National University of Computer and Emerging Sciences

Laboratory Manuals

for

Database Systems Lab

(CL -2005)

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Lab Manual 10

SQL

SQL tutorial gives unique learning on Structured Query Language and it helps to make practice on SQL commands which provides immediate results. SQL is a language of database, it includes database creation, deletion, fetching rows and modifying rows etc. SQL is an ANSI (American National Standards Institute) standard, but there are many different versions of the SQL language.

Why SQL?

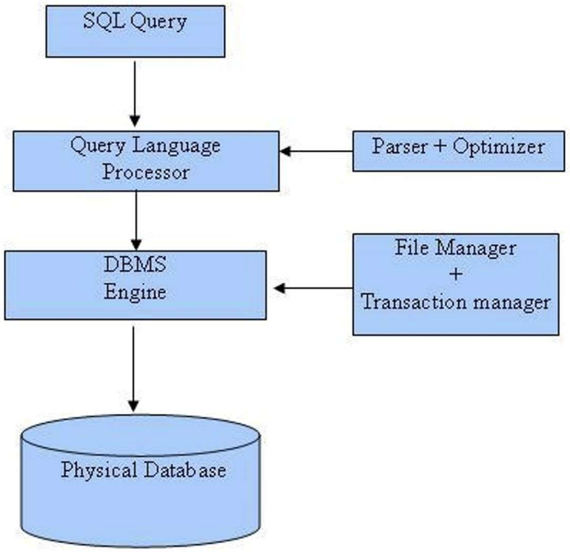
- Allows users to access data in relational database management systems.
- Allows users to describe the data.
- Allows users to define the data in the database and manipulate that data.
- Allows embedding within other languages using SQL modules, libraries & pre-compilers.
- Allows users to create and drop databases and tables.
- Allows users to create views, stored procedure, functions in a database.
- Allows users to set permissions on tables, procedures and views

SQL Process

When you are executing an SQL command for any RDBMS, the system determines the best way to carry out your request and SQL engine figures out how to interpret the task.

There are various components included in the process. These components are Query Dispatcher, Optimization Engines, Classic Query Engine and SQL Query Engine, etc. Classic query engine handles all non-SQL queries, but SQL query engine won't handle logical files.

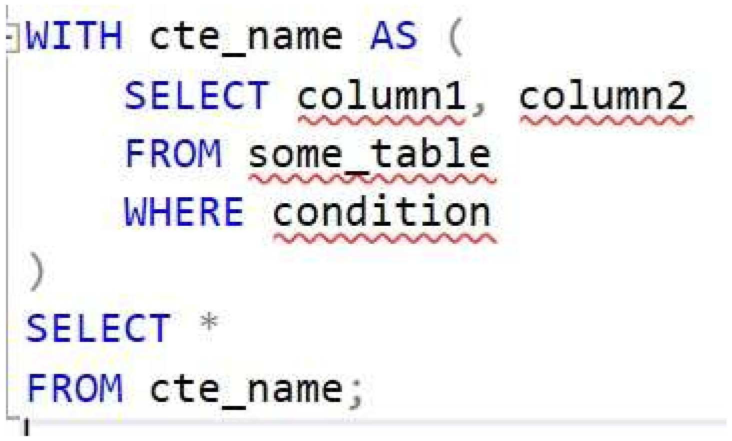
Following is a simple diagram showing SQL Architecture:



1. CTEs

A CTE (Common Table Expression) is a temporary named result set in SQL that you can reference within a SELECT, INSERT, UPDATE, or DELETE statement.

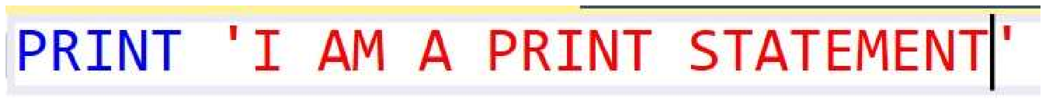
Think of it as a temporary view that's only available during the execution of a single query.



```
WITH cte_name AS (
    SELECT column1, column2
    FROM some_table
    WHERE condition
)
SELECT *
FROM cte_name;
```

2. PRINT KEYWORD

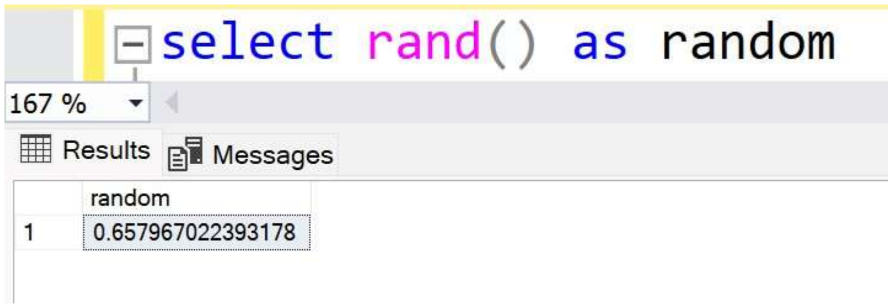
- Used to display a message in the query output (mainly in SQL Server).
- Helpful for debugging and tracking execution flow inside stored procedures or scripts.



```
PRINT 'I AM A PRINT STATEMENT'
```

3. RAND() FUNCTION

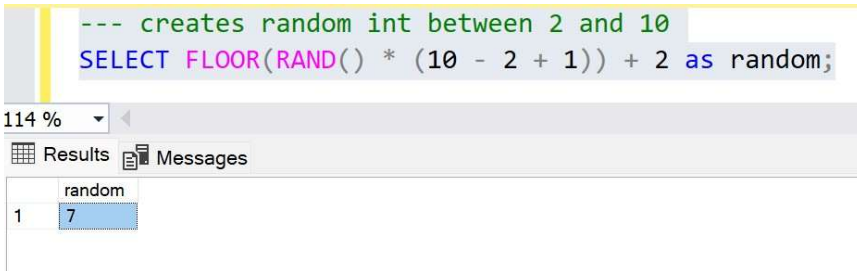
- Returns a random float value between 0 and 1.
- Useful for generating test data or randomizing results.



```
select rand() as random
```

```
    random
1   0.657967022393178
```

- To generate a random integer between two numbers:



```
--- creates random int between 2 and 10
SELECT FLOOR(RAND() * (10 - 2 + 1)) + 2 as random;
```

```
    random
1   7
```

PL SQL

PL/SQL stands for Procedural Language extensions to SQL. It is Oracle's procedural programming language, designed to extend the power of SQL with the ability to use programming constructs like variables, loops, conditions, and error handling.

Key Features:

a. Block-structured: Code is written in logical blocks (DECLARE, BEGIN, EXCEPTION, END).

b. Supports control flow: Includes IF, LOOP, WHILE, FOR, CASE, etc.

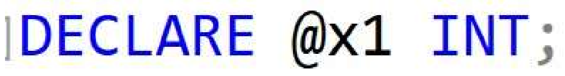
c. Reusable logic: Write stored procedures, functions, triggers, and packages.

d. Exception handling: Built-in error management using EXCEPTION blocks.

e. Tightly integrated with SQL: Allows use of DML/DDL statements within procedural code.

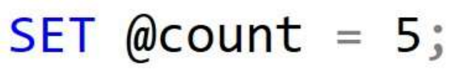
Handling Variables

- **Declaration**
    - You declare a variable to store and reuse data within SQL blocks, procedures, or functions.



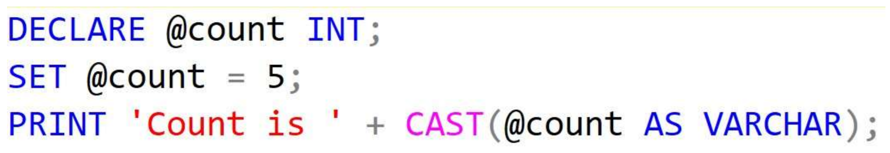
```sql
DECLARE @x1 INT;
```

- **Setting**



```sql
SET @count = 5;
```

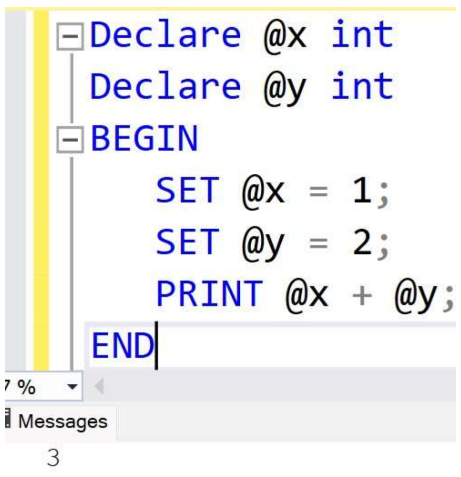
- **Using**
    - Once declared and set, variables can be used in conditions, calculations, and output.



```sql
DECLARE @count INT;
SET @count = 5;
PRINT 'Count is ' + CAST(@count AS VARCHAR);
```

Code Block

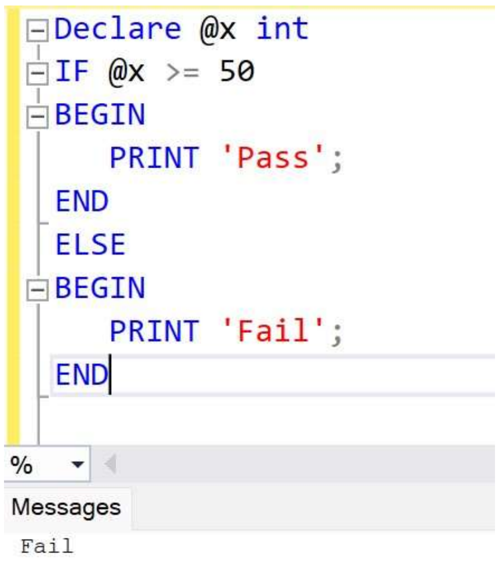
- A group of statements executed together, often enclosed in BEGIN ... END



```sql
Declare @x int
Declare @y int
BEGIN
    SET @x = 1;
    SET @y = 2;
    PRINT @x + @y;
END
```

```
3
```

IF...ELSE

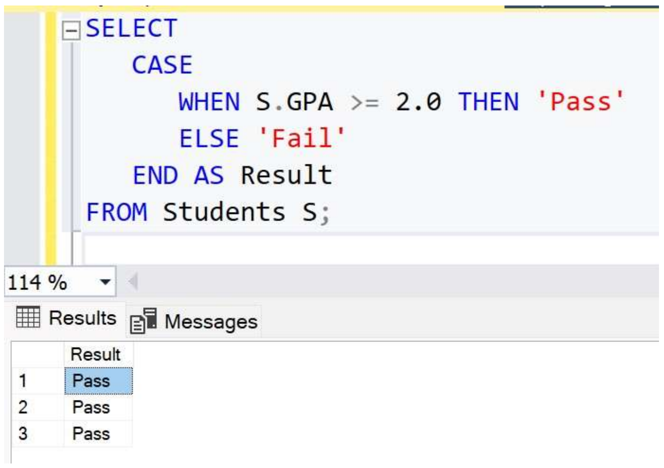


```sql
Declare @x int
IF @x >= 50
BEGIN
    PRINT 'Pass';
END
ELSE
BEGIN
    PRINT 'Fail';
END
```

```
Fail
```

CASE Expression

- Inline conditional logic—used in SELECT, WHERE, ORDER BY, etc.

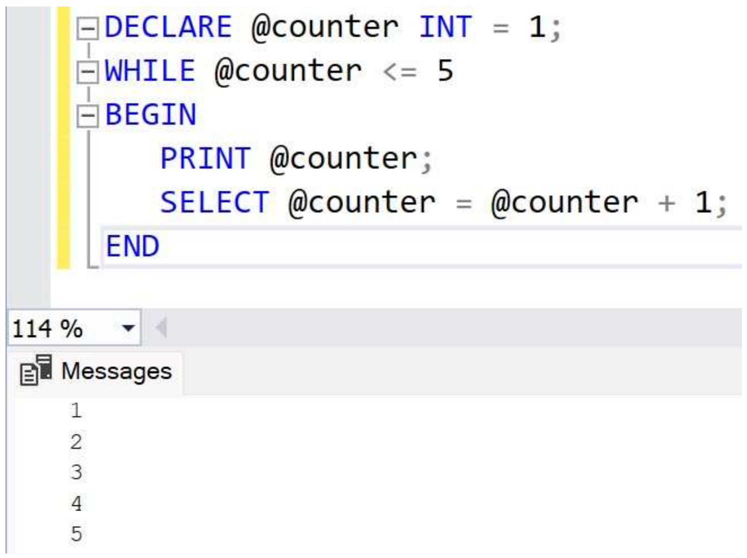


```sql
SELECT
    CASE
        WHEN S.GPA >= 2.0 THEN 'Pass'
        ELSE 'Fail'
    END AS Result
FROM Students S;
```

	Result
1	Pass
2	Pass
3	Pass

WHILE Loop

- Repeats code block while a condition is true.



```
DECLARE @counter INT = 1;
WHILE @counter <= 5
BEGIN
    PRINT @counter;
    SELECT @counter = @counter + 1;
END
```

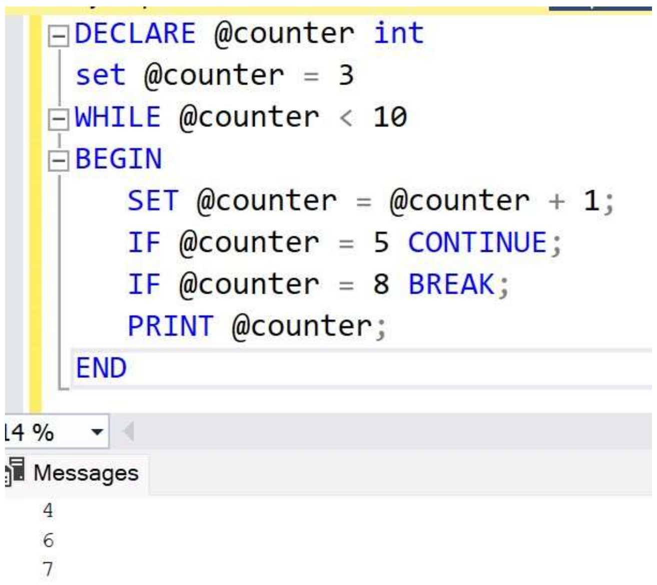
114 %

Messages

```
1
2
3
4
5
```

BREAK and CONTINUE

- Used within WHILE loops:
  - BREAK exits the loop.
  - CONTINUE skips current iteration and moves to next.



```
DECLARE @counter int
set @counter = 3
WHILE @counter < 10
BEGIN
    SET @counter = @counter + 1;
    IF @counter = 5 CONTINUE;
    IF @counter = 8 BREAK;
    PRINT @counter;
END
```

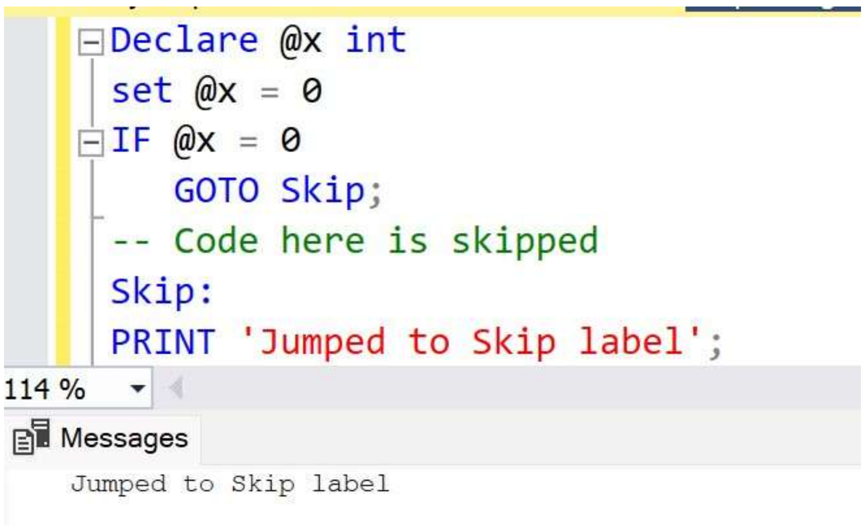
14 %

Messages

```
4
6
7
```

GOTO

- Transfers execution to a labeled part of the script (less recommended for clarity).

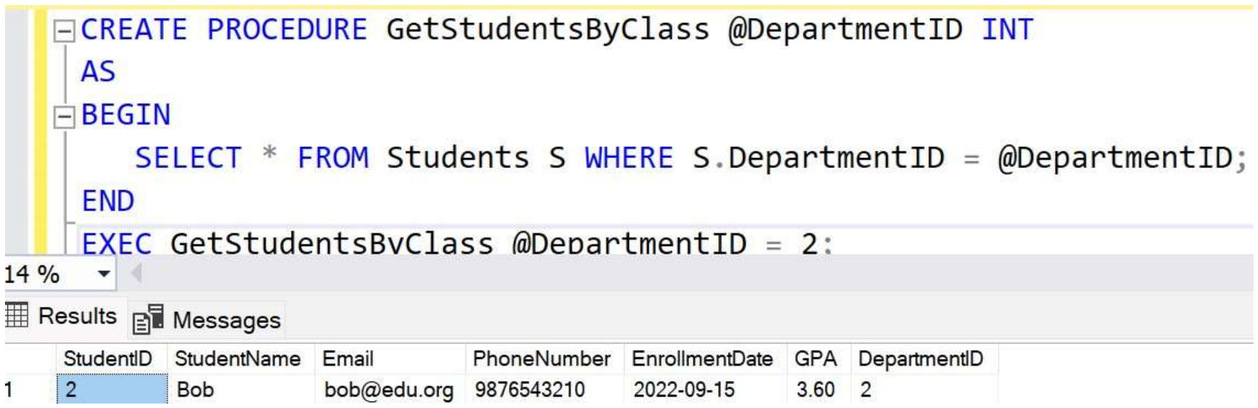


```
Declare @x int
set @x = 0
IF @x = 0
   GOTO Skip;
-- Code here is skipped
Skip:
PRINT 'Jumped to Skip label';
```

```
Jumped to Skip label
```

Stored Procedure (For detail, refer previous manual for SPs)

- Reusable collection of SQL statements with optional input/output parameters.

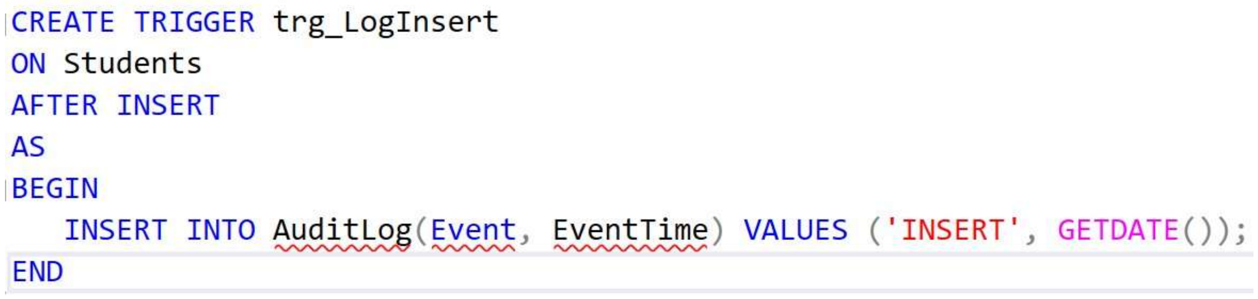


```
CREATE PROCEDURE GetStudentsByClass @DepartmentID INT
AS
BEGIN
   SELECT * FROM Students S WHERE S.DepartmentID = @DepartmentID;
END
EXEC GetStudentsByClass @DepartmentID = 2;
```

	StudentID	StudentName	Email	PhoneNumber	EnrollmentDate	GPA	DepartmentID
1	2	Bob	bob@edu.org	9876543210	2022-09-15	3.60	2

Trigger (For Detail, refer previous manuals specific to triggers)

- Automatically executes in response to a SQL event (INSERT, UPDATE, DELETE).



```
CREATE TRIGGER trg_LogInsert
ON Students
AFTER INSERT
AS
BEGIN
   INSERT INTO AuditLog(Event, EventTime) VALUES ('INSERT', GETDATE());
END
```

Scalar Function

A scalar function is a user-defined or built-in SQL function that returns a single value (a scalar), based on input values or expressions. Unlike table-valued functions (which return rows/columns), scalar functions always return only one value of a defined data type.

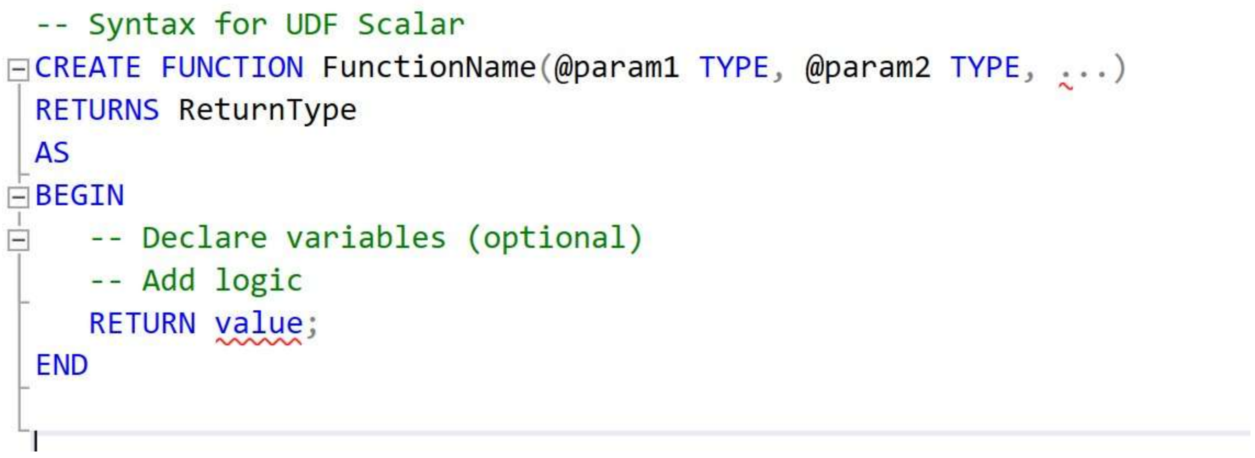
Built-In Types

These are provided by SQL and categorized into:

- String Functions: LEN(), UPPER(), LOWER(), SUBSTRING()
- Numeric Functions: ROUND(), ABS(), POWER()
- Date/Time Functions: GETDATE(), DATEADD(), DATEDIFF()
- Conversion Functions: CAST(), CONVERT()
- System Functions: ISNULL(), COALESCE(), NEWID()

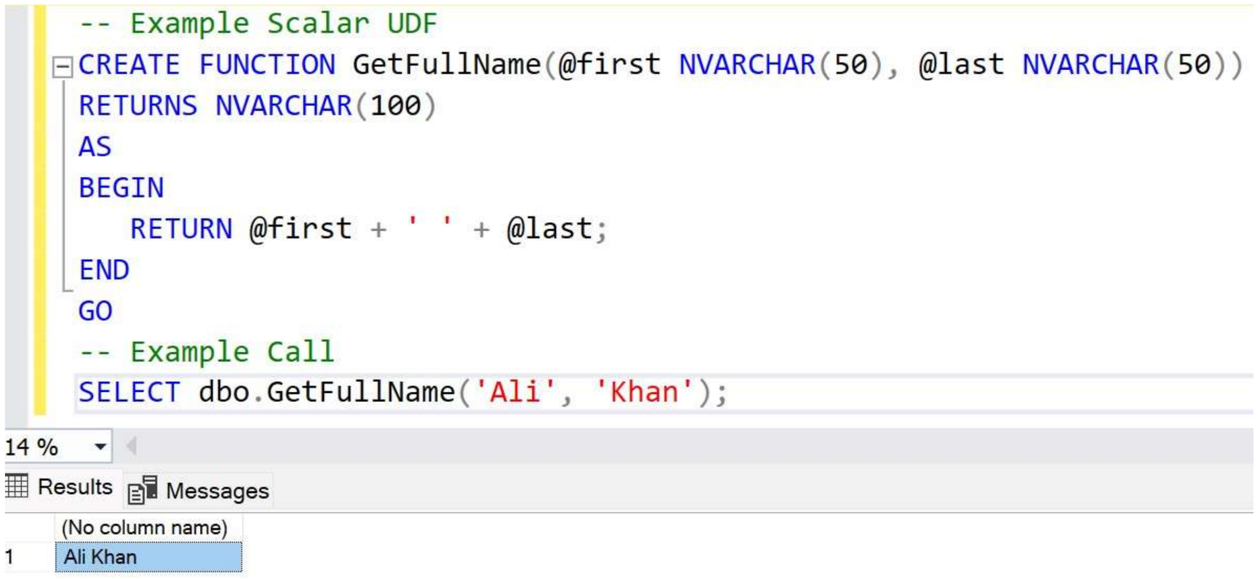
User Defined Types

These are custom functions created by users to encapsulate logic and reuse it across queries.



```sql
-- Syntax for UDF Scalar
CREATE FUNCTION FunctionName(@param1 TYPE, @param2 TYPE, ...)
RETURNS ReturnType
AS
BEGIN
    -- Declare variables (optional)
    -- Add logic
    RETURN value;
END
```

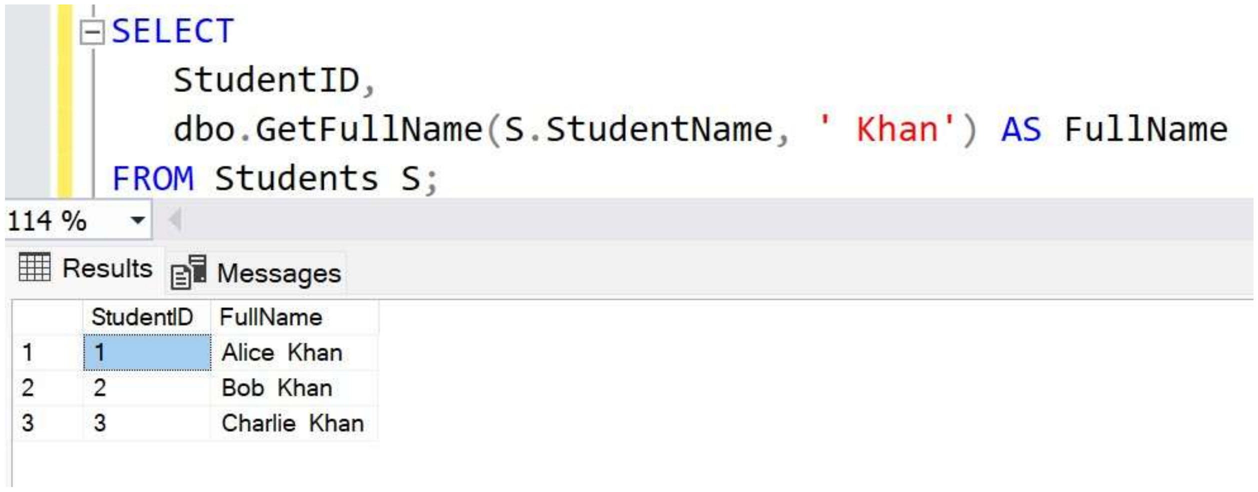
Example



```sql
-- Example Scalar UDF
CREATE FUNCTION GetFullName(@first NVARCHAR(50), @last NVARCHAR(50))
RETURNS NVARCHAR(100)
AS
BEGIN
   RETURN @first + ' ' + @last;
END
GO
-- Example Call
SELECT dbo.GetFullName('Ali', 'Khan');
```

```
14 %
Results  Messages
   (No column name)
1  Ali Khan
```

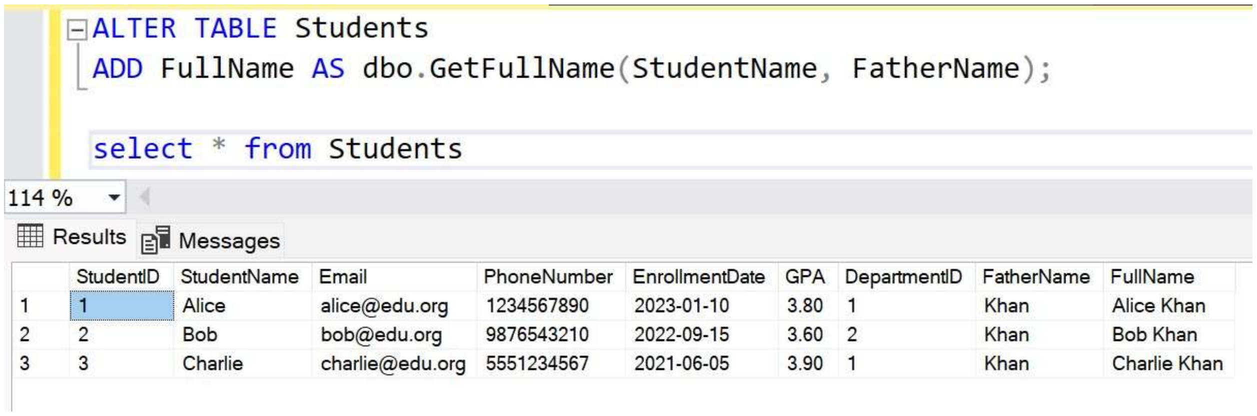
Using Scalar Function as Computed Column in SELECT



```
SELECT
    StudentID,
    dbo.GetFullName(S.StudentName, ' Khan') AS FullName
FROM Students S;
```

	StudentID	FullName
1	1	Alice Khan
2	2	Bob Khan
3	3	Charlie Khan

Using Scalar Function as Computed Column in `ALTER TABLE`



```sql
ALTER TABLE Students
ADD FullName AS dbo.GetFullName(StudentName, FatherName);

select * from Students
```

	StudentID	StudentName	Email	PhoneNumber	EnrollmentDate	GPA	DepartmentID	FatherName	FullName
1	1	Alice	alice@edu.org	1234567890	2023-01-10	3.80	1	Khan	Alice Khan
2	2	Bob	bob@edu.org	9876543210	2022-09-15	3.60	2	Khan	Bob Khan
3	3	Charlie	charlie@edu.org	5551234567	2021-06-05	3.90	1	Khan	Charlie Khan

- The column FullName will automatically compute using the function.
- It is virtual (not physically stored unless PERSISTED is specified).

Applications

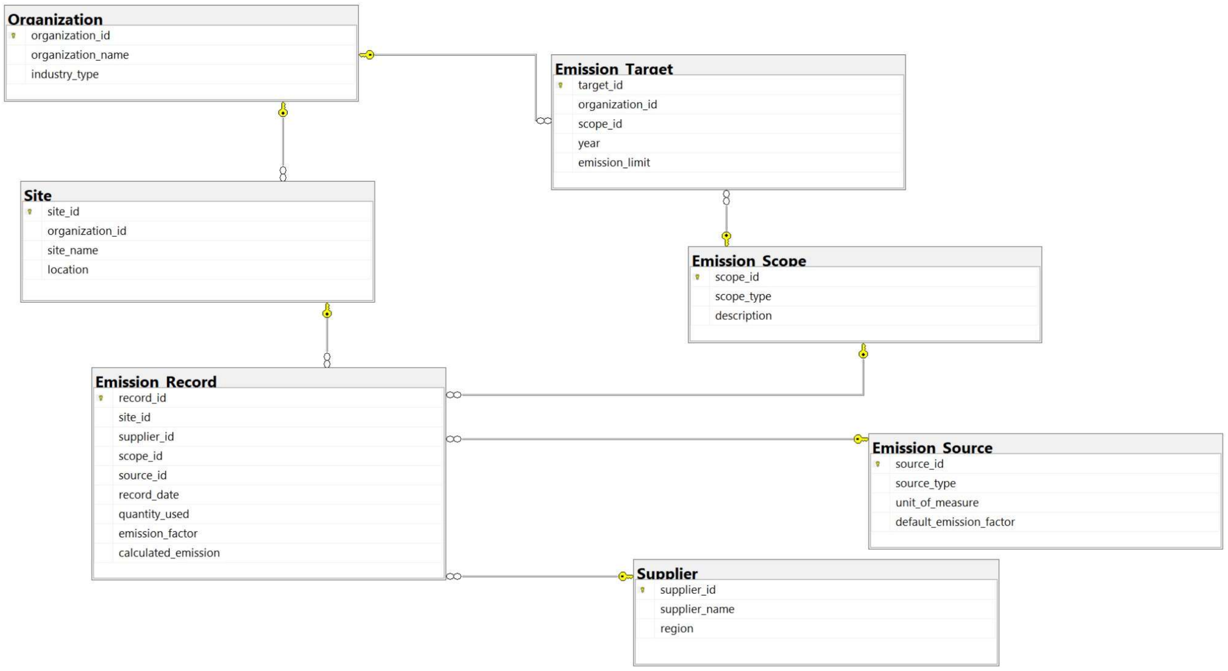
1. Scalar Function
    - Data formatting (e.g., full names, initials)
    - Reusable business logic (e.g., tax calculations)
    - Clean up complex queries
2. Trigger
    - Maintain audit logs
    - Auto-enforce data integrity rules
    - Prevent/limit unwanted data changes
3. Stored Procedure
    - Wrap and reuse large logic blocks
    - Improve performance via precompiled execution
    - Parameterized operations (e.g., filter by user input)

Comparison of Stored Procedures, Triggers and Scalar Functions

Feature	**Stored Procedure**	**Scalar Function**	**Trigger**
Returns	None / Result sets	Single scalar value	No return (executes automatically)
Execution	Manually invoked	Called in expressions	Automatically triggered
Parameters	Supports IN/OUT/INOUT	Input only	None
Can Modify Data	Yes	No	Yes
Usage Context	Batch operations, workflows	Computation, formatting	Auditing, enforcing rules

Happy learning and querying!

Download sql file provided with this manual. Run that file and a schema with following details will be created:



In Lab Exercises

Super Dog and the Carbon Code Crackdown

In a futuristic city called EcoMetra, pollution has been on the rise. But there's hope! The legendary hero, Super Dog, has sniffed out a new mission — to analyze and reduce carbon emissions across the city. With his sharp instincts, high-speed tail-powered jetpack, and a team of brilliant animal sidekicks, he sets out to understand where all the carbon is coming from.

Characters:

- Super Dog – The hero! Can fly, analyze data at super-speed, and communicate with AI systems.
- EcoCat – Expert in Scope 1, 2, and 3 emissions, has infrared vision to detect direct emissions.
- PandaBytes – The coder panda, good with spreadsheets, databases, and modeling.
- Chameleon Camo – Disguises herself to infiltrate polluting facilities and collect raw data.

Mission Objective:

Help Super Dog and his team **gather, calculate, and analyze carbon emissions data** from different **suppliers, sites, and emission scopes** to build a full emissions profile for EcoMetra's organizations.

Write these queries to getting started with in-lab work

1. SuperDog noticed that Site Managers accidentally submit the same emission patrol record multiple times for the same source on the same day. Help SuperDog by writing a trigger that blocks duplicate entries for the same site_id, source_id, and record_date

2. Professor Bark wants to classify all emission records into "Low," "Moderate," or "High" levels so he can assign cleanup teams accordingly. Create a scalar function called fn_GetEmissionCategory that:

    - Returns Low if emissions < 500

    - Returns Moderate if < 5000

    - Returns High otherwise

    Use this function in a SELECT query to show all records and their category!

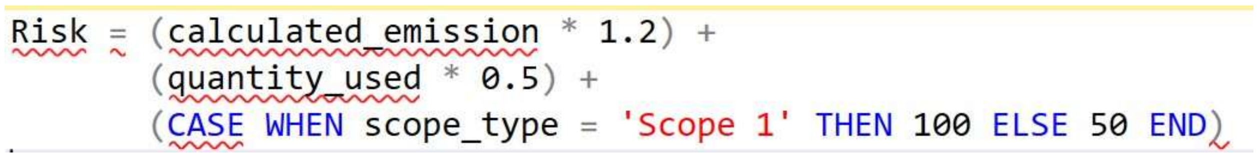
3. GadgetTail wants each emission record to show its category right in the table for dashboard display.

    ○ Use ALTER TABLE to add a computed column emission_category

    ○ Use your earlier function fn_GetEmissionCategory in it

    ○ Remember to PERSIST the computed column!

4. Dr. Barkstein is building a Risk Dashboard using a Risk Index formula



```
Risk = (calculated_emission * 1.2) +
       (quantity_used * 0.5) +
       (CASE WHEN scope_type = 'Scope 1' THEN 100 ELSE 50 END)
```

    Write a scalar function fn_ComputeRiskScore to do the formula and ALTER TABLE Emission_Record to add a computed column risk_score that uses this function

5. If a site consumes > 20000 liters of diesel in a single record, it's considered an emergency fuel burn. This requires:

    - Auto-sending an alert (insert into Emergency_Alerts)
    - Auto-tagging the emission source (e.g., source_type += ' - Emergency Burn')

Write a trigger that:

- ○ Detects this case on insert/update
- ○ Performs both of the above actions
- ○ Handles potential string length overflow in source_type safely

Part-II: Snake & Ladder Game Simulation using SQL

Simulate a two-player Snake & Ladder game using SQL. Players take turns rolling a dice, and their positions on a board are updated based on the dice roll. The game alternates between Player 1 and Player 2, with every odd record being Player 1's turn and every even record being Player 2's turn

Requirements:

1. Table Design: Create a table LudoGamePlay to track each player's move. The table should store the following
   - game_id (auto-incremented primary key)
   - player_id (1 for Player 1, 2 for Player 2)
   - dice_roll (random number between 1 and 6)
   - position (current position of the player on the board)
2. Game Flow
   - Player 1 starts first. Each player rolls a dice and moves accordingly.
   - The dice roll is randomly generated using SQL.

○ If the dice roll takes a player past position 100, they remain at position 100.

○ The game alternates between Player 1 and Player 2 until one of them reaches position 100.

Logic Help & Tips:

1. **Dice Roll**

   A record will be inserted into the LudoGamePlay table having the value for dice_roll calculated by rand()

2. **Create a Scalar Function: Calculate New Position**

   CalculateNewPosition(@current_position INT, @dice_roll INT)

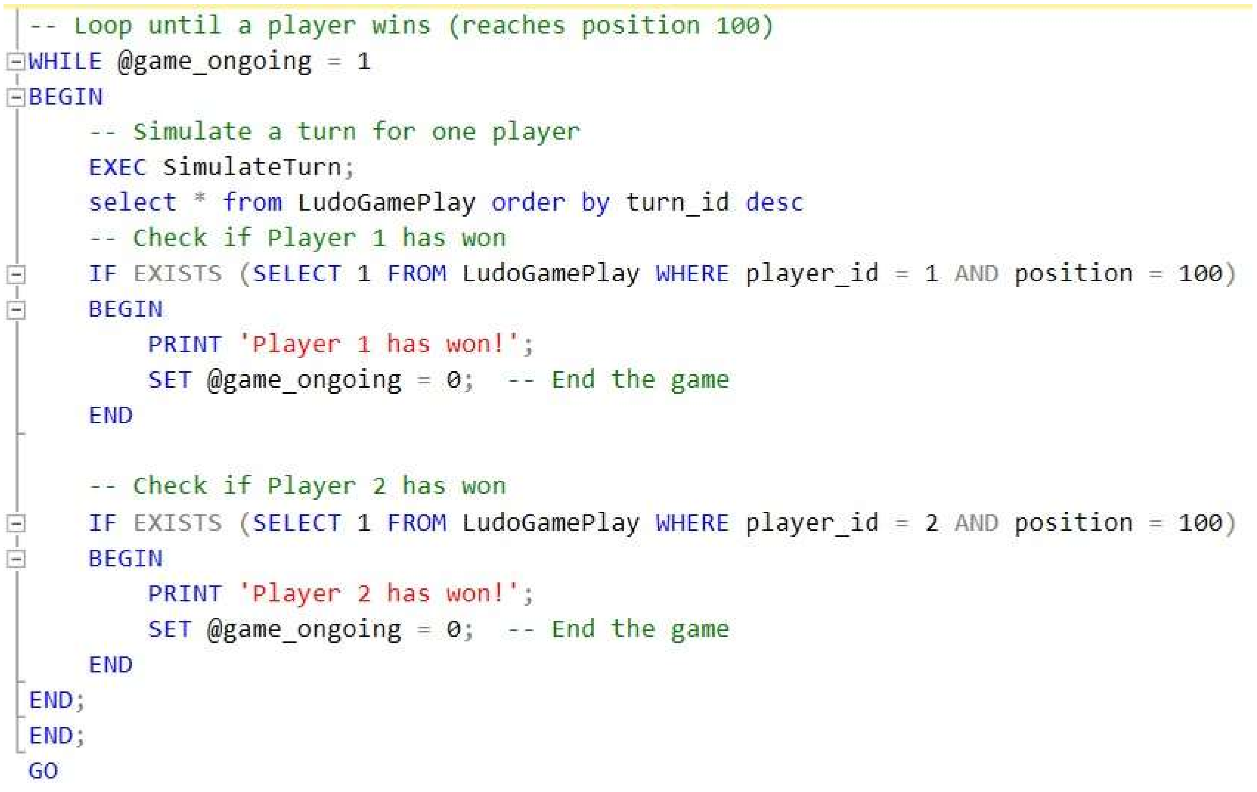
3. **Create a Trigger to Update Position on each dice roll e.g.**

   CREATE TRIGGER trg_UpdatePosition

   ON LudoGamePlay

   AFTER INSERT

4. **Create a Stored Procedure to Simulate a Turn 5.**
To perform a turn run the stored procedure
6. **Make a gameloop like this:**



```sql
-- Loop until a player wins (reaches position 100)
WHILE @game_ongoing = 1
BEGIN
    -- Simulate a turn for one player
    EXEC SimulateTurn;
    select * from LudoGamePlay order by turn_id desc
    -- Check if Player 1 has won
    IF EXISTS (SELECT 1 FROM LudoGamePlay WHERE player_id = 1 AND position = 100)
    BEGIN
        PRINT 'Player 1 has won!';
        SET @game_ongoing = 0;  -- End the game
    END

    -- Check if Player 2 has won
    IF EXISTS (SELECT 1 FROM LudoGamePlay WHERE player_id = 2 AND position = 100)
    BEGIN
        PRINT 'Player 2 has won!';
        SET @game_ongoing = 0;  -- End the game
    END
END;
END;
GO
```

Submission Guidelines

1. submit following files strictly following the naming convention: l231234.sql

Best of Luck! Happy Querying