

SQL server 2012 – Database Development

Lesson 00:



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Document History

| | | | | |
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| 12 June 2008 | 1.0 | SQL server 2005 | Kishori Khadilkar Vaishali Kunchur | Newly Created |
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| 5 May 2016 | 2.4 | SQL Server 2012 | Shital Patil | Changes in material made base on integration process as per Capgemini Course Structure |



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Course Goals and Non Goals

■ Course Goals

- Understanding database concepts
- How to use T-SQL statements for implementing database concepts
- Writing Stored procedures



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Course Goals and Non Goals

- Course Non Goals

- Database administration will not be covered
- Different services Like SSIS,SSRS,SSAS will not be covered



Intended Audience

- Developers.



Day Wise Schedule

- Day 1

Lesson 1: Introduction to RDBMS
Lesson 2: Introduction to SQL Server 2012
Lesson3: Working with Data Types, DDL ,DML and DCL statements

- Day 2

Lesson3: Working with Data Types, DDL ,DML and DCL statements
Lesson 4: Beginning with Transact-SQL

- Day 3

Lesson 4: Beginning with Transact-SQL
Lesson 5: Working with Joins and Subqueries

- Day 4

Lesson 6: Database Objects: Indexes & Views
Lesson 7: Procedures



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Next Step Courses

- SQL server 2012 services like SSIS,SSRS,SSAS
- Database Administration using SQL server 2012



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Other Parallel Technology Areas

- Oracle
- MySQL



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SQL Server 2012 – Database Development

Lesson 1: Introduction to
RDBMS

Lesson Objectives

- In this lesson, you will learn:
 - What Is Database and DBMS?
 - Data Models
 - Properties of RDBMS



What is Data?

- Data (plural of the word datum) is a factual information used as a basis for reasoning, discussion, or calculation
- Data may be numerical data which may be integers or floating point numbers, and non-numerical data such as characters, date etc.
- Data by itself normally doesn't have a meaning associated with it.
 - e.g.: - Krishnan ,01-jan-71,15-jun-05,50000



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Information – Related Data

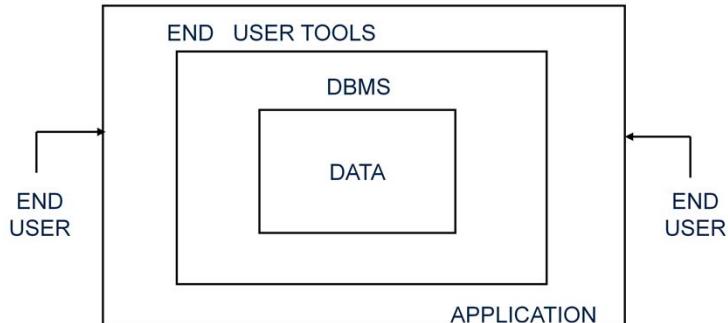
- Related data is called as information.
- Information will always have a meaning and context attached to the data element.
- When we add meaning and context to the data it becomes information.
 - Employee name: Krishnan
 - Date of birth: 01-jan-71
 - Date of joining: 15-jun-05
 - Salary: 50000
 - Department number: 10



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Introduction to Database

- DATABASE - A set of inter-related data
- DBMS - A software that manages the data
- SCHEMA - A set of structures and relationships, which meet a specific need

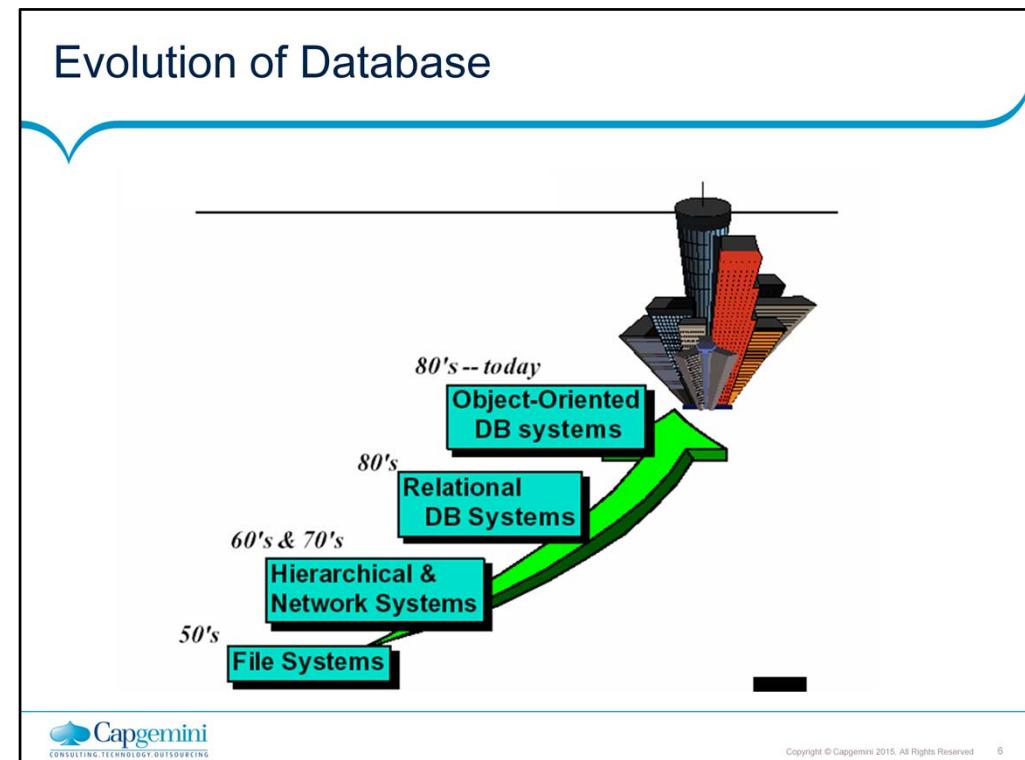


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Introduction

A set of inter-related data is known as database and the software that manages it is known as database management system or DBMS. Hence DBMS can be described as "a computer-based record keeping system which consists of software for processing a collection of interrelated data". A set of structures and relationships that meet a specific need is called as a schema.

The database is centrally managed by a person known as the database administrator or the DBA. The DBA initially studies the System and accordingly decides the types of data to be used, then the structures to be used to hold the data and the interrelationships between the data structures. He then defines data to the DBMS. The DBA also ensures the security of the database. The DBA usually controls access to the data through the user codes and passwords and by restricting the views or operations that the users can perform on the database.



Database Management System

- A database is a collection of logically related information.
- Database Management is the task of maintaining databases so that information is readily and accurately available.
- The software required to perform the task of database management is called a Database Management System (DBMS).



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Introduction to Database

- Control of Data Redundancy
 - Same data is stored at number of places
 - DBMS helps in removing redundancies by providing means of integration.
- Sharing of Data
 - DBMS allow many applications to share the data.
- Maintenance of Integrity
 - Refers to the correctness, consistency and interrelationship of data with respect to the application, which uses the data.



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Characteristics of DBMS

Some of the characteristics of the DBMS have been discussed below:

Control of Data Redundancy

When the same data is stored in a number of files it brings in data redundancy. In such cases, if the data is changed at one place, the change has to be duplicated in each of the files.

The main disadvantages of data redundancy are:

Storage space gets wasted.

Processing time may be wasted as more data is to be handled.

Inconsistencies may creep in.

DBMS help in removing redundancies by providing means of integration.

Sharing of Data

DBMS allow many applications to share the data.

Maintenance of Integrity

Integrity of data refers to the correctness, consistency and interrelationship of data with respect to the application that uses the data. Some of the aspects of data integrity are:

Many data items can only take a restricted set of values.

Certain field values are not to be duplicated across records. Such restrictions, called primary key constraints can be defined to the DBMS.

Data integrity, which defines the relationships between different files, is called referential integrity rule, which can also be specified to the DBMS.

Characteristics of DBMS

- Support for Transaction Control and Recovery
 - DBMS ensures that updates take place physically after a logical transaction is complete.
- Data Independence
 - In DBMS, the application programs are transparent to the physical organization and access techniques.
- Availability of Productivity Tools
 - Tools like query language, screen and report painter and other 4GL tools are available.



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Support for Transaction Control and Recovery

Multiple changes to the database can be clubbed together as a single 'logical transaction'. The DBMS will ensure that the updates take place physically only when the logical transaction is complete.

Data Independence

In conventional file based applications, programs need to know the data organization and access technique to be able to access the data. This means that if you make any change in the way the data is organized you will also have to take care to make changes to the application programs that apply to the data. In DBMS, the application programs are transparent to the physical organization and access techniques.

Availability of Productivity Tools

Tools like query language, screen and report painter and other 4GL tools are available. These tools can be utilized by the end-users to query, print reports etc. SQL is one such language, which has emerged as standard.

Characteristics of DBMS

- **Security**

- DBMS provide tools by which the DBA can ensure security of the database.

- **Hardware Independence**

- Most DBMS are available across hardware platforms and operating systems.

- **Centralized Business Logic Implementation**

- Business Logic can be stored centrally in DBMS which can be shared across multiple applications



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Security

DBMSs provide tools by which the DBA can ensure security of the database.

Hardware Independence

Most DBMSs are available across hardware platforms and operating systems. Thus the application programs need not be changed or rewritten when the hardware platform or operating system is changed or upgraded.

Definition of a Model

- An integrated collection of concepts for describing data, relationships between data, and constraints on the data used by an organization.
- A representation of ‘real world’ objects and events, and their associations.
- It attempts to represent the data requirements of the organization that you wish to model
- Modeling is an integral part of the design and development of any system.
- A correct model is essential.



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What is a model?

A model serves two primary purposes:

As a true representation of some aspects of the real world, a model enables clearer communication about those aspects.

A model serves as a blueprint to shape and construct the proposed structures in the real world.

So, what is a data model? A data model is an instrument that is useful in the following ways:

1) A model helps the users or stakeholders clearly understand the database system that is being implemented. It helps them understand the system with reference to the information requirements of an organization.

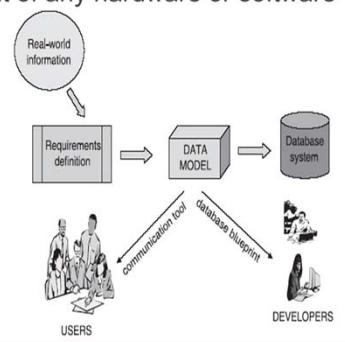
2) It enables the database practitioners to implement the database system exactly conforming to the information requirements.

A data model, therefore, serves as a critical tool for communication with the users and it also serves as a blueprint of the database system for the developers.

Without a proper data model, an adequate database system cannot be correctly designed and implemented. A good data model forms an essential prerequisite for any successful database system. Unless the data modelers represent the information requirements of the organization in a proper data model, the database design will be totally ineffective.

What is Data Modeling?

- Data modeling is a technique for exploring the data structures needed to support an organization's information need.
- It would be a conceptual representation or a replica of the data structure required in the database system.
- A data model focuses on which data is required and how the data should be organized.
- At the conceptual level, the data model is independent of any hardware or software constraints.



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What is Data Modeling?

At this level, the data model is generic; it does not vary whether you want to implement an object-relational database, a relational database, a hierarchical database, or a network database.

At the next level down, a data model is a logical model relating to the particular type of database relational, hierarchical, network, and so on. This is because in each of these types, data structures are perceived differently.

If you proceed further down, a data model is a physical model relating to the particular database management system (DBMS) you may use to implement the database.

Why Use Data Modeling?

- Leverage
 - Data model serves as a blueprint for the database system.
- Conciseness
 - Data model functions as an effective communication tool for discussions with the users.
- Data Quality
 - Data model acts as a bridge from real-world information to database storing relevant data content.



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Why Use Data Modeling?

Leverage: The key reason for giving special attention to data organization is the leverage. A small change to a data model may have a major impact on the whole system. Therefore, you can opt for modifying the data model instead of the system. For the most commercial information systems, the programs are far more complex. Also, considerable time is consumed in specifying and constructing them, as compared to the database. However, their contents and structures are heavily influenced by the database design.

Conciseness: A data model is a very powerful tool for establishing requirements and capabilities of information systems. Its valuable because of its conciseness. It implicitly defines a whole set of screens, reports, and processes needed to capture, update, retrieve, and delete the specified data. The data modeling process can tremendously facilitate our understanding of the essence of business requirements.

Data Quality: The data held in a database is usually a valuable business asset built up over a long period. Inaccurate data (poor data quality) reduces the value of the asset and can be expensive or impossible to correct. Frequently, problems with data quality can be traced back to a lack of consistency in (a) defining and interpreting data, and (b) implementing mechanisms to enforce the definitions.

Data Models

- It is a specification of how the data in a database is structured and accessed .
- Common models are
 - Flat Model
 - Hierarchical
 - Network
 - Relational



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Data Models

- Flat Model

- Data is stored in an array of two dimensions

- Hierarchical model

- Data and the relationships among them are represented in the form of a tree structure ,.

- Network model

- Data and the relationships among them are represented in the form of records and links.

- Relational model

- Data is stored in tables and the relationship among them is represented in common column called foreign key



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The Relational Model

- Relational Model – developed by Dr. E. F. Codd at IBM in the late 1960s
- He was looking for ways to solve the problems with the existing models
- Relational Model - core concept is of a table (also called a relation) in which all data is stored
- Each table is made up of
 - records (horizontal rows also known as tuples) and
 - fields (vertical columns also known as attributes)



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The Relational Model

- Because of lack of linkages relational model is easier to understand and implement.

| Student Table | |
|---------------|-------|
| Scode | Sname |
| S1 | A |
| S2 | B |

| Course Table | |
|--------------|-----------|
| Ccode | Cname |
| C1 | Physics |
| C2 | Chemistry |
| C3 | Maths |
| C4 | Biology |

| Marks Table | | |
|-------------|-------|-------|
| Ccode | Scode | Marks |
| C1 | S1 | 65 |
| C2 | S1 | 78 |
| C3 | S1 | 83 |
| C4 | S1 | 85 |
| C3 | S2 | 83 |
| C4 | S2 | 85 |

Possibilities in Relational Model

- **INSERT**

- Inserting a course record or student record poses no problems because tables are separate

- **DELETE**

- Deleting any record affects only a particular table

- **UPDATE**

- Update can be done only to a particular table



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The Relational DBMS

- Examples of Relational Tables

| DEPT table | | |
|------------|------------|----------|
| Deptno | Dname | Loc |
| 10 | Accounting | New York |
| 20 | Research | Dallas |
| 30 | Sales | Chicago |
| 40 | Operations | Boston |

↳ 'row' or 'tuple'

á
'column' or 'attribute'

EMPLOYEE table

| Empno | Empname | Job | Mgr | Deptno |
|-------|---------|-----------|------|--------|
| 7369 | Smith | Clerk | 7902 | 20 |
| 7499 | Allen | Salesman | 7839 | 30 |
| 7566 | Jones | Manager | 7839 | 20 |
| 7839 | King | President | | 10 |
| 7902 | Ford | Analyst | 7566 | 20 |



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Properties of Relational Data Structures

- Tables must satisfy the following properties to be classified as relational.
 - Entries of attributes are single valued
 - Entries of attribute are of the same kind.
 - No two rows are identical
 - The order of attributes is unimportant
 - The order of rows is unimportant
 - Every column can be uniquely identified.



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Relational tables have six properties, which must be satisfied for any table to be classified as relational. These are :

1. *Entries of attributes are single valued*

Entry in every row and column position in a table must be single valued. This means columns do not contain repeating groups

2. *Entries of attribute are of the same kind*

Entries in a column must be of same kind. A column supposed to store sal of a employee should not store comm.

3. *No two rows are identical*

Each row should be unique, this uniqueness is ensured by the values in a specific set of columns called the primary key.

4. *The order of attributes is unimportant*

There is no significance attached to order in which columns are stored in the table. A user can retrieve columns in any order.

5. *The order of rows is unimportant*

There is no significance attached to the order in which rows are stored in the table. A user can retrieve rows in any order.

6. *Every column can be uniquely identified.*

Each column is identified by its name and not its position. A column name should be unique in the table.

What is Data Integrity?

- Data integrity is the assurance that data is consistent, correct, and accessible
- Two important steps in planning tables are to identify valid values for a column and to decide how to enforce the integrity of the data in the column
- Data integrity falls into these categories
 - Entity Integrity
 - Domain Integrity
 - Referential Integrity
 - User Defined Integrity



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Types of Data Integrity

Entity Integrity

- Entity integrity ensures that no records are duplicated and that no attributes that make up the primary key are NULL
- It is one of the properties necessary to ensure the consistency of the database.

Domain Integrity

- Domain integrity is the validity of entries for a given column
- Domain integrity can be enforced by restricting the type, the format, or the range of possible values.



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Entity integrity defines a row as a unique entity for a particular table. Entity integrity enforces the integrity of the identifier column(s) or the primary key of a table (through indexes, UNIQUE constraints, PRIMARY KEY constraints, or IDENTITY properties).

Domain Integrity

You can enforce domain integrity by restricting the type (through data types), the format (through CHECK constraints and rules), or the range of possible values (through FOREIGN KEY constraints, CHECK constraints, DEFAULT definitions, NOT NULL definitions, and rules).

Types of Data Integrity

- Referential Integrity

- Referential integrity preserves the defined relationships between tables when records are entered or deleted
- The referential integrity rule : If a foreign key in table A refers to the primary key in table B, then every value of the foreign key in table A must be null or must be available in table B

- User-defined integrity:

- Refers to a set of rules specified by a user, which do not belong to the entity, domain, and referential integrity categories



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In Microsoft SQL Server, referential integrity is based on relationships between foreign keys and primary keys or between foreign keys and unique keys (through FOREIGN KEY and CHECK constraints). Referential integrity ensures that key values are consistent across tables. Such consistency requires that there be no references to nonexistent values and that if a key value changes, all references to it change consistently throughout the database.

How to implement Data Integrity?

- Data integrity is maintained by:
 - Applying Constraints
 - Applying Rules
 - Using User defined Types



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T-SQL Languages

- SQL is a special-purpose language used to define, access, and manipulate data
- SQL is nonprocedural language, it only describes the necessary components like tables and desired results without specifying exactly how those results should be computed
- SQL comes in many flavors
- Microsoft SQL Server makes use of Transact-SQL



T-SQL Sub Language

- The Data Definition Language (DDL)
- Data Manipulation Language (DML)
- Data Control Language (DCL)
- Transactional Control Language (TCL)



T-SQL Sub Language - DDL

- It is the subset of SQL which contains the commands used to create and destroy databases and database objects
- DDL includes the commands for handling tasks such as creating tables, indexes, views, and constraints
- The commands are
 - CREATE
 - ALTER
 - DROP
 - TRUNCATE



T-SQL Sub Language - DML

- It is the subset of SQL used to access and manipulate data contained within the data structures previously defined via DDL
- The Commands are:
 - INSERT
 - UPDATE
 - DELETE
 - MERGE
 - [SELECT]



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T-SQL Sub Language - DCL

- It is the subset of SQL Commands that control a database, including administering privileges and committing data
- It is used to create roles, permissions, and to control access to database.
- The Commands are
 - GRANT
 - REVOKE
 - DENY



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T-SQL Sub Language - Transactional Control Language

- It is used to manage different transactions occurring within a database.
- The commands are
 - COMMIT
 - ROLLBACK
 - SAVE TRANSACTION



Summary

- In this lesson, you have learnt:
 - A set of inter-related data is known as database and the software that manages it is known as database management system or DBMS
 - Different data models are Hierarchical Model, Network Model and Relational Model
 - Data integrity is the assurance that data is consistent, correct, and accessible



Review Question

- Question 1: A set of structures and relationships that meet a specific need is called as a _____.
- Question 2: What are the characteristics of DBMS?
- Question 3: What are the various types on Data Integrity?
- Question 4: What are the SQL Sublanguages?



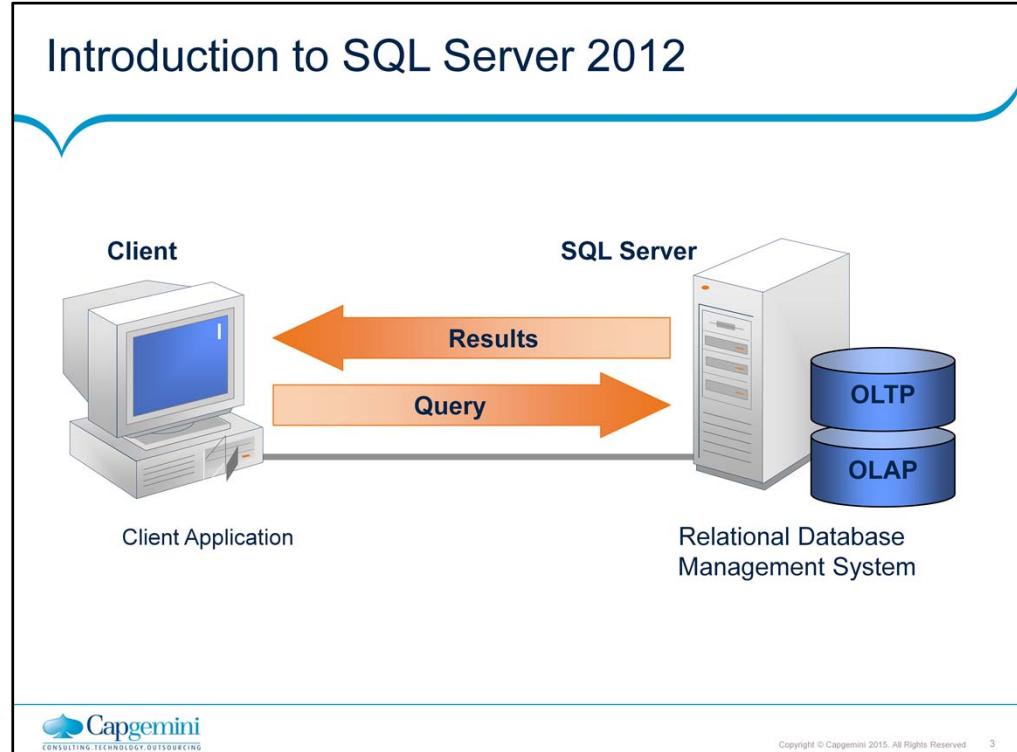
SQL Server 2012 – Database Development

Lesson 2: Introduction to SQL
Server 2012

Lesson Objectives

- In this lesson, you will learn:
 - What Is SQL Server?
 - SQL Server Components
 - SQL Server Versions, Editions and Tools
 - SQL Server Databases
 - Features of SQL Server





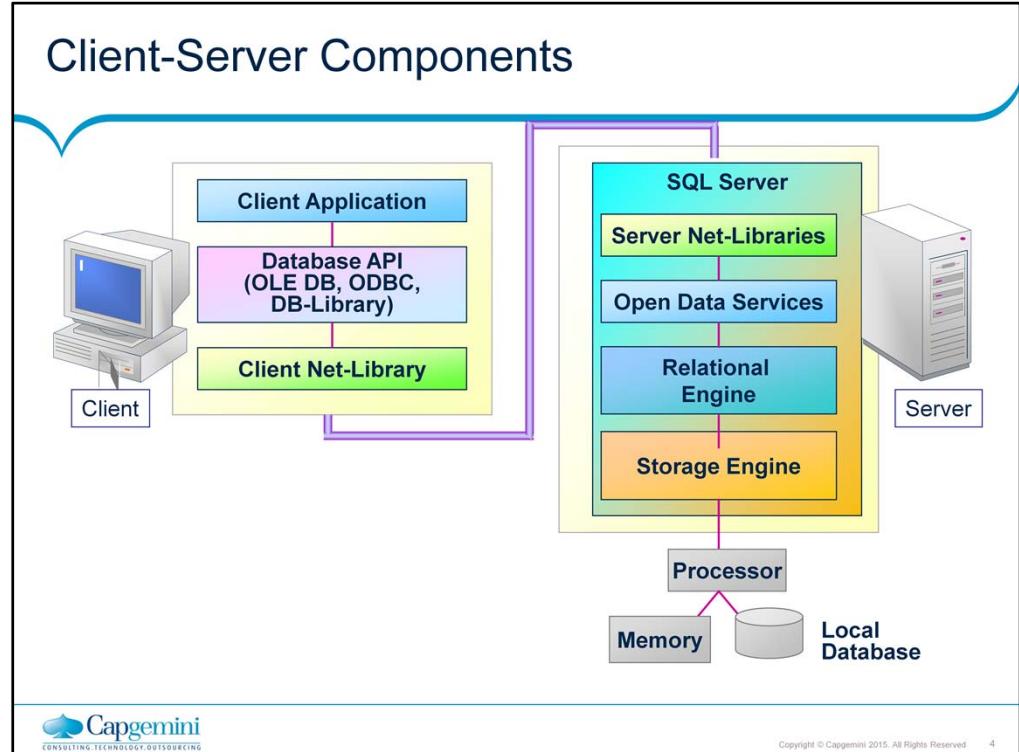
What is SQL Server 2012?

SQL Server 2012 is a database that follows the relational model of data management system.

The emphasis of relational Model is that the data is fundamentally organized in table which can also be termed as a collection of rows and columns .The relational concept maintains the relationships amongst data by adhering to the rules defined by the database administrator. In situations of power failure, which is normally termed as crash situations, the data should be free of corruption (invalid).

SQL Server 2012 is a Relational Database Management System (RDBMS) that provides:

- Maintaining Relationship among Data stored in the Database
- Ensuring Data is stored correctly and rules defining relationship are not violated.
- Recovering all data to a point of consistency , in the event of failure.



The Net-Library

The Net-Library abstraction layer enables SQL Server to read from and write to many different network protocols, and each such protocol (such as TCP/IP sockets) can have a specific driver. The Net-Library layer makes it relatively easy to support many different network protocols without having to change the core server code.

Open Data Services

Open Data Services (ODS) functions as the client manager for SQL Server; it is basically an interface between server Net-Libraries and server-based applications, including SQL Server. ODS manages the network: it listens for new connections, cleans up failed connections, acknowledges "attentions" (cancellations of commands), coordinates threading services to SQL Server, and returns result sets, messages, and status back to the client.

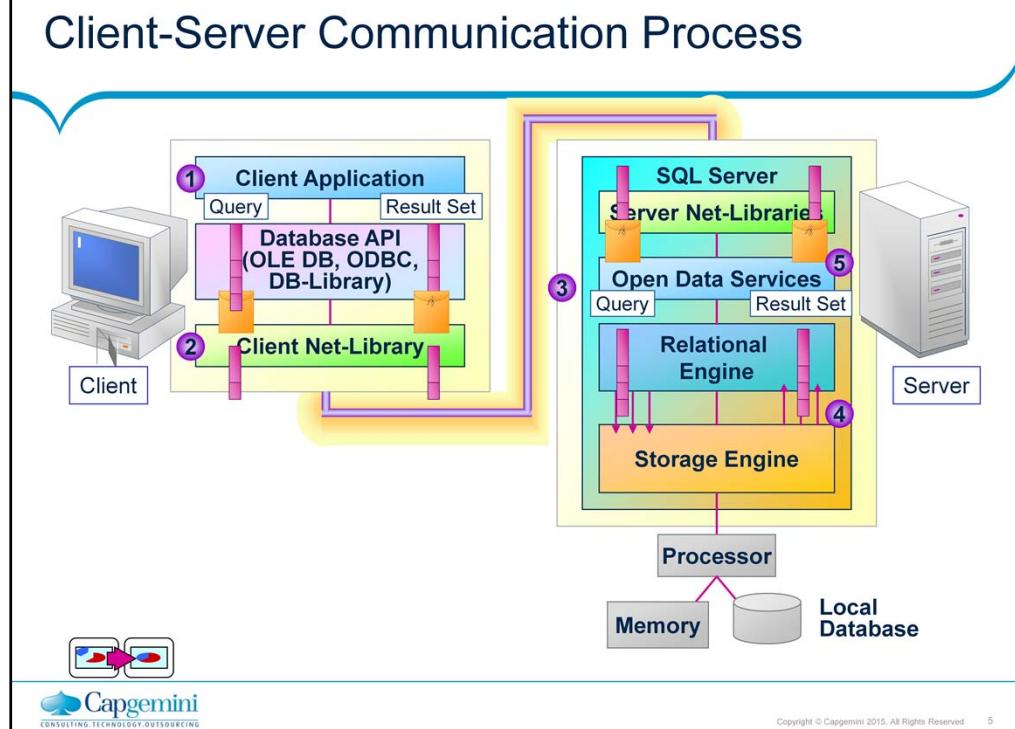


Figure shows the path from the SQL Server client application to the SQL Server engine and shows where the Net-Library interface fits in. On the server side, ODS provides functionality that mirrors that of ODBC, OLE DB, or DB-Library at the client. Calls exist for an ODS server application to describe and send result sets, to convert values between datatypes, to assume the security context associated with the specific connection being managed, and to raise errors and messages to the client application.

ODS uses an event-driven programming model. Requests from servers and clients trigger events that your server application must respond to. Using the ODS API, you create a custom routine, called an *event handler*, for each possible type of event. Essentially, the ODS library drives a server application by calling its custom event handlers in response to incoming requests.

ODS server applications respond to the following events:

Connect events When a connect event occurs, SQL Server initiates a security check to determine whether a connection is allowed. Other ODS applications, such as a gateway to DB/2, have their own logon handlers that determine whether connections are allowed. Events also exist that close a connection, allowing the proper connection cleanup to occur.

Language events When a client sends a command string, such as an SQL statement, SQL Server passes this command along to the command parser. A different ODS application, such as a gateway, would install its own handler that accepts and is responsible for execution of the command.

Remote stored procedure events These events occur each time a client or SQL Server directs a remote stored procedure request to ODS for processing.

The Relational Engine and the Storage Engine

The SQL Server database engine is made up of two main components, the relational engine and the storage engine. Unlike in earlier versions of SQL Server, these two pieces are clearly separated, and their primary method of communication with each other is through OLE DB. The relational engine comprises all the components necessary to parse and optimize any query. It requests data from the storage engine in terms of OLE DB rowsets and then processes the rowsets returned. The storage engine comprises the components needed to actually access and modify data on disk.

Communication Between the Relational Engine and the Storage Engine

The relational engine uses OLE DB for most of its communication with the storage engine. The following description of that communication is adapted from the section titled "Database Server" in the SQL Server Books Online. It describes how a SELECT statement that processes data from local tables only is processed:

The relational engine compiles the **SELECT** statement into an optimized execution plan. The execution plan defines a series of operations against simple rowsets from the individual tables or indexes referenced in the **SELECT** statement. (Rowset is the OLE DB term for a result set.) The rowsets requested by the relational engine return the amount of data needed from a table or index to perform one of the operations used to build the **SELECT** result set. For example, this **SELECT** statement requires a table scan if it references a table with no indexes:

```
SELECT * FROM ScanTable
```

The relational engine implements the table scan by requesting one rowset containing all the rows from ScanTable. This next SELECT statement needs only information available in an index:

```
SELECT DISTINCT LastName  
FROM Northwind.dbo.Employees
```

The relational engine implements the index scan by requesting one rowset containing the leaf rows from the index that was built on the LastName column.

The following SELECT statement needs information from two indexes:

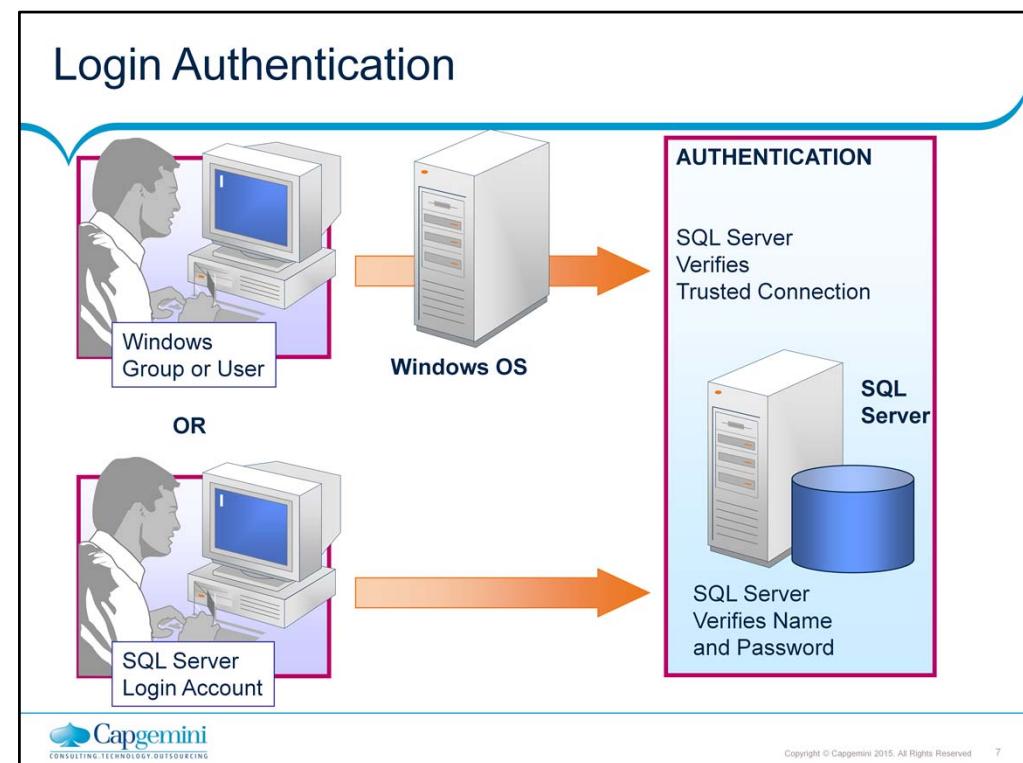
```
SELECT CompanyName, OrderID, ShippedDate  
FROM Northwind.dbo.Customers AS Cst  
JOIN Northwind.dbo.Orders AS Ord  
ON (Cst.CustomerID = Ord.CustomerID)
```

The relational engine requests two rowsets: one for the clustered index on Customers and the other for one of the nonclustered indexes on Orders.

The relational engine then uses the OLE DB API to request that the storage engine open the rowsets.

As the relational engine works through the steps of the execution plan and needs data, it uses OLE DB to fetch the individual rows from the rowsets it requested the storage engine to open. The storage engine transfers the data from the data buffers to the relational engine.

The relational engine combines the data from the storage engine rowsets into the final result set transmitted back to the user.



Authentication Modes

Microsoft® SQL Server can operate in one of two security (authentication) modes:
Windows Authentication Mode (Windows Authentication) Windows Authentication mode allows a user to connect through a Microsoft Windows OS user account.

Mixed Mode (Windows Authentication and SQL Server Authentication) Mixed Mode allows users to connect to an instance of SQL Server using either Windows Authentication or SQL Server Authentication. Users who connect through a Windows user account can make use of trusted connections in either Windows Authentication Mode or Mixed Mode.

SQL Server Versions

| | |
|-----------------------|---|
| SQL Server 1.0 (1989) | Developed by Microsoft, Sybase and Ashton-Tate for OS/2 |
| SQL Server 4.2 (1992) | Developed for Windows NT 3.1 |
| SQL Server 6.0 (1995) | First version designed specifically for Windows NT |
| SQL Server 7.0 (1999) | Total rewrite of code base resulted in performance and scalability improvements |
| SQL Server 2000 | Further improvements in performance, scalability and reliability |
| SQL Server 2005 | New and improved features: Integration Services, Analysis Services, Notification Services, Reporting Services, and XML support |
| SQL Server 2008 | Microsoft SQL Server 2008 is a powerful and reliable data management system that delivers a rich set of features, data protection, and performance for embedded application clients, light Web applications, and local data stores. Designed for easy deployment and rapid prototyping. |
| SQL Server 2012 | SQL Server Database Engine introduces new features and enhancements that increase the power and productivity of architects, developers, and administrators who design, develop, and maintain data storage systems. |



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SQL Server – Editions

Enterprise For large-scale, business-critical applications

Standard For small to medium departmental applications

Workgroup For small-scale branch applications

Web For low-cost, large-scale Web applications

Express For entry-level and learning applications

Compact For embedded databases

Developer For development and testing



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Tools & Utilities

- **SQL Server management Studio**
 - Tool for developing and managing the SQL Server database objects.
- **Business Intelligence Development Studio**
 - Tool for developing business intelligence solutions, data analysis, reports, and SQL Server 2012 Integration Services (SSIS) packages.



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Tools & Utilities

- **SQL Server Configuration manager**

- Helps the database administrators to manage the services associated with the SQL Server.
- Administrators can start, pause, resume or stop the services by using this tool.
- Used to manage the network connectivity configuration from the SQL Server client computers.



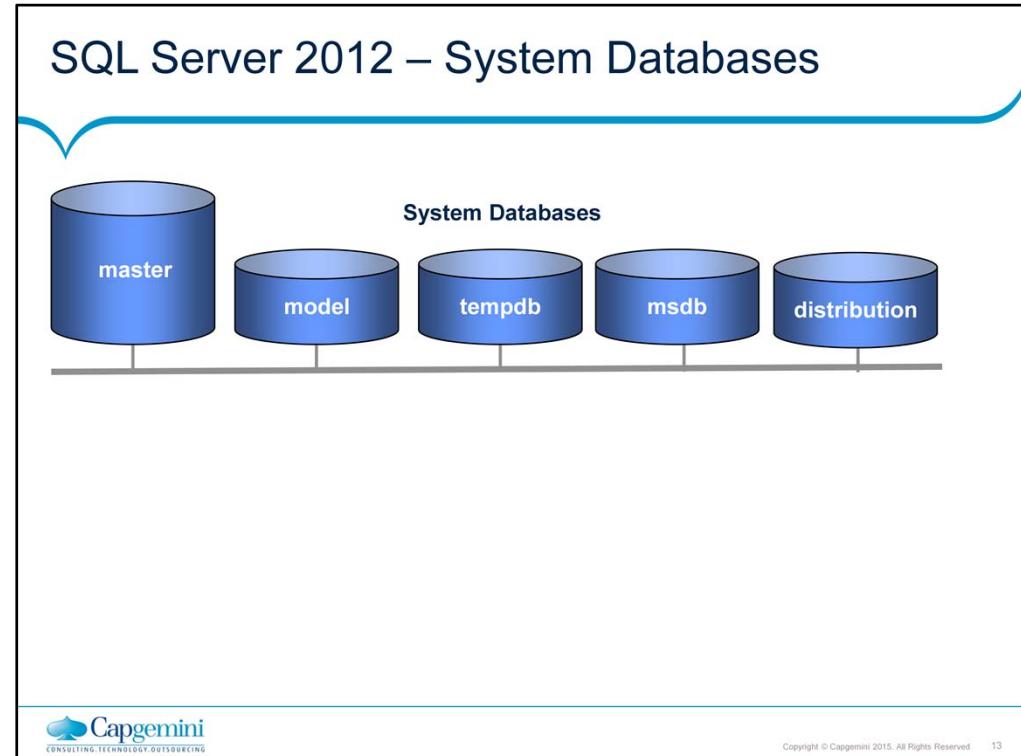
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Tools & Utilities

- Database Engine Tuning Advisor
 - GUI tool used to provide tuning recommendations.
 - Acts as a tuning advisory.
 - Tuning information is stored in the msdb database
- SQL Server Profiler
 - Graphical user interface to SQL Trace for monitoring an instance of the SQL Server Database Engine or Analysis Services.
 - Used to capture and save data about each event to a file or table to analyze later.



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Types of Databases

SQL Server databases are categorized as below :

System databases.

User-defined databases.

Figure above displays the two categories of databases.

System Databases

A system database is created to support the operation of the SQL server. When SQL Server is installed , four system databases – Master, Model, Tempdb, Msdb and two user databases are created automatically.

These databases are discussed as :

Master database

The master database is the basic database used by SQL Server in its operation. The master database controls the user databases and the operation of SQL Server as a whole. The default size of this database is 12.25 MB. This database contains pointers to all other databases stored on your system. It also includes server-wide information such as login information, system stored procedures and related services.

Since the information stored in the master database is very critical in nature, no user is allowed direct access to the master database, which is updated on a continuous basis.

Model database

The model database is the template database for user-defined databases in SQL Server. This database consists of the system tables, which should belong to every user database. The structure of the model database is copied into each new database that is created by the database administrator (DBA). Hence, whenever a new database is created its size should be at least the same as size of model database, so that the structure of the model database can be accustomed in new database.

Msdb database

The msdb database contains task scheduling, event handling, replication, alert management and system operator information (all these keywords would be discussed in detail in the later chapters).

Tempdb database

The tempdb database provides storage area from temporary tables, as also the result of sort operations, join operations, and other activities that require temporary space to execute. There is only one tempdb database regardless of the number of the databases stored on the server. No special permission is required to use this database. They are deleted when the user logs out of the SQL Server session.

There are two types of temporary tables that are supported by SQL Server as mentioned below:

Global temporary tables: These tables are available to all the users that are connected and are prefixed with double-hash signs(##), to the name of the table.

Local temporary tables: These tables are only visible to the user who have created these and are prefaced with a single hash (#) sign.

The information about the various system databases can be summarized in Table below

Table: System Databases

| Databases | Class | Size (in MB) |
|-----------|------------------|--------------|
| Master | System databases | 12.25 |
| Model | System databases | 1.5 |
| Tempdb | System databases | 8.5 |
| Msdb | System databases | |

User Databases

A user database is a database that is created by the Database Administrator or a user. User defined databases are those created as per the needs of the users of SQL Server.

An example of the sample user database is the **AdventureWorks** database.

Database Objects

- Some major database objects are as follows
 - Tables
 - Views,
 - Indexes,
 - Triggers,
 - Procedures / functions ,
 - Constraints
 - Rules
- And so on...



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A database can also be defined as a collection of interrelated data. The data is stored in the form of different objects that allow the users to store and retrieve information. These objects help in structuring different objects that allow the users to store and retrieve information. These objects help in structuring data and in defining data integrity mechanisms. The different database objects are:

| Database Object | Description |
|-----------------|--|
| Table | It is a fundamental method of storing data in the form of a collection of columns and rows (records). |
| Data Types | An identifier that specifies the nature of data that can be stored in a column. |
| Defaults | Specifies a value to be assigned by SQL Server for a column if the user does not enter any value |
| Index | A structure that helps faster access to records of a table based on the values of one or more columns. It contains data values and pointers to the records where those values occur. |
| Constraint | Is a restriction that is enforced by SQL Server to limit the values that the user can enter into a column. |
| Rule | Specifies acceptable values that can be inserted into a particular column. |
| Stored Proc | A pre-complied collection of SQL statements, which are used to perform specific tasks. |
| Trigger | A special type of stored procedure that is automatically executed by SQL Server in response to an DML statement. |
| View | A virtual table that provides an alternate way to look at data from one or more tables in a database. |

System Tables

- System Tables Store Information (Metadata) about the System and Database Objects
- Database Catalog Stores Metadata about a specific database
- System Catalog Stores Metadata about the entire system and all other databases
 - SYS.DATABASES
 - SYS.OBJECTS
 - SYS.TABLES
 - SYS.PROCEDURES
 - SYS.INDEXES



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System Catalog:

The system tables that SQL server needs to configure and manage itself are collectively grouped together and called the “System Catalog”. The **system catalog** consists primarily of the system tables contained in the master table.

Database Catalog

The system tables that are needed to define the structure of a new user database are collectively known as the “Database Catalog”. The database catalog consists primarily of system tables contained in the model database.

The various system tables in all the SQL Server system databases are discussed below as follows:

Some MASTER system Tables

Syslockinfo - Contains information on all granted, converting, and waiting lock requests.

```
SELECT * FROM Syslockinfo
```

Syscacheobjects - Contains information about how the cache is used.

```
SELECT * FROM Syscacheobjects
```

Syslogins - Contains one row for each login account.

```
SELECT * FROM Syslogins
```

Sysdatabases - Contains one row for each database on SQL server 2012.

```
SELECT * FROM Sysdatabases
```

| <u>Model System Tables</u> | |
|-----------------------------------|---|
| Name | Utility |
| Syscolumns | Contains one row for every column in every table and view, and a row for each parameter in a stored procedure. SELECT * FROM Syscolumns |
| Syscomments | Contains entries for each view, rule, default, trigger, CHECK constraint , DEFAULT constraint , and stored procedure. SELECT * FROM Syscomments |
| Sysfiles | Contains one row for each file in a database SELECT * FROM Sysfiles |
| Sysindexes | Contains one row for each index and table in the database SELECT * FROM Sysindexes |
| Sysobjects | Contains one rows for each object (Constraint, default, log, rule, stored procedure, and so on) created within a database. Syscomments and Sysobjects, combined together, give detailed information on my object in SQL Server. SELECT * FROM Sysobjects |
| Syspermissions | Contains information about permissions granted and denied to users , groups and roles in the database. SELECT * FROM Syspermissions |
| Systypes | Contains one row for each system-supplied and each user-defined data type SELECT * FROM Systypes |
| Sysusers | Contains one row for each windows user, windows group, SQL server user, or SQL Server role in the database SELECT * FROM Sysusers |

MSDB System Tables

| Name | Utility |
|------------------------|---|
| Sysalerts | Contains one row for each alert. An alert is a message sent in response to an event. USE msdb SELECT * FROM Sysalerts |
| Syscategories | Contains the categories used by SQL Server Enterprise Manager to organize jobs, alerts, and operators. USE msdb SELECT * FROM syscategories |
| Sysjobs | Stores the information for each scheduled job to be executed by the SQL Server Agent USE msdb SELECT * FROM Sysjobs |
| Sysoperators | Contains one row for each SQL Server operator. USE msdb SELECT * FROM sysoperators |
| Sysnotification | Contains one row for each notification to an operator USE msdb SELECT * FROM sysnotifications |

TEMPDB System Tables

| Name | Utility |
|--------------------------------|--|
| Local Temporary tables | These tables are only visible to the user who have created these and are prefaced with a single hash (#) sign. |
| Global Temporary tables | These tables are available to all the users that are connected and are prefaced with two-hash signs(##). |

Metadata Retrieval

- System Stored Procedures

```
EXEC sp_help Employees
```

- System and Metadata Functions

```
SELECT USER_NAME(10)
```

- Information Schema Views

```
SELECT * FROM INFORMATION_SCHEMA.TABLES
```



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System Stored Procedures

Many of your administrative activities in SQL Server are performed through a special kind of procedure known as a **system stored procedure**. System stored procedures are created and stored in the **master** database and have the **sp_** prefix. System stored procedures can be executed from any database without having to qualify the stored procedure name fully using the database name **master**.

It is strongly recommended that you do not create any stored procedures using **sp_** as a prefix. SQL Server always looks for a stored procedure beginning with **sp_** in this order:

The stored procedure in the **master** database.

The stored procedure based on any qualifiers provided (database name or owner).

The stored procedure using **dbo** as the owner, if one is not specified.

Therefore, although the user-created stored procedure prefixed with **sp_** may exist in the current database, the **master** database is always checked first, even if the stored procedure is qualified with the database name.

Important

If any user-created stored procedure has the same name as a system stored procedure, the user-created stored procedure will never be executed.

System Procedures

`sp_add_data_file_recover_suspect_db, sp_add_log_file_recover_suspect_db
sp_helpconstraint, sp_addextendedproc, sp_helpdb, sp_addextendedproperty,
sp_helpdevice, sp_helpextendedproc, sp_addrmessage, sp_helpfile, sp_addtype`

Summary

- In this lesson, you have learnt:
 - SQL Server 2012 database follows the relational model of data management system
 - SQL Server databases are categorized as:
 - System databases.
 - User-defined databases
 - SQL Server offers various Tools and Utilities to work with



Review Question

- Question 1: List the two authentication modes available in MS SQL Server.
- Question 2: List the System Databases in SQL Server.



SQL Server 2012 – Database Development

Lesson3: Working with Data
Types, DDL ,DML and DCL
statements

Lesson Objectives

- In this lesson, you will learn:
 - Working with Data Types
 - Working with SQL Server Schemas
 - Working with DDL, DML ,DCL statements
 - Implementing Data Integrity



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Lesson Objectives

Designing, creating and maintaining tables are one of the very important tasks a database developer performs while maintaining databases for any enterprise. In this particular lesson, you walk through these and other tasks related to tables. You also take a look at the Data Types available in SQL Server 2012. You will be also introduced to implementing declarative data integrity in your tables.

Introduction to Data Types in SQL Server

- SQL Server has an extensive list of data types to choose from, including some that are new to respected versions.
- In SQL Server, each column, local variable, expression and parameter has a related data type
- A data type is an element that specifies the kind of data that the item can hold
- SQL Server introduces new additions of data types that can simplify your database development code
- You can also define your own data types in SQL Server
- These User Defined Data Types (UTDs)/ Alias Data Types are based on the system-supplied data types



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Introduction to Data Types in SQL Server

SQL Server 2012 has an extensive list of data types to choose from, including some that are new to SQL Server 2012. While working with SQL server data, a developer extensively works with objects like table column, local variable, expression, parameter and so on.

At the same time before you can create a table, you must define the data types for the data that will be stored in that table. Data types specify the type of information (characters, numbers, or dates) that a column can hold, as well as how the data is stored. SQL Server 2012 supplies more than 30 specific system data types. It also supports alias data types, which are user-defined data types based on system data types.

You should take into consideration following important attributes while assigning data type to an Object.

The type of data contained by the Object

The length or size of the stored value

The precision of the number (Numeric Data Types only)

The scale of the number (Numeric Data Types only)

What are System-Supplied Data Types?

- Integers (whole number)
 - int -2^31 to 2^31-1
 - smallint -2^15 to 2^15 -1
 - bigint -2^63 to 2^63-1
 - tinyint 0 to 255
 - bit 1 or 0
- numeric (Fixed precision)
 - decimal -10^38 +1 to 10^38 -1
 - numeric Equivalent to decimal
- Approximate numeric
 - float -1.79E + 308 to 1.79E + 308
 - real -3.40E + 38 to 3.40E + 38



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Transact-SQL has these base data types :

Exact Numerics

Integers

bigint - Integer (whole number) data from -9223372036854775808 through 223372036854775807.

int - Integer (whole number) data from -2,147,483,648 through 2,147,483,647.

smallint - Integer data from 2^15 (-32,768) through 2^15 - 1 (32,767).

tinyint - Integer data from 0 through 255.

bit - Integer data with either a 1 or 0 value.

decimal and numeric

decimal - Fixed precision and scale numeric data from -10^38 +1 through 10^38 - 1.

numeric - Functionally equivalent to decimal.

Approximate Numerics

float - Floating precision number data from -1.79E + 308 through 1.79E + 308.

real - Floating precision number data from -3.40E + 38 through 3.40E + 38.

What are System-Supplied Data Types?

- Monetary (with accuracy to a ten-thousandth of a monetary unit)
 - money -2⁶³ to 2⁶³ - 1
 - smallmoney -214,748.3648 through +214,748.3647
- Date and Time
 - datetime
 - smalldatetime
- Character (s)
 - char Fixed-length non-Unicode character data
 - varchar Variable-length non-Unicode data (max length 8,000)



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money and smallmoney

money - Monetary data values from -922,337,203,685,477.5808 through +922,337,203,685,477.5807, with accuracy to a ten-thousandth of a monetary unit.
smallmoney - Monetary data values from -214,748.3648 through +214,748.3647, with accuracy to a ten-thousandth of a monetary unit.

datetime and smalldatetime

datetime - Date and time data from January 1, 1753, through December 31, 9999, with an accuracy of three-hundredths of a second, or 3.33 milliseconds.
range, a larger default fractional precision, and optional user-specified precision.
smalldatetime - Date and time data from January 1, 1900, through June 6, 2079, with an accuracy of one minute.

Character Strings

char - Fixed-length non-Unicode character data with a maximum length of 8,000 characters.
varchar - Variable-length non-Unicode data with a maximum of 8,000 characters.

What are System-Supplied Data Types?

- Binary
 - Binary Fixed-length binary data ,max of 8000 bytes
 - Varbinary Varying length binary data ,max of 8000 bytes
- Large Objects
 - Image
 - Text
- Unicode Data type storage is two times the byte size
 - Nchar
 - Nvarchar, nvarchar(max)
 - ntext



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Binary Strings

binary - Fixed-length binary data with a maximum length of 8,000 bytes.

varbinary - Variable-length binary data with a maximum length of 8,000 bytes.

Large Objects

text - Variable-length non-Unicode data with a maximum length of $2^{31} - 1$ (2,147,483,647) characters.

image - Variable-length binary data with a maximum length of $2^{31} - 1$ (2,147,483,647) bytes.

Unicode Data types

Unicode is a character encoding system for representing characters from different language like traditional Chinese, kanji etc. .

Unicode provides a unique number for every character. The numbers occupy two bytes. The unicode data type supported in SQL Server are

Nchar - Fixed-length Unicode data with a maximum length of 4,000 characters.

Nvarchar - Variable-length Unicode data with a maximum length of 4,000 characters.

nvarchar(max) - Variable-length Unicode data with a maximum length of 230 characters

ntext - Variable-length Unicode data with a maximum length of 1,073,741,823 characters.

What are System-Supplied Data Types?

■ Other Data Types

- cursor - A reference to a cursor ,used only in procedures
- table - A special data type used to store a result set for later processing
- Sql_variant - Stores values of various SQL Server-supported data types, except text, ntext, and timestamp.
- timestamp - A database-wide unique number that gets updated every time a row gets updated
- uniqueidentifier - A globally unique identifier (GUID)
- xml datatype - xml data type lets you store XML documents and fragments



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Other Data Types

cursor - A reference to a cursor, used only in procedures

sql_variant - A data type that stores values of various SQL Server-supported data types, except text, ntext, timestamp, and sql_variant.

table - A special data type used to store a result set for later processing.

timestamp - A database-wide unique number that gets updated every time a row gets updated.

uniqueidentifier - A globally unique identifier (GUID).

Microsoft SQL Server introduces the max specifier. This specifier expands the storage capabilities of the varchar, nvarchar, and varbinary data types. varchar(max), nvarchar(max), and varbinary(max) are collectively called large-value data types. You can use the large-value data types to store up to $2^{31}-1$ bytes of data.

Example:

```
Create table cust(custcode int primary key, custname varchar(50) comment varchar(max))
```

xml datatype - The xml data type lets you store XML documents and fragments in a SQL Server database. An XML fragment is an XML instance that is missing a single top-level element. You can create columns and variables of the xml type and store XML instances in them. Note that the stored representation of xml data type instances cannot exceed 2 GB.

What are System-Supplied Data Types?

- Large value data types:
 - varchar(max)
 - nvarchar(max)
 - varbinary(max)
- For non-unicode data MAX allows up to $2^{31} - 1$ bytes
- For unicode data MAX allows up to $2^{30} - 1$ bytes
- XML
 - To store data in XML Format
 - XML DML for performing insert, update and deletes on the XML based columns



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You can optionally associate an XML schema collection with a column, a parameter, or a variable of the xml data type. The schemas in the collection are used to validate and type the XML instances. In this case, the XML is said to be typed.

The xml data type and associated methods help integrate XML into the relational framework of SQL Server.

Example:

```
CREATE TABLE T1(Col1 int primary key, Col2 xml)
```

SQL Server - New Data Types

- SQL Server Date Data Types
 - DATE
 - TIME
 - DATETIME2
 - DATETIMEOFFSET



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SQL Server Date Data Types

Previous versions of SQL Server offered two date data types: datetime and smalldatetime. These data types were sufficient for most applications, but could be cumbersome in certain cases. For instance, both data types have a date and time portion, which is great if that's what you want, but cumbersome if all you need to store is just the date or just the time.

Similarly, the date ranges imposed by these two data types - 1753-01-01 to 9999-12-31 for datetime and 1900-01-01 to 2079-06-06 for smalldatetime - are insufficient for a small percentage of applications. SQL Server 2008 remedies these ills by keeping the datetime and smalldatetime and introducing four new date data types: time, date, datetime2, and datetimeoffset.

As you can probably guess by their names, the time and date data types track just a time and just a date portion, respectively. The datetime2 data type is like the datetime data type, but has a larger window of dates (from 0001-01-01 to 9999-12-31) and greater precision on the time portion.

The datetimeoffset data type has the same range and precision as the datetime2 data type, but enables an offset from UTC to be specified, which makes it easier to record and display times respective to the end user's timezone.

SQL Server - Date Data Types

| Data Type | Format | Range | Storage Size (bytes) |
|----------------|--|--|---|
| time | hh:mm:ss[.nnnnnnn] | 00:00:00.0000000 through 23:59:59.9999999 | 5 |
| date | YYYY-MM-DD | 0001-01-01 through 9999-12-31 | 3 bytes, fixed |
| smalldatetime | YYYY-MM-DD hh:mm:ss | 1900-01-01 through 2079-06-06 | 4 bytes, fixed. |
| datetime | YYYY-MM-DD hh:mm:ss[.nnn] | 1753-01-01 through 9999-12-31 | 8 bytes |
| datetime2 | YYYY-MM-DD hh:mm:ss[.nnnnnnn] | 0001-01-01 00:00:00.0000000 through 9999-12-31 23:59:59.9999999 | 6 bytes for precisions less than 3; 7 bytes for precisions 3 and 4. All other precisions require 8 bytes. |
| datetimeoffset | YYYY-MM-DD hh:mm:ss[.nnnnnnn] [+ -]hh:mm | 0001-01-01 00:00:00.0000000 through 9999-12-31 23:59:59.9999999 (in UTC) | 10 bytes, fixed is the default with the default of 100ns fractional second precision |



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TIME

The datatype TIME is primarily used for storing the time of a day. This includes Hours, minutes, Seconds etc. It is based on a 24-hour clock. The datatype TIME can store seconds up to the fraction of 9999999.

Syntax : time [(fractional second precision)]

Usage : DECLARE @MyTime time(7)

```
CREATE TABLE Table1 ( Column1 time(7) )
```

DATE

This data type is useful to store the dates without the time part, we can store dates starting from 00001-01-01 through 9999-12-31 i.e. January 1, 1 A.D. through December 31, 9999 A.D. It supports the Gregorian Calendar and uses 3 bytes to store the date.

Syntax: date

Usage: DECLARE @MyDate date

```
CREATE TABLE Table1 ( Column1 date )
```

DATETIME2

This is a new data type introduced in SQL Server and this date/time data type is introduced to store the high precision date and time data. The data type can be defined for variable lengths depending on the requirement. This data type also follows the Gregorian Calendar. The Time Zone can't be specified in this data type. This is still useful because it gives you a complete flexibility to store the date time data as per your requirement..

Syntax: datetime2 [(fractional seconds precision)]

Usage: DECLARE @MyDatetime2 datetime2(7)
CREATE TABLE Table1 (Column1 datetime2(7))

SMALLDATETIME and DATETIME

Microsoft SQL Server continues to support existing data types such as datetime and smalldatetime.

SMALLDATETIME: Defines a date that is combined with a time of day. The time is based on a 24-hour day, with seconds always zero (:00) and without fractional seconds. The date range for the datatype smalldatetime is from 1900-01-01 through 2079-06-06 and time range supported is 00:00:00 through 23:59:59.

Syntax: smalldatetime

Usage: DECLARE @MySmalldatetime smalldatetime
CREATE TABLE Table1 (Column1 smalldatetime)

DATETIME: This data type Defines a date that is combined with a time of day with fractional seconds that is based on a 24-hour clock. The date range for the datatype datetime is from January 1, 1753, through December 31, 9999 and time range supported is 00:00:00 through 23:59:59.997.

Syntax: datetime

Usage: DECLARE @MyDatetime datetime
CREATE TABLE Table1 (Column1 datetime)

DATETIMEOFFSET

This is the new data type that is included in SQL Server and this data type is the most advanced in the league. We can store high precision date/ time with the Date Time Offset. We can't store the Time Zone like Eastern Time, Central Time etc. in the data type but can store the offset -5:00 for EST and -6:00 CST and so on. The data type is not Day light saving aware.

The date range is between 0001-01-01 and 9999-12-31 or January 1, 1 A.D. through December 31, 9999 A.D. and the Time Range is between 00:00:00 and 23:59:59.9999999. The offset range is between -14:00 through +14:00. The precision of the data type can be set manually and it follows the Gregorian Calendar.

Usage: datetimeoffset [(fractional seconds precision)]

Usage: DECLARE @MyDatetimeoffset datetimeoffset(7)
CREATE TABLE Table1 (Column1 datetimeoffset(7))

Examples:
DATE & TIME Data Type

```
Use AdventureWorks
Go

Create Schema Trade
Go

CREATE TABLE Trade.BankTran
(
    TransID      BIGINT IDENTITY(1,1) PRIMARY KEY ,
    AccountNo   INT,
    BankTranType VARCHAR(50),
    TransDate    DATE,
    TransTime    Time(7)
)
Go

INSERT INTO Trade.BankTran
(AccountNo,BankTranType,TransDate,TransTime)
Values(101,'Transfer',sysdatetime(),sysdatetime())
Go
INSERT INTO Trade.BankTran
(AccountNo,BankTranType,TransDate,TransTime)
Values(102,'Transfer',sysdatetime(),sysdatetime())
Go

SELECT * FROM Trade.BankTran
```

Result:

| TransID | AccountNo | BankTranType | TransDate | TransTime |
|---------|-----------|--------------|------------|------------------|
| 1 | 101 | Transfer | 2012-04-22 | 18:13:59.4657106 |
| 2 | 102 | Transfer | 2012-04-22 | 18:13:59.4807114 |

(2 row(s) affected)

Examples:**Comparison between DATETIME2 & DATETIME data type with example:**

```
USE AdventureWorks
GO

CREATE TABLE TimeTable
(
    FirstDate DATETIME,
    LastDate DATETIME2(4)
)
GO

DECLARE @Interval INT
SET @Interval = 1000
WHILE (@Interval > 0)
BEGIN
    INSERT TimeTable (FirstDate, LastDate)
    VALUES (SYSDATETIME(), SYSDATETIME())
    SET @Interval = @Interval - 1
END
GO

SELECT * FROM TimeTable
GO
```

Output:

| FirstDate | LastDate |
|-------------------------|------------------------|
| 2012-04-22 19:54:52.700 | 2012-04-22 19:54:52.69 |
| 2012-04-22 19:54:52.703 | 2012-04-22 19:54:52.70 |
| 2012-04-22 19:54:52.703 | 2012-04-22 19:54:52.70 |
| 2012-04-22 19:54:52.707 | 2012-04-22 19:54:52.70 |
| 2012-04-22 19:54:52.707 | 2012-04-22 19:54:52.70 |
| 2012-04-22 19:54:52.707 | 2012-04-22 19:54:52.70 |
| 2012-04-22 19:54:52.707 | 2012-04-22 19:54:52.70 |
| 2012-04-22 19:54:52.710 | 2012-04-22 19:54:52.70 |
| 2012-04-22 19:54:52.710 | 2012-04-22 19:54:52.70 |
| 2012-04-22 19:54:52.713 | 2012-04-22 19:54:52.71 |
| 2012-04-22 19:54:52.713 | 2012-04-22 19:54:52.71 |
| 2012-04-22 19:54:52.717 | 2012-04-22 19:54:52.71 |

Note that when using the datetime data type is rounded to increments of .000, .003, or .007 seconds. However the datetime2 has a larger date range, a larger default fractional precision, and optional user-specified precision.

Examples:**DATETIMEOFFSET:**

```
SELECT  
    CAST(SYSDATETIMEOFFSET() AS datetimeoffset(7)) AS  
        'datetimeoffset'
```

Output:

```
datetimeoffset  
-----  
2012-04-22 20:28:16.1262803 +05:30  
  
(1 row(s) affected)
```

SYSDATETIMEOFFSET(): This function returns a datetimeoffset(7) value that contains the date and time of the computer on which the instance of SQL Server is running. The time zone offset is included.

NOTE – IST, which is GMT plus 5.30 hrs, came into existence in 1905.

Spatial Data Type – What is Spatial Data?

- Information about the location and shape of a geometric object:
 - Store locations
 - Sales regions
 - Customer sites
 - Area within a specific distance of a location
- Two types:
 - Planar (or Euclidean) data for coordinate points on a flat, bounded surface. Distances are measured directly between points
 - Geodetic (or ellipsoidal) data for latitude and longitude points on the surface of the Earth. Distances are measured taking into account the curvature of the ellipsoidal surface



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What is Spatial Data?

Spatial data is information that stores the location and shape of geometric objects, for example, a building, a road, a river, a city, a continent, or an ocean.

The object can be identified by a single point or a set of points that create a geometric shape. Spatial data is rapidly becoming more important to many industries. You can use it to locate stores, identify sales regions, pinpoint customer sites, and generate areas that are local to a location.

There are two types of spatial data: planar and geodetic. Planar, or Euclidean, spatial data views the Earth as if it is projected onto a planar surface like a map. Geodetic, or ellipsoidal, data views the Earth as an ellipsoid and works with information such as latitude and longitude coordinates.

The key difference between planar and ellipsoidal data is the way that operations on the data are performed. For example, distances between planar points are measured directly between the points by using simple trigonometry, whereas distances between geodetic data points take into account the curvature of the ellipsoidal surface.

The geometry and geography Data Types

- SQL Server supports two spatial data types:
 - geometry for planar spatial data
 - geography for ellipsoidal spatial data
- Both data types:
 - Are implemented as .NET Framework common language runtime types
 - Can store points, lines, and areas
 - Provide members to perform spatial operations
- Common uses:
 - Geometry - localized geospatial data such as street maps
 - Geography - locations on the Earth's surface and integration
 - geospatial systems



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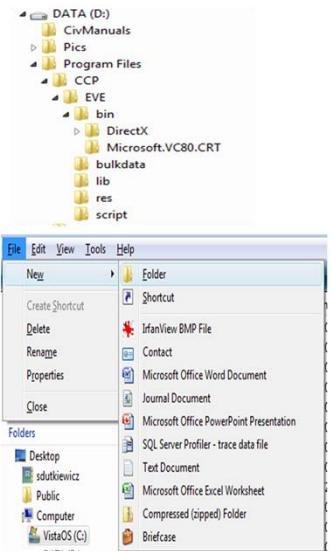
Types of Spatial Data

There are two types of spatial data. The **geometry** data type supports planar, or Euclidean (flat-earth), data. The geometry data type conforms to the Open Geospatial Consortium (OGC) Simple Features for SQL Specification version 1.1.0.

In addition, SQL Server supports the **geography** data type, which stores ellipsoidal (round-earth) data, such as GPS latitude and longitude coordinates.

SQL Server 2008 – Hierarchyid Data Types

- SQL Server 2008 introduces a new system-provided data type “Hierarchyid” to encapsulate hierarchical relationships
- We can use hierarchyid as a data type to create tables with a hierarchical structure
- It is designed to store values that represent the position of nodes of a hierachal tree structure
- This type is internally stored as a VARBINARY value
- Examples where the hierarchyid type makes it easier to store and query hierarchical data include the following:
 - Organizational structures
 - A set of tasks that make up a larger projects (like a GANTT chart)
 - File systems (folders and their sub-folders)
 - A graphical representation of links between web pages



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Hierarchyid

While hierarchical tree structures are commonly used in many applications, SQL Server has not made it easy to represent and store them in relational tables. In SQL Server 2008, the HIERARCHYID data type has been added to help resolve this problem. It is designed to store values that represent the position of nodes of a hierachal tree structure.

The new HIERARCHYID data type in SQL Server 2008 is a system-supplied CLR UDT that can be useful for storing and manipulating hierarchies. This type is internally stored as a VARBINARY value that represents the position of the current node in the hierarchy (both in terms of parent-child position and position among siblings).

Unlike standard data types, the HIERARCHYID data type is a CLR user-defined type, and it exposes many methods that allow you to manipulate the date stored within it. For example, there are methods to get the current hierarchy level, get the previous level, get the next level, and many more. In fact, the HIERARCHYID data type is only used to store hierarchical data; it does not automatically represent a hierarchical structure. It is the responsibility of the application to create and assign HIERARCHYID values in a way that represents the desired relationship. Think of a HIERARCHYID data type as a place to store positional nodes of a tree structure, not as a way to create the tree structure.

The HIERARCHYID data type makes it easier to express these types of relationships without requiring multiple parent/child tables and complex joins.

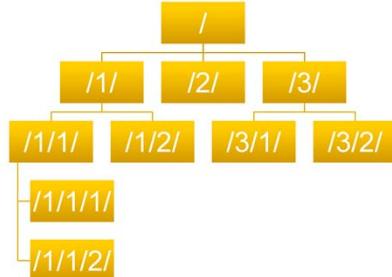
Hierarchyid – Key Properties & Limitations

Key Properties

- Extremely compact
- Comparison is in depth-first order
- Support for arbitrary insertions and deletions

Limitations

- Does not automatically represent a tree
- No guarantee that hierarchyid values in a column would be unique
- Hierarchical relationships represented by hierarchyid values are not enforced like a foreign key relationship



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Key Properties of hierarchyid

A value of the hierarchyid data type represents a position in a tree hierarchy. Values for hierarchyid have the following properties:

Extremely compact

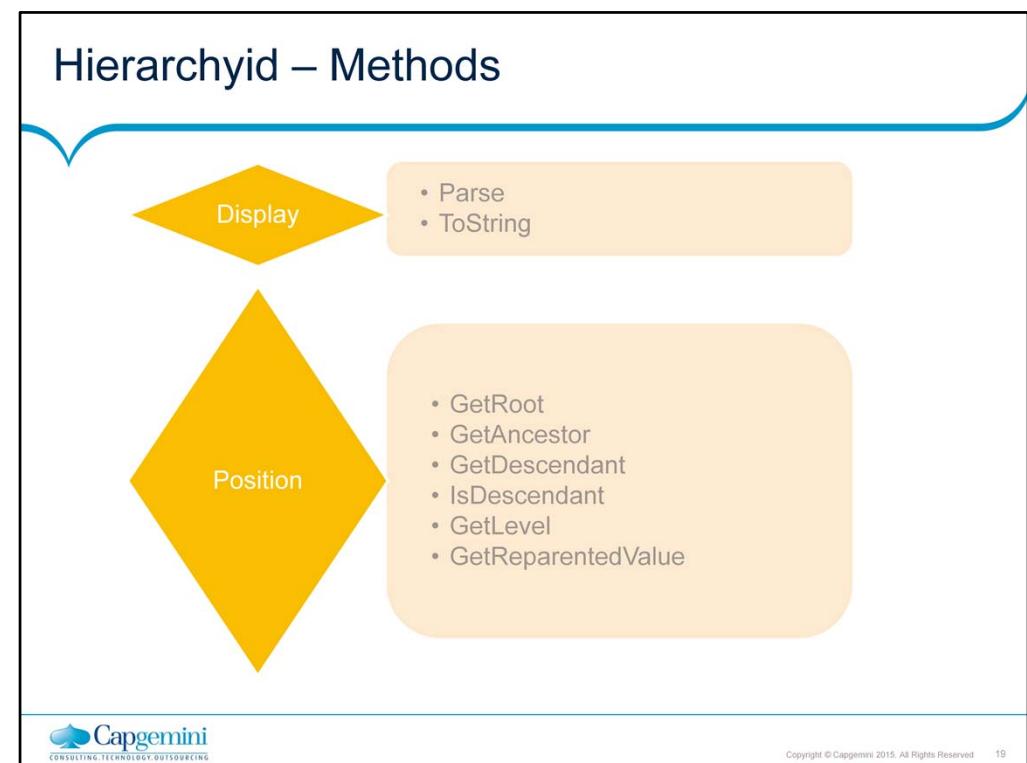
The average number of bits that are required to represent a node in a tree with n nodes depends on the average fanout (the average number of children of a node). For small fanouts, (0-7) the size is about $6 \cdot \log_2 A$ bits, where A is the average fanout. A node in an organizational hierarchy of 100,000 people with an average fanout of 6 levels takes about 38 bits. This is rounded up to 40 bits, or 5 bytes, for storage.

Comparison is in depth-first order

Given two hierarchyid values a and b, $a < b$ means a comes before b in a depth-first traversal of the tree. Indexes on hierarchyid data types are in depth-first order, and nodes close to each other in a depth-first traversal are stored near each other. For example, the children of a record are stored adjacent to that record.

Support for arbitrary insertions and deletions

By using the GetDescendant method, it is always possible to generate a sibling to the right of any given node, to the left of any given node, or between any two siblings. The comparison property is maintained when an arbitrary number of nodes is inserted or deleted from the hierarchy. Most insertions and deletions preserve the compactness property. However, insertions between two nodes will produce hierarchyid values with a slightly less compact representation.



Hierarchyid Methods

Parse: Converts a string representation of a hierarchy to a Hierarchyid value. Static.

ToString: Returns a string that contains the logical representation of this Hierarchyid .

GetRoot: Returns the root Hierarchyid node of this hierarchy tree. Static.

GetAncestor: Returns a Hierarchyid that represents the nth ancestor of this HierarchyID node.

GetDescendant: Returns a child node of this Hierarchyid node.

IsDescendant: Returns true if the passed-in child node is a descendant of this HierarchyID node.

GetLevel: Returns an integer that represents the depth of this Hierarchyid node in the overall hierarchy.

GetReparentedValue: Returns a node whose path from the root is the path to newRoot, followed by the path from oldRoot to this.

Example:**-- Create database and table**

```
CREATE DATABASE HierarchyDB
```

```
GO
```

```
USE HierarchyDB
```

```
GO
```

```
IF ( Object_id('HierarchyTab') > 0 )
```

```
DROP TABLE HierarchyTab
```

```
GO
```

```
CREATE TABLE HierarchyTab
```

```
(
```

```
    Nodeld INT IDENTITY(1, 1)  
    ,NodeDepth VARCHAR(100) NOT NULL  
    ,NodePath HIERARCHYID NOT NULL  
    ,NodeDesc VARCHAR(100)
```

```
)
```

```
GO
```

-- Creating constraint on hierarchy data type.

```
ALTER TABLE HierarchyTab ADD CONSTRAINT U_NodePath UNIQUE  
CLUSTERED (NodePath)
```

```
GO
```

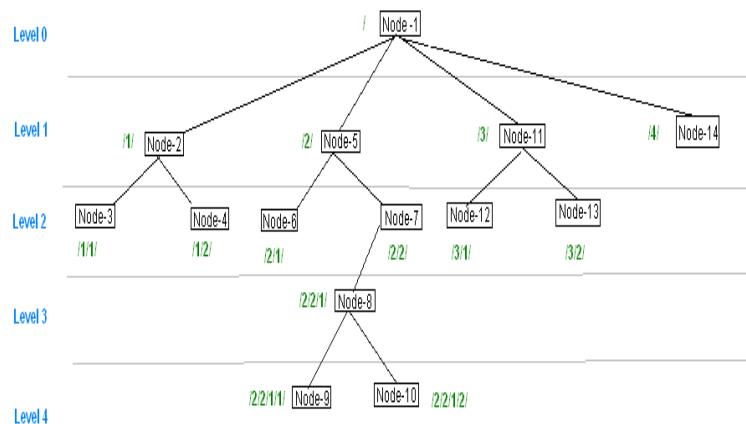
-- Inserting data in above created table.

```
INSERT INTO HierarchyTab(NodeDepth,NodePath,NodeDesc)
```

```
VALUES
```

```
('1',HIERARCHYID::Parse('/'),'Node-1'),  
('1.1',HIERARCHYID::Parse('/1/'),'Node-2'),  
('1.1.1',HIERARCHYID::Parse('/1/1/'),'Node-3'),  
('1.1.2',HIERARCHYID::Parse('/1/2/'),'Node-4'),  
('1.2',HIERARCHYID::Parse('/2/'),'Node-5'),  
('1.2.1',HIERARCHYID::Parse('/2/1/'),'Node-6'),  
('1.2.2',HIERARCHYID::Parse('/2/2/'),'Node-7'),  
('1.2.2.1',HIERARCHYID::Parse('/2/2/1/'),'Node-8'),  
('1.2.2.1.1',HIERARCHYID::Parse('/2/2/1/1/'),'Node-9'),  
('1.2.2.1.2',HIERARCHYID::Parse('/2/2/1/2/'),'Node-10'),  
('1.3',HIERARCHYID::Parse('/3/'),'Node-11'),  
('1.3.1',HIERARCHYID::Parse('/3/1/'),'Node-12'),  
('1.3.2',HIERARCHYID::Parse('/3/2/'),'Node-13'),  
('1.4',HIERARCHYID::Parse('/4/'),'Node-14')
```

```
GO
```

Logical Representation of the table :**Working with Methods to display data from the table:****-- GetRoot()**

```

SELECT
HIERARCHYID::GetRoot() AS RootNode,
HIERARCHYID::GetRoot().ToString() AS RootNodePath
GO
  
```

Result :

| | |
|----------|--------------|
| RootNode | RootNodePath |
| 0x/ | |

-- ToString()

```

SELECT
NodePath.ToString() AS NodeStringPath
,NodId
,NodeDepth
,NodePath
,NodeDesc
FROM HierarchyTab
GO
  
```

Result :

| NodeStringPath | NodeId | NodeDepth | NodePath | NodeDesc |
|----------------|--------|-----------|----------|----------|
| / | 1 | 1 | 0x | Node-1 |
| /1/ | 2 | 1.1 | 0x58 | Node-2 |
| /1/1/ | 3 | 1.1.1 | 0x5AC0 | Node-3 |
| /1/2/ | 4 | 1.1.2 | 0x5B40 | Node-4 |
| /2/ | 5 | 1.2 | 0x68 | Node-5 |
| /2/1/ | 6 | 1.2.1 | 0x6AC0 | Node-6 |
| /2/2/ | 7 | 1.2.2 | 0x6B40 | Node-7 |
| /2/2/1/ | 8 | 1.2.2.1 | 0x6B56 | Node-8 |
| /2/2/1/1/ | 9 | 1.2.2.1.1 | 0x6B56B0 | Node-9 |
| /2/2/1/2/ | 10 | 1.2.2.1.2 | 0x6B56D0 | Node-10 |
| /3/ | 11 | 1.3 | 0x78 | Node-11 |
| /3/1/ | 12 | 1.3.1 | 0x7AC0 | Node-12 |
| /3/2/ | 13 | 1.3.2 | 0x7B40 | Node-13 |
| /4/ | 14 | 1.4 | 0x84 | Node-14 |

Introduction to Alias Data Types (User Defined Data Types)

- An alias data type is a user defined custom data type based on system-supplied data type
- In SQL Server alias data types offers a great deal of data consistency while working with various tables or databases
- You should create an alias data type when :
 - You need to define a commonly used data element with specific format
 - Database tables must store the same type of data in a column
 - These columns have identical data type, length & nullability
- Example

```
CREATE TYPE EmailAddress  
FROM varchar(30) NOT NULL;
```



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Introduction to Alias Data Types (User Defined Data Types) :

An alias data type is a user defined custom data type based on system supplied data type. An alias data type allows you to refine a data type further to guarantee consistency when working with common data elements in various tables or databases.

It provides you with a convenient way to standardize the usage of native data types for columns that have same domain of possible values. Assume that you need to store many email addresses in your database, in various tables. As there is no single & definitive way to store Email Address, it is very hard to maintain consistency in all those tables which store email address in a column. However, if the Email Address will be used regularly throughout the database, you could define a EmailAddress alias data type and use that instead. This also makes it easier to understand the object definitions and code in your database.

1. Name
2. System data type upon which the new data type is based Nullability (whether the data type allows null values)

Note - When nullability is not explicitly defined, it will be assigned based on the ANSI null default setting for the database or connection.

Dropping Alias Data Types

- You can drop alias data type by using Object Explorer in SQL Server Management Studio
- You can also use DROP TYPE Transact-SQL Statement to remove the alias data type from a database
- The DROP TYPE statement removes an alias data type from the current database
- You cannot drop a user-defined type until all references to that type have been removed
- Example

```
DROP TYPE EmailAddress
```



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Note that when you create an alias data type, you can specify its nullability. An alias data type created with the NOT NULL option can never be used to store a NULL value.

It is important to specify the appropriate nullability when you create a data type, because it can be a lengthy procedure to change a data type. You must use the DROP TYPE statement to drop the data type and then re-create a new data type to replace it.

Because you cannot drop a data type that is used by tables in the database, you also need to ALTER every table that uses the data type first.

Tip – Alias data types that you create in the model database are automatically included in all databases that are subsequently created. However, if the data type is created in a user-defined database, the data type exists only in that user-defined database.

Dropping Alias Data Types:

You can drop alias data types by using Object Explorer in SQL Server Management studio or by using DROP TYPE Transact-SQL statement.

The DROP TYPE statement will not execute when :

1. There are tables in the database that contain columns of the alias data type or the user-defined type.
2. There are computed columns, CHECK constraints, schema-bound views, and schema-bound functions whose definitions reference the alias or user-defined type.
3. There are functions, stored procedures, or triggers created in the database, and these routines use variables and parameters of the alias or user-defined type.

Demo

- Creating alias data types (UDTs)
- Dropping alias data types (UDTs)



Data Types in SQL Server –Best Practices

- If column length varies, use a variable data type
- Use tinyint appropriately
- For numeric data types, commonly use decimal
- If storage is greater than 8000 bytes, use text or image
- Use money for currency
- Do not use float or real as primary keys
- If your character data type columns use the same or a similar number of characters consistently, use fixed length data types (char, nchar)
- Choose the smallest numeric or character data type required to store the data
- If you are going to be using a column for frequent sorts, consider an integer-based column rather than a character-based column



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What is a Database Schema?

- A Database Schema is a way to logically group SQL Server objects such as tables, views, stored procedures etc
- A schema is a distinct namespace, a container of SQL Server objects, distinct from users those who have created those objects
- In earlier releases of SQL Server, an object's namespace was determined by the user name of its owner
- An object owned by a database user is no longer tied to that user
- By introducing Schemas in database objects can now be manipulated independently of user
- A SQL Server user can be defined with default schema
- If no default schema is defined, sql server will assume dbo as the default schema



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What is a Database Schema?

Microsoft introduced the concept of database schemas. A schema is an independent entity- a container of objects distinct from the user who created those objects. A schema is a distinct namespace to facilitate the separation, management, and ownership of database objects. It removed the tight coupling of database objects and owners.

In earlier releases of SQL Server, database object owners and users were the same things. This meant that if, say, a user creates a table in the database, that user cannot be deleted without deleting the table or first transferring it to another user. SQL Server introduced the concept of database schemas and the separation between database objects and ownership by users. An object owned by a database user is no longer tied to that user. The object now belongs to a schema – a container that can hold many database objects. The schema owner may own one or many schemas. This concept creates opportunities to expose database objects within a database for consumption yet protect them from modification, direct access using poor query techniques, or removal by users other than the owner.

When a schema is created, it is owned by a principal. A principal is any entity or object that has access to SQL Server resources. These are:

- Windows domain logins
- Windows local logins
- SQL Server logins
- Windows groups
- Database roles
- Server roles
- Application roles

Creating Database Schema

- Example : Creating Database Schema

```
Use AdventureWorks  
GO  
CREATE SCHEMA Sales  
GO
```

- Example : Assigning a Default Schema

```
ALTER USER Anders WITH DEFAULT_SCHEMA = Sales
```



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Creating Database Schema

As shown on the above slide, you can create a database schema by using CREATE SCHEMA Transact-SQL Statement.

The dbo Schema

Every database contains a schema named dbo. The dbo schema is the default schema for all users who do not have any other explicitly defined default schema.

How Object Name Resolution Works?

When a database contains multiple schemas, object name resolution can become confusing. For example, a database might contain two tables named Order in two different schemas, Sales and dbo. The qualified names of the objects within the Database are unambiguous: Sales.Order and dbo.Order, respectively. However, the use of the unqualified name Order can produce unexpected results. You can assign users a default schema to control how unqualified object names are resolved.



How Name Resolution Works?

SQL Server uses the following process to resolve an unqualified object name:

1. If the user has a default schema, SQL Server attempts to find the object in the default schema.
2. If the object is not found in the user's default schema, or if the user has no default schema, SQL Server attempts to find the object in the dbo schema.

For example, a user with the default schema Person executes the following Transact-SQL statement.

SELECT * FROM Contact

SQL Server will first attempt to resolve the object name to Person.Contact.

If the Person schema does not contain an object named Contact, SQL Server will attempt to resolve the object name to dbo.Contact.

If a user with no defined default schema executes the same statement, SQL Server will immediately resolve the object name to dbo.Contact.

Demo

- Creating Database Schema



Create Table

- Once you define all the data types in your database, you can create the Tables to store your business data
- The Table is the most important and central object of any RDBMS
- These tables may be temporary, lasting only for a single interactive SQL Session
- They also can be permanent, lasting weeks or for months
- Creating a database table involves :
 - Naming the table
 - Defining the columns
 - Assigning properties to the column
- In SQL Server, you can use CREATE TABLE Transact-SQL Statement for creating table



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Create table in SQL Server

After you have designed the database , the tables that will store the data in the database can be created. The data is usually stored in permanent tables. Tables are stored in the database files until they are deleted and are available to any user who has the appropriate permissions.

Temporary Tables

You can also create temporary tables. Temporary tables are similar to permanent tables, except temporary tables are stored in tempdb and are deleted automatically when no longer in use.

The two types of temporary tables, local and global, differ from each other in their names, their visibility, and their availability. Local temporary tables have a single number sign (#) as the first character of their names; they are visible only to the current connection for the user; and they are deleted when the user disconnects from instances of SQL Server. Global temporary tables have two number signs (##) as the first characters of their names; they are visible to any user after they are created; and they are deleted when all users referencing the table disconnect from SQL Server.

Example

If you create a table named employees, the table can be used by any person who has the security permissions in the database to use it, until the table is deleted. If you create a local temporary table named #employees, you are the only person who can work with the table, and it is deleted when you disconnect.

```
CREATE TABLE #Employee
(
    EmpID      INT,
    Name       VARCHAR(20),
    DOJ        DATETIME
)
```

If you create a global temporary table named ##employees, any user in the database can work with this table. If no other user works with this table after you create it, the table is deleted when you disconnect. If another user works with the table after you create it, SQL Server deletes it when both of you disconnect.

Table Properties

You can define up to 1,024 columns per table. Table and column names must follow the rules for identifiers; they must be unique within a given table, but you can use the same column name in different tables in the same database. You must also define a data type for each column.

Although table names must be unique for each owner within a database, you can create multiple tables with the same name if you specify different owners for each. You can create two tables named employees and designate Jonah as the owner of one and Sally as the owner of the other. When you need to work with one of the employees tables, you can distinguish between the two tables by specifying the owner with the name of the table.

Tables & Columns - Naming Guidelines

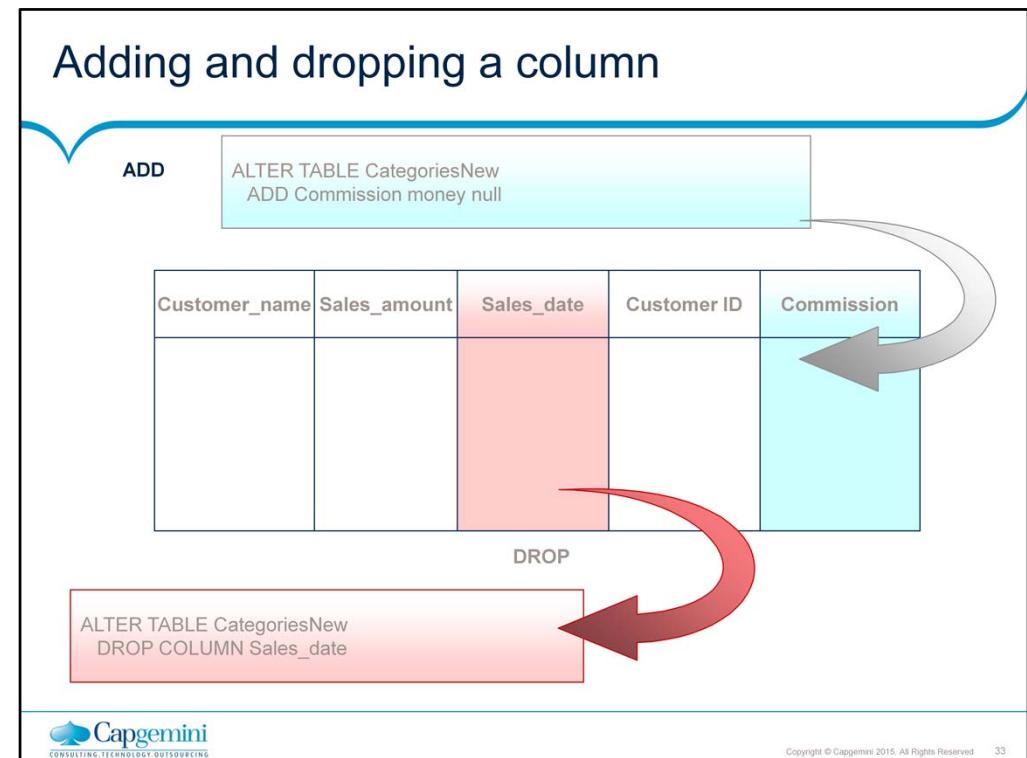
1. Use Pascal Casing (also known as upper camel casing)
2. Avoid abbreviations
3. A long name that users understand is preferred over a short name that users might not understand

Creating Table

- Given a Table Structure for Employee

| Column Name | Data Type | Nullability |
|------------------|-------------|-------------|
| Employee_Code | Int | NOT NULL |
| Employee_Name | Varchar(40) | NOT NULL |
| Employee_DOB | Datetime | NOT NULL |
| Employee_EmailID | Varchar(20) | NULL |

```
CREATE TABLE Employee
(
    Employee_Code int NOT NULL,
    Employee_Name varchar(40) NOT NULL,
    Employee_DOB datetime NOT NULL,
    Employee_EmailID varchar(20) NULL
)
```



Modifying tables in SQL Server

After a table is created, you can change many of the options that were defined for the table when it was originally created. You can modify tables in many different ways.

You can modify tables to make changes to the columns, constraints, and indexes associated with tables. You can use ALTER TABLE statement to implement most common modifications to table

Using ALTER TABLE Columns can be added, modified, or deleted. For example, the column name, length, data type, precision, scale, and nullability can all be changed, although some restrictions exist. PRIMARY KEY and FOREIGN KEY constraints can be added or deleted. UNIQUE and CHECK constraints and DEFAULT definitions (and objects) can be added or deleted.

Adding & Dropping Columns :

When you use the ALTER TABLE statement to add a column, the new column is added at the end of the table.

There are also some things you need to consider with regard to the null option specified for a new column. In the case of a column that allows nulls, there is no real issue. SQL Server adds the column and allows a NULL value for all rows. If NOT NULL is specified, however, the column must be an identity column or have a default specified. Note that even if a default is specified, if the column allows nulls, the column does not be populated with the default. You use the WITH VALUES clause as part of the default specification to override this and populate the column with the default.

With some restrictions, columns can also be dropped from a table.

The following columns cannot be dropped:

- A column in a schema-bound view
- An indexed column
- A replicated column
- A column used in a CHECK, FOREIGN KEY, UNIQUE, or PRIMARY KEY constraints
- A column that is associated with a default or bound to a default object
- A column that is bound to a rule

Special Types of Columns in SQL Server

- Computed Columns

```
CREATE TABLE Marks
```

```
( Test1 int, Test2 int,
    TestAvg AS (Test1 + Test2)/2 )
```

- Identity Columns

```
CREATE TABLE Printer
```

```
(PrinterId int IDENTITY (1000, 1) NOT NULL)
```

- Uniqueidentifier Columns

```
CREATE TABLE Customer ( CustomerID uniqueidentifier NOT NULL)
```

```
INSERT INTO Customer Values (NewID())
```



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Special Types of Columns in SQL Server

Computed Columns - A computed column is a column whose value is calculated based on other columns. Generally speaking, the column is a virtual column because it is calculated on-the-fly, and no value is stored in the database table. With SQL Server 2008, you have an option of actually storing the calculated value in the database. You do so by marking the column as persisted. If the computed column is persisted, you can create an index on this column as well.

Identity Columns - You can use the Identity property to create columns that contain system-generated sequential values that identify each row inserted into a table. Having SQL Server automatically provide key values can reduce costs and improve performance. It can be assigned only to columns that are of the following types:

- decimal
- int
- numeric
- smallint
- bigint
- Tinyint

Only one identity column can exist for each table, and that column cannot allow nulls. When implementing the IDENTITY property, you supply a seed and an increment. The seed is the starting value for the numeric count, and the increment is the amount by which it grows. A seed of 10 and an increment of 10 would produce values of 10, 20, 30, 40, and so on. If not specified, the default seed value is 1, and the increment is 1.

Uniqueidentifier Columns - Columns defined with the uniqueidentifier data type can be used to store globally unique identifiers (GUIDs), which are guaranteed to be universally unique. You can generate a value for a uniqueidentifier column by using the NEWID Transact-SQL function.

SEQUENCE

- SQL Server 2012 introduces Sequence as database object.
- Sequence is an object in each database and is similar to IDENTITY in its functionality.
- It can have start value, incrementing value and an end value defined in it.
- It can be added to a column whenever required rather than defining an identity column individually for tables.
- Limitations of using the Identity property can be overcome by the introduction of this new object SEQUENCE.



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SEQUENCE

- CREATESEQUENCE SQ1 AS INT
- START WITH 100
- INCREMENT BY 25
- MINVALUE 100
- MAXVALUE 200
- CYCLE
- CACHE 10
- GO
- SELECT NEXT VALUE FOR SQ1



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```
CREATE SEQUENCE [schema_name . ] sequence_name [ AS [ built_in_integer_type | user-defined_integer_type ] ] [ START WITH <constant> ][ INCREMENT BY <constant> ][ { MINVALUE [ <constant> ] } | { NOMINVALUE } ][ { MAXVALUE [ <constant> ] } | { NOMAXVALUE } ][ CYCLE | { NOCYCLE } ][ { CACHE [ <constant> ] } | { NO CACHE } ][ ; ]
```

sequence_name Specifies the unique name by which the sequence is known in the database. Type is **sysname**.

[*built_in_integer_type* | *user-defined_integer_type*] A sequence can be defined as any integer type. The following types are allowed.

tinyint - Range 0 to 255

smallint - Range -32,768 to 32,767

int - Range -2,147,483,648 to 2,147,483,647

bigint - Range -9,223,372,036,854,775,808 to 9,223,372,036,854,775,807

decimal and **numeric** with a scale of 0.

Any user-defined data type (alias type) that is based on one of the allowed types.

If no data type is provided, the **bigint** data type is used as the default.

START WITH <constant>The first value returned by the sequence object. The **START** value must be a value less than or equal to the maximum and greater than or equal to the minimum value of the sequence object. The default start value for a new sequence object is the minimum value for an ascending sequence object and the maximum value for a descending sequence object.

INCREMENT BY <constant>Value used to increment (or decrement if negative) the value of the sequence object for each call to the **NEXT VALUE FOR** function. If the increment is a negative value, the sequence object is descending; otherwise, it is ascending. The increment cannot be 0. The default increment for a new sequence object is 1.

SEQUENCE

- CREATE SEQUENCE mySeq
- START WITH 10
- INCREMENT BY 5;
- SELECT NEXT VALUE FOR mySeq;
- SELECT NEXT VALUE FOR mySeq;
- SELECT NEXT VALUE FOR mySeq;
- create table myTable
- (sid int,
- Sname varchar(15))
- INSERT INTO myTable(sid, sname) VALUES
- (NEXT VALUE FOR mySeq, 'Tom');
- select * from myTable
- INSERT INTO myTable(sid, sname) VALUES
- (NEXT VALUE FOR mySeq, 'Moody');



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[MINVALUE <constant> | NO MINVALUE]Specifies the bounds for the sequence object. The default minimum value for a new sequence object is the minimum value of the data type of the sequence object. This is zero for the **tinyint** data type and a negative number for all other data types.

[MAXVALUE <constant> | NO MAXVALUE]Specifies the bounds for the sequence object. The default maximum value for a new sequence object is the maximum value of the data type of the sequence object.

[CYCLE | NO CYCLE]Property that specifies whether the sequence object should restart from the minimum value (or maximum for descending sequence objects) or throw an exception when its minimum or maximum value is exceeded. The default cycle option for new sequence objects is NO CYCLE.

Note that cycling restarts from the minimum or maximum value, not from the start value.

[CACHE [<constant>] | NO CACHE]Increases performance for applications that use sequence objects by minimizing the number of disk IOs that are required to generate sequence numbers. Defaults to CACHE.

For example, if a cache size of 50 is chosen, SQL Server does not keep 50 individual values cached. It only caches the current value and the number of values left in the cache. This means that the amount of memory required to store the cache is always two instances of the data type of the sequence object.

Demo

- Creating Table



Enforcing Data Integrity

- The term Data Integrity refers to correctness and completeness of the data in a database
- To preserve the consistency and accuracy of data, every RDBMS imposes one or more data integrity constraints in a database
- These constraints restricts the wrong or invalid data values that can be inserted or updated in a database
- How and what kind of integrity is enforced in the database depends on the type integrity being enforced
- Enforcing data integrity ensures quality of the data in the database
- The quality of data refers to :
 - Accuracy
 - Completeness
 - Consistent
 - Correct



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An important step in database planning is deciding the best way to enforce the integrity of the data. Data integrity refers to the consistency and accuracy of data that is stored in a database.

What Is Data Integrity?

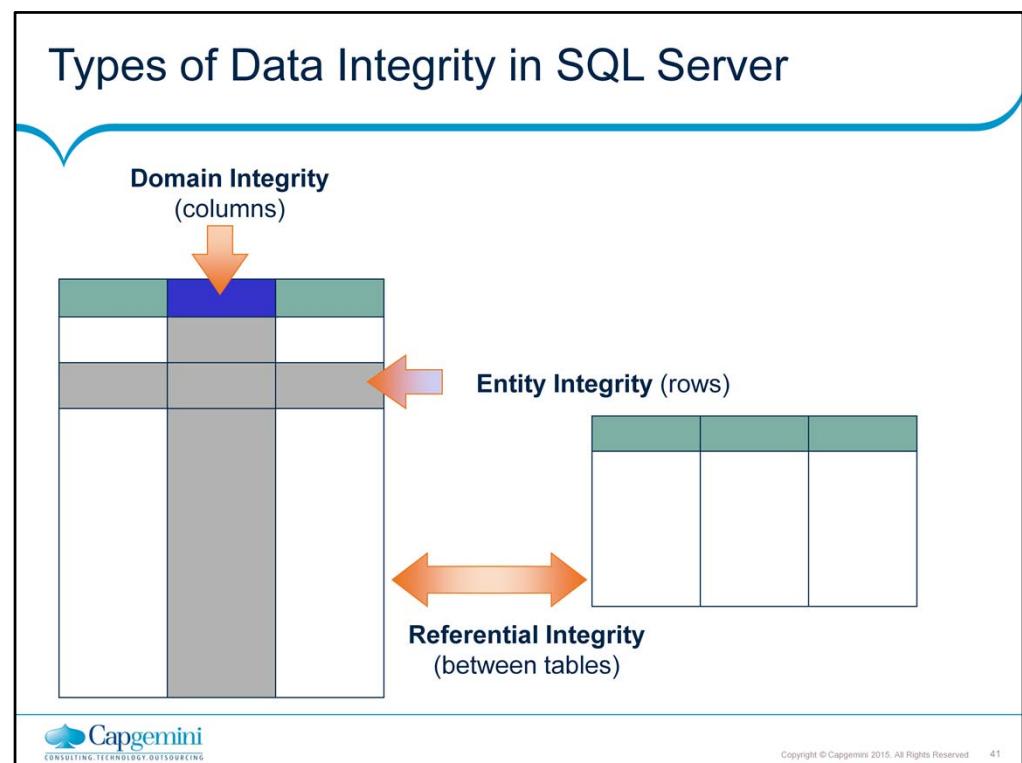
The term *data integrity* refers to the correctness and completeness of the data in a database. When the contents of a database are modified with the INSERT, DELETE, or UPDATE statements, the integrity of the stored data can be lost in many different ways.

For example:

- Invalid data may be added to the database, such as an Employee that belongs to a nonexistent department.
- Existing data may be modified to an incorrect value, such as reassigning an Employee to a nonexistent project.
- Changes to the database may be lost due to a system error or power failure.
- Changes may be partially applied, such as adding an order for a product without adjusting the quantity available for sale.

One of the important roles of a relational DBMS is to preserve the integrity of its stored data to the greatest extent possible.

Enforcing data integrity ensures the quality of the data in the database.



Types of Data Integrity in SQL Server

Enforcing data integrity guarantees the quality of the data in the database. For example, if an employee is entered with an employee ID value of 123, the database should not permit another employee to have an ID with the same value. If you have an employee_rating column intended to have values ranging from 1 to 5, the database should not accept a value outside that range. If the table has a dept_id column that stores the department number for the employee, the database should permit only values that are valid for the department numbers in the company.

Two important steps in planning tables are to identify valid values for a column and to decide how to enforce the integrity of the data in the column. Data integrity falls into the following categories:

- Entity integrity
- Domain integrity
- Referential integrity

Ways of implementing Data Integrity in SQL Server

- Declarative Data Integrity
 - Criteria defined in object definitions
 - SQL Server enforces automatically
 - Implement by using constraints, defaults, and rules
 - Simplest integrity check
- Procedural Data Integrity
 - Implement by using triggers, stored procedures & application code
 - Data validation criteria will be defined in script
 - Allows more advanced data integrity checks



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There are two ways to implement data integrity in SQL Server, either using declarative data integrity or procedural data integrity.

Declarative Data Integrity – It is a set of rules that are applied to a table and its columns using the CREATE TABLE or ALTER TABLE statements. These rules are called constraints, rules and defaults. This is the preferred and simplest method of enforcing integrity because it has low overhead and requires little or no custom programming.

Procedural Data Integrity - Procedural integrity can be implemented with stored procedures, triggers, and application code. It allows more advanced integrity check as You can implement the custom code in many different ways to enforce the integrity of your data.

Determining the type of constraint to be used

| Type of integrity | Constraint type |
|-------------------|-----------------|
| Domain | DEFAULT |
| | CHECK |
| | REFERENTIAL |
| Entity | PRIMARY KEY |
| | UNIQUE |
| Referential | FOREIGN KEY |
| | CHECK |



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Determining the type of constraint to be used

Entity Integrity

Entity integrity defines a row as a unique entity for a particular table. Entity integrity enforces the integrity of the identifier columns or the primary key of a table, through UNIQUE indexes, UNIQUE constraints or PRIMARY KEY constraints.

Domain Integrity

Domain integrity is the validity of entries for a specific column. You can enforce domain integrity to restrict the type by using data types, restrict the format by using CHECK constraints and rules, or restrict the range of possible values by using FOREIGN KEY constraints, CHECK constraints, DEFAULT definitions, NOT NULL definitions, and rules.

Referential Integrity

Referential integrity preserves the defined relationships between tables when rows are entered or deleted. In SQL Server, referential integrity is based on relationships between foreign keys and primary keys or between foreign keys and unique keys, through FOREIGN KEY and CHECK constraints. Referential integrity makes sure that key values are consistent across tables. This kind of consistency requires that there are no references to nonexistent values and that if a key value changes, all references to it change consistently throughout the database.

When you enforce referential integrity, SQL Server prevents users from doing the following:

- Adding or changing rows to a related table if there is no associated row in the primary table.
- Changing values in a primary table that causes orphaned rows in a related table.
- Deleting rows from a primary table if there are matching related rows.

Creating Constraints

- Use CREATE TABLE or ALTER TABLE
- Can Add Constraints to a Table with existing Data
- Can Place Constraints on Single or Multiple Columns
 - Single column, called column-level constraint
 - Multiple columns, called table-level constraint



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You must declare constraints that operate on more than one column as table-level constraints.

For example, the following create table statement has a check constraint that operates on two columns, pub_id and pub_name:

```
create table my_publishers
```

```
(
```

```
pub_id char(4), pub_name varchar(40),
```

```
constraint my_chk_constraint check (pub_id in ("1234", "4321", "1212") or  
pub_name not like "Bad Books")
```

```
)
```

You can declare constraints that operate on just one column as column-level constraints, but it is not required. For example, if the above check constraint uses only one column (pub_id), you can place the constraint on that column:

```
create table my_publishers
```

```
(
```

```
pub_id char(4) constraint my_chk_constraint check (pub_id in ("1389", "0736",  
"0877")),
```

```
pub_name varchar(40)
```

```
)
```

In either case, the constraint keyword and accompanying constraint_name are optional.

Consideration for using constraints

- Can be changed without recreating a table
- Require error-checking in applications and transactions
- Verify existing data



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Types constraints

- DEFAULT Constraints
- CHECK Constraints
- PRIMARY KEY Constraints
- UNIQUE Constraints
- FOREIGN KEY Constraints
- Cascading Referential Integrity



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SQL Server supports the following classes of constraints:

NOT NULL specifies that the column does not accept NULL values.

CHECK constraints enforce domain integrity by limiting the values that can be put in a column. A CHECK constraint specifies a Boolean (evaluates to TRUE, FALSE, or unknown) search condition that is applied to all values that are entered for the column. All values that evaluate to FALSE are rejected. You can specify multiple CHECK constraints for each column.

UNIQUE constraints enforce the uniqueness of the values in a set of columns. In a UNIQUE constraint, no two rows in the table can have the same value for the columns. Primary keys also enforce uniqueness, but primary keys do not allow for NULL as one of the unique values.

PRIMARY KEY constraints identify the column or set of columns that have values that uniquely identify a row in a table.

No two rows in a table can have the same primary key value. You cannot enter NULL for any column in a primary key. We recommend using a small, integer column as a primary key. Each table should have a primary key. A column or combination of columns that qualify as a primary key value is referred to as a candidate key.

FOREIGN KEY constraints identify and enforce the relationships between tables.

DEFAULT constraints

- Apply only to INSERT statements
- Only one DEFAULT constraint per column
- Cannot be used with IDENTITY property or rowversion data type
- Allow some system-supplied values

```
USE Northwind  
ALTER TABLE dbo.Customers  
ADD  
CONSTRAINT DF_contactname DEFAULT 'UNKNOWN'  
FOR ContactName
```



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Defaults specify what values are used in a column if you do not specify a value for the column when you insert a row. Defaults can be anything that evaluates to a constant, such as a constant, built-in function, or mathematical expression.

To apply defaults, create a default definition by using the DEFAULT keyword in CREATE TABLE. This assigns a constant expression as a default on a column.

Each column in a record must contain a value, even if that value is NULL. There may be situations when you must load a row of data into a table but you do not know the value for a column, or the value does not yet exist. If the column allows for null values, you can load the row with a null value. Because nullable columns may not be desirable, a better solution could be to define, where appropriate, a DEFAULT definition for the column. For example, it is common to specify zero as the default for numeric columns, or N/A as the default for string columns when no value is specified.

When you load a row into a table with a DEFAULT definition for a column, you implicitly instruct the SQL Server Database Engine to insert a default value in the column when a value is not specified for it.

Note: You can also use the DEFAULT VALUES clause of the INSERT STATEMENT to explicitly instruct the Database Engine to insert a default value for a column.

If a column does not allow for null values and does not have a DEFAULT definition, you must explicitly specify a value for the column, or the Database Engine returns an error that states that the column does not allow null values.

The value inserted into a column that is defined by the combination of the DEFAULT definition and the nullability of the column can be summarized as shown in the following table.

| Column definition | No entry, no DEFAULT value | No entry, DEFAULT | Enter null |
|-------------------|----------------------------|-------------------|------------|
|-------------------|----------------------------|-------------------|------------|

| | | |
|----------------------|-------|---------------------|
| Allows null value | NULL | Default value |
| Disallow null values | Error | Default value Error |

CHECK constraints

- Are used with INSERT and UPDATE statements
- Can reference other columns in the same table
- Cannot:
 - Be used with the rowversion data type
 - Contain subqueries

```
USE Northwind  
ALTER TABLE dbo.Employees  
ADD  
CONSTRAINT CK_birthdate  
CHECK (BirthDate > '01-01-1900' AND BirthDate < getdate())
```



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You can declare a **check** constraint to limit the values users insert into a column in a table. Check constraints are useful for applications that check a limited, specific range of values. A **check** constraint specifies a *search_condition* that any value must pass before it is inserted into the table. A *search_condition* can include:

A list of constant expressions introduced with **in**

A range of constant expressions introduced with **between**

A set of conditions introduced with **like**, which may contain wildcard characters

An expression can include arithmetic operations and Transact-SQL built-in functions. The *search_condition* cannot contain subqueries, a set function specification, or a target specification.

PRIMARY KEY constraints

- Only one PRIMARY KEY constraint per table
- Values must be unique
- Null values are not allowed

```
USE Northwind  
ALTER TABLE dbo.Customers  
ADD  
CONSTRAINT PK_Customers  
PRIMARY KEY NONCLUSTERED (CustomerID)
```



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A table typically has a column or combination of columns that contain values that uniquely identify each row in the table. This column, or columns, is called the primary key (PK) of the table and enforces the entity integrity of the table. You can create a primary key by defining a PRIMARY KEY constraint when you create or modify a table.

A table can have only one PRIMARY KEY constraint, and a column that participates in the PRIMARY KEY constraint cannot accept null values. Because PRIMARY KEY constraints guarantee unique data, they are frequently defined on an identity column.

When you specify a PRIMARY KEY constraint for a table, the SQL Server Database Engine enforces data uniqueness by creating a unique index for the primary key columns. This index also permits fast access to data when the primary key is used in queries. Therefore, the primary keys that are chosen must follow the rules for creating unique indexes.

If a PRIMARY KEY constraint is defined on more than one column, values may be duplicated within one column, but each combination of values from all the columns in the PRIMARY KEY constraint definition must be unique.

UNIQUE constraints

- Allow One Null Value
- Allow Multiple UNIQUE Constraints on a Table
- Defined with One or More Columns

```
USE Northwind  
ALTER TABLE dbo.Suppliers  
ADD  
CONSTRAINT U_CompanyName  
UNIQUE NONCLUSTERED (CompanyName)
```



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You can use UNIQUE constraints to make sure that no duplicate values are entered in specific columns that do not participate in a primary key. Although both a UNIQUE constraint and a PRIMARY KEY constraint enforce uniqueness, use a UNIQUE constraint instead of a PRIMARY KEY constraint when you want to enforce the uniqueness of a column, or combination of columns, that is not the primary key.

Multiple UNIQUE constraints can be defined on a table, whereas only one PRIMARY KEY constraint can be defined on a table.

Also, unlike PRIMARY KEY constraints, UNIQUE constraints allow for the value NULL. However, as with any value participating in a UNIQUE constraint, only one null value is allowed per column.

A UNIQUE constraint can be referenced by a FOREIGN KEY constraint.

FOREIGN KEY constraints

- Must Reference a PRIMARY KEY or UNIQUE Constraint
- Provide Single or Multicolumn Referential Integrity
- Do Not Automatically Create Indexes
- Users Must Have SELECT or REFERENCES Permissions on Referenced Tables
- Use Only REFERENCES Clause Within Same Table

```
USE Northwind  
ALTER TABLE dbo.Orders  
ADD CONSTRAINT FK_Orders_Customers  
FOREIGN KEY (CustomerID)  
REFERENCES dbo.Customers(CustomerID)
```

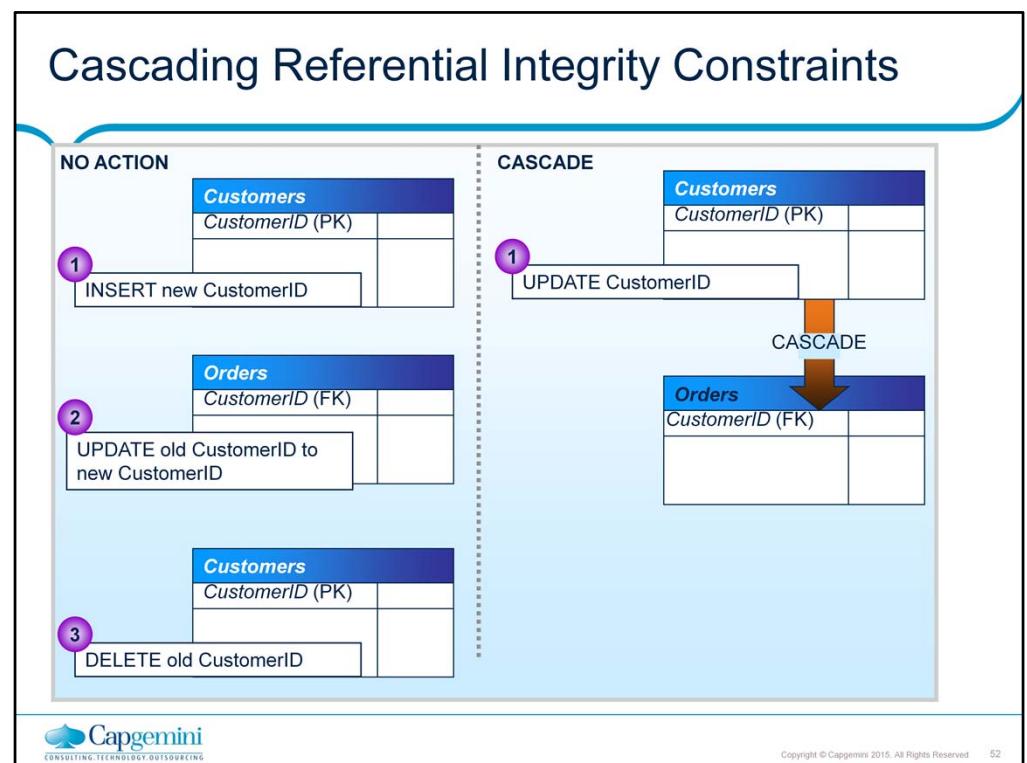


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A foreign key (FK) is a column or combination of columns that is used to establish and enforce a link between the data in two tables. You can create a foreign key by defining a FOREIGN KEY constraint when you create or modify a table.

In a foreign key reference, a link is created between two tables when the column or columns that hold the primary key value for one table are referenced by the column or columns in another table. This column becomes a foreign key in the second table.

A FOREIGN KEY constraint does not have to be linked only to a PRIMARY KEY constraint in another table; it can also be defined to reference the columns of a UNIQUE constraint in another table. A FOREIGN KEY constraint can contain null values; however, if any column of a composite FOREIGN KEY constraint contains null values, verification of all values that make up the FOREIGN KEY constraint is skipped. To make sure that all values of a composite FOREIGN KEY constraint are verified, specify NOT NULL on all the participating columns.



Cascading Referential Integrity Constraints

Cascading referential integrity constraints allow you to define the actions SQL Server takes when a user attempts to delete or update a key to which existing foreign keys point.

The REFERENCES clauses of the CREATE TABLE and ALTER TABLE statements support ON DELETE and ON UPDATE clauses:

```
[ ON DELETE { CASCADE | NO ACTION } ]
[ ON UPDATE { CASCADE | NO ACTION } ]
```

NO ACTION is the default if ON DELETE or ON UPDATE is not specified. NO ACTION specifies the same behavior that occurs in earlier versions of SQL Server. CASCADE allows deletions or updates of key values to cascade through the tables defined to have foreign key relationships that can be traced back to the table on which the modification is performed. CASCADE cannot be specified for any foreign keys or primary keys that have a timestamp column.

ON DELETE CASCADE

Specifies that if an attempt is made to delete a row with a key referenced by foreign keys in existing rows in other tables, all rows containing those foreign keys are also deleted. If cascading referential actions have also been defined on the target tables, the specified cascading actions are also taken for the rows deleted from those tables.

ON UPDATE CASCADE

Specifies that if an attempt is made to update a key value in a row, where the key value is referenced by foreign keys in existing rows in other tables, all of the foreign key values are also updated to the new value specified for the key. If cascading referential actions have also been defined on the target tables, the specified cascading actions are also taken for the key values updated in those tables.

Demo

- Demonstration on all types of SQL Server Constraints



Disabling Constraints

- Disabling constraint checking on existing data
- Disabling constraint checking when loading new data



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Sometimes you need to perform some actions that require the FOREIGN KEY or CHECK constraints be disabled, for example, your company do not hire foreign employees, you made the appropriate constraint, but the situation was changed and your boss need to hire the foreign employee, but only this one. In this case, you need to disable the constraint by using the ALTER TABLE statement. After these actions will be performed, you can re-enable the FOREIGN KEY and CHECK constraints by using the ALTER TABLE statement.

Disabling Constraint Checking on Existing Data

- Applies to CHECK and FOREIGN KEY constraints
- Use WITH NOCHECK option when adding a new constraint
- Use if existing data will not change
- Can change existing data before adding constraints

```
USE Northwind  
ALTER TABLE dbo.Employees  
WITH NOCHECK  
ADD CONSTRAINT FK_Employees_Employees  
FOREIGN KEY (ReportsTo)  
REFERENCES dbo.Employees(EmployeeID)
```



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WITH CHECK | WITH NOCHECK

Specifies whether the data in the table is or is not validated against a newly added or re-enabled FOREIGN KEY or CHECK constraint. If not specified, WITH CHECK is assumed for new constraints, and WITH NOCHECK is assumed for re-enabled constraints.

If you do not want to verify new CHECK or FOREIGN KEY constraints against existing data, use WITH NOCHECK. We do not recommend doing this, except in rare cases. The new constraint will be evaluated in all later data updates. Any constraint violations that are suppressed by WITH NOCHECK when the constraint is added may cause future updates to fail if they update rows with data that does not comply with the constraint.

The query optimizer does not consider constraints that are defined WITH NOCHECK. Such constraints are ignored until they are re-enabled by using ALTER TABLE table CHECK CONSTRAINT ALL.

Disabling constraint checking when loading new data

- Applies to CHECK and FOREIGN KEY constraints
- Use when:
 - Data conforms to constraints
 - You load new data that does not conform to constraints

```
USE Northwind  
ALTER TABLE dbo.Employees  
NOCHECK  
CONSTRAINT FK_Employees_Employees
```



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Using DEFAULTS & RULES

- As independent objects they:
 - Are defined once
 - Can be bound to one or more columns or user-defined data types

```
CREATE DEFAULT phone_no_default
AS '(000)000-0000'
GO
EXEC sp_bindefault phone_no_default,
'Customers.Phone'
```

```
CREATE RULE regioncode_rule
AS @regioncode IN ('IA', 'IL', 'KS', 'MO')
GO
EXEC sp_bindrule regioncode_rule,
'Customers.Region'
```


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Using Defaults and Rules

Default :-

When bound to a column or an alias data type, a default specifies a value to be inserted into the column to which the object is bound (or into all columns, in the case of an alias data type), when no value is explicitly supplied during an insert.

```
CREATE DEFAULT [ schema_name . ] default_name
AS constant_expression [ ; ]
```

A default name can be created only in the current database. Within a database, default names must be unique by schema. When a default is created, use `sp_bindefault` to bind it to a column or to an alias data type.

Rules :-

Creates an object called a rule. When bound to a column or an alias data type, a rule specifies the acceptable values that can be inserted into that column.

A column or alias data type can have only one rule bound to it. However, a column can have both a rule and one or more check constraints associated with it. When this is true, all restrictions are evaluated.

A rule can be created only in the current database. After you create a rule, execute `sp_bindrule` to bind the rule to a column or to alias data type. A rule must be compatible with the column data type. For example, "`@value LIKE A%`" cannot be used as a rule for a numeric column. A rule cannot be bound to a text, ntext, image, varchar(max), nvarchar(max), varbinary(max), xml, CLR user-defined type, or timestamp column. A rule cannot be bound to a computed column.

Demo

- Disabling Constraints
- Working with DEFAULTS & RULES



Deciding - Enforcement method to use

| Data integrity components | Functionality | Performance costs | Before or after modification |
|------------------------------|---------------|-------------------|------------------------------|
| Constraints | Medium | Low | Before |
| Defaults and rules | Low | Low | Before |
| Triggers | High | Medium-High | After |
| Data types, Null/Not Null | Low | Low | Before |



TRUNCATE

- Removes all rows from a table
- TRUNCATE TABLE is similar to the DELETE statement with no WHERE clause

```
TRUNCATE TABLE Employees
```



Dropping table

- At times you need to delete a table, for example when you want to implement a new design or free up space in the database
- You can use DROP TABLE Transact-SQL statement to drop the table from Database

```
DROP TABLE Employee
```

- You can reference multiple tables in a single DROP TABLE command by separating the table names with comma



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Dropping table SQL Server

At times you need to delete a table (for example, when you want to implement a new design or free up space in the database). When you delete a table, its structural definition, data, full-text indexes, constraints, and indexes are permanently deleted from the database, and the space formerly used to store the table and its indexes is made available for other tables. You can explicitly drop a temporary table if you do not want to wait until it is dropped automatically.

A big consideration when dropping a table is the table's relationship to other tables. If a foreign key references the table that you want to drop, the referencing table or foreign key constraint must be dropped first. In a database that has many related tables, this can get complicated. Fortunately, a few tools can help you through this. The system Stored procedure sp_helpconstraint is one of the tools. This procedure lists all the foreign key constraints that reference a table.

The other approach is to right-click the table in Object Explorer and choose View Dependencies. The dialog that appears gives you the option of viewing the objects that depend on the table or viewing the objects on which the table depends.

To delete a table - DROP TABLE

A. Drop a table in the current database

DROP TABLE titles

This example removes the titles table and its data and indexes from the current database.

B. Drop a table in another database

DROP TABLE pubs.dbo.authors

This example drops the authors table in the pubs database. It can be executed from any database.

Commonly used T-SQL Statement

- Transact-SQL statements can be used for:
 - Creating a database
 - Creating and altering table
 - Insert, update & delete data in the table
 - Reading data from the table



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Data Manipulation Language

- INSERT - Adds a new row to a table
- UPDATE - Changes existing data in a table
- DELETE - Removes rows from a table
- MERGE- Merges the data



Using INSERT

- INSERT statement adds one or more new rows to a table
INSERT [INTO] table or view [(column_list)] data_values

```
INSERT INTO MyTable (PriKey, Description)
VALUES (123, 'A description of part 123.')
GO
```

- INSERT using SELECT statement

```
INSERT INTO MyTable (PriKey, Description)
SELECT ForeignKey, Description
FROM SomeTable
GO
```



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The INSERT statement adds one or more new rows to a table. In a simplified treatment, INSERT has the following form:

INSERT [INTO] table_or_view [(column_list)] data_values

The INSERT statement inserts data_values as one or more rows into the specified table or view. column_list is a list of column names, separated by commas, that can be used to specify the columns for which data is supplied. If column_list is not specified, all the columns in the table or view receive data.

When column_list does not specify all the columns in a table or view, either the default value, if a default is defined for the column, or NULL is inserted into any column that is not specified in the list. All columns that are not specified in the column list must either allow for null values or have a default value assigned.

INSERT statements do not specify values for the following types of columns because the SQL Server Database Engine generates the values for these columns: 1.Columns with an IDENTITY property that generates the values for the column.2.Columns that have a default that uses the NEWID function to generate a unique GUID value.

```
CREATE TABLE dbo.T1
(
    column_1 int IDENTITY, column_2 varchar(30)
    CONSTRAINT default_name DEFAULT ('my column default')
)
INSERT INTO dbo.T1 (column_2) VALUES ('Explicit value');
INSERT INTO T1 DEFAULT VALUES;
If we have to insert into column_1 value explicitly into this table then we need to
SET IDENTITY_INSERT ON
SET IDENTITY_INSERT dbo.T1 ON
INSERT INTO dbo.t1 (column_1,column_2) values(3,'some data');
```

UPDATE statement

- UPDATE statement can change data values in single rows, groups of rows, or all the rows in a table or view

```
UPDATE products  
SET unitprice=unitprice*1.1  
WHERE categoryid=2  
GO
```



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The UPDATE statement can change data values in single rows, groups of rows, or all the rows in a table or view. It can also be used to update rows in a remote server. An UPDATE statement referencing a table or view can change the data in only one base table at a time.

The UPDATE statement has the following major clauses:

SET

Contains a comma-separated list of the columns to be updated and the new value for each column, in the form *column_name = expression*. The value supplied by the expressions includes items such as constants, values selected from a column in another table or view, or values calculated by a complex expression.

FROM

Identifies the tables or views that supply the values for the expressions in the SET clause, and optional join conditions between the source tables or views.

WHERE

Specifies the search condition that defines the rows from the source tables and views that qualify to provide values to the expressions in the SET clause.

DELETE statement

- Removes one or more rows in a table or view
- A simplified form of the DELETE syntax is:

```
DELETE table_or_view  
FROM table_sources  
WHERE search_condition
```

- If a WHERE clause is not specified, all the rows in table_or_view are deleted



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The DELETE statement removes one or more rows in a table or view. A simplified form of the DELETE syntax is:

```
DELETE table_or_view  
FROM table_sources  
WHERE search_condition
```

The parameter table_or_view names a table or view from which the rows are to be deleted. All rows in table_or_view that meet the qualifications of the WHERE search condition are deleted. If a WHERE clause is not specified, all the rows in table_or_view are deleted. The FROM clause specifies additional tables or views and join conditions that can be used by the predicates in the WHERE clause search condition to qualify the rows to be deleted from table_or_view. Rows are not deleted from the tables named in the FROM clause, only from the table named in table_or_view.

Any table that has all rows removed remains in the database. The DELETE statement deletes only rows from the table; the table must be removed from the database by using the DROP TABLE statement.

MERGE statement (SQL Server 2008 onwards)

- In a typical database application, quite often you need to perform INSERT, UPDATE and DELETE operations on a TARGET table by matching the records from the SOURCE table
- To accomplish this, In previous versions of SQL Server, we had to write separate statements to INSERT, UPDATE, or DELETE data based on certain conditions
- Though it seems to be straight forward at first glance, but it becomes cumbersome when you have do it very often or on multiple tables
- Even the performance degrades significantly with this approach
- Now you can use MERGE SQL command to perform these operations in a single statement
- Using MERGE statement we can include the logic of such data modifications in one statement that even checks when the data is matched then just update it and when unmatched then insert it



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MERGE Statement

In a typical database application, quite often you need to perform INSERT, UPDATE and DELETE operations on a TARGET table by matching the records from the SOURCE table. For example, a products dimension table has information about the products; you need to sync-up this table with the latest information about the products from the source table. You would need to write separate INSERT, UPDATE and DELETE statements to refresh the target table with an updated product list or do lookups. Though it seems to be straight forward at first glance, but it becomes cumbersome when you have do it very often or on multiple tables, even the performance degrades significantly with this approach.

With SQL Server 2008, now you can use MERGE SQL command to perform these operations in a single statement. The MERGE statement basically merges data from a source result set to a target table based on a condition that you specify and if the data from the source already exists in the target or not. The new SQL command combines the sequence of conditional INSERT, UPDATE and DELETE commands in a single atomic statement, depending on the existence of a record.

MERGE statement

- The Merge statement comprises Five clauses
 - MERGE - Used to specify the Target tables to be inserted/updated/deleted
 - USING - Used to specify the Source table
 - ON - Used to specify the join condition on source and target tables
 - WHEN - Used to specify the action to be taken place based on the result of the ON clause
 - OUTPUT - Used to return the value of Insert/Update/Delete operations using the INSERTED / DELETED magic tables
- MERGE Statement - Syntax

```
MERGE <target_table> [AS TARGET]
USING <table_source> [AS SOURCE]
ON <search_condition>
[WHEN MATCHED THEN <merge_matched> ]
[WHEN NOT MATCHED [BY TARGET] THEN <merge_not_matched> ]
[WHEN NOT MATCHED BY SOURCE THEN <merge_matched> ];
```



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The Clauses used in MERGE Statement

The Merge statement uses two tables (Source and Target tables). The Source table is specified with USING clause. The Target table is specified with MERGE INTO clause.

Merge statement is similar to OUTER joins. We can use condition with Merge statement like WHEN MATCHED THEN, WHEN NOT MATCHED [BY TARGET] THEN , WHEN NOT MATCHED BY SOURCE THEN.

If the record is already there in target table then we can update the data, If its not there in target table then we an insert.

The OUTPUT clause can be used with Merge statement to return an output as INSERTED / DELETED like magic tables. We can use \$action function to identify that what kind of action taken place like INSERT / UPDATE / DELETE.

MERGE statement

- MERGE Statement - Example

```
MERGE INTO dbo.Customers AS TGT
USING dbo.CustomersStage AS SRC
ON TGT.custid = SRC.custid
WHEN MATCHED THEN
UPDATE SET
TGT.companyname = SRC.companyname,
TGT.phone = SRC.phone,
TGT.address = SRC.address
WHEN NOT MATCHED THEN
INSERT (custid, companyname, phone, address)
VALUES (SRC.custid, SRC.companyname, SRC.phone, SRC.address)
WHEN NOT MATCHED BY SOURCE THEN
DELETE
OUTPUT
$action, deleted.custid AS del_custid, inserted.custid AS ins_custid;
```



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MERGE statement

- The given example does the following
 - MERGE statement defines the Customers table as the target for the modification
 - CustomersState table as the source
 - The MERGE condition matches the custid attribute in the source with the custid attribute in the target
 - When a match is found in the target, the target customer's attributes are overwritten with the source customer attributes
 - When a match is not found in the target, a new row is inserted into the target, using the source customer attributes
 - When a match is not found in the source, the target customer row is deleted



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Demo

- Using MERGE Statement



DCL Statements

- DCL (Data Control Language)
 - DCL Statement is used for securing the database
 - DCL Statement control access to database
 - DCL statements supported by T-SQL are GRANT , REVOKE and DENY



DCL Statements

- GRANT authorizes one or more users to perform an operation or a set of operations on an object.
 - GRANT PRIVILEGES ON object-name
TO endusers;
 - grant select, update on My_table to some_user, another_user;
 - grant insert (empno, ename, job) on
 - emp to endusers;
- REVOKE removes or restricts the capability of a user to perform an operation or a set of operations.
 - REVOKE PRIVILEGES ON
object_name FROM endusers
 - revoke insert, delete on
 - emp from enduser
- DENY denies permission to a user/group , even though he may belong to a group/role having the permission
 - DENY SELECT ON Employees TO Ruser1



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Summary

- In this lesson, you have learnt:
 - Different datatypes to store numeric, character, monetary and date time data
 - New data types in SQL Server 2008 - Hierarchyid & Spatial
 - Creating UDTs
 - Creating Tables ,Manipulating Data and Assigning and revoking privileges.
 - MERGE provides an efficient way to perform multiple DML operations
 - Implement constraints like – Primary key, Foreign key, check, default and unique
 - Alter table to change structure, enable/disable constraints



Review Question

- Question 1: To create a user defined data type we use _____.
- Question 2: If we want the column data to have unique values with null then we should use _____ constraint.
- Question 3: _____ and _____ are objects like constraints that are bound to the table.
- Question 4: _____ option is used to create a constraint that should not be temporarily checked for.
- Question 5: Use _____ as a data type to create tables with a hierarchical structure.
- Question 6: _____ Used to return the value of Insert/Update/Delete operations using the INSERTED / DELETED magic tables



SQL Server 2012 – Database Development

Lesson 4: Beginning with
Transact-SQL

Lesson Objectives

- In this lesson, you will learn:
 - Transact-SQL Programming Language
 - Types of Transact-SQL Statements
 - Transact-SQL Syntax Elements
 - Restricting rows
 - Operators
 - Functions – String, Date, Mathematical, System, Others
 - Grouping and summarizing data



Transact-SQL Programming Language

- Transact SQL, also called T-SQL, is Microsoft's extension to the ANSI SQL language
- Structured Query Language(SQL), is a standardized computer language that was originally developed by IBM
- T-SQL expands on the SQL standard to include procedural programming, local variables, various support functions for string processing, date processing, mathematics, etc
- Transact-SQL is central to using SQL Server
- All applications that communicate with SQL Server do so by sending Transact-SQL statements to the server, regardless of the user interface of the application



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Transact-SQL Programming Language

T-SQL (Transact SQL) is a proprietary SQL extension used by Microsoft SQL Server. T-SQL adds extensions for procedural programming.

Transact-SQL is central to using SQL Server. All applications that communicate with an instance of SQL Server do so by sending Transact-SQL statements to the server, regardless of the user interface of the application.

Querying Data – SELECT Statement

- The Transact-SQL language has one basic statement for retrieving information from a database: the SELECT statement
- With this statement, it is possible to query information from one or more tables of a database
- The result of a SELECT statement is another table, also known as a result set
- **SELECT Statement Syntax**

```
SELECT [DISTINCT][TOP n] <columns>
      [FROM] <table names>
      [WHERE] <criteria that must be true for a row to be chosen>
      [GROUP BY] <columns for grouping aggregate functions>
      [HAVING] <criteria that must be met for aggregate functions>
      [ORDER BY] <optional specification of how the results should be sorted>
```



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Querying Data – SELECT Statement

You wouldn't have any reason to store data if you didn't want to retrieve it. Relational databases gained wide acceptance principally because they enabled users to query, or access, data easily, without using predefined, rigid navigational paths. Indeed, the acronym SQL stands for Structured Query Language. Microsoft SQL Server provides rich and powerful query capabilities.

The SELECT statement is the most frequently used SQL command and is the fundamental way to query data. The SQL syntax for the SELECT statement is intuitive—at least in its simplest forms—and resembles how you might state a request in English. As its name implies, it is also structured and precise. However, a SELECT statement can be obscure or even tricky. As long as you write a query that's syntactically correct, you get a result.

The basic form of SELECT, which uses brackets ([]) to identify optional items, is shown in the slide.

Notice that the only clause that must always be present is the verb SELECT; the other clauses are optional. For example, if the entire table is needed, you don't need to restrict data using certain criteria, so you can omit the WHERE clause.

SELECT statements primary properties

- Number and attributes of the columns
- The following attributes must be defined for each result set column
 - The data type of the column.
 - The size of the column, and for numeric columns, the precision and scale.
 - The source of the data values returned in the column
- Tables from which the result set data is retrieved
- Conditions that the rows in the source tables must meet
- Sequence in which the rows of the result set are ordered



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SELECT statements primary properties

The full syntax of the SELECT statement is complex, but most SELECT statements describe four primary properties of a result set:

- The number and attributes of the columns in the result set.
- The following attributes must be defined for each result set column:
 - The data type of the column.
 - The size of the column, and for numeric columns, the precision and scale.
 - The source of the data values returned in the column.
- The tables from which the result set data is retrieved, and any logical relationships between the tables.
- The conditions that the rows in the source tables must meet to qualify for the SELECT. Rows that do not meet the conditions are ignored.
- The sequence in which the rows of the result set are ordered.

SELECT statement

- Simple query that retrieves specific columns of all rows from a table

```
Use pubs  
GO  
SELECT au_lname, au_fname,  
       city, state, zip  
  FROM authors  
 GO
```

- Using WHERE clause

```
SELECT au_lname, au_fname, city, state, zip  
  FROM authors  
 WHERE au_lname='Ringer'  
    GO
```



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SELECT Statement

Here's a simple query that retrieves all columns of all rows from the *authors* table in the *pubs* sample database:

```
SELECT au_lname, au_fname, city, state, zip  
  FROM authors
```

You can specify a query from one table return only certain columns or rows that meet your stated criteria. In the select list, you specify the exact columns you want, and then in the WHERE clause, you specify the criteria that determine whether a row should be included in the answer set. Still using the *pubs* sample database, suppose we want to find the first name and the city, state, and zip code of residence for authors whose last name is *Ringer*.

```
SELECT au_lname, au_fname, city, state, zip  
  FROM authors  
 WHERE au_lname='Ringer'
```

Retrieving only Anne Ringer's data requires an additional expression that is combined (AND'ed) with the original. In addition, we'd like the output to have more intuitive names for some columns, so the query would be:

```
SELECT 'Last Name'=au_lname, 'First'=au_fname, city, state, zip  
  FROM authors  
 WHERE au_lname='Ringer' AND au_fname='Anne'
```

SELECT statement – Order By Clause

- Specifies the sort order used on columns returned in a SELECT statement

```
USE Northwind  
GO  
SELECT ProductId, ProductName, UnitPrice  
FROM Products  
ORDER BY ProductName ASC  
GO
```



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SELECT Statement – Order By Clause

Specifies the sort order used on columns returned in a SELECT statement. Default is ASCending sort, DESC is used to sort in a descending manner

```
SELECT ProductId, ProductName, UnitPrice  
FROM Products  
ORDER BY ProductName DESC
```

ORDER BY is the last operation to be done, before the result set is submitted to the client, therefore ORDER BY cannot be used in certain places like subquery, SELECT INTO etc.

Use of DISTINCT

- DISTINCT is used to eliminate duplicate rows
- Precedes the list of columns to be selected from the table(s)
- The DISTINCT considers the values of all the columns as a single unit and evaluates on a row-by-row basis to eliminate any redundant rows
- Example

```
SELECT DISTINCT Region  
FROM Northwind.dbo.Employees
```



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Demo

- Using SELECT Statement



Use of Operators

- An operator is a symbol specifying an action that is performed on one or more expressions.
- Arithmetic Operators
- Logical Operators
- Assignment Operator
- String Concatenation Operator
- Comparison Operators
- Compound Assignment Operator



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Use of Operators

An operator is a symbol specifying an action that is performed on one or more expressions. The following tables lists the operator categories that SQL Server uses.

- Arithmetic Operators
- Logical Operators
- Assignment Operator
- String Concatenation Operator
- Comparison Operators
- Compound Assignment Operator
- Bitwise Operators
- Unary Operators

Arithmetic Operators

| | |
|--------------|---|
| + (Add) | Addition |
| - (Subtract) | Subtraction |
| * (Multiply) | Multiplication |
| / (Divide) | Division |
| % (Modulo) | Returns the integer remainder of a division |



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Arithmetic operators perform mathematical operations on two expressions of one or more of the data types of the numeric data type category.

Operator Meaning

| | |
|--------------|--|
| + (Add) | Addition |
| - (Subtract) | Subtraction |
| * (Multiply) | Multiplication |
| / (Divide) | Division |
| % (Modulo) | Returns the integer remainder of a division. |

For example, $12 \% 5 = 2$ because the remainder of 12 divided by 5 is 2. The plus (+) and minus (-) operators can also be used to perform arithmetic operations on **datetime** and **smalldatetime** values.

Logical Operators

| Operator | Meaning |
|----------|--|
| ALL | TRUE if all of a set of comparisons are TRUE |
| AND | TRUE if both Boolean expressions are TRUE |
| ANY | TRUE if any one of a set of comparisons are TRUE |
| BETWEEN | TRUE if the operand is within a range |
| EXISTS | TRUE if a subquery contains any rows |
| IN | TRUE if the operand is equal to one of a list of expressions |
| LIKE | TRUE if the operand matches a pattern. |
| NOT | Reverses the value of any other Boolean operator |
| OR | TRUE if either Boolean expression is TRUE. |



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Logical operators test for the truth of some condition. Logical operators, like comparison operators, return a **Boolean** data type with a value of TRUE, FALSE, or UNKNOWN.

| Operator | Meaning |
|----------|--|
| ALL | TRUE if all of a set of comparisons are TRUE. |
| AND | TRUE if both Boolean expressions are TRUE. |
| ANY | TRUE if any one of a set of comparisons are TRUE. |
| BETWEEN | TRUE if the operand is within a range. |
| EXISTS | TRUE if a subquery contains any rows. |
| IN | TRUE if the operand is equal to one of a list of expr. |
| LIKE | TRUE if the operand matches a pattern. |
| NOT | Reverses the value of any other Boolean operator. |
| OR | TRUE if either Boolean expression is TRUE. |
| SOME | TRUE if some of a set of comparisons are TRUE. |

Example for IN:

```
USE Northwind
SELECT FirstName, LastName, Title
FROM Employees
WHERE Title IN ('Design Engineer', 'Tool Designer', 'Marketing
Assistant');
GO
```

Like Operators

- Pattern: The pattern to search for in match_expression.

Wildcard character

% Any string of zero or more characters.

_ (underscore)Any single character.

Example

WHERE title LIKE '%computer%' finds all book titles with the word 'computer' anywhere in the book title

WHERE au_fname LIKE '_ean' finds all four-letter first names that end with ean, such as Dean or Sean.



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Determines whether a given character string matches a specified pattern. A pattern can include regular characters and wildcard characters. During pattern matching, regular characters must match exactly the characters specified in the character string. Wildcard characters, however, can be matched with arbitrary fragments of the character string. Using wildcard characters makes the LIKE operator more flexible than using the = and != string comparison operators.

For example to list out all titles which starts with a The , the query would be

```
SELECT title, price  
FROM pubs.dbo.titles  
WHERE title LIKE 'The%'
```

The output will not be the same if the pattern is given as

```
SELECT title, price  
FROM pubs.dbo.titles  
WHERE title LIKE '%The%'
```

This would list all titles have the somewhere - beginning , middle or end

Working with NULL Values

- NULL values are treated differently from other values
- NULL is used as a placeholder for unknown or inapplicable values
- We have to use the IS NULL and IS NOT NULL operators to test for NULL Values

```
SELECT LastName, FirstName, Address  
      FROM Persons  
     WHERE Address IS NULL
```

```
SELECT LastName, FirstName, Address  
      FROM Persons  
     WHERE Address IS NOT NULL
```



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Assignment Operator

- Can create a variable
- Sets a value returned by an expression
- Can be used to establish the relationship between a column heading and the expression that defines the values for the column

```
USE AdventureWorks;
GO
SELECT FirstColumnHeading = 'xyz',
SecondColumnHeading = ProductID
FROM Products;
GO
```



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The equal sign (=) is the only Transact-SQL assignment operator. In the following example, the @MyCounter variable is created, and then the assignment operator sets @MyCounter to a value returned by an expression.

```
DECLARE @MyCounter INT;
SET @MyCounter = 1;
```

The assignment operator can also be used to establish the relationship between a column heading and the expression that defines the values for the column. The following example displays the column headings FirstColumnHeading and SecondColumnHeading. The string xyz is displayed in the FirstColumnHeading column heading for all rows. Then, each product ID from the Product table is listed in the SecondColumnHeading column heading.

```
USE AdventureWorks;
SELECT FirstColumnHeading = 'xyz',
SecondColumnHeading = ProductID
FROM Products;
```

Comparison Operator

- = (Equals) Equal to
- > (Greater Than) Greater than
- < (Less Than) Less than
- >= (Greater Than or Equal To) Greater than or equal to
- <= (Less Than or Equal To) Less than or equal to
- <> (Not Equal To) Not equal to
- != (Not Equal To) Not equal to
- !< (Not Less Than) Not less than
- !> (Not Greater Than) Not greater than



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Comparison operators test whether two expressions are the same. Comparison operators can be used on all expressions except expressions of the **text**, **ntext**, or **image** data types. The following table lists the Transact-SQL comparison operators.

| Operator | Meaning |
|----------|---|
| = | (Equals) Equal to |
| > | (Greater Than) Greater than |
| < | (Less Than) Less than |
| >= | (Greater Than or Equal To) Greater than or equal to |
| <= | (Less Than or Equal To) Less than or equal to |
| <> | (Not Equal To) Not equal to |
| != | (Not Equal To) Not equal to (not SQL-92 standard) |
| !< | (Not Less Than) Not less than (not SQL-92 standard) |
| !> | (Not Greater Than) Not greater than (not SQL-92 standard) |

Example:

```
use Northwind;
SELECT ProductID, ProductName, UnitPrice AS Price
FROM Products
WHERE SupplierID = 7 AND UnitsInStock < 25
ORDER BY ProductName ASC ;
```

Compound Assignment Operators

- `+=` Plus Equals**
- `-=` Minus Equals**
- `*=` Multiplication Equals**
- `/=` Division Equals**
- `%=` Modulo Equals**



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Compound Assignment Operators

Compound assignment operators help abbreviate code that assigns a value to a column or a variable. The new operators are:

- `+=` (plus equals)
- `-=` (minus equals)
- `*=` (multiplication equals)
- `/=` (division equals)
- `%=` (modulo equals)

You can use these operators wherever assignment is normally allowed—for example, in the SET clause of an UPDATE statement or in a SET statement that assigns values to variables. The following code example demonstrates the use of the `+=` operator:

```
DECLARE @price AS MONEY = 10.00;
SET @price += 2.00;
SELECT @price;
```

This code sets the variable `@price` to its current value, 10.00, plus 2.00, resulting in 12.00.

Demo

- Using LIKE operator
- Working with commonly used operators



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Using System Functions

- String Functions
- Date and Time Functions
- Mathematical Functions
- Aggregate Functions
- System Functions



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Using System Functions

1. **String Functions** - Perform operations on a string (**char** or **varchar**) input value and return a string or numeric value.
2. **Date and Time Functions** - Perform operations on a date and time input values and return string, numeric, or date and time values.
3. **Mathematical Functions** - Perform calculations based on input values provided as parameters to the functions, and return numeric values.
4. **Aggregate Functions** - You can use aggregate functions to calculate and summarize data.
5. **System Functions** - Perform operations and return information about values, objects, and settings in an instance of SQL Server.

Using System Functions – String Functions

- STR - Returns character data converted from numeric data
- REPLACE - Replaces all occurrences of a specified string value with another string value
- LEFT - Returns the left part of a character string with the specified number of characters
- RIGHT - Returns the right part of a character string with the specified number of characters



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Examples

The following example replaces the string code in abcdefghi with xxx.

```
SELECT REPLACE('abcdefghi','cde','xxx');
```

Here is the result set.

abxxxfgihxxx

The following example converts an expression that is made up of five digits and a decimal point to a six-position character string. The fractional part of the number is rounded to one decimal place.

```
SELECT STR(123.45, 6, 1)
```

Here is the result set.

123.5 (1 row(s) affected)

The following example returns the five leftmost characters of each product name.

```
USE Northwind;
SELECT LEFT(ProductName, 5)
FROM Products
ORDER BY ProductID;
```

Using System Functions – String Functions

- SUBSTRING - Returns part of a character, binary, text, or image expression
- LEN - Returns the number of characters of the specified string expression, excluding trailing blanks
- REVERSE - Returns the reverse of a character expression
- LOWER - Returns a character expression after converting uppercase character data to lowercase
- UPPER - Returns a character expression with lowercase character data converted to uppercase
- + -- used for concatenating strings



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The following example returns the five rightmost characters of the first name for each contact

```
USE AdventureWorks
GO
SELECT RIGHT(FirstName, 5) AS 'First Name'
FROM Person.Contact
WHERE ContactID < 5
ORDER BY FirstName; GO
```

Here is the result set.

First Name

erine
stavo
berto
Kim



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```
use Northwind;
Go
```

```
SELECT LastName, SUBSTRING(FirstName, 1, 1) AS Initial FROM Employees
WHERE LastName like 'S%'
```

```
SELECT LEN(CompanyName) AS Length, CompanyName, city
FROM Suppliers
WHERE Country = 'USA'
```

Some more string functions are:

ASCII, NCHAR, SOUNDEX, CHAR, PATINDEX, SPACE, CHARINDEX, QUOTENAME, DIFFERENCE, STUFF, REPLICATE, UNICODE, LTRIM, RTRIM. All built-in string functions are deterministic. This means they return the same value any time they are called with a specific set of input values

Example of string concatenation
SELECT TitleOfCourtesy + ' ' + LastName + ',' + FirstName
FROM northwind.dbo.Employees
ORDER BY TITLE

Using System Functions – Date Functions

- **GETDATE** - Returns the current database system timestamp as a datetime value without the database time zone offset
- **GETUTCDATE** - Returns the current database system timestamp as a datetime value. The database time zone offset is not included
- **CURRENT_TIMESTAMP** - Returns the current database system timestamp as a datetime value without the database time zone offset
- **SYSDATETIME** - Returns a datetime2(7) value that contains the date and time of the computer on which the instance of SQL Server is running. The time zone offset is not included



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Date Functions Examples

GETDATE

```
SELECT GETDATE()
```

Result - 2012-03-10 13:56:36.620

GETUTCDATE

```
SELECT GETUTCDATE()
```

Result - 2012-03-10 13:56:36.620

CURRENT_TIMESTAMP

```
SELECT CURRENT_TIMESTAMP
```

Result - 2012-03-10 13:56:36.620

SYSDATETIME

```
Result - 2012-04-10 14:04:46.50
```

Using System Functions – Date Functions

- **SYSDATETIMEOFFSET** - Returns a datetimeoffset(7) value that contains the date and time of the computer on which the instance of SQL Server is running. The time zone offset is included.
- **SYSUTCDATETIME** - Returns a datetime2(7) value that contains the date and time of the computer on which the instance of SQL Server is running. The date and time is returned as UTC time (Coordinated Universal Time).



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SYSDATETIMEOFFSET – DATETIMEOFFSET Defines a date that is combined with a time of a day that has time zone awareness and is based on a 24-hour clock

```
SELECT SYSDATETIMEOFFSET()
```

Result - 2012-03-10 14:06:56.7418989 +05:30

SYSUTCDATETIME

```
SELECT SYSUTCDATETIME()
```

Result - 2012-03-10 08:39:06.94

Date Functions – To retrieve Date & Time Parts

- **DATENAME** - Returns a character string that represents the specified datepart of the specified date
- **DATEPART** - Returns an integer that represents the specified datepart of the specified date

| datepart | Return value – DATEPART | Return Value - DATENAME |
|------------------|-------------------------|-------------------------|
| year, yyyy, yy | 2007 | 2007 |
| quarter, qq, q | 4 | 4 |
| month, mm, m | 9 | October |
| dayofyear, dy, y | 303 | 303 |
| day, dd, d | 30 | 30 |
| week, wk, ww | 44 | 44 |
| weekday, dw | 3 | Tuesday |
| hour, hh | 12 | 12 |
| minute, n | 15 | 15 |
| second, ss, s | 32 | 32 |
| millisecond, ms | 123 | 123 |
| microsecond, mcs | 123456 | 123456 |



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Examples

The following example extracts the month name from the date returned by GETDATE.

```
SELECT DATENAME(month, GETDATE()) AS 'Month Name';
```

Result

Month Name

February

The following example extracts the month name from a column.

USE AdventureWorks

GO

```
SELECT StartDate, DATENAME(month, StartDate) AS StartMonth FROM Production.WorkOrder WHERE WorkOrderID = 1; GO
```

Result

StartDate StartMonth

2001-07-04 00:00:00.000 July

Try this :

```
SELECT DATENAME(YEAR,GETDATE())
SELECT DATEPART(YEAR,GETDATE())
SELECT DATENAME(MONTH,GETDATE())
SELECT DATEPART(MONTH,GETDATE())
```

Using System Functions – Date Functions

- **DATEDIFF** - Returns the count (signed integer) of the specified datepart boundaries crossed between the specified startdate and enddate.
- **DATEADD** - Returns a specified date with the specified number interval (signed integer) added to a specified datepart of that date.



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Examples

DATEDIFF

```
CREATE TABLE dbo.Duration
(
    startDate datetime2 ,endDate datetime2
)
INSERT INTO dbo.Duration(startDate,endDate)
VALUES('2007-05-06 12:10:09','2007-05-07 12:10:09')
```

```
SELECT DATEDIFF(day,startDate,endDate) AS 'Duration' FROM dbo.Duration;
-- Returns: 1
```

DATEADD-

The following example adds 2 days to each OrderDate to calculate a new PromisedShipDate.

```
USE AdventureWorks;
GO
SELECT SalesOrderID
    ,OrderDate
    ,DATEADD(day,2,OrderDate) AS PromisedShipDate
FROM Sales.SalesOrderHeader;
```

Using System Functions – Mathematical Functions

- **ABS** - A mathematical function that returns the absolute (positive) value of the specified numeric expression
- **RAND** - Returns a random float value from 0 through 1
- **ROUND** - Returns a numeric value, rounded to the specified length or precision
- **SQRT** - Returns the square root of the specified float value



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The following scalar functions perform a calculation, usually based on input values that are provided as arguments, and return a numeric value:

ABS - A mathematical function that returns the absolute (positive) value of the specified numeric expression.

RAND - Returns a random **float** value from 0 through 1.

RAND ([seed])

ROUND - Returns a numeric value, rounded to the specified length or precision.

ROUND (*numeric_expression* , *length* [,*function*])

SQRT - Returns the square root of the specified float value.

SQRT (*float_expression*)

Examples:

`SELECT ABS(-1.0), ABS(0.0), ABS(1.0);`

Here is the result set.

| | | |
|-----|----|-----|
| 1.0 | .0 | 1.0 |
|-----|----|-----|

`SELECT ROUND(123.4545, 2); GO` (Output: 123.4500)

`SELECT ROUND(123.45, -2);GO` (Output: 100.00)

Some more mathematical functions are:

DEGREES, ACOS, EXP, ASIN, FLOOR, SIGN, ATAN, LOG, SIN, ATN2, LOG10, CEILING, PI, SQUARE, COS, POWER, TAN, COT, RADIANS

Using System Functions – Aggregate Functions

- The aggregate functions are: sum, avg, count, min, max, and count(*)
- Aggregate functions are used to calculate and summarize data

```
USE pubs  
GO
```

```
SELECT AVG(price * 2)  
FROM titles  
GO
```

```
SELECT MAX(price) as Maxprice,MIN(price) as Minprice  
FROM titles  
GO
```



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Using aggregate functions

The aggregate functions are: **sum, avg, count, min, max, and count(*)**. You can use aggregate functions to calculate and summarize data.

Examples:

```
use pubs;  
select sum(ytd_sales)  
from titles;
```

Note that there is no column heading for the aggregate column.

An aggregate function takes as an argument the column name on whose values it will operate. You can apply aggregate functions to all the rows in a table, to a subset of the table specified by a **where** clause, or to one or more groups of rows in the table. From each set of rows to which an aggregate function is applied, Adaptive Server generates a single value.

Here is the syntax of the aggregate function:

aggregate_function ([all | distinct] expression)

Expression is usually a column name. However, it can also be a constant, a function, or any combination of column names, constants, and functions connected by arithmetic or bitwise operators. You can also use a **case** expression or subquery in an expression.

System Functions – To retrieve System Information

- **CURRENT_TIMESTAMP** - Returns the current date and time, equivalent to GETDATE.
- **CURRENT_USER** - Returns the name of the current user, equivalent to USER_NAME().
- **HOST_ID & HOST_NAME** - Returns the workstation identification number and name.



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The following functions perform operations on and return information about values, objects, and settings in SQL Server

CURRENT_TIMESTAMP - Returns the current date and time. This function is the ANSI SQL equivalent to GETDATE.

CURRENT_USER - Returns the name of the current user. This function is equivalent to USER_NAME().

HOST_ID - Returns the workstation identification number. The workstation identification number is the process ID (PID) of the application on the client computer that is connecting to SQL Server.

HOST_NAME - Returns the workstation name.

System Functions – To retrieve System Information

- CAST and CONVERT - Explicitly converts an expression of one data type to another
- CAST (expression AS data_type [(length)])
- CONVERT (data_type [(length)] , expression [, style])

Example

```
Select CONVERT(char,100) --converts 100 to '100'
```

```
Select CAST(100 as char)
```



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CAST and CONVERT - Explicitly converts an expression of one data type to another. CAST and CONVERT provide similar functionality.

Syntax

Syntax for CAST: CAST (expression AS data_type [(length)])

Syntax for CONVERT: CONVERT (data_type [(length)] , expression [, style])

Demo

- Working with commonly used Functions



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Organizing Query result into Groups

- Using group by clause
- Group by clause divides the output of a query into groups
- Can group by one or more column names

Example

lists no of employees in each region

```
SELECT Region, count(EmployeeID)
FROM Northwind.dbo.Employees
GROUP by REGION
GO
```



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Organizing query results into groups: the **group by** clause

The **group by** clause divides the output of a query into groups. You can group by one or more column names, or by the results of computed columns using numeric datatypes in an expression. When used with aggregates, **group by** retrieves the calculations in each subgroup, and may return multiple rows. The maximum number of columns or expressions you can use in a **group by** clause is 16. You cannot **group by** columns of text or image datatypes.

While you can use **group by** without aggregates, such a construction has limited functionality and may produce confusing results. The following example groups the results by title type:

select type, advance from titles group by type,advance

| type | advance |
|--------------|-----------|
| business | 5,000.00 |
| business | 5,000.00 |
| business | 10,125.00 |
| business | 5,000.00 |
| mod_cook | 0.00 |
| mod_cook | 15,000.00 |
| UNDECIDED | NULL |
| popular_comp | 7,000.00 |
| popular_comp | 8,000.00 |
| popular_comp | NULL |
| | |

Groups By

- SQL standards for group by are more restrictive
- SQL standard requires that:
 - Columns in a select list must be in the group by expression or they must be arguments of aggregate functions
 - A group by expression can only contain column names in the select list

```
USE pubs;
GO
select pub_id, type, avg(price), sum(ytd_sales)
from titles
group by pub_id, type
GO
```



Using Aggregation with Groups

```
USE pubs;
GO
select type, sum(advance)
from titles
group by type;
GO
```



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With an aggregate for the *advance* column, the query returns the sum for each group:

select type, sum(advance) from titles group by type

| type | |
|--------------|-----------|
| UNDECIDED | NULL |
| business | 25,125.00 |
| mod_cook | 15,000.00 |
| popular_comp | 15,000.00 |
| psychology | 21,275.00 |
| trad_cook | 19,000.00 |

The summary values in a **group by** clause using aggregates are called vector aggregates, as opposed to scalar aggregates, which result when only one row is returned.

Selecting Group

- Use the having clause to display or reject rows defined by the group by clause

Example

```
USE pubs;
GO
select type
from titles
group by type
having count(*) > 1
GO
```

```
USE pubs;
GO
select type
from titles
where count(*) > 1
GO
```



Selecting groups of data: the **having** clause

Use the **having** clause to display or reject rows defined by the **group by** clause. The **having** clause sets conditions for the **group by** clause in the same way **where** sets conditions for the **select** clause, except **where** cannot include aggregates, while **having** often does.

How the **having**, **group by**, and **where** clauses interact

When you include the **having**, **group by**, and **where** clauses in a query, the sequence in which each clause affects the rows determines the final results:

The **where** clause excludes rows that do not meet its search conditions.

The **group by** clause collects the remaining rows into one group for each unique value in the **group by** expression.

Aggregate functions specified in the select list calculate summary values for each group.

The **having** clause excludes rows from the final results that do not meet its search conditions.

The following query illustrates the use of **where**, **group by**, and **having** clauses in one **select** statement containing aggregates:

```
select stor_id, title_id, sum(qty)
from salesdetail
where title_id like 'PS%'
group by stor_id, title_id having sum(qty) > 200
```

Grouping Sets

- SQL Server 2008 introduces several extensions to the GROUP BY clause that enable you to define multiple groupings in the same query
- We can use grouping set for single result set instead of using UNION ALL with multiple queries for various grouping sets for various calculations
- SQL Server optimizes the data for access and grouping



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Grouping Sets

SQL Server 2008 introduces several extensions to the GROUP BY clause that enable you to define multiple groupings in the same query. We can use grouping set for single result set instead of using UNION ALL with multiple queries for various grouping sets for various calculations. SQL Server optimizes the data for access and grouping.

Without the extensions, a single query normally defines one “grouping set” (a set of attributes to group by) in the GROUP BY clause. If you want to calculate aggregates for multiple grouping sets, you usually need multiple queries. If you want to unify the result sets of multiple GROUP BY queries, each with a different grouping set, you must use the UNION ALL set operation between the queries.

You might need to calculate and store aggregates for various grouping sets in a table. By pre-processing and materializing the aggregates, you can support applications that require fast response time for aggregate requests. However, the aforementioned approach, in which you have a separate query for each grouping set, is very inefficient. This approach requires a separate scan of the data for each grouping set and expensive calculation of aggregates.

Grouping Sets

- Example – Grouping Sets equivalent to UNION ALL

```
SELECT customer, NULL as  
year, SUM(sales) FROM T  
GROUP BY customer UNION  
ALL SELECT NULL as  
customer, year, SUM(sales)  
FROM T GROUP BY year
```

```
SELECT customer, year,  
SUM(sales) FROM T  
GROUP BY GROUPING  
SETS ((customer), (year))
```



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With the new GROUPING SETS subclause, you simply list all grouping sets that you need. Logically, you get the same result set as you would by unifying the result sets of multiple queries.

However, with the GROUPING SETS subclause, which requires much less code, SQL Server optimizes data access and the calculation of aggregates. SQL Server will not necessarily need to scan data once for each grouping set; plus, in some cases it calculates higher-level aggregates based on lower-level aggregates instead of re-aggregating base data.

Demo

- Working with Group By



Introduction

- SET operators are mainly used to combine the same type of data from two or more tables into a single result
- SET Operators supported in SQL Server are
 - UNION /UNION ALL
 - INTERSECT
 - EXCEPT



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UNION

Combine two or more result sets into a single set, without duplicates.

UNION ALL

Combine two or more result sets into a single set, including all duplicates.

INTERSECT

Takes the data from both result sets which are in common.

EXCEPT

Takes the data from first result set, but not the second (i.e. no matching to each other)

Introduction (Contd...)

■ UNION /UNION ALL

- Combine two or more result sets into a single set, without duplicates.
- The number of columns have to match
- UNION ALL works exactly like UNION except that duplicates are NOT removed

```
SELECT ProductID,ProductName FROM Products  
WHERE categoryID=1234  
UNION  
SELECT ProductID,ProductName FROM Products  
WHERE categoryID=5678  
GO
```



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The above query will list all products belonging to category 1234 and 5678

The number of columns in the SELECT clauses must be same . In case the result has to be sorted on any order , the last query can only have Order by clause

Introduction (Contd...)

■ INTERSECT

- Takes the data from both result sets which are in common.
- All the other conditions remain same

```
SELECT CustomerID FROM Customers  
INTERSECT  
SELECT CustomerID FROM Orders
```

■ EXCEPT

- Takes the data from first result set, which is not available in the second
- It is like a complement operation

```
SELECT CustomerID FROM Customers  
EXCEPT  
SELECT CustomerID FROM Orders
```



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Here in this example using an INTERSECT operation I can find out all Customers who have placed orders

Using an EXCEPT operation , I can find out all Customers who haven't placed any Orders

Rules of Set Operation

- The result sets of all queries must have the same number of columns.
- In every result set the data type of each column must match the data type of its corresponding column in the first result set.
- In order to sort the result, an ORDER BY clause should be part of the last statement.
- The records from the top query must match the positional ordering of the records from the bottom query.
- The column names or aliases of the result set are given in the first select statement



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Summary

- Transact-SQL is central to using SQL Server
- SELECT is the basic & commonly used data retrieval statement used in SQL Server
- SQL Server provides variety of System functions which can help us in performing our day to day activities
- For example, String Functions, Date Functions, Mathematical functions, Aggregate Functions and so on
- We can make use of Group By to divide the SQL query result into groups
- We can use grouping set for single result set instead of using UNION ALL with multiple queries for various grouping sets for various calculations



Review Question

- Question 1: _____ is central to using SQL Server
- Question 2: _____ returns the current database system timestamp as a datetime value without the database time zone offset
- Question 3: We can use _____ for single result set instead of using UNION ALL with multiple queries



Review Question

- Question 1: The Set operation that will show all the rows from both the resultsets including duplicates is
 - Option 1: Union All
 - Option 2: Union
 - Option 3: Intersect
 - Option 4: Minus

- Question 2: The Except operator returns _____



SQL Server 2012 – Database Development

Lesson 5: Working with Joins
and Subqueries

Lesson Objectives

- In this lesson, you will learn:
 - What are joins?
 - Types of Joins
 - Using Subqueries
 - Restrictions on Subqueries



Joins

- Retrieving data from several tables ,based on a relationship between certain columns in these tables
- Most of the time it would be the Foreign key
- One can join maximum 256 tables in single query



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By using joins, you can retrieve data from two or more tables based on logical relationships between the tables. Joins indicate how SQL Server should use data from one table to select the rows in another table.

A join condition defines the way two tables are related in a query by:

A join operation compares two or more tables (or views) by specifying a column from each, comparing the values in those columns row by row, and linking the rows that have matching values. It then displays the results in a new table. The tables specified in the join can be in the same database or in different databases.

When you join two or more tables, the columns being compared must have similar values--that is, values using the same or similar datatypes.

There are several types of joins, such as equijoins, natural joins, and outer joins. The most common join, the equijoin, is based on equality

If the joining table have the same column names the query engine would report an error because of ambiguity . Therefore one has to qualify the column names with Table names as given in the example.

Types of Joins

- INNER join
 - Equijoin
 - Nonequijoin
- Outer join
 - LEFT outer
 - RIGHT outer
 - FULL outer
- Self join
- Cross join



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Inner Join

Retrieves records from multiple tables based on the equality on the values of the common column. Inner joins are commutative in nature i.e same results come when A is joined with B or B is joined with A .

Self Join

A table joined with itself.

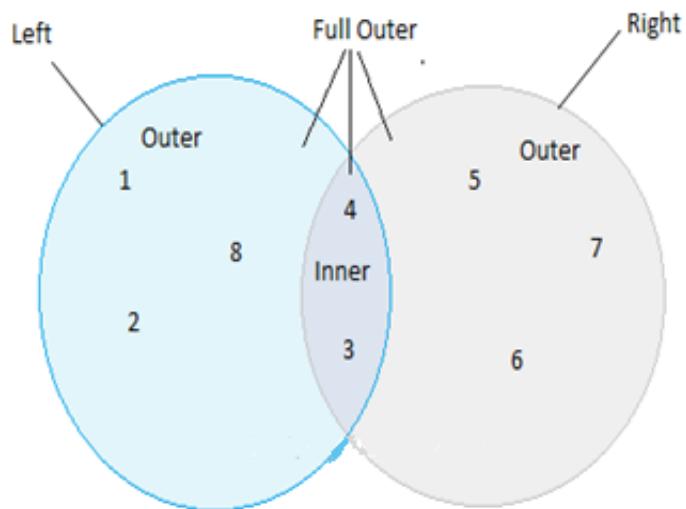
Outer Join

Displays the result set containing all the rows from one table and the matching rows from the another table. The table from where all the rows are retrieved is called OUTER table and other table is called as inner table . Based on the direction of the OUTER table , the outer joins can be LEFT , RIGHT FULL outer joins have both matched and unmatched rows of all tables

Cross Join (Cartesian Product)

Cross Join happens when each row from one table is joined with all the row of the other table. This typically can be done by removing the where clause

The syntax of all the joins are explained in the next section

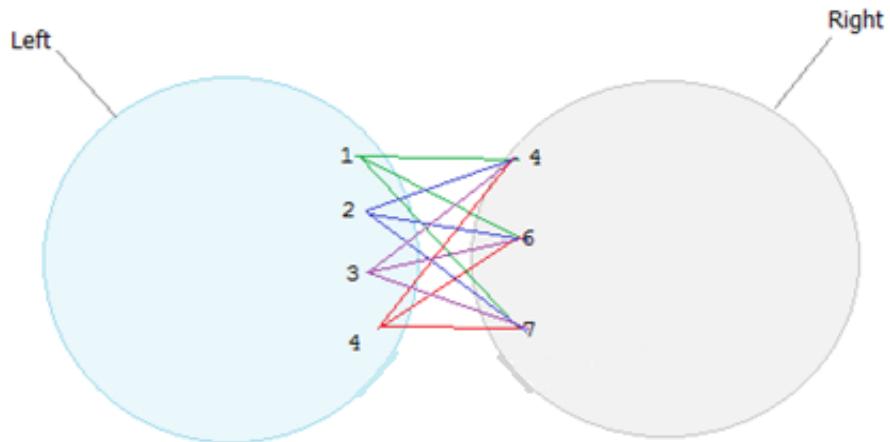


Inner Join Result : (4,3)

Left Join Result : (1,2,8,4,3)

Right Join Result : (5,6,7,4,3)

Full Outer Join Result : (1,2,8,4,3,5,6,7)



Cross Join Result : ((1,4),(1,6),(1,7),(2,4),(2,6),(2,7),
(3,4),(3,6),(3,7),(4,4),(4,6),(4,7))

Introducing T- SQL JOIN Syntax

```
SELECT <>Column List>>
FROM Table name1
[INNER] JOIN Table name2
ON join criteria
WHERE condition criteria
```

OR

```
SELECT <>Column List>>
FROM Table name1 , Table name2
WHERE Join criteria
AND condition criteria
```



Inner Join

```
USE Northwind
```

```
GO
```

```
SELECT ProductID, ProductName, CategoryName  
FROM Products, Categories  
WHERE Products.CategoryID=Categories.CategoryID  
GO
```



INNER JOIN – More than 2 tables

- Number of joins = number of tables - 1

```
USE northwind  
GO
```

```
SELECT categoryname, description,  
productname, productid, companynname, suppliers.city  
FROM products, categories, suppliers  
WHERE Products.categoryid = Categories.categoryid  
AND Products.supplierid = Suppliers.supplierid  
AND Suppliers.city = 'London'  
ORDER by productname  
GO
```



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When more than 2 tables need to be joined, the number of joins to be created will be one less than the total number of tables to be joined.

INNER JOIN – More than 2 tables

Example :-

```
SELECT categoryname, description, productname,  
productid, companyname, Suppliers.city  
FROM products  
INNER JOIN categories  
ON Products.categoryid = Categories.categoryid  
INNER JOIN Suppliers  
ON Products.supplierid = Suppliers.supplierid  
WHERE Suppliers.city = 'london'  
ORDER by Prodcts.productname
```



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An inner join is a join in which the values in the columns being joined are compared using a comparison operator.

In the SQL-92 standard, inner joins can be specified in either the FROM or WHERE clause. This is the only type of join that SQL-92 supports in the WHERE clause. Inner joins specified in the WHERE clause are known as old-style inner joins.

This inner join is known as an equijoin. It returns all the columns in both tables, and returns only the rows for which there is an equal value in the join column.

Example:

```
select colum1 FROM Table1  
INNER JOIN Table2  
ON Table1.col1=Table2.col1
```

OUTER JOIN

- Inner joins eliminates rows which doesn't have a match in the joining tables
- Outer joins returns all rows from one of the joining tables and matched rows from the others
- Outer joins can be further classified as
 - LEFT OUTER JOIN or LEFT JOIN
 - RIGHT OUTER JOIN or RIGHT JOIN
 - FULL OUTER JOIN or FULL JOIN



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Inner joins return rows only when there is at least one row from both tables that matches the join condition. Inner joins eliminate the rows that do not match with a row from the other table. Outer joins, however, return all rows from at least one of the tables (or views) mentioned in the FROM clause, as long as those rows meet any WHERE or HAVING search conditions. All rows are retrieved from the left table referenced with a left outer join, and all rows from the right table referenced in a right outer join. All rows from both tables are returned in a full outer join.

Microsoft SQL Server 2008 uses these SQL-92 keywords for outer joins specified in a FROM clause.

- LEFT OUTER JOIN or LEFT JOIN
- RIGHT OUTER JOIN or RIGHT JOIN
- FULL OUTER JOIN or FULL JOIN

Using Left Outer Joins

- Left Outer - all records from left table and corresponding matching records from right

T-SQL Syntax

```
SELECT categoryname, description,
productname, productid
FROM CATEGORIES
LEFT OUTER JOIN PRODUCTS
ON PRODUCTS.categoryid = CATEGORIES.categoryid
GO
```



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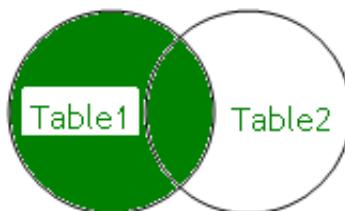
Using Left Outer Joins

Consider a join of the Products table and the Categories table on their CategoryID columns.

To include all category id, regardless of whether a product exists for that category or not, use an SQL-92 left outer join. The following is the query:

```
SELECT categoryname, description,
productname, productid
FROM CATEGORIES
LEFT OUTER JOIN PRODUCTS
ON PRODUCTS.categoryid = CATEGORIES.categoryid
GO
```

The LEFT OUTER JOIN includes all rows in the categories table in the results, whether or not there is a match on the CategoryID column in the Products table. Notice that in the results where there is no matching categoryID for a product, the row contains a null value in the productname and productID column.



RIGHT OUTER Join

- T-SQL Syntax

```
SELECT categoryname, description,  
productname, productid  
FROM CATEGORIES  
RIGHT OUTER JOIN PRODUCTS  
ON PRODUCTS.categoryid = CATEGORIES.categoryid  
GO
```



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A right outer join (or right join) closely resembles a left outer join, except with the treatment of the tables reversed. Every row from the right table is retrieved with corresponding match from the left table.

FULL OUTER JOIN

- FULL OUTER JOIN - includes all rows from both tables

```
USE Northwind;
GO
SELECT categoryname, description,
productname, productid
FROM CATEGORIES
FULL OUTER JOIN PRODUCTS
ON PRODUCTS.categoryid = CATEGORIES.categoryid
GO
```



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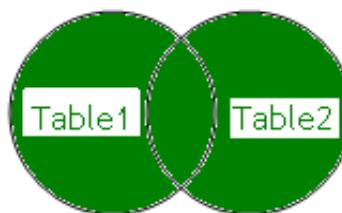
Using Full Outer Joins

To retain the non-matching information by including non-matching rows in the results of a join, use a full outer join. SQL Server provides the full outer join operator, FULL OUTER JOIN, which includes all rows from both tables, regardless of whether or not the other table has a matching value.

Consider a join of the Product table and the Categories table on their categoryID columns. The results show only the Products that have sales orders on them. The SQL-92 FULL OUTER JOIN operator indicates that all rows from both tables are to be included in the results, regardless of whether there is matching data in the tables.

You can include a WHERE clause with a full outer join to return only the rows where there is no matching data between the tables.

There is no T-SQL equivalent of FULL JOIN .



SELF JOIN

- A self join is when a table joins with itself
- Self join is possible when the table has references to itself
For example to query employees along with managers who are also employees

```
SELECT emp.EmployeeID , emp.EmployeeName, mgr.EmployeeName  
FROM Employee emp  
INNER JOIN Employee mgr  
ON emp.ManagerID = mgr.EmployeeID
```



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A table can be joined to itself in a self-join. This typically happens, when the records in a table have a reference in the same table itself. For example Given an employee table with the following structure

EmployeeID
EmployeeName
SupervisorID
Basic

Here supervisor is also an employee, therefore to list all employees along with manager names, one has to do a self join. Appropriate aliases are used to distinguish the columns.

A self join is a join in all possible ways except that it joins to another instance of itself

CROSS JOIN

- Cross join does not have a WHERE clause
- Result set is the number of rows in the first table multiplied by the number of rows in the second table- a Cartesian product

```
USE Northwind;
GO
SELECT categoryname, description, productname, productid
FROM CATEGORIES ,PRODUCTS
GO
```

```
USE Northwind;
GO
SELECT categoryname, description, productname, productid
FROM CATEGORIES CROSS JOIN PRODUCTS
ORDER BY CategoryName
```



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A cross join that does not have a WHERE clause produces the Cartesian product of the tables involved in the join. The size of a Cartesian product result set is the number of rows in the first table multiplied by the number of rows in the second table.

Subquery

- A sub query is an SQL statement that is used within another SQL statement
- Subqueries are used to handle query requests that are expressed as the results of other queries
- Subquery can be embedded in WHERE /HAVING statement

```
USE Northwind;
GO
SELECT EmployeeID,EmployeeName
FROM Employees
WHERE Region=
(SELECT Region from Employees
 WHERE EmployeeID=12345)
```



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How subqueries work

Subqueries, also called inner queries, appear within a **where** or **having** clause of another SQL statement or in the select list of a statement. You can use subqueries to handle query requests that are expressed as the results of other queries. A statement that includes a subquery operates on rows from one table, based on its evaluation of the subquery's **select** list, which can refer either to the same table as the outer query, or to a different table. In Transact-SQL, a subquery can also be used almost anywhere an expression is allowed, if the subquery returns a single value. A **case** expression can also include a subquery.

For example, this subquery lists the employee details of all employees who belong to the same region as employee 12345

```
USE Northwind;
GO
SELECT EmployeeID, EmployeeName
FROM Employees
WHERE Region=
(SELECT Region from Employees
 WHERE EmployeeID=12345)
```



select statements that contain one or more subqueries are sometimes called nested queries or nested select statements.

You can formulate as joins many SQL statements that include a subquery. Other questions can be posed only with subqueries. Some people find subqueries easier to understand. Other SQL users avoid subqueries whenever possible. You can choose whichever formulation you prefer.

The result of a subquery that returns no values is NULL. If a subquery returns NULL, the query failed.

Subquery restrictions

- Subquery_select_list can consist of only one column name
- Subqueries can be nested inside the where or having clause
- Subquery can appear almost anywhere an expression can be used, if it returns a single value
- Subqueries cannot manipulate their results internally i.e. ORDER BY Clause cannot be used inside the subquery
- If the sub query returns more than 1 row then outer query has to use appropriate operator like IN , ANY etc.



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A subquery is subject to the following restrictions:

1. The subquery_select_list can consist of only one column name, except in the **exists** subquery, where an (*) is usually used in place of the single column name. Do not specify more than one column name. Qualify column names with table or view names if there is ambiguity about the table or view to which they belong.
2. Subqueries can be nested inside the **where** or **having** clause of an outer **select**, **insert**, **update**, or **delete** statement, inside another subquery, or in a select list. Alternatively, you can write many statements that contain subqueries as joins; Adaptive Server processes such statements as joins.
3. In Transact-SQL, a subquery can appear almost anywhere an expression can be used, if it returns a single value.
4. The select list of an inner subquery introduced with a comparison operator can include only one expression or column name, and the subquery must return a single value. The column you name in the **where** clause of the outer statement must be join-compatible with the column you name in the subquery select list.
5. Subqueries cannot manipulate their results internally, that is, a subquery cannot include the **order by** clause, the **compute** clause, or the **into** keyword.

Types of Subqueries

- Single Row Sub query
- Multi Row Sub query
- Sub query for Existence
- Correlated Sub Query



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6. Correlated (repeating) subqueries are not allowed in the **select** clause of an updatable cursor defined by **declare cursor**.
7. There is a limit of 16 nesting levels.
8. The maximum number of subqueries on each side of a union is 16.
9. The **where** clause of a subquery can contain an aggregate function only if the subquery is in a **having** clause of an outer query and the aggregate value is a column from a table in the **from** clause of the outer query.

There are three basic types of subqueries.

Single ROW subquery

Such subquery returns only 1 value . Therefore the operator which can be used =, >, >=, <, <=, and <>.

The subquery can be used in WHERE and HAVING clause

Multiple ROW Subqueries

Subqueries which return more than 1 row . Some operators that can be used with multiple-row subqueries are:

IN, equal to any member in the list

ANY, compare values to each value returned by the subquery.

ALL , All the values

The examples of each type is explained in the next few sections

Multi Row Subquery

- Subqueries returns a list of zero or more values and can include a GROUP BY or HAVING clause
- >ALL means greater than every value
- >ANY means greater than at least one value

```
SELECT ProductID, ProductName, UnitPrice  
FROM PRODUCTS WHERE SupplierID IN  
(SELECT SupplierID  
FROM Suppliers  
WHERE CITY="NEW York")
```



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Comparison operators that introduce a subquery can be modified by the keywords ALL or ANY. SOME is an SQL-92 standard equivalent for ANY.

Subqueries introduced with a modified comparison operator return a list of zero or more values and can include a GROUP BY or HAVING clause. These subqueries can be restated with EXISTS.

Using the > comparison operator as an example, >ALL means greater than every value. In other words, it means greater than the maximum value. For example, >ALL (1, 2, 3) means greater than 3. >ANY means greater than at least one value, that is, greater than the minimum. So >ANY (1, 2, 3) means greater than 1.

For a row in a subquery with >ALL to satisfy the condition specified in the outer query, the value in the column introducing the subquery must be greater than each value in the list of values returned by the subquery.

Similarly, >ANY means that for a row to satisfy the condition specified in the outer query, the value in the column that introduces the subquery must be greater than at least one of the values in the list of values returned by the subquery.

Multi Row Subquery

```
SELECT ProductID, ProductName, SupplierID  
FROM Products  
WHERE UnitPrice > ALL  
(Select UnitPrice  
FROM Products  
WHERE SupplierID=10098)
```



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In this example you are listing all those products whose price is above all the price of products supplied by supplier 10098

EXISTS

- EXISTS checks for a existence of a condition
- The EXISTS condition is considered "to be met" if the subquery returns at least one row.

```
SELECT SupplierID  
FROM suppliers  
WHERE EXISTS  
(select 'A'  
     from orders  
    where suppliers.supplier_id =  
          orders.supplier_id);
```



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Subquery that is introduced with **exists** is different from other subqueries, in these ways:

- The keyword **exists** is not preceded by a column name, constant, or other expression.
- The subquery **exists** evaluates to TRUE or FALSE rather than returning any data.

Since EXISTS evaluates to TRUE /FALSE for a condition , there Is no need to return all the columns , a single column or a value can be returned back which will improve performance.

Summary

- In this lesson, you have learnt:
 - Joins are used to fetch data from more than 2 tables.
 - Join types: equijoin, non-equijoin, outer join, self join
 - Subquery is query within a query or nested query
 - Subquery types



Review Question

- Question 1: If we do not include a join condition then the result leads to _____
- Question 2: _____ return all rows from at least one of the tables in the FROM clause
- Question 3: When subquery depends on the outer query for its execution then it is _____ subquery.
- Question 4: Subquery _____ evaluates to TRUE or FALSE rather than returning any data



SQL Server 2012 – Database Development

Lesson 6: Database Objects:
Indexes & Views

Lesson Objectives

- In this lesson, you will learn:
 - Creating Indexes
 - Querying the sysindexes Table
 - Performance Considerations
 - Creating Views



Index – An Overview

- Database systems generally use indexes to provide fast access to relational data
- An index is a separate physical data structure that enables queries to access one or more data rows fast
- This structure is known as B-Tree Structure
- Proper tuning of index is therefore a key for query performance
- Database Engine uses index to find the data just like one uses index in a book
- When a table is dropped , indexes also get dropped automatically
- Only the owner of the table can create indexes
- SQL Server supports two types of indexes
 - Clustered
 - Non clustered



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Index – An Overview

Database systems generally use indexes to provide fast access to relational data. An index is a separate physical data structure that enables queries to access one or more data rows faster. This structure is known as B-Tree Structure. B-Tree helps the SQL Server find the row or rows associated with the key values. Proper tuning of indexes is therefore a key for query performance.

An index is in many ways similar to a book index.

When you are looking for a particular topic in a book, you use its index to find the page where that topic is described. Similarly, when you search for a row of a table, Database Engine uses an index to find its physical location.

However, there are two main differences between a book index and a database index:

- As a book reader, you have a choice to decide whether or not to use the book's index. This possibility generally does not exist if you use a database system
- A particular book's index is edited together with the book and does not change at all. This means that you can find a topic exactly on the page where it is determined in the index. In contrast, a database index can change each time the corresponding data is changed.

How SQL Server access data?

- SQL Server accesses data in one of two ways:

By scanning all the data pages in a table, which is called a table scan. When SQL Server performs a table scan, it:

- Starts at the beginning of the table
 - Scans from page to page through all the rows in the table
 - Extracts the rows that meet the criteria of the query
- By using indexes. When SQL Server uses an index, it:
 - Traverses the index tree structure to find rows that the query requests
 - Extracts only the needed rows that meet the criteria of the query



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How SQL Server access data?

If a table does not have an appropriate index, the database system uses the table scan method to retrieve rows. Table scan means that each row is retrieved and examined in sequence (from first to last) and returned in the result set if the search condition in the WHERE clause evaluates to true. Therefore, all rows are fetched according to their physical memory location. This method is less efficient than an index access, as explained next.

SQL Server first determines whether an index exists. Then the query optimizer—the component responsible for generating the optimal execution plan for a query—determines whether scanning a table or using the index is more efficient for accessing data.

Clustered Index

- A clustered index determines the physical order of the data in a table
- Database Engine allows the creation of a single clustered index per table
- If a clustered index is defined for a table, the table is called a clustered table
- A Unique Clustered index is built by default for each table, for which you define the primary key using the primary key constraint
- Also, each clustered index is unique by default that is, each data value can appear only once in a column for which the clustered index is defined



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Non-Clustered Index

- A Non-Clustered index has the same index structure as a clustered index
- A Non-Clustered index does not change the physical order of the rows in the table
- A table can have more than one non clustered index
- Unique Non-Clustered index will be created automatically when you create unique key on a column to enforce uniqueness of key value



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Filtered Index

- SQL Server 2008 introduces filtered indexes and statistics
- The Non-Clustered indexes now can be created based on a predicate, and only the subset of rows for which the predicate holds true are stored in the index B-Tree
- Well-designed filtered indexes can improve query performance and plan quality because they are smaller than non-filtered indexes
- We can also reduce index maintenance cost by using filtered indexes because there is less data to maintain
- Filtered indexes also obviously reduce storage costs

```
USE AdventureWorks  
GO  
CREATE NONCLUSTERED INDEX idx_currate_notnull  
ON Sales.SalesOrderHeader(CurrencyRateID)  
WHERE CurrencyRateID IS NOT NULL
```



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Filtered Indexes

SQL Server 2008 introduces filtered indexes. You can now create a nonclustered index based on a predicate, and only the subset of rows for which the predicate holds true are stored in the index B-Tree. Well-designed filtered indexes can improve query performance and plan quality because they are smaller than nonfiltered indexes.

You can also reduce index maintenance cost by using filtered indexes because there is less data to maintain. This includes modifications against the index, index rebuilds, and the cost of updating statistics. Filtered indexes also obviously reduce storage costs.

Points to remember when creating Filtered Index

- They can be created only as Nonclustered Index
- They can be used on Views only if they are persisted views.
- They cannot be created on full-text Indexes.

Let's look at a few examples that demonstrate filtered indexes.

The following code creates an index on the CurrencyRateID column in the Sales.SalesOrderHeader table, with a filter that excludes NULLs:

```
USE AdventureWorks;  
GO  
CREATE NONCLUSTERED INDEX idx_currate_notnull  
ON Sales.SalesOrderHeader(CurrencyRateID)  
WHERE CurrencyRateID IS NOT NULL;
```

Considering query filters, besides the IS NULL predicate that explicitly looks for NULLs, all other predicates exclude NULLs, so the optimizer knows that there is the potential to use the index.

```
SELECT *
FROM Sales.SalesOrderHeader
WHERE CurrencyRateID = 4;
```

The CurrencyRateID column has a large percentage of NULLs; therefore, this index consumes substantially less storage than a nonfiltered one on the same column. You can also create similar indexes on sparse columns.

The following code creates a nonclustered index on the Freight column, filtering rows where the Freight is greater than or equal to 5000.00:

```
CREATE NONCLUSTERED INDEX idx_freight_5000_or_more
ON Sales.SalesOrderHeader(Freight)
WHERE Freight >= 5000.00;
```

```
SELECT *
FROM Sales.SalesOrderHeader
WHERE Freight BETWEEN 5500.00 AND 6000.00;
```

Filtered indexes can also be defined as UNIQUE and have an INCLUDE clause as with regular nonclustered indexes.

Creating and Dropping Indexes

- Indexes are created automatically on tables with PRIMARY KEY or UNIQUE constraints
 - Indexes can also be created using the CREATE INDEX Statement

```
USE Northwind  
CREATE CLUSTERED INDEX CL_lastname  
ON employees(lastname)
```

- Indexes can be dropped using the DROP command

```
USE Northwind  
DROP INDEX employees.CL_lastname
```



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Creating and dropping Indexes

Indexes are created in the following ways:

By defining a PRIMARY KEY or UNIQUE constraint on a column by using CREATE TABLE or ALTER TABLE

By default, a unique clustered index is created to enforce a PRIMARY KEY constraint, unless a clustered index already exists on the table, or you specify a unique nonclustered index.

By default, a unique nonclustered index is created to enforce a UNIQUE constraint unless a unique clustered index is explicitly specified and a clustered index on the table does not exist.

An index created as part of a PRIMARY KEY or UNIQUE constraint is automatically given the same name as the constraint name.

By creating an index independent of a constraint by using the CREATE INDEX statement, or **New Index** dialog box in SQL Server Management Studio Object Explorer

You must specify the name of the index, table, and columns to which the index applies. Index options and index location, filegroup or partition scheme, can also be specified. By default, a nonclustered, nonunique index is created if the clustered or unique options are not specified.

Creating and Dropping Indexes

- To create non clustered index ncl_deptno

```
USE Northwind  
CREATE NON CLUSTERED INDEX NCL_deptno  
ON employees(deptno)
```

- Using the DROP INDEX Statement

```
USE Northwind  
DROP INDEX employees.NCL_deptno
```



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Creating Unique Indexes

- Unique index can be non clustered or clustered
- Unique non clustered index is automatically created when a column has UNIQUE constraint
- Unique Clustered index is automatically created when column has a PRIMARY KEY constraint
- Ensures column(s) have unique value
- There is no difference in the way Unique constraint and Unique index work, except for syntax

```
USE Northwind  
CREATE UNIQUE NONCLUSTERED INDEX U_CustID  
ON customers(CustomerID)
```



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Creating a unique index guarantees that any attempt to duplicate key values fails. There are no significant differences between creating a UNIQUE constraint and creating a unique index that is independent of a constraint. Data validation occurs in the same manner, and the query optimizer does not differentiate between a unique index created by a constraint or manually created. However, you should create a UNIQUE constraint on the column when data integrity is the objective. This makes the objective of the index clear.

Unique indexes are implemented in the following ways:
PRIMARY KEY or UNIQUE constraint

When you create a PRIMARY KEY constraint, a unique clustered index on the column or columns is automatically created if a clustered index on the table does not already exist and you do not specify a unique nonclustered index. The primary key column cannot allow NULL values.

You can specify a unique clustered index if a clustered index on the table does not already exist.

Index independent of a constraint

Multiple unique nonclustered indexes can be defined on a table.

Creating Composite Indexes

- Index of two /more columns are said to be composite

USE Northwind

```
CREATE UNIQUE NONCLUSTERED INDEX U_OrdID_ProdID  
ON [Order Details] (OrderID, ProductID)
```

| Order Details | | | | |
|---------------|-----------|-----------|----------|----------|
| OrderID | ProductID | UnitPrice | Quantity | Discount |
| 10248 | 11 | 14.000 | 12 | 0.0 |
| 10248 | 42 | 9.800 | 10 | 0.0 |
| 10248 | 72 | 34.800 | 5 | 0.0 |

Column 1

Column 2

Composite Key



Columnstore Indexes

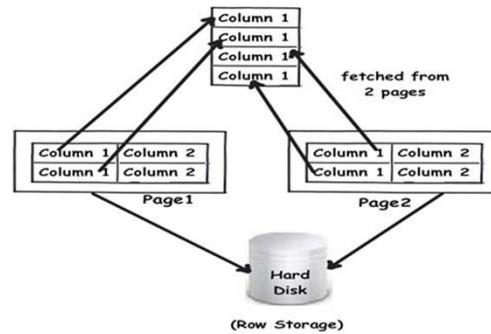
- SQL Server 2012 introduces ColumnStore Indexes.
- Benefits of using SQL Server ColumnStore Indexes
- Faster query performance for common data warehouse queries as only required columns/pages in the query are fetched from disk
- Data is stored in a highly compressed form to reduce the storage space
- Frequently accessed columns (pages that contains data for these columns) remain in memory because a high ratio of compression is used in the pages and less pages are involved



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Columnstore Indexes

- Relational database store data “row wise”. These rows are further stored in 8 KB page size.
- For instance you can see in the below figure we have table with two columns “Column1” and “Column2”. You can see how the data is stored in two pages i.e. “page1” and “page2”. “Page1” has two rows and “page2” also has two rows.



Columnstore Indexes

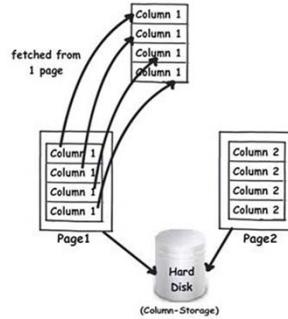
- If you want to fetch only “column1”, you have to pull records from two pages i.e. “Page1” and “Page2”.
- As we have to fetch data from two pages its bit performance intensive.



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Columnstore Indexes

- If somehow we can store data column wise we can avoid fetching data from multiple pages.
- That's what column store indexes do.
- When you create a column store index it stores same column data in the same page. You can see from the diagram (shown below), we now need to fetch "column1" data only from one page rather than querying multiple pages.



Limitations of SQL Server ColumnStore Indexes

There are several limitations of using SQL Server ColumnStore indexes over Row Store indexes including:

- A table with a ColumnStore Index cannot be updated
- ColumnStore index creation takes more time (1.5 times almost) than creating a B-tree index (on same set of columns) because the data is compressed
- A table can have only one ColumnStore Index and hence you should consider including all columns or at least all those frequently used columns of the table in the index
- A ColumnStore Index can only be non cluster and non unique index; you cannot specify ASC/DESC or INCLUDE clauses
- Not all data types (binary, varbinary, image, text, ntext, varchar(max), nvarchar(max), etc.) are supported



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Limitations of SQL Server ColumnStore Indexes (Contd...)

- The definition of a ColumnStore Index cannot be changed with the ALTER INDEX command, you need to drop and create the index or disable it then rebuild it
- You can create a ColumnStore index on a table which has compression enabled, but you cannot specify the compression setting for the column store index
- A ColumnStore Index cannot be created on view
- A ColumnStore Index cannot be created on table which uses features like Replication, Change Tracking, Change Data Capture and Filestream



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Columnstore Indexes

```
CREATE NONCLUSTERED COLUMNSTORE  
INDEX idx_colSale  
ON myTable (OrderDate, ProductID, SaleAmount)
```



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Obtaining information on Indexes

- Using the sp_helpindex System Stored Procedure

```
USE Northwind  
EXEC sp_helpindex Customers
```

- Using the sp_help tablename System Stored Procedure



Indexes – Performance Considerations

- Create indexes on foreign keys
- Create the clustered index before nonclustered indexes
- Consider before creating composite indexes
- Create multiple indexes for a table that is read frequently
- Use the index tuning wizard get statics of index usage



Demo

- Creating Indexes



Views – An Overview

- Views are Virtual tables, which provides access to a subset of columns from one or more tables
- Created from one or more base tables or other views
- Internally Views are stored queries
- Views are created when
 - To hide the complexity of the underlying database schema, or customize the data and schema for a set of users.
 - To control access to rows and columns of data.
- Objective of creating views is Abstraction , not performance



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A view is a virtual table whose contents are defined by a query. Like a real table, a view consists of a set of named columns and rows of data., a Views does not exist with a stored set of data values in a database. The rows and columns of data come from tables referenced in the query defining the view and are produced dynamically when the view is referenced.

A view acts as a filter on the underlying tables referenced in the view. The query that defines the view can be from one or more tables or from other views in the current or other databases. Distributed queries can also be used to define views that use data from multiple heterogeneous sources. This is useful, for example, if you want to combine similarly structured data from different servers, each of which stores data for a different region of your organization.

There are no restrictions on querying through views and few restrictions on modifying data through them.

Views – An Overview

Employees

| EmployeeID | LastName | Firstname | Title |
|------------|-----------|-----------|-------|
| 1 | Davolio | Nancy | ~~~ |
| 2 | Fuller | Andrew | ~~~ |
| 3 | Leverling | Janet | ~~~ |



```
USE Northwind  
GO  
CREATE VIEW dbo.EmployeeView  
AS  
SELECT LastName, FirstName  
FROM Employees
```

EmployeeView

| Lastname | Firstname |
|-----------|-----------|
| Davolio | Nancy |
| Fuller | Andrew |
| Leverling | Janet |

User's View



Views – Advantages

- Focus the Data for Users
 - Focus on important or appropriate data only
 - Limit access to sensitive data
- Mask Database Complexity
 - Hide complex database design
 - Simplify complex queries, including distributed queries to heterogeneous data
- Simplify Management of User Access on Data



Views – Types

- Standard Views
- Indexed Views
- Partitioned Views



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In SQL Server, you can create standard views, indexed views, and partitioned views.

Standard Views

Combining data from one or more tables through a standard view lets you satisfy most of the benefits of using views. These include focusing on specific data and simplifying data manipulation. These benefits are described in more detail in Scenarios for Using Views.

Indexed Views

An indexed view is a view that has been materialized. This means it has been computed and stored. You index a view by creating a unique clustered index on it. Indexed views dramatically improve the performance of some types of queries. Indexed views work best for queries that aggregate many rows. They are not well-suited for underlying data sets that are frequently updated.

Partitioned Views

A partitioned view joins horizontally partitioned data from a set of member tables across one or more servers. This makes the data appear as if from one table. A view that joins member tables on the same instance of SQL Server is a local partitioned view.

When a view joins data from tables across servers, it is a distributed partitioned view. Distributed partitioned views are used to implement a federation of database servers. A federation is a group of servers administered independently, but which cooperate to share the processing load of a system.

Defining Views

- Creating views
- Altering and dropping views
- Locating view definition information
- Hiding view definitions



Creating Views

- Creating a View

```
CREATE VIEW dbo.OrderSubtotalsView (OrderID, Subtotal)
AS
SELECT OD.OrderID,
       SUM(CONVERT(money,(OD.UnitPrice*Quantity*(1-
Discount)/100)*100)
FROM [Order Details] OD
GROUP BY OD.OrderID
GO
```

- Restrictions on View Definitions

- Cannot include ORDER BY clause
- Cannot include INTO keyword



Example – Views with Join Query

Orders

| OrderID | CustomerID | RequiredDate | ShippedDate |
|---------|------------|--------------|-------------|
| 10663 | BONAP | 1997-09-24 | 1997-10-03 |
| 10827 | BONAP | 1998-01-26 | 1998-02-06 |
| 10427 | PICCO | 1997-02-24 | 1997-03-03 |
| 10451 | QUICK | 1997-03-05 | 1997-03-12 |
| 10515 | QUICK | 1997-05-07 | 1997-05-23 |

Customers

| CustomerID | CompanyName | ContactName |
|------------|------------------|------------------|
| BONAP | Bon app' | Laurence Lebihan |
| PICCO | Piccolo und mehr | Georg Pippes |
| QUICK | QUICK-Stop | Horst Kloss |

```
USE Northwind
GO
CREATE VIEW dbo.ShipStatusView
AS
SELECT OrderID, RequiredDate,
       ShippedDate, ContactName
FROM Customers
INNER JOIN Orders
    ON Customers.CustomerID =
       Orders.CustomerID
WHERE RequiredDate < ShippedDate
```

ShipStatusView

| OrderID | ShippedDate | ContactName |
|---------|-------------|------------------|
| 10264 | 1996-08-23 | Laurence Lebihan |
| 10271 | 1996-08-30 | Georg Pippes |
| 10280 | 1996-09-12 | Horst Kloss |



Altering & Dropping Views

▪ Altering Views

- Retains assigned permissions
- Causes new SELECT statement and options to replace existing definition

```
USE Northwind  
GO  
ALTER VIEW dbo.EmployeeView  
AS  
SELECT LastName, FirstName, Extension  
FROM Employees
```

▪ Dropping Views

```
DROP VIEW dbo.ShipStatusView
```



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Modifies a previously created view. This includes an indexed view. ALTER VIEW does not affect dependent stored procedures or triggers and does not change permissions.

ALTER VIEW [schema_name .] view_name [(column [,...n])] [WITH <view_attribute> [,...n]] AS select_statement [WITH CHECK OPTION][;]

If a view currently used is modified by using ALTER VIEW, the Database Engine takes an exclusive schema lock on the view. When the lock is granted, and there are no active users of the view, the Database Engine deletes all copies of the view from the procedure cache. Existing plans referencing the view remain in the cache but are recompiled when invoked.

ALTER VIEW can be applied to indexed views; however, ALTER VIEW unconditionally drops all indexes on the view.

Removes one or more views from the current database. DROP VIEW can be executed against indexed views.

DROP VIEW [schema_name .] view_name [...,n] [;]

Note : when base table are dropped , views dependent on them DON'T get dropped

Locating View Definition Information

- Locating View Definitions
 - Not available if view was created using WITH ENCRYPTION option
- Locating View Dependencies
 - Lists objects upon which view depends
 - Lists objects that depend on a view



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ENCRYPTION

Encrypts the entries in sys.syscomments that contain the text of the CREATE VIEW statement. Using WITH ENCRYPTION prevents the view from being published as part of SQL Server replication

Dependencies:

Contains a row for each dependency on a referenced (independent) entity as referenced in the SQL expression or statements that define some other referencing (dependent) object. The **sys.sql_dependencies** view is meant to track by-name dependencies between entities. For each row in **sys.sql_dependencies**, the referenced entity appears by-name in a persisted SQL expression of the referencing object.

Hiding View Definition

- Use the WITH ENCRYPTION Option
- Do not delete entries in the syscomments table

```
USE Northwind
GO
CREATE VIEW dbo.[Order Subtotals]
    WITH ENCRYPTION
AS
SELECT OrderID,
    Sum(CONVERT(money,(UnitPrice*Quantity*(1-
    Discount)/100)*100)
        AS Subtotal
FROM [Order Details]
GROUP BY OrderID
GO
```



Modifying Data through View

- Cannot affect more than one underlying table
- Cannot be made to columns having aggregation
- Depends on the constraints placed on the base tables
- Are verified if the WITH CHECK OPTION has been specified



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You can modify the data of an underlying base table through a view, in the same manner as you modify data in a table by using UPDATE, INSERT and DELETE statements or by using the **bcp** utility and BULK INSERT statement. However, the following restrictions apply to updating views, but do not apply to tables:

- Any modifications, including UPDATE, INSERT, and DELETE statements, must reference columns from only one base table.
- The columns that are being modified in the view must reference the underlying data in the table columns directly. They cannot be derived in any other way, such as through:
 - An aggregate function (AVG, COUNT, SUM, MIN, MAX, GROUPING, STDEV, STDEVP, VAR and VARP).
 - A computation; the column cannot be computed from an expression using other columns. Columns formed using set operators (UNION, UNION ALL, CROSSJOIN, EXCEPT, and INTERSECT) amount to a computation and are also not updatable
- The columns that are being modified cannot be affected by GROUP BY, HAVING, or DISTINCT clauses.
- TOP cannot be used anywhere in the *select_statement* of the view when WITH CHECK OPTION is also specified.

Views – Recommended Practices

- Use a Standard Naming Convention
- dbo Should Own All Views
- Verify Object Dependencies Before You Drop Objects
- Never Delete Entries in the syscomments Table
- Carefully Evaluate Creating Views Based on Views



Demo

- Working with Views



Summary

- In this lesson, you have learnt:
 - Creating Indexes
 - Types of indexes
 - Clustered Index, Non clustered index ,Filtered Indexes ,Column store Indexes
 - Creating and modifying Views



Review Question

- Question 1: ----- Gets created automatically for Primary key constraint
 - clustered index
 - Unique clustered index
 - Unique Non clustered index
- Question 2: ----- option with views will not store base query of views in syscomments table
- Question 3: A table can have multiple unique non clustered index
 - True/False



SQL Server 2012 – Database Development

Lesson 7: Procedures

Lesson Objectives

- Database programming
- Creating, Executing, Modifying and Dropping Stored Procedures
- Implementing Exception Handling



Overview

- Introduction to Stored Procedures
- Creating, Executing, Modifying, and Dropping Stored Procedures
- Using Parameters in Stored Procedures
- Executing Extended Stored Procedures
- Handling Error Messages



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Definition

- Named Collections of pre compiled Transact-SQL Statements
- Stored procedures can be used by multiple users and client programs leading to reuse of code
- Abstraction of code and better security control
- Reduces network work and better performance
- Can accept parameters and return value or result set



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In the simplest terms, a stored procedure is a collection of compiled T-SQL commands that are directly accessible by SQL Server. The commands placed within a stored procedure are executed as one single unit, or batch, of work. In addition to SELECT, UPDATE, or DELETE statements, stored procedures are able to call other stored procedures, use statements that control the flow of execution, and perform aggregate functions or other calculations.

Any developer with access rights to create objects within SQL Server can build a stored procedure.

If the stored procedure is on same machine it is called as Local procedure, otherwise if it is stored at different machine then it is called as remote procedure.

Types

- T-SQL supports the following types of procedure
 - System -
 - Procedures pre-built in SQL Server itself
 - Available in master database
 - Name starts with sp_
 - Temporary
 - name starts with #(Local) or ## (Global) and stored in tempdb
 - Available only for that session
 - Extended
 - execute routines written in programming languages like C,C++,C# or VB.NET
 - May have names starting with xp_



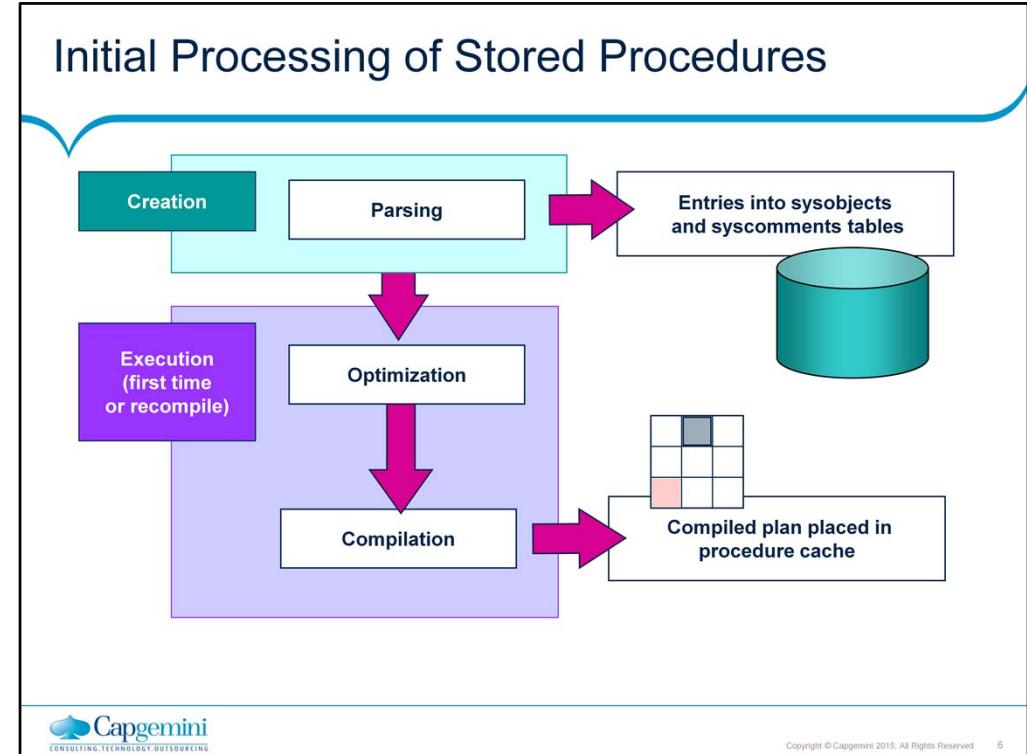
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Types of stored procedure

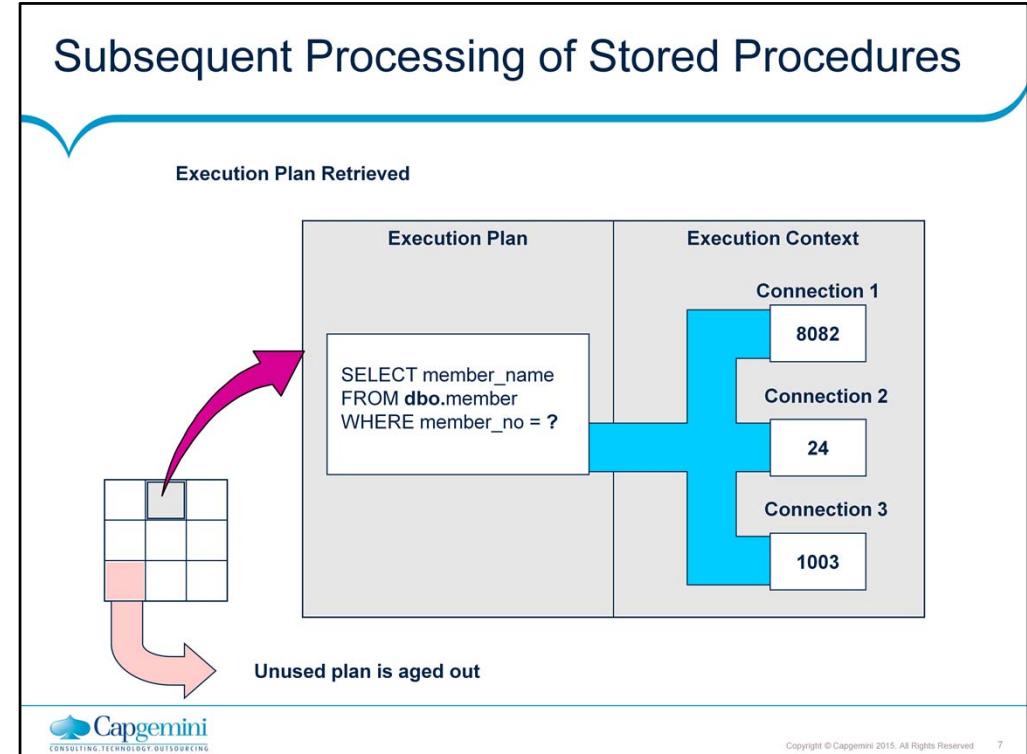
1. System procedure : The name of all system procedure starts with a prefix of sp_, within SQL Server. One cannot modify any system stored procedure that belongs to SQL Server, as this could corrupt not only your database, but also other databases

2. Temporary Procedure : The Database Engine supports two types of temporary procedures: local and global. A local temporary procedure is visible only to the user that created it. A global temporary procedure is available to all currently connected users. Local temporary procedures are automatically dropped at the end of the current session. Global temporary procedures are dropped at the end of the last session using the procedure. To create local temporary procedure name should start with # for global temporary procedure name should start with ##.

3. Extended procedure : Extended stored procedures let you create your own external routines in a programming language such as C,C++,.NET etc. The extended stored procedures appear to users as regular stored procedures and are executed in the same way. Parameters can be passed to extended stored procedures, and extended stored procedures can return results and return status. Extended stored procedures are DLLs that an instance of SQL Server can dynamically load and run. Extended stored procedures run directly in the address space of an instance of SQL Server and are programmed by using the SQL Server Extended Stored Procedure API.



1. When you create a stored procedure
2. SQL server parses your code and make entries in appropriate system table.
3. SQL server analyzes and optimizes the queries within stored procedure and generates an execution plan. An execution plan holds the instructions to process the query. These instruction include which order to access the table in, which indexes, access methods and join algorithm to use and so on.
4. SQL server generates multiple permutation of execution plan and choose the one with lowest cost
5. After execution of query or procedure we can see the execution plan in result window by clicking on display estimated execution plan button in the tool bar.



6. Stored procedures can reuse a previously cached execution plan, which saves the resources involved in generating a new execution plan
7. But if changes have been made to database objects (like adding or dropping column or index) or changes to set option that affect query results or if plan is removed from cache after a while for lack of reuse, causes recompilation and SQL server will generate a new one when the procedure is invoked again.

Advantages

- Share Application Logic across multiple clients
- Shield Database Schema Details (Abstraction)
- Provide Security Mechanisms
- Reduce Network Traffic
- Improve Performance



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1. **Share application logic-** Same procedure can be executed n times by multiple clients .
2. **Shield Database schema details -** Even If user does not have access to tables he can use tables through procedure.
3. **Provide security mechanism -** Restricted access can be given to tables and user also does not get to know which tables are used to get the data.
4. **Reduced Network traffic -** Assume that you are using some front end application and calling stored procedure. Then instead of sending SQL statements to server front end, will pass only function call with parameters and call gets executed at server side and result gets transferred to front end application.
5. **Improve performance -** If in case there is any change in procedure (like change in tables or logic changes) . It does not affect front end application if we are using stored procedure. Which improves performance.

CREATE PROCEDURE Statement

Syntax

```
CREATE { PROC | PROCEDURE } [schema_name.]  
procedure_name [ { @parameter data_type } [ VARYING ] [= default] [ [ OUT [ PUT ] ] [,..n ] ]  
AS  
{ <sql_statement> [;][ ..n ] |  
<methodSpecifier> } [;]  
Return <value>
```



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CREATE { PROC | PROCEDURE } [schema_name.] procedure_name
[{ @parameter [type_schema_name.] data_type } [[OUT [PUT]] [,..n]] { [BEGIN] statements [END] }

schema_name

Is the name of the schema to which the procedure belongs.

procedure_name

Is the name of the new stored procedure. Procedure names must comply with the rules for identifiers and must be unique within the schema.

you should not use the prefix sp_ in the procedure name. This prefix is used by SQL Server to designate system stored procedures.

Local or global temporary procedures can be created by using one number sign (#) before procedure_name (#procedure_name) for local temporary procedures, and two number signs for global temporary procedures (##procedure_name). Temporary names cannot be specified for CLR stored procedures.

The complete name for a stored procedure or a global temporary stored procedure, including ##, cannot exceed 128 characters. The complete name for a local temporary stored procedure, including #, cannot exceed 116 characters.

@ parameter

Is a parameter in the procedure. One or more parameters can be declared in a CREATE PROCEDURE statement. The value of each declared parameter must be supplied by the user when the procedure is called, unless a default for the parameter is defined or the value is set to equal another parameter. A stored procedure can have a maximum of 2,100 parameters.

Specify a parameter name by using an at sign (@) as the first character. The parameter name must comply with the rules for identifiers. Parameters are local to the procedure; the same parameter names can be used in other procedures. By default, parameters can take the place only of constant expressions; they cannot be used instead of table names, column names, or the names of other database objects.

OUTPUT

Indicates that the parameter is an output parameter. The value of this option can be returned to the calling EXECUTE statement. Use OUTPUT parameters to return values to the caller of the procedure. **text**, **ntext**, and **image** parameters cannot be used as OUTPUT parameters, unless the procedure is a CLR procedure. An output parameter that uses the OUTPUT keyword can be a cursor placeholder, unless the procedure is a CLR procedure.

The maximum size of a Transact-SQL stored procedure is 128 MB.

A user-defined stored procedure can be created only in the current database. Temporary procedures are an exception to this because they are always created in **tempdb**. If a schema name is not specified, the default schema of the user that is creating the procedure is used.

Ex.

```
CREATE PROC dbo.usp_GetCitiwiseEmployee
    @city      VARCHAR(20)
AS
BEGIN
    SELECT Employee_Name
    FROM Employee
    WHERE City = @city
END
```

Example

- Code Snippet

```
USE AdventureWorks2012;
GO
CREATE PROCEDURE HumanResources.uspGetEmployeesTest2
@LastName nvarchar(50),
@FirstName nvarchar(50) AS
SET NOCOUNT ON;
SELECT FirstName, LastName, Department FROM
HumanResources.vEmployeeDepartmentHistory WHERE FirstName =
@FirstName AND LastName = @LastName AND EndDate IS NULL;
GO
```



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```
USE Northwind
GO
CREATE PROC dbo.OverdueOrders
AS
BEGIN
    SELECT COUNT(Order_id)
    FROM dbo.Orders
    WHERE RequiredDate < GETDATE() AND ShippedDate IS Null
End
GO
```

Executing Stored Procedures

- Code Snippet

```
EXECUTE HumanResources.uspGetEmployeesTest2 N'Ackerman', N'Pilar';
-- Or
EXEC HumanResources.uspGetEmployeesTest2 @LastName = N'Ackerman', @FirstName =
N'Pilar';
GO
-- Or
EXECUTE HumanResources.uspGetEmployeesTest2 @FirstName = N'Pilar', @LastName =
N'Ackerman';
GO
```

Note : You need to have execute permission for the procedure to execute it



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Execute statement:

Executes a command string or character string within a Transact-SQL batch, or one of the following modules: system stored procedure, user-defined stored procedure, or extended stored procedure.

You can use insert with the results of stored procedure or dynamic execute statement taking place of values clause. Execute should return exactly one result set with types that match the table you have set up for it.

Executing a Stored Procedure by Itself

EXEC OverdueOrders

Executing a Stored Procedure Within an INSERT Statement

**INSERT INTO Customers
EXEC EmployeeCustomer**

e.g If you want to store results of executing sp_configure stored procedure in temporary table

```
Create table #config_out
(
Name_col varchar(50),
Minval int,
Maxval int,configval int,
Runval int
)
insert #config_out
Exec sp_configure
```

Altering and Dropping Procedures

- Altering Stored Procedures

- Include any options in ALTER PROCEDURE
- Does not affect nested stored procedures

```
ALTER { PROC | PROCEDURE } [schema_name.]  
procedure_name [ ; number ] [ { @parameter [  
type_schema_name.] data_type } [ VARYING ] [= default ] [  
OUT | OUTPUT ] [READONLY] ][ ,...n ][ WITH  
<procedure_option> [ ,...n ] ][ FOR REPLICATION ] AS { [ BEGIN  
] sql_statement [;][ ...n ][ END ] } [;]  
<procedure_option> ::= [  
ENCRYPTION ] [ RECOMPILE ] [ EXECUTE AS Clause ]
```

```
DROP PROCEDURE <stored procedure name>;
```



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sp_depends

Is system procedure which Displays information about database object dependencies, such as: the views and procedures that depend on a table or view, and the tables and views that are depended on by the view or procedure. References to objects outside the current database are not reported.

I. Listing dependencies on a table

The following example lists the database objects that depend on the Sales.Customer table in the AdventureWorks2012 database. Both the schema name and table name are specified.

```
USE AdventureWorks2012;  
GO  
EXEC sp_depends @objname = N'Sales.Customer' ;
```

Demo

- Creating Stored Procedures



Stored Procedures Using Parameters

- Stored procedures can take parameters OR arguments and return value
- Parameters can of the following type
- **INPUT**
 - Default Type
 - IN or INPUT keyword is used to define variables of IN type
 - Used to pass a data value to the stored procedure
- **OUTPUT**
 - Allow the stored procedure to pass a data value or a back to the caller.
 - OUT keyword is used to identify output parameter



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Parameters are used to exchange data between stored procedures that called the stored procedure:

Input parameters allow the caller to pass a data value to the stored procedure.

Output parameter

Output parameters allow the stored procedure to pass a data value or a cursor variable back to the caller.

Parameters to procedure can be passed in the following manner

Passing values by parameter name

If you don't want to send all parameter values in same sequence as they are defined in create or procedure, you can pass them by parameter name Useful when many default values are defined , So required to pass very few parameters.

```
EXECUTE mytables @type='S'
```

Passing values by position

If you want to pass all parameters in the same sequence as they are defined in create or alter procedure. Then use this method.

If a parameter has default values , if default value is assigned to the INPUT parameters . DEFAULT keyword is used during execution to indicate DEFAULT value

CREATE PROCEDURE mytables

```
(
```

```
    @type char(2)='U'
```

```
)
```

AS

```
    SELECT count(id) FROM sysobjects WHERE type = @type
```

GO

EXECUTE mytables

EXECUTE mytables DEFAULT

EXECUTE mytables 'P'

Stored Procedures Using Parameters

```
CREATE PROCEDURE usp_ProductCountByCategory (
    @i_catid INT,
    @o_Prodcount INT OUT
)
AS
BEGIN
    IF @i_catid IS NULL OR @i_catid < 0
        RETURN -1
    SELECT @o_Prodcount = COUNT(ProductID) FROM Products
    WHERE CategoryID = @i_catid
END
```

- To execute

```
DECLARE @prodcount INT
EXEC usp_ProductCountByCategory 1234, @prodcount OUT
```



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In this example the procedure usp_ProductCountByCategory takes a category id as input and returns the count of products belonging to that category as output

To execute the procedure having OUT variables , one has to declare the Variable first and then pass that variable to the procedure using the OUT keyword.

The procedure also handles erroneous situation of invalid inputs by returning -1. More about return statement is discussed later in the session.

As with all Good programming practices , input values must be validated and all variables must be initialized

In case the procedure has default values then the procedure can be defined as

```
CREATE PROCEDURE usp_ProductCountByCategory (
    @i_catid INT = 2345,
    @o_Prodcount INT OUT
)
And to execute with default value it would be
EXEC usp_ProductCountByCategory DEFAULT, @pcount OUTPUT
```

Example of INPUT and OUTPUT Parameter:-

The following example shows a procedure with an input and an output parameter. The @SalesPerson parameter would receive an input value specified by the calling program. The SELECT statement uses the value passed into the input parameter to obtain the correct SalesYTD value. The SELECT statement also assigns the value to the @SalesYTD output parameter, which returns the value to the calling program when the procedure exits.

```
USE AdventureWorksLT;
GO
IF OBJECT_ID('Sales.uspGetEmployeeSalesYTD', 'P') IS NOT NULL
DROP PROCEDURE Sales.uspGetEmployeeSalesYTD;
GO
CREATE PROCEDURE Sales.uspGetEmployeeSalesYTD @SalesPerson nvarchar(50),
@salesYTD money OUTPUT
AS
SET NOCOUNT ON;
SELECT @SalesYTD = SalesYTD FROM Sales.SalesPerson AS sp JOIN HumanResources.vEmployee AS e ON e.BusinessEntityID = sp.BusinessEntityID WHERE LastName = @SalesPerson;
RETURN
GO
```

The following example calls the procedure created in the first example and saves the output value returned from the called procedure in the @SalesYTD variable, which is local to the calling program.

```
-- Declare the variable to receive the output value of the procedure.
DECLARE @SalesYTDBySalesPerson money;
-- Execute the procedure specifying a last name for the input parameter
-- and saving the output value in the variable @SalesYTDBySalesPerson
EXECUTE Sales.uspGetEmployeeSalesYTD 'N.Blythe', @SalesYTD = @SalesYTDBySalesPerson OUTPUT;
-- Display the value returned by the procedure.
PRINT 'Year-to-date sales for this employee is ' + convert(varchar(10),@SalesYTDBySalesPerson);
GO
```

Returning a Value from Stored Procedures

- Values can be returned from stored procedure using the following options
 - **OUTPUT** parameter
 - More than 1 parameter can be of type OUTPUT
 - **Return statement**
 - Used to provide the execution status of the procedure to the calling program
 - Only one value can be returned
 - to -99 are reserved for internal usage , one can return customized values also
- **Return value** can be processed by the calling program as
`exec @return_value = <storedprocname>`



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The above example checks the state for the ID of a specified contact. If the state is Washington (WA), a status of 1 is returned. Otherwise, 2 is returned for any other condition (a value other than WA for StateProvince or ContactID that did not match a row).

Output parameters: Scalar data can be returned from a stored procedure with output variables.

RETURN: A single integer value can be returned from a stored procedure with a RETURN statement.

Result sets: A stored procedure can return data via one or more SELECT statements.

RAISERROR or THROW: Informational or error messages can be returned to the calling application via RAISERROR or THROW.

Example 1:

```
CREATE Procedure usp_updateprodprice
    @i_vccategory int,
    As
BEGIN
    if @i_vccategory is NULL or @i_vccategory <=0
    begin
        raiserror (50001, 1,1)
        return -1
    end
    Update Products set ProductPrice = ProductPrice*1.1
    WHERE CategoryID= @i_vccategory
    return 0
END
```

```
DECLARE @return_value int
Exec @return_value = usp_updateprodprice 7
```

Example 2

```
USE AdventureWorks2012;
GO
CREATE PROCEDURE checkstate @param varchar(11)
AS
IF (SELECT StateProvince FROM Person.vAdditionalContactInfo WHERE ContactID = @param) = 'WA'
    RETURN 1
ELSE
    RETURN 2;
GO
DECLARE @return_status int;
EXEC @return_status = checkstate '2';
SELECT 'Return Status' = @return_status;
GO
```

WITH RESULT SETS

- In earlier versions of SQL server when we wished to change a column name or datatype in the resultset of a stored procedure, all the references needed to be changed. There was no simple way to dump the output of a stored procedure without worrying about the column names and data types.
- The EXECUTE statement has been extended in SQL Server 2012 to include the WITH RESULT SETS option. This allows you to change the column names and data types of the result set returned in the execution of a stored procedure



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Example 1:

```
Use AdventureWorks2012
    CREATE PROC spGet_Employees
    AS
        SELECT BusinessEntityID, JobTitle, OrganizationLevel
        FROM HumanResources.Employee
        ORDER BY BusinessEntityID
```

To execute the stored procedure

```
EXEC spGet_Employees
WITH RESULT SETS
(
(
BEID int,
Title varchar(30),
OL int
)
)
```

Example :-2

```
use northwind
CREATE PROCEDURE GetData @pid int
AS
BEGIN
SELECT ProductID,ProductName,UnitPrice FROM products
WHERE productid= @pid
END
```

CALLING PROCEDURE WITH RESULT SETS:

```
exec GetData 5
with result sets((PID INT,PNAME VARCHAR(10),UPrice money))
```

Recompiling Stored Procedures

- Stored Procedures are recompiled to optimize the queries which makes up that Stored Procedure
- Stored Procedure needs recompilation when
 - Data in underlying tables are changed
 - Indexes are added /removed in tables
- Recompilation can be done by Using
 - CREATE PROCEDURE [WITH RECOMPILE]
 - EXECUTE [procedure]WITH RECOMPILE
 - sp_recompile [procedure]



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Example of Procedure with Recompile

```
USE AdventureWorks2012;
CREATE PROCEDURE dbo.uspProductByVendor @Name varchar(30) = '%'
WITH RECOMPILE
AS
SET NOCOUNT ON;
SELECT v.Name AS 'Vendor name', p.Name AS 'Product name' FROM
Purchasing.Vendor AS v JOIN Purchasing.ProductVendor AS pv ON
v.BusinessEntityID = pv.BusinessEntityID JOIN Production.Product AS p
ON pv.ProductID = p.ProductID WHERE v.Name LIKE @Name;
```

Example of Execute With Recompile

```
USE AdventureWorks2012;
GO
EXECUTE HumanResources.uspGetAllEmployees WITH RECOMPILE;
GO
```

Example of sp_recompile

```
USE AdventureWorks2012;
GO
EXEC sp_recompile N'HumanResources.uspGetAllEmployees';
GO
```

To View the Definition of Stored Procedure

- To view the definition of a procedure in Query Editor
 - EXEC sp_helptext N'AdventureWorks2012.dbo.usp.LogError';
- To view the definition of a procedure with System Function: OBJECT_DEFINITION
 - SELECT OBJECT_DEFINITION(OBJECT_ID(N'AdventureWorks2012.dbo.usp.LogError'));
 - Change the database name and stored procedure name to reference the database and stored procedure that you want.



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```
CREATE PROC usp_GetStudentNameInOutputVariable
    @studentid INT, --Input parameter
    @studentname VARCHAR(200) OUT -- Out parameter
AS
BEGIN
    SELECT @studentname= Firstname+' '+Lastname
    FROM Students
    WHERE studentid=@studentid
END
```

To execute :

```
DECLARE @name VARCHAR(30)
EXEC usp_GetStudentNameInOutputVariable 1012, @name OUT
SELECT @name
```

To view definition of stored procedure in Query Editor
EXEC sp_helptext 'usp_GetStudentNameInOutputVariable'**To view definition of stored procedure with System Functions**

```
SELECT
OBJECT_DEFINITION(
    OBJECT_ID
    ('usp_GetStudentNameInOutputVariable'));
```

Guidelines

- One Stored Procedure for One Task
- Create, Test, and Troubleshoot
- Avoid sp_ Prefix in Stored Procedure Names
- Use Same Connection Settings for All Stored Procedures
- Minimize Use of Temporary Stored Procedures



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Error Handling in Procedures

- SQL Server 2005 onwards error handling can be done with
 - TRY .. CATCH blocks
 - @@ERROR global variable
- If a statements inside a TRY block raises an exception then processing of TRY blocks stops and is then picked up in the CATCH block
- The syntax of the TRY CATCH is

```
BEGIN TRY  
    --- statements  
END TRY  
BEGIN CATCH  
    --- statements  
END CATCH
```



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It is a known thing that during an application development one of the most common things we need to take care is Exception Handling . The same point holds good when we are building our databases also .

Typical scenarios where we need to handle errors in DB

1. When we perform some DML operations and need to check the output
2. When a transaction fails – we need to rollback or undo the changes done to the data

Error handling can be done in two ways in SQL Server

Using @@ERROR

Using TRY..CATCH BLOCK

Earlier version of SQL Server like (2000 or 7.x) did not support this TRY ..CATCH construct , therefore error handling was done only using @@ERROR global variable . Whenever an error occurs the variable automatically populates the error message , which needs to be traced in the next line for example

Insert into sometable values(....)

Select @@error

This will show the errorcode generated in the last SQL statement

Error Handling

Using @@Error

```

DECLARE @v_deptcode int
DECLARE @v_deptname varchar(10)
DECLARE @errorcode int

set @v_deptcode=10
set @v_deptname='Pre sales'

insert into dept values(@v_deptcode,'Pre sales')

set @errorcode = @@ERROR
if @errorcode > 0
begin
    print 'error'
    print @errorcode
end
else
    print 'added successfully'
```

Using TRY ..CATCH

```

DECLARE @v_deptcode int
DECLARE @v_deptname varchar(10)
DECLARE @errorcode int

set @v_deptcode=10
set @v_deptname='Pre sales'

BEGIN TRY
    insert into dept values(@v_deptcode,'Pre sales')
END TRY

BEGIN CATCH
    PRINT 'An error occurred while inserting'
    PRINT ERROR_NUMBER()
END CATCH
```

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TRY ..CATCH blocks are standard approach to exception handling in any modern language (Java, VB, C++, C# etc) . The syntax of TRY ..CATCH block is almost similar to that of the programming languages . Nested Try catch is also possible
The general syntax of the TRY..CATCH is as follows

```
--sql statements
BEGIN TRY
    sql statements
    sql statements
END TRY
BEGIN CATCH
--sql statemnts
END CATCH
```

A set of system functions has been provided by SQL server to handle errors

| | |
|--------------------------|--|
| ERROR_MESSAGE() | Returns the complete description of the error message |
| ERROR_NUMBER() | Returns the number of the error |
| ERROR_SEVERITY() | Returns the number of the Severity |
| ERROR_STATE() | Returns the error state number |
| ERROR_PROCEDURE() | Returns the name of the stored procedure where the error occurred |
| ERROR_LINE() | Returns the line number that caused the error |

Error Handling using RAISEERROR

- RAISERROR can be used to
 - Return user defined or system messages back to the application
 - Assign a specific error number , severity and state to a message
- Can be associated to a Query or a Procedure
- Has the following syntax
 - RAISERROR (message ID | message str),severity, state
- Message ID has to be a number greater than 50,000
- Can be used along with TRY ..CATCH /other error handling mechanisms



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Every stored procedure returns an integer return code to the caller. If the stored procedure does not explicitly set a value for the return code, the return code is 0.

RAISERROR statement

```
RAISERROR ( { msg_id | msg_str | @local_variable } { ,severity ,state } [ ,argument [ ,...n ] ] )
```

msg_id

Is a user-defined error message number stored in the **sys.messages** catalog view using **sp_addmessage**. Error numbers for user-defined error messages should be greater than 50000. When msg_id is not specified, RAISERROR raises an error message with an error number of 50000.

msg_str

Is a user-defined message with formatting similar to the **printf** function in the C standard library. The error message can have a maximum of 2,047 characters. If the message contains 2,048 or more characters, only the first 2,044 are displayed and an ellipsis is added to indicate that the message has been truncated. Note that substitution parameters consume more characters than the output shows because of internal storage behavior. For example, the substitution parameter of %d with an assigned value of 2 actually produces one character in the message string but also internally takes up three additional characters of storage. This storage requirement decreases the number of available characters for message output. When msg_str is specified, RAISERROR raises an error message with an error number of 5000.

@local_variable

Is a variable of any valid character data type that contains a string formatted in the same manner as *msg_str*. **@local_variable** must be char or varchar, or be able to be implicitly converted to these data types.

severity

Is the user-defined severity level associated with this message. When using *msg_id* to raise a user-defined message created using sp_addmessage, the severity specified on RAISERROR overrides the severity specified in sp_addmessage.

Severity levels from 0 through 18 can be specified by any user. Severity levels from 19 through 25 can only be specified by members of the sysadmin fixed server role or users with ALTER TRACE permissions. For severity levels from 19 through 25, the WITH LOG option is required.

RAISERROR is used to return messages back to applications using the same format as a system error or warning message generated by the SQL Server Database Engine.

RAISERROR can return either:

- A user-defined error message that has been created using the sp_addmessage system stored procedure. These are messages with a message number greater than 50000 that can be viewed in the sys.messages catalog view.
- A message string specified in the RAISERROR statement.

A RAISERROR severity of 11 to 19 executed in the TRY block of a TRY...CATCH construct causes control to transfer to the associated CATCH block. Specify a severity of 10 or lower to return messages using RAISERROR without invoking a CATCH block. PRINT does not transfer control to a CATCH block.

When RAISERROR is used with the *msg_id* of a user-defined message in sys.messages, *msg_id* is returned as the SQL Server error number, or native error code. When RAISERROR is used with a *msg_str* instead of a *msg_id*, the SQL Server error number and native error number returned is 50000.

When you use RAISERROR to return a user-defined error message, use a different state number in each RAISERROR that references that error. This can help in diagnosing the errors when they are raised.

Use RAISERROR to:

- Help in troubleshooting Transact-SQL code.
- Check the values of data.
- Return messages that contain variable text.
- Cause execution to jump from a TRY block to the associated CATCH block.
- Return error information from the CATCH block to the calling batch or application

Example of Raiserror with TRY ..CATCH

```

CREATE Procedure usp_updateprodprice
    @i_vcategory int,
    @_vpriceinc money
As
BEGIN
    if @_vcategory is NULL or @_vcategory <=0
        begin
            raiserror (50001, 1,1)
            return
        end
    if @_vpriceinc <= 0
        begin
            raiserror (50002, 1,1)
            return
        end

```



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The structure of the new table is as follows

```

create table revised_product
    (ProductID int not null,
    ProductName nvarchar(80),
    unitPrice money,
    CategoryID int,
    revisedprice money
)

```

The procedure takes a CategoryID and price increase percentage and updates the revised product table with product details, old price and revised price . The procedure can be executed as follows

All the error codes and messages has been added in the sysmessages table using the procedure sp_addmessage
`sp_addmessage 50001,1,'invalid category'`

When the procedure is executed , it will display the message associated with 50001

```

BEGIN TRY
    exec usp_updateprodprice -7,.2
END TRY
BEGIN CATCH
    select ERROR_MESSAGE()
END CATCH

```

Example of Raiserror with TRY ..CATCH

```

if not exists( SELECT 'a' FROM Categories
    WHERE CategoryID = @_vcategory)
begin
    raiserror (50003,1,1)
    return
end
BEGIN TRY
    insert into revised_product
    select ProductID,ProductName, unitPrice,@_vcategory,unitPrice+unitPrice* @_vpriceinc
    FROM Products where CategoryID=@_vcategory

    return
END TRY

BEGIN CATCH
    raiserror (50004,1,1)
    rollback tran
    -- return -1
END CATCH
END

```



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The structure of the Departments and Employee table is as follows

```
CREATE TABLE Departments (DeptID INT PRIMARY KEY, DeptName
VARCHAR(20));
```

```
CREATE TABLE Employee (EmployeeID INT PRIMARY KEY, EmployeeName
VARCHAR(30), DeptID INT FOREIGN KEY REFERENCES Departments(DeptID))
```

The procedure takes a DeptID and gives the number of employees from the department if DeptID exists otherwise raises an error. The procedure can be executed as follows

```

CREATE PROC dbo.usp_DepartmentwiseEmployee
    @DeptIDINT
AS
BEGIN
    IF EXISTS (SELECT DeptID FROM Departments
        WHERE DeptID = @DeptID)
        BEGIN
            SELECT COUNT(EmployeeID)
            FROM Employee
            WHERE DeptID = @DeptID
        END
    ELSE
        BEGIN
            RAISERROR('Department ID Does Not Exist', 1, 1)
        END
    END
EXEC usp_DepartmentwiseEmployee 13

```

If Department ID 13 not exist then it will raise error message

THROW Statement

- Exception handling is now made easier with the introduction of the THROW statement in SQL Server 2012.
- In previous versions, RAISERROR was used to show an error message.



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Drawbacks of RAISERROR:

It requires a proper message number to be shown when raising any error.

The message number should exist in sys.messages.

RAISERROR cannot be used to re-throw an exception raised in a TRY..CATCH block.

RAISERROR has been considered as deprecated features

Unlike RAISERROR, THROW does not require that an error number to exist in sys.messages (although it has to be between 50000 and 2147483647).

You can throw an error using Throw as below:

```
THROW 50001, 'Error message', 1;
```

This will return an error message:

```
Msg 50001, Level 16, State 1, Line 1 Error message
```

Difference Between RaiseError and Throw

```
BEGIN TRY
DECLARE @MyInt int
SET @MyInt = 1 / 0
END TRY
BEGIN CATCH
DECLARE @ErrorMessage nvarchar(4000),
@ErrorSeverity int
SELECT @ErrorMessage =
ERROR_MESSAGE(),
@ErrorSeverity = ERROR_SEVERITY()
RAISERROR (@ErrorMessage,
@ErrorSeverity, 1)
END CATCH
```



```
BEGIN TRY
DECLARE @MyInt int
SET @MyInt = 1/0
END TRY
BEGIN CATCH
-- throw out the error
THROW
END CATCH
```



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Note: All exceptions being raised by THROW have a severity of 16.

RAISERROR statement THROW statement

If a msg_id is passed to RAISERROR, the ID must be defined in sys.messages.
The error_number parameter does not have to be defined in sys.messages.

RAISERROR statement THROW statement

The msg_str parameter can contain printf formatting styles.
The message parameter does not accept printf style formatting.

RAISERROR statement THROW statement

The severity parameter specifies the severity of the exception.
There is no severity parameter. The exception severity is always set to 16.

```
BEGIN TRY      SELECT 1/0
END TRY

BEGIN CATCH    THROW
END CATCH

USE tempdb;
GO
CREATE TABLE dbo.TestRethrow ( ID INT PRIMARY KEY );
BEGIN TRY
INSERT dbo.TestRethrow(ID) VALUES(1);
-- Force error 2627, Violation of PRIMARY KEY constraint to be raised.
INSERT dbo.TestRethrow(ID) VALUES(1);
END TRY
BEGIN CATCH
PRINT 'In catch block.';
THROW;
END CATCH;
```

Advantages of THROW:

- THROW has now made the developer's life much easier and developers can now code independent of the Tester's input on the exception message.
- It can be used in a TRY..CATCH block.
- No restrictions on error message number to exist in sys.messages.



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Using Throw and Catch statements allows for clear error handling and showing error messages.

SQL Server 2005 added TRY/CATCH, which was borrowed from .NET's Try catch model

It brought vast improvements over using @@ERROR

But still we were using RAISERROR for generating errors.

SQL Server 2012 adds THROW

It is a recommended alternative way to generate your own errors

Two usages for THROW:

- With error code, description, and state parameters (like RAISERROR)
- Inside a CATCH block with no parameters (re-throw)

Best Practices

- Verify Input Parameters
- Design Each Stored Procedure to Accomplish a Single Task
- Validate Data Before You Begin Transactions
- Use the Same Connection Settings for All Stored Procedures
- Use WITH ENCRYPTION to Hide Text of Stored Procedures



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Example of WITH ENCRYPTION

Use AdventureWorks2012

```
CREATE PROCEDURE HumanResources.uspEncryptThis
WITH ENCRYPTION
AS
SET NOCOUNT ON;
SELECT BusinessEntityID, JobTitle, NationalIDNumber, VacationHours,
SickLeaveHours FROM HumanResources.Employee;
GO
```

The WITH ENCRYPTION option obfuscates the definition of the procedure when querying the system catalog or using metadata functions, as shown by the following examples.

Run sp_helptext:

```
EXEC sp_helptext 'HumanResources.uspEncryptThis';
```

Here is the result set.

The text for object 'HumanResources.uspEncryptThis' is encrypted.

Demo

- Stored Procedures



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The structure of the Category and Product table is as follows

```
CREATE TABLE Category
(
    CategoryID INT PRIMARY KEY,
    CategoryName VARCHAR(20)
)

CREATE TABLE Product
(
    ProductID INT PRIMARY KEY,
    ProductName VARCHAR(30),
    UnitPrice MONEY,
    Quantity INT,
    CategoryID INT
    FOREIGN KEY REFERENCES Category(CategoryID)
)
```

Ex. 1 : Insert record in Category table using Stored Procedure

```
CREATE PROC usp_InsertCategory
(
    @CatID INT,
    @CatName VARCHAR(20)
)
AS
BEGIN
    IF(@CatID IS NULL OR @CatID < 0)
        BEGIN
            RAISERROR('Category ID cannot be null or negative', 1, 1)
        END
    ELSE
        BEGIN
            IF EXISTS (SELECT CategoryID FROM Category WHERE CategoryID = @CatID)
                BEGIN
                    RAISERROR('Category ID already exists', 1, 1)
                END
            ELSE
                BEGIN
                    INSERT INTO Category
                    (CategoryID, CategoryName)
                    VALUES
                    (@CatID, @CatName)
                END
        END
END
```

Select the procedure and press F5, to create the procedure.
Execute procedure as follows :

EXEC usp_InsertCategory 1, 'Bikes'

OR

EXEC usp_InsertCategory @CatName = 'Electronics', @CatID = 2

Ex. 2 : Insert record in Product table using Stored Procedure

```

CREATE PROC usp_InsertProduct
(
    @ProdID INT,
    @ProdName VARCHAR(20),
    @Price MONEY,
    @Qty INT,
    @CatID INT
)
AS
BEGIN
    IF(@ProdID IS NULL OR @ProdID < 0)
        BEGIN
            RAISERROR('Product ID cannot be null or negative', 1, 1)
        END
    ELSE
        BEGIN
            IF EXISTS (SELECT ProductName FROM Product WHERE ProductID = @ProdID)
                BEGIN
                    RAISERROR('Product ID already exists', 1, 1)
                END
            ELSE
                BEGIN
                    IF EXISTS (SELECT CategoryName FROM Category WHERE CategoryID = @CatID OR @CatID IS NULL)
                        BEGIN
                            IF (@Price <= 0 OR @Qty <=0)
                                BEGIN
                                    RAISERROR('Unit Price or Quantity cannot be negative or zero', 1, 1)
                                END
                            ELSE
                                BEGIN
                                    INSERT INTO Product
                                    (ProductID, ProductName, UnitPrice, Quantity,
                                    CategoryID)
                                    VALUES
                                    (@ProdID, @ProdName, @Price, @Qty, @CatID)
                                END
                            END
                        ELSE
                            BEGIN
                                RAISERROR('Category ID does not exists', 1, 1)
                            END
                        END
                END
        END
END

```

Select the procedure and press F5, to create the procedure.
Execute procedure as follows :

```
EXEC usp_InsertProduct 101, 'Cover', 400, 5, 1
```

```
Ex. 3 : Update record of Category table using Stored Procedure
CREATE PROC usp_UpdateCategory
(
    @CatID INT,
    @CatName VARCHAR(20)
)
AS
BEGIN
    IF(@CatID IS NULL OR @CatID < 0)
        BEGIN
            RAISERROR('Category ID cannot be null or negative', 1, 1)
        END
    ELSE
        BEGIN
            IF EXISTS (SELECT CategoryID FROM Category WHERE CategoryID
= @CatID)
                BEGIN
                    UPDATE Category
                    SET CategoryName = @CatName
                    WHERE CategoryID = @CatID
                END
            ELSE
                BEGIN
                    RAISERROR('Category ID not exists', 1, 1)
                END
        END
END
END
```

Select the procedure and press F5, to create the procedure.
Execute procedure as follows :

```
EXEC usp_UpdateCategory 1, 'Bikes Accessories'
```

```

Ex. 4 : Update record of Product table using Stored Procedure
CREATE PROC usp_UpdateProduct
(
    @ProdID INT,
    @ProdName VARCHAR(20),
    @Price MONEY,
    @Qty INT,
    @CatID INT
)
AS
BEGIN
    IF(@ProdID IS NULL OR @ProdID < 0)
    BEGIN
        RAISERROR('Product ID cannot be null or negative', 1, 1)
    END
    ELSE
    BEGIN
        IF EXISTS (SELECT ProductName FROM Product WHERE ProductID
= @ProdID)
        BEGIN
            IF EXISTS (SELECT CategoryName FROM Category WHERE
CategoryID = @CatID OR @CatID IS NULL)
            BEGIN
                IF (@Price <= 0 OR @Qty <=0)
                BEGIN
                    RAISERROR('Unit Price or Quantity cannot be
negative or zero', 1, 1)
                END
                ELSE
                BEGIN
                    UPDATE Product SET
                    ProductName = @ProdName,
                    UnitPrice = @Price,
                    Quantity = @Qty,
                    CategoryID = @CatID
                    WHERE ProductID = @ProdID
                END
            END
            ELSE
            BEGIN
                RAISERROR('Category ID does not exists', 1, 1)
            END
        END
        ELSE
        BEGIN
            RAISERROR('Product ID does not exists', 1, 1)
        END
    END
END

```

Select the procedure and press F5, to create the procedure.

Execute procedure as follows :

EXEC usp_UpdateProduct 101, 'Cover', 400, 4, 1

Ex. 5 : Delete record from Category table using Stored Procedure

```

CREATE PROC usp_DeleteCategory
(
    @CatID INT
)
AS
BEGIN
    IF(@CatID IS NULL OR @CatID < 0)
    BEGIN
        RAISERROR('Category ID cannot be null or negative', 1, 1)
    END
    ELSE
    BEGIN
        IF EXISTS (SELECT CategoryID FROM Category WHERE CategoryID
= @CatID)
        BEGIN
            DELETE FROM Category WHERE CategoryID = @CatID
        END
        ELSE
        BEGIN
            RAISERROR('Category ID not exists', 1, 1)
        END
    END
END

```

EXEC usp_DeleteCategory 2

Ex. 6 : Delete record from Product table using Stored Procedure

```

CREATE PROC usp_DeleteProduct
(
    @ProdID INT
)
AS
BEGIN
    IF(@ProdID IS NULL OR @ProdID < 0)
    BEGIN
        RAISERROR('Product ID cannot be null or negative', 1, 1)
    END
    ELSE
    BEGIN
        IF EXISTS (SELECT ProductName FROM Product WHERE ProductID
= @ProdID)
        BEGIN
            DELETE FROM Product WHERE ProductID = @ProdID
        END
        ELSE
        BEGIN
            RAISERROR('Product ID does not exists', 1, 1)
        END
    END
END

```

Ex. 7 : Stored procedure to display all products information with category name

```
CREATE PROC usp_DisplayAllProducts
AS
BEGIN
    SELECT p.ProductID, p.ProductName, p.UnitPrice, p.Quantity,
    c.CategoryName
    FROM Product p INNER JOIN Category c
    ON p.CategoryID = c.CategoryID
END
```

Execute the stored procedure by using record sets as follows :

```
EXEC usp_DisplayAllProducts WITH RESULT SETS
((PID INT,
PName VARCHAR(30),
Price MONEY,
Quantity INT,
Category VARCHAR(20)))
```

Ex. 8 : Stored procedure to display all products as per category

```
CREATE PROC usp_DisplayProductCategoryWise
(
    @CatID  INT
)
AS
BEGIN
    IF EXISTS (SELECT CategoryName FROM Category WHERE CategoryID =
    @CatID)
        BEGIN
            SELECT ProductID, ProductName, UnitPrice, Quantity
            FROM Product
            WHERE CategoryID = @CatID
        END
    ELSE
        BEGIN
            RAISERROR('Category ID does not exists', 1, 1)
        END
END
```

```
EXEC usp_DisplayProductCategoryWise 1
```

Ex. 9 : Stored procedure to search product

```
CREATE PROC usp_SearchProduct
(
    @ProdID  INT
)
AS
BEGIN
    IF EXISTS (SELECT ProductName FROM Product WHERE ProductID =
    @ProdID)
        BEGIN
            SELECT ProductID, ProductName, UnitPrice, Quantity, CategoryName
            FROM Product INNER JOIN Category
            ON Product.CategoryID = Category.CategoryID
            WHERE ProductID = @ProdID
        END
    ELSE
        BEGIN
            RAISERROR('Product ID does not exists', 1,1)
        END
END
EXEC usp_SearchProduct 101
```

Summary

- In this lesson, you have learnt:
- Creating, Executing, Modifying, and Dropping Stored Procedures
- Using Parameters in Stored Procedures



Summary



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Review Question

- Question 1: A stored procedure can return a single integer value
 - True
 - False
- Question 2: ----- stored procedures call subroutines written in languages like c, c++, .NET



SQL Server 2012 – Database Development Lab Book

Document Revision History

| Date | Revision No. | Author | Summary of Changes |
|-----------------------------|--------------|-------------------|---|
| 25 th July 2011 | 2.0 | Latha S. | Changes in Material made based on integration process |
| 3 rd April, 2012 | 3.0 | Shilpa Bhosle | Changes in Lab Book are made as an upgrade to SQL Server 2008 |
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| 14 th May 2015 | 5.0 | Vaishali Kasture | Changes in Lab Book as per new curriculum of SQL Server 2012 |
| 9 th May 2016 | 6.0 | Shital A Patil | Changes in Material made based on integration process as per Capgemini Course Structure |

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Getting Started

Overview

This Lab book is a guided tour for Learning SQL server 2012. Each section contains some examples and assignments. Follow the steps provided in the solved examples and then work out the Assignments given.

Setup Checklist for SQL Server 2012

Here is what is expected on your machine in order for the lab to work.

Minimum System Requirements

Processor, HDD & RAM

- Processor - Minimum: AMD Opteron, AMD Athlon 64, Intel Xeon with Intel EM64T support, Intel Pentium IV with EM64T support
- Processor speed: Minimum: 1.4 GHz
- Recommended: 2.0 GHz or faster
- RAM - Minimum:512 MB, Recommended: 2.048 GB or more
- HDD – 150 GB

Operating System

- Windows XP Professional x64
- Windows 7 Professional 64 bit

SQL Server 2012 Developer Edition

- SQL server 2012 client and a SQL server 2012 Server instance running on the Server.

A database called Training will be available. All objects for the lab session would be stored in that database alone.

Lab 1. Getting connected to the SQL Server 2012 Server

1.1 Steps to connect to the SQL Server 2012 Server

Step 1: Click Start, Programs, Microsoft SQL Server 2012, SQL Server Management Studio.

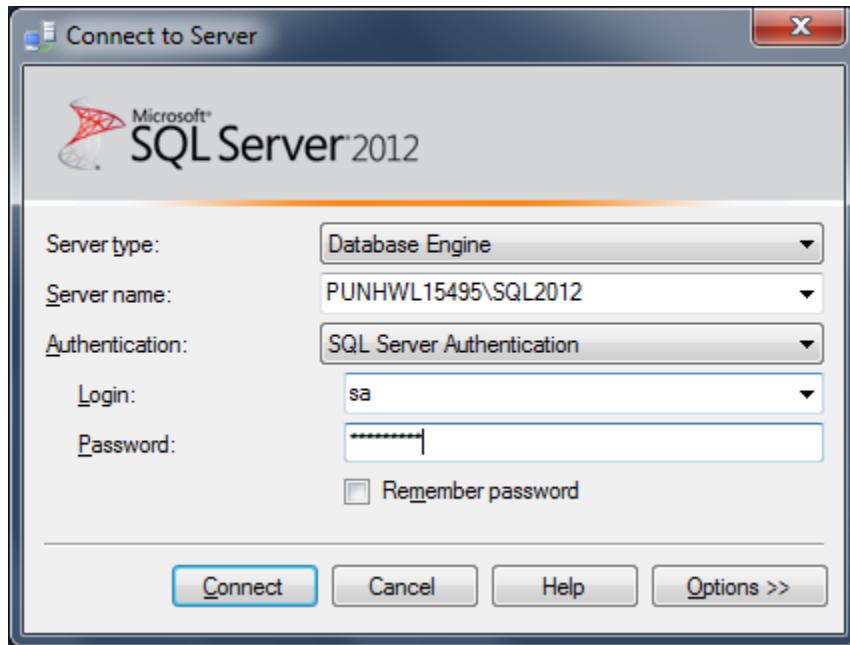


Figure 1: Connecting to SQL Server 2012

Step 2:

Enter the Login, Password and the Server name provided to you.

Login: <loginid> Passwd: <password>

Step 3: Click on New Query.

1.2 Getting Familiar with SQL Server

1. Identify all the system and user defined database in your system.
2. Make master database as your current database , by using the command

```
Use <databasename>
go
```

3. Find out if your active database is master ,by giving the command

```
Select DB_NAME()
go
```

4. Now make Training database as your active database
5. Find out the content of the database by giving the following command. Observe the output

```
sp_help
go
```

6. Repeat the above steps for master database and Northwind database
7. Find out the version of your SQL Server by giving the following command

```
Select @@version
go
```

8. Find out the server date by giving the following commands

```
Select getdate()
go
```

9. Make Northwind as your current database , find out information about tables using the command - Categories ,Products , Orders, Order Details , Employees

```
sp_help <tablename>
go
```

10. Make a note of all related tables and foreign key columns

11. Repeat the above operation of Training database tables as well

1.3 SQL Languages – DDL- Creating Tables, Alias Data Type and Constraints

The following questions will be solved using the Training database only

1. Create a Table called Customer_<empid> with the following Columns

| | | |
|----------------|-------------|-----------------|
| Customerid | Int | Unique NOT NULL |
| CustomerName | varchar(20) | Not Null |
| Address1 | varchar(30) | |
| Address2 | varchar(30) | |
| Contact Number | varchar(12) | Not Null |
| Postal Code | Varchar(10) | |

2. Create a table called Employees_<empid>

```
CREATE TABLE Employees
(
    EmployeeId      INT          NOT NULL PRIMARY KEY,
    Name            NVARCHAR(255)  NULL
);
```

3. Create a table called Contractors_<empid>

```
CREATE TABLE Contractors
(
    ContractorId    INT          NOT NULL PRIMARY KEY,
    Name            NVARCHAR(255)  NULL
);
```

');

4. Create a table called TestRethrow_<empid>

```
USE Training;
CREATE TABLE dbo.TestRethrow
(
    ID INT PRIMARY KEY
);
```

In Object Explorer, go to Databases | Training| Tables and you should see Customers, Employees, Contractors and TestRethrow tables created

1. Create a user defined data type called Region, which would store a character string of size 15.



Hint: Use Create Type Statement

2. Create a Default which would store the value 'NA' (North America)



Hint: create default

3. Bind the default to the Alias Data Type of Q1 i.e. region



Hint: use sp_bindefault

Syntax - EXEC sp_bindefault <DefaultName>, '<AliasName>'

4. Modify the table Customers to add the a column called Customer_Region which would be of data type:

Region

5. Add the column to the Customer Table.

Gender char (1)

6. Using alter table statement add a constraint to the Gender column such that it would not accept any other values except 'M','F' and 'T'.

7. Create the Table Orders with the following Columns:

| | | |
|-------------|----------|---|
| OrdersID | Int | NOT NULL IDENTITY with starting values 1000 |
| CustomerID | Int | Not Null |
| OrdersDate | Datetime | |
| Order_State | char(1) | can be only 'P' or 'C' |

8. Add referential integrity constraint for Orders & Customer tables through CustomerID with the name fk_CustOrders.

Using sp_help check if the constraints have been added properly.

9. Creating and using Sequence Numbers

Task 1 – Creating the Sequence

1. Copy and paste the following code segment in query editor.

SQL**USE Training;**

```
CREATE SEQUENCE IdSequence AS INT  
START WITH 10000  
INCREMENT BY 1;
```

2. In Object Explorer, go to Databases | Training | Programmability | Sequences, right-click and select Refresh.
Click on the plus sign at the left of Sequences, and you should see the IdSequence sequence

Task 2 – Using the Sequence to Insert New Rows

Finally, you have both the sequence and tables to insert new rows with sequential identifiers.

1. Copy and paste the following code segment in query editor.

SQL**USE Training;**

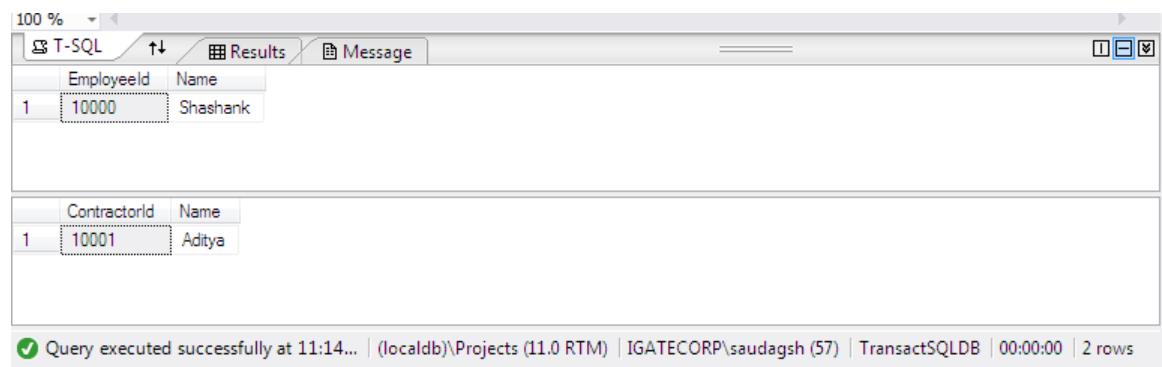
```
INSERT INTO Employees (EmployeeId, Name)  
VALUES (NEXT VALUE FOR IdSequence, 'Shashank');
```

```
INSERT INTO Contractors (ContractorId, Name)  
VALUES (NEXT VALUE FOR IdSequence, 'Aditya');
```

```
SELECT * FROM Employees;
```

```
SELECT * FROM Contractors;
```

2. You should be able to see now the result of the execution below the Results tab. As you can see, the Employees table has an employee named Shashank, with EmployeeId 10000, while the Contractors table has a contractor named Aditya with EmployeeId 10001. Asking for the next value while inserting a row in both tables obtained a new value for the EmployeeId field.



| EmployeeId | Name |
|------------|-------|
| 1 | 10000 |

| ContractorId | Name |
|--------------|-------|
| 1 | 10001 |

| ✔ | Query executed successfully at 11:14... | (localdb)\Projects (11.0 RTM) | IGATECORP\saudagsh (57) | TransactSQLDB | 00:00:00 | 2 rows |
Figure 2: Result of Sequence

1.4 Simple Queries & Merge Statement

For these questions, you will be using the University Schema; the table structure has been given in the appendix. These tables would be available in the Training database

1. List out Student_Code, Student_Name and Department_Code of every Student
2. Do the same for all the staff's
3. Retrieve the details (Name, Salary and dept code) of the employees who are working in department 20, 30 and 40.
4. Display Student_Code, Subjects and Total_Marks for every student. Total_Marks will calculate as Subject1 + Subject2 + Subject3 from Student_Marks. The records should be displayed in the descending order of Total Score
5. List out all the books which starts with 'An', along with price
6. List out all the department codes in which students have joined this year
7. Display name and date of birth of students where date of birth must be displayed in the format similar to "January, 12 1981" for those who were born on Saturday or Sunday.



Hint: Use datename or datepart function

8. List out a report like this

| StaffCode | StaffName | Dept Code | Date of Joining | No of years in the Company |
|-----------|-----------|-----------|-----------------|----------------------------|
|-----------|-----------|-----------|-----------------|----------------------------|
9. List out all staffs who have joined before Jan 2000
10. Write a query which will display Student_Name, Department_Code and DOB of all students who born between January 1, 1981 and March 31, 1983.
11. List out all student codes who did not appear in the exam subject2

Working with Merge Statement

Case Study – The Countryside Confectioneries is one of the well-known names in the brands of confectioneries in Switzerland. The company Database Administrator John & his team, maintains the entire business data in SQL Server. As a database administrator, John, need to perform the ETL (Extract, Transform & Load) on database quite often, wherein he needs to execute multiple INSERT, UPDATE & DELETE Operations on database target table by matching the records from the source table. For example, a products dimension table has information about the products; you need to sync-up this table with the latest information about the products from the source table.

To simplify above task John & his team uses SQL Server one of the remarkable programming enhancement called MERGE statement as MERGE SQL command to perform these operations in a single statement. He uses MERGE statement to so that he can eliminate the need of writing multiple and separate DML statements to refresh the target table with an updated product list or do lookups.

The following example demonstrates the use of MERGE statement in above given case study.

1. Create following tables in SQL Server 2012 – In this demo you will be creating Products table as Target table & UpdateProducts as Source Table. You will also populate these tables with some sample data.

```

CREATE TABLE Products
(
    ProductID INT PRIMARY KEY,
    ProductName VARCHAR(100),
    Rate MONEY
)
--Insert records into target table

```

```

INSERT INTO Products
VALUES
(1,'Tea', 10.00),
(2, 'Coffee', 20.00),
(3, 'Muffin', 30.00),
(4, 'Biscuit', 40.00)

```

```

CREATE TABLE UpdatedProducts
(
    ProductID INT PRIMARY KEY,
    ProductName VARCHAR(100),
    Rate MONEY
)
--Insert records into source table

```

```

INSERT INTO UpdatedProducts
VALUES
(1, 'Tea', 10.00),
(2, 'Coffee', 25.00),
(3, 'Muffin', 35.00),
(5, 'Pizza', 60.00)

```


MERGE Statement

```
--Synchronize the target table with
--refreshed data from source table
MERGE Products AS TARGET
USING UpdatedProducts AS SOURCE
ON (TARGET.ProductID = SOURCE.ProductID)
--When records are matched, update
--the records if there is any change
WHEN MATCHED AND TARGET.ProductName <> SOURCE.ProduActName
OR TARGET.Rate <> SOURCE.Rate THEN
UPDATE SET TARGET.ProductName = SOURCE.ProductName,
TARGET.Rate = SOURCE.Rate
--When no records are matched, insert
--the incoming records from source
--table to target table
WHEN NOT MATCHED BY TARGET THEN
INSERT (ProductID, ProductName, Rate)
VALUES (SOURCE.ProductID, SOURCE.ProductName, SOURCE.Rate)
--When there is a row that exists in target table and
--same record does not exist in source table
--then delete this record from target table
WHEN NOT MATCHED BY SOURCE THEN
```

```
DELETE
--$action specifies a column of type nvarchar(10)
--in the OUTPUT clause that returns one of three
--values for each row: 'INSERT', 'UPDATE', or 'DELETE',
--according to the action that was performed on that row
OUTPUT $action,
DELETED.ProductID AS TargetProductID,
DELETED.ProductName AS TargetProductName,
DELETED.Rate AS TargetRate,
INSERTED.ProductID AS SourceProductID,
INSERTED.ProductName AS SourceProductName,
INSERTED.Rate AS SourceRate;
SELECT @@ROWCOUNT;
GO
```

Target Table

```
CREATE TABLE EmployeeTarget
(
    EmpID INT NOT NULL,
    Designation VARCHAR (25) NOT NULL,
    Phone VARCHAR (20) NOT NULL,
    Address VARCHAR (50) NOT NULL,
    CONSTRAINT PK_EmployeeTG
    PRIMARY KEY (EmpID)
)
```

Source Table

```
CREATE TABLE EmployeeSource
(
    EmpID INT NOT NULL,
    Designation VARCHAR (25) NOTNULL,
    Phone VARCHAR (20) NOT NULL,
    Address VARCHAR (50) NOT NULL,
    CONSTRAINT PK_EmployeeSC
    PRIMARY KEY (EmpID)
)
```

Working with Grouping Set

1. Create the following table & populate with some sample data.
2. Write following query which uses Grouping Set in the query window.

Employee Table

```
CREATE TABLE Employee
(
    Employee_Number INT NOT NULL PRIMARY
    KEY,
    Employee_Name VARCHAR(30) NULL,
    Salary FLOAT NULL,
    Department_Number INT NULL,
    Region VARCHAR(30) NULL
)
```

```
SELECT Region, Department_Number, AVG (Salary)
Average_Salary
From Employee
Group BY      GROUPING SETS
              (
                  (Region, Department_Number),
                  (Region),
                  (Department_Number)
              )
```

3. Execute above query & observe the output.
4. The query performs following :
 - a. It generates result set grouped by each set mentioned in the Grouping Sets.
 - b. It also calculates average salary of every employee for each region and department.

One can get the same result achieved in early SQL Server versions using the following query:

(NOTE – This part of Lab is not compulsory to perform)

```
SELECT Region, Department_Number, AVG (Salary) Average_Salary
From Employee
Group BY (Region, Department_Number)
UNION
SELECT Region, Department_Number, AVG (Salary) Average_Salary
From Employee
Group BY (Region)
UNION
SELECT Region, Department_Number, AVG (Salary) Average_Salary
From Employee
Group BY (Department_Number)
```

1.5 Data Retrieval - Joins, Subqueries, SET Operators and DML

1. Write a query which displays Staff Name, Department Code, Department Name, and Salary for all staff who earns more than 20000.
2. Write a query to display Staff Name, Department Code, and Department Name for all staff who do not work in Department code 10
3. Print out a report like this

| Book Name | No of times issued |
|-----------|--------------------|
|-----------|--------------------|

| | |
|-----------------|----|
| Let us C | 12 |
| Linux Internals | 9 |

4. List out number of students joined each department last year. The report should be displayed like this

| | |
|-----------|----|
| Physics | 12 |
| Chemistry | 40 |

5. List out a report like this

| Staff Code | Staff Name | Manager Code | Manager Name |
|------------|------------|--------------|--------------|
|------------|------------|--------------|--------------|



Hint: Use Self Join

6. Display the Staff Name, Hire date and day of the week on which staff was hired. Label the column as DAY. Order the result by the day of the week starting with Monday.
7. Display Staff Code, Staff Name, and Department Name for those who have taken more than one book.
8. List out the names of all student code whose score in subject1 is equal to the highest score
9. Modify the above query to display student names along with the codes.
10. Display the Student Code, Student Name, and Department Name for that department in which maximum number of student are studying.

11. List out the names of all the books along with the author name, book code and category which have not been issued at all. Try solving this question using EXISTS.

12. List out the code and names of all staff and students belonging to department 20.



Hint: Use UNION

13. List out all the students who have not appeared for exams this year.

14. List out all the student codes who have never taken books

15. Add the following records to the Customers Table , created in our earlier exercises

| CustomerID | CustomerName | Address1 | Address2 | Contact | PostalCode | Region | Gender |
|------------|------------------------------------|-------------------------------|--------------------|----------------|------------|--------|--------|
| ALFKI | AlfredsFutterkiste | Obere Str. 57 | Berlin,Germany | 030-0074321 | 12209 | NULL | NULL |
| ANATR | Ana Trujillo Emparedados y helados | Avda. de la Constitución 2222 | México D.F.,Mexico | (5) 555-4729 | 5021 | NA | NUL L |
| ANTON | Antonio Moreno Taquería | Matadero s 2312 | México D.F.,Mexico | (5) 555-3932 | 5023 | NUL L | NUL L |
| AROUT | Around the Horn | 120 Hanover Sq. | London,UK | (171) 555-7788 | WA1 1DP | NUL L | NUL L |
| BERGS | Berglundsnabbköp | Berguvsvägen 8 | Luleå,Sweden | 0921-1234 65 | S-958 22 | NUL L | NUL L |
| BLAUS | Blauer See Delikatessen | Forsterstr. 57 | Mannheim,Germany | 0621-08460 | 68306 | NA | NUL L |
| BLONP | BlondesddsIpère et fils | 24, place Kléber | Strasbourg,France | 88.60.1 5.31 | 67000 | NUL L | NUL L |

| | | | | | | | |
|-------|-------------------------|----------------------|-------------------|----------------|---------|-------|-------|
| BOLID | BólidoComidaspreparadas | C/ Araquil, 67 | Madrid, Spain | (91) 555 22 82 | 28023 | EU | NUL L |
| BONAP | Bon app' | 12, rue des Bouchers | Marseille, France | 91.24.4 5.40 | 13008 | NUL L | NUL L |
| BOTTM | Bottom-Dollar Markets | 23 Tsawassen Blvd. | Tsawassen, Canada | (604) 555-4729 | T2F 8M4 | BC | |

16. Replace the contact number of Customer id ANATR to (604) 3332345.
17. Update the Address and Region of Customer BOTTM to the following
19/2 12th Block, Spring Fields.
Ireland - UK
Region - EU
18. Insert the following records in the Orders table. The Order id should be automatically generated
Save the commands in a script file (Script file has a .sql extension)

| Customer ID | OrderDate | Order State |
|-------------|-----------|-------------|
| AROUT | 4-Jul-96 | P |
| ALFKI | 5-Jul-96 | C |
| BLONP | 8-Jul-96 | P |
| ANTON | 8-Jul-96 | P |
| ANTON | 9-Jul-96 | P |
| BOTTM | 10-Jul-96 | C |
| BONAP | 11-Jul-96 | P |
| ANATR | 12-Jul-96 | P |
| BLAUS | 15-Jul-96 | C |
| HILAA | 16-Jul-96 | P |

19. Delete all the Customers whose Orders have been cleared.

20. Remove all the records from the table using the truncate command. Rerun the script to populate the records once again

21. Change the order status to C, for all orders before `15th July.

1.6 Indexes and Views

1. Create a Unique index on Department Name for Department master Table.
2. Try inserting the following values and observe the output

| Dept Code | Dept Name |
|-----------|--------------|
| 100 | Home Science |
| 200 | Home Science |
| 300 | NULL |
| 400 | NULL |

3. Create a non-clustered index for Book_Trans table on the following columns Boo_code, Staff_name, student name, date of issue. Try adding some values. Do you experience any difficulties?

4. List the indexes created in the previous questions, from the sysindexes table.
5. Create a View with the name StaffDetails_view with the following column name Staff Code, Staff Name, Department Name, Desig Name salary

6. Try inserting some records in the view; Are you able to add records? Why not? Write your answers here.

7. Working with Filtered Index – The following Filtered Index created on Production.BillOfMaterials table, cover queries that return the columns defined in The index and that select only rows with a non-NULL value for EndDate.

```
USE Adventure Works;
GO

CREATE NONCLUSTERED INDEX FIBillOfMaterialsWithEndDate
ON Production.BillOfMaterials (ComponentID, StartDate)
WHERE EndDate IS NOT NULL;
```

```
GO
```

8. View the definition of the view using the following syntax.

```
Sp_helptext <viewname>
```

9. Using the view , List out all the staffs who have joined in the month of June
10. Create a non-clustered column store index on EmployeeID of Employees table

1.7 Procedures and Exception Handling in SQL server

1. Write a procedure that accept Staff_Code and updates the salary and store the old salary details in Staff_Master_Back (Staff_Master_Back has the same structure without any constraint) table. The procedure should return the updated salary as the return value

Exp< 2 then no Update

Exp>= 2 and <= 5 then 20% of salary

Exp> 5 then 25% of salary

2. Write a procedure to insert details into Book_Transaction table. Procedure should accept the book code and staff/student code. Date of issue is current date and the expected return date should be 10 days from the current date. If the expected return date falls on Saturday or Sunday, then it should be the next working day. Suitable exceptions should be handled.
3. Modify question 1 and display the results by specifying With result sets
4. Create a procedure that accepts the book code as parameter from the user. Display the details of the students/staff that have borrowed that book and has not returned the same. The following details should be displayed

| | | | |
|-------------------|-------------------|-----------|-------------|
| Student/StaffCode | Student/StaffName | IssueDate | Designation |
| ExpectedRet_Date | | | |

5. Write a procedure to update the marks details in the Student_marks table. The following is the logic.

- The procedure should accept student code , and marks as input parameter
- Year should be the current year.
- Student code cannot be null, but marks can be null.
- Student code should exist in the student master.
- The entering record should be unique ,i.e. no previous record should exist
- Suitable exceptions should be raised and procedure should return -1.
- IF the data is correct, it should be added in the Student marks table and a success value of 0 should be returned.

Working with THROW Statement

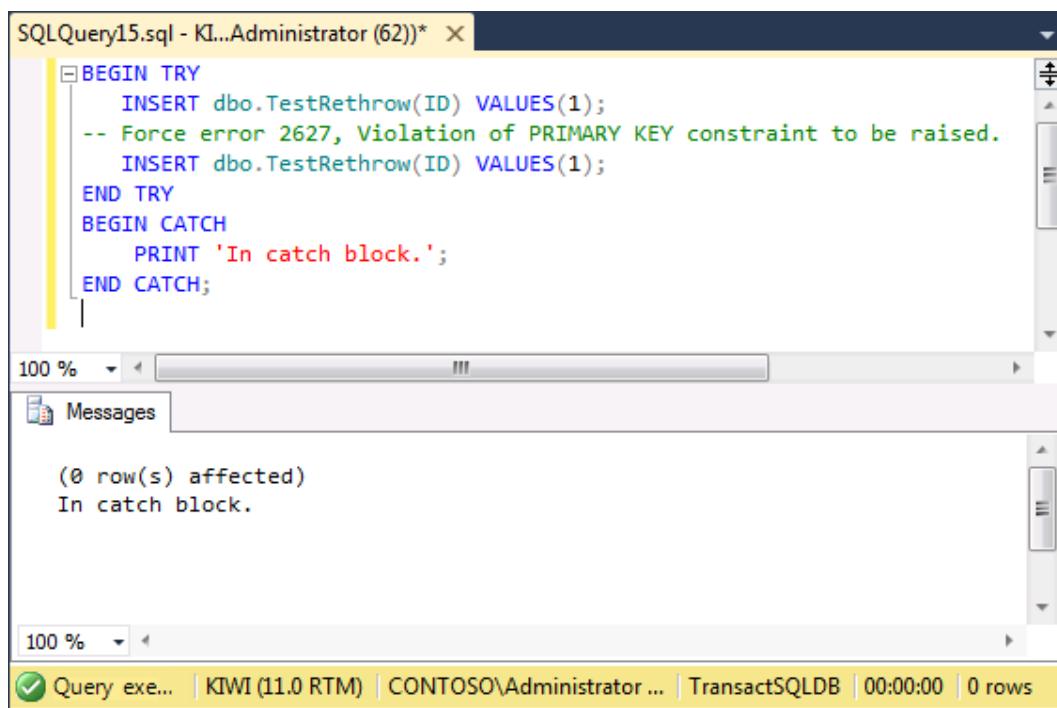
Task 1 – Raising and Catching an Exception

Now, we can use the **TestRethrow** table to force an exception. As you will see, the query runs successfully, but catches the error when attempting to insert the same primary key twice in the table, and shows an error message.

1. Copy and paste the following code segment in query editor.

SQL

```
USE Training;
BEGIN TRY
    INSERT dbo.TestRethrow(ID) VALUES(1);
    -- Force error 2627, Violation of PRIMARY KEY constraint to be raised.
    INSERT dbo.TestRethrow(ID) VALUES(1);
END TRY
BEGIN CATCH
    PRINT 'In catch block.';
END CATCH;
```



The screenshot shows the SQL Server Management Studio interface. A query window titled "SQLQuery15.sql - KI...Administrator (62)*" contains the T-SQL code provided in the figure. The code uses a TRY-CATCH block to attempt to insert a row into the "dbo.TestRethrow" table twice. The second insertion fails because it violates the primary key constraint. The "Messages" pane at the bottom displays the results: "(0 row(s) affected)" followed by the message "In catch block.". The status bar at the bottom of the window shows "Query exec..." and "0 rows".

Figure 3: Attempting to insert the same row twice raises an exception

Task 3 – Using Throw to Raise an Exception Again in a Catch Block

Finally, we can add a **Throw** statement in the **Catch** block. This can be useful when there is a chain of procedures executed, so exceptions are bubbled up.

1. Copy and paste the following code segment in query editor.

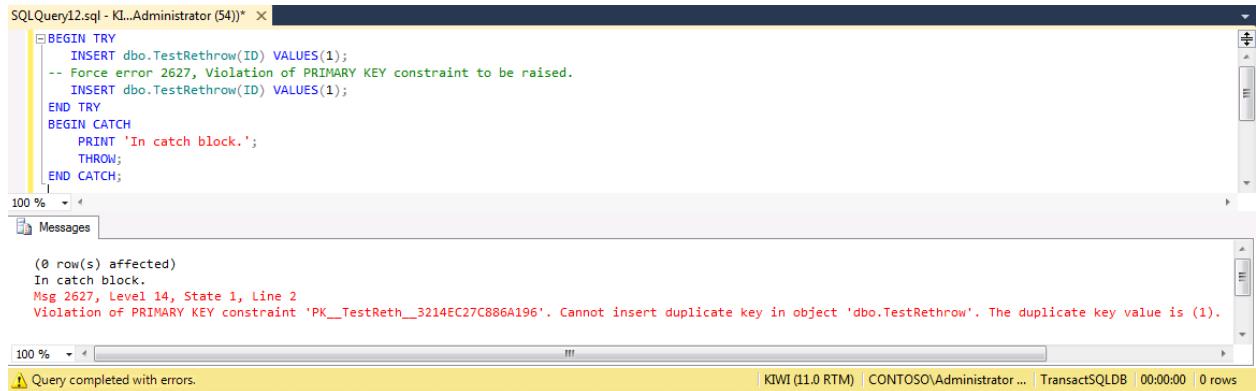
SQL

USE Training;

```

BEGIN TRY
    INSERT dbo.TestRethrow(ID) VALUES(1);
    -- Force error 2627, Violation of PRIMARY KEY constraint to be raised.
    INSERT dbo.TestRethrow(ID) VALUES(1);
END TRY
BEGIN CATCH
    PRINT 'In catch block.';
    THROW;
END CATCH;

```



The screenshot shows the SSMS interface with the following details:

- Query Editor:** The code is pasted into the query editor window.
- Results Pane:** Shows the error message: "Violation of PRIMARY KEY constraint 'PK__TestReth__3214EC27C886A196'. Cannot insert duplicate key in object 'dbo.TestRethrow'. The duplicate key value is (1)."
- Status Bar:** Displays "Query completed with errors."
- Bottom Status:** Shows connection information: "KIWI (11.0 RTM) | CONTOSO\Administrator ... | TransactSQLDB | 00:00:00 | 0 rows".

Figure 4:Re-throwing the exception shows actual error, & the query completes with errors

Lab 2.SQL Server 2012 Stretched Assignment

2.1 Transact-SQL Statements

1. List the empno, name and Department No of the employees who have got experience of more than 18 years.
2. Display the name and salary of the staff. Salary should be represented as X. Each X represents a 1000 in salary. It is assumed that a staff's salary to be multiples of 1000 , for example a salary of 5000 is represented as XXXXX

Sample Output

| | | |
|-------|-------|--------------|
| JOHN | 10000 | XXXXXXXXXX |
| ALLEN | 12000 | XXXXXXXXXXXX |

3. List out all the book code and library member codes whose return is still pending
4. List all the staff's whose birthday falls on the current month
5. How many books are stocked in the library?
6. How many books are there for topics Physics and Chemistry?
7. How many members are expected to return their books today?
8. Display the Highest, Lowest, Total & Average salary of all staff. Label the columns Maximum, Minimum, Total and Average respectively. Round the result to nearest whole number
9. How many staffs are managers”?
10. List out year wise total students passed. The report should be as given below. A student is considered to be passed only when he scores 60 and above in all 3 subjects individually

Year No of students passed

11. List out all the departments which is having a headcount of more than 10
12. List the total cost of library inventory (sum of prices of all books)
13. List out category wise count of books costing more than Rs 1000/-
14. How many students have joined in Physics dept (dept code is 10) last year?

2.2 Data Retrieval - Joins, Subqueries, SET Operators and DML

1. Write a query that displays Staff Name, Salary, and Grade of all staff. Grade depends on the following table.

| Salary | Grade |
|-------------------------|-------|
| Salary >=50000 | A |
| Salary >= 25000 < 50000 | B |
| Salary>=10000 < 25000 | C |

2. Generate a report which contains the following information.

Staff Code, Staff Name, Designation, Department, Book Code, Book Name,

Author, Fine

For the staff who have not return the book. Fine will be calculated as Rs. 5 per day.

Fine = 5 * (No. of days = Current Date – Expected return date), for others it should be displayed as –

3. List out all the staffs who are reporting to the same manager to whom staff 100060 reports to.
4. List out all the students along with the department who reads the same books which the professors read
5. List out all the authors who have written books on same category as written by Author David Gladstone.
6. Display the Student report Card for this year. The report Card should contain the following information.

Student Code Student Name Department Name Total Marks Grade

Grade is calculated as follows. If a student has scored < 60 or has not attempted an exam he is considered to an F

>80 - E

70-80 - A

60- 69 - B

<60 – F

2.3 Indexes and Views

1. Create a Filtered Index HumanResources.Employee table present in the AdventureWorks database for the column EmployeeID. The index should cover all the queries that uses EmployeeID for its search & that select only rows with "Marketing Manager" for Title column.

Appendices

Appendix A: Table Structure

Design_Master

| Name | Null? | Type |
|--------------------|----------|-------------|
| <u>Design_code</u> | Not Null | int |
| Design_name | | Varchar(50) |

Department_Master

| Name | Null? | Type |
|------------------|----------|-------------|
| <u>Dept_Code</u> | Not Null | int |
| Dept_name | | Varchar(50) |

Student_Master Table

| Name | Null? | Type | |
|---------------------|----------|--------------|------------------|
| <u>Student_Code</u> | Not Null | int | |
| Student_name | Not Null | Varchar2(50) | |
| Dept_Code | | int | FK ->Dept_Master |
| Student_dob | | Datetime | |
| Student_Address | | Varchar(240) | |

Student_Marks

| Name | Null? | Type | |
|---------------------|----------|------|--------------------|
| <u>Student_Code</u> | | int | FK->Student_master |
| <u>Student_Year</u> | Not Null | int | |
| Subject1 | | int | |
| Subject2 | | int | |
| Subject3 | | int | |

Staff_Master

| Name | Null? | Type | |
|-------------------|----------|----------------|-------------------|
| <u>Staff_code</u> | Not Null | int | |
| Staff_Name | Not Null | Varchar(50) | |
| Design_code | | int | FK->Design_master |
| Dept_code | | int | FK->Dept_Master |
| HireDate | | Datetime | |
| Staff_dob | | Datetime | |
| Staff_address | | Varchar(240) | |
| Mgr_code | | int | |
| Staff_sal | | decimal (10,2) | |

Book_Master

| Name | Null? | Type |
|------------------|----------|-------------|
| <u>Book_Code</u> | Not Null | int |
| Book_Name | Not Null | Varchar(50) |
| Book_pub_year | | int |
| Book_pub_author | Not Null | Varchar(50) |
| Book_category | Not null | Varchar(10) |

Book_Transaction

| Name | Null? | Type | |
|---------------------------|----------|----------|--------------------|
| <u>Book_Code</u> | | int | Fk ->Book_master |
| <u>Student_code</u> | Null | int | FK->Student_master |
| <u>Staff_code</u> | Null | int | FK->Staff_master |
| <u>Book_Issue_date</u> | Not Null | Datetime | |
| Book_expected_return_date | Not Null | Datetime | |
| Book_actual_return_date | Null | Datetime | |

Appendix B: Table of Figures

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