The DATEFROMPARTS() function returns a date from the specified parts (year, month, and day values).

Syntax : Select DATEFROMPARTS(*year*, *month*, *day*)

Example :

```
SELECT DATEFROMPARTS(2018, 10, 31) AS DateFromParts;
```

8. The DATENAME() function returns a specified part of a date.

   This function returns the result as a string value.

Syntax : Select DATENAME(*interval*, *date*)

Example :

```
SELECT DATENAME(year, '2017/08/25') AS DatePartString;
SELECT DATENAME(yy, '2017/08/25') AS DatePartString;
SELECT DATENAME(month, '2017/08/25') AS DatePartString;
SELECT DATENAME(hour, '2017/08/25 08:36') AS DatePartString;
SELECT DATENAME(minute, '2017/08/25 08:36') AS DatePartString;
```

9. The DATEPART() function returns a specified part of a date.

   This function returns the result as an integer value.

   Syntax : Select DATEPART(*interval*, *date*)

   Example :

```
SELECT DATEPART(yy, '2017/08/25') AS DatePartInt;
SELECT DATEPART(month, '2017/08/25') AS DatePartInt;
SELECT DATEPART(hour, '2017/08/25 08:36') AS DatePartInt;
SELECT DATEPART(minute, '2017/08/25 08:36') AS DatePartInt;
```

10. The ISDATE() function checks an expression and returns 1 if it is a valid date, otherwise 0.

    Syntax : ISDATE(*expression*)

    Example : SELECT ISDATE('2023-08-14')

    SELECT ISDATE(‘Hello’)

11. Day, Month, Year : Syntax SELECT Day/Month/Year(Date)

    The DAY() function returns the day of the month (from 1 to 31) for a specified date.

```
SELECT DAY('2017/08/25') AS DayOfMonth;
SELECT DAY('2017/08/13 09:08') AS DayOfMonth;
```

    The MONTH() function returns the month part for a specified date (a number from 1 to 12).

```
SELECT MONTH('2017/08/25') AS Month;
SELECT MONTH('2017/05/25 09:08') AS Month;
```

    The YEAR() function returns the year part for a specified date.

```
SELECT YEAR('2017/08/25') AS Year;
SELECT YEAR('1998/05/25 09:08') AS Year;
```

Exercise :

CREATE StudentData table with columns (Id,StName, DOB, City, JoiningDate)

Data type for DOB & JoiningDate should be Date

Insert below data in table

Id	StName	DOB	City	JoiningDate
1	Steward	2001-03-02	London	2022-05-02
2	Lucman	2000-08-19	New York	2022-05-02
3	Brathwaite	2001-01-07	Oslo	2022-05-03
4	Lourel	1999-11-05	Mumbai	2022-05-03
5	Joe Stephen	2003-08-25	China	2022-05-05
6	Jack	2000-08-19	New York	2022-05-02
7	Mike	2001-01-07	Oslo	2022-05-03
8	Paul Harry	1999-11-05	Mumbai	2022-05-03
9	Mike Hamper	1998-12-20	China	2022-05-05
10	Sara Jones	2000-08-12	Mumbai	2022-05-02
11	Johnson	1999-01-09	China	2022-05-02
12	David Stephen	2002-03-06	China	2022-05-03
13	Mark John	1997-10-12	New York	2022-05-02
14	Ken Villy	1997-11-30	New York	2022-05-02
15	Harry Teckor	2000-08-14	Oslo	2022-05-04
16	Karl Hoope	2001-03-19	China	2022-05-04
17	Jacky Laurel	1999-06-25	Mumbai	2022-05-06

1. Calculate Age of Student. Display name and age of student.

   ```
   SELECT StName,DATEDIFF(YEAR,BirthDate,GETDATE()) AgeOfStudent FROM StudentData
   ```

2. Find number of students who were born before 2000.

   ```
   SELECT COUNT(1) AS StudentCount FROM StudentData WHERE YEAR(BirthDate)>2000
   ```

3. Calculate average age of students from New York City

   ```
   SELECT AVG(DATEDIFF(YEAR,BirthDate,GETDATE())) AS AverageAge FROM StudentData WHERE City='New York'
   ```

4. Find number of students joined for each day. Display count & day name.

   ```
   SELECT COUNT(1) AS DayCount, DATENAME(WEEKDAY,JoiningDate) AS JoiningDay FROM StudentData GROUP BY DATENAME(WEEKDAY,JoiningDate)
   ```

5. Find average age of student for each city.

   ```
   SELECT AVG(DATEDIFF(YEAR,BirthDate,GETDATE())) AverageAgeByCity, City FROM StudentData GROUP BY City
   ```

6. Find number of students from each city who were born after 2000.
7. `SELECT COUNT(1) AS StudentCount FROM StudentData WHERE YEAR(BirthDate)<2000`

8. Find count of Students from each city

   ```
   SELECT Count(1) AS StudentCount , City FROM StudentData GROUP BY City
   ```

Also write SQL queries for below questions :

1. Display all the records by adding 25 years to its birthdate
2. Display all the records who are born in January irrespective of birth year
3. Display count of students & year born in particular year
4. Display count & average age of students having average age more than 22 years.
5. Display Count & joining date of all the students where count for a day is more than 2.

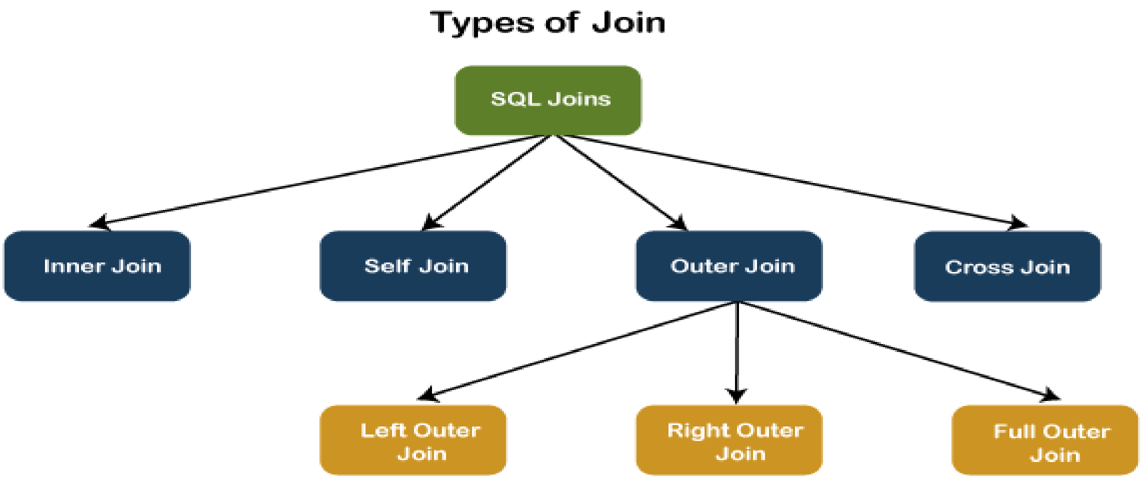
SQL Server Joins:

Summary : In a relational database, data is distributed in multiple logical tables. To get a complete meaningful set of data, you need to query data from these tables using joins. SQL Server supports many kinds of joins, including inner join, left join, right join, full outer join, self join and cross join. Each join type specifies how SQL Server uses data from one table to select rows in another table.

SQL Server (Transact-SQL) JOINS are used to retrieve data from multiple tables. A SQL Server JOIN is performed whenever two or more tables are joined in a SQL statement.

There are 4 different types of SQL Server joins:

- SQL Server INNER JOIN (or sometimes called simple join)
- SQL Server LEFT OUTER JOIN (or sometimes called LEFT JOIN)
- SQL Server RIGHT OUTER JOIN (or sometimes called RIGHT JOIN)
- SQL Server FULL OUTER JOIN (or sometimes called FULL JOIN)



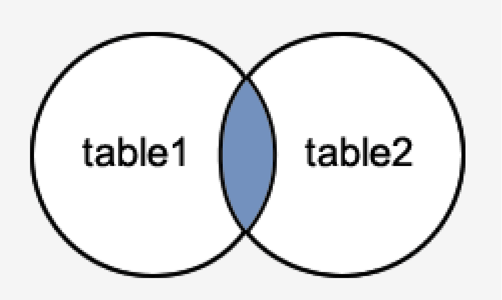
INNER JOIN (simple join)

It is the most common type of join. SQL Server INNER JOINS return all rows from multiple tables where the join condition is met.

Syntax
The syntax for the INNER JOIN in SQL Server (Transact-SQL) is:

```
SELECT column_list
From Table1
INNER Join Table2
ON Table1.column = Table2.column
```

Visual Illustration
In this visual diagram, the SQL Server INNER JOIN returns the shaded area:



The SQL Server INNER JOIN would return the records where *table1* and *table2* intersect.

Let us first create two tables "**StudentDetails**" and "**FeeDetails**" & insert some sample records in those tables :

Table StudentDetails

SdId	**Admission_No**	**First_Name**	**Last_Name**	**Age**	**City**
1	3354	Luisa	Evans	13	Texas
2	2135	Paul	Ward	15	Alaska
3	4321	Peter	Bennett	14	California
4	4213	Carlos	Patterson	17	New York
5	5112	Rose	Huges	16	Florida
6	6113	Marielia	Simmons	15	Arizona
7	7555	Antonio	Butler	14	New York
8	8345	Diego	Cox	13	California

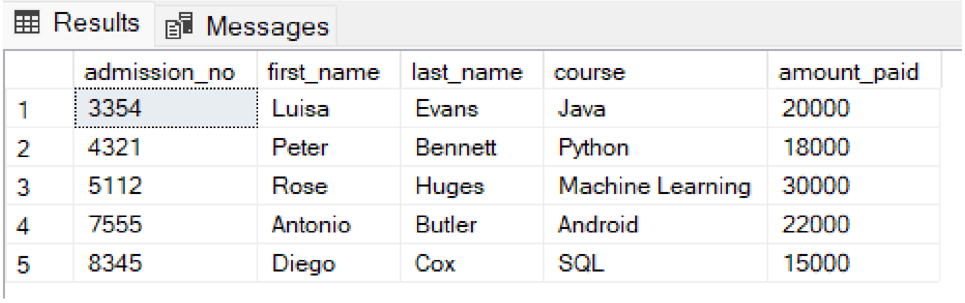
Table FeeDetails

FdId	Admission_no	Course	Amount_Paid
1	3354	Java	20000
2	7555	Android	22000
3	4321	Python	18000
4	8345	SQL	15000
5	5112	Machine Learning	30000

Now suppose we have to fetch result as all the columns from table StudentDetails who paid their fees & their fees paid amount from table FeeDetails :
We can achieve this by joining two tables with inner join as below :

```
SELECT StudentDetails.admission_no, StudentDetails.first_name, StudentDetails.last_name, FeeDetails.course, FeeDetails.amount_paid  FROM StudentDetails
INNER JOIN FeeDetails
ON StudentDetails.admission_no = FeeDetails.admission_no;
```

Our output data will be as below,



	admission_no	first_name	last_name	course	amount_paid
1	3354	Luisa	Evans	Java	20000
2	4321	Peter	Bennett	Python	18000
3	5112	Rose	Huges	Machine Learning	30000
4	7555	Antonio	Butler	Android	22000
5	8345	Diego	Cox	SQL	15000

Here have used the **admission_no column** as a join condition to get the data from both tables. Depending on this table, we can see the information of the students who have paid their fee.

A join that displays only the rows that have a match in both joined tables. **Columns containing NULL do not match any values when you are creating an inner join and are therefore excluded from the result set**. Null values do not match other null values.

OUTER JOIN

In the SQL outer JOIN all the content of the both tables are integrated together either they are matched or not.

Outer join of two types:

1.Left outer join (also known as left join): this join returns all the rows from left table combine with the matching rows of the right table. If you get no matching in the right table it returns NULL values.

2.Right outer join (also known as right join): this join returns all the rows from right table are combined with the matching rows of left table .If you get no column matching in the left table .it returns null value. This diagram shows the different type of joins:

1. **Left Outer Join:**

   The SQL left join returns all the values from the left table and it also includes matching values from right table, if there are no matching join value it returns NULL.

   Basic Syntax of Left Join:

```
    SELECT table1.column1, table2.column2....
    FROM table1
    LEFTJOIN table2
    ON table1.column_field = table2.column_field;
```

Lets consider above studentdetails & feedetails table:

```
SELECT StudentDetails.admission_no, StudentDetails.first_name, StudentDetails.last_name, FeeDetails.course,
FeeDetails.amount_paid
FROM StudentDetails
left JOIN FeeDetails
ON StudentDetails.admission_no = FeeDetails.admission_no;
```

Output of this query will contain matching records from both tables & non matching records from left table.

2. **Right Outer Join:**

   The SQL right join returns all the values from the rows of right table. It also includes the matched values from left table but if there is no matching in both tables, it returns NULL.

   Basic syntax for right join:

```
SELECT table1.column1, table2.column2.....
FROM table1
RIGHT JOIN table2
ON table1.column_field = table2.column_field;
```

Lets consider above studentdetails & feedetails table:

```
SELECT StudentDetails.admission_no, StudentDetails.first_name, StudentDetails.last_name, FeeDetails.course,
FeeDetails.amount_paid
FROM StudentDetails
```

```
RIGHT JOIN FeeDetails
ON StudentDetails.admission_no = FeeDetails.admission_no;
```

3. Full Outer Join

The SQL full join is the result of combination of both left and right outer join and the join tables have all the records from both tables. It puts NULL on the place of matches not found.

SQL full outer join and SQL join are same. generally it is known as SQL FULL JOIN.

SQL full outer join is used to combine the result of both left and right outer join and returns all rows (don't care its matched or unmatched) from the both participating tables.

Syntax for full outer join:

```
SELECT *
FROM table1
FULL OUTER JOIN table2
ON table1.column_name = table2.column_name;
```

Let us take two tables to demonstrate full outer join:

SELF Join

A self join allows you to join a table to itself. It helps query hierarchical data or compare rows within the same table.
A self join uses the inner join or left join clause. Because the query that uses the self join references the same table, the table alias is used to assign different names to the same table within the query.
Note that referencing the same table more than one in a query without using table aliases will result in an error.

The following shows the syntax of joining the table T to itself:

```
SELECT select_list FROM T t1
[INNER | LEFT]  JOIN T t2
ON join_predicate;
```

The query references the table T twice. The table aliases t1 and t2 are used to assign the T table different names in the query.

Lets create a sample table to work with Self Join & insert some records:

```
CREATE TABLE [dbo].[tblEmployeeDetails](
[Emp_id] [bigint] IDENTITY(1,1) PRIMARY KEY,
[Emp_name] [nvarchar](200) NULL,
[Emp_mgr_id] [bigint] NULL )

SELECT * FROM tblEmployeeDetails

Insert into tblEmployeeDetails (Emp_name,Emp_mgr_id) values
 ('Rakesh', NULL)
,('Namam',      1)
,('Sanket',     2)
,('Vishal',     3)
,('Ram',        1)
,('Karan',      2)
,('Suhas',      3)
```

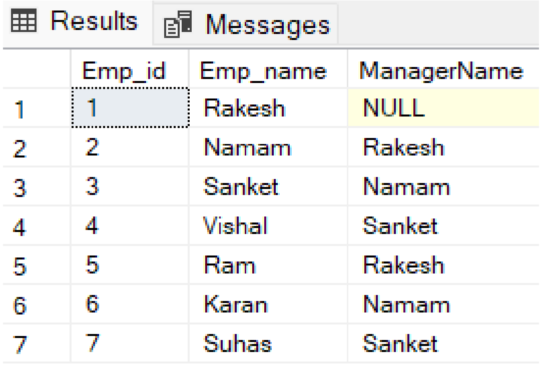
Now suppose in this table each employee is manager to some other person and same is mentioned using Emp_mgr_id column in table.

Then how to find which employee belongs to which manager??

Here we can use self-join as below query using allies names to same table & column

```
SELECT E.Emp_id, E.Emp_name, M.EMP_NAME AS 'ManagerName' FROM tblEmployeeDetails E
LEFT JOIN tblEmployeeDetails M ON E.Emp_mgr_id=M.Emp_id
```

Result will be:



	Emp_id	Emp_name	ManagerName
1	1	Rakesh	NULL
2	2	Namam	Rakesh
3	3	Sanket	Namam
4	4	Vishal	Sanket
5	5	Ram	Rakesh
6	6	Karan	Namam
7	7	Suhas	Sanket

If we use Inner join or Join in above query to join this two tables. Null values will be ignored.

Cross Join:

Join operation in SQL is used to combine multiple tables together into a single table.

If we use the cross join to combine two different tables, then we will get the Cartesian product of the sets of rows from the joined table. When each row of the first table is combined with each row from the second table, it is known as Cartesian join or cross join.

After performing the cross join operation, the total number of rows present in the final table will be equal to the product of the number of rows present in table 1 and the number of rows present in table 2.

For example:

If there are two records in table 1 and three records in table 2, then after performing cross join operation, we will get six records in the final table.

Let us take a look at the syntax of writing a query to perform the cross join operation in SQL.

Syntax:

```
Select Column_list From Table1 Cross Join Table2 (Full Join will not have ON condition)
```

Sub Queries & Co-related Sub Queries in SQL:

A Subquery or Inner query or a Nested query is a query within another SQL query and embedded within the WHERE clause.

A subquery is used to return data that will be used in the main query as a condition to further restrict the data to be retrieved.

Subqueries can be used with the SELECT, INSERT, UPDATE, and DELETE statements along with the operators like =, <, >, >=, <=, IN, BETWEEN, etc.

There are a few rules that subqueries must follow –

- Subqueries must be enclosed within parentheses.

- A subquery can have only one column in the SELECT clause, unless multiple columns are in the main query for the subquery to compare its selected columns.
- An ORDER BY command cannot be used in a subquery, although the main query can use an ORDER BY. The GROUP BY command can be used to perform the same function as the ORDER BY in a subquery.
- Subqueries that return more than one row can only be used with multiple value operators such as the IN operator.
- The BETWEEN operator cannot be used with a subquery. However, the BETWEEN operator can be used within the subquery.

Subqueries with the SELECT Statement

Subqueries are most frequently used with the SELECT statement. The basic syntax is as follows –

```
SELECT column_name [, column_name ]
FROM table1 [, table2 ]
WHERE column_name OPERATOR
(SELECT column_name [, column_name ]
FROM table1 [, table2 ]
[WHERE])
```

Students

S_Id	**S_Name**	**S_Address**	**S_Phone**
S1	RAM	Manali	9455123451
S2	RAMESH	Delhi	9652431543
S3	SUJIT	Rohtak	9652431543
S4	AJIT	Jalandhar	9156768971

Courses

C_Id	C_Name
C1	DSA
C2	Programming
C3	DBMS

Student_Course

S_Id	C_Id
S1	C1
S1	C3
S2	C1
S3	C2
S4	C2
S4	C3

There are mainly two types of nested queries:

- **Independent Nested Queries:** In independent nested queries, query execution starts from innermost query to outermost queries. The execution of the inner query is independent of the outer query, but the result of the inner query is used in the execution of the outer query. Various operators like IN, NOT IN, ANY, ALL etc are used in writing independent nested queries.

IN: If we want to find out S_ID who are enrolled in C_NAME 'DSA' or 'DBMS', we can write it with the help of independent nested query and IN operator. From COURSE table, we can find out C_ID for C_NAME 'DSA' or DBMS' and we can use these C_IDs for finding S_IDs from STUDENT_COURSE TABLE.

STEP 1: Finding C_ID for C_NAME ='DSA' or 'DBMS' Select C_ID from COURSE where C_NAME = 'DSA' or C_NAME = 'DBMS'

STEP 2: Using C_ID of step 1 for finding S_ID Select S_ID from STUDENT_COURSE where C_ID IN (SELECT C_ID from COURSE where C_NAME = 'DSA' or C_NAME='DBMS');

The inner query will return a set with members C1 and C3 and the outer query will return those S_IDs for which C_ID is equal to any member of the set (C1 and C3 in this case). So, it will return S1, S2 and S4.

Note: If we want to find out names of STUDENTs who have either enrolled in 'DSA' or 'DBMS', it can be done as:

Select S_NAME from STUDENT where S_ID IN (Select S_ID from STUDENT_COURSE where C_ID IN (SELECT C_ID from COURSE where C_NAME='DSA' or C_NAME='DBMS'));

NOT IN: If we want to find out S_IDs of STUDENTs who have neither enrolled in 'DSA' nor in 'DBMS', it can be done as:
Select S_ID from STUDENT where S_ID NOT IN (Select S_ID from STUDENT_COURSE where C_ID IN (SELECT C_ID from COURSE where C_NAME='DSA' or C_NAME='DBMS'));

The innermost query will return a set with members C1 and C3. Second inner query will return those S_IDs for which C_ID is equal to any member of set (C1 and C3 in this case) which are S1, S2 and S4. The outermost query will return those S_IDs where S_ID is not a member of set (S1, S2 and S4). So it will return S3.

- **Co-related Nested Queries:** In co-related nested queries, the output of inner query depends on the row which is being currently executed in outer query. e.g.; If we want to find out S_NAME of STUDENTs who are enrolled in C_ID 'C1', it can be done with the help of co-related nested query as:

Select S_NAME from STUDENT S where EXISTS (select * from STUDENT_COURSE SC where S.S_ID=SC.S_ID and SC.C_ID='C1');

For each row of STUDENT S, it will find the rows from STUDENT_COURSE where S.S_ID = SC.S_ID and SC.C_ID='C1'. If for a S_ID from STUDENT S, atleast a row exists in STUDENT_COURSE SC with C_ID='C1', then inner query will return true and corresponding S_ID will be returned as output.

SQL Set Operators:

A set operator in SQL is a keyword that lets you combine the results of two queries into a single query. Sometimes when working with SQL, you'll have a need to query data from two more tables. But instead of joining these two tables, you'll need to list the results from both tables in a single result, or in different rows. That's what set operators do.

Types Of Set Operators:

There are a few different set operators that can be used, depending on your needs, and which database vendor you're using.

The different set operators are:

- UNION
- UNION ALL
- MINUS/ EXCEPT
- INTERSECT

Let’s take a look at each of these, using some sample data.

Standard Syntax for SET operators:

```
SELECT your_select_query
set_operator
SELECT another_select_query;
```

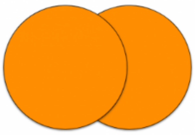
It uses two (or more) SELECT queries, with a set operator in the middle.

There are a few things to keep in mind though.

- When selecting your columns, the **number of columns needs to match** between queries, and the **data type of each column needs to be compatible**.
- So, if you select three columns in the first query, you need to select three columns in the second query. The data types also need to be compatible, so if you select a number and two-character types in the first query, you need to do the same in the second query.
- Also, if you want to order your results, the ORDER BY must go at the end of the last query. You can’t add ORDER BY inside each SELECT query before the set operator.

1. Union (Combining Results)

The UNION keyword or set operator will allow you to combine the results of two queries. It removes any duplicate results and shows you the combination of both.
Expressed as a Venn diagram, where each circle represents a query result, it looks like this:



Lets see Customer & Emp tables as below :

```
SELECT first_name, last_name
FROM customer
UNION
SELECT first_name, last_name
FROM employee;
```

We can use Where clause to filter data in all SET operators.
Union with where & order by:

```
SELECT ‘Customer’ AS record_type, first_name, last_name
FROM customer
WHERE status = ‘Active’
UNION
```

```
SELECT ‘Employee’, first_name, last_name
FROM employee
WHERE emp_status = ‘Current’
ORDER BY record_type, first_name, last_name;
```

What’s the Difference Between a UNION and a JOIN?

The UNION and JOIN keywords both combine results from two different tables or queries.
The difference is how they are combined.

- UNION combines data into separate rows, and JOIN combines data into separate columns.
- When performing a JOIN, there is a column that matches between the two tables, and additional data may be displayed.

2. Union All:

The UNION ALL set operator also combines the results from two queries.
It’s very similar to UNION, but it does not remove duplicates.

```
SELECT first_name, last_name
FROM customer
UNION ALL
SELECT first_name, last_name
FROM employee;
```

There are some records in this table that appear twice (Stephen Jones and Paula Johnson). Why is that?

This is because **UNION ALL does not remove duplicates**. So the same first name and last name values exist in both the customer and employee tables, and this query shows each of them.

What’s the Difference between UNION and UNION ALL?

The major difference between UNION ALL and UNION in SQL is that UNION removes any duplicate results from the final result set, and UNION ALL does not. UNION performs a DISTINCT on the result set to remove duplicates.

To remember this, consider that “ALL” in UNION ALL means “show all records”.

Therefore, UNION ALL will almost always show more results, as it does not remove duplicate records.

As a result of this, UNION is often slower than UNION ALL, because there is an operation to remove duplicate values (a.k.a DISTINCT), which is often a costly step in a query.

UNION ALL does not perform a distinct, so is usually faster.

So, if you don’t need to have unique rows in your result set, or if you’re sure the rows in the database or query are unique already, then use UNION ALL.

3. Except

Another set operator we can use is the MINUS keyword.
The MINUS set operator will return results that are found in the first query specified that don't exist in the second query.

Using our example data, we could use the MINUS set operator to find all names in the customer table that don't exist in the employee table.

Our query would look like this:

```
SELECT first_name, last_name
FROM customer
EXCEPT
SELECT first_name, last_name
FROM employee;
```

If a result exists in the employee table as well as the customer table, it is not shown. Only the results from the customer table that are not in the employee table are shown.

4. Intersect

The INTERSECT keyword allows you to find results that exist in both queries. Two SELECT statements are needed, and any results that are found in both of them are returned if INTERSECT is used.

Using our example data, we could use the INTERSECT set operator to find all names in the customer table that don't exist in the employee table.

Our query would look like this:

```
SELECT first_name, last_name
FROM customer
INTERSECT
SELECT first_name, last_name
FROM employee;
```

The SQL CASE Statement:

The CASE statement goes through conditions and returns a value when the first condition is met (like an if-then-else statement). So, once a condition is true, it will stop reading and return the result. If no conditions are true, it returns the value in the ELSE clause.

If there is no ELSE part and no conditions are true, it returns NULL.

CASE Syntax

```
CASE
   WHEN condition1 THEN result1
   WHEN condition2 THEN result2
   WHEN conditionN THEN resultN
   ELSE result
END;
```

Below is a selection from the "OrderDetails" table in the Northwind sample database:

```
SELECT Order_No, Quantity,PRODUCT_ID,
CASE
   WHEN Quantity > 30 THEN 'The quantity is greater than 30'
   WHEN Quantity = 30 THEN 'The quantity is 30'
   ELSE 'The quantity is under 30'
END AS QuantityText
FROM Orders;
```

```
SELECT Order_No, Quantity,PRODUCT_ID,
FROM Orders;
ORDER  BY
          (CASE WHEN PRODUCT_ID IS NULL THEN Quantity
          ELSE PRODUCT_ID END)
```

Different ways to Replace NULL value:

Null functions are required **to perform operations on the null values stored in our database**. We can perform functions on NULL values, which explicitly recognize if a value is null or not. Helps us to replace NULL values with the desired value.

Suppose in Product_Master we need to calculate total cost of each product.
Our query will be like below:

```
SELECT product, Quantity * (Rate + GST) AS 'TotalCost'
FROM Product_Master;
```

If any value in GST column contains null value. Total cost will return as null. Which results in inaccurate data.
To avoid this, we need to replace null with sum other value:

In MS SQL we have ISNULL & Coalesce functions to replace null values.

The SQL Server ISNULL() function lets you return an alternative value when an expression is NULL:

It contains two parameters. The first parameter is to evaluate the expression for NULL. If the first parameter is NULL, the function replaces the second parameter.

```
SELECT product, Quantity * (Rate + ISNULL(GST,0)) AS 'TotalCost'
FROM Product_Master;
```

or we can use the COALESCE() function, like this:

COALESCE evaluates the expression in order and returns the first non-null value.
COALESCE (expression1, expression2 [, … expressionN])

It can contain N no of parameters. It returns the first non-null parameter value.

```
SELECT product, Quantity * (Rate + COALESCE(GST,NULL,NULL,0)) AS 'TotalCost'
FROM Product_Master;
```

SQL Server CAST() Function

The CAST() function converts a value (of any DATA type) into a specified datatype.
Syntax:
CAST(*expression* AS *datatype(length)*)

```
SELECT CAST('2017-08-25' AS datetime);
SELECT CAST(25.65 AS int);
```

SQL Server CONVERT() Function

The CONVERT() function converts a value (of any type) into a specified datatype.

Syntax:

```
CONVERT(data_type(length), expression, style)
```

The SQL SELECT INTO Statement

The SELECT INTO statement copies data from one table into a new table.

Copy all columns into a new table:

```
SELECT *
INTO newtable [IN externaldb]
FROM oldtable
WHERE condition;
```

Copy only some columns into a new table:

```
SELECT column1, column2, column3, ...
INTO newtable [IN externaldb]
FROM oldtable
WHERE condition;
```

The new table will be created with the column-names and types as defined in the old table. You can create new column names using the AS clause.

SQL SELECT INTO Examples

The following SQL statement creates a backup copy of Customers:

```
SELECT * INTO CustomersBackup2017
FROM Customers;
```

The following SQL statement uses the IN clause to copy the table into a new table in another database:

```
SELECT * INTO CustomersBackup2017 IN 'Backup.mdb'
FROM Customers;
```

The following SQL statement copies only a few columns into a new table:

```
SELECT CustomerName, ContactName INTO CustomersBackup2017
FROM Customers;
```

The following SQL statement copies only the German customers into a new table:

```
SELECT * INTO CustomersGermany
FROM Customers
WHERE Country = 'Germany';
```

The following SQL statement copies data from more than one table into a new table:

```
SELECT Customers.CustomerName, Orders.OrderID
INTO CustomersOrderBackup2017
FROM Customers
LEFT JOIN Orders ON Customers.CustomerID = Orders.CustomerID;
```

Tip: SELECT INTO can also be used to create a new, empty table using the schema of another. Just add a WHERE clause that causes the query to return no data:

```
SELECT * INTO newtable
FROM oldtable
WHERE 1 = 0;
```

The SQL INSERT INTO SELECT Statement

The INSERT INTO SELECT statement copies data from one table and inserts it into another table.
The INSERT INTO SELECT statement requires that the data types in source and target tables match.

Note: The existing records in the target table are unaffected.

INSERT INTO SELECT Syntax

Copy all columns from one table to another table:

```
INSERT INTO table2
SELECT * FROM table1
WHERE condition;
```

Copy only some columns from one table into another table:

```
INSERT INTO table2 (column1, column2, column3, ...)
SELECT column1, column2, column3, ...
FROM table1
WHERE condition;
```

The following SQL statement copies "Suppliers" into "Customers" (the columns that are not filled with data, will contain NULL):

Example

```
INSERT INTO Customers (CustomerName, City, Country)
SELECT SupplierName, City, Country FROM Suppliers;
```

The following SQL statement copies "Suppliers" into "Customers" (fill all columns):

Example

```
INSERT INTO Customers (CustomerName, ContactName, Address, City, PostalCode, Country)
SELECT SupplierName, ContactName, Address, City, PostalCode, Country FROM Suppliers;
```

The following SQL statement copies only the German suppliers into "Customers":

Example

```
INSERT INTO Customers (CustomerName, City, Country)
SELECT SupplierName, City, Country FROM Suppliers
WHERE Country='Germany';
```

INDEX in SQL Server:

The CREATE INDEX statement is used to create indexes in tables.

Indexes are used to retrieve data from the database more quickly than otherwise. The users cannot see the indexes, they are just used to speed up searches/queries.

```
CREATE INDEX index_name
ON table_name (column1, column2, ...);
```

What is a SQL Server Clustered Index?

A clustered index is one of the main index types in SQL Server. A clustered index stores the index key in a B-tree structure along with the actual table data in each leaf node of the index. Having a clustered index defined on a table eliminates the heap table structure we described in the previous section. Since the rest of the table data (eg. non-key columns) is stored in the leaf nodes of the index structure, a table can only have one clustered index defined on it.

SQL Server Clustered Index Benefits and Usage

The are many benefits to having a clustered index defined on a table but the main benefit is speeding up query performance. Queries that contain the index key columns in the WHERE clause use the index structure to go straight to the table data. A clustered index also removes the need for an extra lookup, to get the rest of the column data, when querying based on the index key values. This is something that is not true of other index types. You can also eliminate the need to sort data. If the ORDER BY clause of a query is based on the index key values then a sort is not required since the data is already ordered by these values.

SQL Server Clustered Index Disadvantages

There are a couple of disadvantages when it comes to clustered indexes. There is some overhead in maintaining the index structure with respect to any DML operation (INSERT, UPDATE, DELETE). This is especially true if you are updating the actual key values in the index as in this case all of the associated table data also has to be moved as it is stored in the leaf node of the index entry. In each case there will be some performance impact to your DML query.

SQL Server Clustered Index Basic Syntax

```
CREATE non CLUSTERED INDEX CIX_TestData_TestId ON dbo.TestData (TestId);

ALTER INDEX IX_TestData_TestId ON TestData REBUILD WITH (ONLINE = ON);

DROP INDEX IX_TestData_TestId on TestData WITH (ONLINE = ON);
```

SQL Server Non-Clustered Index

What is a SQL Server Non-Clustered Index?

A non-clustered index is the other main type of index used in SQL Server. Similar to its clustered index counterpart, the index key columns are stored in a B-tree structure except in this case the actual data is not stored in the leaf nodes. In this type of index, a pointer to the actual table data is stored in the leaf node. This could point to the data value in the clustered index or in a heap structure depending on how the table data is stored.

SQL Server Non-Clustered Index Benefits and Usage

The benefits of a non-clustered index are similar to that of the clustered index we mentioned above, the main benefit being speeding up query performance. There are however two differences. The first is that you can have multiple non-clustered indexes defined on a single table. This allows you to index different columns which can help queries with different columns in the WHERE clause allowing you to fetch data faster and in the ORDER BY clause to eliminate a need for a sort. The second is that although there is overhead for a non-clustered index when it comes to DML operations there is less than its clustered counterpart.

SQL Server Non-Clustered Index Disadvantages

Similar to the clustered index the main disadvantage of a non-clustered index is the extra overhead required in maintaining the index during DML operations. It can sometimes be tricky to balance query performance as having too many non-clustered indexes on a table, while they will help all of your SELECT queries, can sometimes really slow down DML performance.

SQL Server Non-Clustered Index Basic Syntax

```
CREATE INDEX IX_TestData_TestDate ON dbo.TestData (TestDate);

ALTER INDEX IX_TestData_TestDate ON TestData REBUILD WITH (ONLINE = ON);

DROP INDEX IX_TestData_TestDate on TestData;
```

TIP: https://dotnettutorials.net/lesson/sql-server-indexes/

T-SQL:

T-SQL, which stands for Transact-SQL and is sometimes referred to as TSQL, is an extension of the SQL language used primarily within Microsoft SQL Server. This means that it provides all the functionality of SQL but with some added extras.

What is the difference between SQL and T-SQL?

Now we have covered the basics of both, let's take a look at the main differences:

Difference #1
The obvious difference is in what they are designed for: SQL is a query language used for manipulating data stored in a database. T-SQL is also a query language, but it's an extension of SQL that is primarily used in Microsoft SQL Server databases and software.

Difference #2
SQL is open-source. T-SQL is developed and owned by Microsoft.

Difference #3
SQL statements are executed one at a time, also known as "non-procedural." T-SQL executes statements in a "procedural" way, meaning that the code will be processed as a block, logically and in a structured order. There are advantages and disadvantages to each approach, but from a learner perspective, this difference isn't too important. You'll be able to get and work with the data you want in either language, it's just that the way you go about doing that will vary a bit depending on which language you're using and the specifics of your query.

Difference #4
On top of these more general differences, SQL and T-SQL also have some slightly different command key words. T-SQL also features functions that are not part of regular SQL.
An example of this is how in we select the top *X* number of rows. In standard SQL, we would use the LIMIT keyword. In T-SQL, we use the TOP keyword.

Difference #5
Finally, and as referenced before, T-SQL offers functionality that does not appear in regular SQL. One example is the ISNULL function. This will replace NULL values coming from a specific column. The below would return an age of "0" for any rows that have a value of NULL in the age column.

Variables in SQL Server:

What is a variable

A variable is an object that holds a single value of a specific type e.g., integer, date, or varying character string.

We typically use variables in the following cases:

- As a loop counter to count the number of times a loop is performed.
- To hold a value to be tested by a control-of-flow statement such as WHILE.
- To store the value returned by a stored procedure or a function

Declaring a variable

To declare a variable, you use the DECLARE statement. For example, the following statement declares a variable named @model_year:

```
DECLARE @model_year AS SMALLINT;
```

We can declare as many variables inside the script:

```
        DECLARE @model_year SMALLINT,
                @product_name VARCHAR(MAX);
```

Assigning a value to a variable

To assign a value to a variable, you use the SET statement. For example, the following statement assigns 2018 to the @model_year variable:

```
        SET @model_year = 2018;
```

Using variables in a query

The following SELECT statement uses the @PaymentAmount variable in the WHERE clause to find the customers who pays less than 5000 payment amount.

```
DECLARE @PaymentAmount SMALLINT;

SET @PaymentAmount = 5000;


SELECT
   cust_name,
   AGENT_CODE,
   OPENING_AMT,
          PAYMENT_AMT
FROM
   CUSTOMER
WHERE
   PAYMENT_AMT < @PaymentAmount
ORDER BY
   AGENT_CODE;
```

Temporary Tables in SQL Server:

Temporary tables are tables that exist temporarily on the SQL Server.
The temporary tables are useful for storing the immediate result sets that are accessed multiple times.

Temporary tables are very similar to normal tables in SQL Server with some limitations:
The name of the temporary table starts with a hash symbol (#). (Example #Employee)
These temporary tables are get stored in TempDb system database.

Creating temporary tables:

SQL Server provided two ways to create temporary tables via SELECT INTO and CREATE TABLE statements.

Create temporary tables using **SELECT INTO** statement

The first way to create a temporary table is to use the SELECT INTO statement as shown below:

```
        SELECT
                select_list
        INTO
                #temporary_table
        FROM
                 table_name
        Where Condition
```

Create temporary tables using **CREATE TABLE** statement

```
CREATE TABLE #haro_products (
    product_name VARCHAR(MAX),
    list_price DEC(10,2)
);
```

This statement has the same syntax as creating a regular table. However, the name of the temporary table starts with a hash symbol (#)
After creating the temporary table, you can insert data into this table as a regular table:

Example:

```
SELECT AGENT_CODE, AGENT_NAME, WORKING_AREA INTO #AgentData FROM AGENTS

SELECT * FROM  #AgentData
```

Temporary Tables are most likely as Permanent Tables. Temporary Tables are Created in TempDB and are automatically deleted as soon as the last connection is terminated. Temporary Tables helps us to store and process intermediate results. Temporary tables are very useful when we need to store temporary data. The Syntax to create a Temporary Table is given below:

To Create Temporary Table:

```
CREATE TABLE #EmpDetails (id INT, name VARCHAR(25))
```

To Insert Values Into Temporary Table:

```
INSERT INTO #EmpDetails VALUES (01, 'Lalit'), (02, 'Atharva')
```

To Select Values from Temporary Table:

```
SELECT * FROM #EmpDetails
```

There are 2 types of Temporary Tables: Local Temporary Table, and Global Temporary Table. These are explained as following below.

Local Temporary Table:

A Local Temp Table is available only for the session that has created it. It is automatically dropped (deleted) when the connection that has created it, is closed. To create Local Temporary Table Single “#” is used as the prefix of a table name.
Also, the user can drop this temporary table by using the “DROP TABLE #EmpDetails” query.
If the Temporary Table is created inside the stored procedure, it get dropped automatically upon the completion of stored procedure execution.

Example:

```
CREATE TABLE #EmpDetails
INSERT INTO #EmpDetails VALUES ( 01, 'Lalit'), ( 02, 'Atharva')
SELECT * FROM #EmpDetails
```

Global Temporary Table:

To create a Global Temporary Table, add the “##” symbol before the table name.
Global Temporary Tables are visible to all connections and dropped when the connection who created the table is closed.

Example:

```
CREATE TABLE ##EmpDetails (id INT, name VARCHAR(25))
SELECT * FROM ##EmpDetails
```

Table Variables in SQL Server:

The table variable is a special type of the local variable that helps to store data temporarily, similar to the temp table in SQL Server. In fact, the table variable provides all the properties of the local variable, but the local variables have some limitations, unlike temp or regular tables.

The following syntax describes how to declare a table variable:

```
DECLARE @LOCAL_TABLEVARIABLE AS TABLE
      (column_1 DATATYPE,
       column_2 DATATYPE,
       column_N DATATYPE)
```

If we want to declare a table variable, we have to start the DECLARE statement which is similar to local variables. The name of the local variable must start with at(@) sign. The TABLE keyword specifies that this variable is a table variable. After the TABLE keyword, we have to define column names and datatypes of the table variable in SQL Server.

In the following example, we will declare a table variable and insert the days of the week and their abbreviations to the table variable:

```
DECLARE @ListOWeekDays TABLE(DyNumber INT,DayAbb VARCHAR(40) , WeekName VARCHAR(40))

INSERT INTO @ListOWeekDays
VALUES
(1,'Mon','Monday')  ,
(2,'Tue','Tuesday') ,
(3,'Wed','Wednesday') ,
(4,'Thu','Thursday'),
(5,'Fri','Friday'),
(6,'Sat','Saturday'),
(7,'Sun','Sunday')

SELECT * FROM @ListOWeekDays
```

What is the storage location of the table variables?

The lifecycle of the table variables starts in the declaration point and ends at the end of the batch. As a result, the table variable in SQL Server is automatically dropped at the end of the batch.

- You can update, delete data into table variable.
- Once declared, structure of table can't change using alter command.
- Truncate will not work on table variables.
- Can not insert data into table variables using Inert into select command.

Differences:

Temp Table (#)	Table Variable (@)
The temp table can be part of Transaction.	The table variable does not have any effect on the Transaction.
Temp table can have a clustered or non clustered index.	Table variable can have only clustered index.

It allows you **SELECT INTO** statements to insert data from the existing table.	It does not allow you **SELECT INTO** statements to insert data from the existing table.
Temp table can be accessed in nested stored procedure. For example you are working on stored procedure A, from stored proc A you are calling stored proc B. The temp table created in stored proc A can be accessed in stored proc B.	Table variable cannot be accessed in the nested stored procedure.
Temp table allows **TRUNCATE** or **ALTER** table statements.	Table variable does not allow **TRUNCATE** or **ALTER** table statements.
Temp table cannot be used in Used defined functions.	Table variable can be used in User defined functions.

IF-Else statement in SQL Server:

The IF...ELSE statement is a control-flow statement that allows you to execute or skip a statement block based on a specified condition.

The IF statement

The following illustrates the syntax of the IF statement:

```
IF boolean_expression
BEGIN
    statement_block
END
```

In this syntax, if the Boolean_expression evaluates to TRUE then the statement_block in the BEGIN...END block is executed. Otherwise, the statement_block is skipped and the control of the program is passed to the statement after the END keyword.
Note that if the Boolean expression contains a SELECT statement, you must enclose the SELECT statement in parentheses.

The following example first gets the sales amount from the AgentOrders table and then prints out a message if the sales amount is greater than 1 million

```
BEGIN
   DECLARE @sales INT;

   SELECT
      @sales = SUM(ORD_AMOUNT + ADVANCE_AMOUNT)
   FROM
      AgentORDERS
   WHERE
      month(ORD_DATE) = 07

   --SELECT @sales;

   IF @sales > 1000
   BEGIN
      PRINT 'Great! The sales amount in 2018 is greater than 1,000,000';
   END
```

```
END
```

The IF ELSE statement

When the condition in the IF clause evaluates to FALSE and you want to execute another statement block, you can use the ELSE clause.
The following illustrates the IF ELSE statement:

```
IF Boolean_expression
BEGIN
    -- Statement block executes when the Boolean expression is TRUE
END
ELSE
BEGIN
    -- Statement block executes when the Boolean expression is FALSE
END
```

Each IF statement has a condition. If the condition evaluates to TRUE then the statement block in the IF clause is executed. If the condition is FALSE, then the code block in the ELSE clause is executed.

See the following example:

```
BEGIN
    DECLARE @sales INT;

    SELECT    @sales = SUM(ORD_AMOUNT + ADVANCE_AMOUNT)   FROM     AgentORDERS
    WHERE  month(ORD_DATE) = 07

    --SELECT @sales;

    IF @sales > 100000
    BEGIN
        PRINT 'Great! The sales amount in 2018 is greater than 100000';
    END
          Else
          BEGIN
                   PRINT 'Sales amount in July did not reach 100000';
          END
END
```

Stored Procedures in SQL Server

A stored procedure is a prepared SQL code that you can save, so the code can be reused over and over again.
So if you have an SQL query that you write over and over again, save it as a stored procedure, and then just call it to execute it.
You can also pass parameters to a stored procedure, so that the stored procedure can act based on the parameter value(s) that is passed.

You can find the stored procedure in the Object Explorer, under **Programmability > Stored Procedures**

What are the Benefits of using a Stored Procedure in SQL?

Stored procedures provide some crucial benefits, which are:

- Reusable: As mentioned, multiple users and applications can easily use and reuse stored procedures by merely calling it.
- Easy to modify: You can quickly change the statements in a stored procedure as and when you want to, with the help of the ALTER proc command.
- Security: Stored procedures allow you to enhance the security of an application or a database by restricting the users from direct access to the table.
- Low network traffic: The server only passes the procedure name instead of the whole query, reducing network traffic.
- Increases performance: Upon the first use, a plan for the stored procedure is created and stored in the buffer pool for quick execution for the next time.

Stored Procedure Syntax:

```
CREATE PROCEDURE procedure_name
AS
Begin
  sql_statement (Code/Calculations as per project requirement)
End
```

Execute/Run a Stored Procedure

```
EXEC procedure_name

EXECute procedure_name
```

In the syntax mentioned above, the only thing to note here are the parameters, which can be the following three types:

- IN: It is the default parameter that will receive input value from the program
- OUT: It will send output value to the program
- IN OUT: It is the combination of both IN and OUT. Thus, it receives from, as well as sends a value to the program

We can write stored procedures for Select, Insert, Update, Delete functionalities & critical calculations.

Parameters are used to exchange data between stored procedures and functions and the application or tool that called the stored procedure or function: Input parameters allow the caller to pass a data value to the stored procedure or function.

A **variable** is an object that holds a single value of a specific type e.g., integer, date, or varying character string.

```
CREATE PROCEDURE Get_AgentData
@AgentId VARCHAR(20)
As

Begin
        SET NOCOUNT ON
        Select * from AGENTS A
        INNER JOIN CUSTOMER C
        ON A.AGENT_CODE=C.AGENT_CODE
        WHERE A.AGENT_CODE=@AgentId

End

EXEC Get_AgentData 'A009'
```

We can modify stored procedure using alter command.

```
Alter Proc Proc_Name
@Parameters
As
( Begin

 End)
```

Also to rename proc we have system stored procedure sp_Rename

```
Exec sp_Rename ‘OldName’, ’New Name’
```

To delete procedure use DROP Proc “ProcName” command

Stored Procedure with Input Parameters:

Consider the following stored procedure example with the input parameters.

```
CREATE PROCEDURE uspUpdateEmpSalary
(
   @empId int
   ,@salary money
)
AS
BEGIN
  UPDATE dbo.Employee
  SET Salary = @salary
  WHERE EmployeeID = @empId
END
```

In the above stored procedure uspUpdateEmpSalary, the @empId and @Salary are INPUT parameters. By default, all the parameters are INPUT parameters in any stored procedure unless suffix with OUTPUT keyword. @empId is of int type and @salary is of money data type. You pass the INPUT parameters while executing a stored procedure, as shown below.

```
EXEC dbo.uspUpdateEmpSalary @EmpId = 4, @Salary = 25000
-- or
EXEC dbo.uspUpdateEmpSalary 4, 25000
```

OUTPUT Parameters:

The OUTPUT parameter is used when you want to return some value from the stored procedure. The calling program must also use the OUTPUT keyword while executing the procedure.
The following stored procedure contains INPUT and OUTPUT parameters.

```
CREATE PROCEDURE uspGetManagerID
  @empId int,
  @managerId int OUTPUT
AS
BEGIN
  SELECT @managerId = ManagerID
  FROM dbo.Employee
  WHERE EmployeeID = @empId
END
```

In the above uspGetManagerID stored procedure, @manageId is an OUTPUT parameter. The value will be assigned in the stored procedure and returned to the calling statement. The following pass the OUTPUT parameter while executing the stored procedure.

```
DECLARE @managerID int

EXECUTE uspGetManagerID @empId = 2, @managerId OUTPUT

PRINT @managerId
```

Above, the uspGetManagerID is called by passing INPUT parameter @employeeID = 2 and @managerID OUTPUT as the output parameter. Notice that we have not assigned any value to an OUTPUT variable @managerID and also specified the OUTPUT keyword.

There are a total of three methods of returning data from a stored procedure: OUTPUT parameter, result sets, and return codes.

Result sets: If the body of the stored procedure has a SELECT statement, then the rows returned by the select statement are directly returned to the client.

Return code: A stored procedure can return an integer value called the Return code which will indicate the execution status of the procedure. You specify the return code using the RETURN keyword in the procedure.

Optional Parameters

SQL Server allows you to specify the default values for parameters. It allows you to skip the parameters that have default values when calling a stored procedure.
The default value is used when no value is passed to the parameter or when the DEFAULT keyword is specified as the value in the procedure call.
Specify the default value when you declare parameters, as shown below.

```
CREATE PROCEDURE uspUpdateEmpSalary
(
    @empId int
   ,@salary money = 1000
)
```

```
AS
BEGIN
   UPDATE dbo.Employee
   SET Salary = @salary
   WHERE EmployeeID = @empId
END
```

Above, @empsalary money = 0 declares @salary parameter and assigns the default value. Now, you can call the above procedure without passing @salary parameter, as shown below.

```
EXEC uspUpdateEmpSalary 4
```

The above statement will update the Salary column with the default value 1000 for the EmployeeID 4. Thus, making @salary parameter as optional.

Useful System Stored Procedures:

1. sp_depends: sp_depends is a system stored procedure that displays information about all object types (e.g. procedures, tables, etc) that depend on the object specified in the input parameter as well as all objects that the specified object depends on.

   Sample Call:

   ```
   EXEC sp_depends tablename
   EXEC sp_depends procname

   EXEC sp_depends uspUpdateEmpSalary
   EXEC sp_depends uspGetEmpDept
   ```

2. sp_help: On Transact SQL language the sp_help is part of Database Engine Stored Procedures and reports information about a database object or a data type.

Sp_help example 1:

```
EXEC sp_help;
```

Sp_help example 2:

```
EXEC sp_help 'students';
```

Error Handling in SQL Server:

With the introduction of Try/Catch blocks in SQL Server 2005, error handling in sql server, is now similar to programming languages like C#, and java. Before understanding error handling using try/catch, let's step back and understand how error handling was done in SQL Server 2000, using system function **@@Error**. Sometimes, system functions that begin with two at signs (@@), are called as global variables. They are not variables and do not have the same behaviours as variables, instead they are very similar to functions.

The **RAISERROR** statement allows you to generate your own error messages and return these messages back to the application using the same format as a system error or warning message generated by SQL Server Database Engine. In addition, the RAISERROR statement allows you to set a specific message id, level of severity, and state for the error messages.

Syntax: RAISEERROR('Message Text',Severity,State)

Severity

The severity level is an integer between 0 and 25, with each level representing the seriousness of the error.
0–10 Informational messages
11–18 Errors
19–25 Fatal errors

State

The state is an integer from 0 through 255. If you raise the same user-defined error at multiple locations, you can use a unique state number for each location to make it easier to find which section of the code is causing the errors. For most implementations, you can use 1.

```
BEGIN TRY
	Insert into tblProduct values(1, 'Laptops', 3000, 150)
END TRY
BEGIN CATCH
	DECLARE @ErrorMessage VARCHAR(500)

	SET @ErrorMessage=ERROR_MESSAGE()
	RAISERROR(@ErrorMessage,16,1)

END CATCH
```

You can take advantage of various functions inside the CATCH block to get detailed information about an error. These functions include the following:

- ERROR_MESSAGE() - you can take advantage of this function to get the complete error message.
- ERROR_LINE() - this function can be used to get the line number on which the error occurred.
- ERROR_NUMBER() - this function can be used to get the error number of the error.
- ERROR_SEVERITY() - this function can be used to get the severity level of the error.
- ERROR_STATE() - this function can be used to get the state number of the error.
- ERROR_PROCEDURE() - this function can be used to know the name of the stored procedure or trigger that has caused the error.

Now let's create **tblProduct** and **tblProductSales**, that we will be using for the rest of this demo.

SQL script to create tblProduct

```
Create Table tblProduct
(
 ProductId int NOT NULL primary key,
 Name nvarchar(50),
 UnitPrice int,
 QtyAvailable int
)
```

SQL script to load data into tblProduct

```
Insert into tblProduct values(1, 'Laptops', 3000, 150), (2, 'Desktops', 3500, 120), (2, 'TV', 2900, 110)
```

SQL script to create tblProductSales

```
Create Table tblProductSales
(
```

```sql
 ProductSalesId int primary key,
 ProductId int,
 QuantitySold int
)
```

Now consider the following code snippet that illustrates how an error generated inside a TRY block is handled in the CATCH block and the relevant error metadata displayed.

```sql
BEGIN TRY
        Insert into tblProduct values(1, 'Laptops', 3000, 150)
END TRY
BEGIN CATCH
  SELECT ERROR_MESSAGE() AS [Error Message]
      ,ERROR_LINE() AS ErrorLine
      ,ERROR_NUMBER() AS [Error Number]
      ,ERROR_SEVERITY() AS [Error Severity]
      ,ERROR_STATE() AS [Error State]
END CATCH
```

Stored procedure - usp_SellProduct, has 2 parameters - **@ProductId** and **@QuantityToSell**. @ProductId specifies the product that we want to sell, and @QuantityToSell specifies, the quantity we would like to sell

```sql
Create Procedure usp_SellProduct
@ProductId int,
@QuantityToSell int
as
Begin
        -- Check the stock available, for the product we want to sell
        Declare @StockAvailable int
        Select @StockAvailable = QtyAvailable
        from tblProduct where ProductId = @ProductId

        -- Throw an error to the calling application, if enough stock is not available
        IF(@StockAvailable < @QuantityToSell)
        Begin
                Raiserror('Not enough stock available',16,1)
        End
        -- If enough stock available
        Else
        Begin
          Begin Tran
              -- First reduce the quantity available
                                Update tblProduct set QtyAvailable = (QtyAvailable - @QuantityToSell)
                                where ProductId = @ProductId

                                Declare @MaxProductSalesId int
         -- Calculate MAX ProductSalesId
                                Select @MaxProductSalesId = Case When
             MAX(ProductSalesId) IS NULL
             Then 0 else MAX(ProductSalesId) end
            from tblProductSales
         -- Increment @MaxProductSalesId by 1, so we don't get a primary key violation
                                Set @MaxProductSalesId = @MaxProductSalesId + 1
                                Insert into tblProductSales values(@MaxProductSalesId, @ProductId, @QuantityToSell)
          Commit Tran
         End
End
```

```
Exec usp_SellProduct 1,10
–-There will not be any error. And operations in both the table will complete without any error.
```

In above stored proc try to insert some error. We can do that by commenting line where we are setting value in variable @ MaxProductSalesId, if we comment this line & alter proc.

Now if we execute above call again as below: it will throw error due to Primary key violation in tblProductSales table.

```
Exec usp_SellProduct 1,10
```

Here table @tblProduct will get updated but data insertion will fail in table tblProductSales. Which in turn leads to inaccurate data. To overcome this, we must capture error & if any code inside transaction fails all the transaction should be rolled back.

SQL Server was using Try-Catch block to capture any error.

Syntax:

```
BEGIN TRY
   { Any set of SQL statements }
END TRY
BEGIN CATCH
   [ Optional: Any set of SQL statements ]
END CATCH
[Optional: Any other SQL Statements]
```

Any set of SQL statements, that can possibly throw an exception are wrapped between BEGIN TRY and END TRY blocks. If there is an exception in the TRY block, the control immediately, jumps to the CATCH block. If there is no exception, CATCH block will be skipped, and the statements, after the CATCH block are executed.

Errors trapped by a CATCH block are not returned to the calling application. If any part of the error information must be returned to the application, the code in the CATCH block must do so by using RAISERROR() function.

1. **In procedure spSellProduct**, Begin Transaction and Commit Transaction statements are wrapped between Begin Try and End Try block. If there are no errors in the code that is enclosed in the TRY block, then COMMIT TRANSACTION gets executed and the changes are made permanent. On the other hand, if there is an error, then the control immediately jumps to the CATCH block. In the CATCH block, we are rolling the transaction back. So, it's much easier to handle errors with Try/Catch construct than with @@Error system function.

2. Also notice that, in the scope of the CATCH block, there are several system functions, that are used to retrieve more information about the error that occurred, these functions return NULL if they are executed outside the scope of the CATCH block.

3. TRY/CATCH cannot be used in a user-defined functions.

```
Create Procedure spSellProduct
@ProductId int,
@QuantityToSell int
as
Begin
        Declare @StockAvailable int
        Select @StockAvailable = QtyAvailable
        from tblProduct where ProductId = @ProductId

        if(@StockAvailable < @QuantityToSell)
          Begin
                Raiserror('Not enough stock available',16,1)
          End
        Else
```

```
    Begin
        Begin Try
            Begin Transaction
                Update tblProduct set QtyAvailable = (QtyAvailable - @QuantityToSell)
                where ProductId = @ProductId

                Declare @MaxProductSalesId int
                Select @MaxProductSalesId = Case When MAX(ProductSalesId) IS NULL
                                                Then 0 else MAX(ProductSalesId)
                                                end
                from tblProductSales

                Set @MaxProductSalesId = @MaxProductSalesId + 1

                Insert into tblProductSales values(@MaxProductSalesId, ProductId,@QuantityToSell)
            Commit Transaction
        End Try
        Begin Catch
            Rollback Transaction
            Select
             ERROR_NUMBER() as ErrorNumber,
             ERROR_MESSAGE() as ErrorMessage,
             ERROR_PROCEDURE() as ErrorProcedure,
             ERROR_STATE() as ErrorState,
             ERROR_SEVERITY() as ErrorSeverity,
             ERROR_LINE() as ErrorLine
        End Catch
    End
End
```

Earlier version of SQL server was using @@Error system function to capture the error.
Note: @@ERROR is cleared and reset on each statement execution. Check it immediately following the statement being verified, or save it to a local variable that can be checked later.

In **tblProduct** table, we already have a record with **ProductId = 2**. So the insert statement causes a primary key violation error. @@ERROR retains the error number, as we are checking for it immediately after the statement that cause the error.

```
Insert into tblProduct values(2, 'Mobile Phone', 1500, 100)
if(@@ERROR <> 0)
 Print 'Error Occurred'
Else
 Print 'No Errors'
```

On the other hand, when you execute the code below, you get message **'No Errors'** printed. This is because the @@ERROR is cleared and reset on each statement execution.

```
Insert into tblProduct values(2, 'Mobile Phone', 1500, 100)
--At this point @@ERROR will have a NON ZERO value
Select * from tblProduct
--At this point @@ERROR gets reset to ZERO, because the
--select statement successfullyexecuted
if(@@ERROR <> 0)
 Print 'Error Occurred'
Else
 Print 'No Errors'
```

In this example, we are storing the value of @@Error function to a local variable, which is then used later.

```
Declare @Error int
Insert into tblProduct values(2, 'Mobile Phone', 1500, 100)
Set @Error = @@ERROR
Select * from tblProduct
if(@Error <> 0)
 Print 'Error Occurred'
Else
 Print 'No Errors'
```

Database→Programmability→Stored Procedures

Functions in SQL Server:

Functions in SQL Server are the database objects that contains a **set of SQL statements to perform a specific task**. A function accepts input parameters, perform actions, and then return the result. We should note that functions always return either a single value or a table. The main purpose of functions is to replicate the common task easily. We can build functions one time and can use them in multiple locations based on our needs. SQL Server does not allow to use of the functions for inserting, deleting, or updating records in the database tables.

The following are the rules for creating SQL Server functions:

- A function must have a name, and the name cannot begin with a special character such as @, $, #, or other similar characters.
- SELECT statements are the only ones that operate with functions.
- We can use a function anywhere such as AVG, COUNT, SUM, MIN, DATE, and other functions with the SELECT query in SQL.
- Whenever a function is called, it compiles.
- Functions must return a value or result.
- Functions use only input parameters.
- We cannot use TRY and CATCH statements in functions.

Types of Functions

SQL Server categorizes the functions into two types:

- System Functions
- User-Defined Functions

Let us describe both types in detail.

System Functions

Functions that are defined by the system are known as system functions. In other words, all the **built-in functions** supported by the server are referred to as System functions. The built-in functions save us time while performing the specific task. These types of functions usually work with the SQL SELECT statement to calculate values and manipulate data.

Here is the list of some system functions used in the SQL Server:

- String Functions (LEN, SUBSTRING, REPLACE, CONCAT, TRIM)
- Date and Time Functions (datetime, datetime2, smalldatetime)
- Aggregate Functions (COUNT, MAX, MIN, SUM, AVG)
- Mathematical Functions (ABS, POWER, SQUARE, SQRT, LOG)
- Ranking Functions (RANK, DENSE_RANK, ROW_NUMBER, NTILE)

You can find system functions in SSMS as below path:
Database→Programmability→Functions→System Functions

Ranking or Window Functions in SQL Server:

The Ranking functions in SQL Server return a ranking value for each row in a partition. Microsoft provides various Functions which allow us to assign different ranks. Depending on the function you select, they return a different number. The following table will show you the list of available Ranking Functions.

Functions	Description
Row_Number()	It will assign the sequential number to each unique record present in a partition.
Rank()	It will assign the rank number to each record present in a partition.
Dense_Ranke()	It will assign the number to each record within a partition without skipping the numbers.
NTILE	This will assign the number to each record present in a partition.
Lag and Lead	It can often be useful to compare rows to preceding or following rows,

SQL ROW_NUMBER

The ROW_NUMBER Function is one of the Ranking functions. This SQL Server row_number function assigns the sequential rank number to each unique record present in a partition.
If the SQL Server ROW_NUMBER function encounters two equal values in the same partition, it will assign the different rank numbers to both values. Here rank numbers will depend upon the order they are displayed.

The syntax of the ROW_NUMBER Function is:

```
SELECT ROW_NUMBER() OVER (PARTITION_BY_Clause ORDER_BY_Clause) FROM [Source]
```

Partition_By_Clause: Divide the records into partitions.

- If you specify the Partition By Clause, ROW_NUMBER Function will assign the rank number to each partition.
- If you haven't defined the Partition By, the Function will consider all the records as a single partition. So, it will assign the rank numbers from top to bottom.

ROW_NUMBER functions without Partition_By clause:

```
SELECT Studentname, Subject, Marks, ROW_NUMBER() OVER(ORDER BY Marks) RowNumber
FROM ExamResult;
```

By default, it sorts the data in ascending order and starts assigning ranks for each row. In the result, we get ROW number 1 for marks 50.
We can specify descending order with Order By clause, and it changes the RANK accordingly.
In the result we can see each row has given a sequential rank starting from 1.

ROW_NUMBER functions with Partition_By clause:

```
SELECT Studentname, Subject, Marks, ROW_NUMBER() OVER(PARTITION BY StudentName ORDER BY Marks)
RowNumber
FROM ExamResult;
```

When we use partition by, SQL will give sequential rank to each row in partition.

RANK() SQL RANK Function

The SQL RANK function will assign the rank number to each record present in a partition. If the SQL Server RANK function encounters two equal values in the same partition, then it will assign the same number to both values. And it skips the next number.

Syntax:

```
SELECT RANK() OVER (PARTITION_BY_Clause ORDER_BY_Clause) FROM [Source]
```

RANK functions without Partition_By clause:

```
SELECT Studentname, Subject, Marks, RANK() OVER(ORDER BY Marks) Rank FROM ExamResult;
```

RANK functions with Partition_By clause:

```
SELECT Studentname, Subject, Marks, RANK() OVER(PARTITION BY StudentName ORDER BY Marks) Rank FROM
ExamResult;
```

SQL DENSE_RANK Function

The SQL DENSE_RANK Function is one of the Ranking functions. The Sql Server DENSE_RANK function will assign the rank number to each record present in a partition without skipping the rank numbers.
If the DENSE_RANK function encounters two equal values in the same partition, it will assign the same rank number to both values. In this article, we will show you, How to write Sql DENSE_RANK Function with an example.

Syntax:

```
SELECT DENSE_RANK() OVER (PARTITION_BY_Clause ORDER_BY_Clause) FROM [Source]
```

```
-- DENSE_RANK functions without Partition_By clause:
SELECT Studentname, Subject, Marks, dense_RANK() OVER(ORDER BY Marks) DenseRank FROM ExamResult;

-- DENSE_RANK functions with Partition_By clause:
SELECT Studentname, Subject, Marks, dense_RANK() OVER(PARTITION BY StudentName ORDER BY Marks)
DenseRank FROM ExamResult;
```

SQL NTILE Function

The SQL Server NTILE Function is one of the ranking functions. This NTILE function will assign the rank number to each record present in a partition, and the syntax of it is:

```
SELECT NTILE(Interger_Value) OVER (PARTITION_BY_Clause ORDER_BY_Clause)
FROM [Source]
```

Integer_Value: It will use this integer value to decide the number of ranks it has to assign for each partition. For instance, If we specify 2, the NTILE Function will assign 2 rank numbers for each category.

```
-- NTILE functions without Partition_By clause:
SELECT Studentname, Subject, Marks, NTILE(2) OVER(ORDER BY Marks) DenseRank FROM ExamResult;

--NTILE functions with Partition_By clause:
SELECT Studentname, Subject, Marks, NTILE(2) OVER(PARTITION BY StudentName ORDER BY Marks) DenseRank
FROM ExamResult;
```

SQL Server User-defined Functions

In this section, you will learn about SQL Server user-defined functions including scalar-valued functions which return a single value and table-valued function which return rows of data.
The SQL Server user-defined functions help you simplify your development by encapsulating complex business logic and make them available for reuse in every query.

1. User Defined Functions in SQL Server
2. Types of User Defined Functions
3. Creating a Scalar User Defined Function
4. Calling a Scalar User Defined Function
5. Places where we can use Scalar User Defined Function
6. Altering and Dropping a User Defined Function

In SQL Server there are 3 types of User Defined functions

1. Scalar functions
2. Inline table-valued functions
3. Multi statement table-valued functions

Scalar functions may or may not have parameters, but always return a single (scalar) value. The returned value can be of any data type, except **text, ntext, image, cursor, and timestamp**.

1. Scalar Functions:

To create a function, we use the following syntax: (Scalar function will always return a single value)

```
CREATE FUNCTION Function_Name(@Parameter1 DataType, @Parameter2 DataType,..@Parametern Datatype)
RETURNS Return_Datatype
AS
BEGIN
   Function Body
   Return Return_Datatype
END
```

Let us now create a function which calculates and returns the age of a person. To compute the age we require, date of birth. So, let's pass date of birth as a parameter. So, AGE() function returns an integer and accepts date parameter.

```
CREATE FUNCTION Age(@DOB Date)
RETURNS INT
AS
BEGIN
            DECLARE @Age INT
            SET @Age = DATEDIFF(YEAR, @DOB, GETDATE()) - CASE WHEN (MONTH(@DOB)
               > MONTH(GETDATE())) OR (MONTH(@DOB) = MONTH(GETDATE()) AND DAY(@DOB)
            > DAY(GETDATE())) THEN 1 ELSE 0 END
RETURN @Age
END
```

When calling a scalar user-defined function, you must supply a two-part name, **OwnerName.FunctionName**. **dbo** stands for database owner.

```
Select dbo.Age ('10/08/1982')
```

You can also invoke it using the complete 3 part name, DatabaseName.OwnerName.FunctionName.

```
Select SampleDB.dbo.Age('10/08/1982')
```

Scalar user defined functions can be used in the Select clause as shown below.

```
Select EmployeeNo,LastName,Department, dbo.Age(dob) as Age from EmpSalary
```

Scalar user defined functions can be used in the Where clause, as shown below.

```
Select EmployeeNo,LastName,Department,dbo.Age(DOB) as Age
from EmpSalary Where dbo.Age(DOB) > 30
```

A stored procedure also can accept DateOfBirth and return Age, but you cannot use stored procedures in a **select or where clause**. This is just one difference between a function and a stored procedure. There are several other differences, which we will talk about in a later session.

To alter a function we use ALTER FUNCTION FuncationName statement and to delete it, we use DROP FUNCTION FuncationName.

2. Inline Table Valued Functions

A scalar function, returns a **single** value. on the other hand, an Inline Table Valued function, return a **table**.

Syntax for creating an inline table valued function

```
CREATE FUNCTION Function_Name(@Param1 DataType, @Param2 DataType..., @ParamN DataType)
RETURNS TABLE
AS
RETURN (Select_Statement)
```

```
CREATE FUNCTION fn_EmployeesByGender(@Gender nvarchar(10))
RETURNS TABLE
AS
RETURN (Select Id, Name, DateOfBirth, Gender, DepartmentId
    from tblEmployees
    where Gender = @Gender)
```

If you look at the way we implemented this function, it is very similar to SCALAR function, with the following differences

1. We specify **TABLE** as the return type, instead of any **scalar** data type
2. The **function body** is not enclosed between **BEGIN and END** block. Inline table valued function body, cannot have BEGIN and END block.
3. The **structure of the table** that gets returned, is determined by the SELECT statement with in the function.

Calling the user defined function

```
Select * from fn_EmployeesByGender('Male')
```

As the inline user defined function, is returning a table, issue the select statement against the function, as if you are selecting the data from a TABLE.

Where can we use Inline Table Valued functions

1. Inline Table Valued functions can be used to achieve the functionality of parameterized views. We will talk about views, in a later session.
2. The table returned by the table valued function, can also be used in joins with other tables.

Consider the Departments Table

Joining the Employees returned by the function, with the Departments table

```
Select Name, Gender, Dept_name
from fn_EmployeesByGender('Male') E
Join Department D on D.Dept_id = E.DepartmentId
```

3. Multi Statement Table Valued Functions

Multi statement table valued functions are very similar to Inline Table valued functions, with a few differences. Let's look at an example, and then note the differences.

Let's write an Inline and multi-statement Table Valued functions that can return the Id, Name & DOB from employees table in output

Inline Table Valued function(ILTVF):

```
Create Function fn_ILTVF_GetEmployees()
Returns Table
as
Return (Select Id, Name, Cast(DateOfBirth as Date) as DOB
     From tblEmployees)
```

Multi-statement Table Valued function(MSTVF):

```
Create Function fn_MSTVF_GetEmployees()
Returns @Table Table (Id int, Name varchar(20), DOB Date)
as
Begin
 Insert into @Table
 Select Id, Name, Cast(DateOfBirth as Date)
 From tblEmployees

 Return
End
```

Calling the Inline Table Valued Function:

```
Select * from fn_ILTVF_GetEmployees()
```

Calling the Multi-statement Table Valued Function:

```
Select * from fn_MSTVF_GetEmployees()
```

Now let's understand the differences between Inline Table Valued functions and Multi-statement Table Valued functions

1. In an Inline Table Valued function, the RETURNS clause cannot contain the structure of the table, the function returns. Where as, with the multi-statement table valued function, we specify the structure of the table that gets returned
2. Inline Table Valued function cannot have BEGIN and END block, where as the multi-statement function can have.
3. Inline Table valued functions are better for performance, than multi-statement table valued functions. If the given task, can be achieved using an inline table valued function, always prefer to use them, over multi-statement table valued functions.
4. It's possible to update the underlying table, using an inline table valued function, but not possible using multi-statement table valued function.

Updating the underlying table using inline table valued function:

This query will change **Sam** to **Sam1**, in the underlying table **tblEmployees**. When you try do the same thing with the multi-statement table valued function, you will get an error stating 'Object 'fn_MSTVF_GetEmployees' cannot be modified.'

```
Update fn_ILTVF_GetEmployees() set Name='Sam1' Where Id = 1
```

Reason for improved performance of an inline table valued function:

Internally, SQL Server treats an inline table valued function much like it would a view and treats a multi-statement table valued function similar to how it would a stored procedure.

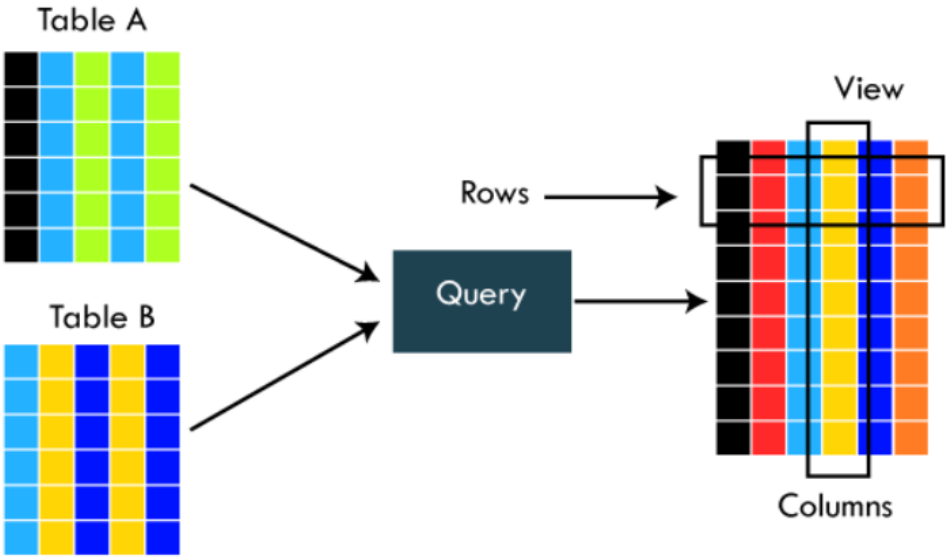
Key Differences between SQL server store procedure and function.

Let's discuss some of the major **differences between SQL server store procedure and function**.

Stored Procedures	**Functions**
A stored procedure in SQL Server can have input as well as output parameters.	A function, on the other hand, can only have input parameters.
A stored procedure can return numerous parameters	A function can only return one value or defined table
Stored procedure may or may not return value (it is optional)	A function in SQL Server must return a value
We cannot use a procedure in a function	We can use a function within a stored procedure
We can handle errors in a stored procedure by using the TRY-CATCH block	We cannot use TRY-CATCH in functions
We can use SELECT as well as DML (INSERT/UPDATE /DELETE) statements in a stored procedure	We can only use SELECT statements within a function, as DML statements are not supported in functions
We cannot use a stored procedure in a SELECT statement	We can easily use functions in a SELECT statement
A procedure is not supported to be used in WHERE/HAVING/SELECT statements	We can use the functions in WHERE/HAVING/SELECT section
We can use the transactions in the stored procedure	We cannot use it in functions

View in SQL Server

A view is a database object that has no values. **It is a virtual table, which is created according to the result set of an SQL query**. However, it looks similar to an actual table containing rows and columns. Therefore, we can say that its contents are based on the base table. It is operated similarly to the base table but does not contain any data of its own. **Its name is always unique, like tables**. The views differ from tables as they are definitions that are created on top of other tables (or views). If any changes occur in the underlying table, the same changes reflected in the views also.



Types Of Views:

1. User-Defined Views

Users define these views to meet their specific requirements. It can also divide into two types one is the simple view, and another is the complex view. The **simple view** is based on the single base table without using any complex queries. The **complex view** is based on more than one table along with group by clause, order by clause, and join conditions.

2. System-Defined Views

System-defined views are predefined and existing views stored in SQL Server, such as Tempdb, Master, and temp. Each system views has its own properties and functions. They can automatically attach to the user-defined databases. We can divide the System-defined views in SQL Server into three types: Information Schema, Catalog View, and Dynamic Management View.

Syntax for Views:

Create View ViewName
AS
Select statement

Let's understand views with an example. We will base all our examples on **tblEmployees** and **tblDepartment** tables.

Now, let's write a Query which returns Id,Name,Salary,Gender,DepartmentName in output:

```
Select E.Id, E.Name, E.Salary, E.Gender, D.DeptName from tblEmployees E
join tblDepartment D on E.DepartmentId = D.DeptId
```

Now let's create a view, using the JOINS query, we have just written.

```
Create View vWEmployeesByDepartment
as
Select Id, Name, Salary, Gender, DeptName from tblEmployees
join tblDepartment on tblEmployee.DepartmentId = tblDepartment.DeptId
```

To select data from the view, SELECT statement can be used the way, we use it with a table.

```
SELECT * from vWEmployeesByDepartment
```

When this query is executed, the database engine actually retrieves the data from the underlying base tables, **tblEmployees and tblDepartments**. The View itself, does not store any data by default. However, we can change this default behaviour, which we will talk about in a later session. So, this is the reason, a view is considered, as just, a stored query or a virtual table.

Advantages of using views:

1. Views can be used to reduce the **complexity of the database schema**, for non-IT users. The sample view, **vWEmployeesByDepartment**, hides the complexity of joins. Non-IT users, finds it easy to query the view, rather than writing complex joins.

2. Views can be used as a mechanism to implement **row and column level security**.

Row Level Security:

For example, I want an end user, to have access only to IT Department employees. If I grant him access to the underlying tblEmployees and tblDepartments tables, he will be able to see, every department employees. To achieve this, I can create a view, which returns only IT Department employees, and grant the user access to the view and not to the underlying table.

View that returns only IT department employees: Create view in SSMS

Column Level Security:

Salary is confidential information and I want to prevent access to that column. To achieve this, we can create a view, which excludes the Salary column, and then grant the end user access to this views, rather than the base tables.

View that returns all columns except Salary column: Create view in SSMS

To look at view definition - sp_helptext vWName
To modify a view - ALTER VIEW statement
To Drop a view - DROP VIEW vWName
To Rename view - SP_RENAME View_Old_Name, View_New_Name

Updatable Views:

Let's create a view, which returns all the columns from the tblEmployees table, except Salary column.

```
Create view vWEmployeesDataExceptSalary
as
Select Id, Name, Gender, DepartmentId from tblEmployees
```

```
Select * from vWEmployeesDataExceptSalary
```

Is it possible to Insert, Update and delete rows, from the underlying tblEmployees table, using view vWEmployeesDataExceptSalary?

Yes, SQL server views are updateable.

The following query updates, Name column from Mike to Mikey. Though, we are updating the view, SQL server, correctly updates the base table tblEmployees. To verify, execute, SELECT statement, on tblEmployee table.

```
Update vWEmployeesDataExceptSalary Set Name = 'Mikey' Where Id = 2
```

Along the same lines, it is also possible to insert and delete rows from the base table using views.

```
Delete from vWEmployeesDataExceptSalary where Id = 2
```

Now, let us see, what happens if our view is based on multiple base tables.

View that joins tblEmployee and tblDepartment

```
Create view vwEmployeeDetailsByDepartment
as
Select Id, Name, Salary, Gender, DeptName from tblEmployees
join tblDepartment on tblEmployees.DepartmentId = tblDepartment.DeptId
```

Select Data from view vwEmployeeDetailsByDepartment

```
Select * from vwEmployeeDetailsByDepartment
```

Now, let's update, John's department, from HR to IT. At the moment, there are 2 employees (Ben, and John) in the HR department.

```
Update vwEmployeeDetailsByDepartment
set DeptName='IT' where Name = 'John'
```

Notice, that Ben's department is also changed to IT. To understand the reasons for incorrect UPDATE, select Data from tblDepartment and tblEmployee base tables.

The UPDATE statement, updated DeptName from HR to IT in tblDepartment table, instead of upadting **DepartmentId** column in **tblEmployee** table. So, the conclusion - If a view is based on multiple tables, and if you update the view, it may not update the underlying base tables correctly. To correctly update a view, that is based on multiple tables, INSTEAD OF triggers are used.
We will discuss about triggers and correctly updating a view that is based on multiple tables, in a later session.

Indexed View

What is an Indexed View or What happens when you create an Index on a view?
A **standard** or **Non-indexed** view, is just a stored SQL query. When, we try to retrieve data from the view, the data is actually retrieved from the underlying base tables. So, a view is just a virtual table it does not store any data, by default.

However, when you create an index, on a view, the view gets materialized. This means, the view is now, capable of storing data. In SQL server, we call them Indexed views and in Oracle, Materialized views.

Let's now, look at an example of creating an Indexed view. For the purpose of this video, we will be using **Product** and **ProductSales** tables.

Script to create view vWTotalSalesByProduct

```
Create view vWTotalSalesByProduct
with SchemaBinding
as
Select Name,SUM(ISNULL((QuantitySold * UnitPrice), 0)) as TotalSales, COUNT_BIG(*) as TotalTransactions
from dbo.ProductSales
join dbo.Product on dbo. Product.ProductId = dbo.ProductSales.ProductId
group by Name
```

If you want to create an Index, on a view, the following rules should be followed by the view. For the complete list of all rules, please check MSDN.
1. The view should be created with SchemaBinding option

2. If an Aggregate function in the SELECT LIST, references an expression, and if there is a possibility for that expression to become NULL, then, a replacement value should be specified. In this example, we are using, ISNULL()

function, to replace NULL values with ZERO.

3. If GROUP BY is specified, the view select list must contain a COUNT_BIG(*) expression

4. The base tables in the view, should be referenced with 2 part name. In this example, tblProduct and tblProductSales are referenced using dbo.tblProduct and dbo.tblProductSales respectively.

Now, let's create an Index on the view:
The first index that you create on a view, must be a unique clustered index. After the unique clustered index has been created, you can create additional nonclustered indexes.

```
Create Unique Clustered Index UIX_vWTotalSalesByProduct_Name
on vWTotalSalesByProduct(Name)
```

Since, we now have an index on the view, the view gets materialized. The data is stored in the view. So when we execute Select * from vWTotalSalesByProduct, the data is retruned from the view itself, rather than retrieving data from the underlying base tables.
Indexed views, can significantly improve the performance of queries that involves JOINS and Aggeregations. The cost of maintaining an indexed view is much higher than the cost of maintaining a table index.

Indexed views are ideal for scenarios, where the underlying data is not frequently changed. Indexed views are more often used in OLAP systems, because the data is mainly used for reporting and analysis purposes. Indexed views, may not be suitable for OLTP systems, as the data is frequently added and changed.

Advantages of views in SQL Server

1. Hiding the complexity of a Complex SQL Query
2. Implementing Row Level Security
3. Implementing Column Level Security
4. Presenting the Aggregated data by Hiding Detailed data

Limitations and Dis-Advantages of Views in SQL Server

1. We cannot pass parameters to SQL Server views
2. Cannot use Order By clause with views without specifying FOR XML, OFFSET, or TOP
3. The Views cannot be created based on Temporary Tables in SQL Server
4. We cannot associate Rules and Defaults with SQL Server views

Triggers in SQL Server

A trigger is a set of SQL statements that reside in system memory with unique names. It is a specialized category of stored procedure that is called automatically when a database server event occurs. Each trigger is always associated with a table.
A **trigger is called a special procedure** because it cannot be called directly like a stored procedure. The key distinction between the trigger and procedure is that a trigger is called automatically when a data modification event occurs against a table. A stored procedure, on the other hand, must be invoked directly.

The following are the main characteristics that distinguish triggers from stored procedures:

- We cannot manually execute/invoked triggers.
- Triggers have no chance of receiving parameters.
- A transaction cannot be committed or rolled back inside a trigger.

Syntax of Trigger

We can create a trigger in SQL Server by using the **CREATE TRIGGER** statement as follows:

```
CREATE TRIGGER schema.trigger_name
ON table_name
AFTER  {INSERT, UPDATE, DELETE}
[NOT FOR REPLICATION]
AS
```

{SQL_Statements}

The parameter descriptions of this syntax illustrate below:
schema: It is an optional parameter that defines which schema the new trigger belongs to.
trigger_name: It is a required parameter that defines the name for the new trigger.
table_name: It is a required parameter that defines the table name to which the trigger applies. Next to the table name, we need to write the AFTER clause where any events like INSERT, UPDATE, or DELETE could be listed.
NOT FOR REPLICATION: This option tells that SQL Server does not execute the trigger when data is modified as part of a replication process.
SQL_Statements: It contains one or more SQL statements that are used to perform actions in response to an event that occurs.

When we use triggers?

Triggers will be helpful when we need to execute some events automatically on certain desirable scenarios. **For example**, we have a constantly changing table and need to know the occurrences of changes and when these changes happen. If the primary table made any changes in such scenarios, we could create a trigger to insert the desired data into a separate table.
DML stands for Data Manipulation Language. INSERT, UPDATE, and DELETE statements are DML statements. DML triggers are fired, whenever data is modified using INSERT, UPDATE, and DELETE events.

DML triggers can be again classified into 2 types.
1. After triggers (Sometimes called as FOR triggers)
2. Instead of triggers

After triggers, as the name says, fires after the triggering action. The INSERT, UPDATE, and DELETE statements, causes an after trigger to fire after the respective statement's complete execution.

On the other hand, as the name says, INSTEAD of triggers, fires instead of the triggering action. The INSERT, UPDATE, and DELETE statements, can cause an INSTEAD OF trigger to fire INSTEAD OF the respective statement execution.

We will use tblEmployees and tblEmployeeAudit tables for our examples

Whenever, a new Employee is added, we want to capture the ID and the date and time, the new employee is added in tblEmployeeAudit table. The easiest way to achieve this, is by having an AFTER TRIGGER for INSERT event.

Example for AFTER TRIGGER for INSERT event on tblEmployee table:

```
CREATE TRIGGER tr_tblEmployee_ForInsert
ON tblEmployees
FOR INSERT
AS
BEGIN
 Declare @Id int
 Select @Id = Id from inserted

 insert into tblEmployeeAudit
 values('New employee with Id  = ' + Cast(@Id as nvarchar(5)) + ' is added at ' + cast(Getdate() as nvarchar(20)))
END
```

In the trigger, we are getting the id from inserted table. So, what is this inserted table? INSERTED table, is a special table used by DML triggers. When you add a new row into tblEmployees table, a copy of the row will also be made into inserted table, which only a trigger can access. You cannot access this table outside the context of the trigger. The structure of the inserted table will be identical to the structure of tblEmployees table.

So, now if we execute the following INSERT statement on tblEmployee. Immediately, after inserting the row into tblEmployee table, the trigger gets fired (executed automatically), and a row into tblEmployeeAudit, is also inserted.

```
Insert into tblEmployee values (7,'Tan', 2300, 'Female', 3)
```

Along, the same lines, let us now capture audit information, when a row is deleted from the table, tblEmployees.

Example for AFTER TRIGGER for DELETE event on tblEmployees table:

```
CREATE TRIGGER tr_tblEMployee_ForDelete
ON tblEmployees
FOR DELETE
AS
BEGIN
 Declare @Id int
 Select @Id = Id from deleted

 insert into tblEmployeeAudit values('An existing employee with Id  = ' + Cast(@Id as nvarchar(5)) + ' is deleted at
' + Cast(Getdate() as nvarchar(20)))
END
```

The only difference here is that, we are specifying, the triggering event as **DELETE** and retrieving the deleted row ID from **DELETED** table. DELETED table, is a special table used by DML triggers. When you delete a row from tblEmployees table, a copy of the deleted row will be made available in DELETED table, which only a trigger can access. Just like INSERTED table, DELETED table cannot be accessed, outside the context of the trigger and, the structure of the DELETED table will be identical to the structure of tblEmployees table.

AFTER TRIGGER for Update

Triggers make use of 2 special tables, INSERTED and DELETED. The inserted table contains the updated data and the deleted table contains the old data. The After trigger for UPDATE event, makes use of both inserted and deleted tables.

Create AFTER UPDATE trigger script:

```
ALTER trigger tr_tblEmployee_ForUpdate
on tblEmployees
for Update
as
Begin
 Select * INTO DeletedAudit from deleted
 Select * INTO InsertedAudit from inserted
End
```

Now, execute this query:

```
Update tblEmployee set Name = 'Tods', Salary = 2000,
Gender = 'Female' where Id = 4
```

Immediately after the UPDATE statement execution, the AFTER-UPDATE trigger gets fired, and you should see the contents of INSERTED and DELETED tables.

Instead Of Triggers:

We know that, AFTER triggers are fired after the triggering event(INSERT, UPDATE or DELETE events), where as, INSTEAD OF triggers are fired instead of the triggering event(INSERT, UPDATE or DELETE events). In general, INSTEAD OF triggers are usually used to correctly update views that are based on multiple tables.

Instead Of Insert Triggers:

let's create a view based on tblEmployees & tblDepartment tables. The view should return Employee Id, Name, Gender and DepartmentName columns. So, the view is obviously based on multiple tables.

Script to create the view:

```
Create view vWEmployeeDetails
as
Select Id, Name, Gender, DeptName
from tblEmployees
join tblDepartment
on tblEmployee.DepartmentId = tblDepartment.DeptId

Select * from vWEmployeeDetails
```

Now, let's try to insert a row into the view, vWEmployeeDetails, by executing the following query. At this point, an error will be raised stating 'View or function vWEmployeeDetails is not updatable because the modification affects multiple base tables.'

```
Insert into vWEmployeeDetails values(7, 'Valarie', 'Female', 'IT')
```

So, inserting a row into a view that is based on multiple tables, raises an error by default. Now, let's understand, how INSTEAD OF TRIGGERS can help us in this situation. Since, we are getting an error, when we are trying to insert a row into the view, let's create an INSTEAD OF INSERT trigger on the view **vWEmployeeDetails.**

Script to create INSTEAD OF INSERT trigger:

```
Create trigger tr_vWEmployeeDetails_InsteadOfInsert
on vWEmployeeDetails
Instead Of Insert
as
Begin
 Declare @DeptId int

 --Check if there is a valid DepartmentId
 --for the given DepartmentName
 Select @DeptId = DeptId
 from tblDepartment
 join inserted
 on inserted.DeptName = tblDepartment.DeptName

 --If DepartmentId is null throw an error
 --and stop processing
 if(@DeptId is null)
 Begin
  Raiserror('Invalid Department Name. Statement terminated', 16, 1)
  return
 End

 --Finally insert into tblEmployee table
 Insert into tblEmployees(Id, Name, Gender, DepartmentId)
 Select Id, Name, Gender, @DeptId
 from inserted
End
```

Now, let's execute the insert query:

```
Insert into vWEmployeeDetails values(7, 'Valarie', 'Female', 'IT')
```

The instead of trigger correctly inserts, the record into tblEmployees table. Since, we are inserting a row, the **inserted** table, contains the newly added row, whereas the **deleted** table will be empty.

Instead Of Update Triggers:

An INSTEAD OF UPDATE triggers gets fired instead of an update event, on a table or a view. For example, let's say we have, an INSTEAD OF UPDATE trigger on a view or a table, and then when you try to update a row with in that view or table, instead of the UPDATE, the trigger gets fired automatically. INSTEAD OF UPDATE TRIGGERS, are of immense help, to correctly update a view, that is based on multiple tables.

Now, let's try to update the view, in such a way that, it affects, both the underlying tables, and see, if we get the same error. The following UPDATE statement changes **Name column** from **tblEmployee** and **DeptName column** from **tblDepartment**. So, when we execute this query, we get the same error.

```
Update vWEmployeeDetails
set Name = 'Johny', DeptName = 'IT'
where Id = 1
```

Now, let's try to change, just the department of John from HR to IT. The following UPDATE query, affects only one table, tblDepartment. So, the query should succeed. But, before executing the query, please note that, employees **JOHN** and **BEN** are in **HR** department.

```
Update vWEmployeeDetails
set DeptName = 'IT'
where Id = 1
```

After executing the query, select the data from the view, and notice that **BEN's DeptName** is also changed to **IT**. We intended to just change **JOHN's DeptName**. So, the UPDATE didn't work as expected. This is because, the UPDATE query, updated the **DeptName from HR to IT**, in tblDepartment table. For the UPDATE to work correctly, we should change the **DeptId** of **JOHN** from 3 to 1.

Record with Id = 3, has the DeptName changed from 'HR' to 'IT'

We should have actually updated, JOHN's DepartmentId from 3 to 1

So, the conclusion is that, if a view is based on multiple tables, and if you update the view, the UPDATE may not always work as expected. To correctly update the underlying base tables, thru a view, INSTEAD OF UPDATE TRIGGER can be used.

Before, we create the trigger, let's update the DeptName to HR for record with Id = 3.

```
Update tblDepartment set DeptName = 'HR' where DeptId = 3
```

Script to create INSTEAD OF UPDATE trigger:

```
Create Trigger tr_vWEmployeeDetails_InsteadOfUpdate
on vWEmployeeDetails
instead of update
as
Begin
 -- if EmployeeId is updated
 if(Update(Id))
 Begin
  Raiserror('Id cannot be changed', 16, 1)
  Return
 End

 -- If DeptName is updated
 if(Update(DeptName))
 Begin
  Declare @DeptId int

  Select @DeptId = DeptId
  from tblDepartment
  join inserted
  on inserted.DeptName = tblDepartment.DeptName

  if(@DeptId is NULL )
  Begin
   Raiserror('Invalid Department Name', 16, 1)
   Return
  End

  Update tblEmployee set DepartmentId = @DeptId
  from inserted
  join tblEmployee
  on tblEmployee.Id = inserted.id
 End

 -- If gender is updated
 if(Update(Gender))
 Begin
  Update tblEmployee set Gender = inserted.Gender
  from inserted
  join tblEmployee
  on tblEmployee.Id = inserted.id
 End

 -- If Name is updated
 if(Update(Name))
 Begin
  Update tblEmployee set Name = inserted.Name
  from inserted
  join tblEmployee
  on tblEmployee.Id = inserted.id
 End
End
```

Now, let's try to update JOHN's Department to IT.

```
Update vWEmployeeDetails
set DeptName = 'IT'
where Id = 1
```

The UPDATE query works as expected. The INSTEAD OF UPDATE trigger, correctly updates, JOHN's DepartmentId to 1, in tblEmployee table.

Now, let's try to update Name, Gender and DeptName. The UPDATE query, works as expected, without raising the error - 'View or function vWEmployeeDetails is not updatable because the modification affects multiple base tables.'

```
Update vWEmployeeDetails
set Name = 'Johny', Gender = 'Female', DeptName = 'IT'
where Id = 1
```

Update() function used in the trigger, returns true, even if you update with the same value. For this reason, I recomend to compare values between inserted and deleted tables, rather than relying on Update() function. The Update() function does not operate on a per row basis, but across all rows.

Instead Of Delete Triggers:

INSTEAD OF DELETE trigger. An INSTEAD OF DELETE trigger gets fired instead of the DELETE event, on a table or a view. For example, let's say we have, an INSTEAD OF DELETE trigger on a view or a table, and then when you try to update a row from that view or table, instead of the actual DELETE event, the trigger gets fired automatically. INSTEAD OF DELETE TRIGGERS, are used, to delete records from a view, that is based on multiple tables.

Now, let's try to delete a row from the view, and we get the same error.

```
Delete from vWEmployeeDetails where Id = 1
```

Script to create INSTEAD OF DELETE trigger:

```
Create Trigger tr_vWEmployeeDetails_InsteadOfDelete
on vWEmployeeDetails
instead of delete
as
Begin
 Delete tblEmployee
 from tblEmployee
 join deleted
 on tblEmployee.Id = deleted.Id

 --Subquery
 --Delete from tblEmployee
 --where Id in (Select Id from deleted)
End
```

Notice that, the trigger tr_vWEmployeeDetails_InsteadOfDelete, makes use of DELETED table. DELETED table contains all the rows, that we tried to DELETE from the view. So, we are joining the DELETED table with tblEmployee, to delete the rows. You can also use sub-queries to do the same. In most cases JOINs are faster than SUB-QUERIEs. However, in cases, where you only need a subset of records from a table that you are joining with, sub-queries can be faster.

Upon executing the following DELETE statement, the row gets DELETED as expected from tblEmployee table

```
Delete from vWEmployeeDetails where Id = 1
```

Trigger	INSERTED or DELETED?
Instead of Insert	DELETED table is always empty and the INSERTED table contains the newly inserted data.
Instead of Delete	INSERTED table is always empty and the DELETED table contains the rows deleted
Instead of Update	DELETED table contains OLD data (before update), and inserted table contains NEW data(Updated data)

What are DDL triggers

DDL triggers fire in response to DDL events - CREATE, ALTER, and DROP (Table, Function, Index, Stored Procedure etc...). For the list of all DDL events please visit https://msdn.microsoft.com/en-us/library/bb522542.aspx

Certain system stored procedures that perform DDL-like operations can also fire DDL triggers.
Example - sp_rename system stored procedure

What is the use of DDL triggers

- If you want to execute some code in response to a specific DDL event
- To prevent certain changes to your database schema
- Audit the changes that the users are making to the database structure

Syntax for creating DDL trigger

```
CREATE TRIGGER [Trigger_Name]
ON [Scope (Server|Database)]
FOR [EventType1, EventType2, EventType3, ...],
AS
BEGIN
   -- Trigger Body
END
```

DDL triggers scope : DDL triggers can be created in a specific database or at the server level.

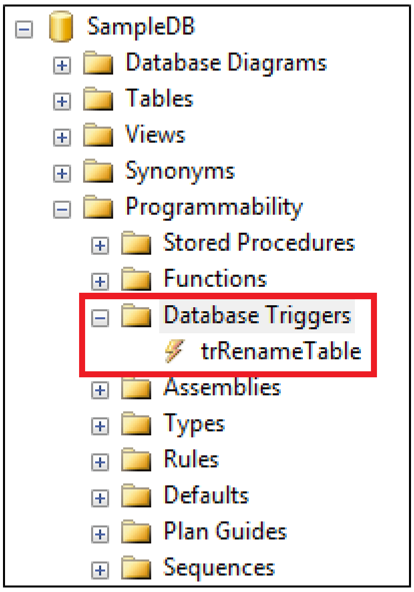
The following trigger will fire in response to CREATE_TABLE DDL event.

```
CREATE TRIGGER trMyFirstTrigger
```

```
ON Database
FOR CREATE_TABLE
AS
BEGIN
  Print 'New table created'
END
```

To check if the trigger has been created

1. In the Object Explorer window, expand the **SampleDB** database by clicking on the plus symbol.
2. Expand **Programmability** folder
3. Expand **Database Triggers** folder



Please note : If you can't find the trigger that you just created, make sure to refresh the Database Triggers folder.

When you execute the following code to create the table, the trigger will automatically fire and will print the message - New table created

```
Create Table Test (Id int)
```

The above trigger will be fired only for one DDL event CREATE_TABLE. If you want this trigger to be fired for multiple events, for example when you alter or drop a table, then separate the events using a comma as shown below.

```
ALTER TRIGGER trMyFirstTrigger
ON Database
FOR CREATE_TABLE, ALTER_TABLE, DROP_TABLE
AS
BEGIN
  Print 'A table has just been created, modified or deleted'
END
```

Now if you create, alter or drop a table, the trigger will fire automatically and you will get the message - A table has just been created, modified or deleted.

The 2 DDL triggers above execute some code in response to DDL events

Now let us look at an example of how to prevent users from creating, altering or dropping tables. To do this modify the trigger as shown below.

```
ALTER TRIGGER trMyFirstTrigger
```

```
ON Database
FOR CREATE_TABLE, ALTER_TABLE, DROP_TABLE
AS
BEGIN
  Rollback
  Print 'You cannot create, alter or drop a table'
END
```

To be able to create, alter or drop a table, you either have to disable or delete the trigger.

To disable trigger
1. Right click on the trigger in object explorer and select **"Disable"** from the context menu
2. You can also disable the trigger using the following T-SQL command

```
DISABLE TRIGGER trMyFirstTrigger ON DATABASE
```

To enable trigger
1. Right click on the trigger in object explorer and select "Enable" from the context menu
2. You can also enable the trigger using the following T-SQL command

```
ENABLE TRIGGER trMyFirstTrigger ON DATABASE
```

To drop trigger
1. Right click on the trigger in object explorer and select "Delete" from the context menu
2. You can also drop the trigger using the following T-SQL command

```
DROP TRIGGER trMyFirstTrigger ON DATABASE
```

Certain system stored procedures that perform DDL-like operations can also fire DDL triggers. The following trigger will be fired when ever you rename a database object using sp_rename system stored procedure.

```
CREATE TRIGGER trRenameTable
ON DATABASE
FOR RENAME
AS
BEGIN
   Print 'You just renamed something'
END
```

The following code changes the name of the TestTable to NewTestTable. When this code is executed, it will fire the trigger trRenameTable:

```
sp_rename 'TestTable', 'NewTestTable'
```

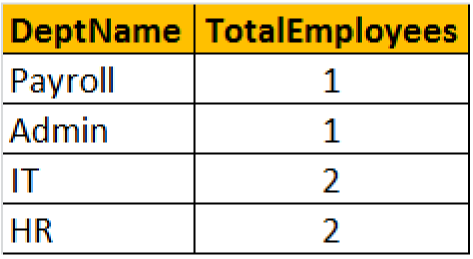
The following code changes the name of the Id column in NewTestTable to NewId. When this code is executed, it will fire the trigger trRenameTable

```
sp_rename 'NewTestTable.Id' , 'NewId', 'column'
```

Common Table Expressions

A **CTE** is a temporary result set, that can be referenced within a SELECT, INSERT, UPDATE, or DELETE statement, that immediately follows the **CTE.**

Write a query using CTE, to display the total number of Employees by Department Name. The output should be as shown below.



DeptName	TotalEmployees
Payroll	1
Admin	1
IT	2
HR	2

Before we write the query, let's look at the syntax for creating a CTE.

```
WITH cte_name (Column1, Column2,)
AS
( CTE_query )
```

SQL query using CTE:

```
With EmployeeCount(DepartmentId, TotalEmployees)
as
( Select DepartmentId, COUNT(*) as TotalEmployees
 from tblEmployee
 group by DepartmentId)
Select DeptName, TotalEmployees
from tblDepartment
join EmployeeCount
on tblDepartment.DeptId = EmployeeCount.DepartmentId
order by TotalEmployees
```

We define a CTE, using **WITH** keyword, followed by the name of the CTE. In our example, **EmployeeCount** is the name of the CTE. Within parentheses, we specify the columns that make up the CTE. **DepartmentId** and **TotalEmployees** are the columns of **EmployeeCount** CTE. These 2 columns map to the columns returned by the **SELECT CTE query**. The CTE column names and CTE query column names can be different. Infact, CTE column names are optional. However, if you do specify, the number of **CTE columns** and the **CTE SELECT query** columns should be same. Otherwise you will get an error stating - 'EmployeeCount has fewer columns than were specified in the column list'. The column list, is followed by the as keyword, following which we have the CTE query within a pair of parentheses.

EmployeeCount CTE is being joined with **tblDepartment** table, in the SELECT query, that immediately follows the CTE. Remember, a CTE can only be referenced by a SELECT, INSERT, UPDATE, or DELETE statement, **that immediately follows the CTE**. If you try to do something else in between, we get an error stating - 'Common table expression defined but not used'. The following SQL, raise an error.

```
With EmployeeCount(DepartmentId, TotalEmployees)
as
( Select DepartmentId, COUNT(*) as TotalEmployees
 from tblEmployee
 group by DepartmentId)

Select 'Hello'

Select DeptName, TotalEmployees
from tblDepartment
join EmployeeCount
on tblDepartment.DeptId = EmployeeCount.DepartmentId
order by TotalEmployees
```

It is also, possible to create multiple CTE's using a single WITH clause.

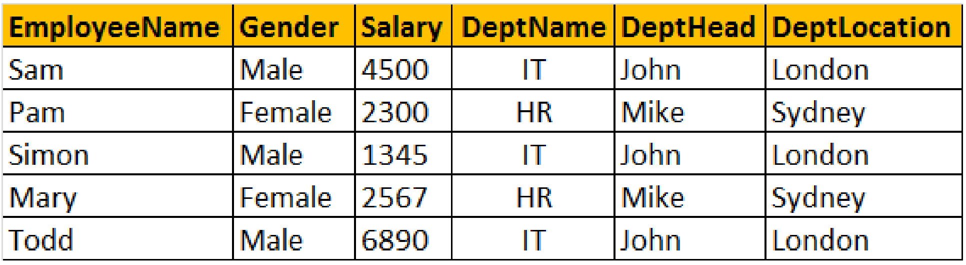
```
With EmployeesCountBy_Payroll_IT_Dept(DepartmentName, Total)
as
(
 Select DeptName, COUNT(Id) as TotalEmployees
 from tblEmployee
 join tblDepartment
 on tblEmployee.DepartmentId = tblDepartment.DeptId
 where DeptName IN ('Payroll','IT')
 group by DeptName
),
EmployeesCountBy_HR_Admin_Dept(DepartmentName, Total)
as
(
 Select DeptName, COUNT(Id) as TotalEmployees
 from tblEmployee
 join tblDepartment
 on tblEmployee.DepartmentId = tblDepartment.DeptId
 group by DeptName
)
Select * from EmployeesCountBy_HR_Admin_Dept
UNION
Select * from EmployeesCountBy_Payroll_IT_Dept
```

Database Normalization

What are the goals of database normalization?
or **Why do we normalize databases**?
or **What is database normalization**?

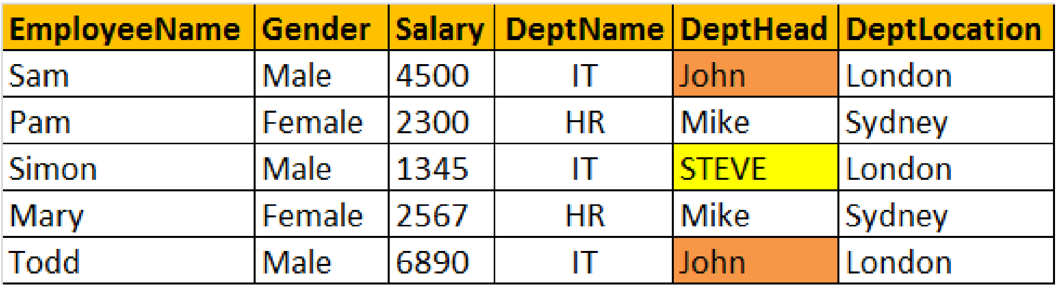
Database normalization is the process of organizing data to minimize data redundancy (data duplication), which in turn ensures data consistency.

Let's understand with an example, how **redundant data** can cause **data inconsistency**. Consider **Employees** table below. For every employee with in the same department, we are repeating, all the 3 columns (DeptName, DeptHead and DeptLocation). Let's say for example, if there 50 thousand employees in the IT department, we would have unnecessarily repeated all the 3 department columns (DeptName, DeptHead and DeptLocation) data 50 thousand times. The obvious problem with redundant data is the disk space wastage.



EmployeeName	Gender	Salary	DeptName	DeptHead	DeptLocation
Sam	Male	4500	IT	John	London
Pam	Female	2300	HR	Mike	Sydney
Simon	Male	1345	IT	John	London
Mary	Female	2567	HR	Mike	Sydney
Todd	Male	6890	IT	John	London

Another common problem, is that data can become inconsistent. For example, let's say, JOHN has resigned, and we have a new department head (STEVE) for IT department. At present, there are 3 IT department rows in the table, and we need to update all of them. Let's assume I updated only one row and forgot to update the other 2 rows, then obviously, the data becomes inconsistent.

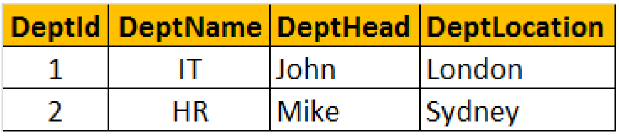


EmployeeName	Gender	Salary	DeptName	DeptHead	DeptLocation
Sam	Male	4500	IT	John	London
Pam	Female	2300	HR	Mike	Sydney
Simon	Male	1345	IT	STEVE	London
Mary	Female	2567	HR	Mike	Sydney
Todd	Male	6890	IT	John	London

Another problem, DML queries (Insert, update and delete), **could become slow**, as there could many records and columns to process.

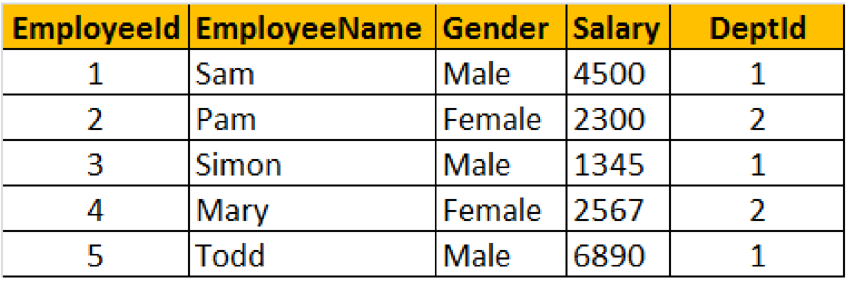
So, to reduce the data redundancy, we can divide this large badly organised table into two (Employees and Departments), as shown below. Now, we have reduced redundant department data. So, if we have to update department head name, we only have one row to update, even if there are 10 million employees in that department.

Normalized Departments Table



DeptId	DeptName	DeptHead	DeptLocation
1	IT	John	London
2	HR	Mike	Sydney

Normalized Employees Table



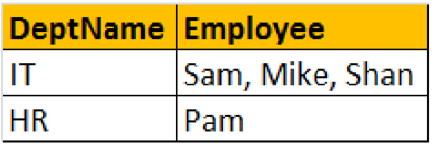
EmployeeId	EmployeeName	Gender	Salary	DeptId
1	Sam	Male	4500	1
2	Pam	Female	2300	2
3	Simon	Male	1345	1
4	Mary	Female	2567	2
5	Todd	Male	6890	1

Database normalization is a step by step process. There are 6 normal forms, First Normal form (1NF) thru Sixth Normal Form (6NF). Most databases are in third normal form (3NF). There are certain rules, that each normal form should follow.

Now, let's explore the first normal form (1NF). A table is said to be in 1NF, if

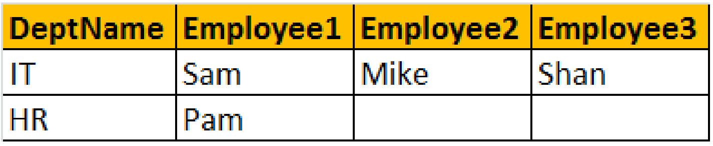
1. The data in each column should be **atomic**. No multiple values, separated by comma.
2. The table does not contain any **repeating column groups**
3. Identify each record **uniquely using primary key**.

In the table below, data in Employee column is not atomic. It contains multiple employees separated by comma. From the data you can see that in the IT department, we have 3 employees - Sam, Mike, Shan. Now, let's say I want to change just, SHAN name. **It is not possible; we have to update the entire cell.** Similarly, it is not possible to select or delete just one employee, as the data in the cell is not atomic.



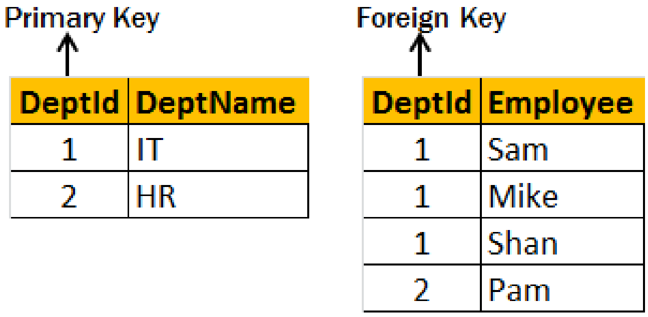
DeptName	Employee
IT	Sam, Mike, Shan
HR	Pam

The 2nd rule of the first normal form is that, the table should not contain any repeating column groups. Consider the Employee table below. We have repeated the Employee column, from Employee1 to Employee3. The problem with this design is that, if a department is going to have more than 3 employees, then we have to **change the table structure** to add Employee4 column. Employee2 and Employee3 columns in the HR department are NULL, as there is only employee in this department. The **disk space is simply wasted.**



DeptName	Employee1	Employee2	Employee3
IT	Sam	Mike	Shan
HR	Pam		

To eliminate the repeating column groups, we are dividing the table into 2. The repeating Employee columns are moved into a seperate table, with a foreign key pointing to the primary key of the other table. We also, introduced primary key to uniquely identify each record.



DeptId	DeptName
1	IT
2	HR

DeptId	Employee
1	Sam
1	Mike
1	Shan
2	Pam

A table is said to be in 2NF, if

1. The table meets all the **conditions of 1NF**
2. Move **redundant** data to a separate table
3. Create **relationship** between these tables using foreign keys.

Now, to put this table in the second normal form, we need to break the table into 2, and move the redundant department data (**DeptName, DeptHead and DeptLocation**) into it's own table. To link the tables with each other, we use the **DeptId** foreign key. The tables below are in 2NF.

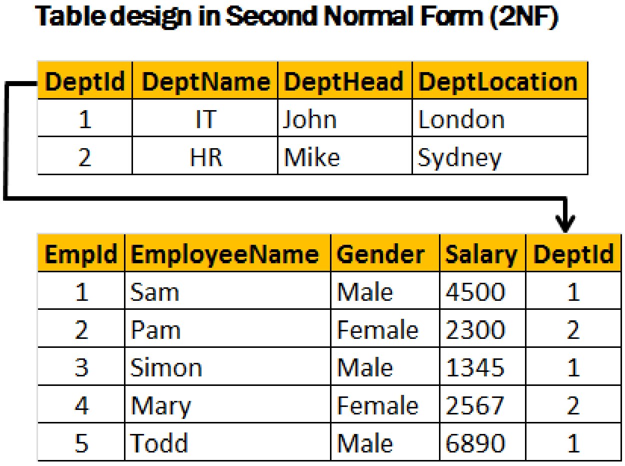


Table design in Second Normal Form (2NF)

DeptId	DeptName	DeptHead	DeptLocation
1	IT	John	London
2	HR	Mike	Sydney

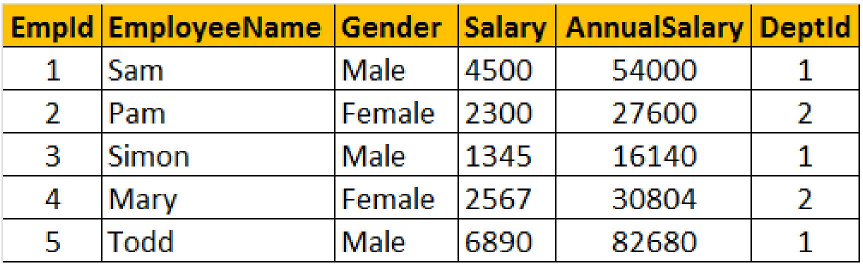
EmpId	EmployeeName	Gender	Salary	DeptId
1	Sam	Male	4500	1
2	Pam	Female	2300	2
3	Simon	Male	1345	1
4	Mary	Female	2567	2
5	Todd	Male	6890	1

Third Normal Form (3NF):

A table is said to be in 3NF, if the table

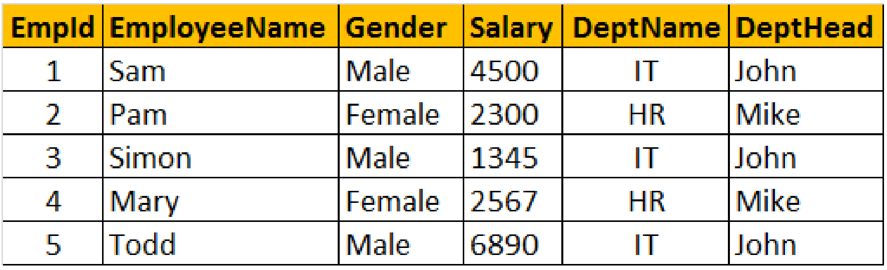
1. Meets all the conditions of **1NF and 2NF**
2. Does not contain columns (attributes) that are not fully **dependent upon the primary key**

The table below, violates third normal form, because **AnnualSalary** column is not fully dependent on the primary key **EmpId**. The **AnnualSalary** is also dependent on the **Salary** column. In fact, to compute the **AnnualSalary**, we multiply the **Salary** by **12**. Since **AnnualSalary** is not fully dependent on the primary key, and it can be computed, we can remove this column from the table, which then, will adhere to 3NF.



EmpId	EmployeeName	Gender	Salary	AnnualSalary	DeptId
1	Sam	Male	4500	54000	1
2	Pam	Female	2300	27600	2
3	Simon	Male	1345	16140	1
4	Mary	Female	2567	30804	2
5	Todd	Male	6890	82680	1

Let's look at another example of Third Normal Form violation. In the table below, **DeptHead** column is not fully dependent on **EmpId** column. **DeptHead** is also dependent on **DeptName**. So, this table is not in **3NF**.



EmpId	EmployeeName	Gender	Salary	DeptName	DeptHead
1	Sam	Male	4500	IT	John
2	Pam	Female	2300	HR	Mike
3	Simon	Male	1345	IT	John
4	Mary	Female	2567	HR	Mike
5	Todd	Male	6890	IT	John

To put this table in 3NF, we break this down into 2, and then move all the columns that are not fully dependent on the primary key to a separate table as shown below. This design is now in 3NF.

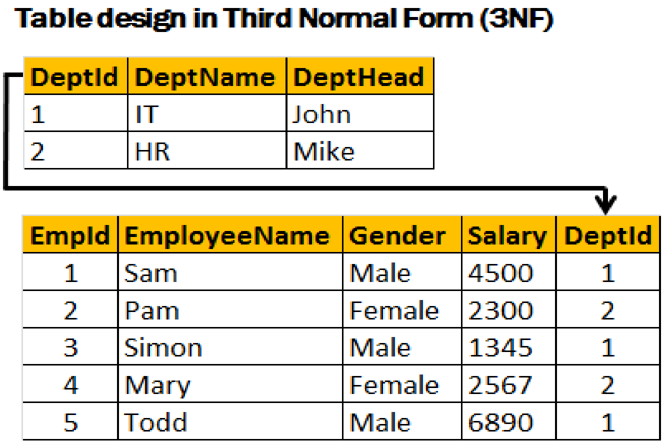


Table design in Third Normal Form (3NF)

DeptId	DeptName	DeptHead
1	IT	John
2	HR	Mike

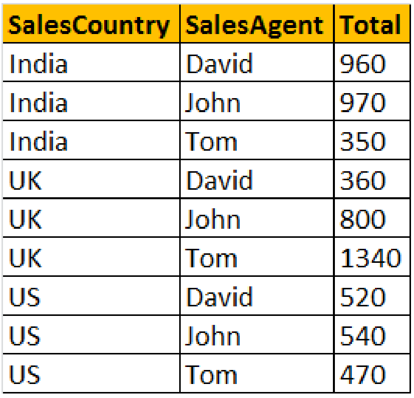
EmpId	EmployeeName	Gender	Salary	DeptId
1	Sam	Male	4500	1
2	Pam	Female	2300	2
3	Simon	Male	1345	1
4	Mary	Female	2567	2
5	Todd	Male	6890	1

Pivot operator in SQL Server

Pivot is a SQL server operator that can be used to turn **unique values from one column**, into **multiple columns** in the output, there by effectively **rotating a table**.
Let's understand the power of PIVOT operator with an example:
Consider Sales Table-

Select * from Sales: As you can see, we have 3 sales agents selling in 3 countries

Now, let's write a query which returns TOTAL SALES, grouped by **SALESCOUNTRY** and **SALESAGENT**. The output should be as shown below.

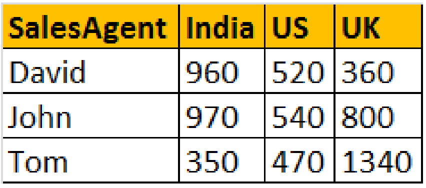


SalesCountry	SalesAgent	Total
India	David	960
India	John	970
India	Tom	350
UK	David	360
UK	John	800
UK	Tom	1340
US	David	520
US	John	540
US	Tom	470

A simple GROUP BY query can produce this output.

```
Select SalesCountry, SalesAgent, SUM(SalesAmount) as Total
from Sales group by SalesCountry, SalesAgent
order by SalesCountry, SalesAgent
```

At, this point, let's try to present the same data in different format using PIVOT operator.



SalesAgent	India	US	UK
David	960	520	360
John	970	540	800
Tom	350	470	1340

Query using PIVOT operator:

```
Select SalesAgent, India, US, UK
from Sales
Pivot
(
  Sum(SalesAmount) for SalesCountry in ([India],[US],[UK])
) as PivotTable
```

```
SELECT PIVOTED VALUES FROM TABLE
PIVOT
(
 FOR PIVOTED COLUMN NAME IN (VALUES)
)
```

This PIVOT query is converting the unique column values (India, US, UK) in **SALESCOUNTRY** column, **into Columns** in the output, along with performing aggregations on the **SALESAMOUNT** column. The Outer query, simply, selects **SALESAGENT** column from **tblProductSales** table, along with pivoted columns from the PivotTable.

Having understood the basics of PIVOT, let's look at another example. Let's create **SalesRev**, a slight variation of **Sales**, that we have already created. The table, that we are creating now, has got an additional **Id** column. **Now, run the same PIVOT query** that we have already created, just by changing the name of the table to **tblProductsSale** instead of **tblProductSales**

```
Select SalesAgent, India, US, UK
from tblProductsSale
Pivot
(
  Sum(SalesAmount) for SalesCountry in ([India],[US],[UK])
)as PivotTable
```

This output is not what we have expected.

This is because of the presence of Id column in tblProductsSale, which is also considered when performing pivoting and group by. To eliminate this from the calculations, we have used derived table, which only selects, SALESAGENT, SALESCOUNTRY, and SALESAMOUNT. The rest of the query is very similar to what we have already seen.

```
Select SalesAgent, India, US, UK
from
(
  Select SalesAgent, SalesCountry, SalesAmount from tblProductsSale
) as SourceTable
Pivot
(
 Sum(SalesAmount) for SalesCountry in (India, US, UK)
) as PivotTable
```

UNPIVOT performs the opposite operation to PIVOT by rotating columns of a table-valued expression into column values.

The syntax of PIVOT operator :

```
SELECT <non-pivoted column>,
   [first pivoted column] AS <column name>,
   [second pivoted column] AS <column name>,
   ...
   [last pivoted column] AS <column name>
```

```
FROM
   (<SELECT query that produces the data>)
   AS <alias for the source query>
PIVOT
(
   <aggregation function>(<column being aggregated>)
FOR
   [<column that contains the values that will become column headers>]
   IN ( [first pivoted column], [second pivoted column], ... [last pivoted column])
)
AS <alias for the pivot table>
<optional ORDER BY clause>;
```

Cursors in SQL server:

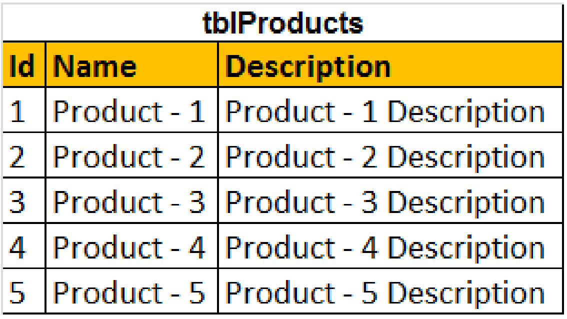
Relational Database Management Systems, including sql server are very good at handling data in SETS. For example, the following "UPDATE" query, updates a set of rows that matches the condition in the "WHERE" clause at the same time.

```
Update tblProductSales1 Set UnitPrice = 50 where ProductId = 101
```

However, if there is ever a need to process the rows, on a row-by-row basis, then cursors are your choice. Cursors are very bad for performance, and should be avoided always. Most of the time, cursors can be very easily replaced using joins.

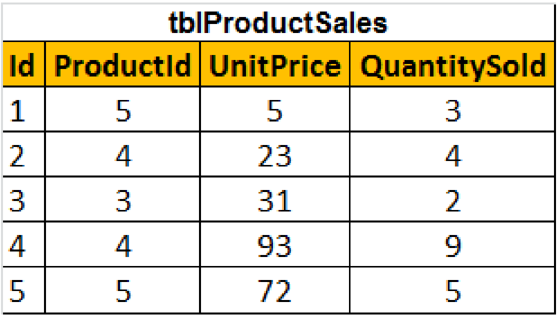
There are different types of cursors in sql server as listed below. We will talk about the differences between these cursor types in a later video session.
1. Forward-Only
2. Static
3. Keyset
4. Dynamic

Let us now look at a simple example of using sql server cursor to process one row at time. We will be using tblProducts1 and tblProductSales1 tables, for this example. The tables here show only 5 rows from each table. However, on my machine, there are 400,000 records in tblProducts1 and 600,000 records in tblProductSales1 tables. If you want to learn about generating huge amounts of random test data



tblProducts

Id	Name	Description
1	Product - 1	Product - 1 Description
2	Product - 2	Product - 2 Description
3	Product - 3	Product - 3 Description
4	Product - 4	Product - 4 Description
5	Product - 5	Product - 5 Description



tblProductSales

Id	ProductId	UnitPrice	QuantitySold
1	5	5	3
2	4	23	4
3	3	31	2
4	4	93	9
5	5	72	5

Cursor Example: Let us say, I want to update the UNITPRICE column in **tblProductSales1** table, based on the following criteria
1. If the ProductName = 'Product - 55', Set Unit Price to 55
2. If the ProductName = 'Product - 65', Set Unit Price to 65
3. If the ProductName is like 'Product - 100%', Set Unit Price to 1000

```
Declare @ProductId int
-- Declare the cursor using the declare keyword
Declare ProductIdCursor CURSOR FOR
Select ProductId from tblProductSales1
-- Open statement, executes the SELECT statment
-- and populates the result set
Open ProductIdCursor
```

```
-- Fetch the row from the result set into the variable
Fetch Next from ProductIdCursor into @ProductId
-- If the result set still has rows, @@FETCH_STATUS will be ZERO
While(@@FETCH_STATUS = 0)
Begin
 Declare @ProductName nvarchar(50)
 Select @ProductName = Name from tblProducts1 where Id = @ProductId

 if(@ProductName = 'Product - 55')
 Begin
  Update tblProductSales1 set UnitPrice = 55 where ProductId = @ProductId
 End
 else if(@ProductName = 'Product - 65')
 Begin
  Update tblProductSales1 set UnitPrice = 65 where ProductId = @ProductId
 End
 else if(@ProductName like 'Product - 100%')
 Begin
  Update tblProductSales1 set UnitPrice = 1000 where ProductId = @ProductId
 End

 Fetch Next from ProductIdCursor into @ProductId
End
-- Release the row set
CLOSE ProductIdCursor
-- Deallocate, the resources associated with the cursor
DEALLOCATE ProductIdCursor
```

The cursor will loop thru each row in tblProductSales1 table. As there are 600,000 rows, to be processed on a row-by-row basis, it takes around 40 to 45 seconds on my machine. We can achieve this very easily using a join, and this will significantly increase the performance. We will discuss about this in our next video session.

To check if the rows have been correctly updated, please use the following query.

```
Select  Name, UnitPrice
from tblProducts1 join
tblProductSales1 on tblProducts1.Id = tblProductSales1.ProductId
where (Name='Product - 55' or Name='Product - 65' or Name like 'Product - 100%')
```

While Loop In SQL

The WHILE statement is a control-flow statement that allows you to execute a statement block repeatedly as long as a specified condition is TRUE.

The following illustrates the syntax of the WHILE statement:

```
WHILE Boolean_expression
   { sql_statement | statement_block}
```

First, the Boolean_expression is an expression that evaluates to TRUE or FALSE.
Second, sql_statement | statement_block is any Transact-SQL statement or a set of Transact-SQL statements. A statement block is defined using the BEGIN...END statement.
If the Boolean_expression evaluates to FALSE when entering the loop, no statement inside the WHILE loop will be executed.
Inside the WHILE loop, you must change some variables to make the Boolean_expression returns FALSE at some points. Otherwise, you will have an indefinite loop.
Note that if the Boolean_expression contains a SELECT statement, it must be enclosed in parentheses.

To exit the current iteration of the loop immediately, you use the BREAK statement. To skip the current iteration of the loop and start the new one, you use the CONTINUE statement.

SQL Server WHILE example

Let's take an example of using the SQL Server WHILE statement to understand it better.

The following example illustrates how to use the WHILE statement to print out numbers from 1 to 5:

```
DECLARE @counter INT = 1;

WHILE @counter <= 5
BEGIN
   PRINT @counter;
   SET @counter = @counter + 1;
END
```

```
CREATE Table tblAuthors
(
   Id int identity primary key,
   Author_name nvarchar(50),
   country nvarchar(50)
)

Declare @Id int
Set @Id = 1

While @Id <= 12000
Begin
   Insert Into tblAuthors values ('Author - ' + CAST(@Id as nvarchar(10)),
              'Country - ' + CAST(@Id as nvarchar(10)) + ' name')
   Print @Id
   Set @Id = @Id + 1
End

select * from tblAuthors
```

Types of Transactions in SQL Server

What are Transactions / Transaction Management??

The process of combining a set of related operations into a single unit and executing those operations by applying to do everything or do-nothing principle is called transaction management. For example, the transfer money task is the combination of two operations

1. **Withdraw money from the Senders account**
2. **Deposit Money into the Receivers account.**

We need to execute these two operations by applying the "do everything or nothing principle" which is nothing but performing the transaction management. So, every transaction has two boundaries

Types of Transactions in SQL Server:

The SQL Server Transactions are classified into three types, they are as follows

1. **Auto Commit Transaction Mode (default)**
2. **Implicit Transaction Mode**
3. **Explicit Transaction Mode**

Lets create below table for understanding each of the type:

```
CREATE TABLE Customers
(
CustomerID INT PRIMARY KEY,
CustomerCode VARCHAR(10),
CustomerName VARCHAR(50)
)
```

Auto Commit Transaction Mode in SQL Server:

This is the default transaction mode in SQL Server. In this transaction mode, each SQL statement is treated as a separate transaction. In this Transaction Mode, as a developer, we are not responsible for either beginning the transaction (i.e. Begin Transaction) or ending a transaction (i.e. either Commit or Roll Back). Whenever we execute any DML statement, the SQL Server will automatically begin the transaction as well as end the transaction with a Commit or Rollback i.e. if the transaction is completed successfully, it is committed. If the transaction faces any error, it is rolled back. So, the programmer does not have any control over them.

Let us understand Auto Commit Transaction Mode with some examples. Please execute the below insert statement.

```
INSERT INTO Customer VALUES (1, 'CODE_1', 'David')
```

When you execute the above statement, the SQL Server will automatically begin the transaction and end the transaction with commit. Now, try to execute the below Insert query.

```
INSERT INTO Customer VALUES (1, 'CODE_2', 'John')
```

When you try to execute the above Insert Query, the insert failed as we are trying to insert a duplicate value into the primary key table, so the SQL Server will automatically begin the transaction and end the transaction with a Rollback. And when you execute the query you will get the below Primary Key Violation error.

Implicit Transaction Mode in SQL Server:

In the Implicit mode of transaction, the SQL Server is responsible for beginning the transaction implicitly before the execution of any DML statement and the developers are responsible to end the transaction with a commit or rollback. Once the transaction is ended ie. once the developer executes either the commit or rollback command, then automatically a new transaction will start by SQL Server. That means, in the case of implicit mode, a new transaction will start automatically by SQL Server after the current transaction is committed or rolled back by the programmer.

In order to use implicit transaction mode in SQL Server, first, we need to set the implicit transaction mode to **ON** using the **SET IMPLICIT_TRANSACTIONS** statement.

The value for **IMPLICIT_TRANSACTIONS can be ON or OFF**. When the value for implicit transaction mode is set to ON then a new transaction is automatically started by SQL Server whenever we execute any SQL statement (Insert, Select, Delete, and Update).

Examples to understand Implicit Mode of Transactions in SQL Server:
Before going to do anything, first, DELETE all the data from the Customer table by executing the below DELETE statement.

```
DELETE FROM Customer;
```

Step1: Set the Implicit transaction mode to ON

```
SET IMPLICIT_TRANSACTIONS ON
```

Step2: Execute the DML Statement

Now let us try to insert two records using the implicit mode of transaction.

```
INSERT INTO Customer VALUES (1, ‘CODE_1’, ‘David’);

INSERT INTO Customer VALUES (2, ‘CODE_2’, ‘John’);
```

Step3: Commit the transaction

```
COMMIT TRANSACTION
```

When you execute the Commit Transaction statement, then data is saved permanently into the database, and after that, a new transaction will automatically be started by SQL Server.

Step4: Now execute the following DML Statements

```
INSERT INTO Customer VALUES (3, ‘CODE_3’, ‘Pam’);

UPDATE Customer SET CustomerName = ‘John Changed’ WHERE CustomerID = 2;

SELECT * FROM Customer;
```

When you execute the above statement and you will get the below data.

Step5: Rollback the transaction

As of now, we have not either committed or rollback the transaction, so let roll back the transaction and see the table data.

```
ROLLBACK TRANSACTION
```

Once you roll back the transaction, issue a select query against the customer table and you will see the following data.

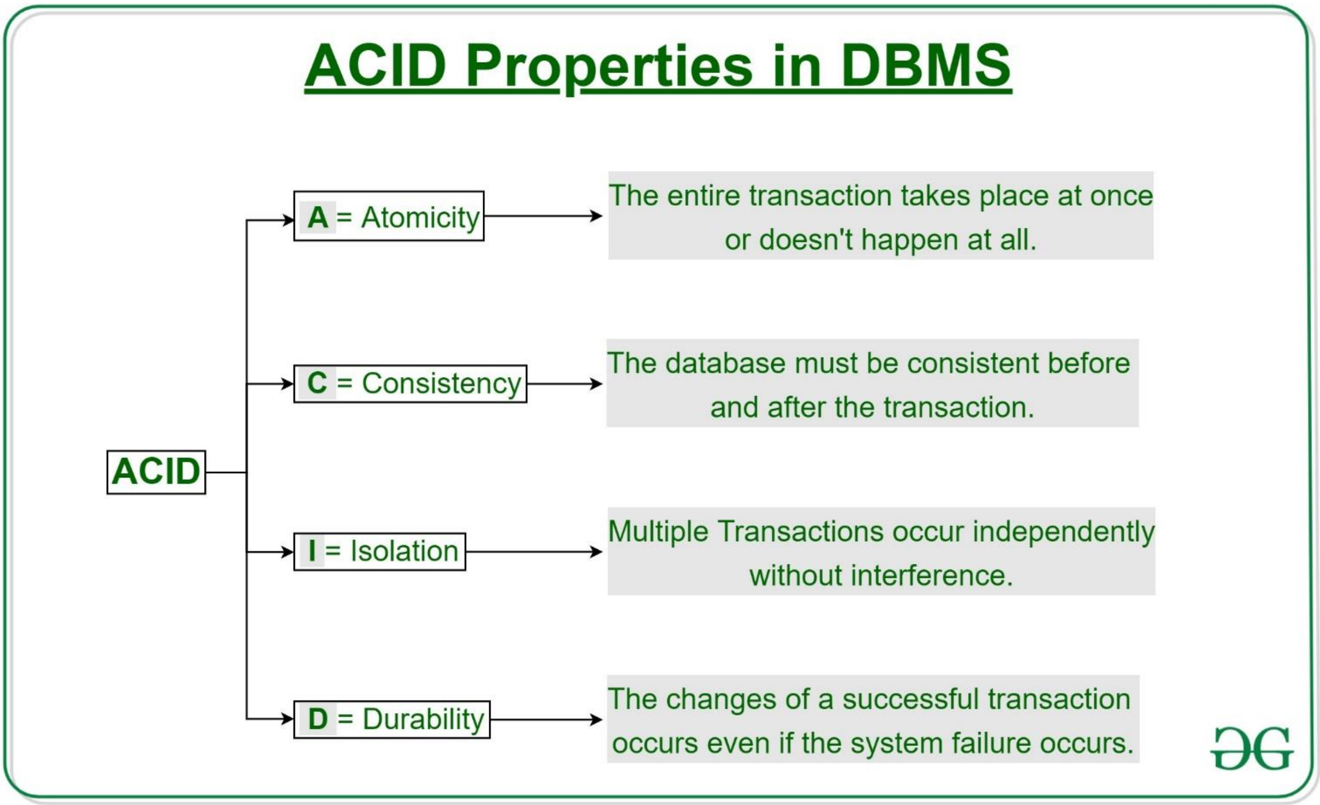
Note: If you don’t want to use implicit transaction mode, then you can turn it off by executing the below statement.

```
SET IMPLICIT_TRANSACTIONS OFF
```

Explicit Transaction Mode in SQL Server:

In the Explicit mode of transaction, the developer is only responsible for beginning the transaction as well as ending the transaction. In other words, we can say that the transactions that have a START and END explicitly written by the programmer are called explicit transactions.
Here, every transaction should start with the **BEGIN TRANSACTION** statement and ends with either a **ROLLBACK TRANSACTION** statement (when the transaction does not complete successfully) or a **COMMIT TRANSACTION** statement (when the transaction completes successfully). The Explicit Transaction Mode is most commonly used in triggers, stored procedures, and application programs.

A **transaction** is a single logical unit of work that accesses and possibly modifies the contents of a database. Transactions access data using read and write operations.
In order to maintain consistency in a database, before and after the transaction, certain properties are followed. These are called **ACID** properties.


ACID Properties in DBMS
ACID
A = Atomicity
The entire transaction takes place at once or doesn't happen at all.
C = Consistency
The database must be consistent before and after the transaction.
I = Isolation
Multiple Transactions occur independently without interference.
D = Durability
The changes of a successful transaction occurs even if the system failure occurs.

Atomicity:

By this, we mean that either the entire transaction takes place at once or doesn't happen at all. There is no midway i.e. transactions do not occur partially. Each transaction is considered as one unit and either runs to completion or is not executed at all. It involves the following two operations.
—**Abort**: If a transaction aborts, changes made to the database are not visible.
—**Commit**: If a transaction commits, changes made are visible.
Atomicity is also known as the 'All or nothing rule'.

Consistency:

This means that integrity constraints must be maintained so that the database is consistent before and after the transaction. It refers to the correctness of a database.

Isolation:

This property ensures that multiple transactions can occur concurrently without leading to the inconsistency of the database state. Transactions occur independently without interference. Changes occurring in a particular transaction will not be visible to any other transaction until that particular change in that transaction is written to memory or has been committed. This property ensures that the execution of transactions concurrently will result in a state that is equivalent to a state achieved these were executed serially in some order.

Durability:

This property ensures that once the transaction has completed execution, the updates and modifications to the database are stored in and written to disk and they persist even if a system failure occurs. These updates now become permanent and are stored in non-volatile memory. The effects of the transaction, thus, are never lost.

All about locking in SQL Server

Locking is essential to successful SQL Server transactions processing and it is designed to allow SQL Server to work seamlessly in a multi-user environment. Locking is the way that SQL Server manages transaction concurrency. To understand better the locking in SQL Server, it is important to understand that locking is designed to ensure the integrity of the data in the database, as it forces every SQL Server transaction to pass the ACID test.

While objects are locked, SQL Server will prevent other transactions from making any change of data stored in objects affected by the imposed lock. Once the lock is released by committing the changes or by rolling back changes to initial state, other transactions will be allowed to make required data changes.
Translated into the SQL Server language, this means that when a transaction imposes the lock on an object, all other transactions that require the access to that object will be forced to wait until the lock is released and that wait will be registered with the adequate wait type

Lock modes

Lock mode considers various lock types that can be applied to a resource that has to be locked:
Exclusive (X)
Shared (S)
Update (U)
Intent (I)
Schema (Sch)
Bulk update (BU)

Exclusive lock (X) – This lock type, when imposed, will ensure that a page or row will be reserved *exclusively* for the transaction that imposed the exclusive lock, as long as the transaction holds the lock.
The exclusive lock will be imposed by the transaction when it wants to modify the page or row data, which is in the case of DML statements DELETE, INSERT and UPDATE. An exclusive lock can be imposed to a page or row only if there is no other shared or exclusive lock imposed already on the target. This practically means that only one exclusive lock can be imposed to a page or row, and once imposed no other lock can be imposed on locked resources

Shared lock (S) – this lock type, when imposed, will reserve a page or row to be available only for reading, which means that any other transaction will be prevented to modify the locked record as long as the lock is active. However, a shared lock can be imposed by several transactions at the same time over the same page or row and in that way several transactions can *share* the ability for data reading since the reading process itself will not affect anyhow the actual page or row data. In addition, a shared lock will allow write operations, but no DDL changes will be allowed

Update lock (U) – this lock is similar to an exclusive lock but is designed to be more flexible in a way. An update lock can be imposed on a record that already has a shared lock. In such a case, the update lock will impose another shared lock on the target row. Once the transaction that holds the update lock is ready to change the data, the update lock (U) will be transformed to an exclusive lock (X). It is important to understand that update lock is asymmetrical in regards of shared locks. While the update lock can be imposed on a record that has the shared lock, the shared lock cannot be imposed on the record that already has the update lock

Intent locks (I) – this lock is a means used by a transaction to inform another transaction about its *intention* to acquire a lock. The purpose of such lock is to ensure data modification to be executed properly by preventing another transaction to acquire a lock on the next in hierarchy object. In practice, when a transaction wants to acquire a lock on the row, it will acquire an intent lock on a table, which is a higher hierarchy object. By acquiring the intent lock, the transaction will not allow other transactions to acquire the exclusive lock on that table (otherwise, exclusive lock imposed by some other transaction would cancel the row lock).

This is an important lock type from the performance aspect as the SQL Server database engine will inspect intent locks only at the table level to check if it is possible for transaction to acquire a lock in a safe manner in that table, and therefore intent lock eliminates need to inspect each row/page lock in a table to make sure that transaction can acquire lock on entire table

There are three regular intent locks and three so-called conversion locks:
Regular intent locks:

Intent exclusive (IX) – when an intent exclusive lock (IX) is acquired it indicates to SQL Server that the transaction has the intention to modify some of lower hierarchy resources by acquiring exclusive (X) locks individually on those lower hierarchy resources

Intent shared (IS) – when an intent shared lock (IS) is acquired it indicates to SQL Server that the transaction has the intention to read some lower hierarchy resources by acquiring shared locks (S) individually on those resources lower in the hierarchy

Intent update (IU) – when an intent shared lock (IS) is acquired it indicates to SQL Server that the transaction has the intention to read some of lower hierarchy resources by acquiring shared locks (S) individually on those resources lower in the hierarchy. The intent update lock (IU) can be acquired only at the page level and as soon as the update operation takes place, it converts to the intent exclusive lock (IX)
Conversion locks:

Shared with intent exclusive (SIX) – when acquired, this lock indicates that the transaction intends to read all resources at a lower hierarchy and thus acquire the shared lock on all resources that are lower in hierarchy, and in turn, to modify part of those, but not all. In doing so, it will acquire an intent exclusive (IX) lock on those lower hierarchy resources that should be modified. In practice, this means that once the transaction acquires a SIX lock on the table, it will acquire intent exclusive lock (IX) on the modified pages and exclusive lock (X) on the modified rows. Only one shared with intent exclusive lock (SIX) can be acquired on a table at a time and it will block other transactions from making updates, but it will not prevent other transactions to read the lower hierarchy resources they can acquire the intent shared (IS) lock on the table

Shared with intent update (SIU) – this is a bit more specific lock as it is a combination of the shared (S) and intent update (IU) locks. A typical example of this lock is when a transaction is using a query executed with the PAGELOCK hint and query, then the update query. After the transaction acquires an SIU lock on the table, the query with the PAGELOCK hint will acquire the shared (S) lock while the update query will acquire intent update (IU) lock

Update with intent exclusive (UIX) – when update lock (U) and intent exclusive (IX) locks are acquired at lower hierarchy resources in the table simultaneously, the update with intent exclusive lock will be acquired at the table level as a consequence

Schema locks (Sch) – The SQL Server database engine recognizes two types of the schema locks: **Schema modification lock (Sch-M)** and **Schema stability lock (Sch-S)**

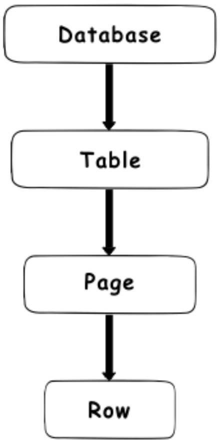
A **Schema modification lock (Sch-M)** will be acquired when a DDL statement is executed, and it will prevent access to the locked object data as the structure of the object is being changed. SQL Server allows a single schema modification lock (Sch-M) lock on any locked object. In order to modify a table, a transaction must wait to acquire a Sch-M lock on the target object. Once it acquires the schema modification lock (Sch-M), the transaction can modify the object and after the modification is completed and the lock will be released. A typical example of the Sch-M lock is an index rebuild, as an index rebuild is table modification process. Once the index rebuild ID is issued, a schema modification lock (Sch-M) will be acquired on that table and will be released only after the index rebuild process is completed (when used with ONLINE option, index rebuild will acquire Sch-M lock shortly at the end of the process)

A **Schema stability lock (Sch-S)** will be acquired while a schema-dependent query is being compiled and executed and execution plan is generated. This particular lock will not block other transactions to access the object data and it is compatible with all lock modes except with the schema modification lock (Sch-M). Essentially, Schema stability locks will be acquired by every DML and select query to ensure the integrity of the table structure (ensure that table doesn’t change while queries are running).

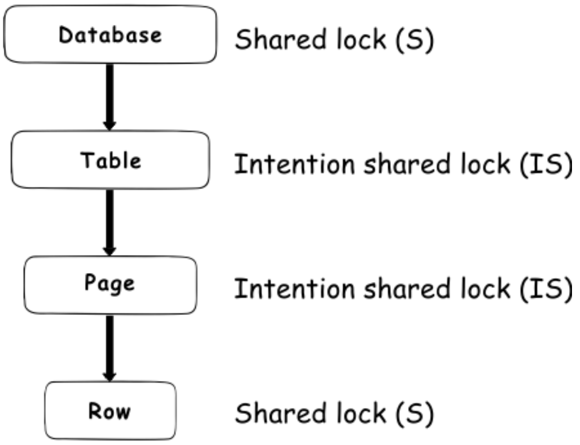
Bulk Update locks (BU) – this lock is designed to be used by bulk import operations when issued with a TABLOCK argument/hint. When a bulk update lock is acquired, other processes will not be able to access a table during the bulk load execution. However, a bulk update lock will not prevent another bulk load to be processed in parallel. But keep in mind that using TABLOCK on a clustered index table will not allow parallel bulk importing.

Locking hierarchy

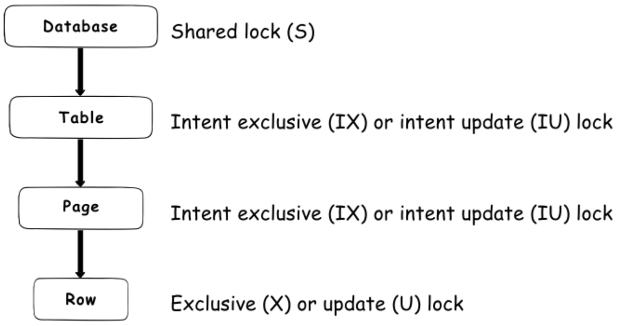
SQL Server has introduced the locking hierarchy that is applied when reading or changing of data is performed. The lock hierarchy starts with the database at the highest hierarchy level and down via table and page to the row at the lowest level



Essentially, there is always a shared lock on the database level that is imposed whenever a transaction is connected to a database. The shared lock on a database level is imposed to prevent dropping of the database or restoring a database backup over the database in use. For example, when a SELECT statement is issued to read some data, a shared lock (S) will be imposed on the database level, an intent shared lock (IS) will be imposed on the table and on the page level, and a shared lock (S) on the row itself



In case of a DML statement (i.e. insert, update, delete) a shared lock (S) will be imposed on the database level, an intent exclusive lock (IX) or intent update lock (IU) will be imposed on the table and on the page level, and an exclusive or update lock (X or U) on the row


Database
Shared lock (S)
Table
Intent exclusive (IX) or intent update (IU) lock
Page
Intent exclusive (IX) or intent update (IU) lock
Row
Exclusive (X) or update (U) lock

Deadlock definition in SQL Server

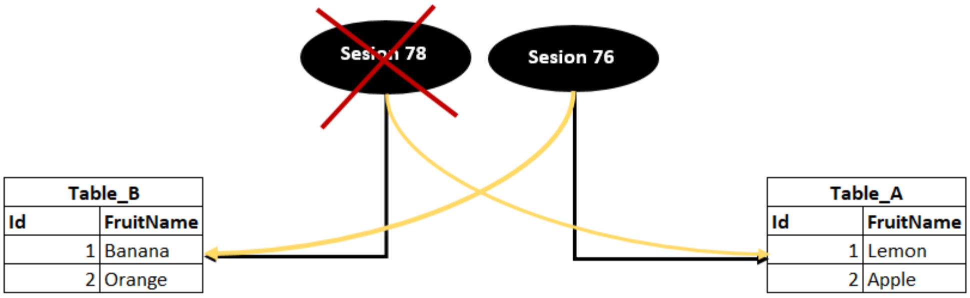
In terms of SQL Server, a deadlock occurs when two (or more) processes lock the separate resource. Under these circumstances, each process cannot continue and begins to wait for others to release the resource. However, the SQL engine understands that this contention would never end with the help of the lock manager warning and then it decides to kill one process to solve this conflict problem so that the other process can be completed. The killed process is called the deadlock victim.

```
DROP TABLE IF EXISTS Table_A
  CREATE TABLE Table_A (Id INT PRIMARY KEY, FruitName VARCHAR(100))
  GO
  INSERT INTO Table_A VALUES(1,'Lemon')
  INSERT INTO Table_A VALUES(2,'Apple')
  GO
  DROP TABLE IF EXISTS Table_B
  CREATE TABLE Table_B (Id INT PRIMARY KEY, FruitName VARCHAR(100))
  GO
  INSERT INTO  Table_B VALUES(1,'Banana')
  INSERT INTO Table_B VALUES(2,'Orange')
GO
```

As we explained in the deadlock definition, we need at least two processes for the deadlock, so that we will execute the following queries at the same time in the separated query windows.

```
  BEGIN TRAN
  UPDATE Table_A SET FruitName ='Mango' WHERE Id=1
  --WAITFOR DELAY '00:00:08'
  UPDATE Table_B SET FruitName ='Avacado' WHERE Id=1
  COMMIT TRAN


  BEGIN TRAN
  UPDATE Table_B SET FruitName ='Papaya' WHERE Id=1
  --WAITFOR DELAY '00:00:08'
  UPDATE Table_A SET FruitName ='Kiwi' WHERE Id=1
COMMIT TRAN
```



Table_B	
Id	FruitName
1	Banana
2	Orange

Table_A	
Id	FruitName
1	Lemon
2	Apple

SQL chooses the victim according to the cost of the rollback. It means that the victim of the process has been decided based on the minimum resource consumption.

SQL Server deadlock analysis and prevention

No we will discuss **how to read and analyse sql server deadlock information captured in the error log**, so we can understand what's causing the deadlocks and take appropriate actions to prevent or minimize the occurrence of deadlocks.

The deadlock information in the error log has three sections

Section	Description
Deadlock Victim	Contains the ID of the process that was selected as the deadlock victim and killed by SQL Server.
Process List	Contains the list of the processes that participated in the deadlock.
Resource List	Contains the list of the resources (database objects) owned by the processes involved in the deadlock

Process List : The process list has lot of items. Here are some of them that are particularly useful in understanding what caused the deadlock.

Node	Description
loginname	The loginname associated with the process
isolationlevel	What isolation level is used
procname	The stored procedure name
Inputbuf	The code the process is executing when the deadlock occured

Resource List : Some of the items in the resource list that are particularly useful in understanding what caused the deadlock.

Node	Description
objectname	Fully qualified name of the resource involved in the deadlock
owner-list	Contains (owner id) the id of the owning process and the lock mode it has acquired on the resource. lock mode determines how the resource can be accessed by concurrent transactions. S for Shared lock, U for Update lock, X for Exclusive lock etc
waiter-list	Contains (waiter id) the id of the process that wants to acquire a lock on the resource and the lock mode it is requesting

To prevent the deadlock that we have in our case, we need to ensure that database objects (Table A & Table B) are accessed in the same order every time.

Capturing Deadlocks:

1. Using SQL Profiler
2. Using Extended Events

On the **Select Events To Capture** screen, we will add the following events from the **Event library** to **Selected events** list.

- database_xml_deadlock_report
- lock_deadlock
- lock_deadlock_chain
- scheduler_monitor_deadlocks_ring_buffer_recorded
- xml_deadlock_report
- xml_deadlock_report_filtered

On the **Capture Global Fields** screen, we will select global events that will be captured with the events:

- client app name
- client connection id
- client hostname
- database id
- database name
- nt username
- sql text
- username

When we click the **xml_report** field on the **xml_deadlock_report** event, the XML report of the deadlock will be opened. This report can be very helpful in understanding the details of the deadlock.

Also, in the **xml_deadlock_report** event, we can see the deadlock graph and it offers a virtual representation of the deadlock.

Preventing Deadlocks in SQL Server

There is no exact and clear resolving formula for the deadlocks because all deadlocks might have unique characteristics. However, it is significant to understand the circumstances and the situation under which these deadlocks have occurred because this approach will broadly help to resolve them. After then, the following solution recommendations might help.

- Access the resources in the same order
- Write the shortest transactions as much as possible and lock the resource for the minimum duration
- Limiting the usage of the cursors
- Design more normalized databases
- Avoid poorly-optimized queries

Conclusion

Resolving the deadlock can be more complicated and struggling, so as a first step, we should clearly understand the deadlock definition and then set to work capturing and handling the deadlocks. In the final step, we can work on preventing or minimizing the deadlock.

Cross apply and Outer apply in SQL server

Consider below two tables for understanding these concepts:

```
SELECT * FROM Department
SELECT * FROM Employee
```

Now to fetch all the matching records we will use Inner join as below:

```
Select D. Dept_name, E.Name, E.Gender, E.Salary
from Department D
Inner Join Employee E
On D. Dept_Id  = E.DepartmentId
```

Now if we want to retrieve all the matching rows between **Department** and **Employee** tables + the non-matching rows from the LEFT table (**Department**)

This can be very easily achieved using a Left Join as shown below.

```
Select D. Dept_name, E.Name, E.Gender, E.Salary
from Department D
Left Join Employee E
On D.Dept_Id = E.DepartmentId
```

Now let's assume we do not have access to the Employee table. Instead, we have access to the following Table Valued function, that returns all employees belonging to a department-by-Department Id.

fn_GetEmployeesByDepartmentId

```
Create function fn_GetEmployeesByDepartmentId(@DepartmentId int)
Returns Table
as
Return
(
   Select Id, Name, Gender, Salary, DepartmentId
   from Employee where DepartmentId = @DepartmentId
)
Go
```

The following query returns the employees of the department with Id =1.

```
Select * from fn_GetEmployeesByDepartmentId(1)
```

Now if you try to perform an Inner or Left join between **Department** table and **fn_GetEmployeesByDepartmentId**() function you will get an error.

```
Select D.Dept_name, E.Name, E.Gender, E.Salary
from Department D
Inner Join fn_GetEmployeesByDepartmentId(D.Dept_id) E
On D.Dept_id = E.DepartmentId
```

If you execute the above query you will get the error

This is where we use **Cross Apply** and **Outer Apply** operators. **Cross Apply** is semantically equivalent to **Inner Join** and **Outer Apply** is semantically equivalent to **Left Outer Join**.

Just like Inner Join, Cross Apply retrieves only the matching rows from the Department table and fn_GetEmployeesByDepartmentId() table valued function.

```
Select D.Dept_name, E.Name, E.Gender, E.Salary
from Department D
Cross Apply fn_GetEmployeesByDepartmentId(D.Dept_id) E
```

Just like Left Outer Join, Outer Apply retrieves all matching rows from the Department table and fn_GetEmployeesByDepartmentId() table valued function + non-matching rows from the left table (Department)

```
Select D.Dept_name, E.Name, E.Gender, E.Salary
from Department D
Outer Apply fn_GetEmployeesByDepartmentId(D.Dept_id) E
```

How does Cross Apply and Outer Apply work

- The APPLY operator introduced in SQL Server 2005, is used to join a table to a table-valued function.
- The Table Valued Function on the right-hand side of the APPLY operator gets called for each row from the left (also called outer table) table.
- Cross Apply returns only matching rows (semantically equivalent to Inner Join)
- Outer Apply returns matching + non-matching rows (semantically equivalent to Left Outer Join). The unmatched columns of the table valued function will be set to NULL.