Chapter 42: Functions (Aggregate)

Section 42.1: Conditional aggregation

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>greater than 50</td>
<td>50</td>
</tr>
<tr>
<td>less than 30</td>
<td>30</td>
</tr>
<tr>
<td>between 10 and 20</td>
<td>15</td>
</tr>
</tbody>
</table>

The values are added using the SUM() function.

Section 42.2: List Concatenation

<table>
<thead>
<tr>
<th>List</th>
<th>Concatenated List</th>
</tr>
</thead>
<tbody>
<tr>
<td>1, 2</td>
<td>1 2</td>
</tr>
<tr>
<td>3, 4</td>
<td>3 4</td>
</tr>
<tr>
<td>5, 6</td>
<td>5 6</td>
</tr>
</tbody>
</table>

The lists are concatenated using the CONCATENATE() function.

Section 52: Subqueries

Section 52.1: Subquery in FROM clause

A subquery is a SELECT clause that is used to generate a temporary table that is used in another SELECT clause.

Section 52.2: Subquery in SELECT clause

A subquery is a SELECT clause that is used to generate a temporary table that is used in another SELECT clause.

Section 52.3: Subquery in WHERE clause

A subquery is a SELECT clause that is used to generate a temporary table that is used in another SELECT clause.

Section 52.4: Correlated Subqueries

A subquery is a SELECT clause that is used to generate a temporary table that is used in another SELECT clause.

Section 52.5: Filter query results using query on different

A subquery is a SELECT clause that is used to generate a temporary table that is used in another SELECT clause.
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<td>Using BEGIN ... END</td>
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<td>Create and call a stored procedure</td>
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<td>55</td>
<td>Transactions</td>
<td>144</td>
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<td>158</td>
</tr>
</tbody>
</table>
About

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Please send feedback and corrections to web@petercv.com
Chapter 1: Getting started with SQL

<table>
<thead>
<tr>
<th>Version</th>
<th>Short Name</th>
<th>Standard</th>
<th>Release Date</th>
</tr>
</thead>
</table>

Section 1.1: Overview

Structured Query Language (SQL) is a special-purpose programming language designed for managing data held in a Relational Database Management System (RDBMS). SQL-like languages can also be used in Relational Data Stream Management Systems (RDSMS), or in "not-only SQL" (NoSQL) databases.

SQL comprises of 3 major sub-languages:

1. Data Definition Language (DDL): to create and modify the structure of the database;
2. Data Manipulation Language (DML): to perform Read, Insert, Update and Delete operations on the data of the database;
3. Data Control Language (DCL): to control the access of the data stored in the database.

SQL article on Wikipedia

The core DML operations are Create, Read, Update and Delete (CRUD for short) which are performed by the statements INSERT, SELECT, UPDATE and DELETE.

There is also a (recently added) MERGE statement which can perform all 3 write operations (INSERT, UPDATE, DELETE).

CRUD article on Wikipedia

Many SQL databases are implemented as client/server systems; the term "SQL server" describes such a database. At the same time, Microsoft makes a database that is named "SQL Server". While that database speaks a dialect of SQL, information specific to that database is not on topic in this tag but belongs into the SQL Server documentation.
Chapter 2: Identifier

This topic is about identifiers, i.e. syntax rules for names of tables, columns, and other database objects.

Where appropriate, the examples should cover variations used by different SQL implementations, or identify the SQL implementation of the example.

Section 2.1: Unquoted identifiers

Unquoted identifiers can use letters (a-z), digits (0-9), and underscore (_), and must start with a letter.

Depending on SQL implementation, and/or database settings, other characters may be allowed, some even as the first character, e.g.

- MS SQL: Ø, $, #, and other Unicode letters
- MySQL: $ (source)
- Oracle: $, #, and other letters from database character set (source)
- PostgreSQL: $, and other Unicode letters (source)

Unquoted identifiers are case-insensitive. How this is handled depends greatly on SQL implementation:

- MS SQL: Case-preserving, sensitivity defined by database character set, so can be case-sensitive.
- MySQL: Case-preserving, sensitivity depends on database setting and underlying file system.
- Oracle: Converted to uppercase, then handled like quoted identifier.
- PostgreSQL: Converted to lowercase, then handled like quoted identifier.
- SQLite: Case-preserving; case insensitivity only for ASCII characters.
Chapter 3: Data Types

Section 3.1: DECIMAL and NUMERIC

Fixed precision and scale decimal numbers. DECIMAL and NUMERIC are functionally equivalent.

Syntax:

```
DECIMAL ( precision [, scale ] )
NUMERIC ( precision [, scale ] )
```

Examples:

```
SELECT CAST(123 AS DECIMAL(5, 2))  -- returns 123.00
SELECT CAST(12345.12 AS NUMERIC(10, 5))  -- returns 12345.12000
```

Section 3.2: FLOAT and REAL

Approximate-number data types for use with floating point numeric data.

```
SELECT CAST(PI() AS FLOAT)  -- returns 3.14159265358979
SELECT CAST(PI() AS REAL)  -- returns 3.141593
```

Section 3.3: Integers

Exact-number data types that use integer data.

<table>
<thead>
<tr>
<th>Data type</th>
<th>Range</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>bigint</td>
<td>-2^63 (-9,223,372,036,854,775,808) to 2^63-1 (9,223,372,036,854,775,807)</td>
<td>8 Bytes</td>
</tr>
<tr>
<td>int</td>
<td>-2^31 (-2,147,483,648) to 2^31-1 (2,147,483,647)</td>
<td>4 Bytes</td>
</tr>
<tr>
<td>smallint</td>
<td>-2^15 (-32,768) to 2^15-1 (32,767)</td>
<td>2 Bytes</td>
</tr>
<tr>
<td>tinyint</td>
<td>0 to 255</td>
<td>1 Byte</td>
</tr>
</tbody>
</table>

Section 3.4: MONEY and SMALLMONEY

Data types that represent monetary or currency values.

<table>
<thead>
<tr>
<th>Data type</th>
<th>Range</th>
<th>Storage</th>
</tr>
</thead>
<tbody>
<tr>
<td>money</td>
<td>-922,337,203,685,477,5808 to 922,337,203,685,477,5807</td>
<td>8 bytes</td>
</tr>
<tr>
<td>smallmoney</td>
<td>-214,748.3648 to 214,748.3647</td>
<td>4 bytes</td>
</tr>
</tbody>
</table>

Section 3.5: BINARY and VARBINARY

Binary data types of either fixed length or variable length.

Syntax:

```
BINARY [ ( n_bytes ) ]
VARBINARY [ ( n_bytes | max ) ]
```

`n_bytes` can be any number from 1 to 8000 bytes. `max` indicates that the maximum storage space is 2^31-1.

Examples:
Section 3.6: CHAR and VARCHAR

String data types of either fixed length or variable length.

Syntax:

```
CHAR [ ( n_chars ) ]
VARCHAR [ ( n_chars ) ]
```

Examples:

```
SELECT CAST(12345 AS BINARY(10)) -- 0x00000000000000003039
SELECT CAST(12345 AS VARBINARY(10)) -- 0x00003039
```

Section 3.7: NCHAR and NVARCHAR

UNICODE string data types of either fixed length or variable length.

Syntax:

```
NCHAR [ ( n_chars ) ]
NVARCHAR [ ( n_chars | MAX ) ]
```

Use MAX for very long strings that may exceed 8000 characters.

Section 3.8: UNIQUEIDENTIFIER

A 16-byte GUID / UUID.

```sql
DECLARE @GUID UNIQUEIDENTIFIER = NEWID();
SELECT @GUID -- 'E28B3BD9-9174-41A9-8508-899A78A33540'
DECLARE @bad_GUID_string VARCHAR(100) = 'E28B3BD9-9174-41A9-8508-899A78A33540_foobarbaz'
SELECT @bad_GUID_string, -- 'E28B3BD9-9174-41A9-8508-899A78A33540_foobarbaz'
CONVERT(UNIQUEIDENTIFIER, @bad_GUID_string) -- 'E28B3BD9-9174-41A9-8508-899A78A33540'
```
Chapter 4: NULL

NULL in SQL, as well as programming in general, means literally "nothing". In SQL, it is easier to understand as "the absence of any value".

It is important to distinguish it from seemingly empty values, such as the empty string ' ' or the number 0, neither of which are actually NULL.

It is also important to be careful not to enclose NULL in quotes, like 'NULL', which is allowed in columns that accept text, but is not NULL and can cause errors and incorrect data sets.

Section 4.1: Filtering for NULL in queries

The syntax for filtering for NULL (i.e. the absence of a value) in WHERE blocks is slightly different than filtering for specific values.

```
SELECT * FROM Employees WHERE ManagerId IS NULL;
SELECT * FROM Employees WHERE ManagerId IS NOT NULL;
```

Note that because NULL is not equal to anything, not even to itself, using equality operators = NULL or <> NULL (or != NULL) will always yield the truth value of UNKNOWN which will be rejected by WHERE.

WHERE filters all rows that the condition is FALSE or UNKNOWN and keeps only rows that the condition is TRUE.

Section 4.2: Nullable columns in tables

When creating tables it is possible to declare a column as nullable or non-nullable.

```
CREATE TABLE MyTable
(
    MyCol1 INT NOT NULL, -- non-nullable
    MyCol2 INT NULL     -- nullable
);
```

By default every column (except those in primary key constraint) is nullable unless we explicitly set NOT NULL constraint.

Attempting to assign NULL to a non-nullable column will result in an error.

```
INSERT INTO MyTable (MyCol1, MyCol2) VALUES (1, NULL); -- works fine

INSERT INTO MyTable (MyCol1, MyCol2) VALUES (NULL, 2);
   -- cannot insert
   -- the value NULL into column 'MyCol1', table 'MyTable';
   -- column does not allow nulls. INSERT fails.
```

Section 4.3: Updating fields to NULL

Setting a field to NULL works exactly like with any other value:

```
UPDATE Employees
SET ManagerId = NULL
WHERE Id = 4
```
Section 4.4: Inserting rows with NULL fields

For example inserting an employee with no phone number and no manager into the Employees example table:

```sql
INSERT INTO Employees
    (Id, FName, LName, PhoneNumber, ManagerId, DepartmentId, Salary, HireDate)
VALUES
    (5, 'Jane', 'Doe', NULL, NULL, 2, 800, '2016-07-22');
```
Chapter 5: Example Databases and Tables

Section 5.1: Auto Shop Database

In the following example - Database for an auto shop business, we have a list of departments, employees, customers and customer cars. We are using foreign keys to create relationships between the various tables.

Live example: SQL fiddle

Relationships between tables

- Each Department may have 0 or more Employees
- Each Employee may have 0 or 1 Manager
- Each Customer may have 0 or more Cars

Departments

<table>
<thead>
<tr>
<th>Id</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HR</td>
</tr>
<tr>
<td>2</td>
<td>Sales</td>
</tr>
<tr>
<td>3</td>
<td>Tech</td>
</tr>
</tbody>
</table>

SQL statements to create the table:

```
CREATE TABLE Departments
(
    Id INT NOT NULL AUTO_INCREMENT,
    Name VARCHAR(25) NOT NULL,
    PRIMARY KEY(Id)
);

INSERT INTO Departments
([Id], [Name])
VALUES
    (1, 'HR'),
    (2, 'Sales'),
    (3, 'Tech');
```

Employees

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>HireDate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
<td>1000</td>
<td>01-01-2002</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
<tr>
<td>3</td>
<td>Michael</td>
<td>Williams</td>
<td>1357911131</td>
<td>1</td>
<td>2</td>
<td>600</td>
<td>12-05-2009</td>
</tr>
<tr>
<td>4</td>
<td>Johnathon</td>
<td>Smith</td>
<td>1212121212</td>
<td>2</td>
<td>1</td>
<td>500</td>
<td>24-07-2016</td>
</tr>
</tbody>
</table>

SQL statements to create the table:

```
CREATE TABLE Employees
(
    Id INT NOT NULL AUTO_INCREMENT,
    FName VARCHAR(35) NOT NULL,
    LName VARCHAR(35) NOT NULL,
    PhoneNumber VARCHAR(11),
    ManagerId INT,
    DepartmentId INT NOT NULL,
    Salary INT NOT NULL,
    HireDate DATETIME NOT NULL,
    PRIMARY KEY(Id),
    FOREIGN KEY (ManagerId) REFERENCES Employees(Id),
    FOREIGN KEY (DepartmentId) REFERENCES Departments(Id)
);```
### Employees

```sql
INSERT INTO Employees ([Id], [FName], [LName], [PhoneNumber], [ManagerId], [DepartmentId], [Salary], [HireDate])
VALUES
(1, 'James', 'Smith', 1234567890, NULL, 1, 1000, '01-01-2002'),
(2, 'John', 'Johnson', 2468101214, '1', 1, 400, '23-03-2005'),
(3, 'Michael', 'Williams', 1357911131, '1', 2, 600, '12-05-2009'),
(4, 'Johnathon', 'Smith', 1212121212, '2', 1, 500, '24-07-2016')
```

### Customers

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>Email</th>
<th>PhoneNumber</th>
<th>PreferredContact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>William</td>
<td>Jones</td>
<td><a href="mailto:william.jones@example.com">william.jones@example.com</a></td>
<td>3347927472</td>
<td>PHONE</td>
</tr>
<tr>
<td>2</td>
<td>David</td>
<td>Miller</td>
<td><a href="mailto:dmliller@example.net">dmliller@example.net</a></td>
<td>2137921892</td>
<td>EMAIL</td>
</tr>
<tr>
<td>3</td>
<td>Richard</td>
<td>Davis</td>
<td><a href="mailto:richard0123@example.com">richard0123@example.com</a></td>
<td>NULL</td>
<td>EMAIL</td>
</tr>
</tbody>
</table>

SQL statements to create the table:

```sql
CREATE TABLE Customers
(Id INT NOT NULL AUTO_INCREMENT,
 FName VARCHAR(35) NOT NULL,
 LName VARCHAR(35) NOT NULL,
 Email varchar(100) NOT NULL,
 PhoneNumber VARCHAR(11),
 PreferredContact VARCHAR(5) NOT NULL,
 PRIMARY KEY(Id))
```

### Cars

<table>
<thead>
<tr>
<th>Id</th>
<th>CustomerId</th>
<th>Employeeld</th>
<th>Model</th>
<th>Status</th>
<th>Total Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>Ford F-150</td>
<td>READY</td>
<td>230</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>2</td>
<td>Ford F-150</td>
<td>READY</td>
<td>200</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>1</td>
<td>Ford Mustang</td>
<td>WAITING</td>
<td>100</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>3</td>
<td>Toyota Prius</td>
<td>WORKING</td>
<td>1254</td>
</tr>
</tbody>
</table>

SQL statements to create the table:

```sql
CREATE TABLE Cars
(Id INT NOT NULL AUTO_INCREMENT,
 CustomerId INT NOT NULL,
 Employeeld INT NOT NULL,
 Model varchar(50) NOT NULL,
 Status varchar(25) NOT NULL,
 TotalCost INT NOT NULL,
 PRIMARY KEY(Id),
 FOREIGN KEY (CustomerId) REFERENCES Customers(Id),
 FOREIGN KEY (Employeeld) REFERENCES Employees(Id))
```

```sql
INSERT INTO Cars
([Id], [CustomerId], [Employeeld], [Model], [Status], [TotalCost])
VALUES
(1, 1, 2, 'Ford F-150', 'READY', 230),
(2, 1, 2, 'Ford F-150', 'READY', 200),
(3, 2, 1, 'Ford Mustang', 'WAITING', 100),
(4, 3, 3, 'Toyota Prius', 'WORKING', 1254)
```
Section 5.2: Library Database

In this example database for a library, we have Authors, Books and BooksAuthors tables.

Live example: [SQL fiddle](https://example.com)

Authors and Books are known as **base tables**, since they contain column definition and data for the actual entities in the relational model. BooksAuthors is known as the **relationship table**, since this table defines the relationship between the Books and Authors table.

**Relationships between tables**

- Each author can have 1 or more books
- Each book can have 1 or more authors

**Authors**

(view table)

<table>
<thead>
<tr>
<th>Id</th>
<th>Name</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>J.D. Salinger</td>
<td>USA</td>
</tr>
<tr>
<td>2</td>
<td>F. Scott. Fitzgerald</td>
<td>USA</td>
</tr>
<tr>
<td>3</td>
<td>Jane Austen</td>
<td>UK</td>
</tr>
<tr>
<td>4</td>
<td>Scott Hanselman</td>
<td>USA</td>
</tr>
<tr>
<td>5</td>
<td>Jason N. Gaylord</td>
<td>USA</td>
</tr>
<tr>
<td>6</td>
<td>Pranav Rastogi</td>
<td>India</td>
</tr>
<tr>
<td>7</td>
<td>Todd Miranda</td>
<td>USA</td>
</tr>
<tr>
<td>8</td>
<td>Christian Wenz</td>
<td>USA</td>
</tr>
</tbody>
</table>

SQL to create the table:

```sql
CREATE TABLE Authors (  
   Id INT NOT NULL AUTO_INCREMENT,  
   Name VARCHAR(70) NOT NULL,  
   Country VARCHAR(100) NOT NULL,  
   PRIMARY KEY(Id)  
);  

INSERT INTO Authors  
(Name, Country)  
VALUES  
('J.D. Salinger', 'USA'),  
('F. Scott. Fitzgerald', 'USA'),  
('Jane Austen', 'UK'),  
('Scott Hanselman', 'USA'),  
('Jason N. Gaylord', 'USA'),  
('Pranav Rastogi', 'India'),  
('Todd Miranda', 'USA'),  
('Christian Wenz', 'USA')  
);  
```

**Books**

```sql
(SELECT '1', '1', '2', 'Ford F-150', 'READY', '230'),  
(SELECT '2', '1', '2', 'Ford F-150', 'READY', '200'),  
(SELECT '3', '2', '1', 'Ford Mustang', 'WAITING', '100'),  
(SELECT '4', '3', '3', 'Toyota Prius', 'WORKING', '1254')  
);  
```
### Id Title
1. The Catcher in the Rye
2. Nine Stories
3. Franny and Zooey
4. The Great Gatsby
5. Tender id the Night
6. Pride and Prejudice
7. Professional ASP.NET 4.5 in C# and VB

SQL to create the table:

```sql
CREATE TABLE Books (
    Id INT NOT NULL AUTO_INCREMENT,
    Title VARCHAR(50) NOT NULL,
    PRIMARY KEY(Id)
);

INSERT INTO Books (Id, Title)
VALUES
    (1, 'The Catcher in the Rye'),
    (2, 'Nine Stories'),
    (3, 'Franny and Zooey'),
    (4, 'The Great Gatsby'),
    (5, 'Tender id the Night'),
    (6, 'Pride and Prejudice'),
    (7, 'Professional ASP.NET 4.5 in C# and VB');
```

### BooksAuthors

<table>
<thead>
<tr>
<th>BookId</th>
<th>AuthorId</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>5</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>7</td>
<td>8</td>
</tr>
</tbody>
</table>

SQL to create the table:

```sql
CREATE TABLE BooksAuthors (AuthorId INT NOT NULL, BookId INT NOT NULL,
FOREIGN KEY (AuthorId) REFERENCES Authors(Id),
FOREIGN KEY (BookId) REFERENCES Books(Id));

INSERT INTO BooksAuthors (BookId, AuthorId)
```
VALUES
(1, 1),
(2, 1),
(3, 1),
(4, 2),
(5, 2),
(6, 3),
(7, 4),
(7, 5),
(7, 6),
(7, 7),
(7, 8);

Examples

View all authors (view live example):

```
SELECT * FROM Authors;
```

View all book titles (view live example):

```
SELECT * FROM Books;
```

View all books and their authors (view live example):

```
SELECT 
    ba.AuthorId, 
    a.Name AuthorName, 
    ba.BookId, 
    b.Title BookTitle 
FROM BooksAuthors ba 
    INNER JOIN Authors a ON a.id = ba.authorid 
    INNER JOIN Books b ON b.id = ba.bookid;
```

### Section 5.3: Countries Table

In this example, we have a Countries table. A table for countries has many uses, especially in Financial applications involving currencies and exchange rates.

Live example: [SQL fiddle](#)

Some Market data software applications like Bloomberg and Reuters require you to give their API either a 2 or 3 character country code along with the currency code. Hence this example table has both the 2-character ISO code column and the 3 character ISO3 code columns.

### Countries

<table>
<thead>
<tr>
<th>Id</th>
<th>ISO</th>
<th>ISO3</th>
<th>ISONumeric</th>
<th>CountryName</th>
<th>Capital</th>
<th>ContinentCode</th>
<th>CurrencyCode</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>AU</td>
<td>AUS</td>
<td>36</td>
<td>Australia</td>
<td>Canberra</td>
<td>OC</td>
<td>AUD</td>
</tr>
<tr>
<td>2</td>
<td>DE</td>
<td>DEU</td>
<td>276</td>
<td>Germany</td>
<td>Berlin</td>
<td>EU</td>
<td>EUR</td>
</tr>
<tr>
<td>2</td>
<td>IN</td>
<td>IND</td>
<td>356</td>
<td>India</td>
<td>New Delhi</td>
<td>AS</td>
<td>INR</td>
</tr>
<tr>
<td>3</td>
<td>LA</td>
<td>LAO</td>
<td>418</td>
<td>Laos</td>
<td>Vientiane</td>
<td>AS</td>
<td>LAK</td>
</tr>
<tr>
<td>4</td>
<td>US</td>
<td>USA</td>
<td>840</td>
<td>United States</td>
<td>Washington NA</td>
<td>USD</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>ZW</td>
<td>ZWE</td>
<td>716</td>
<td>Zimbabwe</td>
<td>Harare</td>
<td>AF</td>
<td>ZWL</td>
</tr>
</tbody>
</table>
SQL to create the table:

```
CREATE TABLE Countries (
    Id INT NOT NULL AUTO_INCREMENT,
    ISO VARCHAR(2) NOT NULL,
    ISO3 VARCHAR(3) NOT NULL,
    ISONumeric INT NOT NULL,
    CountryName VARCHAR(64) NOT NULL,
    Capital VARCHAR(64) NOT NULL,
    ContinentCode VARCHAR(2) NOT NULL,
    CurrencyCode VARCHAR(3) NOT NULL,
    PRIMARY KEY (Id)
)
;

INSERT INTO Countries
    (ISO, ISO3, ISONumeric, CountryName, Capital, ContinentCode, CurrencyCode)
VALUES
    ('AU', 'AUS', 36, 'Australia', 'Canberra', 'OC', 'AUD'),
    ('DE', 'DEU', 276, 'Germany', 'Berlin', 'EU', 'EUR'),
    ('IN', 'IND', 356, 'India', 'New Delhi', 'AS', 'INR'),
    ('LA', 'LAO', 418, 'Laos', 'Vientiane', 'AS', 'LAK'),
    ('US', 'USA', 840, 'United States', 'Washington', 'NA', 'USD'),
    ('ZW', 'ZWE', 716, 'Zimbabwe', 'Harare', 'AF', 'ZWL')
;
```
Chapter 6: SELECT

The SELECT statement is at the heart of most SQL queries. It defines what result set should be returned by the query, and is almost always used in conjunction with the FROM clause, which defines what part(s) of the database should be queried.

Section 6.1: Using the wildcard character to select all columns in a query

Consider a database with the following two tables.

**Employees table:**

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>DeptId</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>4</td>
</tr>
</tbody>
</table>

**Departments table:**

<table>
<thead>
<tr>
<th>Id</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sales</td>
</tr>
<tr>
<td>2</td>
<td>Marketing</td>
</tr>
<tr>
<td>3</td>
<td>Finance</td>
</tr>
<tr>
<td>4</td>
<td>IT</td>
</tr>
</tbody>
</table>

**Simple select statement**

* is the **wildcard character** used to select all available columns in a table.

When used as a substitute for explicit column names, it returns all columns in all tables that a query is selecting FROM. This effect applies to all tables the query accesses through its JOIN clauses.

Consider the following query:

```
SELECT * FROM Employees
```

It will return all fields of all rows of the Employees table:

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>DeptId</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>4</td>
</tr>
</tbody>
</table>

**Dot notation**

To select all values from a specific table, the wildcard character can be applied to the table with *dot notation*.

Consider the following query:

```
SELECT Employees.*, Departments.Name
FROM Employees
JOIN Departments
ON Departments.Id = Employees.DeptId
```
This will return a data set with all fields on the Employee table, followed by just the Name field in the Departments table:

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>DeptId</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>3</td>
<td>Finance</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>4</td>
<td>IT</td>
</tr>
</tbody>
</table>

**Warnings Against Use**

It is generally advised that using `*` is avoided in production code where possible, as it can cause a number of potential problems including:

1. Excess IO, network load, memory use, and so on, due to the database engine reading data that is not needed and transmitting it to the front-end code. This is particularly a concern where there might be large fields such as those used to store long notes or attached files.
2. Further excess IO load if the database needs to spool internal results to disk as part of the processing for a query more complex than `SELECT <columns> FROM <table>.
3. Extra processing (and/or even more IO) if some of the unneeded columns are:
   - computed columns in databases that support them
   - in the case of selecting from a view, columns from a table/view that the query optimiser could otherwise optimise out
4. The potential for unexpected errors if columns are added to tables and views later that results ambiguous column names. For example `SELECT * FROM orders JOIN people ON people.id = orders.personid ORDER BY displayname` - if a column column called `displayname` is added to the orders table to allow users to give their orders meaningful names for future reference then the column name will appear twice in the output so the `ORDER BY` clause will be ambiguous which may cause errors ("ambiguous column name" in recent MS SQL Server versions), and if not in this example your application code might start displaying the order name where the person name is intended because the new column is the first of that name returned, and so on.

**When Can You Use *, Bearing The Above Warning In Mind?**

While best avoided in production code, using `*` is fine as a shorthand when performing manual queries against the database for investigation or prototype work.

Sometimes design decisions in your application make it unavoidable (in such circumstances, prefer `tablealias.*` over just `*` where possible).

When using `EXISTS`, such as `SELECT A.col1, A.Col2 FROM A WHERE EXISTS (SELECT * FROM B where A.ID = B.A_ID)`, we are not returning any data from B. Thus a join is unnecessary, and the engine knows no values from B are to be returned, thus no performance hit for using `*`. Similarly `COUNT(*)` is fine as it also doesn't actually return any of the columns, so only needs to read and process those that are used for filtering purposes.

**Section 6.2: SELECT Using Column Aliases**

Column aliases are used mainly to shorten code and make column names more readable.

Code becomes shorter as long table names and unnecessary identification of columns (e.g., *there may be 2 IDs in the table, but only one is used in the statement*) can be avoided. Along with table aliases this allows you to use longer descriptive names in your database structure while keeping queries upon that structure concise.

Furthermore they are sometimes *required*, for instance in views, in order to name computed outputs.

**All versions of SQL**
Aliases can be created in all versions of SQL using double quotes (").

```
SELECT
    FName AS "First Name",
    MName AS "Middle Name",
    LName AS "Last Name"
FROM Employees
```

### Different Versions of SQL

You can use single quotes ('), double quotes ("), and square brackets ([ ]) to create an alias in Microsoft SQL Server.

```
SELECT
    FName AS 'First Name',
    MName AS 'Middle Name',
    LName AS [Last Name]
FROM Employees
```

Both will result in:

<table>
<thead>
<tr>
<th>First Name</th>
<th>Middle Name</th>
<th>Last Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>James</td>
<td>John</td>
<td>Smith</td>
</tr>
<tr>
<td>John</td>
<td>James</td>
<td>Johnson</td>
</tr>
<tr>
<td>Michael</td>
<td>Marcus</td>
<td>Williams</td>
</tr>
</tbody>
</table>

This statement will return `FName` and `LName` columns with a given name (an alias). This is achieved using the `AS` operator followed by the alias, or simply writing alias directly after the column name. This means that the following query has the same outcome as the above.

```
SELECT
    FName "First Name",
    MName "Middle Name",
    LName "Last Name"
FROM Employees
```

<table>
<thead>
<tr>
<th>First Name</th>
<th>Middle Name</th>
<th>Last Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>James</td>
<td>John</td>
<td>Smith</td>
</tr>
<tr>
<td>John</td>
<td>James</td>
<td>Johnson</td>
</tr>
<tr>
<td>Michael</td>
<td>Marcus</td>
<td>Williams</td>
</tr>
</tbody>
</table>

However, the explicit version (i.e., using the `AS` operator) is more readable.

If the alias has a single word that is not a reserved word, we can write it without single quotes, double quotes or brackets:

```
SELECT
    FName AS FirstName,
    LName AS LastName
FROM Employees
```

<table>
<thead>
<tr>
<th>FirstName</th>
<th>LastName</th>
</tr>
</thead>
<tbody>
<tr>
<td>James</td>
<td>Smith</td>
</tr>
<tr>
<td>John</td>
<td>Johnson</td>
</tr>
<tr>
<td>Michael</td>
<td>Williams</td>
</tr>
</tbody>
</table>

A further variation available in MS SQL Server amongst others is `<alias> = <column-or-calculation>`, for instance:

```
SELECT FullName = FirstName + ' ' + LastName,
```
Addr1 = FullStreetAddress,
Addr2 = TownName
FROM CustomerDetails

which is equivalent to:

```
SELECT FirstName + ' ' + LastName As FullName,
       FullStreetAddress As Addr1,
       TownName As Addr2
FROM CustomerDetails
```

Both will result in:

<table>
<thead>
<tr>
<th>FullName</th>
<th>Addr1</th>
<th>Addr2</th>
</tr>
</thead>
<tbody>
<tr>
<td>James Smith</td>
<td>123 AnyStreet</td>
<td>TownVille</td>
</tr>
<tr>
<td>John Johnson</td>
<td>668 MyRoad</td>
<td>Anytown</td>
</tr>
<tr>
<td>Michael Williams</td>
<td>999 High End Dr</td>
<td>Williamsburgh</td>
</tr>
</tbody>
</table>

Some find using = instead of As easier to read, though many recommend against this format, mainly because it is not standard so not widely supported by all databases. It may cause confusion with other uses of the = character.

**All Versions of SQL**

Also, if you need to use reserved words, you can use brackets or quotes to escape:

```
SELECT FName as "SELECT",
       MName as "FROM",
       LName as "WHERE"
FROM Employees
```

**Different Versions of SQL**

Likewise, you can escape keywords in MSSQL with all different approaches:

```
SELECT FName AS "SELECT",
       MName AS "FROM",
       LName AS [WHERE]
FROM Employees
```

**SELECT FROM WHERE**

James John Smith
John James Johnson
Michael Marcus Williams

Also, a column alias may be used any of the final clauses of the same query, such as an ORDER BY:

```
SELECT FName AS FirstName,
       LName AS LastName
FROM Employees
ORDER BY
       LastName DESC
```

However, you may not use

```
SELECT
```
To create an alias from these reserved words (SELECT and FROM).

This will cause numerous errors on execution.

Section 6.3: Select Individual Columns

```
SELECT
  PhoneNumber,
  Email,
  PreferredContact
FROM Customers
```

This statement will return the columns PhoneNumber, Email, and PreferredContact from all rows of the Customers table. Also the columns will be returned in the sequence in which they appear in the SELECT clause.

The result will be:

<table>
<thead>
<tr>
<th>PhoneNumber</th>
<th>Email</th>
<th>PreferredContact</th>
</tr>
</thead>
<tbody>
<tr>
<td>3347927472</td>
<td><a href="mailto:william.jones@example.com">william.jones@example.com</a> PHONE</td>
<td>PHONE</td>
</tr>
<tr>
<td>2137921892</td>
<td><a href="mailto:dmiller@example.net">dmiller@example.net</a> EMAIL</td>
<td>EMAIL</td>
</tr>
<tr>
<td>NULL</td>
<td><a href="mailto:richard0123@example.com">richard0123@example.com</a> EMAIL</td>
<td>EMAIL</td>
</tr>
</tbody>
</table>

If multiple tables are joined together, you can select columns from specific tables by specifying the table name before the column name: `[table_name].[column_name]`

```
SELECT
  Customers.PhoneNumber,
  Customers.Email,
  Customers.PreferredContact,
  Orders.Id AS OrderId
FROM Customers
case
  LEFT JOIN Orders
    ON Orders.CustomerId = Customers.Id
```

*AS  OrderId means that the Id field of Orders table will be returned as a column named OrderId. See selecting with column alias for further information.

To avoid using long table names, you can use table aliases. This mitigates the pain of writing long table names for each field that you select in the joins. If you are performing a self join (a join between two instances of the same table), then you must use table aliases to distinguish your tables. We can write a table alias like Customers c or Customers AS c. Here c works as an alias for Customers and we can select let's say Email like this: c.Email.

```
SELECT
  c.PhoneNumber,
  c.Email,
  c.PreferredContact,
  o.Id AS OrderId
FROM Customers c
```
Section 6.4: Selecting specified number of records

The SQL 2008 standard defines the `FETCH FIRST` clause to limit the number of records returned.

```
SELECT Id, ProductName, UnitPrice, Package
FROM Product
ORDER BY UnitPrice DESC
FETCH FIRST 10 ROWS ONLY
```

This standard is only supported in recent versions of some RDMSs. Vendor-specific non-standard syntax is provided in other systems. Progress OpenEdge 11.x also supports the `FETCH FIRST <n> ROWS ONLY` syntax.

Additionally, `OFFSET <m> ROWS before FETCH FIRST <n> ROWS ONLY` allows skipping rows before fetching rows.

```
SELECT Id, ProductName, UnitPrice, Package
FROM Product
ORDER BY UnitPrice DESC
OFFSET 5 ROWS
FETCH FIRST 10 ROWS ONLY
```

The following query is supported in SQL Server and MS Access:

```
SELECT TOP 10 Id, ProductName, UnitPrice, Package
FROM Product
ORDER BY UnitPrice DESC
```

To do the same in MySQL or PostgreSQL the `LIMIT` keyword must be used:

```
SELECT Id, ProductName, UnitPrice, Package
FROM Product
ORDER BY UnitPrice DESC
LIMIT 10
```

In Oracle the same can be done with `ROWNUM`:

```
SELECT Id, ProductName, UnitPrice, Package
FROM Product
WHERE ROWNUM <= 10
ORDER BY UnitPrice DESC
```

Results: 10 records.

<table>
<thead>
<tr>
<th>Id</th>
<th>ProductName</th>
<th>UnitPrice</th>
<th>Package</th>
</tr>
</thead>
<tbody>
<tr>
<td>38</td>
<td>Côte de Blaye</td>
<td>263.50</td>
<td>12 - 75 cl bottles</td>
</tr>
<tr>
<td>29</td>
<td>Thüringer Rostbratwurst</td>
<td>123.79</td>
<td>50 bags x 30 sausgs.</td>
</tr>
<tr>
<td>9</td>
<td>Mishi Kobe Niku</td>
<td>97.00</td>
<td>18 - 500 g pkgs.</td>
</tr>
<tr>
<td>20</td>
<td>Sir Rodney's Marmalade</td>
<td>81.00</td>
<td>30 gift boxes</td>
</tr>
<tr>
<td>18</td>
<td>Carnarvon Tigers</td>
<td>62.50</td>
<td>16 kg pkg.</td>
</tr>
<tr>
<td>59</td>
<td>Raclette Coudavault</td>
<td>55.00</td>
<td>5 kg pkg.</td>
</tr>
<tr>
<td>51</td>
<td>Manjimup Dried Apples</td>
<td>53.00</td>
<td>50 - 300 g pkgs.</td>
</tr>
<tr>
<td>62</td>
<td>Tarte au sucre</td>
<td>49.30</td>
<td>48 pies</td>
</tr>
<tr>
<td>43</td>
<td>Ipoh Coffee</td>
<td>46.00</td>
<td>16 - 500 g tins</td>
</tr>
<tr>
<td>28</td>
<td>Rössle Sauerkraut</td>
<td>45.60</td>
<td>25 - 825 g cans</td>
</tr>
</tbody>
</table>
Vendor Nuances:

It is important to note that the `TOP` in Microsoft SQL operates after the `WHERE` clause and will return the specified number of results if they exist anywhere in the table, while `ROWNUM` works as part of the `WHERE` clause so if other conditions do not exist in the specified number of rows at the beginning of the table, you will get zero results when there could be others to be found.

Section 6.5: Selecting with Condition

The basic syntax of SELECT with WHERE clause is:

```
SELECT column1, column2, columnN
FROM table_name
WHERE [condition]
```

The `[condition]` can be any SQL expression, specified using comparison or logical operators like `>`, `<`, `=`, `<>`, `>=`, `<=`, `LIKE`, `NOT`, `IN`, `BETWEEN` etc.

The following statement returns all columns from the table 'Cars' where the status column is 'READY':

```
SELECT * FROM Cars WHERE status = 'READY'
```

See WHERE and HAVING for more examples.

Section 6.6: Selecting with CASE

When results need to have some logic applied 'on the fly' one can use CASE statement to implement it.

```
SELECT CASE WHEN Col1 < 50 THEN 'under' ELSE 'over' END threshold
FROM TableName
```

also can be chained

```
SELECT
    CASE
        WHEN Col1 < 50 THEN 'under'
        WHEN Col1 > 50 AND Col1 <100 THEN 'between'
        ELSE 'over'
    END threshold
FROM TableName
```

one also can have CASE inside another CASE statement

```
SELECT
    CASE WHEN Col1 < 50 THEN 'under'
    ELSE
        CASE WHEN Col1 > 50 AND Col1 <100 THEN Col1
        ELSE 'over'
    END
END threshold
FROM TableName
```

Section 6.7: Select columns which are named after reserved keywords

When a column name matches a reserved keyword, standard SQL requires that you enclose it in double quotation marks:
SELECT  
  "ORDER",  
  ID  
FROM  ORDERS

Note that it makes the column name case-sensitive.

Some DBMSes have proprietary ways of quoting names. For example, SQL Server uses square brackets for this purpose:

SELECT  
  [Order],  
  ID  
FROM  ORDERS

while MySQL (and MariaDB) by default use backticks:

SELECT  
  `Order`,  
  id  
FROM  orders

Section 6.8: Selecting with table alias

SELECT  
  e.Fname,  
  e.LName  
FROM  Employees e

The Employees table is given the alias 'e' directly after the table name. This helps remove ambiguity in scenarios where multiple tables have the same field name and you need to be specific as to which table you want to return data from.

SELECT  
  e.Fname,  
  e.LName,  
  m.Fname AS ManagerFirstName  
FROM  Employees e  
JOIN  Managers m  
ON  e.ManagerId = m.Id

Note that once you define an alias, you can't use the canonical table name anymore. i.e.,

SELECT  
  e.Fname,  
  Employees.LName,  
  m.Fname AS ManagerFirstName  
FROM  Employees e  
JOIN  Managers m  
ON  e.ManagerId = m.Id

would throw an error.

It is worth noting table aliases -- more formally 'range variables' -- were introduced into the SQL language to solve the problem of duplicate columns caused by INNER JOIN. The 1992 SQL standard corrected this earlier design flaw by introducing NATURAL JOIN (implemented in mySQL, PostgreSQL and Oracle but not yet in SQL Server), the result of which never has duplicate column names. The above example is interesting in that the tables are joined on columns with different names (Id and ManagerId) but are not supposed to be joined on the columns with the same name (LName, FName), requiring the renaming of the columns to be performed before the join:

SELECT  
  Fname,  
  LName,  
  ManagerFirstName  
FROM  Employees  
NATURAL JOIN  
  ( SELECT  
      Id AS ManagerId,  
      Fname AS ManagerFirstName  
    FROM  Managers ) m;
Note that although an alias/range variable must be declared for the derived table (otherwise SQL will throw an error), it never makes sense to actually use it in the query.

**Section 6.9: Selecting with more than 1 condition**

The **AND** keyword is used to add more conditions to the query.

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Gender</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sam</td>
<td>18</td>
<td>M</td>
</tr>
<tr>
<td>John</td>
<td>21</td>
<td>M</td>
</tr>
<tr>
<td>Bob</td>
<td>22</td>
<td>M</td>
</tr>
<tr>
<td>Mary</td>
<td>23</td>
<td>F</td>
</tr>
</tbody>
</table>

```
SELECT name FROM persons WHERE gender = 'M' AND age > 20;
```

This will return:

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>John</td>
</tr>
<tr>
<td>Bob</td>
</tr>
</tbody>
</table>

using OR keyword

```
SELECT name FROM persons WHERE gender = 'M' OR age < 20;
```

This will return:

<table>
<thead>
<tr>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sam</td>
</tr>
<tr>
<td>John</td>
</tr>
<tr>
<td>Bob</td>
</tr>
</tbody>
</table>

These keywords can be combined to allow for more complex criteria combinations:

```
SELECT name FROM persons WHERE (gender = 'M' AND age < 20) OR (gender = 'F' AND age > 20);
```

This will return:

<table>
<thead>
<tr>
<th>name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sam</td>
</tr>
<tr>
<td>Mary</td>
</tr>
</tbody>
</table>

**Section 6.10: Selecting without Locking the table**

Sometimes when tables are used mostly (or only) for reads, indexing does not help anymore and every little bit counts, one might use selects without LOCK to improve performance.

SQL Server

```
SELECT * FROM TableName WITH (nolock)
```

MySQL
SET SESSION TRANSACTION ISOLATION LEVEL READ UNCOMMITTED;
SELECT * FROM TableName;
SET SESSION TRANSACTION ISOLATION LEVEL REPEATABLE READ;

Oracle

SET TRANSACTION ISOLATION LEVEL READ UNCOMMITTED;
SELECT * FROM TableName;

DB2

SELECT * FROM TableName WITH UR;

where UR stands for "uncommitted read".

If used on table that has record modifications going on might have unpredictable results.

Section 6.11: Selecting with Aggregate functions

Average
The \text{AVG()} aggregate function will return the average of values selected.

\text{SELECT AVG(Salary) FROM Employees}

Aggregate functions can also be combined with the where clause.

\text{SELECT AVG(Salary) FROM Employees where DepartmentId = 1}

Aggregate functions can also be combined with group by clause.

If employee is categorized with multiple department and we want to find avg salary for every department then we can use following query.

\text{SELECT AVG(Salary) FROM Employees GROUP BY DepartmentId}

Minimum
The \text{MIN()} aggregate function will return the minimum of values selected.

\text{SELECT MIN(Salary) FROM Employees}

Maximum
The \text{MAX()} aggregate function will return the maximum of values selected.

\text{SELECT MAX(Salary) FROM Employees}

Count
The \text{COUNT()} aggregate function will return the count of values selected.

\text{SELECT Count(*) FROM Employees}

It can also be combined with where conditions to get the count of rows that satisfy specific conditions.

\text{SELECT Count(*) FROM Employees where ManagerId IS NOT NULL}

Specific columns can also be specified to get the number of values in the column. Note that \text{NULL} values are not counted.

\text{SELECT Count(ManagerId) from Employees}

Count can also be combined with the distinct keyword for a distinct count.

\text{SELECT Count(DISTINCT DepartmentId) from Employees}

Sum
The \text{SUM()} aggregate function returns the sum of the values selected for all rows.

\text{SELECT SUM(Salary) FROM Employees}
Section 6.12: Select with condition of multiple values from column

```sql
SELECT * FROM Cars WHERE status IN ('Waiting', 'Working')
```

This is semantically equivalent to

```sql
SELECT * FROM Cars WHERE (status = 'Waiting' OR status = 'Working')
```

i.e. value IN ( <value list> ) is a shorthand for disjunction (logical OR).

Section 6.13: Get aggregated result for row groups

Counting rows based on a specific column value:

```sql
SELECT category, COUNT(*) AS item_count
FROM item
GROUP BY category;
```

Getting average income by department:

```sql
SELECT department, AVG(income)
FROM employees
GROUP BY department;
```

The important thing is to select only columns specified in the GROUP BY clause or used with aggregate functions.

There WHERE clause can also be used with GROUP BY, but WHERE filters out records before any grouping is done:

```sql
SELECT department, AVG(income)
FROM employees
WHERE department <> 'ACCOUNTING'
GROUP BY department;
```

If you need to filter the results after the grouping has been done, e.g. to see only departments whose average income is larger than 1000, you need to use the HAVING clause:

```sql
SELECT department, AVG(income)
FROM employees
WHERE department <> 'ACCOUNTING'
GROUP BY department
HAVING avg(income) > 1000;
```

Section 6.14: Selection with sorted Results

```sql
SELECT * FROM Employees ORDER BY LName
```

This statement will return all the columns from the table Employees.

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
</tr>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
</tr>
<tr>
<td>3</td>
<td>Michael</td>
<td>Williams</td>
<td>1357911131</td>
</tr>
</tbody>
</table>

```sql
SELECT * FROM Employees ORDER BY LName DESC
```
Or

```
SELECT * FROM Employees ORDER BY LName ASC
```

This statement changes the sorting direction.

One may also specify multiple sorting columns. For example:

```
SELECT * FROM Employees ORDER BY LName ASC, FName ASC
```

This example will sort the results first by LName and then, for records that have the same LName, sort by FName. This will give you a result similar to what you would find in a telephone book.

In order to save retyping the column name in the `ORDER BY` clause, it is possible to use instead the column's number. Note that column numbers start from 1.

```
SELECT Id, FName, LName, PhoneNumber FROM Employees ORDER BY 3
```

You may also embed a `CASE` statement in the `ORDER BY` clause.

```
SELECT Id, FName, LName, PhoneNumber FROM Employees ORDER BY CASE WHEN LName='Jones' THEN 0 ELSE 1 END ASC
```

This will sort your results to have all records with the LName of "Jones" at the top.

**Section 6.15: Selecting with null**

```
SELECT Name FROM Customers WHERE PhoneNumber IS NULL
```

Selection with nulls take a different syntax. Don't use `=`, use `IS NULL` or `IS NOT NULL` instead.

**Section 6.16: Select distinct (unique values only)**

```
SELECT DISTINCT ContinentCode
FROM Countries;
```

This query will return all `DISTINCT` (unique, different) values from `ContinentCode` column from `Countries` table

**ContinentCode**

OC  
EU  
AS  
NA  
AF

**SQLFiddle Demo**

**Section 6.17: Select rows from multiple tables**

```
SELECT *
FROM table1, table2
```

To select rows from multiple tables, you can use a comma to join tables in the `FROM` clause.
This is called cross product in SQL it is same as cross product in sets

These statements return the selected columns from multiple tables in one query.

There is no specific relationship between the columns returned from each table.
Chapter 7: GROUP BY

Results of a SELECT query can be grouped by one or more columns using the GROUP BY statement: all results with the same value in the grouped columns are aggregated together. This generates a table of partial results, instead of one result. GROUP BY can be used in conjunction with aggregation functions using the HAVING statement to define how non-grouped columns are aggregated.

Section 7.1: Basic GROUP BY example

It might be easier if you think of GROUP BY as "for each" for the sake of explanation. The query below:

```sql
SELECT EmpID, SUM (MonthlySalary)
FROM Employee
GROUP BY EmpID
```

is saying:

"Give me the sum of MonthlySalary's for each EmpID"

So if your table looked like this:

<table>
<thead>
<tr>
<th>EmpID</th>
<th>MonthlySalary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
</tr>
</tbody>
</table>

Result:

```
+--+---+
| 1|200|
+--+---+
| 2|300|
+--+---+
```

Sum wouldn't appear to do anything because the sum of one number is that number. On the other hand if it looked like this:

<table>
<thead>
<tr>
<th>EmpID</th>
<th>MonthlySalary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>200</td>
</tr>
<tr>
<td>1</td>
<td>300</td>
</tr>
<tr>
<td>2</td>
<td>300</td>
</tr>
</tbody>
</table>

Result:

```
+--+---+
| 1|200|
+--+---+
| 1|300|
+--+---+
| 2|300|
+--+---+
```
Then it would because there are two EmpID 1's to sum together.

**Section 7.2: Filter GROUP BY results using a HAVING clause**

A HAVING clause filters the results of a GROUP BY expression. Note: The following examples are using the Library example database.

**Examples:**

Return all authors that wrote more than one book ([live example]).

```sql
SELECT
  a.Id,
  a.Name,
  COUNT(*) BooksWritten
FROM BooksAuthors ba
INNER JOIN Authors a ON a.id = ba.authorid
GROUP BY
  a.Id,
  a.Name
HAVING COUNT(*) > 1  -- equals to HAVING BooksWritten > 1
;
```

Return all books that have more than three authors ([live example]).

```sql
SELECT
  b.Id,
  b.Title,
  COUNT(*) NumberOfAuthors
FROM BooksAuthors ba
INNER JOIN Books b ON b.id = ba.bookid
GROUP BY
  b.Id,
  b.Title
HAVING COUNT(*) > 3  -- equals to HAVING NumberOfAuthors > 3
;
```

**Section 7.3: USE GROUP BY to COUNT the number of rows for each unique entry in a given column**

Let's say you want to generate counts or subtotals for a given value in a column.

Given this table, "Westerosians":

<table>
<thead>
<tr>
<th>Name</th>
<th>GreatHouseAllegience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arya</td>
<td>Stark</td>
</tr>
<tr>
<td>Cersei</td>
<td>Lannister</td>
</tr>
<tr>
<td>Myrcella</td>
<td>Lannister</td>
</tr>
<tr>
<td>Yara</td>
<td>Greyjoy</td>
</tr>
<tr>
<td>Catelyn</td>
<td>Stark</td>
</tr>
<tr>
<td>Sansa</td>
<td>Stark</td>
</tr>
</tbody>
</table>
Without GROUP BY, COUNT will simply return a total number of rows:

```sql
SELECT Count(*) Number_of_Westerosians
FROM Westerosians
```
returns...

**Number_of_Westerosians**
6

But by adding GROUP BY, we can COUNT the users for each value in a given column, to return the number of people in a given Great House, say:

```sql
SELECT GreatHouseAllegience House, Count(*) Number_of_Westerosians
FROM Westerosians
GROUP BY GreatHouseAllegience
```
returns...

<table>
<thead>
<tr>
<th>House</th>
<th>Number_of_Westerosians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stark</td>
<td>3</td>
</tr>
<tr>
<td>Greyjoy</td>
<td>1</td>
</tr>
<tr>
<td>Lannister</td>
<td>2</td>
</tr>
</tbody>
</table>

It's common to combine GROUP BY with ORDER BY to sort results by largest or smallest category:

```sql
SELECT GreatHouseAllegience House, Count(*) Number_of_Westerosians
FROM Westerosians
GROUP BY GreatHouseAllegience
ORDER BY Number_of_Westerosians Desc
```
returns...

<table>
<thead>
<tr>
<th>House</th>
<th>Number_of_Westerosians</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stark</td>
<td>3</td>
</tr>
<tr>
<td>Lannister</td>
<td>2</td>
</tr>
<tr>
<td>Greyjoy</td>
<td>1</td>
</tr>
</tbody>
</table>

**Section 7.4: ROLAP aggregation (Data Mining)**

**Description**

The SQL standard provides two additional aggregate operators. These use the polymorphic value "ALL" to denote the set of all values that an attribute can take. The two operators are:

- **with data cube** that it provides all possible combinations than the argument attributes of the clause.
- **with roll up** that it provides the aggregates obtained by considering the attributes in order from left to right compared how they are listed in the argument of the clause.


**Examples**

Consider this table:

<table>
<thead>
<tr>
<th>Food</th>
<th>Brand</th>
<th>Total_amount</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
With cube

```sql
select Food, Brand, Total_amount
from Table
group by Food, Brand, Total_amount with cube
```

Food  Brand  Total_amount
Pasta Brand1 100
Pasta Brand2 250
Pasta ALL 350
Pizza Brand2 300
Pizza ALL 300
ALL Brand1 100
ALL Brand2 550
ALL ALL 650

With roll up

```sql
select Food, Brand, Total_amount
from Table
group by Food, Brand, Total_amount with roll up
```

Food  Brand  Total_amount
Pasta Brand1 100
Pasta Brand2 250
Pizza Brand2 300
Pasta ALL 350
Pizza ALL 300
ALL ALL 650
Chapter 8: ORDER BY

Section 8.1: Sorting by column number (instead of name)

You can use a column's number (where the leftmost column is '1') to indicate which column to base the sort on, instead of describing the column by its name.

**Pro:** If you think it's likely you might change column names later, doing so won't break this code.

**Con:** This will generally reduce readability of the query (It's instantly clear what 'ORDER BY Reputation' means, while 'ORDER BY 14' requires some counting, probably with a finger on the screen.)

This query sorts result by the info in relative column position 3 from select statement instead of column name Reputation.

```
SELECT DisplayName, JoinDate, Reputation FROM Users ORDER BY 3
```

<table>
<thead>
<tr>
<th>DisplayName</th>
<th>JoinDate</th>
<th>Reputation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>2008-09-15</td>
<td>1</td>
</tr>
<tr>
<td>Jarrod Dixon</td>
<td>2008-10-03</td>
<td>11739</td>
</tr>
<tr>
<td>Geoff Dalgas</td>
<td>2008-10-03</td>
<td>12567</td>
</tr>
<tr>
<td>Joel Spolsky</td>
<td>2008-09-16</td>
<td>25784</td>
</tr>
<tr>
<td>Jeff Atwood</td>
<td>2008-09-16</td>
<td>37628</td>
</tr>
</tbody>
</table>

Section 8.2: Use ORDER BY with TOP to return the top x rows based on a column’s value

In this example, we can use GROUP BY not only determined the sort of the rows returned, but also what rows are returned, since we're using TOP to limit the result set.

Let's say we want to return the top 5 highest reputation users from an unnamed popular Q&A site.

**Without ORDER BY**

This query returns the Top 5 rows ordered by the default, which in this case is "Id", the first column in the table (even though it's not a column shown in the results).

```
SELECT TOP 5 DisplayName, Reputation
FROM Users
```

returns...

<table>
<thead>
<tr>
<th>DisplayName</th>
<th>Reputation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>1</td>
</tr>
<tr>
<td>Geoff Dalgas</td>
<td>12567</td>
</tr>
<tr>
<td>Jarrod Dixon</td>
<td>11739</td>
</tr>
<tr>
<td>Jeff Atwood</td>
<td>37628</td>
</tr>
<tr>
<td>Joel Spolsky</td>
<td>25784</td>
</tr>
</tbody>
</table>

**With ORDER BY**

```
SELECT TOP 5 DisplayName, Reputation
FROM Users
ORDER BY Reputation desc
```

returns...
returns...

**DisplayName Reputation**
JonSkeet 865023
Darin Dimitrov 661741
BalusC 650237
Hans Passant 625870
Marc Gravell 601636

**Remarks**

Some versions of SQL (such as MySQL) use a **LIMIT** clause at the end of a **SELECT**, instead of **TOP** at the beginning, for example:

```sql
SELECT DisplayName, Reputation
FROM Users
ORDER BY Reputation DESC
LIMIT 5
```

### Section 8.3: Customized sorting order

To sort this table Employee by department, you would use **ORDER BY** Department. However, if you want a different sort order that is not alphabetical, you have to map the Department values into different values that sort correctly; this can be done with a CASE expression:

**Name Department**

<table>
<thead>
<tr>
<th>Name</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hasan</td>
<td>IT</td>
</tr>
<tr>
<td>Yusuf</td>
<td>HR</td>
</tr>
<tr>
<td>Hillary</td>
<td>HR</td>
</tr>
<tr>
<td>Joe</td>
<td>IT</td>
</tr>
<tr>
<td>Merry</td>
<td>HR</td>
</tr>
<tr>
<td>Ken</td>
<td>Accountant</td>
</tr>
</tbody>
</table>

```sql
SELECT * 
FROM Employee
ORDER BY CASE Department
  WHEN 'HR' THEN 1 
  WHEN 'Accountant' THEN 2 
  ELSE 3 
END;
```

**Name Department**

<table>
<thead>
<tr>
<th>Name</th>
<th>Department</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yusuf</td>
<td>HR</td>
</tr>
<tr>
<td>Hillary</td>
<td>HR</td>
</tr>
<tr>
<td>Merry</td>
<td>HR</td>
</tr>
<tr>
<td>Ken</td>
<td>Accountant</td>
</tr>
<tr>
<td>Hasan</td>
<td>IT</td>
</tr>
<tr>
<td>Joe</td>
<td>IT</td>
</tr>
</tbody>
</table>

### Section 8.4: Order by Alias

Due to logical query processing order, alias can be used in order by.

```sql
SELECT DisplayName, JoinDate as jd, Reputation as rep
FROM Users
ORDER BY jd, rep
```
And can use relative order of the columns in the select statement. Consider the same example as above and instead of using alias use the relative order like for display name it is 1, for Jd it is 2 and so on

```sql
SELECT DisplayName, JoinDate as jd, Reputation as rep
FROM Users
ORDER BY 2, 3
```

**Section 8.5: Sorting by multiple columns**

```sql
SELECT DisplayName, JoinDate, Reputation FROM Users ORDER BY JoinDate, Reputation
```

<table>
<thead>
<tr>
<th>DisplayName</th>
<th>JoinDate</th>
<th>Reputation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Community</td>
<td>2008-09-15</td>
<td>1</td>
</tr>
<tr>
<td>Jeff Atwood</td>
<td>2008-09-16</td>
<td>25784</td>
</tr>
<tr>
<td>Joel Spolsky</td>
<td>2008-09-16</td>
<td>37628</td>
</tr>
<tr>
<td>Jarrod Dixon</td>
<td>2008-10-03</td>
<td>11739</td>
</tr>
<tr>
<td>Geoff Dalgas</td>
<td>2008-10-03</td>
<td>12567</td>
</tr>
</tbody>
</table>
Chapter 9: AND & OR Operators

Section 9.1: AND OR Example

Have a table

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>City</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bob</td>
<td>10</td>
<td>Paris</td>
</tr>
<tr>
<td>Mat</td>
<td>20</td>
<td>Berlin</td>
</tr>
<tr>
<td>Mary</td>
<td>24</td>
<td>Prague</td>
</tr>
</tbody>
</table>

```
select Name from table where Age > 10 AND City = 'Prague'
```

Gives

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mary</td>
</tr>
</tbody>
</table>

```
select Name from table where Age = 10 OR City = 'Prague'
```

Gives

<table>
<thead>
<tr>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bob</td>
</tr>
<tr>
<td>Mary</td>
</tr>
</tbody>
</table>

Chapter 10: CASE

The CASE expression is used to implement if-then logic.

**Section 10.1: Use CASE to COUNT the number of rows in a column match a condition**

**Use Case**

CASE can be used in conjunction with SUM to return a count of only those items matching a pre-defined condition. (This is similar to COUNTIF in Excel.)

The trick is to return binary results indicating matches, so the "1"s returned for matching entries can be summed for a count of the total number of matches.

Given this table ItemSales, let's say you want to learn the total number of items that have been categorized as "Expensive":

<table>
<thead>
<tr>
<th>Id</th>
<th>ItemId</th>
<th>Price</th>
<th>PriceRating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>34.5</td>
<td>EXPENSIVE</td>
</tr>
<tr>
<td>2</td>
<td>145</td>
<td>2.3</td>
<td>CHEAP</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>34.5</td>
<td>EXPENSIVE</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>34.5</td>
<td>EXPENSIVE</td>
</tr>
<tr>
<td>5</td>
<td>145</td>
<td>10</td>
<td>AFFORDABLE</td>
</tr>
</tbody>
</table>

**Query**

```
SELECT COUNT(Id) AS ItemsCount,
       SUM(CASE WHEN PriceRating = 'Expensive' THEN 1
             ELSE 0
             END) AS ExpensiveItemsCount
FROM ItemSales
```

**Results:**

<table>
<thead>
<tr>
<th>ItemsCount</th>
<th>ExpensiveItemsCount</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

**Alternative:**

```
SELECT COUNT(Id) AS ItemsCount,
       SUM(CASE PriceRating
             WHEN 'Expensive' THEN 1
             ELSE 0
             END) AS ExpensiveItemsCount
FROM ItemSales
```
Section 10.2: Searched CASE in SELECT (Matches a boolean expression)

The searched CASE returns results when a boolean expression is TRUE.

(This differs from the simple case, which can only check for equivalency with an input.)

```sql
SELECT Id, ItemId, Price,
    CASE WHEN Price < 10 THEN 'CHEAP'
         WHEN Price < 20 THEN 'AFFORDABLE'
         ELSE 'EXPENSIVE'
    END AS PriceRating
FROM ItemSales
```

<table>
<thead>
<tr>
<th>Id</th>
<th>ItemId</th>
<th>Price</th>
<th>PriceRating</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>100</td>
<td>34.5</td>
<td>EXPENSIVE</td>
</tr>
<tr>
<td>2</td>
<td>145</td>
<td>2.3</td>
<td>CHEAP</td>
</tr>
<tr>
<td>3</td>
<td>100</td>
<td>34.5</td>
<td>EXPENSIVE</td>
</tr>
<tr>
<td>4</td>
<td>100</td>
<td>34.5</td>
<td>EXPENSIVE</td>
</tr>
<tr>
<td>5</td>
<td>145</td>
<td>10</td>
<td>AFFORDABLE</td>
</tr>
</tbody>
</table>

Section 10.3: CASE in a clause ORDER BY

We can use 1,2,3.. to determine the type of order:

```sql
SELECT * FROM DEPT
ORDER BY CASE DEPARTMENT
    WHEN 'MARKETING' THEN 1
    WHEN 'SALES' THEN 2
    WHEN 'RESEARCH' THEN 3
    WHEN 'INNOVATION' THEN 4
    ELSE 5
END,
CITY
```

<table>
<thead>
<tr>
<th>ID</th>
<th>REGION</th>
<th>CITY</th>
<th>DEPARTMENT</th>
<th>EMPLOYEES_NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>12</td>
<td>New England</td>
<td>Boston</td>
<td>MARKETING</td>
<td>9</td>
</tr>
<tr>
<td>15</td>
<td>West</td>
<td>San Francisco</td>
<td>MARKETING</td>
<td>12</td>
</tr>
<tr>
<td>9</td>
<td>Midwest</td>
<td>Chicago</td>
<td>SALES</td>
<td>8</td>
</tr>
<tr>
<td>14</td>
<td>Mid-Atlantic</td>
<td>New York</td>
<td>SALES</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>West</td>
<td>Los Angeles</td>
<td>RESEARCH</td>
<td>11</td>
</tr>
<tr>
<td>10</td>
<td>Mid-Atlantic</td>
<td>Philadelphia</td>
<td>RESEARCH</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>Midwest</td>
<td>Chicago</td>
<td>INNOVATION</td>
<td>11</td>
</tr>
<tr>
<td>2</td>
<td>Midwest</td>
<td>Detroit</td>
<td>HUMAN RESOURCES</td>
<td>9</td>
</tr>
</tbody>
</table>

Section 10.4: Shorthand CASE in SELECT

CASE’s shorthand variant evaluates an expression (usually a column) against a series of values. This variant is a bit shorter, and saves repeating the evaluated expression over and over again. The ELSE clause can still be used, though:

```sql
SELECT Id, ItemId, Price,
    CASE Price
         WHEN 5 THEN 'CHEAP'
         WHEN 15 THEN 'AFFORDABLE'
         ELSE 'EXPENSIVE'
    END as PriceRating
FROM ItemSales
```
FROM ItemSales

A word of caution. It's important to realize that when using the short variant the entire statement is evaluated at each WHEN. Therefore the following statement:

```
SELECT CASE ABS(CHECKSUM(NEWID())) % 4
    WHEN 0 THEN 'Dr'
    WHEN 1 THEN 'Master'
    WHEN 2 THEN 'Mr'
    WHEN 3 THEN 'Mrs'
END
```

may produce a NULL result. That is because at each WHEN NEWID() is being called again with a new result. Equivalent to:

```
SELECT CASE
    WHEN ABS(CHECKSUM(NEWID())) % 4 = 0 THEN 'Dr'
    WHEN ABS(CHECKSUM(NEWID())) % 4 = 1 THEN 'Master'
    WHEN ABS(CHECKSUM(NEWID())) % 4 = 2 THEN 'Mr'
    WHEN ABS(CHECKSUM(NEWID())) % 4 = 3 THEN 'Mrs'
END
```

Therefore it can miss all the WHEN cases and result as NULL.

**Section 10.5: Using CASE in UPDATE**

Sample on price increases:

```
UPDATE ItemPrice
SET Price = Price *
    CASE ItemId
        WHEN 1 THEN 1.05
        WHEN 2 THEN 1.10
        WHEN 3 THEN 1.15
        ELSE 1.00
    END
```

**Section 10.6: CASE use for NULL values ordered last**

In this way '0' representing the known values are ranked first, '1' representing the NULL values are sorted by the last:

```
SELECT ID,
    ,REGION
    ,CITY
    ,DEPARTMENT
    ,EMPLOYEES_NUMBER
FROM DEPT
ORDER BY
    CASE WHEN REGION IS NULL THEN 1
        ELSE 0
    END,
    REGION
```

<table>
<thead>
<tr>
<th>ID</th>
<th>REGION</th>
<th>CITY</th>
<th>DEPARTMENT</th>
<th>EMPLOYEES_NUMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Mid-Atlantic</td>
<td>Philadelphia</td>
<td>RESEARCH</td>
<td>13</td>
</tr>
</tbody>
</table>
Section 10.7: CASE in ORDER BY clause to sort records by lowest value of 2 columns

Imagine that you need sort records by lowest value of either one of two columns. Some databases could use a non-aggregated MIN() or LEAST() function for this (... ORDER BY MIN(Date1, Date2)), but in standard SQL, you have to use a CASE expression.

The CASE expression in the query below looks at the Date1 and Date2 columns, checks which column has the lower value, and sorts the records depending on this value.

Sample data
<table>
<thead>
<tr>
<th>Id</th>
<th>Date1</th>
<th>Date2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2017-01-01</td>
<td>2017-01-31</td>
</tr>
<tr>
<td>2</td>
<td>2017-01-31</td>
<td>2017-01-03</td>
</tr>
<tr>
<td>3</td>
<td>2017-01-31</td>
<td>2017-01-02</td>
</tr>
<tr>
<td>4</td>
<td>2017-01-06</td>
<td>2017-01-31</td>
</tr>
<tr>
<td>5</td>
<td>2017-01-31</td>
<td>2017-01-05</td>
</tr>
<tr>
<td>6</td>
<td>2017-01-04</td>
<td>2017-01-31</td>
</tr>
</tbody>
</table>

Query

```sql
SELECT Id, Date1, Date2
FROM YourTable
ORDER BY CASE
WHEN COALESCE(Date1, '1753-01-01') < COALESCE(Date2, '1753-01-01') THEN Date1
ELSE Date2
END
```

Results
<table>
<thead>
<tr>
<th>Id</th>
<th>Date1</th>
<th>Date2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2017-01-01</td>
<td>2017-01-31</td>
</tr>
<tr>
<td>3</td>
<td>2017-01-31</td>
<td>2017-01-02</td>
</tr>
<tr>
<td>2</td>
<td>2017-01-31</td>
<td>2017-01-03</td>
</tr>
<tr>
<td>6</td>
<td>2017-01-04</td>
<td>2017-01-31</td>
</tr>
<tr>
<td>5</td>
<td>2017-01-31</td>
<td>2017-01-05</td>
</tr>
<tr>
<td>4</td>
<td>2017-01-06</td>
<td>2017-01-31</td>
</tr>
</tbody>
</table>

Explanation

As you see row with Id = 1 is first, that because Date1 have lowest record from entire table 2017-01-01, row where Id = 3 is second that because Date2 equals to 2017-01-02 that is second lowest value from table and so on.

So we have sorted records from 2017-01-01 to 2017-01-06 ascending and no care on which one column Date1 or Date2 are those values.
Chapter 11: LIKE operator

Section 11.1: Match open-ended pattern

The % wildcard appended to the beginning or end (or both) of a string will allow 0 or more of any character before the beginning or after the end of the pattern to match.

Using % in the middle will allow 0 or more characters between the two parts of the pattern to match.

We are going to use this Employees Table:

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>Hire_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
<tr>
<td>2</td>
<td>Sophie</td>
<td>Amudsen</td>
<td>2479100211</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>11-01-2010</td>
</tr>
<tr>
<td>3</td>
<td>Ronny</td>
<td>Smith</td>
<td>2462544026</td>
<td>2</td>
<td>1</td>
<td>600</td>
<td>06-08-2015</td>
</tr>
<tr>
<td>4</td>
<td>Jon</td>
<td>Sanchez</td>
<td>2454124602</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
<tr>
<td>5</td>
<td>Hilde</td>
<td>Knag</td>
<td>2468021911</td>
<td>2</td>
<td>1</td>
<td>800</td>
<td>01-01-2000</td>
</tr>
</tbody>
</table>

Following statement matches for all records having FName containing string 'on' from Employees Table.

```
SELECT * FROM Employees WHERE FName LIKE '%on%';
```

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>Hire_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Ronny</td>
<td>Smith</td>
<td>2462544026</td>
<td>2</td>
<td>1</td>
<td>600</td>
<td>06-08-2015</td>
</tr>
<tr>
<td>4</td>
<td>Jon</td>
<td>Sanchez</td>
<td>2454124602</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
</tbody>
</table>

Following statement matches all records having PhoneNumber starting with string '246' from Employees.

```
SELECT * FROM Employees WHERE PhoneNumber LIKE '246%';
```

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>Hire_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
<tr>
<td>3</td>
<td>Ronny</td>
<td>Smith</td>
<td>2462544026</td>
<td>2</td>
<td>1</td>
<td>600</td>
<td>06-08-2015</td>
</tr>
<tr>
<td>5</td>
<td>Hilde</td>
<td>Knag</td>
<td>2468021911</td>
<td>2</td>
<td>1</td>
<td>800</td>
<td>01-01-2000</td>
</tr>
</tbody>
</table>

Following statement matches all records having PhoneNumber ending with string '11' from Employees.

```
SELECT * FROM Employees WHERE PhoneNumber LIKE '%11';
```

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>Hire_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Sophie</td>
<td>Amudsen</td>
<td>2479100211</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>11-01-2010</td>
</tr>
<tr>
<td>5</td>
<td>Hilde</td>
<td>Knag</td>
<td>2468021911</td>
<td>2</td>
<td>1</td>
<td>800</td>
<td>01-01-2000</td>
</tr>
</tbody>
</table>

All records where FName 3rd character is 'n' from Employees.

```
SELECT * FROM Employees WHERE FName LIKE '__n%';
```

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>Hire_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>Ronny</td>
<td>Smith</td>
<td>2462544026</td>
<td>2</td>
<td>1</td>
<td>600</td>
<td>06-08-2015</td>
</tr>
<tr>
<td>4</td>
<td>Jon</td>
<td>Sanchez</td>
<td>2454124602</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
</tbody>
</table>

Section 11.2: Single character match

To broaden the selections of a structured query language (SQL-SELECT) statement, wildcard characters, the percent
sign (%) and the underscore (_), can be used.

The _ (underscore) character can be used as a wildcard for any single character in a pattern match.

Find all employees whose Fname start with 'j' and end with 'n' and has exactly 3 characters in Fname.

```sql
SELECT * FROM Employees WHERE FName LIKE 'j_n'
```

_ (underscore) character can also be used more than once as a wild card to match patterns.

For example, this pattern would match "jon", "jan", "jen", etc.

These names will not be shown "jn", "john", "jordan", "justin", "jason", "julian", "jillian", "joann" because in our query one underscore is used and it can skip exactly one character, so result must be of 3 character Fname.

For example, this pattern would match "LaSt", "LoSt", "HaLt", etc.

```sql
SELECT * FROM Employees WHERE FName LIKE '__A_T'
```

**Section 11.3: ESCAPE statement in the LIKE-query**

If you implement a text-search as LIKE-query, you usually do it like this:

```sql
SELECT * FROM T_Whatever WHERE SomeField LIKE CONCAT('%', @in_SearchText, '%')
```

However, (apart from the fact that you shouldn't necessarily use LIKE when you can use fulltext-search) this creates a problem when somebody inputs text like "50%" or "a_b".

So (instead of switching to fulltext-search), you can solve that problem using the LIKE-escape statement:

```sql
SELECT * FROM T_Whatever WHERE SomeField LIKE CONCAT('%', @in_SearchText, '%') ESCAPE '\'
```

That means \ will now be treated as ESCAPE character. This means, you can now just prepend \ to every character in the string you search, and the results will start to be correct, even when the user enters a special character like % or _.

e.g.

```c
string stringToSearch = "abc_def 50%";
string newString = "";
foreach (char c in stringToSearch)
    newString += @"\" + c;

sqlCmd.Parameters.Add("@in_SearchText", newString);
// instead of sqlCmd.Parameters.Add("@in_SearchText", stringToSearch);
```

Note: The above algorithm is for demonstration purposes only. It will not work in cases where 1 grapheme consists out of several characters (utf-8). e.g. string stringToSearch = "Les Mise\u0301rables"; You'll need to do this for each grapheme, not for each character. You should not use the above algorithm if you're dealing with Asian/East-Asian/South-Asian languages. Or rather, if you want correct code to begin with, you should just do that for each graphemeCluster.
Section 11.4: Search for a range of characters

Following statement matches all records having FName that starts with a letter from A to F from Employees Table.

```sql
SELECT * FROM Employees WHERE FName LIKE '[A-F]%'
```

Section 11.5: Match by range or set

Match any single character within the specified range (e.g.: [a-f]) or set (e.g.: [abcdef]).

This range pattern would match "gary" but not "mary":

```sql
SELECT * FROM Employees WHERE FName LIKE '[a-g]ary'
```

This set pattern would match "mary" but not "gary":

```sql
SELECT * FROM Employees WHERE Fname LIKE '[lmnop]ary'
```

The range or set can also be negated by appending the ^ caret before the range or set:

This range pattern would not match "gary" but will match "mary":

```sql
SELECT * FROM Employees WHERE FName LIKE '[^a-g]ary'
```

This set pattern would not match "mary" but will match "gary":

```sql
SELECT * FROM Employees WHERE Fname LIKE '[^lmnop]ary'
```

Section 11.6: Wildcard characters

Wildcard characters are used with the SQL LIKE operator. SQL wildcards are used to search for data within a table.

Wildcards in SQL are: %, _, [charlist], [^charlist]

% - A substitute for zero or more characters

Eg:  //selects all customers with a City starting with "Lo"
    SELECT * FROM Customers
    WHERE City LIKE 'Lo%';

    //selects all customers with a City containing the pattern "es"
    SELECT * FROM Customers
    WHERE City LIKE '%es%';

_ - A substitute for a single character

Eg://selects all customers with a City starting with any character, followed by "erlin"
SELECT * FROM Customers
WHERE City LIKE '_erlin';

[charlist] - Sets and ranges of characters to match

Eg://selects all customers with a City starting with "a", "d", or "l"
SELECT * FROM Customers
WHERE City LIKE '[adl]%';

//selects all customers with a City starting with "a", "d", or "l"
SELECT * FROM Customers
WHERE City LIKE '[a-c]%';

[charlist] - Matches only a character NOT specified within the brackets

Eg://selects all customers with a City starting with a character that is not "a", "p", or "l"
SELECT * FROM Customers
WHERE City LIKE '[^apl]%';

or

SELECT * FROM Customers
WHERE City NOT LIKE '[apl]%' and city like '_';
Chapter 12: IN clause

Section 12.1: Simple IN clause

To get records having any of the given ids

```sql
select *
from products
where id in (1, 8, 3)
```

The query above is equal to

```sql
select *
from products
where id = 1
  or id = 8
  or id = 3
```

Section 12.2: Using IN clause with a subquery

```sql
SELECT *
FROM customers
WHERE id IN (
    SELECT DISTINCT customer_id
    FROM orders
);
```

The above will give you all the customers that have orders in the system.
Chapter 13: Filter results using WHERE and HAVING

Section 13.1: Use BETWEEN to Filter Results

The following examples use the Item Sales and Customers sample databases.

Note: The BETWEEN operator is inclusive.

Using the BETWEEN operator with Numbers:

```
SELECT * FromItemSales
WHERE Quantity BETWEEN 10 AND 17
```

This query will return all ItemSales records that have a quantity that is greater or equal to 10 and less than or equal to 17. The results will look like:

<table>
<thead>
<tr>
<th>Id</th>
<th>SaleDate</th>
<th>ItemId</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2013-07-01</td>
<td>100</td>
<td>10</td>
<td>34.5</td>
</tr>
<tr>
<td>4</td>
<td>2013-07-23</td>
<td>100</td>
<td>15</td>
<td>34.5</td>
</tr>
<tr>
<td>5</td>
<td>2013-07-24</td>
<td>145</td>
<td>10</td>
<td>34.5</td>
</tr>
</tbody>
</table>

Using the BETWEEN operator with Date Values:

```
SELECT * FromItemSales
WHERE SaleDate BETWEEN '2013-07-11' AND '2013-05-24'
```

This query will return all ItemSales records with a SaleDate that is greater than or equal to July 11, 2013 and less than or equal to May 24, 2013.

<table>
<thead>
<tr>
<th>Id</th>
<th>SaleDate</th>
<th>ItemId</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>2013-07-11</td>
<td>100</td>
<td>20</td>
<td>34.5</td>
</tr>
<tr>
<td>4</td>
<td>2013-07-23</td>
<td>100</td>
<td>15</td>
<td>34.5</td>
</tr>
<tr>
<td>5</td>
<td>2013-07-24</td>
<td>145</td>
<td>10</td>
<td>34.5</td>
</tr>
</tbody>
</table>

When comparing datetime values instead of dates, you may need to convert the datetime values into a date values, or add or subtract 24 hours to get the correct results.

Using the BETWEEN operator with Text Values:

```
SELECT Id, FName, LName FROM Customers
WHERE LName BETWEEN 'D' AND 'L'
```

Live example: [SQL fiddle](#)

This query will return all customers whose name alphabetically falls between the letters 'D' and 'L'. In this case, Customer #1 and #3 will be returned. Customer #2, whose name begins with a 'M' will not be included.

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>William</td>
<td>Jones</td>
</tr>
<tr>
<td>3</td>
<td>Richard</td>
<td>Davis</td>
</tr>
</tbody>
</table>
Section 13.2: Use HAVING with Aggregate Functions

Unlike the WHERE clause, HAVING can be used with aggregate functions.

An aggregate function is a function where the values of multiple rows are grouped together as input on certain criteria to form a single value of more significant meaning or measurement. Common aggregate functions include COUNT(), SUM(), MIN(), and MAX().

This example uses the Car Table from the Example Databases.

```sql
SELECT CustomerId, COUNT(Id) AS [Number of Cars]
FROM Cars
GROUP BY CustomerId
HAVING COUNT(Id) > 1
```

This query will return the CustomerId and Number of Cars count of any customer who has more than one car. In this case, the only customer who has more than one car is Customer #1.

The results will look like:

<table>
<thead>
<tr>
<th>CustomerId</th>
<th>Number of Cars</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Section 13.3: WHERE clause with NULL/NOT NULL values

This statement will return all Employee records where the value of the ManagerId column is NULL.

```sql
SELECT * 
FROM Employees 
WHERE ManagerId IS NULL
```

The result will be:

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
</tr>
</tbody>
</table>

This statement will return all Employee records where the value of the ManagerId is not NULL.

```sql
SELECT * 
FROM Employees 
WHERE ManagerId IS NOT NULL
```

The result will be:

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>Michael</td>
<td>Williams</td>
<td>1357911131</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>Johnathon</td>
<td>Smith</td>
<td>1212121212</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Note: The same query will not return results if you change the WHERE clause to WHERE ManagerId = NULL or WHERE ManagerId <> NULL.
Section 13.4: Equality

```sql
SELECT * FROM Employees
```

This statement will return all the rows from the table Employees.

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>Hire_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
<td>1000</td>
<td>01-01-2002</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
<tr>
<td>3</td>
<td>Michael</td>
<td>Williams</td>
<td>1357911113</td>
<td>1</td>
<td>2</td>
<td>600</td>
<td>12-05-2009</td>
</tr>
<tr>
<td>4</td>
<td>Johnathon</td>
<td>Smith</td>
<td>1212121212</td>
<td>2</td>
<td>1</td>
<td>500</td>
<td>24-07-2016</td>
</tr>
</tbody>
</table>

Using a `WHERE` at the end of your `SELECT` statement allows you to limit the returned rows to a condition. In this case, where there is an exact match using the `=` sign:

```sql
SELECT * FROM Employees WHERE DepartmentId = 1
```

Will only return the rows where the `DepartmentId` is equal to 1:

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>Hire_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
<td>1000</td>
<td>01-01-2002</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
<tr>
<td>4</td>
<td>Johnathon</td>
<td>Smith</td>
<td>1212121212</td>
<td>2</td>
<td>1</td>
<td>500</td>
<td>24-07-2016</td>
</tr>
</tbody>
</table>

Section 13.5: The WHERE clause only returns rows that match its criteria

Steam has a games under $10 section of their store page. Somewhere deep in the heart of their systems, there's probably a query that looks something like:

```sql
SELECT * FROM Items WHERE Price < 10
```

Section 13.6: AND and OR

You can also combine several operators together to create more complex `WHERE` conditions. The following examples use the Employees table:

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>Hire_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
<td>1000</td>
<td>01-01-2002</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
</tbody>
</table>
### Section 13.7: Use IN to return rows with a value contained in a list

This example uses the Car Table from the Example Databases.

```
SELECT * FROM Cars WHERE TotalCost IN (100, 200, 300)
```

This query will return Car #2 which costs 200 and Car #3 which costs 100. Note that this is equivalent to using multiple clauses with OR, e.g.:

```
SELECT * FROM Cars WHERE TotalCost = 100 OR TotalCost = 200 OR TotalCost = 300
```

### Section 13.8: Use LIKE to find matching strings and substrings

See full documentation on LIKE operator.

This example uses the Employees Table from the Example Databases.

```
SELECT * FROM Employees
```
WHERE FName LIKE 'John'

This query will only return Employee #1 whose first name matches 'John' exactly.

```sql
SELECT *
FROM Employees
WHERE FName like 'John'
```

Adding % allows you to search for a substring:

- John% - will return any Employee whose name begins with 'John', followed by any amount of characters
- %John - will return any Employee whose name ends with 'John', proceeded by any amount of characters
- %John% - will return any Employee whose name contains 'John' anywhere within the value

In this case, the query will return Employee #2 whose name is 'John' as well as Employee #4 whose name is 'Johnathon'.

**Section 13.9: Where EXISTS**

Will select records in TableName that have records matching in TableName1.

```sql
SELECT * FROM TableName t WHERE EXISTS (SELECT 1 FROM TableName1 t1 where t.Id = t1.Id)
```

**Section 13.10: Use HAVING to check for multiple conditions in a group**

Orders Table

<table>
<thead>
<tr>
<th>CustomerId</th>
<th>ProductId</th>
<th>Quantity</th>
<th>Price</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>2</td>
<td>200</td>
</tr>
<tr>
<td>1</td>
<td>4</td>
<td>1</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>4</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>5</td>
<td>6</td>
<td>700</td>
</tr>
</tbody>
</table>

To check for customers who have ordered both - ProductID 2 and 3, HAVING can be used

```sql
select customerId
from orders
where productID in (2,3)
group by customerId
having count(distinct productID) = 2
```

Return value:

```sql
customerId
1
```

The query selects only records with the productIDs in questions and with the HAVING clause checks for groups having 2 productIds and not just one.

Another possibility would be

```sql
select customerId
```
This query selects only groups having at least one record with productID 2 and at least one with productID 3.
Chapter 14: SKIP TAKE (Pagination)

Section 14.1: Limiting amount of results

ISO/ANSI SQL:

```
SELECT * FROM TableName FETCH FIRST 20 ROWS ONLY;
```

MySQL; PostgreSQL; SQLite:

```
SELECT * FROM TableName LIMIT 20;
```

Oracle:

```
SELECT Id, Col1
FROM (SELECT Id, Col1,
        row_number() over (order by Id) RowNumber
        FROM TableName)
WHERE RowNumber <= 20
```

SQL Server:

```
SELECT TOP 20 *
FROM dbo.[Sale]
```

Section 14.2: Skipping then taking some results (Pagination)

ISO/ANSI SQL:

```
SELECT Id, Col1
FROM TableName
ORDER BY Id
OFFSET 20 ROWS FETCH NEXT 20 ROWS ONLY;
```

MySQL:

```
SELECT * FROM TableName LIMIT 20, 20; -- offset, limit
```

Oracle; SQL Server:

```
SELECT Id, Col1
FROM (SELECT Id, Col1,
        row_number() over (order by Id) RowNumber
        FROM TableName)
WHERE RowNumber BETWEEN 21 AND 40
```

PostgreSQL; SQLite:

```
SELECT * FROM TableName LIMIT 20 OFFSET 20;
```
Section 14.3: Skipping some rows from result

ISO/ANSI SQL:

```sql
SELECT Id, Col1
FROM TableName
ORDER BY Id
OFFSET 20 ROWS
```

MySQL:

```sql
SELECT * FROM TableName LIMIT 20, 42424242424242;
-- skips 20 for take use very large number that is more than rows in table
```

Oracle:

```sql
SELECT Id,
    Col1
FROM (SELECT Id,
            Col1,
            row_number() over (order by Id) RowNumber
    FROM TableName)
WHERE RowNumber > 20
```

PostgreSQL:

```sql
SELECT * FROM TableName OFFSET 20;
```

SQLite:

```sql
SELECT * FROM TableName LIMIT -1 OFFSET 20;
```
Chapter 15: EXCEPT

Section 15.1: Select dataset except where values are in this other dataset

```sql
--dataset schemas must be identical
SELECT 'Data1' as 'Column' UNION ALL
SELECT 'Data2' as 'Column' UNION ALL
SELECT 'Data3' as 'Column' UNION ALL
SELECT 'Data4' as 'Column' UNION ALL
SELECT 'Data5' as 'Column'
EXCEPT
SELECT 'Data3' as 'Column'
--Returns Data1, Data2, Data4, and Data5
```
Chapter 16: EXPLAIN and DESCRIBE

Section 16.1: EXPLAIN Select query

An `Explain` in front of a `select` query shows you how the query will be executed. This way you see if the query uses an index or if you could optimize your query by adding an index.

Example query:

```sql
explain select * from user join data on user.test = data.fk_user;
```

Example result:

```
id  select_type  table   type    possible_keys  key     key_len ref       rows  Extra
1   SIMPLE       user    index   test           test    5       (null)    1     Using where; Using index
1   SIMPLE       data    ref     fk_user        fk_user 5       user.test 1     (null)
```

On `type` you see if an index was used. In the column `possible_keys` you see if the execution plan can choose from different indexes of if none exists. `key` tells you the actual used index. `key_len` shows you the size in bytes for one index item. The lower this value is the more index items fit into the same memory size and they can be faster processed. `rows` shows you the expected number of rows the query needs to scan, the lower the better.

Section 16.2: DESCRIBE tablename;

`DESCRIBE` and `EXPLAIN` are synonyms. `DESCRIBE` on a tablename returns the definition of the columns.

Example Result:

```
COLUMN_NAME     COLUMN_TYPE     IS_NULLABLE     COLUMN_KEY     COLUMN_DEFAULT    EXTRA
id              int(11)         NO              PRI             0               auto_increment
 test            varchar(255)  YES             (null)           (null)
```

Here you see the column names, followed by the columns type. It shows if `null` is allowed in the column and if the column uses an index. The default value is also displayed and if the table contains any special behavior like an `auto_increment`. 
Chapter 17: EXISTS CLAUSE

Section 17.1: EXISTS CLAUSE

Customer Table

<table>
<thead>
<tr>
<th>Id</th>
<th>FirstName</th>
<th>LastName</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ozgur</td>
<td>Ozturk</td>
</tr>
<tr>
<td>2</td>
<td>Youssef</td>
<td>Medi</td>
</tr>
<tr>
<td>3</td>
<td>Henry</td>
<td>Tai</td>
</tr>
</tbody>
</table>

Order Table

<table>
<thead>
<tr>
<th>Id</th>
<th>CustomerId</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>123.50</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
<td>14.80</td>
</tr>
</tbody>
</table>

Get all customers with a least one order

```
SELECT * FROM Customer WHERE EXISTS (
    SELECT * FROM Order WHERE Order.CustomerId=Customer.Id
)
```

Result

<table>
<thead>
<tr>
<th>Id</th>
<th>FirstName</th>
<th>LastName</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Youssef</td>
<td>Medi</td>
</tr>
<tr>
<td>3</td>
<td>Henry</td>
<td>Tai</td>
</tr>
</tbody>
</table>

Get all customers with no order

```
SELECT * FROM Customer WHERE NOT EXISTS (
    SELECT * FROM Order WHERE Order.CustomerId = Customer.Id
)
```

Result

<table>
<thead>
<tr>
<th>Id</th>
<th>FirstName</th>
<th>LastName</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Ozgur</td>
<td>Ozturk</td>
</tr>
</tbody>
</table>

Purpose

`EXISTS`, `IN` and `JOIN` could sometime be used for the same result, however, they are not equals:

- `EXISTS` should be used to check if a value exist in another table
- `IN` should be used for static list
- `JOIN` should be used to retrieve data from other(s) table(s)
Chapter 18: JOIN

JOIN is a method of combining (joining) information from two tables. The result is a stitched set of columns from both tables, defined by the join type (INNER/OUTER/CROSS and LEFT/RIGHT/FULL, explained below) and join criteria (how rows from both tables relate).

A table may be joined to itself or to any other table. If information from more than two tables needs to be accessed, multiple joins can be specified in a FROM clause.

Section 18.1: Self Join

A table may be joined to itself, with different rows matching each other by some condition. In this use case, aliases must be used in order to distinguish the two occurrences of the table.

In the below example, for each Employee in the example database Employees table, a record is returned containing the employee's first name together with the corresponding first name of the employee's manager. Since managers are also employees, the table is joined with itself:

```
SELECT 
  e.FName AS "Employee",
  m.FName AS "Manager"
FROM 
  Employees e 
JOIN 
  Employees m 
ON  e.ManagerId = m.Id
```

This query will return the following data:

**Employee Manager**
John    James
Michael James
Johnathon John

So how does this work?

The original table contains these records:

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>HireDate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
<td>1000</td>
<td>01-01-2002</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
<tr>
<td>3</td>
<td>Michael</td>
<td>Williams</td>
<td>1357911131</td>
<td>1</td>
<td>2</td>
<td>600</td>
<td>12-05-2009</td>
</tr>
<tr>
<td>4</td>
<td>Johnathon</td>
<td>Smith</td>
<td>1212121212</td>
<td>2</td>
<td>1</td>
<td>500</td>
<td>24-07-2016</td>
</tr>
</tbody>
</table>

The first action is to create a *Cartesian* product of all records in the tables used in the FROM clause. In this case it's the Employees table twice, so the intermediate table will look like this (I've removed any fields not used in this example):

<table>
<thead>
<tr>
<th>e.Id</th>
<th>e.FName</th>
<th>e.ManagerId</th>
<th>m.Id</th>
<th>m.FName</th>
<th>m.ManagerId</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>NULL</td>
<td>1</td>
<td>James</td>
<td>NULL</td>
</tr>
<tr>
<td>1</td>
<td>James</td>
<td>NULL</td>
<td>2</td>
<td>John</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>James</td>
<td>NULL</td>
<td>3</td>
<td>Michael</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>James</td>
<td>NULL</td>
<td>4</td>
<td>Johnathon</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>1</td>
<td>1</td>
<td>James</td>
<td>NULL</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>1</td>
<td>2</td>
<td>John</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>John</td>
<td>1</td>
<td>3</td>
<td>Michael</td>
<td>1</td>
</tr>
</tbody>
</table>
The next action is to only keep the records that meet the **JOIN** criteria, so any records where the aliased `e` table `ManagerId` equals the aliased `m` table `Id`:

```
<table>
<thead>
<tr>
<th>e.Id</th>
<th>e.FName</th>
<th>e.ManagerId</th>
<th>m.Id</th>
<th>m.FName</th>
<th>m.ManagerId</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>John</td>
<td>1</td>
<td>1</td>
<td>James</td>
<td>NULL</td>
</tr>
<tr>
<td>3</td>
<td>Michael</td>
<td>1</td>
<td>1</td>
<td>James</td>
<td>NULL</td>
</tr>
<tr>
<td>4</td>
<td>Johnathon</td>
<td>2</td>
<td>2</td>
<td>John</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Johnathon</td>
<td>2</td>
<td>3</td>
<td>Michael</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>Johnathon</td>
<td>2</td>
<td>4</td>
<td>Johnathon</td>
<td>2</td>
</tr>
</tbody>
</table>
```

Then, each expression used within the **SELECT** clause is evaluated to return this table:

```
e.FName  m.FName
John      James
Michael   James
Johnathon John
```

Finally, column names `e.FName` and `m.FName` are replaced by their alias column names, assigned with the **AS** operator:

**Employee Manager**

```
John      James
Michael   James
Johnathon John
```

**Section 18.2: Differences between inner/outer joins**

SQL has various join types to specify whether (non-)matching rows are included in the result: **INNER JOIN, LEFT OUTER JOIN, RIGHT OUTER JOIN**, and **FULL OUTER JOIN** (the **INNER** and **OUTER** keywords are optional). The figure below underlines the differences between these types of joins: the blue area represents the results returned by the join, and the white area represents the results that the join will not return.
Cross Join SQL Pictorial Presentation (reference):

SELECT * FROM table1 CROSS JOIN table2;

In CROSS JOIN, each row from 1st table joins with all the rows of another table.
If 1st table contain x rows and y rows in 2nd one the result set will be x * y rows.

Below are examples from this answer.

For instance there are two tables as below:
Note that (1,2) are unique to A, (3,4) are common, and (5,6) are unique to B.

**Inner Join**

An inner join using either of the equivalent queries gives the intersection of the two tables, i.e. the two rows they have in common:

```sql
select *
from a
INNER JOIN b
on a.a = b.b;

select a.*, b.*
from a, b
where a.a = b.b;
```

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**Left outer join**

A left outer join will give all rows in A, plus any common rows in B:

```sql
select *
from a
LEFT OUTER JOIN b
on a.a = b.b;
```

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>null</td>
</tr>
<tr>
<td>2</td>
<td>null</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

**Right outer join**

Similarly, a right outer join will give all rows in B, plus any common rows in A:

```sql
select *
from a
RIGHT OUTER JOIN b
on a.a = b.b;
```

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>null</td>
<td>5</td>
</tr>
<tr>
<td>null</td>
<td>6</td>
</tr>
</tbody>
</table>

**Full outer join**

A full outer join will give you the union of A and B, i.e., all the rows in A and all the rows in B. If something in A doesn't have a corresponding datum in B, then the B portion is null, and vice versa.

```sql
select *
from a
FULL OUTER JOIN b
on a.a = b.b;
```

<table>
<thead>
<tr>
<th>a</th>
<th>b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Section 18.3: JOIN Terminology: Inner, Outer, Semi, Anti..

Let's say we have two tables (A and B) and some of their rows match (relative to the given JOIN condition, whatever it may be in the particular case):

<table>
<thead>
<tr>
<th></th>
<th>null</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>null</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>null</td>
<td>6</td>
</tr>
<tr>
<td>null</td>
<td>5</td>
</tr>
</tbody>
</table>
We can use various join types to include or exclude matching or non-matching rows from either side, and correctly name the join by picking the corresponding terms from the diagram above.

The examples below use the following test data:

```
CREATE TABLE A (  
  x varchar(255) PRIMARY KEY
)  
```
CREATE TABLE B (  
  Y varchar(255) PRIMARY KEY  
);

INSERT INTO A VALUES  
  ('Amy'),  
  ('John'),  
  ('Lisa'),  
  ('Marco'),  
  ('Phil');

INSERT INTO B VALUES  
  ('Lisa'),  
  ('Marco'),  
  ('Phil'),  
  ('Tim'),  
  ('Vincent');

**Inner Join**

Combines left and right rows that match.

```
<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lisa</td>
<td>Lisa</td>
</tr>
<tr>
<td>Marco</td>
<td>Marco</td>
</tr>
<tr>
<td>Phil</td>
<td>Phil</td>
</tr>
</tbody>
</table>
```

**Left Outer Join**

Sometimes abbreviated to "left join". Combines left and right rows that match, and includes non-matching left rows.

```
<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lisa</td>
<td>Lisa</td>
</tr>
<tr>
<td>Marco</td>
<td>Marco</td>
</tr>
<tr>
<td>Phil</td>
<td>Phil</td>
</tr>
</tbody>
</table>
```
### Right Outer Join

Sometimes abbreviated to "right join". Combines left and right rows that match, and includes non-matching right rows.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amy</td>
<td>NULL</td>
</tr>
<tr>
<td>John</td>
<td>NULL</td>
</tr>
<tr>
<td>Lisa</td>
<td>Lisa</td>
</tr>
<tr>
<td>Marco</td>
<td>Marco</td>
</tr>
<tr>
<td>Phil</td>
<td>Phil</td>
</tr>
</tbody>
</table>
### Full Outer Join

Sometimes abbreviated to "full join". Union of left and right outer join.

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lisa</td>
<td>Lisa</td>
</tr>
<tr>
<td>Marco</td>
<td>Marco</td>
</tr>
<tr>
<td>Phil</td>
<td>Phil</td>
</tr>
<tr>
<td>NULL</td>
<td>Tim</td>
</tr>
<tr>
<td>NULL</td>
<td>Vincent</td>
</tr>
</tbody>
</table>
SELECT * FROM A FULL JOIN B ON X = Y;

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amy</td>
<td>NULL</td>
</tr>
<tr>
<td>John</td>
<td>NULL</td>
</tr>
<tr>
<td>Lisa</td>
<td>Lisa</td>
</tr>
<tr>
<td>Marco</td>
<td>Marco</td>
</tr>
<tr>
<td>Phil</td>
<td>Phil</td>
</tr>
<tr>
<td>NULL</td>
<td>Tim</td>
</tr>
<tr>
<td>NULL</td>
<td>Vincent</td>
</tr>
</tbody>
</table>

**Left Semi Join**

Includes left rows that match right rows.
Right Semi Join

Includes right rows that match left rows.
As you can see, there is no dedicated IN syntax for left vs. right semi join - we achieve the effect simply by switching the table positions within SQL text.

**Left Anti Semi Join**

Includes left rows that do **not** match right rows.

```
SELECT * FROM A WHERE X NOT IN (SELECT Y FROM B);
```

**WARNING:** Be careful if you happen to be using NOT IN on a NULL-able column! More details [here](#).

**Right Anti Semi Join**

Includes right rows that do **not** match left rows.
As you can see, there is no dedicated NOT IN syntax for left vs. right anti semi join - we achieve the effect simply by switching the table positions within SQL text.

**Cross Join**

A Cartesian product of all left with all right rows.

```
SELECT * FROM A CROSS JOIN B;
```

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amy</td>
<td>Lisa</td>
</tr>
<tr>
<td>John</td>
<td>Lisa</td>
</tr>
<tr>
<td>Lisa</td>
<td>Lisa</td>
</tr>
<tr>
<td>Marco</td>
<td>Lisa</td>
</tr>
<tr>
<td>Phil</td>
<td>Lisa</td>
</tr>
<tr>
<td>Amy</td>
<td>Marco</td>
</tr>
<tr>
<td>John</td>
<td>Marco</td>
</tr>
<tr>
<td>Lisa</td>
<td>Marco</td>
</tr>
<tr>
<td>Marco</td>
<td>Marco</td>
</tr>
<tr>
<td>Phil</td>
<td>Marco</td>
</tr>
<tr>
<td>Amy</td>
<td>Phil</td>
</tr>
<tr>
<td>John</td>
<td>Phil</td>
</tr>
<tr>
<td>Lisa</td>
<td>Phil</td>
</tr>
<tr>
<td>Marco</td>
<td>Phil</td>
</tr>
<tr>
<td>Phil</td>
<td>Phil</td>
</tr>
<tr>
<td>Amy</td>
<td>Tim</td>
</tr>
<tr>
<td>John</td>
<td>Tim</td>
</tr>
</tbody>
</table>
Cross join is equivalent to an inner join with join condition which always matches, so the following query would have returned the same result:

```
SELECT * FROM A JOIN B ON 1 = 1;
```

**Self-Join**

This simply denotes a table joining with itself. A self-join can be any of the join types discussed above. For example, this is an inner self-join:

```
SELECT * FROM A A1 JOIN A A2 ON LEN(A1.X) < LEN(A2.X);
```

<table>
<thead>
<tr>
<th>X</th>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amy</td>
<td>John</td>
</tr>
<tr>
<td>Amy</td>
<td>Lisa</td>
</tr>
<tr>
<td>Amy</td>
<td>Marco</td>
</tr>
<tr>
<td>John</td>
<td>Marco</td>
</tr>
<tr>
<td>Lisa</td>
<td>Marco</td>
</tr>
<tr>
<td>Phil</td>
<td>Marco</td>
</tr>
<tr>
<td>Amy</td>
<td>Phil</td>
</tr>
</tbody>
</table>

**Section 18.4: Left Outer Join**

A Left Outer Join (also known as a Left Join or Outer Join) is a Join that ensures all rows from the left table are represented; if no matching row from the right table exists, its corresponding fields are `NULL`.

The following example will select all departments and the first name of employees that work in that department. Departments with no employees are still returned in the results, but will have NULL for the employee name:

```
SELECT Departments.Name, Employees.FName
FROM Departments
LEFT OUTER JOIN Employees
ON Departments.Id = Employees.DepartmentId
```

This would return the following from the example database:

<table>
<thead>
<tr>
<th>Departments.Name</th>
<th>Employees.FName</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>James</td>
</tr>
<tr>
<td>HR</td>
<td>John</td>
</tr>
<tr>
<td>HR</td>
<td>Johnathon</td>
</tr>
<tr>
<td>Sales</td>
<td>Michael</td>
</tr>
<tr>
<td>Tech</td>
<td>NULL</td>
</tr>
</tbody>
</table>

**So how does this work?**

There are two tables in the FROM clause:

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>HireDate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
<td>1000</td>
<td>01-01-2002</td>
</tr>
</tbody>
</table>
and

<table>
<thead>
<tr>
<th>Id</th>
<th>Name</th>
<th>Id</th>
<th>FName</th>
<th>LName</th>
<th>PhoneNumber</th>
<th>ManagerId</th>
<th>DepartmentId</th>
<th>Salary</th>
<th>HireDate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>HR</td>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
<td>1000</td>
<td>01-01-2002</td>
</tr>
<tr>
<td>2</td>
<td>Sales</td>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
<td>1000</td>
<td>01-01-2002</td>
</tr>
<tr>
<td>3</td>
<td>Sales</td>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
<tr>
<td>4</td>
<td>Sales</td>
<td>3</td>
<td>Michael</td>
<td>Williams</td>
<td>1357911131</td>
<td>1</td>
<td>2</td>
<td>600</td>
<td>12-05-2009</td>
</tr>
<tr>
<td>5</td>
<td>Sales</td>
<td>4</td>
<td>Johnathon</td>
<td>Smith</td>
<td>1212121212</td>
<td>2</td>
<td>1</td>
<td>500</td>
<td>24-07-2016</td>
</tr>
<tr>
<td>6</td>
<td>Tech</td>
<td>1</td>
<td>James</td>
<td>Smith</td>
<td>1234567890</td>
<td>NULL</td>
<td>1</td>
<td>1000</td>
<td>01-01-2002</td>
</tr>
<tr>
<td>7</td>
<td>Tech</td>
<td>2</td>
<td>John</td>
<td>Johnson</td>
<td>2468101214</td>
<td>1</td>
<td>1</td>
<td>400</td>
<td>23-03-2005</td>
</tr>
<tr>
<td>8</td>
<td>Tech</td>
<td>3</td>
<td>Michael</td>
<td>Williams</td>
<td>1357911131</td>
<td>1</td>
<td>2</td>
<td>600</td>
<td>12-05-2009</td>
</tr>
<tr>
<td>9</td>
<td>Tech</td>
<td>4</td>
<td>Johnathon</td>
<td>Smith</td>
<td>1212121212</td>
<td>2</td>
<td>1</td>
<td>500</td>
<td>24-07-2016</td>
</tr>
</tbody>
</table>

Finally each expression used within the SELECT clause is evaluated to return our final table:

<table>
<thead>
<tr>
<th>Departments.Name</th>
<th>Employees.FName</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>James</td>
</tr>
<tr>
<td>HR</td>
<td>John</td>
</tr>
<tr>
<td>Sales</td>
<td>Richard</td>
</tr>
<tr>
<td>Tech</td>
<td>NULL</td>
</tr>
</tbody>
</table>

**Section 18.5: Implicit Join**

Joins can also be performed by having several tables in the from clause, separated with commas , and defining the relationship between them in the where clause. This technique is called an Implicit Join (since it doesn't actually contain a join clause).

All RDBMSs support it, but the syntax is usually advised against. The reasons why it is a bad idea to use this syntax are:

- It is possible to get accidental cross joins which then return incorrect results, especially if you have a lot of joins in the query.
- If you intended a cross join, then it is not clear from the syntax (write out CROSS JOIN instead), and someone is likely to change it during maintenance.
The following example will select employee's first names and the name of the departments they work for:

```sql
SELECT e.FName, d.Name
FROM Employee e, Departments d
WHERE e.DeptartmentId = d.Id
```

This would return the following from the example database:

<table>
<thead>
<tr>
<th>e.FName</th>
<th>d.Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>James</td>
<td>HR</td>
</tr>
<tr>
<td>John</td>
<td>HR</td>
</tr>
<tr>
<td>Richard</td>
<td>Sales</td>
</tr>
</tbody>
</table>

**Section 18.6: CROSS JOIN**

Cross join does a Cartesian product of the two members, A Cartesian product means each row of one table is combined with each row of the second table in the join. For example, if TABLEA has 20 rows and TABLEB has 20 rows, the result would be \(20 \times 20 = 400\) output rows.

Using example database

```sql
SELECT d.Name, e.FName
FROM Departments d CROSS JOIN Employees e;
```

Which returns:

<table>
<thead>
<tr>
<th>d.Name</th>
<th>e.FName</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>James</td>
</tr>
<tr>
<td>HR</td>
<td>John</td>
</tr>
<tr>
<td>HR</td>
<td>Michael</td>
</tr>
<tr>
<td>HR</td>
<td>Johnathon</td>
</tr>
<tr>
<td>Sales</td>
<td>James</td>
</tr>
<tr>
<td>Sales</td>
<td>John</td>
</tr>
<tr>
<td>Sales</td>
<td>Michael</td>
</tr>
<tr>
<td>Sales</td>
<td>Johnathon</td>
</tr>
<tr>
<td>Tech</td>
<td>James</td>
</tr>
<tr>
<td>Tech</td>
<td>John</td>
</tr>
<tr>
<td>Tech</td>
<td>Michael</td>
</tr>
<tr>
<td>Tech</td>
<td>Johnathon</td>
</tr>
</tbody>
</table>

It is recommended to write an explicit CROSS JOIN if you want to do a cartesian join, to highlight that this is what you want.

**Section 18.7: CROSS APPLY & LATERAL JOIN**

A very interesting type of JOIN is the LATERAL JOIN (new in PostgreSQL 9.3+), which is also known as CROSS APPLY/OUTER APPLY in SQL-Server & Oracle.

The basic idea is that a table-valued function (or inline subquery) gets applied for every row you join.

This makes it possible to, for example, only join the first matching entry in another table. The difference between a normal and a lateral join lies in the fact that you can use a column that you previously joined in the subquery that you "CROSS APPLY".
Syntax:

PostgreSQL 9.3+

left | right | inner JOIN LATERAL

SQL-Server:

CROSS | OUTER APPLY

INNER JOIN LATERAL is the same as CROSS APPLY
and LEFT JOIN LATERAL is the same as OUTER APPLY

Example usage (PostgreSQL 9.3+):

```sql
SELECT * FROM T_Contacts
--LEFT JOIN T_MAP_Contacts_Ref_OrganisationalUnit ON MAP_CTCOU_CT_UID = T_Contacts.CT_UID AND
MAP_CTCOU_SoftDeleteStatus = 1
--WHERE T_MAP_Contacts_Ref_OrganisationalUnit.MAP_CTCOU_UID IS NULL -- 989

LEFT JOIN LATERAL
( SELECT
    --MAP_CTCOU_UID
    MAP_CTCOU_CT_UID,
    MAP_CTCOU_COU_UID,
    MAP_CTCOU_DateFrom,
    MAP_CTCOU_DateTo
    FROM T_MAP_Contacts_Ref_OrganisationalUnit
    WHERE MAP_CTCOU_SoftDeleteStatus = 1
    AND MAP_CTCOU_CT_UID = T_Contacts.CT_UID
    /*
    AND
    ( __in_DateFrom <= T_MAP_Contacts_Ref_OrganisationalUnit.MAP_KTKOE_DateTo)
    AND
    ( __in_DateTo >= T_MAP_Contacts_Ref_OrganisationalUnit.MAP_KTKOE_DateFrom)
    */
    ORDER BY MAP_CTCOU_DateFrom
    LIMIT 1
) AS FirstOE
```

And for SQL-Server

```sql
SELECT * FROM T_Contacts
--LEFT JOIN T_MAP_Contacts_Ref_OrganisationalUnit ON MAP_CTCOU_CT_UID = T_Contacts.CT_UID AND
MAP_CTCOU_SoftDeleteStatus = 1
--WHERE T_MAP_Contacts_Ref_OrganisationalUnit.MAP_CTCOU_UID IS NULL -- 989

-- CROSS APPLY -- = INNER JOIN
OUTER APPLY -- = LEFT JOIN
```
( 
    SELECT TOP 1 
    --MAP_CTCOU_UID
    MAP_CTCOU_CT_UID,
    MAP_CTCOU_COU_UID,
    MAP_CTCOU_DateFrom,
    MAP_CTCOU_DateTo 
    FROM T_MAP_Contacts_Ref_OrganisationalUnit 
    WHERE MAP_CTCOU_SoftDeleteStatus = 1 
    AND MAP_CTCOU_CT_UID = T_Contacts.CT_UID 
    /* 
    AND 
    (@in_DateFrom <= T_MAP_Contacts_Ref_OrganisationalUnit.MAP_KTKOE_DateTo) 
    AND 
    (@in_DateTo >= T_MAP_Contacts_Ref_OrganisationalUnit.MAP_KTKOE_DateFrom) 
    */ 
    ORDER BY MAP_CTCOU_DateFrom 
) AS FirstOE

Section 18.8: FULL JOIN

One type of JOIN that is less known, is the FULL JOIN. 
(Note: FULL JOIN is not supported by MySQL as per 2016)

A FULL OUTER JOIN returns all rows from the left table, and all rows from the right table.

If there are rows in the left table that do not have matches in the right table, or if there are rows in right table that do not have matches in the left table, then those rows will be listed, too.

Example 1:

```sql
SELECT * FROM Table1
FULL JOIN Table2
ON 1 = 2
```

Example 2:

```sql
SELECT 
    COALESCE(T_Budget.Year, tYear.Year) AS RPT_BudgetInYear
,COALESCE(T_Budget.Value, 0.0) AS RPT_Value
FROM T_Budget
FULL JOIN tfu_RPT_All_CreateYearInterval(@budget_year_from, @budget_year_to) AS tYear
ON tYear.Year = T_Budget.Year
```

Note that if you’re using soft-deletes, you’ll have to check the soft-delete status again in the WHERE-clause (because FULL JOIN behaves kind-of like a UNION).

It’s easy to overlook this little fact, since you put AP_SoftDeleteStatus = 1 in the join clause.

Also, if you are doing a FULL JOIN, you’ll usually have to allow NULL in the WHERE-clause; forgetting to allow NULL on a value will have the same effects as an INNER join, which is something you don’t want if you’re doing a FULL JOIN.

Example:
SELECT  
  T_AccountPlan.AP_UID,  
  T_AccountPlan.AP_Code,  
  T_AccountPlan.AP_Lang_EN,  
  T_BudgetPositions.BUP_Budget,  
  T_BudgetPositions.BUP_UID,  
  T_BudgetPositions.BUP_Jahr  
FROM T_BudgetPositions  
FULL JOIN T_AccountPlan  
  ON T_AccountPlan.AP_UID = T_BudgetPositions.BUP_AP_UID  
  AND T_AccountPlan.AP_SoftDeleteStatus = 1  

WHERE (1=1)  
AND (T_BudgetPositions.BUP_SoftDeleteStatus = 1 OR T_BudgetPositions.BUP_SoftDeleteStatus IS NULL)  
AND (T_AccountPlan.AP_SoftDeleteStatus = 1 OR T_AccountPlan.AP_SoftDeleteStatus IS NULL)

Section 18.9: Recursive JOINs

Recursive joins are often used to obtain parent-child data. In SQL, they are implemented with recursive common table expressions, for example:

WITH RECURSIVE MyDescendants AS (  
  SELECT Name  
  FROM People  
  WHERE Name = 'John Doe'  
  UNION ALL  
  SELECT People.Name  
  FROM People  
  JOIN MyDescendants ON People.Name = MyDescendants.Parent  
)  
SELECT * FROM MyDescendants;

Section 18.10: Basic explicit inner join

A basic join (also called "inner join") queries data from two tables, with their relationship defined in a join clause.

The following example will select employees' first names (FName) from the Employees table and the name of the department they work for (Name) from the Departments table:

SELECT Employees.FName, Departments.Name  
FROM Employees  
JOIN Departments  
ON Employees.DepartmentId = Departments.Id

This would return the following from the example database:

Employees.FName Departments.Name  
James HR  
John HR  
Richard Sales

Section 18.11: Joining on a Subquery

Joining a subquery is often used when you want to get aggregate data from a child/details table and display that
along with records from the parent/header table. For example, you might want to get a count of child records, an average of some numeric column in child records, or the top or bottom row based on a date or numeric field. This example uses aliases, which arguably makes queries easier to read when you have multiple tables involved. Here's what a fairly typical subquery join looks like. In this case we are retrieving all rows from the parent table Purchase Orders and retrieving only the first row for each parent record of the child table PurchaseOrderLineItems.

```sql
SELECT po.Id, po.PODate, po.VendorName, po.Status, item.ItemNo, item.Description, item.Cost, item.Price
FROM PurchaseOrders po
LEFT JOIN
  (  
    SELECT l.PurchaseOrderId, l.ItemNo, l.Description, l.Cost, l.Price, Min(l.id) as Id
    FROM PurchaseOrderLineItems l
    GROUP BY l.PurchaseOrderId, l.ItemNo, l.Description, l.Cost, l.Price
  ) AS item
  ON item.PurchaseOrderId = po.Id
```
Chapter 19: UPDATE

Section 19.1: UPDATE with data from another table

The examples below fill in a PhoneNumber for any Employee who is also a Customer and currently does not have a phone number set in the Employees Table.

(These examples use the Employees and Customers tables from the Example Databases.)

**Standard SQL**

Update using a correlated subquery:

```
UPDATE Employees
SET PhoneNumber =
  (SELECT c.PhoneNumber
   FROM Customers c
   WHERE c.FName = Employees.FName
   AND c.LName = Employees.LName)
WHERE Employees.PhoneNumber IS NULL
```

**SQL:2003**

Update using **MERGE**:

```
MERGE INTO Employees e
USING Customers c
ON  e.FName = c.Fname
AND e.LName = c.LName
AND e.PhoneNumber IS NULL
WHEN MATCHED THEN
  UPDATE
    SET PhoneNumber = c.PhoneNumber
```

**SQL Server**

Update using **INNER JOIN**:

```
UPDATE Employees
SET PhoneNumber = c.PhoneNumber
FROM Employees e
INNER JOIN Customers c
  ON e.FName = c.FName
  AND e.LName = c.LName
WHERE PhoneNumber IS NULL
```
Section 19.2: Modifying existing values

This example uses the Cars Table from the Example Databases.

```
UPDATE Cars
SET TotalCost = TotalCost + 100
WHERE Id = 3 or Id = 4
```

Update operations can include current values in the updated row. In this simple example the TotalCost is incremented by 100 for two rows:

- The TotalCost of Car #3 is increased from 100 to 200
- The TotalCost of Car #4 is increased from 1254 to 1354

A column’s new value may be derived from its previous value or from any other column’s value in the same table or a joined table.

Section 19.3: Updating Specified Rows

This example uses the Cars Table from the Example Databases.

```
UPDATE Cars
SET Status = 'READY'
WHERE Id = 4
```

This statement will set the status of the row of 'Cars' with id 4 to "READY".

**WHERE** clause contains a logical expression which is evaluated for each row. If a row fulfills the criteria, its value is updated. Otherwise, a row remains unchanged.

Section 19.4: Updating All Rows

This example uses the Cars Table from the Example Databases.

```
UPDATE Cars
SET Status = 'READY'
```

This statement will set the 'status' column of all rows of the 'Cars' table to "READY" because it does not have a **WHERE** clause to filter the set of rows.

Section 19.5: Capturing Updated records

Sometimes one wants to capture the records that have just been updated.

```
CREATE TABLE #TempUpdated (ID INT)

Update TableName
SET Col1 = 42
OUTPUT inserted.ID INTO #TempUpdated
WHERE Id > 50
```
Chapter 20: CREATE Database

Section 20.1: CREATE Database

A database is created with the following SQL command:

```
CREATE DATABASE myDatabase;
```

This would create an empty database named myDatabase where you can create tables.
Chapter 21: CREATE TABLE

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>tableName</td>
<td>The name of the table</td>
</tr>
<tr>
<td>columns</td>
<td>Contains an 'enumeration' of all the columns that the table have. See Create a New Table for more details.</td>
</tr>
</tbody>
</table>

The CREATE TABLE statement is used create a new table in the database. A table definition consists of a list of columns, their types, and any integrity constraints.

Section 21.1: Create Table From Select

You may want to create a duplicate of a table:

```
CREATE TABLE ClonedEmployees AS SELECT * FROM Employees;
```

You can use any of the other features of a SELECT statement to modify the data before passing it to the new table. The columns of the new table are automatically created according to the selected rows.

```
CREATE TABLE ModifiedEmployees AS
SELECT Id, CONCAT(FName," ",LName) AS FullName FROM Employees
WHERE Id > 10;
```

Section 21.2: Create a New Table

A basic Employees table, containing an ID, and the employee's first and last name along with their phone number can be created using

```
CREATE TABLE Employees(
    Id int identity(1,1) primary key not null,
    FName varchar(20) not null,
    LName varchar(20) not null,
    PhoneNumber varchar(10) not null
);
```

This example is specific to Transact-SQL.

CREATE TABLE creates a new table in the database, followed by the table name, Employees.

This is then followed by the list of column names and their properties, such as the ID

<table>
<thead>
<tr>
<th>Value</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id</td>
<td>int identity(1,1) not null</td>
</tr>
<tr>
<td>FName</td>
<td>varchar(20) not null</td>
</tr>
<tr>
<td>LName</td>
<td>varchar(20) not null</td>
</tr>
<tr>
<td>PhoneNumber</td>
<td>varchar(10) not null</td>
</tr>
</tbody>
</table>

Section 21.3: CREATE TABLE With FOREIGN KEY

Below you could find the table Employees with a reference to the table Cities.

```
CREATE TABLE Cities(
```
CREATE TABLE Employees(
  EmployeeID INT IDENTITY(1,1) NOT NULL,
  FirstName VARCHAR(20) NOT NULL,
  LastName VARCHAR(20) NOT NULL,
  PhoneNumber VARCHAR(10) NOT NULL
);
CREATE TEMP TABLE MyTable(...);

**SQL Server**

To create a temporary table local to the session:

```
CREATE TABLE #TempPhysical(...);
```

To create a temporary table visible to everyone:

```
CREATE TABLE ##TempPhysicalVisibleToEveryone(...);
```

To create an in-memory table:

```
DECLARE @TempMemory TABLE(...);
```
## Chapter 22: CREATE FUNCTION

<table>
<thead>
<tr>
<th>Argument</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>function_name</td>
<td>the name of function</td>
</tr>
<tr>
<td>list_of_parameters</td>
<td>parameters that function accepts</td>
</tr>
<tr>
<td>return_data_type</td>
<td>type that function returns. Some SQL data type</td>
</tr>
<tr>
<td>function_body</td>
<td>the code of function</td>
</tr>
<tr>
<td>scalar_expression</td>
<td>scalar value returned by function</td>
</tr>
</tbody>
</table>

### Section 22.1: Create a new Function

```sql
CREATE FUNCTION FirstWord (@input varchar(1000))
RETURNS varchar(1000)
AS
BEGIN
    DECLARE @output varchar(1000)
    SET @output = SUBSTRING(@input, 0, CASE CHARINDEX(' ', @input)
                            WHEN 0 THEN LEN(@input) + 1
                            ELSE CHARINDEX(' ', @input)
                        END)
    RETURN @output
END
```

This example creates a function named **FirstWord**, that accepts a varchar parameter and returns another varchar value.
Chapter 23: TRY/CATCH

Section 23.1: Transaction In a TRY/CATCH

This will rollback both inserts due to an invalid datetime:

```
BEGIN TRANSACTION
BEGIN TRY
    INSERT INTO dbo.Sale(Price, SaleDate, Quantity)
    VALUES (5.2, GETDATE(), 1)
    INSERT INTO dbo.Sale(Price, SaleDate, Quantity)
    VALUES (5.2, 'not a date', 1)
    COMMIT TRANSACTION
END TRY
BEGIN CATCH
    THROW
    ROLLBACK TRANSACTION
END CATCH
```

This will commit both inserts:

```
BEGIN TRANSACTION
BEGIN TRY
    INSERT INTO dbo.Sale(Price, SaleDate, Quantity)
    VALUES (5.2, GETDATE(), 1)
    INSERT INTO dbo.Sale(Price, SaleDate, Quantity)
    VALUES (5.2, GETDATE(), 1)
    COMMIT TRANSACTION
END TRY
BEGIN CATCH
    THROW
    ROLLBACK TRANSACTION
END CATCH
```
Chapter 24: UNION / UNION ALL

**UNION** keyword in SQL is used to combine to **SELECT** statement results with out any duplicate. In order to use UNION and combine results both **SELECT** statement should have same number of column with same data type in same order, but the length of column can be different.

### Section 24.1: Basic UNION ALL query

```sql
CREATE TABLE HR_EMPLOYEES
(
    PersonID int,
    LastName VARCHAR(30),
    FirstName VARCHAR(30),
    Position VARCHAR(30)
);  

CREATE TABLE FINANCE_EMPLOYEES
(
    PersonID INT,
    LastName VARCHAR(30),
    FirstName VARCHAR(30),
    Position VARCHAR(30)
);  

Let's say we want to extract the names of all the managers from our departments.

Using a **UNION** we can get all the employees from both HR and Finance departments, which hold the position of a manager.

```sql
SELECT FirstName, LastName
FROM HR_EMPLOYEES
WHERE Position = 'manager'
UNION ALL
SELECT FirstName, LastName
FROM FINANCE_EMPLOYEES
WHERE Position = 'manager'
```

The **UNION** statement removes duplicate rows from the query results. Since it is possible to have people having the same Name and position in both departments we are using **UNION ALL**, in order not to remove duplicates.

If you want to use an alias for each output column, you can just put them in the first select statement, as follows:

```sql
SELECT FirstName as 'First Name', LastName as 'Last Name'
FROM HR_EMPLOYEES
WHERE Position = 'manager'
UNION ALL
SELECT FirstName, LastName
FROM FINANCE_EMPLOYEES
WHERE Position = 'manager'
```
Section 24.2: Simple explanation and Example

In simple terms:

- **UNION** joins 2 result sets while removing duplicates from the result set
- **UNION ALL** joins 2 result sets without attempting to remove duplicates

One mistake many people make is to use a **UNION** when they do not need to have the duplicates removed. The additional performance cost against large results sets can be very significant.

**When you might need UNION**

Suppose you need to filter a table against 2 different attributes, and you have created separate non-clustered indexes for each column. A **UNION** enables you to leverage both indexes while still preventing duplicates.

```sql
SELECT C1, C2, C3 FROM Table1 WHERE C1 = @Param1
UNION
SELECT C1, C2, C3 FROM Table1 WHERE C2 = @Param2
```

This simplifies your performance tuning since only simple indexes are needed to perform these queries optimally. You may even be able to get by with quite a bit fewer non-clustered indexes improving overall write performance against the source table as well.

**When you might need UNION ALL**

Suppose you still need to filter a table against 2 attributes, but you do not need to filter duplicate records (either because it doesn't matter or your data wouldn't produce any duplicates during the union due to your data model design).

```sql
SELECT C1 FROM Table1
UNION ALL
SELECT C1 FROM Table2
```

This is especially useful when creating Views that join data that is designed to be physically partitioned across multiple tables (maybe for performance reasons, but still wants to roll-up records). Since the data is already split, having the database engine remove duplicates adds no value and just adds additional processing time to the queries.
Chapter 25: ALTER TABLE

ALTER command in SQL is used to modify column/constraint in a table

Section 25.1: Add Column(s)

```sql
ALTER TABLE Employees
ADD StartingDate date NOT NULL DEFAULT GetDate(),
    DateOfBirth date NULL
```

The above statement would add columns named StartingDate which cannot be NULL with default value as current date and DateOfBirth which can be NULL in Employees table.

Section 25.2: Drop Column

```sql
ALTER TABLE Employees
DROP COLUMN salary;
```

This will not only delete information from that column, but will drop the column salary from table employees (the column will no more exist).

Section 25.3: Add Primary Key

```sql
ALTER TABLE EMPLOYEES ADD pk_EmployeeID PRIMARY KEY (ID)
```

This will add a Primary key to the table Employees on the field ID. Including more than one column name in the parentheses along with ID will create a Composite Primary Key. When adding more than one column, the column names must be separated by commas.

```sql
ALTER TABLE EMPLOYEES ADD pk_EmployeeID PRIMARY KEY (ID, FName)
```

Section 25.4: Alter Column

```sql
ALTER TABLE Employees
ALTER COLUMN StartingDate DATETIME NOT NULL DEFAULT (GETDATE())
```

This query will alter the column datatype of StartingDate and change it from simple date to datetime and set default to current date.

Section 25.5: Drop Constraint

```sql
ALTER TABLE Employees
DROP CONSTRAINT DefaultSalary
```

This Drops a constraint called DefaultSalary from the employees table definition.

**Note:** Ensure that constraints of the column are dropped before dropping a column.
Chapter 26: INSERT

Section 26.1: INSERT data from another table using SELECT

```sql
INSERT INTO Customers (FName, LName, PhoneNumber)
SELECT FName, LName, PhoneNumber FROM Employees
```

This example will insert all Employees into the Customers table. Since the two tables have different fields and you don't want to move all the fields over, you need to set which fields to insert into and which fields to select. The correlating field names don't need to be called the same thing, but then need to be the same data type. This example is assuming that the Id field has an Identity Specification set and will auto increment. If you have two tables that have exactly the same field names and just want to move all the records over you can use:

```sql
INSERT INTO Table1
SELECT * FROM Table2
```

Section 26.2: Insert New Row

```sql
INSERT INTO Customers
VALUES ('Zack', 'Smith', 'zack@example.com', '7049989942', 'EMAIL');
```

This statement will insert a new row into the Customers table. Note that a value was not specified for the Id column, as it will be added automatically. However, all other column values must be specified.

Section 26.3: Insert Only Specified Columns

```sql
INSERT INTO Customers (FName, LName, Email, PreferredContact)
VALUES ('Zack', 'Smith', 'zack@example.com', 'EMAIL');
```

This statement will insert a new row into the Customers table. Data will only be inserted into the columns specified - note that no value was provided for the PhoneNumber column. Note, however, that all columns marked as not null must be included.

Section 26.4: Insert multiple rows at once

Multiple rows can be inserted with a single insert command:

```sql
INSERT INTO tbl_name (field1, field2, field3)
VALUES (1, 2, 3), (4, 5, 6), (7, 8, 9);
```

For inserting large quantities of data (bulk insert) at the same time, DBMS-specific features and recommendations exist.

MySQL - LOAD DATA INFILE

MSSQL - BULK INSERT
Chapter 27: MERGE

MERGE (often also called UPSERT for "update or insert") allows to insert new rows or, if a row already exists, to update the existing row. The point is to perform the whole set of operations atomically (to guarantee that the data remain consistent), and to prevent communication overhead for multiple SQL statements in a client/server system.

Section 27.1: MERGE to make Target match Source

```
MERGE INTO targetTable t 
  USING sourceTable s 
  ON t.PKID = s.PKID 
  WHEN MATCHED AND NOT EXISTS ( 
    SELECT s.ColumnA, s.ColumnB, s.ColumnC 
    INTERSECT 
  ) 
  THEN UPDATE SET 
    t.ColumnA = s.ColumnA 
    , t.ColumnB = s.ColumnB 
    , t.ColumnC = s.ColumnC 
  
  WHEN NOT MATCHED BY TARGET 
  THEN INSERT (PKID, ColumnA, ColumnB, ColumnC) 
    VALUES (s.PKID, s.ColumnA, s.ColumnB, s.ColumnC) 
  
  WHEN NOT MATCHED BY SOURCE 
  THEN DELETE 
; 
```

Note: The AND NOT EXISTS portion prevents updating records that haven't changed. Using the INTERSECT construct allows nullable columns to be compared without special handling.

Section 27.2: MySQL: counting users by name

Suppose we want to know how many users have the same name. Let us create table `users` as follows:

```
create table users( 
  id int primary key auto_increment, 
  name varchar(8), 
  count int, 
  unique key name(name) 
);
```

Now, we just discovered a new user named Joe and would like to take him into account. To achieve that, we need to determine whether there is an existing row with his name, and if so, update it to increment count; on the other hand, if there is no existing row, we should create it.

MySQL uses the following syntax: `insert ... on duplicate key update ...`. In this case:

```
insert into users(name, count) 
values ('Joe', 1) 
on duplicate key update count=count+1;
```

Section 27.3: PostgreSQL: counting users by name

Suppose we want to know how many users have the same name. Let us create table `users` as follows:
create table users(
    id serial,
    name varchar(8) unique,
    count int
);

Now, we just discovered a new user named Joe and would like to take him into account. To achieve that, we need to determine whether there is an existing row with his name, and if so, update it to increment count; on the other hand, if there is no existing row, we should create it.

PostgreSQL uses the following syntax: `insert ... on conflict ... do update ...`. In this case:

```sql
insert into users(name, count)
    values('Joe', 1)
on conflict (name) do update set count = users.count + 1;
```
Chapter 28: cross apply, outer apply

Section 28.1: CROSS APPLY and OUTER APPLY basics

Apply will be used when when table valued function in the right expression.

create a Department table to hold information about departments. Then create an Employee table which hold information about the employees. Please note, each employee belongs to a department, hence the Employee table has referential integrity with the Department table.

First query selects data from Department table and uses CROSS APPLY to evaluate the Employee table for each record of the Department table. Second query simply joins the Department table with the Employee table and all the matching records are produced.

```sql
SELECT *
FROM Department D
CROSS APPLY (SELECT *
              FROM Employee E
              WHERE E.DepartmentID = D.DepartmentID)
A
GO
SELECT *
FROM Department D
INNER JOIN Employee E
  ON D.DepartmentID = E.DepartmentID
GO
```

If you look at the results they produced, it is the exact same result-set; How does it differ from a JOIN and how does it help in writing more efficient queries.

The first query in Script #2 selects data from Department table and uses OUTER APPLY to evaluate the Employee table for each record of the Department table. For those rows for which there is not a match in Employee table, those rows contains NULL values as you can see in case of row 5 and 6. The second query simply uses a LEFT OUTER JOIN between the Department table and the Employee table. As expected the query returns all rows from Department table; even for those rows for which there is no match in the Employee table.

```sql
SELECT *
FROM Department D
OUTER APPLY (SELECT *
              FROM Employee E
              WHERE E.DepartmentID = D.DepartmentID)
A
GO
SELECT *
FROM Department D
LEFT OUTER JOIN Employee E
  ON D.DepartmentID = E.DepartmentID
GO
```

Even though the above two queries return the same information, the execution plan will be bit different. But cost wise there will be not much difference.

Now comes the time to see where the APPLY operator is really required. In Script #3, I am creating a table-valued function which accepts DepartmentID as its parameter and returns all the employees who belong to this department. The next query selects data from Department table and uses CROSS APPLY to join with the function
we created. It passes the DepartmentID for each row from the outer table expression (in our case Department
table) and evaluates the function for each row similar to a correlated subquery. The next query uses the OUTER
APPLY in place of CROSS APPLY and hence unlike CROSS APPLY which returned only correlated data, the OUTER
APPLY returns non-correlated data as well, placing NULLs into the missing columns.

```sql
CREATE FUNCTION dbo.fn_GetAllEmployeeOfADepartment (@DeptID AS int)
RETURNS TABLE
AS
    RETURN
    (  
        SELECT *
        FROM Employee E
        WHERE E.DepartmentID = @DeptID
    )
GO
SELECT *
FROM Department D
CROSS APPLY dbo.fn_GetAllEmployeeOfADepartment(D.DepartmentID)
GO
SELECT *
FROM Department D
OUTER APPLY dbo.fn_GetAllEmployeeOfADepartment(D.DepartmentID)
GO
```

So now if you are wondering, can we use a simple join in place of the above queries? Then the answer is NO, if you
replace CROSS/OUTER APPLY in the above queries with INNER JOIN/LEFT OUTER JOIN, specify ON clause (something
as 1=1) and run the query, you will get "The multi-part identifier "D.DepartmentID" could not be bound." error. This
is because with JOINS the execution context of outer query is different from the execution context of the function
(or a derived table), and you can not bind a value/variable from the outer query to the function as a parameter.
Hence the APPLY operator is required for such queries.
Chapter 29: DELETE

The DELETE statement is used to delete records from a table.

Section 29.1: DELETE all rows

Omitting a WHERE clause will delete all rows from a table.

DELETE FROM Employees

See TRUNCATE documentation for details on how TRUNCATE performance can be better because it ignores triggers and indexes and logs to just delete the data.

Section 29.2: DELETE certain rows with WHERE

This will delete all rows that match the WHERE criteria.

DELETE FROM Employees
WHERE FName = 'John'

Section 29.3: TRUNCATE clause

Use this to reset the table to the condition at which it was created. This deletes all rows and resets values such as auto-increment. It also doesn't log each individual row deletion.

TRUNCATE TABLE Employees

Section 29.4: DELETE certain rows based upon comparisons with other tables

It is possible to DELETE data from a table if it matches (or mismatches) certain data in other tables.

Let's assume we want to DELETE data from Source once its loaded into Target.

DELETE FROM Source
WHERE EXISTS ( SELECT 1 -- specific value in SELECT doesn't matter
                FROM Target
                Where Source.ID = Target.ID )

Most common RDBMS implementations (e.g. MySQL, Oracle, PostgresSQL, Teradata) allow tables to be joined during DELETE allowing more complex comparison in a compact syntax.

Adding complexity to original scenario, let's assume Aggregate is built from Target once a day and does not contain the same ID but contains the same date. Let us also assume that we want to delete data from Source only after the aggregate is populated for the day.

On MySQL, Oracle and Teradata this can be done using:

DELETE FROM Source
WHERE Source.ID = TargetSchema.Target.ID
    AND TargetSchema.Target.Date = AggregateSchema.Aggregate.Date

In PostgreSQL use:
DELETE FROM Source
USING TargetSchema.Target, AggregateSchema.Aggregate
WHERE Source.ID = TargetSchema.Target.ID
    AND TargetSchema.Target.DataDate = AggregateSchema.Aggregate.AggregateDate

This essentially results in INNER JOINs between Source, Target and Aggregate. The deletion is performed on Source when the same IDs exist in Target AND date present in Target for those IDs also exists in Aggregate.

Same query may also be written (on MySQL, Oracle, Teradata) as:

DELETE Source
FROM Source, TargetSchema.Target, AggregateSchema.Aggregate
WHERE Source.ID = TargetSchema.Target.ID
    AND TargetSchema.Target.DataDate = AggregateSchema.Aggregate.AggregateDate

Explicit joins may be mentioned in Delete statements on some RDBMS implementations (e.g. Oracle, MySQL) but not supported on all platforms (e.g. Teradata does not support them)

Comparisons can be designed to check mismatch scenarios instead of matching ones with all syntax styles (observe NOT EXISTS below)

DELETE FROM Source
WHERE NOT EXISTS ( SELECT 1 -- specific value in SELECT doesn't matter
                      FROM Target
                      WHERE Source.ID = Target.ID )
Chapter 30: TRUNCATE

The TRUNCATE statement deletes all data from a table. This is similar to DELETE with no filter, but, depending on the database software, has certain restrictions and optimizations.

Section 30.1: Removing all rows from the Employee table

```sql
TRUNCATE TABLE Employee;
```

Using truncate table is often better then using DELETE TABLE as it ignores all the indexes and triggers and just removes everything.

Delete table is a row based operation this means that each row is deleted. Truncate table is a data page operation the entire data page is reallocated. If you have a table with a million rows it will be much faster to truncate the table than it would be to use a delete table statement.

Though we can delete specific Rows with DELETE, we cannot TRUNCATE specific rows, we can only TRUNCATE all the records at once. Deleting All rows and then inserting a new record will continue to add the Auto incremented Primary key value from the previously inserted value, where as in Truncate, the Auto Incremental primary key value will also get reset and starts from 1.

Note that when truncating table, no foreign keys must be present, otherwise you will get an error.
Chapter 31: DROP Table

Section 31.1: Check for existence before dropping

MySQL Version ≥ 3.19

DROP TABLE IF EXISTS MyTable;

PostgreSQL Version ≥ 8.x

DROP TABLE IF EXISTS MyTable;

SQL Server Version ≥ 2005

If Exists (Select * From Information_Schema.Tables
          Where Table_Schema = 'dbo'
          And Table_Name = 'MyTable')
  Drop Table dbo.MyTable

SQLite Version ≥ 3.0

DROP TABLE IF EXISTS MyTable;

Section 31.2: Simple drop

Drop Table MyTable;
Chapter 32: DROP or DELETE Database

Section 32.1: DROP Database

Dropping the database is a simple one-liner statement. Drop database will delete the database, hence always ensure to have a backup of the database if required.

Below is the command to drop Employees Database

```
DROP DATABASE [dbo].[Employees]
```
Chapter 33: Cascading Delete

Section 33.1: ON DELETE CASCADE

Assume you have a application that administers rooms.
Assume further that your application operates on a per client basis (tenant).
You have several clients.
So your database will contain one table for clients, and one for rooms.

Now, every client has N rooms.

This should mean that you have a foreign key on your room table, referencing the client table.

```sql
ALTER TABLE dbo.T_Room WITH CHECK
ADD CONSTRAINT FK_T_Room_T_Client
FOREIGN KEY(RM_CLI_ID)
REFERENCES dbo.T_Client (CLI_ID)
GO
```

Assuming a client moves on to some other software, you'll have to delete his data in your software. But if you do

```sql
DELETE FROM T_Client WHERE CLI_ID = x
```

Then you'll get a foreign key violation, because you can't delete the client when he still has rooms.

Now you'd have write code in your application that deletes the client's rooms before it deletes the client. Assume further that in the future, many more foreign key dependencies will be added in your database, because your application's functionality expands. Horrible. For every modification in your database, you'll have to adapt your application's code in N places. Possibly you'll have to adapt code in other applications as well (e.g. interfaces to other systems).

There is a better solution than doing it in your code.
You can just add `ON DELETE CASCADE` to your foreign key.

```sql
ALTER TABLE dbo.T_Room
-- WITH CHECK
-- SQL-Server can specify WITH CHECK/WITH NOCHECK
ADD CONSTRAINT FK_T_Room_T_Client
FOREIGN KEY(RM_CLI_ID)
REFERENCES dbo.T_Client (CLI_ID)
ON DELETE CASCADE
```

Now you can say

```sql
DELETE FROM T_Client WHERE CLI_ID = x
```

and the rooms are automagically deleted when the client is deleted.
Problem solved - with no application code changes.

One word of caution: In Microsoft SQL-Server, this won't work if you have a table that references itselfs. So if you try to define a delete cascade on a recursive tree structure, like this:

```sql
IF NOT EXISTS (SELECT * FROM sys.foreign_keys WHERE object_id = OBJECT_ID(N'[dbo].[FK_T_FMS_Navigation_T_FMS_Navigation]') AND parent_object_id = OBJECT_ID(N'[dbo].[T_FMS_Navigation]'))
ALTER TABLE [dbo].[T_FMS_Navigation] WITH CHECK
ADD CONSTRAINT [FK_T_FMS_Navigation_T_FMS_Navigation]
FOREIGN KEY([NA_NA_UID])
REFERENCES [dbo].[T_FMS_Navigation] ([NA_UID])
ON DELETE CASCADE
```
IF EXISTS (SELECT * FROM sys.foreign_keys WHERE object_id = OBJECT_ID(N'[dbo].[FK_T_FMS_Navigation_T_FMS_Navigation]') AND parent_object_id = OBJECT_ID(N'[dbo].[T_FMS_Navigation]'))
GO

it won't work, because Microsoft-SQL-server doesn't allow you to set a foreign key with ON DELETE CASCADE on a recursive tree structure. One reason for this is, that the tree is possibly cyclic, and that would possibly lead to a deadlock.

PostgreSQL on the other hand can do this; the requirement is that the tree is non-cyclic.
If the tree is cyclic, you'll get a runtime error.
In that case, you'll just have to implement the delete function yourselves.

A word of caution:
This means you can't simply delete and re-insert the client table anymore, because if you do this, it will delete all entries in "T_Room"... (no non-delta updates anymore)
Chapter 34: GRANT and REVOKE

Section 34.1: Grant/revoke privileges

```sql
GRANT SELECT, UPDATE
ON Employees
TO User1, User2;
```

Grant User1 and User2 permission to perform SELECT and UPDATE operations on table Employees.

```sql
REVOKE SELECT, UPDATE
ON Employees
FROM User1, User2;
```

Revoke from User1 and User2 the permission to perform SELECT and UPDATE operations on table Employees.
Chapter 35: XML

Section 35.1: Query from XML Data Type

```sql
DECLARE @xmlIN XML = '
<aaa Main="First">
  <row name="a" value="1" />
  <row name="b" value="2" />
  <row name="c" value="3" />
</aaa>

<aaa Main="Second">
  <row name="a" value="3" />
  <row name="b" value="4" />
  <row name="c" value="5" />
</aaa>

<aaa Main="Third">
  <row name="a" value="10" />
  <row name="b" value="20" />
  <row name="c" value="30" />
</aaa>
</TableData>'

SELECT t.col.value('../@Main', 'varchar(10)') [Header],
       t.col.value('@name', 'VARCHAR(25)') [name],
       t.col.value('@value', 'VARCHAR(25)') [Value]
FROM   @xmlIN.nodes('//TableData/aaa/row') AS t (col)
```

Results

<table>
<thead>
<tr>
<th>Header</th>
<th>name</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>First</td>
<td>a</td>
<td>1</td>
</tr>
<tr>
<td>First</td>
<td>b</td>
<td>2</td>
</tr>
<tr>
<td>First</td>
<td>c</td>
<td>3</td>
</tr>
<tr>
<td>Second</td>
<td>a</td>
<td>3</td>
</tr>
<tr>
<td>Second</td>
<td>b</td>
<td>4</td>
</tr>
<tr>
<td>Second</td>
<td>c</td>
<td>5</td>
</tr>
<tr>
<td>Third</td>
<td>a</td>
<td>10</td>
</tr>
<tr>
<td>Third</td>
<td>b</td>
<td>20</td>
</tr>
<tr>
<td>Third</td>
<td>c</td>
<td>30</td>
</tr>
</tbody>
</table>
Chapter 36: Primary Keys

Section 36.1: Creating a Primary Key

CREATE TABLE Employees (  
    Id int NOT NULL,  
    PRIMARY KEY (Id),  
    ...  
);  

This will create the Employees table with 'Id' as its primary key. The primary key can be used to uniquely identify the rows of a table. Only one primary key is allowed per table.

A key can also be composed by one or more fields, so called composite key, with the following syntax:

CREATE TABLE EMPLOYEE (  
    e1_id INT,  
    e2_id INT,  
    PRIMARY KEY (e1_id, e2_id)  
)  

Section 36.2: Using Auto Increment

Many databases allow to make the primary key value automatically increment when a new key is added. This ensures that every key is different.

MySQL

CREATE TABLE Employees (  
    Id int NOT NULL AUTO_INCREMENT,  
    PRIMARY KEY (Id)  
);  

PostgreSQL

CREATE TABLE Employees (  
    Id SERIAL PRIMARY KEY  
);  

SQL Server

CREATE TABLE Employees (  
    Id int NOT NULL IDENTITY,  
    PRIMARY KEY (Id)  
);  

SQLite

CREATE TABLE Employees (  
    Id INTEGER PRIMARY KEY  
);
Chapter 37: Indexes

Indexes are a data structure that contains pointers to the contents of a table arranged in a specific order, to help the database optimize queries. They are similar to the index of book, where the pages (rows of the table) are indexed by their page number.

Several types of indexes exist, and can be created on a table. When an index exists on the columns used in a query's WHERE clause, JOIN clause, or ORDER BY clause, it can substantially improve query performance.

Section 37.1: Sorted Index

If you use an index that is sorted the way you would retrieve it, the SELECT statement would not do additional sorting when in retrieval.

```
CREATE INDEX ix_scoreboard_score ON scoreboard (score DESC);
```

When you execute the query

```
SELECT * FROM scoreboard ORDER BY score DESC;
```

The database system would not do additional sorting, since it can do an index-lookup in that order.

Section 37.2: Partial or Filtered Index

SQL Server and SQLite allow to create indexes that contain not only a subset of columns, but also a subset of rows.

Consider a constant growing amount of orders with order_state_id equal to finished (2), and a stable amount of orders with order_state_id equal to started (1).

If your business make use of queries like this:

```
SELECT id, comment
FROM orders
WHERE order_state_id = 1
AND product_id = @some_value;
```

Partial indexing allows you to limit the index, including only the unfinished orders:

```
CREATE INDEX Started_Orders
    ON orders(product_id)
WHERE order_state_id = 1;
```

This index will be smaller than an unfiltered index, which saves space and reduces the cost of updating the index.

Section 37.3: Creating an Index

```
CREATE INDEX ix_cars_employee_id ON Cars (EmployeeId);
```

This will create an index for the column EmployeeId in the table Cars. This index will improve the speed of queries asking the server to sort or select by values in EmployeeId, such as the following:

```
SELECT * FROM Cars WHERE EmployeeId = 1
```
The index can contain more than 1 column, as in the following:

```
CREATE INDEX ix_cars_e_c_o_ids ON Cars (EmployeeId, CarId, OwnerId);
```

In this case, the index would be useful for queries asking to sort or select by all included columns, if the set of conditions is ordered in the same way. That means that when retrieving the data, it can find the rows to retrieve using the index, instead of looking through the full table.

For example, the following case would utilize the second index:

```
SELECT * FROM Cars WHERE EmployeeId = 1 Order by CarId DESC
```

If the order differs, however, the index does not have the same advantages, as in the following:

```
SELECT * FROM Cars WHERE OwnerId = 17 Order by CarId DESC
```

The index is not as helpful because the database must retrieve the entire index, across all values of EmployeeId and CarId, in order to find which items have OwnerId = 17.

(The index may still be used; it may be the case that the query optimizer finds that retrieving the index and filtering on the OwnerId, then retrieving only the needed rows is faster than retrieving the full table, especially if the table is large.)

### Section 37.4: Dropping an Index, or Disabling and Rebuilding it

```
DROP INDEX ix_cars_employee_id ON Cars;
```

We can use command **DROP** to delete our index. In this example we will **DROP** the index called `ix_cars_employee_id` on the table `Cars`.

This deletes the index entirely, and if the index is clustered, will remove any clustering. It cannot be rebuilt without recreating the index, which can be slow and computationally expensive. As an alternative, the index can be disabled:

```
ALTER INDEX ix_cars_employee_id ON Cars DISABLE;
```

This allows the table to retain the structure, along with the metadata about the index.

Critically, this retains the index statistics, so that it is possible to easily evaluate the change. If warranted, the index can then later be rebuilt, instead of being recreated completely:

```
ALTER INDEX ix_cars_employee_id ON Cars REBUILD;
```

### Section 37.5: Clustered, Unique, and Sorted Indexes

Indexes can have several characteristics that can be set either at creation, or by altering existing indexes.

```
CREATE CLUSTERED INDEX ix_clust_employee_id ON Employees(EmployeeId, Email);
```

The above SQL statement creates a new clustered index on Employees. Clustered indexes are indexes that dictate the actual structure of the table; the table itself is sorted to match the structure of the index. That means there can be at most one clustered index on a table. If a clustered index already exists on the table, the above statement will
Tables with no clustered indexes are also called heaps.

```sql
CREATE UNIQUE INDEX uq_customers_email ON Customers(Email);
```

This will create an unique index for the column `Email` in the table `Customers`. This index, along with speeding up queries like a normal index, will also force every email address in that column to be unique. If a row is inserted or updated with a non-unique `Email` value, the insertion or update will, by default, fail.

```sql
CREATE UNIQUE INDEX ix_eid_desc ON Customers(EmployeeID);
```

This creates an index on `Customers` which also creates a table constraint that the EmployeeID must be unique. (This will fail if the column is not currently unique - in this case, if there are employees who share an ID.)

```sql
CREATE INDEX ix_eid_desc ON Customers(EmployeeID Desc);
```

This creates an index that is sorted in descending order. By default, indexes (in MSSQL server, at least) are ascending, but that can be changed.

### Section 37.6: Rebuild index

Over the course of time B-Tree indexes may become fragmented because of updating/deleting/inserting data. In SQLServer terminology we can have internal (index page which is half empty) and external (logical page order doesn’t correspond physical order). Rebuilding index is very similar to dropping and re-creating it.

We can re-build an index with

```sql
ALTER INDEX index_name REBUILD;
```

By default rebuilding index is offline operation which locks the table and prevents DML against it, but many RDBMS allow online rebuilding. Also, some DB vendors offer alternatives to index rebuilding such as `REORGANIZE` (SQLServer) or `COALESCE`/`SHRINK SPACE` (Oracle).

### Section 37.7: Inserting with a Unique Index

```sql
UPDATE Customers SET Email = "richard0123@example.com" WHERE id = 1;
```

This will fail if an unique index is set on the `Email` column of `Customers`. However, alternate behavior can be defined for this case:

```sql
UPDATE Customers SET Email = "richard0123@example.com" WHERE id = 1 ON DUPLICATE KEY;
```
Chapter 38: Row number

Section 38.1: Delete All But Last Record (1 to Many Table)

WITH cte AS (
    SELECT ProjectID,
       ROW_NUMBER() OVER (PARTITION BY ProjectID ORDER BY InsertDate DESC) AS rn
    FROM ProjectNotes
)
DELETE FROM cte WHERE rn > 1;

Section 38.2: Row numbers without partitions

Include a row number according to the order specified.

SELECT
   ROW_NUMBER() OVER(ORDER BY Fname ASC) AS RowNumber,
   Fname,
   LName
FROM Employees

Section 38.3: Row numbers with partitions

Uses a partition criteria to group the row numbering according to it.

SELECT
   ROW_NUMBER() OVER(PARTITION BY DepartmentId ORDER BY DepartmentId ASC) AS RowNumber,
   DepartmentId, Fname, LName
FROM Employees
Chapter 39: SQL Group By vs Distinct

Section 39.1: Difference between GROUP BY and DISTINCT

*GROUP BY* is used in combination with aggregation functions. Consider the following table:

<table>
<thead>
<tr>
<th>orderId</th>
<th>userId</th>
<th>storeName</th>
<th>orderValue</th>
<th>orderDate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>43</td>
<td>Store A</td>
<td>25</td>
<td>20-03-2016</td>
</tr>
<tr>
<td>2</td>
<td>57</td>
<td>Store B</td>
<td>50</td>
<td>22-03-2016</td>
</tr>
<tr>
<td>3</td>
<td>43</td>
<td>Store A</td>
<td>30</td>
<td>25-03-2016</td>
</tr>
<tr>
<td>4</td>
<td>82</td>
<td>Store C</td>
<td>10</td>
<td>26-03-2016</td>
</tr>
<tr>
<td>5</td>
<td>21</td>
<td>Store A</td>
<td>45</td>
<td>29-03-2016</td>
</tr>
</tbody>
</table>

The query below uses *GROUP BY* to perform aggregated calculations.

```
SELECT storeName,
       COUNT(*) AS total_nr_orders,
COUNT(DISTINCT userId) AS nr_unique_customers,
AVG(orderValue) AS average_order_value,
MIN(orderDate) AS first_order,
MAX(orderDate) AS lastOrder
FROM orders
GROUP BY storeName;
```

and will return the following information:

<table>
<thead>
<tr>
<th>storeName</th>
<th>total_nr_orders</th>
<th>nr_unique_customers</th>
<th>average_order_value</th>
<th>first_order</th>
<th>lastOrder</th>
</tr>
</thead>
<tbody>
<tr>
<td>Store A</td>
<td>3</td>
<td>2</td>
<td>33.3</td>
<td>20-03-2016</td>
<td>29-03-2016</td>
</tr>
<tr>
<td>Store B</td>
<td>1</td>
<td>1</td>
<td>50</td>
<td>22-03-2016</td>
<td>22-03-2016</td>
</tr>
<tr>
<td>Store C</td>
<td>1</td>
<td>1</td>
<td>10</td>
<td>26-03-2016</td>
<td>26-03-2016</td>
</tr>
</tbody>
</table>

While *DISTINCT* is used to list a unique combination of distinct values for the specified columns.

```
SELECT DISTINCT storeName,
              userId
FROM orders;
```

<table>
<thead>
<tr>
<th>storeName</th>
<th>userId</th>
</tr>
</thead>
<tbody>
<tr>
<td>Store A</td>
<td>43</td>
</tr>
<tr>
<td>Store B</td>
<td>57</td>
</tr>
<tr>
<td>Store C</td>
<td>82</td>
</tr>
<tr>
<td>Store A</td>
<td>21</td>
</tr>
</tbody>
</table>
Chapter 40: Finding Duplicates on a Column Subset with Detail

Section 40.1: Students with same name and date of birth

```sql
WITH CTE (StudentId, Fname, LName, DOB, RowCnt)
as
( SELECT StudentId, FirstName, LastName, DateOfBirth as DOB, SUM(1) OVER (Partition By FirstName, LastName, DateOfBirth) as RowCnt
FROM tblStudent
)
SELECT * from CTE where RowCnt > 1
ORDER BY DOB, LName
```

This example uses a Common Table Expression and a Window Function to show all duplicate rows (on a subset of columns) side by side.
Chapter 41: String Functions

String functions perform operations on string values and return either numeric or string values.

Using string functions, you can, for example, combine data, extract a substring, compare strings, or convert a string to all uppercase or lowercase characters.

Section 41.1: Concatenate

In (standard ANSI/ISO) SQL, the operator for string concatenation is `||`. This syntax is supported by all major databases except SQL Server:

```
SELECT 'Hello' || 'World' || '!'; -- returns HelloWorld!
```

Many databases support a `CONCAT` function to join strings:

```
SELECT CONCAT('Hello', 'World'); -- returns 'HelloWorld'
```

Some databases support using `CONCAT` to join more than two strings (Oracle does not):

```
SELECT CONCAT('Hello', 'World', '!'); -- returns 'HelloWorld!'
```

In some databases, non-string types must be cast or converted:

```
SELECT CONCAT('Foo', CAST(42 AS VARCHAR(5)), 'Bar'); -- returns 'Foo42Bar'
```

Some databases (e.g., Oracle) perform implicit lossless conversions. For example, a `CONCAT` on a `CLOB` and `NCLOB` yields a `NCLOB`. A `CONCAT` on a number and a `varchar2` results in a `varchar2`, etc.:

```
SELECT CONCAT(CONCAT('Foo', 42), 'Bar') FROM dual; -- returns Foo42Bar
```

Some databases can use the non-standard `+` operator (but in most, `+` works only for numbers):

```
SELECT 'Foo' + CAST(42 AS VARCHAR(5)) + 'Bar';
```

On SQL Server < 2012, where `CONCAT` is not supported, `+` is the only way to join strings.

Section 41.2: Length

**SQL Server**

The `LEN` doesn't count the trailing space.

```
SELECT LEN('Hello') -- returns 5
SELECT LEN('Hello '); -- returns 5
```

The `DATALENGTH` counts the trailing space.

```
SELECT DATALENGTH('Hello') -- returns 5
SELECT DATALENGTH('Hello '); -- returns 6
```
It should be noted though, that `DATALENGTH` returns the length of the underlying byte representation of the string, which depends, i.a., on the charset used to store the string.

```sql
DECLARE @str varchar(100) = 'Hello ' -- varchar is usually an ASCII string, occupying 1 byte per char
SELECT DATALENGTH(@str) -- returns 6

DECLARE @nstr nvarchar(100) = 'Hello ' -- nvarchar is a unicode string, occupying 2 bytes per char
SELECT DATALENGTH(@nstr) -- returns 12
```

**Oracle**

Syntax: `Length ( char )`

Examples:

```sql
SELECT Length('Bible') FROM dual; --Returns 5
SELECT Length('righteousness') FROM dual; --Returns 13
SELECT Length(NULL) FROM dual; --Returns NULL
```

See Also: `LengthB`, `LengthC`, `Length2`, `Length4`

### Section 41.3: Trim empty spaces

Trim is used to remove write-space at the beginning or end of selection

In MSSQL there is no single TRIM( )

```sql
SELECT LTRIM(' Hello ') --returns 'Hello '
SELECT RTRIM(' Hello ') --returns ' Hello'
SELECT LTRIM(RTRIM(' Hello ')) --returns 'Hello'
```

MySql and Oracle

```sql
SELECT TRIM(' Hello ') --returns 'Hello'
```

### Section 41.4: Upper & lower case

```sql
SELECT UPPER('HelloWorld') --returns 'HELOWORLD'
SELECT LOWER('HelloWorld') --returns 'helloworld'
```

### Section 41.5: Split

Splits a string expression using a character separator. Note that `STRING_SPLIT()` is a table-valued function.

```sql
SELECT value FROM STRING_SPLIT('Lorem ipsum dolor sit amet.', ', ');
```

Result:

<table>
<thead>
<tr>
<th>value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lorem</td>
</tr>
<tr>
<td>ipsum</td>
</tr>
<tr>
<td>dolor</td>
</tr>
<tr>
<td>sit</td>
</tr>
</tbody>
</table>
Section 41.6: Replace

Syntax:

```
REPLACE( String to search, String to search for and replace, String to place into the original string )
```

Example:

```
SELECT REPLACE('Peter Steve Tom', 'Steve', 'Billy') --Return Values: Peter Billy Tom
```

Section 41.7: REGEXP

MySQL Version ≥ 3.19

Checks if a string matches a regular expression (defined by another string).

```
SELECT 'bedded' REGEXP '[a-f]' -- returns True
SELECT 'beam' REGEXP '[a-f]' -- returns False
```

Section 41.8: Substring

Syntax is: `SUBSTRING ( string_expression, start, length )`. Note that SQL strings are 1-indexed.

```
SELECT SUBSTRING('Hello', 1, 2) --returns 'He'
SELECT SUBSTRING('Hello', 3, 3) --returns 'llo'
```

This is often used in conjunction with the `LEN()` function to get the last n characters of a string of unknown length.

```
DECLARE @str1 VARCHAR(10) = 'Hello', @str2 VARCHAR(10) = 'FooBarBaz';
SELECT SUBSTRING(@str1, LEN(@str1) - 2, 3) --returns 'llo'
SELECT SUBSTRING(@str2, LEN(@str2) - 2, 3) --returns 'Baz'
```

Section 41.9: Stuff

Stuff a string into another, replacing 0 or more characters at a certain position.

Note: `start` position is 1-indexed (you start indexing at 1, not 0).

Syntax:

```
STUFF ( character_expression, start, length, replaceWith_expression )
```

Example:

```
SELECT STUFF('FooBarBaz', 4, 3, 'Hello') --returns 'FooHelloBaz'
```

Section 41.10: LEFT - RIGHT

Syntax is:

```
LEFT ( string-expression, integer )
```

amet.
RIGHT ( string-expression , integer )

```
SELECT LEFT('Hello', 2) --return He
SELECT RIGHT('Hello', 2) --return lo
```

Oracle SQL doesn't have LEFT and RIGHT functions. They can be emulated with SUBSTR and LENGTH.

```
SELECT SUBSTR('Hello', 1, 2) --return He
SELECT SUBSTR('Hello', LENGTH('Hello')-2+1, 2) --return lo
```

### Section 41.11: REVERSE

Syntax is: REVERSE ( string-expression )

```
SELECT REVERSE('Hello') --returns olleH
```

### Section 41.12: REPLICATE

The `REPLICATE` function concatenates a string with itself a specified number of times.

Syntax is: REPLICATE ( string-expression , integer )

```
SELECT REPLICATE ('Hello', 4) --returns 'HelloHelloHelloHello'
```

### Section 41.13: Replace function in sql Select and Update query

The Replace function in SQL is used to update the content of a string. The function call is REPLACE( ) for MySQL, Oracle, and SQL Server.

The syntax of the Replace function is:

```
REPLACE ( str, find, repl)
```

The following example replaces occurrences of South with Southern in Employees table:

<table>
<thead>
<tr>
<th>FirstName</th>
<th>Address</th>
</tr>
</thead>
<tbody>
<tr>
<td>James</td>
<td>South New York</td>
</tr>
<tr>
<td>John</td>
<td>South Boston</td>
</tr>
<tr>
<td>Michael</td>
<td>South San Diego</td>
</tr>
</tbody>
</table>

**Select Statement:**

If we apply the following Replace function:

```
SELECT
  FirstName,
  REPLACE ( Address, 'South', 'Southern' ) Address
FROM Employees
ORDER BY FirstName
```

Result:
Update Statement:

We can use a replace function to make permanent changes in our table through following approach.

```
Update Employees
Set city = (Address, 'South', 'Southern');
```

A more common approach is to use this in conjunction with a WHERE clause like this:

```
Update Employees
Set Address = (Address, 'South', 'Southern')
Where Address LIKE 'South%';
```

Section 41.14: INSTR

Return the index of the first occurrence of a substring (zero if not found)

Syntax: INSTR ( string, substring )

```
SELECT INSTR('FooBarBar', 'Bar') -- return 4
SELECT INSTR('FooBarBar', 'Xar') -- return 0
```

Section 41.15: PARSENAME

DATABASE: SQL Server

PARSENAME function returns the specific part of given string(object name). object name may contains string like object name, owner name, database name and server name.

More details [MSDN:PARSENAME](#)

Syntax

```
PARSENAME('NameOfStringToParse', PartIndex)
```

Example

To get object name use part index 1

```
SELECT PARSENAME('ServerName.DatabaseName.SchemaName.ObjectName',1)  // returns 'ObjectName'
SELECT PARSENAME('[1012-1111].SchoolDatabase.school.Student',1)  // returns 'Student'
```

To get schema name use part index 2

```
SELECT PARSENAME('ServerName.DatabaseName.SchemaName.ObjectName',2)  // returns 'SchemaName'
SELECT PARSENAME('[1012-1111].SchoolDatabase.school.Student',2)  // returns 'school'
```

To get database name use part index 3

```
SELECT PARSENAME('ServerName.DatabaseName.SchemaName.ObjectName',3)  // returns 'DatabaseName'
```
SELECT PARSENAME('[1012-1111].SchoolDatabase.school.Student', 3) // returns `SchoolDatabase`

To get server name use part index 4

SELECT PARSENAME('ServerName.DatabaseName.SchemaName.ObjectName', 4) // returns `ServerName`
SELECT PARSENAME('[1012-1111].SchoolDatabase.school.Student', 4) // returns `[1012-1111]`

PARSENAME will returns null is specified part is not present in given object name string
Chapter 42: Functions (Aggregate)

Section 42.1: Conditional aggregation

Payments Table

<table>
<thead>
<tr>
<th>Customer</th>
<th>Payment_type</th>
<th>Amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter</td>
<td>Credit</td>
<td>100</td>
</tr>
<tr>
<td>Peter</td>
<td>Credit</td>
<td>300</td>
</tr>
<tr>
<td>John</td>
<td>Credit</td>
<td>1000</td>
</tr>
<tr>
<td>John</td>
<td>Debit</td>
<td>500</td>
</tr>
</tbody>
</table>

```sql
select customer,
    sum(case when payment_type = 'credit' then amount else 0 end) as credit,
    sum(case when payment_type = 'debit' then amount else 0 end) as debit
from payments
group by customer
```

Result:

<table>
<thead>
<tr>
<th>Customer</th>
<th>Credit</th>
<th>Debit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter</td>
<td>400</td>
<td>0</td>
</tr>
<tr>
<td>John</td>
<td>1000</td>
<td>500</td>
</tr>
</tbody>
</table>

```sql
select customer,
    sum(case when payment_type = 'credit' then 1 else 0 end) as credit_transaction_count,
    sum(case when payment_type = 'debit' then 1 else 0 end) as debit_transaction_count
from payments
group by customer
```

Result:

<table>
<thead>
<tr>
<th>Customer</th>
<th>credit_transaction_count</th>
<th>debit_transaction_count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peter</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>John</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Section 42.2: List Concatenation

Partial credit to [this SO answer](link).

List Concatenation aggregates a column or expression by combining the values into a single string for each group. A string to delimit each value (either blank or a comma when omitted) and the order of the values in the result can be specified. While it is not part of the SQL standard, every major relational database vendor supports it in their own way.

**MySQL**

```sql
SELECT ColumnA,
    GROUP_CONCAT(ColumnB ORDER BY ColumnB SEPARATOR ',') AS ColumnBs
FROM TableName
GROUP BY ColumnA
ORDER BY ColumnA;
```

**Oracle & DB2**

```sql
SELECT ColumnA,
    LISTAGG(ColumnB, ',') WITHIN GROUP (ORDER BY ColumnB) AS ColumnBs
FROM TableName
GROUP BY ColumnA;
```
PostgreSQL

```sql
SELECT ColumnA,
    STRING_AGG(ColumnB, ',') AS ColumnBs
FROM TableName
GROUP BY ColumnA
ORDER BY ColumnA;
```

**SQL Server**

**SQL Server 2016 and earlier**

(CTE included to encourage the [DRY principle](http://example.com))

```sql
WITH CTE_TableName AS (
    SELECT ColumnA, ColumnB
    FROM TableName)
SELECT t0.ColumnA,
    STUFF((
        SELECT ', ' + t1.ColumnB
        FROM CTE_TableName t1
        WHERE t1.ColumnA = t0.ColumnA
        ORDER BY t1.ColumnB
        FOR XML PATH(''))', 1, 1, '') AS ColumnBs
FROM CTE_TableName t0
GROUP BY t0.ColumnA
ORDER BY ColumnA;
```

**SQL Server 2017 and SQL Azure**

```sql
SELECT ColumnA,
    STRING_AGG(ColumnB, ',') WITHIN GROUP (ORDER BY ColumnB) AS ColumnBs
FROM TableName
GROUP BY ColumnA
ORDER BY ColumnA;
```

**SQLite**

without ordering:

```sql
SELECT ColumnA,
    GROUP_CONCAT(ColumnB, ',') AS ColumnBs
FROM TableName
GROUP BY ColumnA
ORDER BY ColumnA;
```

ordering requires a subquery or CTE:

```sql
WITH CTE_TableName AS (
    SELECT ColumnA, ColumnB
    FROM TableName
    ORDER BY ColumnA, ColumnB)
SELECT ColumnA,
    GROUP_CONCAT(ColumnB, ',') AS ColumnBs
FROM CTE_TableName
GROUP BY ColumnA
ORDER BY ColumnA;
```

**Section 42.3: SUM**

Sum function sum the value of all the rows in the group. If the group by clause is omitted then sums all the rows.
```sql
select sum(salary) TotalSalary
from employees;
```

TotalSalary
2500

```sql
select DepartmentId, sum(salary) TotalSalary
from employees
group by DepartmentId;
```

<table>
<thead>
<tr>
<th>DepartmentId</th>
<th>TotalSalary</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2000</td>
</tr>
<tr>
<td>2</td>
<td>500</td>
</tr>
</tbody>
</table>

**Section 42.4: AVG()**

The aggregate function AVG() returns the average of a given expression, usually numeric values in a column. Assume we have a table containing the yearly calculation of population in cities across the world. The records for New York City look similar to the ones below:

**EXAMPLE TABLE**

<table>
<thead>
<tr>
<th>city_name</th>
<th>population</th>
<th>year</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York City</td>
<td>8,550,405</td>
<td>2015</td>
</tr>
<tr>
<td>New York City</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>New York City</td>
<td>8,000,906</td>
<td>2005</td>
</tr>
</tbody>
</table>

To select the average population of the New York City, USA from a table containing city names, population measurements, and measurement years for last ten years:

**QUERY**

```sql
select city_name, AVG(population) avg_population
from city_population
where city_name = 'NEW YORK CITY';
```

```
<table>
<thead>
<tr>
<th>city_name</th>
<th>avg_population</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York City</td>
<td>8,250,754</td>
</tr>
</tbody>
</table>
```

Notice how measurement year is absent from the query since population is being averaged over time.

**RESULTS**

<table>
<thead>
<tr>
<th>city_name</th>
<th>avg_population</th>
</tr>
</thead>
<tbody>
<tr>
<td>New York City</td>
<td>8,250,754</td>
</tr>
</tbody>
</table>

Note: The AVG() function will convert values to numeric types. This is especially important to keep in mind when working with dates.

**Section 42.5: Count**

You can count the number of rows:

```sql
SELECT count(*) TotalRows
FROM employees;
```

TotalRows
4

Or count the employees per department:

```sql
SELECT DepartmentId, count(*) NumEmployees
FROM employees
```
GROUP BY DepartmentId;

<table>
<thead>
<tr>
<th>DepartmentId</th>
<th>NumEmployees</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

You can count over a column/expression with the effect that will not count the NULL values:

```sql
SELECT count(ManagerId) mgr
FROM EMPLOYEES;

mgr
3
```

(There is one null value managerId column)

You can also use DISTINCT inside of another function such as COUNT to only find the DISTINCT members of the set to perform the operation on.

For example:

```sql
SELECT COUNT(ContinentCode) AllCount,
       COUNT(DISTINCT ContinentCode) SingleCount
FROM Countries;
```

Will return different values. The SingleCount will only Count individual Continents once, while the AllCount will include duplicates.

<table>
<thead>
<tr>
<th>ContinentCode</th>
</tr>
</thead>
<tbody>
<tr>
<td>OC</td>
</tr>
<tr>
<td>EU</td>
</tr>
<tr>
<td>AS</td>
</tr>
<tr>
<td>NA</td>
</tr>
<tr>
<td>NA</td>
</tr>
<tr>
<td>AF</td>
</tr>
<tr>
<td>AF</td>
</tr>
</tbody>
</table>

AllCount: 7 SingleCount: 5

**Section 42.6: Min**

Find the smallest value of column:

```sql
select min(age) from employee;
```

Above example will return smallest value for column age of employee table.

Syntax:

```sql
SELECT MIN(column_name) FROM table_name;
```

**Section 42.7: Max**

Find the maximum value of column:

```sql
select max(age) from employee;
```
Above example will return largest value for column age of employee table.

Syntax:

```
SELECT MAX(column_name) FROM table_name;
```
SQL provides several built-in scalar functions. Each scalar function takes one value as input and returns one value as output for each row in a result set.

You use scalar functions wherever an expression is allowed within a T-SQL statement.

## Section 43.1: Date And Time

In SQL, you use date and time data types to store calendar information. These data types include the time, date, smalldatetime, datetime, datetime2, and datetimeoffset. Each data type has a specific format.

<table>
<thead>
<tr>
<th>Data type</th>
<th>Format</th>
</tr>
</thead>
<tbody>
<tr>
<td>time</td>
<td>hh:mm:ss[nnnnnn]</td>
</tr>
<tr>
<td>date</td>
<td>YYYY-MM-DD</td>
</tr>
<tr>
<td>smalldatetime</td>
<td>YYYY-MM-DD hh:mm:ss</td>
</tr>
<tr>
<td>datetime</td>
<td>YYYY-MM-DD hh:mm:ss[.nnn]</td>
</tr>
<tr>
<td>datetime2</td>
<td>YYYY-MM-DD hh:mm:ss[nnnnnn]</td>
</tr>
<tr>
<td>datetimeoffset</td>
<td>YYYY-MM-DD hh:mm:ss[nnnnnn] [+/-]hh:mm</td>
</tr>
</tbody>
</table>

The `DATENAME` function returns the name or value of a specific part of the date.

```sql
SELECT DATENAME (weekday, '2017-01-14') as Datename
```

**Datename**

Saturday

You use the `GETDATE` function to determine the current date and time of the computer running the current SQL instance. This function doesn't include the time zone difference.

```sql
SELECT GETDATE() as Systemdate
```

**Systemdate**

2017-01-14 11:11:47.7230728

The `DATEDIFF` function returns the difference between two dates.

In the syntax, `datepart` is the parameter that specifies which part of the date you want to use to calculate difference. The `datepart` can be `year`, `month`, `week`, `day`, `hour`, `minute`, `second`, or `millisecond`. You then specify the start date in the `startdate` parameter and the end date in the `enddate` parameter for which you want to find the difference.

```sql
SELECT SalesOrderID, DATEDIFF (day, OrderDate, ShipDate) AS 'Processing time'
FROM Sales.SalesOrderHeader
```

**SalesOrderID** **Processing time**

<table>
<thead>
<tr>
<th>SalesOrderID</th>
<th>Processing time</th>
</tr>
</thead>
<tbody>
<tr>
<td>43659</td>
<td>7</td>
</tr>
<tr>
<td>43660</td>
<td>7</td>
</tr>
<tr>
<td>43661</td>
<td>7</td>
</tr>
<tr>
<td>43662</td>
<td>7</td>
</tr>
</tbody>
</table>

The `DATEADD` function enables you to add an interval to part of a specific date.

```sql
SELECT DATEADD (day, 20, '2017-01-14') AS Added20MoreDays
```

**Added20MoreDays**
Section 43.2: Character modifications

Character modifying functions include converting characters to upper or lower case characters, converting numbers to formatted numbers, performing character manipulation, etc.

The \( \text{lower}(\text{char}) \) function converts the given character parameter to be lower-cased characters.

```sql
SELECT customer_id, lower(customer_last_name) FROM customer;
```

would return the customer's last name changed from "SMITH" to "smith".

Section 43.3: Configuration and Conversion Function

An example of a configuration function in SQL is the \( @@\text{SERVERNAME} \) function. This function provides the name of the local server that's running SQL.

```sql
SELECT @@SERVERNAME AS 'Server'
```

Server
SQL064

In SQL, most data conversions occur implicitly, without any user intervention.

To perform any conversions that can't be completed implicitly, you can use the \( \text{CAST} \) or \( \text{CONVERT} \) functions.

The \( \text{CAST} \) function syntax is simpler than the \( \text{CONVERT} \) function syntax, but is limited in what it can do.

In here, we use both the \( \text{CAST} \) and \( \text{CONVERT} \) functions to convert the datetime data type to the \( \text{varchar} \) data type.

The \( \text{CAST} \) function always uses the default style setting. For example, it will represent dates and times using the format YYYY-MM-DD.

The \( \text{CONVERT} \) function uses the date and time style you specify. In this case, 3 specifies the date format dd/mm/yy.

```sql
USE AdventureWorks2012
GO
SELECT FirstName + ' ' + LastName + ' was hired on ' +
    CAST(HireDate AS varchar(20)) AS 'Cast',
    FirstName + ' ' + LastName + ' was hired on ' +
    CONVERT(varchar, HireDate, 3) AS 'Convert'
FROM Person.Person AS p
JOIN HumanResources.Employee AS e
ON p.BusinessEntityID = e.BusinessEntityID
GO
```

Cast     Convert
David Hamiltion was hired on 2003-02-04 David Hamiltion was hired on 04/02/03

Another example of a conversion function is the \( \text{PARSE} \) function. This function converts a string to a specified data type.

In the syntax for the function, you specify the string that must be converted, the \( \text{AS} \) keyword, and then the required data type. Optionally, you can also specify the culture in which the string value should be formatted. If you don't specify this, the language for the session is used.

If the string value can't be converted to a numeric, date, or time format, it will result in an error. You'll then need to
use **CAST** or **CONVERT** for the conversion.

```sql
SELECT PARSE('Monday, 13 August 2012' AS datetime2 USING 'en-US') AS 'Date in English'
```

<table>
<thead>
<tr>
<th>Date in English</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012-08-13 00:00:00.000000</td>
</tr>
</tbody>
</table>

**Section 43.4: Logical and Mathematical Function**

SQL has two logical functions – **CHOOSE** and **IIF**.

The **CHOOSE** function returns an item from a list of values, based on its position in the list. This position is specified by the index.

In the syntax, the index parameter specifies the item and is a whole number, or integer. The val_1 ... val_n parameter identifies the list of values.

```sql
SELECT CHOOSE(2, 'Human Resources', 'Sales', 'Admin', 'Marketing') AS Result;
```

<table>
<thead>
<tr>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales</td>
</tr>
</tbody>
</table>

In this example, you use the **CHOOSE** function to return the second entry in a list of departments.

The **IIF** function returns one of two values, based on a particular condition. If the condition is true, it will return true value. Otherwise it will return a false value.

In the syntax, the boolean_expression parameter specifies the Boolean expression. The true_value parameter specifies the value that should be returned if the boolean_expression evaluates to true and the false_value parameter specifies the value that should be returned if the boolean_expression evaluates to false.

```sql
SELECT BusinessEntityID, SalesYTD,
      IIF(SalesYTD > 200000, 'Bonus', 'No Bonus') AS 'Bonus?'
FROM Sales.SalesPerson
GO
```

<table>
<thead>
<tr>
<th>BusinessEntityID</th>
<th>SalesYTD</th>
<th>Bonus?</th>
</tr>
</thead>
<tbody>
<tr>
<td>274</td>
<td>559697.5639</td>
<td>Bonus</td>
</tr>
<tr>
<td>275</td>
<td>3763178.1787</td>
<td>Bonus</td>
</tr>
<tr>
<td>285</td>
<td>172524.4512</td>
<td>No Bonus</td>
</tr>
</tbody>
</table>

In this example, you use the **IIF** function to return one of two values. If a sales person's year-to-date sales are above 200,000, this person will be eligible for a bonus. Values below 200,000 mean that employees don't qualify for bonuses.

SQL includes several mathematical functions that you can use to perform calculations on input values and return numeric results.

One example is the **SIGN** function, which returns a value indicating the sign of an expression. The value of -1 indicates a negative expression, the value of +1 indicates a positive expression, and 0 indicates zero.

```sql
SELECT SIGN(-20) AS 'Sign'
```

<table>
<thead>
<tr>
<th>Sign</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1</td>
</tr>
</tbody>
</table>

In the example, the input is a negative number, so the Results pane lists the result -1.
Another mathematical function is the `POWER` function. This function provides the value of an expression raised to a specified power.

In the syntax, the `float_expression` parameter specifies the expression, and the `y` parameter specifies the power to which you want to raise the expression.

```
SELECT POWER(50, 3) AS Result
```

Result
125000
Chapter 44: Functions (Analytic)

You use analytic functions to determine values based on groups of values. For example, you can use this type of function to determine running totals, percentages, or the top result within a group.

Section 44.1: LAG and LEAD

The LAG function provides data on rows before the current row in the same result set. For example, in a SELECT statement, you can compare values in the current row with values in a previous row.

You use a scalar expression to specify the values that should be compared. The offset parameter is the number of rows before the current row that will be used in the comparison. If you don't specify the number of rows, the default value of one row is used.

The default parameter specifies the value that should be returned when the expression at offset has a NULL value. If you don't specify a value, a value of NULL is returned.

The LEAD function provides data on rows after the current row in the row set. For example, in a SELECT statement, you can compare values in the current row with values in the following row.

You specify the values that should be compared using a scalar expression. The offset parameter is the number of rows after the current row that will be used in the comparison.

You specify the value that should be returned when the expression at offset has a NULL value using the default parameter. If you don't specify these parameters, the default of one row is used and a value of NULL is returned.

```sql
SELECT BusinessEntityID, SalesYTD,
    LEAD(SalesYTD, 1, 0) OVER(ORDER BY BusinessEntityID) AS "Lead value",
    LAG(SalesYTD, 1, 0) OVER(ORDER BY BusinessEntityID) AS "Lag value"
FROM SalesPerson;
```

This example uses the LEAD and LAG functions to compare the sales values for each employee to date with those of the employees listed above and below, with records ordered based on the BusinessEntityID column.

<table>
<thead>
<tr>
<th>BusinessEntityID</th>
<th>SalesYTD</th>
<th>Lead value</th>
<th>Lag value</th>
</tr>
</thead>
<tbody>
<tr>
<td>274</td>
<td>559697.5639</td>
<td>3763178.1787</td>
<td>0.0000</td>
</tr>
<tr>
<td>275</td>
<td>3763178.1787</td>
<td>4251368.5497</td>
<td>559697.5639</td>
</tr>
<tr>
<td>276</td>
<td>4251368.5497</td>
<td>3189418.3662</td>
<td>3763178.1787</td>
</tr>
<tr>
<td>277</td>
<td>3189418.3662</td>
<td>1453719.4653</td>
<td>4251368.5497</td>
</tr>
<tr>
<td>278</td>
<td>1453719.4653</td>
<td>2315185.6110</td>
<td>3189418.3662</td>
</tr>
<tr>
<td>279</td>
<td>2315185.6110</td>
<td>1352577.1325</td>
<td>1453719.4653</td>
</tr>
</tbody>
</table>

Section 44.2: PERCENTILE_DISC and PERCENTILE_CONT

The PERCENTILE_DISC function lists the value of the first entry where the cumulative distribution is higher than the percentile that you provide using the numeric_literal parameter.

The values are grouped by rowset or partition, as specified by the WITHIN GROUP clause.

The PERCENTILE_CONT function is similar to the PERCENTILE_DISC function, but returns the average of the sum of the first matching entry and the next entry.

```sql
SELECT BusinessEntityID, JobTitle, SickLeaveHours,
    CUME_DIST() OVER(PARTITION BY JobTitle ORDER BY SickLeaveHours ASC)
FROM SalesPerson;
```
To find the exact value from the row that matches or exceeds the 0.5 percentile, you pass the percentile as the numeric literal in the PERCENTILE_DISC function. The Percentile Discreet column in a result set lists the value of the row at which the cumulative distribution is higher than the specified percentile.

<table>
<thead>
<tr>
<th>BusinessEntityID</th>
<th>JobTitle</th>
<th>SickLeaveHours</th>
<th>Cumulative Distribution</th>
<th>Percentile Discreet</th>
</tr>
</thead>
<tbody>
<tr>
<td>272</td>
<td>Application Specialist</td>
<td>55</td>
<td>0.25</td>
<td>56</td>
</tr>
<tr>
<td>268</td>
<td>Application Specialist</td>
<td>56</td>
<td>0.75</td>
<td>56</td>
</tr>
<tr>
<td>269</td>
<td>Application Specialist</td>
<td>56</td>
<td>0.75</td>
<td>56</td>
</tr>
<tr>
<td>267</td>
<td>Application Specialist</td>
<td>57</td>
<td>1</td>
<td>56</td>
</tr>
</tbody>
</table>

To base the calculation on a set of values, you use the PERCENTILE_CONT function. The "Percentile Continuous" column in the results lists the average value of the sum of the result value and the next highest matching value.

<table>
<thead>
<tr>
<th>BusinessEntityID</th>
<th>JobTitle</th>
<th>SickLeaveHours</th>
<th>Cumulative Distribution</th>
<th>Percentile Discreet</th>
<th>Percentile Continuous</th>
</tr>
</thead>
<tbody>
<tr>
<td>272</td>
<td>Application Specialist</td>
<td>55</td>
<td>0.25</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>268</td>
<td>Application Specialist</td>
<td>56</td>
<td>0.75</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>269</td>
<td>Application Specialist</td>
<td>56</td>
<td>0.75</td>
<td>56</td>
<td>56</td>
</tr>
<tr>
<td>267</td>
<td>Application Specialist</td>
<td>57</td>
<td>1</td>
<td>56</td>
<td>56</td>
</tr>
</tbody>
</table>

**Section 44.3: FIRST_VALUE**

You use the FIRST_VALUE function to determine the first value in an ordered result set, which you identify using a scalar expression.

```
SELECT StateProvinceID, Name, TaxRate,
       FIRST_VALUE(StateProvinceID)
       OVER(ORDER BY TaxRate ASC) AS FirstValue
FROM SalesTaxRate;
```

In this example, the FIRST_VALUE function is used to return the ID of the state or province with the lowest tax rate. The OVER clause is used to order the tax rates to obtain the lowest rate.

<table>
<thead>
<tr>
<th>StateProvinceID</th>
<th>Name</th>
<th>TaxRate</th>
<th>FirstValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>74</td>
<td>Utah State Sales Tax</td>
<td>5.00</td>
<td>74</td>
</tr>
<tr>
<td>36</td>
<td>Minnesota State Sales Tax</td>
<td>6.75</td>
<td>74</td>
</tr>
<tr>
<td>30</td>
<td>Massachusetts State Sales Tax</td>
<td>7.00</td>
<td>74</td>
</tr>
<tr>
<td>1</td>
<td>Canadian GST</td>
<td>7.00</td>
<td>74</td>
</tr>
<tr>
<td>57</td>
<td>Canadian GST</td>
<td>7.00</td>
<td>74</td>
</tr>
<tr>
<td>63</td>
<td>Canadian GST</td>
<td>7.00</td>
<td>74</td>
</tr>
</tbody>
</table>
Section 44.4: LAST_VALUE

The **LAST_VALUE** function provides the last value in an ordered result set, which you specify using a scalar expression.

```sql
SELECT TerritoryID, StartDate, BusinessentityID,
       LAST_VALUE(BusinessentityID)
       OVER(Order BY TerritoryID) AS LastValue
FROM SalesTerritoryHistory;
```

This example uses the **LAST_VALUE** function to return the last value for each rowset in the ordered values.

<table>
<thead>
<tr>
<th>TerritoryID</th>
<th>StartDate</th>
<th>BusinessentityID</th>
<th>LastValue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2005-07-01 00.00.00.000</td>
<td>280</td>
<td>283</td>
</tr>
<tr>
<td>1</td>
<td>2006-11-01 00.00.00.000</td>
<td>284</td>
<td>283</td>
</tr>
<tr>
<td>1</td>
<td>2005-07-01 00.00.00.000</td>
<td>283</td>
<td>283</td>
</tr>
<tr>
<td>2</td>
<td>2007-01-01 00.00.00.000</td>
<td>277</td>
<td>275</td>
</tr>
<tr>
<td>2</td>
<td>2005-07-01 00.00.00.000</td>
<td>275</td>
<td>275</td>
</tr>
<tr>
<td>3</td>
<td>2007-01-01 00.00.00.000</td>
<td>275</td>
<td>277</td>
</tr>
</tbody>
</table>

Section 44.5: PERCENT_RANK and CUME_DIST

The **PERCENT_RANK** function calculates the ranking of a row relative to the row set. The percentage is based on the number of rows in the group that have a lower value than the current row.

The first value in the result set always has a percent rank of zero. The value for the highest-ranked – or last – value in the set is always one.

The **CUME_DIST** function calculates the relative position of a specified value in a group of values, by determining the percentage of values less than or equal to that value. This is called the cumulative distribution.

```sql
SELECT BusinessEntityID, JobTitle, SickLeaveHours,
       PERCENT_RANK() OVER(PARTITION BY JobTitle ORDER BY SickLeaveHours DESC)
       AS "Percent Rank",
       CUME_DIST() OVER(PARTITION BY JobTitle ORDER BY SickLeaveHours DESC)
       AS "Cumulative Distribution"
FROM Employee;
```

In this example, you use an **ORDER** clause to partition – or group – the rows retrieved by the **SELECT** statement based on employees' job titles, with the results in each group sorted based on the numbers of sick leave hours that employees have used.

<table>
<thead>
<tr>
<th>BusinessEntityID</th>
<th>JobTitle</th>
<th>SickLeaveHours</th>
<th>Percent Rank</th>
<th>Cumulative Distribution</th>
</tr>
</thead>
<tbody>
<tr>
<td>267</td>
<td>Application Specialist</td>
<td>57</td>
<td>0</td>
<td>0.25</td>
</tr>
<tr>
<td>268</td>
<td>Application Specialist</td>
<td>56</td>
<td>0.333333333333333</td>
<td>0.75</td>
</tr>
<tr>
<td>269</td>
<td>Application Specialist</td>
<td>56</td>
<td>0.333333333333333</td>
<td>0.75</td>
</tr>
<tr>
<td>272</td>
<td>Application Specialist</td>
<td>55</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>262</td>
<td>Assistant to the Chief Financial Officer</td>
<td>48</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>239</td>
<td>Benefits Specialist</td>
<td>45</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>252</td>
<td>Buyer</td>
<td>50</td>
<td>0.125</td>
<td>0.111111111111111111111</td>
</tr>
<tr>
<td>251</td>
<td>Buyer</td>
<td>49</td>
<td>0.125</td>
<td>0.333333333333333</td>
</tr>
<tr>
<td>256</td>
<td>Buyer</td>
<td>49</td>
<td>0.125</td>
<td>0.333333333333333</td>
</tr>
<tr>
<td>253</td>
<td>Buyer</td>
<td>48</td>
<td>0.375</td>
<td>0.555555555555555</td>
</tr>
<tr>
<td>254</td>
<td>Buyer</td>
<td>48</td>
<td>0.375</td>
<td>0.555555555555555</td>
</tr>
</tbody>
</table>
The `PERCENT_RANK` function ranks the entries within each group. For each entry, it returns the percentage of entries in the same group that have lower values.

The `CUME_DIST` function is similar, except that it returns the percentage of values less than or equal to the current value.
Chapter 45: Window Functions

Section 45.1: Setting up a flag if other rows have a common property

Let’s say I have this data:

Table items

<table>
<thead>
<tr>
<th>id</th>
<th>name</th>
<th>tag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>example</td>
<td>unique_tag</td>
</tr>
<tr>
<td>2</td>
<td>foo</td>
<td>simple</td>
</tr>
<tr>
<td>42</td>
<td>bar</td>
<td>simple</td>
</tr>
<tr>
<td>3</td>
<td>baz</td>
<td>hello</td>
</tr>
<tr>
<td>51</td>
<td>quux</td>
<td>world</td>
</tr>
</tbody>
</table>

I’d like to get all those lines and know if a tag is used by other lines

```
SELECT id, name, tag, COUNT(*) OVER (PARTITION BY tag) > 1 AS flag FROM items
```

The result will be:

<table>
<thead>
<tr>
<th>id</th>
<th>name</th>
<th>tag</th>
<th>flag</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>example</td>
<td>unique_tag</td>
<td>false</td>
</tr>
<tr>
<td>2</td>
<td>foo</td>
<td>simple</td>
<td>true</td>
</tr>
<tr>
<td>42</td>
<td>bar</td>
<td>simple</td>
<td>true</td>
</tr>
<tr>
<td>3</td>
<td>baz</td>
<td>hello</td>
<td>false</td>
</tr>
<tr>
<td>51</td>
<td>quux</td>
<td>world</td>
<td>false</td>
</tr>
</tbody>
</table>

In case your database doesn’t have OVER and PARTITION you can use this to produce the same result:

```
SELECT id, name, tag, (SELECT COUNT(tag) FROM items B WHERE tag = A.tag) > 1 AS flag FROM items A
```

Section 45.2: Finding "out-of-sequence" records using the LAG() function

Given these sample data:

```
<table>
<thead>
<tr>
<th>ID</th>
<th>STATUS</th>
<th>STATUS_TIME</th>
<th>STATUS_BY</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ONE</td>
<td>2016-09-28-19.47.52.501398</td>
<td>USER_1</td>
</tr>
<tr>
<td>3</td>
<td>ONE</td>
<td>2016-09-28-19.47.52.501511</td>
<td>USER_2</td>
</tr>
<tr>
<td>1</td>
<td>THREE</td>
<td>2016-09-28-19.47.52.501517</td>
<td>USER_3</td>
</tr>
<tr>
<td>3</td>
<td>TWO</td>
<td>2016-09-28-19.47.52.501521</td>
<td>USER_2</td>
</tr>
<tr>
<td>3</td>
<td>THREE</td>
<td>2016-09-28-19.47.52.501524</td>
<td>USER_4</td>
</tr>
</tbody>
</table>
```

Items identified by ID values must move from STATUS 'ONE' to 'TWO' to 'THREE' in sequence, without skipping statuses. The problem is to find users (STATUS_BY) values who violate the rule and move from 'ONE' immediately to 'THREE'.

The LAG() analytical function helps to solve the problem by returning for each row the value in the preceding row:

```
SELECT * FROM (SELECT ...

```
LAG(status) OVER (PARTITION BY id ORDER BY status_time) AS prev_status
FROM test t
) t1 WHERE status = 'THREE' AND prev_status != 'TWO'

In case your database doesn't have LAG() you can use this to produce the same result:

```
SELECT A.id, A.status, B.status as prev_status, A.status_time, B.status_time as prev_status_time
FROM Data A, Data B
WHERE A.id = B.id
AND B.status_time = (SELECT MAX(status_time) FROM Data where status_time < A.status_time and id = A.id)
AND A.status = 'THREE' AND NOT B.status = 'TWO'
```

### Section 45.3: Getting a running total

Given this data:

<table>
<thead>
<tr>
<th>date</th>
<th>amount</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-03-12</td>
<td>200</td>
</tr>
<tr>
<td>2016-03-11</td>
<td>-50</td>
</tr>
<tr>
<td>2016-03-14</td>
<td>100</td>
</tr>
<tr>
<td>2016-03-15</td>
<td>100</td>
</tr>
<tr>
<td>2016-03-10</td>
<td>-250</td>
</tr>
</tbody>
</table>

```sql
SELECT date, amount, SUM(amount) OVER (ORDER BY date DESC) AS running
FROM operations
ORDER BY date ASC
```

will give you

<table>
<thead>
<tr>
<th>date</th>
<th>amount</th>
<th>running</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-03-10</td>
<td>-250</td>
<td>-250</td>
</tr>
<tr>
<td>2016-03-11</td>
<td>-300</td>
<td>-300</td>
</tr>
<tr>
<td>2016-03-12</td>
<td>-100</td>
<td>-100</td>
</tr>
<tr>
<td>2016-03-14</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2016-03-15</td>
<td>-100</td>
<td>-100</td>
</tr>
</tbody>
</table>

### Section 45.4: Adding the total rows selected to every row

```
SELECT your_columns, COUNT(*) OVER() as Ttl_Rows FROM your_data_set
```

id name  Ttl_Rows
1 example | 5 |
2 foo      | 5 |
3 bar      | 5 |
4 baz      | 5 |
5 quux     | 5 |

Instead of using two queries to get a count then the line, you can use an aggregate as a window function and use the full result set as the window.

This can be used as a base for further calculation without the complexity of extra self joins.

### Section 45.5: Getting the N most recent rows over multiple grouping

Given this data
### User ID Completion Date

<table>
<thead>
<tr>
<th>User_ID</th>
<th>Completion_Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2016-07-20</td>
</tr>
<tr>
<td>1</td>
<td>2016-07-21</td>
</tr>
<tr>
<td>2</td>
<td>2016-07-20</td>
</tr>
<tr>
<td>2</td>
<td>2016-07-21</td>
</tr>
<tr>
<td>2</td>
<td>2016-07-22</td>
</tr>
</tbody>
</table>

```sql
WITH CTE AS
(SELECT *
, ROW_NUMBER() OVER (PARTITION BY User_ID
ORDER BY Completion_Date DESC) Row_Num
FROM Data)
SELECT * FROM CTE WHERE Row_Num <= n
```

Using n=1, you'll get the one most recent row per user_id:

### User ID Completion Date Row_Num

<table>
<thead>
<tr>
<th>User_ID</th>
<th>Completion_Date</th>
<th>Row_Num</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2016-07-21</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>2016-07-22</td>
<td>1</td>
</tr>
</tbody>
</table>
Chapter 46: Common Table Expressions

Section 46.1: generating values

Most databases do not have a native way of generating a series of numbers for ad-hoc use; however, common table expressions can be used with recursion to emulate that type of function.

The following example generates a common table expression called Numbers with a column i which has a row for numbers 1-5:

```
--Give a table name `Numbers` and a column `i` to hold the numbers
WITH Numbers(i) AS (  
  --Starting number/index
  SELECT 1
  --Top-level UNION ALL operator required for recursion
  UNION ALL
  --Iteration expression:
  SELECT i + 1
  --Table expression we first declared used as source for recursion
  FROM Numbers
  --Clause to define the end of the recursion
  WHERE i < 5
)

--Use the generated table expression like a regular table
SELECT i FROM Numbers;
```

This method can be used with any number interval, as well as other types of data.

Section 46.2: recursively enumerating a subtree

```
WITH RECURSIVE ManagedByJames(Level, ID, FName, LName) AS (  
  -- start with this row
  SELECT 1, ID, FName, LName
  FROM Employees
  WHERE ID = 1

  UNION ALL

  -- get employees that have any of the previously selected rows as manager
  SELECT ManagedByJames.Level + 1,
         Employees.ID,
         Employees.FName,
         Employees.LName
  FROM Employees
  JOIN ManagedByJames
  ON Employees.ManagerID = ManagedByJames.ID

  ORDER BY 1 DESC

)

SELECT * FROM ManagedByJames;
```

Level   ID   FName   LName
Section 46.3: Temporary query

These behave in the same manner as nested subqueries but with a different syntax.

```sql
WITH ReadyCars AS (
    SELECT *
    FROM Cars
    WHERE Status = 'READY'
)
SELECT ID, Model, TotalCost
FROM ReadyCars
ORDER BY TotalCost;
```

Equivalent subquery syntax

```sql
SELECT ID, Model, TotalCost
FROM (SELECT * FROM Cars WHERE Status = 'READY') AS ReadyCars
ORDER BY TotalCost;
```

Section 46.4: recursively going up in a tree

```sql
WITH RECURSIVE ManagersOfJonathon AS (
    -- start with this row
    SELECT *
    FROM Employees
    WHERE ID = 4

    UNION ALL

    -- get manager(s) of all previously selected rows
    SELECT Employees.*
    FROM Employees
    JOIN ManagersOfJonathon ON Employees.ID = ManagersOfJonathon.ManagerID
)
SELECT * FROM ManagersOfJonathon;
```

Section 46.5: Recursively generate dates, extended to include
team rostering as example

DECLARE @DateFrom DATETIME = '2016-06-01 06:00'
DECLARE @DateTo DATETIME = '2016-07-01 06:00'
DECLARE @IntervalDays INT = 7

-- Transition Sequence = Rest & Relax into Day Shift into Night Shift
-- RR (Rest & Relax) = 1
-- DS (Day Shift) = 2
-- NS (Night Shift) = 3

WITH roster AS

(SELECT @DateFrom AS RosterStart, 1 AS TeamA, 2 AS TeamB, 3 AS TeamC
UNION ALL
SELECT DATEADD(d, @IntervalDays, RosterStart),
    CASE TeamA WHEN 1 THEN 2 WHEN 2 THEN 3 WHEN 3 THEN 1 END AS TeamA,
    CASE TeamB WHEN 1 THEN 2 WHEN 2 THEN 3 WHEN 3 THEN 1 END AS TeamB,
    CASE TeamC WHEN 1 THEN 2 WHEN 2 THEN 3 WHEN 3 THEN 1 END AS TeamC
FROM roster WHERE RosterStart < DATEADD(d, -@IntervalDays, @DateTo))

SELECT RosterStart,
    ISNULL(LEAD(RosterStart) OVER (ORDER BY RosterStart), RosterStart + @IntervalDays) AS RosterEnd,
    CASE TeamA WHEN 1 THEN 'RR' WHEN 2 THEN 'DS' WHEN 3 THEN 'NS' END AS TeamA,
    CASE TeamB WHEN 1 THEN 'RR' WHEN 2 THEN 'DS' WHEN 3 THEN 'NS' END AS TeamB,
    CASE TeamC WHEN 1 THEN 'RR' WHEN 2 THEN 'DS' WHEN 3 THEN 'NS' END AS TeamC
FROM roster

Result

I.e. For Week 1 TeamA is on R&R, TeamB is on Day Shift and TeamC is on Night Shift.

<table>
<thead>
<tr>
<th>RosterStart</th>
<th>RosterEnd</th>
<th>TeamA</th>
<th>TeamB</th>
<th>TeamC</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016-06-01 06:00:00.000</td>
<td>2016-06-08 06:00:00.000</td>
<td>RR</td>
<td>DS</td>
<td>NS</td>
</tr>
<tr>
<td>2016-06-09 06:00:00.000</td>
<td>2016-06-15 06:00:00.000</td>
<td>DS</td>
<td>NS</td>
<td>RR</td>
</tr>
<tr>
<td>2016-06-15 06:00:00.000</td>
<td>2016-06-22 06:00:00.000</td>
<td>NS</td>
<td>RR</td>
<td>DS</td>
</tr>
<tr>
<td>2016-06-22 06:00:00.000</td>
<td>2016-06-29 06:00:00.000</td>
<td>RR</td>
<td>DS</td>
<td>NS</td>
</tr>
<tr>
<td>2016-06-29 06:00:00.000</td>
<td>2016-07-06 06:00:00.000</td>
<td>DS</td>
<td>NS</td>
<td>RR</td>
</tr>
</tbody>
</table>

Section 46.6: Oracle CONNECT BY functionality with recursive CTEs

Oracle's CONNECT BY functionality provides many useful and nontrivial features that are not built-in when using SQL standard recursive CTEs. This example replicates these features (with a few additions for sake of completeness), using SQL Server syntax. It is most useful for Oracle developers finding many features missing in their hierarchical queries on other databases, but it also serves to showcase what can be done with a hierarchical query in general.

WITH tbl AS

(SELECT id, name, parent_id
FROM mytable)
, tbl_hierarch AS

/* Anchor */

SELECT 1 AS "LEVEL"
CONNECT BY features demonstrated above, with explanations:

- **Clauses**
  - CONNECT BY: Specifies the relationship that defines the hierarchy.
  - START WITH: Specifies the root nodes.
  - ORDER SIBLINGS BY: Orders results properly.

- **Parameters**
  - NOCYCLE: Stops processing a branch when a loop is detected. Valid hierarchies are Directed Acyclic Graphs, and circular references violate this construct.

- **Operators**
  - PRIOR: Obtains data from the node's parent.
  - CONNECT_BY_ROOT: Obtains data from the node's root.

- **Pseudocolumns**
  - LEVEL: Indicates the node's distance from its root.
  - CONNECT_BY_ISLEAF: Indicates a node without children.
  - CONNECT_BY_ISCYCLE: Indicates a node with a circular reference.

- **Functions**
  - SYS_CONNECT_BY_PATH: Returns a flattened/concatenated representation of the path to the node from its root.
Chapter 47: Views

Section 47.1: Simple views

A view can filter some rows from the base table or project only some columns from it:

```
CREATE VIEW new_employees_details AS
SELECT E.id, Fname, Salary, Hire_date
FROM Employees E
WHERE hire_date > date '2015-01-01';
```

If you select form the view:

```
select * from new_employees_details
```

<table>
<thead>
<tr>
<th>Id</th>
<th>FName</th>
<th>Salary</th>
<th>Hire_date</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Johnathon</td>
<td>500</td>
<td>24-07-2016</td>
</tr>
</tbody>
</table>

Section 47.2: Complex views

A view can be a really complex query (aggregations, joins, subqueries, etc). Just be sure you add column names for everything you select:

```
CREATE VIEW dept_income AS
SELECT d.Name as DepartmentName, sum(e.salary) as TotalSalary
FROM Employees e
JOIN Departments d on e.DepartmentId = d.id
GROUP BY d.Name;
```

Now you can select from it as from any table:

```
SELECT *
FROM dept_income;
```

<table>
<thead>
<tr>
<th>DepartmentName</th>
<th>TotalSalary</th>
</tr>
</thead>
<tbody>
<tr>
<td>HR</td>
<td>1900</td>
</tr>
<tr>
<td>Sales</td>
<td>600</td>
</tr>
</tbody>
</table>
Chapter 48: Materialized Views

A materialized view is a view whose results are physically stored and must be periodically refreshed in order to remain current. They are therefore useful for storing the results of complex, long-running queries when realtime results are not required. Materialized views can be created in Oracle and PostgreSQL. Other database systems offer similar functionality, such as SQL Server's indexed views or DB2's materialized query tables.

Section 48.1: PostgreSQL example

```sql
CREATE TABLE mytable (number INT);
INSERT INTO mytable VALUES (1);

CREATE MATERIALIZED VIEW myview AS SELECT * FROM mytable;

SELECT * FROM myview;

<table>
<thead>
<tr>
<th>number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>(1 row)</td>
</tr>
</tbody>
</table>

INSERT INTO mytable VALUES(2);

SELECT * FROM myview;

<table>
<thead>
<tr>
<th>number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>(1 row)</td>
</tr>
</tbody>
</table>

REFRESH MATERIALIZED VIEW myview;

SELECT * FROM myview;

<table>
<thead>
<tr>
<th>number</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>(2 rows)</td>
</tr>
</tbody>
</table>
```
Chapter 49: Comments

Section 49.1: Single-line comments

Single line comments are preceded by `--`, and go until the end of the line:

```
SELECT *
FROM Employees -- this is a comment
WHERE FName = 'John'
```

Section 49.2: Multi-line comments

Multi-line code comments are wrapped in `/* ... */`:

```
/* This query
   returns all employees */
SELECT *
FROM Employees
```

It is also possible to insert such a comment into the middle of a line:

```
SELECT /* all columns: */ *
FROM Employees
```
Chapter 50: Foreign Keys

Section 50.1: Foreign Keys explained

Foreign Keys constraints ensure data integrity, by enforcing that values in one table must match values in another table.

An example of where a foreign key is required is: In a university, a course must belong to a department. Code for the this scenario is:

```sql
CREATE TABLE Department ( 
  Dept_Code CHAR(5) PRIMARY KEY, 
  Dept_Name VARCHAR(20) UNIQUE 
);
```

Insert values with the following statement:

```sql
INSERT INTO Department VALUES ('CS205', 'Computer Science');
```

The following table will contain the information of the subjects offered by the Computer science branch:

```sql
CREATE TABLE Programming_Courses ( 
  Dept_Code CHAR(5), 
  Prg_Code CHAR(9) PRIMARY KEY, 
  Prg_Name VARCHAR(50) UNIQUE, 
  FOREIGN KEY (Dept_Code) REFERENCES Department(Dept_Code) 
);
```

(The data type of the Foreign Key must match the datatype of the referenced key.)

The Foreign Key constraint on the column Dept_Code allows values only if they already exist in the referenced table, Department. This means that if you try to insert the following values:

```sql
INSERT INTO Programming_Courses Values ('CS300', 'FDB-DB001', 'Database Systems');
```

the database will raise a Foreign Key violation error, because CS300 does not exist in the Department table. But when you try a key value that exists:

```sql
INSERT INTO Programming_Courses VALUES ('CS205', 'FDB-DB001', 'Database Systems');
INSERT INTO Programming_Courses VALUES ('CS205', 'DB2-DB002', 'Database Systems II');
```

then the database allows these values.

**A few tips for using Foreign Keys**

- A Foreign Key must reference a UNIQUE (or PRIMARY) key in the parent table.
- Entering a NULL value in a Foreign Key column does not raise an error.
- Foreign Key constraints can reference tables within the same database.
- Foreign Key constraints can refer to another column in the same table (self-reference).

Section 50.2: Creating a table with a foreign key

In this example we have an existing table, SuperHeros.
This table contains a primary key ID.

We will add a new table in order to store the powers of each super hero:

```sql
CREATE TABLE HeroPowers
(
    ID int NOT NULL PRIMARY KEY,
    Name nvarchar(MAX) NOT NULL,
    HeroId int REFERENCES SuperHeros(ID)
)
```

The column HeroId is a foreign key to the table SuperHeros.
Chapter 51: Sequence

Section 51.1: Create Sequence

```
CREATE SEQUENCE orders_seq
START WITH 1000
INCREMENT BY 1;
```

Creates a sequence with a starting value of 1000 which is incremented by 1.

Section 51.2: Using Sequences

A reference to `seq_name`.NEXTVAL is used to get the next value in a sequence. A single statement can only generate a single sequence value. If there are multiple references to NEXTVAL in a statement, they will use the same generated number.

NEXTVAL can be used for INSERTS

```
INSERT INTO Orders (Order_UID, Customer) 
VALUES (orders_seq.NEXTVAL, 1032);
```

It can be used for UPDATES

```
UPDATE Orders
SET Order_UID = orders_seq.NEXTVAL
WHERE Customer = 581;
```

It can also be used for SELECTS

```
SELECT Order_seq.NEXTVAL FROM dual;
```
Chapter 52: Subqueries

Section 52.1: Subquery in FROM clause

A subquery in a `FROM` clause acts similarly to a temporary table that is generated during the execution of a query and lost afterwards.

```
SELECT Managers.Id, Employees.Salary
FROM ( 
    SELECT Id
    FROM Employees
    WHERE ManagerId IS NULL
) AS Managers
JOIN Employees ON Managers.Id = Employees.Id
```

Section 52.2: Subquery in SELECT clause

```
SELECT Id,
    FName,
    LName,
    (SELECT COUNT(*) FROM Cars WHERE Cars.CustomerId = Customers.Id) AS NumberOfCars
FROM Customers
```

Section 52.3: Subquery in WHERE clause

Use a subquery to filter the result set. For example this will return all employees with a salary equal to the highest paid employee.

```
SELECT *
FROM Employees
WHERE Salary = (SELECT MAX(Salary) FROM Employees)
```

Section 52.4: Correlated Subqueries

Correlated (also known as Synchronized or Coordinated) Subqueries are nested queries that make references to the current row of their outer query:

```
SELECT EmployeeId
FROM Employee AS eOuter
WHERE Salary > ( 
    SELECT AVG(Salary)
    FROM Employee eInner
    WHERE eInner.DepartmentId = eOuter.DepartmentId
)
```

Subquery `SELECT AVG(Salary) ... is correlated` because it refers to Employee row eOuter from its outer query.

Section 52.5: Filter query results using query on different table

This query selects all employees not on the Supervisors table.

```
SELECT *
```
The same results can be achieved using a LEFT JOIN.

```
SELECT *
FROM Employees AS e
LEFT JOIN Supervisors AS s ON s.EmployeeID=e.EmployeeID
WHERE s.EmployeeID is NULL
```

Section 52.6: Subqueries in FROM clause

You can use subqueries to define a temporary table and use it in the FROM clause of an "outer" query.

```
SELECT * FROM (SELECT city, temp_hi - temp_lo AS temp_var FROM weather) AS w
WHERE temp_var > 20;
```

The above finds cities from the weather table whose daily temperature variation is greater than 20. The result is:

<table>
<thead>
<tr>
<th>city</th>
<th>temp_var</th>
</tr>
</thead>
<tbody>
<tr>
<td>ST LOUIS</td>
<td>21</td>
</tr>
<tr>
<td>LOS ANGELES</td>
<td>31</td>
</tr>
<tr>
<td>LOS ANGELES</td>
<td>23</td>
</tr>
<tr>
<td>LOS ANGELES</td>
<td>31</td>
</tr>
<tr>
<td>LOS ANGELES</td>
<td>27</td>
</tr>
<tr>
<td>LOS ANGELES</td>
<td>28</td>
</tr>
<tr>
<td>LOS ANGELES</td>
<td>28</td>
</tr>
<tr>
<td>LOS ANGELES</td>
<td>32</td>
</tr>
</tbody>
</table>

Section 52.7: Subqueries in WHERE clause

The following example finds cities (from the cities example) whose population is below the average temperature (obtained via a sub-query):

```
SELECT name, pop2000 FROM cities
WHERE pop2000 < (SELECT avg(pop2000) FROM cities);
```

Here: the subquery (SELECT avg(pop2000) FROM cities) is used to specify conditions in the WHERE clause. The result is:

<table>
<thead>
<tr>
<th>name</th>
<th>pop2000</th>
</tr>
</thead>
<tbody>
<tr>
<td>San Francisco</td>
<td>776733</td>
</tr>
<tr>
<td>ST LOUIS</td>
<td>348189</td>
</tr>
<tr>
<td>Kansas City</td>
<td>146866</td>
</tr>
</tbody>
</table>
Chapter 53: Execution blocks

Section 53.1: Using BEGIN ... END

```
BEGIN
  UPDATE Employees SET PhoneNumber = '5551234567' WHERE Id = 1;
  UPDATE Employees SET Salary = 650 WHERE Id = 3;
END
```
Chapter 54: Stored Procedures

Section 54.1: Create and call a stored procedure

Stored procedures can be created through a database management GUI (SQL Server example), or through a SQL statement as follows:

```sql
-- Define a name and parameters
CREATE PROCEDURE Northwind.getEmployee
    @LastName nvarchar(50),
    @FirstName nvarchar(50)
AS

-- Define the query to be run
SELECT FirstName, LastName, Department
FROM Northwind.vEmployeeDepartment
WHERE FirstName = @FirstName AND LastName = @LastName
    AND EndDate IS NULL;
```

Calling the procedure:

```sql
EXECUTE Northwind.getEmployee N'Ackerman', N'Pilar';
-- Or
EXEC Northwind.getEmployee @LastName = N'Ackerman', @FirstName = N'Pilar';
GO
-- Or
EXECUTE Northwind.getEmployee @FirstName = N'Pilar', @LastName = N'Ackerman';
GO
```
Chapter 55: Triggers

Section 55.1: CREATE TRIGGER

This example creates a trigger that inserts a record to a second table (MyAudit) after a record is inserted into the table the trigger is defined on (MyTable). Here the "inserted" table is a special table used by Microsoft SQL Server to store affected rows during INSERT and UPDATE statements; there is also a special "deleted" table that performs the same function for DELETE statements.

```sql
CREATE TRIGGER MyTrigger
ON MyTable
AFTER INSERT
AS
BEGIN
-- insert audit record to MyAudit table
INSERT INTO MyAudit(MyTableId, User)
(SELECT MyTableId, CURRENT_USER FROM inserted)
END
```

Section 55.2: Use Trigger to manage a "Recycle Bin" for deleted items

```sql
CREATE TRIGGER BooksDeleteTrigger
ON MyBooksDB.Books
AFTER DELETE
AS
INSERT INTO BooksRecycleBin
SELECT *
FROM deleted;
GO
```
Chapter 56: Transactions

Section 56.1: Simple Transaction

BEGIN TRANSACTION
  INSERT INTO DeletedEmployees(EmployeeID, DateDeleted, User)
  (SELECT 123, GetDate(), CURRENT_USER);
  DELETE FROM Employees WHERE EmployeeID = 123;
COMMIT TRANSACTION

Section 56.2: Rollback Transaction

When something fails in your transaction code and you want to undo it, you can rollback your transaction:

BEGIN TRY
  BEGIN TRANSACTION
  INSERT INTO Users(ID, Name, Age)
  VALUES(1, 'Bob', 24)

  DELETE FROM Users WHERE Name = 'Todd'
  COMMIT TRANSACTION
END TRY
BEGIN CATCH
  ROLLBACK TRANSACTION
END CATCH
Chapter 57: Table Design

Section 57.1: Properties of a well designed table

A true relational database must go beyond throwing data into a few tables and writing some SQL statements to pull that data out. At best a badly designed table structure will slow the execution of queries and could make it impossible for the database to function as intended.

A database table should not be considered as just another table; it has to follow a set of rules to be considered truly relational. Academically it is referred to as a 'relation' to make the distinction.

The five rules of a relational table are:

1. Each value is atomic; the value in each field in each row must be a single value.
2. Each field contains values that are of the same data type.
3. Each field heading has a unique name.
4. Each row in the table must have at least one value that makes it unique amongst the other records in the table.
5. The order of the rows and columns has no significance.

A table conforming to the five rules:

<table>
<thead>
<tr>
<th>Id</th>
<th>Name</th>
<th>DOB</th>
<th>Manager</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fred</td>
<td>11/02/1971</td>
<td>3</td>
</tr>
<tr>
<td>2</td>
<td>Fred</td>
<td>11/02/1971</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Sue</td>
<td>08/07/1975</td>
<td>2, 1</td>
</tr>
</tbody>
</table>

- Rule 1: Each value is atomic. Id, Name, DOB and Manager only contain a single value.
- Rule 2: Id contains only integers, Name contains text (we could add that it's text of four characters or less), DOB contains dates of a valid type and Manager contains integers (we could add that corresponds to a Primary Key field in a managers table).
- Rule 3: Id, Name, DOB and Manager are unique heading names within the table.
- Rule 4: The inclusion of the Id field ensures that each record is distinct from any other record within the table.

A badly designed table:

<table>
<thead>
<tr>
<th>Id</th>
<th>Name</th>
<th>DOB</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Fred</td>
<td>11/02/1971</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>Fred</td>
<td>11/02/1971</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Sue</td>
<td>Friday the 18th July 1975</td>
<td>2, 1</td>
</tr>
</tbody>
</table>

- Rule 1: The second name field contains two values - 2 and 1.
- Rule 2: The DOB field contains dates and text.
- Rule 3: There's two fields called 'name'.
- Rule 4: The first and second record are exactly the same.
- Rule 5: This rule isn't broken.
Chapter 58: Synonyms

Section 58.1: Create Synonym

CREATE SYNONYM EmployeeData
FOR MyDatabase.dbo.Employees
Chapter 59: Information Schema

Section 59.1: Basic Information Schema Search

One of the most useful queries for end users of large RDBMS's is a search of an information schema.

Such a query allows users to rapidly find database tables containing columns of interest, such as when attempting to relate data from 2 tables indirectly through a third table, without existing knowledge of which tables may contain keys or other useful columns in common with the target tables.

Using T-SQL for this example, a database's information schema may be searched as follows:

```
SELECT *
FROM INFORMATION_SCHEMA.COLUMNS
WHERE COLUMN_NAME LIKE '%Institution%'
```

The result contains a list of matching columns, their tables' names, and other useful information.
Chapter 60: Order of Execution

Section 60.1: Logical Order of Query Processing in SQL

The order in which a query is processed and description of each section.

VT stands for 'Virtual Table' and shows how various data is produced as the query is processed.

1. FROM: A Cartesian product (cross join) is performed between the first two tables in the FROM clause, and as a result, virtual table VT1 is generated.

2. ON: The ON filter is applied to VT1. Only rows for which the IS TRUE are inserted to VT2.

3. OUTER (join): If an OUTER JOIN is specified (as opposed to a CROSS JOIN or an INNER JOIN), rows from the preserved table or tables for which a match was not found are added to the rows from VT2 as outer rows, generating VT3. If more than two tables appear in the FROM clause, steps 1 through 3 are applied repeatedly between the result of the last join and the next table in the FROM clause until all tables are processed.

4. WHERE: The WHERE filter is applied to VT3. Only rows for which the IS TRUE are inserted to VT4.

5. GROUP BY: The rows from VT4 are arranged in groups based on the column list specified in the GROUP BY clause. VT5 is generated.

6. CUBE | ROLLUP: Supergroups (groups of groups) are added to the rows from VT5, generating VT6.

7. HAVING: The HAVING filter is applied to VT6. Only groups for which the IS TRUE are inserted to VT7.

8. SELECT: The SELECT list is processed, generating VT8.

9. DISTINCT: Duplicate rows are removed from VT8. VT9 is generated.

10. ORDER BY: The rows from VT9 are sorted according to the column list specified in the ORDER BY clause. A cursor is generated (VC10).

11. TOP: The specified number or percentage of rows is selected from the beginning of VC10. Table VT11 is generated and returned to the caller. LIMIT has the same functionality as TOP in some SQL dialects such as Postgres and Nettezza.
Chapter 61: Clean Code in SQL

How to write good, readable SQL queries, and example of good practices.

Section 61.1: Formatting and Spelling of Keywords and Names

Table/Column Names

Two common ways of formatting table/column names are CamelCase and snake_case:

```
SELECT FirstName, LastName
FROM Employees
WHERE Salary > 500;

SELECT first_name, last_name
FROM employees
WHERE salary > 500;
```

Names should describe what is stored in their object. This implies that column names usually should be singular. Whether table names should use singular or plural is a heavily discussed question, but in practice, it is more common to use plural table names.

Adding prefixes or suffixes like tbl or col reduces readability, so avoid them. However, they are sometimes used to avoid conflicts with SQL keywords, and often used with triggers and indexes (whose names are usually not mentioned in queries).

Keywords

SQL keywords are not case sensitive. However, it is common practice to write them in upper case.

Section 61.2: Indenting

There is no widely accepted standard. What everyone agrees on is that squeezing everything into a single line is bad:

```
SELECT d.Name, COUNT(*) AS Employees FROM Departments AS d JOIN Employees AS e ON d.ID = e.DepartmentID WHERE d.Name != 'HR' HAVING COUNT(*) > 10 ORDER BY COUNT(*) DESC;
```

At the minimum, put every clause into a new line, and split lines if they would become too long otherwise:

```
SELECT d.Name,
    COUNT(*) AS Employees
FROM Departments AS d
JOIN Employees AS e ON d.ID = e.DepartmentID
WHERE d.Name != 'HR'
HAVING COUNT(*) > 10
ORDER BY COUNT(*) DESC;
```

Sometimes, everything after the SQL keyword introducing a clause is indented to the same column:

```
SELECT d.Name,
    COUNT(*) AS Employees
FROM Departments AS d
JOIN Employees AS e ON d.ID = e.DepartmentID
WHERE d.Name != 'HR'
HAVING COUNT(*) > 10
```
ORDER BY COUNT(*) DESC;

(This can also be done while aligning the SQL keywords right.)

Another common style is to put important keywords on their own lines:

```sql
SELECT d.Name, COUNT(*) AS Employees
FROM Departments AS d
JOIN Employees AS e
ON d.ID = e.DepartmentID
WHERE d.Name != 'HR'
HAVING COUNT(*) > 10
ORDER BY COUNT(*) DESC;
```

Vertically aligning multiple similar expressions improves readability:

```sql
SELECT Model,
EmployeeID
FROM Cars
WHERE CustomerID = 42
AND Status = 'READY';
```

Using multiple lines makes it harder to embed SQL commands into other programming languages. However, many languages have a mechanism for multi-line strings, e.g., `@...` in C#, ```...``` in Python, or `R(...)"` in C++.

**Section 61.3: SELECT ***

SELECT * returns all columns in the same order as they are defined in the table.

When using SELECT *, the data returned by a query can change whenever the table definition changes. This increases the risk that different versions of your application or your database are incompatible with each other.

Furthermore, reading more columns than necessary can increase the amount of disk and network I/O.

So you should always explicitly specify the column(s) you actually want to retrieve:

```sql
--SELECT *                                 don't
SELECT ID, FName, LName, PhoneNumber -- do
FROM Employees;
```

(When doing interactive queries, these considerations do not apply.)

However, SELECT * does not hurt in the subquery of an EXISTS operator, because EXISTS ignores the actual data anyway (it checks only if at least one row has been found). For the same reason, it is not meaningful to list any specific column(s) for EXISTS, so SELECT * actually makes more sense:

```
-- list departments where nobody was hired recently
SELECT ID, Name
FROM Departments
```
WHERE NOT EXISTS (SELECT * 
    FROM Employees 
    WHERE DepartmentID = Departments.ID 
    AND HireDate >= '2015-01-01');

Section 61.4: Joins

Explicit joins should always be used; implicit joins have several problems:

- The join condition is somewhere in the WHERE clause, mixed up with any other filter conditions. This makes it harder to see which tables are joined, and how.
- Due to the above, there is a higher risk of mistakes, and it is more likely that they are found later.
- In standard SQL, explicit joins are the only way to use outer joins:

```sql
SELECT d.Name, 
       e.Fname || e.LName AS EmpName 
FROM Departments AS d 
LEFT JOIN Employees AS e ON d.ID = e.DepartmentID;
```

- Explicit joins allow using the USING clause:

```sql
SELECT RecipeID, 
       Recipes.Name, 
       COUNT(*) AS NumberOfIngredients 
FROM Recipes 
LEFT JOIN Ingredients USING (RecipeID);
```

(This requires that both tables use the same column name. USING automatically removes the duplicate column from the result, e.g., the join in this query returns a single RecipeID column.)
Chapter 62: SQL Injection

SQL injection is an attempt to access a website's database tables by injecting SQL into a form field. If a web server does not protect against SQL injection attacks, a hacker can trick the database into running the additional SQL code. By executing their own SQL code, hackers can upgrade their account access, view someone else's private information, or make any other modifications to the database.

Section 62.1: SQL injection sample

Assuming the call to your web application's login handler looks like this:

https://somepage.com/ajax/login.ashx?username=admin&password=123

Now in login.ashx, you read these values:

strUserName = getHttpsRequestParameterString("username");
strPassword = getHttpsRequestParameterString("password");

and query your database to determine whether a user with that password exists.

So you construct an SQL query string:

```
txtSQL = "SELECT * FROM Users WHERE username = " + strUserName + " AND password = " + strPassword + ";
```

This will work if the username and password do not contain a quote.

However, if one of the parameters does contain a quote, the SQL that gets sent to the database will look like this:

```
-- strUserName = "d'Alambert";
txtSQL = "SELECT * FROM Users WHERE username = 'd'Alambert' AND password = '123'";
```

This will result in a syntax error, because the quote after the d in d'Alambert ends the SQL string.

You could correct this by escaping quotes in username and password, e.g.:

```
strUserName = strUserName.Replace("'", "'");
strPassword = strPassword.Replace("'", "'");
```

However, it's more appropriate to use parameters:

```
cmd.CommandText = "SELECT * FROM Users WHERE username = @username AND password = @password";
```

```
cmd.Parameters.Add("@username", strUserName);
cmd.Parameters.Add("@password", strPassword);
```

If you do not use parameters, and forget to replace quote in even one of the values, then a malicious user (aka hacker) can use this to execute SQL commands on your database.

For example, if an attacker is evil, he/she will set the password to

```
'lol'; DROP DATABASE master; --
```

and then the SQL will look like this:
Unfortunately for you, this is valid SQL, and the DB will execute this!

This type of exploit is called an SQL injection.

There are many other things a malicious user could do, such as stealing every user's email address, steal everyone's password, steal credit card numbers, steal any amount of data in your database, etc.

This is why you always need to escape your strings.
And the fact that you'll invariably forget to do so sooner or later is exactly why you should use parameters. Because if you use parameters, then your programming language framework will do any necessary escaping for you.

**Section 62.2: simple injection sample**

If the SQL statement is constructed like this:

```sql
SELECT * FROM Users WHERE username = 'somebody' AND password = 'lol'; DROP DATABASE master; --'
```

Then a hacker could retrieve your data by giving a password like `pw' or '1'=1`; the resulting SQL statement will be:

```sql
SELECT * FROM Users WHERE username = 'somebody' AND password = 'pw' or '1'=1
```

This one will pass the password check for all rows in the `Users` table because `'1'=1` is always true.

To prevent this, use SQL parameters:

```sql
SQL = "SELECT * FROM Users WHERE username = ? AND password = ?;
```

```javascript
db.execute(SQL, [user, pw]);
```
Credits

Thank you greatly to all the people from Stack Overflow Documentation who helped provide this content, more changes can be sent to web@petercv.com for new content to be published or updated.

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